Organization for Cross-regional Coordination of Transmission Operators, Japan

Annual Report

- Fiscal Year 2022 -

December 2022

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 for Electricity Supply and Demand (Data for FY 2021)”, “Report on the Quality of Electricity Supply (Data for FY 2021)”, and “Outlook of Cross-regional Interconnection Lines (Data for FY 2021)”.
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 2021”.
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 2022 to 2031” and “Review of the Adequate Level of Balancing Capacity in Each Regional Service Area” (Evaluation of Proper Standard of Soliciting Balancing Capacity for FY 2023).

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.

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I. Actual Electric Supply and Demand

Outlook for Electricity Supply and Demand

- Actual Data for FY 2021 -

November 2022

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 the provisions of 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 2021.

SUMMARY

This report is presented to review the outlook for electricity supply–demand and cross-regional interconnection lines in fiscal year 2021 (FY 2021), based on the provisions of Article 181 of the Operational Rules of the Organization.

This report is comprised of two parts: the electricity supply and demand situation, and the interconnection line situation.

Regarding supply and demand, the peak demand nationwide (16,460 $\times 10^4$ kW), was recorded in August, and the monthly peak electric energy requirement nationwide (87,962 GWh) was recorded in January.

The reserve margin against summer and winter peak demands was 14.2% and 11.0%, respectively.

Power exchange instructions were issued by the Organization for Cross-regional Coordination of Transmission Operators, Japan (the Organization hereafter) 21 times, with 11 of them being issued for improvements in supply-demand tightness caused by the Fukushima Earthquake in March 2022.
Additionally, long-cycle frequency control was implemented 72 times during the year.

Instructions for output shedding of the renewable-energy generating facilities were issued for 252,834 MW in FY 2021, which increased from 108,019 MW of output shedding in the previous year. The actual output shed on the day totaled 116,980 MW in FY 2021.

We hope that the information of this report proves useful.

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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 from FY 2016 beyond. As for the data before FY 2015 which include figures at the generating and receiving end, please see 2016 Annual Report.
https://www.occto.or.jp/en/information_disclosure/annual_report/files/annual_report_FY2016.pdf

CHAPTER I: ACTUAL ELECTRICITY SUPPLY AND DEMAND

1. Regional Service Areas for 10 General Transmission and Distribution (GT&D) Companies, and the Definition of a Season

(1) Regional Service Areas for 10 GT&D Companies

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

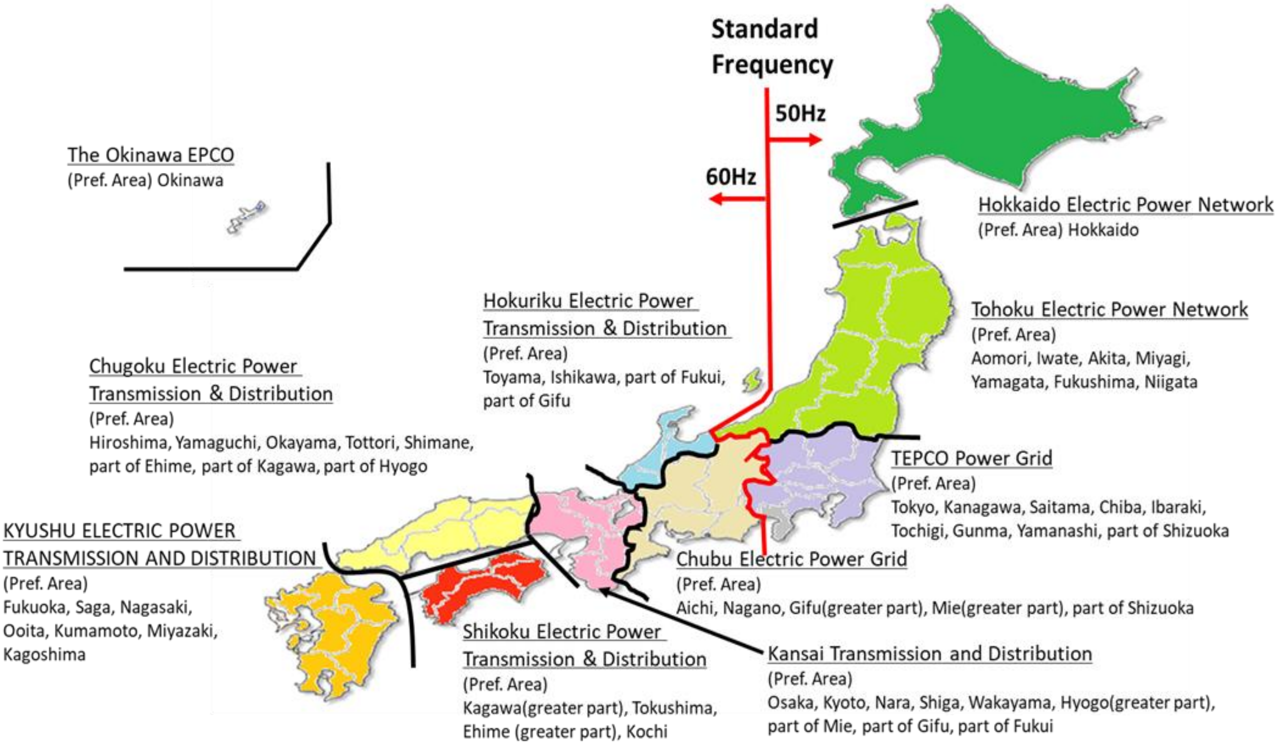

Figure 1-1: The 10 Regional Service Areas in Japan and their Prefectural Distribution

(2) Definition of Seasons

This report divides the seasons into the summer and winter periods. The summer period starts from July and ends in September, and the winter period starts from December and ends in February.

In this report, we compared our outlook of the actual weather for the previous year with the Seasonal Climate Report over Japan prepared by the Japan Meteorological Agency (JMA). The JMA defines the summer and winter periods as June–August and December–February, respectively.

Note that the definitions of the summer period differed between this report and that of the JMA

2. Outlook for Actual Weather Nationwide

(1) Weather During the Summer Period (from June to August 2021)

Table 1-1 shows anomalies in the temperature and precipitation ratios from June to August in FY 2021.

(a) Seasonal precipitation amounts were significantly above normal on the Pacific side of eastern Japan and in western Japan, mainly due to active stationary fronts and moist air inflow in August. Seasonal precipitation amounts on the Sea of Japan side of northern Japan were significantly below normal.

(b) Seasonal mean temperatures and seasonal sunshine durations were significantly above normal in northern Japan. Seasonal mean temperatures were above normal in eastern Japan and seasonal sunshine durations were above normal on Sea of Japan side of eastern Japan. These can be attributed to high-pressure systems in early June and late July.

(c) Sunshine durations were below normal in Okinawa/Amami due to tropical low-pressure systems passed around the region.

Table 1-1: Anomalies in temperature, precipitation, and sunshine duration by weather region from June to August 2021

Weather Region	Mean Temperature Anomaly[°C]	Precipitation Ratio[%]	Sunshine Duration Ratio[%]
Northern	+1.4	78	126
Eastern	+0.4	140	104
Western	+0.1	140	96
Okinawa/Amami	+0.0	141	89

Source: Japan Meteorological Agency (JMA), Tokyo Climate Center.
Seasonal Climate Report over Japan for Summer (FY 2021).
https://ds.data.jma.go.jp/tcc/tcc/products/japan/climate/index.php?kikan=3mon&month=8&year=2021
https://www.data.jma.go.jp/gmd/cpd/cgi-bin/view/kikohyo/en.php?kikan=3mon&month=8&year=2021

(2) Weather During the Winter Period (from December 2021 to February 2022)

Table 1-2 shows the anomalies in temperature and the ratios of rainfall and snowfall from December to February in FY 2021.

(a) The winter monsoon was stronger than normal around eastern and western Japan since late December, but the strength of the monsoon varied throughout this winter. Seasonal temperatures were below normal in eastern and western Japan.

(b) Seasonal precipitation amounts were significantly below normal in western Japan and seasonal sunshine durations were above normal in western Japan and on the Pacific side of eastern Japan due to less passage of low-pressure systems.

(c) In Okinawa/Amami, seasonal precipitation amounts were above normal and seasonal sunshine durations were below normal due to fronts and frequent passage of low-pressure systems since late January.

Table 1-2: Anomalies in temperature, precipitation, sunshine duration and snowfall by weather region from December 2021 to February 2022

Weather Region	Mean Temperature Anomaly[°C]	Precipitation Ratio[%]	Sunshine Duration Ratio[%]	Snowfall Ratio[%]
Northern	+0.1	110	106	107
Eastern	-0.5	97	106	98
Western	-0.5	57	112	67
Okinawa/Amami	+0.0	113	86	-

Source：Japan Meteorological Agency, Tokyo Climate Center.
Seasonal Climate Report over Japan for Winter (FY 2021).
https://ds.data.jma.go.jp/tcc/tcc/products/japan/climate/index.php?kikan=3mon&month=2&year=2022
https://www.data.jma.go.jp/gmd/cpd/cgi-bin/view/kikohyo/en.php?kikan=3mon&month=2&year=2022

3. Actual Nationwide Peak Demand

Peak demand refers to the highest consumption of electricity during a given period. Table 1-3 shows the monthly peak demand for regional service areas in FY 2021. Figures 1-2 and 1-3 show the nationwide monthly peak demand for FY 2021 and the actual annual peak demands from FY 2016 to 2021, respectively. Table 1-4 presents the actual nationwide peak demand at the sending-end data since FY 2016. In this report, "peak demand" refers to the maximum hourly value of the electric energy requirement.

The values in red are the maximum monthly peak demand (i.e., the annual peak demand), and those in blue are the minimum monthly peak demand for each regional service area. The names of the regional service areas are indicated in the names of the GT&D companies.

The maximum monthly peak demand nationwide for FY 2021 was registered as 16,640 × 10^4 kW in August, which was lower than the previous year's data, and stayed almost the same level as FY 2019's peak demand during 6 years since they were recorded at the sending-end data.

Table 1-3: Monthly peak demand for regional service areas[1]

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	398	361	369	449	469	362	389	435	490	501	495	463
Tohoku	1,085	989	1,105	1,412	1,490	1,106	1,090	1,193	1,440	1,483	1,463	1,249
Tokyo	3,525	3,737	4,152	5,407	5,665	4,265	4,121	4,130	4,621	5,374	5,278	4,534
Chubu	1,742	1,821	2,076	2,401	2,480	2,126	1,998	1,998	2,291	2,448	2,375	2,107
Hokuriku	375	348	397	498	523	416	406	421	508	541	549	448
Kansai	1,752	1,813	2,158	2,639	2,826	2,424	2,092	1,965	2,369	2,540	2,526	2,196
Chugoku	724	748	852	1,023	1,108	918	826	839	970	1,044	1,068	924
Shikoku	331	348	388	477	503	472	393	370	437	470	495	420
Kyushu	975	1,040	1,291	1,503	1,559	1,398	1,257	1,139	1,409	1,466	1,470	1,204
Okinawa	104	146	149	153	149	160	145	107	98	102	104	102
Nationwide	10,757	10,939	12,502	15,670	16,460	12,977	12,502	12,363	14,519	15,119	14,932	13,174

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

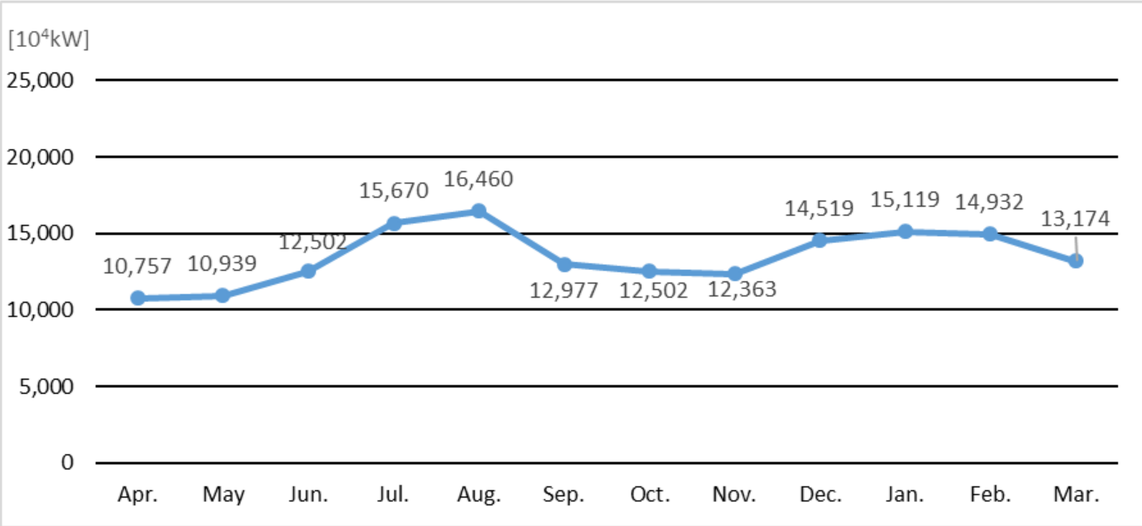

Figure 1-2: Nationwide monthly peak demand

Table 1-4: Actual annual peak demand (from FY 2016–2021, at the sending-end)

[10^4 kW]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Nationwide	15,589	15,577	16,482	16,461	16,645	16,460

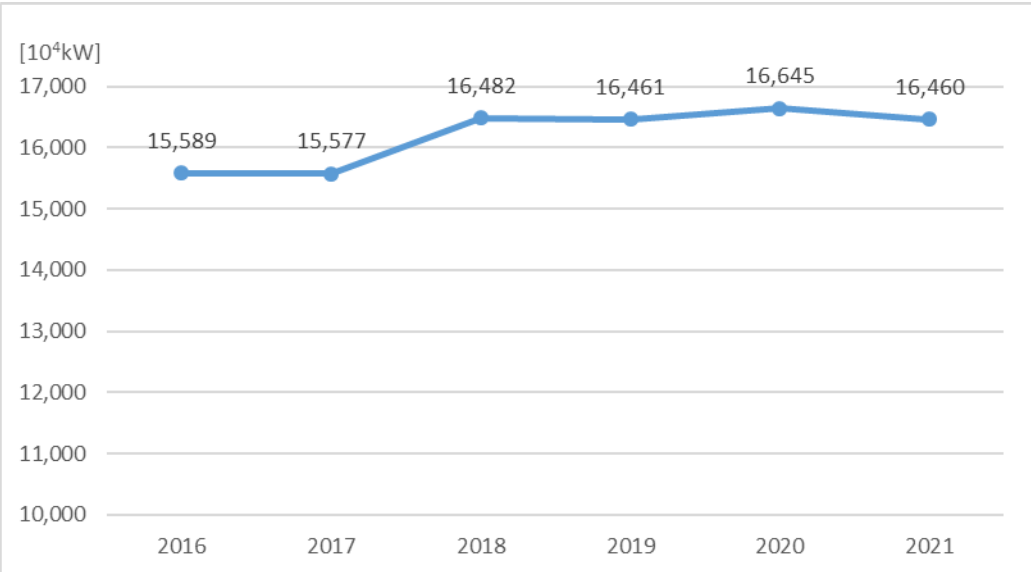

Figure 1-3: Actual annual peak demand (Nationwide)

4. Actual Nationwide Electric Energy Requirements

Table 1-5 shows the monthly electric energy requirements for regional service areas in FY 2021. Figures 1-4 and 1-5 show the nationwide monthly electric energy requirements and the actual annual electric energy requirements from FY 2016 to 2021, respectively. Table 1-6 presents the actual annual electric energy requirement at the sending-end data since FY 2016.
The values in red are the maximum monthly energy requirement, and those in blue are the minimum monthly energy requirement for each regional service area.
The actual annual nationwide electric energy requirement for FY 2020 was 885,171 GWh, which was higher than that for the previous year, which was the lowest in 6 years since they were recorded at the sending-end data.

Table 1-5: Monthly and annual electric energy requirements for regional service areas[2]

[GWh]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Hokkaido	2,388	2,217	2,104	2,395	2,323	2,114	2,307	2,481	3,051	3,280	2,886	2,818	30,364
Tohoku	6,240	5,955	6,095	7,005	6,958	6,066	6,313	6,649	8,058	8,786	7,938	7,491	83,554
Tokyo	20,330	20,143	21,643	25,825	26,820	21,570	21,681	21,623	26,021	28,506	25,864	23,571	283,597
Chubu	9,971	9,623	10,505	12,271	11,801	10,605	10,352	10,479	12,117	12,956	12,043	11,387	134,109
Hokuriku	2,217	2,073	2,179	2,550	2,460	2,211	2,231	2,342	2,802	3,051	2,839	2,621	29,577
Kansai	10,367	10,142	11,113	13,331	13,151	11,439	11,143	10,857	12,782	14,017	12,924	12,006	143,270
Chugoku	4,415	4,339	4,564	5,329	5,247	4,729	4,652	4,788	5,549	5,905	5,551	5,137	60,207
Shikoku	2,006	1,961	2,065	2,434	2,428	2,155	2,105	2,113	2,465	2,675	2,468	2,274	27,151
Kyushu	6,039	6,077	6,737	8,010	7,738	7,066	6,635	6,520	7,790	8,185	7,622	6,876	85,295
Okinawa	556	718	751	826	818	831	726	576	567	600	520	560	8,048
Nationwide	64,529	63,248	67,757	79,977	79,744	68,785	68,145	68,428	81,200	87,962	80,655	74,741	885,171

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

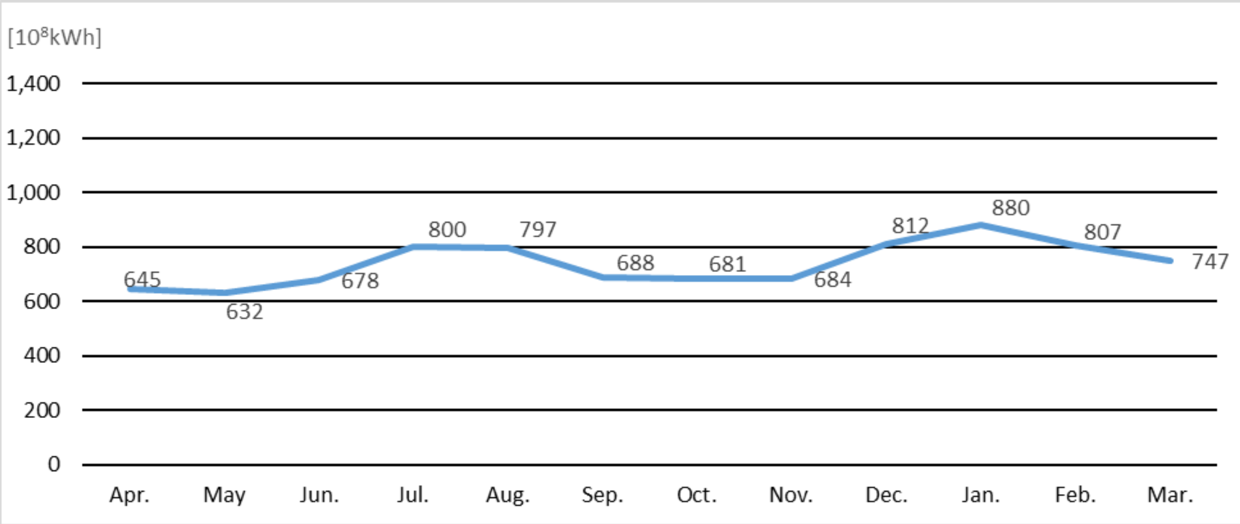

Figure 1-4: Nationwide monthly electric energy requirements

Table 1-6: Actual annual electric energy requirement (from FY 2016–2021, at the sending-end)

[GWh]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Nationwide	890,451	900,902	896,473	878,383	867,842	885,171

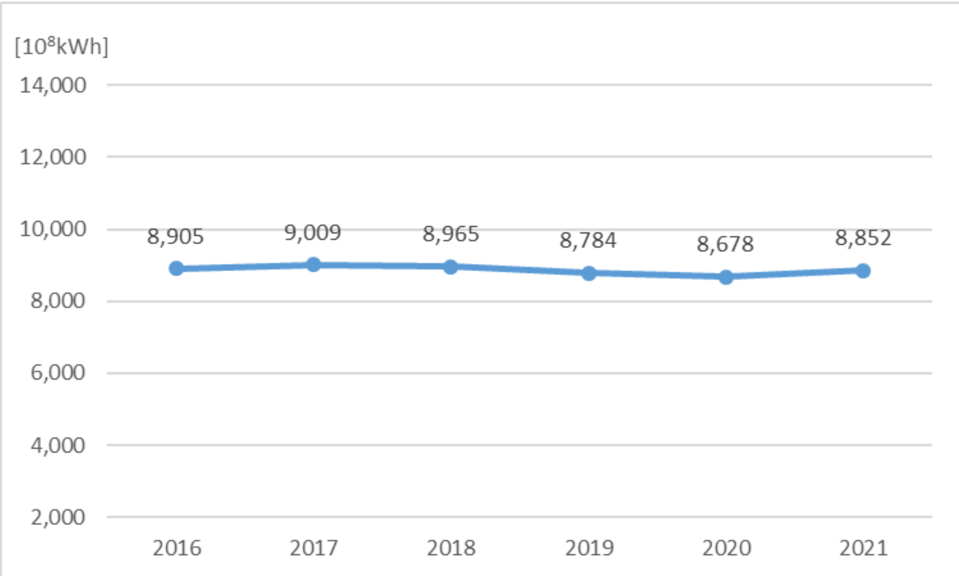

Figure 1-5: Actual annual electric energy requirements (Nationwide)

5. Nationwide Load Factor

The load factor describes the ratio of the average demand to the peak demand within a given period. Table 1-7 shows the monthly load factor for regional service areas in FY 2021, while Figures 1-6 and 1-7 show the nationwide monthly and annual load factors, respectively. Table 1-8 presents the actual annual load factor at the sending-end data since FY 2016.

The values in red and blue are the highest and lowest load factors, respectively, for each regional service area.

The nationwide annual load factor for FY 2021 was 61.4%, which was higher than that for the previous year, which was the minimum figure for 6 years since they were recorded at the sending-end data. The improvement was estimated to be attributable to an increase in the electric energy requirement due to the recovery of economic activities, despite the decrease in the peak demand due to mild summer.

Table 1-7: Monthly and annual load factors for regional service areas[3]

[%]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Hokkaido	83.4	82.6	79.2	71.6	66.6	81.0	79.6	79.3	83.8	88.0	86.8	81.9	69.2
Tohoku	79.9	80.9	76.6	66.7	62.8	76.2	77.8	77.4	75.2	79.6	80.8	80.6	64.0
Tokyo	80.1	72.5	72.4	64.2	63.6	70.2	70.7	72.7	75.7	71.3	72.9	69.9	57.1
Chubu	79.5	71.0	70.3	68.7	64.0	69.3	69.7	72.8	71.1	71.1	75.5	72.6	61.7
Hokuriku	82.2	80.1	76.2	68.8	63.3	73.8	73.8	77.3	74.2	75.8	77.0	78.6	61.5
Kansai	82.2	75.2	71.5	67.9	62.6	65.5	71.6	76.7	72.5	74.2	76.1	73.5	57.9
Chugoku	84.7	78.0	74.4	70.1	63.7	71.6	75.7	79.3	76.9	76.0	77.3	74.7	62.1
Shikoku	84.2	75.9	73.9	68.6	64.9	63.4	72.1	79.3	75.9	76.6	74.3	72.8	61.6
Kyushu	86.0	78.5	72.5	71.6	66.7	70.2	71.0	79.5	74.3	75.1	77.1	76.7	62.4
Okinawa	74.1	66.2	69.9	72.5	73.9	72.2	67.3	74.5	77.4	78.7	74.5	73.8	57.5
Nationwide	83.3	77.7	75.3	68.6	65.1	73.6	73.3	76.9	75.2	78.2	80.4	76.3	61.4

[3] "Nationwide load factor" refers to the load factor calculated for all of Japan. It is not simply the average of each regional load factor.

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

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

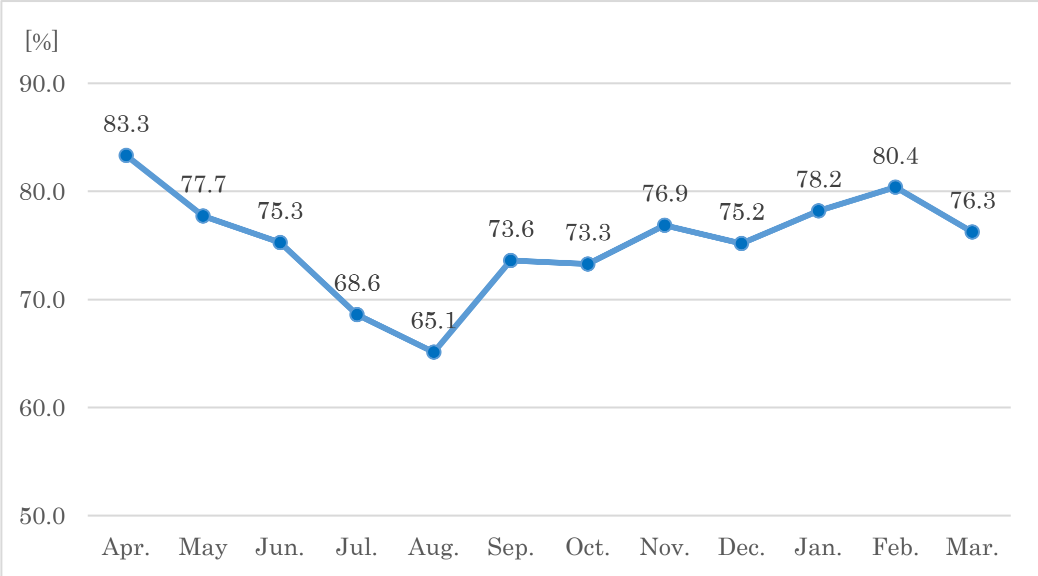

Figure 1-6: Nationwide monthly load factor

Table 1-8: Actual annual load factor (from FY 2016–2021)

[%]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Nationwide	65.8	66.0	62.1	60.7	59.5	61.4

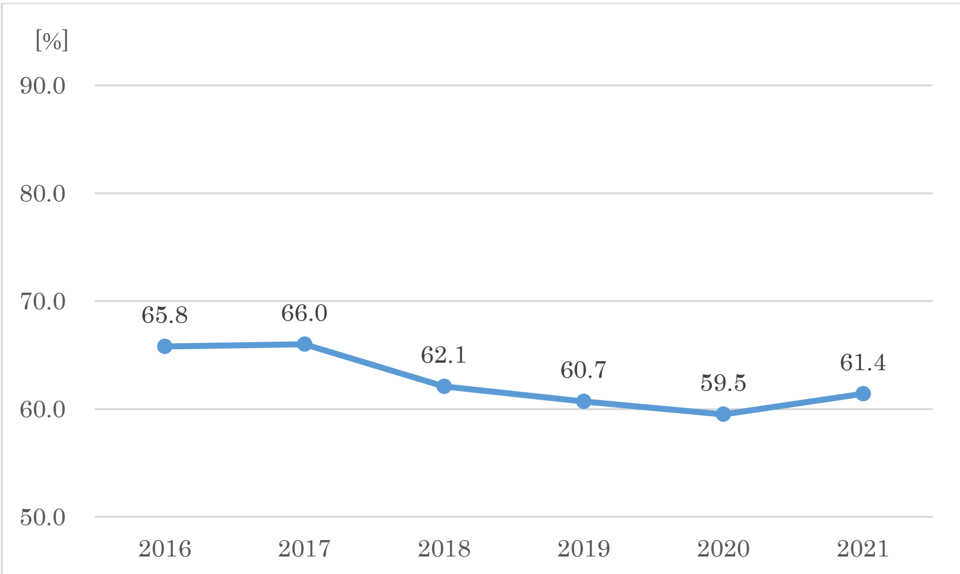

Figure 1-7: Actual annual load factor (Nationwide)

6. Nationwide Supply–Demand Status During the Peak Demand

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

Table 1-9 shows the supply–demand status during the summer peak demand period for regional service areas in FY 2021.

The actual nationwide summer peak demand for FY 2021 was 16,460 × 10^4 kW, which was registered at 14:00 on August 5, against the supply capacity of 18,804 × 10^4 kW with a reserve margin of 14.2%. This was the highest figure for the past 6 years since data were recorded at the sending-end. Table 1-10 presents the summer peak supply–demand status data since FY 2016.

Table 1-9: Supply–demand status during the summer peak demand period for nationwide and regional service areas[4]

Area	Peak Demand [10^4kW]	Occurrence Date & Time			Daily Maximum Temperature [℃]	Supply Capacity [10^4kW]	Reserve Capacity [10^4kW]	Reserve Margin [%]	Daily Energy Supply [10^4kWh]	Daily Load Facter [%]
Hokkaido	469	8/6	Fri.	11:00～12:00	35.0	547	79	16.8	9,243	82.2
Tohoku	1,490	8/4	Wed.	11:00～12:00	33.4	1,759	269	18.1	27,840	77.8
Tokyo	5,665	8/26	Thur.	13:00～14:00	35.7	6,248	583	10.3	103,835	76.4
Chubu	2,480	8/30	Mon.	14:00～15:00	35.7	2,910	430	17.4	44,436	74.7
Hokuriku	523	8/5	Thur.	14:00～15:00	34.1	585	62	11.9	9,982	79.6
Kansai	2,826	8/5	Thur.	14:00～15:00	38.9	3,191	365	12.9	51,705	76.2
Chugoku	1,108	8/5	Thur.	13:00～14:00	36.9	1,208	100	9.1	20,922	78.7
Shikoku	503	8/5	Thur.	13:00～14:00	37.0	622	119	23.6	9,480	78.6
Kyushu	1,559	8/5	Thur.	16:00～17:00	36.4	1,778	219	14.0	29,966	80.1
Okinawa	160	9/10	Fri.	13:00～14:00	33.5	232	72	45.1	3,066	79.9
Nationwide	16,460	8/5	Thur.	13:00～14:00	-	18,804	2,344	14.2	308,249	78.0

[4] The daily maximum and mean temperatures were provided by the JMA based on the data for the cities where the headquarters of the GT&D companies (except for the Okinawa EPCO) are located. (Instead, for the regional service area of the Okinawa EPCO, the data from Naha, the prefectural capital of Okinawa, were used).

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

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

Table 1-10: Actual supply–demand status for summer peak demand (FY 2016–2021)

FY	Peak Demand [10^4kW]	Occurrence Date & Time			Daily Maximum Temperature [℃]	Supply Capacity [10^4kW]	Reserve Capacity [10^4kW]	Reserve Margin [%]	Daily Energy Supply [10^4kWh]	Daily Load Facter [%]
2016	15,589	8/9	Tue.	14:00～15:00	-	17,764	2,176	14.0	297,969	79.6
2017	15,550	8/24	Thur.	14:00～15:00	-	17,716	2,165	13.9	300,493	80.5
2018	16,482	8/3	Fri.	14:00～15:00	-	18,749	2,267	13.8	315,434	79.7
2019	16,461	8/2	Fri.	14:00～15:00	-	18,584	2,122	12.9	314,988	79.7
2020	16,645	8/20	Thur.	14:00～15:00	-	18,608	1,964	11.8	310,303	77.7
2021	16,460	8/5	Thur.	13:00～14:00	-	18,804	2,344	14.2	308,249	78.0

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

Table 1-11 shows the supply–demand status during the winter peak demand period for regional service areas in FY 2021. Table 1-12 presents the winter peak supply–demand status data since FY 2016.

The actual nationwide winter peak demand for FY 2021 was 15,119 × 10^4 kW, which occurred at 10:00 on January 14, against a supply capacity of 16,783 × 10^4 kW, with a reserve margin of 11.0%. No area had a reserve margin below 3% (the minimum acceptable margin criteria).

Table 1-11: Supply–demand status during the winter peak demand period for regional service areas[5]

Area	Peak Demand [10^4kW]	Occurrence Date & Time			Daily Mean Temperature [℃]	Supply Capacity [10^4kW]	Reserve Capacity [10^4kW]	Reserve Margin [%]	Daily Energy Supply [10^4kWh]	Daily Load Facter [%]
Hokkaido	501	1/11	Tue.	13:00～14:00	-1.3	563	61	12.2	11,161	92.8
Tohoku	1,483	1/18	Tue.	09:00～10:00	-0.7	1,694	211	14.2	31,994	89.9
Tokyo	5,374	1/6	Thur.	16:00～17:00	0.7	5,606	232	4.3	107,790	83.6
Chubu	2,448	1/14	Fri.	09:00～10:00	2.0	2,640	192	7.8	49,114	83.6
Hokuriku	549	2/17	Thur.	10:00～11:00	-0.4	592	43	7.9	11,690	88.7
Kansai	2,540	1/14	Fri.	09:00～10:00	3.6	2,716	177	7.0	51,689	84.8
Chugoku	1,068	2/17	Thur.	09:00～10:00	0.4	1,189	120	11.3	22,361	87.2
Shikoku	495	2/17	Thur.	11:00～12:00	1.9	543	49	9.8	10,019	84.4
Kyushu	1,470	2/17	Thur.	18:00～19:00	1.7	1,546	76	5.1	30,522	86.5
Okinawa	104	2/21	Mon.	19:00～20:00	14.4	138	34	32.7	2,112	84.7
Nationwide	15,119	1/14	Fri.	09:00～10:00	-	16,783	1,665	11.0	317,617	87.5

Table 1-12: Actual supply–demand status for winter peak demand (FY 2016–2021)

FY	Peak Demand [10^4kW]	Occurrence Date & Time			Daily Mean Temperature [℃]	Supply Capacity [10^4kW]	Reserve Capacity [10^4kW]	Reserve Margin [%]	Daily Energy Supply [10^4kWh]	Daily Load Facter [%]
2016	14,914	1/24	Tue.	18:00～19:00	-	16,354	1,440	9.7	314,968	88.0
2017	15,577	1/25	Thur.	18:00～19:00	-	16,915	1,339	8.6	330,605	88.4
2018	14,603	1/10	Thur.	09:00～10:00	-	16,104	1,501	10.3	308,436	88.0
2019	14,619	2/7	Fri.	09:00～10:00	-	16,808	2,189	15.0	303,347	86.5
2020	15,607	1/8	Fri.	09:00～10:00	-	17,012	1,406	9.0	329,833	88.1
2021	15,119	1/14	Fri.	09:00～10:00	-	16,783	1,665	11.0	317,617	87.5

7. Nationwide Lowest Demand Period

Table 1-13 and 1-14 show the status of the lowest demand period for nationwide and regional service areas in FY 2021 and the actual annual lowest demands at the sending-end from FY 2016 to FY 2021, respectively.

Table 1-13: Lowest demand period for nationwide and regional service areas[5]

	Lowest Demand [10^4kW]	Occurrence Date & Time			Daily Mean Temperature [℃]	Daily Energy Supply [10^4kWh]
Hokkaido	217	8/15	Sun.	01:00～02:00	19.8	6,087
Tohoku	594	8/15	Sun.	01:00～02:00	18.4	16,633
Tokyo	1,955	5/5	Wed.	06:00～07:00	18.3	56,394
Chubu	858	5/5	Wed.	01:00～02:00	17.1	24,335
Hokuriku	198	8/15	Sun.	01:00～02:00	23.2	5,548
Kansai	985	5/5	Wed.	01:00～02:00	17.3	28,201
Chugoku	451	5/6	Thur.	00:00～01:00	17.4	13,349
Shikoku	195	5/2	Sun.	07:00～08:00	13.6	5,308
Kyushu	626	5/2	Sun.	08:00～09:00	13.9	17,077
Okinawa	57	4/26	Mon.	01:00～02:00	22.0	1,839
Nationwide	6,332	5/5	Wed.	01:00～02:00	-	171,847

Table 1-14: Actual annual lowest demand (FY 2016–2021, at the sending-end)

[10^4 kW]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Nationwide	6,516	6,477	6,496	6,398	6,065	6,332

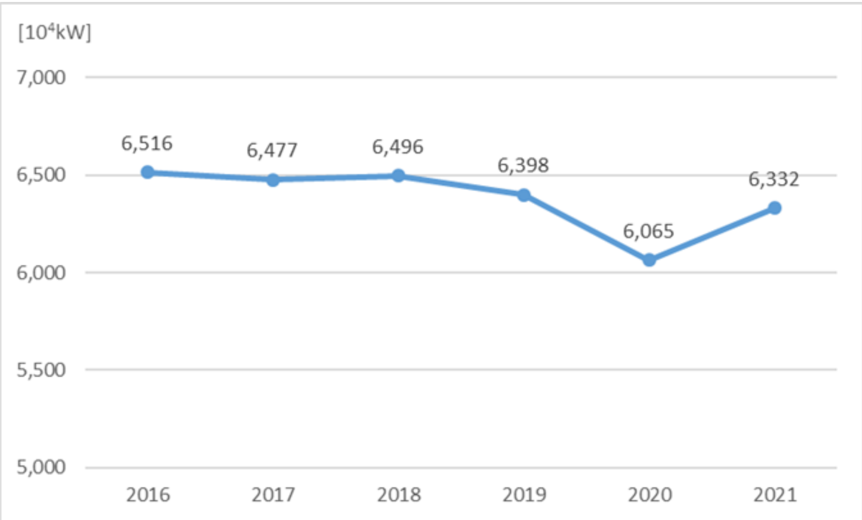

Figure 1-8: Actual annual lowest demand (Nationwide)

[5] See footnote 4.

8. Nationwide Peak Daily Energy Supply

Tables 1-15 and 1-16 show the summer peak daily energy supply for nationwide and regional service areas in FY 2021 (July–September 2021) and the winter peak daily energy supply for nationwide and regional service areas in FY 2021 (from December 2021 to February 2022), respectively.[6]

Table 1-15: Summer peak daily energy Supply for nationwide and regional service areas

Area	Peak Daily Energy Supply [10^4kWh]	Occurrence Date		Daily Mean Temperature [˚C]
Hokkaido	9,243	8/6	Fri.	29.2
Tohoku	27,840	8/4	Wed.	28.5
Tokyo	103,835	8/26	Thur.	30.5
Chubu	46,221	8/5	Thur.	30.4
Hokuriku	9,982	8/5	Thur.	34.1
Kansai	51,705	8/5	Thur.	31.3
Chugoku	20,922	8/5	Thur.	31.2
Shikoku	9,480	8/5	Thur.	31.3
Kyushu	29,966	8/5	Thur.	31.7
Okinawa	3,066	9/10	Fri.	29.9
Nationwide	308,249	8/5	Thur.	-

Table 1-16: Winter peak daily energy supply for nationwide and regional service areas

Area	Peak Daily Energy Supply [10^4kWh]	Occurrence Date		Daily Mean Temperature [˚C]
Hokkaido	11,480	1/31	Mon.	-7.8
Tohoku	31,994	1/18	Tue.	-0.7
Tokyo	107,790	1/6	Thur.	0.7
Chubu	49,114	1/14	Fri.	2.0
Hokuriku	11,690	2/17	Thur.	-0.4
Kansai	51,809	1/21	Fri.	3.4
Chugoku	22,361	2/17	Thur.	0.4
Shikoku	10,019	2/17	Thur.	1.9
Kyushu	30,522	2/17	Thur.	1.7
Okinawa	2,112	2/21	Mon.	14.4
Nationwide	318,052	1/21	Fri.	-

[6] See footnote 4.

9. Instructions, Requests Issued and Controls Implemented by the Organization

Instructions and Requests

According to the provisions of paragraph 1 of Article 28-44 of the Electricity Business Act (the Act hereafter), the Organization finds it necessary to improve the electricity supply–demand status, the Organization may require members such as EPCOs 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 2021, the Organization issued instructions to GT&D companies on 21 occasions for them to exchange power according to the provisions of items 1–3, paragraph 1 of Article 111 of the Operational Rules (Table 1-17). The instructions included measures for improving the supply–demand status during the winter of 2021/22. Furthermore, the Fukushima Earthquake on March 16, 2022 caused the shutdown of six generators, totaling 3,350 MW, and the snowfall and midwinter temperature TEPCO Power Grid (PG) area had a supply capacity shortage and, sharply increasing the heating demand. The Organization issued the instructions for exchanging power according to the provisions of the paragraphs 1 and 2 of Article 111 and requested generation companies and electric suppliers to procure additional supply capacity, the same as in the previous year. Moreover, the Organization requested retail companies to reduce their demand.

For the details of the instructions and requests, please see <Reference> Details of Actual Power Exchange Instructions, and Instructions and Requests to Generation Companies and Retail Companies Issued by the Organization.[7] The specific instructions are stated below.

(1) Instructions for the improvement of supply–demand status (from May to July 2021 and January 2022)

The Organization has issued instructions to the GT&D companies that the supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of the shortage of supply capacity in the corresponding area, following a decrease in solar power output, and unexpected demand growth caused by higher temperatures.

- Shikoku EPCO Transmission & Distribution
  May 19: 500 MW at most, following an unexpected decrease in solar power output, (one instruction)
- Hokuriku EPCO Transmission & Distribution
  July 15 : 200 MW, following generator shutdown (one instruction)
- Hokuriku EPCO Transmission & Distribution
  January 11 : 200 MW, following generator troubles (one instruction)

(2) Instructions for improving the supply–demand status during winter of 2021/22 (from January to February, 2022)

[7] https://www.occto.or.jp/oshirase/shiji/jukyu_taiou_2021.html (in Japanese only)

Unexpected demand growth caused by cold weather led to a shortage of supply capacity, which contributes to keeping the balance between supply and demand in the corresponding area. The Organization has issued instructions six times to the areas of GT&D companies that the supply–demand status may degrade without power exchanges through cross-regional interconnection lines, according to the provisions of paragraph 1 of Article 28-44 of the Act.

・TEPCO PG

1) January 6, 2022 at 13:30–20:00, 1220 MW at most
2) January 6, 2022 at 15:30–20:00, 1320 MW at most
3) January 6, 2022 at 20:00–24:00, 2760 MW at most
4) January 7, 2022 at 00:00–09:00, 2740 MW at most
5) February 10, 2022 at 10:00–13:00, 800 MW at most
6) February 10, 2022 at 13:30–17:00, 751 MW at most

(3) Instructions and Requests for improvement of supply–demand status triggered by the Fukushima Earthquake in March, 2022

a. Instructions to GT&D companies.

The Organization issued instructions on 12 occasions on March 17–23, 2022, as stated below. According to the provisions of paragraph 1 of Article 28-44 of the Act and Article 111 of the Operating Rule of the Organization, the instructions were issued to GT&D companies for supplying electricity to the GT&D companies in the corresponding areas.

・Tohoku EPCO Network

1) March 17, 2022 at 02:30–06:00, 1400 MW at most
2) March 17, 2022 at 06:00–11:00, 1000 MW at most
3) March 18, 2022 at 09:00–12:00, 500 MW
4) March 18, 2022 at 12:00–16:00, 600 MW
5) March 22, 2022 at 10:30–16:00, 613.6 MW at most
6) March 22, 2022 at 16:00–17:00, 95.9 MW at most

・TEPCO PG

1) March 18, 2022 at 16:00–24:00, 943.6 MW at most
2) March 19, 2022 at 00:00–04:00, 600 MW
3) March 22, 2022 at 07:00–16:00, 1417.8 MW at most
4) March 22, 2022 at 16:00–24:00, 927.4 MW at most
5) March 23, 2022 at 00:00–11:00, 1000 MW at most

b. Requests to member electric power suppliers

The Fukushima Earthquake caused the shutdown of generators, which are sited in the regional service areas of Tohoku EPCO Network and TEPCO PG. Further. Moreover, due to cold waves and bad weather, the Eastern Region of Japan experienced a tight supply–demand condition. The

Organization requested electric power suppliers that are members of the Organization four times on March 21–22 to improve the balance between supply and demand, according to the provisions of paragraph 2 of Article 111 of the Operational Rules.

Table 1-17: Actual instructions to GT&D companies issued by the Organization (FY 2015–2021)

[occasions]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Nationwide	2	2	10	25	6	226	21

Controls

The Organization implemented long-cycle cross-regional frequency controls[8] to send surplus electric energy generated from renewable energy generating facilities in the Kyushu EPCO area to the Chugoku and Shikoku EPCO areas through cross-regional interconnection lines by utilizing their available transfer capability (ATC), according to the provisions of Article 132 of the Operational Rules. The Organization received the request from the Kyushu EPCO to control the inability to reduce power supply.[9] Such controls were implemented on 72 occasions during FY 2021.

[8] This refers to the frequency control by utilizing the balancing capacity of other regional service areas of member GT&D companies through interconnection lines. This is used when the balancing capacity for redundancy becomes or might become insufficient in a regional service area.

[9] This refers to the ability to decrease the power supply from generators, such as thermal power generators. The output of renewable energy can fluctuate over a short period. Then, controlling the output of thermal power generators according to such fluctuations is essential. Among such output controls, the capacity to vary the output of generators is generally called the "balancing capacity for redundancy."

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 EPCOs to shed their output in cases of expected oversupply of demand for its regional service areas after shedding the output of generators, other than the renewable energy generating facilities of the GT&D companies, 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 1-18 and 1-19 show the actual output shedding of renewable-energy-generating facilities in FY 2021 for the Kyushu mainland and isolated islands, respectively.[10] In Table 1-18, "Shedding Instructed" indicates the total effect of the instructions issued on both the day ahead, which is shed by offline control, and the current day, which is shed by online control. The actual shed capacity is expressed in parentheses for that day. A bar in parentheses indicates that there was no output shedding for that day. The necessary output shedding for the isolated island is indicated in Table 1-19. It is calculated by deducting the demand from the supply capacity and procured by offline control. Output shedding of renewable energy generating facilities was implemented in cases where the balancing capacity for redundancy might become insufficient. The shedding period was from 09:00 to 16:00 in each implementation for the isolated islands, and from 8:00 to 16:00 on the Kyushu mainland, except for a few cases.

Instructions for output shedding were issued only for the regional service area of Kyushu GT&D. In the midst of the increasing capacity of variable renewable energy, such as solar and wind power, instructions for output shedding of the renewable energy generating facilities were issued for 252,834 MW of output shedding in FY 2021, which increased from 108,019 MW of output shedding in the previous year. The actual output shed on the day totaled 116,980 MW in FY 2021.

The Organization confirms and verifies whether the output shedding of renewable-energy-generating facilities that Kyushu EPCO implemented to facilities of EPCOs according to the provisions of Article 180 of the Operational Rules. The result of the confirmation and verification was that it was appropriate.

