Report on the Quality of the Electricity Supply

- Data for Fiscal Year 2023 -

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

Introduction

The Organization for Cross-regional Coordination of Transmission Operators, Japan (OCCTO) evaluates supply reliability conditions to secure a stable electricity supply. To meet this objective, the OCCTO continuously gathers and publishes real data on the electricity supply quality according to the provisions of Article 181 of its Operational Rules.

This report aggregates real data for frequency, voltage, and interruptions in a report titled “Quality of the Electricity Supply” and presents the data evaluation. These data are collected from each regional service area for the 2023 fiscal year (FY 2023). On the basis of these data, the OCCTO evaluates and analyzes whether frequencies or voltages have been maintained within certain parameters or whether there have been frequent supply interruptions. Additionally, although the data conditions regarding supply interruption are not uniform, data were compared with the leading states in the United States (U.S.) as a reference.
The OCCTO’s goal is to facilitate the use of aggregated data, evaluations, and analyses by the electricity sector as a reference.

The data presented in the report were submitted by general transmission and distribution 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 the nationwide electricity supply in FY 2023 was reviewed on the basis of the provisions of Article 181 of the OCCTO's Operational Rules.
This report evaluated three aspects of the electricity supply's quality: frequency, standard voltage, and interruption.
Although different indices are available for evaluating each aspect, this report used the same indices published in previous years to allow for historical comparison.

Frequency
The frequency time-kept ratio was used to analyze the frequency, which is the ratio of time that the metered frequency is maintained within a given target control range. Four areas were grouped by synchronized frequency: Hokkaido, Eastern Japan, Central and Western Japan, and Okinawa. Transmission operators in Japan's Eastern and Western areas use 50 and 60 Hz, respectively.
This study reviewed the frequency time-kept ratios in these four synchronized areas, and reported the challenge to the Central and Western areas.

Standard Voltage
The evaluation of the standard voltage considered the 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.
At the request of the OCCTO, the transmission operators submitted their data. Nationwide, there was no violation of standard voltage among 6,681 points for 100 V and 6,574 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 15,132, 2.3% higher than the recorded number in the previous fiscal year. Natural disasters caused the rise of supply disturbances, such as the Noto Peninsular Earthquake in January 2024, which increased the supply disturbances in the Hokuriku area by 70.1%, and Typhoon No. 6 of 2023, which increased the number of supply disturbances in the Okinawa area by 80.2%.
The second analysis categorizes the causes of supply disturbances by two factors: maintenance problems and natural disasters, with the latter being irrelevant to maintenance problems.
These analyses indicate 17 cases of supply disturbances, an increase of five cases over the previous year. Regarding the causes of disturbances, five cases were triggered by natural disasters, one fewer than the previous year. However, nine disturbances were caused by the fault of the facility or

maintenance, such as physical contact, an increase of four cases over the previous year. Additionally, the number of supply disturbances above a certain scale for FY 2023 was lower than the 5-year average.

In the final analysis, the SAIFI and SAIDI values were historically monitored. The data for FY 2023 indicate there were 0.15 interruptions of 36 min. per customer. The SAIFI value was lower than the corresponding data from the previous year by 0.1 point, whereas the SAIDI value was 11 min. higher than the previous year. The values of supply interruptions in the Hokuriku area also increased: SAIFI increased from 0.16 to 0.55, while SAIDI increased from 26 to 510 compared with the previous year. These increases were attributed to the major disaster caused by the Noto Peninsular Earthquake.

The number of supply interruptions in the Okinawa area also increased due to the major disaster caused by Typhoon No.6 of 2023: SAIFI increased from 1.03 to 2.34, and SAIDI increased from 61 to 1,278.

This report also compares SAIFI and SAIDI values with European countries and the major U.S. states, even though the comparison is not direct given that index definitions are not identical across European countries and the U.S. states.

We believe this report will help to understand the quality of Japan’s electricity supply.

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

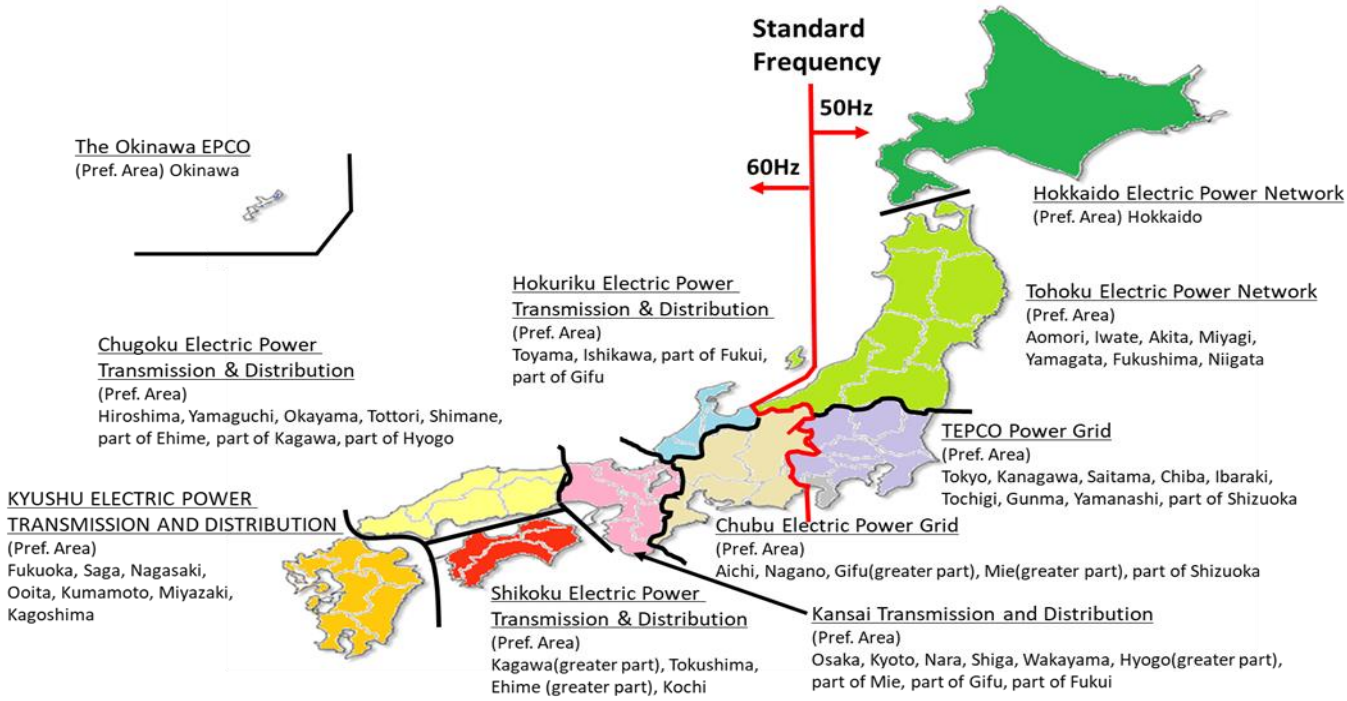

Figure 1 Regional Service Areas of 10 GT&D Companies and Their Standard Frequencies

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 following formula calculates the frequency time-kept ratio:

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

3. Frequency Control Rule

The frequency control rule under normal conditions for the regional service areas according to the indices of the time-kept ratio formula is shown in Table 1.[1]

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	—

4. Frequency time-kept ratio by the Frequency-synchronized Area (FY 2019–2023)

The frequency time-kept ratios by frequency-synchronized areas from FY 2019 to 2023 and the trend of maintaining the frequency within 0.1 Hz variance are shown in Tables 2–5.

The frequency time-kept ratio established by the GT&D companies was recorded as 100% throughout the year except in the Central and Western areas for FY 2023. At the 101st meeting of the Study Committee on Regulating and Marginal Supply Capability and Long-Term Supply–Demand Balance Evaluation (September 30, 2024), the GT&D companies in the area reported the following concerns regarding the Central and Western regions[2]: the monthly frequency time-kept ratio sometimes deviated from the control target of ±0.2 Hz, and the ratio decreased and neared the control target of ±0.1 Hz, which is uniquely determined to be 95.00% for the lower limit by the area. These conditions were due to the increase of variable renewable energy and the decrease in synchronized generators in the transmission network, which were apparent during the light load period. The Organization carefully monitors these conditions, continuously cooperating with GT&D companies to secure a stable and quality electricity supply.

