Power system damage, recovery and challenges from Great East Japan Earthquake

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The Federation of Electric Power Companies of Japan

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Contents

1. Outline of the Great East Japan Earthquake (1)

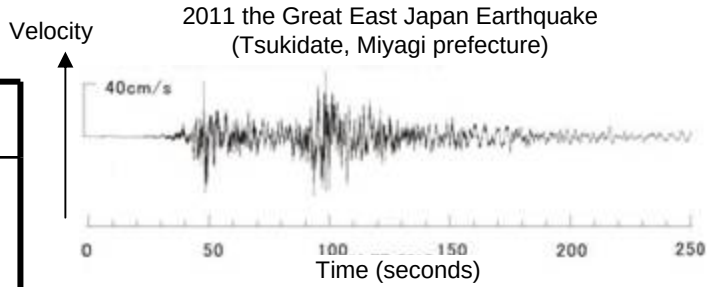
- **Time and date of occurrence: 14:46, March 11, 2011**
- **Size of earthquake: Magnitude 9.0, Centered in off the coast of Sanriku (38.0° N, 142.9° E, depth of approximately 24 km)**

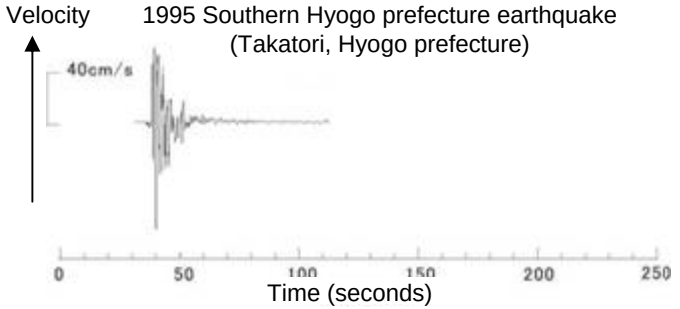
  The focal area ranges from off the coast of Iwate Prefecture to off the coast of Ibaraki Prefecture with the length of more than 400 km and the width of approximately 200 km.
- **Maximum seismic intensity: 7 (at Kurihara City, Miyagi Prefecture)**
- **Tsunami: More than 8.5 m at Miyako city, Iwate prefecture, more than 8.0 m at Ofunato, Iwate Prefecture, more than 7.6 m at Ishinomaki City, Miyagi Prefecture, and more than 9.3 m at Soma, Fukushima Prefecture. Run-up exceeding 30 m was observed at Miyako City, Iwate Prefecture.**
- **State of quake: Duration of quake was longer than that of past earthquakes.**

  : The peak of quake period continued for 0.1 to 1 second. It was 1 to 2 or 3 seconds in the case of the Southern Hyogo prefecture earthquake in 1995.

【Observed duration of quake】 [Source: Website of Japan Meteorological Agency]

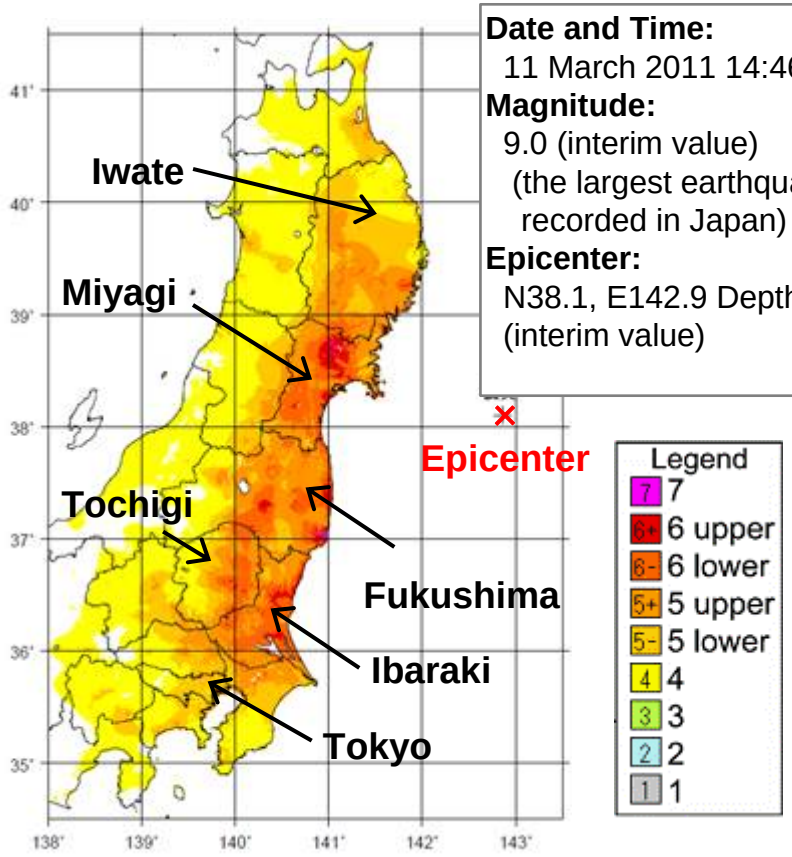
Seismic intensity	2011 The Great East Japan Earthquake			Past earthquakes	
	Morioka City (Iwate Prefecture)	Sendai City (Miyagi Prefecture)	Fukushima City (Fukushima Prefecture)	2003 Tokachi-Oki Earthquake	2008 Iwate-Miyagi Nairiku Earthquake
More than 3	210 sec.	240 sec.	250 sec.	120 sec.	80 sec.
More than 4	160 sec.	170 sec.	150 sec.	70 sec.	50 sec.
More than 5 lower	70 sec.	110 sec.	120 sec.	30 sec.	30 sec.





1. Outline of the Great East Japan Earthquake (2)

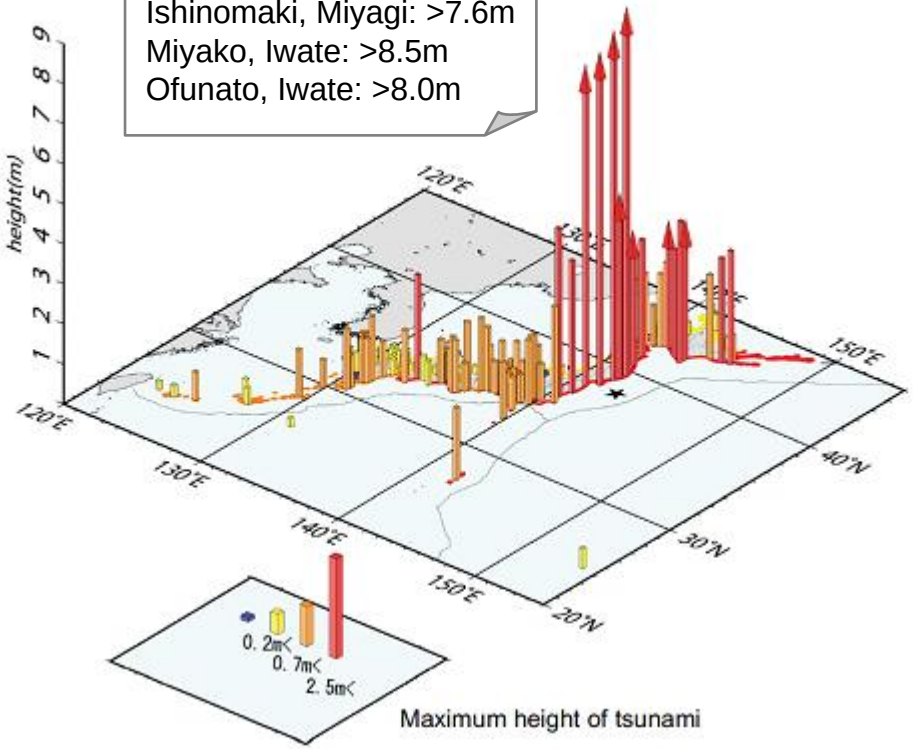
Distribution of JMA Seismic Intensity



Date and Time:
11 March 2011 14:46 JST
Magnitude:
9.0 (interim value)
(the largest earthquake recorded in Japan)
Epicenter:
N38.1, E142.9 Depth 24km
(interim value)

Observed Tsunami

Soma, Fukushima: >9.3m
Ishinomaki, Miyagi: >7.6m
Miyako, Iwate: >8.5m
Ofunato, Iwate: >8.0m



* Maximum height of tsumami cannot be retrieved so far due to the troubles. Actual maximum height might be higher.

2. Power demand and supply after the Earthquake
2.1 State of power outage

- **On the day of the Earthquake, power outage occurred in a broad area that covered Tohoku region, which was close to the epicenter, and Kanto region.**
- **Maximum number of households with power outage**

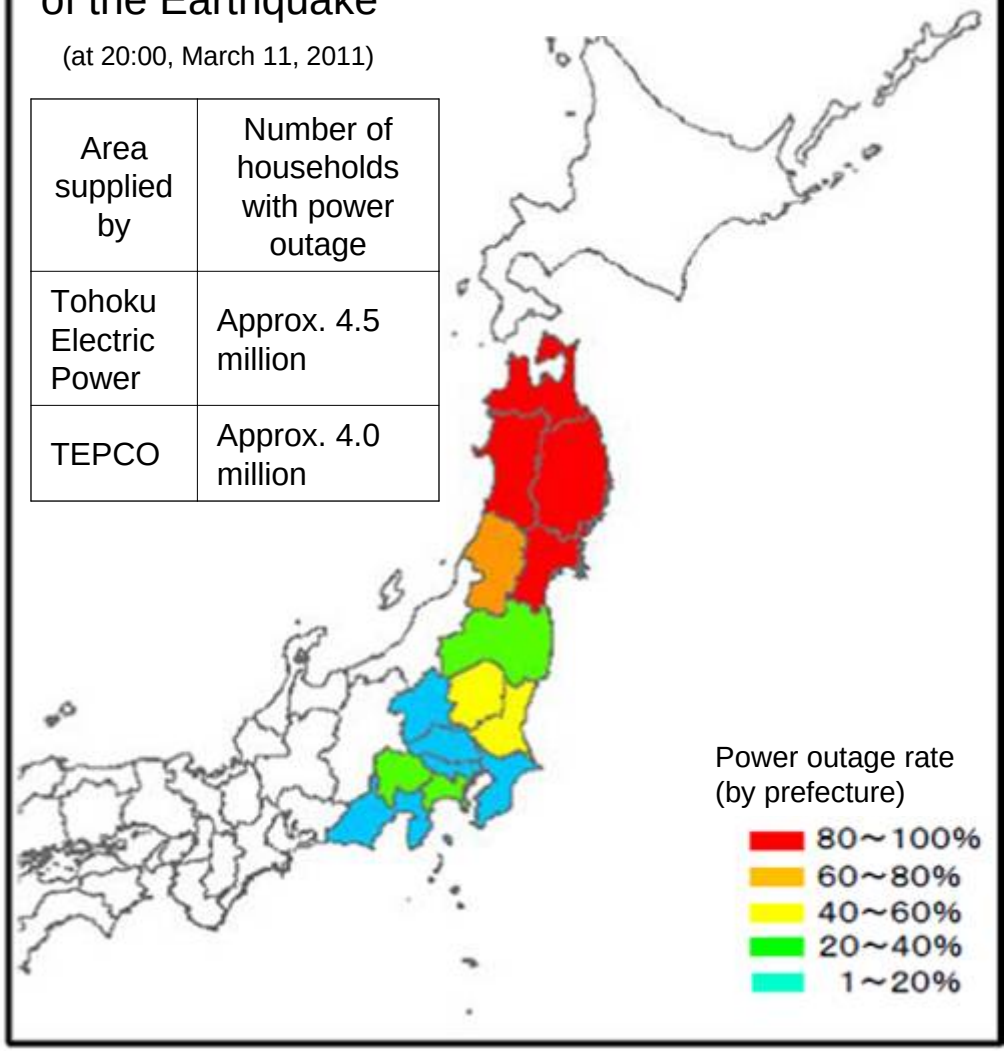
・ Area supplied by Tohoku Electric Power Co.:
Approx. 4.66 million households
(15:44, March 11, 2011)
(Approx. 70% of all households in the area)

・Area supplied by TEPCO:
Approx. 4.05 million households
(15:30, March 11, 2011)
(Approx. 20% of all households in the area)

Occurrence of power outage on the day of the Earthquake

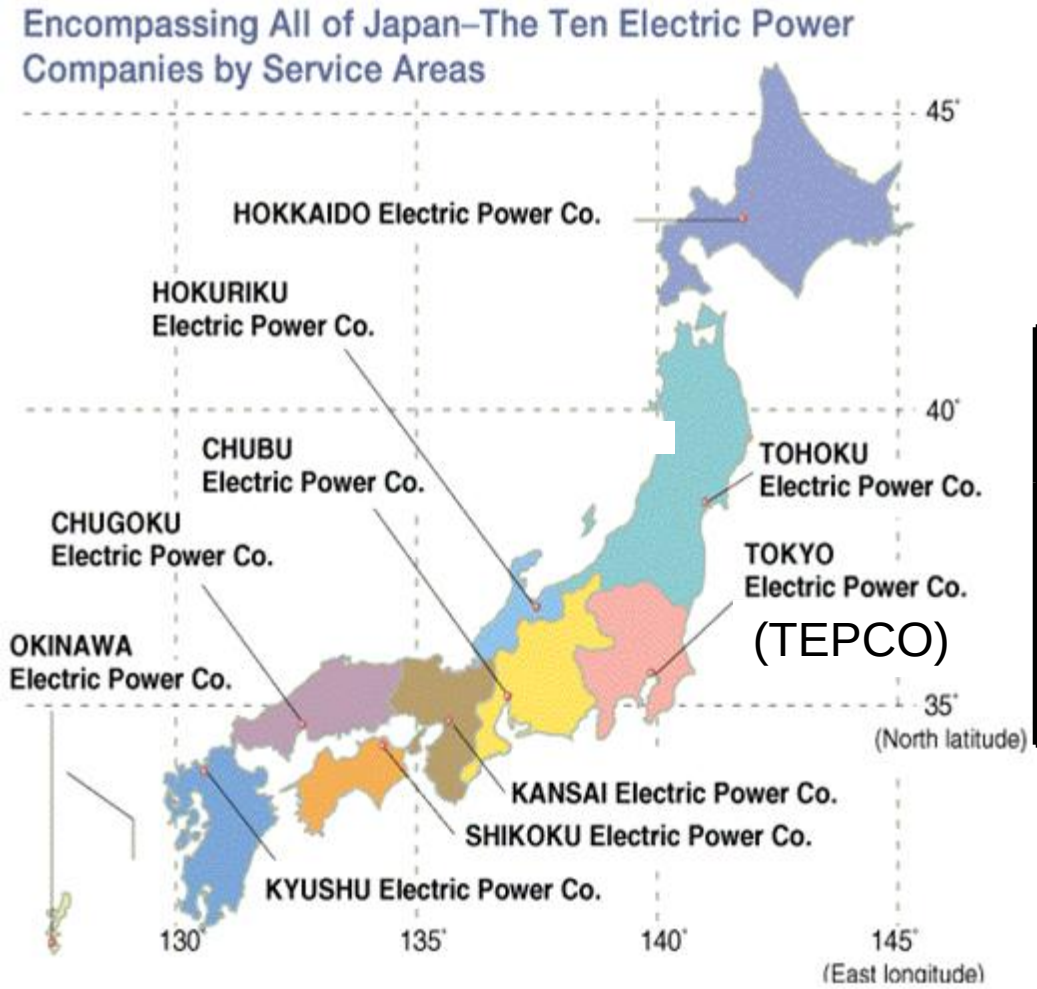
(at 20:00, March 11, 2011)

