Organization for Cross-regional Coordination of Transmission Operators, Japan

Annual Report

- Fiscal Year 2020 -

February 2021

電力広域的運営推進機関
Organization for Cross-regional Coordination of Transmission Operators,JAPAN

Introduction

The Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO), is responsible for promoting cross-regional coordination of electric power business, and in charge of broad range of business, including securing stable electricity supply, and fostering the utilization environment of the electric power network in a fair and effective manner. Among the business stated above, OCCTO aggregates and publishes the respective reports as an "Annual Report" according to the provisions of Article 181 of the Operational Rules of the Organization.

With regards to securing a stable electricity supply in both normal and abnormal conditions, the annual report contains "Outlook of Electricity Supply and Demand (Data for FY 2019)", "Report on the Quality of Electricity Supply (Data for FY 2019)", and "Outlook of Cross-regional Interconnection Lines (Data for FY 2019)".
With regards to fostering the utilization environment of the electric power network in a fair and effective manner, the Report covers "Actual Data of Preliminary Consultation, System Impact Study and Contract Applications in FY 2019".
With regards to the mid to long-term security of a stable electricity supply, the report includes "Projection and Challenges Regarding Electricity Supply-Demand and Network based on the Aggregation of the Electricity Supply Plan for the Period FY 2020 to 2029" and "Review of the Adequate Level of Balancing Capacity in Each Regional Service Area" (Evaluation of Proper Standard of Soliciting Balancing Capacity for FY 2021).

OCCTO considers that this report could assist the electricity business concerned or be used as a reference by those who have interests in the electric power business or a stable supply of electricity.

CONTENTS

I. Actual Electric Supply and Demand

Outlook of Electricity Supply and Demand

- Actual Data for FY 2019 -

September 2020

Organization for Cross-regional Coordination

of Transmission Operators, Japan

FOREWORD

The Organization for Cross-regional Coordination of Transmission Operators, Japan (hereinafter, the Organization), prepares and publishes its Annual Report according to Article 181 of the Operational Rules regarding the matters specified below.

i. Actual electric supply and demand (including evaluation and analysis of quality of electricity in light of frequency, voltage, and blackouts of each regional service area)

ii. State of electric network

iii. Actual Network Access Business until the previous year.

iv. Forecast on electric demand and electric network (including forecast of improvement of restriction on network interconnection of generation facilities) for the next fiscal year and a mid- and long-term period based on a result of compiling of electricity supply plans and their issues.

v. Evaluation and verification of proper standards of reserve margin and balancing capacities of each regional service area based on the next article, as well as contents of review as needed

The Organization published the actual data for electricity supply–demand and network system utilization ahead of the Annual Report because of the completion of actual data collection up to fiscal year 2019 (FY 2019).

SUMMARY

This report is presented to review the outlook of electricity supply–demand and cross-regional interconnection lines in FY 2019, based on Article 181 of the Operational Rules of the Organization.

The report consists of two parts: the situation of electricity supply and demand, and interconnection lines.

Regarding supply and demand, the peak demand nationwide, 164,610 MW, was recorded in August, and the monthly electric energy requirement nationwide, 83,165 GWh, was recorded in August.

The reserve margin against summer and winter peak demand was 12.9% and 15.0%, respectively.

Power exchange instructions were issued by the Organization 6 times: 5 of them were dispatched for improvements of supply and demand due to the heatwave following Typhoon No.15.
In addition, long-cycle frequency control was implemented 58 times during the year.

There were 122 requests to shed power generation of renewables in FY 2019, which occurred on isolated islands as well as on the Kyushu mainland.

We hope this report provides useful information.

CONTENTS

Note:
Data for Chapter I include figures at the sending end, i.e., the electricity supplied to the public network system from power plants with energy deducted for station services.

CHAPTER I:　ACTUAL ELECTRICITY SUPPLY AND DEMAND

1. Regional Service Areas for 10 General Transmission and Distribution Companies, and the Definition of a Season

(1) Regional Service Areas for 10 General Transmission and Distribution Companies

A regional service area describes the specific area to which a general transmission and distribution (GT&D) company transmits its electricity through cross-regional interconnection lines. Japan is divided into 10 regional service areas as shown in Figure 1-1. Regional service areas served by GT&D companies other than the Okinawa Electric Power Company (EPCO), are connected by cross-regional interconnection lines.

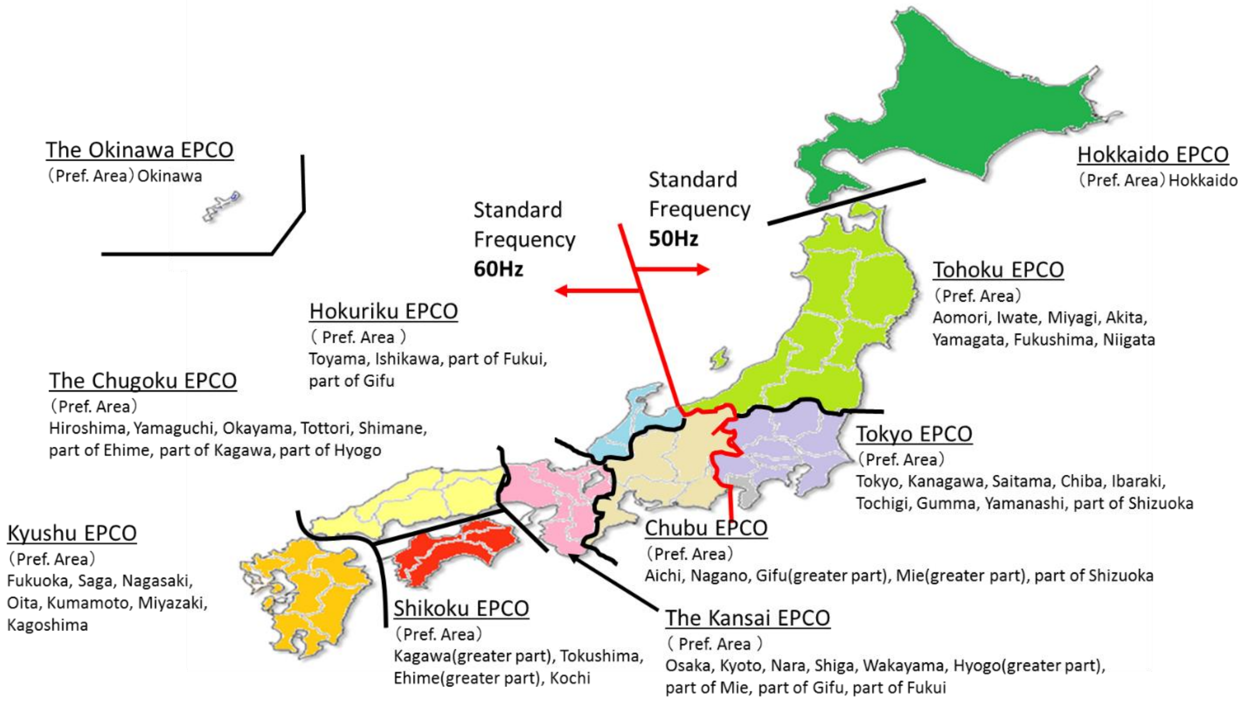


Figure 1-1: The 10 Regional Service Areas in Japan and their Prefectural Distribution

(2) Definition of Seasons

This report divides the seasons into summer and winter periods. The summer period is defined as July to September and the winter as December to February.

This report refers to the actual weather outlook for the previous year from the Seasonal Climate Report over Japan prepared by the Japan Meteorological Agency (JMA), which defines the summer and winter periods as June to August and December to February, respectively.

However, the definitions of the three-month summer period differ by one month between this report and JMA's report.

2. Outlook of Actual Weather Nationwide

(1) Weather during the Summer Period (June to August 2019)

Table 1-1 shows anomalies in the temperature and precipitation ratios from June to August in FY 2019.

(a) The end of the rainy season was delayed in several regions due to a delay in the northward movement of the Baiu front compared with a normal year. In the latter half of August, a low - pressure system and stationary front impacted the weather nationwide. Frequent heavy rainfalls mainly occurred in the western region. Rainfall during the period was significant on the Pacific Sea coast along the western region, while much rain was also recorded on the Pacific coast along the eastern region and on the Japan Sea coast along the western region. The sunshine duration during the period was less than in a normal year on the Pacific coast along the eastern and western regions.

(b) The mean temperature during the period was high in the northern, Okinawa/Amami, and eastern regions. The northern and Okinawa/Amami regions were covered by warm air for long periods, while the eastern region had prolonged sunshine and experienced a severe heatwave due to a Pacific high-pressure system from the end of July to the first half of August.

(c) Rainfall was significant in the Okinawa/Amami region and there was not much sunshine because of the wet air blowing from the Baiu front and typhoons.

Table 1-1: Anomalies in Temperature, Precipitation and Sunshine Duration by Weather Region from June to August

Weather Region	Mean Temperature Anomaly[°C]	Precipitation Ratio[%]	Sunshine Duration Ratio[%]
Northern	+0.8	104	99
Eastern	+0.5	119	94
Western	+0.0	128	89
Okinawa/Amami	+0.2	152	81

Source: Japan Meteorological Agency (JMA), Tokyo Climate Center.
Seasonal Climate Report over Japan for Summer (FY 2019).
http://ds.data.jma.go.jp/tcc/tcc/products/japan/climate/index.php?kikan=3mon&month=8&year=2019
http://www.data.jma.go.jp/gmd/cpd/cgi-bin/view/kikohyo/en.php?kikan=3mon&month=8&year=2019

(2) Weather during the Winter Period (December 2019 to February 2020)

Table 1-2 shows the anomalies in temperature and the ratios of rainfall and snowfall from December to February in FY 2019.

(a) Seasonal mean temperatures were very high throughout the nation except in the northern region. Warm days continued during the period due to a weaker cold air flow throughout the nation caused by a shorter winter-pressure pattern. In particular, the highest records were updated in the eastern and western regions.

(b) Snowfall during the period was quite scarce throughout the nation because of the reduced effect of cold air. In particular, the Japan Sea coast along the northern and eastern regions recorded the least snowfall that they had ever had.

(c) There was significantly little sunshine duration on the Pacific Sea coast along the eastern region, while there was plenty of precipitation on the Japan Sea coast along the western region during the period because of a greater effect from a low-pressure system and stationary front.

Table 1-2: Anomalies in Temperature, Precipitation, Sunshine Duration and Snowfall by Weather Region from December to February

Weather Region	Mean Temperature Anomaly[°C]	Precipitation Ratio[%]	Sunshine Duration Ratio[%]	Snowfall Ratio[%]
Northern	+1.2	95	104	44
Eastern	+2.2	116	95	13
Western	+2.0	139	96	6
Okinawa/Amami	+1.3	73	133	-

Source：Japan Meteorological Agency, Tokyo Climate Center.
Seasonal Climate Report over Japan for Winter (FY 2019).
http://ds.data.jma.go.jp/tcc/tcc/products/japan/climate/index.php?kikan=3mon&month=2&year=2020
http://www.data.jma.go.jp/gmd/cpd/cgi-bin/view/kikohyo/en.php?kikan=3mon&month=2&year=2020

3. Actual Nationwide Peak Demand

Peak demand describes the highest consumption of electricity during a given period, such as day, month, or year. Table 1-3 shows the monthly peak demand for regional service areas in FY 2019. Figures 1-2 and 1-3 show the nationwide monthly peak demand, and the annual peak demand by regional service areas, respectively. In this report, "peak demand" refers to the maximum hourly value of electric energy requirement.

The values in red are the maximum monthly peak demand (i.e., the annual peak demand) and the values in blue are the lowest monthly peak demand for each regional service area.[1]

Table 1-3: Monthly Peak Demand for Regional Service Areas[2]

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	409	365	356	433	446	417	378	468	485	488	516	461
Tohoku	1,169	1,107	1,070	1,348	1,448	1,266	1,073	1,202	1,243	1,264	1,380	1,166
Tokyo	4,313	4,229	4,186	5,340	5,543	5,390	4,219	4,291	4,482	5,042	4,852	4,162
Chubu	1,986	1,980	2,006	2,486	2,565	2,568	2,160	1,929	2,034	2,161	2,266	2,014
Hokuriku	450	397	404	492	521	489	401	409	451	450	512	455
Kansai	2,032	1,995	2,136	2,666	2,816	2,725	2,326	1,960	2,090	2,254	2,414	2,097
Chugoku	809	746	853	1,034	1,080	1,048	882	854	949	1,014	1,045	893
Shikoku	364	348	398	486	501	500	411	377	399	431	439	392
Kyushu	1,102	1,073	1,212	1,526	1,573	1,466	1,227	1,100	1,260	1,338	1,393	1,186
Okinawa	117	115	145	145	151	151	137	112	98	97	101	95
Nationwide	12,237	12,163	12,553	15,936	16,461	15,914	13,063	12,597	13,127	13,916	14,619	12,545

[1] Please note that the same figures showing a maximum or minimum value is due to rounding at the first decimal place. The same is applied to the following.

[2] "Nationwide peak demand" means the maximum of the aggregated demand in a given period for regional service areas of the 10 GT&D companies, not the addition of each regional peak demand.

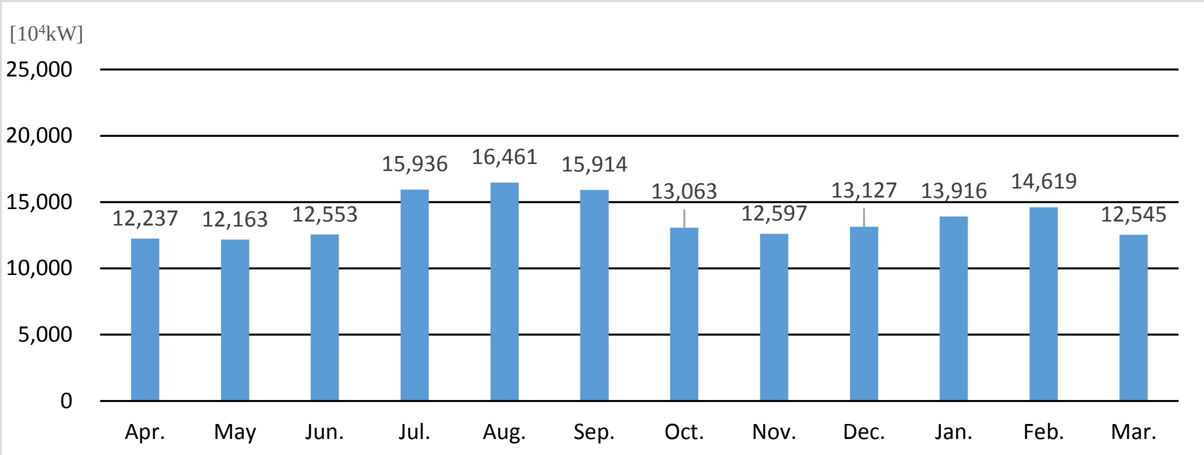


Figure 1-2: Nationwide Monthly Peak Demand

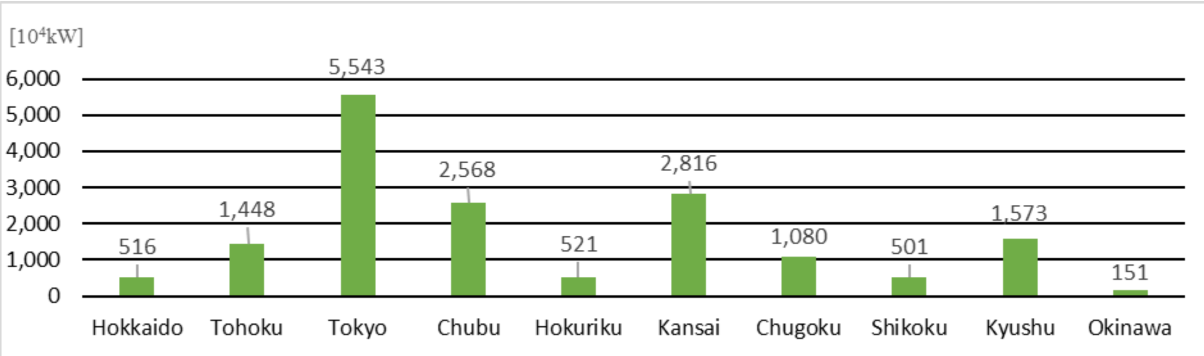


Figure 1-3: Annual Peak Demand for Regional Service Areas

4. Actual Nationwide Electric Energy Requirements

Table 1-4 shows the monthly electric energy requirements for regional service areas in FY 2019. Figures 1-4 and 1-5 show the nationwide monthly electric energy requirements, and annual electric energy requirements for regional service areas, respectively.
The values in red are the maximum monthly energy requirement and the values in blue are the lowest monthly energy requirement for each regional service area.

Table 1-4: Monthly Electric Energy Requirements for Regional Service Areas[3]

[GWh]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Hokkaido	2,365	2,199	2,123	2,339	2,385	2,215	2,310	2,588	3,071	3,138	2,945	2,728	30,407
Tohoku	6,432	6,036	5,972	6,652	7,156	6,179	6,106	6,540	7,543	7,760	7,402	7,072	80,849
Tokyo	21,382	20,903	21,655	24,608	27,921	24,048	21,896	21,961	25,567	26,228	23,946	23,559	283,673
Chubu	10,278	10,007	10,469	11,838	12,422	11,595	10,456	10,278	11,456	11,746	11,485	11,211	133,241
Hokuriku	2,318	2,133	2,169	2,474	2,596	2,314	2,193	2,287	2,595	2,653	2,619	2,541	28,891
Kansai	10,844	10,616	11,132	12,763	13,775	12,206	11,065	10,740	12,356	12,548	12,142	11,605	141,793
Chugoku	4,560	4,367	4,636	5,241	5,536	5,022	4,727	4,801	5,514	5,506	5,251	4,976	60,138
Shikoku	2,017	1,966	2,080	2,389	2,512	2,322	2,136	2,101	2,400	2,429	2,334	2,264	26,947
Kyushu	6,306	6,337	6,641	7,728	7,990	7,293	6,572	6,369	7,468	7,610	7,141	6,929	84,383
Okinawa	582	640	747	847	871	784	703	688	545	536	579	538	8,061
Nationwide	67,084	65,203	67,624	76,879	83,165	73,977	68,164	68,353	78,515	80,155	75,843	73,424	878,383

[3] Here and elsewhere, the annual total may not equal the sum of 12 months due to independent rounding.

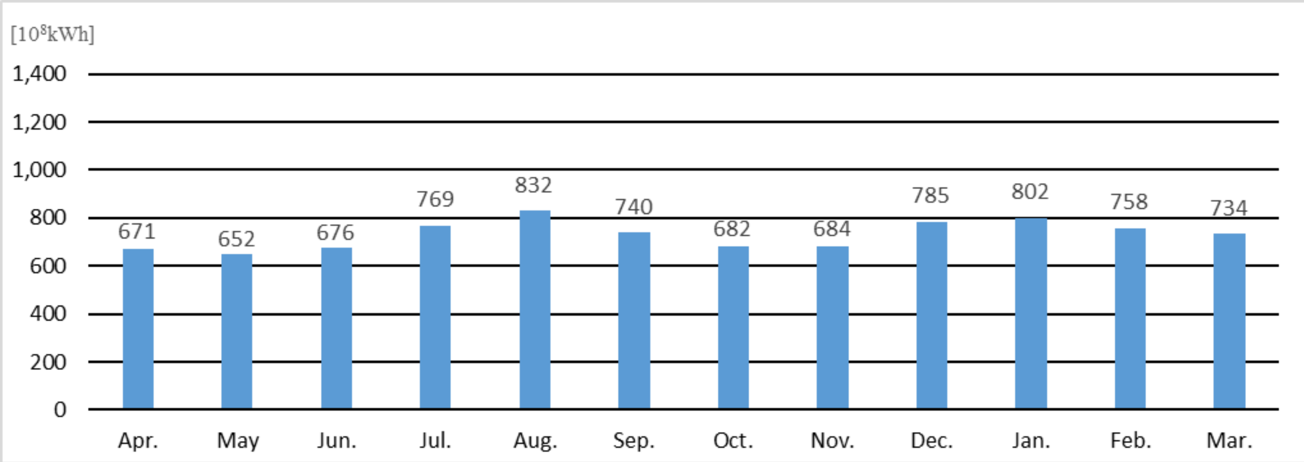


Figure 1-4: Nationwide Monthly Electric Energy Requirements

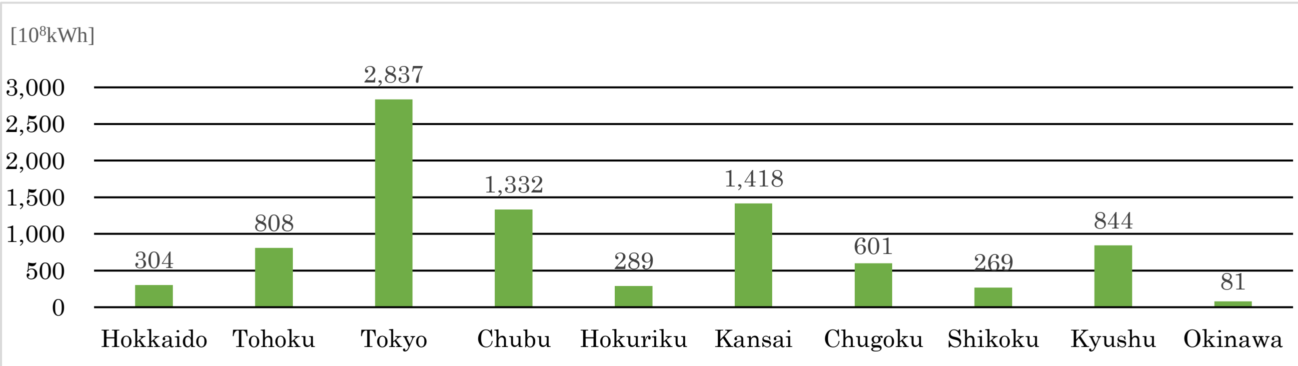


Figure 1-5: Annual Electric Energy Requirements for Regional Service Areas

5. Nationwide Load Factor

The load factor describes the ratio of average demand to peak demand in a given period. Table 1-5 shows the monthly load factor for regional service areas in FY 2019, and Figures 1-6 and 1-7 show the nationwide monthly load factor, and the annual load factor for regional service areas, respectively.

The values in red are the highest monthly load factor and the values in blue are the lowest monthly load factor for each regional service area.

Table 1-5: Monthly Load Factor for Regional Service Areas[4]

[%]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Hokkaido	80.3	81.1	82.8	72.6	71.8	73.8	82.2	76.8	85.0	86.4	82.0	79.6	67.1
Tohoku	76.4	73.3	77.5	66.3	66.4	67.8	76.5	75.6	81.6	82.5	77.0	81.5	63.6
Tokyo	68.9	66.4	71.9	61.9	67.7	62.0	69.8	71.1	76.7	69.9	70.9	76.1	58.3
Chubu	71.9	67.9	72.5	64.0	65.1	62.7	65.1	74.0	75.7	73.1	72.8	74.8	59.1
Hokuriku	71.5	72.2	74.5	67.6	67.0	65.7	73.4	77.6	77.3	79.2	73.6	75.1	63.1
Kansai	74.1	71.5	72.4	64.4	65.7	62.2	63.9	76.1	79.5	74.8	72.3	74.4	57.3
Chugoku	78.3	78.7	75.5	68.1	68.9	66.6	72.0	78.1	78.1	73.0	72.2	74.9	63.4
Shikoku	76.9	76.0	72.6	66.1	67.4	64.5	69.9	77.4	80.8	75.7	76.4	77.5	61.2
Kyushu	79.5	79.4	76.1	68.1	68.3	69.1	72.0	80.4	79.7	76.4	73.7	78.5	61.1
Okinawa	69.0	74.6	71.7	78.6	77.7	72.2	69.1	84.9	74.6	74.7	82.1	76.5	60.9
Nationwide	76.1	72.0	74.8	64.8	67.9	64.6	70.1	75.4	80.4	77.4	74.5	78.7	60.7

4 "Nationwide load factor" refers to the load factor calculated for Japan, and not the average of each regional load factor.

$$\text{Monthly Load Factor (\%)} = \frac{\text{Monthly Energy Requirement}}{\text{Monthly Peak Demand} \times \text{Calendar Hours (24H} \times \text{Monthly Days)}}$$

$$\text{Annual Load Factor (\%)} = \frac{\text{Annual Energy Requirement}}{\text{Annual Peak Demand} \times \text{Calendar Hours (24H} \times \text{Annual Days)}}$$

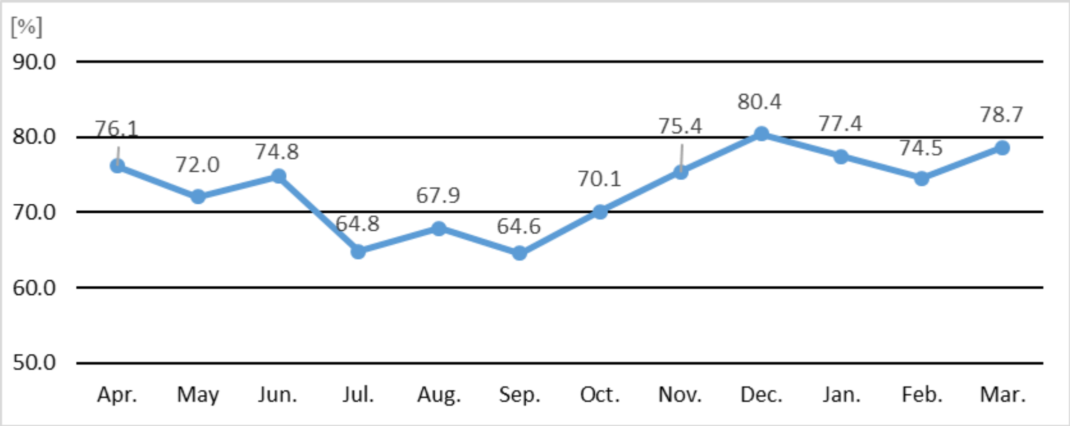


Figure 1-6: Nationwide Monthly Load Factor

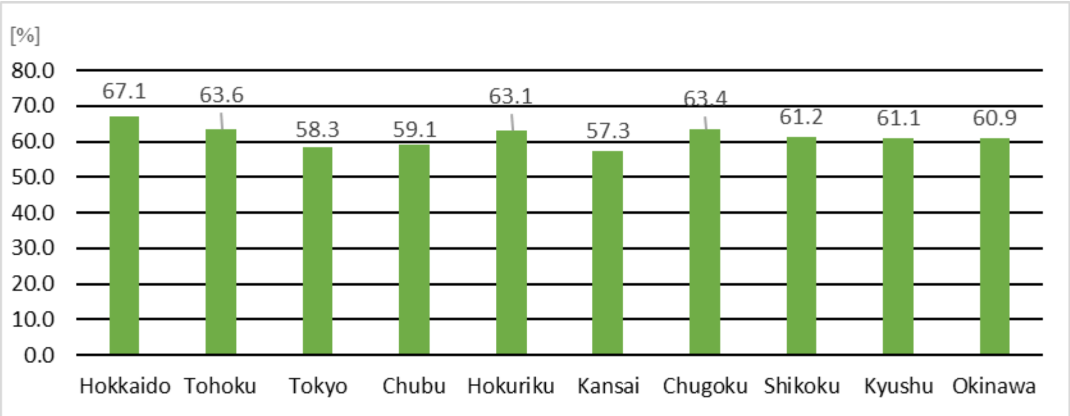


Figure 1-7: Annual Load Factor for Regional Service Areas

6. Nationwide Supply–Demand Status during Peak Demand

(1) Nationwide Supply–Demand Status during the Summer Peak Demand Period (July to September)

Table 1-6 shows the supply–demand status during the summer peak demand period for regional service areas in FY 2019.

Table 1-6: Supply–Demand Status during the Summer Peak Demand Period for Regional Service Areas[5]

	Peak Demand [10^4kW]	Occurrence Date & Time			Daily Maximum Temperature [°C]	Supply Capacity [10^4kW]	Reserve Capacity [10^4kW]	Reserve Margin [%]	Daily Energy Supply [10^4kWh]	Daily Load Facter [%]
Hokkaido	446	8/1	Thur.	12	33.0	534	87	19.6	8,999	84.1%
Tohoku	1,448	8/8	Thur.	14	32.5	1,749	301	20.8	26,891	77.4%
Tokyo	5,543	8/7	Wed.	15	35.6	6,126	582	10.5	103,938	78.1%
Chubu	2,568	9/10	Tue.	15	36.6	2,804	236	9.2	48,437	78.6%
Hokuriku	521	8/7	Wed.	15	35.3	586	65	12.4	10,116	80.9%
Kansai	2,816	8/2	Fri.	15	37.5	3,146	330	11.7	53,080	78.5%
Chugoku	1,080	8/5	Mon.	15	37.0	1,257	177	16.4	20,721	79.9%
Shikoku	501	8/2	Fri.	15	36.3	620	119	23.8	9,510	79.1%
Kyushu	1,573	8/2	Fri.	16	34.9	1,829	256	16.3	30,429	80.6%
Okinawa	151	9/12	Thur.	12	32.9	209	58	38.3	2,940	81.1%
Nationwide	16,461	8/2	Fri.	15	-	18,584	2,122	12.9	314,988	79.7%

[5] The daily maximum temperatures are provided by the Japan Meteorological Agency based on the data for the cities where the headquarters of GT&D companies (except for the Okinawa EPCO) are located. (For the regional service area of the Okinawa EPCO, the data from Naha, prefectural capital of Okinawa, were used instead).

$$\text{Daily Load Factor (\%)} = \frac{\text{Daily Energy Requirement}}{\text{Daily Peak Demand} \times 24\text{H}}$$

"Supply capacity" in the table above refers to the maximum power that can be generated during peak demand. This capacity is the addition of installed generating capacity including the deducted portion, such as generator suspension for maintenance work, derating with the decrease in river flow, and unplanned generator outages.

(2) Nationwide Supply–Demand Status during the Winter Peak Demand Period (December to February)

Table 1-7 shows the supply–demand status during the winter peak demand period for regional service areas in FY 2019.

Table 1-7: Supply–Demand Status during the Winter Peak Demand Period for Regional Service Areas[5]

	Peak Demand [10^4kW]	Occurrence Date & Time			Daily Mean Temperature [°C]	Supply Capacity [10^4kW]	Reserve Capacity [10^4kW]	Reserve Margin [%]	Daily Energy Supply [10^4kWh]	Daily Load Facter [%]
Hokkaido	516	2/6	Thur.	7	-7.2	575	59	11.4	11,628	93.9%
Tohoku	1,380	2/6	Thur.	10	-1.7	1,638	257	18.6	30,211	91.2%
Tokyo	5,042	1/28	Tue.	10	4.4	5,749	707	14.0	100,472	83.0%
Chubu	2,266	2/7	Fri.	10	2.8	2,515	248	10.9	45,652	83.9%
Hokuriku	512	2/6	Thur.	10	-1.6	565	54	10.5	11,087	90.2%
Kansai	2,414	2/7	Fri.	10	3.4	2,669	255	10.5	48,869	84.3%
Chugoku	1,045	2/7	Fri.	10	5.1	1,145	101	9.6	21,128	84.2%
Shikoku	439	2/7	Fri.	10	3.8	484	45	10.3	9,193	87.3%
Kyushu	1,393	2/18	Tue.	10	4.8	1,483	90	6.4	29,101	87.0%
Okinawa	101	2/18	Tue.	20	13.2	137	36	35.4	2,030	83.7%
Nationwide	14,619	2/7	Fri.	10	-	16,808	2,189	15.0	303,347	86.5%

7. Nationwide Bottom Demand Period

Table 1-8 shows the status of the bottom demand period for regional service areas (FY 2019).

Table 1-8: Bottom Demand Period for Regional Service Areas[6]

	Bottom Demand [10^4kW]	Occurrence Date & Time			Daily Mean Temperature [℃]	Daily Energy Supply [10^4kWh]
Hokkaido	228	5/5	Sun.	8	16.8	6,153
Tohoku	621	10/13	Sun.	2	18.4	16,833
Tokyo	1,984	5/4	Sat.	6	18.4	56,185
Chubu	882	5/5	Sun.	7	19.8	24,810
Hokuriku	198	5/4	Sat.	1	14.0	5,186
Kansai	1,017	5/5	Sun.	2	19.8	28,390
Chugoku	442	5/4	Sat.	9	20.2	11,586
Shikoku	183	5/5	Sun.	8	19.4	5,169
Kyushu	633	5/5	Sun.	2	20.7	17,460
Okinawa	57	4/1	Mon.	2	16.6	1,747
Nationwide	6,398	5/5	Sun.	2	-	174,027

[6] The daily mean temperatures are provided by the Japan Meteorological Agency based on the data for the cities where the headquarters of GT&D companies (except for the Okinawa EPCO) are located. (For the regional service area of the Okinawa EPCO, the data for Naha, prefectural capital of Okinawa, were used instead).

8. Nationwide Peak Daily Energy Supply

Tables 1-9 and 1-10 show the summer peak daily energy supply for regional service areas in FY 2019 (July to September) and the winter peak daily energy supply for regional service areas in FY 2019 (December to February), respectively.[7]

Table 1-9: Summer Peak Daily Energy Supply for Regional Service Areas

	Peak Daily Energy Supply [10^4kWh]	Occurrence Date		Daily Mean Temperature [˚C]
Hokkaido	11,628	2/6	Thur.	-7.2
Tohoku	30,211	2/6	Thur.	-1.7
Tokyo	100,472	1/28	Tue.	4.4
Chubu	46,194	2/6	Thur.	2.3
Hokuriku	11,087	2/6	Thur.	-1.6
Kansai	48,869	2/7	Fri.	3.4
Chugoku	21,380	2/6	Thur.	4.0
Shikoku	9,193	2/7	Fri.	3.8
Kyushu	29,101	2/18	Tue.	4.8
Okinawa	2,030	2/18	Tue.	13.2
Nationwide	304,091	2/6	Thur.	-

Table 1-10: Winter Peak Daily Energy Supply for Regional Service Areas

	Peak Daily Energy Supply [10^4kWh]	Occurrence Date		Daily Mean Temperature [˚C]
Hokkaido	8,999	8/1	Thur.	28.7
Tohoku	27,573	8/6	Tue.	28.7
Tokyo	104,831	8/2	Fri.	30.2
Chubu	48,437	9/10	Tue.	31.3
Hokuriku	10,130	8/8	Thur.	31.1
Kansai	53,080	8/2	Fri.	31.4
Chugoku	20,812	8/2	Fri.	31.2
Shikoku	9,510	8/2	Fri.	31.1
Kyushu	30,429	8/2	Fri.	30.5
Okinawa	3,049	8/28	Wed.	29.6
Nationwide	314,988	8/2	Fri.	-

[7] See footnote 6.

9. Actual Power Exchange Instructions by the Organization

Instructions

According to the provisions of paragraph 1 of Article 28-44 of the Electricity Business Act, the Organization may, when it finds it necessary to improve the electricity supply–demand status, require members such as electric power companies to undertake certain necessary actions, if the status of the electricity supply–demand from an electricity business conducted by a member has worsened or is likely to worsen.

During FY 2019, the Organization required electric power companies to exchange power as stated in Table 1-11 according to items 1 to 3, paragraph 1 of Article 111 of the Operational Rules.[8] [9]

In addition, according to items 4 and 5, paragraph 1 of Article 111, the Organization shall instruct the member to lend, deliver, borrow, or share electrical facilities to or from other members, and take the necessary steps to improve their supply–demand status, in addition to the directions; however, no actual instructions were issued.

Controls

The Organization implemented long-cycle cross-regional frequency control[10] to send surplus electric energy generated from renewable energy-generating facilities in the Kyushu EPCO area to the areas of the Chugoku and Shikoku EPCOs through cross-regional interconnection lines by utilizing their available transfer capability. The Organization received the request for control by Kyushu EPCO for measures against the shortage of ability to reduce power supply.[11] Such controls were implemented 56 times in total during FY 2019.

---

[8] http://www.occto.or.jp/oshirase/shiji/index.html (in Japanese only).

[9] Numbers in the left cells in Table 1-11 are the order of publishing instructions on the website.

[10] This means that frequency control by utilizing the balancing capacity of members that are GT&D companies of other regional service areas through interconnection lines when balancing capacity for redundancy becomes or might become insufficient in regional service areas.

[11] This means the ability to decrease power supply of generators such as thermal power generators. The output of renewable energy fluctuates over a short period; it is indispensable to control output of thermal power generators according to the fluctuation. Among such output controls, the range that can control the output of generators is generally called the "balancing capacity for redundancy."

Table 1-11: Actual Power Exchange Instructions by the Organization

[1]	Date	July 9, 2019 at 18:08
	Instruction	・The Kansai EPCO shall supply 500 MW of electricity to Kyushu EPCO from 18:30 till 19:30 on July 9. ・Kyushu EPCO shall be supplied 5000 MW of electricity by The Kansai EPCO from 18:30 till 19:30 on July 9.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of generator shutdown in the regional service area of Kyushu EPCO.
[2] & [3]	Date	September 9, 2019 at 15:07 and 15:39
	Instruction	At 15:07 ・The Kansai EPCO shall supply 200 MW of electricity to The Chugoku EPCO from 15:30 till 16:00 on September 9. ・The Chugoku EPCO shall be supplied 200 MW of electricity by The Kansai EPCO from 15:30 till 16:00 on September 9. At 15:39 ・Chubu EPCO shall supply 100 MW of electricity to The Chugoku EPCO from 16:00 till 17:00 on September 9. ・The Kansai EPCO shall supply 200 MW of electricity at most to The Chugoku EPCO from 17:00 till 20:00 on September 9. ・Shikoku EPCO shall supply 200 MW of electricity at most to The Chugoku EPCO from 16:00 till 20:30 on September 9. ・The Chugoku EPCO shall be supplied 300 MW of electricity at most by Chubu, The Kansai, and Shikoku EPCO from 16:00 till 20:30 on September 9.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of unexpected demand growth caused by higher temperature.
[4]	Date	September 10, 2019 at 14:27
	Instruction	・Hokkaido EPCO shall supply 100 MW of electricity to TEPCO PG from 16:00 till 17:00 on September 10. ・The Kansai EPCO shall supply 600 MW of electricity to TEPCO PG from 16:00 till 17:00 on September 10. ・TEPCO PG shall be supplied 700 MW of electricity by Hokkaido EPCO and the Kansai EPCO from 16:00 till 17:00 on September 10.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of unexpected demand growth caused by higher temperature.

Table 1-11(continued): Actual Power Exchange Instructions by the Organization

[5]	Date	September 10, 2019 at 16:18
	Instruction	・The Kansai EPCO shall supply 500 MW of electricity to Chubu EPCO from 16:30 till 18:30 on September 10. ・Chubu EPCO shall be supplied 500 MW of electricity by the Kansai EPCO from 16:30 till 18:30 on September 10.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of unexpected demand growth caused by higher temperature.
[6]	Date	September 10, 2019 at 17:02
	Instruction	・The Kansai EPCO shall supply 300 MW of electricity at most to Kyushu EPCO from 17:30 till 19:00 on September 10. ・The Chugoku EPCO shall supply 100 MW of electricity at most to Kyushu EPCO from 17:30 till 19:00 on September 10. ・Kyushu EPCO shall be supplied 400 MW of electricity at most by The Kansai EPCO and The Chugoku EPCO from 17:30 till 19:00 on September 10.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of unexpected demand growth caused by higher temperature.

10. Output Shedding of Renewable Energy-generating Facilities Operated by Electric Power Companies other than GT&D Companies

GT&D companies may order renewable energy-generating facilities from other electric power companies to shed their output in case of expected oversupply to demand for its regional service areas after shedding the output of generators other than renewable energy-generating facilities of the GT&D company according to the provisions of the Ministerial Ordinance of Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electric Utilities.
Tables 1-12 to 1-19 show the actual output shedding of renewable energy-generating facilities in FY 2019.[12] The bar in each table indicates that there was no output shedding for the day.
Output shedding of renewable energy-generating facilities was implemented in the case that balancing capacity for redundancy might become insufficient; the shedding period was from 09:00 to 16:00 in each implementation for isolated islands, and from 8:00 to 16:00 on the Kyushu mainland.
The Organization confirms and verifies whether the output shedding of renewable energy-generating facilities from other EPCOs that Kyushu EPCO has implemented according to the provisions of Article 180 of the Operational Rules. The result of the confirmation and verification is judged to be proper.

Table 1-12: Actual Output Shedding of Renewable Energy-generating Facilities (April 2019)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
4/1/(Mon)	630	-	-	115.1
4/2/(Tue)	-	-	-	128.9
4/3/(Wed)	2,340	-	-	138.1
4/4/(Thu)	3,970	-	-	168.9
4/6/(Sat)	3,490	1,780	-	248.2
4/7/(Sun)	3,860	-	-	253.3
4/8/(Mon)	3,150	-	-	195.5
4/9/(Tue)	2,340	-	-	128.6
4/12/(Fri)	-	410	-	152.3
4/13/(Sat)	-	-	-	68.7
4/15/(Mon)	-	1,530	-	155.2
4/16/(Tue)	-	-	-	73.3
4/18/(Thu)	-	240	-	132.5
4/19/(Fri)	-	-	-	154.7
4/20/(Sat)	-	1,450	-	240.5
4/21/(Sun)	-	1,370	-	250.3
4/22/(Mon)	-	660	-	164.0
4/26/(Fri)	1,340	-	-	30.3
4/27/(Sat)	4,580	1,440	-	210.0
4/28/(Sun)	610	-	-	97.1

[12] http://www.occto.or.jp/oshirase/shutsuryokuyokusei/index.html (in Japanese only).

Table 1-13: Actual Output Shedding of Renewable Energy-generating Facilities (May 2019)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
5/2/(Thu)	3,620	1,630	-	226.3
5/3/(Fri)	3,570	1,640	-	208.3
5/4/(Sat)	3,300	1,350	-	207.6
5/5/(Sun)	3,050	530	-	216.9
5/6/(Mon)		1,660	-	143.5
5/7/(Tue)	2,460	370	-	95.6
5/8/(Wed)	150	-	-	66.4
5/10/(Fri)	270	-	-	57.3
5/11/(Sat)	310	1,290	-	122.3
5/12/(Sun)	3,190	1,860	-	193.6
5/15/(Wed)	-	510	-	-
5/21/(Tue)	2,950	140	-	-
5/22/(Wed)	1,990	-	-	-
5/23/(Thu)	2,670	-	-	-
5/24/(Fri)	2,570	-	-	-
5/25/(Sat)	2,840	-	-	-
5/26/(Sun)	990	-	-	-
5/30/(Thu)	1,910	-	-	-

Table 1-14: Actual Output Shedding of Renewable Energy-generating Facilities (June 2019)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
6/5/(Wed)	2,010	-	-	-
6/9/(Sun)	-	630	-	-
6/10/(Mon)	900	-	-	-
6/11/(Tue)	1,310	-	-	-
6/12/(Wed)	590	-	-	-
6/15/(Sat)	190	-	-	-
6/16/(Sun)	590	-	-	-
6/20/(Thu)	990	-	-	-
6/23/(Sun)	-	150	-	-
6/24/(Mon)	1,120	-	-	-

Table 1-15: Actual Output Shedding of Renewable Energy-generating Facilities (October 2019)[13]

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
10/12/(Sat)	230	-	-	-
10/13/(Sun)	-	880	-	62.2
10/14/(Mon)	-	1,150	-	29.3
10/20/(Sun)	-	660	-	-
10/22/(Tue)	-	450	-	-
10/27/(Sun)	-	1,230	-	26.7
10/28/(Mon)	-	-	-	53.0
10/30/(Wed)	330	-	-	58.6
10/31/(Thu)	10	490	-	24.9

Table 1-16: Actual Output Shedding of Renewable Energy-generating Facilities (November 2019)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
11/1/(Fri)	-	610	-	8.1
11/2/(Sat)	-	430	-	115.3
11/4/(Mon)	-	380	-	101.8
11/5/(Tue)	-	-	-	12.8
11/6/(Wed)	1,390	-	-	55.0
11/9/(Sat)	1,170	450	-	110.5
11/10/(Sun)	850	-	-	109.9
11/12/(Tue)	1,130	-	-	86.1
11/14/(Thu)	410	-	-	-
11/15/(Fri)	430	-	-	90.1
11/16/(Sat)	2,040	-	-	71.6
11/17/(Sun)	1,830	-	-	123.0
11/21/(Thu)	-	-	-	28.2
11/23/(Sat)	-	890	-	80.1
11/29/(Fri)	160	-	-	-
11/30/(Sat)	-	-	-	107.3

[13] Generating facilities with online output control that were capable of flexible output control according to the condition at two hours ahead of real supply and demand were utilized effectively. The system was implemented by reviewing the operation method for output shedding of renewable energy-generating facilities in the aspect of reduction in output shedding after October 2019.

Table 1-17: Actual Output Shedding of Renewable Energy-generating Facilities (December 2019)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
12/4/(Wed)	220	-	-	-
12/15/(Sun)	-	-	-	157.7
12/23/(Mon)	280	-	-	-

Table 1-18: Actual Output Shedding of Renewable Energy-generating Facilities (January 2020)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
1/1/(Wed)	1,320	-	-	161.2
1/2/(Thu)	-	-	-	125.6
1/3/(Fri)	-	-	-	59.7
1/4/(Sat)	500	-	-	178.0
1/5/(Sun)	700	-	-	146.7
1/9/(Thu)	-	-	-	111.7
1/10/(Fri)	-	-	-	66.2
1/13/(Mon)	-	-	-	45.0
1/17/(Fri)	170	-	-	-

Table 1-19: Actual Output Shedding of Renewable Energy-generating Facilities (February 2020)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
2/1/(Sat)	170	-	-	51.2
2/2/(Sun)	230	-	-	204.8
2/5/(Wed)	1,420	-	-	106.6
2/6/(Thu)	1,550	-	-	-
2/8/(Sat)	970	-	-	46.1
2/9/(Sun)	840	-	-	-
2/11/(Tue)	-	-	-	186.7
2/13/(Thu)	-	-	-	104.3
2/14/(Fri)	-	-	-	41.9
2/19/(Wed)	-	-	-	129.5
2/20/(Thu)	-	-	-	146.3
2/21/(Fri)	-	-	-	183.5
2/22/(Sat)	-	-	-	175.1
2/23/(Sun)	2,880	-	600	262.7
2/24/(Mon)	3,830	-	-	224.0
2/26/(Wed)	360	-	-	87.9
2/27/(Thu)	2,300	-	-	53.3

Table 1-20: Actual Output Shedding of Renewable Energy-generating Facilities (March 2020)

Date	Location & Shed Output			
	Tanegashima (island: kW)	Iki (island: kW)	Tokunoshima (island: kW)	Kyushu (mainland: 10^4 kW)
3/2/(Mon)	3,370	-	-	197.2
3/5/(Thu)	2,230	-	-	227.8
3/6/(Fri)	-	-	-	243.1
3/8/(Sun)	3,380	-	-	363.9
3/9/(Mon)	-	-	-	140.4
3/11/(Wed)	3,350	-	-	244.9
3/12/(Thu)	-	-	-	254.8
3/14/(Sat)	2,570	-	-	277.6
3/15/(Sun)	-	680	-	355.7
3/16/(Mon)	3,910	-	-	-
3/17/(Tue)	590	-	-	96.0
3/18/(Wed)	990	220	-	88.6
3/19/(Thu)	410	590	-	115.6
3/20/(Fri)	4,740	1,010	1,150	154.5
3/21/(Sat)	4,590	1,640	710	164.7
3/23/(Mon)	2,650	200	-	76.4
3/24/(Tue)	4,820	500	-	78.6
3/25/(Wed)	620	1,110	-	96.5
3/29/(Sun)	-	-	-	257.3

CONCLUSION

Actual Electricity Supply–Demand

For actual electricity supply–demand, data on the peak demand, electric energy requirement, load factor, and supply–demand status during the peak demand period and the bottom demand period, and peak daily energy supply are collected. In addition, instructions concerning power exchange according to the provisions of paragraph 1 of Article 28-44 of the Electricity Business Act, and actual output shedding of renewable energy-generating facilities according to the provisions of the Ministerial Ordinance of the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electric Utilities are aggregated.

(Left Blank)

Organization for Cross-regional
Coordination of Transmission
Operators, Japan
http://www.occto.or.jp/en/index.html

Report on the Quality of Electricity Supply

- Data for Fiscal Year 2019 -

February 2021

電力広域的運営推進機関
Organization for Cross-regional Coordination of Transmission Operators,JAPAN
OCCTO

Introduction

Part of the role of the Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO) is to evaluate supply reliability conditions in securing a stable electricity supply. For this purpose, OCCTO continuously gathers and publishes actual data on the quality of electricity supply according to the provisions of Article 181 of OCCTO's Operational Rules.

This report aggregates actual data for frequency, voltage, and interruptions under the title "Quality of Electricity Supply" and presents their evaluation of the data, which are collected from each regional service area for the 2019 fiscal year (FY 2019). With these data, OCCTO evaluates and analyzes whether frequencies or voltages have been maintained within certain parameters, or whether the occurrence of supply interruption has become more frequent. In addition, regarding supply interruption, although the data conditions are not uniform, a comparison with some European Union (EU) countries and major states in the United States (US) was conducted as a reference. OCCTO's objective is to facilitate the use of the aggregated data, evaluations, and analyses as a reference for the electricity business.

The data presented in the report were submitted by general transmission and distribution companies and aggregated by OCCTO according to the provisions of Article 268 of OCCTO's Network Codes.

SUMMARY

The quality of nationwide electricity supply in FY 2019 was reviewed in this report based on Article 181 of OCCTO's Operational Rules.

Three aspects of the quality of electricity supply were evaluated in this report, namely, frequency, standard voltage, and interruption.

Although indices are available for evaluating each of these items, this report used the same indices as those published in previous years to allow for historical comparison.

Frequency

Frequency was analyzed using the frequency time-kept ratio, which is the ratio of time that the metered frequency is maintained within a given target control range. Four areas were grouped into synchronized frequency regions: Hokkaido, Eastern Japan, Central and Western Japan, and Okinawa. The transmission operators in the Eastern and Western areas of Japan use 50 Hz and 60 Hz, respectively.

For this report, the frequency time-kept ratios in these four synchronized regions were reviewed, and no deviation beyond the target control range was recognized.

Standard Voltage

The standard voltage was evaluated using the number of points where the standard voltage did not satisfy the target values, as defined by the enforcement regulations of the Electricity Business Act (hereafter, the Act), which sets the targets for transmission operators to maintain a standard voltage supply within a certain range of values.

Transmission operators handed in their data at OCCTO's request. Nationwide, no violation of standard voltage was observed among 6,596 points for 100 V and 6,529 points for 200 V.

Interruption

Finally, interruptions were monitored from three perspectives; i.e., the number of supply disturbances by the place of occurrence, the number of supply disturbances by cause, i.e., beyond the given standards in time duration and lost capacity, and System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) values for low-voltage (LV) customers.

The first analysis indicated that the total number of supply disturbances was 14,872, which was lower compared with the data for FY 2018.

The second analysis divided the causes into two factors, i.e., maintenance problems or natural disasters, the latter being irrelevant to maintenance problems.

These analyses indicate that the total number of reported supply disturbances was 18, also lower than in the previous year. The number of supply disturbances caused by natural disasters was 11, which was similar to the average of the last 5 years.
The final analysis was the historical monitoring of SAIFI and SAIDI values, which were both at slightly higher levels compared with the data from the past 5 years. In particular, a markedly significant increase was observed in SAIDI values in the Tokyo Power Grid (PG) area, which was attributable to damage caused by typhoons.

For reference, the report also compares SAIFI and SAIDI values with those of some EU countries and US states, although comparison is not straightforward given that index definitions are not identical across EU countries and US states.

We hope that this report will help to understand the quality of electricity supply in Japan.

CONTENTS

<Errata>

2021/11/17	P38, P40	Table 8 & Figure 9 (Nationwide), Table 14 & Figure 15 (Kansai) Number of Supply Disturbances Where Interruptions Were Originated	Data for FY 2018 are partly altered.
	P47 P49	Table 34(Hokkaido), Table 42(Kyushu) Indices of System Average Interruption	Descripiton of data are partly corrected.
2024/2/2	P36	Table 7	Data from FY 2017 to 2019 are altered.

I. Frequency Data

1. Standard Frequency in Japan

General transmission and distribution companies must endeavor to maintain the frequency value of the electricity supply at the levels specified by the Ordinance of the Ministry of Economy, Trade and Industry, in principle according to Article 26 of the Act. Figure 1 shows the regional service areas of the 10 general transmission and distribution companies and their standard frequency.