[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. https://laws.e-gov.go.jp/law/407M50000400077#Mp-Ch_2-Se_2-Ss_2

[2] https://www.occto.or.jp/iinkai/chouseiryoku/2024/files/chousei_101_05.pdf

【Criteria】

Control target ··· 100.00%

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

Table 2 Frequency Time -Kept Ratio (Hokkaido, FY 2019–2023) [%]

Variance	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Within 0.1 Hz	99.98	99.93	99.87	99.90	99.91
Within 0.2 Hz	100.00	100.00	99.99	99.99	99.99
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

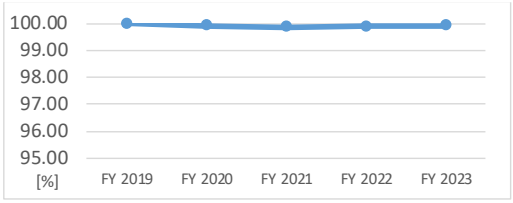

Figure 2 Frequency time kept ratio within 0.1 Hz (Hokkaido, FY 2019-2023)

Table 3 Frequency Time -Kept Ratio (Eastern area,[3] FY 2019–2023) [%]

Variance	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Within 0.1 Hz	99.83	99.71	99.50	99.43	99.01
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	100.00

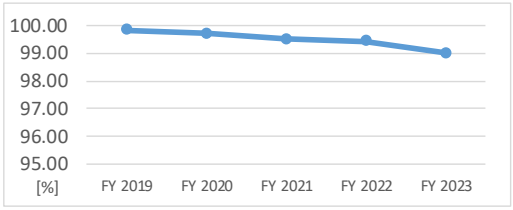

Figure 3 Frequency time kept ratio within 0.1 Hz (Eastern area,[3] FY 2019-2023)

Table 4 Frequency Time -Kept Ratio (Central & Western area,[4] FY 2019–2023 [%]

Variance	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Within 0.1 Hz	99.02	98.50	98.12	98.46	97.68
Within 0.2 Hz	100.00	100.00	100.00	100.00	99.99
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	100.00

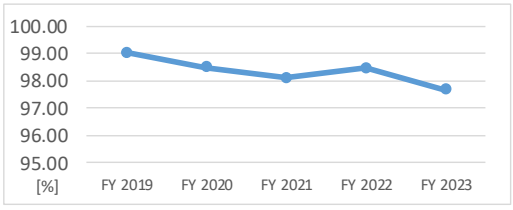

Figure 4 Frequency time kept ratio within 0.1 Hz (Central & Western area,[4] FY 2019–2023)

Table 5 Frequency Time -Kept Ratio (Okinawa, FY 2019–2023) [%]

Variance	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
Within 0.1 Hz	99.89	99.92	99.89	99.98	99.97
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

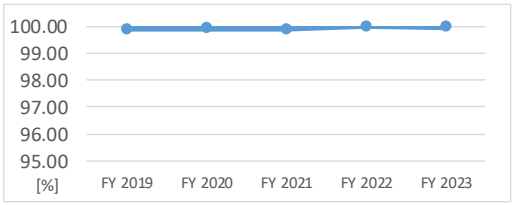

Figure 5 Frequency time kept ratio within 0.1 Hz (Okinawa, FY 2019–2023)

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

[4] The Central and Western areas of Japan include the regional service areas of the 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 Article 26 provisions of the Act. The voltage standard and the nationwide target voltage control are presented in Table 6.[5]

Table 6 Voltage Standard and Target Voltage Control

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

2. Voltage Measurements

According to Article 39 provisions 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.[6] 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.[7] GT&D companies calculate an 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 2019–2023)

The total measured points, deviated measured points, and nationwide deviation ratio from FY 2019 to 2023 are shown in Table 7.

GT&D companies reported that the voltage standard was adequately maintained, with no deviation, according to FY 2023 data.

Table 7 Voltage Deviation Measurement (Nationwide, FY 2019–2023)

Voltage		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023
100V	Total measured points	6,567	6,562	6,589	6,578	6,681
	Deviated points	0	0	0	0	0
200V	Total measured points	6,502	6,498	6,523	6,496	6,574
	Deviated points	0	0	0	0	0

[5] As defined in the provisions of Paragraph 1 of Article 38 of the Ministerial Ordinance of the Act
[6] Method for selecting the measuring points of electric voltage defined in the provisions of Item 1, Paragraph 1 of Article 39 of the Ministerial Ordinance (No. 619 of 1995, Ministry of International Trade and Industry)
[7] As defined in the provisions of Item 2, Paragraph 1 of Article 39 of the Ministerial Ordinance of the Act

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" is defined as an interruption of the electricity supply or an emergency restriction of electricity use due to a malfunction or misuse of the electric facilities.[8] The case in which the electricity supply is resumed by the automatic reclosing [9] of the transmission line does not apply to supply disturbances.[10]

[8] 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.

[9] Automatic reclosing of a transmission line means a transmission line is reconnected by reswitching 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 a protective relay.

[10] 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 the electricity supply is resumed by the automatic reclosing of the transmission line is not applicable to the supply disturbance.

(2) Data on Number of Supply Disturbances Nationwide and by Regional Service Area (FY 2019–2023)

Table 8 and Figure 6 show the number of supply disturbances nationwide, where the interruptions originated in FY 2019–2023. Tables 9–18 and Figures 7–16 present the number of supply disturbances from the regional service areas. Additionally, the category "Involving Accidents" in the tables indicates the number of supply disturbances caused 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. The analysis of FY 2023 data indicates the following.

Regarding FY 2023 data, the total number of supply disturbances was found to be 15,132, which was higher than the record of the previous fiscal year by 2.3%. Natural disasters caused the increase in the number of supply disturbances, such as the Noto Peninsular Earthquake in January 2024, which increased the supply disturbances in the Hokuriku region by 70.1%, as well as Typhoon No. 6 of 2023 has increased the supply disturbances in the Okinawa region by 80.2%.[11]

Table 8 Number of Supply Disturbances where Interruption Originated (Nationwide, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		56	48	65	57	65	58.2
Transmission lines & Extra High Voltage Lines	Overhead	246	274	260	308	312	280.0
	Underground	13	9	17	9	7	11.0
	Total	259	283	277	317	319	291.0
High Voltage Lines	Overhead	13,958	13,539	10,775	13,847	14,152	13,254.2
	Underground	227	201	201	210	187	205.2
	Total	14,185	13,740	10,976	14,057	14,339	13,459.4
Demand Facilities					1		0.2
Involvng Accidents		372	277	245	361	409	332.8
Total Disturbances		14,872	14,348	11,563	14,793	15,132	14,141.6

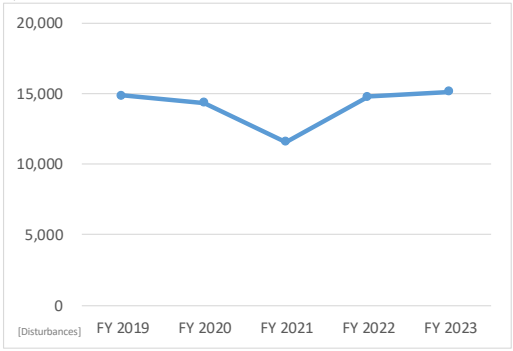

Figure 6 Transition of Supply Disturbances (Nationwide, FY 2019–2023)

[11] Although they are only written in Japanese, information on supply interruptions and facility damages due to natural disasters in FY 2023 is shown in the following links: https://www.bousai.go.jp/updates/#r6
For the Hokuriku area, please refer to https://www.bousai.go.jp/updates/r60101notojishin/r60101notojishin/pdf/r60101notojishin_47.pdf
For the Okinawa area, please refer to https://www.bousai.go.jp/updates/r5typhoon6/pdf/r5typhoon6_03.pdf

Table 9 Number of Supply Disturbances where Interruption Originated (Hokkaido, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		2	2	3	3	3	2.6
Transmission lines & Extra High Voltage Lines	Overhead	12	21	20	20	13	17.2
	Underground	1	1				0.4
	Total	13	22	20	20	13	17.6
High Voltage Lines	Overhead	600	801	848	973	859	816.2
	Underground	15	15	12	15	18	15.0
	Total	615	816	860	988	877	831.2
Demand Facilities							
Involvng Accidents		11	10	14	16	18	13.8
Total Disturbances		641	850	897	1,027	911	865.2