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

Table 1-18: Instructed and actual output shedding of renewable-energy-generating facilities for FY 2021 (Kyushu Mainland, 10^4 kW)[11]

Date	Shedding Instructed (Actually shed)	Date	Shedding Instructed (Actually shed)
2021/4/1(Thur.)	201.2(123.4)	2021/10/1(Fri.)	87.9(0.0)
2021/4/2(Fri.)	225.9(0.0)	2021/10/2(Sat.)	237.2(165.1)
2021/4/5(Sat.)	367.2(280.4)	2021/10/3(Sun.)	282.0(222.6)
2021/4/6(Tue.)	356.7(224.1)	2021/10/4(Mon.)	8.1(0.0)
2021/4/7(Wed.)	372.0(271.9)	2021/10/5(Tue.)	77.3(0.0)
2021/4/8(Thur.)	283.1(0.0)	2021/10/6(Wed.)	111.3(0.0)
2021/4/9(Fri.)	356.5(170.6)	2021/10/7(Thur.)	38.9(0.0)
2021/4/10(Sat.)	362.2(286.0)	2021/10/8(Fri.)	51.3(0.0)
2021/4/11(Sun.)	441.4(332.2)	2021/10/9(Sat.)	122.6(0.0)
2021/4/14(Wed.)	308.0(116.7)	2021/10/10(Sun.)	240.4(35.6)
2021/4/15(Thur.)	360.8(312.9)	2021/10/16(Sat.)	163.1(0.0)
2021/4/17(Sat.)	257.4(127.1)	2021/10/17(Sun.)	274.8(95.6)
2021/4/18(Sun.)	463.4(381.9)	2021/10/18(Mon.)	86.9(0.0)
2021/4/19(Mon.)	374.8(278.9)	2021/10/22(Fri.)	185.8(0.0)
2021/4/20(Tue.)	365.1(285.0)	2021/10/23(Sat.)	378.0(168.7)
2021/4/21(Wed.)	271.8(203.4)	2021/10/24(Sun.)	372.4(47.2)
2021/4/22(Thur.)	256.3(167.2)	2021/10/26(Tue.)	303.9(101.5)
2021/4/23(Fri.)	64.8(74.7)	2021/10/27(Wed.)	149.1(41.1)
2021/4/24(Sat.)	331.1(193.0)	2021/10/28(Thur.)	201.4(39.2)
2021/4/25(Sun.)	434.1(331.9)	2021/10/29(Fri.)	128.1(66.7)
2021/4/26(Mon.)	316.7(274.4)	2021/10/31(Sun.)	242.3(66.9)
2021/4/27(Tue.)	242.6(29.6)	2021/11/1(Mon.)	112.4(0.0)
2021/4/30(Fri.)	254.6(87.8)	2021/11/4(Thur.)	186.5(13.4)
2021/5/1(Sat.)	234.2(22.4)	2021/11/5(Fri.)	130.3(23.0)
2021/5/2(Sun.)	298.1(101.4)	2021/11/7(Sun.)	309.9(213.3)
2021/5/3(Mon.)	363.1(345.4)	2021/11/14(Sun.)	134.4(0.0)
2021/5/4(Tue.)	384.8(143.1)	2021/11/17(Wed.)	89.2(32.5)
2021/5/5(Wed.)	53.5(107.5)	2021/11/18(Thur.)	205.8(0.0)
2021/5/6(Thur.)	260.3(243.9)	2021/11/19(Fri.)	154.2(36.0)
2021/5/8(Sat.)	224.3(0.0)	2021/11/20(Sat.)	151.9(90.7)
2021/5/9(Sun.)	373.8(289.4)	2021/11/27(Sat.)	35.9(0.0)
2021/5/10(Mon.)	259.6(107.9)	2021/11/28(Sun.)	103.6(114.6)
2021/5/19(Wed.)	196.9(102.4)	2021/12/5(Sun.)	185.8(0.0)
2021/5/22(Sat.)	266.6(63.1)	2021/12/22(Wed.)	66.3(0.0)
2021/5/23(Sun.)	332.7(348.5)	2021/12/30(Thur.)	104.8(0.0)
2021/5/25(Tue.)	267.3(50.8)	2021/12/31(Fri.)	178.7(149.5)
2021/5/28(Fri.)	298.1(0.0)	2022/1/1(Sat.)	251.4(218.3)
2021/5/29(Sat.)	339.2(301.8)	2022/1/2(Sun.)	177.6(45.5)
2021/5/30(Sun.)	342.6(341.5)	2022/1/3(Mon.)	230.6(183.0)
2021/5/31(Mon.)	284.7(205.1)	2022/1/4(Tue.)	190.7(0.0)
2021/6/1(Tue.)	157.6(133.4)	2022/1/10(Mon.)	207.6(35.6)
2021/6/6(Sun.)	174.3(23.0)	2022/2/11(Fri.)	167.5(0.0)
2021/6/7(Mon.)	119.8(0.0)	2022/2/26(Sat.)	135.2(24.7)
2021/6/19(Sat.)	25.7(0.0)	2022/2/27(Sun.)	218.9(174.1)
2021/6/20(Sun.)	166.9(137.2)	2022/2/28(Mon.)	75.6(0.0)
2021/6/23(Wed.)	46.9(0.0)	2022/3/2(Wed.)	208.0(24.2)
2021/7/11(Sun.)	38.6(38.8)	2022/3/3(Thur.)	225.4(34.8)
2021/8/29(Sun.)	81.6(0.0)	2022/3/5(Sat.)	353.5(117.6)
2021/9/18(Sat.)	148.7(0.0)	2022/3/6(Sun.)	420.3(236.9)
2021/9/19(Sun.)	310.7(193.8)	2022/3/8(Tue.)	252.8(59.9)
2021/9/20(Mon.)	115.7(42.6)	2022/3/9(Wed.)	234.4(29.0)
2021/9/23(Thur.)	119.0(0.0)	2022/3/10(Thur.)	230.8(41.7)
2021/9/24(Fri.)	62.1(0.0)	2022/3/12(Sat.)	287.2(73.3)
2021/9/25(Sat.)	173.9(72.0)	2022/3/15(Tue.)	266.8(133.4)
2021/9/26(Sun.)	233.7(134.0)	2022/3/16(Wed.)	287.3(128.9)
		2022/3/20(Sun.)	226.1(13.1)
		2022/3/24(Thur.)	227.4(0.0)
		2022/3/25(Fri.)	172.7(11.1)
		2022/3/27(Sun.)	320.4(287.6)

[11] The instructions were issued for the hours between 08:00 and 16:00, other than the 8:00–17:00 period from May 19 to June 23 and the 9:00–12:00 period in July 11. Dates expressed in blue refer to days without actual shedding.

Table 1-19: Output shedding needed for FY 2020 (Isolated islands of Kyushu, kW)[12]

Date	Tanegashima	Iki	Tokunoshima	Tsushima
2021/4/6(Tue.)		1,210		
2021/4/7(Wed.)	390	1,700	1,000	
2021/4/8(Thur.)		1,030		
2021/4/9(Fri.)	4,050	810		
2021/4/10(Sat.)	1,130	2,040		
2021/4/11(Sun.)	680	2,190	550	
2021/4/14(Wed.)	1,180	1,610		
2021/4/15(Thur.)		1,050		
2021/4/16(Fri.)	60			
2021/4/17(Sat.)		2,300		
2021/4/18(Sun.)	4,580	1,820	620	
2021/4/19(Mon.)	5,170	1,820		
2021/4/20(Tue.)	4,430	1,290		
2021/4/21(Wed.)	3,180	140		
2021/4/24(Sat.)	1,790	290		
2021/4/25(Sun.)	4,910	2,510		
2021/4/26(Mon.)	4,580	3,030		
2021/4/27(Tue.)	740			
2021/4/30(Fri.)	4,850	1,820		
2021/5/1(Sat.)	3,770	1,090		
2021/5/2(Sun.)	2,590	310	270	
2021/5/3(Mon.)	4,660	1,910	260	
2021/5/4(Tue.)	3,510			
2021/5/5(Wed.)		740		
2021/5/6(Thur.)	3,070			
2021/5/9(Sun.)	2,420	800		
2021/5/10(Mon.)	2,290			
2021/5/23(Sun.)	3,110	610		
2021/5/25(Tue.)	1,260	750		
2021/5/29(Sat.)	810	1,390		
2021/5/30(Sun.)	1,160	1,600		
2021/5/31(Mon.)	1,730			
2021/6/1(Tue.)	1,500			
2021/6/6(Sun.)		1,190		
2021/9/19(Sun.)		1,190		
2021/10/2(Sat.)	620			
2021/10/22(Fri.)	510			
2021/10/23(Sat.)	400	380		
2021/10/26(Tue.)	290	730		
2021/10/27(Wed.)	580			
2021/10/28(Thur.)	790	630		
2021/10/29(Fri.)	780			
2021/10/31(Sun.)		1,080		
Period of Instruction	08:00-16:00			

Date	Tanegashima	Iki	Tokunoshima	Tsushima
2021/11/2(Tue.)	2,100	300		
2021/11/3(Wed.)	2,340	520		
2021/11/4(Thur.)	2,180	1,100		
2021/11/6(Sat.)		870		
2021/11/7(Sun.)	170	1,940		
2021/11/15(Mon.)	1,500			
2021/11/16(Tue.)	1,180			
2021/11/17(Wed.)	390	260		
2021/11/18(Thur.)		250		
2021/11/20(Sat.)	990			
2021/11/26(Fri.)	270			
2021/11/27(Sat.)	1,530	300		
2021/11/28(Sun.)		1,080		
2021/12/4(Sat.)	1,280			
2021/12/7(Tue.)	1,250			
2021/12/8(Wed.)	1,180			
2021/12/15(Wed.)	580			
2021/12/23(Thur.)	320			
2022/1/3(Mon.)	550			
2022/1/4(Tue.)	120			
2022/1/10(Mon.)	2,280			
2022/1/19(Wed.)	970			
2022/1/31(Mon.)	1,930			
2022/2/11(Fri.)	2,720			
2022/2/24(Thur.)	1,030			
2022/2/25(Fri.)	2,070			
2022/2/26(Sat.)	2,160			
2022/2/27(Sun.)	4,870		990	
2022/2/28(Mon.)	3,260			
2022/3/2(Wed.)	630			
2022/3/3(Thur.)	3,310			
2022/3/5(Sat.)	3,130			
2022/3/6(Sun.)	2,700			
2022/3/8(Tue.)	3,090			
2022/3/9(Wed.)	2,950			
2022/3/10(Thur.)	2,850			
2022/3/12(Sat.)	3,400	280		
2022/3/13(Sun.)	270			
2022/3/14(Mon.)	1,750			
2022/3/15(Tue.)	3,030			
2022/3/16(Wed.)	3,870	900		
2022/3/19(Sat.)	970			
2022/3/20(Sun.)	2,290			
2022/3/24(Thur.)	3,840			
2022/3/25(Fri.)	360			
2022/3/27(Sun.)	1,770	1,440		1,850
2022/3/29(Tue.)		1,230		
2022/3/30(Wed.)	260			
Period of Instruction	08:00-16:00			

12 The instructions were issued for the hours between 08:00 and 16:00, other than the 9:00–16:00 period at the Iki island on October 23, 26, 28, and 31.

CONCLUSION

Actual Electricity Supply–Demand

For the actual electricity supply–demand, data on the peak demand, the electric energy requirement, the load factor, and the supply–demand status during the peak and lowest demand periods and the peak daily energy supply have been collected. Additionally, instructions with respect to power exchanges (according to the provisions of paragraph 1 of Article 28-44 of the Electricity Business Act) and the 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) have been aggregated. Furthermore, instructions and requests regarding the tight supply–demand balance in the winter of 2021/2022 are described in detail.

<Reference> Detailes on the Actual Power Exchange Instructions, with Instructions and Requests to Generation Companies and Retail Companies Issued by the Oraganization.

The details on the actual power exchange instructions, with instructions and requests to generation and retail companies issued by the Organization in FY 2021, are listed below. They include measures for avoiding supply–demand tightness during the winter of 2021/2022 and the Fukushima Earthquake, which occurred on March 16, 2022.

Actual power exchange instructions by the Organization

1	Issued at	8:59 on May 19, 2021
	Instruction	･Kansai T&D shall supply 500 MW of electricity at most to Shikoku T&D from 9:30 to 12:00 on May 19. ･Shikoku T&D shall be supplied 500 MW of electricity at most by Kansai T&D from 9:30 to 12:00 on May 19.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of unexpected demand growth and decreasing output of solar power caused by weather change.
2	Issued at	08:33 on July 15, 2021
	Instruction	･Kansai T&D shall supply 200 MW of electricity to Hokuriku T&D from 9:00 to 10:00 on July 15. ･Hokuriku T&D shall be supplied 200 MW of electricity by Kansai T&D from 9:00 to 10:00 on July 15.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a generator shutdown in Hokuriku T&D regional service area.
3	Issued at	13:02 on January 6, 2022
	Instruction	･Hokkaido NW shall supply 250 MW of electricity at most to TEPCO PG from 13:30 to 20:00 on January 6. ･Tohoku NW shall supply 900 MW of electricity at most to TEPCO PG from 13:30 to 20:00 on January 6. ･Chubu PG shall supply 170 MW of electricity to TEPCO PG from 17:00 to 20:00 on January 6. ･TEPCO PG shall be supplied 1220 MW of electricity at most by Hokkaido NW, Tohoku NW, and Chubu PG from 13:30 to 20:00 on January 6.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply-demand balance due to unexpected demand growth caused by cold weather.
4	Issued at	14:56 on January 6, 2022
	Instruction	･Hokkaido NW shall supply 200 MW of electricity at most to TEPCO PG from 15:30 to 19:30 on January 6. ･Tohoku NW shall supply 600 MW of electricity at most to TEPCO PG from 15:30 to 20:00 on January 6. ･Chubu PG shall supply 300 MW of electricity to TEPCO PG from 15:30 to 20:00 on January 6. ･Kansai T&D shall supply 220 MW of electricity at most to TEPCO PG from 15:30 to 17:00 on January 6. ･TEPCO PG shall be supplied 1320 MW of electricity at most by Hokkaido NW, Tohoku NW, Chubu PG, and Kansai T&D from 15:30 to 20:00 on January 6. (The transmission margin of an interconnection line was partly utilized to the power exchange.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply-demand balance due to unexpected demand growth caused by cold weather.
5	Issued at	19:17 on January 6, 2022
	Instruction	･Hokkaido NW shall supply 50 MW of electricity to TEPCO PG from 23:30 to 24:00 on January 6. ･Tohoku NW shall supply 1000 MW of electricity at most to TEPCO PG from 20:00 to 24:00 on January 6. ･Chubu PG shall supply 790 MW of electricity at most to TEPCO PG from 22:00 to 24:00 on January 6. ･Kansai T&D shall supply 920 MW of electricity at most to TEPCO PG from 21:00 to 24:00 on January 6. ･TEPCO PG shall be supplied 2760 MW of electricity at most by Hokkaido NW, Tohoku NW, Chubu PG, and Kansai T&D from 20:00 to 24:00 on January 6.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply-demand balance due to unexpected demand growth caused by cold weather.

6	Issued at	21:18 on January 6, 2022
	Instruction	・Tohoku NW shall supply 1200 MW of electricity at most to TEPCO PG from 0:00 to 9:00 on January 7. ・Chubu PG shall supply 1500 MW of electricity at most to TEPCO PG from 0:00 to 9:00 on January 7. ・Kansai T&D shall supply 700 MW of electricity at most to TEPCO PG from 0:00 to 9:00 on January 7. ・TEPCO PG shall be supplied 2740 MW of electricity at most by Tohoku NW, Chubu PG, and Kansai T&D from 0:00 to 9:00 on January 7.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply-demand balance due to unexpected demand growth caused by cold weather.
7	Issued at	5:31 on January 11, 2022
	Instruction	・Kansai T&D shall supply 200 MW of electricity to Hokuriku T&D from 6:00 to 8:00 on January 11. ・Hokuriku T&D shall be supplied 200 MW of electricity by Kansai T&D from 6:00 to 8:00 on January 11.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a generator shutdown in Hokuriku T&D regional service area.
8	Issued at	9:07 on February 10, 2022
	Instruction	・Chubu PG shall supply 629 MW of electricity at most to TEPCO PG from 10:00 to 13:00 on February 10. ・Kansai T&D shall supply 171 MW of electricity to TEPCO PG from 10:00 to 13:00 on February 10. ・TEPCO PG shall be supplied 800 MW of electricity at most by Chubu PG, and Kansai T&D from 10:00 to 13:00 on February 10. (The transmission margin of an interconnection line was partly utilized to the power exchange.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected demand growth caused by cold weather. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up due to further demand growth; further supply–demand tightness is likely to occur. The Organization shall intermittently issue additional instructions for power exchange for tight supply–demand to restore the water level of the upper reservoir pond.
9	Issued at	12:26 on February 10, 2022
	Instruction	・Chubu PG shall supply 629 MW of electricity at most to TEPCO PG from 13:00 to 17:00 on February 10. ・Kansai T&D shall supply 171 MW of electricity to TEPCO PG from 13:00 to 17:00 on February 10. ・TEPCO PG shall be supplied 800 MW of electricity at most by Chubu PG, and Kansai T&D from 13:00 to 17:00 on February 10. (The transmission margin of an interconnection line was partly utilized to the power exchange.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected demand growth caused by cold weather. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up due to further demand growth; further supply–demand tightness is likely to occur. The Organization shall intermittently issue additional instructions for power exchange for tight supply–demand to restore the water level of the upper reservoir pond.
10	Issued at	2:02 on March 17, 2022
	Instruction	・Hokkaido NW shall supply 200 MW of electricity at most to Tohoku NW from 4:00 to 5:30 on March 17. ・TEPCO PG shall supply 1200 MW of electricity at most to to Tohoku NW from 2:30 to 6:00 on March 17. ・Tohoku NW shall be supplied 1400 MW of electricity at most by Hokkaido NW and TEPCO PG from 2:30 to 6:00 on March 17.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to the earthquqke.
11	Issued at	4:45 on March 17, 2022
	Instruction	・Hokkaido NW shall supply 100 MW of electricity to Tohoku NW from 6:00 to 7:00 on March 17. ・TEPCO PG shall supply 900 MW of electricity at most to to Tohoku NW from 6:00 to 11:00 on March 17. ・Tohoku NW shall be supplied 1000 MW of electricity at most by Hokkaido NW and TEPCO PG from 6:00 to 11:00 on March 17.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to the earthquqke.

12	Issued at	7:58 on March 18, 2022
	Instruction	・Hokkaido NW shall supply 200 MW of electricity at most to Tohoku NW from 4:00 to 5:30 on March 17. ・TEPCO PG shall supply 1200 MW of electricity at most to to Tohoku NW from 2:30 to 6:00 on March 17. ・Tohoku NW shall be supplied 1400 MW of electricity at most by Hokkaido NW and TEPCO PG from 2:30 to 6:00 on March 17. (The transmission margin of an interconnection line was partly utilized to the power exchange.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to the earthquqke.
13	Issued at	11:19 on March 18, 2022
	Instruction	・Chubu PG shall supply 300 MW of electricity to Tohoku NW from 12:00 to 16:00 on March 18. ・Kansai T&D shall supply 300 MW of electricity to Tohoku NW from 12:00 to 16:00 on March 18. ・Tohoku NW shall be supplied 600 MW of electricity at most by Chubu PG, and Kansai T&D from 12:00 to 16:00 on March 18.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to the earthquqke.
14	Issued at	15:28 on March 18, 2022
	Instruction	・Hokkaido NW shall supply 250 MW of electricity at most to Tohoku NW from 16:00 to 20:00 on March 18. ・Chugoku NW shall supply 115 MW of electricity to at most to Tohoku NW from 16:00 to 20:00 on March 18. ・Kyushu T&D shall supply 350 MW of electricity at most to Tohoku NW from 16:00 to 21:00 on March 18. ・Tohoku NW shall be supplied 600 MW of electricity at most by Hokkaido NW, Chugoku NW, and Kyushu T&D from 16:00 to 21:00 on March 18. (The transmission margin of an interconnection line was partly utilized to the power exchange.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to the earthquqke.
15	Issued at	15:28 on March 18, 2022
	Instruction	・Hokkaido NW shall supply 350 MW of electricity at most to TEPCO PG from 21:00 to 24:00 on March 18. ・Chubu PG shall supply 400 MW of electricity to TEPCO PG from 21:00 to 24:00 on March 18. ・Hokuriku T&D shall supply 100 MW of electricity at most to TEPCO PG from 16:00 to 21:00 on March 18. ・Chugoku NW shall supply 200 MW of electricity at most to TEPCO PG from 16:00 to 21:00 on March 18. ・Kyushu T&D shall supply 320 MW of electricity at most to TEPCO PG from 16:30 to 21:00 on March 18. ・TEPCO PG shall be supplied 943.6 MW of electricity at most by Hokkaido NW, Chubu PG, Hokuriku T&D, Chugoku NW, and Kyushu T&D from 16:00 to 24:00 on March 18. (Transmission margin of interconnection line was partly utilized to the power exchage.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected operation more than planned. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up, the Organization issued the instructions of power exchange for tight supply–demand to restore the water level of the upper reservoir pond.
16	Issued at	23:03 on March 18, 2022
	Instruction	・Chubu PG shall supply 300 MW of electricity to TEPCO PG from 0:00 to 4:00 on March 19. ・Kansai T&D shall supply 300 MW of electricity to TEPCO PG from 0:00 to 4:00 on March 19. ・TEPCO PG shall be supplied 600 MW of electricity by Chubu PG, and Kansai T&D from 0:00 to 4:00 on March 19.
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected operation more than planned. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up, the Organization issued the instructions of power exchange for tight supply–demand to restore the water level of the upper reservoir pond.

17	Issued at	5:59 on March 22, 2022
	Instruction	・Tohoku NW shall supply 817.8 MW of electricity at most to TEPCO PG from 7:00 to 16:00 on March 22. ・Chubu PG shall supply 300 MW of electricity to TEPCO PG from 7:00 to 16:00 on March 22. ・Hokuriku T&D shall supply 300 MW of electricity at most to TEPCO PG from 7:00 to 9:00 on March 22. ・Kansai T&D shall supply 269.4 MW of electricity at most to TEPCO PG from 7:00 to 16:00 on March 22. ・Chugoku NW shall supply 100 MW of electricity at most to TEPCO PG from 8:00 to 15:00 on March 22. ・Shikoku T&D shall supply 100 MW of electricity at most to TEPCO PG from 8:30 to 15:00 on March 22. ・Kyushu T&D shall supply 103.3 MW of electricity at most to TEPCO PG from 8:30 to 10:00 on March 22. ・TEPCO PG shall be supplied 1417.8 MW of electricity at most by Tohoku NW, Chubu PG, Hokuriku T&D, Kansai T&D, Chugoku NW, Shikoku T&D, and Kyushu T&D from 7:00 to 16:00 on March 22. (The transmission margin of an interconnection line was utilized to the power exchange for TEPCO PG, and the available transfer capacity of the line was utilized to its upper limit.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected demand growth caused by cold weather. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up due to further demand growth; further supply–demand tightness is likely to occur. The Organization shall intermittently issue additional instructions for power exchange for tight supply–demand to restore the water level of the upper reservoir pond.
18	Issued at	9:39 on March 22, 2022
	Instruction	・Hokkaido NW shall supply 613.6 MW of electricity at most to Tohoku NW from 10:30 to 16:00 on March 22. ・Tohoku NW shall be supplied 613.6 MW of electricity at most by Hokkaido NW from 10:30 to 16:00 on March 22
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to earthquqke occurred on March 16, and unexpected demand growth triggered by cold weather.
19	Issued at	14:18 on March 22, 2022
	Instruction	・Hokkaido NW shall supply 95.9 MW of electricity at most to Tohoku NW from 16:00 to 17:00 on March 22. ・Tohoku NW shall be supplied 95.9 MW of electricity at most by Hokkaido NW from 16:00 to 17:00 on March 22
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a supply capacity shortage in Tohoku NW regional service area due to earthquqke occurred on March 16, and unexpected demand growth triggered by cold weather.
20	Issued at	14:18 on March 22, 2022
	Instruction	・Hokkaido NW shall supply 327.4 MW of electricity at most to TEPCO PG from 17:00 to 24:00 on March 22. ・Chubu PG shall supply 300 MW of electricity to TEPCO PG from 16:00 to 24:00 on March 22. ・Chugoku NW shall supply 100 MW of electricity at most to TEPCO PG from 16:00 to 24:00 on March 22. ・Shikoku T&D shall supply 200 MW of electricity at most to TEPCO PG from 16:00 to 24:00 on March 22. ・Kyushu T&D shall supply 200 MW of electricity at most to TEPCO PG from 16:30 to 24:00 on March 22. ・TEPCO PG shall be supplied 927.4 MW of electricity at most by Hokkaido NW, Chubu PG, Chugoku NW, Shikoku T&D, and Kyushu T&D from 16:00 to 24:00 on March 22. (The transmission margin of an interconnection line was utilized to the power exchange for TEPCO PG, and the available transfer capacity of the line was utilized to its upper limit.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected demand growth caused by cold weather. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up due to further demand growth; further supply–demand tightness is likely to occur. The Organization shall intermittently issue additional instructions for power exchange for tight supply–demand to restore the water level of the upper reservoir pond.

21	Issued at	23:19 on March 22, 2022
	Instruction	・Hokkaido NW shall supply 200 MW of electricity at most to TEPCO PG from 0:00 to 7:30 on March 23. ・Tohoku NW shall supply 200 MW of electricity at most to TEPCO PG from 0:00 to 9:30 on March 23. (Supply from Tohoku NW shall be implemented after securing a 3% reserve margin as its criteria of stable supply.) ・Chubu PG shall supply 300 MW of electricity to TEPCO PG from 0:00 to 11:00 on March 23. ・Kansai T&D shall supply 300 MW of electricity to TEPCO PG from 0:00 to 11:00 on March 23. ・TEPCO PG shall be supplied 1000 MW of electricity at most by Hokkaido NW, Tohoku NW, Chubu PG, and Kansai T&D from 0:00 to 11:00 on March 23. (The transmission margin of an interconnection line was utilized to the power exchange for TEPCO PG, and the available transfer capacity of the line was utilized to its upper limit.)
	Background	The supply–demand status may degrade without power exchanges through cross-regional interconnection lines because of a shortage of supply capacity for balancing generators in the regional service area of TEPCO PG, which is necessary for supply–demand balance due to unexpected demand growth caused by cold weather. An upper reservoir pond of pumped storage hydropower plant, which has an ultimate supply–demand balancing function, may dry up due to further demand growth; further supply–demand tightness is likely to occur. The Organization shall intermittently issue additional instructions for power exchange for tight supply–demand to restore the water level of the upper reservoir pond.

Actual requests for additional supply capcity, and demand reduction by the Organization

[1]	Issued on	March 21, 2022
	Background	Due to the Fukushima Earthquake that occurred on March 16, some generators sited in the regional service areas of Tohoku EPCO NW and TEPCO PG were shut down. Furthermore, a cold wave and bad weather were forecasted in Eastern Japan on March 22. It is estimated that the supply–demand will be tight, particularly in the TEPCO PG area. In the TEPCO PG area, increasing measures for supply capacity, such as power exchange instruction by the Organization or additional generation by the GT&D companies, shall be implemented. However, due to the condition of supply capacity, temperature, and weather, further supply–demand tightness will be possible. To cope with the aforementioned condition, the Organization requests the members to implement measures for improving the supply–demand condition stated below.
	Period	March 22 (on expiry of the period, it shall be informed later).
	Requested Items	(1) For Generator III or private power installation, which is owned by the member or procured power from other entity by power purchase contract (including demand reduction [DR]), it shall generate electricity in increased capacity as possible in the regional service area with a tight supply–demand. However, if the generator has other power purchase contracts with other retail companies, such contracts will be prioritized, and generation increase will be implemented to the extent possible. (2) Each retail company must reduce its demand to the extent possible by the agreed economic DR contract or power-saving request to its customer. However, if there is a bilateral contract with other electric power suppliers, such a contract will be prioritized, and demand reduction will be implemented to the extent possible. (3) Surplus power provided by the additional generation or DR shall be traded in the day-ahead or 1-h ahead market. If such power has a bilateral contract with retail company (including economic DR contract), delivery or demand reduction shall be implemented by such a contract. Clearing shall be implemented according to the market rule or the bilateral contract.
	Additional Notice	・The corresponding area is the TEPCO Power Grid area. ・For correspondence to the aforementioned request, life safety shall be prioritized, particularly operational safety and compliance with laws and ordinances. ・Please comply with the corresponding regulatory direction for operating generators, which is deemed an environmental regulation. ・The Organization shall not be liable to the cost (including imbalance cost) or loss incurred by responding to the aforementioned request.
[2]	Issued on	March 22, 2022
	Request	The Organization newly requested the measures for coping with the tight supply-demand adding Tohoku EPCO Network for the corresponding area.
[3]	Issued on	March 22, 2022 at 14:30
	Request	The Organization newly requested the measures for coping with the tight supply-demand based on the additional about 5% (2000 MW/h) saving needed from 15:00 to 20:00 on March 22 in the TEPCO PG area.
[4]	Issued on	March 22, 2022 at 23:30
	Request	The Organization newly requested the measures for coping with the tight supply-demand based on the estimation of continuous tight supply-demand condition on March 23 in the TEPCO PG area.
	Issued on	March 23, 2022 at 11:30
	Termination Notice	The Organization has continuously issued request based on the estimate that it is likely to be tight supply-demand situation in TEPCO PG area on March 23 based on the condition which partly suspended operation of thermal power plants in Tohoku and Tokyo area due to Fukushima Earthquake occurred on March 16. Following improvement in the supply–demand condition, the Organization has announced the termination of the requests at 11:00 on March 23, according to the release of warning for tight supply-demand condition. The Organization express sincere thanks to the members who cooperated to cope with the condition, and also express our deep thanks to the electric power suppliers other than our members. The Organization shall continuously strive to ensure stable supply, coping with the government and GT&D companies.

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 2021 -

January 2023

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

OCCTO

Introduction

One of the objectives of the Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO) is to evaluate supply reliability conditions in securing a stable electricity supply. Thus, 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 the evaluation of the data. These data are collected from each regional service area for the 2021 fiscal year (FY 2021). OCCTO uses these data to evaluate and analyze whether frequencies or voltages have been maintained within certain parameters, or whether there are frequent supply interruptions. In addition, although the data conditions regarding supply interruption, are not uniform, a comparison with major states in the United States (US) was conducted as a reference.
Here, the goal of the OCCTO 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

In this report, the quality of nationwide electricity supply in FY 2021 was reviewed in this report based on the provisions of Article 181 of OCCTO's Operational Rules.
Three aspects, namely, frequency, standard voltage, and interruption, of the quality of electricity supply were evaluated in this report, namely, frequency, standard voltage, and interruption.
Although different 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
The frequency time-kept ratio, which is the ratio of time that the metered frequency is maintained within a given target control range, was used to analyze frequency. Four areas, i.e., were grouped into synchronized frequency regions: Hokkaido, Eastern Japan, Central and Western Japan, and Okinawa, were grouped into synchronized frequency regions. 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 found.

Standard Voltage
The standard voltage was evaluated considering 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). The Act sets the targets for transmission operators to ensure a standard voltage supply within a certain range of values.
At the request by OCCTO, the transmission operators submitted their data. Nationwide, there was no violation of standard voltage among 6,636 points for 100 V and 6,569 points for 200 V.

Interruption
Interruptions were monitored from three perspectives: 1) the number of supply disturbances by the place of occurrence, 2) the number of supply disturbances by cause, i.e., beyond the given standards in time duration and lost capacity, and 3) system average interruption frequency index (SAIFI) and system average interruption duration index (SAIDI) values for low-voltage (LV) customers.
In the first analysis, the total number of supply disturbances was found to be 11,563, which is below the level of disturbances recorded in the previous year. This decreasing trend was observed for the third consecutive year. In addition, the number of supply disturbances decreased or stayed at the same level compared to the previous year in every regional service area.
The second analysis categorizes the causes of supply disturbances into two factors, i.e., maintenance problems or natural disasters, the latter being irrelevant to maintenance problems.

These analyses indicate 27 cases of supply disturbances, i.e., the number of supply disturbances is increased by 8 cases compared to that of the previous year. With respect to the causes of disturbances, there were 17 cases of disturbances triggered by natural disasters, i.e., this number increased by 12 cases compared to that of the previous year. The main cause triggered by natural disasters was earthquake. In particular, 8 cases of 9 disturbances by natural disaster were caused by the Fukushima Earthquake in March 2022 in Tohoku area. However, the number of disturbances triggered by the fault of facility or maintenance was decreased compared to that of the previous year. In the final analysis, SAIFI and SAIDI values were historically monitored. The data for FY 2021 were 0.13 interruptions and 10 minutes, per one customer, respectively. These values were lower compared with the corresponding data from the previous year and were the least values for the past 5 years. The number of supply disturbances either decreased or stayed at the same level compared with the previous year data for all study areas, except for Hokkaido area, which was affected by wind and rain.
For reference, the report also compares SAIFI and SAIDI values with those of the US states, although the comparison is not straightforward given that index definitions are not identical across the US states.

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

CONTENTS

<Errata>

2024/2/2	P40	Table 7	Data from FY 2017 to 2021 are altered.

I. Frequency data

1. Standard frequency in Japan

General transmission and distribution (GT&D) companies are required to maintain the frequency value of the electricity supply at the levels specified by the Ordinance of the Ministry of Economy, Trade and Industry, i.e., according to the provisions of Article 26 of the Electricity Business Act (hereafter, the Act). Figure 1 shows the regional service areas of the 10 GT&D companies considered in this report and their standard frequencies.

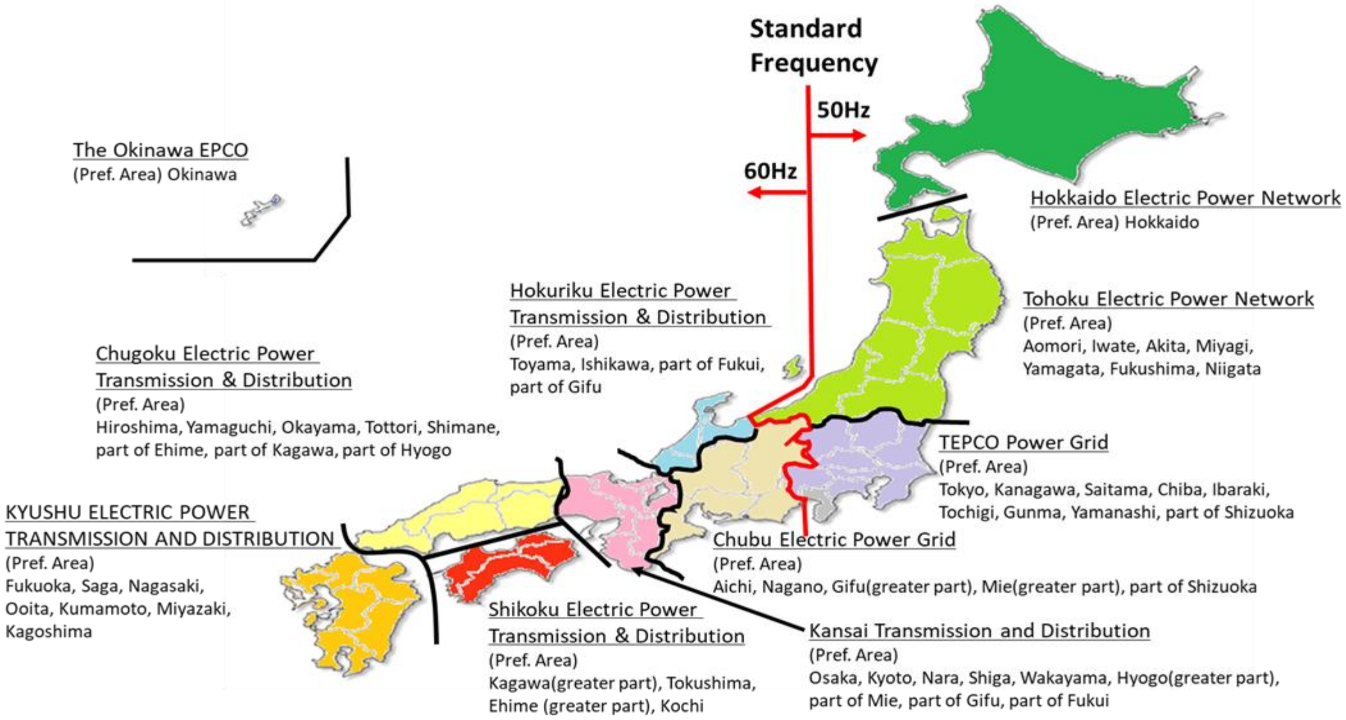

Figure 1 Regional service areas of the 10 GT&D companies and their standard frequencies

2. Frequency time-kept ratio

The maintained frequency was examined using 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 is calculated by the following formula:

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

3. Frequency control rule[1]

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

Table 1 Frequency control rule under normal condition for each regional service areas

Areas	Hokkaido	Tohoku, Tokyo	Chubu, Hokuriku, Kansai, Chugoku, Shikoku, Kyushu	Okinawa
Frequency standard	50 Hz	50 Hz	60 Hz	60 Hz
Control target (for the standard)	±0.3 Hz	±0.2 Hz	±0.2 Hz	±0.3 Hz
Target time-kept ratio within ± 0.1 Hz	—	—	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 be the same frequency that general transmission and distribution companies supplies; general transmission and distribution companies set their frequency control target by its code, standard or manual.

4. Frequency time-kept ratio by frequency-synchronized region (FY 2017–2021)

Tables 2–5 show the frequency time-kept ratios by frequency-synchronized regions from FY 2017 to 2021, while Figures 2–5 show the trend of maintaining the frequency within 0.1 Hz variance.

The frequency time-kept ratio set by GT&D companies was recorded as 100% in all regions for FY 2021. In the Central and Western region, the target frequency time-kept ratio within 0.1 Hz variance for FY 2021 was 98.12%, which was slightly lower than that of the previous year (98.50%), but above the target time-kept ratio of 95.00%.

【Criteria】

Control target	···	100.00%
Target time-kept ratio within ±0.1 Hz	···	95.00% Over

Table 2 Frequency time-kept ratio (Hokkaido, FY 2017–2021) [%]

Variance	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Within 0.1 Hz	99.97	99.86	99.98	99.93	99.87
Within 0.2 Hz	100.00	99.95	100.00	100.00	99.99
Within 0.3 Hz	100.00	99.98	100.00	100.00	100.00
Beyond 0.3 Hz	0.00	0.02	0.00	0.00	0.00

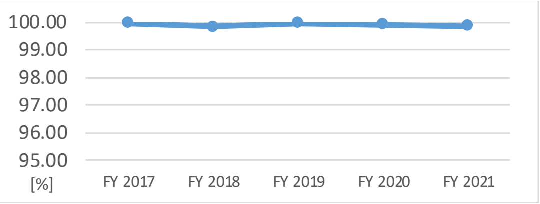

Figure 2 Frequency time-kept ratio within 0.1 Hz (Hokkaido, FY 2017-2021)

Table 3 Frequency time-kept ratio (Eastern region,[2] FY 2017–2021) [%]

Variance	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Within 0.1 Hz	99.80	99.84	99.83	99.71	99.50
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

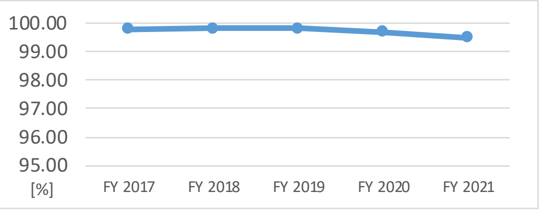

Figure 3 Frequency time-kept ratio within 0.1 Hz (Eastern region,[2] FY 2017-2021)

Table 4 Frequency time-kept ratio (Central & Western region,[3] FY 2017–2021) [%]

Variance	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Within 0.1 Hz	99.17	99.13	99.02	98.50	98.12
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

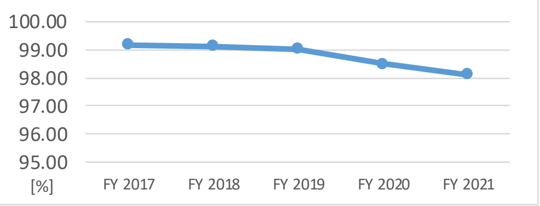

Figure 4 Frequency time-kept ratio (Central & Western region,[3] FY 2017–2021)

Table 5 Frequency time-kept ratio (Okinawa, FY 2017–2021) [%]

Variance	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Within 0.1 Hz	99.92	99.89	99.89	99.92	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

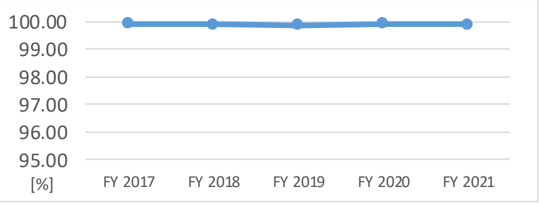

Figure 5 Frequency time-kept ratio (Okinawa, FY 2017–2021)

[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

GT&D companies should endeavor to maintain the voltage value of the electricity supply at the levels specified by the provisions of 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 the provisions of Article 39 of the Ordinance of the Act, GT&D companies should measure voltage during the period designated by the Director General of the Regional Bureau of Economy, Trade, and Industry. The Director General 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. GT&D 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 2017–2021)

Table 7 shows the total measured points, deviated measured points, and nationwide deviation ratio from FY 2017 to 2021.

For the FY 2021 data, the GT&D companies reported that the voltage standard was maintained adequately, with no deviation in voltage standard.

Table7 Voltage deviation measurement (Nationwide, FY 2017–2021) [points]

Voltage		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
100V	Total measured points	6,593	6,603	6,596	6,589	6,636
	Deviated points	0	0	0	0	0
200V	Total measured points	6,534	6,533	6,529	6,525	6,569
	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 interruption of 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]

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[4] Electric facilities include machinery, apparatus, dams, conduits, reservoirs, electric lines, and other facilities installed for the generation, storage transformation, transmission, distribution, or consumption of electricity as defined by the provisions of the item 18, paragraph 1 of the Article 2 of the Act.

[5] 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 on 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 vii, 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 on number of supply disturbances nationwide and by regional service area (FY 2017–2021)

Table 8 and Figure 6 show the number of supply disturbances nationwide, where the interruptions originated in the period FY 2017–2021. Tables 9–18 and Figures 7–16 show the number of supply disturbances from regional service areas. In addition, 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 GT&D companies. The table columns are blank for zero values or if the data are not available. An analysis of the FY 2021 data indicates the following.

With respect to FY 2021 data, the total number of supply disturbances was 11,563, which was below the level of disturbances recorded in the previous year. This decrease in value was for the third consecutive year. The number of supply disturbances decreased or stayed at the same level from the previous year in every regional service area.