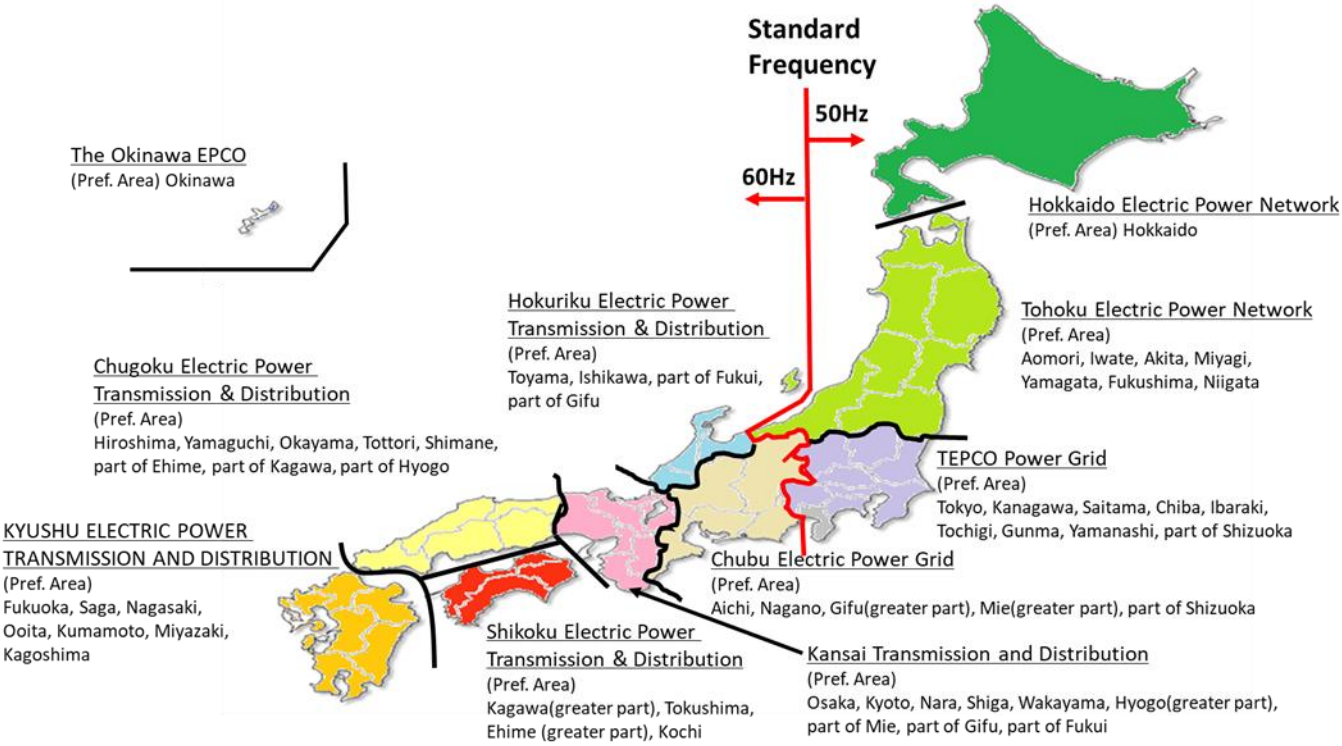


Figure 1　Regional service areas of the 10 general transmission and distribution companies and their standard frequency

2. Frequency Time-kept Ratio

The time-kept ratio is the criterion of maintained frequency. The time-kept ratio means the ratio of time that the metered frequency is maintained within a given variance of the standard, and is calculated by the following formula:

$$\text{Frequency Time kept ratio}(\%) = \frac{\Sigma\ \text{time that the metered frequency is maintained within a given variance of the standard}}{\text{total time in a given period}} \times 100$$

3. Frequency Control Rule [1]

According to the indices of the time-kept ratio formula, Table 1 shows the frequency control rule under normal conditions for the regional service areas.

Table 1　Frequency Control Rule under Normal Condition for the Regional Service Areas

Areas	Hokkaido	Tohoku, Tokyo	Chubu, Hokuriku, Kansai, Chugoku, Shikoku, Kyushu	Okinawa
Frequency Standard	50Hz	50Hz	60Hz	60Hz
Control Target(for Standard)	±0.3Hz	±0.2Hz	±0.2Hz	±0.3Hz
Target Time Kept Ratio within ±0.1Hz	—	—	95% over	—

[1] According to item 2 of Article 38 of the Ministerial Ordinance of the Act, frequency value defined by Ministerial Order is deemed to the same frequency that general transmission and distribution companies supplies; general transmission and distribution company sets respectively its frequency control target by its code, standard or manual.

4. Frequency Time-kept Ratio by Frequency-synchronized Region (FY 2015–2019)

Tables 2–5 show the frequency time-kept ratio by frequency-synchronized region from FY 2015 to 2019 and Figures 2–5 show the trend of maintaining the frequency within 0.1 Hz variance.

The frequency time-kept ratio set by general transmission and distribution companies was recorded as 100% in all regions for FY 2019. In the Central and Western Japan region, the target frequency time-kept ratio within 0.1 Hz variance for FY 2019 was 99.02%, which was slightly lower than for the previous year, but above the target time-kept ratio of 95.00%.

【Criteria】

(pink)	Control Target ···	100.00%
(light blue)	Target Time Kept Ratio within ±0.1Hz ···	95.00% Over

Table 2 Frequency Time Kept Ratio (Hokkaido, FY 2015–2019) [%]

Variance	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Within 0.1 Hz	99.83	99.96	99.97	99.86	99.98
Within 0.2 Hz	100.00	100.00	100.00	99.95	100.00
Within 0.3 Hz	100.00	100.00	100.00	99.98	100.00
Beyond 0.3 Hz	0.00	0.00	0.00	0.02	0.00

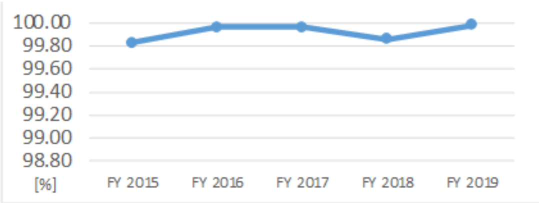


Figure 2 Frequency Time Kept Ratio within 0.1 Hz (Hokkaido, FY 2015-2019)

Table 3 Frequency Time Kept Ratio (Eastern region,[2] FY 2015–2019) [%]

Variance	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Within 0.1 Hz	99.85	99.78	99.80	99.84	99.83
Within 0.2 Hz	100.00	100.00	100.00	100.00	100.00
Within 0.3 Hz	100.00	100.00	100.00	100.00	100.00
Beyond 0.3 Hz	0.00	0.00	0.00	0.00	0.00

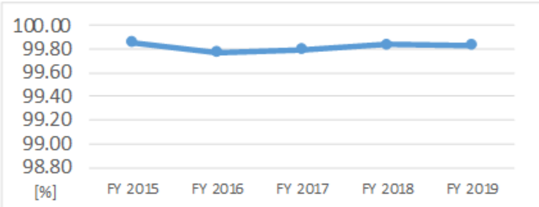


Figure 3 Frequency Time Kept Ratio within 0.1 Hz (Eastern region,[2] FY 2015-2019)

Table 4 Frequency Time Kept Ratio (Central & Western region,[3] FY 2015–2019) [%]

Variance	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Within 0.1 Hz	99.22	99.08	99.17	99.13	99.02
Within 0.2 Hz	100.00	100.00	100.00	100.00	100.00
Within 0.3 Hz	100.00	100.00	100.00	100.00	100.00
Beyond 0.3 Hz	0.00	0.00	0.00	0.00	0.00

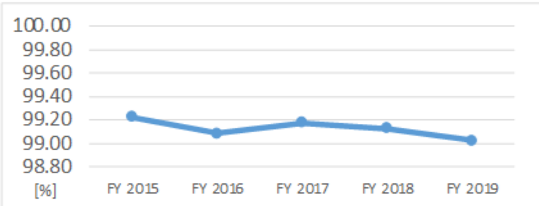


Figure 4 Frequency Time Kept Ratio (Central & Western region,[3] FY 2015–2019)

Table 5 Frequency Time Kept Ratio (Okinawa, FY 2015–2019) [%]

Variance	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Within 0.1 Hz	99.89	99.94	99.92	99.89	99.89
Within 0.2 Hz	100.00	100.00	100.00	100.00	100.00
Within 0.3 Hz	100.00	100.00	100.00	100.00	100.00
Beyond 0.3 Hz	0.00	0.00	0.00	0.00	0.00

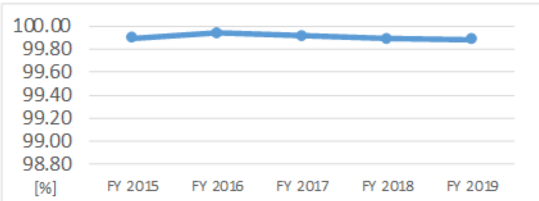


Figure 5 Frequency Time Kept Ratio (Okinawa, FY 2015–2019)

[2] Eastern region includes the regional service areas of the Tohoku Electric Power Network and TEPCO Power Grid. Actual data were collected from the area of TEPCO Power Grid.

[3] Central and Western regions of Japan include the regional service areas of Chubu Electric Power Grid, Hokuriku Electric Transmission & Distribution, Kansai Transmission & Distribution, Chugoku Electric Power Transmission & Distribution, Shikoku Electric Power Transmission & Distribution, and Kyushu Electric Power Transmission & Distribution. Actual data were collected from the area of Kansai Transmission & Distribution.

II. Voltage Data

1. Japanese Voltage Standard

General transmission and distribution companies should endeavor to maintain the voltage value of the electricity supply at the levels specified by Article 26 of the Act. Table 6 shows the voltage standard and nationwide target voltage control.

Table 6 Voltage Standard and Target Voltage Control

Voltage Standard	Target Voltage Control
100 V	within ±6 V of 101 V
200 V	within ±20 V of 202 V

2. Voltage Measurements

According to Article 39 of the Ordinance of the Act, general transmission and distribution companies should measure voltage during the period designated by the Director General of the Regional Bureau of Economy, Trade, and Industry, who administers regional service areas or supply points (for Hokuriku EPCO, this is the Director General of Chubu Bureau of Economy, Trade, and Industry, Electricity and Gas Department Hokuriku) once over 24 consecutive hours at selected measuring points, unless otherwise stated. General transmission and distribution companies calculate the average of 30 minutes, including the maximum and the minimum values, and review whether these values deviated from the average or not.

3. Nationwide Voltage Deviation Ratio (FY 2015–2019)

Table 7 shows the total measured points, deviated measured points, and nationwide deviation ratio from FY 2015 to 2019.

For the FY 2019 data, the general transmission and distribution companies reported that the voltage standard was maintained adequately and no deviation was observed with respect to the voltage standard.

Table7 Voltage Deviation Measurement (Nationwide, FY 2015-2019) [points]

Voltage		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
100V	Total Measured Points	6,554	6,590	6,593	6,603	6,596
	Deviated Points	0	0	0	0	0
200V	Total Measured Points	6,508	6,532	6,534	6,533	6,529
	Deviated Points	0	0	0	0	0

III. Interruption Data

1. Data of Number of Supply Disturbances Where Interruption Originated

(1) Indices and Definition of Supply Disturbances

The criteria for supply interruption include the number of supply disturbances where interruption originated, indicating where and how many supply disturbances occurred, according to the electric facilities in the system.

A supply disturbance means the interruption of the electricity supply or emergency restriction of electricity use due to malfunction or misuse of electric facilities.[4] The case in which electricity supply is resumed by automatic reclosing[5] of the transmission line is not applicable to supply disturbance.[6]

---

[4] Electric facilities include machinery, apparatus, dams, conduits, reservoirs, electric lines, and other facilities installed for the generation, transformation, transmission, distribution, or consumption of electricity as defined by the Article 38 of the Act.

[5] The automatic reclosing of a transmission line means the reconnection of a transmission line by re-switching of the circuit breaker after a given period, when an accident such as a lightning strike occurs to the transmission or distribution line and isolated fault section by opening of the circuit breaker due to the action of a protective relay.

[6] According to the provision of Item viii, Paragraph 2 of Article 1 of Reporting Rules of the Electricity Business, supply disturbance means the interruption of electricity supply or emergency restriction of electricity use for electricity consumers (excluding a person who manages the corresponding electric facility; hereafter, the same shall apply in this article) due to malfunction, misuse, or disoperation of the electric facility. However, the case in which electricity supply is resumed by automatic reclosing of the transmission line is not applicable to supply disturbance.

(2) Data for the Number of Supply Disturbances Nationwide and by Regional Service Area (FY 2015–2019)

Table 8 and Figure 6 show the number of supply disturbances nationwide, where the interruptions originated in the period FY 2015–2019. Tables 9–18 and Figures 7–16 show the data from regional service areas. Furthermore, the category "Involving Accidents" in the tables indicates the number of supply disturbances that were induced from accidents of electric facilities other than from the corresponding general transmission and distribution companies. The table columns are blank for zero values or if the data are not available. An analysis of the FY 2019 data indicates the following points.

- The total number of supply disturbances was 14,872, in contrast to FY 2018, which had significant supply disturbances caused by natural disasters over the previous 5-year period. In particular, the regional service area of the TEPCO PG had a considerable number of supply disturbances, which contributed to the increase in nationwide supply disturbances.
- A breakdown of Tables 9–18 shows that most of the supply disturbances occurred in the high-voltage (HV) overhead lines in the regional service area of TEPCO PG. The significant increase in supply disturbances on HV overhead lines was attributable to natural disasters.[7] Specifically, Typhoon No. 15 (Faxai), in September 2019, which hit the Kanto Plain, was the most powerful typhoon ever recorded. Its fierce winds caused severe damage over a wide area, mainly in Chiba Prefecture. In addition, in October 2019, powerful Typhoon No. 19 (Hagibis) struck the Izu Peninsula bringing record-breaking rainfall to the regional service areas of Tokyo, Chubu, and Tohoku. The supply disturbances of the HV overhead lines are attributable to these natural disasters.

Table 8 Number of Supply Disturbances Where Interruption Originated (Nationwide, FY 2015–2019)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		45	70	45	65	56	56.2
Transmission Lines & Extra High Voltage Lines	Overhead	204	230	278	409	246	273.4
	Under-ground	13	9	14	10	13	11.8
	Total	217	239	292	419	259	285.2
High Voltage Lines	Overhead	10,370	10,235	12,679	20,729	13,958	13,594.2
	Under-ground	198	215	216	265	227	224.2
	Total	10,568	10,450	12,895	20,994	14,185	13,818.4
Demand Facilities				1			0.2
Involvng Accidents		333	269	343	359	372	335.2
Total Disturbances		11,163	11,028	13,576	21,837	14,872	14,495.2

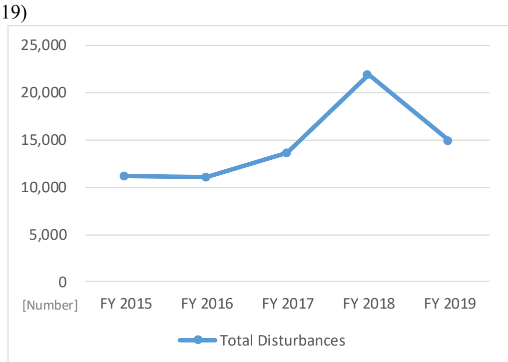


Figure 6 Transition of Supply Disturbances (Nationwide, FY 2015–2019)

[7] Natural disasters occurred in FY 2019 and their response
Industrial and Product Safety Policy Group, Dec. 5, 2019 (in Japanese only)
https://www.meti.go.jp/shingikai/sankoshin/hoan_shohi/denryoku_anzen/pdf/021_01_00.pdf

Table 9 Number of Supply Disturbances Where Interruption Originated (Hokkaido, FY 2015–2019)

Occurrence in			FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities								
	Substations		1	1		5	2	1.8
	Transmission Lines & Extra High Voltage Lines	Overhead	20	24	30	25	12	22.2
		Under-ground					1	0.2
		Total	20	24	30	25	13	22.4
	High Voltage Lines	Overhead	1,145	1,289	1,144	1,139	600	1,063.4
		Under-ground	10	13	19	13	15	14.0
		Total	1,155	1,302	1,163	1,152	615	1,077.4
	Demand Facilities							
Involvng Accidents			24	28	17	12	11	18.4
Total Disturbances			1,200	1,355	1,210	1,194	641	1,120.0

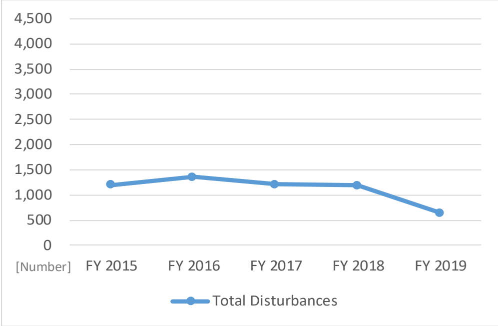


Figure 7 Transition of Supply Disturbances (Hokkaido, FY 2015–2019)

Table 10 Number of Supply Disturbances Where Interruption Originated (Tohoku, FY 2015–2019)

Occurrence in			FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities								
	Substations		5	8	4	9	8	6.8
	Transmission Lines & Extra High Voltage Lines	Overhead	7	11	16	11	16	12.2
		Under-ground			1			0.2
		Total	7	11	17	11	16	12.4
	High Voltage Lines	Overhead	1,327	1,403	1,957	1,478	1,646	1,562.2
		Under-ground	5	12	5	11	7	8.0
		Total	1,332	1,415	1,962	1,489	1,653	1,570.2
	Demand Facilities							
Involvng Accidents			22	22	26	20	29	23.8
Total Disturbances			1,366	1,456	2,009	1,529	1,706	1,613.2

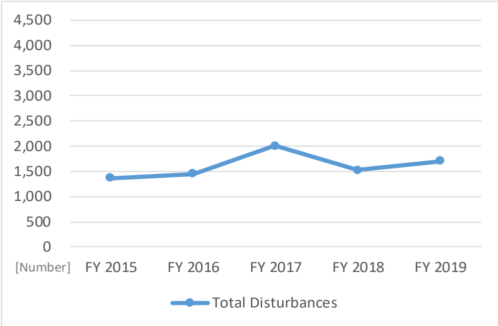


Figure 8 Transition of Supply Disturbances (Tohoku, FY 2015–2019)

Table 11 Number of Supply Disturbances Where Interruption Originated (Tokyo, FY 2015–2019)

Occurrence in			FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities								
	Substations		10	14	17	16	17	14.8
	Transmission Lines & Extra High Voltage Lines	Overhead	30	16	24	38	21	25.8
		Under-ground	5	2	4		4	3.0
		Total	35	18	28	38	25	28.8
	High Voltage Lines	Overhead	1,755	2,204	2,311	3,841	5,186	3,059.4
		Under-ground	74	75	65	100	97	82.2
		Total	1,829	2,279	2,376	3,941	5,283	3,141.6
	Demand Facilities							
Involvng Accidents			125	93	96	107	134	111.0
Total Disturbances			1,999	2,404	2,517	4,102	5,459	3,296.2

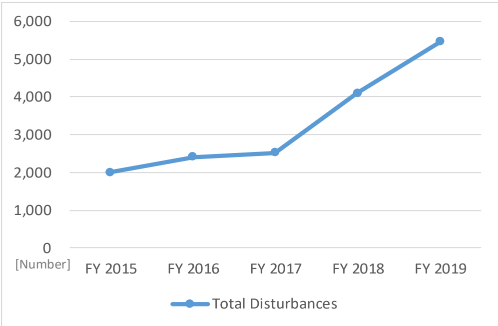


Figure 9 Transition of Supply Disturbances (Tokyo, FY 2015–2019)

Table 12 Number of Supply Disturbances Where Interruption Originated (Chubu, FY 2015–2019)

Occurrence in			FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities								
	Substations		5	6	3	6	10	6.0
	Transmission Lines & Extra High Voltage Lines	Overhead	8	16	9	26	19	15.6
		Under-ground						
		Total	8	16	9	26	19	15.6
	High Voltage Lines	Overhead	1,066	1,069	1,607	4,053	1,570	1,873.0
		Under-ground	7	5	11	39	6	13.6
		Total	1,073	1,074	1,618	4,092	1,576	1,886.6
	Demand Facilities							
Involvng Accidents			38	40	49	66	60	50.6
Total Disturbances			1,124	1,136	1,679	4,190	1,665	1,958.8

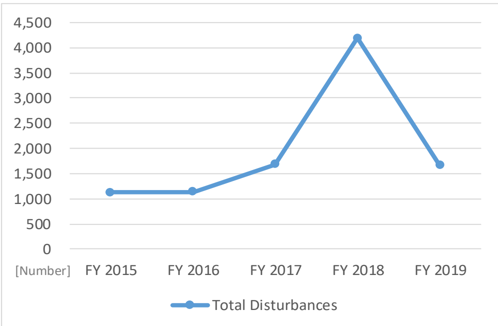


Figure 10 Transition of Supply Disturbances (Chubu, FY 2015–2019)

Table 13 Number of Supply Disturbances Where Interruption Originated (Hokuriku, FY 2015–2019)

Occurrence in			FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities								
	Substations			3	1		2	1.2
	Transmission Lines & Extra High Voltage Lines	Overhead	5	7	4	7	2	5.0
		Under-ground	1			2	2	1.0
		Total	6	7	4	9	4	6.0
	High Voltage Lines	Overhead	258	303	542	385	199	337.4
		Under-ground	7	10	5	3	1	5.2
		Total	265	313	547	388	200	342.6
	Demand Facilities							
Involvng Accidents			10	17	15	21	10	14.6
Total Disturbances			281	340	567	418	216	364.4

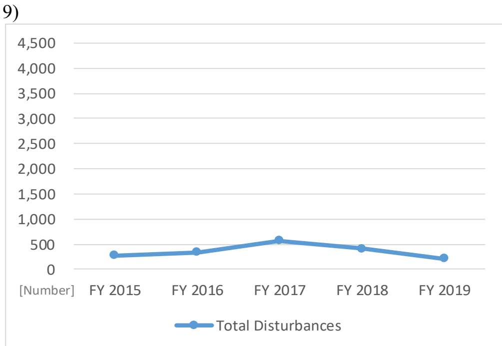


Figure 11 Transition of Supply Disturbances (Hokuriku, FY 2015–2019)

Table 14 Number of Supply Disturbances Where Interruption Originated (Kansai, FY 2015–2019)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		7	13	9	8	3	8.0
Transmission Lines & Extra High Voltage Lines	Overhead	42	80	102	190	82	99.2
	Under-ground	6	3	7	6	3	5.0
	Total	48	83	109	196	85	104.2
High Voltage Lines	Overhead	943	1,171	1,695	5,270	1,300	2,075.8
	Under-ground	51	63	48	56	50	53.6
	Total	994	1,234	1,743	5,326	1,350	2,129.4
Demand Facilities							
Involvng Accidents		43		65	70	64	48.4
Total Disturbances		1,092	1,330	1,926	5,600	1,502	2,290.0

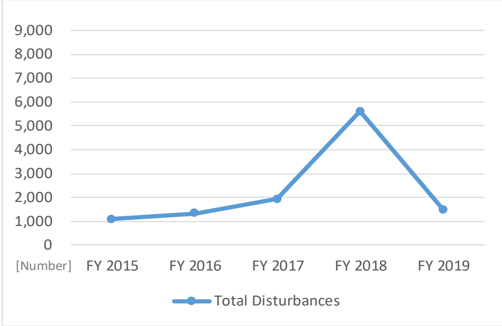


Figure 12 Transition of Supply Disturbances (Kansai, FY 2015–2019)

Table 15 Number of Supply Disturbances Where Interruption Originated (Chugoku, FY 2015–2019)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		10	7	2	8	6	6.6
Transmission Lines & Extra High Voltage Lines	Overhead	14	16	16	14	17	15.4
	Under-ground			1	1	1	0.6
	Total	14	16	17	15	18	16.0
High Voltage Lines	Overhead	1,211	960	1,066	1,172	1,015	1,084.8
	Under-ground	23	13	24	20	16	19.2
	Total	1,234	973	1,090	1,192	1,031	1,104.0
Demand Facilities				1			0.2
Involvng Accidents		37	25	33	31	35	32.2
Total Disturbances		1,295	1,021	1,143	1,246	1,090	1,159.0

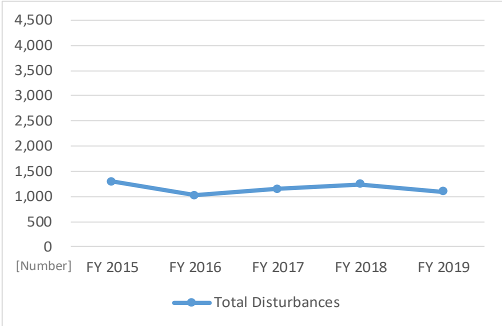


Figure 13 Transition of Supply Disturbances (Chugoku, FY 2015–2019)

Table 16 Number of Supply Disturbances Where Interruption Originated (Shikoku, FY 2015–2019)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		3		6	4	2	3.0
Transmission Lines & Extra High Voltage Lines	Overhead	3	5	3	4	4	3.8
	Under-ground						
	Total	3	5	3	4	4	3.8
High Voltage Lines	Overhead	425	357	630	616	439	493.4
	Under-ground	5	4	9	8	6	6.4
	Total	430	361	639	624	445	499.8
Demand Facilities							
Involvng Accidents		8	6	5	5	7	6.2
Total Disturbances		444	372	653	637	458	512.8

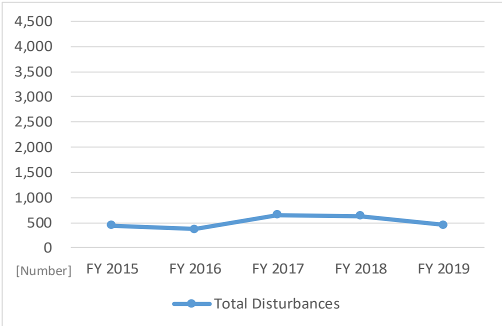


Figure 14 Transition of Supply Disturbances (Shikoku, FY 2015–2019)

Table 17 Number of Supply Disturbances Where Interruption Originated (Kyushu, FY 2015–2019)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		3	15	3	1	4	5.2
Transmission Lines & Extra High Voltage Lines	Overhead	24	21	32	42	38	31.4
	Under-ground	1	4		1		1.2
	Total	25	25	32	43	38	32.6
High Voltage Lines	Overhead	1,751	1,237	1,349	1,888	1,547	1,554.4
	Under-ground	15	18	30	15	22	20.0
	Total	1,766	1,255	1,379	1,903	1,569	1,574.4
Demand Facilities							
Involvng Accidents		18	20	23	16	19	19.2
Total Disturbances		1,812	1,315	1,437	1,963	1,630	1,631.4

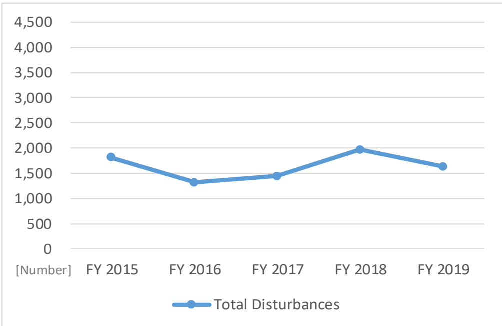


Figure 15 Transition of Supply Disturbances (Kyushu, FY 2015–2019)

Table 18 Number of Supply Disturbances Where Interruption Originated (Okinawa, FY 2015–2019)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		1	3		8	2	2.8
Transmission Lines & Extra High Voltage Lines	Overhead	51	34	42	52	35	42.8
	Under-ground			1		2	0.6
	Total	51	34	43	52	37	43.4
High Voltage Lines	Overhead	489	242	378	887	456	490.4
	Under-ground	1	2			7	2.0
	Total	490	244	378	887	463	492.4
Demand Facilities							
Involvng Accidents		8	18	14	11	3	10.8
Total Disturbances		550	299	435	958	505	549.4

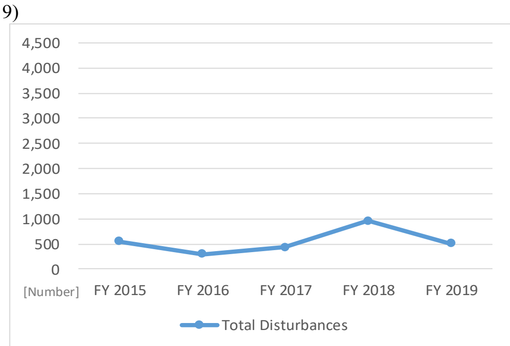


Figure 16 Transition of Supply Disturbances (Okinawa, FY 2015–2019)

2. Number of Supply Disturbances Where Interruptions Originated with Their Causes

(1) Data for Supply Disturbances over a Certain Scale

For the data of supply disturbances where the interruption originated as described in the previous section, disturbances over a certain scale were reported with their causes. This section analyzes their causes.

The term "supply disturbances over a certain scale" refers to the following. Figure 17 illustrates the number of supply disturbances indicating where interruptions originated versus the scale of interruption. Table 19 shows the nationwide data for FY 2019;[8] in the table, columns are left blank if values are zero or data are unavailable. It should be noted that supply disturbances caused by blackout are not included in the statistics.

- Capacity lost by disturbance was 7,000–70,000 kW with a duration longer than 1 hour
- Capacity lost by disturbance was over 70,000 kW with a duration longer than 10 minutes

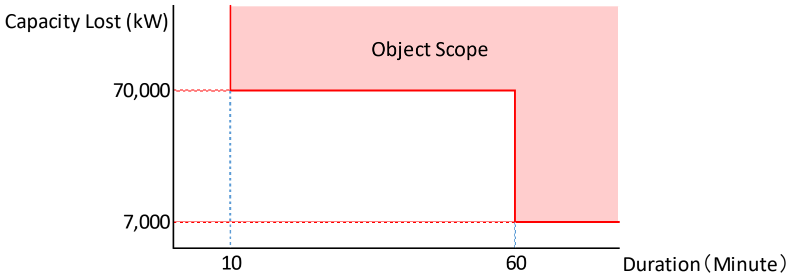


Figure 20 Image of Supply Disturbances over a Certain Scale

Table 19 Number of Supply Disturbances Where Interruption Originated by Scale of Interruption (Nationwide, FY 2019) [Number]

Scale of Disturbance [Duration & Capacity lost] / Occurrence at		10 min. till 30 min.: 70,000kW to 100,000kW under	10 min. till 30 min.: 100,000kW over[8]	30 min. till 1 hour: 70,000kW to 100,000kW under	30 min. till 1 hour: 100,000kW over[8]	1hour till 3 hours: 7,000kW to 70,000kW under	1hour till 3 hours: 70,000kW to 100,000kW under	1hour till 3 hours: 100,000kW over[8]	Longer than 3 hours: 7,000kW to 70,000kW under	Longer than 3 hours: 70,000kW to 100,000kW under	Longer than 3 hours: 100,000kW over[8]	Total Disturbance
Accidents of Facilities of General Transmission /Distribution Companies												
Substations			2			2		1	1			6
Transmission Lines & Extra High Voltage Lines	Overhead	1	2			3			5		1	12
	Under-ground											
	Total	1	2			3			5		1	12
High Voltage Distribution Lines	Overhead											
	Under-ground											
	Total											
Demand Facilities												
Involved Accidents												
Total Disturbance		1	4			5		1	6		1	18

[8] Supply disturbance over a certain scale of 10 minutes and longer was reported for different destinations according to lost capacity under the provisions of Article 3 of the Reporting Rules of the Electricity Business. In the case the lost capacity is 70,000–100,000 kW, the loss is reported to the Director of Regional Industrial Safety and the Inspection Department that directs the area the disturbed electric facility is sited. In the case the lost capacity is over 100,000 kW, the loss is reported to the Ministry of Economy, Trade, and Industry. Thus, the reporting destination differs according to the lost capacity, Table 19 presents the number of disturbances by lost capacity.

(2) Classification and Description of Causes of Supply Disturbances over a Certain Scale

Table 20 classifies and describes the causes of supply disturbances.

Table 20 Classification and Description of the Causes of Supply Disturbances

<table>
<tr><th colspan="2">Classification of Causes</th><th>Description</th></tr>
<tr><td colspan="2">Facility fault</td><td>Due to imperfect production (improper design, fabrication, or material of electric facilities) or imperfect installation (improper operation of construction or maintenance work).</td></tr>
<tr><td colspan="2">Maintenance fault</td><td>Due to imperfect maintenance (improper operation of patrols, inspections or cleaning), natural deterioration (deterioration of material or mechanism of electric facilities not due to production, installations or maintenance), or overloading (current over the rated capacity).</td></tr>
<tr><td colspan="2">Accident/malice</td><td>Due to accident by worker, intentional act, or accident by public (stone throwing, wire theft, etc.). In case of accompanying electric shock, instances are classified under “Electric shock (worker)” or “Electric shock (public).”</td></tr>
<tr><td colspan="2">Physical contact</td><td>Due to physical contact by tree, wildlife, or others (kite, model airplane).</td></tr>
<tr><td colspan="2">Corrosion</td><td>Due to corrosion by leakage of current from DC electric railroad or by chemical action.</td></tr>
<tr><td colspan="2">Vibration</td><td>Due to vibration from traffic of heavy vehicle traffic or construction work.</td></tr>
<tr><td colspan="2">Involving an accident</td><td>Due to accident involving the electric facilities of another company.</td></tr>
<tr><td colspan="2">Improper fuel</td><td>Due to accident with improper fuel of notably different ingredients from that designated.</td></tr>
<tr><td colspan="2">Electric fire</td><td>Due to accident with electric fire caused by facility fault, maintenance fault, natural disaster, accident, or work without permission.</td></tr>
<tr><td colspan="2">Electric shock (worker)</td><td>Due to workers’ accident from electric shock caused by misuse of equipment, malfunction of electric facilities, accident by injured or third person, etc.</td></tr>
<tr><td colspan="2">Electric shock (public)</td><td>Due to accident with electric shock of public by misuse of equipment, malfunction of electric facilities, accident by injured or third person, etc.</td></tr>
<tr><td rowspan="7">Natural disaster</td><td>Thunderbolt</td><td>Due to direct or indirect lightning strike.</td></tr>
<tr><td>Rainstorm</td><td>Due to rain, wind, or rainstorm (including contact with fallen branches, etc.)</td></tr>
<tr><td>Snowstorm</td><td>Due to snow, frazil, hail, sleet, or snowstorm.</td></tr>
<tr><td>Earthquake</td><td>Due to earthquake.</td></tr>
<tr><td>Flood</td><td>Due to flood, storm surge, or tsunami</td></tr>
<tr><td>Landslide</td><td>Due to rock fall, avalanche, landslide, or ground subsidence.</td></tr>
<tr><td>Dust/gas</td><td>Due to briny air, volcanic dust and ash, fog, offensive gas, or smoke and soot.</td></tr>
<tr><td colspan="2">Unknown</td><td>Due to causes that remain unknown despite investigation.</td></tr>
<tr><td colspan="2">Miscellaneous</td><td>Due to causes not categorized above.</td></tr>
</table>

(3) The Number and Causes of Supply Disturbances over a Certain Scale (FY 2015–2019)

For the number of supply disturbances where interruption originated over a certain scale, Table 21 and Figure 18 show the nationwide data; Tables 22–31 show the data from each regional service area for the period FY 2015–2019.[9,10]

For the FY 2019 data, the number and the causes of supply disturbances over a certain scale were analyzed. Nationwide, there were 18 cases of supply disturbances over a certain scale, which was a decrease from 31 cases in the previous year. There were 11 cases of supply disturbances over a certain scale caused by natural disasters such as rainstorms or thunderbolts. In particular, the Tokyo PG area had five cases, which was the highest number of supply disturbances in the past 5 years.

Table 21 Causes of Disturbances over a Certain Scale (Nationwide, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault	1	2	1	4		1.6
Maintenance fault	1	1	4	1		1.4
Accident/Malice		1	1	1	1	0.8
Physical contact		4	2	2	5	2.6
Involved accident	1	1		1		0.6
Electric shock(worker)	1					0.2
Subtotal	4	9	8	9	6	7.2
Natural Disaster						
Thunderbolt		3	2	1	5	2.2
Rainstorm		3	3	17	5	5.6
Snowstorm		2	2			0.8
Earthquake		6				1.2
Dust/Gas		2		2	1	1.0
Subtotal		16	7	20	11	10.8
Unknown	1					0.2
Miscellaneous		1		2	1	0.8
Total Disturbances	5	26	15	31	18	19.0

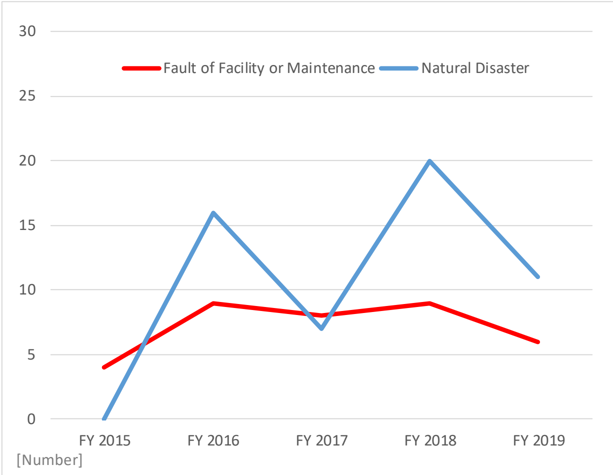


Figure 18 Transition of Disturbances by Causes (Nationwide, FY 2015–2019)

Table 22 Causes of Disturbances over a Certain Scale (Hokkaido, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault				1		0.2
Maintenance fault		1		1		0.4
Accident/Malice						
Physical contact				1		0.2
Involved accident						
Electric shock(worker)						
Subtotal		1		3		0.8
Natural Disaster						
Thunderbolt					1	0.2
Rainstorm		2				0.4
Snowstorm			1			0.2
Earthquake						
Dust/Gas						
Subtotal		2	1		1	0.8
Unknown						
Miscellaneous				1		0.2
Total Disturbances		3	1	4	1	1.8

Table 23 Causes of Disturbances over a Certain Scale (Tohoku, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault						
Accident/Malice		1				0.2
Physical contact		2				0.4
Involved accident						
Electric shock(worker)	1					0.2
Subtotal	1	3				0.8
Natural Disaster						
Thunderbolt					1	0.2
Rainstorm						
Snowstorm			1			0.2
Earthquake						
Dust/Gas						
Subtotal			1		1	0.4
Unknown						
Miscellaneous						
Total Disturbances	1	3	1		1	1.2

9 Causes of the disturbances that did not occur in the period FY 2015–2019 are omitted from the tables.
10 Column of the tables left blank if zero or the data are not available.

Table 24 Causes of Disturbances over a Certain Scale (Tokyo, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault	1	1	1			0.6
Maintenance fault	1					0.2
Accident/Malice				1	1	0.4
Physical contact		1	1	1	1	0.8
Involved accident	1					0.2
Electric shock(worker)						
Subtotal	3	2	2	2	2	2.2
Natural Disaster						
Thunderbolt		1	1	1	2	1.0
Rainstorm					3	0.6
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal		1	1	1	5	1.6
Unknown	1					0.2
Miscellaneous				1		0.2
Total Disturbances	4	3	3	4	7	4.2

Table 25 Causes of Disturbances over a Certain Scale (Chubu, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault						
Accident/Malice						
Physical contact					2	0.4
Involved accident						
Electric shock(worker)						
Subtotal					2	0.4
Natural Disaster						
Thunderbolt		1				0.2
Rainstorm				1		0.2
Snowstorm		2				0.4
Earthquake						
Dust/Gas				2		0.4
Subtotal		3		3		1.2
Unknown						
Miscellaneous					1	0.2
Total Disturbances		3		3	3	1.8

Table 26 Causes of Disturbances over a Certain Scale (Hokuriku, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault						
Accident/Malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Subtotal						
Natural Disaster						
Thunderbolt						
Rainstorm						
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal						
Unknown						
Miscellaneous						
Total Disturbances						

Table 27 Causes of Disturbances over a Certain Scale (Kansai, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault				3		0.6
Maintenance fault			3			0.6
Accident/Malice			1			0.2
Physical contact			1		2	0.6
Involved accident		1		1		0.4
Electric shock(worker)						
Subtotal		1	5	4	2	2.4
Natural Disaster						
Thunderbolt					1	0.2
Rainstorm		1	3	10	1	3.0
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal		1	3	10	2	3.2
Unknown						
Miscellaneous						
Total Disturbances		2	8	14	4	5.6

Table 28 Causes of Disturbances over a Certain Scale (Chugoku, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault						
Accident/Malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Subtotal						
Natural Disaster						
Thunderbolt			1			0.2
Rainstorm				2		0.4
Snowstorm						
Earthquake		1				0.2
Dust/Gas					1	0.2
Subtotal		1	1	2	1	1.0
Unknown						
Miscellaneous		1				0.2
Total Disturbances		2	1	2	1	1.2

Table 29 Causes of Disturbances over a Certain Scale (Shikoku, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault			1			0.2
Accident/Malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Subtotal			1			0.2
Natural Disaster						
Thunderbolt						
Rainstorm						
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal						
Unknown						
Miscellaneous						
Total Disturbances			1			0.2

Table 30 Causes of Disturbances over a Certain Scale (Kyushu, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault		1				0.2
Maintenance fault						
Accident/Malice						
Physical contact		1				0.2
Involved accident						
Electric shock(worker)						
Subtotal		2				0.4
Natural Disaster						
Thunderbolt						
Rainstorm				2		0.4
Snowstorm						
Earthquake		5				1.0
Dust/Gas		2				0.4
Subtotal		7		2		1.8
Unknown						
Miscellaneous						
Total Disturbances		9		2		2.2

Table 31 Causes of Disturbances over a Certain Scale (Okinawa, FY 2015–2019) [Number]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault						
Accident/Malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Subtotal						
Natural Disaster						
Thunderbolt		1				0.2
Rainstorm				2	1	0.6
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal		1		2	1	0.8
Unknown						
Miscellaneous						
Total Disturbances		1		2	1	0.8

3. Data of Interruptions for LV Customers

(1) Indices of System Average Interruption for LV Customers

The criteria for customer interruption include two indices that indicate frequency and duration of forced or planned outages that occurred for one customer and over 1 year.

System Average Interruption Frequency Index (SAIFI/number)

$$= \frac{\text{Low voltage customers affected by interruption}}{\text{Low voltage customers served at the beginning of the fiscal year}}$$

System Average Interruption Duration Index (SAIDI/minute)

$$= \frac{\text{Interruption duration (min)} \times \text{Low voltage customers affected by interruption}}{\text{Low voltage customers served at the beginning of the fiscal year}}$$

Table 32 shows the definitions of terms relating to outage.

Table 32 Definition of Outage-related Terms

Term	Definition
Forced outage	Supply interruption occurred to end-use customers by accident, such as the malfunction of the electric facility, excluding resumption of electricity supply by automatic reclosing.[11][12]
Planned outage	Electric power company interrupts its electricity supply in planned manner to construct, improve, and maintain its electric facility.

[11] See footnote 5 for definitions.
[12] See footnote 6 for definitions.

(2) Data of System Average Interruption Nationwide and by Regional Service Area (FY 2015–2019)

Table 33 and Figure 19 show the nationwide data for system average interruptions for FY 2015–2019. Tables 34–43 and Figures 20–29 show the data for each regional service area. Table 44 shows the nationwide data for system average interruptions for FY 2019. In addition, Table 46 shows the number of instances and the duration of the damage caused by Typhoon no. 15 (Faxai) to LV customers in the Tokyo area as a reference.

The actual data of system average interruption for LV customers are summarized below.

・The SAIFI and SAIDI values were higher compared with the data from the past 5 years.

・Regarding the data by regional service area, the Tokyo PG area suffered damage from two major typhoons. In particular, Typhoon no. 15 (Faxai) brought system interruption for 930,000 LV customers mainly in Chiba Prefecture, causing damage to numerous facilities such as transmission towers and distribution poles, and requiring about 2 weeks for power restoration.

・Regarding the nationwide data, there was little variance compared with the data for an ordinary year, except for the damage caused by Typhoon no. 15 in the Tokyo PG area.

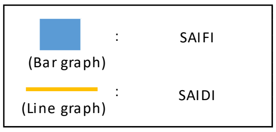


Table 33 Indices of System Average Interruption (Nationwide, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.10	0.14	0.11	0.28	0.19	0.17
	Planned	0.03	0.03	0.03	0.03	0.04	0.03
	Total ●	0.13	0.18	0.14	0.31	0.23	0.20
SAIDI [Minute]	Forced	18	21	12	221	82	71
	Planned	4	4	3	4	3	4
	Total ●	21	25	16	225	86	74

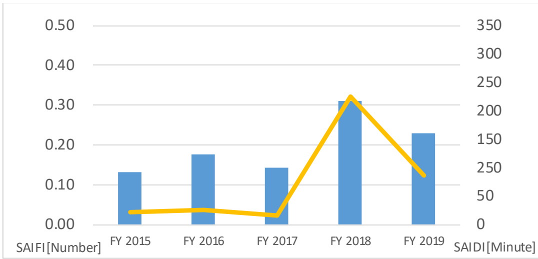


Figure 19 System Average Interruption Indices of LV Customers (Nationwide, FY 2015–2019)

Table 34 Indices of System Average Interruption (Hokkaido, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.15	0.17	0.13	1.19	0.11	0.35
	Planned	α	α	0.01	α	α	0.01
	Total ●	0.15	0.17	0.14	1.19	0.11	0.35
SAIDI [Minute]	Forced	10	35	10	2,154	4	443
	Planned	α	1	α	α	α	1
	Total ●	10	36	10	2,154	4	443

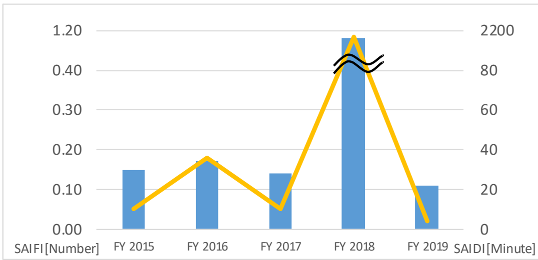


Figure 20 System Average Interruption Indices of LV Customers (Hokkaido, FY 2015–2019)

Table 35 Indices of System Average Interruption (Tohoku, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.08	0.11	0.13	0.09	0.11	0.10
	Planned	0.04	0.03	0.02	0.02	0.02	0.03
	Total ●	0.12	0.14	0.15	0.11	0.12	0.13
SAIDI [Minute]	Forced	11	24	10	7	15	14
	Planned	4	4	3	2	2	3
	Total ●	15	28	13	10	17	17

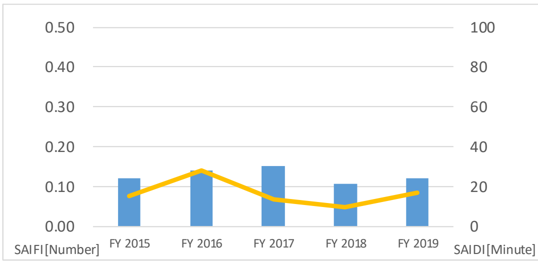


Figure 21 System Average Interruption Indices of LV Customers (Tohoku, FY 2015–2019)

Table 36 Indices of System Average Interruption (Tokyo, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.06	0.13	0.09	0.13	0.33	0.15
	Planned	0.01	0.02	0.01	0.01	0.03	0.02
	Total ●	0.07	0.15	0.10	0.14	0.36	0.16
SAIDI [Minute]	Forced	6	7	6	19	200	47
	Planned	1	1	1	3	1	1
	Total ●	6	8	7	22	201	49

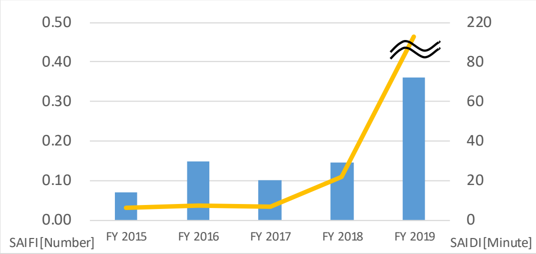


Figure 22 System Average Interruption Indices of LV Customers (Tokyo, FY 2015–2019)

Table 37 Indices of System Average Interruption (Chubu, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.07	0.17	0.08	0.39	0.11	0.16
	Planned	0.06	0.06	0.06	0.06	0.06	0.06
	Total ●	0.13	0.23	0.14	0.45	0.17	0.22
SAIDI [Minute]	Forced	4	5	10	348	32	80
	Planned	7	7	7	8	8	7
	Total ●	11	12	17	356	40	87

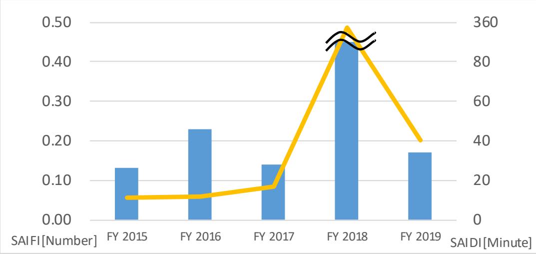


Figure 23 System Average Interruption Indices of LV Customers (Chubu, FY 2015–2019)

Table 38 Indices of System Average Interruption (Hokuriku, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.04	0.06	0.09	0.06	0.03	0.06
	Planned	0.10	0.10	0.09	0.09	0.09	0.09
	Total ●	0.14	0.16	0.17	0.15	0.13	0.15
SAIDI [Minute]	Forced	4	4	11	9	3	6
	Planned	16	17	15	15	16	16
	Total ●	20	21	26	24	19	22

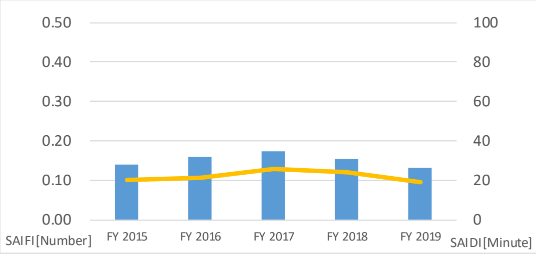


Figure 24 System Average Interruption Indices of LV Customers (Hokuriku, FY 2015–2019)

Table 39 Indices of System Average Interruption (Kansai, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.07	0.07	0.12	0.40	0.10	0.15
	Planned	0.01	0.01	0.01	0.01	0.01	0.01
	Total ●	0.08	0.09	0.13	0.41	0.11	0.17
SAIDI [Minute]	Forced	3	4	14	396	5	84
	Planned	1	1	1	1	1	1
	Total ●	4	5	15	397	6	86

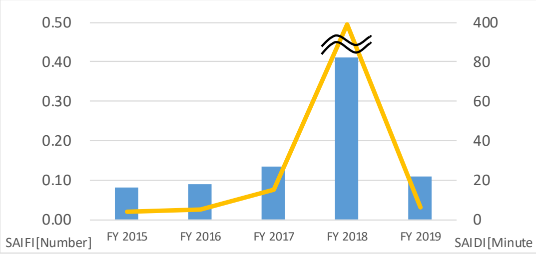


Figure 25 System Average Interruption Indices of LV Customers (Kansai, FY 2015–2019)

Table 40 Indices of System Average Interruption (Chugoku, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.18	0.15	0.12	0.14	0.13	0.15
	Planned	0.11	0.11	0.11	0.09	0.09	0.10
	Total ●	0.29	0.26	0.23	0.23	0.21	0.24
SAIDI [Minute]	Forced	17	6	7	24	10	13
	Planned	12	12	12	10	9	11
	Total ●	29	18	19	33	19	24

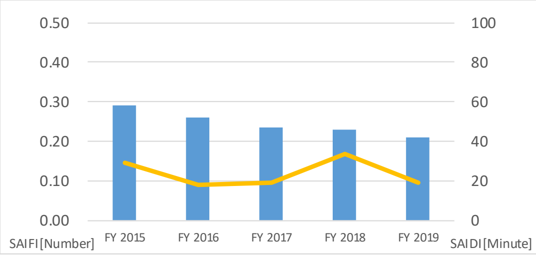


Figure 26 System Average Interruption Indices of LV Customers (Chugoku, FY 2015–2019)

Table 41 Indices of System Average Interruption (Shikoku, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.12	0.09	0.19	0.20	0.13	0.15
	Planned	0.19	0.18	0.16	0.14	0.14	0.16
	Total ●	0.31	0.27	0.36	0.34	0.27	0.31
SAIDI [Minute]	Forced	13	6	21	32	8	16
	Planned	21	20	17	15	15	18
	Total ●	34	26	38	47	23	34

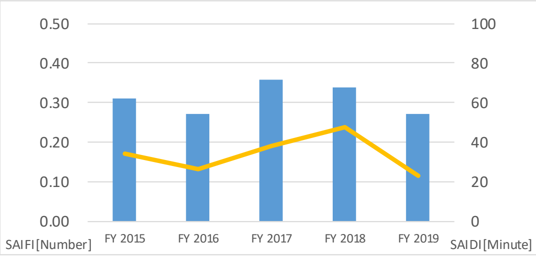


Figure 27 System Average Interruption Indices of LV Customers (Shikoku, FY 2015–2019)

Table 42 Indices of System Average Interruption (Kyushu, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	0.16	0.24	0.08	0.14	0.08	0.14
	Planned	0	0	0	0	0	0
	Total ●	0.16	0.24	0.08	0.14	0.08	0.14
SAIDI [Minute]	Forced	101	128	25	103	15	74
	Planned	0	0	0	0	0	0
	Total ●	101	128	25	103	15	74

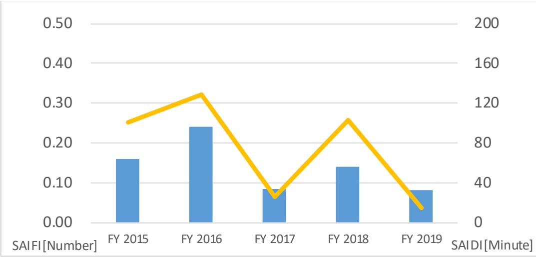


Figure 28 System Average Interruption Indices of LV Customers (Kyushu, FY 2015–2019)

Table 43 Indices of System Average Interruption (Okinawa, FY 2015–2019)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	5-years Average
SAIFI [Number]	Forced	1.04	0.57	0.98	3.62	1.11	1.46
	Planned	0.08	0.08	0.07	0.07	0.05	0.07
	Total ●	1.12	0.65	1.05	3.69	1.17	1.54
SAIDI [Minute]	Forced	150	35	117	1,269	215	357
	Planned	8	8	7	6	6	7
	Total ●	158	43	124	1,275	221	364

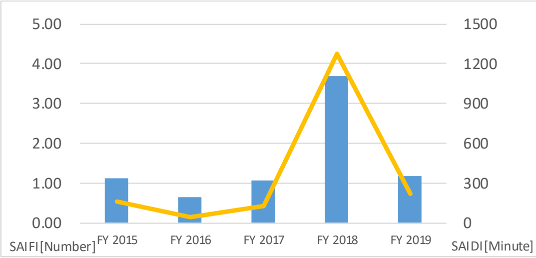


Figure 29 System Average Interruption Indices of LV Customers (Okinawa, FY 2015–2019)

Table 44 System Average Disturbances where Interruptions Were Caused by Outages (Nationwide, FY 2019)[13,]

			Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa	Nationwide
SAIFI [Number]	Forced Outage												
		Generators	0.06	0.01	0.10	0.02	α	0.04	0.01	0.01	0.02	0.15	
		HV Lines	0.05	0.09	0.23	0.08	0.03	0.06	0.12	0.11	0.06	0.95	
		LV Lines	α	α	α	α	α	α	α	α	α	0.01	
		Subtotal	0.11	0.11	0.33	0.11	0.03	0.10	0.13	0.13	0.08	1.11	0.19
	Planned Outage												
		Generators	α	α	0.00	α	α	α	α	0.00	0.00	α	
		HV Lines	α	0.01	0.03	0.04	0.08	α	0.06	0.09	0.00	0.01	
		LV Lines	α	α	α	0.02	0.02	0.01	0.02	0.05	0.00	0.04	
		Subtotal	α	0.02	0.03	0.06	0.09	0.01	0.09	0.14	0.00	0.05	0.04
	Total Outage												
		Generators	0.06	0.01	0.10	0.03	α	0.04	0.01	0.01	0.02	0.15	
		HV Lines	0.06	0.10	0.26	0.12	0.11	0.07	0.18	0.20	0.06	0.96	
		LV Lines	α	0.01	α	0.02	0.02	0.01	0.02	0.06	α	0.05	
		Total	0.11	0.12	0.36	0.17	0.13	0.11	0.21	0.27	0.08	1.17	0.23
SAIDI [Minute]	Forced Outage												
		Generators	1	2	7	7	α	1	α	α	1	8	
		HV Lines	3	12	193	25	2	4	9	7	14	201	
		LV Lines	α	1	α	1	1	α	1	1	α	6	
		Subtotal	4	15	200	32	3	5	10	8	15	215	82
	Planned Outage												
		Generators	α	α	0	α	α	α	α	0	0	α	
		HV Lines	α	2	1	6	14	α	8	12	0	2	
		LV Lines	α	α	α	2	2	α	1	3	0	4	
		Subtotal	α	2	1	8	16	1	9	15	0	6	3
	Total Outage												
		Generators	1	2	7	7	α	1	α	α	1	8	
		HV Lines	3	14	194	31	16	5	17	19	14	203	
		LV Lines	α	1	α	3	2	1	2	4	α	10	
		Total	4	17	201	40	19	6	19	23	15	221	86

* Nationwide values are calculated by weighing the values of whole regional service areas.