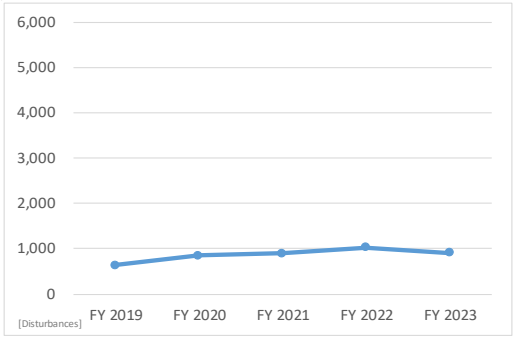

Figure 7 Transition of Supply Disturbances (Hokkaido, FY 2019–2023)

Table 10 Number of Supply Disturbances where Interruption Originated (Tohoku, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		8	9	9	8	17	10.2
Transmission lines & Extra High Voltage Lines	Overhead	16	31	31	20	10	21.6
	Underground						
	Total	16	31	31	20	10	21.6
High Voltage Lines	Overhead	1,646	2,528	1,686	2,036	1,855	1,950.2
	Underground	7	13	7	19	11	11.4
	Total	1,653	2,541	1,693	2,055	1,866	1,961.6
Demand Facilities					1		0.2
Involvng Accidents		29	17	18	27	35	25.2
Total Disturbances		1,706	2,598	1,751	2,111	1,928	2,018.8

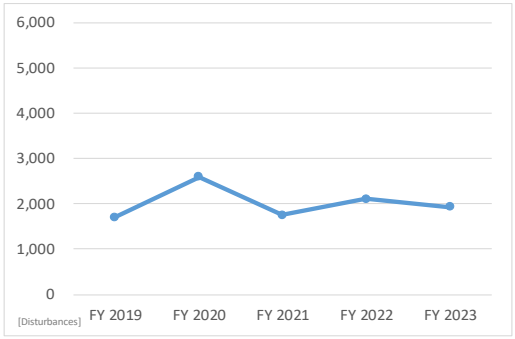

Figure 8 Transition of Supply Disturbances (Tohoku, FY 2019–2023)

Table 11 Number of Supply Disturbances where Interruption Originated (Tokyo, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		17	5	10	8	12	10.4
Transmission lines & Extra High Voltage Lines	Overhead	21	10	10	20	24	17.0
	Underground	4	3	5	3	1	3.2
	Total	25	13	15	23	25	20.2
High Voltage Lines	Overhead	5,186	2,472	2,316	2,309	2,994	3,055.4
	Underground	97	75	87	73	61	78.6
	Total	5,283	2,547	2,403	2,382	3,055	3,134.0
Demand Facilities							
Involvng Accidents		134	74		67	81	71.2
Total Disturbances		5,459	2,639	2,428	2,480	3,173	3,235.8

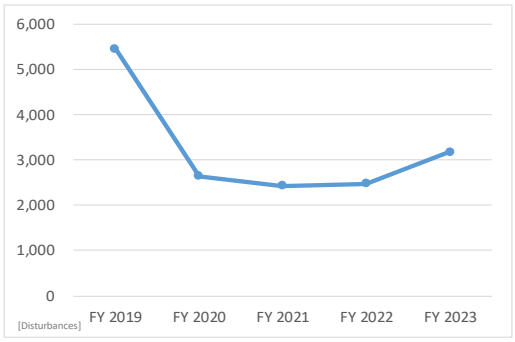

Figure 9 Transition of Supply Disturbances (Tokyo, FY 2019–2023)

Table 12 Number of Supply Disturbances where Interruption Originated (Chubu, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		10	4	7	7	5	6.6
Transmission lines & Extra High Voltage Lines	Overhead	19	15	9	13	23	15.8
	Underground		1		1	2	0.8
	Total	19	16	9	14	25	16.6
High Voltage Lines	Overhead	1,570	1,359	1,338	1,397	1,914	1,515.6
	Underground	6	4	10	9	5	6.8
	Total	1,576	1,363	1,348	1,406	1,919	1,522.4
Demand Facilities							
Involvng Accidents		60	71	64	69	76	68.0
Total Disturbances		1,665	1,454	1,428	1,496	2,025	1,613.6

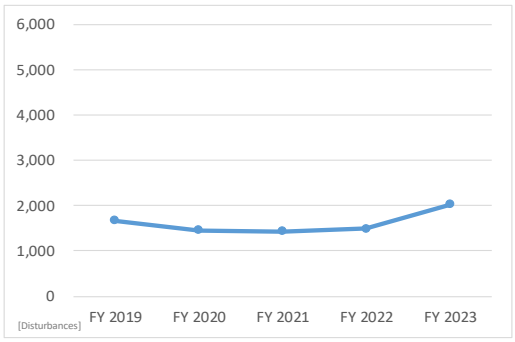

Figure 10 Transition of Supply Disturbances (Chubu, FY 2019–2023)

Table 13 Number of Supply Disturbances where Interruption Originated (Hokuriku, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		2	3	4	2	8	3.8
Transmission lines & Extra High Voltage Lines	Overhead	2	3		5	11	4.2
	Underground	2					0.4
	Total	4	3		5	11	4.6
High Voltage Lines	Overhead	199	444	215	567	962	477.4
	Underground	1	4	1	2	8	3.2
	Total	200	448	216	569	970	480.6
Demand Facilities							
Involvng Accidents		10	10	14	16	18	13.6
Total Disturbances		216	464	234	592	1,007	502.6

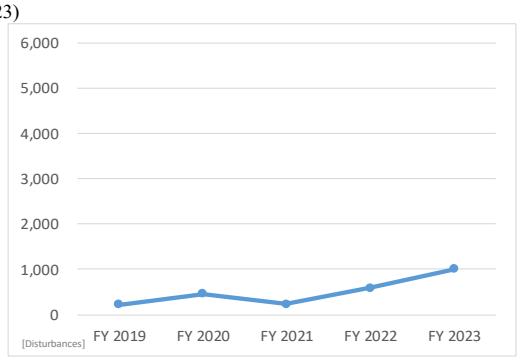

Figure 11 Transition of Supply Disturbances (Hokuriku, FY 2019–2023)

Table 14 Number of Supply Disturbances where Interruption Originated (Kansai, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		3	6	10	9	6	6.8
Transmission lines & Extra High Voltage Lines	Overhead	82	84	86	99	116	93.4
	Underground	3	4	8	2	3	4.0
	Total	85	88	94	101	119	97.4
High Voltage Lines	Overhead	1,300	1,254	1,384	1,480	1,723	1,428.2
	Underground	50	50	33	37	35	41.0
	Total	1,350	1,304	1,417	1,517	1,758	1,469.2
Demand Facilities							
Involvng Accidents		64	44	56	79	82	65.0
Total Disturbances		1,502	1,442	1,577	1,706	1,965	1,638.4

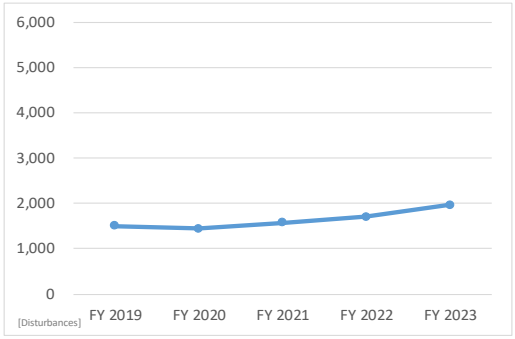

Figure 12 Transition of Supply Disturbances (Kansai, FY 2019–2023)

Table 15 Number of Supply Disturbances where Interruption Originated (Chugoku, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		6	3	6	11	8	6.8
Transmission lines & Extra High Voltage Lines	Overhead	17	11	25	11	14	15.6
	Underground	1		1	3	1	1.2
	Total	18	11	26	14	15	16.8
High Voltage Lines	Overhead	1,015	1,163	1,193	1,449	981	1,160.2
	Underground	16	12	15	20	16	15.8
	Total	1,031	1,175	1,208	1,469	997	1,176.0
Demand Facilities							
Involvng Accidents		35	32	37	32	34	34.0
Total Disturbances		1,090	1,221	1,277	1,526	1,054	1,233.6

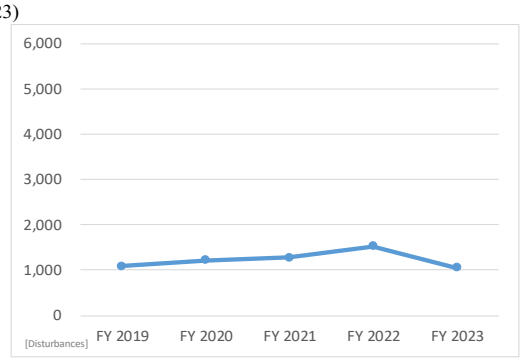

Figure 13 Transition of Supply Disturbances (Chugoku, FY 2019–2023)