Area supplied by	Number of households with power outage
Tohoku Electric Power	Approx. 4.5 million
TEPCO	Approx. 4.0 million



[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

【Ref】Overview of Japanese utilities

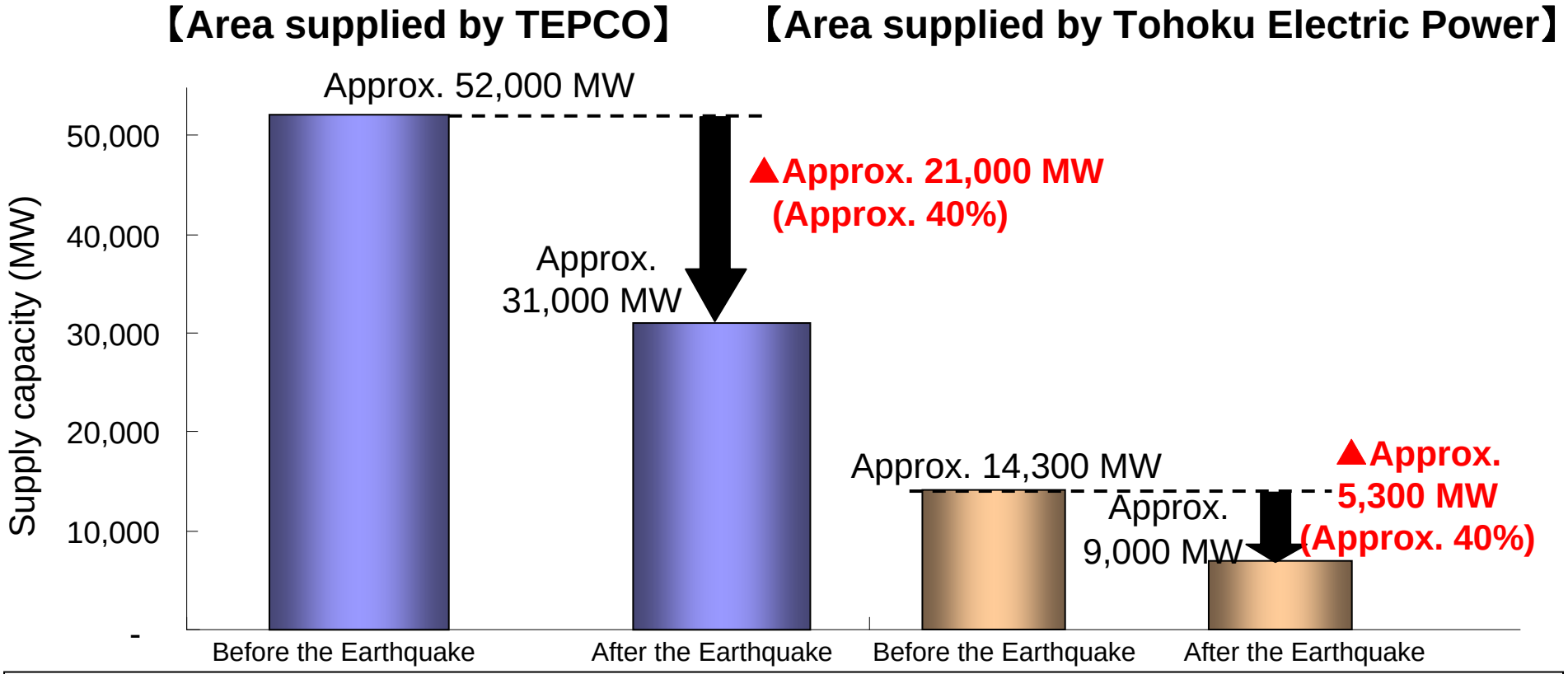


	Maximum power (MW)	Electric power sales (GWh)
Tohoku Electric Power	15,572	82,706
TEPCO	59,988	293,386
Japan Total	177,752	898,896

(From April 2010 to March 2011)

2. Power demand and supply after the Earthquake
2.2 Disruption of power supply

■ Changes in power supply capacity before and after the Earthquake



Major power stations that were forced to reduce the supply capacity after the Earthquake

[Area supplied by TEPCO]
- Nuclear power stations (Fukushima Daiichi and Daini, Tokai Daini)
- Thermal power stations (Kashima, Hirono, Hitachi-Naka, etc.)

[Area supplied by Tohoku Electric Power]
- Nuclear power station (Onagawa)
- Thermal power stations (Hachinohe, Sendai, Shin-Sendai, Haramachi, Joban, Soma, etc.)

2. Power demand and supply after the Earthquake

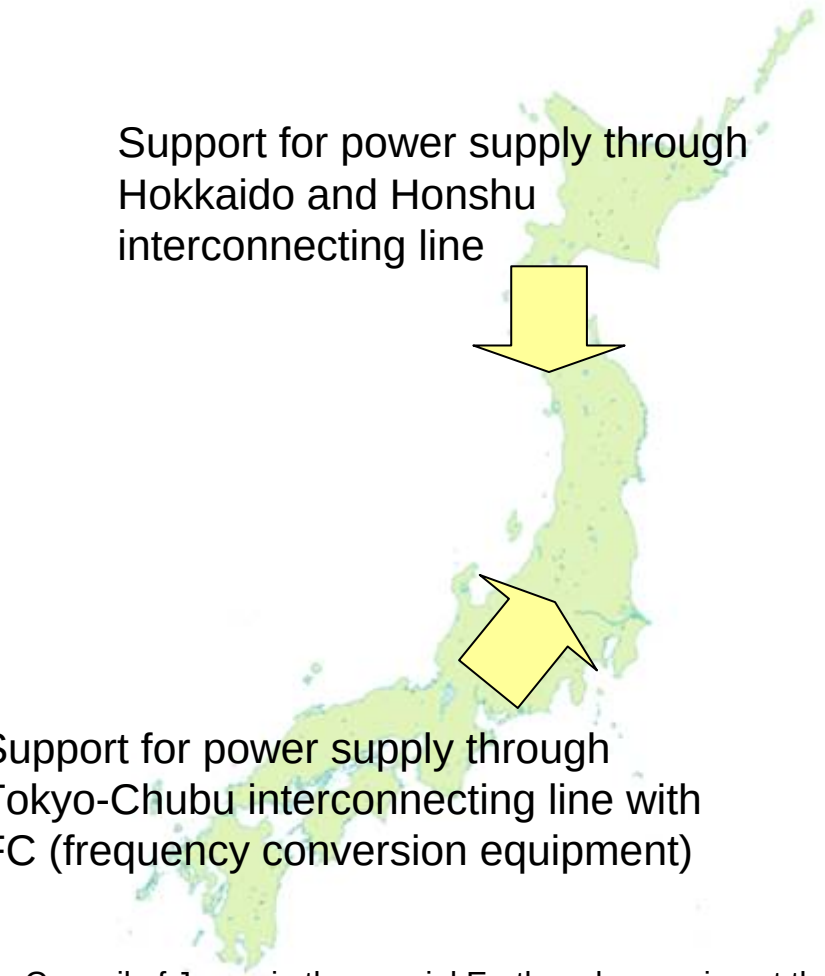
2.3 Effects soon after the Earthquake and response to the situation (1)

<Frequency of Tohoku/Tokyo system>

- Immediately before the Earthquake: 50 Hz
- Significant decrease in frequency due to a demand-supply gap caused by power station's stop, etc.
- Automatic response of the corresponding frequency supporting equipment of other areas (See the right figure)
- The demand-supply gap was not resolved. Frequency continued to decrease (to 48.5 Hz or less).
- Five minutes after the Earthquake, frequency recovered to 50 Hz as a result of automatic stop of supply to some demands and increased output at continuously operated stations.

Avoid disruption of power supply (blackout) in the entire Tohoku and Kanto system

<Electricity provided from other areas>

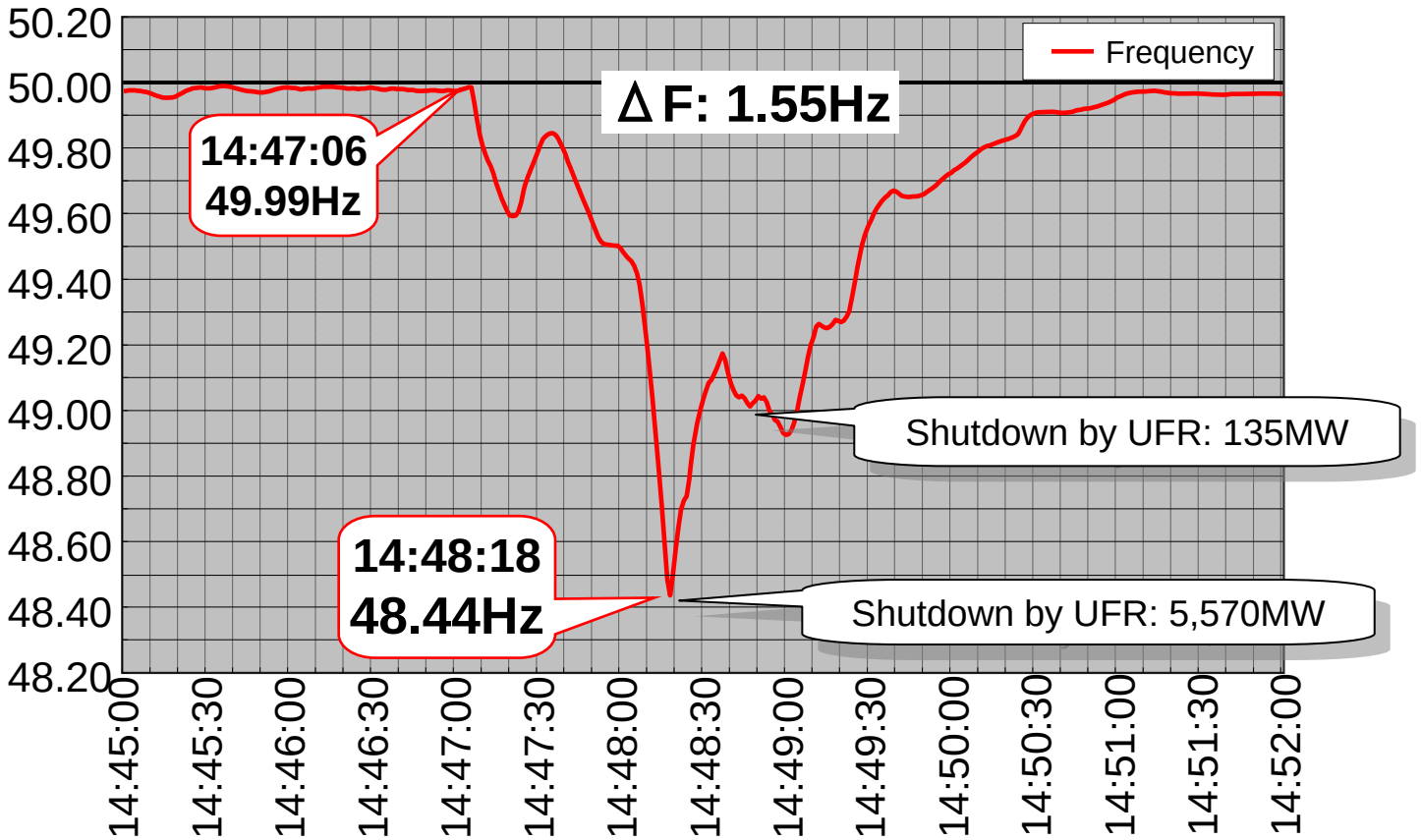


[Source: Created based on the document released by Electric System Council of Japan in the special Earthquake session at the conference of Electricity/energy segment, 2011 The Institute of Electrical Engineers of Japan Conference]

2. Power demand and supply after the Earthquake

2.3 Effects soon after the Earthquake and response to the situation (2)

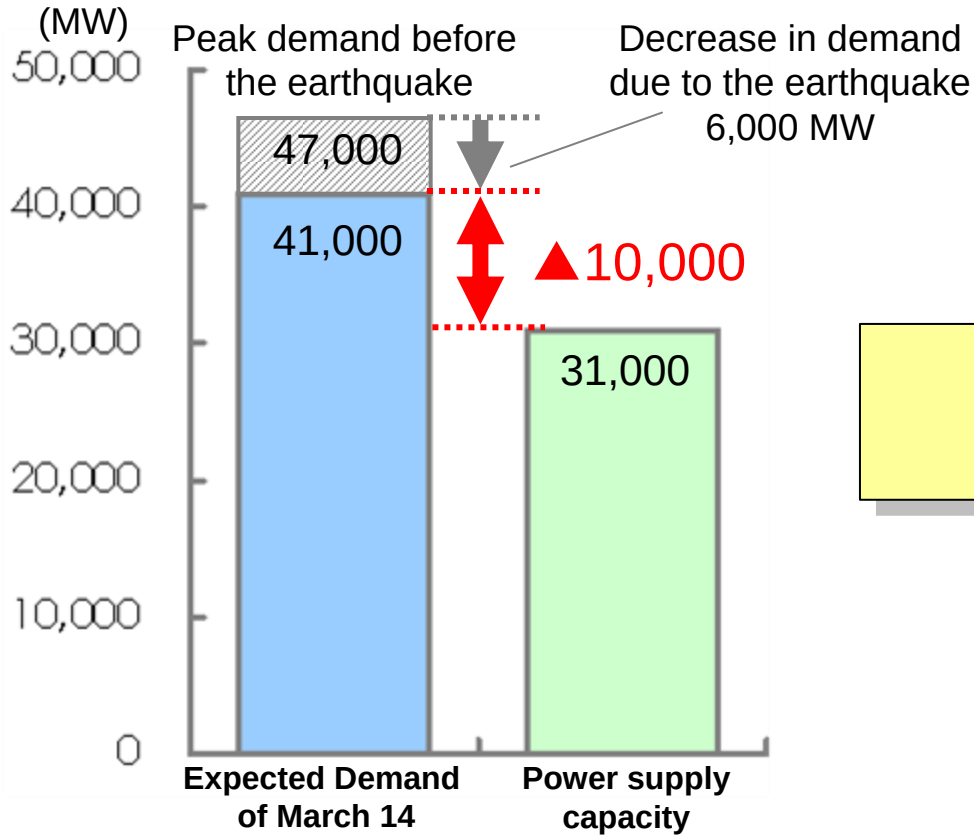
- Frequency fell to 48.44 Hz due to the loss of power supply.
- The system blackout was avoided by UFR (under frequency load shedding relay)
- By UFR and increasing the output of the generators of ongoing operation, Frequency was recovered in about 5 min.



