Report on the Quality of Electricity Supply

- Data for Fiscal Year 2022 -

January 2024

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

Introduction

One of the objectives of the Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO) is to evaluate supply reliability conditions for securing a stable electricity supply. Thus, the OCCTO continuously gathers and publishes actual data on the quality of electricity supply according to the provisions of Article 181 of the Operational Rules of the OCCTO.

This report aggregates actual data on frequency, voltage, and interruptions under the title "Quality of Electricity Supply" and evaluates the data. These data are collected from each regional service area for the fiscal year 2022 (FY 2022). The 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) and European countries was conducted as a reference.
The goal of the OCCTO is to facilitate the use of aggregated data, evaluations, and analyses as a reference for the electricity business.

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

SUMMARY

In this report, the quality of nationwide electricity supply in FY 2022 was reviewed on the basis of the provisions of Article 181 of the OCCTO's Operational Rules.
Three aspects — frequency, standard voltage, and interruption, — of the quality of electricity supply were evaluated in this report.
Although different indices are available for evaluating each of these aspects, 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 were grouped into synchronized frequency regions: Hokkaido, Eastern Japan, Central and Western Japan, and Okinawa. Transmission operators in the eastern and western areas of Japan use 50 and 60 Hz, respectively.
In this study, 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 by considering the number of points at which 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 targets for transmission operators to ensure a standard voltage supply within a certain range of values.
At the request of the OCCTO, the transmission operators submitted their data. Nationwide, there was no violation of standard voltage among 6,578 points for 100 V and 6,496 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 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 14,793, which was a low level of disturbances, similar to the record for FY 2020, despite the actual 2022 record being higher by 27.9% than that of the previous year. Heavy rainfall in August 2022, which was designated as a severe disaster, increased the number of supply disturbances in the Hokuriku area by 153.0%, and Typhoon No.14 (Nanmadol) increased the number of supply disturbances in the Kyushu area by 133.5%.
The second analysis categorizes the causes of supply disturbances into two factors, namely, maintenance problems and natural disasters, with the latter being irrelevant to maintenance problems.

These analyses indicate 12 cases of supply disturbances, i.e., the number of supply disturbances decreased by 15 cases compared with that of the previous year, and became the lowest during the past five years. With respect to the causes of disturbances, there were six cases of disturbances triggered by natural disasters, i.e., this number decreased by 11 cases compared with that in the previous year. Furthermore, the number of disturbances triggered by the fault of facility or maintenance was five cases, which decreased by four cases, compared with that of the previous year, becoming the lowest during the past five years.
In the final analysis, the SAIFI and SAIDI values were historically monitored. The data for FY 2022 were 0.16 interruptions and 25 min. per customer. These values were higher than the corresponding data from the previous year. The number of supply disturbances in the Kyushu area increased; SAIFI increased from 0.07 to 0.15, and SAIDI increased from 3 to 115 compared with that in the previous year. This was attributable to the major disaster caused by Typhoon No.14.
For reference, this report also compares SAIFI and SAIDI values with those of the European countries and the major US states, even though the comparison is not straightforward given that index definitions are not identical across European countries and the US states.

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

CONTENTS

I. Frequency data

1. Standard Frequency in Japan

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 Act. Figure 1 shows the regional service areas of the 10 GT&D companies considered in this report and their standard frequencies.

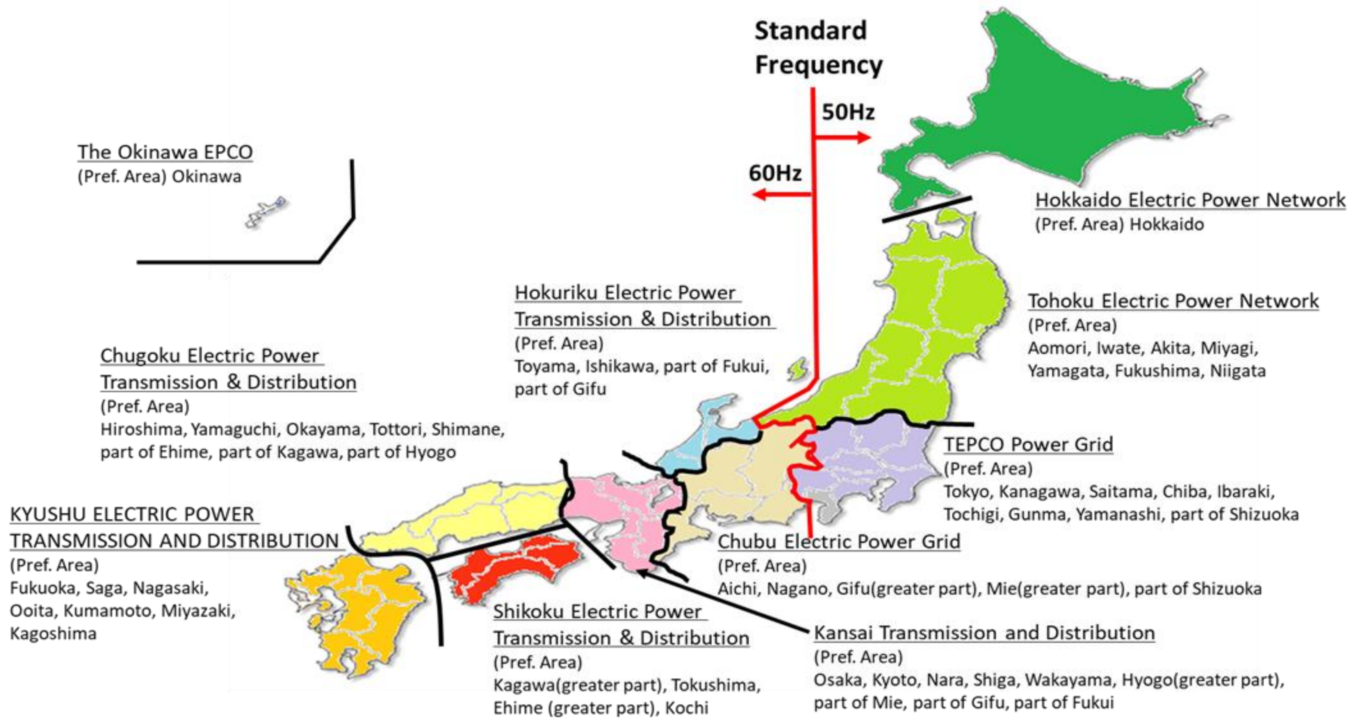

Figure 1　Regional service areas of 10 GT&D companies and their standard frequencies

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 ratio is calculated as follows:

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

3. Frequency Control Rule[1]

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

Table 1　Frequency control rule under normal conditions 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 the provisions of item 2 of Article 38 of the Ministerial Ordinance of the Act, the frequency value defined by the Ministerial Order is deemed to be the same frequency that general transmission and distribution companies supply; general transmission and distribution companies respectively set their frequency control target by their code, standard or manual.

4. Frequency time-kept ratio by Frequency-synchronized Region (FY 2018–2022)

Tables 2–5 show the frequency time-kept ratios by frequency-synchronized regions from FY 2018 to 2022, and Figures 2–5 show the trend of maintaining the frequency within 0.1 Hz variance.