Table 16 Number of Supply Disturbances where Interruption Originated (Shikoku, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		2	5	3		1	2.2
Transmission lines & Extra High Voltage Lines	Overhead	4	1	10	16	6	7.4
	Underground						
	Total	4	1	10	16	6	7.4
High Voltage Lines	Overhead	439	447	393	673	478	486.0
	Underground	6	6	10	3	6	6.2
	Total	445	453	403	676	484	492.2
Demand Facilities							
Involvng Accidents		7	6	10	10	21	10.8
Total Disturbances		458	465	426	702	512	512.6

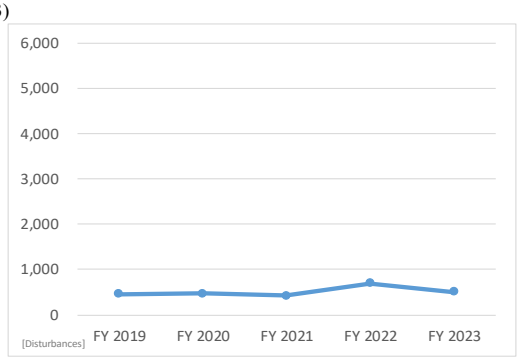

Figure 14 Transition of Supply Disturbances (Shikoku, FY 2019–2023)

Table 17 Number of Supply Disturbances where Interruption Originated (Kyushu, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		4	7	11	8	4	6.8
Transmission lines & Extra High Voltage Lines	Overhead	38	42	24	48	38	38.0
	Underground			1			0.2
	Total	38	42	25	48	38	38.2
High Voltage Lines	Overhead	1,547	2,614	1,088	2,605	1,677	1,906.2
	Underground	22	17	22	25	22	21.6
	Total	1,569	2,631	1,110	2,630	1,699	1,927.8
Demand Facilities							
Involvng Accidents		19	13	18	32	32	22.8
Total Disturbances		1,630	2,693	1,164	2,718	1,773	1,995.6

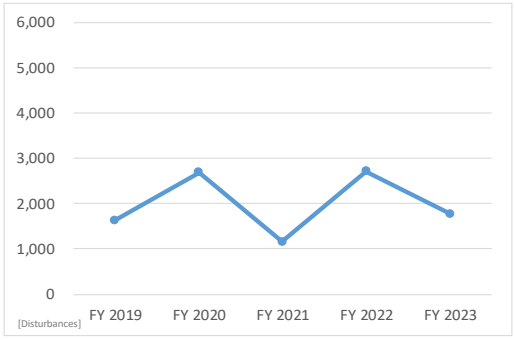

Figure 15 Transition of Supply Disturbances (Kyushu, FY 2019–2023)

Table 18 Number of Supply Disturbances where Interruption Originated (Okinawa, FY 2019–2023)

Occurrence at		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		2	4	2	1	1	2.0
Transmission lines & Extra High Voltage Lines	Overhead	35	56	45	56	57	49.8
	Underground	2		2			0.8
	Total	37	56	47	56	57	50.6
High Voltage Lines	Overhead	456	457	314	358	709	458.8
	Underground	7	5	4	7	5	5.6
	Total	463	462	318	365	714	464.4
Demand Facilities							
Involvng Accidents		3		14	13	12	8.4
Total Disturbances		505	522	381	435	784	525.4

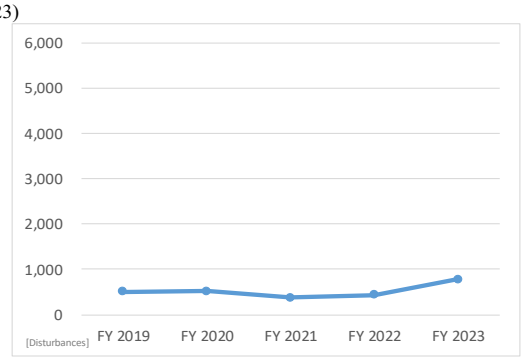

Figure 16 Transition of Supply Disturbances (Okinawa, FY 2019–2023)

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

(1) Data on Supply Disturbances above a Certain Scale

As described in the previous section, disturbances above a particular scale and their causes were reported for the data on supply disturbances where the interruption originated. This section analyzes these causes. Figure 17 illustrates the number of supply disturbances, indicating where the interruptions originated versus the scale of the interruption. Table 19 shows the nationwide data for FY 2023.[12] The columns in the table were left blank if the value was zero or the data were unavailable. 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

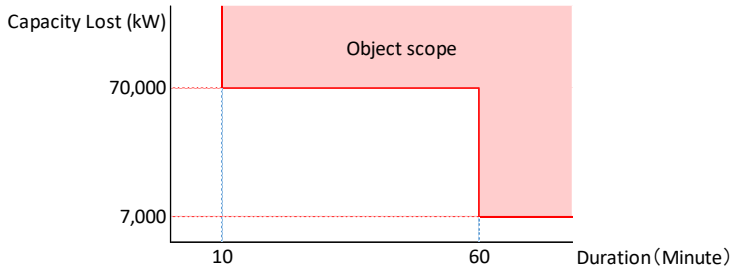

Figure 17 Image of Supply Disturbances above a Certain Scale

Table 19 Number of Supply Disturbances where Interruption Originated by Scale of Interruption (Nationwide, FY 2023) [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 Disturbances
		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]	
Accidents of Facilities of General Transmission & Distribution Companies												
Substations		1				4			6			11
Transmission lines & Extra High Voltage Lines	Overhead	1				1			3			5
	Under-ground								1			1
	Total	1				1			4			6
High Voltage Distribution Lines	Overhead											
	Under-ground											
	Total											
Demand Facilities												
Involved Accidents												
Total Disturbances		2				5			10			17

[12] Supply disturbances above a certain scale of 10 minutes and longer were reported for different destinations according to the lost capacity under the Article 3 provisions of the Reporting Rules of the Electricity Business. Capacity losses of 70,000–100,000 kW are reported to the Director of Regional Industrial Safety and the Inspection Department, which directs the disturbed electric facility is located. Capacity losses over 100,000 kW are reported to the Ministry of Economy, Trade, and Industry. Thus, the reporting destination varies by lost capacity. Table 19 presents the number of disturbances by lost capacity.

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

Table 20 classifies and describes the causes of the supply disturbances.[13]

Table 20 Classification and description of causes of supply disturbances

Classification of Causes		Description
Facility fault		Flawed production (improper design, fabrication, or material of electric facilities) or installation (improper operation of construction or maintenance work).
Maintenance fault		Flawed 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 above the rated capacity).
Accident/vandalism		Worker accident, intentional act, or accident by 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		Physical contact by trees, wildlife, or others (kite, model airplane).
Corrosion		Corrosion caused by current leakage from DC electric railroad or by chemical action.
Vibration		Vibration from heavy vehicle traffic or construction work.
Involving an accident		Accident involving the electric facilities of another company.
Improper fuel		Accident with improper fuel of notably different ingredients from that designated.
Electric fire		Electric fire accident caused by facility fault, maintenance fault, natural disaster, accident, or work without permission.
Electric shock (worker)		Workers' accident from electric shock caused by misuse of equipment, malfunction of electric facilities, accident by injured or third person, etc.
Electric shock (public)		Electric shock accident to the public due to misuse of equipment, malfunction of electric facilities, accident by injured or third person, etc.
Natural disaster	Thunderbolt	Direct or indirect lightning strike,.
	Rainstorm	Rain, wind, or rainstorm (including contact with fallen branches, etc.)
	Snowstorm	Snow, frazil, hail, sleet, or snowstorm.
	Earthquake	Earthquake.
	Flood	Flood, storm surge, or tsunami
	Landslide	Rock slide, avalanche, landslide, or ground subsidence.
	Dust/gas	Briny air, volcanic dust and ash, fog, offensive gas, or smoke and soot.
Unknown		Unknown causes, despite investigation.
Miscellaneous		Causes not categorized above.