2. Power demand and supply after the Earthquake

2.4 Rolling blackout (within the area supplied by TEPCO)

- Approximately 10,000 MW demand-supply gap was expected to occur on weekdays after the Earthquake.
- "Rolling Blackout" was conducted for 10 days between March 14 and March 28, affecting a total of approx. 70 million customers.
- After that, rolling blackout could be avoided thanks to a decreased demand due to temperature rise and recovery of suspended units.



Example of blackout groups

Example of blackout schedule

2. Power demand and supply after the Earthquake

2.5 Measures for steady power supply 2011 summer (1)

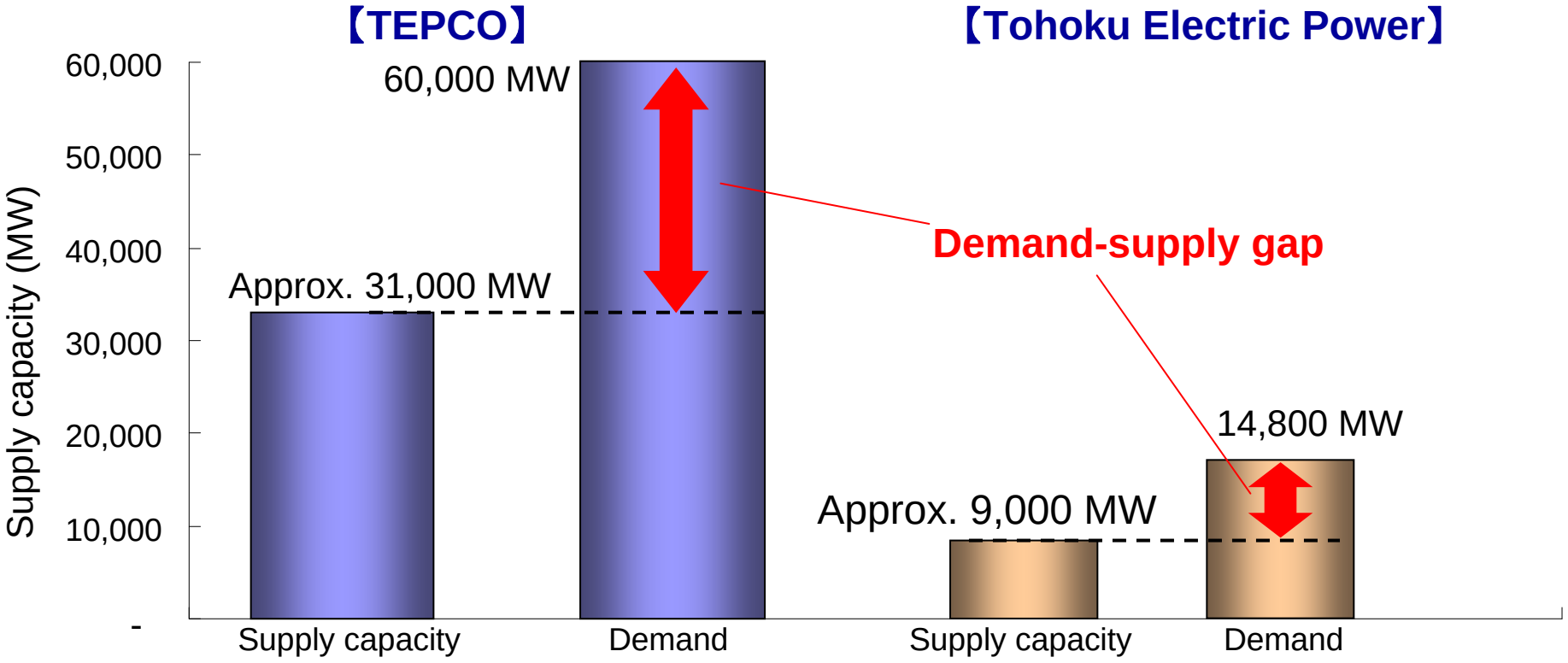
Implement countermeasures in terms of supply and demand toward the peak demand time in Summer.

【Response to supply】

- Early recovery of damaged power source
- Resumption of operation of un-operated thermal power stations based on the long-term plan
- Installation of urgently-installed power source

【Response to demand】

- Request customers to save electricity
- Expand the demand-supply contract
- Issue an electricity use restriction order (Government)



2. Power demand and supply after the Earthquake

2.5 Measures for steady power supply(within the area supplied by TEPCO)

- As the result of utmost efforts by the cooperation of the relating section in TEPCO and affiliates, supply capacity of 20 GW was secured by the end of August 2011.

(MW)

	Day before the Earthquake	After the Earthquake	2 weeks after	1 month after	4 months after (End of July)	5 months after (End of August)	Remarks
	0	4,240	7,090	9,460	18,660	19,580	
Recovery from stop due to the Earthquake (Including recovery of repair stop power sources)	0	2,440	3,790	7,160	16,010	16,010	TEPCO's facilities: 8 locations and 18 units Other companies' facilities: 14 locations and 19 units
Resumption of operation of un-operated thermal power station on a long-term basis	0	0	0	0	870	870	Yokosuka 3T, 4T, 1GT, 2GT
Installation of urgently-installed power source	0	0	0	0	370	1,290	GT, GE, DE 1.71 million kW by the end of September
Further utilization of generating facilities of auto producers	0	100	800	800	1,100	1,100	
Electric power interchange by other companies for support		1,700	2,500	1,500	300	300	

(Note) Total doesn't necessarily equal to the sum of the figures due to the rounding method.

2. Power demand and supply after the Earthquake

2.5 Measures for steady power supply(within the area supplied by TEPCO)

(1) Request for saving electricity

■**Request to the customers for saving electricity**
Requested the customers to save electricity with mail and telephone

■**Electricity forecast**
Visualized electricity demand and supply on the Electricity Forecast page in the website. Transmitted information in collaboration with mass media, etc.

(2) Expansion of demand-supply adjustment contract

■**Planned adjustment contract**
Contract to shift non-business days to weekdays in summer (except for weekdays in the period during the Obon holidays)

■**Demand-responsive adjustment contract**
Contract to reduce the use of electricity in response to the notice when electricity supply is tight against demand

(3) Issue of electricity use restriction order (Article 27 of Electricity Utilities Industry Law)

…Demand-supply countermeasures taken by the Government

■**Target:** Commercial-scale customers (with contract electricity of more than 500 kW)

■**Period and time of day:** 9:00 to 20:00 in July through September 2011 (weekdays)

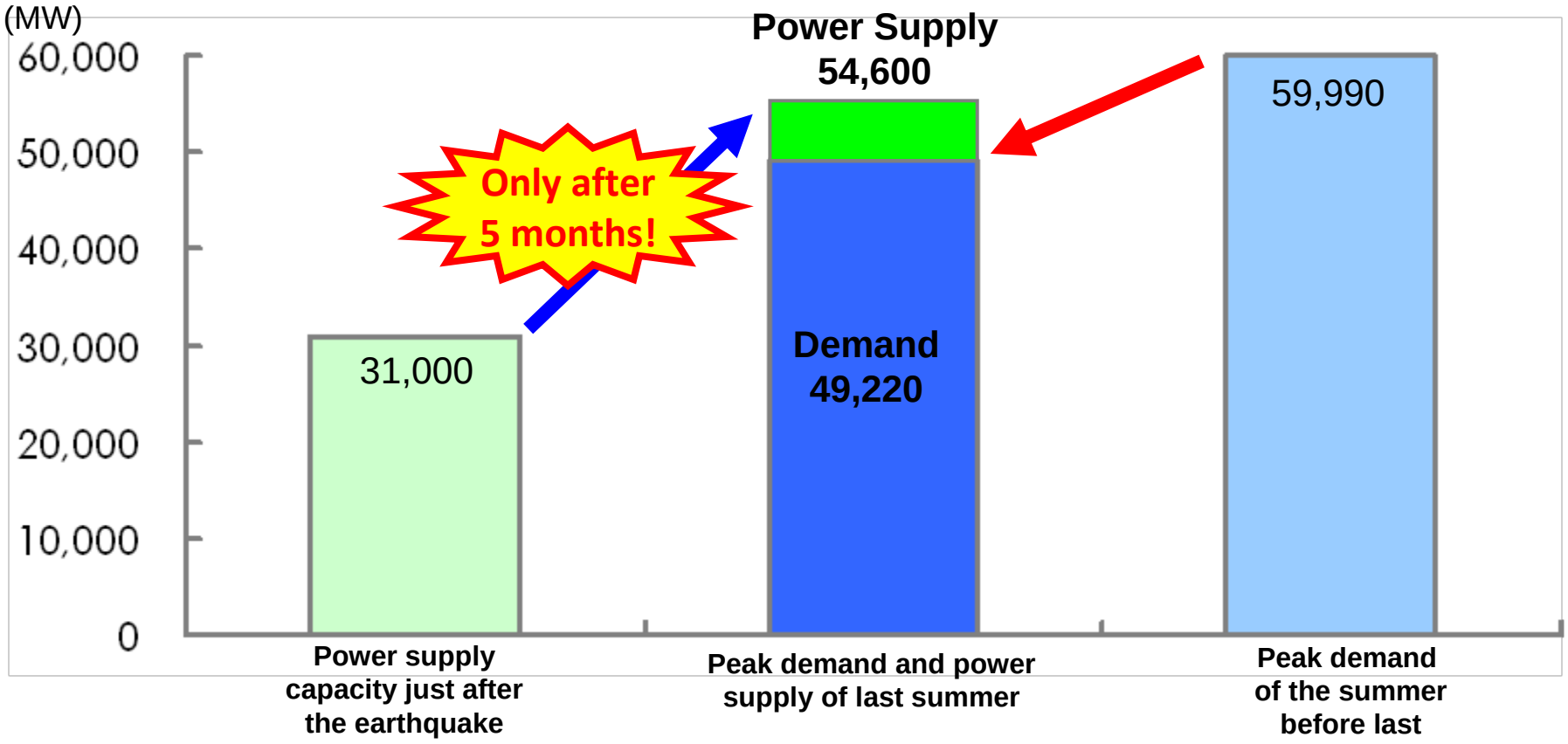
■**Specific details**

In general, the upper limit of electricity use shall be 85% of the maximum electricity use (per hour) in the above period and time of day last year.

2. Power demand and supply after the Earthquake

2.5 Measures for steady power supply(within the area supplied by TEPCO)

- Secured the supply capacity of 54.6 GW at the peak time when the maximum electricity use occurred last summer.
- Thanks to the customers' efforts to save electricity, demand was lower than that of two years ago by 9 to 10 GW.
- Secured the steady electricity supply as a result of countermeasures for demand and supply.



3. Damages to power generation facilities and recovery
3.1 Damages to the facilities (1)

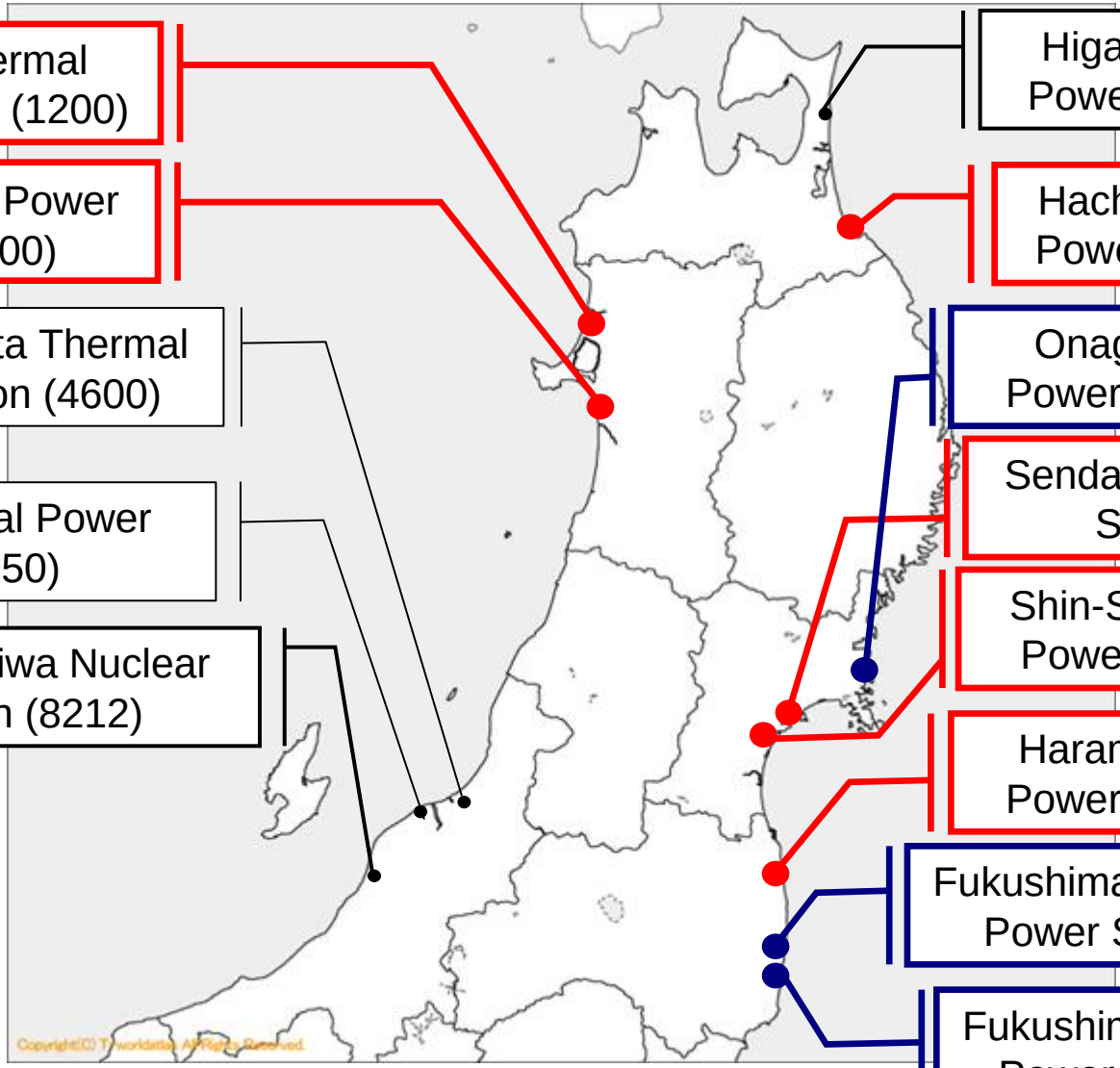
- **For both Tohoku Electric Power and TEPCO, their electrical power stations, power transmission lines and distribution lines were extensively damaged due to earthquake, tsunami, and liquefaction.**