Table 8 Number of supply disturbances where interruption originated (Nationwide, FY 2017–2021)

Occurrence at			FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations		45	65	56	48	65	55.8
	Transmission lines & Extra High Voltage lines	Overhead	278	409	246	274	260	293.4
		Under-ground	14	10	13	9	17	12.6
		Total	292	419	259	283	277	306.0
	High Voltage lines	Overhead	12,679	20,729	13,958	13,539	10,775	14,336.0
		Under-ground	216	265	227	201	201	222.0
		Total	12,895	20,994	14,185	13,740	10,976	14,558.0
	Demand facilities		1					0.2
Involvng accidents			343	359	372	277	245	319.2
Total disturbances			13,576	21,837	14,872	14,348	11,563	15,239.2

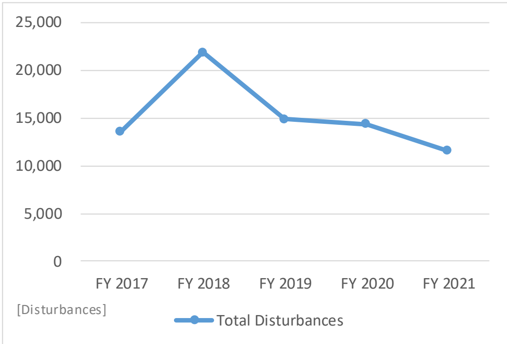

Figure 6 Transition of supply disturbances (Nationwide, FY 2017–2021)

Table 9 Number of supply disturbances where interruption originated (Hokkaido, FY 2016–2020)

Occurrence at		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations			5	2	2	3	2.4
Transmission lines & Extra High Voltage lines	Overhead	30	25	12	21	20	21.6
	Under-ground			1	1		0.4
	Total	30	25	13	22	20	22.0
High Voltage lines	Overhead	1,144	1,139	600	801	848	906.4
	Under-ground	19	13	15	15	12	14.8
	Total	1,163	1,152	615	816	860	921.2
Demand facilities							
Involvng accidents		17	12	11	10	14	12.8
Total disturbances		1,210	1,194	641	850	897	958.4

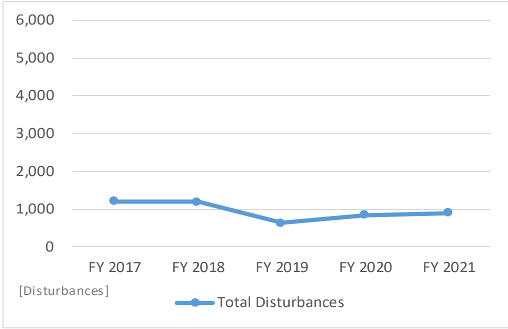

Figure 7 Transition of supply disturbances (Hokkaido, FY 2016–2020)

Table 10 Number of supply disturbances where interruption originated (Tohoku, FY 2017–2021)

Occurrence at		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		4	9	8	9	9	7.8
Transmission lines & Extra High Voltage lines	Overhead	16	11	16	31	31	21.0
	Under-ground	1					0.2
	Total	17	11	16	31	31	21.2
High Voltage lines	Overhead	1,957	1,478	1,646	2,528	1,686	1,859.0
	Under-ground	5	11	7	13	7	8.6
	Total	1,962	1,489	1,653	2,541	1,693	1,867.6
Demand facilities							
Involvng accidents		26	20	29	17	18	22.0
Total disturbances		2,009	1,529	1,706	2,598	1,751	1,918.6

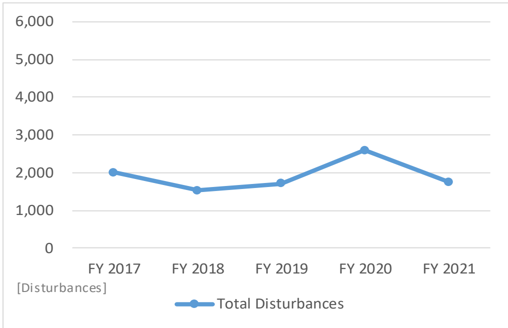

Figure 8 Transition of supply disturbances (Tohoku, FY 2017–2021)

Table 11 Number of supply disturbances where interruption originated (Tokyo, FY 2017–2021)

Occurrence at		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		17	16	17	5	10	13.0
Transmission lines & Extra High Voltage lines	Overhead	24	38	21	10	10	20.6
	Under-ground	4		4	3	5	3.2
	Total	28	38	25	13	15	23.8
High Voltage lines	Overhead	2,311	3,841	5,186	2,472	2,316	3,225.2
	Under-ground	65	100	97	75	87	84.8
	Total	2,376	3,941	5,283	2,547	2,403	3,310.0
Demand facilities							
Involvng accidents		96	107	134	74		82.2
Total disturbances		2,517	4,102	5,459	2,639	2,428	3,429.0

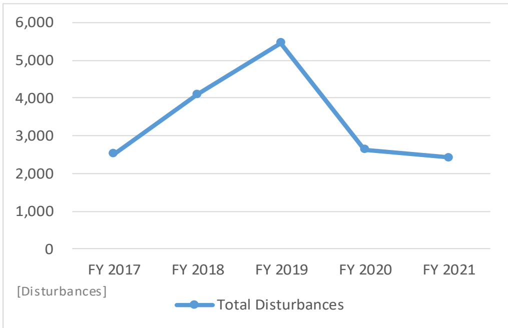

Figure 9 Transition of supply disturbances (Tokyo, FY 2017–2021)

Table 12 Number of supply disturbances where interruption originated (Chubu, FY 2017–2021)

Occurrence at		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		3	6	10	4	7	6.0
Transmission lines & Extra High Voltage lines	Overhead	9	26	19	15	9	15.6
	Under-ground				1		0.2
	Total	9	26	19	16	9	15.8
High Voltage lines	Overhead	1,607	4,053	1,570	1,359	1,338	1,985.4
	Under-ground	11	39	6	4	10	14.0
	Total	1,618	4,092	1,576	1,363	1,348	1,999.4
Demand facilities							
Involvng accidents		49	66	60	71	64	62.0
Total disturbances		1,679	4,190	1,665	1,454	1,428	2,083.2

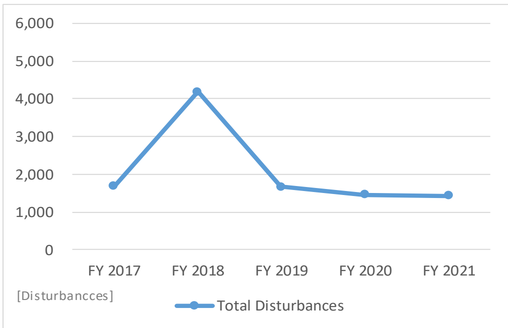

Figure 10 Transition of supply disturbances (Chubu, FY 2017–2021)

Table 13 Number of supply disturbances where interruption originated (Hokuriku, FY 2017–2021)

Occurrence at		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		1		2	3	4	2.0
Transmission lines & Extra High Voltage lines	Overhead	4	7	2	3		3.2
	Under-ground		2	2			0.8
	Total	4	9	4	3	0	4.0
High Voltage lines	Overhead	542	385	199	444	215	357.0
	Under-ground	5	3	1	4	1	2.8
	Total	547	388	200	448	216	359.8
Demand facilities							
Involvng accidents		15	21	10	10	14	14.0
Total disturbances		567	418	216	464	234	379.8

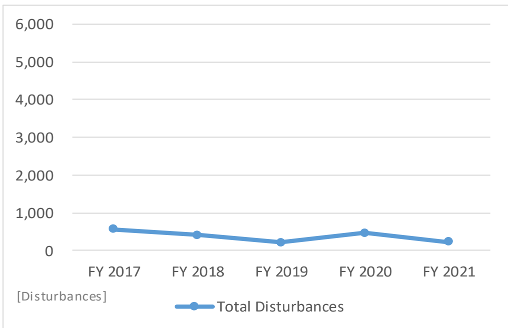

Figure 11 Transition of supply disturbances (Hokuriku, FY 2017–2021)

Table 14 Number of supply disturbances where interruption originated (Kansai, FY 2017–2021)

Occurrence at			FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations		9	8	3	6	10	7.2
	Transmission lines & Extra High Voltage lines	Overhead	102	190	82	84	86	108.8
		Under-ground	7	6	3	4	8	5.6
		Total	109	196	85	88	94	114.4
	High Voltage lines	Overhead	1,695	5,270	1,300	1,254	1,384	2,180.6
		Under-ground	48	56	50	50	33	47.4
		Total	1,743	5,326	1,350	1,304	1,417	2,228.0
	Demand facilities							
Involvng accidents			65	70	64	44	56	59.8
Total disturbances			1,926	5,600	1,502	1,442	1,577	2,409.4

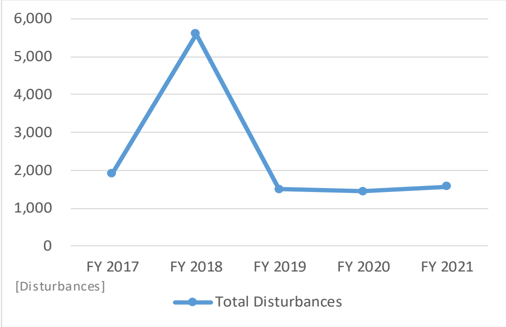

Figure 12 Transition of supply disturbances (Kansai, FY 2017–2021)

Table 15 Number of supply disturbances where interruption originated (Chugoku, FY 2017–2021)

Occurrence at			FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations		2	8	6	3	6	5.0
	Transmission lines & Extra High Voltage lines	Overhead	16	14	17	11	25	16.6
		Under-ground	1	1	1		1	0.8
		Total	17	15	18	11	26	17.4
	High Voltage lines	Overhead	1,066	1,172	1,015	1,163	1,193	1,121.8
		Under-ground	24	20	16	12	15	17.4
		Total	1,090	1,192	1,031	1,175	1,208	1,139.2
	Demand facilities		1					0.2
Involvng accidents			33	31	35	32	37	33.6
Total disturbances			1,143	1,246	1,090	1,221	1,277	1,195.4

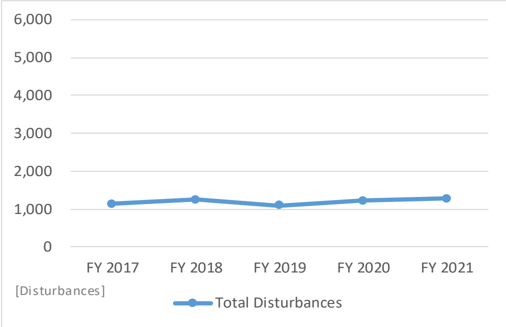

Figure 13 Transition of supply disturbances (Chugoku, FY 2017–2021)

Table 16 Number of supply disturbances where interruption originated (Shikoku, FY 2017–2021)

Occurrence at			FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations		6	4	2	5	3	4.0
	Transmission lines & Extra High Voltage lines	Overhead	3	4	4	1	10	4.4
		Under-ground						
		Total	3	4	4	1	10	4.4
	High Voltage lines	Overhead	630	616	439	447	393	505.0
		Under-ground	9	8	6	6	10	7.8
		Total	639	624	445	453	403	512.8
	Demand facilities							
Involvng accidents			5	5	7	6	10	6.6
Total disturbances			653	637	458	465	426	527.8

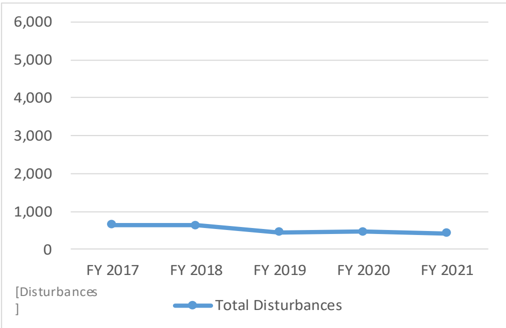

Figure 14 Transition of supply disturbances (Shikoku, FY 2017–2021)

Table 17 Number of supply disturbances where interruption originated (Kyushu, FY 2017–2021)

Occurrence at			FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations		3	1	4	7	11	5.2
	Transmission lines & Extra High Voltage lines	Overhead	32	42	38	42	24	35.6
		Under-ground		1			1	0.4
		Total	32	43	38	42	25	36.0
	High Voltage lines	Overhead	1,349	1,888	1,547	2,614	1,088	1,697.2
		Under-ground	30	15	22	17	22	21.2
		Total	1,379	1,903	1,569	2,631	1,110	1,718.4
	Demand facilities							
Involvng accidents			23	16	19	13	18	17.8
Total disturbances			1,437	1,963	1,630	2,693	1,164	1,777.4

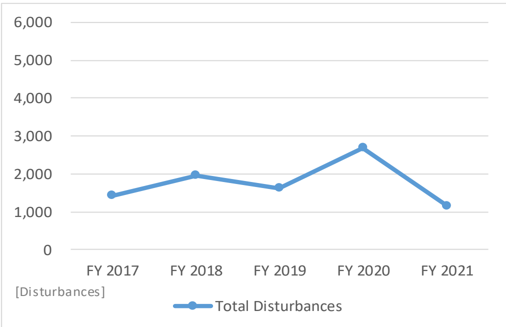

Figure 15 Transition of supply disturbances (Kyushu, FY 2017–2021)

Table 18 Number of supply disturbances where interruption originated (Okinawa, FY 2017–2021)

Occurrence at			FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations			8	2	4	2	3.2
	Transmission lines & Extra High Voltage lines	Overhead	42	52	35	56	45	46.0
		Under-ground	1		2		2	1.0
		Total	43	52	37	56	47	47.0
	High Voltage lines	Overhead	378	887	456	457	314	498.4
		Under-ground			7	5	4	3.2
		Total	378	887	463	462	318	501.6
	Demand facilities							
Involvng accidents			14	11	3		14	8.4
Total disturbances			435	958	505	522	381	560.2

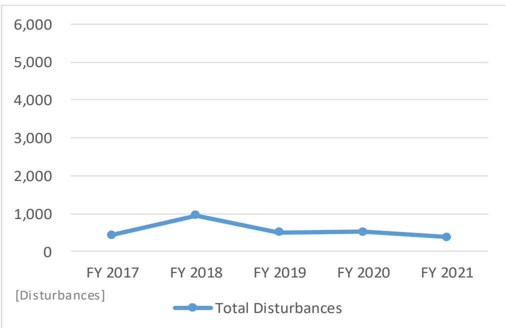

Figure 16 Transition of supply disturbances (Okinawa, FY 2017–2021)

2. Number of supply disturbances where interruptions originated with their causes

(1) Data on supply disturbances over a certain scale

Disturbances over a certain scale were reported along with their causes for the data on supply disturbances where the interruption originated as described in the previous section. This section analyzes these causes. 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 2020[7]. The columns in the table were left blank if value was zero or data are unavailable. It should be noted here that supply disturbances that was 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

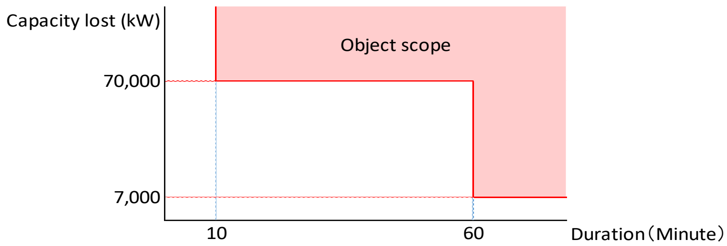

Figure 17 Image of supply disturbances over a certain scale

Table 19 Number of supply disturbances where interruption originated by scale of interruption (Nationwide, FY 2021) [Disturbances]

Occurrence at \ Scale of disturbance [Duration & Capacity lost]		10 min. till 30 min.		30 min. till 1 hour		1hour till 3 hours			Longer than 3 hours			Total
		70,000kW to 100,000kW under	100,000kW over[8]	70,000kW to 100,000kW under	100,000kW over[8]	7,000kW to 70,000kW under	70,000kW to 100,000kW under	100,000kW over[8]	7,000kW to 70,000kW under	70,000kW to 100,000kW under	100,000kW over[8]	Disturbances
Accidents of facilities of General transmission & distribution companies												
Substations						5			3		1	9
Transmission lines & Extra High Voltage lines	Overhead		1			5		1	11			18
	Under-ground											
	Total		1			5		1	11			18
High Voltage distribution lines	Overhead											
	Under-ground											
	Total											
Demand facilities												
Involved accidents												
Total disturbances			1			10		1	14		1	27

[7] 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 of lost capacity of 70,000–100,000 kW, the loss is reported to the Director of Regional Industrial Safety and the Inspection Department that directs the area where 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

Classification of Causes		Description
Facility fault		Due to improper production (improper design, fabrication, or material of electric facilities) or improper installation (improper operation of construction or maintenance work).
Maintenance fault		Due to improper 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).
Accident/malice		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).”
Physical contact		Due to physical contact by tree, wildlife, or others (kite, model airplane).
Corrosion		Due to corrosion by leakage of current from DC electric railroad or by chemical action.
Vibration		Due to vibration from heavy vehicle traffic or construction work.
Involving an accident		Due to accident involving the electric facilities of another company.
Improper fuel		Due to accident with improper fuel of notably different ingredients from that designated.
Electric fire		Due to accident with electric fire caused by facility fault, maintenance fault, natural disaster, accident, or work without permission.
Electric shock (worker)		Due to workers’ accident from electric shock caused by misuse of equipment, malfunction of electric facilities, accident by injured or third person, etc.
Electric shock (public)		Due to public’s accident with electric shock of public by misuse of equipment, malfunction of electric facilities, accident by injured or third person, etc.
Natural disaster	Thunderbolt	Due to direct or indirect lightning strike.
	Rainstorm	Due to rain, wind, or rainstorm (including contact with fallen branches, etc.)
	Snowstorm	Due to snow, frazil, hail, sleet, or snowstorm.
	Earthquake	Due to earthquake.
	Flood	Due to flood, storm surge, or tsunami
	Landslide	Due to rock fall, avalanche, landslide, or ground subsidence.
	Dust/gas	Due to briny air, volcanic dust and ash, fog, offensive gas, or smoke and soot.
Unknown		Due to causes that remain unknown despite investigation.
Miscellaneous		Due to causes not categorized above.

(3) Number and causes of supply disturbances over a certain scale (FY 2017–2021)

Table 21 and Figure 18 show the nationwide data for the number of supply disturbances where interruption originated over a certain scale. Tables 22–31 show the same data from each regional service area for the period FY 2017–2021.[8,9]

The number and the causes of supply disturbances over a certain scale for the FY 2021 data were analyzed. Nationwide, there were 27 cases of supply disturbance over a certain scale; this value was increased by 8 cases compared to that of the previous year. For the causes of disturbances, there were 17 cases of disturbance triggered by natural disaster; this value was an increased of 12 cases compared to the previous year. The major cause of disturbance was earthquake, particularly the 8 cases of 9 disturbances by natural disaster were caused by the Fukushima Earthquake in March 2022 in Tohoku area.　In comparison, there was a decrease in the number of disturbances triggered by fault of facility or maintenance.

Table 21 Causes of disturbances over a certain scale (Nationwide, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault	1	3	1	1	2	1.6
Maintenance fault	4	1	1	1	1	1.6
Accident/malice	1	2	4	4	1	2.4
Physical contact	2	2	5	6	4	3.8
Involved accident		1	1			0.4
Electric shock(worker)						
Electric shock(public)					1	
Subtotal	8	9	12	12	9	10.0
Natural disaster						
Thunderbolt	2	1	2	2	4	2.2
Rainstorm	3	17			2	4.4
Snowstorm	2				2	0.8
Earthquake			3	3	9	3.0
Dust/Gas		2				0.4
Subtotal	7	20	5	5	17	10.8
Unknown			1	1	1	0.6
Miscellaneous		2	1	1		0.8
Total disturbances	15	31	18	19	27	22.0

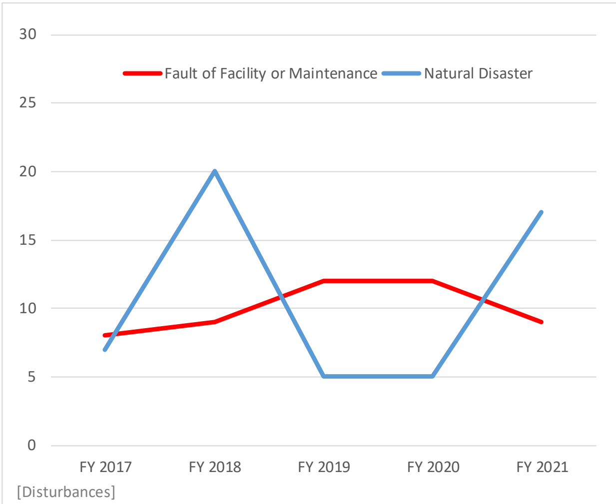

Figure 18 Transition of disturbances by causes (Nationwide, FY 2017–2021)

Table 22 Causes of disturbances over a certain scale (Hokkaido, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault		1				0.2
Accident/malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal		1				0.2
Natural disaster						
Thunderbolt						
Rainstorm					1	0.2
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal	1		1		1	0.6
Unknown					1	0.2
Miscellaneous						
Total disturbances	1	1	1		2	1.0

Table 23 Causes of disturbances over a certain scale (Tohoku, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice					1	0.2
Physical contact					1	0.2
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal					2	0.4
Natural disaster						
Thunderbolt			1			0.2
Rainstorm						
Snowstorm	1					0.2
Earthquake				3	8	2.2
Dust/Gas						
Subtotal	1		1	3	8	2.6
Unknown						
Miscellaneous						
Total disturbances	1		1	3	10	3.0

8 Causes of the disturbances that did not occur in the period FY 2017–2021 are omitted from the tables.
9 Column of the tables are left blank if zero or the data are not available.

Table 24 Causes of disturbances over a certain scale (Tokyo, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault	1					0.2
Maintenance fault					1	0.2
Accident/malice		1	1	2		0.8
Physical contact	1	1	1	1	1	1.0
Involved accident						
Electric shock(worker)						
Electric shock(public)					1	
Subtotal	2	2	2	3	3	2.4
Natural disaster						
Thunderbolt	1	1	2		2	1.2
Rainstorm			3			0.6
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal	1	1	5		2	1.8
Unknown				1		0.2
Miscellaneous		1		1		0.4
Total disturbances	3	4	7	5	5	4.8

Table 25 Causes of disturbances over a certain scale (Chubu, FY 2017–2021) [Disturbances

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice				1		0.2
Physical contact			2		2	0.8
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal			2	1	2	1.0
Natural disaster						
Thunderbolt				1		0.2
Rainstorm		1				0.2
Snowstorm						
Earthquake						
Dust/Gas		2				0.4
Subtotal		3		1		0.8
Unknown						
Miscellaneous			1			0.2
Total disturbances		3	3	2	2	2.0

Table 26 Causes of disturbances over a certain scale (Hokuriku, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
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 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault		3			2	1.0
Maintenance fault	3			1		0.8
Accident/malice	1			1		0.4
Physical contact	1		2	4		1.4
Involved accident		1				0.2
Electric shock(worker)						
Electric shock(public)						
Subtotal	5	4	2	6	2	3.8
Natural disaster						
Thunderbolt			1	1	1	0.6
Rainstorm	3	10	1		1	3.0
Snowstorm					1	0.2
Earthquake						
Dust/Gas						
Subtotal	3	10	2	1	3	3.8
Unknown						
Miscellaneous						
Total disturbances	8	14	4	7	5	7.6

Table 28 Causes of disturbances over a certain scale (Chugoku, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal						
Natural disaster						
Thunderbolt	1				1	0.4
Rainstorm		2				0.4
Snowstorm					1	0.2
Earthquake						
Dust/Gas			1			0.2
Subtotal	1	2	1		2	1.2
Unknown						
Miscellaneous						
Total disturbances	1	2	1		2	1.2

Table 29 Causes of disturbances over a certain scale (Shikoku, FY 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault	1					0.2
Accident/malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
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 2017–2021) [Disturbances]

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal						
Natural disaster						
Thunderbolt						
Rainstorm		2				0.4
Snowstorm						
Earthquake					1	0.2
Dust/Gas						
Subtotal		2			1	0.6
Unknown						
Miscellaneous						
Total disturbances		2			1	0.6

Table 31 Causes of disturbances over a certain scale (Okinawa, FY 2017–2021) [Disturbances

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice						
Physical contact				1		0.2
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal				1		0.2
Natural disaster						
Thunderbolt						
Rainstorm		2	1			0.6
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal		2	1			0.6
Unknown						
Miscellaneous						
Total disturbances		2	1	1		0.8

3. Data of interruptions for low-voltage 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 one year.

System average interruption frequency index (SAIFI/interruptions)

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

System average interruption duration index (SAIDI/minutes)

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

Table 32 shows the definitions of terms related 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.[10][11]
Planned outage	Electric power company interrupts its electricity supply in planned manner to construct, improve, and maintain its electric facility.

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

(2) Data on system average interruption nationwide and by regional service area (FY 2017–2021)

Table 33 and Figure 19 show the nationwide data for system average interruptions for FY 2017–2021. 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 2021.[12]

The actual data on system average interruption for LV customers are summarized below. Regarding the nationwide SAIFI and SAIDI data, the data for FY 2021 were 0.13 interruptions and 10 minutes, per one customer, respectively. These values were lower compared with the corresponding data from the previous year and were the least values in the past 5 years. All regional service areas showed that the number of interruptions decreased or stayed at the same level compared with the previous data, except for Hokkaido area, which was affected by wind and rain.

Table 33 Indices of system average interruption (Nationwide, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.11	0.28	0.19	0.13	0.10	0.16
	Planned	0.03	0.03	0.04	0.04	0.03	0.03
	Total ●	0.14	0.31	0.23	0.17	0.13	0.20
SAIDI [Minutes]	Forced	12	221	82	24	7	69
	Planned	3	4	3	3	3	3
	Total ●	16	225	86	27	10	73

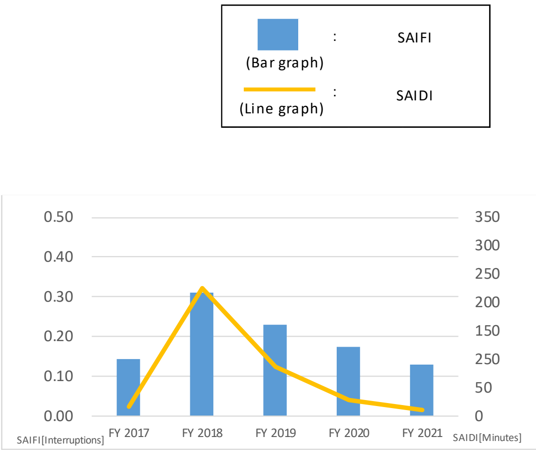

Figure 19 System average interruption indices of LV customers (Nationwide, FY 2017–2021)

[12] Alpha (α) is shown if the data are a fraction less than a unit. For SAIFI, α falls to 0 <α< 0.005, while for SAIDI, α falls to 0 <α< 0.5.

Table 34 Indices of system average interruption (Hokkaido, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.13	1.19	0.11	0.09	0.14	0.33
	Planned	0.01	α	α	α	α	0.01
	Total ●	0.14	1.19	0.11	0.09	0.14	0.33
SAIDI [Minutes]	Forced	10	2,154	4	5	12	437
	Planned	0	α	α	α	α	0
	Total ●	10	2,154	4	5	12	437

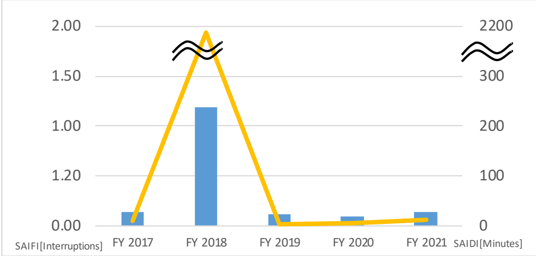

Figure 20 System average interruption indices of LV customers (Hokkaido, FY 2017–2021)

Table 35 Indices of system average interruption (Tohoku, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.13	0.09	0.11	0.16	0.11	0.12
	Planned	0.02	0.02	0.02	0.02	0.02	0.02
	Total ●	0.15	0.11	0.12	0.18	0.13	0.14
SAIDI [Minutes]	Forced	10	7	15	25	15	15
	Planned	3	2	2	4	2	3
	Total ●	13	10	17	29	18	17

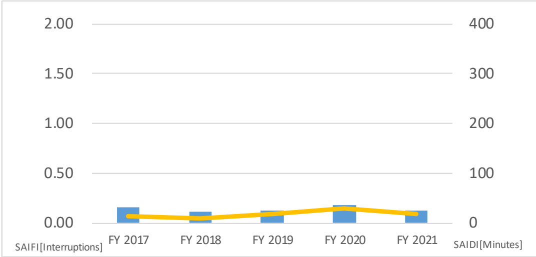

Figure 21 System average interruption indices of LV customers (Tohoku, FY 2017–2021)

Table 36 Indices of system average interruption (Tokyo, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.09	0.13	0.33	0.11	0.10	0.15
	Planned	0.01	0.01	0.03	0.06	0.01	0.02
	Total ●	0.10	0.14	0.36	0.17	0.11	0.18
SAIDI [Minutes]	Forced	6	19	200	7	6	48
	Planned	1	3	1	1	1	1
	Total ●	7	22	201	8	7	49

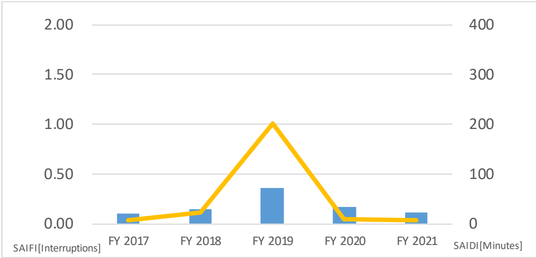

Figure 22 System average interruption indices of LV customers (Tokyo, FY 2017–2021)

Table 37 Indices of system average interruption (Chubu, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.08	0.39	0.11	0.07	0.09	0.15
	Planned	0.06	0.06	0.06	0.05	0.05	0.06
	Total ●	0.14	0.45	0.17	0.13	0.14	0.20
SAIDI [Minutes]	Forced	10	348	32	6	5	80
	Planned	7	8	8	7	7	7
	Total ●	17	356	40	12	12	87

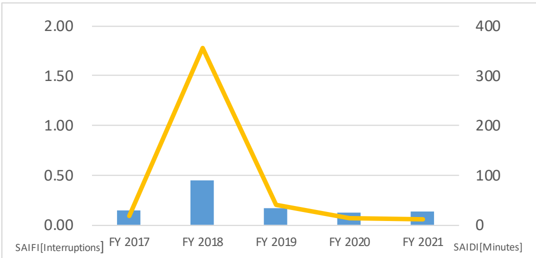

Figure 23 System average interruption indices of LV customers (Chubu, FY 2017–2021)

Table 38 Indices of system average interruption (Hokuriku, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.09	0.06	0.03	0.06	0.04	0.05
	Planned	0.09	0.09	0.09	0.08	0.08	0.09
	Total ●	0.17	0.15	0.13	0.14	0.12	0.14
SAIDI [Minutes]	Forced	11	9	3	7	3	7
	Planned	15	15	16	15	14	15
	Total ●	26	24	19	22	17	21

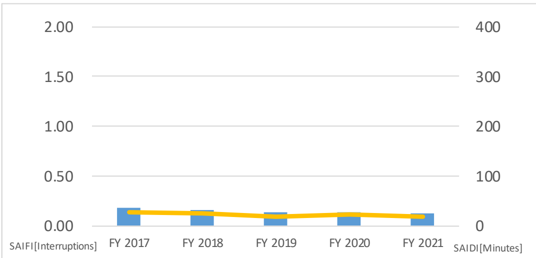

Figure 24 System average interruption indices of LV customers (Hokuriku, FY 2017–2021)

Table 39 Indices of system average interruption (Kansai, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.12	0.40	0.10	0.09	0.08	0.16
	Planned	0.01	0.01	0.01	0.01	0.01	0.01
	Total	0.13	0.41	0.11	0.10	0.10	0.17
SAIDI [Minutes]	Forced	14	396	5	7	6	85
	Planned	1	1	1	1	2	1
	Total	15	397	6	8	7	87

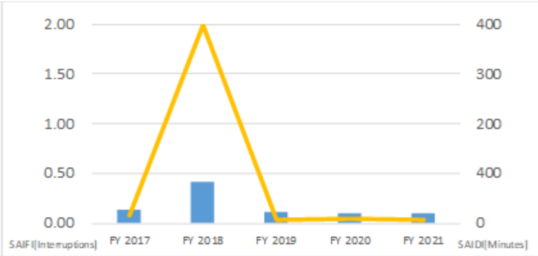

Figure 25 System average interruption indices of LV customers (Kansai, FY 2017–2021)

Table 40 Indices of system average interruption (Chugoku, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.12	0.14	0.13	0.15	0.15	0.14
	Planned	0.11	0.09	0.09	0.10	0.08	0.09
	Total	0.23	0.23	0.21	0.25	0.23	0.23
SAIDI [Minutes]	Forced	7	24	10	20	10	14
	Planned	12	10	9	11	9	10
	Total	19	33	19	31	19	24

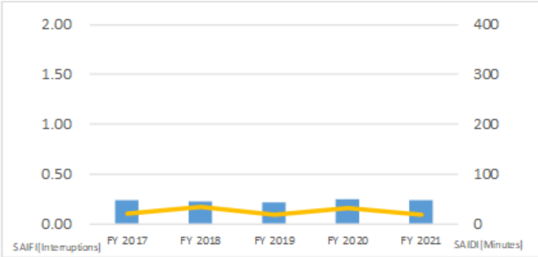

Figure 26 System average interruption indices of LV customers (Chugoku, FY 2017–2021)

Table 41 Indices of system average interruption (Shikoku, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.19	0.20	0.13	0.14	0.12	0.16
	Planned	0.16	0.14	0.14	0.14	0.14	0.15
	Total	0.36	0.34	0.27	0.28	0.26	0.30
SAIDI [Minutes]	Forced	21	32	8	10	7	16
	Planned	17	15	15	15	15	15
	Total	38	47	23	24	23	31

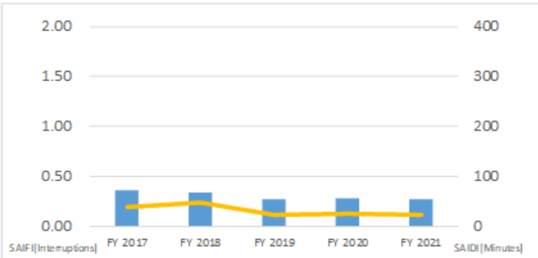

Figure 27 System average interruption indices of LV customers (Shikoku, FY 2017–2021)

Table 42 Indices of system average interruption (Kyushu, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.08	0.14	0.08	0.21	0.07	0.12
	Planned	0	0	0	0	0	0
	Total	0.08	0.14	0.08	0.21	0.07	0.12
SAIDI [Minutes]	Forced	25	103	15	139	3	57
	Planned	0	0	0	0	0	0
	Total	25	103	15	139	3	57

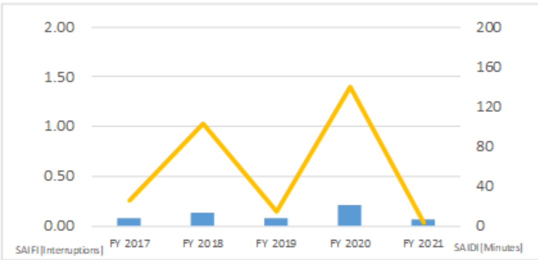

Figure 28 System average interruption indices of LV customers (Kyushu, FY 2017–2021)

Table 43 Indices of system average interruption (Okinawa, FY 2017–2021)

		FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	5-years Average
SAIFI [Interruptions]	Forced	0.98	3.62	1.11	1.12	0.57	1.48
	Planned	0.07	0.07	0.05	0.06	0.05	0.06
	Total	1.05	3.69	1.17	1.18	0.61	1.54
SAIDI [Minutes]	Forced	117	1,269	215	90	40	346
	Planned	7	6	6	11	5	7
	Total	124	1,275	221	101	45	353

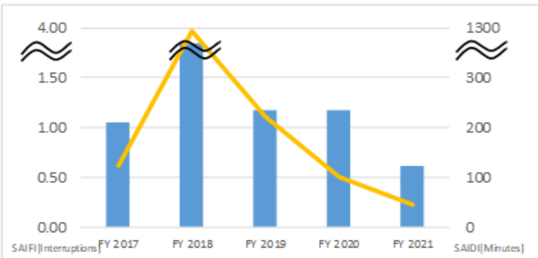

Figure 29 System average interruption indices of LV customers (Okinawa, FY 2017–2021)

Table 44 System average disturbances where interruptions were occurred by outages (Nationwide, FY 2021)[13,]

			Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa	Nationwide
SAIFI [Interruptions]	Forced outage												
		Generators	0.07	0.02	0.07	0.03	0.01	0.02	0.03	0.01	0.03	0.15	
		HV lines	0.07	0.08	0.04	0.05	0.03	0.06	0.11	0.10	0.04	0.40	
		LV lines	α	α	α	α	α	α	α	α	α	0.01	
		Subtotal	0.14	0.11	0.10	0.09	0.04	0.08	0.15	0.12	0.07	0.56	0.10
	Planned outage												
		Generators	0.00	α	α	0.00	α	α	α	0.00	0.00	α	
		HV lines	α	0.01	0.01	0.04	0.07	0.01	0.06	0.08	0.00	0.02	
		LV lines	α	α	α	0.01	0.02	0.01	0.02	0.06	0.00	0.03	
		Subtotal	α	0.02	0.01	0.05	0.08	0.01	0.08	0.14	0.00	0.05	0.03
	Total outage												
		Generators	0.07	0.02	0.07	0.03	0.01	0.02	0.03	0.01	0.03	0.15	
		HV lines	0.07	0.10	0.04	0.09	0.10	0.07	0.17	0.19	0.04	0.42	
		LV lines	α	0.01	α	0.02	0.02	0.01	0.02	0.06	α	0.04	
		Total	0.14	0.13	0.11	0.14	0.12	0.10	0.23	0.26	0.07	0.61	0.13
SAIDI [Minutes]	Forced outage												
		Generators	5	6	2	α	α	1	1	α	1	4	
		HV lines	7	8	3	4	2	4	8	6	2	32	
		LV lines	α	2	α	1	1	α	1	1	α	4	
		Subtotal	12	15	6	5	3	6	10	7	3	40	7
	Planned outage												
		Generators	0	α	α	0	α	α	α	0	0	α	
		HV lines	α	2	1	5	12	1	8	11	0	2	
		LV lines	α	1	α	2	2	α	1	4	0	3	
		Subtotal	α	2	1	7	14	2	9	15	0	5	3
	Total outage												
		Generators	5	6	2	α	α	1	1	α	1	4	
		HV lines	7	9	4	9	14	6	16	18	2	34	
		LV lines	α	2	α	3	3	1	2	5	α	7	
		Total	12	18	7	12	17	7	19	23	3	45	10

* 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 frequency time-kept ratio, which is the ratio of time where 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 2021 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 2021.

Supply disturbances and interruption for LV customers

Supply interruption include the following criteria: number of supply disturbances and the system average interruption indices, SAIFI and SAIDI.

In FY 2021, the total number of supply disturbances was 11,563, which was below the level of disturbances recorded in the previous year, and the decrease trend was observed for the third consecutive year. The number of supply disturbances decreased or stayed at the same level from the previous year in every regional service area.

The number of supply disturbances over a certain scale is deemed to report to the government. For FY 2021, the number of supply disturbances was 27, which was more than that of the previous year by 8 cases. The disturbance triggered by the natural disaster was observed in 17 cases, which was an increase of 12 cases from that of the previous year. These disturbances were mainly caused due to earthquakes. In particular, 8 cases of 9 disturbances by natural disaster were caused by the Fukushima Earthquake in March 2022 in Tohoku area.　The disturbance triggered by the fault of facility or maintenance was found to decrease compared to that in the previous year.

The nationwide SAIFI and SAIDI data on interruptions for LV customers for FY 2021 were 0.13 interruptions and 10 minutes, per one customer, respectively. These values were lower compared with the corresponding data from the previous year and were the least in the past 5 years. The number of disturbances in all areas was found to be either decreased or stayed at the same level compared with that of the previous year, except for the Hokkaido area, which was affected by wind and rain.

Based on the analysis and the results indicating that the frequency, voltage and the interruption have remained within the target variance, OCCTO concludes that the quality of the electricity supply was adequately maintained nationwide in FY 2021. OCCTO will continue to collect and publish information on the quality of electricity on the annual basis.

<Reference > Comparison of average system interruptions in Japan with major US States for 2017–2021

Table 47 and Figure 30 show the SAIDI values for Japan and major US states for the period 2017–2021, while Table 48 and Figure 31 show the SAIFI values for the same regions and time periods. The data for EU countries is cited from the report[14] of the Council of European Energy Regulators; however, the data for EU countries could not be collected as there is no publication of reports in recent years. 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]

The monitoring conditions, such as observed voltage, annual monitoring period (whether starting from January or April),[17] and data including/excluding natural disasters, vary across the US states. Therefore, the interruption data may not be directly comparable between Japan and the US states. However, both SAIDI and SAIFI values for Japan are lower than those for the major US states. In addition, only the data for LV customers are monitored for Japan. However, interruptions of such customers are estimated to have only a marginal effect on the interruption data because very few customers are supplied by means other than the LV network.

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[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.
<Reference>
SAIDI of EU countries (totaling planned and forced outages; minutes/year, customer) in 2016; Germany 24, Italy 144, France 71, Spain 66, UK 55, Sweden 94, Finland 81, and Norway 129.
SAIFI of EU countries (totaling planned and forced outages; interruptions/year, customer) in 2016; Germany 0.59, Italy 2.17, France 0.22, Spain 1.18, UK 0.57, Sweden 1.33, Finland 1.58, and Norway 1.89

[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 Major US States for 2017–2021 by forced and planned outages

(Minutes/year· customer)

			Year					Condition		
Country/State			2017	2018	2019	2020	2021	Event of	Observed voltage	Natural disaster
JAPAN			16	225	86	76	10	except auto re-closing	LV	Include
		Forced	12	221	82	72	7			
		Planned	3	4	3	3	3			
U.S.A.	California		308	266	737	327	355	5 minutes and longer	All	Include
		Forced	244	201	690	310	330			
		Planned	64	65	48	18	25			
	Texas		522	175	335	356	1136			
		Forced	509	158	319	343	1121			
		Planned	13	17	15	13	15			
	New York		270	409	228	538	167			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			

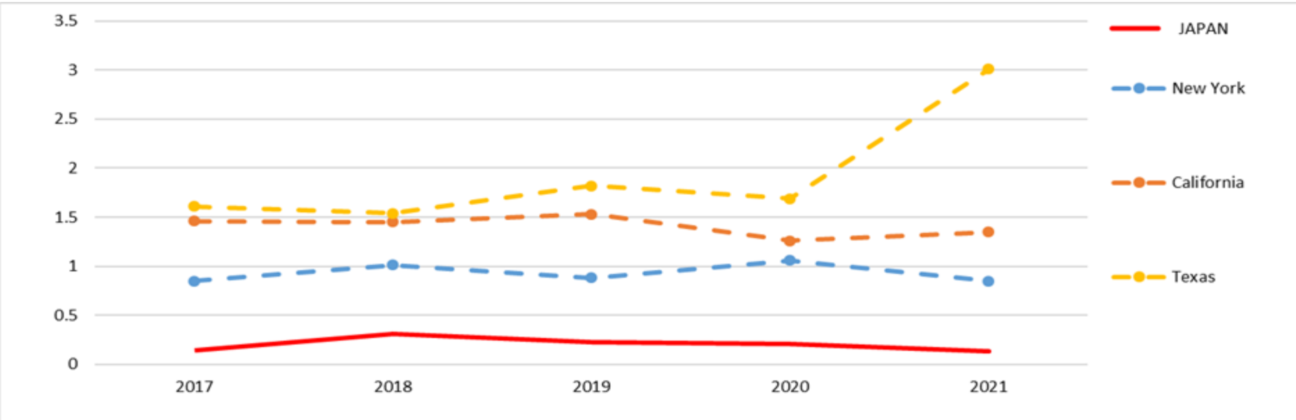

Figure 30 SAIDI of Japan and Major US States for 2017–2021 (Minutes/Year· Customer)

Table 48 SAIFI of Japan and Major US States for 2017–2021 by forced and planned outages

(Interruptions/year· customer)

Country/State			2017	2018	2019	2020	2021	Event of	Observed voltage	Natural disaster
			Year					Condition		
JAPAN			0.14	0.31	0.23	0.21	0.13	except auto re-closing	LV	Include
		Forced	0.11	0.28	0.19	0.17	0.10			
		Planned	0.03	0.03	0.04	0.03	0.03			
U.S.A.	California		1.46	1.45	1.53	1.26	1.35	5 minutes and longer	All	Include
		Forced	1.26	0.94	1.37	1.19	1.20			
		Planned	0.20	0.50	0.16	0.07	0.14			
	Texas		1.61	1.54	1.82	1.69	3.01			
		Forced	1.51	1.40	1.68	1.57	2.88			
		Planned	0.15	0.13	0.14	0.12	0.13			
	New York		0.85	1.01	0.88	1.06	0.85			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			

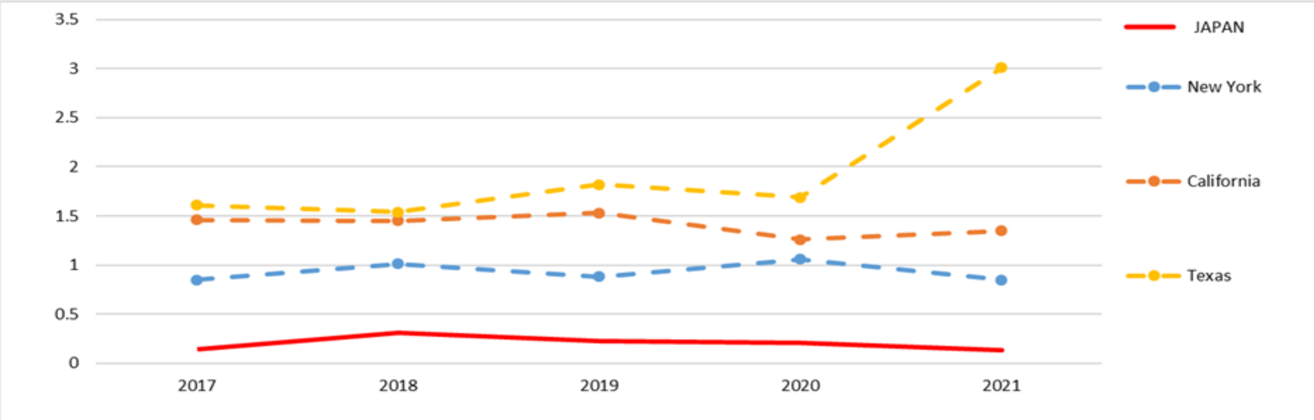

Figure 31 SAIFI of Japan and Major US States for 2017–2021 (Interruptions/year· customer)

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

II. State of Electric Network

Outlook for Cross-regional Interconnection Lines

- Actual Data for FY 2021 -

November 2022

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 the provisions of 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 2021.

SUMMARY

This report is presented to review the outlook for electricity supply–demand and cross-regional interconnection lines in fiscal year 2021 (FY 2021), based on the provisions of Article 181 of the Operational Rules of the Organization.

This report is comprised of two parts: the electricity supply and demand situation, and the interconnection line situation.

The total volume of utilization of the interconnection lines was 111,076 GWh, which was a significant increase from the 100,007 GWh in FY 2020.

In FY 2021, 379 interconnection line maintenance events occurred, which required 909 days-worth of work in FY 2021.

We hope that the information of this report proves useful.

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

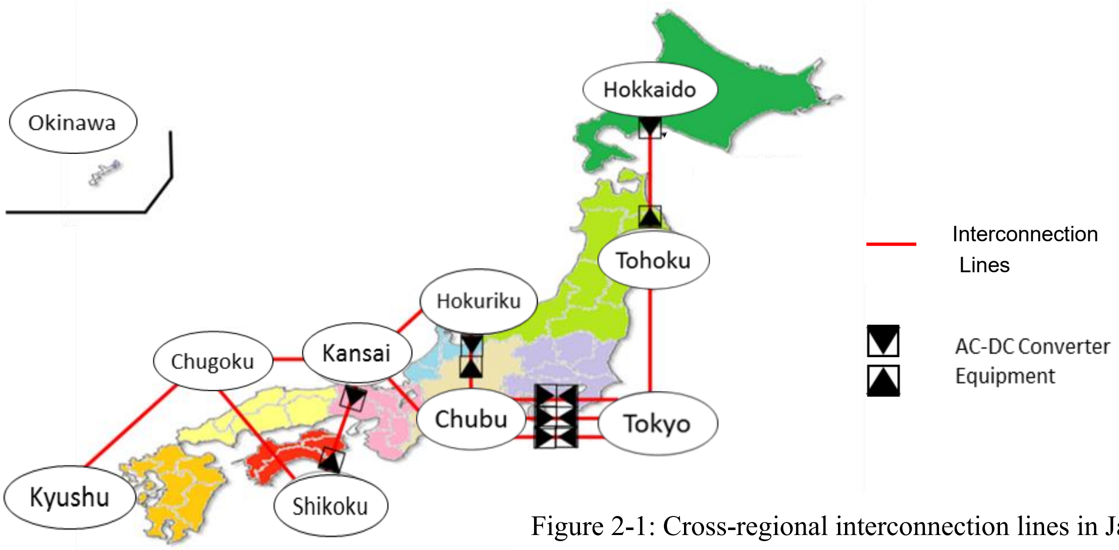

Figure 2-1: Cross-regional interconnection lines in Japan

Table 2-1: Summary of cross-regional interconnection lines (at the end of FY 2021)

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 Hida–Shinano 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 Converter Station 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 Converter Station	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 the cross-regional interconnection utilization rules from those based on a first-come, first-served principle to being based on an "implicit auction scheme"[1] with respect to the effective utilization of interconnection lines, security of fairness and transparency among interconnection line users, and environmental development of the energy trading market. An implicit auction scheme allocates all capabilities of the interconnection lines through the energy trading market, rather than directly allocate the position or right of utilization through auctions. The rule revision is described in Figure 2-2.

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

Figure 2-2 describes the before-and-after introduction of the implicit auction scheme. Before introduction, the capability allocation was implemented on an accumulated first-come, first-served basis, and the resulting ATC at 10:00 on the day before was used for day-ahead spot trading in the energy market. After the introduction, virtually all the ATC was traded in the day-ahead spot market. With this arrangement, there are no capability allocation plans, with the capability being 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.

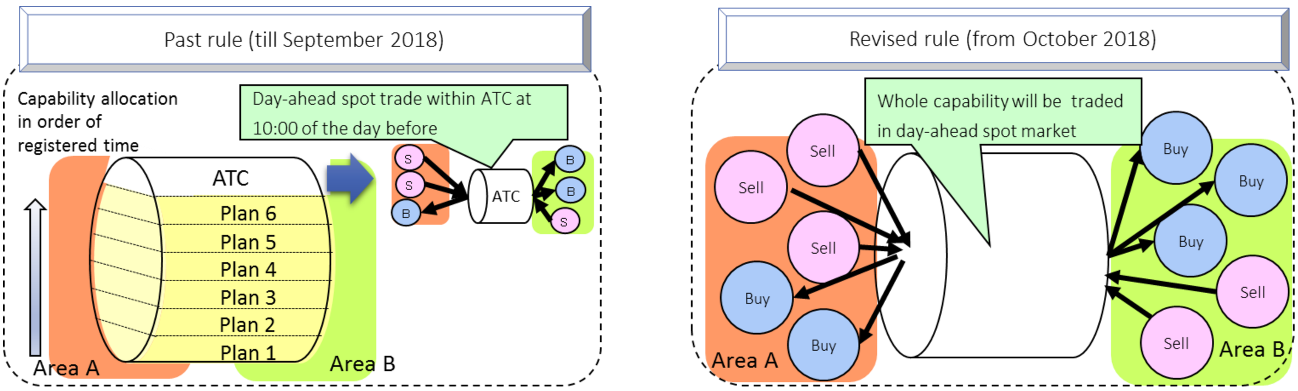

Figure 2-2: Management of interconnection lines

[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 were managed according to the provisions of Article 124 of the Operational Rules.

(1) Actual Utilization of Cross-regional Interconnection Lines in FY 2021

Table 2-2 and Figure 2-3 show the monthly and annual utilization of cross-regional interconnection lines for regional service areas in FY 2021.

Table 2-2: Monthly and annual utilization of cross-regional interconnection lines for regional service areas[2]

[GWh]

		Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Hokkaido - Honshu	→Tohoku (Forward)	82	89	149	124	290	112	200	386	333	313	258	271	2,607
	→Hokkaido (Counter)	86	63	52	67	19	23	13	10	9	9	7	24	382
Tohoku-Tokyo	→Tokyo (Forward)	1,818	1,794	2,005	2,316	2,679	2,621	2,501	2,496	3,082	3,072	2,865	1,844	29,092
	→Tohoku (Counter)	80	68	33	60	62	35	57	44	121	90	71	175	897
Tokyo-Chubu	→Chubu (Forward)	194	413	764	778	303	652	707	607	722	507	280	274	6,200
	→Tokyo (Counter)	442	329	87	181	500	162	138	123	103	252	317	409	3,043
Chubu-Kansai	→Kansai (Forward)	254	299	449	325	193	401	150	396	67	178	94	157	2,964
	→Chubu (Counter)	374	1,079	663	1,271	2,235	759	1,321	950	2,783	2,029	2,004	1,782	17,251
Chubu-Hokuriku	→Hokuriku (Forward)	30	7	5	3	1	10	7	12	16	0	0	4	96
	→Chubu (Counter)	139	1	3	43	179	781	430	253	143	24	39	29	2,063
Hokuriku - Kanasai	→Kansai (Forward)	362	438	235	484	601	3	82	0	256	157	97	289	3,005
	→Hokuriku (Counter)	23	16	22	46	31	0	1	0	16	46	98	77	376
Kansai-Chugoku	→Chugoku (Forward)	66	89	28	68	46	32	31	69	23	42	32	39	564
	→Kansai (Counter)	954	794	911	1,013	1,653	1,366	1,667	967	1,423	1,707	1,380	1,221	15,056
Kansai-Shikoku	→Shikoku (Forward)	0	1	3	0	16	4	3	0	0	0	0	0	28
	→Kansai (Counter)	478	763	600	817	779	331	406	480	855	958	898	979	8,343
Chugoku - Shikoku	→Shikoku (Forward)	14	9	7	11	14	19	11	4	6	7	6	5	113
	→Chugoku (Counter)	78	49	81	103	218	57	252	184	157	184	183	210	1,756
Chugoku - Kyushu	→Kyushu (Forward)	8	13	9	14	27	13	4	20	8	19	2	4	142
	→Chugoku (Counter)	1,274	912	979	1,168	1,514	1,523	1,581	1,383	1,607	1,829	1,664	1,665	17,098

* Based on the scheduled power flows of cross-regional interconnection lines. Figures are shown before offsetting is performed.
* The figures in red and blue represent the annual maximum and minimum capabilities for each line and direction, respectively.