[13] https://www.meti.go.jp/policy/safety_security/industrial_safety/sangyo/electric/files/12hoan-tokei/024.PDF

(3) Number and causes of supply disturbances above a certain scale (FY 2019–2023)

Table 21 and Figure 18 present nationwide data on the number of supply disturbances from which interruption originated above a certain scale. Tables 22–31 show the same data from each regional service region for FY 2019–2023.[14,15]

The number and causes of supply disturbances above a certain scale for FY 2023 data were analyzed. Nationwide, there were 17 cases of supply disturbances, an increase of five cases over the previous year. Five disturbances were caused by natural disasters, one fewer than the previous year. However, nine disturbances were caused by the fault of the facility or maintenance, such as physical contact, four cases higher than the previous year. Additionally, the number of supply disturbances above a certain scale for FY 2023 was below the 5-year average.

Table 21 Causes of Disturbances above a Certain Scale (Nationwide, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault		1	2	1	2	1.5
Maintenance fault		1	1		1	1.0
Accident/vandalism	1	4	1	3	3	2.4
Physical contact	5	6	4	1	3	3.8
Involved accident						
Electric shock(worker)						
Electric shock(public)			1			0.3
Subtotal	6	12	9	5	9	8.2
Natural Disaster						
Thunderbolt	5	2	4	3	2	3.2
Rainstorm	5		2	1	1	1.8
Snowstorm			2	1	1	0.8
Earthquake		3	9		1	4.3
Landslide, avalanche				1		0.3
Dust/Gas	1					0.2
Subtotal	11	5	17	6	5	8.8
Unknown		1	1		2	1.3
Miscellaneous	1	1		1	1	0.8
Total disturbances	18	19	27	12	17	18.6

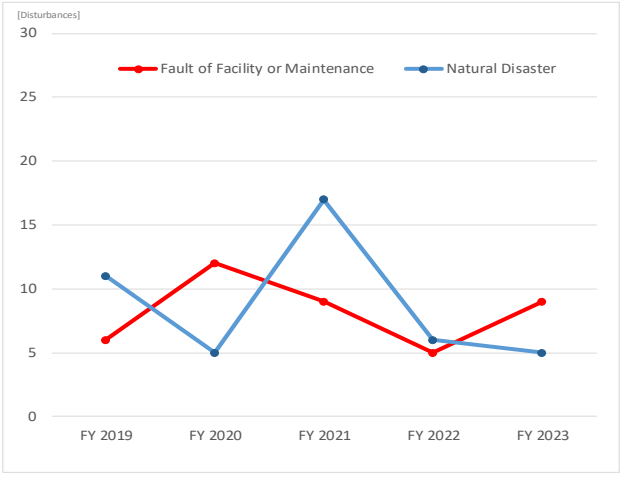

Figure 18 Transition of Disturbances by Cause (Nationwide, FY 2019–2023)

Table 22 Causes of Disturbances above a Certain Scale (Hokkaido, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault		1				0.2
Maintenance fault						
Accident/vandalism						
Physical contact				1	1	0.4
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal		1		1	1	0.6
Natural Disaster						
Thunderbolt	1					0.2
Rainstorm			1			0.2
Snowstorm				1		0.2
Earthquake						
Landslide, avalanche						
Dust/Gas						
Subtotal	1		1	1		0.6
Unknown			1			0.2
Miscellaneous						
Total disturbances	1	1	2	2	1	1.4

Table 23 Causes of Disturbances above a Certain Scale (Tohoku, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault				1		0.2
Maintenance fault						
Accident/vandalism			1	1	1	0.6
Physical contact			1			0.2
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal			2	2	1	1.0
Natural Disaster						
Thunderbolt	1					0.2
Rainstorm					1	0.2
Snowstorm						
Earthquake		3	8			2.8
Landslide, avalanche						
Dust/Gas						
Subtotal	1	3	8		1	2.6
Unknown						
Miscellaneous						
Total disturbances	1	3	10	2	2	3.6

[14] Tables include the causes of disturbances that most occur.
[15] The table columns are left blank if zero or the data are not available.

Table 24 Causes of Disturbances above a Certain Scale (Tokyo, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault			1			0.2
Accident/vandalism	1	2		1	1	1.0
Physical contact	1	1	1		2	1.0
Involved accident						
Electric shock(worker)						
Electric shock(public)			1			0.2
Subtotal	2	3	3	1	3	2.4
Natural Disaster						
Thunderbolt	2		2	2	1	1.4
Rainstorm	3			1		0.8
Snowstorm						
Earthquake						
Landslide, avalanche						
Dust/Gas						
Subtotal	5		2	3	1	2.2
Unknown		1			1	0.4
Miscellaneous		1				0.2
Total disturbances	7	5	5	4	5	5.2

Table 25 Causes of Disturbances above a Certain Scale (Chubu, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault						
Accident/vandalism		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						
Snowstorm					1	0.2
Earthquake						
Landslide, avalanche				1		0.2
Dust/Gas						
Subtotal		1		1	1	0.6
Unknown						
Miscellaneous	1					0.2
Total disturbances	3	2	2	1	1	1.8

Table 26 Causes of Disturbances above a Certain Scale (Hokuriku, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault						
Accident/vandalism						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal						
Natural Disaster						
Thunderbolt						
Rainstorm						
Snowstorm						
Earthquake					1	0.2
Landslide, avalanche						
Dust/Gas						
Subtotal					1	0.2
Unknown						
Miscellaneous						
Total disturbances					1	0.2

Table 27 Causes of Disturbances above a Certain Scale (Kansai, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault			2		2	0.8
Maintenance fault		1				0.2
Accident/vandalism		1				0.2
Physical contact	2	4				1.2
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal	2	6	2		2	2.4
Natural Disaster						
Thunderbolt	1	1	1			0.6
Rainstorm	1		1			0.4
Snowstorm			1			0.2
Earthquake						
Landslide, avalanche						
Dust/Gas						
Subtotal	2	1	3			1.2
Unknown						
Miscellaneous				1		0.2
Total disturbances	4	7	5	1	2	3.8

Table 28 Causes of Disturbances above a Certain Scale (Chugoku, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault						
Accident/vandalism				1	1	0.4
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal				1	1	0.4
Natural Disaster						
Thunderbolt			1	1	1	0.6
Rainstorm						
Snowstorm			1			0.2
Earthquake						
Landslide, avalanche						
Dust/Gas	1					0.2
Subtotal	1		2	1	1	1.0
Unknown						
Miscellaneous						
Total disturbances	1		2	2	2	1.4

Table 29 Disturbances above a Certain Scale (Shikoku, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault						
Accident/vandalism						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal						
Natural Disaster						
Thunderbolt						
Rainstorm						
Snowstorm						
Earthquake						
Landslide, avalanche						
Dust/Gas						
Subtotal						
Unknown						
Miscellaneous						
Total disturbances						

Table 30 Causes of Disturbances above a Certain Scale (Kyushu, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault						
Accident/vandalism						
Physical contact						
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal						
Natural Disaster						
Thunderbolt						
Rainstorm						
Snowstorm						
Earthquake			1			0.2
Landslide, avalanche						
Dust/Gas						
Subtotal			1			0.2
Unknown					1	0.2
Miscellaneous					1	0.2
Total disturbances			1		2	0.6

Table 31 Causes of Disturbances above a Certain Scale (Okinawa, FY 2019–2023) [Disturbances]

	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
Fault of Facility or Maintenance						
Facility fault						
Maintenance fault					1	0.2
Accident/vandalism						
Physical contact		1				0.2
Involved accident						
Electric shock(worker)						
Electric shock(public)						
Subtotal		1			1	0.4
Natural Disaster						
Thunderbolt						
Rainstorm	1					0.2
Snowstorm						
Earthquake						
Landslide, avalanche						
Dust/Gas						
Subtotal	1					0.2
Unknown						
Miscellaneous						
Total disturbances	1	1			1	0.6

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

(1) Indices of System Average Interruption for LV Customers

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

$$\text{System average interruption frequency index (SAIFI/interruptions)} = \frac{\text{LV customers affected by interruption}}{\text{LV customers served at the beginning of the fiscal year}}$$

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

Table 32 shows the definitions of terms related to outages.[16]

Table 32 Definition of outage-related terms

Term	Definition
Forced outage	Supply interruptions caused by accident occurred to end-use customers, such as the malfunction of the electric facility, excluding the resumption of electricity supply by automatic reclosing.[17][18]
Planned outage	The electric power company interrupts its electricity supply in a planned manner for construction, improvements and maintenance.

[16] https://www.meti.go.jp/policy/safety_security/industrial_safety/sangyo/electric/files/12hoan-tokei/501.PDF
[17] See footnote 9 for definitions.
[18] See footnote 10 for definitions.