		Tohoku-Electric Power	TEPCO
Nuclear power facilities		Stop of 3 units (Approx. 1,350 MW) *1	Stop of 7 units (Approx. 6,400 MW)
Thermal power facilities		Stop of 12 units (Approx. 4,950 MW)	Stop of 13 units (Approx. 8,500 MW)
Hydraulic power facilities	Dam	0	2 locations
	Water way	19 locations	3 locations
Transmission facilities	Steel tower (Collapsed, broken, etc.)	46 towers (40 towers)	15 towers
	Insulator (Damaged, etc.)	17 units	41 units
Transforming facilities	Transformer	90 units (23 units)	147 units
	Breaker	177 units (171 units)	33 units
	Disconnector	403 units (331 units)	268 units
Distribution facilities	Poles (Inclined, collapsed, etc.)	36,048 (27,523) poles *2	14,288 (8) poles

(Note)1. Figures in ( ) are posted again to represent damages by tsunami.
(Note)2. *1: Unit 2 of Onagawa Nuclear Power Station stopped during the operation of the nuclear reactor.
(Note)3. *2: Figures compiled on August 1, 2011

Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety

【Reference】Locations of major power Stations(1)



Noshiro Thermal Power Station (1200)

Akita Thermal Power Station (1300)

Higashi-Niigata Thermal Power Station (4600)

Niigata Thermal Power Station (250)

Kashiwazaki-Kariwa Nuclear Power Station (8212)

Higashidori Nuclear Power Station (1100)

Hachinohe Thermal Power Station (250)

Onagawa Nuclear Power Station (2174)

Sendai Thermal Power Station (446)

Shin-Sendai Thermal Power Station (950)

Haramachi Thermal Power Station (2000)

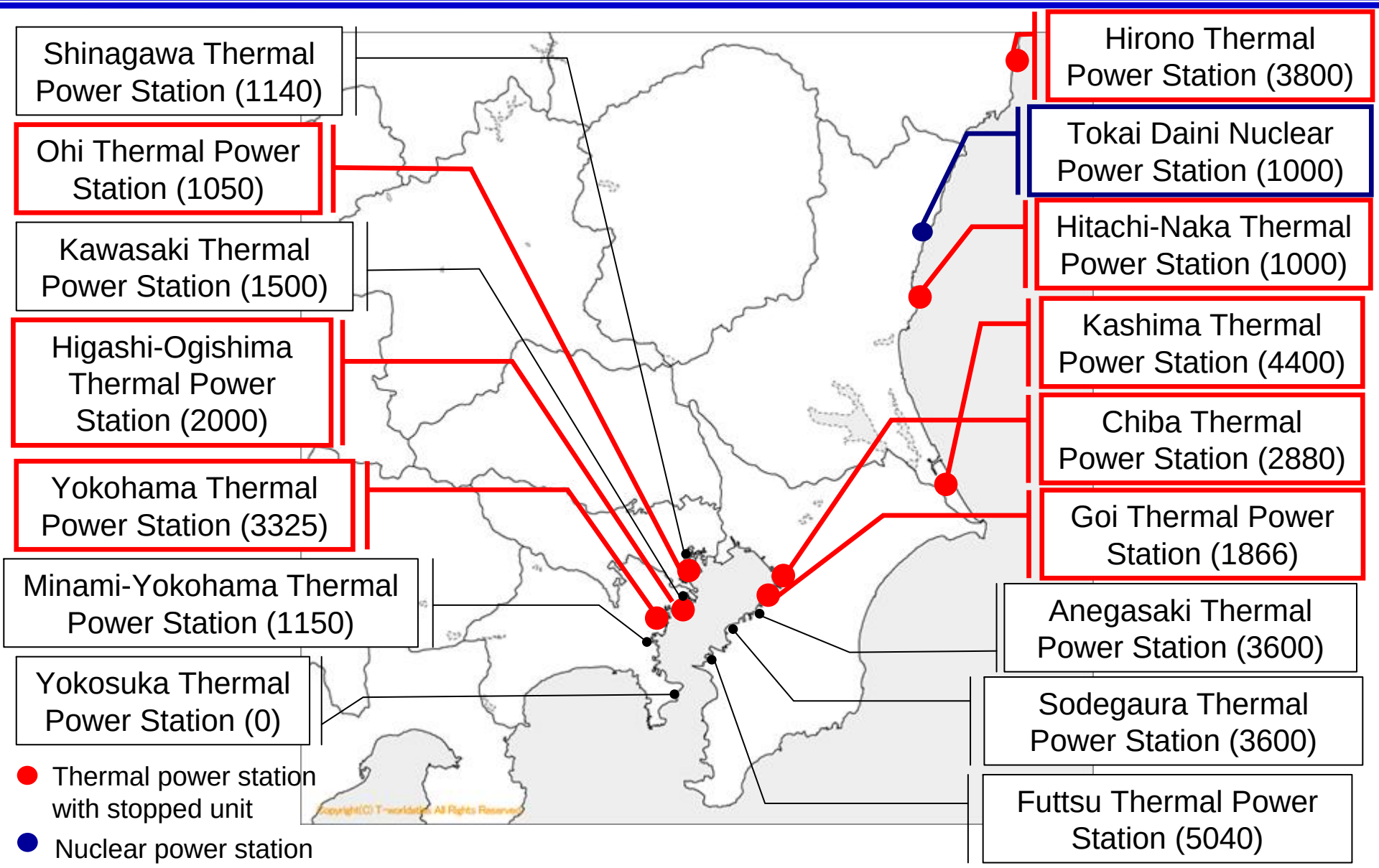
Fukushima Daiichi Nuclear Power Station (4696)

Fukushima Daini Nuclear Power Station (4400)

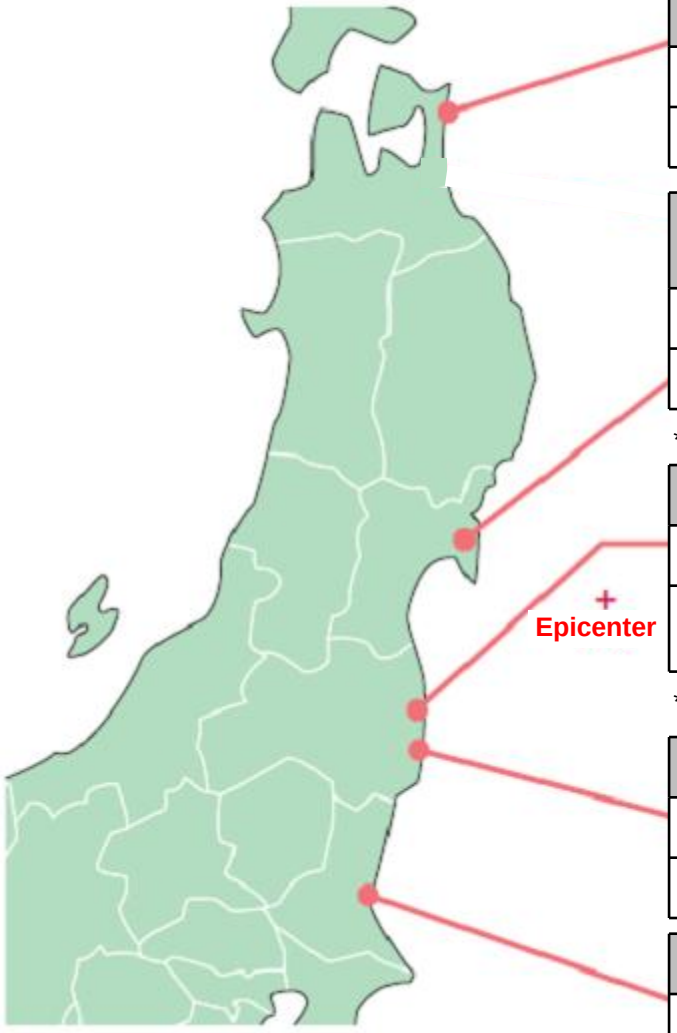
- Thermal power station with stopped unit
- Nuclear power station with stopped unit

( ): Output (MW)

【Reference】Locations of major power stations (2)



【Reference】
States of nuclear power stations after the Earthquake



○: Automatically stopped due to the Earthquake and be brought to cold shutdown.
□: Operation is suspended due to the regular inspection at earthquake.
×: Automatically stopped due to the Earthquake but was not brought to cold shutdown.
(Brought to cold shutdown in December 2011)

Higashidori Nuclear Power Station, Tohoku Electric Power Co., Inc.
Unit 1
□

Onagawa Nuclear Power Station, Tohoku Electric Power Co., Inc.		
Unit 1	Unit 2	Unit 3
○	□	○

* Unit 2 automatically stopped during the regular inspection (with the reactor in operation).

Fukushima Daiichi Nuclear Power Station, TEPCO					
Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
× (Decommissioned)	× (Decommissioned)	× (Decommissioned)	□ (Decommissioned)	□	□

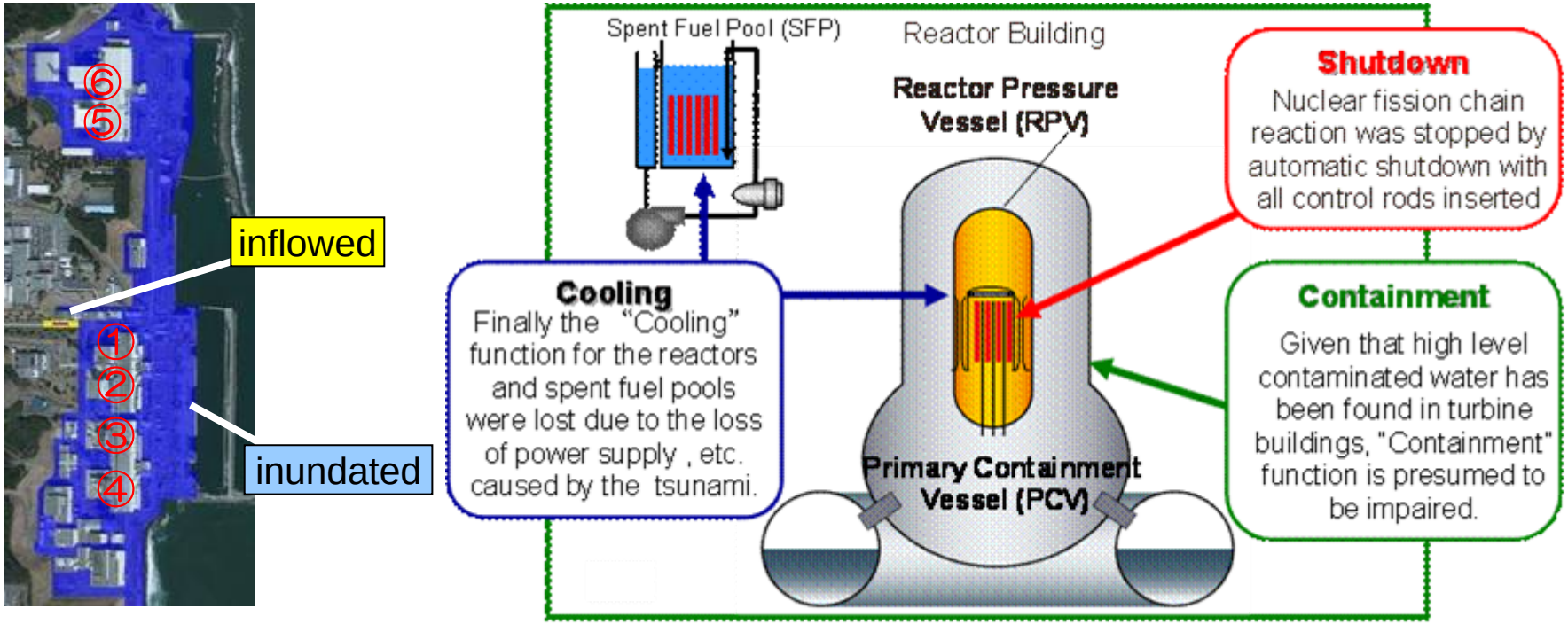
* Units 1 to 4 were decided to be decommissioned.