[13] Electric facilities such as generating plants, substations, transmission lines, or extra high voltage lines. Alpha (α) is shown if the data are a fraction less than a unit.

IV. Conclusion

Frequency

The criterion for maintained frequency is the frequency time-kept ratio, which is the ratio of time that the metered frequency is maintained within a given variance of the standard. The frequency time-kept ratio within the target variance of the standard for frequency-synchronized regions for FY 2019 was achieved at 100%.

Voltage

The criteria of maintained voltage include the number of measured points where the metered voltage deviates from the above-stated standard and the deviation ratio, which is the ratio of deviated points against the total number of measured points. No deviation from the voltage standard was observed nationwide in FY 2019.

Supply Disturbances and Interruption for LV Customers

The criteria of supply interruption include the number of supply disturbances and the system average interruption indices, SAIFI and SAIDI. In FY 2019, the total number of supply disturbances nationwide was lower compared with the previous year, which had significant supply disturbances caused by natural disasters occurring in the previous 5-year period. Regarding regional service areas, TEPCO PG area had numerous supply disturbances, which contributed to the increase in supply disturbances nationwide. In particular, the disturbances of overhead HV lines caused by two major typhoons are estimated to have contributed significantly to the total number of supply disturbances.

The 18 supply disturbances over a certain scale for FY 2019 constitute a decrease by 13 from the 31 supply disturbances recorded in FY 2018. Among these supply disturbances, the number due to natural disasters such as rainstorms or thunderbolts was 11; the number in the Tokyo PG area was five, the highest in the past 5 years.

Considering the data on interruptions for LV customers, the SAIFI and SAIDI data nationwide for FY 2019 registered the second highest values (after FY 2018) in the past 5 years. The damage caused by typhoons in the Tokyo PG area had a significant impact; for example, power restoration after the damage caused by Typhoon no. 15 took a considerable time compared with a normal year.

Based on the analysis and the results indicating that the frequency and voltage have remained within the target variance, OCCTO concludes that the quality of the electricity supply was adequately maintained nationwide in FY 2019. With regard to supply disturbances, the electric facilities in the Tokyo PG area experienced serious damage caused by natural disasters, i.e., mainly by the two major typhoons. Although this damage brought variance and increased interruption to the corresponding area, there was little interruption caused by factors other than natural disasters—such as malfunction of electrical facilities—both nationwide and in the Tokyo PG area.

OCCTO will continue to collect and publish information on the quality of electricity in the future.

<Reference 1> Comparison of Nationwide Data with or without the Damage Caused by Typhoon No. 15 in the Tokyo PG Regional Service Area

Tables 45 and 46 show the comparison of nationwide data with or without the damage caused by Typhoon no. 15 in the Tokyo PG area in FY 2019. The typhoon caused serious damage to electrical facilities mainly in Chiba Prefecture.

・Number of Supply Disturbances Indicating Where Interruptions Originated

Comparison between the inclusion and exclusion of data on damage caused by Typhoon no. 15 indicates that there was considerable damage to overhead HV lines—over 2,000 cases—in FY 2019.

Table 45 Number of Supply Disturbances Where Interruption Originated
(Tokyo and Nationwide, FY 2015–2019, Including or excluding the specified disturbances)

Occurrence in		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019: Including the supply disturbances caused by Typhoon No.15	FY 2019: Excluding the supply disturbances caused by Typhoon No.15	FY 2019(Nationwide): Including the supply disturbances caused by Typhoon No.15	FY 2019(Nationwide): Excluding the supply disturbances caused by Typhoon No.15
Disturbance of General Transmission & Distribution Companies' Facilities									
Substations		10	14	17	16	17	17	56	56
Transmission Lines & Extra High Voltage Lines	Overhead	30	16	24	38	21	19	246	244
	Under-ground	5	2	4		4	3	13	12
	Total	35	18	28	38	25	22	259	256
High Voltage Lines	Overhead	1,755	2,204	2,311	3,841	5,186	3,139	13,958	11,911
	Under-ground	74	75	65	100	97	82	227	212
	Total	1,829	2,279	2,376	3,941	5,283	3,221	14,185	12,123
Demand Facilities									
Involvng Accidents		125	93	96	107	134	134	372	372
Total Disturbances		1,999	2,404	2,517	4,102	5,459	3,394	14,872	12,807

・System Average Interruption Nationwide

Comparison between the inclusion and exclusion of data on damage caused by Typhoon no. 15 indicates that the major part of the SAIDI is accounted for by the damage caused by the typhoon. When the nationwide data exclude the corresponding damage by the typhoon, there is little variance compared with the data from a normal year.

Table 46 Indices of System Average Interruption
(Tokyo and Nationwide, FY 2015–2019, Including or excluding the specified disturbances)

		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019: Including the supply disturbances caused by Typhoon No.15	FY 2019: Excluding the supply disturbances caused by Typhoon No.15	FY 2019(Nationwide): Including the supply disturbances caused by Typhoon No.15	FY 2019(Nationwide): Excluding the supply disturbances caused by Typhoon No.15
SAIFI [Number]	Forced	0.06	0.13	0.09	0.13	0.33	0.23	0.19	0.16
	Planned	0.01	0.02	0.01	0.01	0.03	0.03	0.04	0.04
	Total	0.07	0.15	0.10	0.14	0.36	0.26	0.23	0.19
SAIDI [Minute]	Forced	6	7	6	19	200	26	82	21
	Planned	1	1	1	3	1	1	3	3
	Total	6	8	7	22	201	27	86	24

<Reference 2> Comparison of System Average Interruptions in Japan with Various Countries and US States for 2015–2019

Table 47 and Figure 30 show the SAIDI values and Table 48 and Figure 31 show the SAIFI values for Japan and various EU countries and US states for the period 2015–2019. The data for EU countries is cited from the report[14] of the Council of European Energy Regulators (CEER); those for major US states are from the report[15] of the Public Utilities Commission in each state. These data were aggregated and analyzed by OCCTO.[16]

With regard to monitoring conditions, such as the observed voltage, annual period of monitoring (whether starting from January or April),[17] or data including/excluding natural disasters, these conditions vary across EU countries and US states. Therefore, interruption data may not be directly comparable between Japan and EU countries and US states. However, we can see that both SAIDI and SAIFI values for Japan are lower than those for the selected EU countries and US states. In addition, for Japan, only the data for LV customers are monitored. However, because there are very few customers who are supplied by other means than the LV network, it is estimated that interruptions of such customers would have only a marginal influence on the interruption data.

[14] Source: "CEER Benchmarking Report 6.1 on the Continuity of Electricity and Gas Supply Data update 2015/2016"
https://www.ceer.eu/documents/104400/-/-/963153e6-2f42-78eb-22a4-06f1552dd34c
This report is published roughly every 3 years using the updated data for the previous 3 years.

[15] Sources:
State of California: California Public Utilities Commission, "Electric System Reliability Annual Reports"
http://www.cpuc.ca.gov/General.aspx?id=4529
State of Texas: Public Utility Commission of Texas,
"Annual Service Quality Report pursuant to PUC Substantive Rule in S.25.81,"
http://www.puc.texas.gov/industry/electrici/reports/sqr/default.aspx
State of New York: Department of Public Service, "Electric Reliability Performance Reports."
http://www3.dps.ny.gov/W/PSCWeb.nsf/All/D82A200687D96D3985257687006F39CA?OpenDocument

[16] Values for states are calculated for California and Texas by weighting the numbers of customers of major electric power companies according to their reliability reports.(For California, SDG&E, PG&E, and SCE are used; for Texas, all electric power companies are used in the calculation.)

[17] The fiscal year (April 1 to March 31) is used for Japan, while the calendar year (January 1 to December 31) is used for other countries/states.

Table 47 SAIDI of Japan and Various Countries/US States for FY 2015–2019 by Forced and Planned Outages

(Minutes/Year: Customer)

Country/State			2015	2016	2017	2018	2019	Event of	Observed Voltage	Natural Disaster
			Year					Condition		
JAPAN			21	25	16	225	86	except auto re-closing	LV	Include
		Forced	18	21	12	221	82			
		Planned	4	4	3	4	3			
U.S.A.	California		122	219	308	266	737	5 minutes and longer	All	Include
		Forced	115	124	244	201	690			
		Planned	7	95	64	65	48			
	Texas		277	214	522	175	335			
		Forced	268	205	509	158	319			
		Planned	10	9	13	17	15			
	New York		130	137	270	409	228			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			
EU	Germany		22	24	-	-	-	3 minutes and longer	All	Include
		Forced	15	13	-	-	-			
		Planned	7	10	-	-	-			
	Italy		196	144	-	-	-		All	Include
		Forced	129	65	-	-	-			
		Planned	67	79	-	-	-			
	France		74	71	-	-	-		All	Include
		Forced	58	53	-	-	-			
		Planned	16	18	-	-	-			
	Spain		69	66	-	-	-		All	Include
		Forced	56	54	-	-	-			
		Planned	13	12	-	-	-			
	UK		61	55	-	-	-		All	Exclude
		Forced	51	47	-	-	-			
		Planned	10	8	-	-	-			
	Sweden		135	94	-	-	-		All	Include
		Forced	118	76	-	-	-			
		Planned	17	19	-	-	-			
	Finland		169	81	-	-	-		except LV	Include
		Forced	158	68	-	-	-			
		Planned	12	13	-	-	-			
	Norway		173	129	-	-	-		All	Include
		Forced	129	88	-	-	-			
		Planned	44	41	-	-	-			

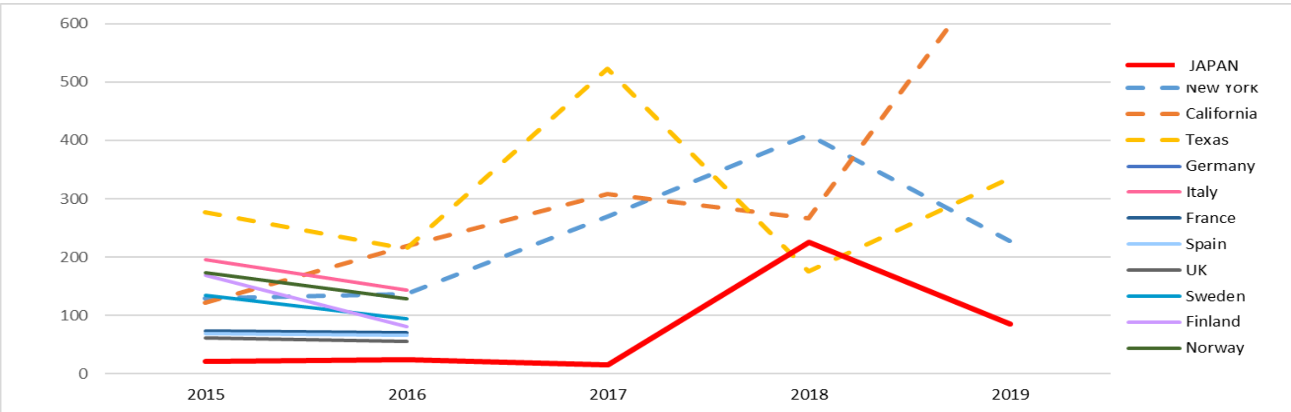


Figure 30 SAIDI of Japan and Various Countries/US States for FY 2015–2019 (Minutes/Year: Customer)

Table 48 SAIFI of Japan and Various Countries/US States for FY 2015–2019 by Forced and Planned Outages

(Number/Year: Customer)

Country/State			2015	2016	2017	2018	2019	Event of	Observed Voltage	Natural Disaster
JAPAN			0.13	0.18	0.14	0.31	0.23	except auto re-closing	LV	Include
		Forced	0.10	0.14	0.11	0.28	0.19			
		Planned	0.03	0.03	0.03	0.03	0.04			
U.S.A.	California		0.94	1.31	1.46	1.45	1.53	5 minutes and longer	All	Include
		Forced	0.91	1.05	1.26	0.94	1.37			
		Planned	0.03	0.26	0.20	0.50	0.16			
	Texas		1.91	1.55	1.61	1.54	1.82			
		Forced	1.82	1.48	1.51	1.40	1.68			
		Planned	0.09	0.07	0.15	0.13	0.14			
	New York		0.67	0.79	0.85	1.01	0.88			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			
EU	Germany		0.91	0.59	-	-	-	3 minutes and longer	All	Include
		Forced	0.83	0.51	-	-	-			
		Planned	0.08	0.08	-	-	-			
	Italy		2.81	2.17	-	-	-		All	Include
		Forced	2.43	1.76	-	-	-			
		Planned	0.37	0.41	-	-	-			
	France		0.22	0.22	-	-	-		All	Include
		Forced	0.09	0.08	-	-	-			
		Planned	0.13	0.14	-	-	-			
	Spain		1.31	1.18	-	-	-		All	Include
		Forced	1.21	1.09	-	-	-			
		Planned	0.10	0.09	-	-	-			
	UK		0.60	0.57	-	-	-		All	Exclude
		Forced	0.56	0.53	-	-	-			
		Planned	0.04	0.04	-	-	-			
	Sweden		1.36	1.33	-	-	-		All	Include
		Forced	1.22	1.17	-	-	-			
		Planned	0.14	0.16	-	-	-			
	Finland		2.78	1.58	-	-	-		except LV	Include
		Forced	2.64	1.42	-	-	-			
		Planned	0.14	0.15	-	-	-			
	Norway		2.17	1.89	-	-	-		All	Include
		Forced	1.87	1.59	-	-	-			
		Planned	0.30	0.30	-	-	-			

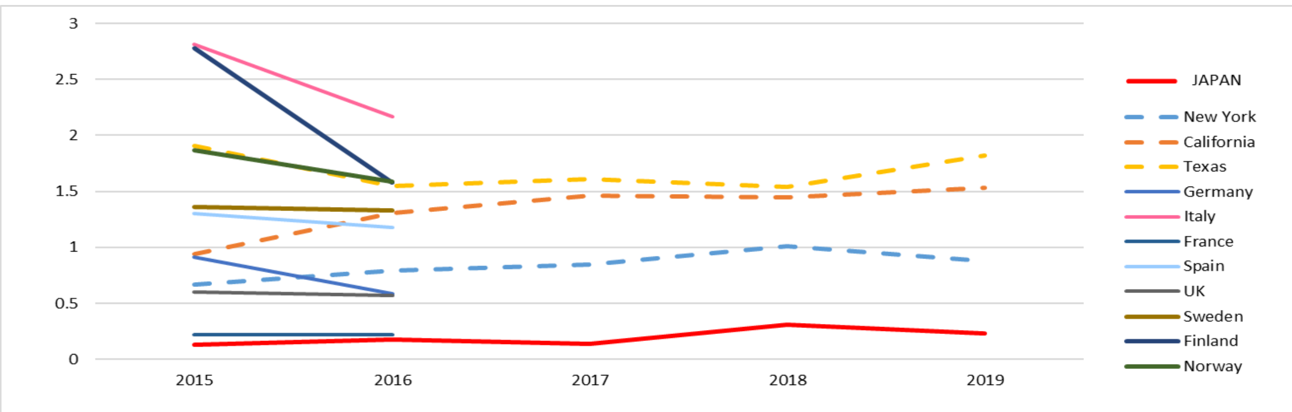


Figure 31 SAIFI of Japan and Various Countries/US States for FY 2015–2019 (Number/Year: Customer)

Organization for Cross-regional
Coordination of Transmission
Operators, Japan
http://www.occto.or.jp/en/index.html

(blank)

II. State of Electric Network

Outlook of Cross-regional Interconnection Lines

- Actual Data for FY 2019 -

September 2020

Organization for Cross-regional Coordination of Transmission Operators, Japan

FOREWORD

The Organization for Cross-regional Coordination of Transmission Operators, Japan (hereinafter, the Organization), prepares and publishes its Annual Report according to Article 181 of the Operational Rules regarding the matters specified below.

i. Actual electric supply and demand (including evaluation and analysis of quality of electricity in light of frequency, voltage, and blackouts of each regional service area)

ii. State of electric network

iii. Actual Network Access Business until the previous year.

iv. Forecast on electric demand and electric network (including forecast of improvement of restriction on network interconnection of generation facilities) for the next fiscal year and a mid- and long-term period based on a result of compiling of electricity supply plans and their issues.

v. Evaluation and verification of proper standards of reserve margin and balancing capacities of each regional service area based on the next article, as well as contents of review as needed

The Organization published the actual data for electricity supply–demand and network system utilization ahead of the Annual Report because of the completion of actual data collection up to fiscal year 2019 (FY 2019).

SUMMARY

This report is presented to review the outlook of electricity supply–demand and cross-regional interconnection lines in FY 2019, based on Article 181 of the Operational Rules of the Organization.

The report consists of two parts: the situation of electricity supply and demand, and interconnection lines.

Regarding actual utilization of interconnection lines, the total volume of the utilization of interconnection lines was 87,471 GWh, −23,291 GWh over FY 2018.

Following the introduction of the implicit auction scheme for utilizing cross-regional interconnection lines, the total number of congestion management hours was zero.

The numbers and days of maintenance of interconnection lines totaled 353 times and 599 days, respectively in FY 2019.

We hope this report provides useful information.

CONTENTS

CHAPTER II: ACTUAL UTILIZATION OF CROSS-REGIONAL INTERCONNECTION LINES

1. Cross-regional Interconnection Lines and their Management

(1) Cross-regional Interconnection Lines

Cross-regional interconnection lines are transmission lines with 250 kV or more and AC/DC convertors that regularly connect the regional service areas of members that are GT&D companies. Electric power supply outside each service area is made available through the interconnection lines. The Organization directs members to supply electricity through the cross-regional interconnection lines and secure the supply–demand balance in case of insufficient supply capacity for each regional service area. Figure 2-1 and Table 2-1 show the cross-regional interconnection lines in Japan.

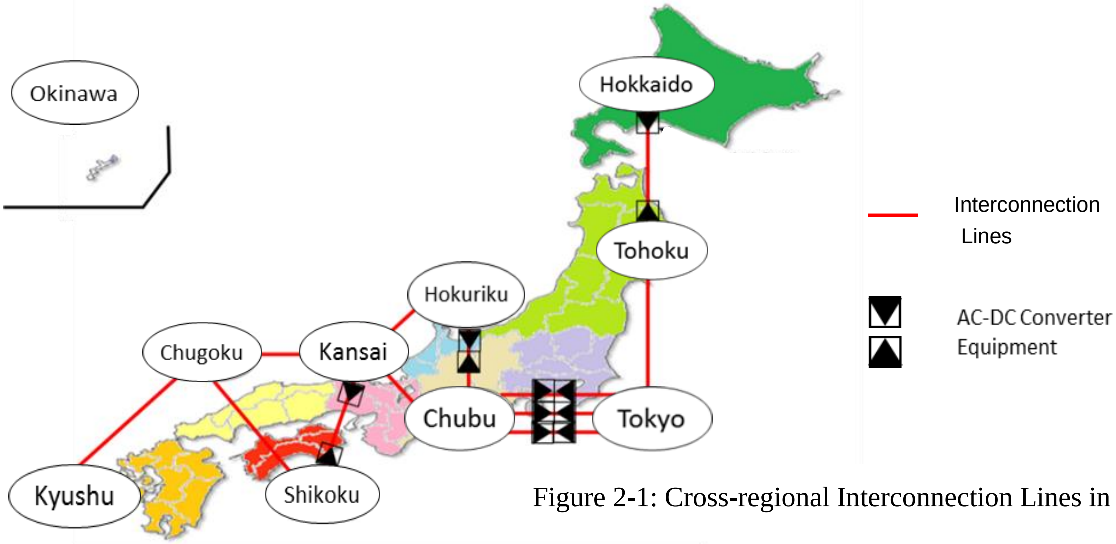


Figure 2-1: Cross-regional Interconnection Lines in Japan

Table 2-1: Summary of Cross-regional Interconnection Lines (at the end of FY 2019)

Interconnection Lines	Areas・Directions				Corresponding Facilities	AC/DC
Interconnection facilities between Hokkaido and Honshu	Forward	Hokkaido	→	Tohoku	Hokkaido-Honshu HVDC Link, New Hokkaido-Honshu HVDC Link	DC
	Counter	Tohoku	→	Hokkaido		
Interconnection line between Tohoku and Tokyo	Forward	Tohoku	→	Tokyo	Soma-Futaba bulk line, Iwaki bulk line	AC
	Counter	Tokyo	→	Tohoku		
Interconnection facilities between Tokyo and Chubu	Forward	Tokyo	→	Chubu	Sakuma FC Shin Shinano FC Higashi Shimizu FC	DC
	Counter	Chubu	→	Tokyo		
Interconnection line between Chubu and Kansai	Forward	Chubu	→	Kansai	Mie-Higashi Omi line	AC
	Counter	Kansai	→	Chubu		
Interconnection facilities between Chubu and Hokuriku	Forward	Chubu	→	Hokuriku	Interconnection facilities of Minami Fukumitsu HVDC BTB C.S.and Minami Fukumitsu Substation	DC
	Counter	Hokuriku	→	Chubu		
Interconnection line between Hokuriku and Kansai	Forward	Hokuriku	→	Kansai	Echizen-Reinan line	AC
	Counter	Kansai	→	Hokuriku		
Interconnection lines between Kansai and Chugoku	Forward	Kansai	→	Chugoku	Seiban-Higashi Okayama line, Yamazaki-Chizu line	AC
	Counter	Chugoku	→	Kansai		
Interconnection facilities between Kansai and Shikoku	Forward	Kansai	→	Shikoku	Interconnection facilities between Kihoku and Anan AC/DC C.S.	DC
	Counter	Shikoku	→	Kansai		
Interconnection line between Chugoku and Shikoku	Forward	Chugoku	→	Shikoku	Honshi interconnection line	AC
	Counter	Shikoku	→	Chugoku		
Interconnection line between Chugoku and Kyushu	Forward	Chugoku	→	Kyushu	Kanmon interconnection line	AC
	Counter	Kyushu	→	Chugoku		

(2) Management of Cross-regional Interconnection Lines

The Organization manages the interconnection lines according to the Operational Rules. The Organization has currently revised cross-regional interconnection utilization rules from those based on a first-come, first-served principle to being based on the "implicit auction scheme"[1] with respect to effective utilization of interconnection lines, security of fairness and transparency among interconnection line users, and environmental development of the energy trading market. The implicit auction scheme entirely allocates capabilities of the interconnection lines through the energy trading market, but does not directly allocate the position or right of utilization through auctions. The rule revision is described in Figure 2-2.

.

<u>Termination of capability allocation plans and change of timing at capability registration</u>

Figure 2-2 describes the before and after of introducing the implicit auction scheme. Before introduction, capability allocation implemented on a first-come, first-served basis piled up, and the resulting available transfer capability (ATC) at 10:00 on the day before was used for day-ahead spot trading of the energy market. After introduction, principally whole capability is traded in day-ahead spot market.

Thus, there are no capability allocation plans, and capability is registered after the day-ahead spot market according to the revision of cross-regional interconnection lines from a first-come, first-served basis to the implicit auction scheme.

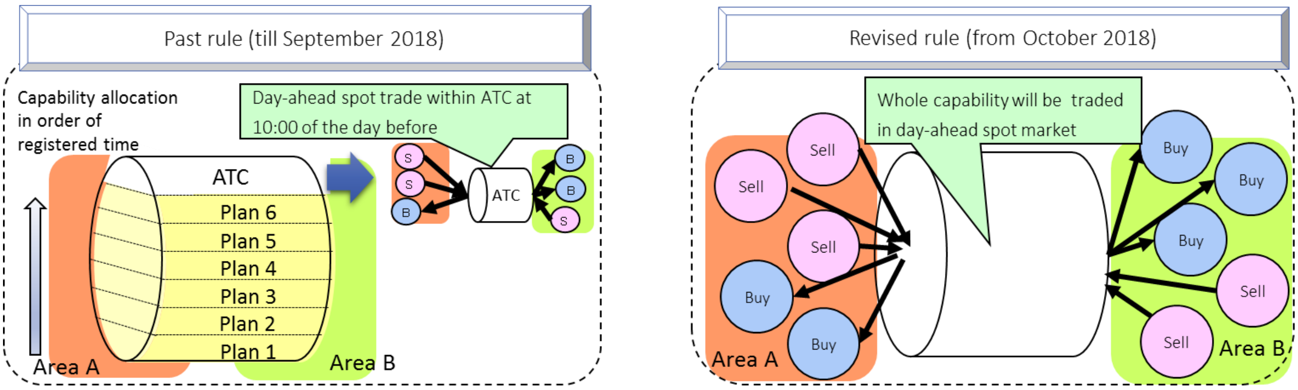


Figure 2-2: Management of Interconnection Lines

[1] http://www.occto.or.jp/occtosystem/kansetsu_auction/kansetsu_auction_gaiyou.html (in Japanese only).

2. Actual Utilization of Cross-regional Interconnection Lines

The following section records the actual utilization of cross-regional interconnection lines that are managed according to the provisions of Article 124 of the Operational Rules.

(1) Actual Utilization of Cross-regional Interconnection Lines in FY 2019

Table 2-2 and Figure 2-3 show the monthly utilization of cross-regional interconnection lines for regional service areas in FY 2019.

Table 2-2: Monthly Utilization of Cross-regional Interconnection Lines for Regional Service Areas

[GWh]

		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	**Annual**
Hokkaido-Honshu	→Tohoku (Forward)	35	69	82	23	25	3	5	10	8	2	1	17	279
	→Hokkaido (Counter)	137	84	73	102	230	129	203	214	287	305	287	66	2,117
Tohoku-Tokyo	→Tokyo (Forward)	1,842	2,156	1,998	2,877	2,800	2,186	1,717	2,086	2,482	2,360	2,573	2,498	27,575
	→Tohoku (Counter)	29	9	10	16	31	13	54	19	20	27	17	7	252
Tokyo-Chubu	→Chubu (Forward)	32	13	34	23	7	40	28	27	40	52	52	5	354
	→Tokyo (Counter)	303	303	361	412	440	403	401	203	330	360	367	264	4,147
Chubu-Kansai	→Kansai (Forward)	41	39	68	74	144	164	77	72	125	68	64	43	980
	→Chubu (Counter)	638	625	724	803	414	350	669	596	276	527	786	768	7,175
Chubu-Hokuriku	→Hokuriku (Forward)	0	1	0	0	1	4	1	0	0	0	0	0	7
	→Chubu (Counter)	0	12	12	2	0	2	6	2	0	0	2	2	40
Hokuriku-Kanasai	→Kansai (Forward)	139	172	312	153	165	164	208	197	307	569	282	249	2,918
	→Hokuriku (Counter)	32	24	18	92	46	136	98	38	23	4	20	15	547
Kansai-Chugoku	→Chugoku (Forward)	62	30	68	35	32	62	45	30	67	47	47	52	578
	→Kansai (Counter)	754	1,106	572	1,091	1,054	784	936	949	731	707	559	549	9,793
Kansai-Shikoku	→Shikoku (Forward)	0	0	11	0	0	0	0	20	0	0	0	0	31
	→Kansai (Counter)	448	501	861	1,025	1,040	998	1,029	596	859	914	867	819	9,956
Chugoku-Shikoku	→Shikoku (Forward)	6	5	29	7	7	15	7	5	6	20	9	15	131
	→Chugoku (Counter)	341	559	325	575	511	365	361	539	354	86	70	56	4,143
Chugoku-Kyushu	→Kyushu (Forward)	4	7	15	23	22	17	16	3	5	3	19	2	138
	→Chugoku (Counter)	1,088	1,087	851	1,306	1,441	1,278	1,380	1,485	1,598	1,703	1,599	1,497	16,311

* Based on the scheduled power flows of cross-regional interconnection lines. The values are shown before offsetting is performed.

* The values in red are the annual maximum capability and the values in blue are the annual minimum capability for each line and direction, respectively.

Figure 2-3: Monthly Utilization of Cross-regional Interconnection Lines for Regional Service Areas

(2) Actual Utilization of Cross-regional Interconnection Lines for FY 2010–2019

Table 2-3 and Figure 2-4 show the annual utilization of cross-regional interconnection lines for regional service areas for FY 2010–2019.

Table 2-3 Annual Utilization of Cross-regional Interconnection Lines for Regional Service Areas (FY 2010–2019)

[GWh]

		FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Hokkaido-Honshu	→Tohoku (Forward)	972	3,925	214	182	143	146	237	340	130	279
	→Hokkaido (Counter)	12	7	673	505	617	804	1,033	1,270	1,005	2,117
Tohoku-Tokyo	→Tokyo (Forward)	27,519	9,454	16,084	22,450	21,273	22,587	23,097	28,238	27,298	27,575
	→Tohoku (Counter)	12,219	5,674	4,520	3,891	4,029	3,714	4,660	7,071	3,139	252
Tokyo-Chubu	→Chubu (Forward)	188	1,151	1,579	2,829	2,702	693	2,729	3,954	1,711	354
	→Tokyo (Counter)	1,271	2,426	1,288	536	2,755	4,513	5,144	5,328	5,116	4,147
Chubu-Kansai	→Kansai (Forward)	943	3,734	7,487	7,049	7,131	3,412	5,538	8,106	3,675	980
	→Chubu (Counter)	10,721	8,403	5,726	4,928	6,342	7,577	6,544	9,889	9,980	7,175
Chubu-Hokuriku	→Hokuriku (Forward)	117	169	452	170	231	108	241	353	134	7
	→Chubu (Counter)	2,310	130	183	310	296	172	59	108	76	40
Hokuriku-Kanasai	→Kansai (Forward)	4,957	1,127	1,590	1,406	2,265	2,047	2,033	2,949	2,033	2,918
	→Hokuriku (Counter)	2,850	730	464	587	491	502	640	1,260	2,540	547
Kansai-Chugoku	→Chugoku (Forward)	1,423	1,483	2,836	2,326	2,252	948	716	4,493	4,734	578
	→Kansai (Counter)	7,916	10,520	6,788	5,468	5,994	9,138	13,179	16,727	13,388	9,793
Kansai-Shikoku	→Shikoku (Forward)	0	0	208	0	1	2	2	1	82	31
	→Kansai (Counter)	9,299	9,810	8,938	9,073	9,362	9,611	8,856	9,510	8,840	9,956
Chugoku-Shikoku	→Shikoku (Forward)	2,502	3,475	3,575	3,583	2,677	3,423	3,294	4,061	2,579	131
	→Chugoku (Counter)	7,496	6,727	3,564	3,694	3,912	4,631	7,638	7,540	4,023	4,143
Chugoku-Kyushu	→Kyushu (Forward)	903	2,582	4,210	3,838	3,596	2,174	1,935	3,014	1,998	138
	→Chugoku (Counter)	13,095	13,905	13,596	13,847	11,218	14,947	15,476	18,183	18,280	16,311

* Based on the scheduled power flows of cross-regional interconnection lines

* The values in red are the annual maximum capability and the values in blue are the annual minimum capability in each line and direction for 2010–2019, respectively.

Figure 2-4: Annual Utilization of Cross-regional Interconnection Lines for Regional Service Areas (FY 2010–2019)

(3) Monthly Utilization of Cross-regional Interconnection Lines by Transaction in FY 2019

Table 2-4 shows the monthly utilization of cross-regional interconnection lines by transaction in FY 2019.

Table 2-4: Monthly Utilization of Cross-regional Interconnection Lines by Transaction

[GWh]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	**Annual**
Bilateral	99	55	14	10	2	4	6	32	7	1	4	20	255
Day-ahead	5,624	6,535	6,060	8,322	8,036	6,706	6,844	6,706	7,181	7,400	7,211	6,592	83,216
1 Hour-ahead	209	213	351	308	371	402	390	353	330	354	405	314	4,000

* The values in red are the annual maximum capability and the values in blue are the annual minimum capability, respectively.
* The implicit auction scheme was introduced in October 2018.

(4) Annual Utilization of Cross-regional Interconnection Lines by Transaction for FY 2010–2019

Table 2-5 and Figures 2-5, 2-6, and 2-7 show the annual utilization of cross-regional interconnection lines by transaction for FY 2010–2019.

Table 2-5: Annual Utilization of Cross-regional Interconnection Lines by Transaction (FY 2010–2019)

[GWh]

	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Bilateral	100,444	79,693	76,328	73,289	71,558	75,947	84,843	109,842	56,710	255
Day-ahead	6,251	5,718	7,155	11,632	14,174	13,152	14,817	18,350	51,120	83,216
1 Hour-ahead	2	22	493	1,750	1,554	2,050	3,392	4,203	2,932	4,000

* "Hour-ahead" means the transaction that is 4 hours ahead of the gate closure in FY 2015. From FY 2016, it refers to the transaction that is 1 hour ahead of the gate closure.

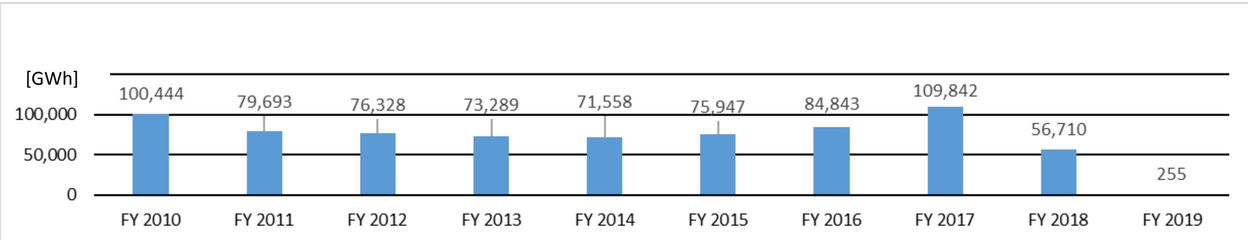


Figure 2-5: Annual Utilization of Cross-regional Interconnection Lines by Bilateral Transaction (FY 2010–2019)

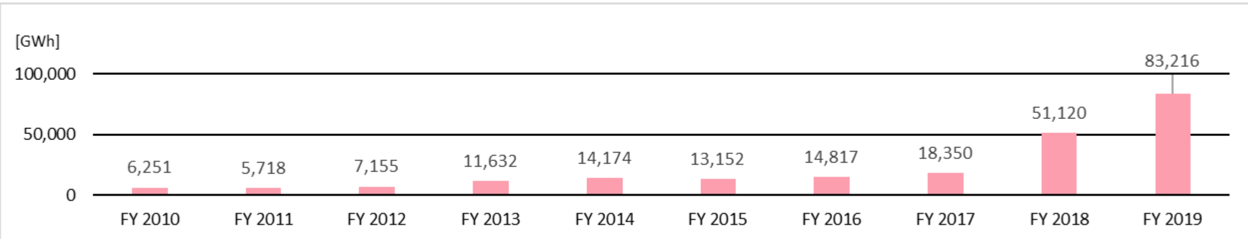


Figure 2-6: Annual Utilization of Cross-regional Interconnection Lines by Day-ahead Transaction (FY 2010–2019)

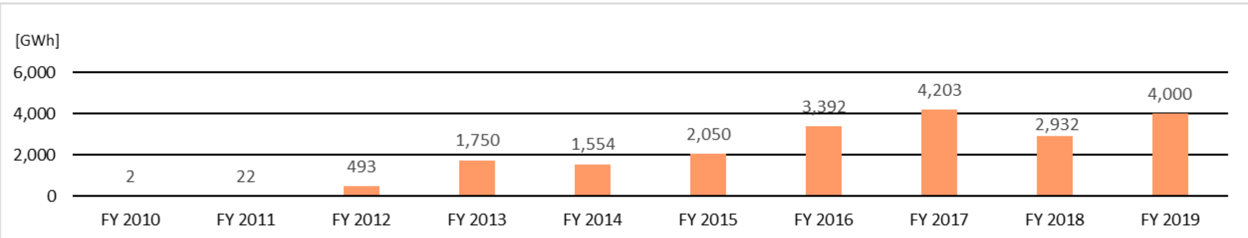


Figure 2-7: Annual Utilization of Cross-regional Interconnection Lines by Hour-ahead Transaction (FY 2010–2019)

3. Congestion Management and Constraints of Cross-regional Interconnection Lines

The following are the actual congestion management and constraints of cross-regional interconnection lines implemented according to the provisions of Article 143 of the Operational Rules.

(1) Monthly Congestion Management of Cross-regional Interconnection Lines by Weekly Plan Submission in FY 2019

There was no congestion management of cross-regional interconnection lines due to the introduction of the implicit auction scheme in FY 2019.

(2) Annual Congestion Management of Cross-regional Interconnection Lines by Weekly Plan Submission for FY 2010–2019

Table 2-6 and Figure 2-8 show the annual congestion management of cross-regional interconnection lines by weekly plan submissions for FY 2010–2019.

Table 2-6: Annual Congestion Management of Cross-regional Interconnection Lines by Weekly Plan Submissions (FY 2010–2019)

[h]

FY	Weekly Plan Submission	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
FY 2019	Total	0	0	0	0	0	0	0	0	0	0	0	0	0
	Before Submission	0	0	0	0	0	0	0	0	0	0	0	0	0
	After Submission	0	0	0	0	0	0	0	0	0	0	0	0	0
FY 2018	Total	5,111	6,677	7,765	7,035	7,553	7,973	0	0	0	0	0	0	42,113
	Before Submission	972	3,044	2,170	1,996	2,388	2,752	0	0	0	0	0	0	13,322
	After Submission	4,139	3,633	5,595	5,039	5,165	5,221	0	0	0	0	0	0	28,791
FY 2017	Total	2,210	3,758	2,789	2,985	2,682	2,851	3,024	4,433	5,188	5,263	4,519	5,659	45,358
	Before Submission	1,000	1,694	1,288	1,764	1,758	1,222	1,798	1,124	762	1,714	636	722	15,482
	After Submission	1,210	2,064	1,501	1,221	924	1,629	1,226	3,309	4,426	3,549	3,883	4,937	29,876
FY 2016	Total	533	1,006	123	221	136	422	703	467	499	508	12	541	5,167
	Before Submission	533	763	0	144	130	310	582	208	476	506	0	431	4,083
	After Submission	0	243	123	77	6	112	121	259	23	2	12	110	1,085
FY 2015	Total	1,175	3,858	1,293	761	791	996	1,396	854	946	774	723	1,275	14,840
	Before Submission	1,076	3,778	1,257	744	744	766	772	734	884	744	696	1,216	13,410
	After Submission	99	80	36	17	47	231	624	120	62	30	27	59	1,430
FY 2014	Total	1,132	1,820	411	18	48	250	101	21	49	76	108	44	4,075
	Before Submission	898	1,701	256	0	12	82	30	0	0	0	0	0	2,978
	After Submission	234	120	155	18	36	168	71	21	49	76	108	44	1,097
FY 2013	Total	1,106	1,189	134	3	19	94	873	0	10	474	205	16	4,121
	Before Submission	736	476	100	0	0	32	814	0	5	196	0	0	2,359
	After Submission	370	713	34	3	19	62	59	0	5	278	205	16	1,762
FY 2012	Total	458	1,237	502	620	727	1,025	299	1,039	795	1	667	469	7,836
	Before Submission	234	1,032	0	0	0	447	198	808	698	0	667	420	4,503
	After Submission	224	205	502	620	727	578	101	231	97	1	0	49	3,333
FY 2011	Total	142	771	994	604	1,236	757	657	296	524	444	2,071	1,622	10,114
	Before Submission	84	541	144	224	1,178	384	302	1	0	0	1,543	1,488	5,889
	After Submission	58	230	850	380	58	373	355	295	524	444	528	134	4,226
FY 2010	Total	553	13	277	52	144	2	5	1	4	551	0	120	1,721
	Before Submission	420	0	0	0	0	0	0	0	0	504	0	0	924
	After Submission	133	13	277	52	144	2	5	1	4	48	0	120	798

* The values in red are the annual maximum capability.
* The managed hours are collected as 30 minutes and rounded up to 1 hour.
* The total number of hours of utilization plans that managed to mitigate congestion.
* In-service dates of function for capability allocation plan revision of the Cross-regional Operation System are as below.

1. The function for revision of the weekly capability allocation plan and its congestion management: September 2016.
2. The function for revision of the monthly capability allocation plan and its congestion management: February 2017.
3. Introduction of the implicit auction scheme: October 2018.

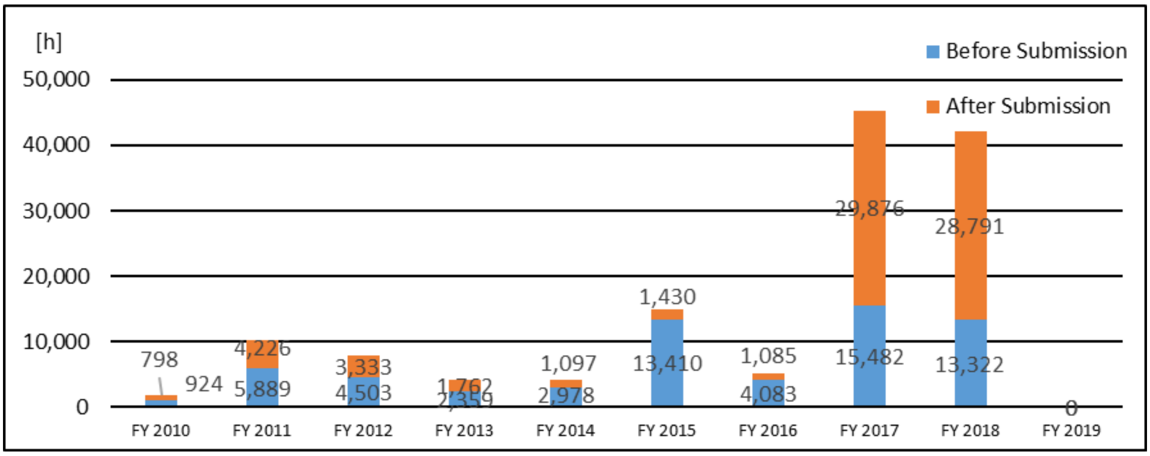


Figure 2-8: Annual Congestion Management of Cross-regional Interconnection Lines by Weekly Plan Submissions (FY 2010–2019)

(3) Monthly Congestion Management of Cross-regional Interconnection Lines by Constraints in FY 2019

There was no congestion management of cross-regional interconnection lines due to the introduction of the implicit auction scheme in FY 2019.

(4) Annual Congestion Management of Cross-regional Interconnection Lines by Constraints for FY 2010–2019

Table 2-7 and Figure 2-9 show the annual congestion management of cross-regional interconnection lines by constraints for FY 2010–2019.

Table 2-7 Annual Congestion Management of Cross-regional Interconnection Lines by Constraints (FY 2010–2019)

[h]

FY	Constraints	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
FY 2019	Total	0	0	0	0	0	0	0	0	0	0	0	0	0
	Over Capability	0	0	0	0	0	0	0	0	0	0	0	0	0
	Minimum Flow	0	0	0	0	0	0	0	0	0	0	0	0	0
FY 2018	Total	768	1,608	2,370	1,790	1,576	2,110	0	0	0	0	0	0	10,222
	Over Capability	768	1,608	2,370	1,790	1,576	2,110	0	0	0	0	0	0	10,222
	Minimum Flow	0	0	0	0	0	0	0	0	0	0	0	0	0
FY 2017	Total	2,210	3,758	2,789	2,985	2,682	2,851	3,024	4,433	5,188	5,263	4,519	5,659	45,358
	Over Capability	2,210	3,758	2,789	2,985	2,682	2,851	3,024	4,433	5,188	5,263	4,519	5,659	45,358
	Minimum Flow	0	0	0	0	0	0	0	0	0	0	0	0	0
FY 2016	Total	533	1,006	123	221	136	422	703	467	499	508	12	541	5,167
	Over Capability	533	1,006	123	221	136	422	703	467	499	508	12	541	5,167
	Minimum Flow	0	0	0	0	0	0	0	0	0	0	0	0	0
FY 2015	Total	1,175	3,858	1,293	761	791	996	1,396	854	946	774	723	1,275	14,840
	Over Capability	1,175	2,437	1,293	761	791	863	1,233	854	946	774	723	1,275	13,123
	Minimum Flow	0	1,421	0	0	0	133	163	0	0	0	0	0	1,717
FY 2014	Total	1,132	1,820	411	18	48	250	101	21	49	76	108	44	4,075
	Over Capability	990	1,661	411	18	48	192	73	21	49	76	108	44	3,688
	Minimum Flow	142	160	0	0	0	58	28	0	0	0	0	0	387
FY 2013	Total	1,106	1,189	134	3	19	94	873	0	10	474	205	16	4,121
	Over Capability	928	853	134	3	19	94	324	0	10	474	205	16	3,058
	Minimum Flow	178	336	0	0	1	0	549	0	0	0	0	0	1,063
FY 2012	Total	458	1,237	502	620	727	1,025	299	1,039	795	1	667	469	7,836
	Over Capability	457	1,160	496	324	511	928	0	325	675	0	667	469	6,010
	Minimum Flow	1	77	6	296	217	97	299	715	120	1	0	0	1,826
FY 2011	Total	142	771	994	604	1,236	757	657	296	524	444	2,071	1,622	10,114
	Over Capability	114	613	144	9	10	143	124	36	496	434	2,069	1,621	5,810
	Minimum Flow	29	158	850	595	1,226	614	534	260	28	10	2	1	4,304
FY 2010	Total	553	13	277	52	144	2	5	1	4	551	0	120	1,721
	Over Capability	500	4	2	49	0	2	5	1	2	19	0	97	680
	Minimum Flow	53	9	276	3	144	0	0	0	2	532	0	24	1,042

* The values in red are the annual maximum capability.
* The managed hours are collected as 30 minutes and rounded up to 1 hour.
* The total number of hours of capability allocation plans that managed to mitigate congestion.
* In-service dates of function for capability allocation plan revision of the Cross-regional Operation System are as below.

1. The function for revision of the weekly capability allocation plan and its congestion management: September 2016.
2. The function for revision of the monthly capability allocation plan and its congestion management: February 2017.
3. Introduction of the implicit auction scheme: October 2018.

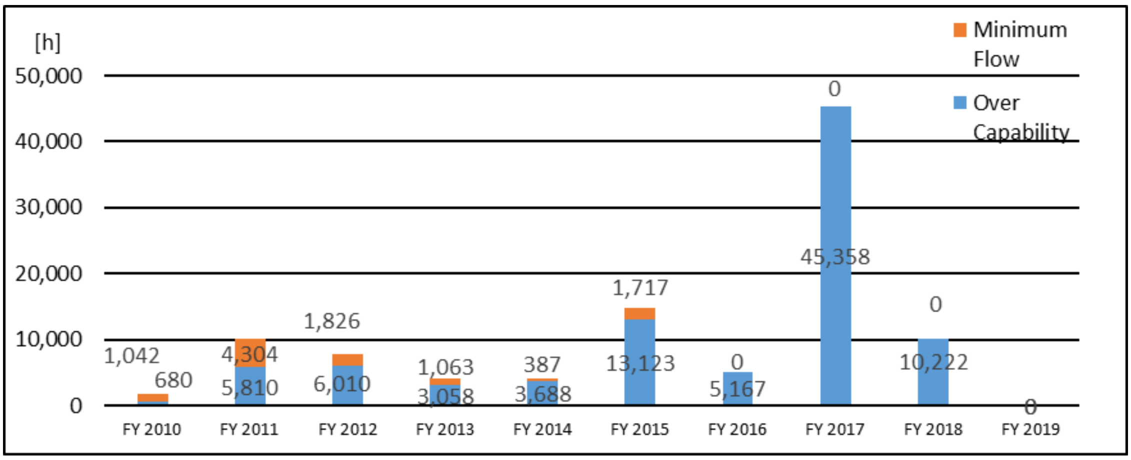


Figure 2-9: Annual Congestion Management of Cross-regional Interconnection Lines by Constraints (FY 2010–2019)

4. Status of Maintenance Work on Cross-regional Interconnection Lines

The following are details of the actual maintenance work on cross-regional interconnection lines as reported by the GT&D companies according to the provisions of Article 167 of the Operational Rules.

(1) Actual Monthly Maintenance Work on Cross-regional Interconnection Lines in FY 2019

Table 2-8 shows the monthly maintenance work on cross-regional interconnection lines in FY 2019, and Figure 2-10 shows the nationwide monthly planned outage rate in FY 2019.