2 Figures were rounded off to the first decimal place, the minimum figure in blue is judged before rounding off.

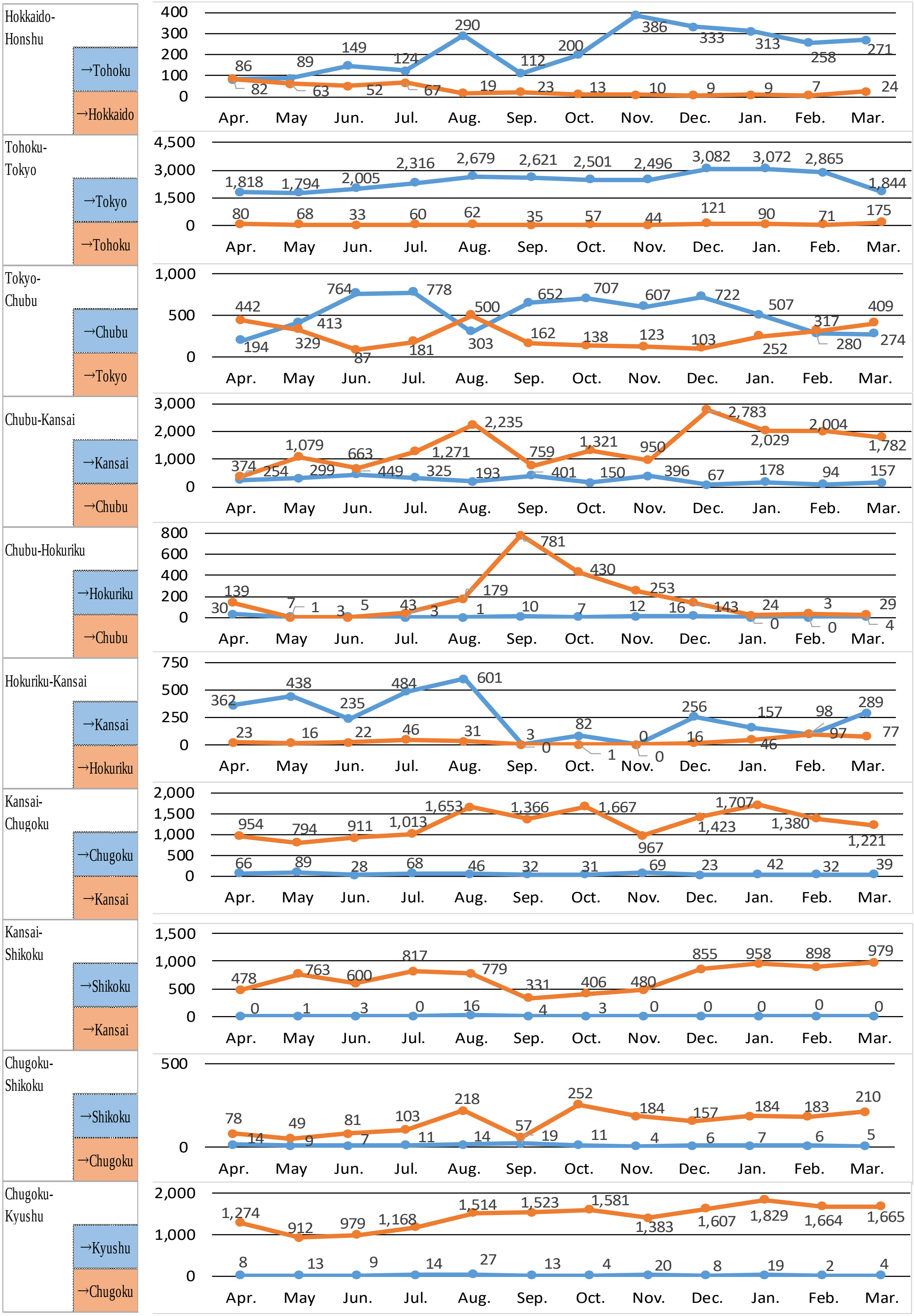

Figure 2-3: Monthly utilization of cross-regional interconnection lines for regional service areas

(2) Actual Utilization of Cross-Regional Interconnection Lines from FY 2012 to FY 2021

Table 2-3 and Figure 2-4 show the annual utilization of cross-regional interconnection lines for regional service areas from FY 2012 to FY 2021.

Table 2-3 Annual utilization of cross-regional interconnection lines for regional service areas (FY 2012 –2021)

[GWh]

		FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Hokkaido-Honshu	→Tohoku (Forward)	214	182	143	146	237	340	130	279	947	2,607
	→Hokkaido (Counter)	673	505	617	804	1,033	1,270	1,005	2,117	1,154	382
Tohoku-Tokyo	→Tokyo (Forward)	16,084	22,450	21,273	22,587	23,097	28,238	27,298	27,575	31,396	29,092
	→Tohoku (Counter)	4,520	3,891	4,029	3,714	4,660	7,071	3,139	252	541	897
Tokyo-Chubu	→Chubu (Forward)	1,579	2,829	2,702	693	2,729	3,954	1,711	354	1,497	6,200
	→Tokyo (Counter)	1,288	536	2,755	4,513	5,144	5,328	5,116	4,147	3,016	3,043
Chubu-Kansai	→Kansai (Forward)	7,487	7,049	7,131	3,412	5,538	8,106	3,675	980	4,413	2,964
	→Chubu (Counter)	5,726	4,928	6,342	7,577	6,544	9,889	9,980	7,175	13,285	17,251
Chubu-Hokuriku	→Hokuriku (Forward)	452	170	231	108	241	353	134	7	91	96
	→Chubu (Counter)	183	310	296	172	59	108	76	40	458	2,063
Hokuriku-Kanasai	→Kansai (Forward)	1,590	1,406	2,265	2,047	2,033	2,949	2,033	2,918	3,223	3,005
	→Hokuriku (Counter)	464	587	491	502	640	1,260	2,540	547	620	376
Kansai-Chugoku	→Chugoku (Forward)	2,836	2,326	2,252	948	716	4,493	4,734	578	584	564
	→Kansai (Counter)	6,788	5,468	5,994	9,138	13,179	16,727	13,388	9,793	12,416	15,056
Kansai-Shikoku	→Shikoku (Forward)	208	0	1	2	2	1	82	31	10	28
	→Kansai (Counter)	8,938	9,073	9,362	9,611	8,856	9,510	8,840	9,956	8,623	8,343
Chugoku-Shikoku	→Shikoku (Forward)	3,575	3,583	2,677	3,423	3,294	4,061	2,579	131	245	113
	→Chugoku (Counter)	3,564	3,694	3,912	4,631	7,638	7,540	4,023	4,143	1,445	1,756
Chugoku-Kyushu	→Kyushu (Forward)	4,210	3,838	3,596	2,174	1,935	3,014	1,998	138	177	142
	→Chugoku (Counter)	13,596	13,847	11,218	14,947	15,476	18,183	18,280	16,311	15,864	17,098

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

* The figures in red and blue represent the annual maximum and the minimum capabilities in each line and direction between FY 2012 and FY 2021, respectively.

* Figures were rounded off to the first decimal place.

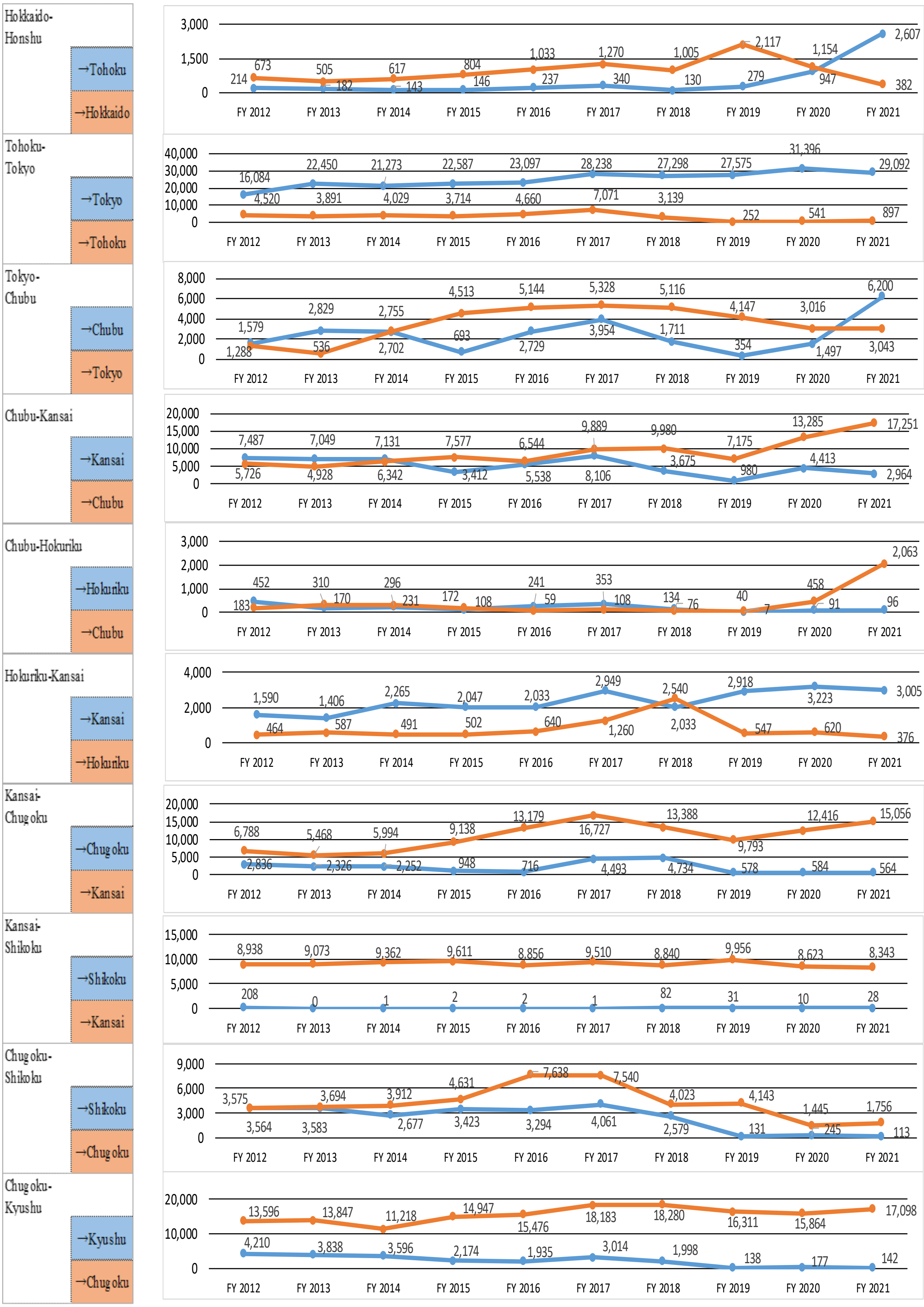

Figure 2-4: Annual utilization of cross-regional interconnection lines for regional service areas (FY 2012–2021)

(3) Monthly Utilization of Cross-Regional Interconnection Lines by Transaction in FY 2021

Table 2-4 shows the monthly and annual utilization of cross-regional interconnection lines by transaction in FY 2021. A bilateral contract includes the transactions at the balancing market that started from April 2021.

Table 2-4: Monthly and annual utilization of cross-regional interconnection lines by transaction

[GWh]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual
Bilateral	27	70	17	30	34	16	11	0	3	46	9	102	366
Day-ahead	6,246	6,476	6,615	7,990	10,311	8,215	8,977	7,858	10,912	10,429	9,688	8,612	102,328
1 Hour-ahead	484	682	455	870	1,015	670	576	526	813	948	598	745	8,382

* The figures in red and blue represent the annual maximum and minimum capabilities, respectively.
* The implicit auction scheme was introduced in October 2018.

(4) Annual Utilization of Cross-Regional Interconnection Lines by Transaction from FY 2012 to FY 2021

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 2012 to FY 2021. Day-ahead and 1 hour-ahead transactions comprised records for the decade (from FY 2012 to FY 2021), which was attributable to the introduction of the implicit auction scheme in October 2018, which made the whole utilization of cross-regional interconnection lines available through the spot market, and the activation of the spot market.

Table 2-5: Annual utilization of cross-regional interconnection lines by transaction (FY 2012–2021)

[GWh]

	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Bilateral	76,328	73,289	71,558	75,947	84,843	109,842	56,710	255	1,103	366
Day-ahead	7,155	11,632	14,174	13,152	14,817	18,350	51,120	83,216	91,229	102,328
1 Hour-ahead	493	1,750	1,554	2,050	3,392	4,203	2,932	4,000	7,675	8,382

* "Hour-ahead" means transactions that are 4 h ahead of the gate closure in FY 2015. From FY 2016, it refers to the transactions that are 1 h ahead of the gate closure.

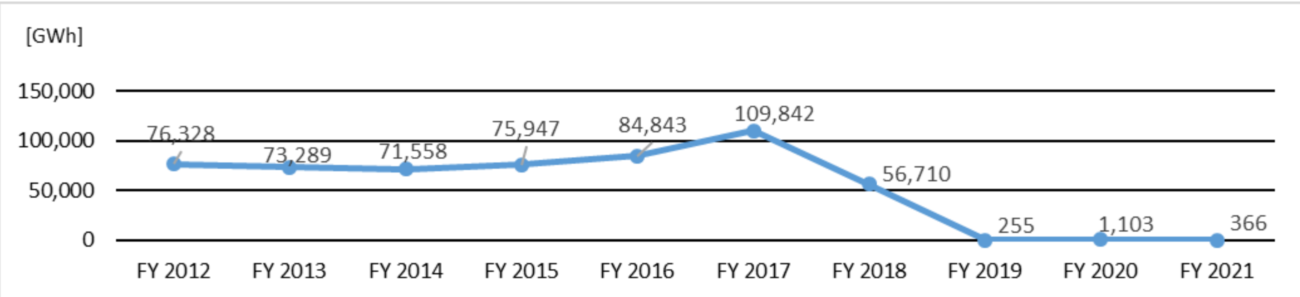

Figure 2-5: Annual utilization of cross-regional interconnection lines by bilateral transaction (FY 2012–2021)

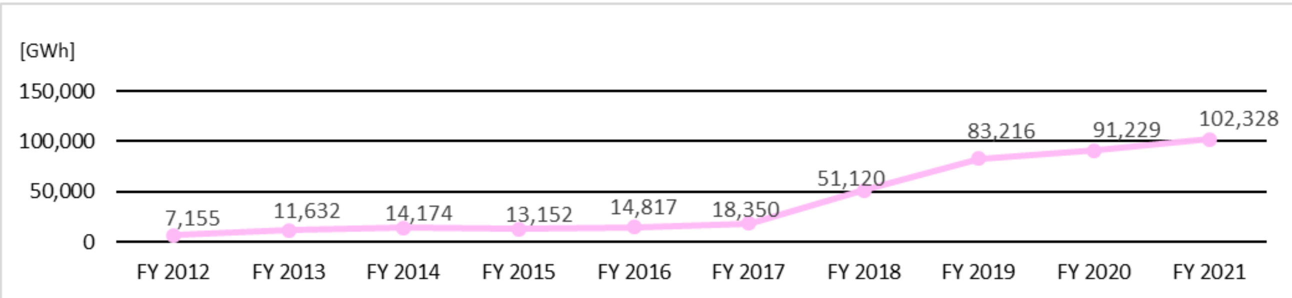

Figure 2-6: Annual utilization of cross-regional interconnection lines by day-ahead transaction (FY 2012–2021)

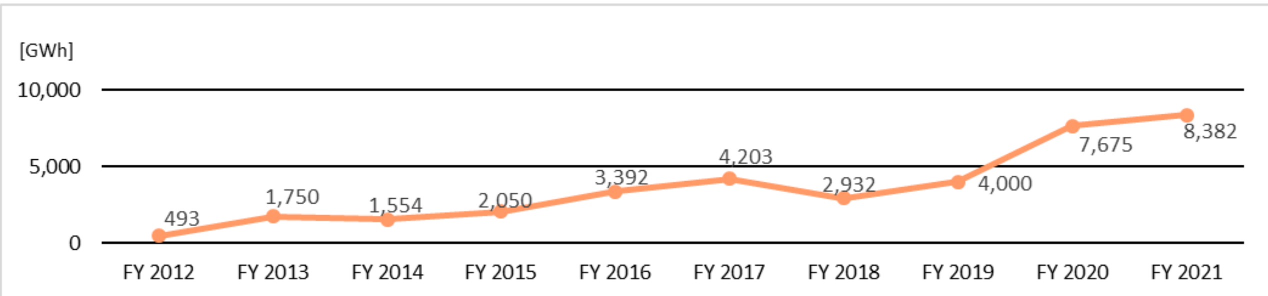

Figure 2-7: Annual utilization of cross-regional interconnection lines by hour-ahead transaction (FY 2012–2021)

3. Status of Maintenance Work on Cross-Regional Interconnection Lines

The following describes the 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 2021

Table 2-6 shows the monthly and annual maintenance works on cross-regional interconnection lines in FY 2021, and Figure 2-8 shows the nationwide monthly planned outage rate for FY 2021.

Table 2-6: Monthly and annual maintenance works 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	0	0	16	16	11	18	0	0	6	3	8	30	14	30	6	17	7	31	2	2	0	0	1	7	71	154
Tohoku-Tokyo	Soma-Futaba bulk line, Iwaki bulk line	0	0	0	0	6	5	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	12	11
Tokyo-Chubu	Sakuma FC C.S.	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	3	3	6	0	0	4	31	14	44
	Shin Shinano FC C.S.	0	0	1	1	5	11	0	0	0	0	3	3	4	17	3	9	9	4	2	2	0	0	0	0	27	47
	Higashi Shimizu FC C.S.	0	0	1	1	0	0	1	1	0	0	1	2	3	12	0	0	0	0	0	0	0	0	0	0	6	16
	Hida–Shinano FC	4	3	1	1	0	0	3	3	0	0	6	9	8	8	17	16	2	7	0	0	0	0	2	17	43	64
Chubu-Kansai	Mie-Higashi Omi line	9	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	2
Chubu-Hokuriku	Minami Fukumitsu HVDC BTB C.S., Minami Fukumitsu Substation	2	7	0	0	5	18	1	2	1	4	1	30	1	26	1	30	1	9	0	0	0	0	0	0	13	126
Hokuriku-Kansai	Echizen-Reinan line	1	5	0	0	0	0	2	2	4	4	27	30	12	26	3	30	6	9	0	0	0	0	0	0	55	106
Kansai-Chugoku	Seiban-Higashi Okayama line, Yamazaki-Chizu line	4	15	0	0	5	15	1	1	0	0	10	25	3	29	0	0	0	0	0	0	0	0	4	31	27	116
Kansai-Shikoku	Kihoku and Anan AC/DC C.S.	7	10	1	1	11	10	0	0	1	11	10	6	3	23	1	25	0	0	0	0	0	0	0	0	34	86
Chugoku-Shikoku	Honshi interconnection line	8	16	8	31	5	30	10	13	0	0	0	0	0	0	0	0	7	6	0	0	0	0	2	18	40	114
Chugoku-Kyushu	Kanmon interconnection line	9	12	15	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	28	23
Nationwide (Cumulative works for the same facilities deducted)		46	72	43	60	48	107	18	22	12	22	66	135	48	171	38	135	36	69	7	10	0	0	17	106	379	909

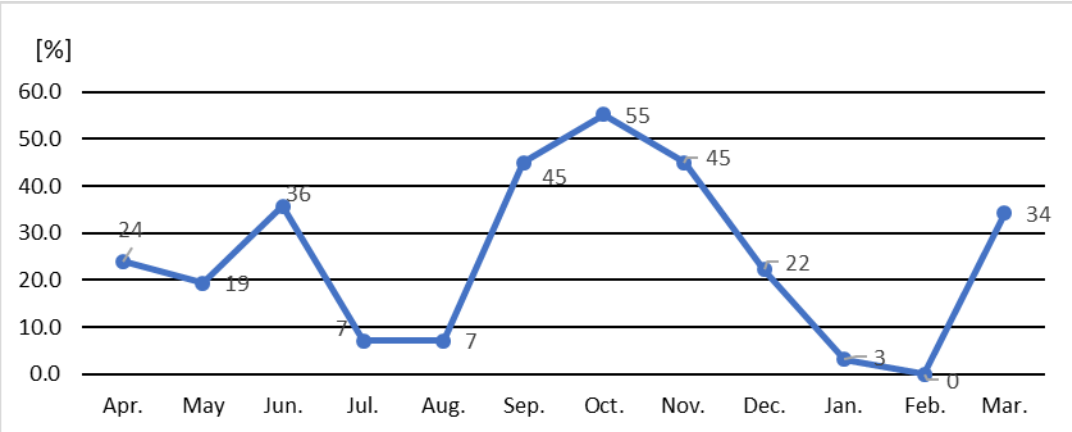

Figure 2-8: Nationwide monthly planned outage rate

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

(2) Annual Maintenance Works on Cross-regional Interconnection Lines from FY 2012 to FY 2021

Table 2-7 shows the annual maintenance work on cross-regional interconnection lines for FY 2012 to FY 2021.

The annual maintenance work on cross-regional interconnection lines for FY 2021 occurred on 379 occasions in nationwide. The annual maintenance work days on the facilities of Echizen–Reinan, Honshi, and Kanmon interconnection lines were recorded. The nationwide annual maintenance work in FY 2021 was almost the same level as that in the previous year, which was the highest annual total for the past decade.

Table 2-7: Annual maintenance work on cross-regional interconnection lines (FY 2012–2021)

	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Total	10-years Average
Number	58	38	63	91	218	267	205	353	385	379	2,057	206

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

4. Forced Outage of Cross-Regional Interconnection Lines

(1) Forced Outage of Cross-Regional Interconnection Lines in FY 2021

Table 2-8 shows the forced outage of cross-regional interconnection lines in FY 2021.

Table 2-8: Forced outage of cross-regional interconnection lines

Date	Facility	Background
July 20	Hida–Shinano FC	Substrate failure
July 31	Shin Shinano FC unit No.2	Secondary accident of network
August 23	Sakuma FC	Secondary accident of network
September 1	Hokkaido and Honshu HVDC Link	Unknown
September 7	Hida–Shinano FC	Substrate failure
September 15	Shin Shinano FC unit No.2	Trip
September 17	Hida–Shinano FC	Multipul failures
September 22	Higashi Shimizu FC	Secondary accident of network
December 1	Sakuma FC	Secondary accident of network
January 8	Sakuma FC	Trip
March 16	Soma Fubtaba Trunk Line	Generators shutdown

* The forced outage affecting the Total Transfer Capability is described.

(2) Annual Forced Outage of Cross-regional Interconnection Lines from FY 2012 to FY 2021

Table 2-9 shows the annual forced outage of cross-regional interconnection lines from FY 2012 to FY 2021. The number of annual forced outages of cross-regional interconnection lines in FY 2021 was 11, which was recorded for the past decade.

Table 2-9: Annual forced outage of cross-regional interconnection lines (FY 2012–2021)

	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	Total	10-years Average
Number	6	9	1	3	3	3	6	9	8	11	59	6

5. Actual Employment of the Transmission Margin

“Employment of the transmission margin” refers to 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, among other such possibilities. Table 2-10 shows the actual employment of the transmission margin for FY 2021 according to the provisions of Article 152 of the Operational Rules.

The actual employment of the transmission margin for FY 2021 was 7 days. This employment was performed in the interconnection facilities between Tokyo and Chubu, where the flow is from Chubu to Tokyo. Five of 7 days were allocated to implement countermeasures for the Fukushima Earthquake that occurred on March 16, 2022.

Table 2-10: Actual employment of the transmission margin

Date	Facility	Background
January 6, 2022	Interconnection facilities between Tokyo and Chubu (Flow from Chubu to Tokyo)	Insufficient ATC of the corresponding facilities which is necessary for the instruction of power exchanges because of shortage of supply capacity in TEPCO PG area due to unexpected demand growth caused by cold weather
February 10, 2022	Interconnection facilities between Tokyo and Chubu (Flow from Chubu to Tokyo)	Insufficient ATC of the corresponding facilities which is necessary for the instruction of power exchanges because of shortage of supply capacity in TEPCO PG area due to unexpected demand growth caused by cold weather
March 18, 2022	Interconnection facilities between Tokyo and Chubu (Flow from Chubu to Tokyo)	Insufficient ATC of the corresponding facilities which is necessary for the instruction of power exchanges because of shortage of supply capacity in Tohoku NW regional service area due to earthquake occurred on March 16, 2022.
March 18 & 19, 2022	Interconnection facilities between Tokyo and Chubu (Flow from Chubu to Tokyo)	Insufficient ATC of the corresponding facilities which is necessary for the instruction of power exchanges because of shortage of supply capacity in TEPCO PG area due to earthquake occurred on March 16, 2022.
March 22 & 23, 2022	Interconnection facilities between Tokyo and Chubu (Flow from Chubu to Tokyo)	Insufficient ATC of the corresponding facilities which is necessary for the instruction of power exchanges because of shortage of supply capacity in TEPCO PG area due to earthquake occurred on March 16, 2022, as well as unexpected demand growth triggered by cold weather.

Table 2-11: Actual employment of transmission margin (FY 2015–2021)

[days]

	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021
Nationwide	1	0	3	15	1	16	7

6. Actual Available Transfer Capabilities of Each Cross-Regional Interconnection Line

The actual ATC values calculated and published are shown in Figures 2-10 to 2-19. (Figures 2-9 and Table 2-12 present how to interpret the ATC graphs.)

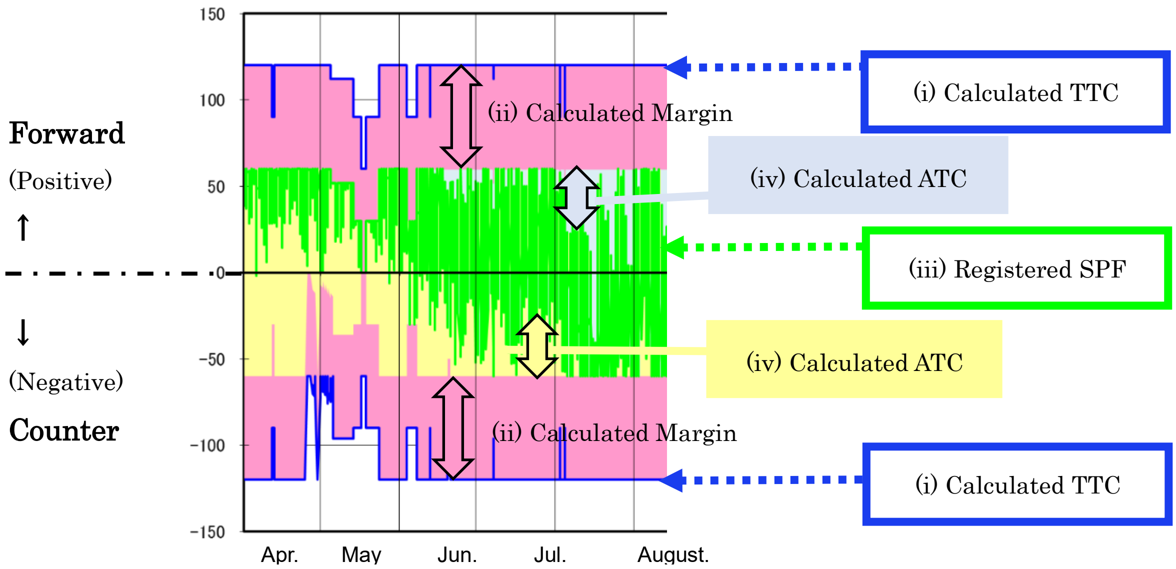

Figure 2-9: How to interpret an ATC graph

Table 2-12: Explanation of ATC graph 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 value between the forward and counter flows, not the simple sum of both directions. In addition, offset values on the graphs are observed as Scheduled Power Flow, rather than observing the capacity of each forward flow 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#

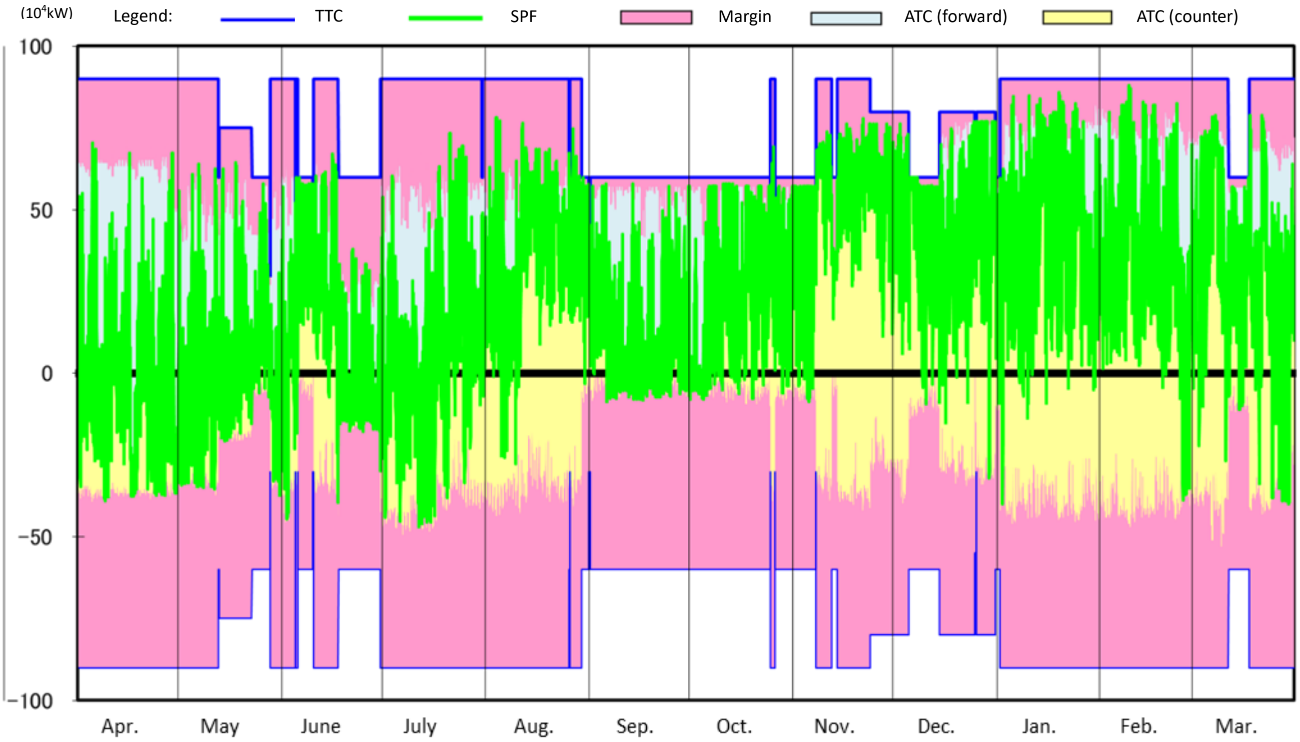

Figure 2-10: Actual ATC for interconnection facilities between Hokkaido and Honshu
(Hokkaido–Honshu HVDC Link, and New Hokkaido–Honshu HVDC Link)

Note: Hokkaido to Tohoku is considered a forward (positive) flow, with Tohoku to Hokkaido being a counter (negative) flow.

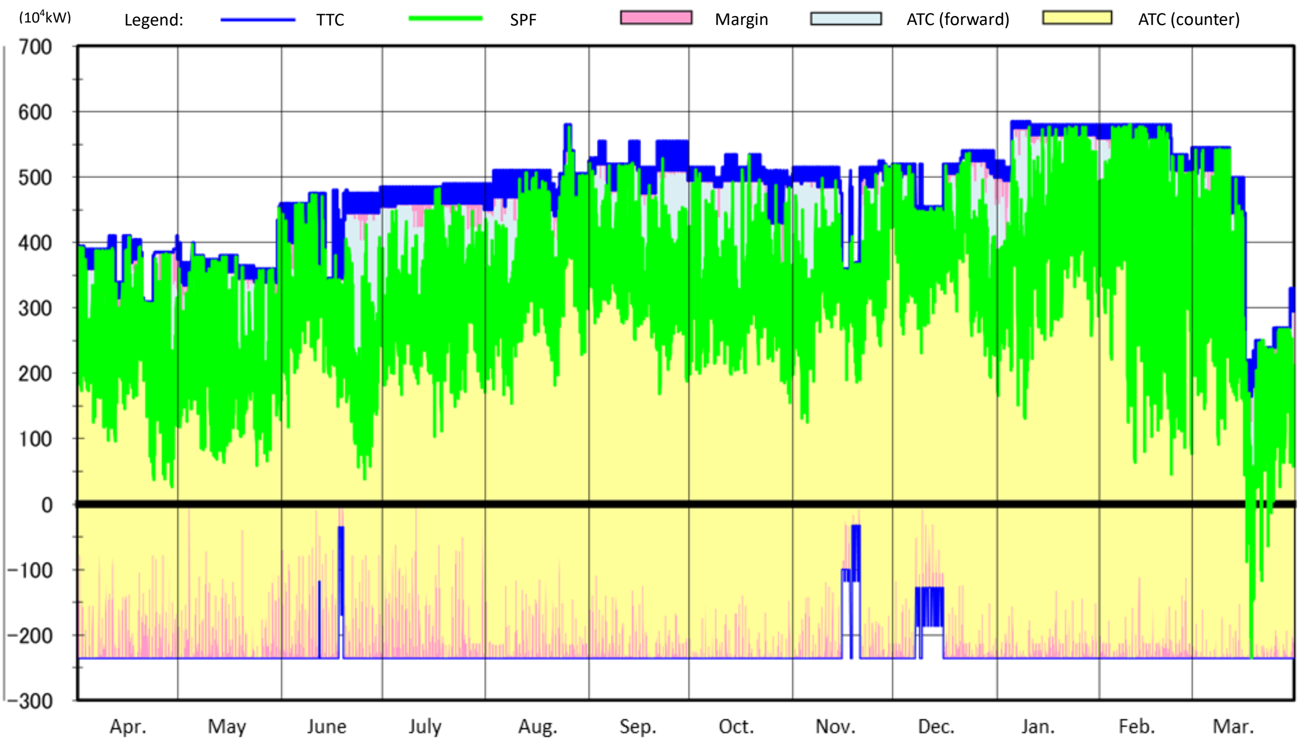

Figure 2-11: Actual ATC for interconnection lines between Tohoku and Tokyo
(Soma–Futaba Bulk Line and Iwaki Bulk Line)

Note: Tohoku to Tokyo is considered a forward (positive) flow, with Tokyo to Tohoku being a counter (negative) flow.

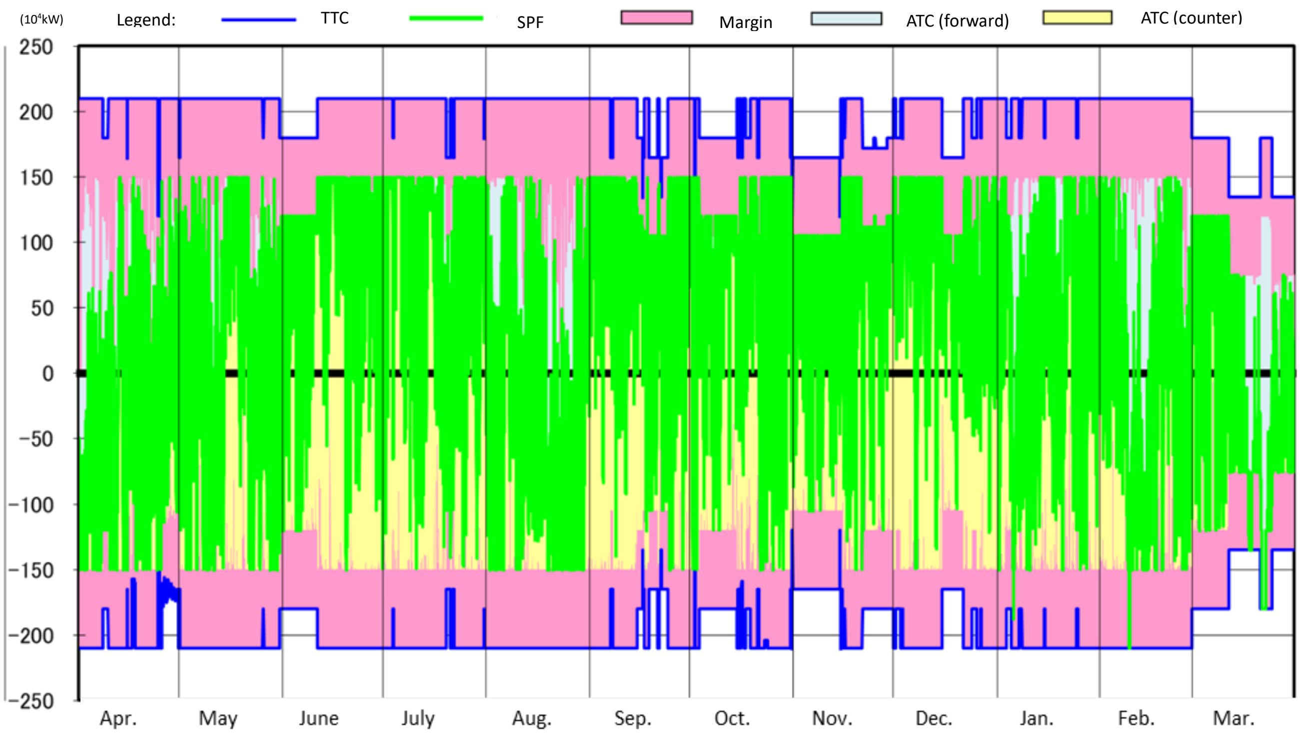

Figure 2-12: Actual ATC for interconnection facilities between Tokyo and Chubu
(Sakuma, Shin Shinano and Higashi Shimizu and Hida–Shinano F.C.)

Note: Tokyo to Chubu is considered a forward (positive) flow, with Chubu to Tokyo being a counter (negative) flow.

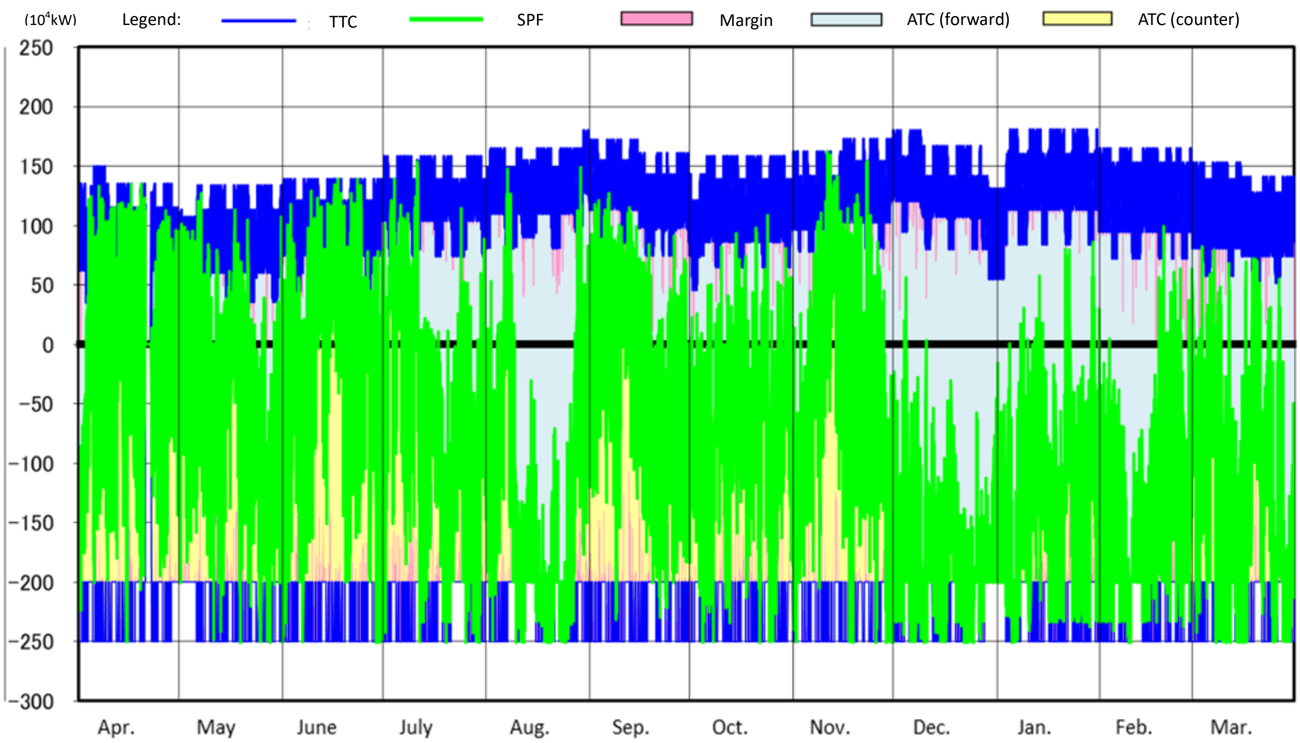

Figure 2-13: Actual ATC for the interconnection line between Chubu and Kansai (Mie–Higashi Omi Line)

Note: Chubu to Kansai is considered a forward (positive) flow, with Kansai to Chubu being a counter (negative) flow.

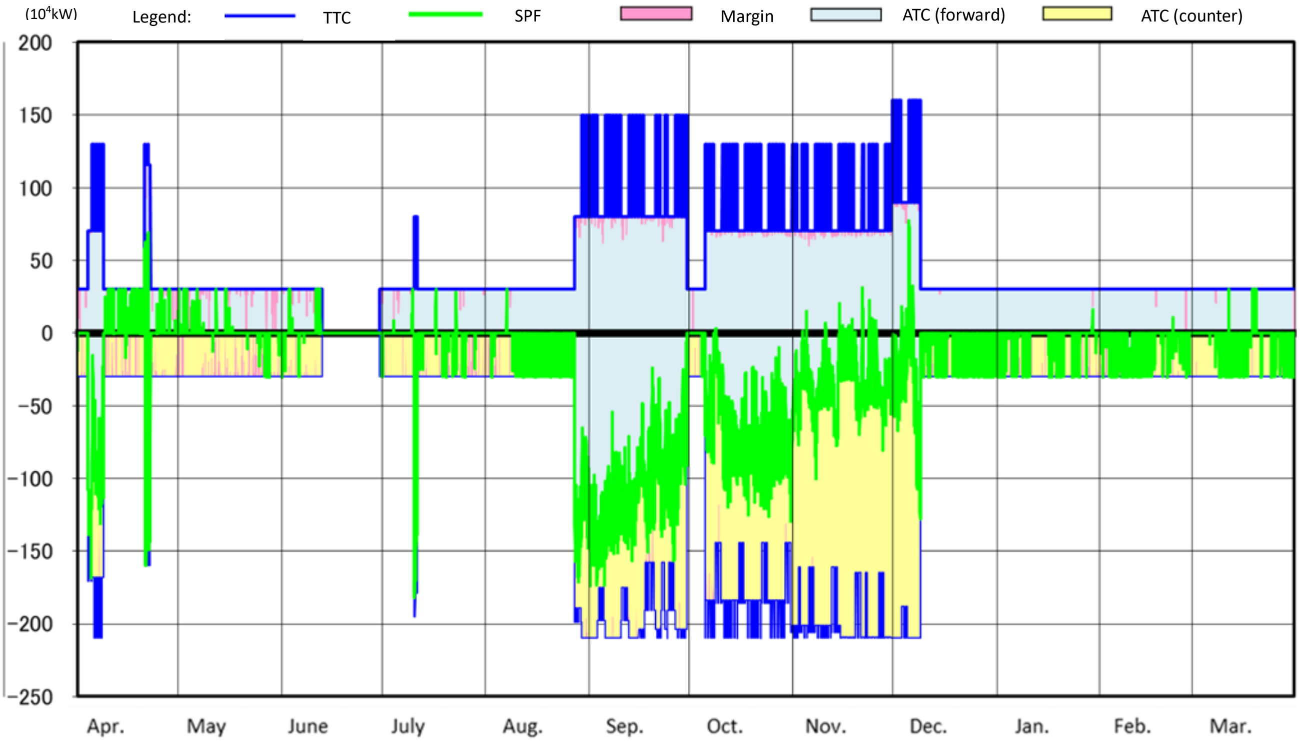

Figure 2-14: Actual ATC for interconnection facilities between Chubu and Hokuriku
(Minami Fukumitsu HVDC BTB Converter Station and Minami Fukumitsu Substation)

Note: Chubu to Hokuriku is considered a forward (positive) flow, with Hokuriku to Chubu being a counter (negative) flow.

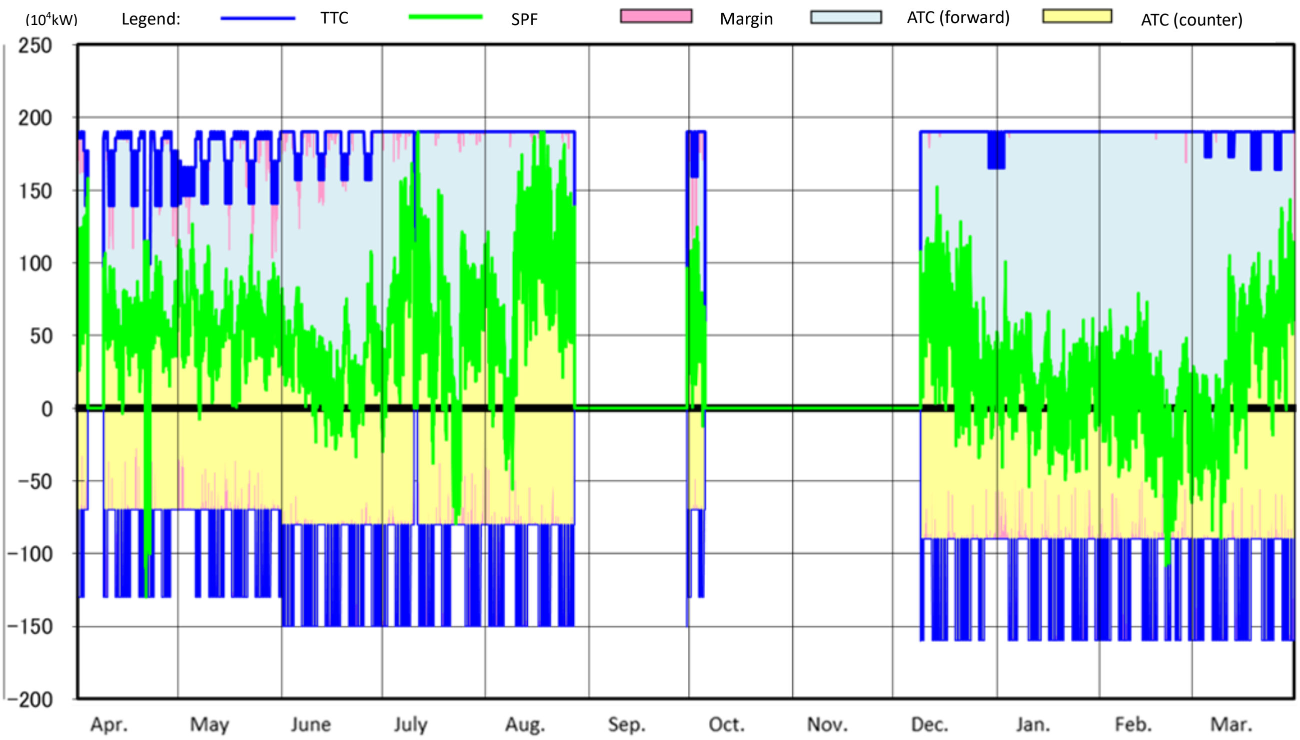

Figure 2-15: Actual ATC for the interconnection line between Hokuriku and Kansai (Echizen–Reinan Line)

Note: Hokuriku to Kansai is considered a forward (positive) flow, with Kansai to Hokuriku being a counter (negative) flow.