The frequency time-kept ratio set by the GT&D companies was recorded as 100% in all regions for FY 2022. In the Central and Western region, the target frequency time-kept ratio within 0.1 Hz variance for FY 2022 was improved to 98.46%, from that of the previous year (98.12%), and 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 2018–2022) [%]

Variance	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Within 0.1 Hz	99.86	99.98	99.93	99.87	99.90
Within 0.2 Hz	99.95	100.00	100.00	99.99	99.99
Within 0.3 Hz	99.98	100.00	100.00	100.00	100.00
Beyond 0.3 Hz	0.00	0.02	0.00	0.00	0.00

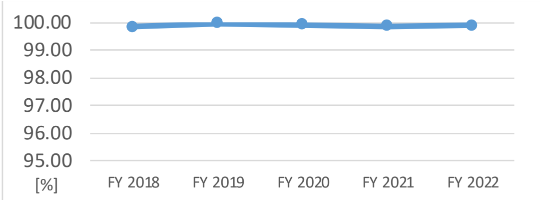

Figure 2 Frequency time-kept ratio within 0.1 Hz (Hokkaido, FY 2018-2022)

Table 3 Frequency time-kept ratio (Eastern region,[2] FY 2018–2022) [%]

Variance	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Within 0.1 Hz	99.84	99.83	99.71	99.50	99.43
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

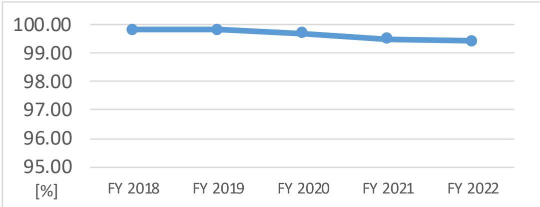

Figure 3 Frequency time-kept ratio within 0.1 Hz (Eastern region,[2] FY 2018-2022)

Table 4 Frequency time-kept ratio (Central & Western region,[3] FY 2018–2022) [%]

Variance	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Within 0.1 Hz	99.13	99.02	98.50	98.12	98.46
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

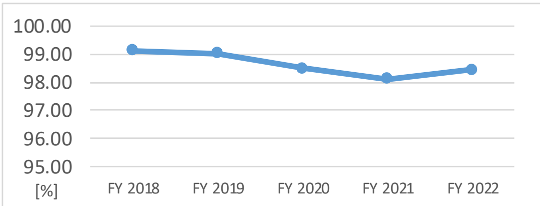

Figure 4 Frequency time-kept ratio within 0.1 Hz (Central & Western region,[3] FY 2018–2022)

Table 5 Frequency time-kept ratio (Okinawa, FY 2018–2022) [%]

Variance	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Within 0.1 Hz	99.89	99.89	99.92	99.89	99.98
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

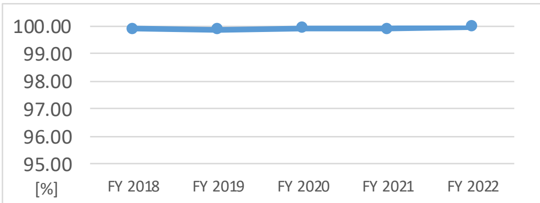

Figure 5 Frequency time-kept ratio within 0.1 Hz (Okinawa, FY 2018–2022)

[2] The 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 the TEPCO Power Grid.

[3] The central and western regions of Japan include the regional service areas of Chubu Electric Power Grid, Hokuriku Electric Power 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 and 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 Electric Power Transmission & Distribution, 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 min., including the maximum and the minimum values, and review whether these values deviate from the average.

3. Nationwide Voltage Deviation Ratio (FY 2018–2022)

Table 7 shows the total measured points, deviated measured points, and nationwide deviation ratio from FY 2018 to 2022.

For FY 2022 data, GT&D companies reported that the voltage standard was adequately maintained, with no deviation.

Table 7 Voltage deviation measurement (Nationwide, FY 2018–2022) [points]

Voltage		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
100V	Total measured points	6,575	6,567	6,562	6,589	6,578
	Deviated points	0	0	0	0	0
200V	Total measured points	6,505	6,502	6,498	6,523	6,496
	Deviated points	0	0	0	0	0

* Corrections were made for the actual data of the measured points from 2018 to 2021 for the portion of Kansai area.

III. Interruption data

1. Data on the Number of Supply Disturbances from which Interruption Originated

(1) Indices and Definitions of Supply Disturbances

The criteria for supply interruption include the number of supply disturbances where the 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 disturbances.[6]

[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 item 18, paragraph 1 of Article 2 of the Act.

[5] Automatic reclosing of a transmission line means the reconnection of a transmission line by reswitching 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 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 2018–2022)

Table 8 and Figure 6 show the number of supply disturbances nationwide, where the interruptions originated in FY 2018–2022. Tables 9–18 and Figures 7–16 show the number of supply disturbances from the regional service areas. In addition, the category “Involving Accidents” in the tables indicates the number of supply disturbances induced by accidents at electric facilities other than those at the corresponding GT&D companies. Table columns are blank for zero values or if the data are unavailable. Analysis of FY 2022 data indicates the following.

With respect to FY 2022 data, the total number of supply disturbances was found to be 14,793 which was a low level of disturbances, similar to the record of FY 2020, despite the actual 2022 record being higher by 27.9% than that of the previous year. Heavy rainfall in August 2022, which was designated as a severe disaster, increased the number of supply disturbances in the Hokuriku area by 153.0%, and Typhoon No.14 (Nanmadol) increased the number of supply disturbances in the Kyushu area by 133.5%.[7]

Table 8 Number of supply disturbances where interruption originated (Nationwide, FY 2018–2022)

Occurrence at			FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities								
	Substations		65	56	48	65	57	58.2
	Transmission lines & Extra High Voltage lines	Overhead	409	246	274	260	308	299.4
		Under-ground	10	13	9	17	9	11.6
		Total	419	259	283	277	317	311.0
	High Voltage lines	Overhead	20,729	13,958	13,539	10,775	13,847	14,569.6
		Under-ground	265	227	201	201	210	220.8
		Total	20,994	14,185	13,740	10,976	14,057	14,790.4
	Demand facilities						1	0.2
Involvng accidents			359	372	277	245	361	322.8
Total disturbances			21,837	14,872	14,348	11,563	14,793	15,482.6

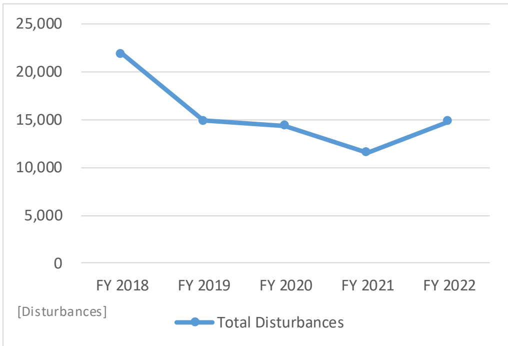

Figure 6 Transition of supply disturbances (Nationwide, FY 2018–2022)

[7] Although they are written in Japanese only, information on supply interruption and facility damage due to natural disasters in FY 2022 is shown in the following links: https://www.bousai.go.jp/updates/#r3
For the Hokuriku area, please refer to r4_08ooame_01.pdf (bousai.go.jp)
For the Kyushu are, please refer to r4typhoon14_09.pdf (bousai.go.jp)

Table 9 Number of supply disturbances where interruption originated (Hokkaido, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		5	2	2	3	3	3.0
Transmission lines & Extra High Voltage lines	Overhead	25	12	21	20	20	19.6
	Under-ground		1	1			0.4
	Total	25	13	22	20	20	20.0
High Voltage lines	Overhead	1,139	600	801	848	973	872.2
	Under-ground	13	15	15	12	15	14.0
	Total	1,152	615	816	860	988	886.2
Demand facilities							
Involvng accidents		12	11	10	14	16	12.6
Total disturbances		1,194	641	850	897	1,027	921.8

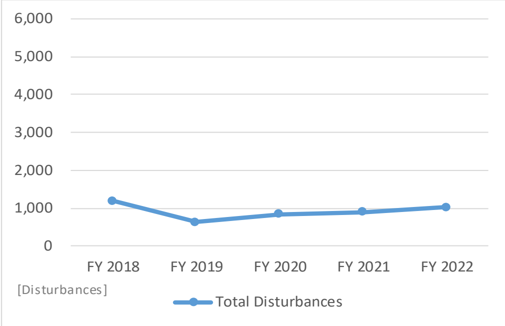

Figure 7 Transition of supply disturbances (Hokkaido, FY 2018–2022)