Fukushima Daini Nuclear Power Station, TEPCO			
Unit 1	Unit 2	Unit 3	Unit 4
○	○	○	○

Tokai Daini Nuclear Power Station, The Japan Atomic Power Company
○

3.1 Damages to facilities (2)
Case of Fukushima Daiichi Nuclear Power Stations

- Nuclear fission chain reaction was stopped by automatic shutdown with all control rods inserted at the same time of the earthquake
- Off-site power was lost due to the impact of the earthquake, etc. and emergency generator started up. However emergency power became unavailable due to flooding by the tsunami except for Unit 6.
- Finally the “Cooling” function for the reactors and spent fuel pools of Units 1 to 4 were lost due to the loss of AC power supply and seawater systems, etc. caused by the tsunami.
- Given that high level contaminated water has been found in turbine buildings, “Containment” function is presumed to be impaired.



【Reference】State of resumption of thermal power generation facilities after the Earthquake

【Tohoku Electric Power】

State before the Earthquake		State after the Earthquake		Resumption state (Number of stopping units)				
				3 days after	End of March	End of April	End of June	End of October
Thermal/geothermal power station located along the Sea of Japan (18 units)	In operation (16 units)	Continued operation	8	—	—	—	—	—
		Stopped due to the Earthquake	8	0	—	—	—	—
	Under suspension* (2 units)		2	2	2	1	0	0
Thermal power station located along the Pacific Ocean (6 units)	In operation (4 units)	Continued operation	0	—	—	—	—	—
		Stopped due to the Earthquake	4	4	3	3	3	3
	Under suspension* (2 units)		2	2	2	2	2	2
Total			24	8	7	6	5	5

【TEPCO】

State before the Earthquake		State after the Earthquake		Resumption state (Number of stopping units)				
				3 days after	End of March	End of April	End of June	End of July
Thermal power station located along Tokyo Bay (69 units)	In operation (56 units)	Continued operation	50	—	—	—	—	—
		Stopped due to the Earthquake	6	2	0	—	—	—
	In operation* (13 units)		13	9	6	0	—	—
Thermal power station located along the Pacific Ocean (12 units)	In operation (7 units)	Continued operation	0	—	—	—	—	—
		Stopped due to the Earthquake	7	7	7	3	2	0
	Under suspension* (5 units)		5	5	5	4	2	0
Total			81	23	18	7	4	0

* Suspended operation or preliminary suspension due to regular inspection, etc. (excluding thermal power station in long suspension)

[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

3. Damages to power generation facilities and recovery
3.2 Efforts to restore facilities (1)

- **Tohoku Electric Power and TEPCO worked on early recovery with power generation and transmission & distribution departments working together soon after the Earthquake with the cooperative companies supported by other electric companies.**

Number of personnel for recovery (at peak time)

	TEPCO	Tohoku Electric Power
Thermal power generation department	Approx. 7,000	Approx. 2,000*
Distribution department	Approx. 7,000	Approx. 7,000

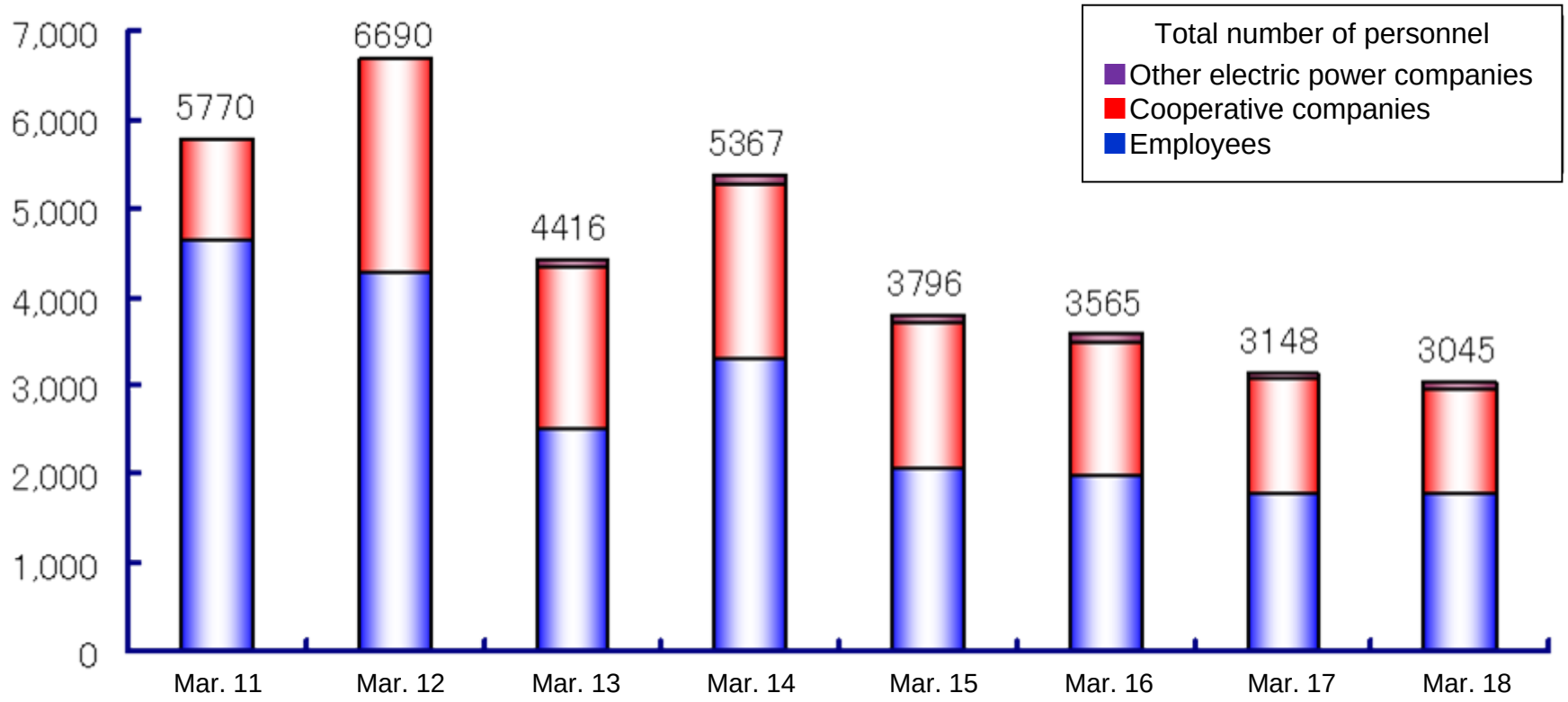
* As of October 2011. Will be increased toward full-scale recovery.

[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

3. Damages to power generation facilities and recovery
3.2 Efforts to restore facilities (2)

<Change in number of recovery personnel in transmission & distribution department (TEPCO)>

- **Put approximately 36,000 people in total by March 18 when the power outage due to the Earthquake was resolved.**



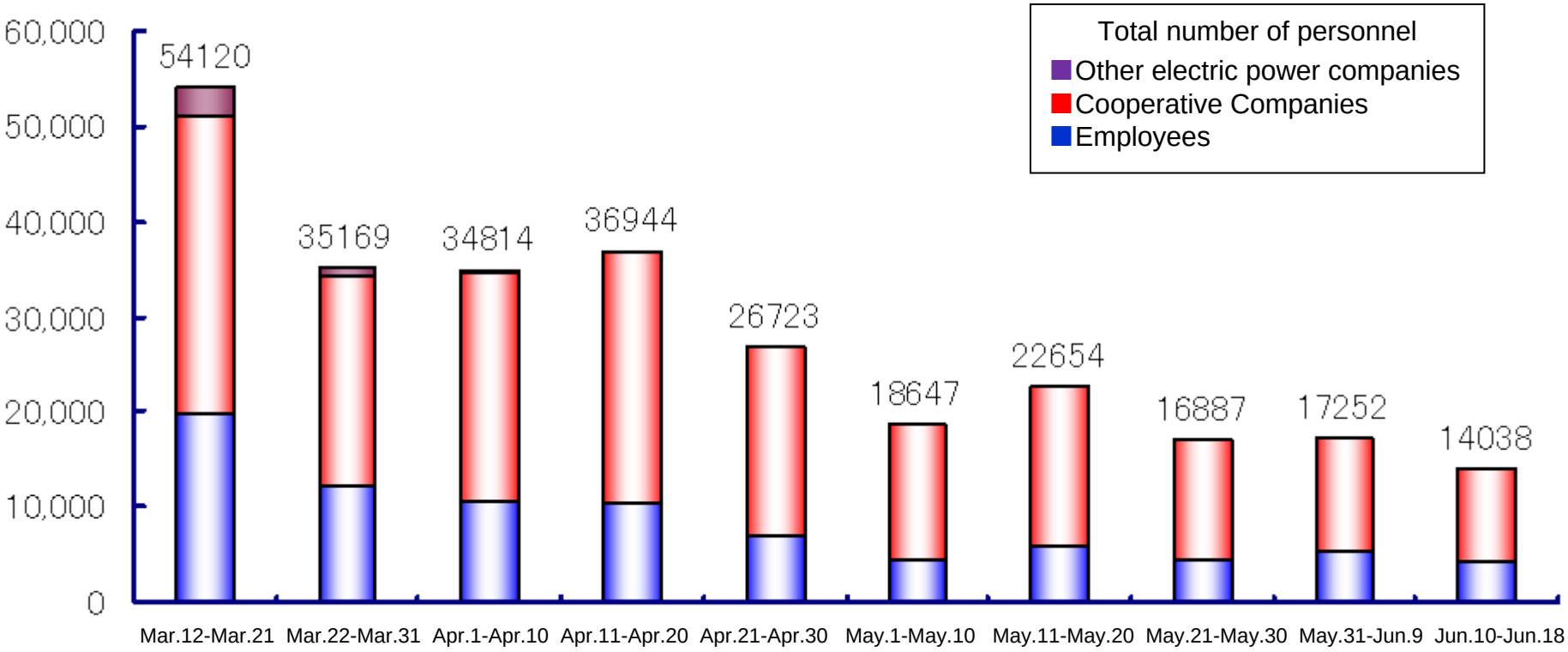
* Transforming and transmission departments posted the figures by March 14 and March 16 respectively when the system was restored.

[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

3. Damages to power generation facilities and recovery
3.2 Efforts to restore facilities (3)

<Change in number of recovery personnel in transmission & distribution department (Tohoku Electric Power)>

- **Put approximately 277,000 people in total by June 18 when all the power outage was resolved in the areas to which the Company could transmit electricity.**



[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

3. Damages to power generation facilities and recovery
3.2 Efforts to restore facilities (4)

State of support among electric power companies

To compensate the damaged distribution facilities, the electric power companies provided their 50/60 Hz electric power generating vehicles and personnel. The supporting companies arranged water, foods, lodging to support life from experience of the past disasters.

(Reference) Support from other electric companies at Tohoku Electric Power (Distribution of electricity)

	Hokkaido	Tokyo	Hokuriku	Chubu	Kansai	Total
Operating person-day	622	454	439	2,458	203	4,176
Number of generating vehicles (vehicles)	17	–	3	19	2	41

[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

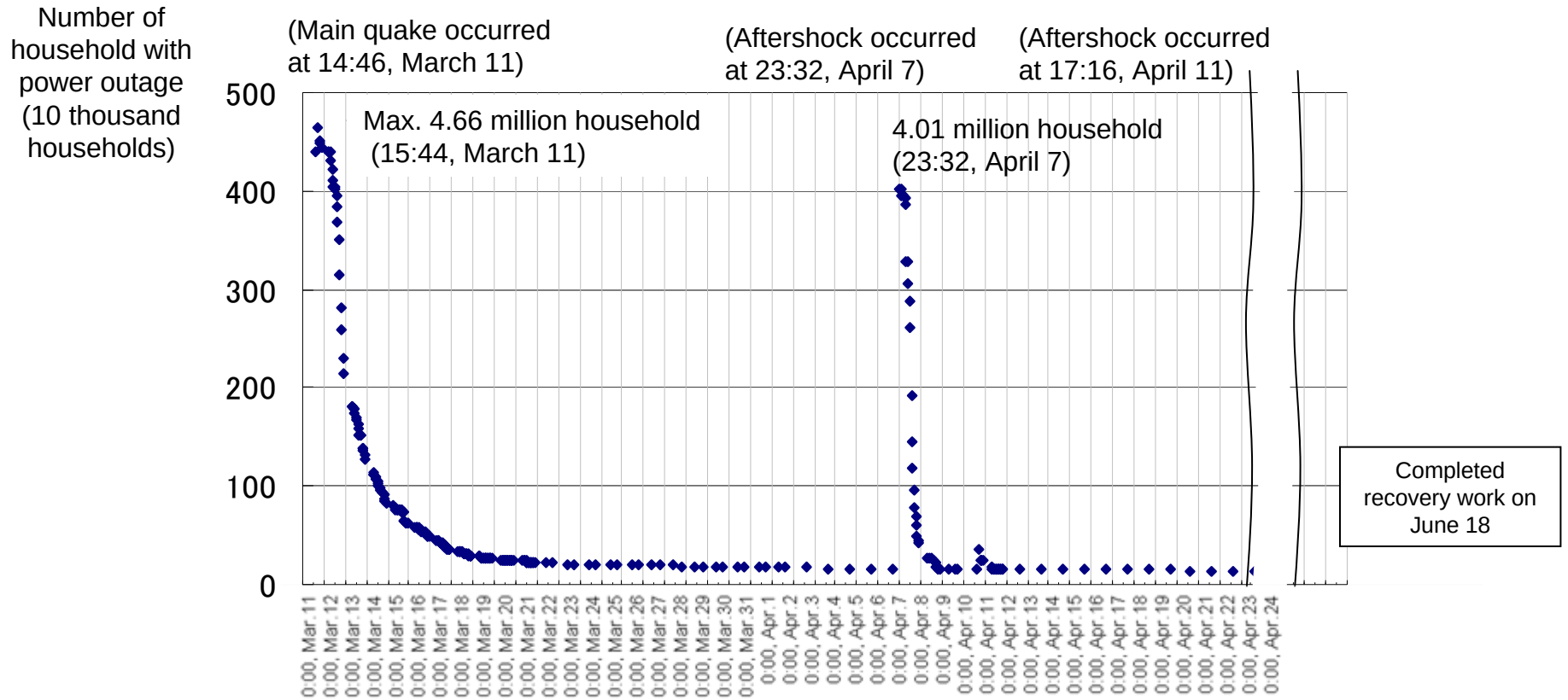
【Reference】Temporary recover of external power supply to Fukushima Daiichi Nuclear Power Station (1)

- **To recover the power supply to Fukushima Daiichi Nuclear Power Station, the transmission & distribution department helped the recovery efforts.**