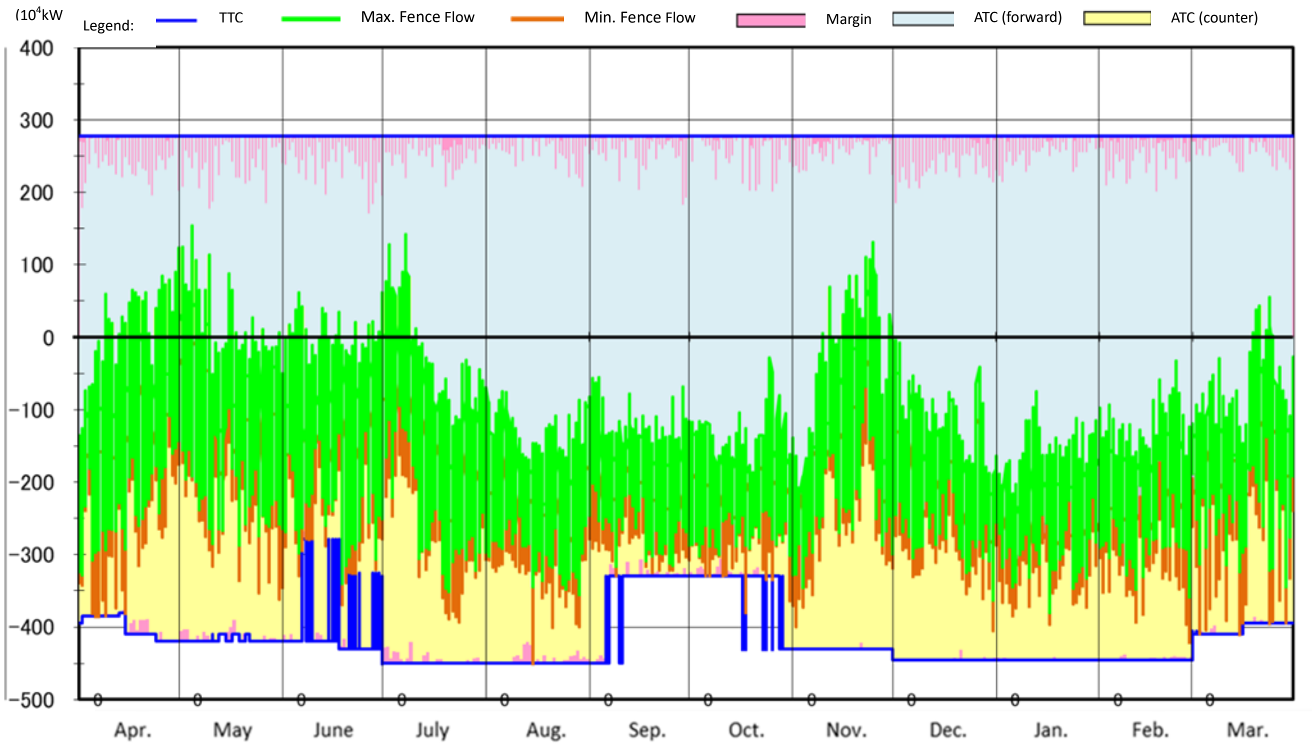

Figure 2-16: Actual ATC for interconnection lines between Kansai and Chugoku
(Seiban—Higashi Okayama Line and Yamazaki—Chizu Line)
Note: Kansai to Chugoku is considered a forward (positive) flow, with Chugoku to Kansai being a counter (negative) flow.

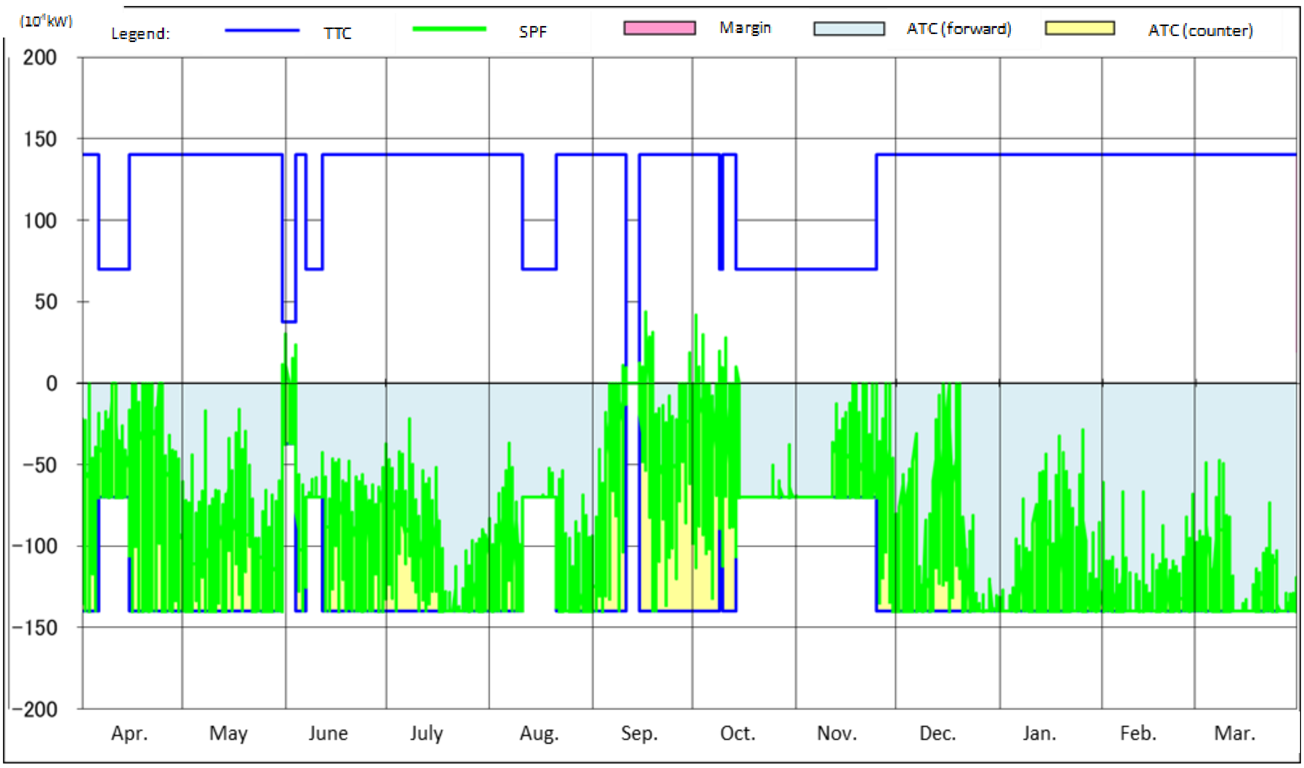

Figure 2-17: Actual ATC for interconnection facilities between Kansai and Shikoku
(Interconnection facilities between Kihoku and Anan AC/DC Converter Station)
Note: Kansai to Shikoku is considered a forward (positive) flow, with Shikoku to Kansai being a counter (negative) flow.
*The ATC for the forward flow is calculated and chosen as the smaller 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).

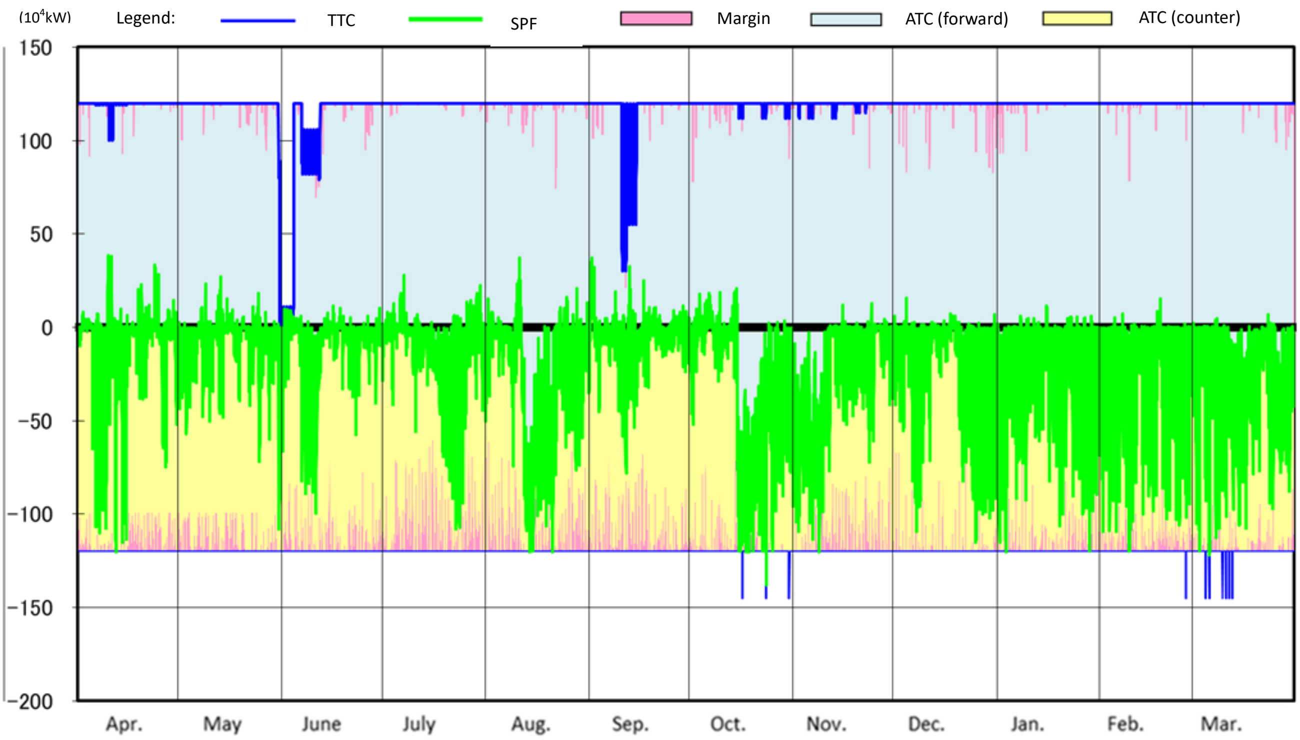

Figure 2-18: Actual ATC for the interconnection line between Chugoku and Shikoku (Honshi Interconnection Line)
Note: Chugoku to Shikoku is considered a forward (positive) flow, with Shikoku to Chugoku being a counter (negative) flow.

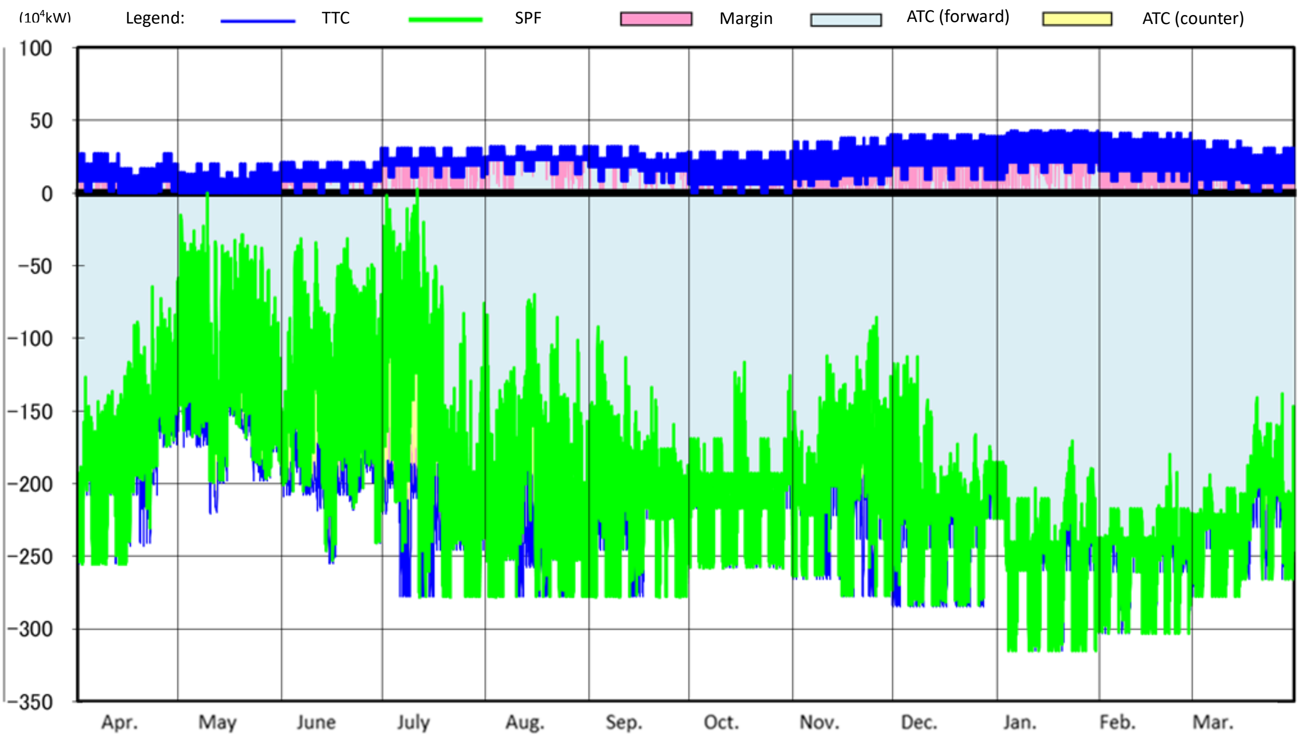

Figure 2-19: Actual ATC for the interconnection line between Chugoku and Kyushu (Kanmon Interconnection Line)
Note: Chugoku to Kyushu is considered a forward (positive) flow, with Kyushu to Chugoku being a counter (negative) flow.

7. Actual Constraints on Cross-Regional Interconnection Lines Nationwide

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

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* 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 the actual utilization of cross-regional interconnection lines, data on the utilization, the maintenance work, the forced outages, the employment of transmission margin, and the ATC are collected.

III. Actual Network Access Business

Actual Data of Preliminary Consultation, System Impact Study, and Contract Applications in FY 2021

[only in Japanese]

https://www.occto.or.jp/houkokusho/2022/files/220622_access_toukei.pdf

June 2022

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 2022

https://www.occto.or.jp/en/information_disclosure/supply_plan/files/2022_Aggregation_of_Electricity_Supply_Plan_230803.pdf

September 2022

Organization for Cross-regional Coordination of Transmission Operators, Japan

Aggregation of Electricity Supply Plans for Fiscal Year 2022

September 2022

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) 2022. This aggregation was conducted 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 electric power companies (EPCOs) to submit their plans and publish the results.

The EPCOs submit the electricity supply plans according to the Network Code of the Organization; they are aggregated by the Organization, and sent to the Ministry of Economy, Trade and Industry (METI) annually by the end of March.
In total, 1,768 electricity supply plans for FY 2022 were aggregated, including 1,767 submissions from companies that became EPCOs by the end of November 2021 and one submission from a company that became EPCOs by March 1, 2022.

Number of Electric Power Companies Subject to the Aggregation in FY 2022

Business License	Number
Generation Companies	1,007
Retail Companies	712
Specified Transmission, Distribution and Retail Companies	30
Specified Transmission and Distribution Companies	6
Transmission Companies	3
General Transmission and Distribution Companies	10
Total	1,768

[Reference] Electricity supply plan

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

The METI shall recommend to EPCOs any alterations to the supply plan if the plan is recognized as inadequate for the security of a stable supply by cross-regional operation or for other development of the electricity business comprehensively and rationally.

Due Date of Submission of Supply Plans	
(1)Electric Power Company (EPCO) except General Transmission and Distribution Company submission to the Organization	March 1 (draft: Feb. 10)
(2)General Transmission and Distribution 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 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 the 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 2020, and Forecast for FY 2021 and 2022 (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 2020, and Projection for FY 2021 and 2022 (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

Page

I. Electricity Demand Forecast

1. Actual and Preliminary Data for FY 2021 and Forecast for FY 2022 and 2023 (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 10 general transmission and distribution (GT&D) companies for FY 2021 and the forecast[3] value for FY 2022 and 2023.

The peak demand (average value of the three highest daily loads) for FY 2022 was forecast at 159,030 MW, representing a 0.1% decrease over 159,160 MW; i.e., the temperature-adjusted[4] value for FY 2021.

Peak demand for FY 2022 was forecast at 159,530 MW, representing a 0.2% increase over the temperature-adjusted[4] value for FY 2020.

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

FY 2021 Actual (temperature adjusted)	FY 2022 Forecast	FY 2023 Forecast
16,230	16,051 (-1.1%*)	16,028 (-1.2%*)

*% change compared with actual data for FY 2021 (temperature adjusted)

b. Forecast for FY 2022 and 2023

Tables 1-2 and 1-3 show the monthly peak demand in FY 2022 and 2023, respectively, from the aggregated peak demand for each regional service area submitted by 10 GT&D companies. The monthly peak demand in summer (August) is greater than that in winter (January) by about 10 GW; therefore, nationwide peak demand occurs in summer.

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[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 2022 is based on normal weather. Thus, weather conditions for forecast assumption may vary in contrast to the actual data or estimated value in FY 2021.

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

Table 1-2 Monthly Peak Demand (average value of the three highest daily loads) in FY 2022
(Nationwide, 10^4 kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Peak Demand	11,631	11,379	12,759	16,001	16,051	14,101
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	11,967	12,425	14,307	15,068	15,041	13,347

Table 1-3 Monthly Peak Demand (average value of the three highest daily loads) in FY 2023
(Nationwide, 10^4 kW at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.
Peak Demand	11,612	11,361	12,741	15,978	16,028	14,079
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	11,950	12,408	14,286	15,045	15,018	13,318

c. Annual Electric Energy Requirements

Table 1-4 shows the preliminary data[5] for FY 2021 and the forecast value for FY 2022 from the aggregated electric energy requirements of each regional service area submitted by the 10 GT&D companies.

The electric energy requirements for FY 2022 are forecast at 877.5 TWh, a 0.9% increase over the 869.3 TWh in the preliminary data for FY 2021.

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

FY 2021 Preliminary (temperature- and leap-year-adjusted)	FY 2022 Forecast
869.3	877.5(+0.9%*)

* % 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 2020 with the preliminary data from December 2020 to March 2021.

2. 10-Year Demand Forecast (Long Term)

Table 1-5 shows the significant economic indicators developed and published on November 25, 2021 by the Organization, which are assumptions to be used by the GT&D companies to forecast the peak demand in their regional service areas.

The real gross domestic product (GDP)[6] is estimated at 541.4 trillion Japanese Yen (JPY) in FY 2021 and 596.1 trillion JPY in FY 2031, with an annual average growth rate (AAGR) of 1.0%. The index of industrial production (IIP)[7] is projected at 96.4 in FY 2021 and 104.2 in FY 2031, with an AAGR of 0.8%. In contrast, the population is estimated at 125.74 M. in FY 2021 and 119.23 M. in FY 2031, with an AAGR of −0.5%.

Table 1-5 Major Economic Indicators Assumed for Demand Forecast

	FY 2021	FY 2031
Gross Domestic Product(GDP)	541.4 trillion JPY	596.1 trillion JPY [+1.0%]*
Index of Industrial Product(IIP)	96.4	104.2 [+0.8%]*
Population	125.74 M	119.23 M [-0.5%]*

* Average annual growth rate for the forecast value of FY 2021.

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

Table 1-6 shows the peak demand forecast for FY 2022, FY 2026, and FY 2031 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 forecast from FY 2010 to 2031. The peak demand nationwide is forecast at 159,260 MW in FY 2026 and 157,460 MW in FY 2031, with an AAGR of −0.3% from FY 2021 to FY 2031.

The peak demand forecast over 10 years shows a slightly decreasing trend, primarily due to negative factors such as efforts to reduce electricity use, wider use of energy-saving electric appliances, a shrinking population, and load-leveling measures, and despite positive factors such as the expansion of the 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 2022 [aforementioned]	FY 2026	FY 2031
16,051	15,926 [-0.4%]*	15,746 [-0.3%]*

* Average Annual Growth Rate for the forecast value of FY 2021.

6 GDP expressed as the chained price for calendar year (CY) 2015.
7 Index value in CY 2015 = 100.

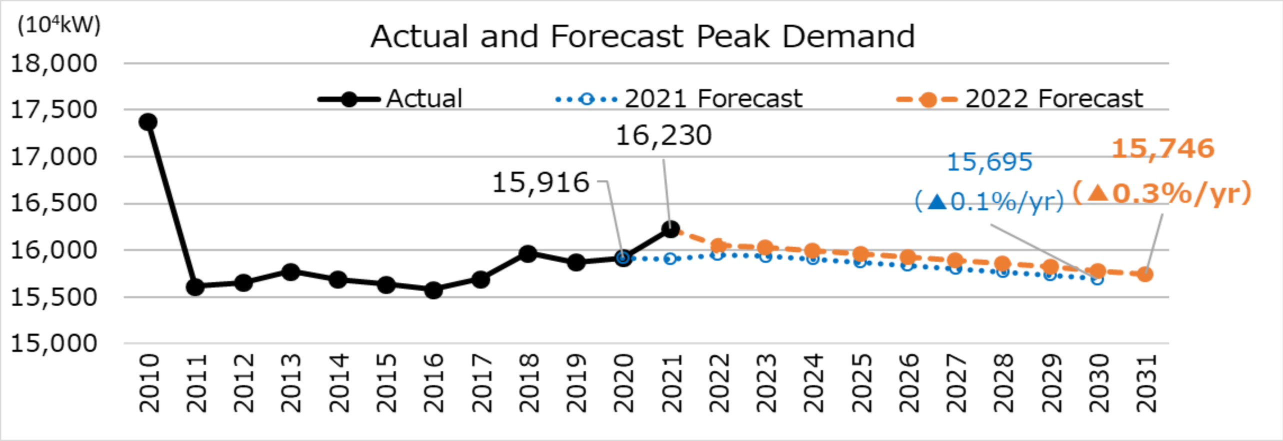

Figure 1-1 Actual and Forecast Peak Demand (August for Nationwide, 10^4 kW at the sending end)

b. Annual Electric Energy Requirement

Table 1-7 shows the forecast for annual electric energy requirements in FY 2022, FY 2026, and FY 2031 as the aggregation of the electric energy requirements for each regional service area submitted by 10 GT&D companies.

The nationwide annual electric energy requirement is forecast at 870.7 TWh in FY 2026 and 863.4 TWh in FY 2031, with an AAGR of −0.1% decrease from FY 2021 to FY 2031.

The annual electric energy requirement forecast over 10 years shows a slightly decreasing trend, which is attributable to negative factors, such as efforts to reduce electricity use, and a shrinking population offsetting the positive factors such as the expansion of economic scale and greater dissemination of electric appliances, in the projected period.

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

FY 2022 [aforementioned]	FY 2026	FY 2031
877.5	870.7 [+0.0%]*	863.4 [-0.1%]*

* AAGR for the forecast value of FY 2021.

II. Electricity Supply and Demand

1. Supply Reliability Criteria

As a new reliability criterion, the Organization has applied expected unserved energy (EUE) to the electricity supply plan based on the discussions of the Study Committee on Regulating and Marginal Supply Capability and Long-Term Supply–Demand Balance Evaluation.[8] From FY 2021, annual EUE values of 0.048kWh/kW-year nationwide and 0.498kWh/kW-year for the Okinawa area, are the newly applied reliability criteria for the electricity supply plan.

The supply reliability criteria for the electricity supply plan now apply annual EUE criteria to confirm supply reliability; however, it is crucial that supply capacity must be balanced for each month according to the consideration of area characteristics, such as winter in the Hokkaido area or severe weather. Therefore, the Organization evaluates whether the supply capacity in the short term(the first and second year of the projected period) is satisfied by the annual EUE criteria, and simultaneously confirms the reserve margin of each area and month.

(Reference) Characteristics of Annual EUE

Figure 2-1 shows characteristics of annual EUE. For evaluation by annual EUE criteria, the stable supply is secured through the year at the usual level if the annual EUE value is less than 0.048 kWh/kW-year.

Still, as it is difficult to understand the lowering reserve margin in a specific area and month solely by the annual EUE evaluation, because of an imbalance in the supply capacity caused by the scheduled maintenance of the generating facilities and other factors. The Organization evaluates the reserve capacity for each month by a conventional approach.

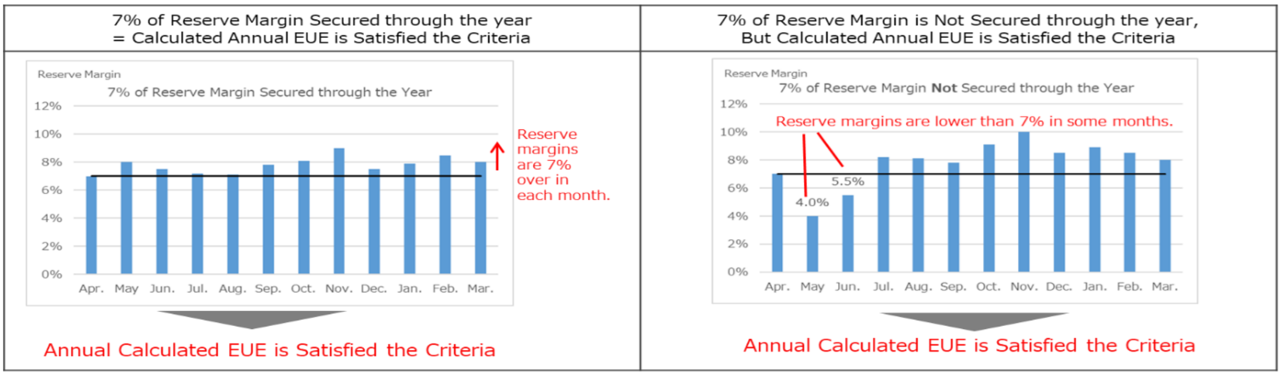

Figure 2-1 Characteristic of Annual EUE

[8] [Source]Material 2, 58th meeting of the Study Committee on Regulating and Marginal Supply Capability and Long-Term Supply–Demand Balance Evaluation (March 3, 2021)
https://www.occto.or.jp/iinkai/chouseiryoku/2020/files/chousei_58_02.pdf

2. Evaluation of Supply Capacity by EUE Approach in the Projected Period (FY 2022 Through 2031)

Table 2-1 shows the calculated result of supply capacity by annual EUE. In the short term (the first and second year of the projected period), the entire area and year fall within the criteria of secure supply (0.048kWh/kW-year nationwide, 0.498kWh/kW-year in Okinawa). The maximum value in the projected period is 0.038kWh/kW-year for the Tokyo area in FY 2022.

In the long term, the calculated result for the Kyushu area from FY 2024 to FY 2029 exceeds the criteria, because of uncertainty in the commercial operation of some large generating facilities in the area. Furthermore, the result for the Okinawa area from FY 2025 to FY 2027 and FY 2029 exceeds its criteria, reflecting scheduled maintenance of generating facilities for the period.

Currently, some areas and years do not satisfy the criteria of reliability; the Organization continues evaluation work for future supply plans keeping watch for development plans of generating facilities in the mid-to-long term.

Table 2-1 Calculated Result of Supply Capacity by Annual EUE

(kWh/kW-year)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Hokkaido	0.000	0.007	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000
Tohoku	0.007	0.001	0.005	0.002	0.001	0.001	0.001	0.001	0.000	0.000
Tokyo	0.038	0.011	0.042	0.008	0.003	0.002	0.001	0.001	0.000	0.000
Chubu	0.003	0.001	0.000	0.002	0.001	0.000	0.000	0.000	0.000	0.001
Hokuriku	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Kansai	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Chugoku	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Shikoku	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Kyushu	0.001	0.001	0.210	0.130	0.119	0.113	0.107	0.096	0.031	0.027
Interconnected	0.014	0.004	0.035	0.016	0.013	0.011	0.010	0.009	0.003	0.003
Okinawa	0.027	0.021	0.354	0.793	0.662	0.860	0.282	0.917	0.311	0.304

3. Evaluation of Supply Capacity by Conventional Approach in the Short Term

The Organization evaluates the supply–demand balance for each regional service area and nationwide using the supply capacity[9] and peak demand data for the regional service areas.

The Organization implements its evaluation using the criterion of whether or not the reserve margin (%)[10] for each regional service area is secured over 8%. In the Okinawa EPCO regional service area, the criterion is to secure the 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. The evaluation is implemented at the time of the least reserve margin.

Figure 2-2 summarizes the supply–demand balance evaluation. The supply capacity includes the generating capacity requirements secured by retail and GT&D companies for their regional service areas and the generation companies' surplus power production.[11] The supply capacity currently secured by retail companies includes power procured[12] from other regional service areas through cross-regional interconnection lines. Thus, the generation companies' surplus power or the reserve capacity of retail companies might provide future supply capacity for other regional service areas.

When the operation of a nuclear power plant becomes uncertain, the corresponding unit or plant's supply capacity is recorded as zero; the corresponding supply capacity is reported as "uncertain" according to Procedures for Electricity Supply Plans of FY 2022, published in December 2021 by the Agency for Natural Resources and Energy. In the electricity supply plans for FY 2022, the supply capacity was reported as "uncertain" for all nuclear power plants except those that had resumed operation by the time of the plans were submitted.

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

[10] 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).

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

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

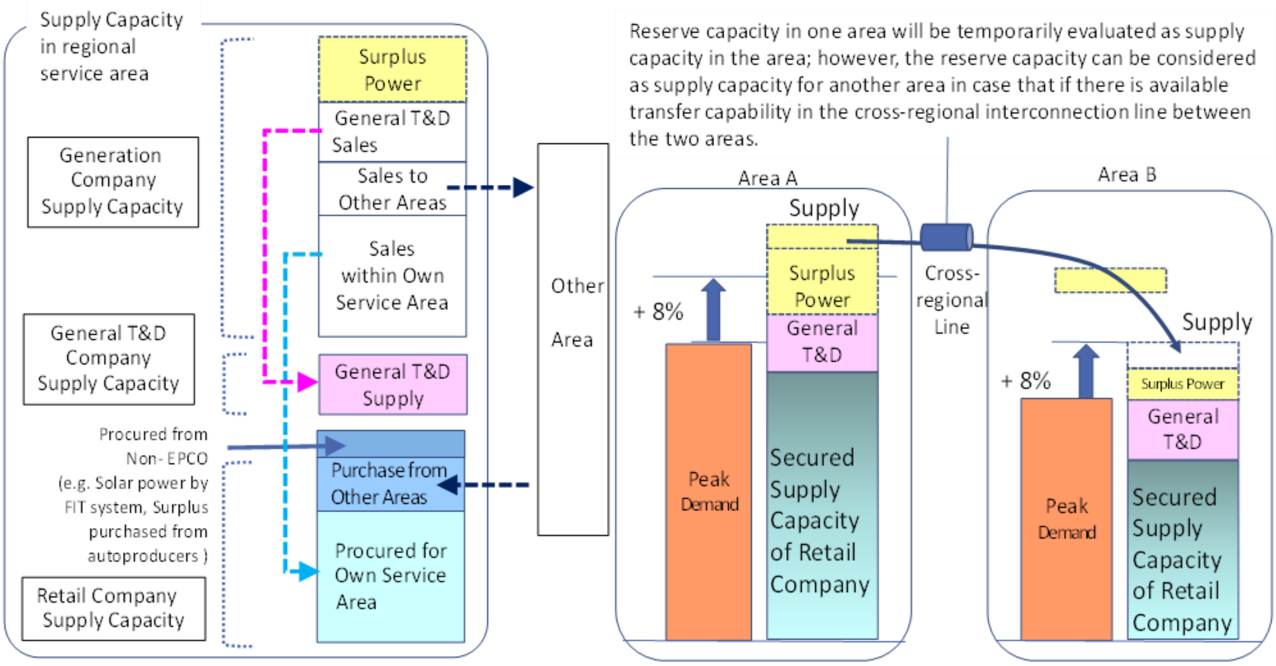

Figure 2-2 Summary of Supply–Demand Balance Evaluation

[Reference] Calculation Method of Supply Capacity

The calculation method for supply capacity or surplus power is based on the description in the "Guideline for the Calculation of Demand and Supply Capacity"[13](Agency for Natural Resources and Energy: December 2021) and "Procedures for Electricity Supply Plans of FY 2022"[14](Agency for Natural Resources and Energy: December 2021).

[13] 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

[14] Procedures for Electricity Supply Plans of FY 2021 (only in Japanese)
https://www.enecho.meti.go.jp/category/electricity_and_gas/electricity_measures/001/pdf/kisai-youryo.pdf

[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 h in August (3).

Short term

(1): Based on "Transfer Capability of Cross-regional Interconnection Lines FY 2022-2031" [annual and long-term plans] (February 10, 2022: The Organization)[15]

(2): Based on "Transfer Margin of Cross-regional Interconnection Lines FY 2022 and 2023" [annual plan] (February 10, 2022: The Organization)[16], and the calculated figures considering expected contribution from external areas (equivalent to 3% of transfer capability of the interconnection lines)

(3): Based on monthly scheduled power flows reported in the "Plan for Transaction of Electricity (Table 36)" of the electricity supply plan for FY 2022

Mid-to-Long term

(1): For FY 2022 and 2023, the August value was calculated from (1) in the short term above; the value for FY 2024-2031 was based on "Transfer Capability of Cross-regional Interconnection Lines FY 2022-2031" [annual and long-term plans] (February 10, 2022: The Organization)[15]

(2): For FY 2022 and 2023, the August value was calculated from (2) in the short term above; the value for FY 2024-2031 was based on "Transfer Margin of Cross-regional Interconnection Lines FY 2022-2031" [long-term plans] (February 10, 2022: The Organization), [16], and the calculated figures considering expected contribution from external areas (equivalent to 3% of transfer capability of the interconnection lines).

(3): Based on 15:00 in August scheduled power flows of the period reported in the "Plan for Transaction of Electricity (Table 32-8)" of the electricity supply plan for FY 2022

15 Reference: material from the "4th Meeting of the Working Group on Cross-regional Transfer Capability" (only in Japanese)
http://www.occto.or.jp/iinkai/unyouyouryou/2021/unyouyouryou_2021_4_haifu.html

16 Reference: material from the "3rd Meeting of the Working Group on Transmission Margin" (only in Japanese)
http://www.occto.or.jp/iinkai/margin/2021/margin_kentoukai_2021_3.html

a. Projection of Supply–Demand Balance in FY 2022 and 2023

To present the cross-regional reserve margin, the Organization recalculates the monthly projection of the least reserve margin for each regional service area to the level around neighboring areas. This recalculation is done by using power exchanges to transfer electricity from areas of over the 8% reserve margin to areas of below the 8% reserve margin based on the available transfer capability of each interconnection line.[17]

In addition, additional supply capacity has been applied to the interconnected areas (except Okinawa) in July and August, which is based on the correlation between solar power generation and electric demand.[18]

Furthermore, information on the environmental assessment of thermal power plants[19] probably includes some generating facilities, in which EPCOs 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; however, they have already applied 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.

(i) Projection for FY 2022

Table 2-2 shows the projected reserve margin in each regional service area for FY 2022. The reserve margin in every area and month is over 8% criteria.

Table 2-2 Monthly Projection of the Cross-regional Reserve Margins Nationwide and for Each Regional Service Area

(Power exchanges through cross-regional interconnection lines and generating facilities are not included at the sending end at the sending end of the electricity supply plans,)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	29.6%	48.7%	55.5%	41.5%	27.6%	31.9%	34.2%	21.1%	16.1%	15.4%	15.6%	20.2%
Tohoku	18.3%	20.3%	13.3%	15.3%	20.1%	16.8%	23.1%	14.6%	11.9%	15.4%	15.6%	19.9%
Tokyo	14.7%	20.3%	13.3%	10.3%	10.2%	16.8%	17.0%	8.1%	11.9%	10.7%	10.6%	18.4%
Chubu	14.7%	20.3%	20.2%	10.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Hokuriku	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Kansai	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Chugoku	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Shikoku	18.0%	20.3%	21.9%	11.3%	10.5%	16.8%	24.2%	11.9%	11.9%	10.7%	10.6%	18.4%
Kyushu	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	27.1%	23.1%	11.9%	10.7%	10.6%	18.4%
Okinawa	62.5%	35.8%	28.0%	35.0%	40.1%	30.8%	53.3%	60.3%	73.5%	57.1%	60.5%	86.2%

* Cross-regional reserve margins becoming the same value are shown in the same background colors after utilization of cross-regional interconnection line.

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17 This evaluation is implemented based on the following. The evaluation of the 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.

18 Reference: 69th meeting of the Study Committee on Regulating and Marginal Supply Capability and Long-Term Supply–Demand Balance Evaluation https://www.occto.or.jp/iinkai/chouseiryoku/2021/files/chousei_69_01.pdf

19 Reference: Information on the 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

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

Table 2-3 shows the monthly reserve margin against the deduction of the capacity of Generator I-a, which indicating that the stable supply was secured in each month.

Table 2-3 Monthly Reserve Margin against the Deduction of the Capacity of Generator I-a (at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Okinawa	33.3%	11.2%	7.4%	14.5%	19.6%	11.0%	30.5%	33.9%	43.0%	27.6%	30.6%	54.2%

(ii) Projection for FY 2023

Table 2-4 shows a result of the similar calculation result for FY 2023, indicating that the reserve margins are over the criteria of 8% in every month and area.

Table 2-4 Monthly Projection of the Cross-regional Reserve Margins Nationwide and for Each Regional Service Area
(Power exchanges through cross-regional interconnection lines and generating facilities are not included at the sending end at the sending end of the electricity supply plans,)

	4月	5月	6月	7月	8月	9月	10月	11月	12月	1月	2月	3月
Hokkaido	30.0%	45.3%	47.6%	29.2%	30.9%	29.7%	26.1%	20.6%	23.7%	18.1%	20.8%	25.1%
Tohoku	30.0%	29.9%	21.1%	19.7%	22.0%	29.7%	26.1%	20.6%	16.5%	15.4%	16.4%	25.1%
Tokyo	11.4%	22.1%	21.1%	13.6%	14.1%	15.8%	18.0%	10.4%	15.1%	14.6%	15.7%	19.6%
Chubu	28.9%	22.1%	22.5%	13.6%	14.1%	15.8%	18.0%	10.6%	15.1%	14.6%	15.0%	19.6%
Hokuriku	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	18.0%	10.6%	15.1%	14.6%	15.0%	20.0%
Kansai	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	30.3%	28.6%	15.6%	14.6%	15.0%	20.0%
Chugoku	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	30.3%	28.6%	15.6%	14.6%	15.0%	20.0%
Shikoku	28.9%	35.4%	34.4%	20.9%	30.9%	25.2%	33.7%	28.6%	15.6%	22.0%	21.3%	41.5%
Kyushu	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	31.0%	28.6%	15.6%	14.6%	15.0%	20.0%
Okinawa	65.1%	59.2%	39.7%	38.7%	36.8%	31.4%	36.6%	52.6%	63.7%	63.2%	68.4%	78.5%

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

The Okinawa EPCO regional service area,[22] which is a small and isolated island system unable to receive power through interconnection lines. In this area, the criterion of stable supply is to secure the supply capacity over peak demand by deducting the capacity of the largest generating unit and the balancing capacity with frequency control ('Generator I-a,' 301 MW in total), without applying the criteria of other interconnected areas.[23]

Table 2-5 shows the monthly reserve margin against the deduction of the capacity of Generator I-a, indicating that the stable supply was secured in each month.

[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.
[22] See footnote 19.
[23] See footnote 20.

Table 2-5 Monthly Reserve Margin against the Deduction of the Capacity of Generator I-a (at the sending end)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Okinawa	36.3%	34.9%	19.6%	18.5%	16.7%	11.8%	14.1%	26.5%	33.6%	34.1%	39.0%	46.9%

b. Difference Between Scheduled Maintenance of Generating Facility for FY 2022 Evaluated by the Conventional Approach

Figure 2-3 shows the monthly scheduled maintenance planned for FY 2022 in the 2022 Supply Plan. Figure 2-4 shows the difference in scheduled maintenance for FY 2022 between the supply plans of FY 2022(the 1st year) and FY 2021 (the 2nd year).

The Organization has requested that all EPCOs avoid the period of tight supply and demand balance for their generating facilities' scheduled maintenance; as a result, the schedule maintenance decreased compared with the 2021 Supply Plan.

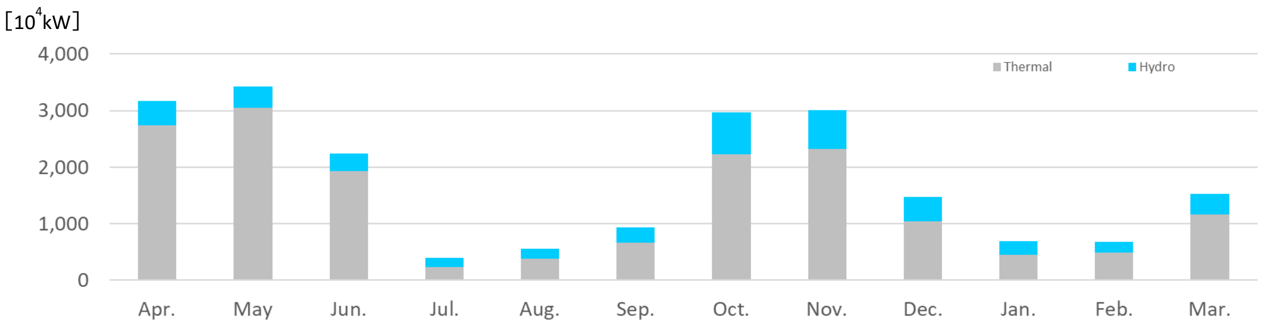


Figure 2-3 Monthly Scheduled Maintenance Planned for FY 2022 in 2022 Supply Plan

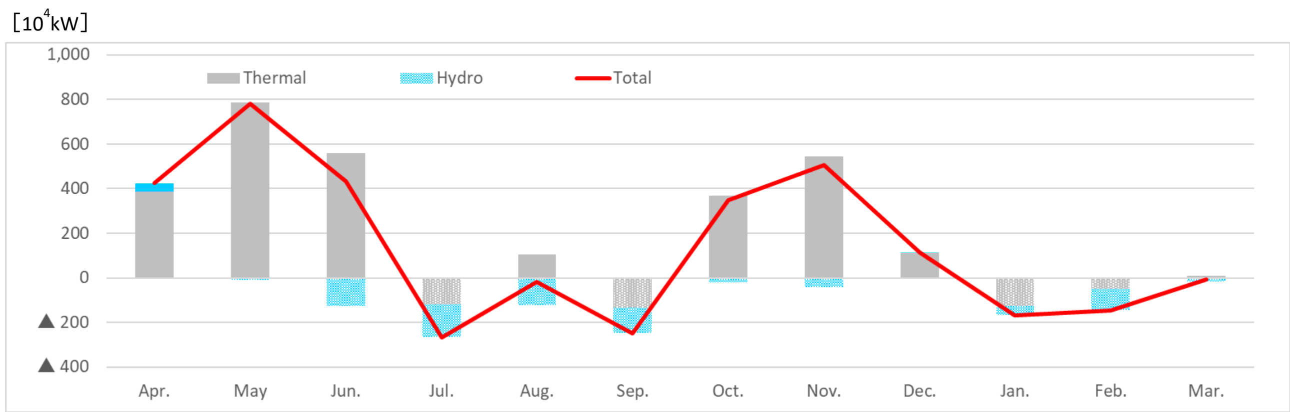


Figure 2-4 Difference in Scheduled Maintenance for FY 2022 between FY 2021 (the 2nd year) and FY 2022 (the 1st year) Supply Plan

c. Suspension and Decommissioning of Generating Facilities in 2022 Supply Plan

Table 2-6 shows the suspension and decommissioning of generating facilities in the 2022 Supply Plan. The plan adds an additional capacity of 140 MW to the suspension and decommissioning plan.

Furthermore, 4,070 MW of generating facilities has already been included in the suspension and decommissioning plan untill FY 2021. In total, a 4,210 MW capacity is planned for the suspension and decommissioning in FY 2022.

Table 2-6 Suspension and Decommissioning of Generating Facilities in 2022 Supply Plan (10^4 kW)

Fuel	Newly Added	Already Included	Total Capacity to be Decommissioned
LNG	—	311	311
Oil	—	60	60
Coal	14	36	50
Total	14	407	421

d. Capacity Secured and Surplus Power Evaluated by the Conventional Approach

Figure 2-5 compares the supply capacity to be procured[24] by a retail company for their forecasted peak demand and the surplus power of generation companies. The supply capacity to be procured exceeds the surplus power in August 2022.

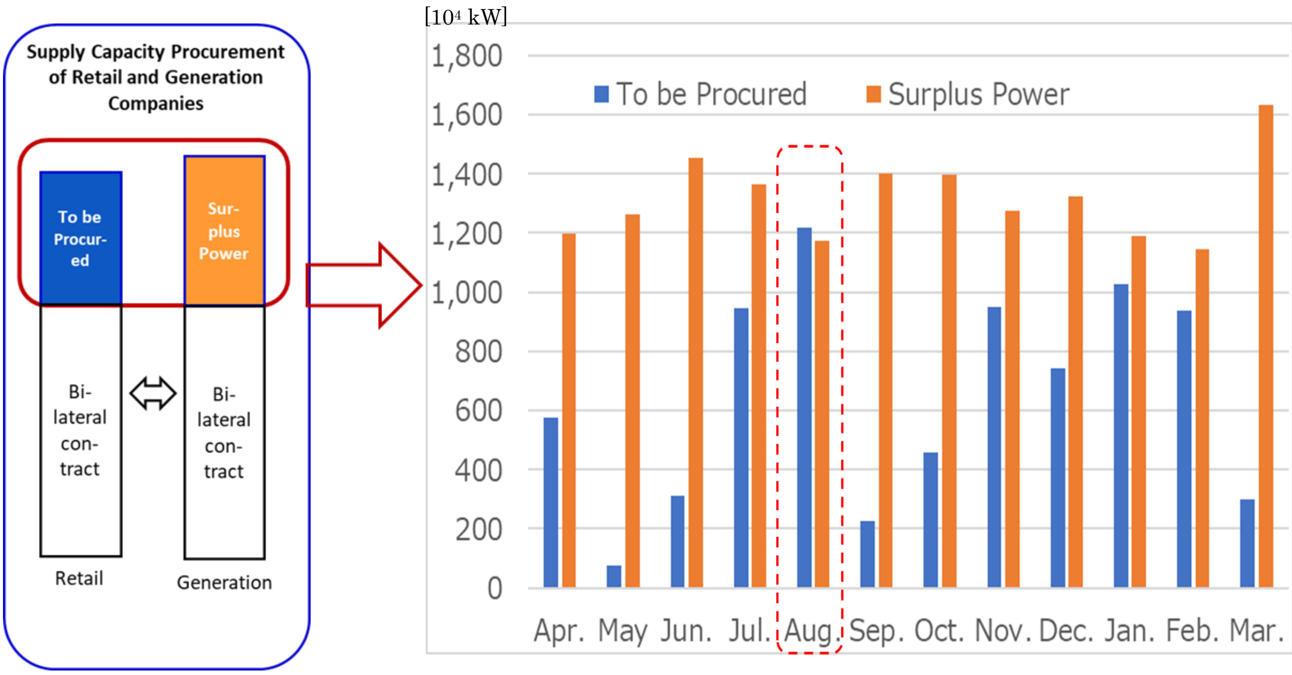


Figure 2-5 Comparison Between Supply Capacity to Be Procured by a Retail Company for Their Forecasted Peak Demand and Surplus Power of Generation Companies

4. Evaluation of Energy Supply

To evaluate the energy supply (kWh), the Organization plans to implement a semi-annual evaluation, known as an "Electricity Supply–demand Verification," in spring and autumn. In these times, information for demand forecast, such as weather forecast is obtained, and additional generation fuel can be available. In addition to the above evaluation, the Organization plans to monitor the

[24] Supply capacity to be procured: Σ(forecasted peak demand of retail companies – procured supply capacity of retail companies).

energy supply twice a month and publish the results.

The Organization does not implement the evaluation of energy supply balance in the aggregation of the supply plans; however, it confirms the annual energy supply balance at this point and publishes information that will lead to a response from the EPCOs.

a. Projection of Energy Supply

Figure 2-6 shows the monthly energy supply balance for a total of nine interconnected areas in FY 2022(the 1st year of the projected period of FY 2022 plans). Table 2-7 shows the forecasted energy requirement of the FY 2022 plan, and volumes and shortage rates from the forecast. It seems that the energy supply[25]* will be 0.2–2.4 TWh/month less than the forecasted energy requirement (equivalent to 0.3 to 3.2% against the forecast energy requirement) throughout the year.

The Organization expects retail companies to premeditatedly procure supply capacity, and generation companies to procure generation fuel to increase energy generation for actual demand and supply timing based on the projection. Additionally, the Organization shall confirm the projection of securing energy supply by implementing kWh monitoring for the high demand period.