Table 10 Number of supply disturbances where interruption originated (Tohoku, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		9	8	9	9	8	8.6
Transmission lines & Extra High Voltage lines	Overhead	11	16	31	31	20	21.8
	Under-ground						
	Total	11	16	31	31	20	21.8
High Voltage lines	Overhead	1,478	1,646	2,528	1,686	2,036	1,874.8
	Under-ground	11	7	13	7	19	11.4
	Total	1,489	1,653	2,541	1,693	2,055	1,886.2
Demand facilities						1	0.2
Involvng accidents		20	29	17	18	27	22.2
Total disturbances		1,529	1,706	2,598	1,751	2,111	1,939.0

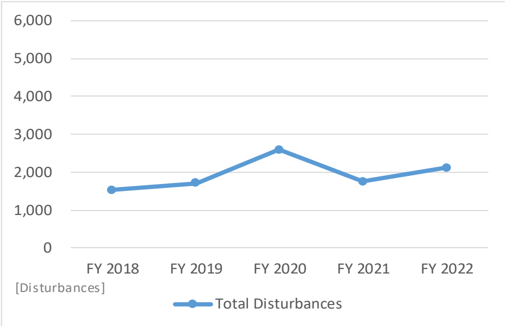

Figure 8 Transition of supply disturbances (Tohoku, FY 2018–2022)

Table 11 Number of supply disturbances where interruption originated (Tokyo, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		16	17	5	10	8	11.2
Transmission lines & Extra High Voltage lines	Overhead	38	21	10	10	20	19.8
	Under-ground		4	3	5	3	3.0
	Total	38	25	13	15	23	22.8
High Voltage lines	Overhead	3,841	5,186	2,472	2,316	2,309	3,224.8
	Under-ground	100	97	75	87	73	86.4
	Total	3,941	5,283	2,547	2,403	2,382	3,311.2
Demand facilities							
Involvng accidents		107	134	74		67	76.4
Total disturbances		4,102	5,459	2,639	2,428	2,480	3,421.6

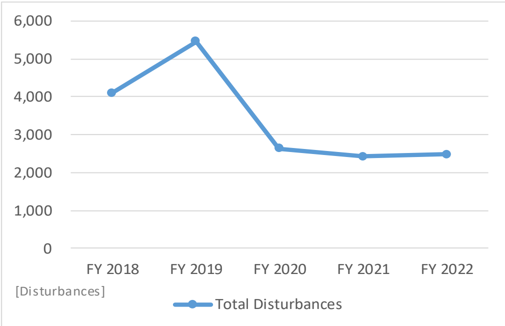

Figure 9 Transition of supply disturbances (Tokyo, FY 2018–2022)

Table 12 Number of supply disturbances where interruption originated (Chubu, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		6	10	4	7	7	6.8
Transmission lines & Extra High Voltage lines	Overhead	26	19	15	9	13	16.4
	Under-ground			1		1	0.4
	Total	26	19	16	9	14	16.8
High Voltage lines	Overhead	4,053	1,570	1,359	1,338	1,397	1,943.4
	Under-ground	39	6	4	10	9	13.6
	Total	4,092	1,576	1,363	1,348	1,406	1,957.0
Demand facilities							
Involvng accidents		66	60	71	64	69	66.0
Total disturbances		4,190	1,665	1,454	1,428	1,496	2,046.6

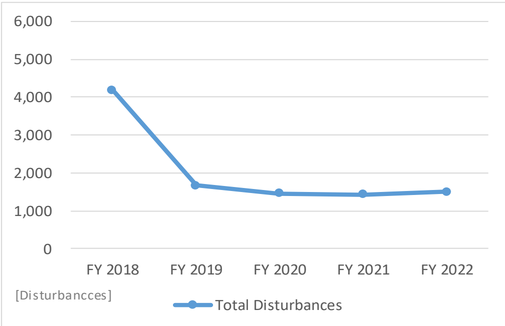

Figure 10 Transition of supply disturbances (Chubu, FY 2018–2022)

Table 13 Number of supply disturbances where interruption originated (Hokuriku, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations			2	3	4	2	2.2
Transmission lines & Extra High Voltage lines	Overhead	7	2	3		5	3.4
	Under-ground	2	2				0.8
	Total	9	4	3		5	4.2
High Voltage lines	Overhead	385	199	444	215	567	362.0
	Under-ground	3	1	4	1	2	2.2
	Total	388	200	448	216	569	364.2
Demand facilities							
Involvng accidents		21	10	10	14	16	14.2
Total disturbances		418	216	464	234	592	384.8

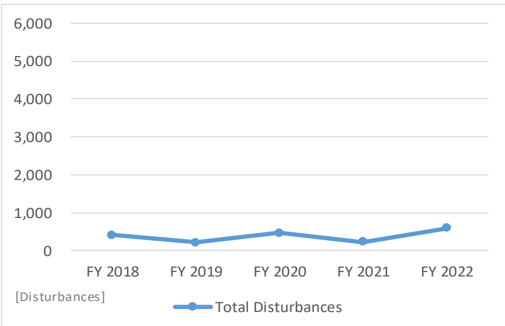

Figure 11 Transition of supply disturbances (Hokuriku, FY 2018–2022)

Table 14 Number of supply disturbances where interruption originated (Kansai, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		8	3	6	10	9	7.2
Transmission lines & Extra High Voltage lines	Overhead	190	82	84	86	99	108.2
	Under-ground	6	3	4	8	2	4.6
	Total	196	85	88	94	101	112.8
High Voltage lines	Overhead	5,270	1,300	1,254	1,384	1,480	2,137.6
	Under-ground	56	50	50	33	37	45.2
	Total	5,326	1,350	1,304	1,417	1,517	2,182.8
Demand facilities							
Involvng accidents		70	64	44	56	79	62.6
Total disturbances		5,600	1,502	1,442	1,577	1,706	2,365.4

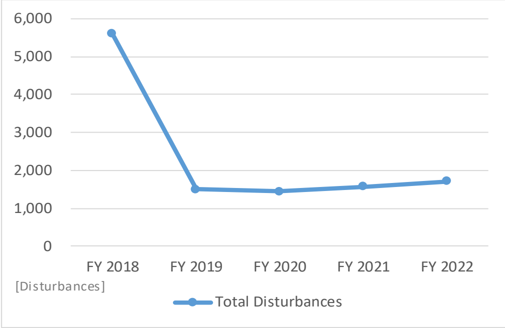

Figure 12 Transition of supply disturbances (Kansai, FY 2018–2022)

Table 15 Number of supply disturbances where interruption originated (Chugoku, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		8	6	3	6	11	6.8
Transmission lines & Extra High Voltage lines	Overhead	14	17	11	25	11	15.6
	Under-ground	1	1		1	3	1.2
	Total	15	18	11	26	14	16.8
High Voltage lines	Overhead	1,172	1,015	1,163	1,193	1,449	1,198.4
	Under-ground	20	16	12	15	20	16.6
	Total	1,192	1,031	1,175	1,208	1,469	1,215.0
Demand facilities							
Involvng accidents		31	35	32	37	32	33.4
Total disturbances		1,246	1,090	1,221	1,277	1,526	1,272.0

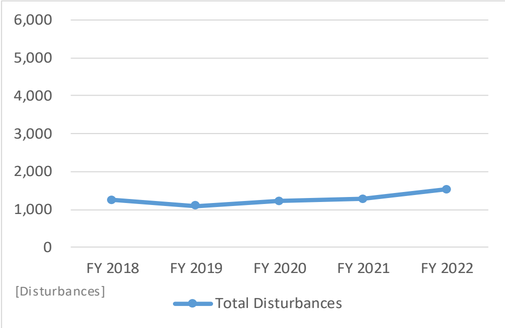

Figure 13 Transition of supply disturbances (Chugoku, FY 2018–2022)

Table 16 Number of supply disturbances where interruption originated (Shikoku, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		4	2	5	3		2.8
Transmission lines & Extra High Voltage lines	Overhead	4	4	1	10	16	7.0
	Under-ground						
	Total	4	4	1	10	16	7.0
High Voltage lines	Overhead	616	439	447	393	673	513.6
	Under-ground	8	6	6	10	3	6.6
	Total	624	445	453	403	676	520.2
Demand facilities							
Involvng accidents		5	7	6	10	10	7.6
Total disturbances		637	458	465	426	702	537.6