3. Damages to power facilities and recovery efforts

3.3 Recovery of power supply (within the areas supplied by Tohoku Electric Power)

- **Within the area supplied by Tohoku Electric Power, the problems of supply were resolved at 20:00, March 19, 2011 except for the areas where they couldn't start the recovery work due to the effects of Tsunami, etc. Although partly affected by the aftershock on April 7, the problems of supply were completely resolved on June 18 except for the areas where they couldn't do the recovery work.**

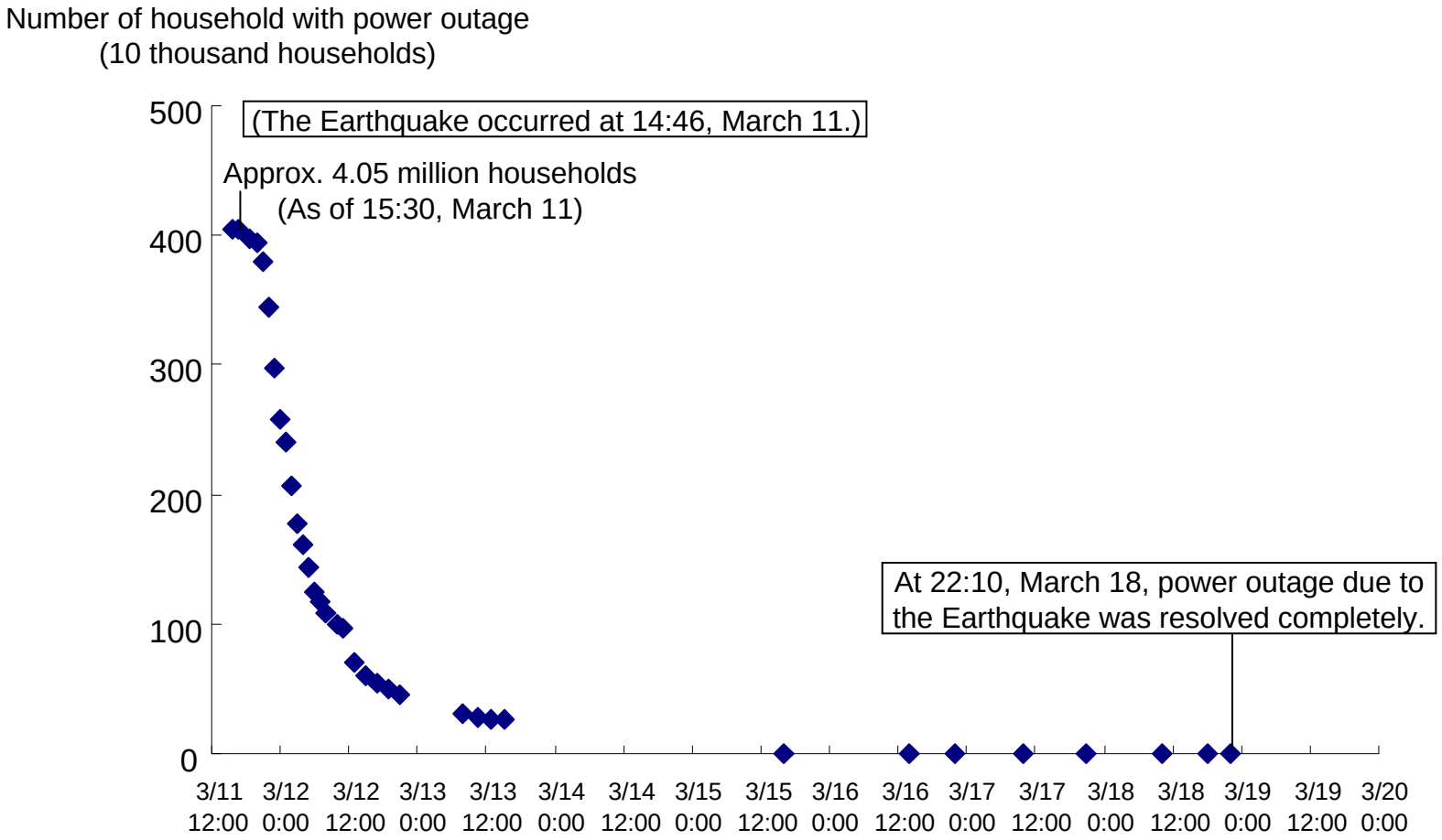


[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

3. Damages to power generation facilities and recovery

3.3 Recovery of power supply (within the areas supplied by TEPCO)

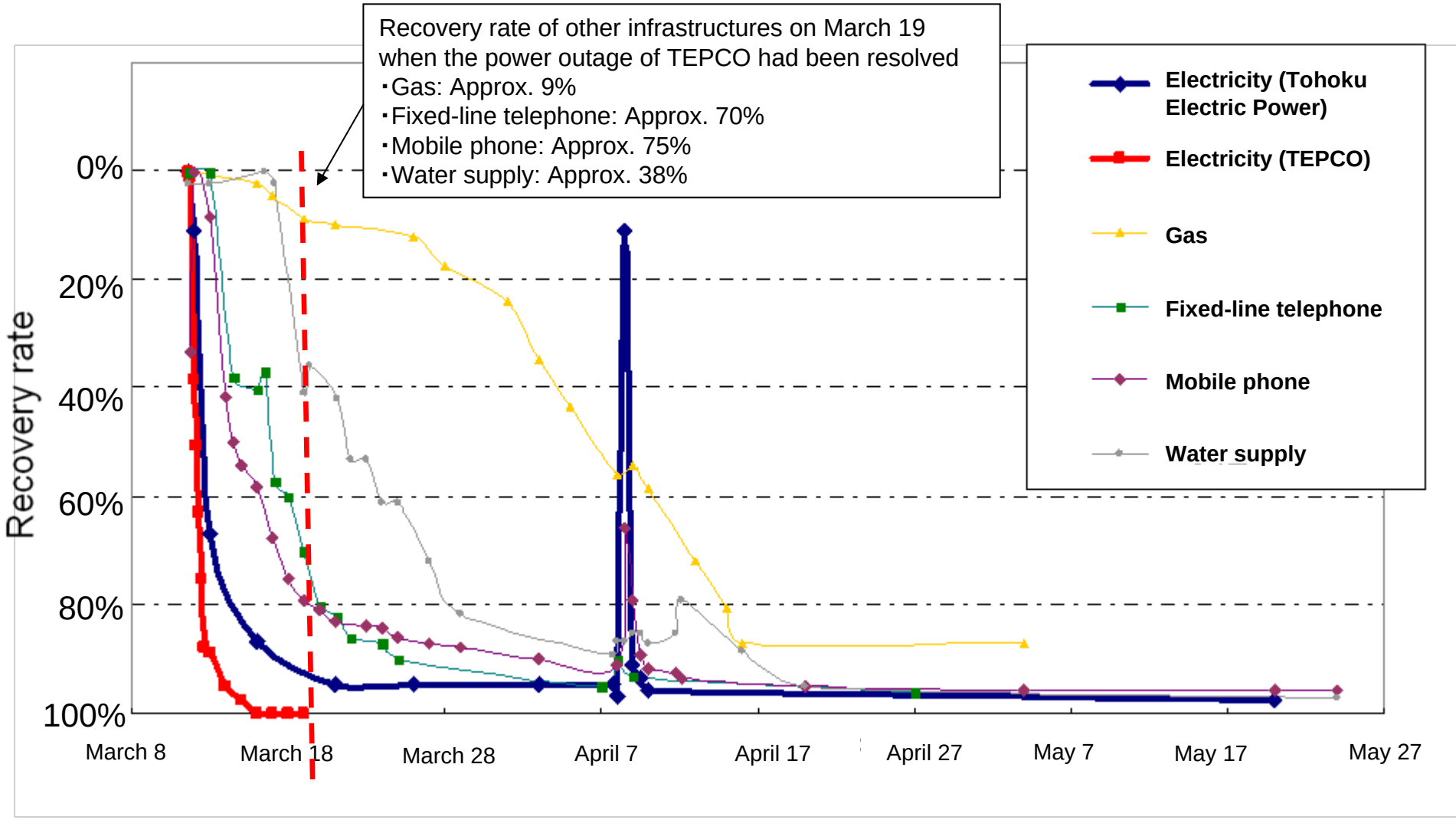
- **The supply problems were resolved at 22:10, March 18, 7 days after the Earthquake, within the area supplied by TEPCO.**



Note: The number of households were the figures announced by TEPCO at the press conference (The number affected by rolling blackout is excluded.)

[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

【Reference】
Comparison with recovery state of other infrastructures (1)



[Source: Material distributed at the 2nd meeting of Electric Facilities Earthquake Countermeasures Working Group, Subcommittee on Electric Power Safety]

4. Future challenges of power system

【Challenges of damages and recovery of electric facilities】

- Preparedness of electric facilities for future earthquake and tsunami
  - ・Reflect knowledge obtained from this experience on design of newly constructed and renewed facilities
  - ・Evaluate the impact of possible tsunami and consider the measures to mitigate damages
- Further speeding up of recovery of power supply
  - ・Consider the use of satellite imagery
  - ・Strengthen the cooperation with local governments and other organizations to prioritize the recovery of infrastructure equipment

【Challenges around power demand and supply】

- Ideal interconnected line among areas
- Measures to promote steady power demand and supply in terms of demand
- Response to a large-scale introduction of renewable energy power source
- Countermeasures against demand for this summer

【Reference】Basic ideas of securing seismic capacity

○ Seismic capacity category of electric facilities and seismic capacity to be secured

Based on the concept of the basic disaster prevention plan (decided by Central Disaster Prevention Council in July 1995), the seismic capacity of electric facilities (except for nuclear power stations) shall be ensured according to the following two categories.

Category I	Dam LNG tank Oil tank

A. In case of general earthquake vibration, significant problems shall not occur with each facility.

B. Even in case of high-level earthquake vibration, it shall not give any significant impact on human lives.

Category II	Power station building, turbine, boiler, Transforming facilities, Transmission facilities, Distribution facilities, Load dispatching center, Electricity security communication facilities, etc.

A. In case of general earthquake vibration, significant problems shall not occur with each facility.

C. Even in case of high-level earthquake vibration, alternative measures and functions of the system shall be ensured comprehensively with multiplexing so as to avoid significant (long and extensive) supply disruption.

*1 General earthquake vibration: General earthquake vibration that is expected to occur once or twice during the service period.

*2 High-level earthquake vibration: Higher-level earthquake vibration caused by an inland earthquake or ocean-trench massive earthquake, although a probability of occurrence is low.

【Reference】Basic ideas to respond to tsunami

【Tsunami with high frequency (Tsunami that occurs once or twice during the service period)】

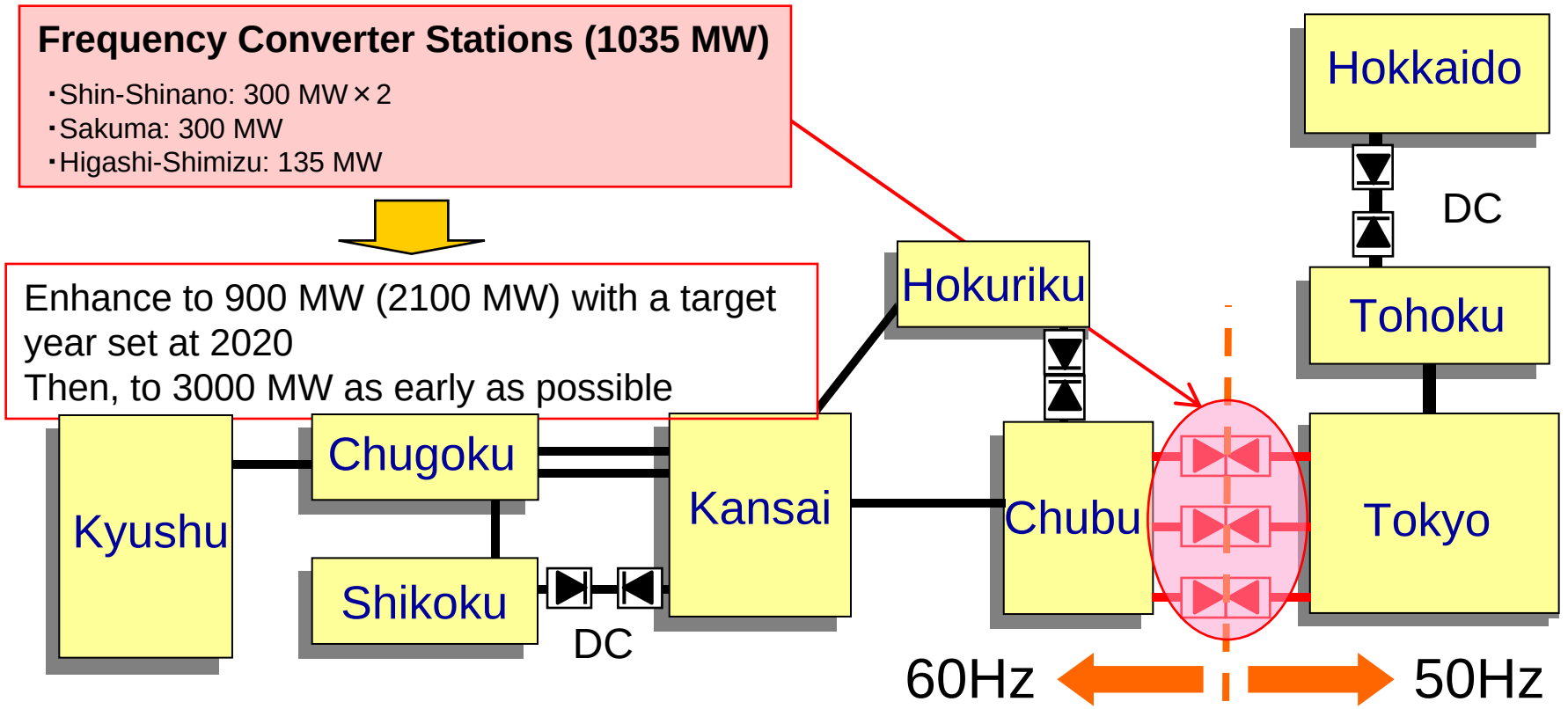
- Penetration of tsunami into demand areas (urban areas, etc.) is expected to prevent by shore protection facilities.
- For the facilities that may give a significant impact on human life once they have lost their functions, a fundamental policy is that countermeasures shall be taken for each facility to avoid causing significant problems to their functions.