Table 2-8: Monthly Maintenance Work on Cross-regional Interconnection Lines

Interconnection	Corresponding Facilities	Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.		Jan.		Feb.		Mar.		Annual	
		Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	Nos.	Days	**Nos.**	**Days**
Hokkaido-Honshu	Hokkaido and Honshu HVDC Link, New Hokkaido and Honshu HVDC Link	24	11	10	8	8	11	10	31	7	2	7	28	7	7	4	3	2	2					11	31	90	134
Tohoku-Tokyo	Soma-Futaba bulk line, Iwaki bulk line			3	12	5	7			3	20	6	30	1	4	4	30	6	31	2	31	2	27			32	192
Tokyo-Chubu	Sakuma FC C.S.	5	4			1	1									9	6									15	11
	Shin Shinano FC C.S.	2	2	6	4	2	1			1	1			1	1	16	19	7	8					5	13	40	49
	Higashi Shimizu FC C.S.	1	1			4	4																	5	12	10	17
Chubu-Kansai	Mie-Higashi Omi line			11	5	7	4					1	1	2	1											21	11
Chubu-Hokuriku	Minami Fukumitsu HVDC BTB C.S., Minami Fukumitsu Substation					1	1							13	16											14	17
Hokuriku-Kansai	Echizen-Reinan line			1	1	1	1							1	1											3	3
Kansai-Chugoku	Seiban-Higashi Okayama line, Yamazaki-Chizu line	18	8									33	20	10	7	11	8									72	43
Kansai-Shikoku	Kihoku and Anan AC/DC C.S.	22	5			2	4					1	2			2	26	2	9							29	46
Chugoku-Shikoku	Honshi interconnection line	3	25	3	27									1	1											7	53
Chugoku-Kyushu	Kanmon interconnection line	10	12	10	11																					20	23
Nationwide (Cumulative works for the same facilities deducted)		85	68	44	68	31	34	10	31	11	23	48	81	36	38	46	92	17	50	2	31	2	27	21	56	353	599

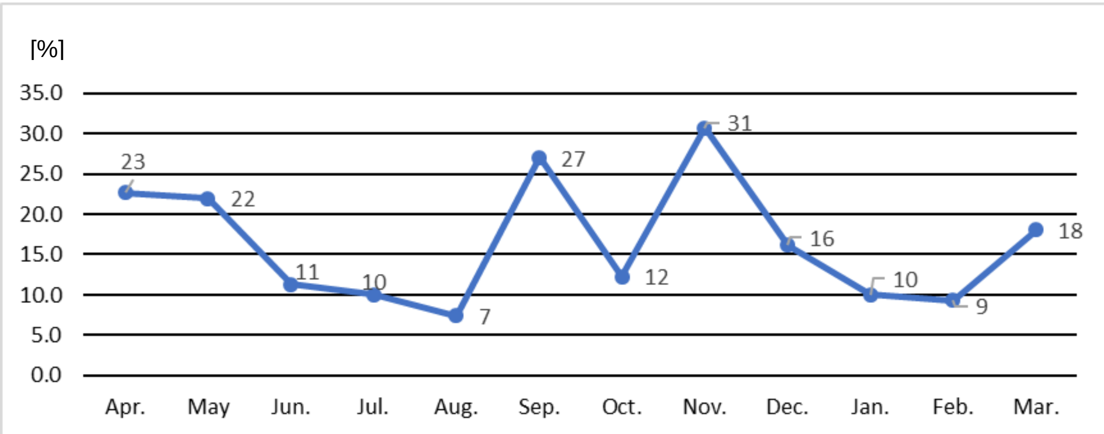


Figure 2-10: Nationwide Monthly Planned Outage Rate

$$\text{* Monthly Planned Outage Rate (\%)} = \frac{\text{Total days of planned outage in the month}}{\text{10 interconnection lines} \times \text{calendar days}}$$

(2) Annual Maintenance Work on Cross-regional Interconnection Lines for FY 2010–2019

Table 2-9 shows the annual maintenance work on cross-regional interconnection lines for FY 2010–2019.

Table 2-9: Annual Maintenance Work on Cross-regional Interconnection Lines (FY 2010–2019)

	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Total	10-years Average
Number	64	56	58	38	63	91	218	267	205	353	1,413	141

* The significant increase from FY 2015 to 2016 is attributable to the introduction of the Cross-regional Operation System, which made detailed data management available.

5. Unplanned Outage of Cross-regional Interconnection Lines

(1) Unplanned Outage of Cross-regional Interconnection Lines in FY 2019

Table 2-10 shows the unplanned outage of cross-regional interconnection lines in FY 2019.

Table 2-10: Unplanned Outage of Cross-regional Interconnection Lines

Date	Facility	Background
May 7	Hokuto-Imabetsu HVDC Link	Secondary accident of Imabetsu Trunk Lines(275 kV) No.1 & 2; estimated cause: thunderstruck
May 19	Hokuto-Imabetsu HVDC Link	Malfunction of cooling system at Hokuto Converter Station
Jun. 9	Kihoku and Anan AC/DC C.S.	Water leakage of cooling system for Group 1 valves at Anan Converter Station
Jun. 11	Shin Shinano FC unit No.2	Secondary accident of network
Aug. 20	Shin Shinano FC unit No.2	Secondary accident of network
Sep. 10	Shin Shinano FC unit No.2	Secondary accident of network
Oct. 12	Shin Shinano FC unit No.1/ Sakuma FC/ Hokuto-Imabetsu HVDC Link	Secondary accident of frequency fall due to shutdown of Chiba Thermal Power Plant caused by outage of North Chiba Lines(275 kV) No.1 and 2; estimated casuse: physical contact by rainstorm
Nov. 26	Hokuto-Imabetsu HVDC Link	Secondary accident of network
Dec. 12	Hokuto-Imabetsu HVDC Link	Secondary accident of network

* The unplanned outage affecting TTC is described.

(2) Annual Unplanned Outage of Cross-regional Interconnection Lines for FY 2010–2019

Table 2-11 shows the annual unplanned outage of cross-regional interconnection lines for FY 2010–2019.

Table 2-11: Annual Unplanned Outage of Cross-regional Interconnection Lines (FY 2010–2019)

	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Total	10-years Average
Number	9	5	6	9	1	3	3	3	6	9	54	5

6. Actual Employment of the Transmission Margin

The “employment of the transmission margin” describes the supply of electricity by GT&D companies utilizing their transmission margin to interconnection lines where the supply–demand balance is restricted or insufficient to reduce power supply, or other such possibilities. Table 2-12 shows the actual employment of the transmission margin for FY 2019 according to the provisions of Article 152 of the Operational Rules.

Table 2-12: Actual Employment of the Transmission Margin

Date	Facility	Background
Sep. 10	Interconnection facilities between Tokyo and Chubu (Flow from Chubu to Tokyo)	Insufficient ATC of the corresponding facilities in the regional service area of TEPCO PG which is subject to the instruction of power exchanges because of demand growth due to higher temperature

7. Actual Available Transfer Capabilities of Each Cross-regional Interconnection Line

The actual ATC values calculated and published are shown in Figures 2-12 to 2-21. Figures 2-11 and Table 2-13 detail how to interpret the ATC graph.

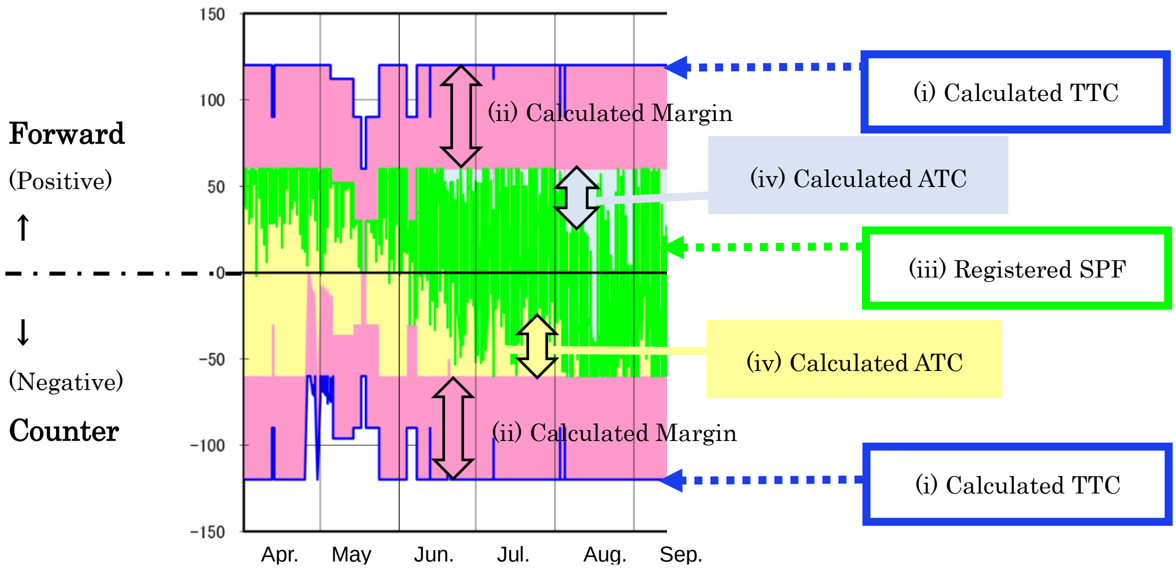


Figure 2-11: How to Interpret the ATC graphs

Table 2-13: Explanations of ATC graphs components

	By the end of September, 2018	After October, 2018 (introduction of implicit auction scheme)
(i) Calculated TTC	The maximum electricity that can be sent to the distribution facilities while securing supply reliability without damaging the transmission and distribution facilities	The same as the left
(ii) Calculated Transmission Margin	The amount of electricity managed by the Organization as a part of total TTC by the directions of scheduled power flows of the interconnection lines to receive electricity from other regional service areas through interconnection lines under abnormal situations of electric network, supply shortage or other emergent situations, to keep stabilizing the electric network, or to develop an environment of market trading of electricity, or to procure balancing capacity from other regional service areas. Power flows of allocation plans utilizing transmission margin and those employing transmission margin shall be deducted.	The amount of electricity managed by the Organization as a part of total transfer capability of the interconnection lines to receive electricity from other regional service areas through interconnection lines under abnormal situations of electric network, supply shortage or other emergent situations, to keep stabilizing the electric network, or to procure balancing capacity from other regional service areas. Scheduled power flows employing transmission margin shall be deducted.
(iii) Registered SPF	Sum of the registered power flows stated below: 1) allocation plans in "first come, first seerved" principle 2) trade in day-ahead spot market 3) trade in 1 hour-ahead market	Sum of the registered power flows stated below: 1) trade in day-ahead spot market 2) trade in 1 hour-ahead market
(iv) Calculated ATC	(iv) = (i) - (ii) - (iii) The necessary capability for long-cycle cross-regional frequency control shall be immediately deducted from ATC at the decision of its implementation.	The same as the left

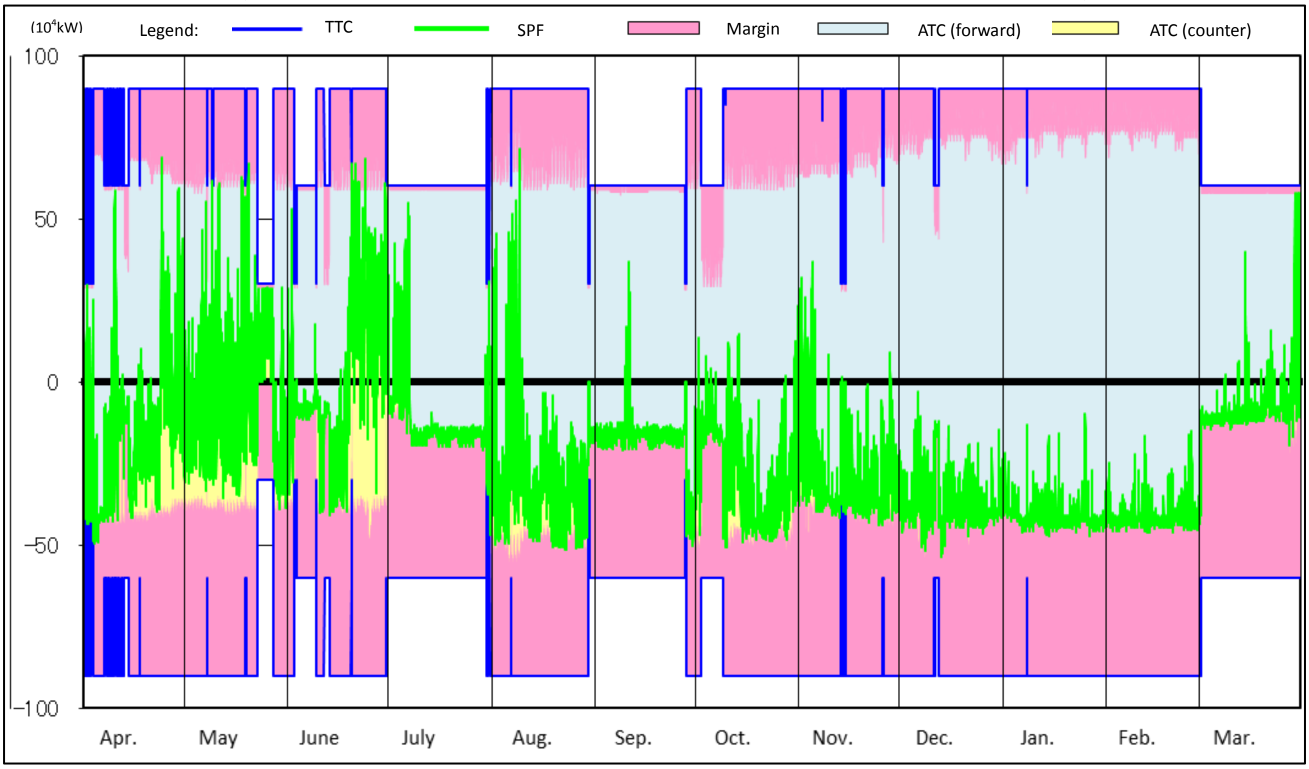
The actual flows on the transmission lines are offset in each direction. Therefore, the scheduled power flow is the offset figure between forward and counter flows, not the simple addition of each direction. In addition, offset figures on the graphs are observed as SPF, not observing the capacity of each forward and counter flow.

(Reference) Publishing actual ATC

Detailed network system information including actual ATC is available at the URL below.

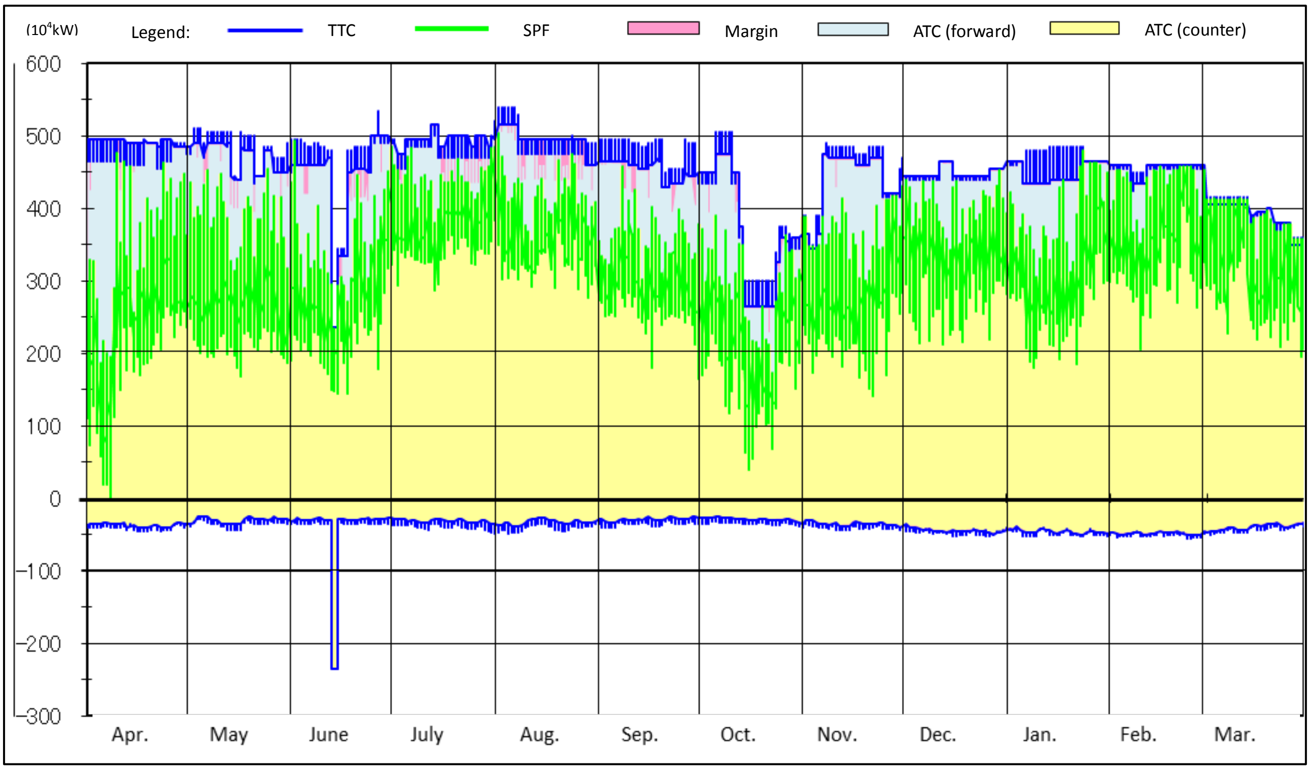
URL http://occtonet.occto.or.jp/public/dfw/RP11/OCCTO/SD/LOGIN_login#

Figure 2-12: Actual ATC of Interconnection Facilities between Hokkaido and Honshu
(Hokkaido–Honshu HVDC Link, and New Hokkaido–Honshu HVDC Link)



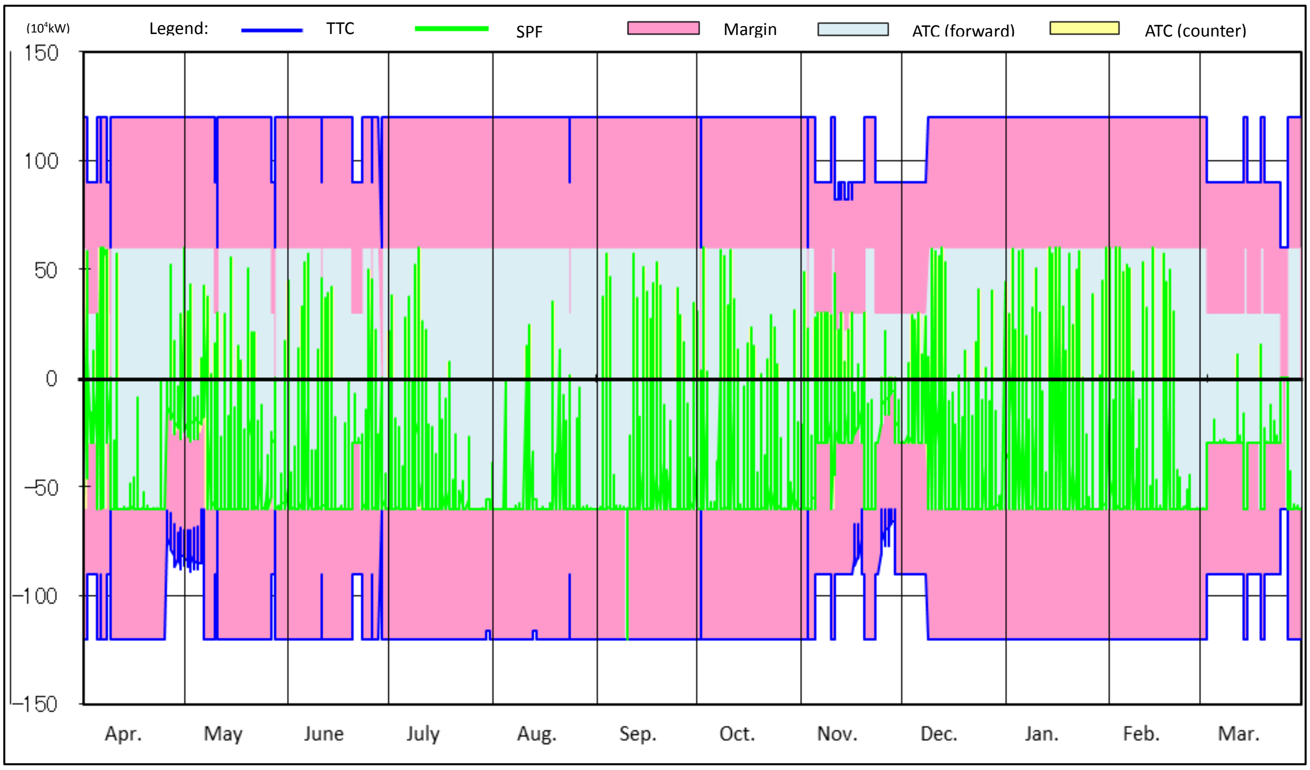
Note: Hokkaido to Tohoku as forward (positive) flow, Tohoku to Hokkaido as counter (negative) flow.

Figure 2-13: Actual ATC of Interconnection Lines between Tohoku and Tokyo
(Soma-Futaba Bulk Line and Iwaki Bulk Line)



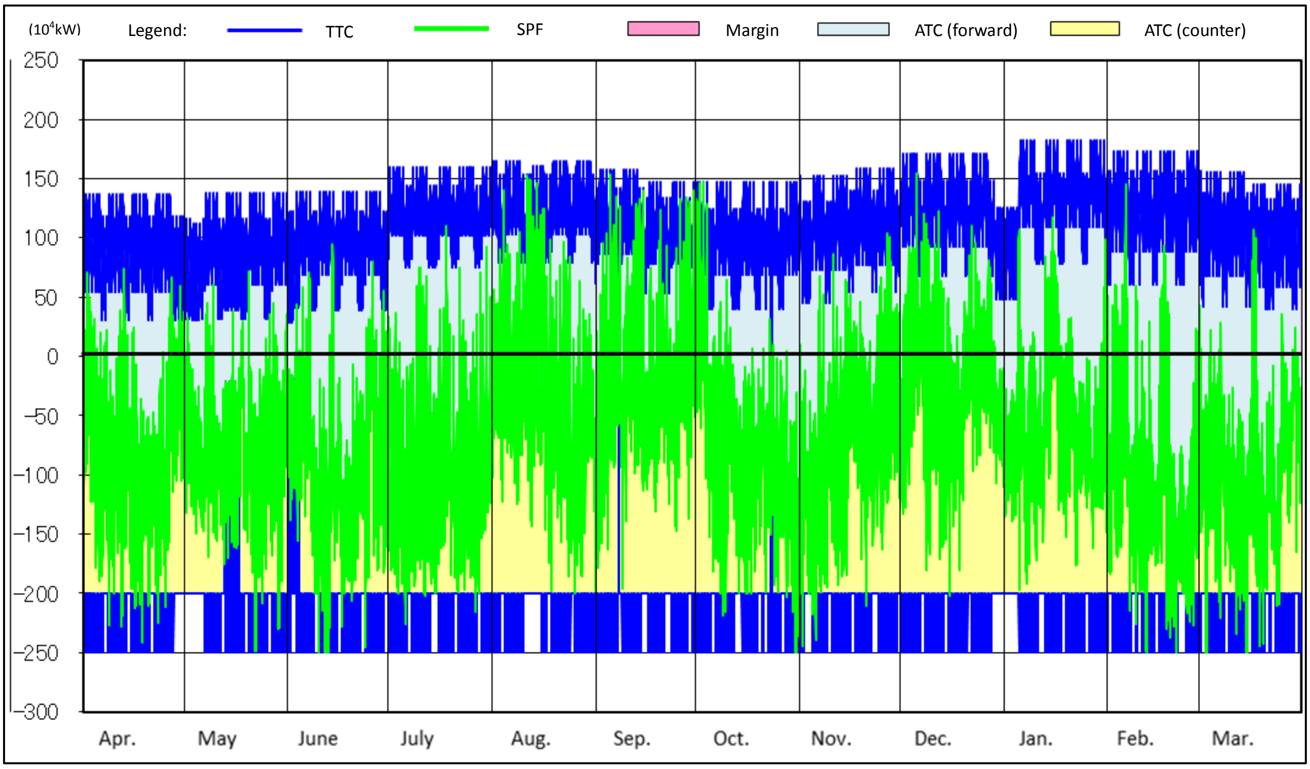
Note: Tohoku to Tokyo as forward (positive) flow, Tokyo to Tohoku as counter (negative) flow.

Figure 2-14: Actual ATC of Interconnection Facilities between Tokyo and Chubu (Sakuma, Shin-Shinano and Higashi Shimizu F.C.)



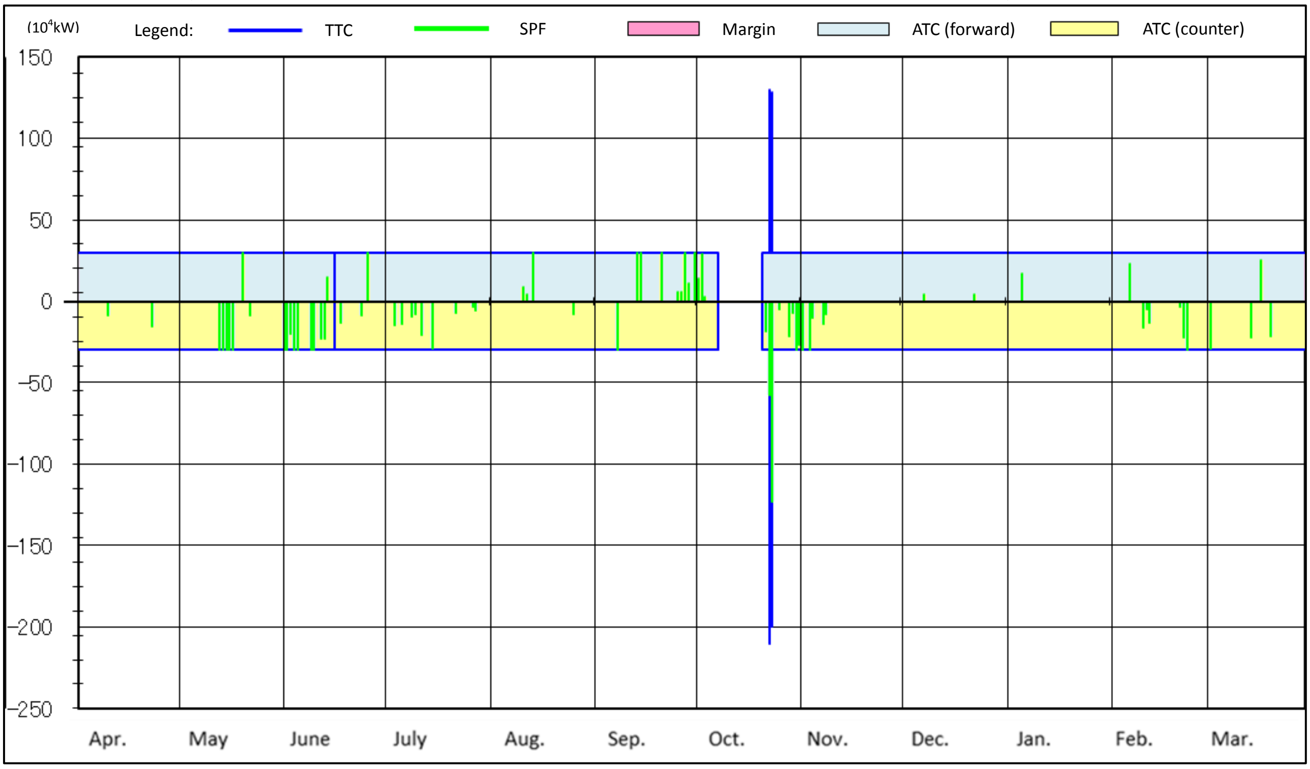
Note: Tokyo to Chubu as forward (positive) flow, Chubu to Tokyo as counter (negative) flow.

Figure 2-15: Actual ATC of the Interconnection Line between Chubu and Kansai (Mie-Higashi Omi Line)



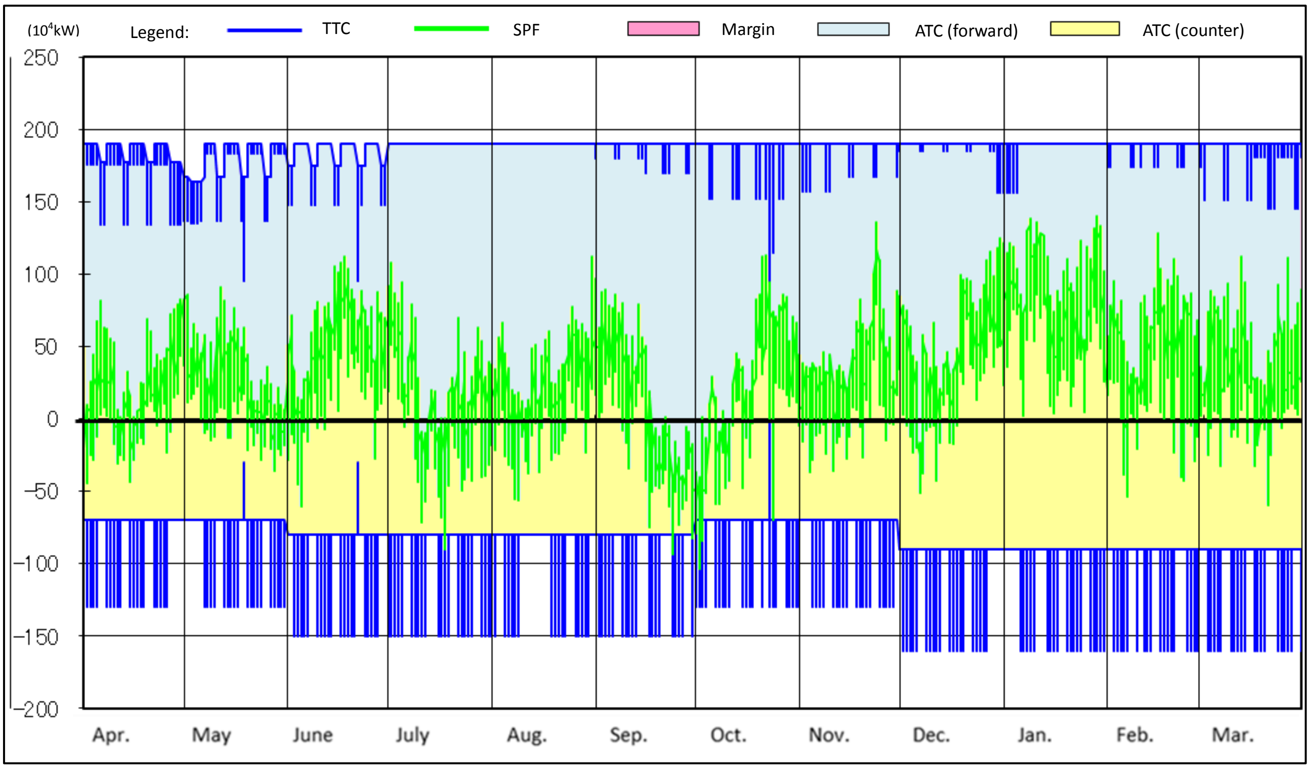
Note: Chubu to Kansai as forward (positive) flow, Kansai to Chubu as counter (negative) flow.

Figure 2-16: Actual ATC of Interconnection Facilities between Chubu and Hokuriku (Minami Fukumitsu HVDC BTB C.S. and Minami Fukumitsu Substation)



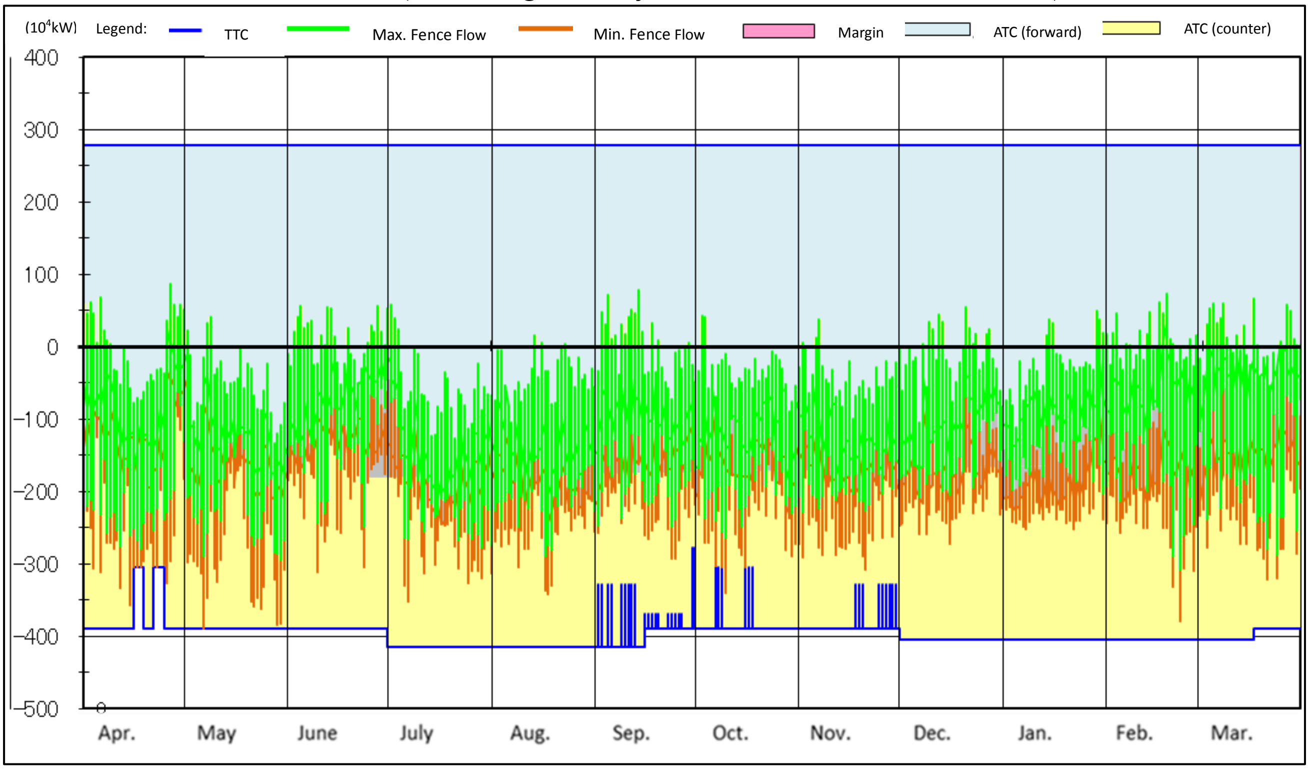
Note: Chubu to Hokuriku as forward (positive) flow, Hokuriku to Chubu as counter (negative) flow.

Figure 2-17: Actual ATC of the Interconnection Line between Hokuriku and Kansai (Echizen-Reinan Line)



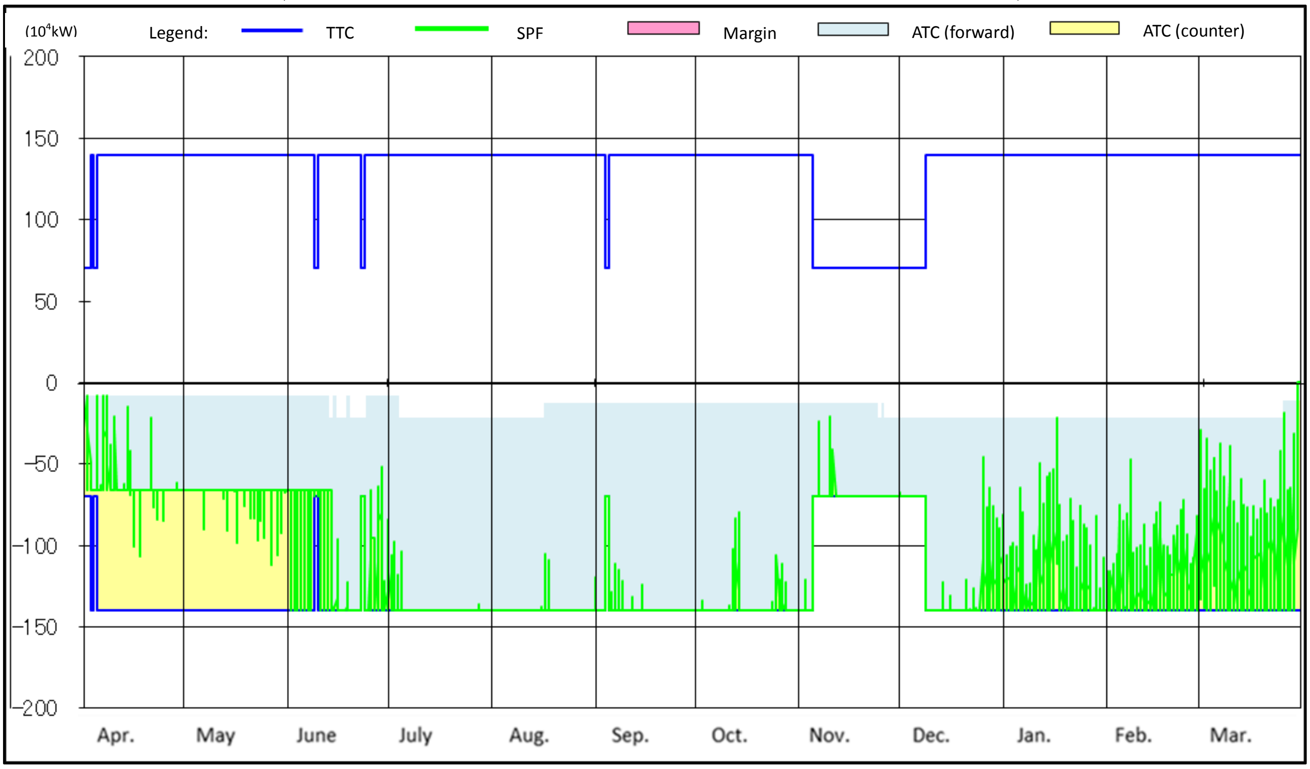
Note: Hokuriku to Kansai as forward (positive) flow, Kansai to Hokuriku as counter (negative) flow.

Figure 2-18: Actual ATC of Interconnection Lines between Kansai and Chugoku
(Seiban-Higashi Okayama Line and Yamazaki-Chizu Line)



Note: Kansai to Chugoku as forward (positive) flow, Chugoku to Kansai as counter (negative) flow.

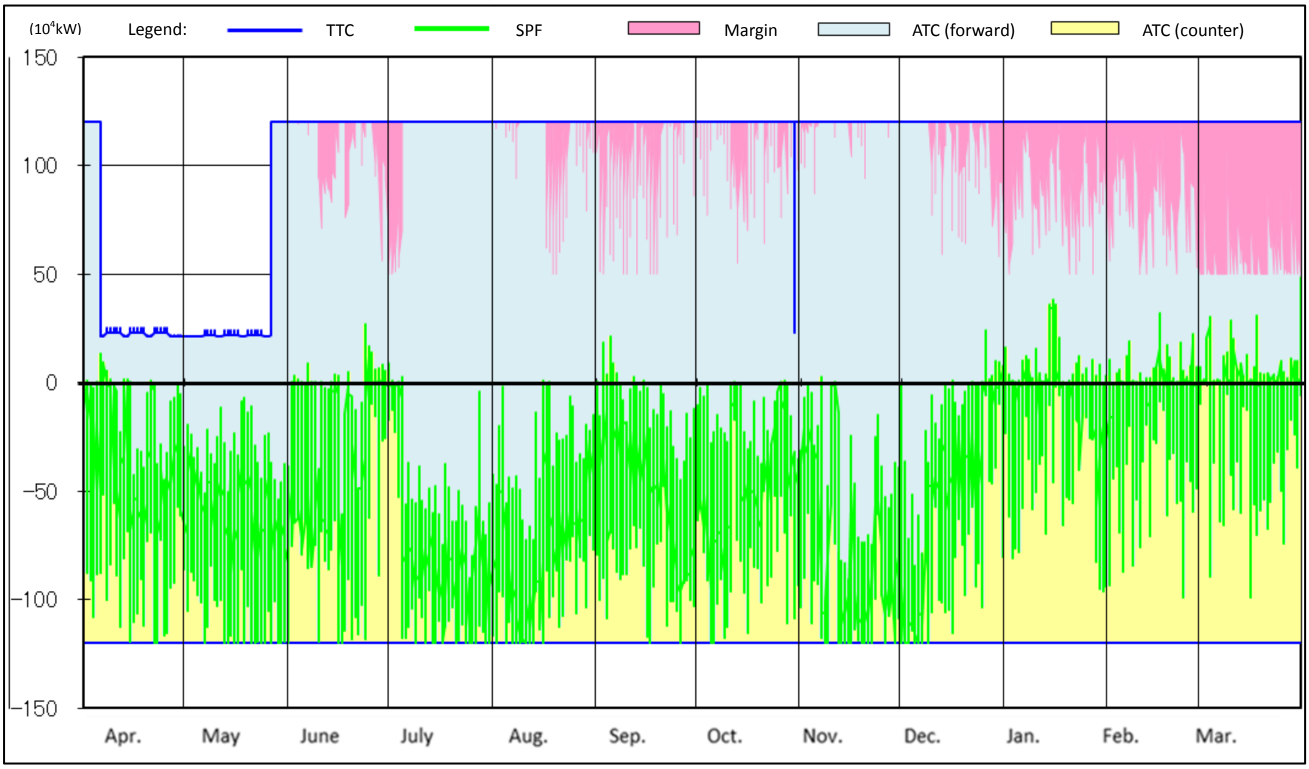
Figure 2-19: Actual ATC of Interconnection Facilities between Kansai and Shikoku
(Interconnection facilities between Kihoku and Anan AC/DC C.S.)



Note: Kansai to Shikoku as forward (positive) flow, Shikoku to Kansai as counter (negative) flow.

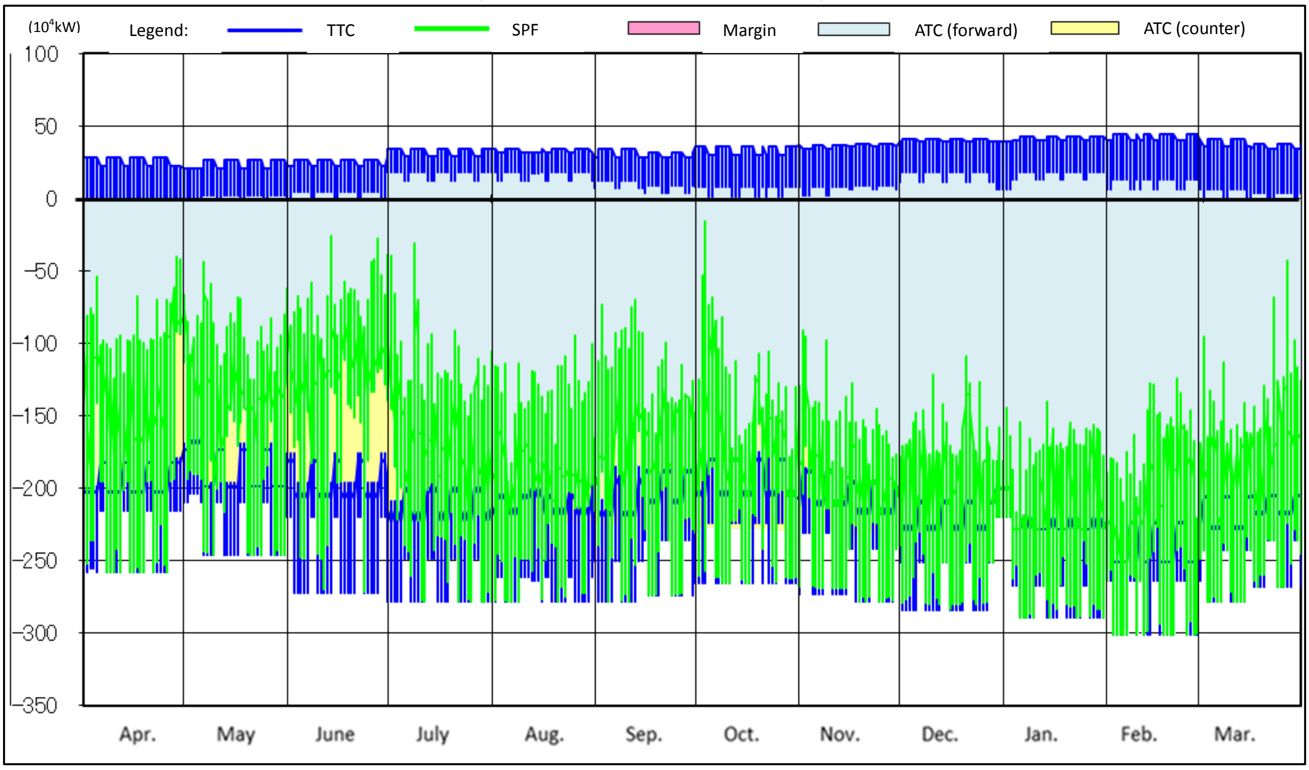
* ATC on forward flow is calculated and chosen from the smaller value from the following.
・TTC − transfer margin − SPF.
・TTC of Minami Awa Bulk Line − (Supply Capacity of Tachibanawan Thermal Power Station − SPF of Anan-Kihoku DC Bulk Line).

Figure 2-20: Actual ATC of the Interconnection Line between Chugoku and Shikoku (Honshi Interconnection Line)



Note: Chugoku to Shikoku as forward (positive) flow, Shikoku to Chugoku as counter (negative) flow.

Figure 2-21: Actual ATC of the Interconnection Line between Chugoku and Kyushu (Kanmon Interconnection Line)



Note: Chugoku to Kyushu as forward (positive) flow, Kyushu to Chugoku as counter (negative) flow.

8. Actual Constraints on Cross-regional Interconnection Lines Nationwide

For the constraints on each regional service area of the 10 GT&D, please see the links below.

---

* Constraints maps are published on the websites below (in Japanese only).

Hokkaido Electric Power Network, Inc.:
http://www.hepco.co.jp/network/con_service/public_document/bid_info.html
Tohoku Electric Power Network Co., Inc.:
https://nw.tohoku-epco.co.jp/consignment/system/announcement/
TEPCO Power Grid, Incorporated:
http://www.tepco.co.jp/pg/consignment/system/index-j.html
Chubu Electric Power Grid Co., Inc.:
https://powergrid.chuden.co.jp/takuso_service/hatsuden_kouri/takuso_kyokyu/rule/map/
Hokuriku Electric Power Transmission & Distribution Company:
http://www.rikuden.co.jp/nw_notification/U_154seiyaku.html#akiyouryu
Kansai Transmission and Distribution, Inc.:
https://www.kansai-td.co.jp/consignment/disclosure/distribution-equipment/index.html
Chugoku Electric Power Transmission & Distribution Company, Incorporated:
https://www.energia.co.jp/nw/service/retailer/keitou/access/
Shikoku Electric Power Transmission & Distribution Company, Incorporated:
https://www.yonden.co.jp/nw/line_access/index.html
Kyushu Electric Power Transmission & Distribution Co., Inc.:
https://www.kyuden.co.jp/td_service_wheeling_rule-document_disclosure
The Okinawa Electric Power Company Incorporated:
http://www.okiden.co.jp/business-support/service/rule/plan/index.html

CONCLUSION

Actual Utilization of Cross-regional Interconnection Lines

For actual utilization of cross-regional interconnection lines, data on the utilization, congestion management, maintenance work, unplanned outage, employment of transmission margin, and available transfer capability are collected.

Organization for Cross-regional
Coordination of Transmission
Operators, Japan
http://www.occto.or.jp/en/index.html

III. Actual Network Access Business

Actual Data of Preliminary Consultation, System Impact Study, and Contract Applications in FY 2019

[only in Japanese]

http://www.occto.or.jp/houkokusho/2020/files/200624_access_toukei.pdf

June 2020

Organization for Cross-regional Coordination of Transmission Operators, Japan

IV. Projection and Challenges regarding Electricity Supply–Demand and Network based on the Aggregation of Electricity Supply Plan

Aggregation of Electricity Supply Plans
Fiscal Year 2020

http://www.occto.or.jp/en/information_disclosure/supply_plan/files/supplyplan_2020.pdf

June 2020

Organization for Cross-regional Coordination of Transmission Operators, Japan

Aggregation of Electricity Supply Plans
Fiscal Year 2020

June 2020

Organization for Cross-regional Coordination of
Transmission Operators, Japan

INTRODUCTION

The Organization for Cross-regional Coordination of Transmission Operators, Japan (hereafter, the Organization) has aggregated the electricity supply plans for fiscal year (FY) 2020 according to the provisions of Article 28 of the Operational Rules of the Organization and Article 29 of the Electricity Business Act(hereafter, the Act), which require the plans to be submitted by electric power companies (EPCOs), and publish their results.

The electricity supply plans are submitted by the EPCOs according to the Network Code of the Organization, aggregated by the Organization, and sent to the Ministry of Economy, Trade and Industry (METI) annually by the end of March.

In total, 1,484 electricity supply plans for FY 2020 were aggregated, including 1,483 plans submitted by companies that became EPCOs by the end of December 2019 and one plan submitted by a company that became an EPCO by February 28, 2020.

Number of Electric Power Companies Subject to the Aggregation in FY 2020

Business License	Number
Generation Companies	821
Retail Companies	620
Specified Transmission, Distribution and Retail Companies	26
Specified Transmission and Distribution Companies	4
Transmission Companies	3
General Transmission and Distribution Companies	10
Total	1,484

[Reference] Electricity supply plan

EPCOs shall develop a comprehensive plan for electricity supply, and development of generation or transmission facility for a 10-year period according to the provisions of Article 29 of the Act.

METI shall recommend to EPCOs any alteration of the supply plan if the plan is recognized as being inadequate for the security of a stable supply by cross-regional operation or for other development of electricity business in a comprehensive and rational manner

Due Date of Submission of Supply Plans	
(1)Electric power company submission to the Organization	February 28 (draft: Feb. 10)
(2)General electric power company submission to the Organization	March 25 (draft: Mar. 10)
(3)The Organization submission to the METI	the End of March

[Reference] Items to be aggregated in the electricity supply plan

Items to be aggregated in the electricity supply plan are described in the covering letter of the aggregation of electricity supply plans according to the provisions of the Ordinance of METI. The Organization has aggregated the plans according to this description.

Items to be reported in the Aggregation (determined by the Ordinance of the METI)	Contents
I. Electricity Demand Forecast	
1. Actual and Preliminary Data for FY 2019, and Forecast for FY 2020 and 2021 (Short-Term)	Actual peak demand for the previous year, and forecast peak demand for the 1st and 2nd years of the projected period in both each regional area and nationwide
2. 10-Year Demand Forecast (Long-Term)	Forecast peak demand from the 3rd to 10th years of the projected period in both each regional area and nationwide
II. Electricity Supply and Demand	
1. Actual Data for FY 2019, and Projection for FY 2020 and 2021 (Short-Term)	Actual supply-demand for the previous year, and projected supply-demand for the 1st and 2nd years of the projected period in both each regional area and nationwide
2. Projection of Supply–Demand Balance for 10 years (Long-Term)	Projected supply-demand from the 3rd to 10th years of the projected period in both each regional area and nationwide
III. Analysis of the Transition of Power Generation Sources	Development and retirement plans of power generation sources which express the transition of power generation in nationwide
IV. Development Plans for Transmission and Distribution Facilities	Aggregated reinforcement plans of inter- and intra-regional transmission and distribution facilities
V. Cross-Regional Operation	Aggregated transaction plans between each area
VI. Analysis of Characteristics of Electric Power Companies	Aggregated situation for electric power companies by each business licenses
VII. Findings and Current Challenges	Opinion to the Minister of Economics, Trade & Industry

CONTENTS

I. Electricity Demand Forecast

1. Actual and Preliminary Data for FY 2019 and Forecast for FY 2020 and 2021 (Short-Term)

a. Peak Demand (average value of the three highest daily loads[1]) in August

Table 1-1 shows the actual data for the aggregated peak demand for each regional service area[2] submitted by the 10 general transmission and distribution (GT&D) companies for FY 2019 and the forecast[3] value for FY 2020 and 2021.

Peak demand (average value of the three highest daily loads) for FY 2020 was forecast at 158,960 MW, which represents a 0.1% increase over 158,740 MW, that is, the temperature-adjusted[4] value for FY 2019.

Peak demand for FY 2021 was forecast at 158,800 MW, which represents 60 MW or a 0.0% increase over the temperature-adjusted[4] value for FY 2019.

Table 1-1 Peak Demand (average value of the three highest daily loads) in August
(nationwide, 10^4 kW at the sending end)

FY 2019 Actual (temperature adjusted)	FY 2020 Forecast	FY 2021 Forecast
15,874	15,896 (+0.1%*)	15,880 (+0.0%*)

*% change compared with actual data for FY 2019 (temperature adjusted).

b. Forecast for FY 2019 and 2020

Tables 1-2 and 1-3 show the monthly peak demand in FY 2020 and 2021, respectively from the aggregated peak demand for each regional service area submitted by the 10 GT&D companies. The monthly peak demand in summer (August) is greater than that in winter (January) by about 9 GW; therefore, nationwide peak demand occurs in summer.

Table 1-2 Monthly Peak Demand (average value of the three highest daily loads) in FY 2020
(nationwide, 10^4 kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Peak Demand	11,607	11,467	12,683	15,856	15,896	13,931
	Oct.	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**
Peak Demand	11,926	12,467	14,341	14,980	14,956	13,480

---

1 Peak demand (average value of the three highest daily loads) corresponds to the average value of the three highest daily loads (hourly average) in each month.