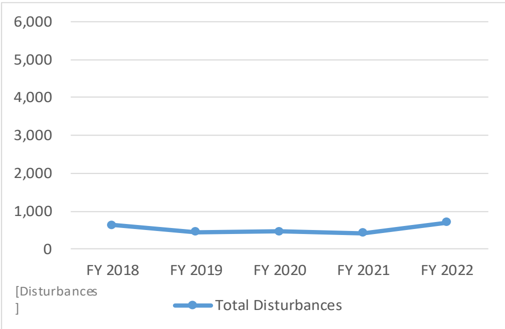

Figure 14 Transition of supply disturbances (Shikoku, FY 2018–2022)

Table 17 Number of supply disturbances where interruption originated (Kyushu, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		1	4	7	11	8	6.2
Transmission lines & Extra High Voltage lines	Overhead	42	38	42	24	48	38.8
	Under-ground	1			1		0.4
	Total	43	38	42	25	48	39.2
High Voltage lines	Overhead	1,888	1,547	2,614	1,088	2,605	1,948.4
	Under-ground	15	22	17	22	25	20.2
	Total	1,903	1,569	2,631	1,110	2,630	1,968.6
Demand facilities							
Involvng accidents		16	19	13	18	32	19.6
Total disturbances		1,963	1,630	2,693	1,164	2,718	2,033.6

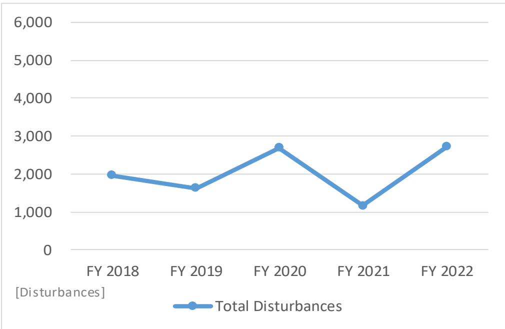

Figure 15 Transition of supply disturbances (Kyushu, FY 2018–2022)

Table 18 Number of supply disturbances where interruption originated (Okinawa, FY 2018–2022)

Occurrence at		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years average
Disturbance of general transmission & distribution companies' facilities							
Substations		8	2	4	2	1	3.4
Transmission lines & Extra High Voltage lines	Overhead	52	35	56	45	56	48.8
	Under-ground		2		2		0.8
	Total	52	37	56	47	56	49.6
High Voltage lines	Overhead	887	456	457	314	358	494.4
	Under-ground		7	5	4	7	4.6
	Total	887	463	462	318	365	499.0
Demand facilities							
Involvng accidents		11	3		14	13	8.2
Total disturbances		958	505	522	381	435	560.2

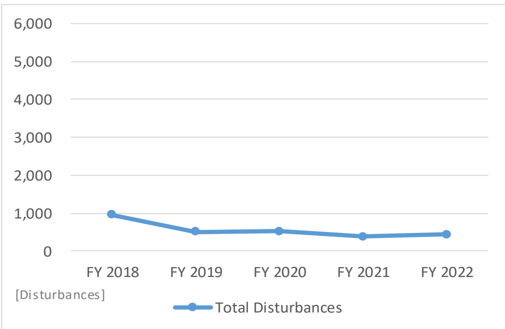

Figure 16 Transition of supply disturbances (Okinawa, FY 2018–2022)

2. Number of Supply Disturbances from which Interruptions Originated

(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 from which the interruption originated, as described in the previous section. This section analyzes the causes.

Figure 17 illustrates the number of supply disturbances indicating from which interruptions originated versus the scale of interruption. Table 19 shows nationwide data for FY 2022.[8] The columns in the table were left blank if the value was zero or data were unavailable. Note that supply disturbances caused by blackouts are not included in the statistics.

- Capacity lost by disturbance was 7,000–70,000 kW with durations longer than 1 h
- Capacity lost by disturbance was over 70,000 kW with durations longer than 10 min

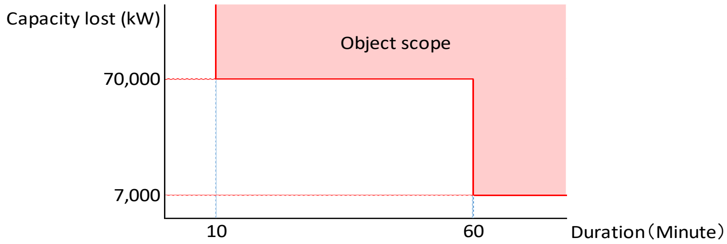

Figure 17 Image of supply disturbances over a certain scale

Table 19 Number of supply disturbances where interruption originated by scale of interruption (Nationwide, FY 2022) [Disturbances]

Scale of disturbance [Duration & Capacity lost] / Occurrence at		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						3						3
Transmission lines & Extra High Voltage lines	Overhead		1			1			3	1		7
	Under-ground								2			2
	Total		1			1			5	1		9
High Voltage distribution lines	Overhead											
	Under-ground											
	Total											
Demand facilities												
Involved accidents												
Total disturbances			1		1	4			5	1		12

---

[8] Supply disturbances over a certain scale of 10 min and longer were reported for different destinations according to lost capacity under the provisions of Article 3 of "Reporting Rules of the Electricity Business". In the case of a lost capacity of 70,000–100,000 kW, the loss is reported to the Director of Regional Industrial Safety and the Inspection Department of METI that directs the area where the disturbed electric facility is located. If the lost capacity is over 100,000 kW, the loss is reported to METI. Thus, the reporting destination differs according to the lost capacity. Table 19 presents the number of disturbances caused 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 causes of supply disturbances

Classification of Causes		Description
Facility fault		Because of 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 the public (stone throwing, wire theft, etc.). In the case of an accompanying electric shock, instances are classified under "Electric shock (worker)" or "Electric shock (public)."
Physical contact		Due to physical contact with trees, wildlife, or others (kite, model airplane).
Corrosion		Because of corrosion by leakage of current from DC electric railroad or by chemical action.
Vibration		Due to vibration from heavy vehicle traffic or construction work.
Involvement in an accident		Due to an accident involving the electric facilities of another company.
Improper fuel		Due to an 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 strikes.
	Rainstorm	Due to rain, wind, or rainstorm (including contact with fallen branches).
	Snowstorm	Due to snow, frazil, hail, sleet, or snowstorm.
	Earthquake	Due to earthquakes.
	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		Causes that remain unknown despite investigation.
Miscellaneous		Because of causes not categorized above.

(3) Number and Causes of Supply Disturbances Over a Certain Scale (FY 2018–2022)

Table 21 and Figure 18 show nationwide data for the number of supply disturbances from which interruption originated over a certain scale. Tables 22–31 show the same data from each regional service area for FY 2018–2022.[9,10]

The number and causes of supply disturbances over a certain scale for FY 2022 data were analyzed. Nationwide, there were 12 cases of supply disturbances, i.e., the number of supply disturbances decreased by 15 cases compared with that of the previous year, and became the lowest during the past five years. With respect to the causes of disturbances, there were six cases of disturbances triggered by natural disasters, i.e., this number decreased by 11 cases compared with that in the previous year. Furthermore, the number of disturbances triggered by the fault of facility or maintenance was five cases, decreased by four cases, compared with that of the previous year, becoming the lowest during the past five years.