(2) Data on System Average Interruption Nationwide and by Regional Service Area (FY 2019–2023)

The nationwide data for system average interruptions for FY 2019–2023 are presented in Table 33 and Figure 19. The data for each regional service area are presented in Tables 34–43 and Figures 20–29. The nationwide data for system average interruptions for FY 2023 are illustrated in Table 44.[19]

The actual system average interruption data for LV customers is summarized below.
The nationwide SAIFI and SAIDI data for FY 2023 were 0.15 interruptions and 36 minutes, per customer, respectively. The SAIFI value was lower than the previous year by 0.1 points, whereas the SAIDI value was 11 minutes higher than the previous year. The values of supply interruptions in the Hokuriku region increased from the previous year: SAIFI increased from 0.16 to 0.55, while SAIDI increased from 26 to 510. This was attributed to the major disaster caused by the Noto Peninsular Earthquake. The major disaster caused by Typhoon No.6 of 2023 increased the number of supply interruptions in the Okinawa region: SAIFI increased from 1.03 to 2.34, and SAIDI increased from 61 to 1,278.

Table 33 Indices of System Average Interruption (Nationwide, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.19	0.13	0.10	0.14	0.13	0.14
	Planned	0.04	0.04	0.03	0.03	0.02	0.03
	Total ●	0.23	0.17	0.13	0.16	0.15	0.17
SAIDI [Minutes]	Forced	82	24	7	22	34	34
	Planned	3	3	3	3	3	3
	Total ●	86	27	10	25	36	37

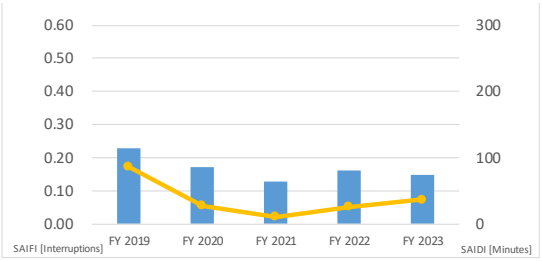

Figure 19 System Average Interruption Indices of LV customers (Nationwide, FY 2019–2023)

[19] 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 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.11	0.09	0.14	0.12	0.09	0.11
	Planned	α	α	α	α	0.01	0.01
	Total 🔵	0.11	0.09	0.14	0.12	0.09	0.11
SAIDI [Minutes]	Forced	4	5	12	20	5	9
	Planned	α	α	α	1	1	1
	Total 🟡	4	5	12	21	6	10

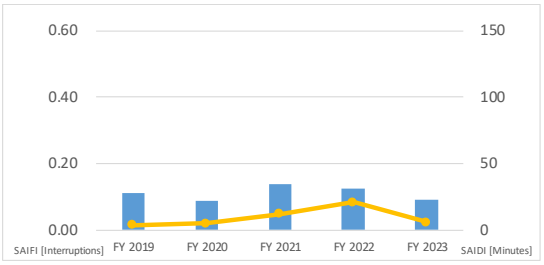

Figure 20 System Average Interruption Indices of LV customers (Hokkaido, FY 2019–2023)

Table 35 Indices of System Average Interruption (Tohoku, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.09	0.11	0.16	0.11	0.12	0.12
	Planned	0.02	0.02	0.02	0.02	0.01	0.02
	Total 🔵	0.11	0.12	0.18	0.13	0.13	0.13
SAIDI [Minutes]	Forced	7	15	25	15	12	15
	Planned	2	2	4	2	2	3
	Total 🟡	10	17	29	18	14	17

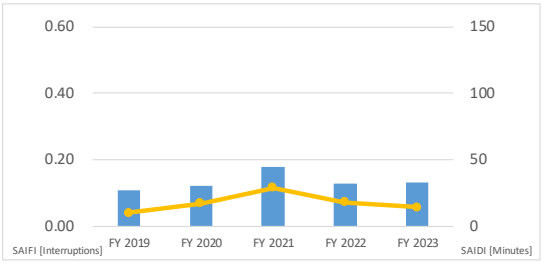

Figure 21 System Average Interruption Indices of LV customers (Tohoku, FY 2019–2023)

Table 36 Indices of System Average Interruption (Tokyo, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.33	0.11	0.10	0.13	0.07	0.15
	Planned	0.03	0.06	0.01	0.01	α	0.02
	Total 🔵	0.36	0.17	0.11	0.13	0.08	0.17
SAIDI [Minutes]	Forced	200	7	6	5	5	45
	Planned	1	1	1	1	α	1
	Total 🟡	201	8	7	6	5	45

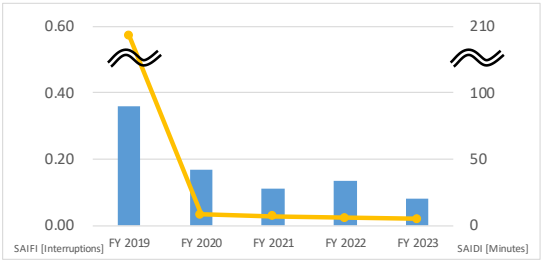

Figure 22 System Average Interruption Indices of LV customers (Tokyo, FY 2019–2023)

Table 37 Indices of System Average Interruption (Chubu, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.11	0.07	0.09	0.14	0.10	0.10
	Planned	0.06	0.05	0.05	0.05	0.05	0.05
	Total 🔵	0.17	0.13	0.14	0.19	0.15	0.15
SAIDI [Minutes]	Forced	32	6	5	16	14	15
	Planned	8	7	7	6	7	7
	Total 🟡	40	12	12	22	19	21

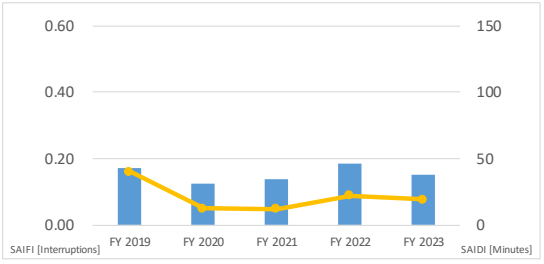

Figure 23 System Average Interruption Indices of LV customers (Chubu, FY 2019–2023)

Table 38 Indices of System Average Interruption (Hokuriku, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.03	0.06	0.04	0.08	0.48	0.14
	Planned	0.09	0.08	0.08	0.08	0.08	0.08
	Total 🔵	0.13	0.14	0.12	0.16	0.55	0.22
SAIDI [Minutes]	Forced	3	7	3	12	495	104
	Planned	16	15	14	14	15	15
	Total 🟡	19	22	17	26	510	119

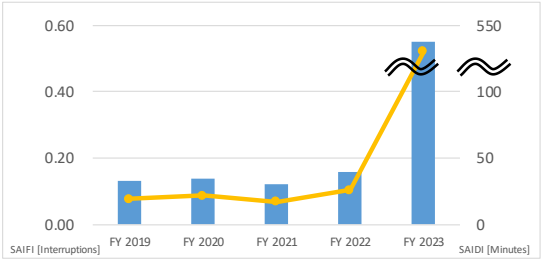

Figure 24 System Average Interruption Indices of LV customers (Hokuriku, FY 2019–2023)

Table 39 Indices of system average interruption (Kansai, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.10	0.09	0.08	0.11	0.12	0.10
	Planned	0.01	0.01	0.01	0.01	0.02	0.01
	Total	0.11	0.10	0.10	0.12	0.13	0.11
SAIDI [Minutes]	Forced	5	7	6	6	8	6
	Planned	1	1	2	1	1	1
	Total	6	8	7	7	9	7

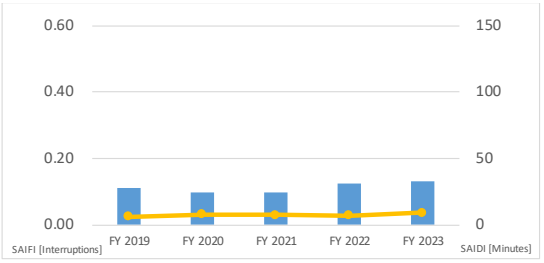

Figure 25 System average interruption indices of LV customers (Kansai, FY 2019–2023)

Table 40 Indices of system average interruption (Chugoku, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.13	0.15	0.15	0.14	0.09	0.13
	Planned	0.09	0.10	0.08	0.08	0.08	0.09
	Total	0.21	0.25	0.23	0.22	0.17	0.22
SAIDI [Minutes]	Forced	10	20	10	12	7	12
	Planned	9	11	9	9	9	9
	Total	19	31	19	21	15	21