2 Peak demand in the regional service areas refers to the average value of the three highest daily loads in public demand supplied by retail companies and GT&D companies through the transmission and distribution network of the GT&D companies. The Organization publishes these average values according to the provisions of paragraph 5, Article 23 of the Operational Rules.

3 Demand forecast beyond FY 2020 is based on normal weather. Thus, weather conditions for forecast assumption may vary in contrast to the actual data or estimated value in FY 2019.

4 Temperature adjustment is implemented to capture the current demand based on normal weather, which excludes demand fluctuations triggered by air-conditioner operation.

Table 1-3 Monthly Peak Demand (average value of the three highest daily loads) in FY 2021
(nationwide, 10^4 kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Peak Demand	11,599	11,458	12,671	15,840	15,880	13,918
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	11,917	12,454	14,325	14,958	14,935	13,466

c. Annual Electric Energy Requirements

Table 1-3 shows the preliminary data[5] for FY 2019 and the forecast value for FY 2020 from the aggregated electric energy requirements of each regional service area submitted by the 10 GT&D companies.

The electric energy requirements for FY 2020 are forecast at 881.8 TWh, a 0.2% increase over the 879.9 TWh in the preliminary data for FY 2019.

Table 1-4 Annual Electric Energy Requirements
(nationwide, TWh at the sending end)

FY 2019 Preliminary (temperature- and leap-year-adjusted)	FY 2020 Forecast
879.9	881.8 (+0.2%*)

* % changes over the preliminary value for the previous year.

[5] Preliminary data for annual electric energy requirements are an aggregation of the actual data from April to November 2019 with the preliminary data from December 2019 to March 2020.

2. 10-Year Demand Forecast (Long-Term)

Table 1-5 shows the major economic indicators developed and published on November 27, 2019 by the Organization, which are assumptions for the GT&D companies to forecast the peak demand in their regional service areas.

The real gross domestic product (GDP)[6] is estimated at ¥539.1 trillion in FY 2019 and ¥575.9 trillion in FY 2029 with an annual average growth rate (AAGR) of 0.7%. The index of industrial production (IIP)[7] is projected at 102.4 in FY 2019 and 109.8 in FY 2029 with an AAGR of 0.7%.

On the other hand, the population is estimated at 126.04 M. in FY 2019 and 120.10 M. in FY 2029 with an AAGR of -0.5%.

Table 1-5 Major Economic Indicators Assumed for Demand Forecast

	FY 2019	FY 2029
Gross Domestic Product(GDP)	¥539.1 trillion	¥575.9 trillion [+0.7%]*
Index of Industrial Product(IIP)	102.4	109.8 [+0.7%]*
Population	126.04 M.	120.10 M. [△0.5%]*

* Average annual growth rate for the forecast value of FY 2019

a. Peak Demand (average value of the three highest daily loads) in August

Table 1-6 shows the peak demand forecast for FY 2020, FY 2024, and FY 2029 as the aggregation of peak demand for each regional service area submitted by the 10 GT&D companies. In addition, Figure 1-1 shows the actual data and the forecast of peak demand from FY 2008 to 2029.

The peak demand nationwide is forecast at 157,870 MW in FY 2024 and 156,660 MW in FY 2029, with an AAGR of -0.1% from FY 2019 to FY 2029.

The peak demand forecast over 10 years shows a slightly decreasing trend, which is largely due to negative factors, such as efforts to reduce electricity use, wider utilization of energy-saving electric appliances, a shrinking population, and load-leveling measures, and despite positive factors such as the expansion of economic scale and greater dissemination of electric appliances.

Table 1-6 Peak Demand Forecast (average value of the three highest daily loads) for August (nationwide, 10^4 kW at the sending end)

FY 2020 [aforementioned]	FY 2024	FY 2029
15,896	15,787 [△0.1%]*	15,666 [△0.1%]*

* Average Annual Growth Rate for the forecast value of FY 2019

[6] GDP expressed as the chained price for CY 2011

[7] Index value in CY 2015 = 100

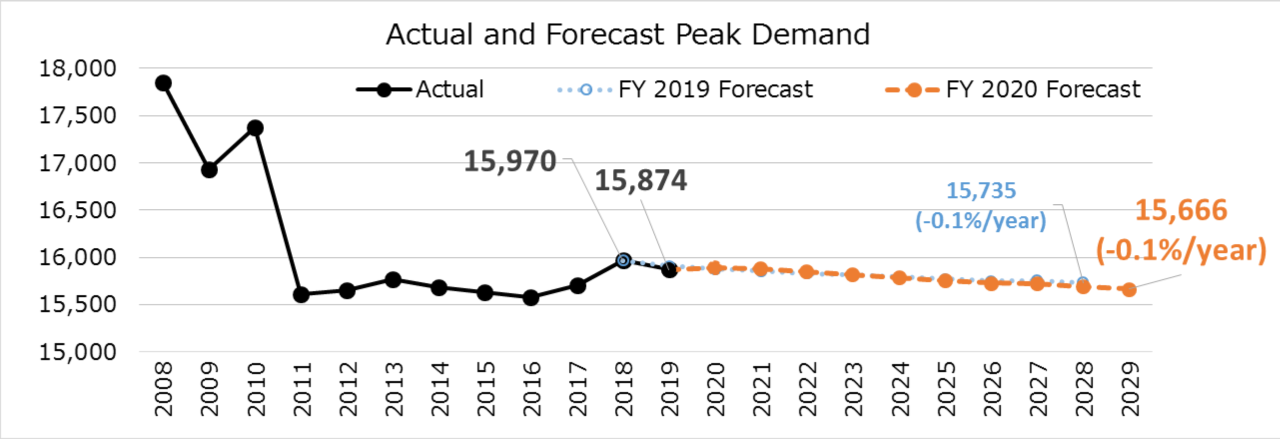


Figure 1-1 Actual and Forecast Peak Demand (August for Nationwide, 10^4 kW at the sending end)

b. Annual Electric Energy Requirement

Table 1-7 shows the forecast for annual electric energy requirements in FY 2020, FY 2024, and FY 2029 as the aggregation of the electric energy requirements for each regional service area submitted by the 10 GT&D companies.

The nationwide annual electric energy requirement is forecast at 876.9 TWh in FY 2024 and 872.1 TWh in FY 2029, with an AAGR of -0.1% from FY 2019 to FY 2029.

The annual electric energy requirement forecast over 10 years shows a slightly decreasing trend, which is largely due to negative factors, such as efforts to reduce electricity use, wider utilization of energy-saving electric appliances, and a shrinking population, and despite positive factors such as the expansion of economic scale and greater dissemination of electric appliances.

Table 1-7 Annual Electric Energy Requirement Forecast
(nationwide, TWh at the sending end)

FY 2020 [aforementioned]	FY 2024	FY 2029
881.8	876.9 [△0.1%]*	872.1 [△0.1%]*

* AAGR for the forecast value of FY 2019.

II. Electricity Supply and Demand

1. Supply–Demand Balance Evaluation Method

The Organization will evaluate the supply–demand balance for each regional service area as well as nationwide using the supply capacity[8] and peak demand data for the regional service areas.

The Organization will implement its evaluation using the criterion of whether the reserve margin (%)[9] for each regional service area is secured over 8% or not. In the Okinawa EPCO regional service area, the criterion is to secure power supply capacity over peak demand against an interruption of its largest generating unit and balancing capacity with frequency control function in its regional service area and the evaluation will be implemented at the time of the least reserve margin.

Figure 2-1 summarizes the supply–demand balance evaluation. Supply capacity includes the generating capacity requirements secured by retail and GT&D companies for their regional service areas and the production of surplus power[10] of generation companies. The supply capacity currently secured by retail companies includes power procured[11] from other regional service areas through cross-regional interconnection lines. Thus, the surplus power of generation companies or reserve capacity of retail companies might provide supply capacity for other regional service areas in the future.

Under the circumstances in which the operation of a nuclear power plant has become uncertain, the supply capacity of the corresponding unit or plant is recorded as zero where the corresponding supply capacity is reported as "uncertain" according to Procedures for Electricity Supply Plans of FY 2020 (published in December 2019 by the Agency for Natural Resources and Energy). In the electricity supply plans for FY 2020, supply capacity was reported as "uncertain" by all nuclear power plants except for those that had resumed operation by the time of the submission of the electricity supply plans (February 28, 2020).

---

[8] Supply capacity is the maximum power that can be generated steadily during the peak demand period (average value of the three highest daily loads).

[9] Reserve margin (%) describes the difference between supply capacity and peak demand (average value of the three highest daily loads) divided by peak demand (average value of the three highest daily loads).

[10] Surplus power is the surplus power generation capacity of generation companies in a regional service area without sales destination.

[11] In case of congestion in cross-regional interconnection lines, the rebated figure to each area calculated by the Organization is added.

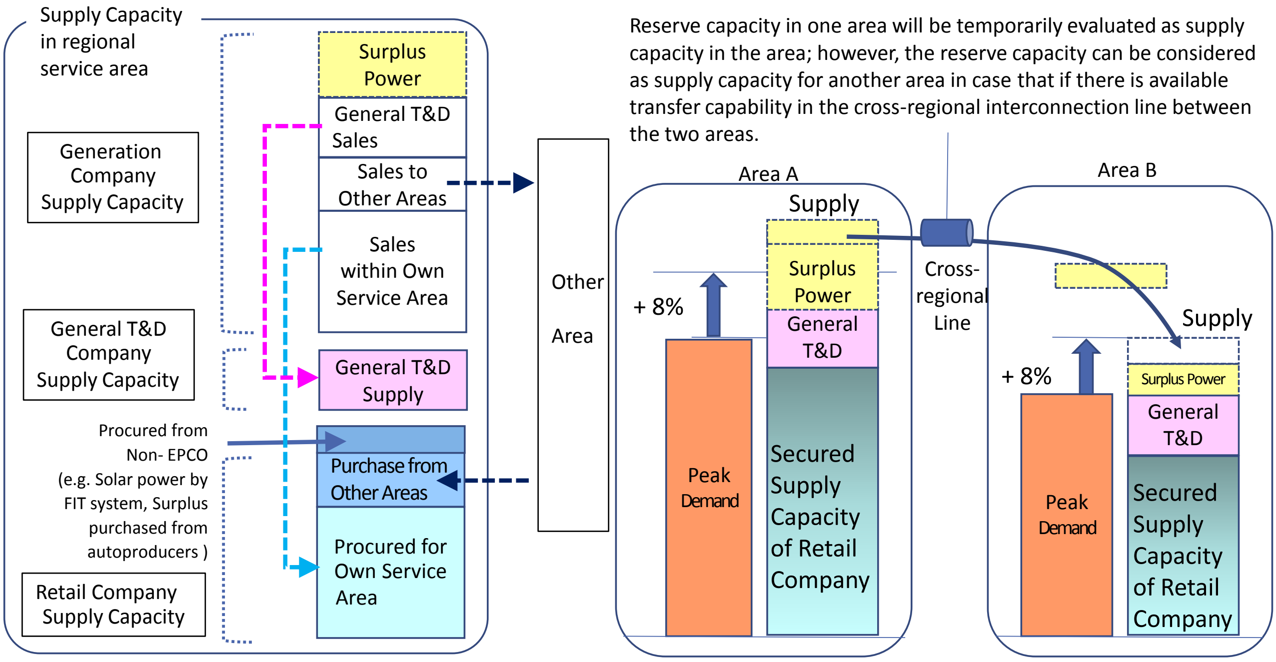


Figure 2-1 Summary of Supply–Demand Balance Evaluation

[Reference] Calculation Method of Supply Capacity

The calculation method of supply capacity or surplus power is based on the description in the "Guideline for the Calculation of Demand and Supply Capacity"[12] (Agency for Natural Resources and Energy: Dec. 2019) and "Procedures for Electricity Supply Plans of FY 2020"[13] (Agency for Natural Resources and Energy: Dec. 2019).

[12] Guideline for the Calculation of Demand and Supply Capacity(only in Japanese) https://www.enecho.meti.go.jp/category/electricity_and_gas/electricity_measures/001/pdf/guideline.pdf

[13] Procedures for Electricity Supply Plans of FY 2020(only in Japanese) https://www.enecho.meti.go.jp/category/electricity_and_gas/electricity_measures/001/pdf/kisai-youryo.pdf

[Reference]Evaluation Steps of Supply-Demand Balance

Evaluation steps of supply-demand balance is stated below.

STEP 1

Evaluate Supply-Demand Balance by aggregating supply capacity in **each regional service area**

（For Okinawa area, evaluation is implemented at the time of least reserve margin instead of the time of occurring peak demand）

↓

STEP 2

Evaluate Supply-Demand Balance by adding supply capacity in other area through **utilization of cross-regional lines**

↓

STEP 3

Evaluate Supply-Demand Balance by further adding **power generation facilities development not reported in the supply plans**

[Reference] Calculation Method of Available Transfer Capability(ATC)

The calculation method of available transfer capability of cross-regional interconnection lines is stated below.

ATC = Transfer Capability (1) – Transfer Margin (2) – Schedule Power Flow of cross-regional interconnection line at 15:00 in August (3)

Short-term

(1): Based on "Transfer Capability of Cross-regional Interconnection Lines FY 2020-2029" [annual and long-term plans] (Feb. 28, 2020: The Organization)[14]

(2): Based on "Transfer Margin of Cross-regional Interconnection Lines FY 2020 and 2021" [annual plan] (Feb. 28, 2020: The Organization)[15,16]

(3): Based on monthly scheduled power flows reported in the "Plan for Transaction of Electricity (Table 36)" of the electricity supply plan for FY 2020

Mid-to-Long-term

(1): For FY 2020 and 2021, the August value calculated from (1) above in Short-term, for FY 2022-2029, based on "Transfer Capability of Cross-regional Interconnection Lines FY 2020-2029" [annual and long-term plans] (Feb. 28, 2020: The Organization)[14]

(2): For FY 2020 and 2021, the August value calculated from (2) above in Short-term, for FY 2022-2029, based on "Transfer Margin of Cross-regional Interconnection Lines FY 2022-2029" [long-term plans] (Mar. 1, 2020: The Organization)

(3): Based on 15:00 in August scheduled power flows of the period reported in "Plan for Transaction of Electricity (Table 32-8)" of the electricity supply plan for FY 2020

[14] Reference: material from the "5th Meeting of the Working Group on Cross-regional Transfer Capability" (in Japanese)
http://www.occto.or.jp/iinkai/unyouyouryou/2019/unyouyouryou_2019_5_haifu.html

[15] Reference: material from the "4th Meeting of the Working Group on Transmission Margin" (in Japanese)
http://www.occto.or.jp/iinkai/margin/2019/margin_kentoukai_2019_4.html

[16] The value of the transfer margin for FY 2021 is calculated based on the "Transfer Margin of Cross-regional Interconnection Lines FY 2020 and 2021" [annual plan] (Feb. 28, 2020: The Organization)

2. Actual Data for FY 2019 and Projection for FY 2020 and 2021 (Short-Term)

a. Actual Data for FY 2019

Table 2-1 shows the actual supply–demand balance in August 2019 based on the nationwide supply capacity and peak demand data.

A reserve margin of 8%, which is the criterion for stable supply, was secured in all regional service areas supplied by GT&D companies.

Table 2-1 Actual Supply–Demand Balance in August 2019
(nationwide, 10^4 kW at the sending end)

Peak Demand (temperature adjusted) [aforementioned]	Supply Capacity (nationwide)	Reserve Capacity	Reserve Margin
15,874	17,835	1,961	12.4%

Table 2-2 shows the actual supply–demand balance in each regional service area in August 2019. Although the reserve margin of Kansai area was below 3%, a reserve margin of 8% was secured utilizing cross-regional interconnection lines to share power from other areas with sufficient supply capacity within the ATC.

Table 2-2 Actual Supply–Demand Balance in August 2019
(each regional service area, 10^4 kW at the sending end)

	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
Peak Demand	423	1,303	5,289	2,454	497	2,691	1,042	488	1,538	150
Supply Capacity	468	1,500	5,858	2,771	591	2,769	1,229	587	1,841	222
Reserve Margin	10.6%	15.1%	10.7%	12.9%	18.9%	**2.9%**	18.0%	20.4%	19.7%	47.8%
Levelized Reserve Margin	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	11.5%	16.6%	47.8%

<Reference> Supply and Demand Balance of Actual Operation

Table 2-3 shows that a reserve margin of 3%, which is the criterion for stable daily operation, was secured at actual supply and demand.

Table 2-3 Supply–Demand Balance of Actual Operation in August 2019
(each regional service area, 10^4 kW at the sending end)

	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
Peak Demand	438	1,440	5,510	2,539	521	2,751	1,067	494	1,546	145
Supply Capacity	469	1,509	5,990	2,847	584	3,081	1,172	600	1,814	206
Reserve Margin	7.2%	4.8%	8.7%	12.1%	12.1%	12.0%	9.8%	21.6%	17.3%	42.4%

b. **Projection of Supply–Demand Balance in FY 2020 and 2021**

i) Projection for FY 2020

Table 2-4 and Figure 2-2 show the projection of a monthly supply–demand balance (at the time of the least reserve margin nationwide[17]) for FY 2020. A reserve margin of 8% is secured for each month nationwide, even in the lowest margin of 11.8% in December.

Table 2-4 Projection of the Monthly Supply–Demand Balance for FY 2019
(at the time of the least reserve margin; nationwide, [17] 10^4 kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Peak Demand	11,607	11,466	12,678	15,854	15,892	13,927
Supply Capacity	14,100	14,354	15,454	17,829	17,948	17,047
Reserve Margin	21.5%	25.2%	21.9%	12.5%	12.9%	22.4%
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	11,926	12,467	14,341	14,980	14,956	13,480
Supply Capacity	14,660	14,485	16,036	16,819	16,911	16,226
Reserve Margin	22.9%	16.2%	11.8%	12.3%	13.1%	20.4%

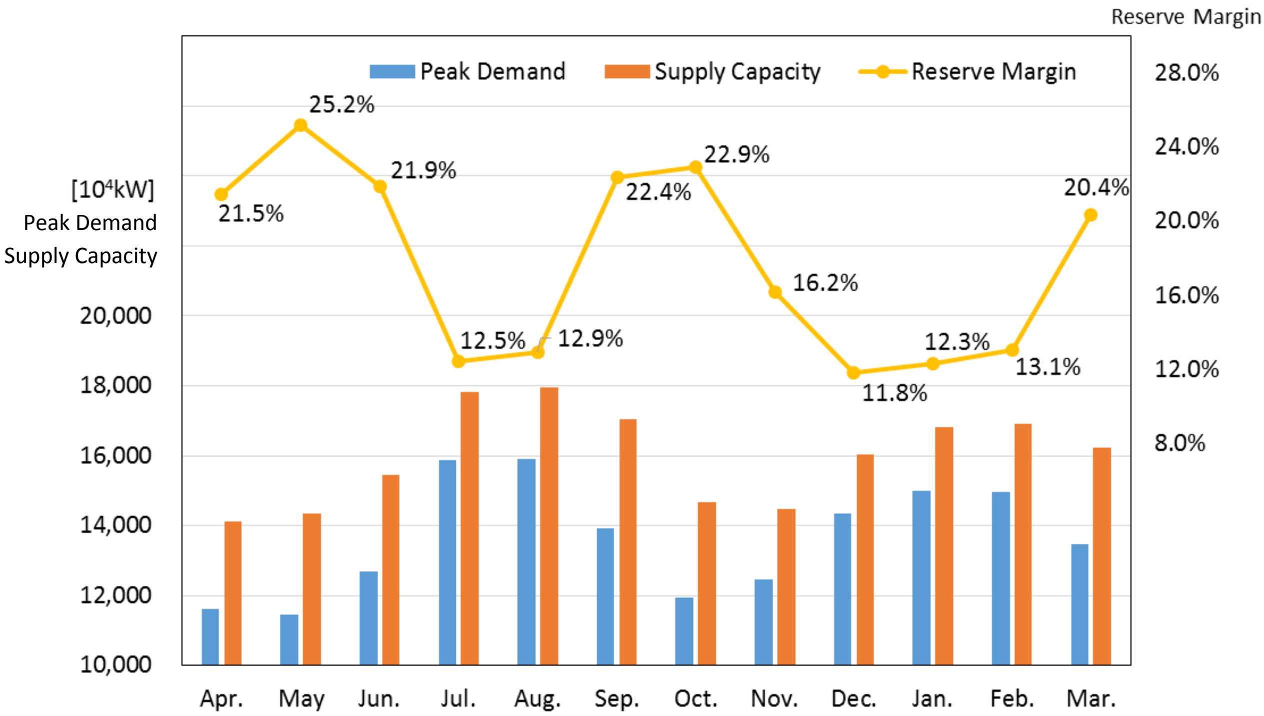


Figure 2-2 Projection of the Monthly Supply–Demand Balance for FY 2020
(at the time of the least reserve margin;[17] nationwide, at the sending end)

[17] Addition of the peak demand and the supply capacity at the time of the least reserve margin.

Table 2-5 shows the monthly projection of the least reserve margin for each regional service area. In addition, Table 2-6 shows the monthly projection of the least reserve margin for each regional service area recalculated to levelize using power exchanges to areas below the 8% reserve margin from areas of over the 8% reserve margin based on the ATC.[18]

The least reserve margin for each regional service area almost secures the criterion of a stable supply, with a reserve margin of 8%, except for some areas and months such as Hokuriku area in December, Kansai area from December to February, and Kyushu area in December and January. However, reserve margins of 8% (the criterion of stable supply) are secured by using cross-regional interconnection lines to share power from other areas with sufficient supply capacity.

Table 2-5 Monthly Projection of the Least Reserve Margins Nationwide and for Each Regional Service Area (resources within own service area only, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	48.9%	69.9%	61.3%	28.7%	31.9%	43.6%	23.8%	38.6%	16.9%	13.9%	13.8%	26.9%
Tohoku	23.0%	33.0%	23.1%	14.6%	16.2%	17.9%	17.6%	16.0%	16.2%	16.5%	16.2%	22.5%
Tokyo	11.1%	18.1%	20.3%	9.2%	10.0%	20.0%	20.1%	11.6%	12.7%	12.3%	13.3%	16.1%
50 Hz areas Total	16.3%	24.7%	23.5%	11.3%	12.5%	21.1%	19.9%	14.7%	13.7%	13.3%	13.9%	18.2%
Chubu	17.0%	21.4%	22.5%	9.1%	10.6%	21.4%	27.1%	23.3%	20.4%	15.9%	15.7%	23.4%
Hokuriku	42.6%	41.3%	24.7%	26.6%	20.9%	22.4%	12.8%	9.9%	**5.7%**	9.6%	11.2%	20.6%
Kansai	21.5%	15.3%	8.8%	8.6%	8.9%	20.6%	13.7%	8.5%	**2.2%**	**5.2%**	**6.7%**	13.5%
Chugoku	29.0%	32.9%	38.2%	24.1%	23.2%	33.7%	41.9%	25.6%	13.0%	14.5%	13.1%	27.1%
Shikoku	34.9%	29.3%	28.1%	22.4%	23.4%	28.1%	53.4%	25.5%	17.4%	20.8%	18.1%	25.8%
Kyushu	32.9%	36.0%	21.2%	12.5%	11.5%	22.5%	23.2%	14.1%	**2.4%**	**7.6%**	10.9%	26.0%
60 Hz areas Total	25.0%	25.0%	20.4%	13.1%	13.1%	23.2%	24.9%	16.9%	9.7%	10.9%	11.7%	21.3%
Interconnected	21.0%	24.9%	21.8%	12.3%	12.8%	22.3%	22.7%	15.9%	11.5%	12.0%	12.7%	19.9%
Okinawa	74.0%	55.8%	31.9%	28.8%	27.9%	31.5%	44.8%	49.4%	63.6%	57.8%	68.2%	85.6%
Nationwide	21.5%	25.2%	21.9%	12.5%	12.9%	22.4%	22.9%	16.2%	11.8%	12.3%	13.1%	20.4%

Below 8% criteria

Table 2-6 Monthly Projection of the Least Reserve Margins Nationwide and for Each Regional Service Area (with power exchanges through cross-regional interconnection lines, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	41.9%	61.2%	61.3%	18.0%	25.8%	35.0%	19.9%	23.1%	13.6%	12.9%	12.9%	18.2%
Tohoku	14.2%	21.9%	20.6%	10.9%	11.6%	20.2%	19.9%	13.9%	13.6%	12.9%	12.9%	18.2%
Tokyo	14.2%	21.9%	20.6%	10.9%	11.6%	20.2%	19.9%	13.9%	13.6%	12.9%	12.9%	18.2%
Chubu	25.0%	24.6%	20.6%	13.1%	13.1%	23.2%	24.9%	17.4%	13.6%	11.2%	12.6%	21.3%
Hokuriku	25.0%	24.6%	20.6%	13.1%	13.1%	23.2%	24.9%	16.7%	8.3%	11.2%	12.6%	21.3%
Kansai	25.0%	24.6%	20.6%	13.1%	13.1%	23.2%	24.9%	16.7%	8.3%	11.2%	12.6%	21.3%
Chugoku	25.0%	24.6%	20.6%	13.1%	13.1%	23.2%	24.9%	16.7%	8.3%	11.2%	12.6%	21.3%
Shikoku	25.0%	24.6%	20.6%	13.1%	13.1%	23.2%	24.9%	16.7%	8.3%	11.2%	12.6%	21.3%
Kyushu	25.0%	27.0%	20.6%	13.1%	13.1%	23.2%	24.9%	16.7%	8.3%	11.2%	12.6%	21.3%
Interconnected	21.0%	24.9%	21.8%	12.3%	12.8%	22.3%	22.7%	15.9%	11.5%	12.0%	12.7%	19.9%
Okinawa	74.0%	55.8%	31.9%	28.8%	27.9%	31.5%	44.8%	49.4%	63.6%	57.8%	68.2%	85.6%
Nationwide	21.5%	25.2%	21.9%	12.5%	12.9%	22.4%	22.9%	16.2%	11.8%	12.3%	13.1%	20.4%

Improve to over 8%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection lines.

[18] This evaluation is implemented based on the following. The evaluation of timing of utilization of interconnection lines varies in the regional service areas; power exchange availability is calculated based on the least reserve margin, and the calculated results are lower than those based on the reserve margin at a given time. Therefore, this evaluation covers a more severe condition, which is better for a stable supply.

Further, information on environmental assessment of thermal power plants[19] probably includes some generating facilities which EPCO confirm their business judgment and proceed to their construction. Therefore, the Organization has investigated generating facilities that are not included in the electricity supply plans, although they have already made application for generator connection to GT&D companies and submitted construction plans according to the provisions of Article 48 of the Act in cooperation with the Government.
As a result, there are 250 MW of such generating facilities nationwide; thus, the Organization includes those facilities to supply capacity and recalculates reserve margins as outlined in Table 2-7.

Table 2-7 Monthly Projection of the Least Reserve Margins Nationwide and for Each Regional Service Area (with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	41.9%	61.2%	61.3%	18.0%	25.8%	35.0%	20.0%	26.9%	13.8%	13.2%	13.1%	18.5%
Tohoku	14.2%	21.9%	20.6%	10.9%	11.6%	20.2%	20.0%	13.9%	13.8%	13.2%	13.1%	18.5%
Tokyo	14.2%	21.9%	20.6%	10.9%	11.6%	20.2%	20.0%	13.9%	13.8%	13.1%	13.1%	18.5%
Chubu	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	17.4%	13.8%	11.3%	12.6%	21.4%
Hokuriku	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Kansai	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Chugoku	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Shikoku	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Kyushu	25.0%	27.0%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Interconnected	21.0%	24.9%	21.8%	12.4%	12.8%	22.4%	22.8%	16.1%	11.6%	12.1%	12.9%	20.1%
Okinawa	74.0%	55.8%	31.9%	28.8%	27.9%	31.5%	44.8%	49.4%	63.6%	57.8%	68.2%	85.6%
Nationwide	21.5%	25.2%	21.9%	12.5%	13.0%	22.5%	23.0%	16.4%	12.0%	12.4%	13.2%	20.6%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

In the Okinawa EPCO regional service area,[20] which is a small and isolated island system unable to receive power through interconnection lines, the criterion of stable supply is to secure supply capacity over peak demand by deducting the capacity of the largest generating unit and balancing capacity with frequency control ('Generator I', total of 301 MW), without applying the criteria of other interconnected areas.[21]
Table 2-8 shows the monthly reserve margin against the deduction of the capacity of Generator I, which indicates the stable supply was secured in each month.

Table 2-8 Monthly Reserve Margin against the Deduction of the Capacity of Generator I (at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Okinawa	44.8%	30.8%	10.0%	8.1%	7.3%	10.4%	21.7%	22.4%	33.1%	28.4%	38.5%	54.0%

[19] Reference: Information on environmental assessment of thermal power plants (METI website, only in Japanese) http://www.meti.go.jp/policy/safety_security/industrial_safety/sangyo/electric/detail/thermal.html
[20] In the Okinawa EPCO regional service area, the evaluation excludes the reserve margins of several isolated islands.
[21] The evaluation is implemented at the time of the least reserve margin instead of the peak demand occurrence.

ii) Projection for FY 2021[22]

Table 2-9 and Figure 2-3 show the projection of a monthly supply–demand balance (at the time of the least reserve margin nationwide[17]) for FY 2021. A reserve margin of 8% is secured for each month nationwide, even in the lowest margin of 9.9% in February.

Table 2-9 Projection of the Monthly Supply–Demand Balance for FY 2021
(at the time of the least reserve margin; nationwide[17], 10^4 kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Peak Demand	11,599	11,457	12,668	15,838	15,876	13,914
Supply Capacity	14,522	14,667	15,403	17,777	17,885	16,814
Reserve Margin	25.2%	28.0%	21.6%	12.2%	12.7%	20.8%
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	11,917	12,454	14,325	14,958	14,935	13,466
Supply Capacity	14,668	14,360	16,018	16,651	16,420	15,355
Reserve Margin	23.1%	15.3%	11.8%	11.3%	9.9%	14.0%

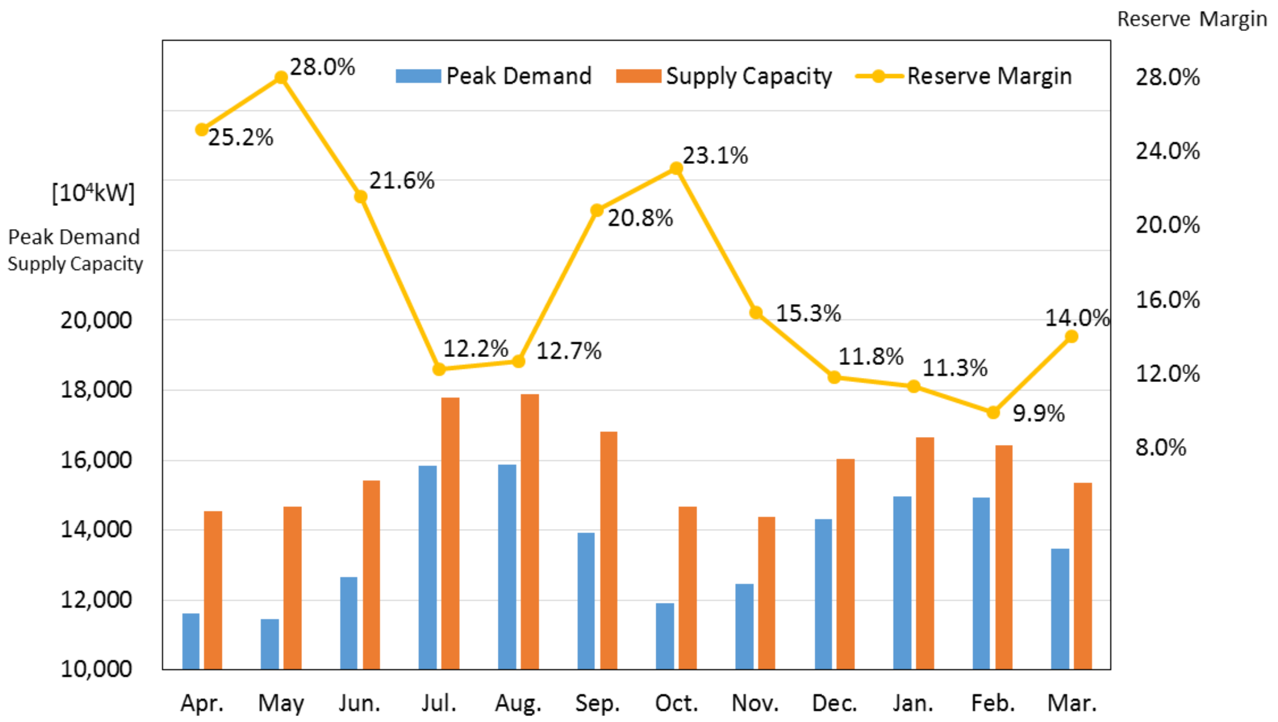


Figure 2-3 Projection of the Monthly Supply–Demand Balance for FY 2021
(at the time of the least reserve margin;[17] nationwide, at the sending end)

[22] The Organization has structured "special generator procurement", which is the scheme for soliciting and utilizing suspended or retiring generation facility as supply capacity in case supply capacity shortage is projected. Accordingly, METI has amended the Ordinance for Enhancement of the Electricity Business; changes include the submission of an enlarged monthly supply–demand balance to the second projected year of the electricity supply plan.

Table 2-10 shows the monthly projection of the least reserve margin for each regional service area. In addition, Table 2-11 shows the monthly projection of the least reserve margin for each regional service area recalculated to levelize using power exchanges to areas below the 8% reserve margin from areas of over the 8% reserve margin based on the ATC.[18]

The least reserve margin for each regional service area almost secures the criterion of a stable supply, with a reserve margin of 8%, except for some areas and months such as Tokyo area in July, August, November, and from January to March, Chubu area in July, August, and from December to February, and Kansai and Chugoku areas, both in December. However, reserve margins of 8% (the criterion of stable supply) are secured by using cross-regional interconnection lines to share power from other areas with sufficient supply capacity.

Table 2-10 Monthly Projection of the Least Reserve Margins Nationwide and for Each Regional Service Area
(resources within own service area only, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	43.5%	54.4%	56.9%	32.3%	27.6%	39.1%	22.7%	34.1%	32.5%	28.3%	29.6%	22.8%
Tohoku	25.6%	37.8%	28.0%	25.4%	24.7%	20.6%	23.9%	18.4%	19.1%	21.3%	21.6%	22.5%
Tokyo	16.8%	22.3%	13.4%	**4.5%**	**5.2%**	16.3%	16.8%	**7.9%**	10.5%	**6.7%**	**4.8%**	**6.9%**
50 Hz areas Total	20.6%	27.6%	19.0%	9.9%	10.1%	18.6%	18.7%	12.2%	14.0%	11.3%	10.1%	11.3%
Chubu	20.6%	20.0%	19.5%	**6.4%**	**6.6%**	11.8%	17.0%	14.2%	**7.7%**	**6.4%**	**4.0%**	10.2%
Hokuriku	23.5%	33.5%	23.4%	14.8%	9.4%	16.1%	29.2%	15.8%	15.0%	9.1%	9.4%	16.3%
Kansai	28.4%	22.0%	17.6%	8.5%	8.9%	17.5%	21.8%	14.6%	**5.7%**	8.3%	10.0%	12.3%
Chugoku	26.5%	35.2%	30.7%	26.2%	27.0%	32.6%	33.6%	16.0%	**6.1%**	12.4%	13.8%	21.4%
Shikoku	37.1%	47.0%	33.4%	24.5%	23.4%	34.5%	48.9%	20.8%	15.9%	19.4%	17.3%	21.2%
Kyushu	43.9%	38.6%	30.1%	21.6%	25.1%	39.3%	35.5%	27.2%	16.3%	17.9%	10.4%	23.5%
60 Hz areas Total	28.6%	27.8%	23.1%	13.6%	14.1%	22.2%	26.0%	17.2%	9.4%	10.7%	9.2%	15.5%
Interconnected	24.9%	27.7%	21.3%	12.0%	12.3%	20.6%	22.8%	14.9%	11.4%	11.0%	9.6%	13.6%
Okinawa	60.1%	55.7%	48.3%	42.9%	44.9%	40.7%	49.7%	55.9%	68.8%	60.9%	59.3%	72.1%
Nationwide	25.2%	28.0%	21.6%	12.2%	12.7%	20.8%	23.1%	15.3%	11.8%	11.3%	9.9%	14.0%

Below 8% criteria

Table 2-11 Monthly Projection of the Least Reserve Margins Nationwide and for Each Regional Service Area
(with power exchanges through cross-regional interconnection lines, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	26.6%	41.2%	49.8%	22.9%	20.0%	36.9%	19.1%	19.5%	17.9%	14.1%	15.3%	13.5%
Tohoku	21.8%	26.5%	17.6%	9.5%	9.7%	16.1%	19.1%	12.1%	11.3%	12.9%	15.3%	13.5%
Tokyo	20.6%	26.5%	17.6%	9.5%	9.7%	16.1%	19.1%	12.1%	11.2%	10.7%	8.0%	10.5%
Chubu	24.3%	26.5%	22.5%	9.9%	10.3%	16.1%	19.9%	16.0%	11.2%	10.7%	8.6%	14.7%
Hokuriku	24.3%	28.4%	22.5%	14.7%	13.9%	16.1%	19.9%	16.0%	11.2%	10.7%	9.5%	15.6%
Kansai	26.0%	28.4%	22.5%	14.7%	13.9%	24.7%	29.0%	17.1%	11.2%	10.7%	9.5%	15.6%
Chugoku	26.0%	28.4%	22.5%	14.7%	13.9%	24.7%	29.0%	17.1%	11.2%	10.7%	9.5%	15.6%
Shikoku	26.0%	28.4%	22.5%	14.7%	13.9%	24.7%	29.0%	17.1%	11.2%	10.7%	9.5%	15.6%
Kyushu	41.3%	28.6%	22.5%	14.7%	20.2%	33.4%	29.5%	17.8%	11.2%	10.7%	9.5%	16.1%
Interconnected	24.9%	27.7%	21.3%	12.0%	12.3%	20.6%	22.8%	14.9%	11.4%	11.0%	9.6%	13.6%
Okinawa	60.1%	55.7%	48.3%	42.9%	44.9%	40.7%	49.7%	55.9%	68.8%	60.9%	59.3%	72.1%
Nationwide	25.2%	28.0%	21.6%	12.2%	12.7%	20.8%	23.1%	15.3%	11.8%	11.3%	9.9%	14.0%

Improve to over 8%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection lines.

Further, information on environmental assessment of thermal power plants[19] probably includes some generating facilities which EPCO confirm their business judgment and proceed to their construction. Therefore, the Organization has investigated generating facilities that are not included in the electricity supply plans, although they have already made application for generator connection to GT&D companies and submitted construction plans according to the provisions of Article 48 of the Act in cooperation with the Government.

As a result, there are 320 MW of such generating facilities nationwide; thus, the Organization includes those facilities to supply capacity and recalculates reserve margins as outlined in Table 2-12.

Table 2-12 Monthly Projection of the Least Reserve Margins Nationwide and for Each Regional Service Area
(with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	31.0%	46.1%	54.6%	27.2%	24.2%	41.4%	19.4%	23.4%	21.5%	17.6%	18.8%	14.6%
Tohoku	21.8%	26.5%	17.6%	9.5%	9.7%	16.1%	19.4%	12.1%	11.3%	12.9%	15.3%	14.6%
Tokyo	20.6%	26.5%	17.6%	9.5%	9.7%	16.1%	19.4%	12.1%	11.3%	10.8%	8.0%	10.5%
Chubu	24.3%	26.5%	22.6%	9.9%	10.3%	16.1%	19.9%	16.0%	11.3%	10.8%	8.6%	14.7%
Hokuriku	24.3%	28.4%	22.6%	14.8%	13.9%	16.1%	19.9%	16.0%	11.3%	10.8%	9.7%	15.6%
Kansai	26.0%	28.4%	22.6%	14.8%	13.9%	24.7%	29.0%	17.1%	11.3%	10.8%	9.7%	15.6%
Chugoku	26.0%	28.4%	22.6%	14.8%	13.9%	24.7%	29.0%	17.1%	11.3%	10.8%	9.7%	15.6%
Shikoku	26.0%	28.4%	22.6%	14.8%	13.9%	24.7%	29.0%	17.1%	11.3%	10.8%	9.7%	15.6%
Kyushu	42.0%	29.3%	22.6%	14.8%	20.7%	34.0%	30.8%	19.0%	11.3%	10.8%	9.7%	17.2%
Interconnected	25.1%	27.9%	21.5%	12.1%	12.5%	20.8%	23.1%	15.2%	11.6%	11.2%	9.8%	13.8%
Okinawa	60.1%	55.7%	48.3%	42.9%	44.9%	40.7%	49.7%	55.9%	68.8%	60.9%	59.3%	72.1%
Nationwide	25.4%	28.2%	21.8%	12.4%	12.8%	21.0%	23.3%	15.6%	12.0%	11.5%	10.2%	14.3%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

In the Okinawa EPCO regional service area, [20] which is a small and isolated island system unable to receive power through interconnection lines, the criterion of stable supply is to secure supply capacity over peak demand by deducting the capacity of the largest generating unit and balancing capacity with frequency control ('Generator I', total of 301 MW), without applying the criteria of other interconnected areas.[21]

Table 2-13 shows the monthly reserve margin against the deduction of the capacity of Generator I, which indicates the stable supply was secured in each month.

Table 2-13 Monthly Reserve Margin against the Deduction of the Capacity of Generator I (at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Okinawa	31.1%	30.9%	27.0%	22.3%	24.5%	19.7%	26.7%	29.0%	38.4%	31.7%	29.8%	40.7%

3. Projection of Supply–Demand Balance for 10 years (Long-Term)

a. Supply–Demand Balance

Table 2-14 and Figure 2-4 show the annual supply–demand balance projection(at 15:00 in August[23]) for a 10-year period.

A reserve margin of 8% is secured each year nationwide, even in the lowest margin of 12.7% in FY 2021.

Table 2-14 Annual Supply–Demand Balance Projection from FY 2020 to 2029
(nationwide at 15:00 in August,[23] 10^4 kW at the sending end)

	2020	2021	2022	2023	2024
Peak Demand	15,892	15,876	15,845	15,814	15,783
Supply Capacity	17,948	17,885	17,891	18,215	18,275
Reserve Margin	12.9%	12.7%	12.9%	15.2%	15.8%
	2025	2026	2027	2028	2029
Peak Demand	15,755	15,725	15,722	15,692	15,662
Supply Capacity	18,383	18,329	18,399	18,411	18,440
Reserve Margin	16.7%	16.6%	17.0%	17.3%	17.7%

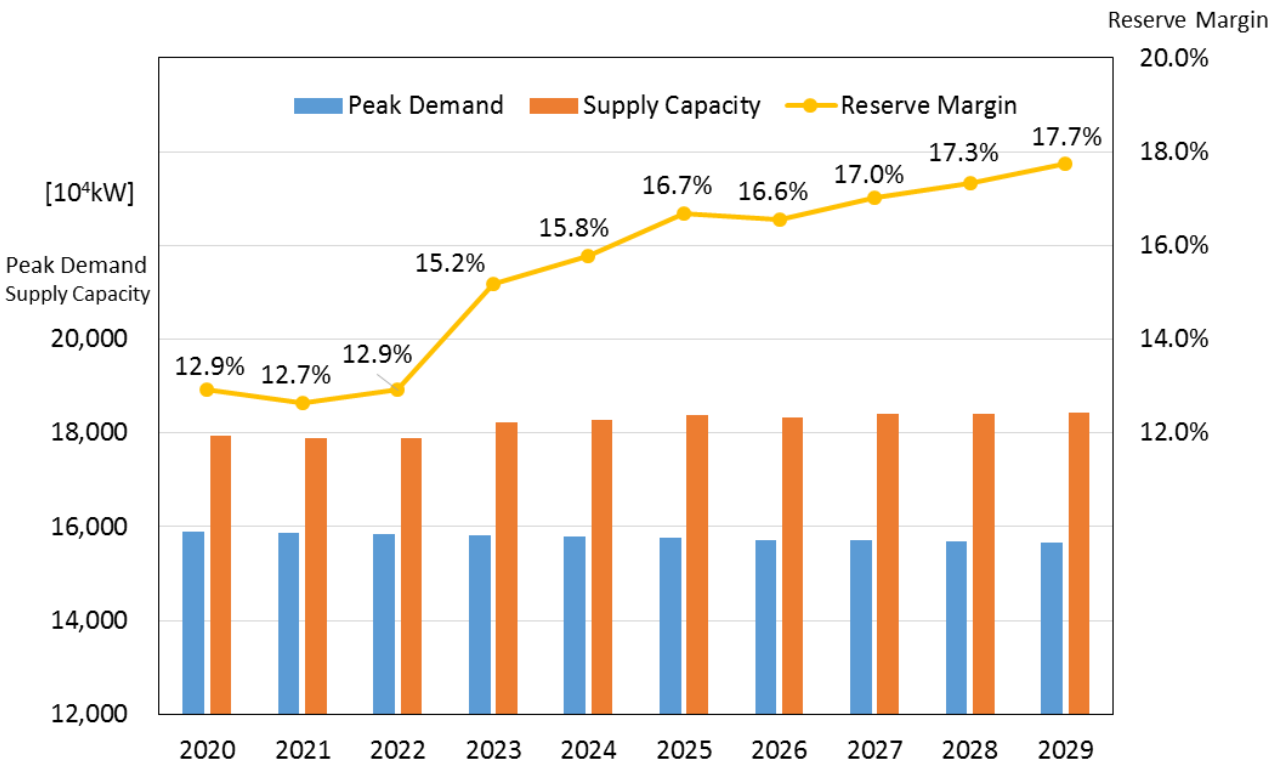


Figure 2-4 Mid-to-Long-Term Annual Supply–Demand Balance Projection
(nationwide at 15:00 in August,[23] at the sending end)

[23] In Okinawa, at 20:00 in August.

Table 2-15 shows the monthly projection of the least reserve margin for each regional service area. In addition, Table 2-16 shows the monthly projection of the least reserve margin for each regional service area recalculated to levelize using power exchanges to areas below the 8% reserve margin from areas over the 8% reserve margin based on the ATC.[18]

Reserve margins at each time calculation include some areas and years that cannot achieve the criterion of a stable supply such as Tokyo in FY 2021 and 2022, Chubu in FY 2021, and Kansai from FY 2025 to 2029. However, the criterion of a stable supply is projected to be secured in all areas and years by sharing power from other areas with sufficient supply capacity through cross-regional interconnection lines

Table 2-15 Annual Projection of Reserve Margins for Each Regional Service Area
(at 15:00 in August[23], resources within own service area only, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	31.9%	27.6%	27.4%	50.2%	50.0%	50.9%	49.7%	61.1%	61.0%	61.1%
Tohoku	16.2%	24.7%	27.8%	30.5%	32.5%	33.9%	37.6%	38.9%	40.3%	41.7%
Tokyo	10.0%	**5.2%**	**5.5%**	9.1%	9.6%	13.7%	13.4%	13.2%	14.1%	14.3%
50 Hz areas Total	12.5%	10.1%	10.9%	15.5%	16.2%	19.6%	19.9%	20.7%	21.6%	22.0%
Chubu	10.6%	**6.6%**	11.0%	11.8%	15.7%	15.9%	16.4%	16.5%	17.0%	17.6%
Hokuriku	20.9%	9.4%	11.9%	14.8%	15.1%	13.9%	14.6%	15.0%	14.7%	15.0%
Kansai	8.9%	8.9%	9.4%	8.7%	9.0%	**5.0%**	**5.7%**	**6.2%**	**6.0%**	**6.4%**
Chugoku	23.2%	27.0%	28.7%	24.4%	25.1%	25.8%	26.0%	25.9%	25.4%	25.8%
Shikoku	23.4%	23.4%	13.0%	23.0%	24.5%	24.7%	26.0%	26.7%	26.1%	27.0%
Kyushu	11.5%	25.1%	18.7%	19.2%	14.0%	14.6%	9.0%	8.7%	8.0%	8.2%
60 Hz areas Total	13.1%	14.1%	14.2%	14.5%	15.0%	13.9%	13.4%	13.6%	13.5%	13.9%
Interconnected	12.8%	12.3%	12.7%	14.9%	15.5%	16.4%	16.3%	16.8%	17.1%	17.5%
Okinawa	27.9%	44.9%	34.4%	43.2%	45.3%	40.9%	40.0%	39.4%	38.7%	38.0%
Nationwide	12.9%	12.7%	12.9%	15.2%	15.8%	16.7%	16.6%	17.0%	17.3%	17.7%

Below 8% criteria

Table 2-16 Annual Projection of Reserve Margins for Each Regional Service Area
(at 15:00 in August[23], with power exchanges through cross-regional interconnection lines, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	25.8%	20.0%	17.4%	40.2%	40.0%	40.8%	40.4%	51.8%	51.7%	51.8%
Tohoku	11.6%	9.7%	16.9%	20.1%	21.8%	23.1%	24.2%	25.6%	16.2%	16.6%
Tokyo	11.6%	9.7%	8.9%	12.4%	12.9%	15.1%	14.9%	15.0%	16.2%	16.6%
Chubu	13.1%	10.3%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Hokuriku	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Kansai	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Chugoku	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Shikoku	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Kyushu	13.1%	20.2%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Interconnected	12.8%	12.3%	12.7%	14.9%	15.5%	16.4%	16.3%	16.8%	17.1%	17.5%
Okinawa	27.9%	44.9%	34.4%	43.2%	45.3%	40.9%	40.0%	39.4%	38.7%	38.0%
Nationwide	12.9%	12.7%	12.9%	15.2%	15.8%	16.7%	16.6%	17.0%	17.3%	17.7%

Improve to over 8%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

Further, information on environmental assessment of thermal power plants[19] probably includes some generating facilities which EPCO confirm their business judgment and proceed to their construction. Therefore, the Organization has investigated generating facilities that are not included in the electricity supply plans, although they have already made application for generator connection to GT&D companies and submitted construction plans according to the provisions of Article 48 of the Act in cooperation with the Government.

As a result, there are 390 MW of such generating facilities nationwide at the end of FY 2029; thus, the Organization includes those facilities to supply capacity and recalculates reserve margins as outlined in Table 2-17.

Table 2-17 Annual Projection of Reserve Margins for Each Regional Service Area

(at 15:00 in August [23], with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	25.8%	24.2%	21.6%	44.4%	44.2%	45.0%	44.6%	56.0%	55.9%	56.0%
Tohoku	11.6%	9.7%	16.9%	20.1%	21.8%	23.1%	24.2%	25.6%	16.3%	16.7%
Tokyo	11.6%	9.7%	9.1%	12.5%	13.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Chubu	13.2%	10.3%	14.3%	14.6%	15.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Hokuriku	13.2%	13.9%	14.3%	14.6%	15.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Kansai	13.2%	13.9%	14.3%	14.6%	15.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Chugoku	13.2%	13.9%	14.3%	14.6%	15.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Shikoku	13.2%	13.9%	14.3%	14.6%	15.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Kyushu	13.2%	20.7%	14.3%	14.6%	15.1%	15.3%	15.0%	15.1%	16.3%	16.7%
Interconnected	12.8%	12.5%	13.0%	15.2%	15.8%	16.7%	16.6%	17.1%	17.4%	17.8%
Okinawa	27.9%	44.9%	34.4%	43.2%	45.3%	40.9%	40.0%	39.4%	38.7%	38.0%
Nationwide	13.0%	12.8%	13.2%	15.4%	16.0%	16.9%	16.8%	17.3%	17.6%	18.0%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

In the Okinawa EPCO regional service area [20], which is a small and isolated island system unable to receive power through interconnection lines, the criterion of stable supply is to secure supply capacity over peak demand by deducting the capacity of the largest generating unit and balancing capacity with frequency control ('Generator I', total of 301 MW), without applying the criteria of other interconnected areas.[21]

Table 2-18 shows the monthly reserve margin against the deduction of the capacity of Generator I, which indicates the stable supply was secured in the projected period.

Table 2-18 Annual Projection of a Reserve Margin with the Capacity Equivalent to Generator I in Okinawa Deducted

(at 20:00 in August, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Okinawa	7.3%	24.5%	14.1%	23.0%	25.3%	21.0%	20.2%	19.6%	19.1%	18.5%

Table 2-19 shows the annual projection of reserve margins in January for winter peak demand in the Hokkaido and Tohoku EPCO areas. A stable supply is secured throughout the period. In addition, Table 2-20 shows the projection of the least reserve margin for each regional service area recalculated to levelize using power exchanges to areas below the 8% reserve margin from areas over the 8% reserve margin based on the ATC.

Table 2-19 Annual Projection of Reserve Margins for Winter Peak Demand in the Hokkaido and Tohoku Areas (at 18:00 in January, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	13.9%	28.3%	33.3%	28.3%	28.8%	29.1%	38.6%	38.5%	38.5%	38.4%
Tohoku	16.5%	21.3%	21.8%	24.2%	25.6%	27.3%	30.7%	32.0%	34.1%	35.8%

Table 2-20 Annual Projection of Reserve Margins for Winter Peak Demand in the Hokkaido and Tohoku Areas (at 18:00 in January, with power exchanges through cross-regional interconnection lines, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	15.3%	23.2%	24.9%	25.3%	26.5%	27.8%	32.9%	33.7%	35.3%	36.5%
Tohoku	16.0%	23.2%	24.9%	25.3%	26.5%	27.8%	32.9%	33.7%	35.3%	36.5%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection lines.