Table 21 Causes of disturbances over a certain scale (Nationwide, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
Fault of facility or maintenance						
Facility fault	3		1	2	1	1.8
Maintenance fault	1		1	1		1.0
Accident/malice	2	1	4	1	3	2.2
Physical contact	2	5	6	4	1	3.6
Involved accident	1					0.2
Electric shock(worker)						
Electric shock(public)				1		0.2
Subtotal	9	6	12	9	5	8.2
Natural disaster						
Thunderbolt	1	5	2	4	3	3.0
Rainstorm	17	5		2	1	5.0
Snowstorm				2	1	0.6
Earthquake			3	9		3.0
Landslide					1	0.2
Dust/Gas	2	1				0.6
Subtotal	20	11	5	17	6	11.8
Unknown			1	1		0.4
Miscellaneous	2	1	1		1	1.0
Total disturbances	31	18	19	27	12	21.4

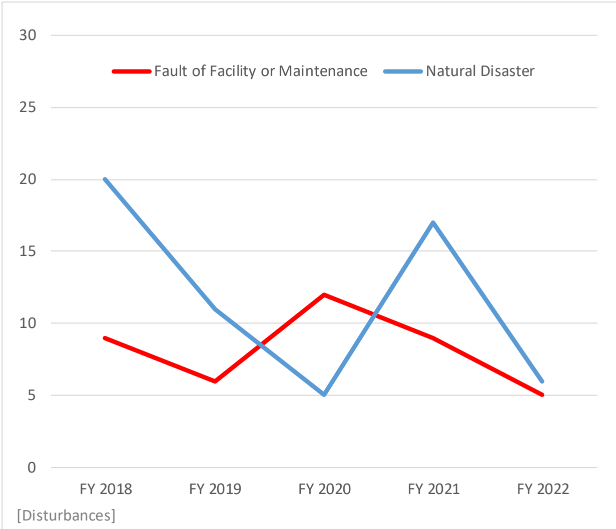

Figure 18 Transition of disturbances by causes (Nationwide, FY 2018–2022)

Table 22 Causes of disturbances over a certain scale (Hokkaido, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
Fault of facility or maintenance						
Facility fault	1		1			0.4
Maintenance fault	1					0.2
Accident/malice						
Physical contact	1				1	0.4
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal	3		1		1	1.0
Natural disaster						
Thunderbolt		1				0.2
Rainstorm				1		0.2
Snowstorm					1	0.2
Earthquake						
Landslide						
Dust/Gas						
Subtotal		1		1	1	0.6
Unknown				1		0.2
Miscellaneous	1					0.2
Total disturbances	4	1	1	2	2	2.0

Table 23 Causes of disturbances over a certain scale (Tohoku, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
Fault of facility or maintenance						
Facility fault					1	0.2
Maintenance fault						
Accident/malice				1	1	0.4
Physical contact				1		0.2
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal				2	2	0.8
Natural disaster						
Thunderbolt		1				0.2
Rainstorm						
Snowstorm						
Earthquake			3	8		2.2
Landslide						
Dust/Gas						
Subtotal		1	3	8		2.4
Unknown						
Miscellaneous						
Total disturbances		1	3	10	2	3.2

9 Causes of disturbances that did not occur in FY 2018–2022 are omitted from the tables.
10 Columns 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 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault				1		0.2
Accident/malice	1	1	2		1	1.0
Physical contact	1	1	1	1		0.8
Involved accident						
Electric shock(worker)						
Electric shock(public)				1		0.2
Subtotal	2	2	3	3	1	2.2
Natural disaster						
Thunderbolt	1	2		2	2	1.4
Rainstorm		3			1	0.8
Snowstorm						
Earthquake						
Landslide						
Dust/Gas						
Subtotal	1	5		2	3	2.2
Unknown			1			0.2
Miscellaneous	1		1			0.4
Total disturbances	4	7	5	5	4	5.0

Table 25 Causes of disturbances over a certain scale (Chubu, FY 2018–2022) [Disturbances

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	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						
Landslide					1	0.2
Dust/Gas	2					0.4
Subtotal	3		1		1	1.0
Unknown						
Miscellaneous		1				0.2
Total disturbances	3	3	2	2	1	2.2

Table 26 Causes of disturbances over a certain scale (Hokuriku, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	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						
Landslide						
Dust/Gas						
Subtotal						
Unknown						
Miscellaneous						
Total disturbances						

Table 27 Causes of disturbances over a certain scale (Kansai, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
Fault of facility or maintenance						
Facility fault	3			2		1.0
Maintenance fault			1			0.2
Accident/malice			1			0.2
Physical contact		2	4			1.2
Involved accident	1					0.2
Electric shock(worker)						
Electric shock(public)						
Subtotal	4	2	6	2		2.8
Natural disaster						
Thunderbolt		1	1	1		0.6
Rainstorm	10	1		1		2.4
Snowstorm				1		0.2
Earthquake						
Landslide						
Dust/Gas						
Subtotal	10	2	1	3		3.2
Unknown						
Miscellaneous					1	0.2
Total disturbances	14	4	7	5	1	6.2

Table 28 Causes of disturbances over a certain scale (Chugoku, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
Fault of facility or maintenance						
Facility fault						
Maintenance fault						
Accident/malice					1	0.2
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal					1	0.2
Natural disaster						
Thunderbolt				1	1	0.4
Rainstorm	2					0.4
Snowstorm				1		0.2
Earthquake						
Landslide						
Dust/Gas		1				0.2
Subtotal	2	1		2	1	1.2
Unknown						
Miscellaneous						
Total disturbances	2	1		2	2	1.4

Table 29 Causes of disturbances over a certain scale (Shikoku, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	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						
Landslide						
Dust/Gas						
Subtotal						
Unknown						
Miscellaneous						
Total disturbances						

Table 30 Causes of disturbances over a certain scale (Kyushu, FY 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	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
Landslide						
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 2018–2022) [Disturbances]

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	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						
Landslide						
Dust/Gas						
Subtotal	2	1				0.6
Unknown						
Miscellaneous						
Total disturbances	2	1	1			0.8

3. Data on Interruptions for Low-Voltage (LV) Customers

(1) Indices of System Average Interruption for LV Customers

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

System average interruption frequency index (SAIFI/interruptions)

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

System average interruption duration index (SAIDI/minutes)

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

Table 32 shows the definitions of terms related to outages.

Table 32 Definition of outage-related terms

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

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

(2) Data on System Average Interruption Nationwide and by Regional Service Area (FY 2018–2022)

Table 33 and Figure 19 show nationwide data for system average interruptions for FY 2018–2022. Tables 34–43 and Figures 20–29 show the data for each regional service area. Table 44 shows nationwide data for system average interruptions for FY 2022.[13]

The actual data on system average interruption for LV customers are summarized below. Regarding the nationwide SAIFI and SAIDI data, the data for FY 2022 were 0.16 interruptions and 25 min, per customer, respectively. These values were higher than the corresponding data from the previous year. The number of supply disturbances in the Kyushu area increased; SAIFI increased from 0.07 to 0.15, and SAIDI increased from 3 to 115 compared with that in the previous year. This was attributable to the major disaster caused by Typhoon No.14.

Table 33 Indices of system average interruption (Nationwide, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.28	0.19	0.13	0.10	0.14	0.17
	Planned	0.03	0.04	0.04	0.03	0.03	0.03
	Total ●	0.31	0.23	0.17	0.13	0.16	0.20
SAIDI [Minutes]	Forced	221	82	24	7	22	71
	Planned	4	3	3	3	3	3
	Total ●	225	86	27	10	25	75

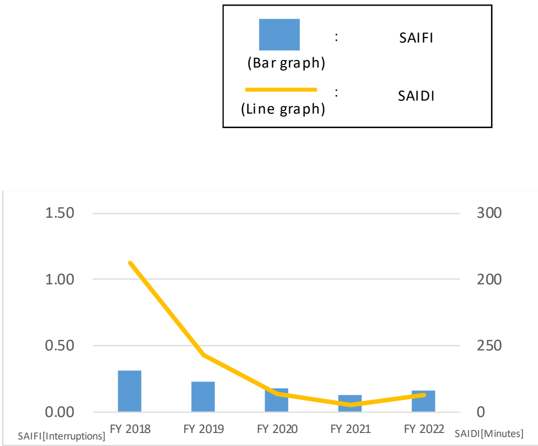

Figure 19 System average interruption indices of LV customers (Nationwide, FY 2018–2022)