【Maximum level of tsunami (Maximum level of tsunami that extremely rarely occurs)】

- To construct facilities that can prevent damages is not practical from a standpoint of cost.
- A fundamental policy is that countermeasures to reduce effects of tsunami shall be taken so that damages may be reduced to the extent possible or recovery may be facilitated, in consideration of the level of impact that damages to the facilities give on electricity supply.

4-1 Ideal interconnected line among areas

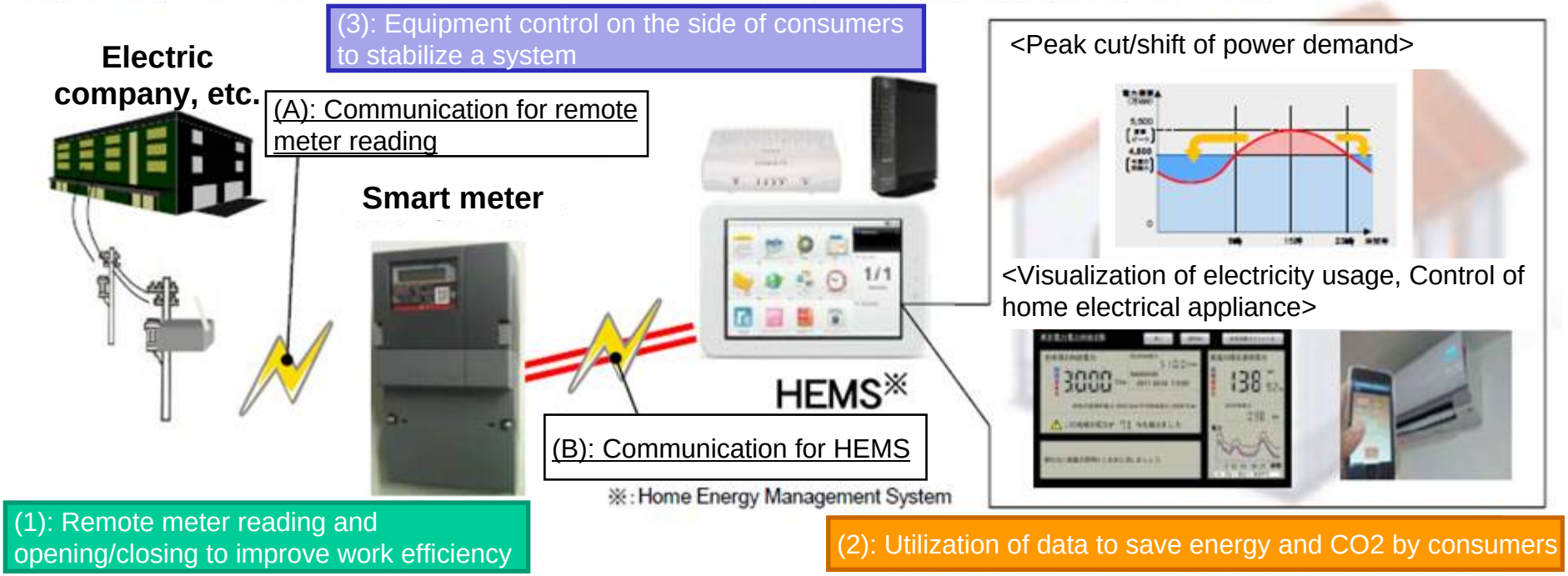
- **Since Japan has the comb-like power supply system, which connects the areas supplied by different electric companies with interconnecting lines, there is a limit to use the supply capacity in a wider area.**
- **We are planning to prepare for the risk of suspension of multiple large-scale power sources and to strengthen the interconnection between east and west Japan.**



4-2 Measures to promote steady power demand and supply in terms of demand

- **To deal with the significant shortage of supply capacity, we had to reduce demand with the rolling blackout and the electricity usage restrictions. We could not fully utilize originality and ingenuity for reducing demand of consumers.**
- **We consider to introduce a new fee menu and services, working to improve a smart meter so that a peak cut and peak shift are promoted by consumers when supply is tight.**
- **We work to introduce a smart meter to 80% of the customers in the next five years.**

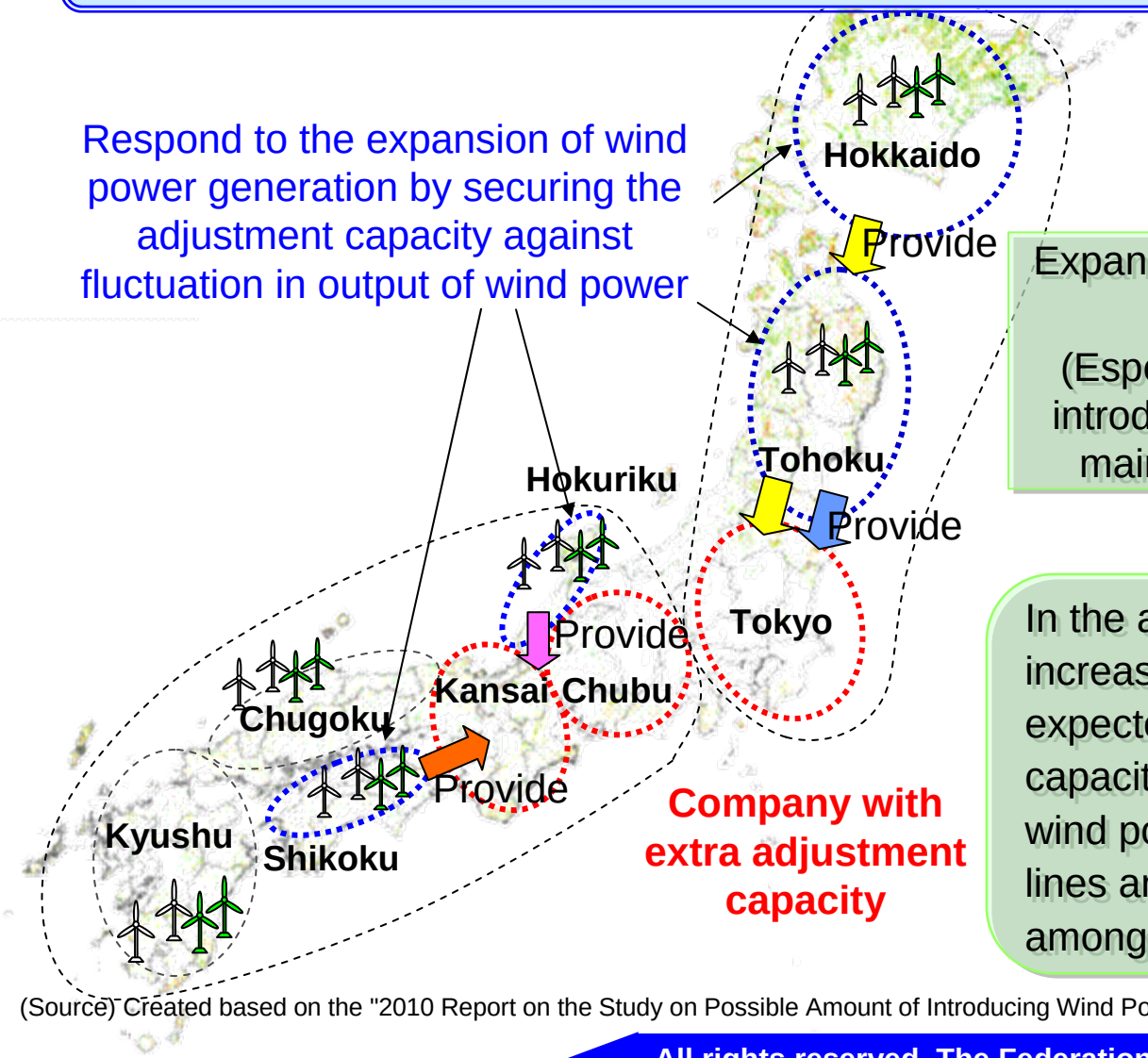
<Image of effects expected with a linkage of smart meter and energy management system>



※ Document No. 3 delivered at the 11th Smart Meter System Study Meeting

4-3 Response to a large-scale introduction of renewable power source (1)

- To expand the introduction of wind power generation, electric power companies promote the efforts in union.



Expansion of wind power generation is expected in the future.

(Especially, locations where we can introduce wind power generation are mainly in Tohoku and Hokkaido.)

In the areas, where a significant increase in wind power generation is expected, secure the adjustment capacity against fluctuation in output of wind power by utilizing interconnected lines and providing electricity mutually among companies.

(Source) Created based on the "2010 Report on the Study on Possible Amount of Introducing Wind Power Energy" by Ministry of Economy, Trade and Industry

4-3 Response to a large-scale introduction of renewable energy power source (2)

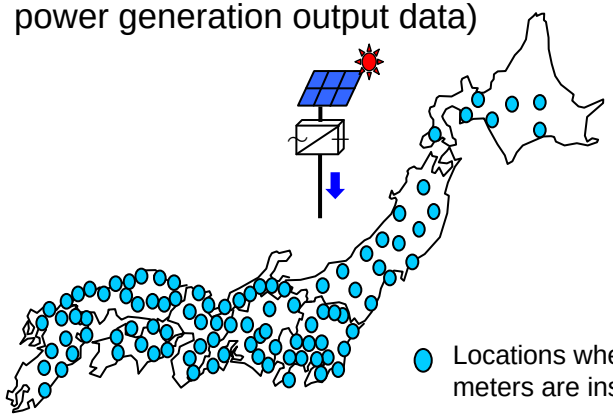
<Overview>

- **Accumulate the output data of solar power generation, which serves as a base for technological development, and analyze and evaluate a fluctuation in output so as to ensure a steady electricity supply even in case of a large-scale introduction of solar power generation**

<Verification items>

(1) Accumulate data such as solar power generation output

Install actinometers and thermometers at 321 locations nation wide (at 116 locations of which, we also collect solar power generation output data)



* Pictures are taken from the website of the manufacturers

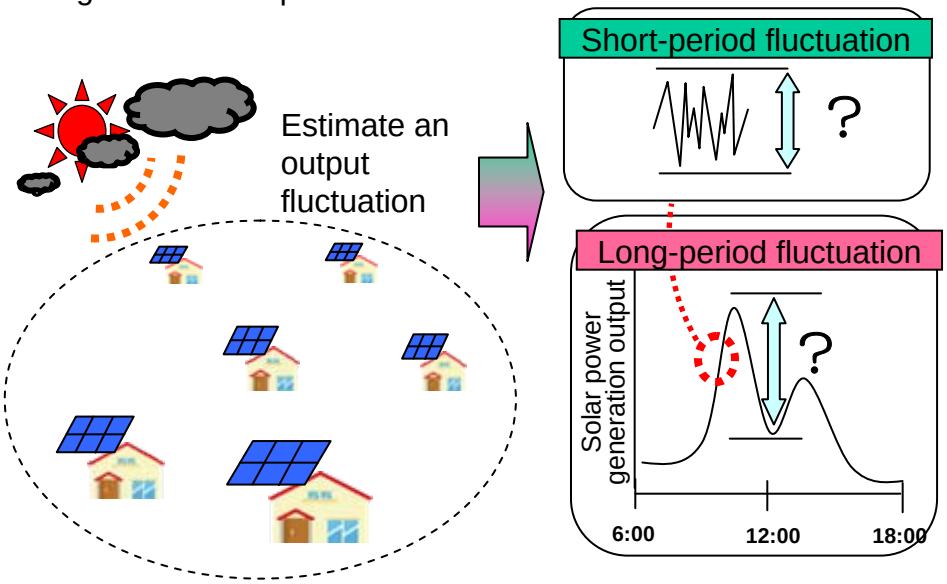
Global solar radiation meter

Thermo meter

Solar power generation output

(2) Analyze a fluctuation in output of solar power generation

- Analyze a fluctuation in solar power generation output and smoothing effect
- Develop a model to estimate a fluctuation in solar power generation output
- Estimate and evaluate a fluctuation in solar power generation output



4-3 Response to a large-scale introduction of renewable energy power source (3)

<Overview>

- **Preparing for the technical issues in operating electric power system, develop and verify the technology to address the issues**
  - **Develop control technologies and equipment that can reduce fluctuations and deviation in voltage in the distribution system due to a large-scale introduction of solar power generation**
  - **Develop and verify countermeasure technologies against surplus electricity that is generated in the lighter load periods (such as the golden week and weekends in spring and autumn)**
  - **Demand creation and shit and evaluation of effects on demand-supply operation, etc.**

<Verification items>

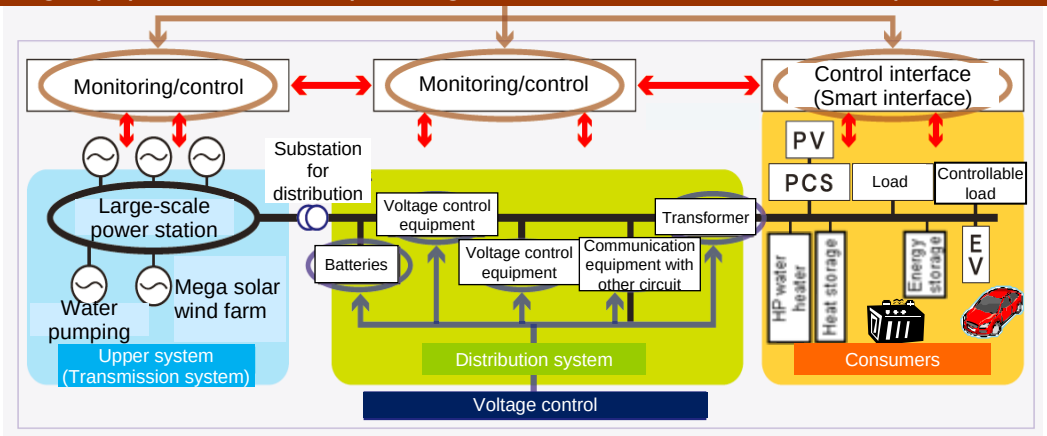
(1) Development of voltage fluctuation reduction technologies of distribution system

(2) Development of equipment with low electromagnetic noise, loss and cost utilizing the next-generation transducer technologies

(3) Development of control technologies responding to the state of system for demand side equipment