There are 390 MW of generating facilities that are not included in the electricity supply plans, although they have already made application for generator connection to GT&D companies and submitted construction plans according to the provisions of Article 48 of the Act. Table 2-21 shows the recalculated reserve margins including those facilities to supply capacity.

Table 2-21 Annual Projection of Reserve Margins for Winter Peak Demand in the Hokkaido and Tohoku Areas (at 18:00 in January, with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	16.8%	24.1%	27.8%	26.2%	27.4%	28.7%	33.8%	34.7%	36.3%	37.4%
Tohoku	16.8%	24.1%	25.1%	26.2%	27.4%	28.7%	33.8%	34.7%	36.3%	37.4%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection lines.

b. Supply Capacity Secured by GT&D Companies

GT&D companies secure their supply capacity for the demand of isolated island areas throughout the projected period, and also secure a balancing capacity equivalent to 7%[24] over their peak demand in their regional service areas for FY 2020 by public solicitation. Table 2-22 shows the secured balancing capacity procured by GT&D companies.[25]

Table 2-22 Secured Balancing Capacity[25] Procured by GT&D Companies (%, 10^4 kW in Okinawa)

	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
Balancing Capacity	7.0%	7.0%	7.0%	7.1%	7.0%	7.0%	7.1%	7.3%	7.1%	30.1

c. Conclusions Concerning Supply–Demand Balance Evaluation

i) Supply–Demand Balance Evaluation for FY 2020 and 2021 (short-term)

The criterion of stable supply (i.e., 8% of reserve margin) is secured throughout the areas and for the short-term period.

On the other hand, there are some months and areas that have scarce reserve margin in the peak demand period, especially in winter. Careful watch shall be kept for abrupt outages or suspension and retirement of generating facilities.

ii) Supply–Demand Balance Evaluation for FY 2020–2029 (mid-to-long-term)

The criterion of stable supply is also secured throughout the areas and for the mid-to-long-term period.

However, the supply-demand balance in the three years from FY 2020 to 2022 is projected to be tight. The Organization continuously and carefully evaluates the supply–demand balance, monitoring the submission of changing supply plans and the accompanying supply–demand balance.

24 Public solicitation of balancing capacity is implemented so as to secure a balancing capacity equivalent to 7% over their peak demand in their regional service areas, and its procurement is based on the peak demand of the second projected year of the previous electric supply plan. Therefore, the procured balancing capacity may be lower than the capacity equivalent to 7% over their peak demand of the current year.

25 The capacity is the ratio of the balancing capacity to the peak demand in the regional service areas of GT&D companies. The ratios for the Hokkaido and Tohoku EPCO areas are in January, and in August for the other areas.

[Reference] Detailed Analysis of the Aggregation

a. Transition of supply capacity by generation sources

Table 2-5 shows the supply capacity (at 15:00 in August,[26] nationwide) by power generation source in the projected period.

Supply capacity of renewables[27] is projected to increase. Thermal power is projected to temporarily decrease through replacement according to future power development and reach its bottom in FY 2021 and 2022, after which it increases due to replacement or new installations.

As a whole, supply capacity is projected to decrease slightly in the coming years, but thereafter increases.

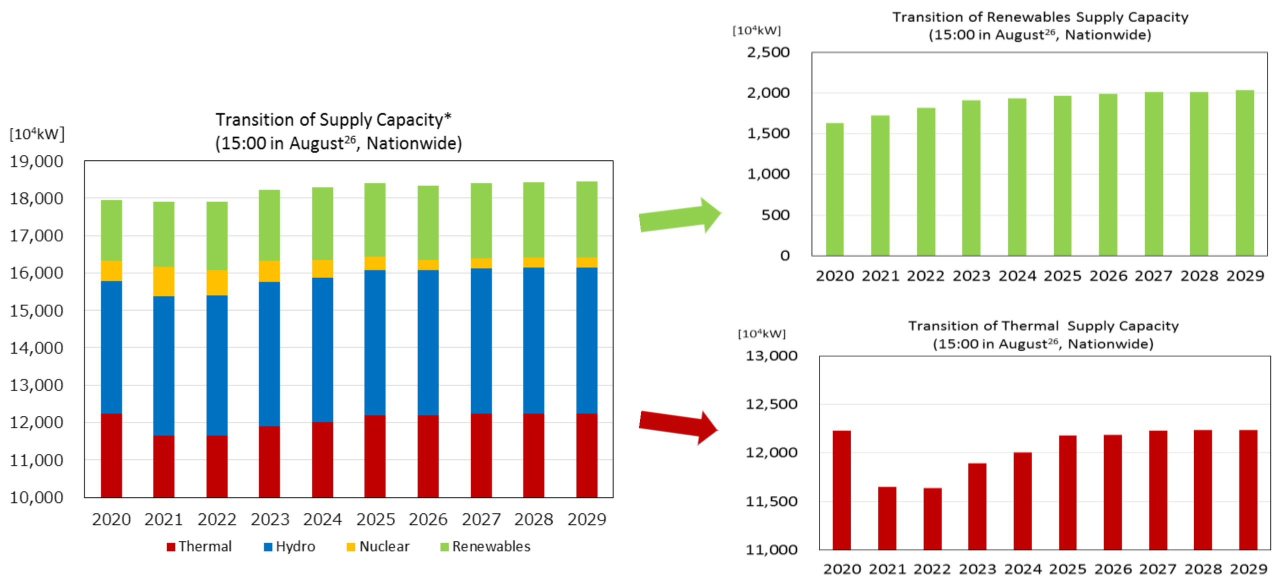


Figure 2-5 Transition of Supply Capacity by Generation Sources

(* Each generation source is added up figure of submission from EPCOs.)

[26] In Okinawa, at 12:00.

[27] In Okinawa, supply capacity of solar and wind power is calculated for the L5 value.

b. Transition of suspended thermal power plants

Figure 2-6 shows mid-to-long-term projections of suspended thermal power plants (19 - 23 GW), which are not counted as supply capacity due to long-term planned outage. The Organization has implemented hearings from EPCOs regarding whether the suspended plants are available for postponement of suspension or rapid power generation around one year with judgment and preparation in the proper timing. As a result, it is possible that suspended thermal power plants of 6 - 13 GW will be counted on as additional supply capacity.

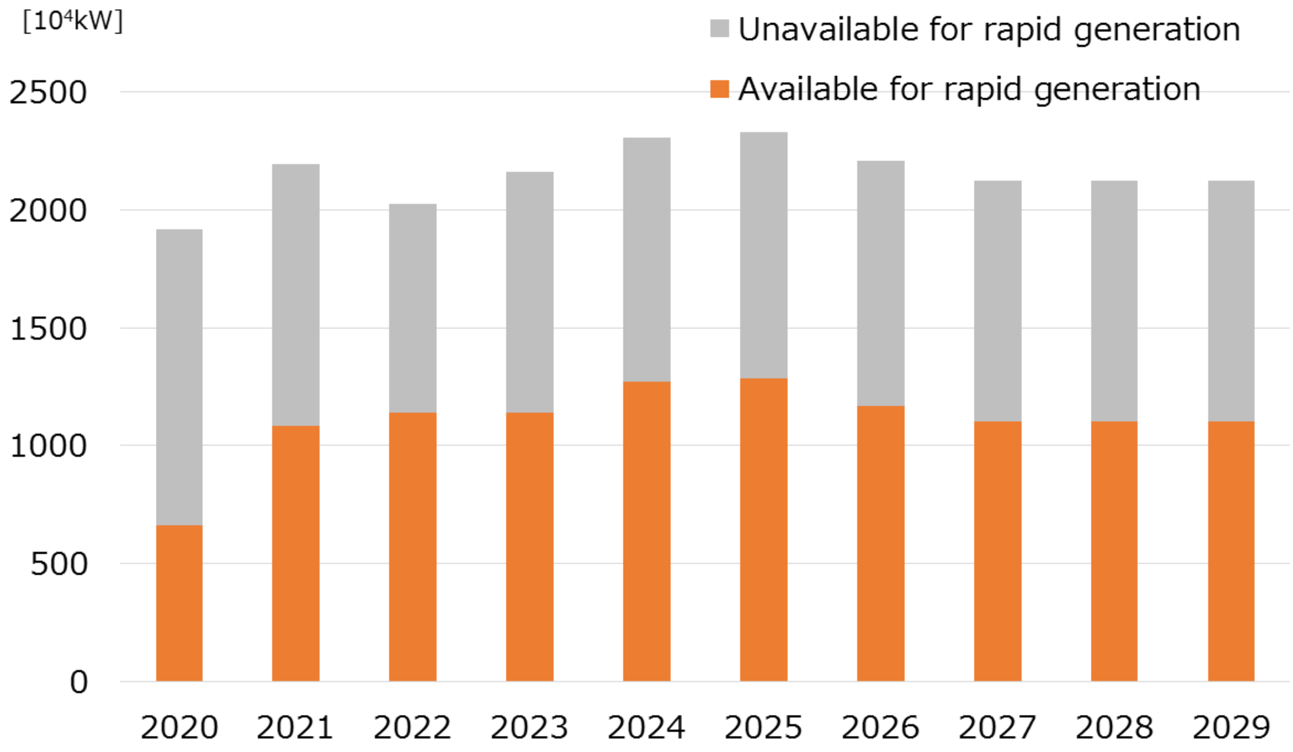


Figure 2-6 Projections of Suspended Thermal Power Plants

III. Analysis of the Transition of Power Generation Sources

Analysis in this chapter is based on the automatic aggregation of values submitted from EPCOs. It is noted that these values will not necessarily be realized in the future due to operating conditions of power plants or actions due to political measures.

1. Transition of Power Generation Sources (Capacity)

The installed power generation capacity is the automatic aggregation of the capacity of electric power plants owned by EPCOs and those as feed-in-tariff (FIT) generators owned by companies other than EPCOs that are registered as the procured supply capacity of retail and GT&D companies in the projected period. For the development plans of EPCOs, only generating facilities that have a given probability of development are included in the calculation; however, not all development plans will necessarily be realized, and inefficient facilities will proceed to be retired resulting from actions due to political measures in the future.

The installed generation capacity by power generation source submitted from EPCOs is calculated from the concepts below.

*1 Hydro and Thermal

For existing facilities, the generation company aggregates the generating facility that it owns. For newly installing facility, generating facility such as in the course of proceeding its environmental assessment or publishing its commercial operation, is included in the aggregation. The same concept is applied to geothermal, biomass and wastes power generation sources.

*2 Nuclear

The generation company aggregates the generating facility in actual operation that it owns, in addition to 33 units for which the date for resuming operation is uncertain, and excluding any operation-terminated facility.

*3 Solar and Wind

The GT&D company aggregates the projected value of integrating the generation facility according to application of preliminary consultation and the available connecting capacity of its transmission lines or the actual growth trend of integration.

Table 3-1 and Figure 3-1 show the transition of installed power generation capacity by power generation source which are automatically aggregated values of EPCOs submission based on the concepts above.

Table 3-1 Composition of the Transition of Installed Power Generation Capacities by Power Generation Source (nationwide, 10^4 kW)

Power Generation Sources		2019	2020	2024	2029
Hydro*1		4,915	4,913	4,930	4,940
	Conventional	2,168	2,166	2,183	2,192
	Pumped Storage	2,747	2,747	2,747	2,747
Thermal*1		15,950	16,062	16,293	16,378
	Coal	4,595	4,752	5,286	5,282
	LNG	8,365	8,414	8,205	8,291
	Oil and others[28]	2,990	2,897	2,802	2,805
Nuclear*2		3,308	3,308	3,308	3,308
Renewables		6,456	6,951	8,537	9,545
	Wind*3	433	486	865	1,272
	Solar*3	5,535	5,970	7,048	7,652
	Geothermal*1	53	54	53	55
	Biomass*1	331	359	500	497
	Waste*1	106	83	71	71
Miscellaneous		40	24	23	23
Total		30,671	31,259	33,092	34,194

Note) The totals are not necessarily equal due to independent rounding.

*1 The Organization automatically aggregates the value of the genererating facility that the generation company owns; however, not all development plans will necessarily be realized, and inefficient facilities will proceed to be retired resulting from actions due to political measures in the future. For newly installing facility, generating facility such as in the course of proceeding its environmental assessment or publishing its commercial operation, is included in the aggregation.

*2 Included are the facilities in actual operation, in addition to 33 units for which the date for resuming operation is uncertain; operation-terminated facilities are excluded.

*3 The GT&D company aggregates the projected value of integrating the generation facility according to application of preliminary consultation and the available connecting capacity of its transmission lines or the actual growth trend of integration.

[28] The category 'Oil and others' includes the total installed capacities from oil, LPG, and other gas and bituminous mixture fired capacities.

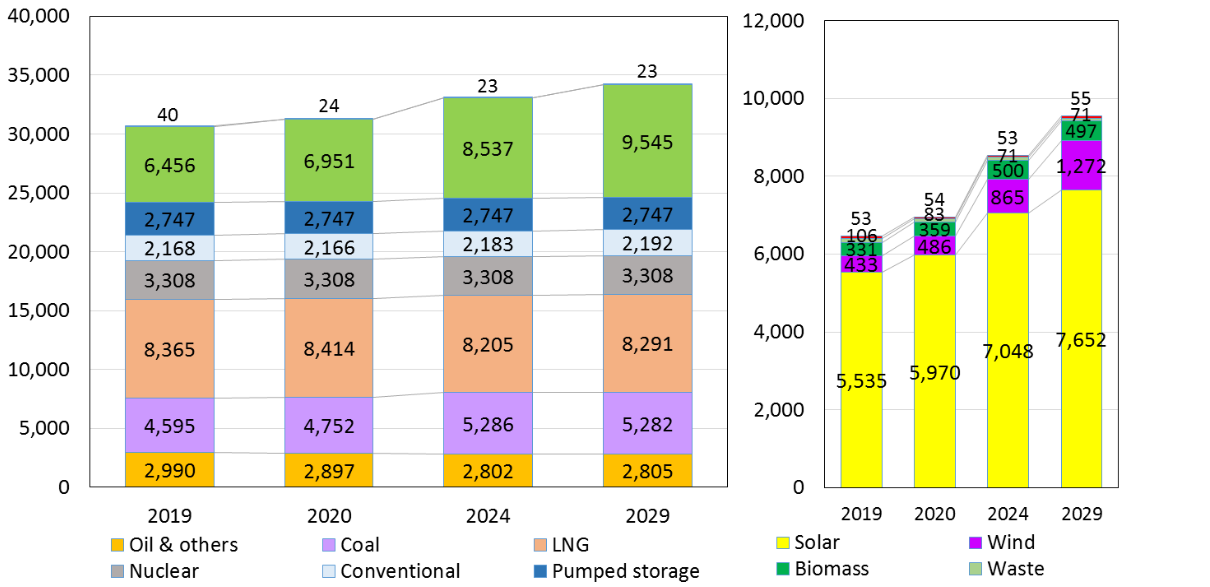


Figure 3-1 Transition of Installed Power Generation Capacities by Power Generation Sources (Nationwide)

* The sum of the installed power generation capacity by each power generation source is the aggregation of the values submitted by EPCOs.

2. Installed Power Generation Capacity for Each Regional Service Area

Figure 3-2 shows the installed power generation capacity for each regional service area at the end of FY 2019.

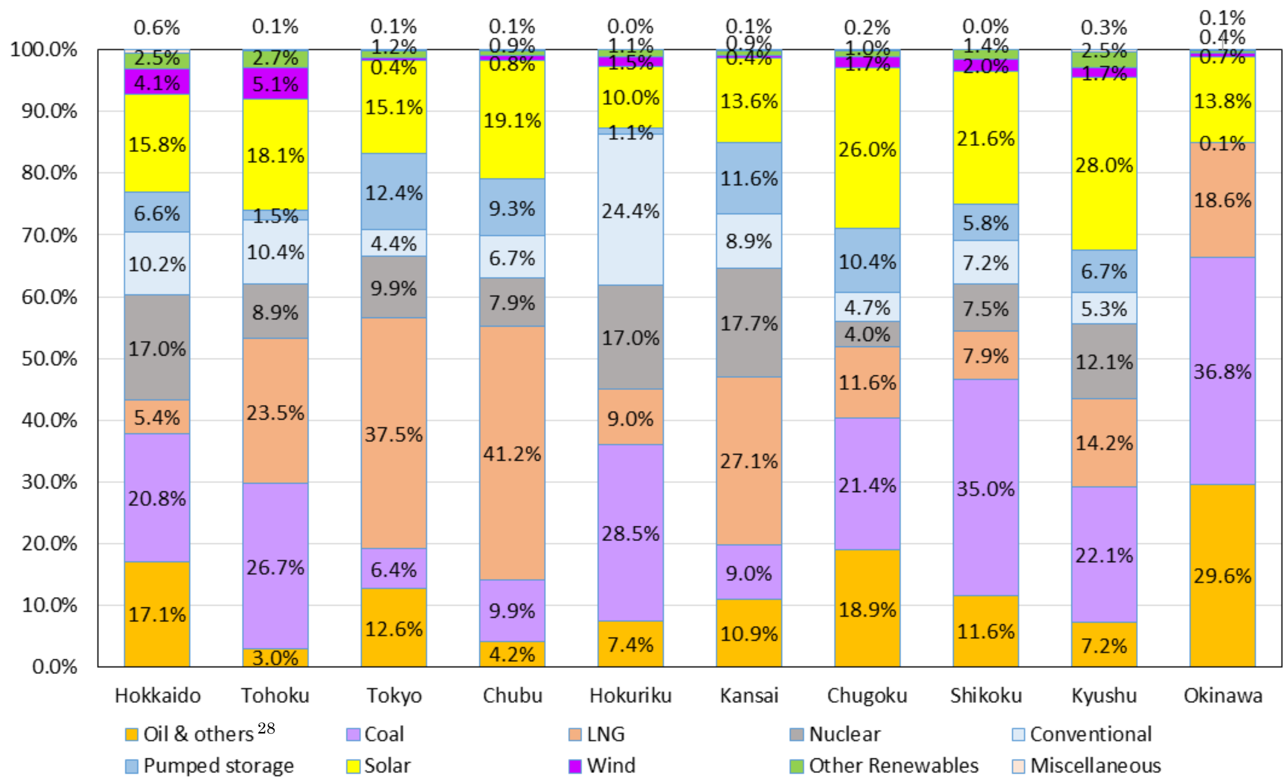


Figure 3-2 Composition of Installed Power Generation Capacity (kW) for Each Regional Service Area

* The ratio of the installed power generation capacity by each power generation source is calculated from automatic aggregation of the values.

3. Transition of Solar and Wind Generation Capacities

Figure 3-3 shows the projection of integrated solar and wind generation capacities by each regional service area (at the end of the indicated fiscal year).[29]

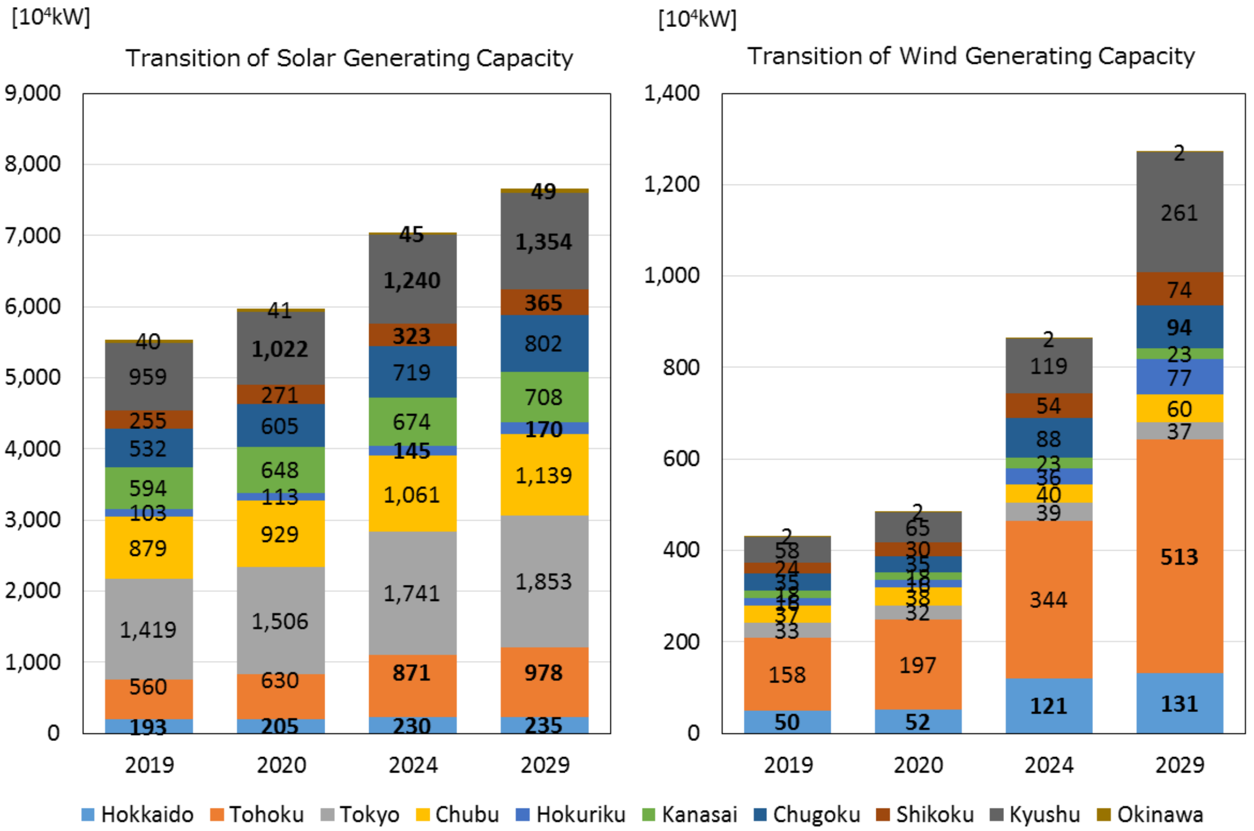


Figure 3-3 Transition of Solar and Wind Generating Capacity for Each Regional Service Area

[29] The GT&D company of each regional area aggregates the projected value of integrating the generation facility according to application of preliminary consultation for generator interconnection, and the available connecting capacity of its transmission lines or the actual growth trend of integration.

4. Development Plans by Power Generation Source

Table 3-2 shows the development plans[30] up to FY 2029 submitted by generation companies, according to their new developments, uprated or derated installed facilities, and planned retirement of facilities in the projected period.

Table 3-2 Generation Development Plans up to FY 2029 by Stages[30] (nationwide, 10^4 kW)

Power Generation Sources		New Installation		Uprating/Derating		Retirement	
		Capacity	Sites	Capacity	Sites	Capacity	Sites
Hydro		**37.9**	**51**	**6.8**	**46**	**△ 22.2**	**32**
	Conventional	37.9	51	6.8	46	△ 22.2	32
	Pumped Storage	-	-	-	-	-	-
Thermal		**1,447.6**	**34**	**5.2**	**1**	**△ 958.6**	**42**
	Coal	685.1	10	-	-	△ 51.8	3
	LNG	757.4	15	5.2	1	△ 763.5	16
	Oil	5.1	9	-	-	△ 143.3	23
	LPG	-	-	-	-	-	-
	Bituminous	-	-	-	-	-	-
	Other Gas	-	-	-	-	-	-
Nuclear		**1,018.0**	**7**	**15.2**	**1**	**-**	**-**
Renewables		**735.3**	**345**	**0.8**	**3**	**△ 31.1**	**49**
	Wind	179.2	54	-	-	△ 14.7	36
	Solar	404.0	253	-	-	△ 0.2	1
	Geothermal	4.4	3	0.6	2	△ 2.4	1
	Biomass	140.5	30	-	-	△ 8.4	6
	Waste	7.2	5	0.2	1	△ 5.6	5
Total		**3,238.7**	**437**	**28.0**	**51**	**△ 1,012.0**	**123**

Note) The totals are not necessarily equal due to independent rounding to two decimal places.

30 These are aggregated including facilities for which the date of commercial operation is “uncertain.”

[Reference] Net Electric Energy Generation (at the sending end)

Net electric energy generation (at the sending end) is an estimation* comprised of calculated values by power generation source in a given premise by each generation company or GT&D company for the projected period. Note that this is not necessarily the same as actual net electric energy generation.

Each generation company has submitted the value of electric energy generation, which is the sum of the energy generation of available generation facilities in the projected period. This is automatically summed in merit order of operation cost. In addition, the value is based on future energy sales led by actual sales and future sales contracts, without considering the effect of regulating measures.

This estimation of net electric energy generation may change according to the operating conditions of nuclear power plants, change in generation sources—specified as "miscellaneous" in future trends—and energy output shedding of inefficient coal-fired thermal power generation according to the regulating measures of generation efficiency under the Energy Conservation Act. Thus, note that the estimation is not necessarily the same as electric energy generation in the future, and is likely to approximate the target value of the energy mix of the nation.

The calculation method and the result of net electric energy generation by power generation source are stated below.

* This estimation includes electric energy generated from generation facilities owned by generationcompanies as well as that of generation facilities such as FIT generators, which retail companies or GT&D companies procure from sources other than generation companies.

(1) Renewables (Table 3-3)

For solar and wind power, the GT&D company calculates their energy generation, based on the aggregation of the projected value of integrating generation facility according to application of preliminary consultation and the available connecting capacity of its transmission lines or the actual growth trend of integration. For geothermal, biomass and waste power generation sources, the generation company calculates their energy generation based on the generation plan that the company develops.

Table 3-3 Composition of the Transition of Electric Energy Generated by Renewable Generation Sources (nationwide, at the sending end; 10^8 kWh)

Generation Source		2019	2020	2024	2029
Renewables		937	1,023	1,362	1,504
	Wind	82	93	166	237
	Solar	634	684	842	912
	Geothermal	25	25	28	29
	Biomass	167	197	305	305
	Waste	28	23	22	21

(2) Hydro and Thermal (Table 3-4)

The generation company calculates their energy generation based on the generation plan that the company develops. For thermal power generation, the energy generated from coal-fired thermal power, which has a relatively low operation cost, has a large share due to its merit-order ranking (by operation cost) without considering the effect of regulating measures.

Table 3-4 Composition of the Transition of Electric Energy Generated by Hydro and Thermal Generation Sources (nationwide, at the sending end; 10^8 kWh)

Generation Source		2019	2020	2024	2029
Hydro		822	819	839	875
	Conventional	757	769	780	802
	Pumped Storage	65	49	60	73
Thermal		6,553	6,539	5,890	5,782
	Coal	2,681	2,884	3,070	3,128
	LNG	3,594	3,370	2,563	2,403
	Oil and others[28]	278	284	256	251

(3) Nuclear (Table 3-5)

The generation company calculates their energy generation based on the generation plan that the company develops for units resuming operation at the end of February 2020. However, units with over 40 years of actual operation require permission from the Nuclear Regulation Authority to resume operation; the energy generation of such units is calculated as zero. In addition, projections concerning resumption of operation are not included in the estimation.

Table 3-5 Composition of the Transition of Electric Energy Generated by Nuclear Generation Sources (nationwide, at the sending end; 10^8 kWh)

Generation Source	2019	2020	2024	2029
Nuclear	604	419	475	303

Table 3-6 shows the sum of (1), (2) and (3) with the energy generation categorized as “miscellaneous”.

Table 3-6 Composition of the Transition of Electric Energy Generated by All Generation Sources (nationwide, at the sending end; 10^8 kWh)

	2019	2020	2024	2029
Total	9,030	8,853	8,597	8,491

[Reference] Net Electric Energy Generation for Each Regional Service Area

Figure 3-4 shows the net electric energy generation for each regional service area in FY 2019.

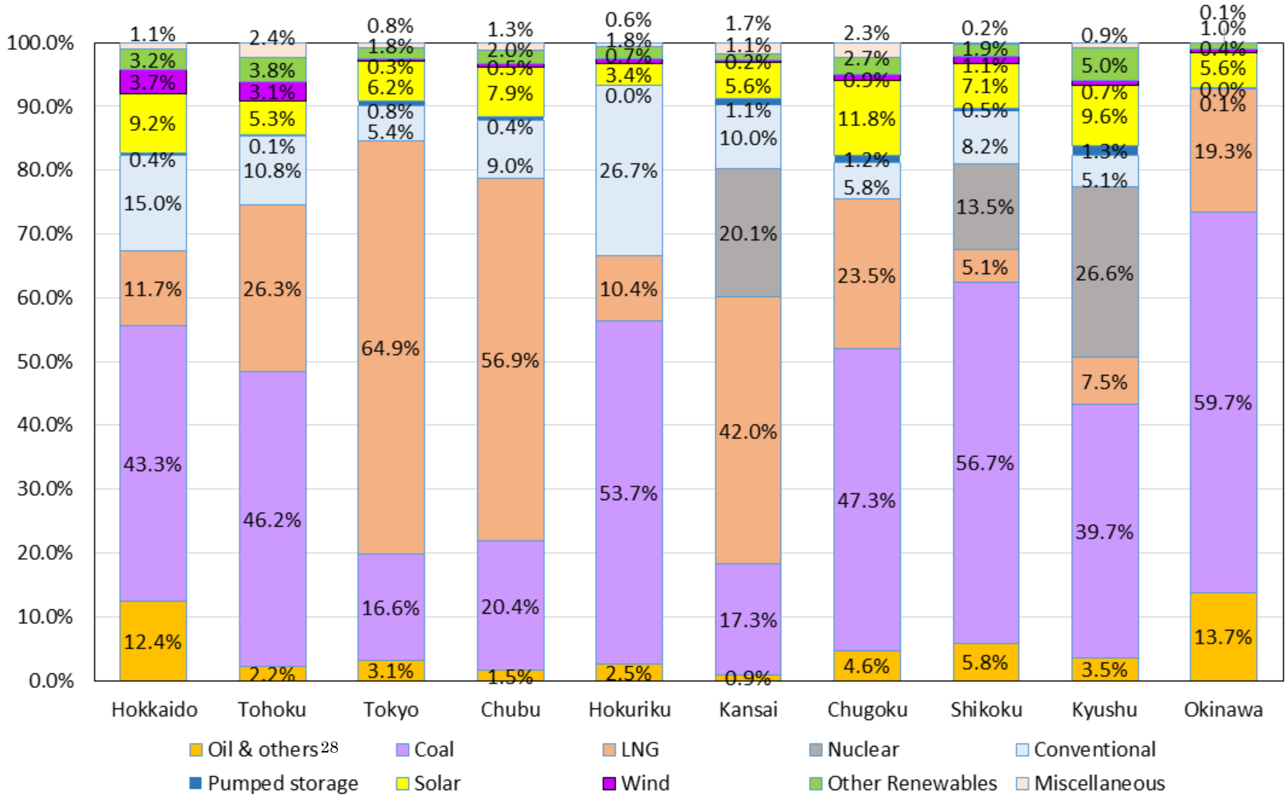


Figure 3-4 Composition of Net Electric Energy Generation (kWh) for Each Regional Service Area

[Reference] Transition of Capacity Factors by Power Generation Source

Table 3-7 and Figure 3-5 show the capacity factors by power generation source. Projection of the capacity factors is automatically calculated using the aforementioned power generation sources and the net electric energy generation data provided by the Organization.

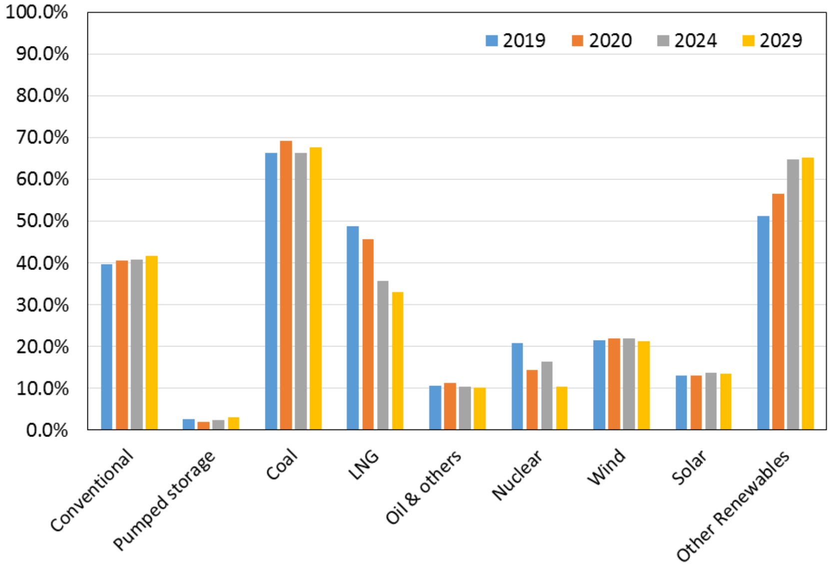
As noted, these values are calculated from a given projection; the capacity factors in this chapter will differ from those in actual operation.

Table 3-3 Capacity Factors by Power Generation Source (nationwide)

Power Generation Sources		FY 2019	FY 2020	FY 2024	FY 2029
Hydro		19.0%	19.0%	19.4%	20.2%
	Conventional	39.8%	40.6%	40.8%	41.8%
	Pumped Storage	2.7%	2.0%	2.5%	3.0%
Thermal		46.8%	46.5%	41.3%	40.3%
	Coal	66.4%	69.3%	66.3%	67.6%
	LNG	48.9%	45.7%	35.7%	33.1%
	Oil and others[28]	10.6%	11.2%	10.4%	10.2%
Nuclear		20.8%	14.5%	16.4%	10.5%
Renewables		16.5%	16.8%	18.2%	18.0%
	Wind[31]	21.6%	21.9%	21.9%	21.3%
	Solar[31]	13.0%	13.1%	13.6%	13.6%
	Geothermal	53.6%	54.1%	60.3%	61.2%
	Biomass	57.4%	62.6%	69.5%	70.0%
	Waste	30.7%	32.1%	34.8%	34.3%

* These values are calculated from a given projection; note that the capacity factors in this chapter will differ from those in actual operation.

31 There is no consideration for low capacity factors of solar and wind power generation due to output shedding.



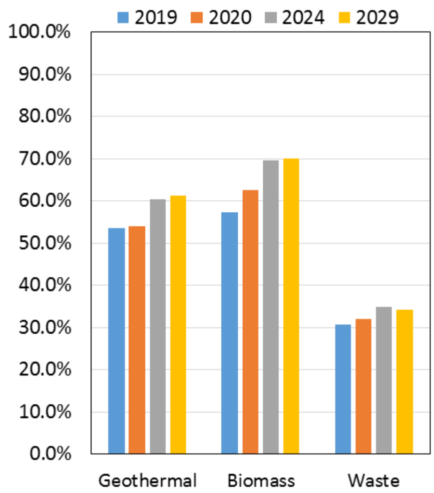


Figure 3-5 Capacity Factors by Power Generation Source (Nationwide)

* These values are calculated from a given projection; note that the capacity factors in this chapter will differ from those in actual operation.

IV. Development Plans for Transmission and Distribution Facilities

The Organization has aggregated the development plans[32] for cross-regional transmission lines and substations (transformers and AC/DC converters) up to FY 2029 submitted by GT&D and transmission companies. Table 4-1 shows the development plans for cross-regional transmission lines and substations. Figure 4-1 shows the outlook for electric systems nationwide. (1), (2), and (3) below list the development plans according to cross-regional transmission lines, major substations, and summaries, respectively.

Newly installing generation facilities, mostly renewables generators, are likely to be sited in remote areas distant from the load center. Thus, new long distance transmission network development plans are under review.

For cross-regional interconnection lines, the necessary enhancement is planned for cross-regional operation.

Table 4-1 Development Plans for Cross-regional Transmission Lines and Substations[33]

Increased Length of Transmission Lines [34][35]*		726km (549km)
	Overhead Lines*	687km (542km)
	Underground Lines	39km (6km)
Uprated Capacities of Transformers		28,290MVA (17,400MVA)
Uprated Capacities of AC/DC Converters[36]		1,800MW (1,800MW)
Decreased Length of Transmission Lines (Retirement)		△ 61km (△108km)
Derated Capacities of Transformers (Retirement)		△ 2,700MVA (△2,700MVA)

Enhancement plans for cross-regional transmission lines are summarized below.

---

[32] Development plans for transmission lines and substations are required to be submitted for voltages of more than 250 kV, or within two classes of the highest voltage available in the regional service areas. (For the Okinawa EPCO, only 132 kV or more is required.) The totals are not necessarily equal due to independent rounding.

[33] Figures in parenthesis are those in the previous year.

[34] Development plans corresponding to changes in line category or circuit numbers that were not included in measuring the increased length of transmission lines were treated as 'no change in the length of transmission lines'.

[35] Increased length does not include the item with * because of an undetermined in-service date.

[36] Installed capacity for the converter station on one side is included in the DC transmission system.

Interconnection Facility Enhancement Plan between Tohoku and Tokyo
(in service: November 2027)

500kV Transmission Lines	・(prov.)Cross-regional North Bulk Line: 81 km ・(prov.)Cross-regional South Bulk Line: 62 km ・Soma-Futaba Bulk Line/ Connecting Point Change: 15 km ・(prov.)Shinchi Access Line/ Cross-regional Switching Station lead-in: 1km ・(prov.)Joban Bulk Line/ Cross-regional Switching Station Dπ lead-in: 1 km
Switching Stations	(prov.)Cross-regional Switching Station: 10 circuits

Interconnection Facility Enhancement Plan between Tokyo and Chubu
(120 MW→210 MW; in service: March 2021)

AC/DC Converter Stations	・Shin Shinano AC/DC Converter Station： 900 MW ・Hida AC/DC Converter Station： 900 MW
DC Bulk Line 500kV Transmission Lines	・Hida-Shinano DC Bulk Line: 89 km ・Hida Branch Line: 0.4 km

Interconnection Facility Enhancement Plan between Tokyo and Chubu
(210 MW→300 MW; in service: FY 2027)

Frequency Converter Stations	・(prov.)Shin Sakuma FC station: 300 MW ・Higashi Shimizu FC station: 300 MW→900 MW
275 kV Transmission Lines	・Higashi Shimizu Line: 20 km ・(prov.)Sakuma Higashi Bulk Line/ Shin Sakuma FC Branch Line: 3 km ・(prov.)Sakuma Nishi Bulk Line/ Shin Sakuma FC Branch Line: 1 km ・Shin Toyone-Toei Line: 1 km ・Sakuma Nishi Bulk Line: 11 km , 2km ・Sakuma Higashi Bulk Line: 123 km
500 kV Transformers	・Shin Fuji Substation: 750MVA×1 ・Shizuoka Substation: 1,000MVA×1 ・Toei Substation: 800MVA×1 →1,500MVA×2

Interconnection Facility Enhancement Plan between Chubu and Kansai
(in service: undetermined)*under review in the master plan[37]

500 kV Transmission Lines	・Sekigahara Kita Oomi Line: 2 km ・Sangi Bulk Line/ Sekigahara Switching Station π lead-in: 1 km ・Kita Oomi Line/ Kita Oomi Switching Station π lead-in: 1 km
Switching Stations	・Sekigahara Switching Station: 6 circuits ・Kita Oomi Switching Station: 6 circuits

[37] The master plan is the facility formation policy that targets the long-term future electricity system.

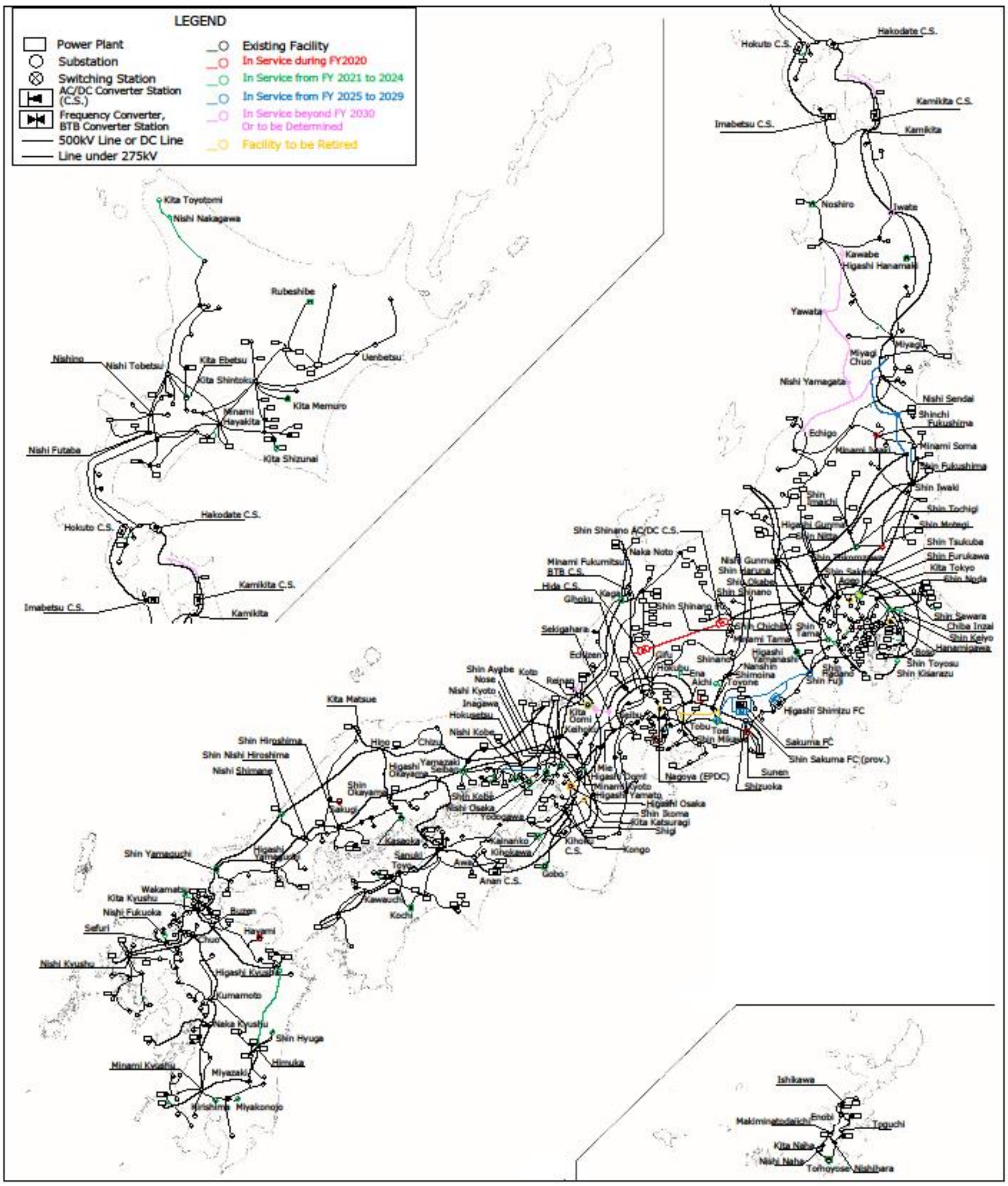


Figure 4-1 Power Grid Configuration in Japan

1. Development Plans for Major Transmission Lines

Table 4-2 Development Plans under Construction

Company	Line[38]	Voltage	Length[39, 40]	Circuit	Under construction	In service	Purpose[41]
TEPCO Power Grid	Shinano-Hida DC Bulk Line	DC± 200kV	89km	BP 1	Jul. 2017	Mar. 2021	Reliability upgrade*4
	Shinjuku-Jonan Line replacement	275kV	16.4km *2,*3	3	Nov. 2017	Jul. 2018(No.1) Apr. 2020(No.2) Apr. 2019(No.3)	Aging management
	Higashi Shinjuku Line replacement	275kV	23.4→5.0km (No.2) *2, *3 23.4→5.3km (No. 3) *2, *3	2	Jan. 2019	Nov. 2032(No.2) Nov. 2025(No.3)	Aging management
	Shinjuku Line replacement	275kV	22.1→ 21.1km (No.1) *2, *3 19.9→ 21.1km (No.2,3) *2, *3	3	Sep. 2019	Aug. 2028(No.1) Nov. 2032(No.2) Nov. 2025(No.3)	Aging management
Chubu EPCO	Hida Branch Line	500kV	0.4km	2	Jun. 2018	Sep. 2020	Reliability upgrade*4
	Yahagi daiichi Branch Line	275kV	5km	1	Jul. 2019	Mar. 2021	Aging management Economic upgrade
	Higashi Nagoya - Tobu Line	275kV	8km*2	2	Apr. 2019	Jun. 2025	Aging management Economic upgrade
Kansai EPCO	Kobelco Power Kobe daini Access Line*1	275kV	4.4km*2	3	Apr. 2017	Feb. 2021(No.1) May 2021(No.2) Feb. 2022(No.3)	Generator connection
	Shin Kobe Line	275kV	20.2km→ 21.5km*2	2	May 2019	Jul. 2020	Generator connection Aging management
Shikoku EPCO	Saijo Access Line*1	187kV	7km*3	2	Nov. 2019	May 2021	Generator connection
Kyushu EPCO	Hyuga Bulk Line	500kV	124km	2	Nov. 2014	Jun. 2022	Reliability upgrade Economic upgrade
	JR Shin Isahaya Branch Line	220kV	1km	2	May 2019	Apr. 2021	Demand coverage
Electric Power Development Company (EPDC)	Ooma Bulk Line	500kV	61.2km	2	May 2006	Uncertain	Generator connection
Northern Hokkaido Wind Energy Transmission Company	NHWETC Toyotomi-Nakagawa Bulk Line	187kV	51km	2	Sep. 2018	Sep. 2022	Generator connection

38 Line with *1 denotes the line renamed not to be identified the fuel of the connecting power plant.
39 Length with *2 denotes "Underground," otherwise "Overhead."
40 Length with *3 denotes the change of line category or circuit numbers, not included in Table 4-1.
41 Purpose is stated below: *4 indicates enforcement related to cross-regional interconnection lines.
*5 indicates the case is under review in the master plan of the cross-regional development plan.

Demand coverage	Related to increase/decrease of demand
Generator connection	Related to generator connection or retirement
Aging management	Related to aging management of facilities (including proper update of facilities with evaluation of obsolescence
Reliability upgrade	Related to improvement in the reliability or security of stable supply
Economic upgrade	Related to improvement in economies, such as reducing transmission loss, facility downsizing, or upgrading the stability of the system

Company	Line[38]	Voltage	Length[39, 40]	Circuit	Under construction	In service	Purpose[41]
(NHWETC)							

Table 4-3 Development Plans in the Planning Stages

Company	Line[38]	Voltage	Length[39, 40]	Circuit	Under construction	In service	Purpose[41]
Hokkaido EPCO	(prov.) Tomakomai Access Line*1	187kV	0.2km	1	May 2021	Jun. 2022	Generator connection
	(prov.) Kaminokuni daini Access Line*1	187kV	0.1km	1	Jan. 2021	Jul. 2021	Generator connection
	Kita Horonobe Line partly uprating	187kV	69km	2	May 2021	Jul. 2022	Generator connection
Tohoku EPCO	Plant A Access Line*1	275kV	3km	1	May 2021	FY 2022	Generator connection
	Plant B Access Line*1	275kV	0.2km	1	May 2021	FY 2022	Generator connection
	(prov.)Cross-regional North Bulk Line	500kV	81km	2	Sep. 2022	Nov. 2027	Generator connection
	(prov.)Cross-regional South Bulk Line	500kV	62km	2	Sep. 2024	Nov. 2027	Generator connection
	Soma-Futaba Bulk Line/connecting point change	500kV	15km	2	Apr. 2022	Nov. 2025	Generator connection
	(prov.)Shinchi Access Line/ Cross-regional Switching Station lead-in*1	500kV	1km	2	Jul. 2024	Jun. 2026	Generator connection Reliability upgrade*4
	(prov.)Joban Bulk Line/ Cross-regional Switching Station Dπ lead-in	500kV	1km	2	May 2025	Jul. 2026	Generator connection Reliability upgrade*4
	(prov.)Cross-regional Switching Station	500kV	-	10	May 2023	Nov. 2027 (Jun. 2026)	Generator connection
	Akita Bulk Line/ Kawabe Substation DT lead-in	275kV	5km	2	Beyond FY 2022	Beyond FY 2029	Generator connection
	Akimori Bulk Line/ Kawabe Substation DT lead-in	275kV	0.2km	2	Beyond FY 2025	Beyond FY 2029	Generator connection
	Asahi Bulk Line uprating	275kV→ 500kV	139km→ 138km	2	Beyond FY 2026	Beyond FY 2030	Generator connection
	Minami Yamagata Bulk Line uprating	275kV→ 500kV	23km→ 23km	2	Beyond FY 2029	Beyond FY 2030	Generator connection
	Dewa Bulk Line	500kV	97km	2	Beyond FY 2021	Beyond FY 2031	Generator connection
	Yamagata Bulk Line uprating/ extension	275kV→ 500kV	53km→ 99km	2	Beyond FY 2025	Beyond FY 2031	Generator connection
TEPCO Power Grid	(prov.)G7060005 Access Line	275kV	1km*2	1	Jul. 2021	Feb. 2022	Generator connection
	MS18GHZ051500 Access Line (prov.)	275kV	0.1km	2	Jul. 2021	Jun. 2022	Generator connection
	Keihin Line No.1&2 /connecting point change	275kV	22.7km→ 23.1km*3	2	Oct. 2021	Apr. 2022	Generator connection
	Higashi Shimizu Line	275kV	13km 7km (diversion)	2	Mar. 2022	Mar. 2027	Reliability upgrade*4

Company	Line[38]	Voltage	Length[39, 40]	Circuit	Under construction	In service	Purpose[41]
TEPCO Power Grid	Nishi Gunma Bulk Line /Higashi Yamanashi Substation T lead-in	500kV	0.1km(No.1) 0.1km(No.2) *3	2→3	May 2022	Nov. 2022	Demand coverage
	Goi Access Line*1	275kV	11km	2	Aug. 2021	Feb. 2024	Generator connection
	(prov.)Chiba Inzai Substation lead-in	275kV	11km*2	2	Feb. 2023	Apr. 2024	Demand coverage
Chubu EPCO	Ena Branch Line	500kV	1km	2	May 2020	Oct. 2024	Demand coverage
	Shimo Ina Branch Line	500kV	0.3km	2	Mar. 2022	Oct. 2024	Demand coverage
	Sekigahara-Kita Oomi Line	500kV	2km	2	Uncertain	Uncertain	Generator connection *4*5
	Sekigahara Switching Station	500kV	—	6	Uncertain	Uncertain	Generator connection *4*5
	Sangi Bulk Line/ Sekigahara Switching Station π lead-in	500kV	1km	2	Uncertain	Uncertain	Generator connection *4*5
Kansai EPCO	Kita Yamato Line/ Minami Kyoto Substation	500kV	0.1km→ 0.2km	2	Jun. 2021	Dec. 2021	Economic upgrade
	Kita Oomi Switching Station	500kV	—	6	Uncertain	Uncertain	Generator connection *4*5
	Kita Oomi Line/ Kita Oomi Switching	500kV	0.5km	2	Uncertain	Uncertain	Generator connection *4*5
	Tsuruga Line/ North side improvement	275kV	9.8km→ 9.3km*3	2	Uncertain	Uncertain	Aging management
	(prov.) Himeji Access Line*1	275kV	0.9km*2	2	Mar. 2021	Jan. 2025	Generator connection
	Shin Kakogawa Line	275kV	25.3km→ 25.3km*3	2	Jul. 2021	Jun. 2025	Generator connection Aging management
	(prov.) Himeji Access West Branch Line*1	275kV	1.2km→ 1.2km*3	2	Nov. 2022	Mar. 2023	Aging management
Kyushu EPCO	Saibu Gas/ Hibiki Access Line*1	220kV	4km	2	Mar. 2022	Jul. 2024	Generator connection
	Shin Kagoshima Line/ Sendai Plant π lead-in*1	220kV	2km→ 4km*3	1→2	Aug. 2020	Jul. 2023	Economic upgrade
EPDC	(prov.)Sakuma Higashi Bulk Line/ Shin Sakuma FC Branch Line	275kV	3km	2	FY 2022	FY 2026	Reliability upgrade*4
	(prov.)Sakuma Nishi Bulk Line/ Shin Sakuma FC Branch Line	275kV	1km	2	FY 2022	FY 2026	Reliability upgrade*4
	Shin Toyone-Toei Line	275kV	1km	1	FY 2022	FY 2026	Reliability upgrade*4
	Sakuma Nishi Bulk Line	275kV	10.6km→ 11km*3	2	FY 2022	FY 2027	Reliability upgrade*4
	Sakuma Nishi Bulk Line	275kV	2km	2	FY 2022	FY 2026	Reliability upgrade*4
	Sakuma Higashi Bulk Line	275kV	123.7km→ 123km*3	2	FY 2022	FY 2027	Reliability upgrade*4

Company	Line[38]	Voltage	Length[39, 40]	Circuit	Under construction	In service	Purpose[41]
Fukushima souden	Abukumananbu Line	154kV	22km*2	1	Apr. 2020	Jun. 2023	Generator connection

Table 4-4 Retirement Plans

Company	Line	Voltage	Length	Circuit	Retirement	Purpose [41]
EPDC	Shin Toyone-Toei Line	275kV	△2.6km	1	FY 2026	Reliability upgrade*4
	Sakuma Nishi Bulk Line	275kV	△58km	2	FY 2026	Economic upgrade

2. Development Plans for Major Substations

Table 4-5 Development Plans under Construction

Company	Substation[38, 42]	Voltage	Capacity	unit	Under construction	In service	Purpose[41]
Tohoku EPCO	Noshiro	275/66kV	100MVA	1	Oct. 2019	Jun. 2021	Generator connection
TEPCO Power Grid	Shin Keiyo	275/154kV	300MVA×2→ 450MVA×2	2→2	Jul. 2018	Sep. 2019(5B) Apr. 2021(6B)	Aging management
	Shin Shinano AC/DC Converter Station*6	—	—	-	Mar. 2016	Mar. 2021	Reliability upgrade*4
	Shin Motegi	500/275kV	1,500MVA	1	May 2019	Mar. 2021	Generator connection
	Higashi Yamanashi	500/154kV	750MVA	1	Apr. 2019	Dec. 2022	Demand coverage
Chubu EPCO	Shunen	275/154kV	450MVA×1→ 300MVA×1	1→1	Feb. 2019	Nov. 2020	Aging management
	Hida Converter Station*6	—	—	-	Aug. 2017	Mar. 2021	Reliability upgrade*4
	Chita Plant*1	275/154kV	300MVA×1→ 450MVA×1	1→1	Jul. 2019	Apr. 2021	Aging management
	Chita Plant*1	275/154kV	450MVA×2	2	Jul. 2019	Nov. 2020(N1B) Aug. 2021(N2B)	Generator connection
Kansai EPCO	Higashi Osaka	275/77kV	300MVA→ 200MVA	1→1	Nov. 2019	Jul. 2020	Aging management
Chugoku EPCO	Sakugi	220/110kV	200MVA	1	Jun. 2019	Nov. 2020	Generator connection
	Shin Yamaguchi	220/110kV	400MVA×2	2	Apr. 2019	Jun. 2021	Economic upgrade
Kyushu EPCO	Hayami	220/66kV	250MVA	1	May 2019	Jun. 2020	Generator connection
	Kirishima	220/66kV	300MVA	1	Jan. 2020	Dec. 2021	Generator connection
Okinawa EPCO	Tomoyose	132/66kV	125MVA×2→ 200MVA×2	2→2	Oct. 2017	Jan. 2021(1B) May 2024(2B)	Aging management
NHWETC	Kita Toyotomi*6	187/66kV	165MVA×3	3	Apr. 2019	Sep. 2022	Generator connection

Table 4-6 Development Plans in the Planning Stages

[42] Substation with *6 denotes a substation or a converter station newly installed, including an uprated electric facility.