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

Table 34 Indices of system average interruption (Hokkaido, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	1.19	0.11	0.09	0.14	0.12	0.33
	Planned	0.01	α	α	α	α	0.01
	Total ●	1.19	0.11	0.09	0.14	0.12	0.33
SAIDI [Minutes]	Forced	2,154	4	5	12	20	439
	Planned	0	0	0	0	1	0
	Total ●	2,154	4	5	12	21	439

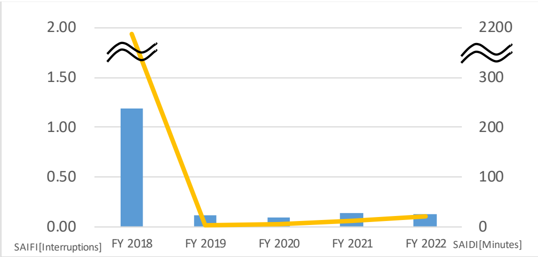

Figure 20 System average interruption indices of LV customers (Hokkaido, FY 2018–2022)

Table 35 Indices of system average interruption (Tohoku, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.09	0.11	0.16	0.11	0.11	0.11
	Planned	0.02	0.02	0.02	0.02	0.02	0.02
	Total ●	0.11	0.12	0.18	0.13	0.13	0.13
SAIDI [Minutes]	Forced	7	15	25	15	24	17
	Planned	2	2	4	2	3	3
	Total ●	10	17	29	18	27	20

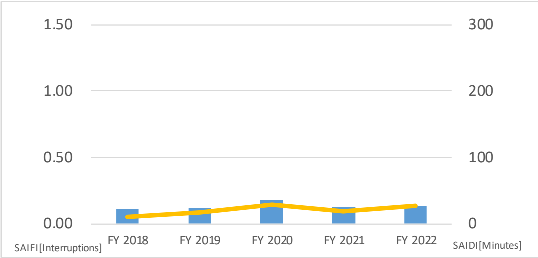

Figure 21 System average interruption indices of LV customers (Tohoku, FY 2018–2022)

Table 36 Indices of system average interruption (Tokyo, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.13	0.33	0.11	0.10	0.13	0.16
	Planned	0.01	0.03	0.06	0.01	0.01	0.02
	Total ●	0.14	0.36	0.17	0.11	0.13	0.18
SAIDI [Minutes]	Forced	19	200	7	6	5	47
	Planned	3	1	1	1	1	1
	Total ●	22	201	8	7	6	49

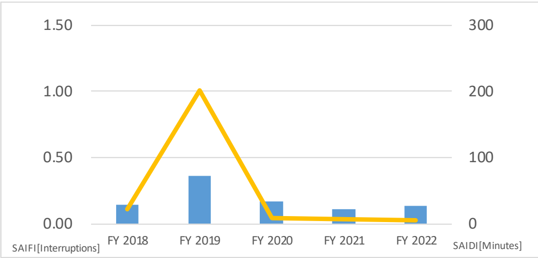

Figure 22 System average interruption indices of LV customers (Tokyo, FY 2018–2022)

Table 37 Indices of system average interruption (Chubu, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.39	0.11	0.07	0.09	0.14	0.16
	Planned	0.06	0.06	0.05	0.05	0.05	0.05
	Total ●	0.45	0.17	0.13	0.14	0.19	0.21
SAIDI [Minutes]	Forced	348	32	6	5	16	81
	Planned	8	8	7	7	6	7
	Total ●	356	40	12	12	22	88

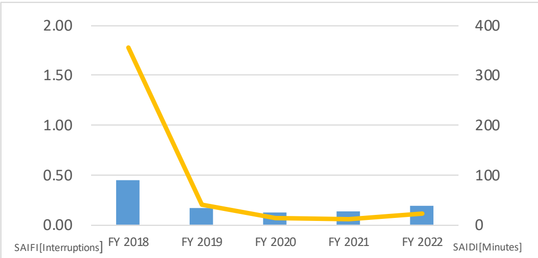

Figure 23 System average interruption indices of LV customers (Chubu, FY 2018–2022)

Table 38 Indices of system average interruption (Hokuriku, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.06	0.03	0.06	0.04	0.08	0.05
	Planned	0.09	0.09	0.08	0.08	0.08	0.08
	Total ●	0.15	0.13	0.14	0.12	0.16	0.14
SAIDI [Minutes]	Forced	9	3	7	3	12	7
	Planned	15	16	15	14	14	15
	Total ●	24	19	22	17	26	21

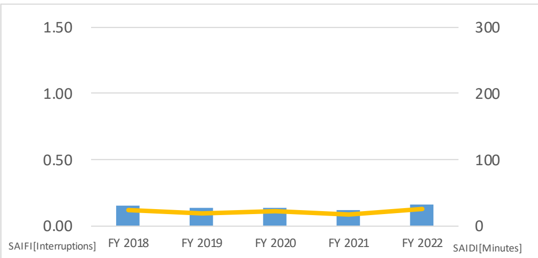

Figure 24 System average interruption indices of LV customers (Hokuriku, FY 2018–2022)

Table 39 Indices of system average interruption (Kansai, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.40	0.10	0.09	0.08	0.11	0.16
	Planned	0.01	0.01	0.01	0.01	0.01	0.01
	Total	0.41	0.11	0.10	0.10	0.12	0.17
SAIDI [Minutes]	Forced	396	5	7	6	6	84
	Planned	1	1	1	2	1	1
	Total	397	6	8	7	7	85

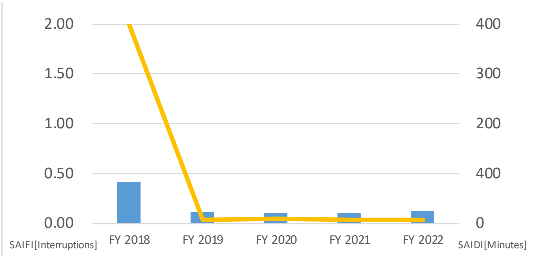

Figure 25 System average interruption indices of LV customers (Kansai, FY 2018–2022)

Table 40 Indices of system average interruption (Chugoku, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.14	0.13	0.15	0.15	0.14	0.14
	Planned	0.09	0.09	0.10	0.08	0.08	0.09
	Total	0.23	0.21	0.25	0.23	0.22	0.23
SAIDI [Minutes]	Forced	24	10	20	10	12	15
	Planned	10	9	11	9	9	9
	Total	33	19	31	19	21	24

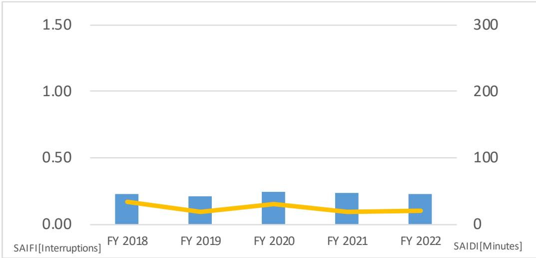

Figure 26 System average interruption indices of LV customers (Chugoku, FY 2018–2022)

Table 41 Indices of system average interruption (Shikoku, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.20	0.13	0.14	0.12	0.23	0.16
	Planned	0.14	0.14	0.14	0.14	0.15	0.14
	Total	0.34	0.27	0.28	0.26	0.38	0.31
SAIDI [Minutes]	Forced	32	8	10	7	35	18
	Planned	15	15	15	15	16	15
	Total	47	23	24	23	51	34

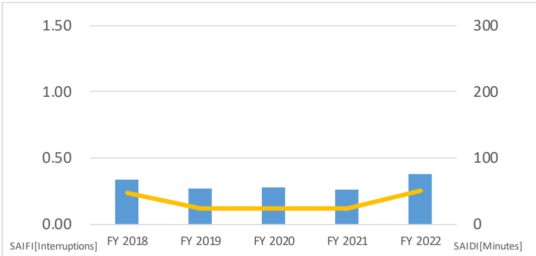

Figure 27 System average interruption indices of LV customers (Shikoku, FY 2018–2022)