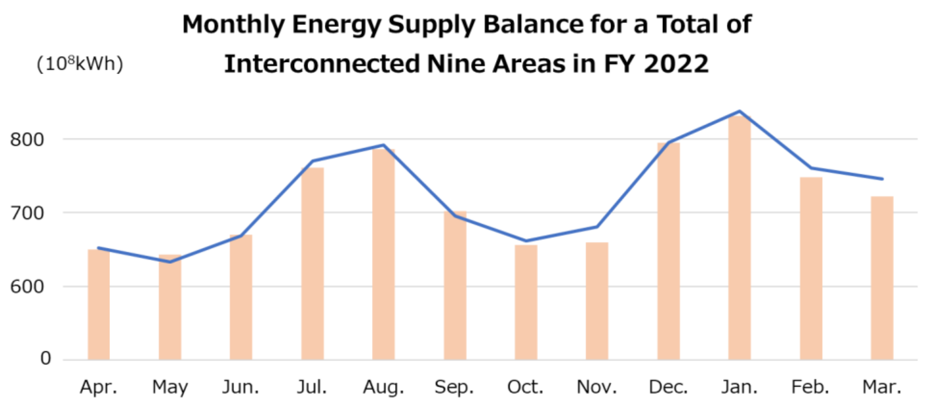


Figure 2-6 Monthly Energy Supply Balance for a Nine Interconnected Areas in FY 2022

Table 2-7 Forecasted Energy Requirement of FY 2022 Plan, Volumes, and Rates of Shortage from the Forecast

(10^8kWh)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Annual total
Forecasted Energy Requirement	652	633	669	770	792	696	662	681	795	838	761	746	8,695
Projected Energy Supply Shortage	-2	10	1	-9	-6	6	-6	-21	0	-7	-13	-24	-71
Projected Shortage Rate	-0.3%	1.6%	0.1%	-1.2%	-0.8%	0.9%	-0.9%	-3.1%	0.0%	-0.8%	-1.7%	-3.2%	-0.8%

b. Evaluation of Energy Supply (Energy to Be Procured and Surplus Energy)

Figure 2-7 shows the comparison of energy supply, which retail companies plan to procure from the energy market and surplus energy that the generation companies are expected to provide. Surplus energy exceeds the procurement by retail companies throughout the year due to the retail companies' planned procurement and the surplus energy provided by generation companies. The Organization monitors the condition to succeed.

[25] Projected energy supply is an addition of energy supply with bilateral contract to retail companies which includes generation of nonelectric power companies, and generation surplus.

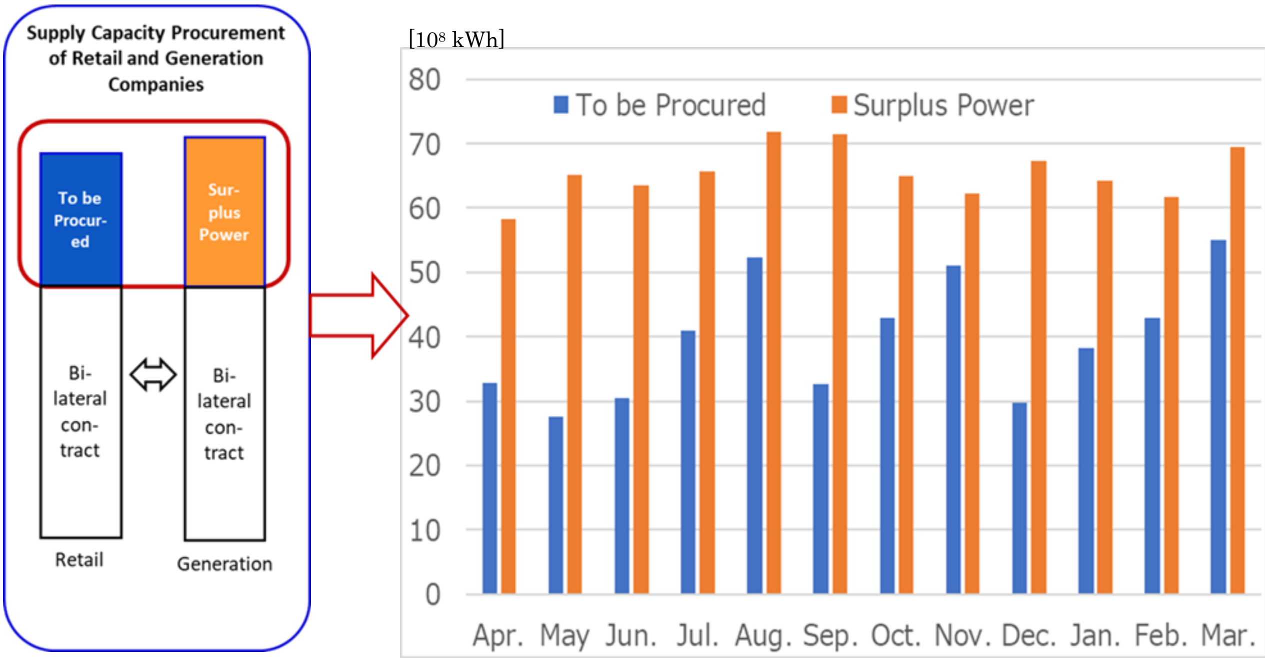


Figure 2-7 Comparison of Retail Companies' Energy Supply Procurement and Surplus Energy Provision

5. Evaluation of Supply-Demand for Supply Capacity and Energy Supply

・ Evaluation of Supply Capacity by the EUE Approach

For the short term of the projected period (FY 2022 and 2023), the EUE indices are satisfied in all areas and years. In contrast, for the mid-to-long term, the EUE indices exceed the criteria for the Kyushu area from FY 2024 to FY 2029, and the Okinawa area from FY 2025 to FY 2027, and FY 2029.

・ Evaluation of Supply Capacity by the Conventional Approach

The 8% resereve margin is secured in FY 2022 and 2023 in every area and for all months.

・ Evaluation of Energy Supply

The energy supply in FY 2022 is expected to be 0.2 to 2.4 TWh/month of volume less than the forecasted energy requirement (equivalent to 0.3 to 3.2% against the forecast energy requirement) throughout the year.

In the short term, all areas or periods satisfy EUE, and none fall below the 8% criteria. The Organization proceeds to review supply measures based on the analytical result of supply–demand variance risk which premises severe climate conditions (heatwave and severe cold) emerge once in 10 years.

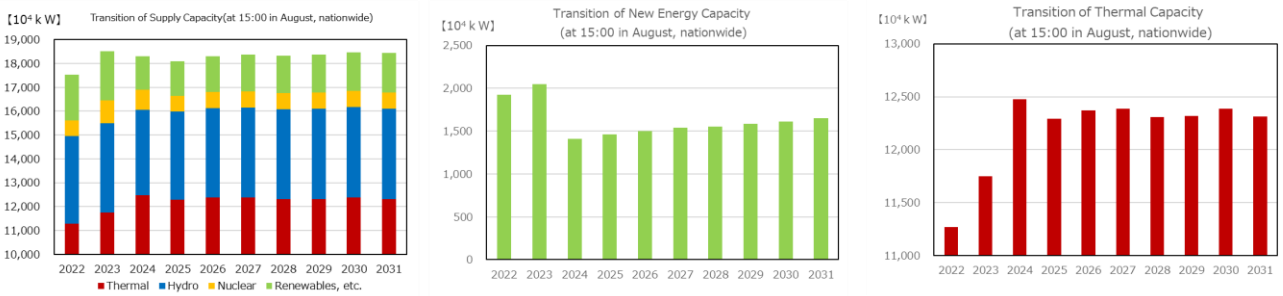
For the mid-to-long term, after FY 2024, considering the area and period of not achieving EUE, the Organization shall carefully examine supply capacity in future supply plans based on the continuous watch on generation facility development

[Reference] Detailed Analysis of the Aggregation

a. Transition of Supply Capacity by Generation Sources

Figure 2-8 shows the power generation sources' supply capacity (nationwide in August, at 15:00) in the projected period.

The supply capacity of new energy, etc. is projected to decrease temporarily in FY 2024 due to the calculation using an annual adjustment factor after the year; however, it is projected to increase afterward. Thermal power is projected to increase till FY 2023 by new and added installations, and stay at almost the same level afterward. As a whole, supply capacity is projected to increase untill FY 2023 and stay almost the same after that.



Aggregated value submitted by each electric power company

New Energy, etc: Wind, Solar, Geothermal, Biomass and Waste, classified by "Guideline for the Calculation of Demand and Supply Capacity" (Agency for Natural Resources and Energy: Dec. 2011)

Renewable Energy : New Energy and Hydro

Figure 2-8 Transition of Supply Capacity by Generation Sources

b. Transition of Suspended Thermal Power Plants

Figure 2-9 shows mid-to-long-term projections of suspended thermal power plants (8–12 GW), which are not counted as part of the supply capacity due to long-term planned outages. They will temporarily decrease in FY 2024 due to resuming operation of the some plants and will keep their capacity at about 10 GW in total.

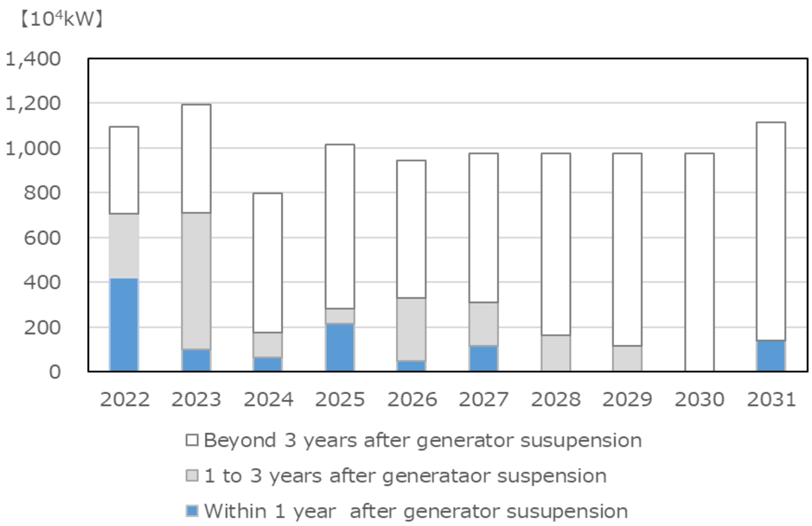


Figure 2-9 Projections of Suspended Thermal Power Plants

III. Analysis of the Transition of Power Generation Sources

This chapter's analysis is based on the automatic aggregation of values submitted by EPCOs. These values will not necessarily be realized in the future due to operating conditions of the 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 an electric power plant's capacity owned by EPCOs and feed-in-tariff (FIT) generators owned by companies (other than EPCOs) registered as procurers of supply capacity of retail and GT&D companies in the projected period. For EPCOs' development plans, only generating facilities with a given probability of development are included in the calculation; however, not all development plans will necessarily be realized; inefficient facilities will proceed toward decomissioning due to political measures in the future.

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

*1 Hydro and Thermal[26]

For existing facilities, the generation company aggregates the generating facility that it owns. For a newly installed facility, a generating facility such as one proceeding with its environmental assessment or publishing its commercial operation, is included in the aggregation.

*2 Nuclear

The generation company aggregates its generating facilities with actual operation experience, in addition to 33 units for which the date for resuming operation is uncertain, and excludes any facility that terminated operation.

*3 Solar and Wind

The GT&D company aggregates the projected value of the generation facility integration according to 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 a power generation source, which are automatically aggregates the EPCOs submission values based on the concepts above.

[26] The same concept is applied to geothermal, biomass, and waste power generation sources.

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

Power Generation Sources		2021	2022	2026	2031
Thermal*1		15,529	15,549	15,353	15,408
	Coal	4,836	5,079	5,234	5,233
	LNG	7,804	7,814	8,244	8,301
	Oil and others[27]	2,888	2,657	1,875	1,874
Nuclear*2		3,308	3,308	3,308	3,308
Hydro and Renewables		12,552	13,109	14,907	16,533
	Conventional Hydro	2,175	2,184	2,191	2,199
	Pumped Storage	2,747	2,747	2,747	2,747
	Wind*3	469	531	1,026	1,575
	Solar*3	6,541	6,940	8,165	9,238
	Geothermal*1	54	49	54	55
	Biomass*1	480	575	656	650
	Waste*1	85	82	68	69
Miscellaneous		79	97	98	98
Total		31,469	32,063	33,666	35,348

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

*1 The Organization automatically aggregates the value of the generation company's genererating facility; however, not all development plans will necessarily be realized; inefficient facilities will be retired resulting from actions due to political measures in the future. For newly installed facilities, generating facilities such as those proceeding with environmental assessments or publishing commercial operations, are included in the aggregation.

*2 Facilities with actual operation experience are included, along with 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 the application of preliminary consultation and the available connecting capacity of its transmission lines or the actual growth trend of integration.

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

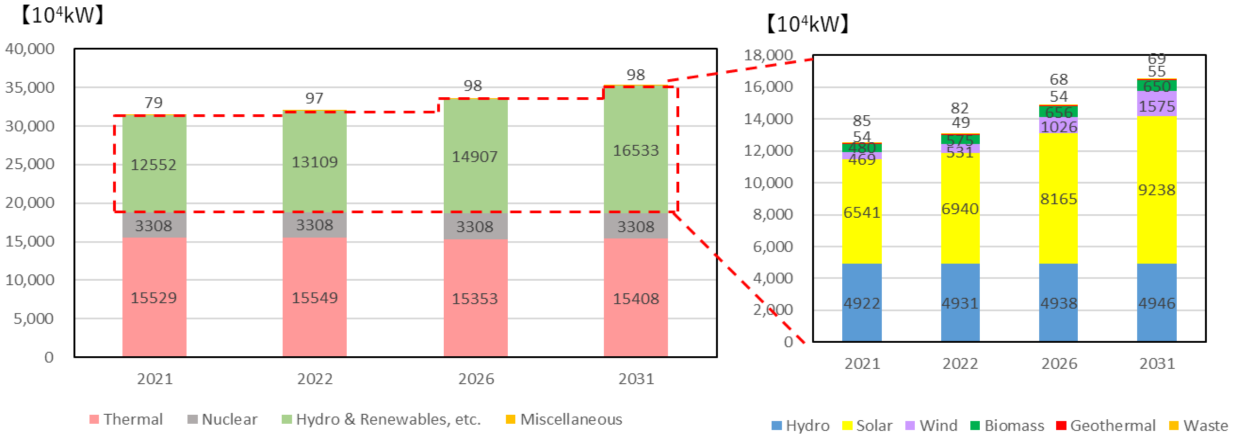


Figure 3-1 Transition of Installed Power Generation Capacities by Power Generation Sources (Nationwide)

* The sum of each power generation source's installed power generation capacity 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 2021.

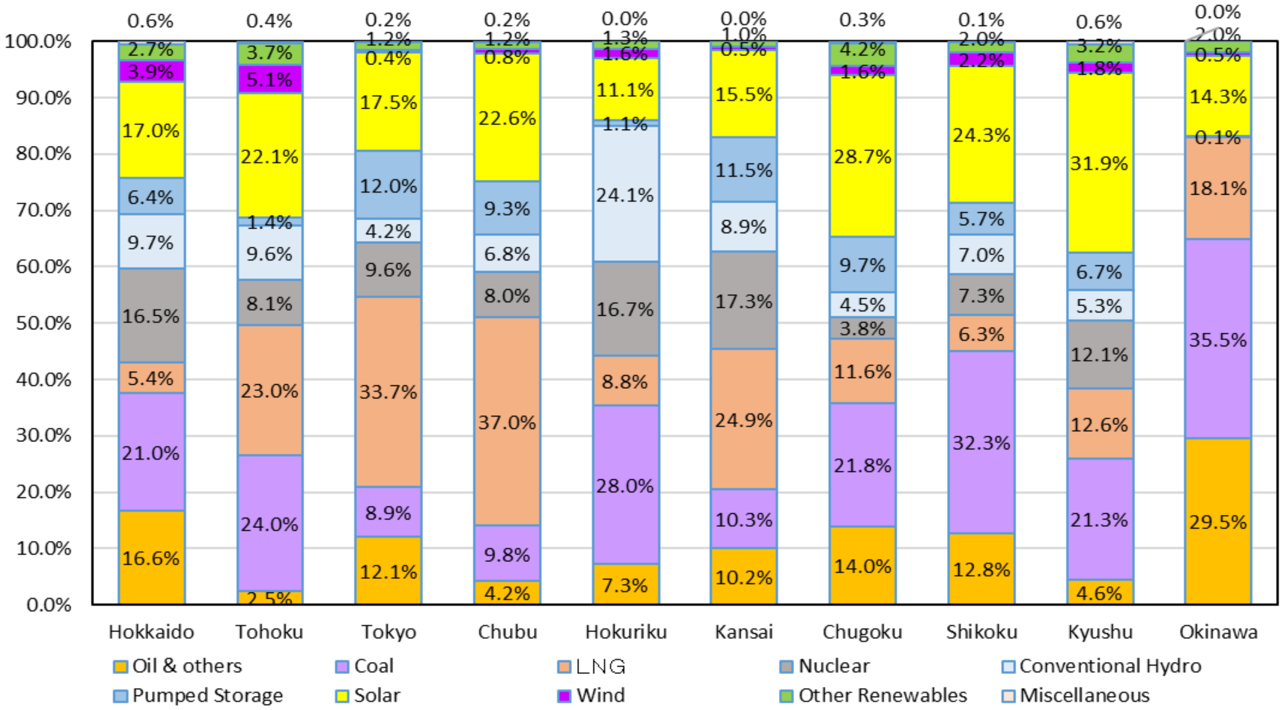


Figure 3-2 Composition of Installed Power Generation Capacity (kW) for Each Regional Service Area

* The ratio of the installed power generation capacity by each power generation source is calculated from the 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 for each regional service area (at the end of the indicated fiscal year).[28]

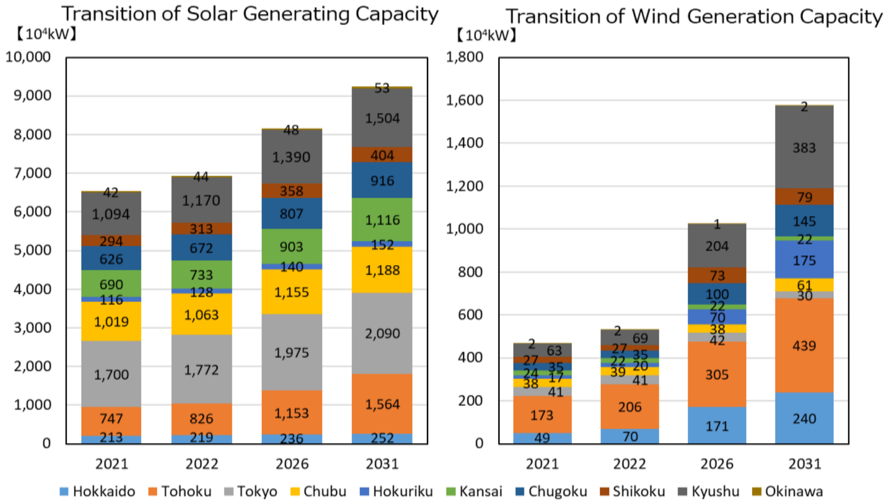


Figure 3-3 Transition of Solar and Wind Generating Capacity for Each Regional Service Area

[28] The GT&D company of each regional area aggregates the projected value of generation facility integration according to the 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 the Power Generation Source

Table 3-2 shows the generation companies' development plans[29] up to FY 2031, according to each company's new developments, uprated or derated installed facilities, and planned decommissioning of facilities in the projected period.

Table 3-2 Generation Development Plans up to FY 2031 by Stages[29] (Nationwide, 10^4 kW)

Power Generation Sources		New Installation		Uprating/Derating		Decommissioning	
		Capacity	Sites	Capacity	Sites	Capacity	Sites
Hydro		**44.6**	**68**	**6.0**	**43**	**△19.3**	**35**
	Conventional	44.6	68	6.0	43	△19.3	35
	Pumped Storage	—	—	—	—	—	—
Thermal		**1,199.5**	**28**	**0.7**	**1**	**△1,172.9**	**37**
	Coal	482.0	7	—	—	△28.8	2
	LNG	714.9	15	0.7	1	△216.8	6
	Oil	2.6	6	—	—	△927.3	29
	LPG	—	—	—	—	—	—
	Bituminous	—	—	—	—	—	—
	Other Gas	—	—	—	—	—	—
Nuclear		**1,018.0**	**7**	**15.2**	**1**	**0.0**	**0**
Renewables		**1,045.7**	**376**	**△0.6**	**2**	**△81.3**	**64**
	Wind	363.6	89	—	—	△65.0	52
	Solar	510.2	241	—	—	△0.2	1
	Geothermal	7.5	5	—	—	△5.0	1
	Biomass	158.3	37	—	—	△4.8	3
	Waste	6.2	4	△0.6	2	△6.3	7
Total		**3,307.8**	**479**	**21.3**	**47**	**△1,273.4**	**136**

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

[29] These are aggregated including facilities for which the commercial operation date is "uncertain."

[Reference] Net Electric Energy Generation (at the Sending End)

The net electric energy generation (at the sending end) for the projected period is an estimation[30] of values calculated by the power generation source in a given premise for each generation or GT&D company. This is not necessarily the same as the actual net electric energy generation.

Each generation company submits 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 operational cost. Furthermore, 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, the estimation is not necessarily the same as the electric energy generation in the future, and is likely to approximate the target value of the country's energy mix.

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

(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 generation facility integration, according to the preliminary consultation and the available connecting capacity of its transmission lines or the actual growth trend of the integration. For geothermal, biomass and waste power generation sources, the generation company calculates its energy generation based on the company's development plans.

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		2021	2022	2026	2031
Renewables		1,159	1,268	1,516	1,727
	Wind	83	95	179	274
	Solar	782	829	967	1,082
	Geothermal	25	26	28	29
	Biomass	242	293	317	316
	Waste	27	26	25	25

[30] This estimation includes the electric energy generated from generation facilities owned by generation companies and generation facilities such as FIT generators, which retail companies or GT&D companies procure from sources other than generation companies.

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

The generation company calculates its energy generation based on the company's development plan. 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		2021	2022	2026	2031
Hydro		857	829	850	871
	Conventional	774	764	790	801
	Pumped Storage	83	65	60	69
Thermal		6,229	6,226	6,104	5,869
	Coal	2,715	2,974	3,004	2,897
	LNG	3,212	3,026	2,894	2,772
	Oil and others [277]	302	226	206	200

(3) Nuclear (Table 3-5)

The generation company calculates its energy generation based on the plan that the company develops for units resuming operation at the end of February 2022. 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 the resumption of operation are excluded from the estimation.

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

Generation Source	2021	2022	2026	2031
Nuclear	675	599	551	552

Table 3-6 sums items (1), (2), and (3) above, with the energy generation categorized as "miscellaneous."

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

	2021	2022	2026	2031
Total	9,038	8,978	9,072	9,065

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

Figure 3-4 shows each regional service area's net electric energy generation in FY 2021.

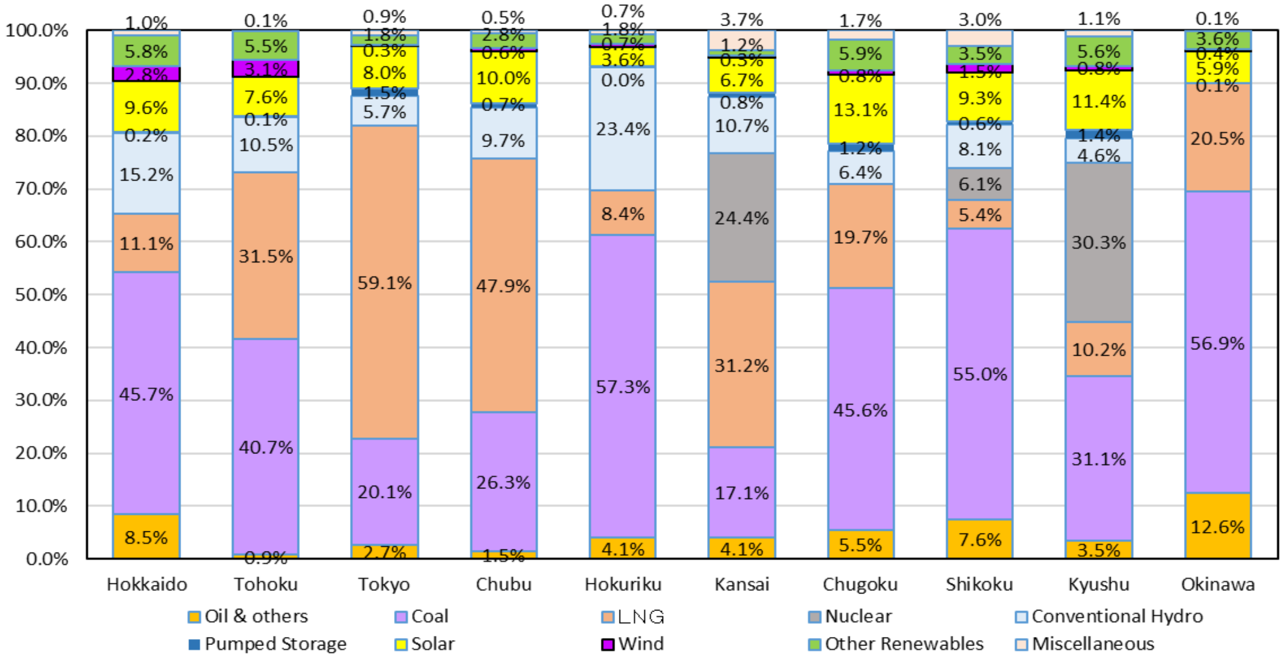


Figure 3-4 Composition of the Net Electric Energy Generation (kWh) for Each Regional Service Area

[Reference] Transition of Capacity Factors by Power Generation Source

Table 3-7 and Figure 3-5 show the capacity factors by the 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 to the Organization.

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

Table 3-7 Capacity Factors by Power Generation Source (Nationwide)

Power Generation Sources		2021	2022	2026	2031
Hydro		19.9%	19.2%	19.6%	20.0%
	Conventional	40.6%	39.9%	41.1%	41.5%
	Pumped Storage	3.5%	2.7%	2.5%	2.9%
Thermal		45.8%	45.7%	45.4%	43.4%
	Coal	64.1%	66.8%	65.5%	63.0%
	LNG	47.0%	44.2%	40.1%	38.0%
	Oil and others [27]	11.9%	9.7%	12.6%	12.1%
Nuclear		23.3%	20.7%	19.0%	19.0%
Renewables		17.3%	17.7%	17.4%	17.0%
	Wind [31]	20.1%	20.3%	19.9%	19.8%
	Solar [31]	13.6%	13.6%	13.5%	13.3%
	Geothermal	52.3%	59.6%	59.2%	59.9%
	Biomass	57.5%	58.2%	55.1%	55.3%
	Waste	36.6%	36.4%	41.8%	41.3%

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

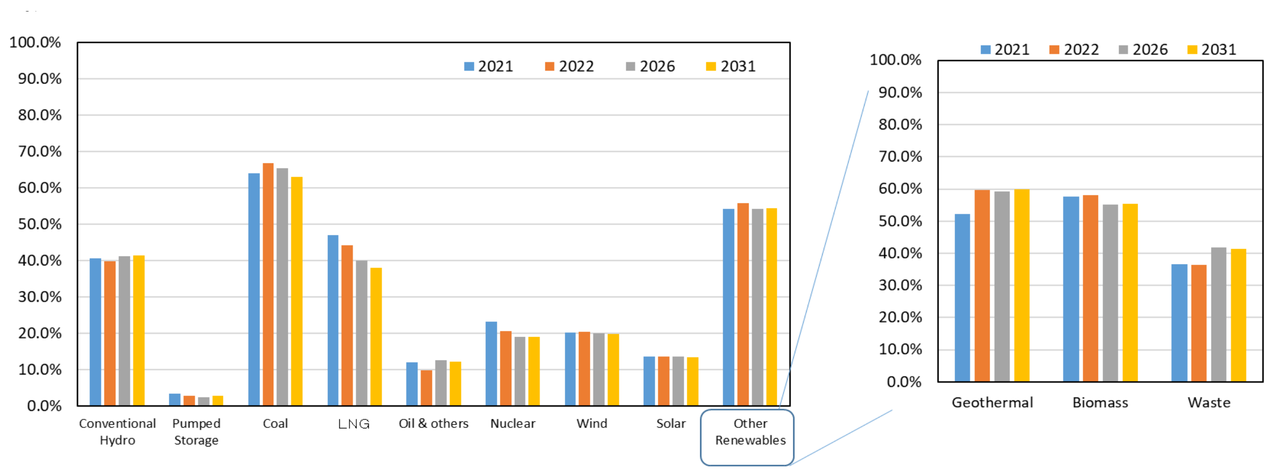


Figure 3-5 Capacity Factors by Power Generation Source (Nationwide)

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

IV. Development Plans for Transmission and Distribution Facilities

The Organization aggregates the development plans[32] for cross-regional transmission lines and substations (transformers and AC/DC converters) up to FY 2031, as submitted by GT&D and transmission companies. Table 4-1 shows the development plans for cross-regional transmission lines and substations, and Figure 4-1 shows the outlook for electric systems nationwide. Items (1), (2), and (3) below list the development plans according to cross-regional transmission lines, major substations, and summaries, respectively.

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

Increased Length of Transmission Lines [34]*[35]		672 km (635 km)
	Overhead Lines*	616 km (597 km)
	Underground Lines	56 km (39 km)
Uprated Capacities of Transformers		28,578 MVA (29,235 MVA)
Uprated Capacities of AC/DC Converters [36]		1,200 MW (900 MW)
Decreased Length of Transmission Lines (Decommissioning)		△101 km (△61 km)
Derated Capacities of Transformers (Decommissioning)		△4,550 MVA (△4,300 MVA)

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

Interconnection Facility Enhancement Plan between Hokkaido and Honshu
(900 MW→1,200 MW; in-service: March 2028)

AC/DC Converter Stations	・Hokuto Converter Station: 300 MW→600 MW ・Imabetsu Converter Station: 300 MW→600 MW
275 kV DC Lines	・Hokuto Imabetsu DC Interconnection Line: 122 km ・Imabetsu Bulk Line extension: 50 km

[32] Development plans for transmission lines and substations must be submitted for voltages higher than 250 kV, or within two classes of the highest voltage available in the regional service areas. (For the Okinawa EPCO, the requirement applies only for 132 kV or more.) The totals are not necessarily equal due to independent rounding.
[33] The figures in parentheses are those from 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] The DC transmission system includes installed capacity for the converter station on one side.

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

500kV Transmission Lines	・(prov.)Cross-regional North Bulk Line: 79 km ・(prov.)Cross-regional South Bulk Line: 64 km ・Soma-Futaba Bulk Line/ Connecting Point Change: 16 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 ・ Fukushima Bulk Line/Mountain Line connecting point change: 1 km
Switching Stations	(prov.)Cross-regional Switching Station: 10 circuits

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

Frequency Converter Stations	・Shin Sakuma FC station: 300 MW ・Higashi Shimizu FC station: 300 MW→900 MW
275 kV Transmission Lines	・Higashi Shimizu Line: 19 km ・Sakuma Higashi Bulk Line/ Shin Sakuma FC Branch Line: 3 km ・Sakuma Nishi Bulk Line/ Shin Sakuma FC Branch Line: 1 km ・Shin Toyone-Toei Line: 1 km ・Sakuma-Toei Line: 11km, 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
275 kV Transformers	・Shin Fuji Substation: 200MVA×1→0MVA

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: 0.5 km
Switching Stations	・Sekigahara Switching Station: 6 circuits ・Kita Oomi Switching Station: 6 circuits

Interconnection Facility Enhancement Plan between Chubu and Hokuriku
(In-service: undetermined)*under review as part of reinforcement in the master plan

BTB Converter Stations	Minami Fukumitsu Converter Station: 300 MW→0 MW (to be decommissioned)

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

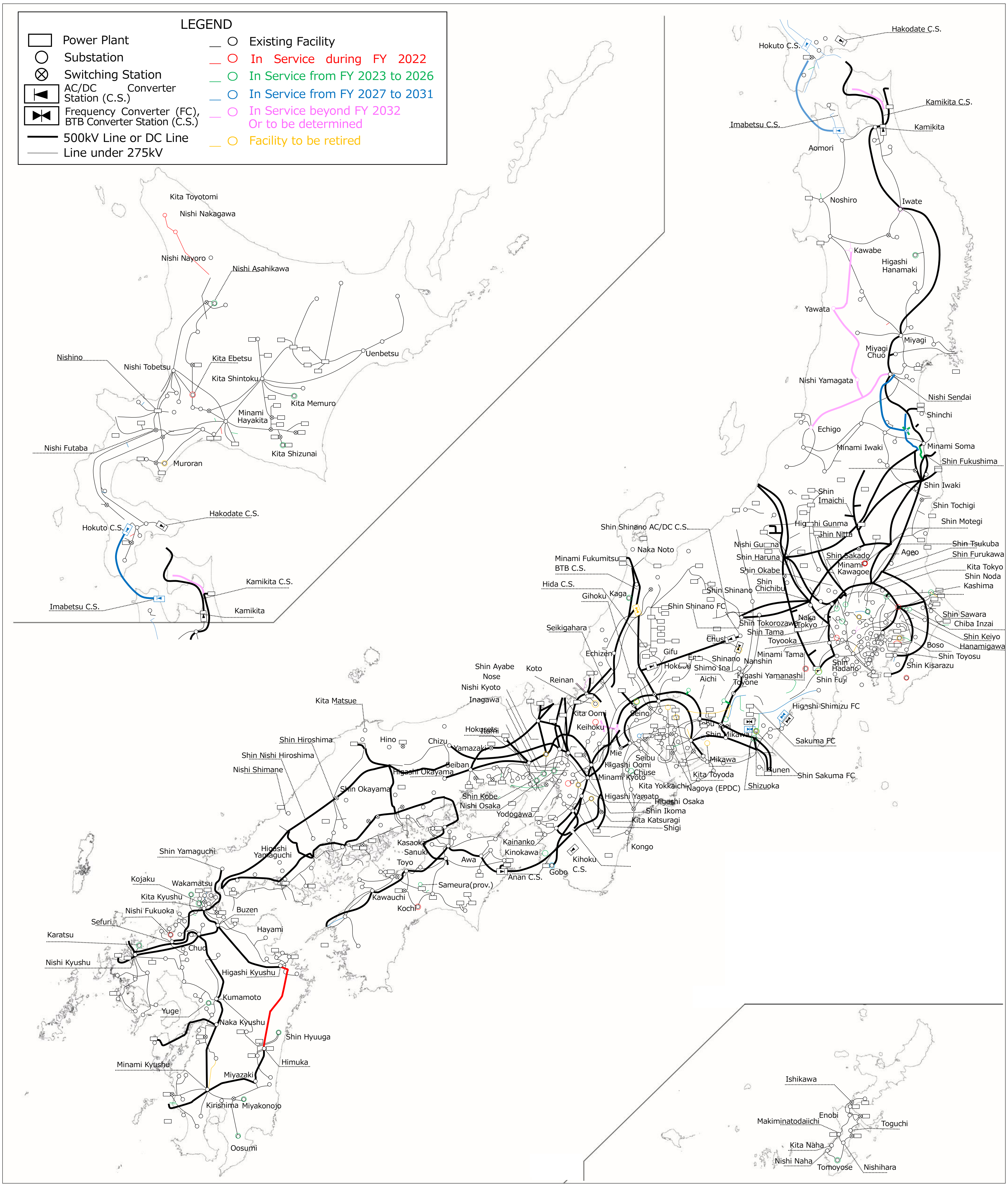


Figure 4-1 Power Grid Configuration in Japan

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]
Hokkaido Electric Power Network, Inc.	Tsuruoka branch Line	187kV	0.1km	1	Sep. 2020	Aug. 2022	Generator connection
Tohoku Electric Power Network Co., Inc.	Kita Horonobe Line	100kV→187kV	69km	2	May 2021	Jul. 2022	Generator connection
	Branch Line B *1	187kV	0.1km	1	May 2021	Aug. 2022	Generator connection
TEPCO Power Grid, Inc.	Plant A Access Line*1	275kV	3km	1	Apr. 2021	Dec. 2022	Generator connection
	Soma-Futaba Bulk Line/connecting point change	500kV	16km	2	Mar. 2022	Nov. 2025	Generator connection, Reliability upgrade*4
	Shinjuku Line replacement	275kV	22.1km→ 21.2km (No.1)*2*3 19.9km→ 21.2km (No.2)*2*3 19.8km→ 21.2km (No.3)*2*3	3	Aug. 2019	Aug. 2028(No.1) Nov. 2032(No.2) Nov. 2025(No.3)	Aging management
	Chiba Inzai Substation lead-in	275kV	10.5km	2	Apr. 2020	Apr. 2024	Demand coverage
	Anegasaki Access Line*1	275kV	0.5km	2	Jun. 2021	May 2022(No.1) Jun. 2022(No.2)	Generator connection
	Johoku Line	275kV	20.9km*2	3	Dec. 2021	Feb. 2030	Economic upgrade
Chubu Electric Power Grid Co., Inc.	Shimo Ina Branch Line	500kV	0.3km	2	Dec. 2021	Oct. 2024	Demand coverage
	Ena Branch Line	500kV	1km	2	Jun. 2020	Oct. 2025	Demand coverage
	Higashi Nagoya -Tobu Line	275kV	8km*3	2	Apr. 2019	Nov. 2025	Aging management, Economic upgrade
Kansai Transmission and Distribution, Inc.	(prov.) Himeji Access Line*1	275kV	0.9km*2	2	Mar. 2021	Jan. 2025	Generator connection
	(prov.) Himeji Access West Branch Line*1	275kV	1.2km*3	2	Sep. 2021	Feb. 2024	Aging management
	Shin Kakogawa Line	275kV	25.3km*3	2	Jul. 2021	Jun. 2025	Generator connection, Aging management

[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 that the change in line category or circuit numbers is not included in Table 4-1.
[41] The purpose is stated below: *4 indicates enforcement related to cross-regional interconnection lines.
*5 indicates that the case is under review in the master plan of the cross-regional development.

Demand coverage	Related to increase/decrease demand
Generator connection	Related to generator connection or retirement
Aging management	Related to aging management of facilities (including the proper update of facilities and 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	Voltage	Length,	Circuit	Under construction	In service	Purpose
Kyushu Electric Power Transmission & Distribution Co., Inc.	Hyuga Bulk Line	500kV	124km	2	Nov. 2014	Jun. 2022	Reliability upgrade, Economic upgrade
	Shin Kagoshima Line/ Sendai Plant π lead-in*1	220kV	2km→ 4km*3	1→2	Aug. 2020	Dec. 2023	Economic upgrade
	Shin Kokura Line	220kV	15km→ 15km*2*3	3→2	Apr. 2021	Oct. 2029	Aging management
J-POWER Transmission Network Co.,Ltd.	Ooma Bulk Line	500kV	61.2km	2	May 2006	TBD	Generator connection
Northern Hokkaido Wind Energy Transmission Company (NHWETC)	NHWETC Toyotomi-Nakagawa Bulk Line	187kV	51km	2	Sep. 2018	Sep. 2022	Generator connection
Fukushima Souden	Abukumananbu Line	154kV	22km*2	1	Jul. 2020	May 2024	Generator connection

Table 4-3 Development Plans in Planning Stages

Company	Line	Voltage	Length,	Circuit	Under construction	In service	Purpose
Hokkaido Electric Power Network, Inc.	Plant C Access Line*1	275kV	0.1km	1	May 2024	Nov. 2025	Generator connection
	Plant D Access Line*1	275kV	0.1km	1	Jun. 2023	Feb. 2025	Generator connection
	Branch Line E *1	187kV	2.4km	2	May 2024	Aug. 2028	Demand coverage
	Branch Line F *1	275kV	7.9km	2	May 2024	Aug. 2028	Demand coverage
	Branch Line G *1	187kV	5.8km	2	May 2024	Aug. 2028	Demand coverage
	Hokuto-Imabetsu DC Interconnection Line	DC-250kV	98km*3 24km*2,3	1→2	Mar. 2024	Mar. 2028	Reliability upgrade
Tohoku Electric Power Network Co., Inc.	Plant B Access Line*1	275kV	0.2km	1	Apr. 2023	May 2024	Generator connection
	Northern Akita Prefecture HS Line	275kV	0.3km	2	May 2023	Dec. 2024	Generator connection
	(prov.)Cross-regional North Bulk Line	500kV	79km	2	Aug. 2022	Nov. 2027	Generator connection, Reliability upgrade*4
	(prov.)Cross-regional South Bulk Line	500kV	64km	2	Aug. 2024	Nov. 2027	Generator connection, Reliability upgrade*4
	(prov.)Shinchi Access Line/ Cross-regional Switching Station lead-in*1	500kV	1km	2	Feb. 2024	Jun. 2026	Generator connection, Reliability upgrade*4
	(prov.)Joban Bulk Line/ Cross-regional Switching Station Dπ lead-in	500kV	1km	2	May 2024	Jul. 2026	Generator connection, Reliability upgrade*4
	(prov.)Cross-regional Switching Station	500kV	-	10	Sep. 2022	Nov. 2027 (Jun. 2026)	Generator connection, Reliability Upgrade*4
	Imabetsu Bulk Line extension	275kV	50km*3	2	Apr. 2023	FY 2027	Generator connection, Reliability upgrade, Aging Management*4
	Akita Bulk Line/ Kawabe Substation DT lead-in	275kV	5km	2	Beyond FY 2023	Beyond FY 2029	Generator connection

Company	Line [33]	Voltage	Length [34,35]	Circuit	Under construction	In service	Purpose [36]
Tohoku Electric Power Network Co., Inc.	Akimori Bulk Line/ Kawabe Substation DT lead-in	275kV	0.3km	2	Beyond FY 2025	Beyond FY 2029	Generator connection
	Asahi Bulk Line uprating	275kV→500kV	139km→138km	2	Beyond FY 2027	Beyond FY 2030	Generator connection
	Minami Yamagata Bulk Line uprating	275kV→500kV	23km→23km	2	Beyond FY 2030	Beyond FY 2030	Generator connection
	Dewa Bulk Line	500kV	96km	2	Apr. 2022	Beyond FY 2031	Generator connection
	Yamagata Bulk Line uprating/ extension	275kV→500kV	53km→103km	2	Beyond FY 2026	Beyond FY 2031	Generator connection
TEPCO Power Grid, Inc.	Higashi Shinjuku Line replacement	275kV	23.4km→5.0km (No.2)*2*3 23.4km→5.3km (No.3)*2*3	2	FY 2024	Nov. 2032 (No.2) Nov. 2025 (No.3)	Aging management
	MS18GHZ051500 Access Line (prov.)	275kV	0.1km	2	Jun. 2024	Jan. 2025	Generator connection
	Higashi Shimizu Line	275kV	12.4km 6.4km (diversion)	2	Dec. 2022	Jan. 2027	Reliability upgrade*4
	Nishi Gunma Bulk Line /Higashi Yamanashi Substation T lead-in	500kV	0.1km(No.2)*3 0.1km(No.2)*3	2→3	May 2022	Nov. 2022	Demand coverage
	Goi Access Line*1	275kV	11.1km	2	Apr. 2022	Oct. 2023	Generator connection
	Shin Sodegaura Line	500kV	0.1km	2	May 2026	Mar. 2027 (No.1) Feb. 2028 (No.2)	Generator connection, Reliability upgrade*4
	Fukushima Bulk Line/Mountain Line connecting point change	500kV	1.1km	2	May 2024	Jan. 2025 (No.1) Apr. 2025 (No.2)	Generator connection, Reliability upgrade*4
	Kashima Keihin Line /connecting point change	275kV	0.4km*3	2	Jul. 2023	Apr. 2025 (No.1) Nov. 2024 (No.2)	Economic upgrade
Chubu Electric Power Grid Co., Inc.	Kita Yokkaichi Branch Line	275kV	3km*2 0.2km	2	Dec. 2024	Nov. 2028	Demand coverage, Economic upgrade
	Sekigahara-Kita Oomi Line	500kV	2km	2	TBD	TBD	Generator connection*4, *5
	Sekigahara Switching Station	500kV	—	6	TBD	TBD	Generator connection*4, *5
	Sangi Bulk Line/ Sekigahara Switching Station π lead-in	500kV	1km	2	TBD	TBD	Generator connection*4, *5
Kansai Transmission and Distribution, Inc.	Kita Oomi Switching Station	500kV	—	6	TBD	TBD	Generator connection*4, *5
	Kita Oomi Line/ Kita Oomi Switching Station πlead-in	500kV	0.5km	2	TBD	TBD	Generator connection*4, *5
	Tsuruga Line/ North side improvement	275kV	9.8km→ 9.3km*3	2	TBD	TBD	Aging management
Shikoku Electrc Power Transmission and Distribution, Inc.	Ikata North Bulk Line	187kV	19km*3	2	Feb. 2024	Sep. 2028	Aging management
Kyushu Electric Power Transmission and Distribution, Inc.	Hibiki Access Line*1	220kV	4km	2	Mar. 2023	Jul. 2025	Generator connection

Company	Line[33]	Voltage	Length[34,35]	Circuit	Under construction	In service	Purpose[36]
J-POWER Transmission Network Co.,Ltd.	Sakuma Higashi Bulk Line/FC Branch Line	275kV	3km	2	FY 2023	FY 2026	Reliability upgrade*4
	Sakuma-Toei Line/ FC Branch Line	275kV	1km	2	FY 2023	FY 2026	Reliability upgrade*4
	Shin Toyone-Toei Line	275kV	1km	1	FY 2023	FY 2026	Reliability upgrade*4
	Sakuma-Toei Line	275kV	11km→ 11km*3	2	FY 2023	FY 2027	Reliability upgrade*4
	Sakuma Higashi Bulk Line	275kV	123.7km→ 123km*3	2	May 2022	FY 2027	Reliability upgrade*4
	Nabari Bulk Line/Reihoku-Kunimisan Branch Line	187kV	0.1km	1	FY 2025	FY 2026	Generator connection

Table 4-4 Decommissioning Plans

Company	Line	Voltage	Length	Circuit	Retirement	Purpose[36]
TEPCO Power Grid, Inc.	Kashima Thermal Power Line No.1, No.2	275kV	△5.0km	2	May 2025	Economic upgrade
Kyushu Electric Power Transmission and Distribution, Inc.	Kagoshima Bulk Line	220kV	△35km	2	Jun. 2022	Aging management
J-POWER Transmission Network Co.,Ltd.	Shin Toyone-Toei Line	275kV	△3km	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 [33,42]	Voltage	Capacity	Unit	Under construction	In service	Purpose [36]
Hokkaido Electric Power Network, Inc.	Nishi Nakagawa*6	187/100kV	100MVA×2	2	Apr. 2020	Jul. 2022	Generator connection
	Kita Ebetsu	187/66kV	100MVA→ 150MVA	1→1	Aug. 2021	Jul. 2022	Aging management
TEPCO Power Grid, Inc.	Higashi Yamanashi	500/154kV	750MVA	1	Nov. 2019	Dec. 2022	Demand coverage
	Shin Kisarazu	275/154kV	450MVA×2	2	Aug. 2020	May 2022 (8B) Jun. 2022 (5B)	Generator connection
	Minami Tama	275/66kV	200MVA→ 300MVA	1→1	Jun. 2021	Jun. 2022	Demand coverage
	Shin Tochigi	500/154kV	750MVA	1	May 2021	Nov. 2022	Generator connection
	Chiba Inzai*6	275/66kV	300MVA×2	2	Mar. 2022	Apr. 2024	Demand coverage
Chubu Electric Power Grid Co., Inc.	Shimo Ina*6	500/154kV	300MVA×2	2	Jun. 2021	Oct. 2024	Demand coverage
	Higashi Shimizu	—	600MW	—	Dec. 2020	Mar. 2028	Reliability upgrade*4
Hokuriku Electric Power Transmission & Distribution Co.	Kaga	275/154kV	400MVA	1	Sep. 2021	Dec. 2023	Reliability upgrade
Kansai Transmission and Distribution, Inc.	Yodogawa	275/77kV	300MVA×2→ 300MVA	2→1	Jan. 2021	Sep. 2022	Aging management
	Koto	275/77kV	200MVA→ 300MVA	1→1	Feb. 2022	Oct. 2022	Aging management
Shikoku Electric Power Transmission & Distribution Co., Inc.	Kochi	187/66kV	200MVA→ 300MVA	1→1	Sep. 2021	Jul. 2022	Aging management, Demand coverage
Kyushu Electric Power Transmission & Distribution Co., Inc.	Shin Hyuga	220/110/66kV	250/150 /200MVA	1	Jun. 2021	Apr. 2023	Generator connection
	Miyakonojo	220/110kV	150MVA	1	Sep. 2021	Mar. 2024	Generator connection
	Oosumi	110/66kV → 220/110 /66kV	60MVA → 250/100 /200MVA	1→1	Mar. 2022	Feb. 2025	Generator connection
	Nishi Fukuoka	220/66kV	180MVA×2→ 300MVA	2→1	Sep. 2020	Apr. 2022	Aging management
	Kojaku	220/66kV	150MVA→ 200MVA	1→1	Jun. 2021	Jun. 2023	Aging management
The Okinawa Electric Power Co., Inc.	Tomoyose	132/66kV	125MVA×2→ 200MVA×2	2→2	Oct. 2017	Mar. 2025	Aging management
NHWETC	Kita Toyotomi*6	187/66kV	165MVA×3	3	Apr. 2019	Sep. 2022	Generator connection