Company	Substation[38, 42]	Voltage	Capacity	unit	Under construction	In service	Purpose[41]
Hokkaido EPCO	Rubeshibe	187/66kV	60MVA×2→ 100MVA	2→1	Mar. 2021	Oct. 2021	Aging management
	Nishi Nakagawa*6	187/100kV	100MVA×2	2	May 2020	Jul. 2022	Generator connection
	Kita Ebetsu	187/66kV	100MVA→ 150MVA	1→1	Mar. 2021	Jul. 2022	Aging management
Hokkaido EPCO	Kita Shizunai	187/66kV /11kV	45MVA→ 60MVA	1→1	Dec. 2021	Feb. 2023	Aging management
	Kita Memuro	187/66kV	60MVA→ 150MVA	1→1	Feb. 2023	Nov. 2023	Aging management
Tohoku EPCO	Fukushima	275/66kV	100MVA	1	Apr. 2020	Jan. 2021	Generator connection
	Higashi Hanamaki	275/154kV	300MVA	1	Jul. 2022	Dec. 2024	Demand coverage
	Iwate	500/275kV	1,000MVA	1	Beyond FY 2024	Beyond FY 2028	Generator connection
	Echigo	500/275kV	1,500MVA×3	3	Beyond FY 2024	Beyond FY 2030	Generator connection
	Yawata	500/154kV	750MVA	1	Beyond FY 2027	Beyond FY 2031	Generator connection
	Kawabe	500/275kV	1,500MVA×3	3	Beyond FY 2025	Beyond FY 2031 (Beyond FY 2029)	Generator connection
	Nishi Yamagata	275/154kV→ 500/154kV	300MVA×2 →450MVA×2	2→2	Beyond FY 2024	Beyond FY 2031	Generator connection
TEPCO Power Grid	Shin Kisarazu	275/154kV	450MVA×2	2	Sep. 2020	Apr. 2022	Generator connection
	Shin Tochigi	500/154kV	750MVA	1	May 2021	Nov. 2022	Generator connection
	Shin Fuji	500/154kV	750MVA	1	FY 2023	FY 2026	Reliability upgrade*4
	Kita Tokyo	275/66kV	300MVA	1	Dec. 2021	Jun. 2023	Economic upgrade
	Shin Keiyo	275/154kV	450MVA	1	Oct. 2021	Feb. 2023	Demand coverage
	(prov.)Chiba Inzai*6	275/66kV	300MVA×2	2	Jul. 2021	Apr. 2024	Demand coverage
	Minami Tama	275/66kV	200MVA→ 300MVA	1→1	Jan. 2021	Jun. 2022	Demand coverage
Chubu EPCO	Ena*6	500/154kV	200MVA×2	2	Jun. 2022	Oct. 2024	Demand coverage
	Shimo Ina*6	500/154kV	300MVA×2	2	Jun. 2021	Oct. 2024	Demand coverage
	Toei	500/275kV	800MVA×1→ 1,500MVA×2	1→2	Apr. 2022	FY 2024(N2B) FY 2026 (1B)	Reliability upgrade*4
	Shizuoka	500/275kV	1,000MVA	1	FY 2024	FY 2026	Reliability upgrade*4
	Higashi Shimizu	—	300MW→ 900MW	—	Oct. 2020	FY 2027	Reliability upgrade*4
Hokuriku EPCO	Kaga	275/154kV	400MVA	1	Jun. 2020	Sep. 2023	Reliability upgrade
Kansai	Gobo	500/154kV	750MVA×2	2	Jul. 2021	Jul. 2024	Generator connection

Company	Substation[38, 42]	Voltage	Capacity	unit	Under construction	In service	Purpose[41]
EPCO	Nishi Kobe	275/77kV	200MVA×2→ 300MVA	2→1	Aug. 2020	Jun. 2021	Aging management
Kansai EPCO	Koto	275/77kV	200MVA→ 300MVA	1→1	Jan. 2022	Oct. 2022	Aging management
	Yodogawa	275/77kV	300MVA×2→ 300MVA	2→1	Dec. 2020	Oct. 2021	Aging management
	Kainanko	275/77kV	300MVA×1, 200MVA×2→ 300MVA×2	3→2	Aug. 2022	Jun. 2024	Aging management
	Nishi Osaka	275/77kV	300MVA	1	Feb. 2021	May 2023	Demand coverage
	Seiban	275/77kV	300MVA×2→ 200MVA×2	2→2	Jan. 2022	Jun. 2024	Aging management
	Shin Kobe	275/77kV	300MVA×1, 200MVA×1→ 200MVA×1	2→1	Aug. 2022	Jan. 2024	Aging management
Chugoku EPCO	Kasaoka	220/110kV	250MVA→ 300MVA	1→1	Aug. 2020	Jun. 2021	Aging management
	Nishi Shimane	500/220kV	1,000MVA	1	Apr. 2020	Mar. 2022	Generator connection
Shikoku EPCO	Kochi	187/66kV	200MVA→ 300MVA	1→1	Nov. 2021	Apr. 2022	Aging management Demand coverage
Kyushu EPCO	Miyakonojo	220/110kV	150MVA	1	Dec. 2021	Mar. 2024	Generator connection
	Shin Hyuga	220/110 /66kV	250/150 /200MVA	1	Jun. 2021	Apr. 2023	Generator connection
	Wakamatsu	220/66kV	250MVA	1	May 2022	Apr. 2024	Generator connection
	Nishi Fukuoka	220/66kV	180MVA×2→ 300MVA	2→1	Sep. 2020	Apr. 2022	Aging management
EPDC	(prov.)Shin Sakuma FC*6	—	—	—	FY 2024	FY 2027	Reliability upgrade*4
Fukushima souden	Abukumaminami *6	154/66 /33kV	170MVA	1	Apr. 2020	Jun. 2023	Generator connection

Table 4-7 Retirement Plans

Company	Substation	Voltage	Capacity	unit	Retirement	Purpose[41]
TEPCO Power Grid	Hanamigawa	275/66kV	300MVA	1	Mar. 2024	Demand coverage
	Kita Tokyo	275/154kV	300MVA	1	Oct. 2021	Economic upgrade
	Ageo	275/66kV	300MVA	1	Jul. 2023	Economic upgrade
Kansai EPCO	Higashi Osaka	275/154kV	300MVA	1	Jan. 2021	Aging management
	Koto	275/77kV	100MVA×2	2	Oct. 2023	Aging management
	Kita Katsuragi	275/77kV	200MVA×2	2	May 2022(3B) May 2023(4B)	Aging management
EPDC	Nagoya	275/154kV	300MVA×3	3	FY 2024	Economic upgrade

3. Summary of Development Plans for Transmission Lines and Substations

Tables 4-8 to 4-11 show the summarized development or extension plans of major transmission lines and substations (transformers and converter stations) up to FY 2029 submitted by GT&D and transmission companies.

Table 4-8 Development Plans for Major Transmission Lines

Category	Voltage	Lines	Length[43]	Extended Length[44]	Total Length	Total Extended Length
Newly Installed or Extended	500kV	Overhead	643 km*	1,286 km*	643 km*	1,286 km*
		Underground	0 km	0 km		
	275kV	Overhead	△171 km	△350 km	△153 km	△312 km
		Underground	17 km	38 km		
	220kV	Overhead	5 km	10 km	5 km	10 km
		Underground	0 km	0 km		
	187kV	Overhead	120 km	240 km	120 km	240 km
		Underground	0 km	0 km		
	154kV	Overhead	0 km	0 km	22 km	22 km
		Underground	22 km	22 km		
	DC	Overhead	89 km	89 km	89 km	89 km
		Underground	0 km	0 km		
	Total	Overhead	687 km	1,275 km	726 km	1,335 km
		Underground	39 km	60 km		
To be Retired	275kV	Overhead	△61 km	△119 km	△61 km	△119 km
		Underground	0 km	0 km		
	Total	Overhead	△61 km	△119 km	△61 km	△119 km
		Underground	0 km	0 km		

Table 4-9 Revised Plans for Line Category and the Numbers of Circuits[45]

Voltage	Length Extended	Total Extended Length
500kV	0 km	1 km
275kV	254 km	535 km
220kV	4 km	8 km
187kV	7 km	14 km

43 Length denotes both the increased length due to newly installed or extended plans, and the decreased length due to retirement. Development plans corresponding to the change of line category or the number of circuits were not included in the increased length of transmission lines shown in Table 4-8 and are treated as 'no change in the length'. The totals of lengths are not necessarily equal due to independent rounding. In addition, the overall total length is not necessarily equal due to independent rounding.

44 Total length denotes the aggregation of length multiplied by the number of circuits. Development plans corresponding to the change of line category or the number of circuits were not included in the increased length of transmission lines in Table 4-8 and are treated as 'no change in the length'.

45 Table 4-9 aggregates the extended and total extended lengths corresponding to the revised plans for the line category and the number of circuits.

Total	265 km	557 km

Table 4-10 Development Plans for Major Substations

Category [46]	Voltage[47]	Increased Numbers	Increased Capacity
Newly Installed or Extended	500kV	23 [4]	22,100MVA [1,000MVA]
	275kV	7 [2]	3,150MVA [600MVA]
	220kV	7 [0]	1,790MVA [0MVA]
	187kV	4 [5]	930MVA [695MVA]
	154kV	1 [1]	170MVA [170MVA]
	132kV	0 [0]	150MVA [0MVA]
	Total	42 [12]	28,290MVA [2,465MVA]
To be Retired	275kV	△11	△2,700 MVA
	Total	△11	△2,700 MVA

[ ] : The aforementioned increase in the number of transformers resulted from new substation installations.

Table 4-11 Development Plans for AC/DC Converter Stations

Category	Company and Number of Sites		Capacity[48]
Newly Installed or Extended	TEPCO Power Grid	1	900MW
	Chubu EPCO	2	900MW 600MW
	Electric Power Development Company	1	300MW

46 Retirement plans with transformer installations are included in Newly Installed or Extended, and negative values are included in the increased numbers or the increased capacity.

47 Voltage class by upstream voltage.

48 Installed capacity of the converter stations on both sides of the DC lines is included.

4. Aging Management of Existing Transmission and Distribution Facility

Existing transmission and distribution facilities that were installed after the period of economic expansion (the 1960s to the 1970s) are approaching their time for replacement. The facilities to be replaced are on the increase, and significant facilities will be remained unreplaced in pace of the recent replacement work. To secure stable electricity supply in the future, appropriate decisions concerning the replacement schedule are vital. Figures 4-2 to 4-5 show the actual installation years of existing transmission and distribution facilities.

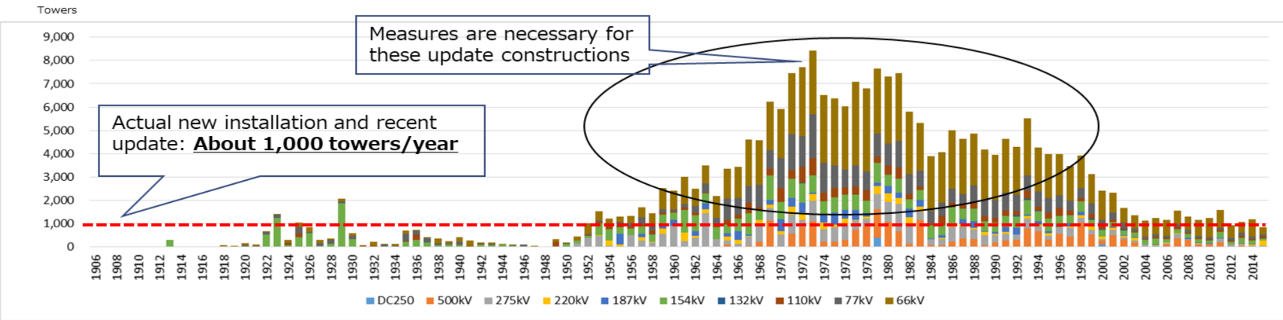


Figure 4-2 Actual Installation Year of Existing Transmission Towers (66kV-500kV)

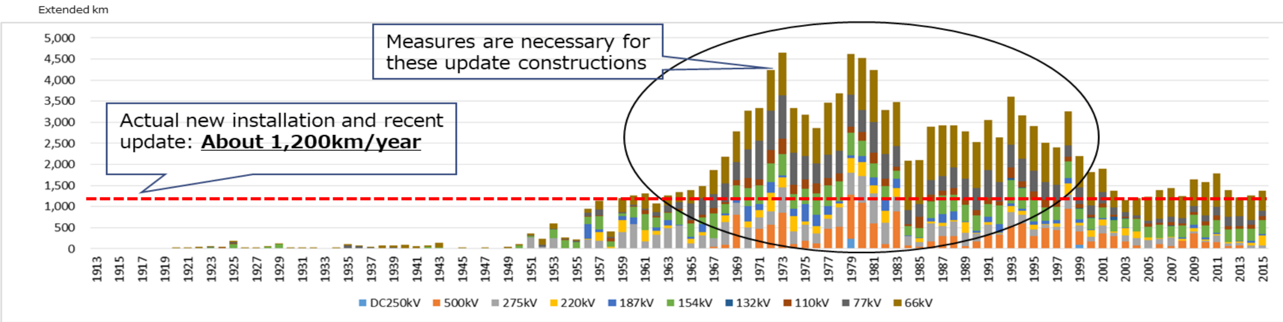


Figure 4-3 Actual Installation Year of Existing Overhead Lines (66kV-500kV)

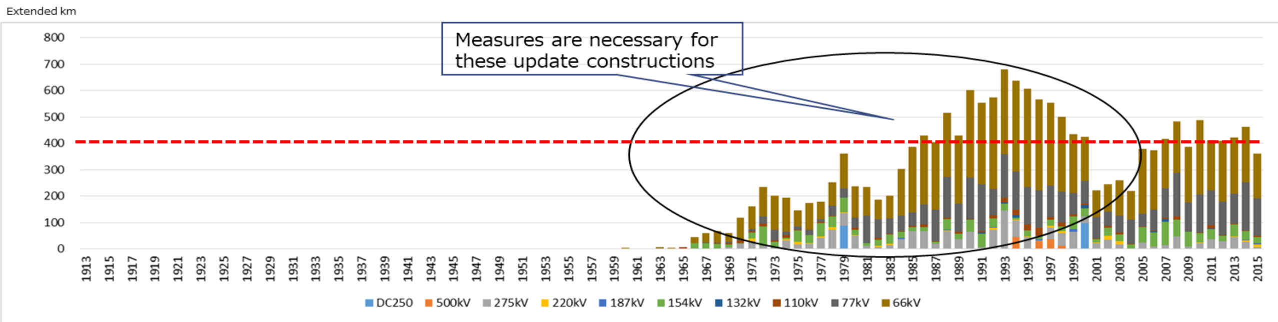


Figure 4-4 Actual Installation Year of Existing Underground Cables (66kV-500kV)

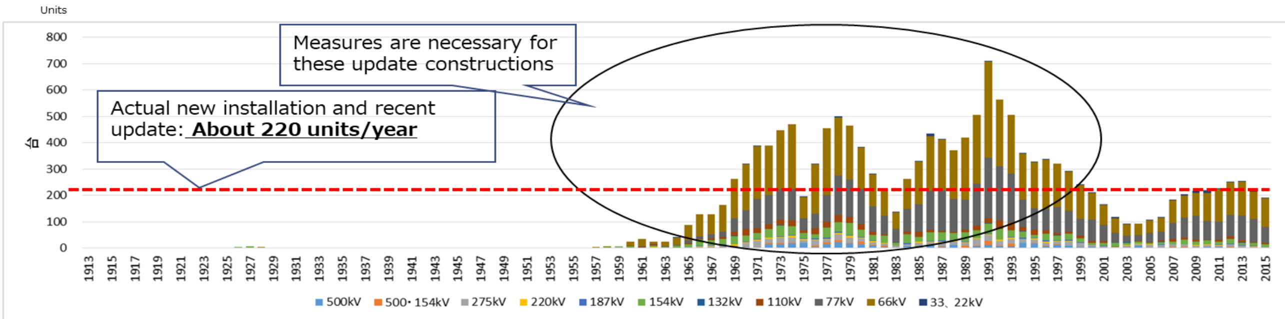


Figure 4-5 Actual Installation Year of Existing Transformers (66kV-500kV; one that is partly 22kV is included)

Furthermore, the number of transmission workers is on the decrease, and a skilled workforce has been in short supply in recent years. Figure 4-6 shows the transition of numbers of tower-climbing workers in transmission construction.[49]

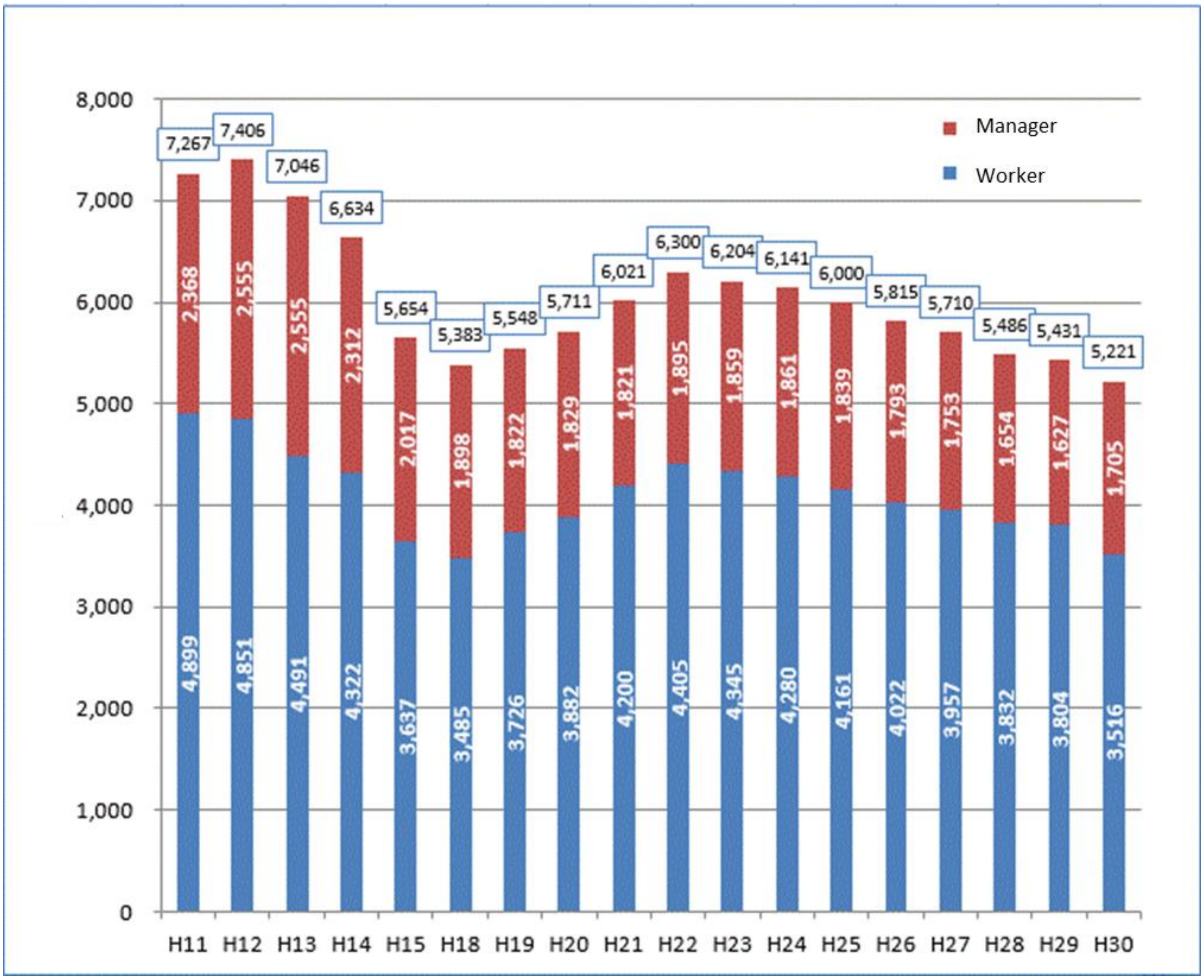


Figure 4-6 Transition of Numbers of Tower-climbing Transmission Workers [49]

[49] Source: Transmission Line Construction Engineering Society of Japan.
http://www.sou-ken.or.jp/01souken/souken_toukei.php (only in Japanese)

V. Cross-regional Operation

Retail companies will procure the supply capacity for their customers in their regional service areas. The scheduled procurement from external service areas at 15:00 in August 2020 is illustrated in four figures. Figures 5-1 and 5-2 show the supply capacity and the ratio of the supply capacity, respectively, at 15:00 in August. Figures 5-3 and 5-4 show the energy supply and the ratio of the energy supply, respectively, in FY 2020.

Higher ratios for procurement from external regional service areas are observed in the Tokyo, Kansai, and Chugoku EPCO areas; those to external regional service areas are observed in the Tohoku, Shikoku, and Kyushu EPCO areas.

Results of analysis show the same tendency as in past years due to no changes in major bilateral contracts of transmission line use.

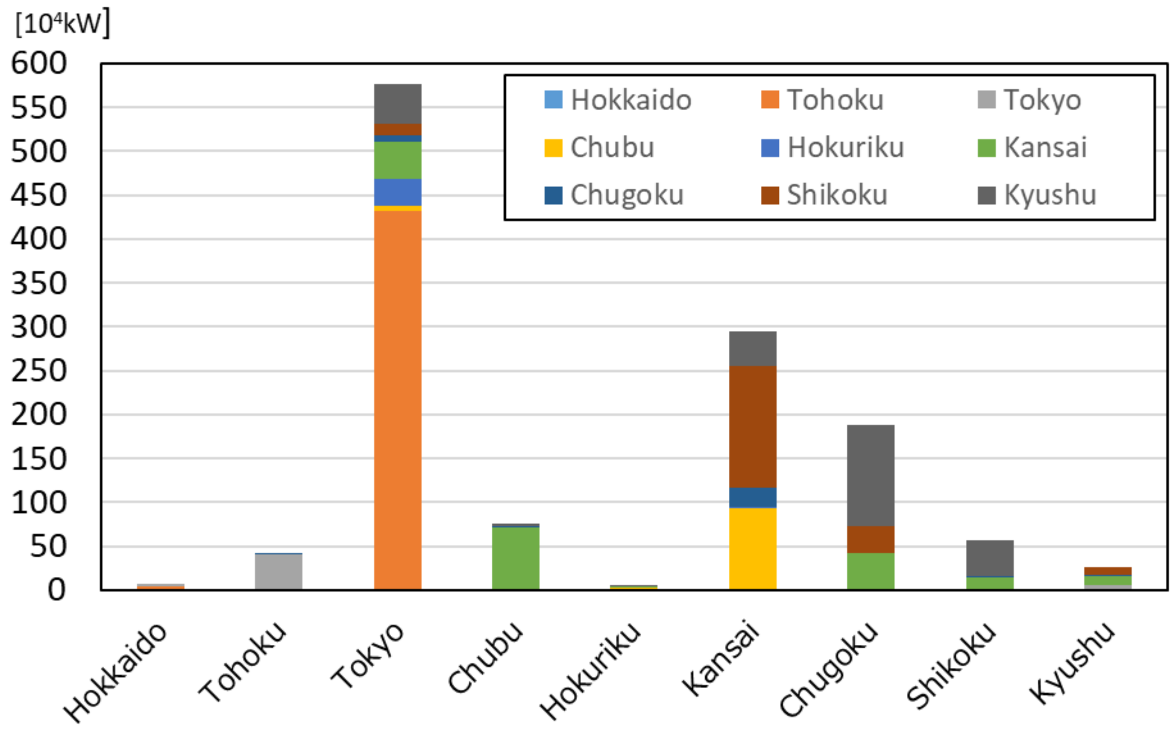


Figure 5-1 Scheduled Procurement of Supply Capacity from External Regional Service Areas

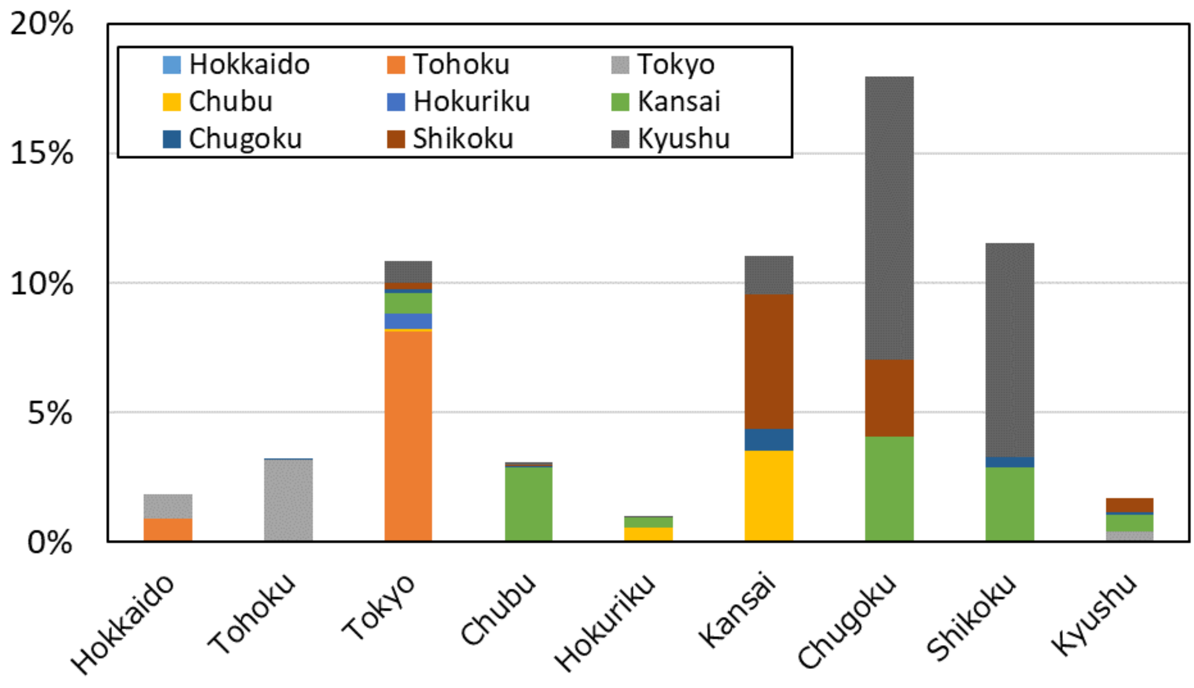


Figure 5-2 Ratio of Scheduled Procurement of Supply Capacity from External Regional Service Areas

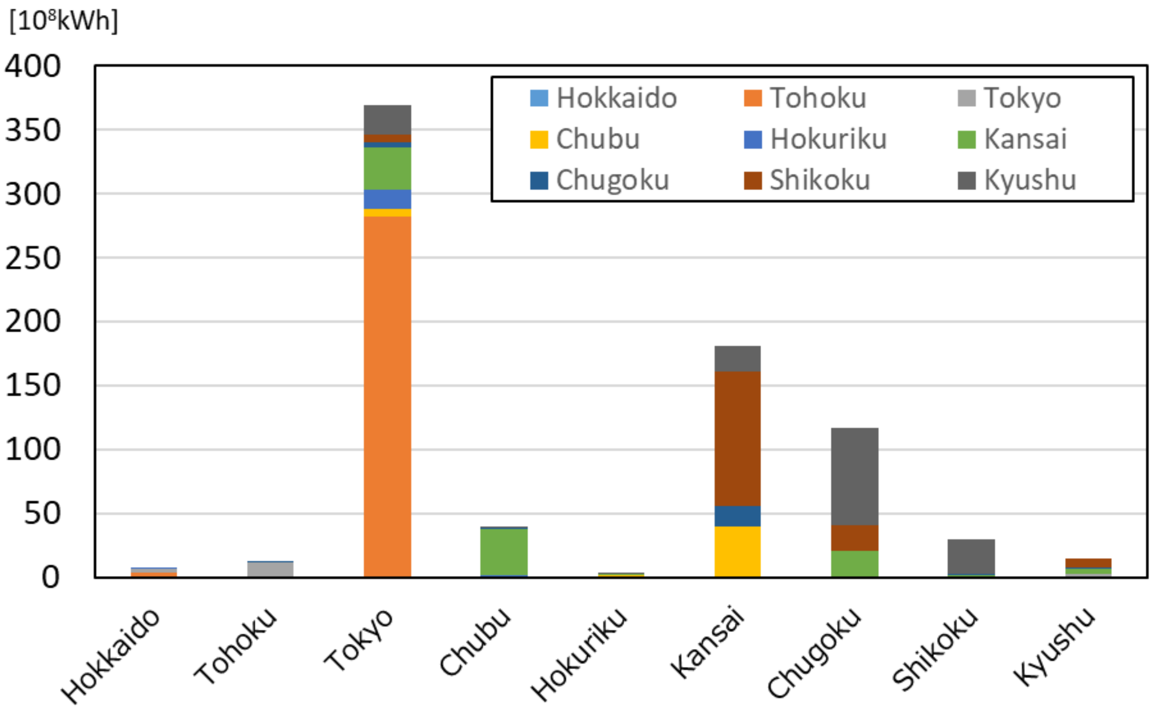


Figure 5-3 Scheduled Procurement of Energy Supply from External Regional Service Areas

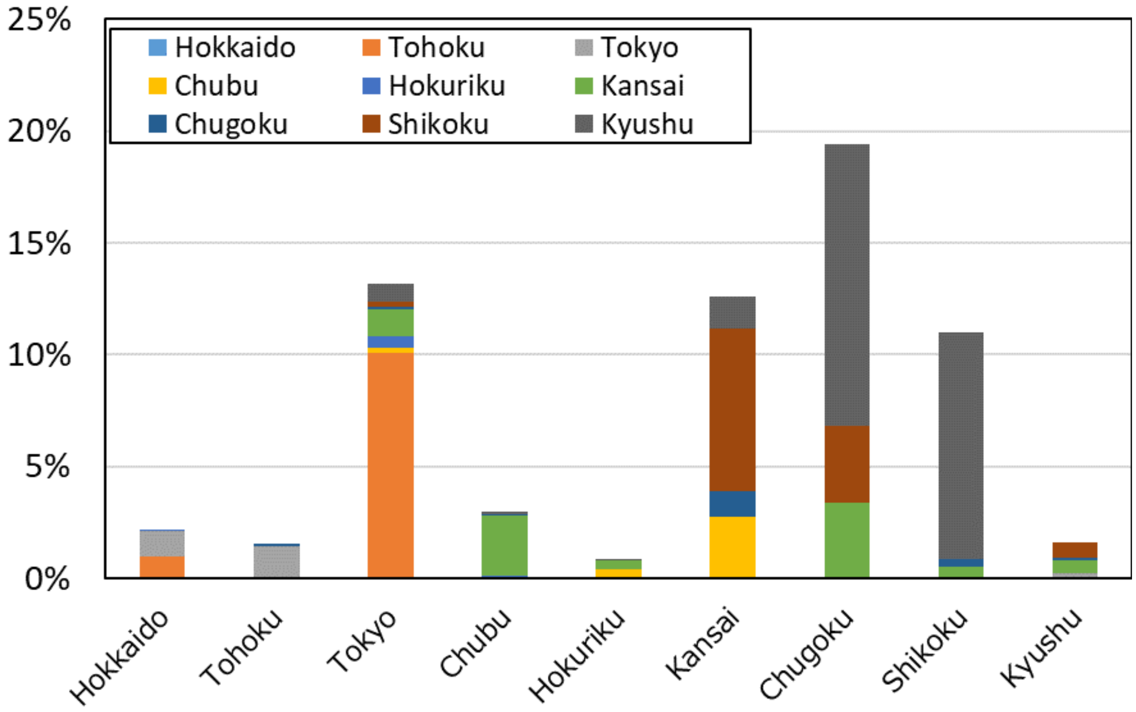


Figure 5-4 Ratio of Scheduled Procurement of Energy Supply from External Regional Service Areas

VI. Analysis of Characteristics of Electric Power Companies

1. Distribution of Retail Companies by Business Scale (Retail Demand)

In total, 620 retail companies submitted their electricity supply plans, and these are classified by the business scale of the retail demand forecast by the corresponding companies. Figures 6-1 and 6-2 show the distributions of the business scale of retail demand and the accumulated retail demand forecast by the corresponding companies, respectively. Notably, small and medium-sized retail companies (business scale of under 1 GW) plan to expand business.

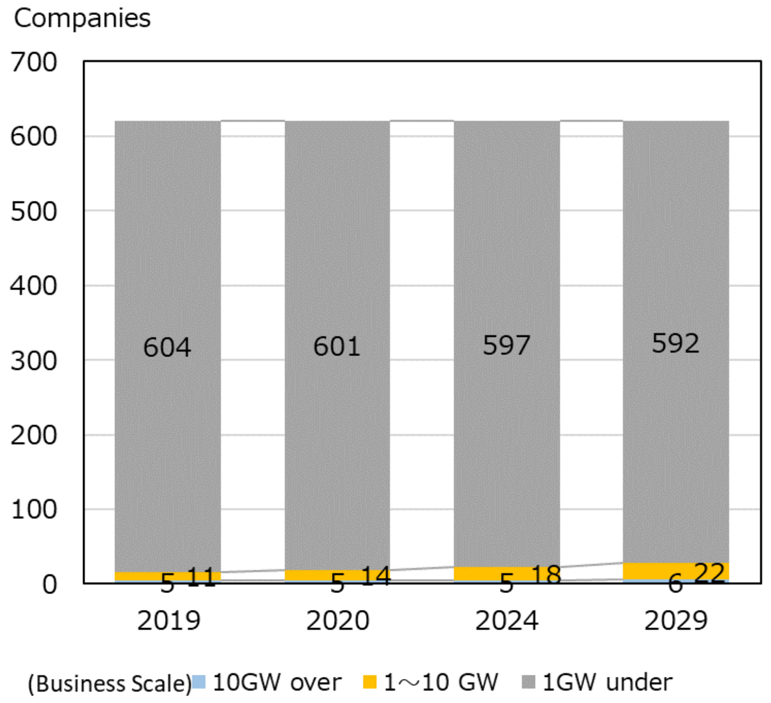


Figure 6-1 Distribution by Business Scale of the Retail Demand by Retail Companies

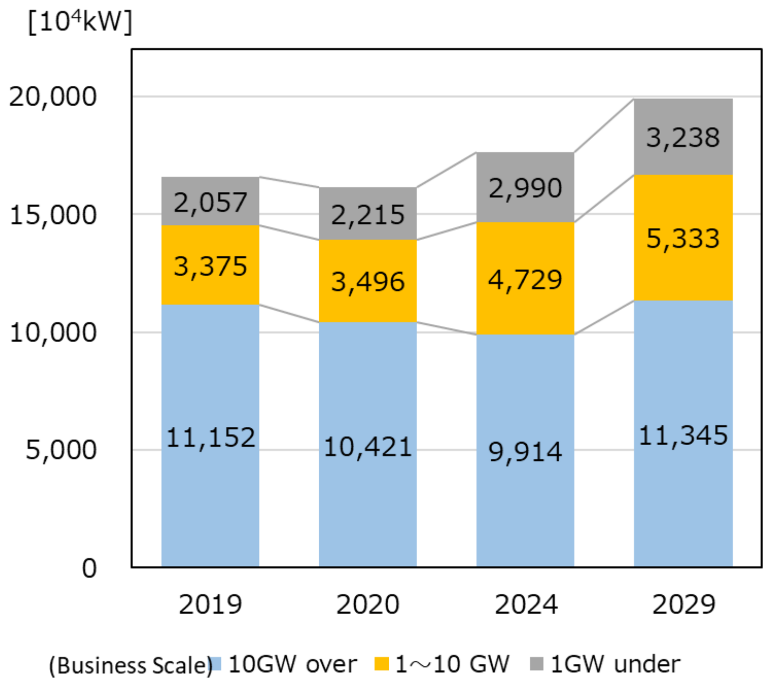


Figure 6-2 Distribution by Accumulated Retail Demand by Retail Companies

Again, retail companies are classified by the business scale of the retail energy sales forecast by the corresponding companies. Figures 6-3 and 6-4 show the distributions of the business scale of retail company energy sales and their accumulated energy sales forecast, respectively. Similarly, small and medium-sized retail companies (business scale of under 1 GW) plan to expand business.

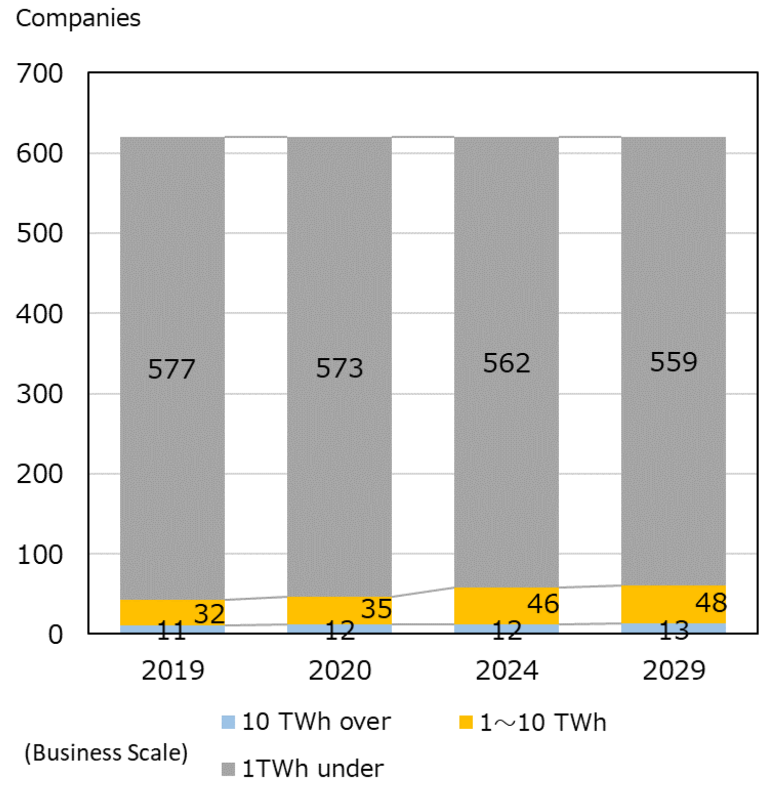


Figure 6-3 Distribution by Business Scale of Retail Company Energy Sales

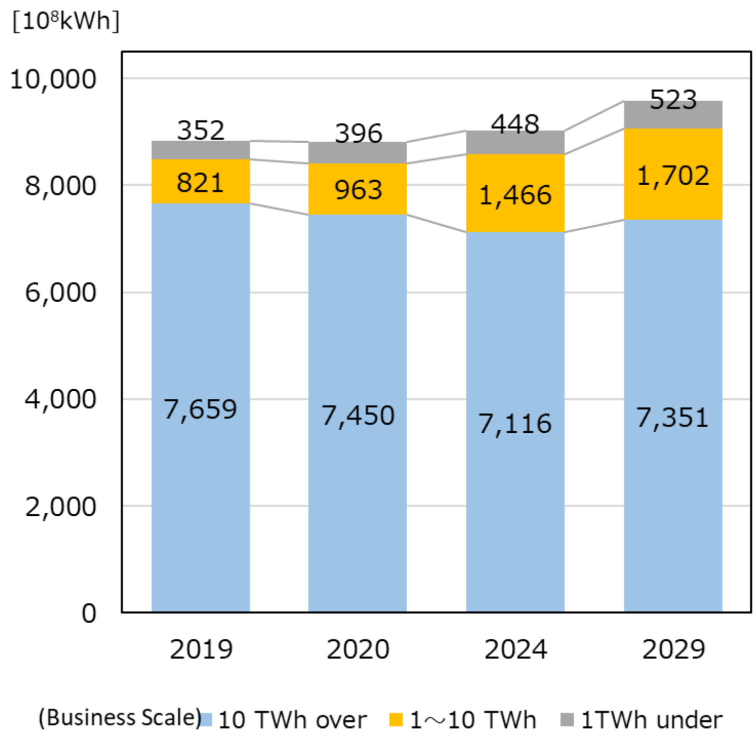


Figure 6-4 Distribution by Retail Company of Accumulated Energy Sales

2. Retail Company Business Areas

Figure 6-5 shows the ratio of retail companies by the number of areas where they plan to conduct their business. Figure 6-6 shows the number of retail companies by their business planning areas in FY 2020. The figures exclude 96 retail companies that had not yet developed their retail business plans. Half of the retail companies plan their business in a single area.

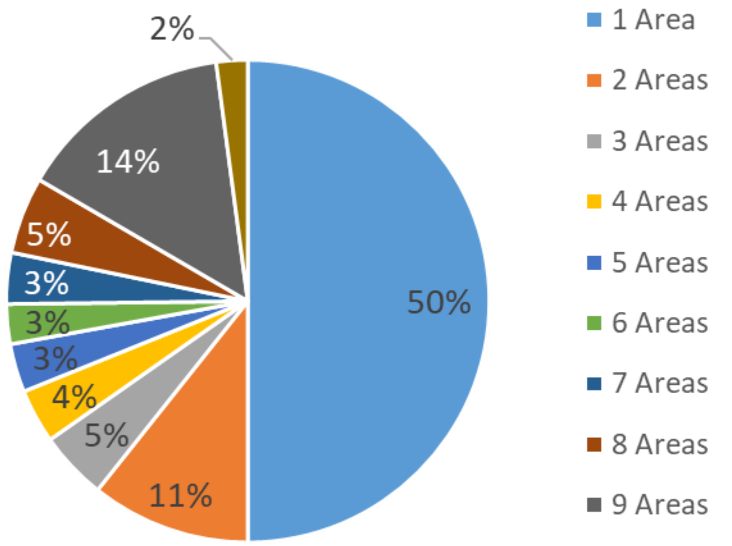


Figure 6-5 Ratio of Retail Companies by the Number of Planned Business Areas in FY 2020

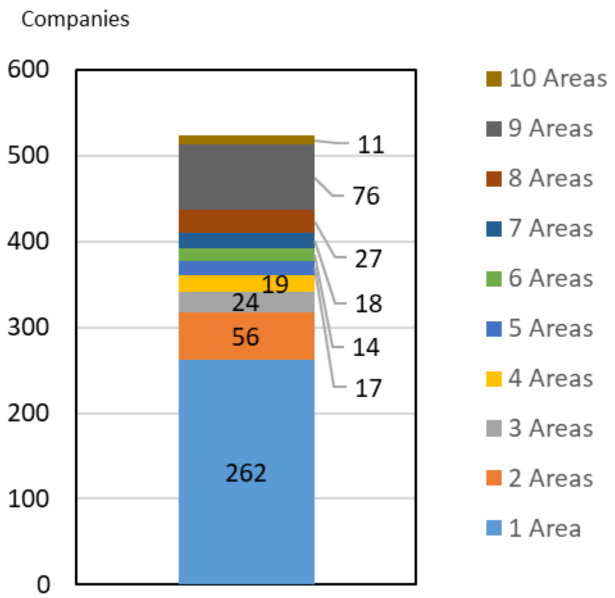
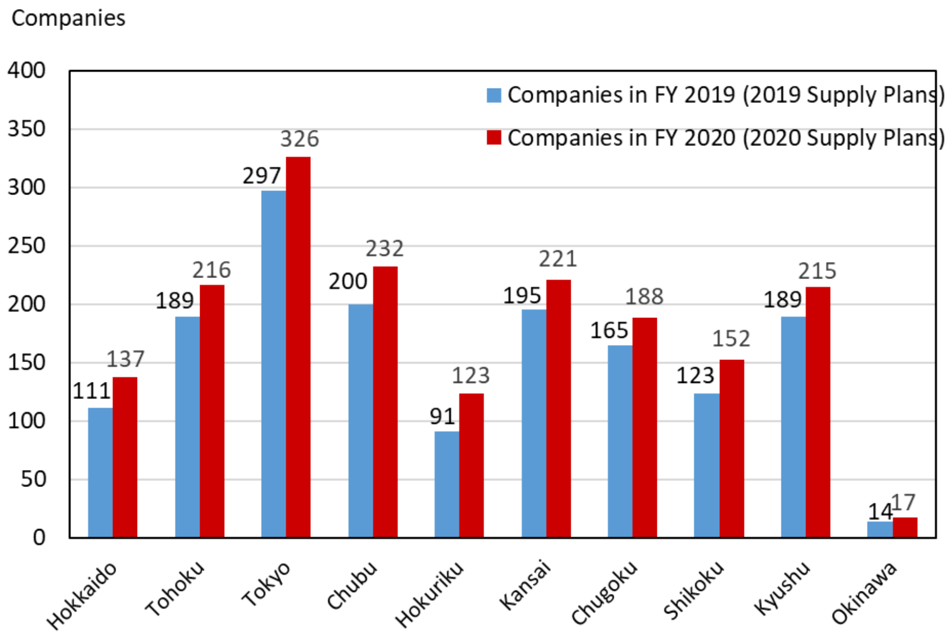


Figure 6-6 Number of Retail Companies by their Business Planning Areas in FY 2020

Figure 6-7 shows the number and the retail demand of retail companies in each regional service areas for GT&D companies in FY 2020. As retail companies increase their numbers in every regional service area, the choice of retail company for electricity customers is expanding.



Projected Peak Demand in FY 2020 (10^4 kW)

Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
419	1,295	5,319	2,464	497	2,672	1,043	498	1,539	150

Figure 6-7 Number and Retail Demand of Retail Companies in Each Regional Service Area

3. Supply Capacity Procurement by Retail Companies

Figure 6-8 shows the retail demand forecast in the regional service area by the retail department of the former general electric utilities and their procured supply capacity to the retail demand. The retail and generation departments of the former general electric utilities secure sufficient supply capacity procured for the retail demand of their own area.

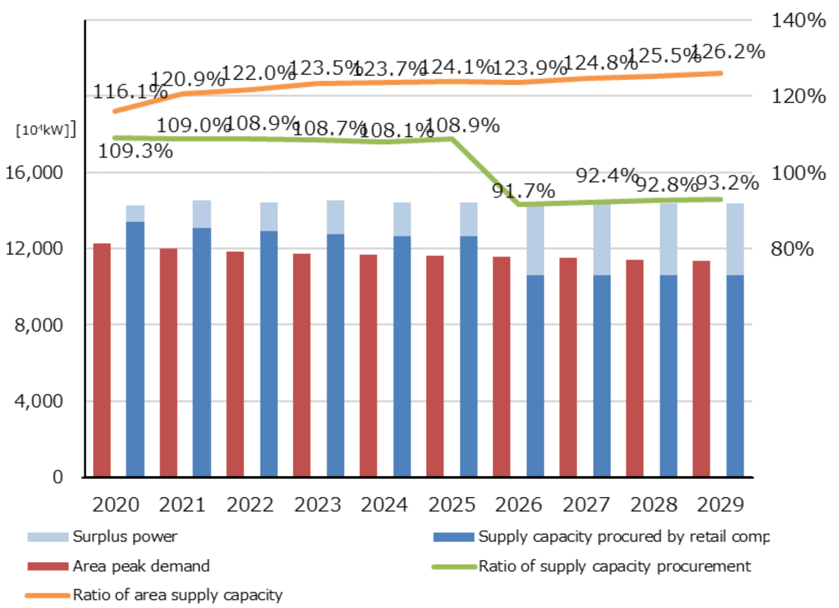


Figure 6-8 Ratio of Secured Supply Capacity to Forecast Retail Demand of Their Own Area for Former General Electric Utilities[50](at 15:00 in August[26], at the sending end)

[50] Includes surplus power of group companies deducting balancing capacity to the secured supply capacity by retail companies.

The competition between retail departments of former general electric utilities has become fierce; the supply capacity procured for the retail demand of external areas that such companies forecast, and the retail demand that power producers and suppliers (PPSs) forecast as their retail demand, indicate a declining trend as shown in Figure 6-9.

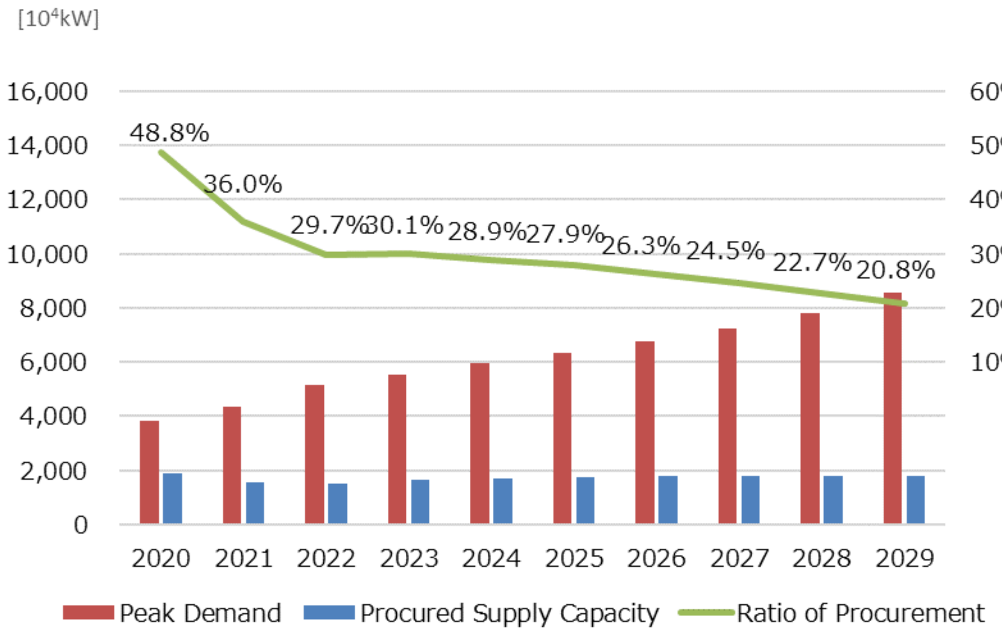


Figure 6-9 Ratio of Procured Supply Capacity to Forecast Retail Demand by Retail Companies [Former General Electric Utilities in External Areas and by PPSs] (at 15:00 in August[26], at the sending end)

4. Distribution of Generation Companies by Business Scale (Installed Capacity)

In total, 821 generation companies submitted their electricity supply plans, and these are classified by the business scale of the installed capacity operated by the corresponding companies. Figure 6-10 shows the distribution by business scale and Figure 6-11 shows the installed capacity operated by the corresponding companies.