(4) Consideration of demand-supply plan/control and communication infrastructure across the system

Collaboration among equipment for solar power generation and demand side depending on a state of the system



4-4 Demand-supply countermeasures

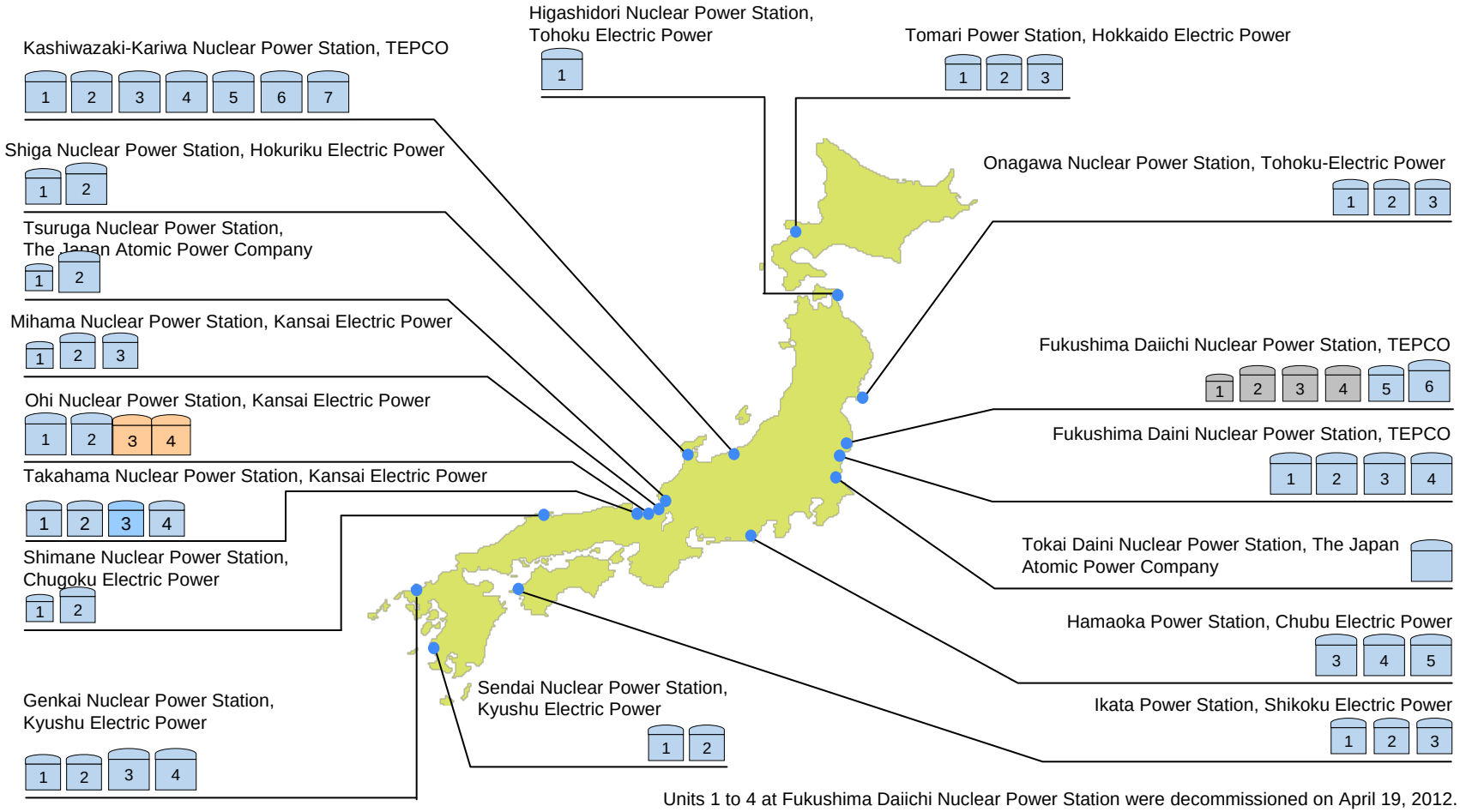
【Response to supply】

- Resumption of operation of un-operated thermal power stations, New additional power generation facilities
- Maximum mutual electricity provision
- Resumption of operation of nuclear power stations on the main premise of safety

【Response to demand】

- Request for saving electricity to consumers
- Expansion of demand and supply adjustment plan
- Preparation of rolling blackout

【Reference】Current state of nuclear power stations in Japan (For commercial use: As of end of December 2012)



Units 1 to 4 at Fukushima Daiichi Nuclear Power Station were decommissioned on April 19, 2012.

Output scale

Less than 500 MW	Less than 1,000 MW	1,000 MW or more

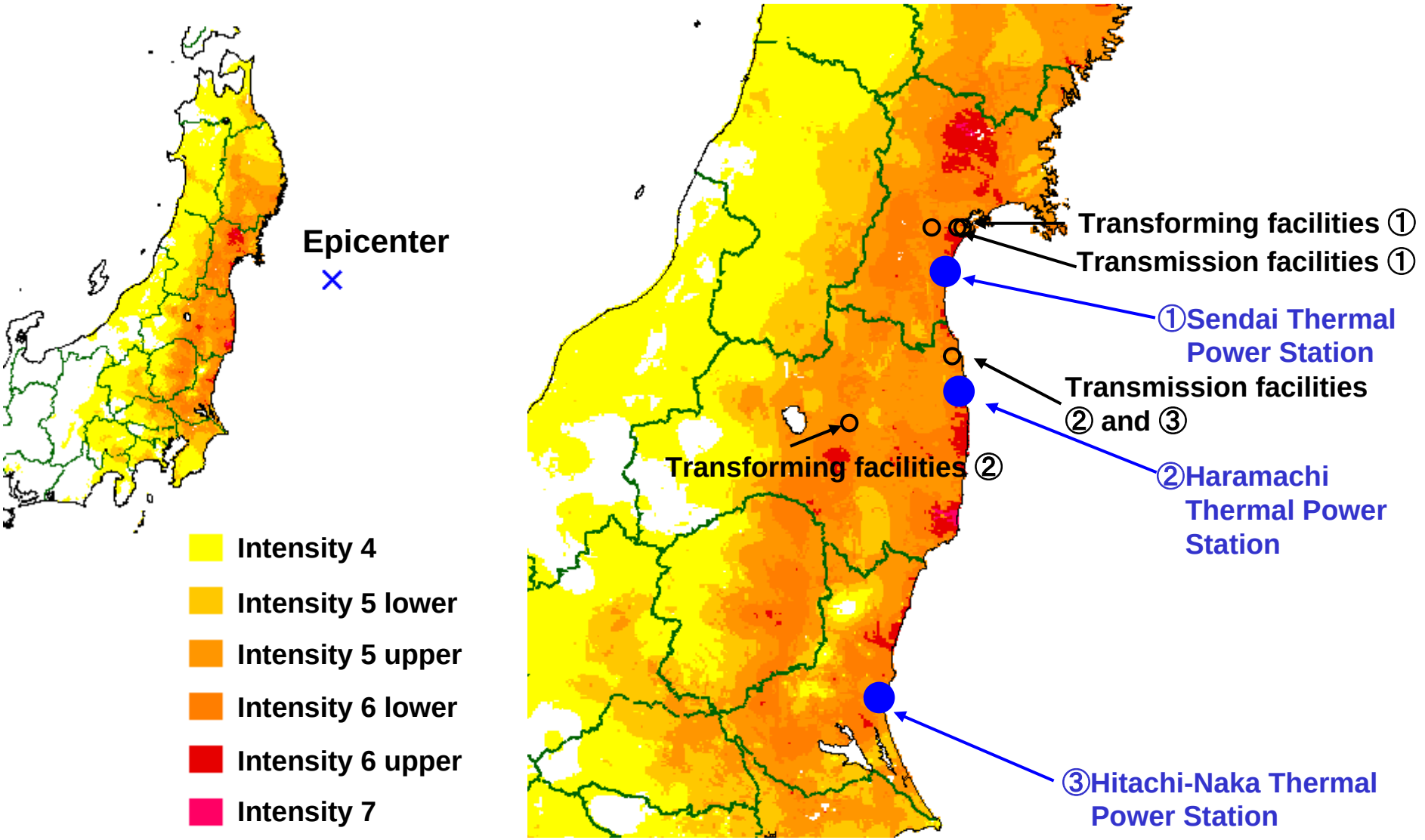
In operation
Suspended

	Number of reactors	Total output (MW)
In operation	2	2,360
Suspended	48	43,940
Total	50	46,300

Source: "Nuclear Power 2010," Resources and Energy Agency

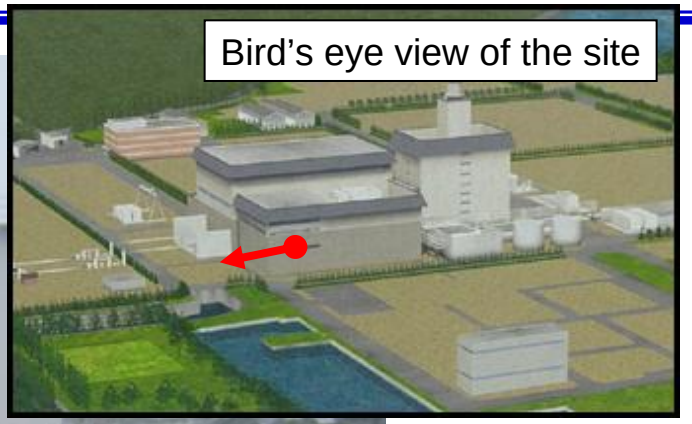
Thank you for your attention.

Distribution of seismic intensity of The Great East Japan Earthquake



*Data of intensity is in accordance with the data of Japan Meteorological Agency.

① Sendai Thermal Power Station



① Sendai Thermal Power Station

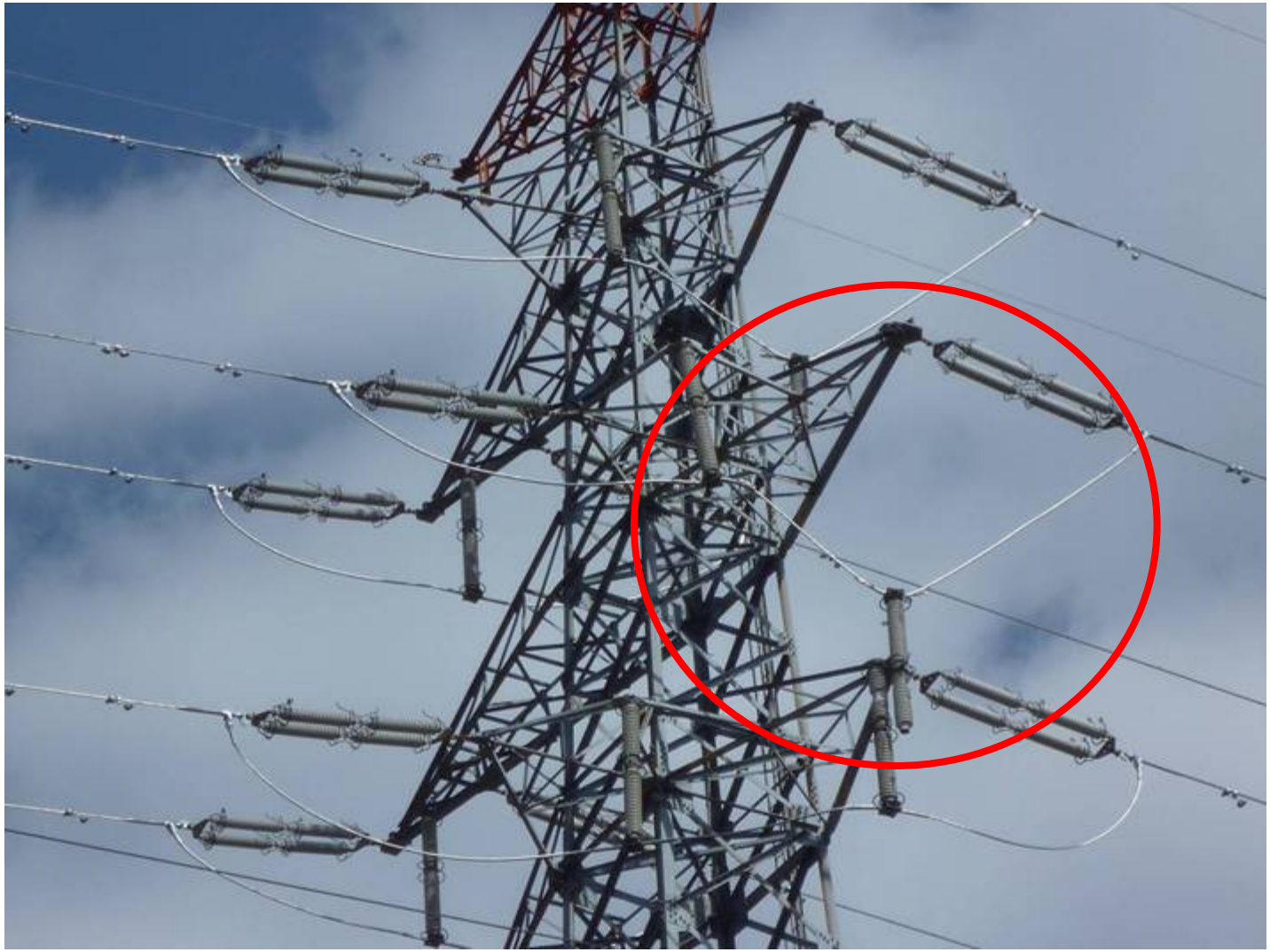
Inside the administration building of Sendai Thermal Power Station

(First floor of the administration building flooded and damaged by Tsunami)

② Haramachi Thermal Power Station

③ Hitachi-Naka Thermal Power Station

–Tohoku Electric Power Transmission facilities ① –



Broken supporting insulator

–Tohoku Electric Power Transmission facilities ② –

Tsunami damage (Collapsed steel tower）

–Tohoku Electric Power Transmission facilities ③ –

Tsunami damage (Broken steel tower)

–Tohoku Electric Power Transforming facilities ① –

Situation of the site

Tsunami damage

–Tohoku Electric Power Transforming facilities ② –

Damaged transformer bushing

-Tohoku Electric Power Distribution facilities -

Pole inclined due to damage to the road
(Fukushima City, Fukushima Prefecture)