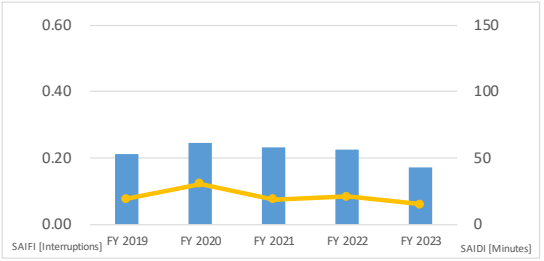

Figure 26 System average interruption indices of LV customers (Chugoku, FY 2019–2023)

Table 41 Indices of system average interruption (Shikoku, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.13	0.14	0.12	0.23	0.14	0.15
	Planned	0.14	0.14	0.14	0.15	0.14	0.14
	Total	0.27	0.28	0.26	0.38	0.28	0.29
SAIDI [Minutes]	Forced	8	10	7	35	8	14
	Planned	15	15	15	16	16	15
	Total	23	24	23	51	24	29

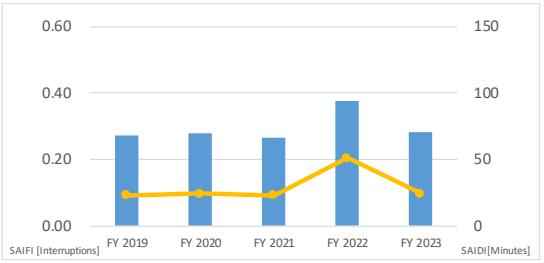

Figure 27 System average interruption indices of LV customers (Shikoku, FY 2019–2023)

Table 42 Indices of system average interruption (Kyushu, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	0.08	0.21	0.07	0.15	0.08	0.12
	Planned	0	0	0	0	0	0
	Total	0.08	0.21	0.07	0.15	0.08	0.12
SAIDI [Minutes]	Forced	15	139	3	115	11	57
	Planned	0	0	0	0	0	0
	Total	15	139	3	115	11	57

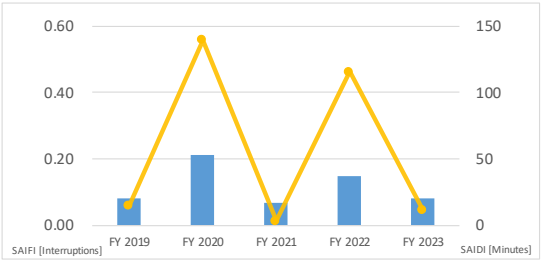

Figure 28 System average interruption indices of LV customers (Kyushu, FY 2019–2023)

Table 43 Indices of system average interruption (Okinawa, FY 2019–2023)

		FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	5-years Average
SAIFI [Interruptions]	Forced	1.11	1.12	0.57	0.98	2.30	1.22
	Planned	0.05	0.06	0.05	0.05	0.04	0.05
	Total	3.69	1.18	0.61	1.03	2.34	1.77
SAIDI [Minutes]	Forced	215	90	40	56	1,274	335
	Planned	6	11	5	5	4	6
	Total	221	101	45	61	1,278	341

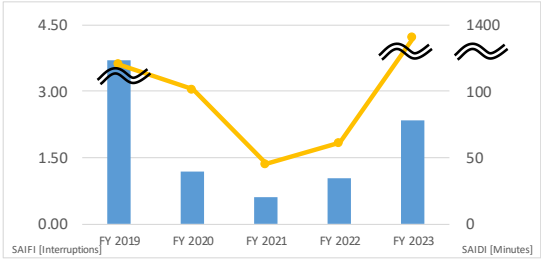

Figure 29 System average interruption indices of LV customers (Okinawa, FY 2019–2023)

Table 44 System average disturbances where interruptions were caused by outages (Nationwide, FY 2023)[20,]

		Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa	Nationwide
SAIFI [Interruptions]	Forced outage											
	Generators	0.02	0.02	0.02	0.01	0.04	0.03	0.01	0.01	0.02	0.40	
	HV lines	0.07	0.10	0.05	0.08	0.43	0.08	0.08	0.12	0.05	1.88	
	LV lines	α	α	α	α	α	α	α	0.00	α	0.02	
	Subtotal	0.09	0.12	0.07	0.10	0.48	0.12	0.09	0.14	0.08	2.30	0.13
	Planned outage											
	Generators	α	α	α	0.00	α	α	0.00	0.00	0.00	0.00	
	HV lines	α	0.01	α	0.04	0.06	0.01	0.06	0.09	0.00	0.01	
	LV lines	α	α	α	0.01	0.01	0.01	0.02	0.06	0.00	0.03	
	Subtotal	0.01	0.01	α	0.05	0.08	0.02	0.08	0.14	0.00	0.04	0.02
	Total outage											
	Generators	0.02	0.02	0.02	0.01	0.04	0.03	0.01	0.01	0.02	0.40	
	HV lines	0.07	0.11	0.05	0.12	0.50	0.09	0.14	0.20	0.05	1.89	
	LV lines	α	α	α	0.01	0.01	0.01	0.02	0.06	α	0.05	
	Total	0.09	0.13	0.08	0.15	0.55	0.13	0.17	0.28	0.08	2.34	0.15
SAIDI [Minutes]	Forced outage											
	Generators	1	1	α	1	2	1	1	0	2	10	
	HV lines	4	10	4	11	491	7	5	7	9	1,219	
	LV lines	α	1	α	2	1	1	1	1	α	45	
	Subtotal	5	12	5	14	495	8	7	8	11	1,274	34
	Planned outage											
	Generators	α	α	α	0	α	α	0	0	0	0	
	HV lines	α	1	α	5	14	1	8	12	0	1	
	LV lines	α	1	α	1	1	α	1	3	0	3	
	Subtotal	1	2	α	7	15	1	9	16	0	4	3
	Total outage											
	Generators	1	1	α	1	2	1	1	0	2	10	
	HV lines	5	11	5	16	505	8	13	19	9	1,220	
	LV lines	α	2	α	3	2	1	2	4	α	48	
	Total	6	14	5	19	510	9	15	24	11	1,278	36

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

[20] 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 set by the GT&D companies was recorded as 100% throughout the year except for the Central and Western regions for FY 2023. At the 101st meeting of the Study Committee on Regulating and Marginal Supply Capability and Long-Term Supply–Demand Balance Evaluation (September 30, 2024), the GT&D companies in the area reported the following concerns regarding the Central and Western regions[21]: monthly frequency time-kept ratio sometimes deviated from the control target of ±0.2 Hz, and the ratio decreased close to the control target of ±0.1 Hz, which is uniquely determined to be 95.00% for the lower limit by the area. These conditions were due to the increase of variable renewable energy and the decrease in synchronized generators in the transmission network, and were apparent during the light load period. The Organization carefully monitors these conditions, continuously cooperating with GT&D companies to secure a stable and quality electricity supply.

Voltage

The criteria for maintaining the 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 the deviated points against the total number of measured points. No deviation from the voltage standard was observed nationwide in FY 2023.

Supply Disturbances and Interruption in LV Customers

The criteria for supply interruption include the number of supply disturbances and the system average interruption indices, SAIFI and SAIDI.

FY 2023 data indicate 15,132 supply disturbances, which was higher than the record of the previous fiscal year by 2.3%. Natural disasters, such as the Noto Peninsular Earthquake in January 2024, increased the supply disturbances in the Hokuriku region by 70.1%, while Typhoon No. 6 of 2023 increased the number of supply disturbances in the Okinawa region by 80.2%.

The number and causes of supply disturbances above a certain scale for FY 2023 data were analyzed. Nationwide, there were 17 cases of supply disturbances, five cases higher than the previous year. With respect to the causes of disturbances, five disturbances were triggered by natural disasters, i.e., this number decreased by one case from the previous year. However, there were nine disturbances caused by the fault of the facility or maintenance, such as physical contact, an increase of four cases from the previous year. Additionally, the number of supply disturbances above a certain scale for FY 2023 was lower than the 5-year average.

[21] See Footnote 2.