Table 42 Indices of system average interruption (Kyushu, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	0.14	0.08	0.21	0.07	0.15	0.13
	Planned	0	0	0	0	0	0
	Total	0.14	0.08	0.21	0.07	0.15	0.13
SAIDI [Minutes]	Forced	103	15	139	3	115	75
	Planned	0	0	0	0	0	0
	Total	103	15	139	3	115	75

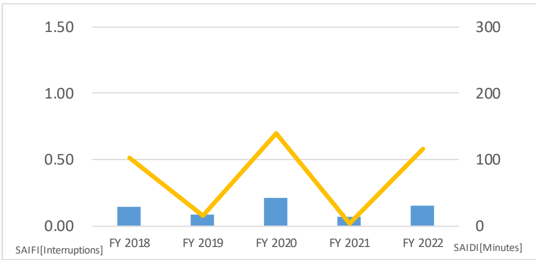

Figure 28 System average interruption indices of LV customers (Kyushu, FY 2018–2022)

Table 43 Indices of system average interruption (Okinawa, FY 2018–2022)

		FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	5-years Average
SAIFI [Interruptions]	Forced	3.62	1.11	1.12	0.57	0.98	1.48
	Planned	0.07	0.05	0.06	0.05	0.05	0.06
	Total	3.69	1.17	1.18	0.61	1.03	1.54
SAIDI [Minutes]	Forced	1,269	215	90	40	56	334
	Planned	6	6	11	5	5	7
	Total	1,275	221	101	45	61	341

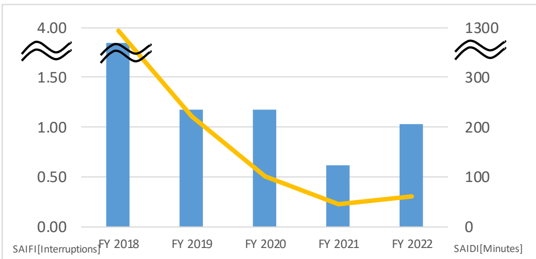

Figure 29 System average interruption indices of LV customers (Okinawa, FY 2018–2022)

Table 44 System average disturbances where interruptions were caused by outages (Nationwide, FY 2021)[14]

		Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa	Nationwide
SAIFI [Interruptions]	Forced outage											
	Generators	0.05	0.02	0.09	0.08	0.02	0.04	0.02	0.01	0.02	0.33	
	HV lines	0.07	0.09	0.04	0.06	0.06	0.07	0.12	0.21	0.13	0.64	
	LV lines	α	α	α	α	α	α	α	0.01	α	0.01	
	Subtotal	0.12	0.11	0.13	0.14	0.08	0.11	0.14	0.23	0.15	0.98	0.14
	Planned outage											
	Generators	α	α	0.00	0.00	α	α	α	0.00	0.00	α	
	HV lines	α	0.01	α	0.03	0.07	0.01	0.06	0.09	0.00	0.02	
	LV lines	α	α	α	0.01	0.01	0.01	0.02	0.06	0.00	0.03	
	Subtotal	α	0.02	0.01	0.05	0.08	0.01	0.08	0.15	0.00	0.05	0.03
	Total outage											
	Generators	0.05	0.02	0.09	0.08	0.02	0.04	0.02	0.01	0.02	0.33	
	HV lines	0.07	0.11	0.04	0.09	0.13	0.08	0.18	0.30	0.13	0.66	
	LV lines	α	0.01	α	0.02	0.02	0.01	0.02	0.06	α	0.04	
	Total	0.12	0.13	0.13	0.19	0.16	0.12	0.22	0.38	0.15	1.03	0.16
SAIDI [Minutes]	Forced outage											
	Generators	13	1	1	9	α	1	1	2	5	12	
	HV lines	7	21	3	6	11	4	10	30	109	39	
	LV lines	α	2	α	1	1	α	1	2	1	5	
	Subtotal	20	24	5	16	12	6	12	35	115	56	22
	Planned outage											
	Generators	α	α	0	0	α	α	α	0	0	α	
	HV lines	1	2	α	5	13	1	8	13	0	2	
	LV lines	α	1	α	1	1	α	1	4	0	3	
	Subtotal	1	3	1	6	14	1	9	16	0	5	3
	Total outage											
	Generators	13	1	1	9	α	1	1	2	5	12	
	HV lines	7	23	4	10	23	5	18	43	109	41	
	LV lines	α	3	α	3	2	1	2	6	1	8	
	Total	21	27	6	22	26	7	21	51	115	61	25

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

[14] Electric facilities such as generating plants, substations, transmission lines, and 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, is the ratio of time that the metered frequency is maintained within a given variance of the standard. The frequency time-kept ratio within the target variance of the standard for frequency-synchronized regions for FY 2022 was 100%.

Voltage

The criteria for maintaining voltage include the number of measured points where the metered voltage deviates from the aforementioned standard and the deviation ratio, which is the ratio of deviated points to the total number of measured points. No deviation from the voltage standard was observed nationwide in FY 2022.

Supply Disturbances and Interruption in LV Customers

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

In FY 2022, the total number of supply disturbances was 14,793 which was a low level of disturbances, similar to the record of FY 2020, despite the actual 2022 record being higher than that of the previous year by 27.9%. Heavy rainfall in August 2022, which was designated as a severe disaster, increased the number of supply disturbances in the Hokuriku area by 153.0%, and Typhoon No.14 (Nanmadol) increased the number of supply disturbances in the Kyushu area by 133.5%.

The number and causes of supply disturbances over a certain scale for the FY 2022 data were analyzed. Nationwide, there were 12 cases of supply disturbances, i.e., the number of supply disturbances decreased by 15 cases compared with that of the previous year, and becomes the lowest during the past five years. With respect to the causes of disturbances, there were six cases of disturbances triggered by natural disasters, i.e., this number decreased by 11 cases compared with that in the previous year. Furthermore, the number of disturbances triggered by the fault of facility or maintenance was five cases, decreased by four cases, compared with that of the previous year, becoming the lowest during the past five years.

The nationwide SAIFI and SAIDI data for FY 2022 were 0.16 interruptions and 25 min per customer, respectively. These values were higher than the corresponding data from the previous year. The number of supply disturbances in the Kyushu area were increased; SAIFI increased from 0.07 to 0.15, and SAIDI increased from 3 to 115 compared with that in the previous year. This was attributable to the major disaster caused by Typhoon No.14.

Based on the analysis and the results indicating that the frequency, voltage, and interruption have remained within the target variance, the OCCTO concludes that the quality of the electricity supply was adequately maintained nationwide in FY 2022. The OCCTO will continue to collect and publish information about the quality of electricity annually.

<Reference > Comparison of average system interruptions in Japan with those in European countries and major US states for 2018–2022

Table 47 and Figure 30 show the SAIDI values for Japan and major US states for 2018–2022, and Table 48 and Figure 31 show the SAIFI values for the same regions and periods. The data for EU countries are cited from the report[15] of the Council of European Energy Regulators; however, the data for 2022 for EU countries could not be collected because the recently publicized report excluded data for recent years. The data for major US states are from the report[16] of the Public Utilities Commission in each state. These data were aggregated and analyzed by the OCCTO.[17]
Monitoring conditions, such as observed voltage, annual monitoring period (whether starting from January or April),[18] 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. However, both the SAIDI and SAIFI values for Japan are lower than those for the major US states. In addition, only 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.

---

[15] Source: "7TH CEER-ECRB BENCHMARKING REPORT ON THE QUALITY OF ELECTRICITY AND GAS SUPPLY 2022"
https://www.ceer.eu/documents/104400/-/-/e19caae8-95cf-f048-0664-0720228881bb
This report is published roughly every 3 years using the updated data for the previous 3 years.