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

Table 4-6 Development Plans in Planning Stages

Company	Substation[33,37]	Voltage	Capacity	Unit	Under construction	In service	Purpose[36]
Hokkaido Electric Power Network, Inc.	Kita Memuro	187/66kV	60MVA→ 150MVA	1→1	May 2023	Nov. 2024	Aging management
	Nishi Asahikawa	187/66kV	60MVA→ 100MVA	1→1	May 2023	Nov. 2024	Aging management
	Kita Shizunai	187/66/11kV	45MVA→ 60MVA	1→1	Dec. 2024	Feb. 2026	Aging management
	Hokuto C.S.	—	300MW	—	Mar. 2023	Mar. 2028	Reliability upgrade*4
	Imabetsu C.S.	—	300MW	—	Aug. 2023	Mar. 2028	Reliability upgrade*4
Tohoku Electric Power Network Co., Inc.	Higashi Hanamaki	275/154kV	300MVA	1	Jan. 2023	Oct. 2025	Demand coverage
	Iwate	500/275kV	1,000MVA	1	Beyond FY 2024	Beyond FY 2028	Generator connection
	Echigo*6	500/275kV	1500MVA×3	3	Beyond FY 2024	Beyond FY 2030	Generator connection
	Yawata*6	500/154kV	750MVA	1	Beyond FY 2026	Beyond FY 2031	Generator connection
	Kawabe*6	500/275kV	1500MVA×3	3	Beyond FY 2024	Beyond FY 2031 (Beyond FY 2029)	Generator connection
	Nishi Yamagata*6	275/154kV →500/154kV	300MVA×2 →450MVA×2	2→2	Beyond FY 2024	Beyond FY 2031 (Beyond FY 2030)	Generator connection
	Higashi Hanamaki	275/154kV	300MVA	1	May 2023	Feb. 2027	Demand coverage
TEPCO Power Grid, Inc.	Shin Fuji	500/154kV	750MVA	1	May 2024	Feb. 2027	Reliability upgrade*4
	Kita Tokyo	275/66kV	300MVA	1	Jul. 2022	Feb. 2024	Economic upgrade
	Shin Keiyo	275/154kV	450MVA	1	Apr. 2022	Mar. 2023	Demand coverage
	Kashima	275/66kV	300MVA	1	Apr. 2023	Jun. 2024	Generator connection
	Shin Noda	275/154kV	220MVA→ 300MVA	1→1	Jan. 2023	Oct. 2023	Aging management
	Toyooka	275/154kV	450MVA	1	Sep. 2024	Jun. 2026	Demand coverage
	Naka Tokyo	275/154kV	200MVA→ 300MVA	2→2	Aug. 2023	Jan. 2025 (1B) Jun. 2025 (2B)	Aging management
Chubu Electric Power Grid Co., Inc.	Nakase	275/77kV	150MVA×1→ 250MVA×1	1→1	Sep. 2024	Apr. 2025	Aging management
	Seino	275/154kV	300MVA×2 →450MVA	2→1	Dec. 2024	Jun. 2025	Aging management
	Ena*6	500/154kV	200MVA×2	2	Jun. 2022	Oct. 2025	Demand coverage
	Sunen	275/77kV	150MVA×2→ 250MVA×1	2→1	Nov. 2025	Oct. 2026	Aging management
	Toei	500/275kV	800MVA×1→ 1,500MVA×2	1→2	Apr. 2022	Oct. 2024 (N 2B) Mar. 2027 (1B)	Reliability upgrade*4
	Shizuoka	500/275kV	1,000MVA	1	Dec. 2024	Mar. 2027	Reliability upgrade*4
	Kita Yokkaichi*6	275/154kV	450MVA×3	3	Dec. 2025	Mar. 2027	Demand coverage, Economic upgrade
	Shin Mikawa	500/275kV	1,500MVA	1	Jul. 2027	Aug. 2030	Generator connection
Kansai Transmission and Distribution, Inc.	Gobo	500/154kV	750MVA×2	2	Aug. 2024	Nov. 2027	Generator connection
	Kainanko	275/77kV	300MVA×1、200MVA×2→ 300MVA×2	3→2	Dec. 2022	Jun. 2024	Aging management
	Nishi Osaka	275/77kV	300MVA	1	May 2022	Jun. 2023	Demand coverage
	Shin Kobe	275/77kV	300MVA×1、200MVA×1→ 200MVA×1	2→1	Feb. 2023	Feb. 2024	Aging management

Company	Substation [33,37]	Voltage	Capacity	Unit	Under construction	In service	Purpose [36]
	Itami	275/154kV	300MVA	1	Feb. 2023	Jun. 2024	Aging management
Kyushu Electric Power Transmission & Distribution Co., Inc.	Wakamatsu	220/66kV	250MVA	1	Nov. 2022	Oct. 2024	Generator connection
	Yuge	220/110/66kV	300/100/250MVA	1	Mar. 2024	Jun. 2025	Demand coverage
	Karatsu	220/66kV	150MVA→ 250 MVA	1→1	Jul. 2022	Nov. 2023	Aging management
J-POWER Transmission Network Co.,Ltd.	Shin Satkuma FC*6	—	300MW	—	FY 2024	FY 2027	Reliability upgrade*4
	Minami Kawagoe	275/154kV	264MVA×3, 300MVA→ 300MVA×2, 450MVA×1	4→3	FY 2023	FY 2023 (6B) FY 2024 (2B) FY 2025 (1B)	Aging management
	Sameura (prov.)*6	187/13kV	25MVA	1	FY 2024	FY 2025	Demand coverage
Fukushima souden	Abukumaminami*6	154/66/33kV	170MVA	1	Oct. 2022	Jun. 2024	Generator connection

Table 4-7 Decommissioning Plans

Company	Substation	Voltage	Capacity	Unit	Retirement	Purpose
Hokkaido Electric Power Network, Inc.	Muroran	187/66kV	100MVA	1	Apr. 2023	Aging management
TEPCO Power Grid, Inc.	Hanamigawa	275/66kV	300MVA	1	Mar. 2027	Demand coverage
	Ageo	275/66kV	300MVA	1	Jun. 2024	Economic upgrade
	Shin Fuji	275/154kV	200MVA	1	Apr. 2025	Economic upgrade*4
Chubu Electric Power Grid Co., Inc.	Kita Toyoda	275/154kV	450MVA	1	Dec. 2023	Aging management
	Mikawa	275/154kV	450MVA	1	Apr. 2025	Aging management
	Chushin	275/154kV	300MVA	1	Oct. 2026	Aging management
	Minami Fukumitsu	—	300MW	—	FY 2026	Aging management*4
Kansai Transmission and Distribution, Inc.	Higashi Osaka	275/154kV	300MVA	1	May 2023	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
	Inagawa	500/154kV	750MVA	1	Apr. 2025	Aging management
J-POWER Transmission Network Co.,Ltd.	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 summarize the development or extension plans of major transmission lines and substations (transformers and converter stations) up to FY 2031 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	648 km*	1,295 km*	648 km*	1,296 km*
		Underground	1 km	1 km		
	275kV	Overhead	△164 km	△333 km	△131 km	△235 km
		Underground	33 km	97 km		
	220kV	Overhead	4 km	8 km	4 km	8 km
		Underground	0 km	0 km		
	187kV	Overhead	129 km	257 km	129 km	257 km
		Underground	0 km	0 km		
	154kV	Overhead	0 km	0 km	22 km	22 km
		Underground	22 km	22 km		
	Total	Overhead	616 km	1,227 km	672 km	1,348 km
		Underground	56 km	121 km		
To be Decommissioned	275kV	Overhead	△61 km	△119 km	△61 km	△119 km
		Underground	0 km	0 km		
	220kV	Overhead	△35 km	△70 km	△35 km	△70 km
		Underground	0 km	0 km		
	Total	Overhead	△101 km	△199 km	△101 km	△199 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	245 km*	511 km*
220kV	19 km	23 km
187kV	19 km	38 km
DC 250kV	122 km	244 km
Total	414 km	835 km

43 Length denotes the increased length due to newly installed or extended plans and the decreased length due to decommissioning. 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 total and the overall total lengths are not necessarily equal due to independent rounding.

44 The total length denotes the aggregation of length multiplied by the number of circuits. Development plans corresponding to changes in 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.

Table 4-10 Development Plans for Major Substations

Category [46]	Voltage [47]	Increased Numbers	Increased Capacity
Newly Installed or Extended	500kV	22 [11]	21,100MVA [10,750MVA]
	275kV	8 [3]	4,988MVA [1,350MVA]
	220kV	4 [0]	1,290MVA [0MVA]
	187kV	6 [6]	1,015MVA [720MVA]
	154kV	1 [1]	170MVA [170MVA]
	132kV	0 [0]	75MVA [0MVA]
	110kV	△1 [0]	△60 MVA [0 MVA]
	Total	40 [21]	28,578MVA [12,990MVA]
To be Decommissioned	500kV	△1	△750 MVA
	275kV	△14	△3,700 MVA
	187kV	△1	△100 MVA
	Total	△16	△4,550 MVA

The figures in [ ] indicate the increase in the number of transformers resulting 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	Hokkaido Electric Power Network, Inc.	2	300 MW×2
	Chubu Electric Power Grid Co.,Inc.	1	600 MW
	J-POWER Transmission Network Co., Ltd.	1	300 MW
To be Decommissioned	Chubu Electric Power Grid Co.,Inc.	1	△300 MW

4. Aging Management of Existing Transmission and Distribution Facility

Existing transmission and distribution facilities installed after the economic expansion (from the 1960s to the 1970s) will reach their replacement time. Facilities to be replaced are increasing trend, and significant facilities will remain unreplaced in place of the recent replacement work. Proper decisions for the replacement schedule are evitable to secure a stable electricity supply in the future. Figures 4-2–4-5 show the actual installation years of existing transmission and distribution facilities, which are prepared as reference.

46 Decommission 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 For DC transmission, the capacities of both converter stations are included.

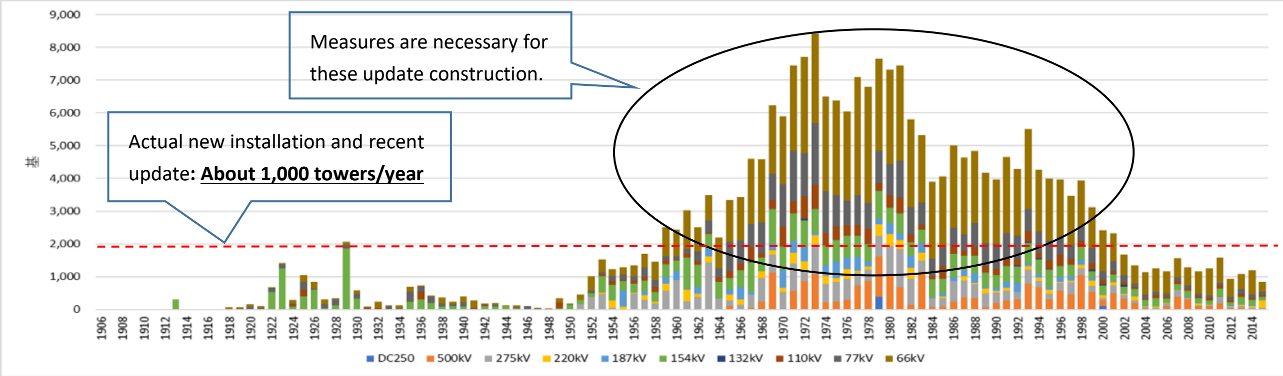


Figure 4-2 Actual Installation Year of Existing Transmission Towers (66kV-500kV)

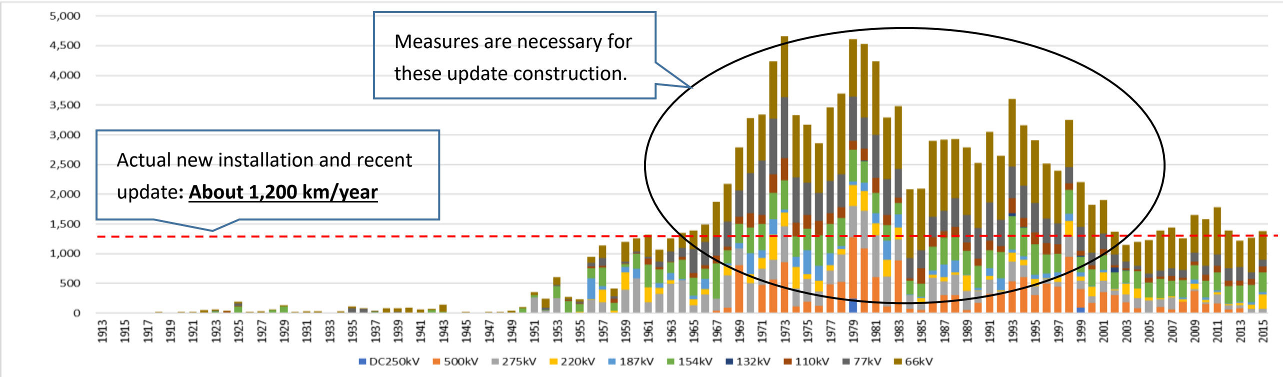


Figure 4-3 Actual Installation Year of Existing Overhead Lines (66kV-500kV)

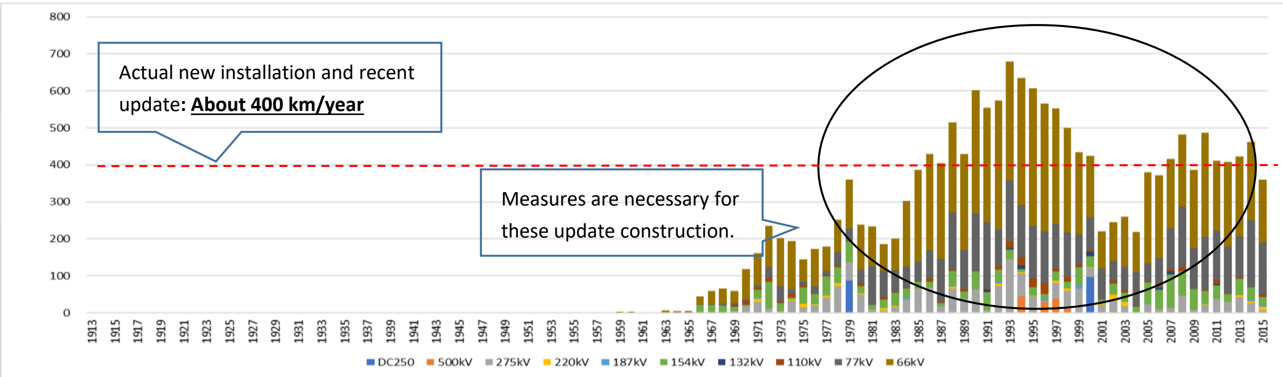


Figure 4-4 Actual Installation Year of Existing Underground Cables (66kV-500kV)

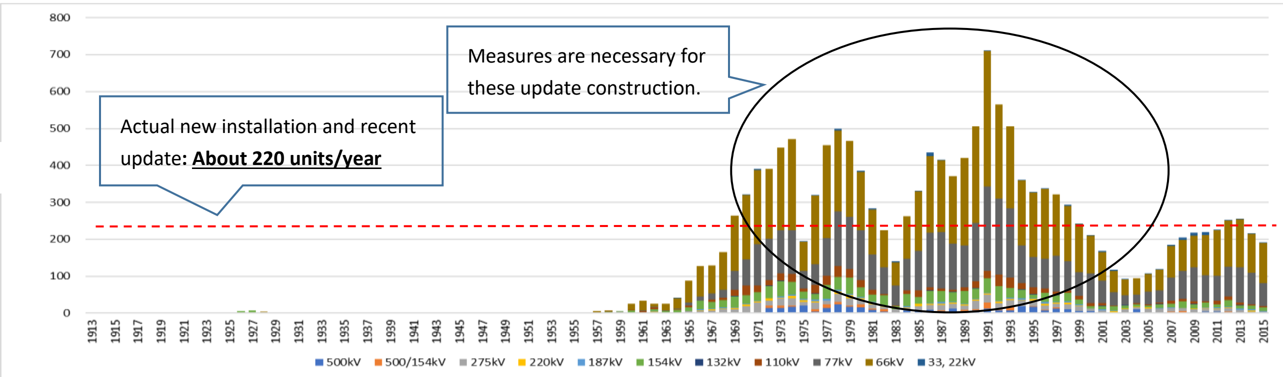


Figure 4-5 Actual Installation Year of Existing Transformers (66kV-500kV; one those of 22kV is partly included)

Furthermore, in recent years the number of working linesmen tends to decrease, and a workforce with skills and ability is in short supply. Figure 4-6 shows the transition in numbers of tower-climbing linesmen working on the transmission construction.[49]

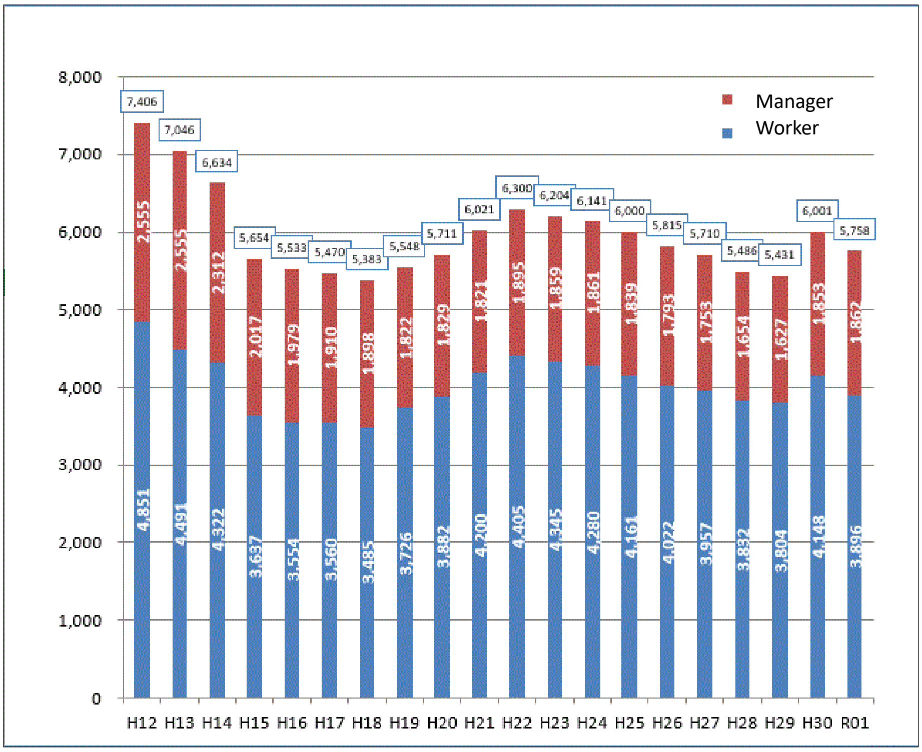


Figure 4-6 Transition of the Number of Tower-climbing Linesmen[49]

[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 procure the supply capacity for their customers in their regional service areas. Four figures illustrate the scheduled procurement from external service areas at 15:00 during August 2022. Figures 5-1 and 5-2 show the supply capacity and the ratio of the supply capacity, respectively, at 15:00 during August. Figures 5-3 and 5-4 show the energy supply and the ratio of the energy supply, respectively, in FY 2022.

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

The analysis result shows the same tendency as in previous years because there were no changes in major bilateral contracts of transmission line use.

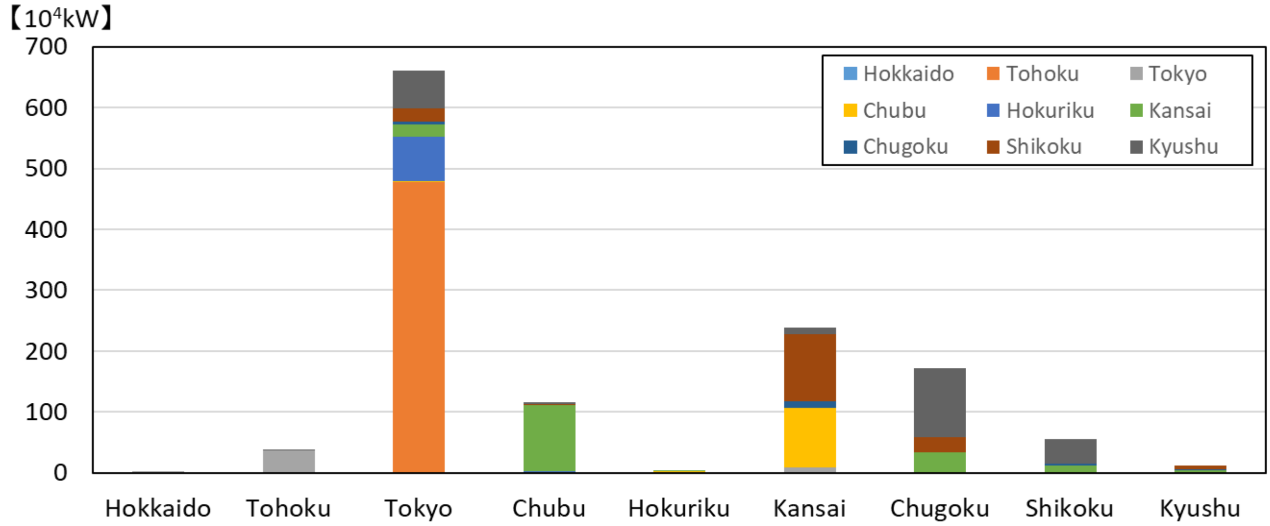


Figure 5-1 Scheduled Procurement of Supply Capacity from External Regional Service Areas

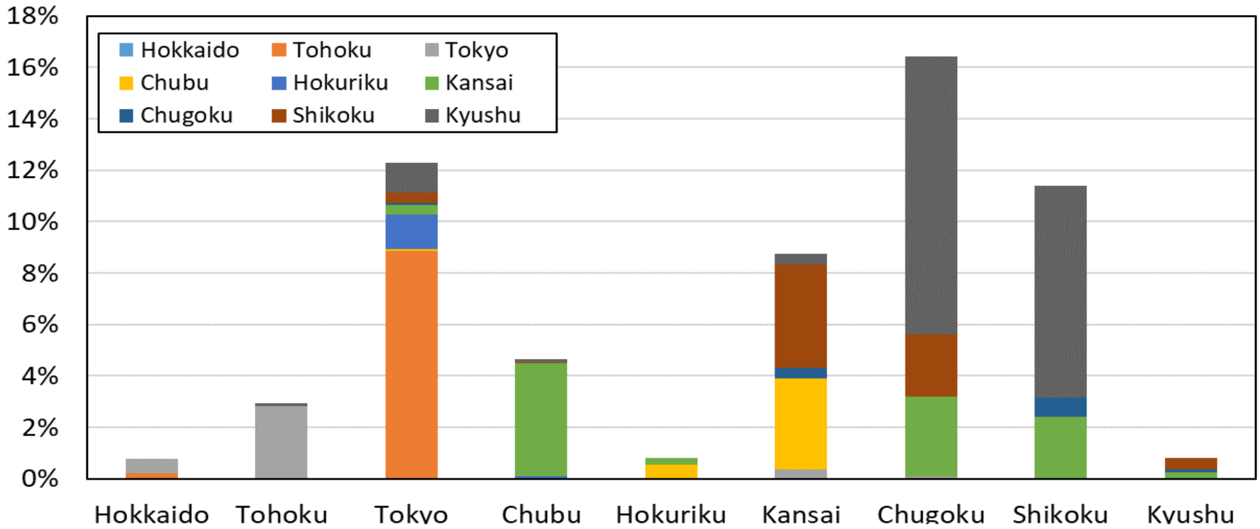


Figure 5-2 Ratio of Scheduled Procurement of Supply Capacity from External Regional Service Areas

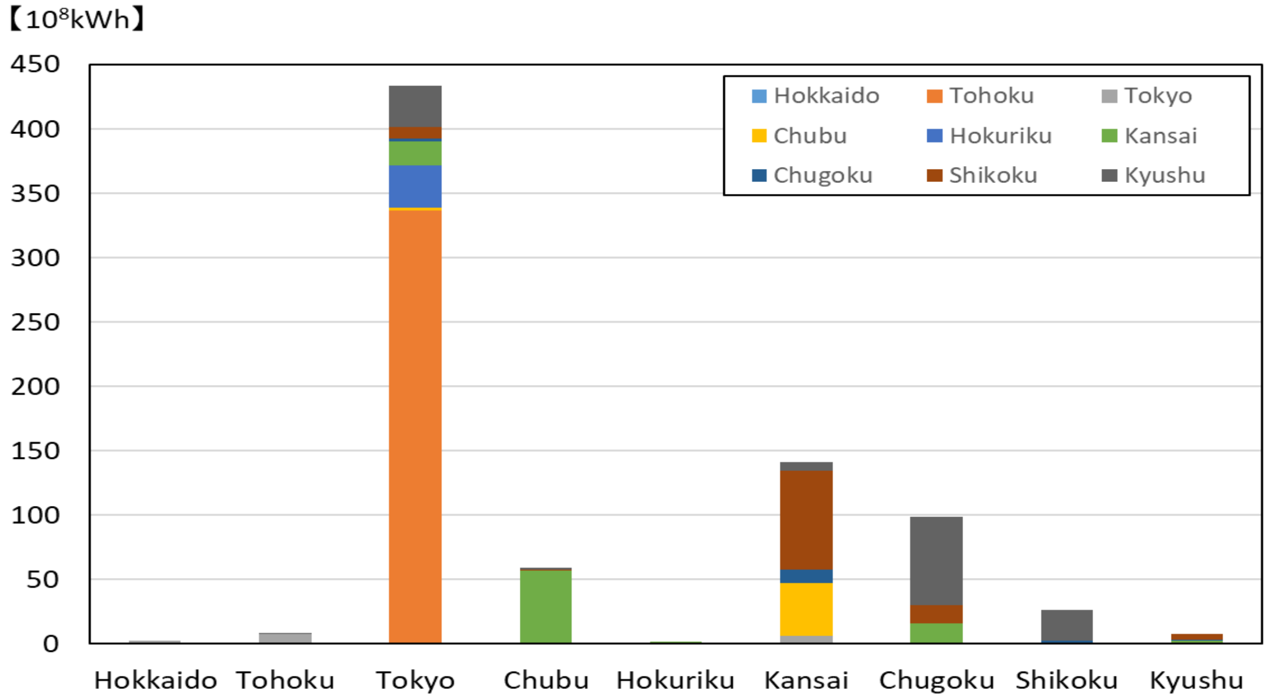


Figure 5-3 Scheduled Procurement of Energy Supply from External Regional Service Areas

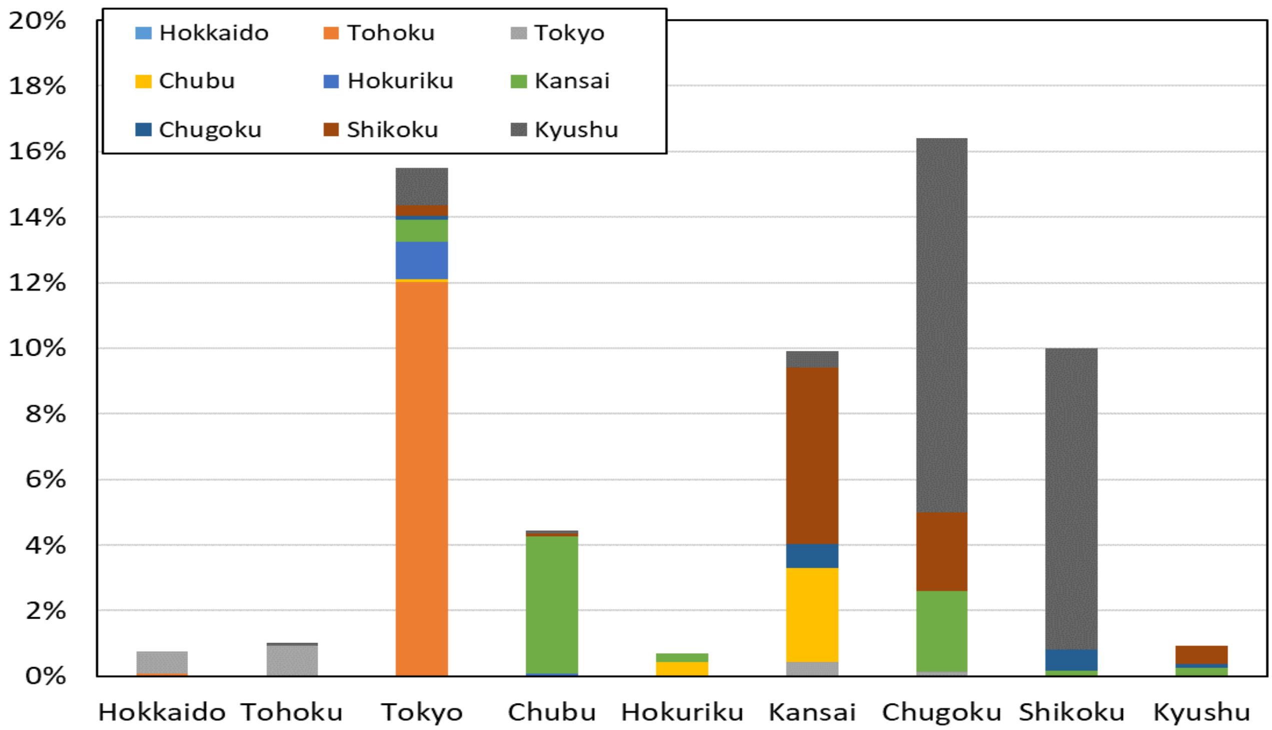


Figure 5-4 Ratio of Scheduled Procurement of Energy Supply from External Regional Service Areas

VI. Analysis of Characteristics of EPCOs

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

In total, 712 retail companies submitted their electricity supply plans, which are classified by the corresponding companies' business scale of the retail demand forecast. 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 their businesses.

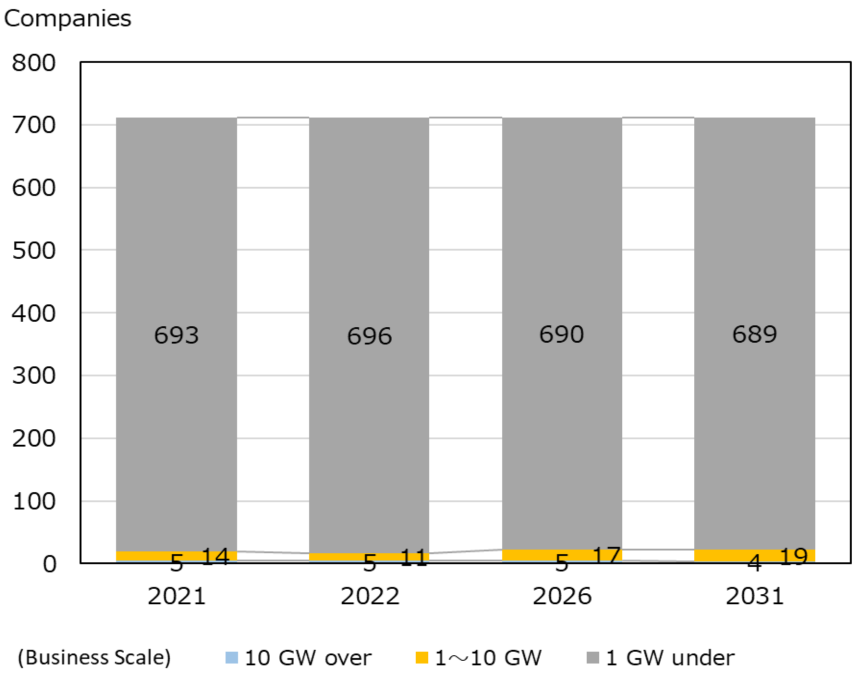


Figure 6-1 Distribution of the Retail Demand by Retail Companies by Business Scale

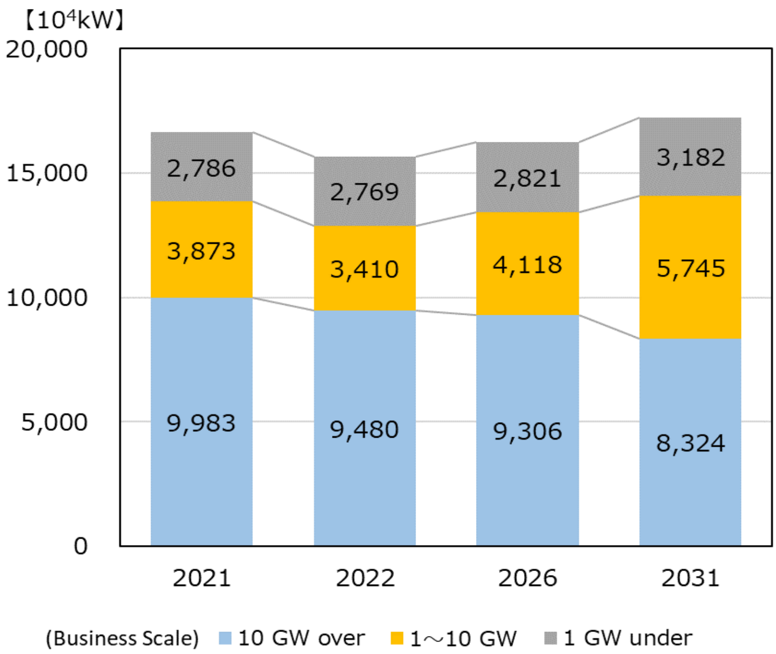


Figure 6-2 Distribution by Accumulated Retail Demand by Retail Companies

Again, retail companies are classified by the corresponding companies' business scale of the retail energy sales forecast. 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 their businesses.

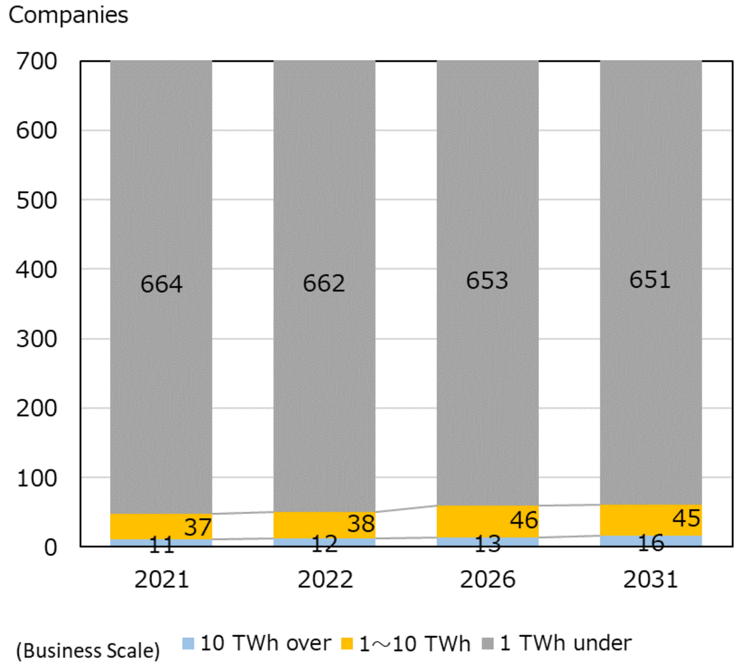


Figure 6-3 Distribution of Retail Company Energy Sales by Business Scale

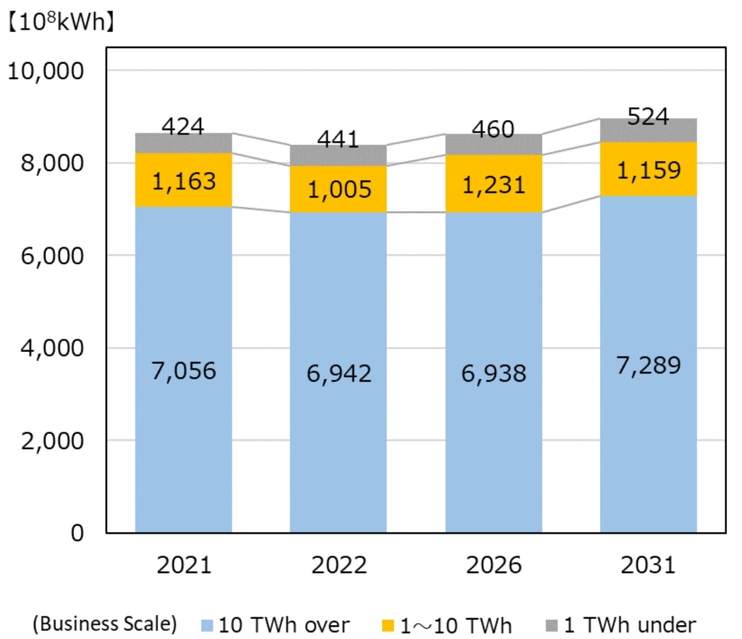


Figure 6-4 Distribution by Retail Company of Accumulated Energy Sales

2. Retail Company Business Areas

Figure 6-5 shows the ratio of retail companies by the number of areas where they plan to conduct business. Figure 6-6 shows the number of retail companies by their business planning areas in FY 2022. The figures exclude 103 retail companies that had not yet developed their business plans. Half of the retail companies plan their business in a single area.

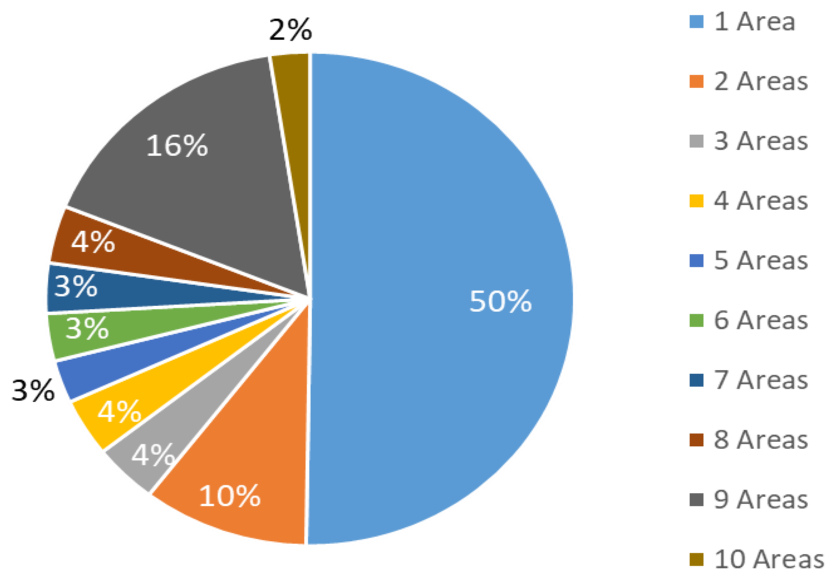


Figure 6-5 Ratio of Retail Companies by the Number of Planned Business Areas in FY 2022

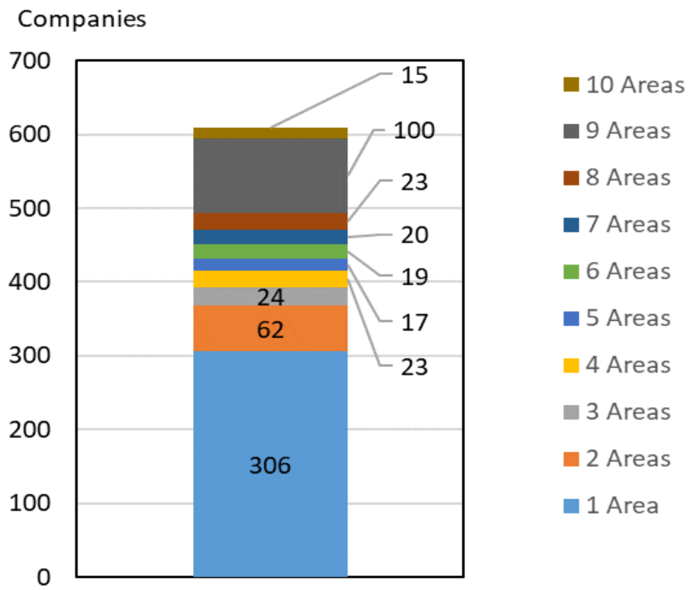
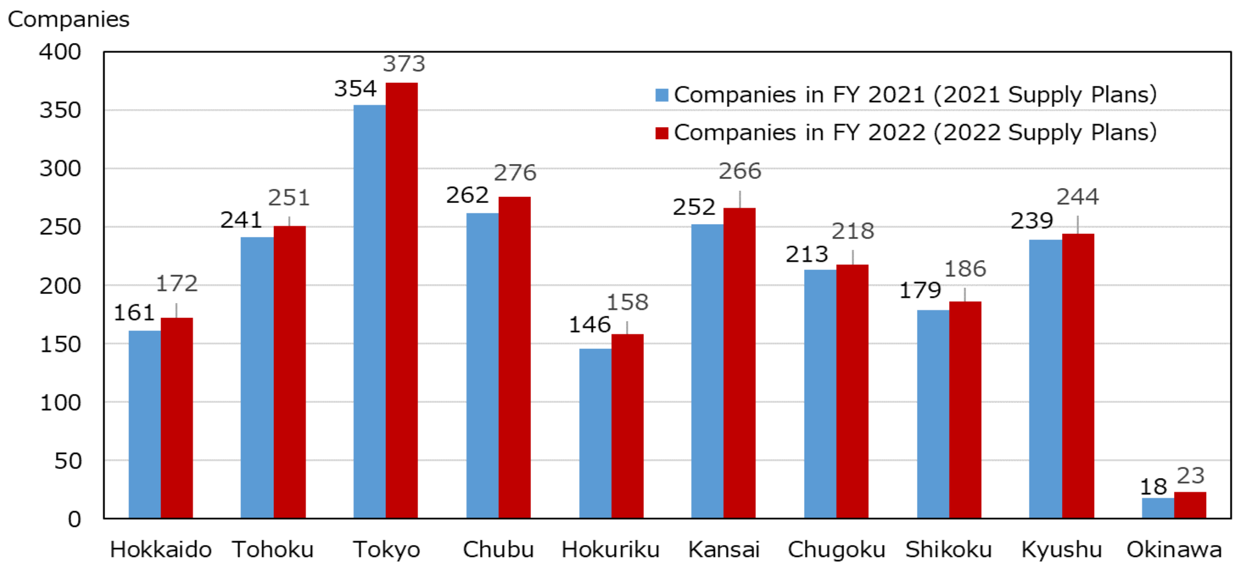


Figure 6-6 Number of Retail Companies by their Business Planning Areas in FY 2022

Figure 6-7 shows the number and the retail demand of retail companies in each regional service area for GT&D companies in FY 2022. As retail companies increase their numbers in every regional service area, the choice of retail companies for electricity customers is expanding.



Projected Peak Demand for FY 2022 (10^4 kW)	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
	417	1,306	5,379	2,485	495	2,739	1,047	494	1,535	154

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 transition of retail demand forecast in the regional service area by the retail department of the former general electric utilities and their procured supply capacity for the demand. The retail and generation departments of the former general electric utilities secure a sufficient supply capacity procured toward the retail demand of their own area.

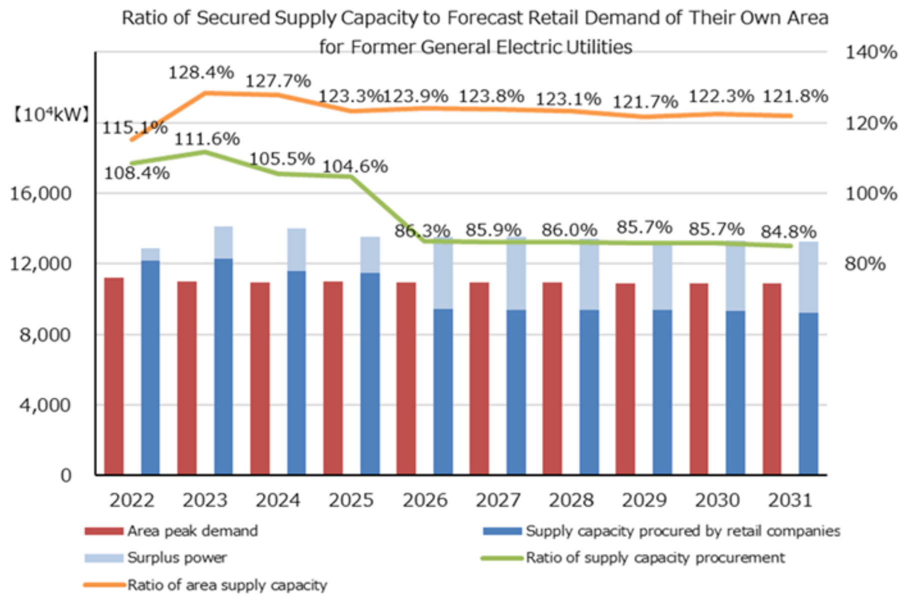


Figure 6-8 Ratio of Secured Supply Capacity to Forecast Retail Demand of Their Own Area for Former General Electric Utilities[50] (at 15:00 in August, at the sending end)

The competition among retail departments of former general electric utilities becomes fierce; there is a declining trend in the supply capacity procured for the retail demand of external areas that such companies forecast and the forecasted retail demand that power producers and suppliers (PPSs) (Figure 6-9).

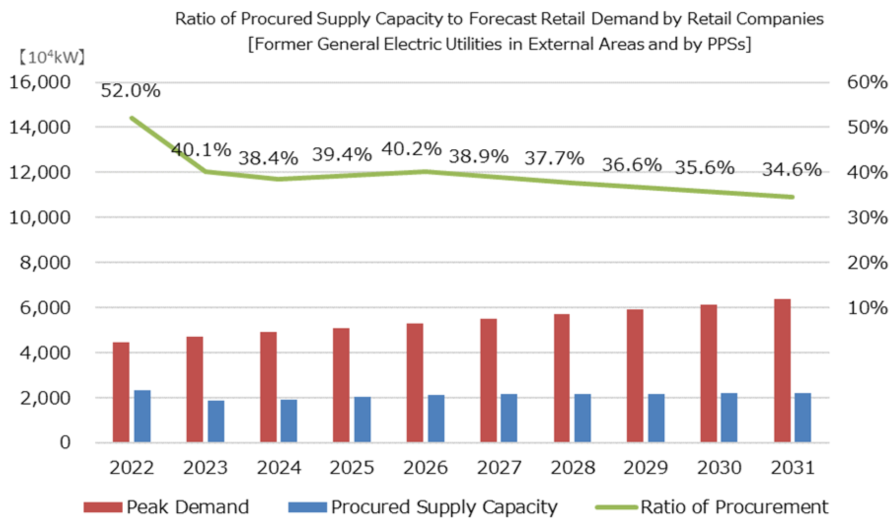


Figure 6-9 Ratio of Retail Companies' Procured Supply Capacity to Forecast Retail Demand [Former General Electric Utilities in External Areas and by PPSs] (at 15:00 in August, at the sending end)

50 Including the surplus power of a group of companies deducting the balancing capacity to the retail companies' secured supply capacity.