Generation companies with an installed capacity of under 10 GW are planning to enlarge the scale of their business.

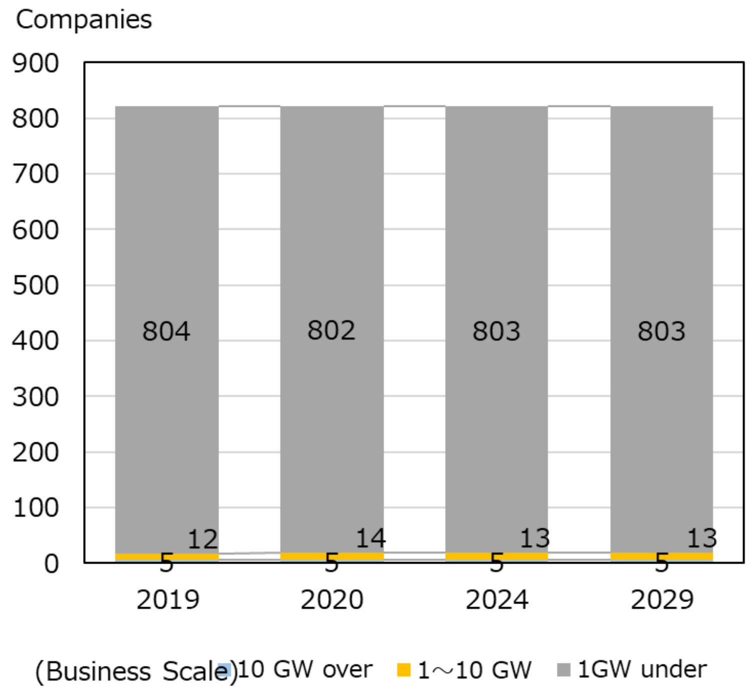


Figure 6-10 Distribution by Business Scale of Generation Company Installed Capacity

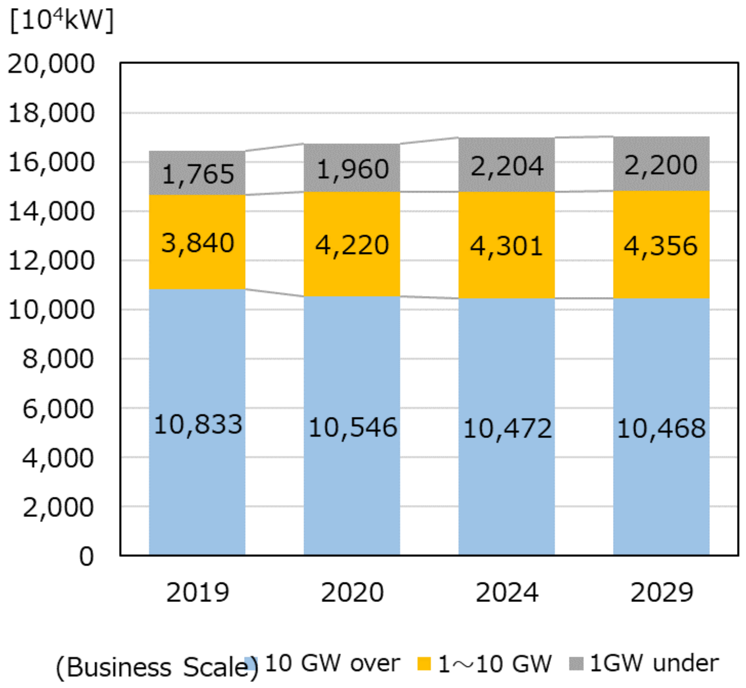


Figure 6-11 Distribution by Generation Company Accumulated Installed Capacity

Similarly, generation companies are classified by the business scale of the corresponding company energy supply forecast. Figure 6-12 shows the distribution by the business scale of the energy supply and Figure 6-13 shows the distribution by the corresponding company accumulated energy supply forecast.
Generation companies with an energy supply of under 10 TWh are planning to decrease their energy generation.

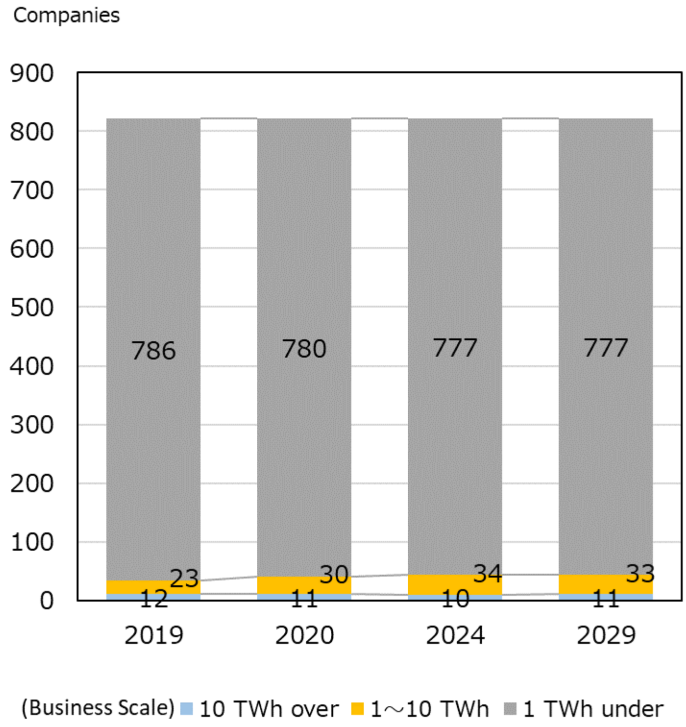


Figure 6-12 Distribution by Business Scale of Generation Company Energy Supply

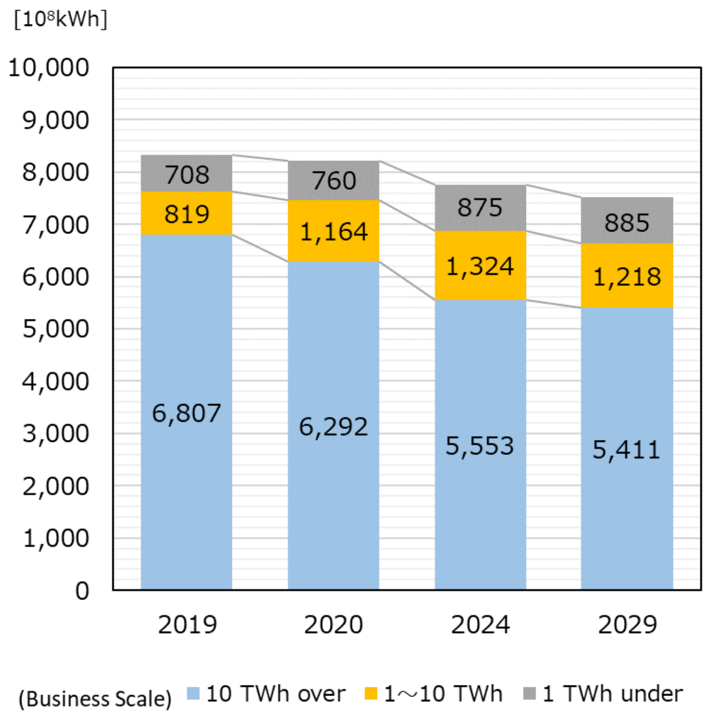


Figure 6-13 Distribution by Generation Company Accumulated Energy Supply

Figure 6-14 shows the number of generation companies by the power generation sources of their own generators at the end of FY 2020. The figures exclude 107 generation companies that do not own their generation plants. Approximately half of all generation companies solely own renewable energy generation facilities.

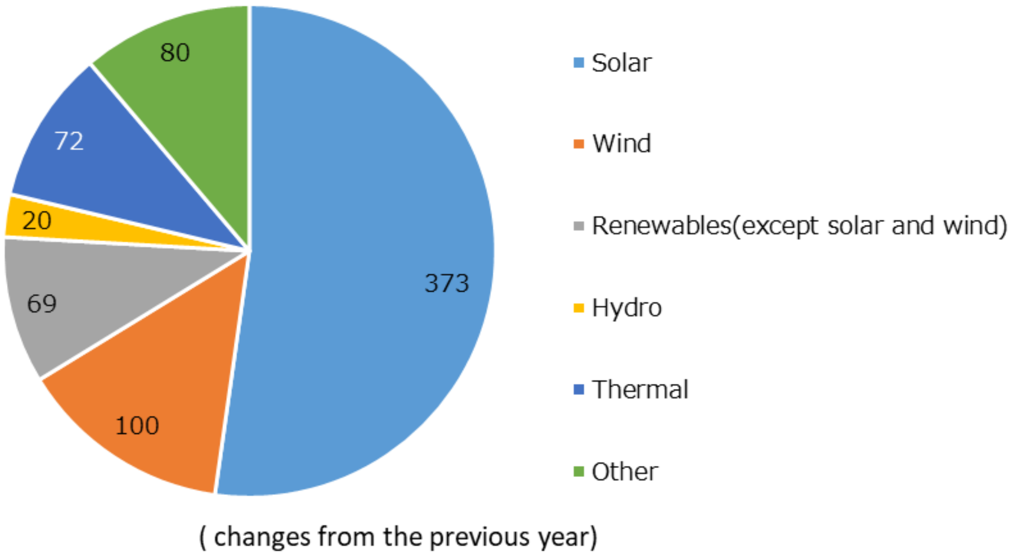


Figure 6-14 Number of Generation Companies by Power Generation Sources

5. Generation Company Business Areas

Figure 6-15 shows the ratio of generation companies to the number of areas where they plan to conduct their business. Figure 6-16 shows the number of generation companies by their business planning areas in FY 2020. The figures exclude 134 generation companies that do not own their generation plants.

Eighty percent of all generation companies plan their business in a single area.

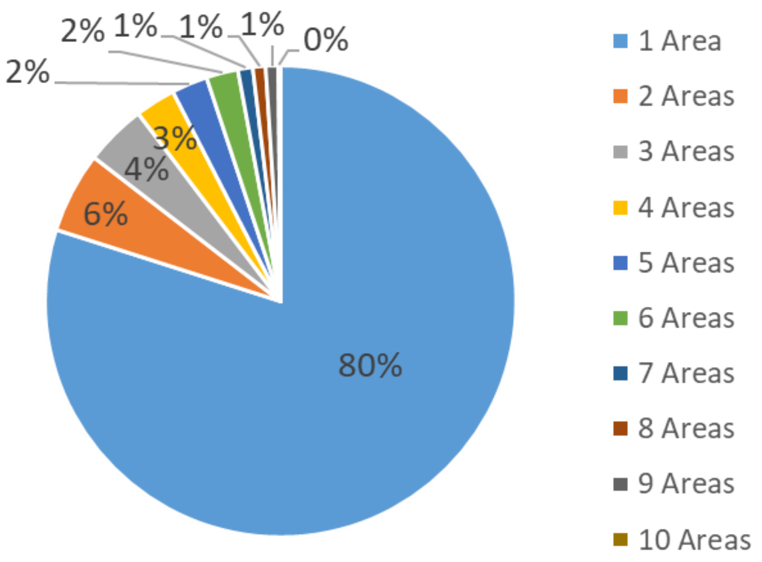


Figure 6-15 Ratio of Generation Companies by the Number of Planned Business Areas in FY 2020

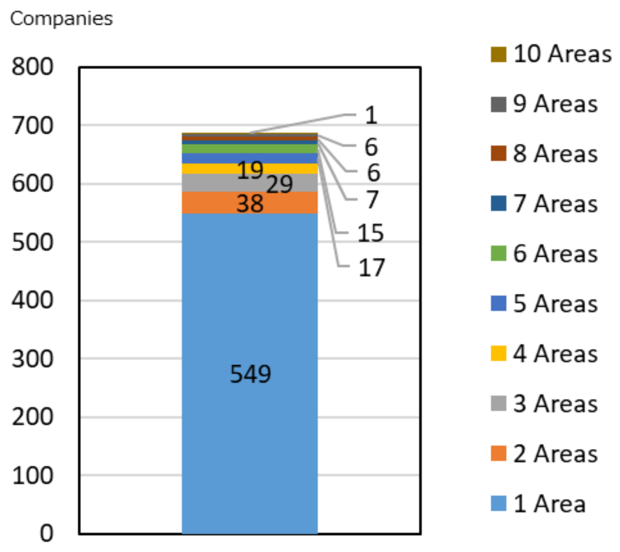
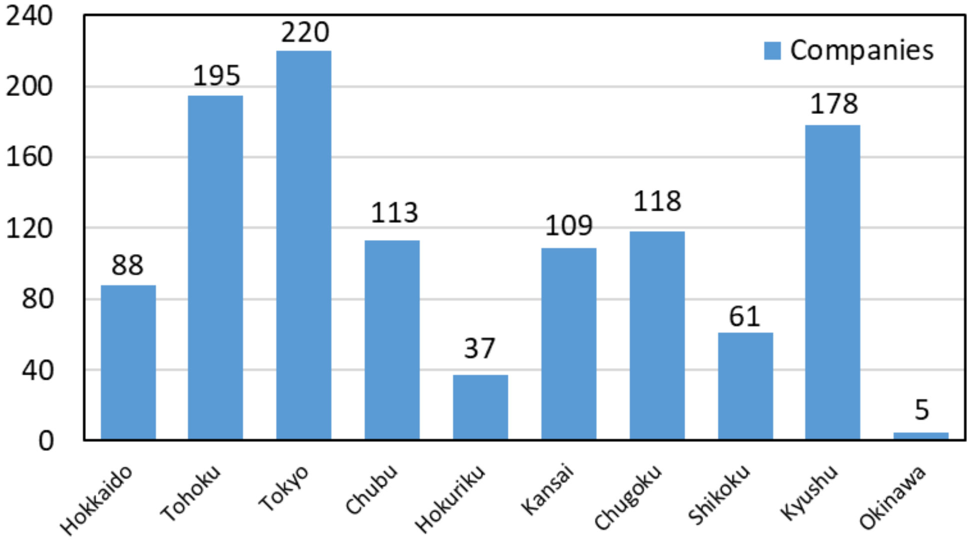


Figure 6-16 Number of Generation Companies by Their Business Planning Areas in FY 2020

Figure 6-17 shows the number and installed capacity of generation companies in each regional service area for GT&D companies in August 2020. In the Hokkaido, Tohoku, Chugoku, and Kyushu regional service areas, the scale of generation companies is rather small and their supply capacity is comparatively small despite the number of generation companies in these regional service areas.



Projected Supply Capacity in FY 2020 (10^4 kW)

Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
531	1,796	5,068	2,516	595	2,604	985	680	1,759	192

Figure 6-17 Number and Installed Capacity of Generation Companies in Each Regional Service Area

VII. Findings and Current Challenges

The current challenges relating to the aggregation of electricity supply plans are as follows.

1. Importance of Coordination of Scheduled Maintenance of Generators toward Stable Supply

In the aggregation of electricity supply plans, it is projected that the adequate 8% reserve margin will be secured for both the short and mid-to-long terms in supply–demand balance evaluation utilizing cross-regional interconnection lines. On the other hand, it is also projected that the supply–demand balance, especially in FY 2020–2022, will be tight due to a decrease of supply capacity of thermal power generation, which includes newly planned suspension or retirement.

For FY 2020 and 2021, adequate reserve margin is projected to be secured as a result of monthly supply–demand evaluation. For FY 2022, the evaluation will be implemented in the following year. For aggregation in the next year, proper coordination of the scheduled maintenance of generators in the peak demand period is important to secure the necessary supply capacity for a stable supply of electricity.

However, in the case that securing the necessary supply capacity fails, the Organization shall strive to secure supply capacity unavoidably utilizing the scheme of solicitation and procurement of supply capacity with the cooperation of the relevant GT&D companies in the current stage where capacity market that procure supply capacity is not introduced yet.

The Organization recommends the Government to review the cost allocation of the above procurement of supply capacity, and its treatment of wheeling charges according to the interim report of the "Subcommittee on Electricity Resilience toward a Decarbonized Society". (https://www.meti.go.jp/shingikai/enecho/denryoku_gas/datsu_tansoka/pdf/20190730_report.pdf only in Japanese)

<Further Utilization of Renewable Energy Generation>

Smooth and effective coordination is expected of the scheduled maintenance of generators in the peak demand period including winter, according to the scheme for coordinating scheduled maintenance of supply capacity (requirement for coordination) two years ahead of actual supply–demand after the introduction of the capacity market.

In these circumstances, the scheduled maintenance of pumped storage generators is avoided during the off-peak period so as not to curtail output of renewable energy, and further utilize energy generated by renewable energy generation, which contributes to reducing CO2 emission. However, after introduction of the capacity market, the scheme for coordinating scheduled maintenance will encourage maintenance work during the off-peak period, which will lead to curtailment of output from renewable energy generation. It is noted that the effective utilization of renewable energy generation will decrease as a result.

The Organization recommends review of the need to assess the value of energy generation that is capable of avoiding scheduled maintenance during the off-peak period so as to utilize renewable energy generation in the process of the larger integration of renewable energy generation.

2. Electricity Supply Plan after Introduction of the Capacity Market

As the electricity supply plan reviews the situation of stable supply and formation of transmission and distribution facilities, its fundamental purpose and role will not change even after the introduction of the capacity market. After its introduction, it is crucial to confirm the existence of sufficient generating facilities (i.e., supply capacity) to procure the necessary supply capacity through the market for the upcoming 10-year period at the annual aggregation of the supply plans. Therefore, the Organization shall focus on understanding the trends in new generator development, suspension or retirement plans of existing facilities owned by generation companies, as well as the possibility of utilizing suspended generation facilities, with the cooperation of the GT&D companies.

In particular, regarding the suspension or retirement of generators, it is crucial to secure the necessary supply capacity, including the transmission capability of transmission and distribution facilities, in the case that significant suspension or retirement of generators is included in the aggregation of the supply plans. Furthermore, to contribute to future projection or review of necessary measures, it is vital for the Organization to understand the trend in suspension or retirement of generators in advance, and cooperate with the Government and GT&D companies to prepare an appropriate response.

On the other hand, the situation continues in which the ratio of supply capacity procurement from the wholesale market is high for procuring action by medium or small-sized retail companies that grow their shares. In future, the scheme for supply capacity to be secured in the long-term through the capacity market will be in place; at the same time, it is projected that the trend of procuring supply capacity from the market or short-term bilateral contracts by retail companies, including the retail departments of former general electric utilities, will continue or increase.

In circumstances that include the diversification of supply capacity procurement by retail companies, and review of the imbalanced charge system, the Organization believes that it is time to reconsider the confirmation method for the situation of supply capacity procurement by retail companies.

3. Drawing up a Replacement Plan for Existing Aged Transmission and Distribution Facilities

As a result of the review of the adequacy of new installation or replacement plans for transmission and distribution facilities for the upcoming 10-year period by the Organization, it is necessary to proceed with the review while paying attention to the four points below in order to adequately replace aged facilities in the future.

<u>Appropriate decisions regarding replacement timing of facilities</u>

The replacement work for existing transmission and distribution facilities that were installed after the period of economic expansion (the 1960s to the 1970s) is an increasing trend. To maintain and manage transmission and distribution facilities, appropriate decisions regarding replacement timing are required.

<u>Securing a highly skilled workforce</u>

It will be crucial to secure a highly skilled workforce for replacement work to respond to the increasing volume of construction work on cross-regional interconnection lines and grid connection of renewable energy generators.

<u>Coordination of maintenance work schedules</u>

The coordination of maintenance work schedules between EPCOs will be important to implement construction work while securing a stable electricity supply, in the conditions under which the period and the frequency of maintenance work will increase at the replacement work.

<u>Compatibility in both reducing national cost sharing and securing adequacy and reliability</u>

It will be indispensable to invest in securing the adequacy and reliability of the electric system while reducing national cost sharing.

Based on the above points, the Organization believes that it is necessary to draw up an appropriate replacement plan that properly evaluates the aging condition or outage severity of existing facilities, and ensures this priority in replacement nationwide.

The Organization will review the scheme for proper improvement and repair of aged facilities based on objective evaluation as part of the master plan for the electric system (see footnote[37]).

In addition, the Organization recommends the Government to take the necessary steps to secure investment in wheeling charge reform to effectively implement replacement of critical infrastructure facilities that support a stable electricity supply.

VIII. Conclusions

1. Electricity Demand Forecast

The AAGRs of both peak demand nationwide (average of the three highest daily loads) and electric energy requirement nationwide in the mid-to-long-term are forecast to decrease by 0.1%. AAGRs have become negative, and this is attributable to a number of major factors, such as efforts to reduce electricity use, wider utilization of energy-saving electric appliances, a shrinking population, and load-leveling measures.

2. Electricity Supply and Demand

Regarding the supply–demand balance evaluation in each regional service area during the upcoming 10-year period, the criterion of a stable supply, that is, a reserve margin of 8% (supply capacity over peak demand by deducting the capacity of the largest generating unit and balancing capacity with frequency control [Generator I] in Okinawa) is projected to be secured in all areas and years by sharing power from other areas with sufficient supply capacity through cross-regional interconnection lines. The Organization will continuously and carefully evaluate the supply–demand balance, by monitoring the submission of changing supply plans and the accompanying supply–demand balance.

3. Analysis of the Transition of Power Generation Sources Nationwide

Regarding the transition of installed power generation capacity and net electricity generation, renewable energy such as solar power is projected to increase greatly. For nuclear power plants, energy generation is calculated as zero given their capacity is reported as "uncertain".

4. Development Plans for Transmission and Distribution Facilities

Regarding the development plans for major transmission lines or substations, a long distance transmission line is planned anew, and there are no changes for cross-regional interconnection lines from the previous year's plans.

5. Cross-regional Operation

For procuring supply capacity or energy from external service areas, aggregated results are almost the same as the previous year in both areas with higher procurement from external service areas and in areas with higher transmission to external areas.

6. Analysis of Characteristics of Electric Power Companies

Distributions are calculated for retail companies and generation companies according to business scale and business areas, and aggregated to the projection during the 10-year period. In addition, the ratios of the secured supply capacity are reviewed. In particular, small and medium-sized retail companies have planned their supply capacity as "unspecified procurement," as in the previous year's plan. As a result, the ratios of the secured supply capacity indicate a declining tendency.

7. Findings and Challenges

The Organization has communicated its opinions to METI concerning three major challenges in relation to the aggregation of electricity supply plans for FY 2020.

Attached are the Appendices on the aggregation of the electricity supply plans.

APPENDIX 1 Supply–Demand Balance for FY 2020 and 2021 (Short-term)

i) Projection for FY 2020

Tables A1-1 to A1-4 show the monthly supply–demand balance,[17] such as peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin for each regional service area in FY 2020, respectively. Table A1-5 shows the monthly projection of the reserve margin for each regional service area recalculated with power exchanges to areas below the 8% reserve margin from areas with over 8% reserve margin with additional supply capacity according to provision of Article 48 of the Act. Further, Table A1-6 shows the monthly peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin at the designated time.

Table A1-1 Monthly Peak Demand Forecast for Each Regional Service Area in FY 2020 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	400	362	364	410	419	394	437	455	490	500	493	455
Tohoku	1,057	985	1,062	1,267	1,295	1,159	1,058	1,180	1,316	1,369	1,354	1,258
Tokyo	3,852	3,728	4,120	5,319	5,319	4,552	3,781	4,019	4,454	4,775	4,775	4,335
50 Hz areas Total	5,309	5,075	5,546	6,996	7,033	6,105	5,276	5,654	6,260	6,644	6,622	6,048
Chubu	1,868	1,887	2,034	2,464	2,464	2,258	1,967	1,945	2,190	2,297	2,297	2,098
Hokuriku	386	367	403	497	497	442	374	412	468	492	492	456
Kansai	1,810	1,863	2,135	2,672	2,672	2,306	1,908	1,984	2,384	2,459	2,459	2,191
Chugoku	745	750	823	1,043	1,043	912	781	836	1,009	1,033	1,033	912
Shikoku	346	348	397	498	498	435	359	370	459	459	459	410
Kyushu	1,040	1,056	1,202	1,539	1,539	1,327	1,131	1,154	1,473	1,493	1,493	1,270
60 Hz areas Total	6,195	6,271	6,994	8,713	8,713	7,680	6,520	6,701	7,983	8,233	8,233	7,337
Interconnected	11,504	11,346	12,540	15,709	15,746	13,785	11,796	12,355	14,243	14,877	14,855	13,385
Okinawa	103	120	138	145	146	142	130	112	98	103	101	95
Nationwide	11,607	11,466	12,678	15,854	15,892	13,927	11,926	12,467	14,341	14,980	14,956	13,480

Table A1-2 Monthly Projection of Supply Capacity for Each Regional Service Area in FY 2020 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	596	615	587	528	553	566	541	631	573	570	561	577
Tohoku	1,300	1,310	1,307	1,452	1,504	1,366	1,244	1,369	1,529	1,595	1,573	1,541
Tokyo	4,281	4,402	4,958	5,808	5,851	5,463	4,541	4,484	5,018	5,361	5,410	5,032
50 Hz areas Total	6,176	6,327	6,852	7,787	7,909	7,395	6,326	6,484	7,119	7,526	7,544	7,150
Chubu	2,185	2,292	2,492	2,687	2,726	2,741	2,500	2,398	2,637	2,663	2,657	2,588
Hokuriku	550	519	503	629	601	541	421	453	494	539	547	549
Kansai	2,199	2,147	2,323	2,903	2,909	2,781	2,170	2,152	2,437	2,586	2,624	2,486
Chugoku	961	997	1,138	1,295	1,285	1,220	1,109	1,050	1,140	1,183	1,169	1,160
Shikoku	467	450	508	610	614	557	551	464	539	555	542	516
Kyushu	1,382	1,436	1,457	1,731	1,716	1,625	1,394	1,317	1,509	1,607	1,656	1,601
60 Hz areas Total	7,745	7,840	8,420	9,855	9,852	9,465	8,145	7,834	8,755	9,131	9,196	8,900
Interconnected	13,921	14,167	15,272	17,642	17,761	16,860	14,471	14,318	15,875	16,657	16,740	16,049
Okinawa	180	187	182	187	187	187	189	167	161	162	170	177
Nationwide	14,100	14,354	15,454	17,829	17,948	17,047	14,660	14,485	16,036	16,819	16,911	16,226

Table A1-3 Monthly Projection of Reserve Capacity for Each Regional Service Area in FY 2020 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	196	253	223	118	134	172	104	176	83	70	68	122
Tohoku	243	325	245	185	209	207	186	189	213	226	219	283
Tokyo	429	674	838	489	532	911	760	465	564	586	635	697
50 Hz areas Total	867	1,252	1,306	791	876	1,290	1,050	830	859	882	922	1,102
Chubu	317	405	458	223	262	483	533	453	447	366	360	490
Hokuriku	164	152	100	132	104	99	48	41	26	47	55	94
Kansai	389	284	188	231	237	475	262	168	53	127	165	295
Chugoku	216	247	315	252	242	308	328	214	131	150	136	248
Shikoku	121	102	111	112	116	122	192	94	80	96	83	106
Kyushu	342	380	255	192	177	298	263	163	36	114	163	331
60 Hz areas Total	1,550	1,569	1,426	1,142	1,139	1,785	1,625	1,133	773	898	963	1,563
Interconnected	2,417	2,821	2,732	1,933	2,015	3,075	2,676	1,963	1,632	1,780	1,885	2,665
Okinawa	76	67	44	42	41	45	58	55	63	59	69	82
Nationwide	2,493	2,888	2,776	1,975	2,055	3,120	2,734	2,018	1,695	1,839	1,955	2,746

Table A1-4 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2020

(resources within own service area only, at the sending end; see Table 2-5)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	48.9%	69.9%	61.3%	28.7%	31.9%	43.6%	23.8%	38.6%	16.9%	13.9%	13.8%	26.9%
Tohoku	23.0%	33.0%	23.1%	14.6%	16.2%	17.9%	17.6%	16.0%	16.2%	16.5%	16.2%	22.5%
Tokyo	11.1%	18.1%	20.3%	9.2%	10.0%	20.0%	20.1%	11.6%	12.7%	12.3%	13.3%	16.1%
50 Hz areas Total	16.3%	24.7%	23.5%	11.3%	12.5%	21.1%	19.9%	14.7%	13.7%	13.3%	13.9%	18.2%
Chubu	17.0%	21.4%	22.5%	9.1%	10.6%	21.4%	27.1%	23.3%	20.4%	15.9%	15.7%	23.4%
Hokuriku	42.6%	41.3%	24.7%	26.6%	20.9%	22.4%	12.8%	9.9%	**5.7%**	9.6%	11.2%	20.6%
Kansai	21.5%	15.3%	8.8%	8.6%	8.9%	20.6%	13.7%	8.5%	**2.2%**	**5.2%**	**6.7%**	13.5%
Chugoku	29.0%	32.9%	38.2%	24.1%	23.2%	33.7%	41.9%	25.6%	13.0%	14.5%	13.1%	27.1%
Shikoku	34.9%	29.3%	28.1%	22.4%	23.4%	28.1%	53.4%	25.5%	17.4%	20.8%	18.1%	25.8%
Kyushu	32.9%	36.0%	21.2%	12.5%	11.5%	22.5%	23.2%	14.1%	**2.4%**	**7.6%**	10.9%	26.0%
60 Hz areas Total	25.0%	25.0%	20.4%	13.1%	13.1%	23.2%	24.9%	16.9%	9.7%	10.9%	11.7%	21.3%
Interconnected	21.0%	24.9%	21.8%	12.3%	12.8%	22.3%	22.7%	15.9%	11.5%	12.0%	12.7%	19.9%
Okinawa	74.0%	55.8%	31.9%	28.8%	27.9%	31.5%	44.8%	49.4%	63.6%	57.8%	68.2%	85.6%
Nationwide	21.5%	25.2%	21.9%	12.5%	12.9%	22.4%	22.9%	16.2%	11.8%	12.3%	13.1%	20.4%

Below 8% criteria

Table A1-5 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2020

(with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	41.9%	61.2%	61.3%	18.0%	25.8%	35.0%	20.0%	26.9%	13.8%	13.2%	13.1%	18.5%
Tohoku	14.2%	21.9%	20.6%	10.9%	11.6%	20.2%	20.0%	13.9%	13.8%	13.2%	13.1%	18.5%
Tokyo	14.2%	21.9%	20.6%	10.9%	11.6%	20.2%	20.0%	13.9%	13.8%	13.1%	13.1%	18.5%
Chubu	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	17.4%	13.8%	11.3%	12.6%	21.4%
Hokuriku	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Kansai	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Chugoku	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Shikoku	25.0%	24.6%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Kyushu	25.0%	27.0%	20.6%	13.2%	13.2%	23.3%	25.0%	16.9%	8.5%	11.3%	12.6%	21.4%
Interconnected	21.0%	24.9%	21.8%	12.4%	12.8%	22.4%	22.8%	16.1%	11.6%	12.1%	12.9%	20.1%
Okinawa	74.0%	55.8%	31.9%	28.8%	27.9%	31.5%	44.8%	49.4%	63.6%	57.8%	68.2%	85.6%
Nationwide	21.5%	25.2%	21.9%	12.5%	13.0%	22.5%	23.0%	16.4%	12.0%	12.4%	13.2%	20.6%

Improve to over 8%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

Table A1-6 Monthly Projection of Supply Demand Balance in Okinawa in FY 2020 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	103	121	143	147	150	146	130	112	98	103	101	95
Supply Capacity	180	190	190	195	200	198	189	167	161	162	170	177
Reserve Capacity	76	69	47	48	50	52	58	55	63	59	69	82
Reserve Margin	74.0%	56.6%	32.9%	32.5%	33.5%	35.6%	44.8%	49.4%	63.6%	57.8%	68.2%	85.6%

ii) Projection for FY 2021

Tables A1-7 to A1-10 show the monthly supply–demand balance,[17] such as peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin for each regional service area in FY 2021, respectively. Table A1-11 shows the monthly projection of the reserve margin for each regional service area recalculated with power exchanges to areas below the 8% reserve margin from areas with over 8% reserve margin with additional supply capacity according to provision of Article 48 of the Act. Further, Table A1-12 shows the monthly peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin at the designated time.

Table A1-7 Monthly Peak Demand Forecast for Each Regional Service Area in FY 2021 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	399	361	363	409	418	393	436	453	488	498	491	453
Tohoku	1,055	984	1,060	1,265	1,293	1,157	1,056	1,177	1,313	1,366	1,351	1,255
Tokyo	3,845	3,720	4,112	5,307	5,307	4,542	3,774	4,010	4,443	4,762	4,762	4,326
50 Hz area Total	5,299	5,065	5,535	6,981	7,018	6,092	5,266	5,640	6,244	6,626	6,604	6,034
Chubu	1,875	1,894	2,041	2,473	2,473	2,266	1,974	1,952	2,198	2,305	2,305	2,106
Hokuriku	385	366	402	495	495	440	372	411	466	490	490	454
Kansai	1,805	1,858	2,129	2,663	2,663	2,300	1,903	1,978	2,378	2,449	2,449	2,186
Chugoku	747	752	825	1,046	1,046	914	783	839	1,011	1,036	1,036	914
Shikoku	345	347	395	496	496	433	358	368	457	457	457	408
Kyushu	1,040	1,055	1,201	1,538	1,538	1,326	1,130	1,154	1,472	1,492	1,492	1,269
60 Hz areas Total	6,197	6,272	6,993	8,711	8,711	7,679	6,520	6,702	7,982	8,229	8,229	7,337
Interconnected	11,496	11,337	12,528	15,692	15,729	13,771	11,786	12,342	14,226	14,855	14,833	13,371
Okinawa	104	121	141	146	147	143	131	112	99	103	102	96
Nationwide	11,599	11,457	12,668	15,838	15,876	13,914	11,917	12,454	14,325	14,958	14,935	13,466

Table A1-8 Monthly Projection of Supply Capacity for Each Regional Service Area in FY 2021 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	573	558	570	541	533	547	535	607	647	639	636	556
Tohoku	1,325	1,356	1,357	1,586	1,613	1,395	1,309	1,394	1,564	1,657	1,643	1,537
Tokyo	4,491	4,549	4,663	5,545	5,584	5,283	4,410	4,327	4,910	5,082	4,989	4,623
50 Hz area Total	6,389	6,462	6,589	7,672	7,730	7,225	6,253	6,328	7,120	7,378	7,269	6,716
Chubu	2,261	2,272	2,439	2,632	2,637	2,533	2,310	2,230	2,367	2,453	2,397	2,320
Hokuriku	475	488	495	568	542	511	481	475	535	534	536	528
Kansai	2,317	2,267	2,503	2,889	2,899	2,702	2,318	2,266	2,513	2,652	2,693	2,455
Chugoku	945	1,017	1,078	1,320	1,328	1,212	1,046	973	1,072	1,165	1,179	1,109
Shikoku	473	510	527	617	612	582	533	444	530	545	536	495
Kyushu	1,497	1,462	1,562	1,869	1,924	1,848	1,531	1,468	1,712	1,758	1,648	1,567
60 Hz areas Total	7,967	8,016	8,605	9,896	9,941	9,388	8,218	7,857	8,730	9,108	8,989	8,473
Interconnected	14,356	14,478	15,194	17,568	17,671	16,612	14,471	14,185	15,850	16,485	16,257	15,190
Okinawa	166	188	209	209	213	202	196	175	167	166	162	165
Nationwide	14,522	14,667	15,403	17,777	17,885	16,814	14,668	14,360	16,018	16,651	16,420	15,355

Table A1-9 Monthly Projection of Reserve Capacity for Each Regional Service Area in FY 2021 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	174	197	207	132	115	154	99	154	159	141	145	103
Tohoku	270	372	297	321	320	238	253	217	251	291	292	282
Tokyo	646	829	551	238	277	741	636	317	467	320	227	297
50 Hz area Total	1,090	1,397	1,054	691	712	1,133	987	688	876	752	665	682
Chubu	386	378	398	159	164	267	336	278	169	148	92	214
Hokuriku	90	122	94	73	47	71	109	65	70	44	46	74
Kansai	512	409	374	226	236	402	415	288	135	203	244	269
Chugoku	198	265	253	274	282	298	263	134	61	129	143	195
Shikoku	128	163	132	121	116	149	175	76	73	88	79	87
Kyushu	457	407	361	331	386	522	401	314	240	266	156	298
60 Hz areas Total	1,771	1,745	1,612	1,185	1,230	1,709	1,698	1,155	749	879	760	1,137
Interconnected	2,860	3,142	2,666	1,876	1,942	2,841	2,685	1,843	1,625	1,630	1,424	1,819
Okinawa	62	67	68	63	66	58	65	63	68	63	60	69
Nationwide	2,923	3,209	2,734	1,938	2,008	2,900	2,750	1,906	1,693	1,693	1,485	1,888

Table A1-10 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2021

(resources within own service area only, at the sending end; see Table 2-10)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	43.5%	54.4%	56.9%	32.3%	27.6%	39.1%	22.7%	34.1%	32.5%	28.3%	29.6%	22.8%
Tohoku	25.6%	37.8%	28.0%	25.4%	24.7%	20.6%	23.9%	18.4%	19.1%	21.3%	21.6%	22.5%
Tokyo	16.8%	22.3%	13.4%	**4.5%**	**5.2%**	16.3%	16.8%	**7.9%**	10.5%	**6.7%**	**4.8%**	**6.9%**
50 Hz areas Total	20.6%	27.6%	19.0%	9.9%	10.1%	18.6%	18.7%	12.2%	14.0%	11.3%	10.1%	11.3%
Chubu	20.6%	20.0%	19.5%	**6.4%**	**6.6%**	11.8%	17.0%	14.2%	**7.7%**	**6.4%**	**4.0%**	10.2%
Hokuriku	23.5%	33.5%	23.4%	14.8%	9.4%	16.1%	29.2%	15.8%	15.0%	9.1%	9.4%	16.3%
Kansai	28.4%	22.0%	17.6%	8.5%	8.9%	17.5%	21.8%	14.6%	**5.7%**	8.3%	10.0%	12.3%
Chugoku	26.5%	35.2%	30.7%	26.2%	27.0%	32.6%	33.6%	16.0%	**6.1%**	12.4%	13.8%	21.4%
Shikoku	37.1%	47.0%	33.4%	24.5%	23.4%	34.5%	48.9%	20.8%	15.9%	19.4%	17.3%	21.2%
Kyushu	43.9%	38.6%	30.1%	21.6%	25.1%	39.3%	35.5%	27.2%	16.3%	17.9%	10.4%	23.5%
60 Hz areas Total	28.6%	27.8%	23.1%	13.6%	14.1%	22.2%	26.0%	17.2%	9.4%	10.7%	9.2%	15.5%
Interconnected	24.9%	27.7%	21.3%	12.0%	12.3%	20.6%	22.8%	14.9%	11.4%	11.0%	9.6%	13.6%
Okinawa	60.1%	55.7%	48.3%	42.9%	44.9%	40.7%	49.7%	55.9%	68.8%	60.9%	59.3%	72.1%
Nationwide	25.2%	28.0%	21.6%	12.2%	12.7%	20.8%	23.1%	15.3%	11.8%	11.3%	9.9%	14.0%

Below 8% criteria

Table A1-11 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2021

(with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end; see Table 2-12)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	31.0%	46.1%	54.6%	27.2%	24.2%	41.4%	19.4%	23.4%	21.5%	17.6%	18.8%	14.6%
Tohoku	21.8%	26.5%	17.6%	9.5%	9.7%	16.1%	19.4%	12.1%	11.3%	12.9%	15.3%	14.6%
Tokyo	20.6%	26.5%	17.6%	9.5%	9.7%	16.1%	19.4%	12.1%	11.3%	10.8%	8.0%	10.5%
Chubu	24.3%	26.5%	22.6%	9.9%	10.3%	16.1%	19.9%	16.0%	11.3%	10.8%	8.6%	14.7%
Hokuriku	24.3%	28.4%	22.6%	14.8%	13.9%	16.1%	19.9%	16.0%	11.3%	10.8%	9.7%	15.6%
Kansai	26.0%	28.4%	22.6%	14.8%	13.9%	24.7%	29.0%	17.1%	11.3%	10.8%	9.7%	15.6%
Chugoku	26.0%	28.4%	22.6%	14.8%	13.9%	24.7%	29.0%	17.1%	11.3%	10.8%	9.7%	15.6%
Shikoku	26.0%	28.4%	22.6%	14.8%	13.9%	24.7%	29.0%	17.1%	11.3%	10.8%	9.7%	15.6%
Kyushu	42.0%	29.3%	22.6%	14.8%	20.7%	34.0%	30.8%	19.0%	11.3%	10.8%	9.7%	17.2%
Interconnected	25.1%	27.9%	21.5%	12.1%	12.5%	20.8%	23.1%	15.2%	11.6%	11.2%	9.8%	13.8%
Okinawa	60.1%	55.7%	48.3%	42.9%	44.9%	40.7%	49.7%	55.9%	68.8%	60.9%	59.3%	72.1%
Nationwide	25.4%	28.2%	21.8%	12.4%	12.8%	21.0%	23.3%	15.6%	12.0%	11.5%	10.2%	14.3%

Improve to over 8%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

Table A1-12 Monthly Projection of Supply Demand Balance in Okinawa in FY 2021 (10^4kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	104	122	144	148	151	147	131	112	99	103	102	96
Supply Capacity	166	191	214	217	227	212	196	175	167	166	162	165
Reserve Capacity	62	69	70	69	76	66	65	63	68	63	60	69
Reserve Margin	60.1%	56.6%	49.0%	46.6%	50.2%	44.7%	49.7%	55.9%	68.8%	60.9%	59.3%	72.1%

APPENDIX 2 Long-Term Supply–Demand Balance for the 10-year Period FY 2020–2029

Tables A2-1 to A2-4 show a 10-year projection of the annual peak demand, annual supply capacity, annual reserve capacity, and reserve margin for each regional service area from FY 2020 to FY 2029, respectively. Table A2-5 shows the annual projection of the reserve margin for each regional service area recalculated with power exchanges from areas with over 8% reserve margin to areas below the 8% reserve margin with additional supply capacity according to provision of Article 48 of the Act. Tables A2-6 to A2-9 show a 10-year projection of the annual peak demand, annual supply capacity, annual reserve capacity, and reserve margin for winter peak areas of Hokkaido and Tohoku, respectively. Table A2-10 shows the 10-year projection of the reserve margin for each regional service area recalculated with power exchanges to areas below the 8% reserve margin from areas with over 8% reserve margin with additional supply capacity according to provision of Article 48 of the Act. Further, Table A2-11 shows the annual peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin for the projected period at the designated time.

Table A2-1 Annual Peak Demand Forecast for Each Regional Service Area
(at 15:00[23] in August, 10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	419	418	418	419	419	419	419	420	420	420
Tohoku	1,295	1,293	1,289	1,283	1,277	1,271	1,265	1,258	1,251	1,244
Tokyo	5,319	5,307	5,304	5,302	5,298	5,295	5,291	5,302	5,298	5,295
50 Hz areas Total	7,033	7,018	7,011	7,004	6,994	6,985	6,975	6,980	6,969	6,959
Chubu	2,464	2,473	2,462	2,451	2,440	2,429	2,418	2,421	2,411	2,401
Hokuriku	497	495	493	491	491	491	491	490	490	490
Kansai	2,672	2,663	2,653	2,643	2,634	2,626	2,617	2,608	2,600	2,591
Chugoku	1,043	1,046	1,046	1,045	1,043	1,042	1,041	1,040	1,038	1,037
Shikoku	498	496	494	492	491	490	488	487	485	484
Kyushu	1,539	1,538	1,538	1,539	1,540	1,541	1,543	1,544	1,545	1,546
60 Hz area Total	8,713	8,711	8,686	8,661	8,639	8,619	8,598	8,590	8,569	8,549
Interconnected	15,746	15,729	15,697	15,665	15,633	15,604	15,573	15,570	15,538	15,508
Okinawa	146	147	148	149	150	151	152	152	153	154
Nationwide	15,892	15,876	15,845	15,814	15,783	15,755	15,725	15,722	15,692	15,662

Table A2-2 Annual Projection of Supply Capacity for Each Regional Service Area
(at 15:00[23] in August, 10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	553	533	533	629	629	632	627	676	676	676
Tohoku	1,504	1,613	1,647	1,674	1,692	1,701	1,740	1,747	1,755	1,763
Tokyo	5,851	5,584	5,595	5,784	5,805	6,018	5,998	6,003	6,046	6,050
50 Hz areas Total	7,909	7,730	7,775	8,088	8,126	8,351	8,365	8,427	8,477	8,489
Chubu	2,726	2,637	2,732	2,739	2,824	2,815	2,814	2,821	2,821	2,824
Hokuriku	601	542	552	564	565	559	563	564	562	564
Kansai	2,909	2,899	2,903	2,872	2,870	2,756	2,766	2,771	2,756	2,757
Chugoku	1,285	1,328	1,346	1,299	1,306	1,311	1,312	1,309	1,302	1,305
Shikoku	614	612	558	605	611	611	615	617	611	614
Kyushu	1,716	1,924	1,826	1,834	1,755	1,766	1,682	1,678	1,669	1,673
60 Hz area Total	9,852	9,941	9,917	9,914	9,931	9,819	9,751	9,760	9,722	9,738
Interconnected	17,761	17,671	17,692	18,002	18,057	18,170	18,116	18,187	18,199	18,227
Okinawa	187	213	199	214	218	213	212	213	213	213
Nationwide	17,948	17,885	17,891	18,215	18,275	18,383	18,329	18,399	18,411	18,440

Table A2-3 Annual Projection of Reserve Capacity for Each Regional Service Area
(at 15:00[23] in August, 10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	134	115	115	210	210	213	208	256	256	256
Tohoku	209	320	358	391	415	430	475	489	504	519
Tokyo	532	277	291	482	507	723	707	701	748	755
50 Hz areas Total	876	712	764	1,084	1,132	1,366	1,390	1,447	1,508	1,530
Chubu	262	164	270	288	384	386	396	400	410	423
Hokuriku	104	47	59	73	74	68	72	74	72	74
Kansai	237	236	250	229	236	130	149	163	156	166
Chugoku	242	282	300	255	262	269	271	270	264	268
Shikoku	116	116	64	113	120	121	127	130	126	130
Kyushu	177	386	288	295	215	225	139	134	124	127
60 Hz areas Total	1,139	1,230	1,231	1,253	1,292	1,200	1,153	1,170	1,153	1,189
Interconnected	2,015	1,942	1,995	2,337	2,424	2,566	2,543	2,617	2,660	2,719
Okinawa	41	66	51	64	68	62	61	60	59	59
Nationwide	2,055	2,008	2,046	2,402	2,492	2,628	2,604	2,677	2,720	2,777

Table A2-4 Annual Projection of Reserve Margin for Each Regional Service Area
(resource within own service area only, at 15:00[23] in August, at the sending end; see Table 2-15)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	31.9%	27.6%	27.4%	50.2%	50.0%	50.9%	49.7%	61.1%	61.0%	61.1%
Tohoku	16.2%	24.7%	27.8%	30.5%	32.5%	33.9%	37.6%	38.9%	40.3%	41.7%
Tokyo	10.0%	**5.2%**	**5.5%**	9.1%	9.6%	13.7%	13.4%	13.2%	14.1%	14.3%
50 Hz areas Total	12.5%	10.1%	10.9%	15.5%	16.2%	19.6%	19.9%	20.7%	21.6%	22.0%
Chubu	10.6%	**6.6%**	11.0%	11.8%	15.7%	15.9%	16.4%	16.5%	17.0%	17.6%
Hokuriku	20.9%	9.4%	11.9%	14.8%	15.1%	13.9%	14.6%	15.0%	14.7%	15.0%
Kansai	8.9%	8.9%	9.4%	8.7%	9.0%	**5.0%**	**5.7%**	**6.2%**	**6.0%**	**6.4%**
Chugoku	23.2%	27.0%	28.7%	24.4%	25.1%	25.8%	26.0%	25.9%	25.4%	25.8%
Shikoku	23.4%	23.4%	13.0%	23.0%	24.5%	24.7%	26.0%	26.7%	26.1%	27.0%
Kyushu	11.5%	25.1%	18.7%	19.2%	14.0%	14.6%	9.0%	8.7%	8.0%	8.2%
60 Hz areas Total	13.1%	14.1%	14.2%	14.5%	15.0%	13.9%	13.4%	13.6%	13.5%	13.9%
Interconnected	12.8%	12.3%	12.7%	14.9%	15.5%	16.4%	16.3%	16.8%	17.1%	17.5%
Okinawa	27.9%	44.9%	34.4%	43.2%	45.3%	40.9%	40.0%	39.4%	38.7%	38.0%
Nationwide	12.9%	12.7%	12.9%	15.2%	15.8%	16.7%	16.6%	17.0%	17.3%	17.7%

Below 8% criteria

Table A2-5 Annual Projection of Reserve Margin for Each Regional Service Area
(15:00[23] in August, with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end; see Table 2-17)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	25.8%	20.0%	17.4%	40.2%	40.0%	40.8%	40.4%	51.8%	51.7%	51.8%
Tohoku	11.6%	9.7%	16.9%	20.1%	21.8%	23.1%	24.2%	25.6%	16.2%	16.6%
Tokyo	11.6%	9.7%	8.9%	12.4%	12.9%	15.1%	14.9%	15.0%	16.2%	16.6%
Chubu	13.1%	10.3%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Hokuriku	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Kansai	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Chugoku	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Shikoku	13.1%	13.9%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Kyushu	13.1%	20.2%	14.2%	14.5%	15.0%	15.1%	14.9%	15.0%	16.2%	16.6%
Interconnected	12.8%	12.3%	12.7%	14.9%	15.5%	16.4%	16.3%	16.8%	17.1%	17.5%
Okinawa	27.9%	44.9%	34.4%	43.2%	45.3%	40.9%	40.0%	39.4%	38.7%	38.0%
Nationwide	12.9%	12.7%	12.9%	15.2%	15.8%	16.7%	16.6%	17.0%	17.3%	17.7%

Improve to over 8%

* Reserve margins with the same value are shown in the same background color after utilization of cross-regional interconnection line.

Table A2-6 Annual Peak Demand Forecast for Winter Peak Areas of Hokkaido and Tohoku
(at 18:00 in January, 10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	500	498	499	499	499	499	500	500	500	501
Tohoku	1,369	1,366	1,362	1,358	1,354	1,350	1,346	1,342	1,338	1,334

Table A2-7 Annual Projection of Supply Capacity for Winter Peak Areas of Hokkaido and Tohoku
(at 18:00 in January, 10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	570	639	665	640	643	644	693	693	693	693
Tohoku	1,595	1,657	1,659	1,686	1,701	1,718	1,759	1,771	1,795	1,811

Table A2-8 Annual Projection of Reserve Capacity for Winter Peak areas of Hokkaido and Tohoku
(at 18:00 in January, 10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	70	141	166	141	144	145	193	193	193	192
Tohoku	226	291	297	328	347	368	413	429	457	477

Table A2-9 Annual Projection of Reserve Margin for Winter Peak Areas of Hokkaido and Tohoku
(at 18:00 in January; see Table 2-19)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	13.9%	28.3%	33.3%	28.3%	28.8%	29.1%	38.6%	38.5%	38.5%	38.4%
Tohoku	16.5%	21.3%	21.8%	24.2%	25.6%	27.3%	30.7%	32.0%	34.1%	35.8%

Table A2-10 Annual Projection of Reserve Margin for Winter Peak Areas of Hokkaido and Tohoku
(at 18:00 in Januar, with power exchanges through cross-regional interconnection lines and generating facilities not included in the electricity supply plans, at the sending end; see Table 2-21)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Hokkaido	16.8%	24.1%	27.8%	26.2%	27.4%	28.7%	33.8%	34.7%	36.3%	37.4%
Tohoku	16.8%	24.1%	25.1%	26.2%	27.4%	28.7%	33.8%	34.7%	36.3%	37.4%

Table A2-11 Annual Projection of Supply Demand Balance in Okinawa (10^4kW at the sending end)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Peak Demand	150	151	152	153	154	155	156	156	157	158
Supply Capacity	200	227	213	228	232	227	227	228	228	229
Reserve Capacity	50	76	61	75	79	73	72	71	71	70
Reserve Margin	33.5%	50.2%	40.2%	48.9%	51.1%	46.9%	46.2%	45.7%	45.2%	44.6%

(blank)

V. Review of the Adequate Level of Balancing Capacity in Each Regional Service Area

Evaluation of Proper Standard of Soliciting Balancing Capacity for FY 2021

[only in Japanese]

http://www.occto.or.jp/houkokusho/2020/files/20200715_chousei_hitsuyoryo_kentoukekka.pdf

July 2020

Organization for Cross-regional Coordination of Transmission Operators, Japan

VI. Research and Study

Capacity Market and its Evolution; SUMMARY OF DISCUSSIONS WITH OCCTO STAFF FOR DEVELOPING THE CAPACITY MARKET IN JAPAN (The Brattle Group, Inc.)

http://www.occto.or.jp/houkokusho/2020/files/report_2020.pdf

Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO)
http://www.occto.or.jp/en/index.html