Regarding the nationwide FY 2023 SAIFI and SAIDI data, there were 0.15 interruptions for 36 minutes, per customer, respectively. The SAIFI value was lower than the previous year by 0.1 point; whereas the SAIDI value was 11 minutes higher than the previous year. The values of supply interruptions in the Hokuriku region increased; in the case of SAIFI, the increase was from 0.16 to 0.55, while SAIDI increased from 26 to 510 over the previous year. This was due to the major disaster caused by the Noto Peninsular Earthquake. The number of supply interruptions in the Okinawa region in 2023 also increased due to the major disaster caused by Typhoon No.6; SAIFI increased from 1.03 to 2.34, while SAIDI increased from 61 to 1,278.

Although topical variance was recognized for certain results triggered by natural disasters, consecutive deterioration due to facility faults or maintenance problems has not been recognized. Based on these analysis results, the OCCTO concludes that the electricity supply quality was generally maintained nationwide during FY 2023.

<Reference > Comparison of average system interruptions in Japan with those in European countries and major U.S. states for 2019–2023

Table 45 and Figure 30 show the SAIDI values for Japan and major U.S. states for 2019–2023. Table 46 and Figure 31 show the SAIFI values for the same regions and periods. The data for EU countries are cited from the report of the Council of European Energy Regulators; however, the data for 2023 for EU countries was excluded from the recently publicized report.[22] The data for major U.S. states are from each state's Public Utilities Commission report.[23] These data were aggregated and analyzed by the OCCTO.[24]

Monitoring conditions, including observed voltage, annual monitoring period (whether starting from January or April),[25] and data including/excluding natural disasters, vary across the U.S. states. Therefore, the interruption data may not be directly comparable with that of Japan. However, both the SAIDI and SAIFI values for Japan are lower than those of major U.S. states. Additionally, only LV customer data are monitored for Japan. However, such customer interruptions are estimated to have only a marginal effect on the interruption data because very few customers are not supplied by the LV network.

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[22] Source: "7TH CEER-ECRB BENCHMARKING REPORT ON THE QUALITY OF ELECTRICITY AND GAS SUPPLY 2022"
This report is published roughly every 3 years using the updated data for the previous 3 years. The latest version is linked below.
https://www.ceer.eu/wp-content/uploads/2024/04/7th-Benchmarking-Report-2022.pdf
This report will be updated to the 7.1 version in the first half of 2025.
https://www.ceer.eu/event/ceer-ecrb-second-webinar-on-the-7th-benchmarking-report-on-the-quality-of-electricity-and-gas-supply/
<Reference>
SAIDI of EU countries (totaling planned and forced outages; minutes/year, customer) in 2018; Germany 24, Italy 164, France 64, Spain 68, UK 47, Sweden 143, Finland 60, and Norway 167.
SAIFI of EU countries (totaling planned and forced outages; interruptions/year, customer) in 2018; Germany 0.35, Italy 2.45, France 0.80, Spain NA, UK 0.53, Sweden 1.63, Finland 1.65, and Norway 2.26

[23] 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://interchange.puc.texas.gov/search/filings/?UtilityType=A&ControlNumber=56005&ItemMatch=Equal&DocumentType=ALL&SortOrder=Ascendin
State of New York: Department of Public Service, "Electric Reliability Performance Reports."
https://dps.ny.gov/electric-service-reliability-reports

[24] Values for California and Texas were 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.)

[25] 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 45 SAIDI of Japan, European countries, and major U.S. states for 2019–2023 by Forced and Planned Outages
(Minutes/year· customer)

Country/State			Year					Events	Voltage	Natural disaster
			2019	2020	2021	2022	2023			
JAPAN			86	76	10	25	36	All*	Low Voltage	Include
		Forced	82	72	7	22	34			
		Planned	3	3	3	3	3			
U.S.A.	California		737	327	355	337	435	> 5 min.	All	Include
		Forced	690	310	330	200	352			
		Planned	48	18	25	138	84			
	Texas		335	356	1136	230	451			
		Forced	319	343	1121	207	438			
		Planned	15	13	15	23	13			
	New York		228	538	167	234	166			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			

* Excludes the case of which is restored by the auto-reclosing of transmission line.

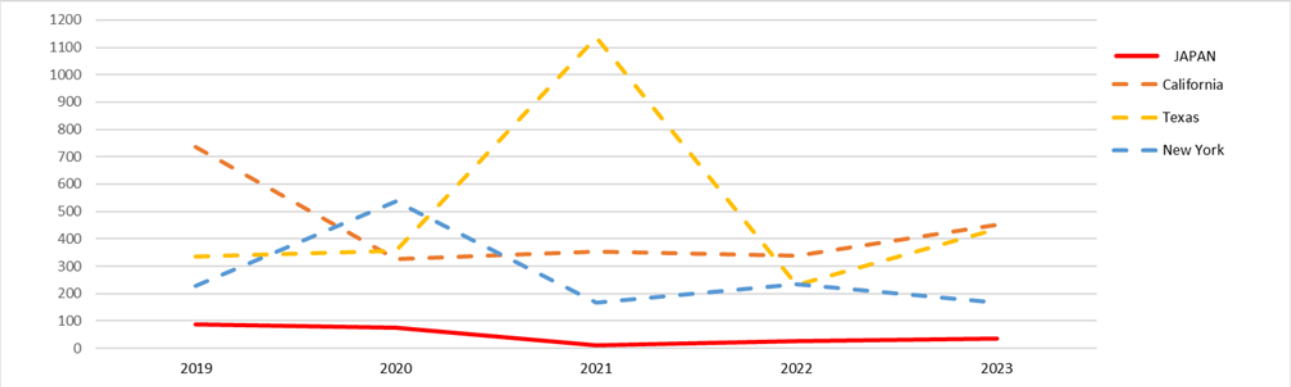

Figure 30 SAIDI of Japan, European countries, and major U.S. states for 2019–2023 (Minutes/Year· Customer)

Table 46 SAIFI of Japan, European countries, and major U.S. states for 2019–2023 by Forced and Planned Outages
(Interruptions/year· customer)

Country/State			Year					Events	Voltage	Natural disaster
			2019	2020	2021	2022	2023			
JAPAN			0.23	0.21	0.13	0.16	0.15	All*	Low Voltage	Include
		Forced	0.19	0.17	0.10	0.14	0.13			
		Planned	0.04	0.03	0.03	0.03	0.02			
U.S.A.	California		1.53	1.26	1.35	1.63	1.68	> 5 min.	All	Include
		Forced	1.37	1.19	1.20	1.31	1.43			
		Planned	0.16	0.07	0.14	0.31	0.25			
	Texas		1.82	1.69	3.01	1.80	1.88			
		Forced	1.68	1.57	2.88	1.58	1.73			
		Planned	0.14	0.12	0.13	0.22	0.15			
	New York		0.88	1.06	0.85	0.87	0.72			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			

* Excludes the case of which is restored by the auto-reclosing of transmission line.

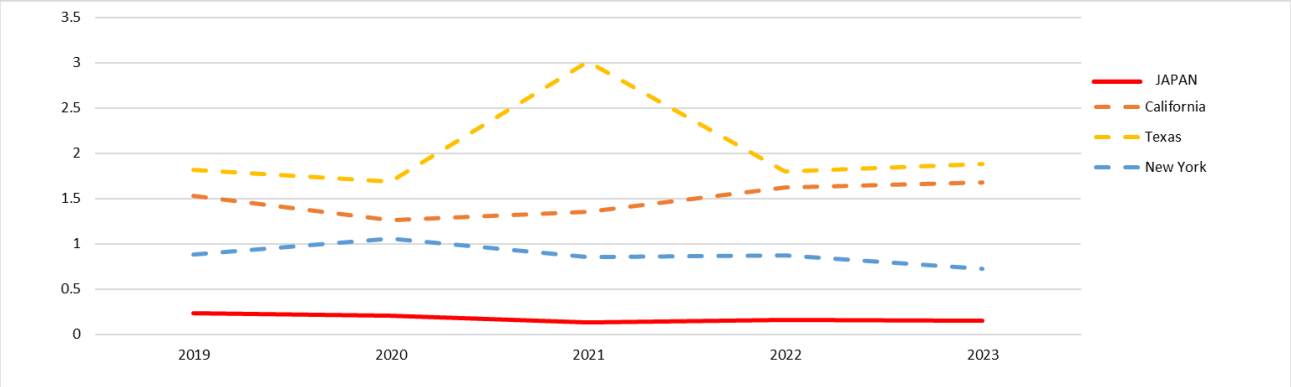

Figure 31 SAIFI of Japan, European countries, and major U.S. states for 2019–2023 (Interruptions/year· customer)

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