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

In total, 1,007 generation companies submitted their electricity supply plans, which are classified by corresponding companies' the business scale of the installed capacity. 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.

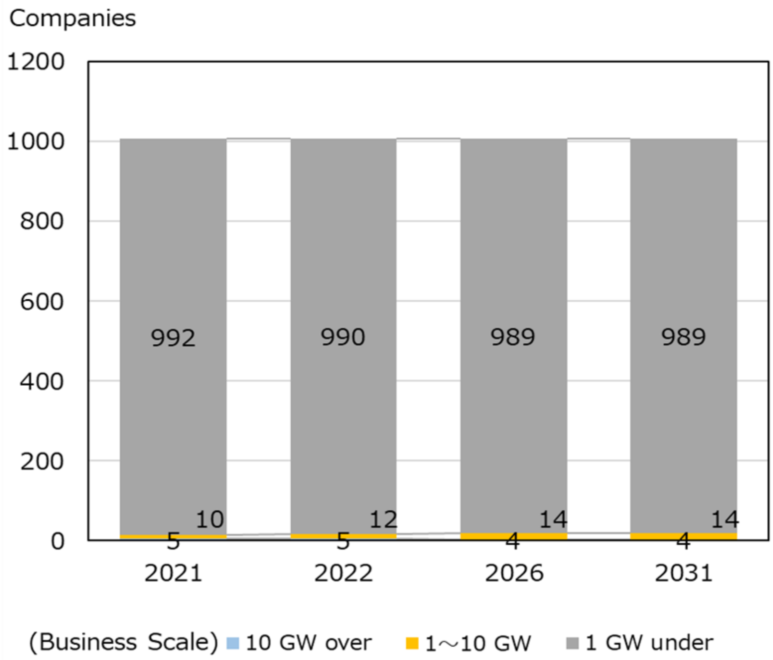


Figure 6-10 Distribution by Business Scale of a Generation Company's Installed Capacity

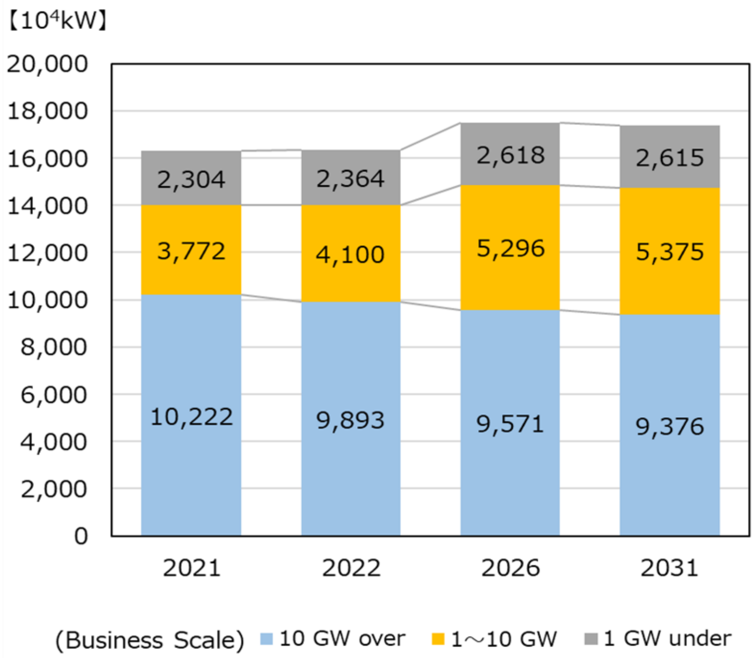


Figure 6-11 Distribution by a Generation Company's Accumulated Installed Capacity

Similarly, generation companies are classified by the business scale of the corresponding company's 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's accumulated energy supply forecast.

Generation companies with an energy supply of under 10 TWh are planning to decrease their energy generation.

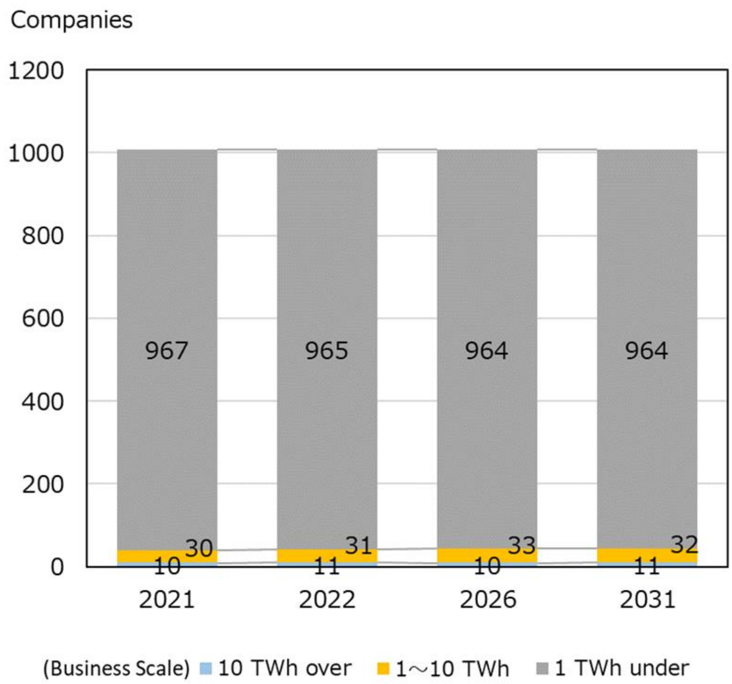


Figure 6-12 Generation Companies' Distribution of Energy Supply by Business Scale

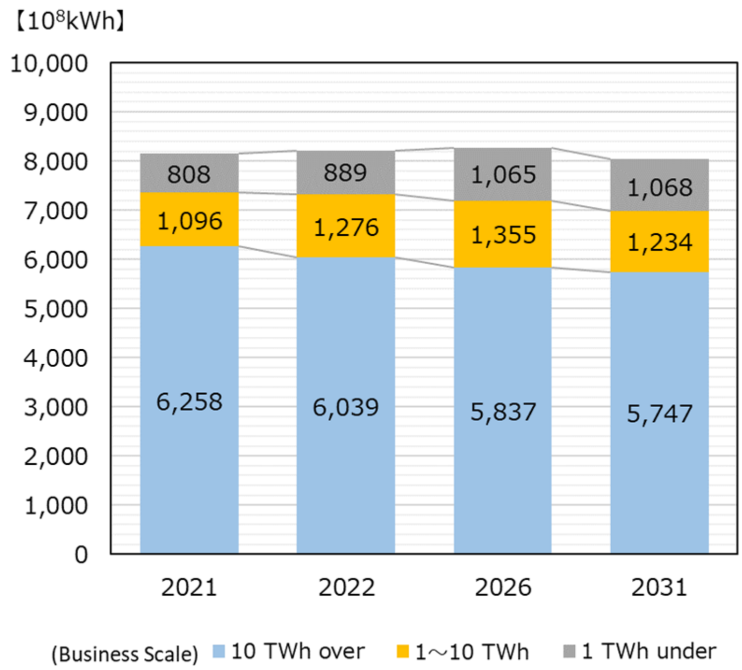


Figure 6-13 Generation Companies' Distribution by Accumulated Energy Supply

Figure 6-14 shows the number of generation companies at the end of FY 2021 by the power generation sources of their generators. The figures exclude 103 generation companies that do not own their generation plants. Approximately half of all generation companies solely own renewable energy generation facilities.

It is prominent that the generation companies with renewable energy (particularly solar power) are increasing, and new generation companies are leading a stronger introduction of renewable energy.

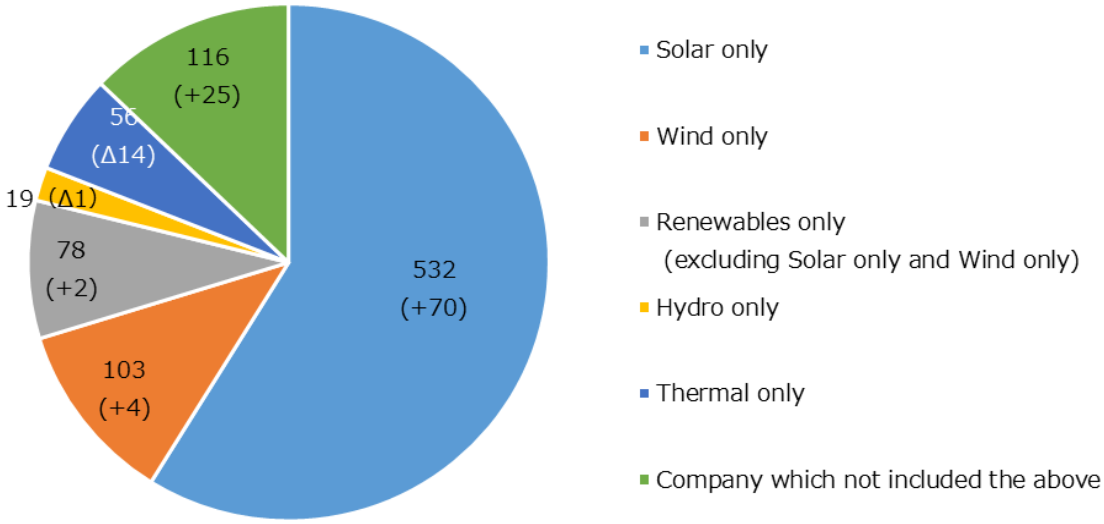


Figure 6-14 Number of Generation Companies by Power Generation Sources

5. Generation Company Business Areas

Figure 6-15 shows the ratio of generation companies to the number of areas where they plan to conduct business. Figure 6-16 shows the number of generation companies by their business planning areas in FY 2022. The figures exclude 136 generation companies that do not own their generation plants.

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

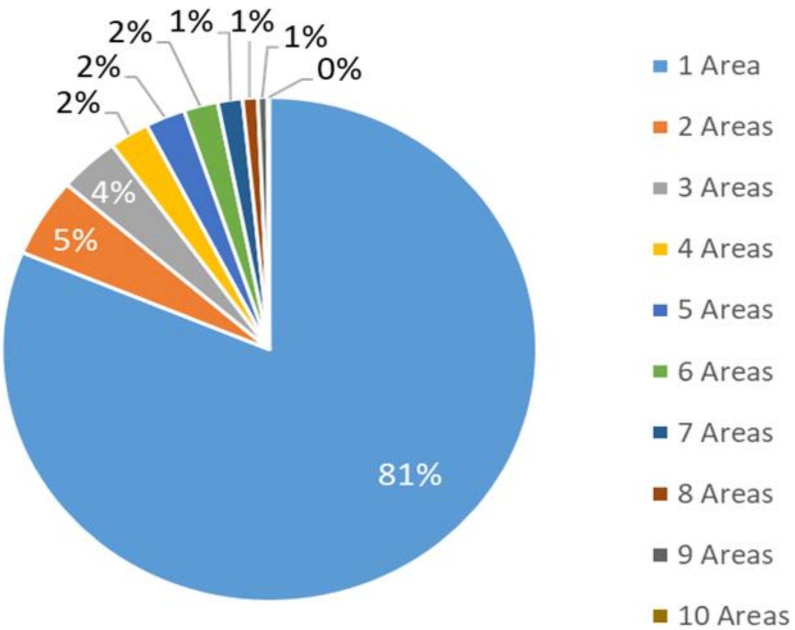


Figure 6-15 Ratio of Generation Companies by the Number of Planned Business Areas in FY 2022

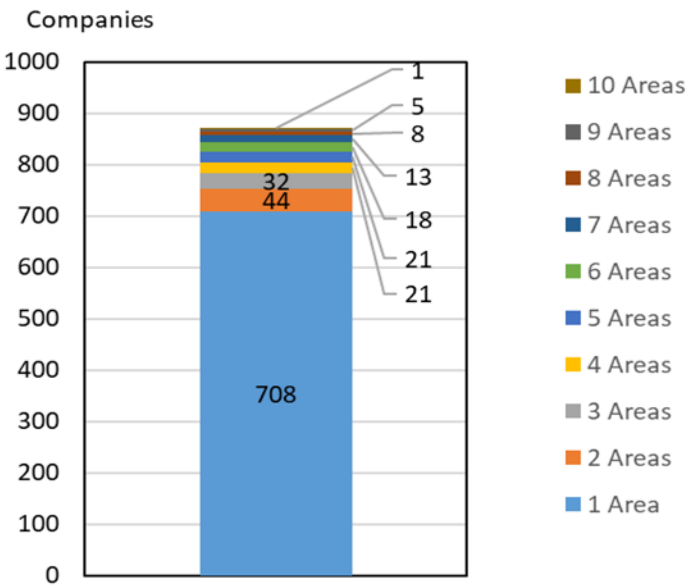
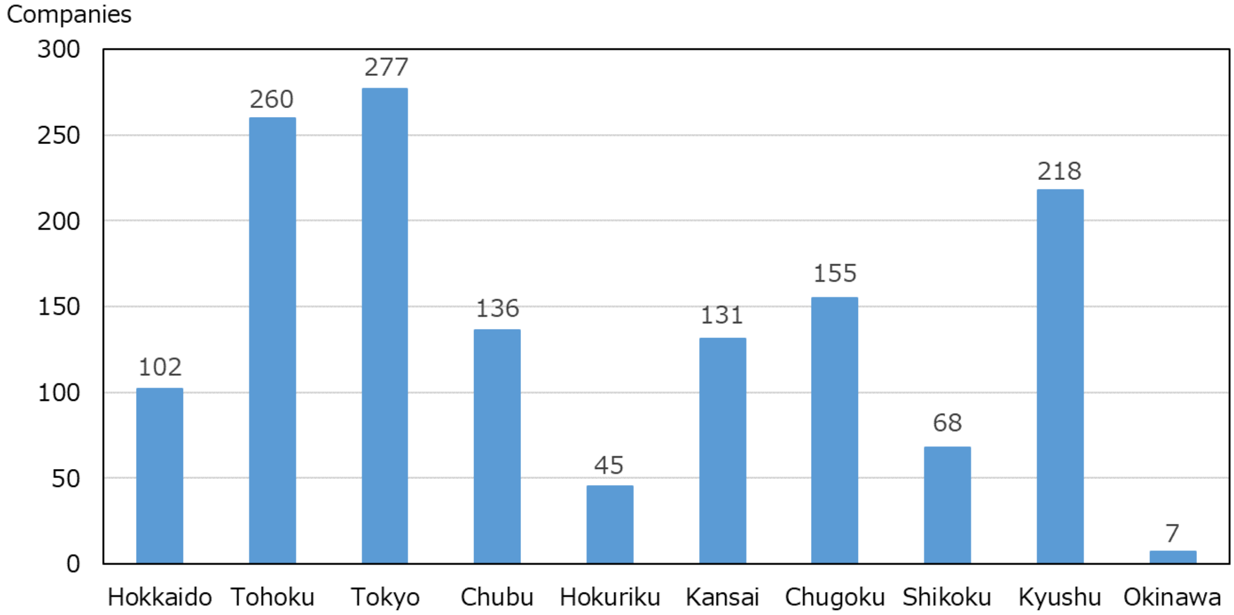


Figure 6-16 Number of Generation Companies by Their Business Planning Areas in FY 2022

Figure 6-17 shows the number and the installed capacity of generation companies in each regional service area for GT&D companies in August 2022. In the Hokkaido, Tohoku, Chugoku, and Kyushu regional service areas, the scale of generation companies is relatively small and their supply capacity is comparatively small despite the number of generation companies in these regional service areas.



Projected Supply Capacity in FY 2022 (10^4 kW)

Projected Supply Capacity for FY 2022 (10^4 kW)	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
	539	1,853	4,904	2,348	559	2,393	990	707	1,804	213

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. Action for the structural challenge of the managing electricity supply-demand

For the management of electricity supply–demand, the Organization confirms the necessary supply capacity procurement by the "Aggregation of Electricity Supply Plans" for a 10-year period and "Electricity Supply–demand Verification" implemented before the coming high demand period, which considers demand increase by severe climate condition. Based on the tight power supply condition occurred in the winter of 2020/2021, there is possibly a structural challenge behind the tight power supply caused by decreasing supply capacity in recent years and demand increase by severe climate conditions.

The Organization recognizes that managing electricity supply–demand shall be more accurately implemented and makes every effort to evaluate and manage the supply–demand condition following the government or EPCOs for the review, including the necessity of revising the evaluation method.

In addition, the tight power supply on March 22 and 23, 2022 triggered by the 2022 Fukushima earthquake, raised concerns about blackouts and the burden of saving electricity. The Organization pays special attention to this incident as the responsible entity for securing the electricity supply.

Cooperating with the government, the Organization shall review, in good time, whether the security of supply capacity and balancing capacity and the supply–demand operation management scheme is adequate given this tight power supply, with the ongoing process of the transmission system reinforcement plan that contributes to the improving the transmission system's resilience.

2. Concerns for supply capacity shortage in recent years

In the aggregation of the supply plans in the previous year, some areas were in the severe condition of lower adequate reserve margins for their monthly demand–supply balance in the short term of the projected period. Before this year's aggregation, the Organization published the condition to widely call related EPCOs for coordinating the scheduled maintenance of generation facilities or transmission and substation facilities, and made every effort to improve supply–demand balance; however, it is not sound to maintain such coordination in the future.

For the aggregation of this year, evaluation in the short term (FY 2022 and FY 2023) , a certain reserve margin is secured against the average three highest loads. But to secure a stable supply for various EPCOs to manage and operate their generation or transmission facilities efficiently, the Organization has a new understanding of the importance that the facilities' scheduled maintenance is implemented for the short-term period at the proper time.

From FY 2022, the actual delivery year of FY 2024 becomes a period of scheduled maintenance coordination in the capacity market. Thus, the Organization shall cope with the market for cooperation and coordination with related EPCOs to effectively execute these actions.

Based on the experience of tight power supply during the winter of 2020/21, the Organization has monitored the condition of supply capacity (kW) and energy (kWh), including fuel procurement of generation companies, during winter of 2021/22—and published the result. Monitoring supply capacity and energy become more critical indicators for capacity procurement decisions or countermeasures for securing stable supply in unforeseen circumstances, such as Ukuranian situation. The Organization continuously implements the monitoring for FY 2022. For fuel procurement, such as liquefied natural gas, generation companies procure their fuel for a long-term contract; however, some of the procurement depends on the spot market. In case of increasing geopolitical risk, it is anticipated that individual generation companies cannot procure generation fuel for their endeavors; thus, the electricity industry expects the government to respond according to the condition.

Furthermore, as for supply–demand projection in FY 2022, the Organization shall make every effort to review supply capacity measures in cooperation with the government and related EPCOs. That is attributable to the difficulty of predicting consequences to the supply capacity triggered by the Fukushima earthquake on March 16, 2022, and the necessity for close watch on supply–demand balance at the highest winter peak demand (i.e., the condition which lowers the 3% of the minimum reserve margin for operation) after reviewing of the highest demand in severe climate condition.

3. Challenges regarding to securing supply capacity in the long term

For the trend of supply capacity in the mid-to-long term in the FY 2022 aggregation, the installation of new facilities, replacement of existed facilities, and resuming operation of nuclear power plant operations are increasing; however, there is a simultaneous increasing trend of suspension and decommissioning of aging thermal power plants.

In these circumstances, generation companies generally plan their power development according to the contract result of the capacity market and the contracted price level. There is a tendency to change suspension or decommissioning plans due to a single-year auction result, and some changes are observed at the auction for delivery in FY 2025.

Thus, the Organization shall analyze new and added installation of the generation facility in the mid-to-long term. These analyses are based on the auction result for the capacity market, transition of suspensions and decommissions, and industrial trends at the aggregation of supply plans. In addition, the Organization shall cooperate with the government to review necessary measures.

Throughout the cooperation, the Organization expects the government to adequately monitor and supervise contracted generators in the capacity market, and implement institutional treatment or action for securing the necessary supply capacity. This supervision includes measures like promoting new installations or replacing existing facilities to move toward decarbonization.

4. Challenges regarding to securing balancing capacity in the long term

The balancing market has started the trade of replacement reserve for FIT in FY 2021, replacement reserve in April 2022, and plans to add additional items. Furthermore, trade in the balancing market and solicitation of balancing capacity (Generator I and II) have been partially implemented. The solicitation process ends in FY 2024; after that, balancing capacity shall be procured in the balancing market.

It means that the necessary supply capacity for a national basis shall be procured in the capacity market in the future, and the supply capacity containing balancing function also shall also be traded in the capacity market. This is critical to the security of stable supply, and both markets shall be coordinated as needed. In the future of promoting integration for renewable energy, it is predicted that the importance of synchronization and inertia shall be increased as new balancing capacity, and necessary to continue reviewing the method for their procurement.

Based on this recognition, existing facilities, such as thermal and pumped storage hydro power plants, function as the balancing capacity. From FY 2024, the solicitation process of the balancing capacity shall be terminated; generation companies must earn their revenue from the kW value in the capacity market and, in a limited way, Δ(delta) kW in the balancing market. Some generation companies are anxious about not maintaining their generators under such conditions.

This anxiety is premature because generation companies cannot predict future incidents with objective evidence. The Organization shall diligently respond with GT&D companies, which are operators of the balancing market, and other related EPCOs to maintain supply capacity with the necessary balancing capacity be procured in the capacity market. Together, they can realize procurement of necessary balancing capacity in the balancing market based on both market coordination.

The Organization expects the government to preemtively review the function and economic value of generators with balancing capacity, such as the function of mitigating output shedding of renewable energy in the light load period, for their market design in political aspect.

VIII. Conclusions

1. Electricity Demand Forecast

The AAGR of peak demand nationwide in the mid-to-long term is forecast to decrease by 0.3%. AAGR is forecasted to be negative, and is attributable to several major decreasing factors, such as a shrinking population, and efforts to reduce electricity use, notwithstanding increasing factors like economic growth and broader use of electric appliances.

2. Electricity Supply and Demand

The Organization applied EUE as a new reliability criterion to the electric supply plan based on the review of the existing reliability criteria. In the short term (the first and second year of the projected period), all the areas and years fall within the criteria of secure supply (0.048 kWh/kW-year nationwide, 0.498 kWh/kW-year in Okinawa). In the long term, the calculated result for the Kyushu area from FY 2024 to FY 2029 exceeds the criteria due to the uncertain supply capacity of some sizable generating units. The result for the Okinawa area also exceeds its EUE from FY 2025 to FY 2027, and FY 2029 due to scheduled maintenance of the generating facilities. The supply–demand balance evaluation by the conventional approach shows that the 8% reserve margin will be achieved in the short term in FY 2022 and 2023.

For energy-supply requirement evaluation, it seems that energy supply will be 0.2 to 2.4 TWh/month of volume below the forecasted energy requirement (equivalent to 0.3 to 3.2% against the forecast energy requirement) throughout FY 2022.

In the short term, all areas and periods satisfy EUE, and none fall below the 8% criteria. The Organization proceeds to review for supply measures based on the analytical result of supply–demand variance risk, which premises severe climate conditions (heatwave and severe cold) emerge once in 10 years.

3. Analysis of the Transition of Power Generation Sources Nationwide

Renewable energy, such as solar and wind power, is projected to increase regarding the transition of installed power generation capacity and net electricity generation. Conversely, thermal is projected to decrease. Nuclear power plants' energy generation is calculated as zero, given that their capacity is reported as "uncertain."

4. Development Plans for Transmission and Distribution Facilities

Regarding the development plans for major transmission lines and substations, significant generator access lines are planned, as are development plans for cross-regional interconnection lines, including facilities necessary for cross-regional operation.

5. Cross-regional Operation

The aggregated results for procuring supply capacity or energy from external service areas, are almost the same as in the previous year, with higher procurement from external services and higher transmission to external areas.

6. Analysis of Characteristics of EPCOs

Distributions are calculated for retail and generation companies according to business scale and business areas, and are aggregated to the projection for a 10-year period. In addition, the ratios of the secured supply capacity are reviewed. Particularly, small and medium-sized retail companies have planned their supply capacity as “unspecified procurement,” as in the previous year’s plan; therefore, the ratios of the secured supply capacity indicate a declining tendency.

7. Findings and Challenges

The Organization has communicated to METI its opinions concerning four significant challenges concerning the aggregation of electricity supply plans for FY 2022.

Attached are the Appendices for the aggregation of the electricity supply plans.

APPENDIX 1 Supply–Demand Balance for FY 2022 and 2023 (Short-term)

i) Projection for FY 2022

Tables A1-1 to A1-4 show the monthly supply–demand balance, such as peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin for each regional service area in FY 2022. 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. Furthermore, 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 2022 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	395	359	357	406	417	391	393	450	484	499	495	452
Tohoku	1,057	982	1,063	1,271	1,306	1,175	1,040	1,166	1,306	1,369	1,347	1,224
Tokyo	3,858	3,681	4,204	5,379	5,379	4,569	3,857	4,016	4,436	4,765	4,765	4,340
50Hz areas Total	5,310	5,022	5,624	7,056	7,102	6,135	5,290	5,632	6,226	6,633	6,607	6,016
Chubu	1,850	1,869	2,045	2,485	2,485	2,342	1,984	1,946	2,207	2,342	2,342	2,074
Hokuriku	390	364	402	495	495	441	378	414	473	511	511	457
Kansai	1,838	1,856	2,126	2,739	2,739	2,341	1,911	1,942	2,366	2,515	2,515	2,150
Chugoku	759	750	823	1,047	1,047	935	783	856	1,029	1,040	1,040	914
Shikoku	344	343	392	494	494	432	362	370	461	461	461	404
Kyushu	1,037	1,053	1,199	1,535	1,535	1,324	1,128	1,152	1,446	1,464	1,464	1,239
60Hz areas Total	6,218	6,235	6,987	8,795	8,795	7,815	6,545	6,679	7,982	8,333	8,333	7,238
Interconnected	11,528	11,257	12,611	15,851	15,897	13,950	11,835	12,311	14,208	14,966	14,940	13,254
Okinawa	103	122	146	147	147	152	132	114	99	102	101	94
Nationwide	11,631	11,379	12,757	15,998	16,044	14,101	11,967	12,425	14,307	15,068	15,041	13,347

Table A1-2 Monthly Projection of Supply Capacity for Each Regional Service Area in FY 2022 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	575	595	576	596	562	549	581	611	633	627	626	609
Tohoku	1,247	1,159	1,175	1,505	1,549	1,379	1,250	1,270	1,429	1,528	1,503	1,468
Tokyo	4,371	4,467	4,773	5,920	5,914	5,549	4,594	4,302	5,094	5,419	5,473	5,248
50Hz areas Total	6,192	6,221	6,524	8,021	8,025	7,477	6,425	6,184	7,156	7,574	7,602	7,325
Chubu	2,040	2,123	2,442	2,597	2,706	2,541	2,293	2,105	2,358	2,438	2,441	2,308
Hokuriku	487	460	475	571	579	526	533	509	523	511	515	526
Kansai	2,061	2,095	2,403	2,806	2,730	2,403	1,805	1,973	2,496	2,644	2,755	2,561
Chugoku	894	936	1,040	1,334	1,309	1,175	1,004	1,016	1,183	1,234	1,214	1,139
Shikoku	541	575	630	695	703	655	604	566	590	594	504	520
Kyushu	1,244	1,231	1,418	1,713	1,690	1,570	1,456	1,441	1,616	1,657	1,587	1,338
60Hz areas Total	7,267	7,421	8,408	9,716	9,717	8,869	7,697	7,610	8,766	9,078	9,016	8,390
Interconnected	13,459	13,641	14,932	17,738	17,742	16,346	14,122	13,793	15,921	16,652	16,619	15,715
Okinawa	168	166	187	198	206	198	203	183	171	160	162	175
Nationwide	13,626	13,807	15,119	17,936	17,948	16,545	14,325	13,976	16,093	16,813	16,780	15,890

Table A1-3 Monthly Projection of Reserve Capacity for Each Regional Service Area in FY 2022 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	180	236	219	190	145	158	188	161	149	128	131	157
Tohoku	190	177	112	234	243	204	210	104	123	159	156	244
Tokyo	513	786	569	541	535	980	737	286	658	654	708	908
50Hz areas Total	882	1,199	900	965	923	1,342	1,135	552	930	941	995	1,309
Chubu	190	254	397	112	221	199	309	159	151	96	99	234
Hokuriku	97	97	74	76	84	85	156	96	50	-0	4	69
Kansai	223	239	277	67	-9	62	-105	31	130	129	240	411
Chugoku	135	186	217	287	262	240	221	160	154	194	174	225
Shikoku	197	232	238	201	209	223	242	196	129	133	43	116
Kyushu	207	178	219	178	155	246	328	289	170	193	123	99
60Hz areas Total	1,049	1,186	1,421	921	922	1,055	1,152	931	783	745	683	1,152
Interconnected	1,931	2,384	2,321	1,887	1,845	2,397	2,287	1,482	1,713	1,686	1,679	2,462
Okinawa	65	44	41	51	59	47	70	69	73	58	61	81
Nationwide	1,996	2,428	2,362	1,938	1,904	2,443	2,358	1,551	1,786	1,745	1,740	2,543

Table A1-4 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2022

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	45.5%	65.6%	61.3%	46.9%	34.9%	40.5%	47.9%	35.8%	30.7%	25.6%	26.5%	34.7%
Tohoku	17.9%	18.0%	10.6%	18.4%	18.6%	17.4%	20.2%	8.9%	9.4%	11.6%	11.6%	19.9%
Tokyo	13.3%	21.4%	13.5%	10.1%	9.9%	21.4%	19.1%	7.1%	14.8%	13.7%	14.9%	20.9%
50Hz areas Total	16.6%	23.9%	16.0%	13.7%	13.0%	21.9%	21.5%	9.8%	14.9%	14.2%	15.1%	21.8%
Chubu	10.3%	13.6%	19.4%	4.5%	8.9%	8.5%	15.6%	8.1%	6.8%	4.1%	4.2%	11.3%
Hokuriku	25.0%	26.7%	18.4%	15.3%	17.0%	19.2%	41.3%	23.1%	10.6%	0.0%	0.8%	15.1%
Kansai	12.1%	12.9%	13.0%	2.5%	-0.3%	2.7%	-5.5%	1.6%	5.5%	5.1%	9.5%	19.1%
Chugoku	17.7%	24.7%	26.3%	27.4%	25.0%	25.6%	28.3%	18.7%	14.9%	18.7%	16.7%	24.6%
Shikoku	57.2%	67.8%	60.6%	40.6%	42.3%	51.7%	67.0%	52.9%	27.9%	28.9%	9.4%	28.6%
Kyushu	20.0%	16.9%	18.3%	11.6%	10.1%	18.6%	29.1%	25.1%	11.8%	13.2%	8.4%	8.0%
60Hz areas Total	16.9%	19.0%	20.3%	10.5%	10.5%	13.5%	17.6%	13.9%	9.8%	8.9%	8.2%	15.9%
Interconnected	16.8%	21.2%	18.4%	11.9%	11.6%	17.2%	19.3%	12.0%	12.1%	11.3%	11.2%	18.6%
Okinawa	62.5%	35.8%	28.0%	38.6%	43.5%	38.0%	53.3%	60.3%	73.5%	57.1%	60.5%	86.2%
Nationwide	17.2%	21.3%	18.5%	12.2%	11.9%	17.4%	19.7%	12.5%	12.5%	11.6%	11.6%	19.1%

Below 8% criteria

Table A1-5 Monthly Projection of Cross-regional Reserve Margin for Each Regional Service Area in FY 2022

(Power exchanges through cross-regional interconnection lines and generating facilities are not included at the sending end at the sending end of the electricity supply plans,)

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	29.6%	48.7%	55.5%	41.5%	27.6%	31.9%	34.2%	21.1%	16.1%	15.4%	15.6%	20.2%
Tohoku	18.3%	20.3%	13.3%	15.3%	20.1%	16.8%	23.1%	14.6%	11.9%	15.4%	15.6%	19.9%
Tokyo	14.7%	20.3%	13.3%	10.3%	10.2%	16.8%	17.0%	8.1%	11.9%	10.7%	10.6%	18.4%
Chubu	14.7%	20.3%	20.2%	10.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Hokuriku	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Kansai	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Chugoku	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	17.0%	11.3%	11.9%	10.7%	10.6%	18.4%
Shikoku	18.0%	20.3%	21.9%	11.3%	10.5%	16.8%	24.2%	11.9%	11.9%	10.7%	10.6%	18.4%
Kyushu	18.0%	20.3%	20.2%	11.3%	10.5%	16.8%	27.1%	23.1%	11.9%	10.7%	10.6%	18.4%
Okinawa	62.5%	35.8%	28.0%	35.0%	40.1%	30.8%	53.3%	60.3%	73.5%	57.1%	60.5%	86.2%

Improved 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 2022 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	103	122	148	150	154	152	132	114	99	102	101	94
Supply Capacity	168	166	190	208	220	209	203	183	171	160	162	175
Reserve Capacity	65	44	42	58	67	58	70	69	73	58	61	81
Reserve Margin	62.5%	35.8%	28.0%	38.6%	43.5%	38.0%	53.3%	60.3%	73.5%	57.1%	60.5%	86.2%

ii) Projection for FY 2023

Tables A1-7 to A1-10 show the monthly supply–demand balance, such as peak demand, monthly supply capacity, monthly reserve capacity, and reserve margin for each regional service area in FY 2023. 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 the provision of Article 48 of the Act. Furthermore, 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 2023 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	395	359	357	406	417	391	393	450	484	499	495	452
Tohoku	1,054	980	1,061	1,268	1,303	1,173	1,037	1,163	1,302	1,365	1,343	1,220
Tokyo	3,846	3,669	4,192	5,364	5,364	4,555	3,846	4,004	4,423	4,751	4,751	4,318
50Hz areas Total	5,295	5,008	5,610	7,038	7,084	6,119	5,276	5,617	6,209	6,615	6,589	5,990
Chubu	1,849	1,868	2,045	2,484	2,484	2,341	1,983	1,945	2,206	2,341	2,341	2,074
Hokuriku	390	364	402	495	495	441	379	415	475	513	513	459
Kansai	1,835	1,854	2,123	2,735	2,735	2,337	1,908	1,938	2,363	2,511	2,511	2,147
Chugoku	758	749	822	1,046	1,046	934	782	856	1,028	1,039	1,039	913
Shikoku	343	341	389	492	492	429	360	368	458	458	458	401
Kyushu	1,038	1,054	1,200	1,536	1,536	1,324	1,129	1,153	1,447	1,465	1,465	1,240
60Hz areas Total	6,213	6,229	6,980	8,788	8,788	7,806	6,541	6,675	7,977	8,327	8,327	7,233
Interconnected	11,508	11,237	12,590	15,826	15,872	13,925	11,817	12,292	14,186	14,942	14,916	13,223
Okinawa	105	124	150	149	149	154	134	116	100	103	102	95
Nationwide	11,612	11,361	12,741	15,975	16,021	14,079	11,950	12,408	14,286	15,045	15,018	13,318

Table A1-8 Monthly Projection of Supply Capacity for Each Regional Service Area in FY 2023 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	557	581	538	555	566	511	514	572	669	661	669	602
Tohoku	1,326	1,363	1,368	1,637	1,693	1,536	1,288	1,373	1,528	1,596	1,624	1,515
Tokyo	4,284	4,331	4,979	5,850	5,868	5,476	4,558	4,407	5,121	5,535	5,640	5,273
50Hz areas Total	6,167	6,275	6,886	8,042	8,128	7,523	6,360	6,353	7,318	7,791	7,934	7,390
Chubu	2,290	2,192	2,438	2,688	2,670	2,445	2,232	2,097	2,399	2,487	2,451	2,310
Hokuriku	467	470	492	554	532	489	515	496	480	506	513	512
Kansai	2,411	2,471	2,795	3,047	3,125	2,950	2,421	2,588	2,868	2,866	2,827	2,601
Chugoku	1,048	1,090	1,205	1,398	1,339	1,131	1,004	952	1,195	1,281	1,214	1,014
Shikoku	479	622	669	763	735	649	584	545	580	664	668	675
Kyushu	1,315	1,338	1,538	1,787	1,748	1,631	1,479	1,495	1,574	1,592	1,659	1,510
60Hz areas Total	8,010	8,183	9,138	10,237	10,150	9,295	8,234	8,172	9,097	9,396	9,331	8,624
Interconnected	14,177	14,458	16,024	18,279	18,277	16,818	14,595	14,525	16,414	17,186	17,265	16,014
Okinawa	173	197	210	207	204	202	183	177	164	169	172	170
Nationwide	14,350	14,655	16,234	18,486	18,482	17,020	14,778	14,701	16,578	17,355	17,437	16,183

Table A1-9 Monthly Projection of Reserve Capacity for Each Regional Service Area in FY 2023 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Hokkaido	162	222	181	149	149	120	121	122	185	162	174	150
Tohoku	272	383	307	369	390	363	251	210	226	231	281	295
Tokyo	438	662	787	486	504	921	712	403	698	784	889	955
50Hz areas Total	872	1,267	1,276	1,004	1,044	1,404	1,084	736	1,109	1,176	1,345	1,400
Chubu	441	324	393	204	186	104	249	152	193	146	110	236
Hokuriku	77	107	91	59	37	48	136	81	5	-7	-0	54
Kansai	576	618	672	312	390	613	513	649	505	355	316	455
Chugoku	290	341	383	352	293	197	222	96	167	242	175	101
Shikoku	136	281	280	271	243	220	224	177	122	206	210	274
Kyushu	277	284	338	251	212	307	350	342	127	127	194	270
60Hz areas Total	1,797	1,954	2,158	1,449	1,362	1,489	1,694	1,497	1,120	1,069	1,004	1,390
Interconnected	2,669	3,221	3,434	2,453	2,405	2,893	2,778	2,233	2,229	2,244	2,349	2,790
Okinawa	68	73	60	58	55	48	49	61	64	65	70	75
Nationwide	2,737	3,294	3,493	2,511	2,460	2,941	2,827	2,293	2,292	2,310	2,419	2,865

Table A1-10 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2023

	4月	5月	6月	7月	8月	9月	10月	11月	12月	1月	2月	3月
Hokkaido	41.0%	61.7%	50.8%	36.7%	35.8%	30.8%	30.9%	27.2%	38.2%	32.4%	35.2%	33.2%
Tohoku	25.8%	39.1%	29.0%	29.1%	30.0%	30.9%	24.2%	18.1%	17.3%	16.9%	21.0%	24.2%
Tokyo	11.4%	18.0%	18.8%	9.1%	9.4%	20.2%	18.5%	10.1%	15.8%	16.5%	18.7%	22.1%
50Hz areas Total	16.5%	25.3%	22.7%	14.3%	14.7%	23.0%	20.6%	13.1%	17.9%	17.8%	20.4%	23.4%
Chubu	23.8%	17.3%	19.2%	8.2%	**7.5%**	**4.5%**	12.6%	**7.8%**	8.8%	**6.3%**	**4.7%**	11.4%
Hokuriku	19.8%	29.3%	22.6%	11.9%	**7.5%**	10.9%	35.8%	19.4%	**1.1%**	**-1.4%**	**0.0%**	11.7%
Kansai	31.4%	33.3%	31.7%	11.4%	14.3%	26.2%	26.9%	33.5%	21.4%	14.1%	12.6%	21.2%
Chugoku	38.3%	45.6%	46.6%	33.6%	28.0%	21.0%	28.4%	11.2%	16.3%	23.3%	16.8%	11.1%
Shikoku	39.6%	82.3%	72.0%	55.2%	49.5%	51.3%	62.3%	48.2%	26.6%	44.9%	45.8%	68.3%
Kyushu	26.7%	26.9%	28.2%	16.3%	13.8%	23.2%	31.0%	29.7%	8.8%	8.7%	13.3%	21.8%
60Hz areas Total	28.9%	31.4%	30.9%	16.5%	15.5%	19.1%	25.9%	22.4%	14.0%	12.8%	12.1%	19.2%
Interconnected	23.2%	28.7%	27.3%	15.5%	15.2%	20.8%	23.5%	18.2%	15.7%	15.0%	15.7%	21.1%
Okinawa	65.1%	59.2%	39.7%	42.3%	40.5%	38.7%	36.6%	52.6%	63.7%	63.2%	68.4%	78.5%
Nationwide	23.6%	29.0%	27.4%	15.8%	15.4%	21.0%	23.7%	18.5%	16.0%	15.4%	16.1%	21.5%

Below 8% criteria

Table A1-11 Monthly Projection of Reserve Margin for Each Regional Service Area in FY 2023

(Power exchanges through cross-regional interconnection lines and generating facilities are not included at the sending end at the sending end of the electricity supply plans,)

	4月	5月	6月	7月	8月	9月	10月	11月	12月	1月	2月	3月
Hokkaido	30.0%	45.3%	47.6%	29.2%	30.9%	29.7%	26.1%	20.6%	23.7%	18.1%	20.8%	25.1%
Tohoku	30.0%	29.9%	21.1%	19.7%	22.0%	29.7%	26.1%	20.6%	16.5%	15.4%	16.4%	25.1%
Tokyo	11.4%	22.1%	21.1%	13.6%	14.1%	15.8%	18.0%	10.4%	15.1%	14.6%	15.7%	19.6%
Chubu	28.9%	22.1%	22.5%	13.6%	14.1%	15.8%	18.0%	10.6%	15.1%	14.6%	15.0%	19.6%
Hokuriku	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	18.0%	10.6%	15.1%	14.6%	15.0%	20.0%
Kansai	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	30.3%	28.6%	15.6%	14.6%	15.0%	20.0%
Chugoku	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	30.3%	28.6%	15.6%	14.6%	15.0%	20.0%
Shikoku	28.9%	35.4%	34.4%	20.9%	30.9%	25.2%	33.7%	28.6%	15.6%	22.0%	21.3%	41.5%
Kyushu	28.9%	35.4%	34.4%	20.9%	20.0%	24.4%	31.0%	28.6%	15.6%	14.6%	15.0%	20.0%
Okinawa	65.1%	59.2%	39.7%	38.7%	36.8%	31.4%	36.6%	52.6%	63.7%	63.2%	68.4%	78.5%

Improved 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 2023 (10^4kW at the sending end)

[10^4kW]

	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Peak Demand	105	124	150	152	156	154	134	116	100	103	102	95
Supply Capacity	173	197	210	216	219	213	183	177	164	169	172	170
Reserve Capacity	68	73	60	64	63	59	49	61	64	65	70	75
Reserve Margin	65.1%	59.2%	39.7%	42.3%	40.5%	38.7%	36.6%	52.6%	63.7%	63.2%	68.4%	78.5%

APPENDIX 2 Long-Term Supply–Demand Balance for a 10-year Period FY 2022–2031

Tables A2-1 and A2-2 show a 10-year projection of the annual peak demand and supply capacity for each regional service area from FY 2022 to 2031. Tables A2-3 and A2-4 show a 10-year projection of the annual peak demand and annual supply capacity for winter peak areas of Hokkaido, Tohoku, and Hokuriku, respectively. Further, Table A2-5 shows the annual projection of supply–demand balance in Okinawa

Table A2-1 Annual Peak Demand Forecast for Each Regional Service Area
(At 15:00 in August, 10^4kW at the sending end)

[10^4kW]

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Hokkaido	417	417	417	417	416	416	416	415	415	416
Tohoku	1,306	1,303	1,298	1,293	1,288	1,284	1,279	1,273	1,268	1,263
Tokyo	5,379	5,364	5,362	5,359	5,356	5,351	5,347	5,342	5,337	5,331
50Hz areas Total	7,102	7,084	7,077	7,069	7,060	7,051	7,042	7,030	7,020	7,010
Chubu	2,485	2,484	2,475	2,466	2,457	2,448	2,439	2,430	2,421	2,412
Hokuriku	495	495	494	492	491	490	489	487	486	485
Kansai	2,739	2,735	2,726	2,720	2,709	2,700	2,692	2,683	2,675	2,666
Chugoku	1,047	1,046	1,045	1,043	1,042	1,040	1,039	1,037	1,036	1,034
Shikoku	494	492	489	486	483	481	478	475	473	470
Kyushu	1,535	1,536	1,533	1,529	1,526	1,522	1,518	1,514	1,510	1,506
60Hz areas Total	8,795	8,788	8,762	8,736	8,708	8,681	8,655	8,626	8,601	8,573
Interconnected	15,897	15,872	15,839	15,805	15,768	15,732	15,697	15,656	15,621	15,583
Okinawa	147	149	156	157	158	159	160	161	162	163
Nationwide	16,044	16,021	15,995	15,962	15,926	15,891	15,857	15,817	15,782	15,746

Table A2-2 Annual Projection of Supply Capacity for Each Regional Service Area
(At 15:00 in August, 10^4kW at the sending end)

[10^4kW]

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Hokkaido	562	566	641	652	650	654	659	663	663	715
Tohoku	1,549	1,693	1,637	1,594	1,587	1,603	1,623	1,638	1,650	1,666
Tokyo	5,914	5,868	5,823	6,022	6,124	6,138	6,118	6,136	6,154	6,168
50Hz areas Total	8,025	8,128	8,101	8,268	8,361	8,395	8,400	8,436	8,467	8,550
Chubu	2,706	2,670	2,832	2,699	2,710	2,711	2,665	2,663	2,661	2,527
Hokuriku	579	532	561	580	555	565	545	549	547	548
Kansai	2,730	3,125	3,075	2,824	2,953	2,958	2,997	3,004	3,010	3,018
Chugoku	1,309	1,339	1,291	1,246	1,250	1,249	1,245	1,247	1,249	1,255
Shikoku	703	735	660	678	689	690	682	683	687	687
Kyushu	1,690	1,748	1,571	1,589	1,584	1,588	1,570	1,573	1,623	1,630
60Hz areas Total	9,717	10,150	9,990	9,616	9,740	9,761	9,703	9,720	9,777	9,664
Interconnected	17,742	18,277	18,091	17,884	18,101	18,155	18,104	18,156	18,244	18,214
Okinawa	206	204	215	208	210	208	220	209	220	221
Nationwide	17,948	18,482	18,306	18,092	18,311	18,363	18,324	18,364	18,464	18,435

* Supply capacity for Okinawa in FY 2022 and 2023 indicates that the supply capacity falls to the least reserve margin.

Table A2-3 Annual Peak Demand Forecast for Winter Peak Areas of Hokkaido, Tohoku, and Hokuriku
(At 18:00 in January, 10^4kW at the sending end)

[10^4kW]

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Hokkaido	499	499	498	498	498	498	497	497	497	498
Tohoku	1,369	1,365	1,361	1,356	1,350	1,345	1,340	1,334	1,329	1,324
Hokuriku	511	513	512	512	512	511	511	511	511	510

Table A2-4 Annual Projection of Supply Capacity for Winter Peak Areas of Hokkaido, Tohoku, and Hokuriku
(At 18:00 in January, 10^4kW at the sending end)

[10^4kW]

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Hokkaido	627	661	692	671	669	673	679	681	731	728
Tohoku	1,544	1,596	1,684	1,641	1,635	1,649	1,670	1,685	1,695	1,712
Hokuriku	511	506	584	590	570	580	561	564	563	564

Table A2-5 Annual Projection of Supply–Demand Balance in Okinawa (10^4kW at the sending end)

[10^4 kW]

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Peak Demand	150	152	154	155	156	157	157	158	159	160
Supply Capacity	206	226	229	234	217	229	229	229	230	230
Reserve Capacity	56	74	75	79	61	72	72	71	71	70
Resreve Margin	37.5%	48.6%	49.0%	50.8%	39.2%	46.2%	45.7%	45.2%	44.6%	44.0%

V. Review of the Adequate Level of Balancing Capacity in Each Regional Service Area

Evaluation of Proper Standard of Soliciting Balancing Capacity for FY 2023

[only in Japanese]

https://www.occto.or.jp/houkokusho/2022/files/20220630_chousei_hitsuyoryo_kentoukekka.pdf

June 2022

Organization for Cross-regional Coordination of Transmission Operators, Japan

VI. Research and Study

“Research on Evaluating Method for Supply Reliability in European Countries and USA”
[only in Japanese]

https://www.occto.or.jp/houkokusho/2022/files/shinraidohyokashuhou_21itakuchousa.pdf

“Research on Grid Codes Revision and Relevant Technical Trend in European Countries and USA”
[only in Japanese]

https://www.occto.or.jp/iinkai/gridcode/2021/files/gridcode_09_12.pdf

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