[16] Sources:
State of California: California Public Utilities Commission, "Electric System Reliability Annual Reports"
https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/electric-reliability/electric-system-reliability-annual-reports/2022-annual-electric-reliability-reports
State of Texas: Public Utility Commission of Texas,
"Annual Service Quality Report pursuant to PUC Substantive Rule in S.25.81,"
https://www.puc.texas.gov/industry/electric/reports/sqr/default.aspx
State of New York: Department of Public Service, "Electric Reliability Performance Reports."
https://dps.ny.gov/electric-service-reliability-reports

[17] Values for California and Texas are calculated 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.)

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

Table 47 SAIDI of Japan, European countries, and major US states for 2018–2022 by Forced and Planned Outages
(Minutes/year· customer)

Country/State			Year 2018	2019	2020	2021	2022	Condition: Event of	Observed voltage	Natural disaster
JAPAN			225	86	76	10	25	except auto re-closing	LV	Include
		Forced	221	82	72	7	22			
		Planned	4	3	3	3	3			
U.S.A.	California		266	737	327	355	337	5 minutes and longer	All	Include
		Forced	201	690	310	330	200			
		Planned	65	48	18	25	138			
	Texas		175	335	356	1136	230			
		Forced	158	319	343	1121	207			
		Planned	17	15	13	15	23			
	New York		409	228	538	167	234			
		Forced	-	-	-	-				
		Planned	-	-	-	-				
EU	Germany		24	-	-	-	-	3 minutes and longer	All	Include
		Forced	16	-	-	-	-			
		Planned	8	-	-	-	-			
	Italy		164	-	-	-	-		All	Include
		Forced	101	-	-	-	-			
		Planned	63	-	-	-	-			
	France		64	-	-	-	-		All	Exclude
		Forced	51	-	-	-	-			
		Planned	13	-	-	-	-			
	Spain		68	-	-	-	-		All	Include
		Forced	59	-	-	-	-			
		Planned	9	-	-	-	-			
	UK(Great Britain)		47	-	-	-	-		All	Include
		Forced	43	-	-	-	-			
		Planned	4	-	-	-	-			
	Sweden		143	-	-	-	-		All	Include
		Forced	127	-	-	-	-			
		Planned	16	-	-	-	-			
	Finland		60	-	-	-	-		except LV	Include
		Forced	49	-	-	-	-			
		Planned	10	-	-	-	-			
	Norway		167	-	-	-	-		All	Include
		Forced	126	-	-	-	-			
		Planned	41	-	-	-	-			

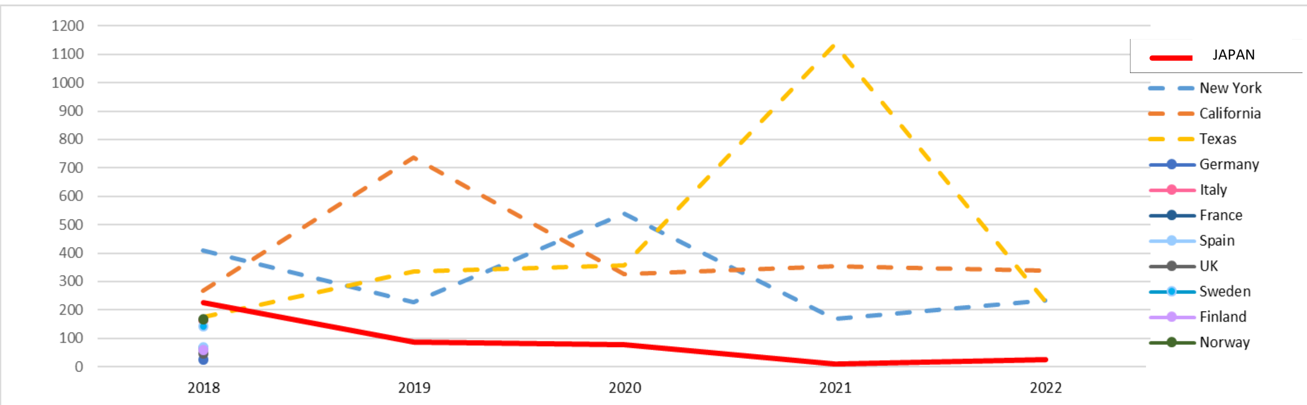

Figure 30 SAIDI of Japan, European countries, and major US states for 2018–2022 (Minutes/Year· Customer)

Table 48 SAIFI of Japan, European countries, and major US states for 2018–2022 by Forced and Planned Outages

(Interruptions/year· customer)

Country/State			2018	2019	2020	2021	2022	Event of	Observed voltage	Natural disaster
JAPAN			0.31	0.23	0.21	0.13	0.16	except auto re-closing	LV	Include
		Forced	0.28	0.19	0.17	0.10	0.14			
		Planned	0.03	0.04	0.03	0.03	0.03			
U.S.A.	California		1.45	1.53	1.26	1.35	1.63	5 minutes and longer	All	Include
		Forced	0.94	1.37	1.19	1.20	1.31			
		Planned	0.50	0.16	0.07	0.14	0.31			
	Texas		1.54	1.82	1.69	3.01	1.80			
		Forced	1.40	1.68	1.57	2.88	1.58			
		Planned	0.13	0.14	0.12	0.13	0.22			
	New York		1.01	0.88	1.06	0.85	0.87			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			
EU	Germany		0.35	-	-	-	-	3 minutes and longer	All	Include
		Forced	0.27	-	-	-	-			
		Planned	0.08	-	-	-	-			
	Italy		2.45	-	-	-	-		All	Include
		Forced	2.14	-	-	-	-			
		Planned	0.31	-	-	-	-			
	France		0.80	-	-	-	-		All	Exclude
		Forced	0.69	-	-	-	-			
		Planned	0.11	-	-	-	-			
	Spain		-	-	-	-	-		All	Include
		Forced	1.26	-	-	-	-			
		Planned	-	-	-	-	-			
	UK(Great Britain)		0.53	-	-	-	-		All	Include
		Forced	0.51	-	-	-	-			
		Planned	0.02	-	-	-	-			
	Sweden		1.63	-	-	-	-		All	Include
		Forced	1.49	-	-	-	-			
		Planned	0.14	-	-	-	-			
	Finland		1.65	-	-	-	-		except LV	Include
		Forced	1.52	-	-	-	-			
		Planned	0.13	-	-	-	-			
	Norway		2.26	-	-	-	-		All	Include
		Forced	1.97	-	-	-	-			
		Planned	0.29	-	-	-	-			

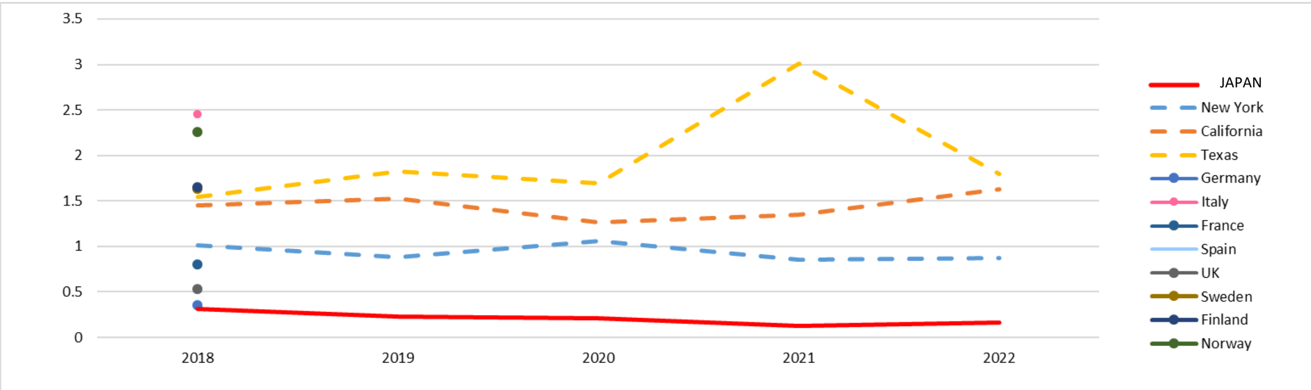

Figure 31 SAIFI of Japan, European countries, and major US states for 2018–2022 (Interruptions/year· customer)

(blank)

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