Report on the Quality of Electricity Supply

- Data for Fiscal Year 2019 -

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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

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

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

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

SUMMARY

The quality of nationwide electricity supply in FY 2019 was reviewed in this report based on Article 181 of OCCTO's Operational Rules.
Three aspects of the quality of electricity supply were evaluated in this report, namely, frequency, standard voltage, and interruption.
Although indices are available for evaluating each of these items, this report used the same indices as those published in previous years to allow for historical comparison.

Frequency
Frequency was analyzed using the frequency time-kept ratio, which is the ratio of time that the metered frequency is maintained within a given target control range. Four areas were grouped into synchronized frequency regions: Hokkaido, Eastern Japan, Central and Western Japan, and Okinawa. The transmission operators in the Eastern and Western areas of Japan use 50 Hz and 60 Hz, respectively.
For this report, the frequency time-kept ratios in these four synchronized regions were reviewed, and no deviation beyond the target control range was recognized.

Standard Voltage
The standard voltage was evaluated using the number of points where the standard voltage did not satisfy the target values, as defined by the enforcement regulations of the Electricity Business Act (hereafter, the Act), which sets the targets for transmission operators to maintain a standard voltage supply within a certain range of values.
Transmission operators handed in their data at OCCTO's request. Nationwide, no violation of standard voltage was observed among 6,567 points for 100 V and 6,502 points for 200 V.

Interruption
Finally, interruptions were monitored from three perspectives; i.e., the number of supply disturbances by the place of occurrence, the number of supply disturbances by cause, i.e., beyond the given standards in time duration and lost capacity, and System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI) values for low-voltage (LV) customers.
The first analysis indicated that the total number of supply disturbances was 14,872, which was lower compared with the data for FY 2018.
The second analysis divided the causes into two factors, i.e., maintenance problems or natural disasters, the latter being irrelevant to maintenance problems.
These analyses indicate that the total number of reported supply disturbances was 18, also lower than in the previous year. The number of supply disturbances caused by natural disasters was 11, which was similar to the average of the last 5 years.

The final analysis was the historical monitoring of SAIFI and SAIDI values, which were both at slightly higher levels compared with the data from the past 5 years. In particular, a markedly significant increase was observed in SAIDI values in the Tokyo Power Grid (PG) area, which was attributable to damage caused by typhoons.

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

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

CONTENTS

<Errata>

2021/11/17	P5, P7	Table 8 & Figure 9 (Nationwide), Table 14 & Figure 15 (Kansai) Number of Supply Disturbances Where Interruptions Were Originated	Data for FY 2018 are partly altered.
	P14 P16	Table 34(Hokkaido), Table 42(Kyushu) Indices of System Average Interruption	Descripiton of data are partly corrected.
2024/2/2	P5	Table 7	Data from FY 2017 to 2019 are altered.

I. Frequency Data

1. Standard Frequency in Japan

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

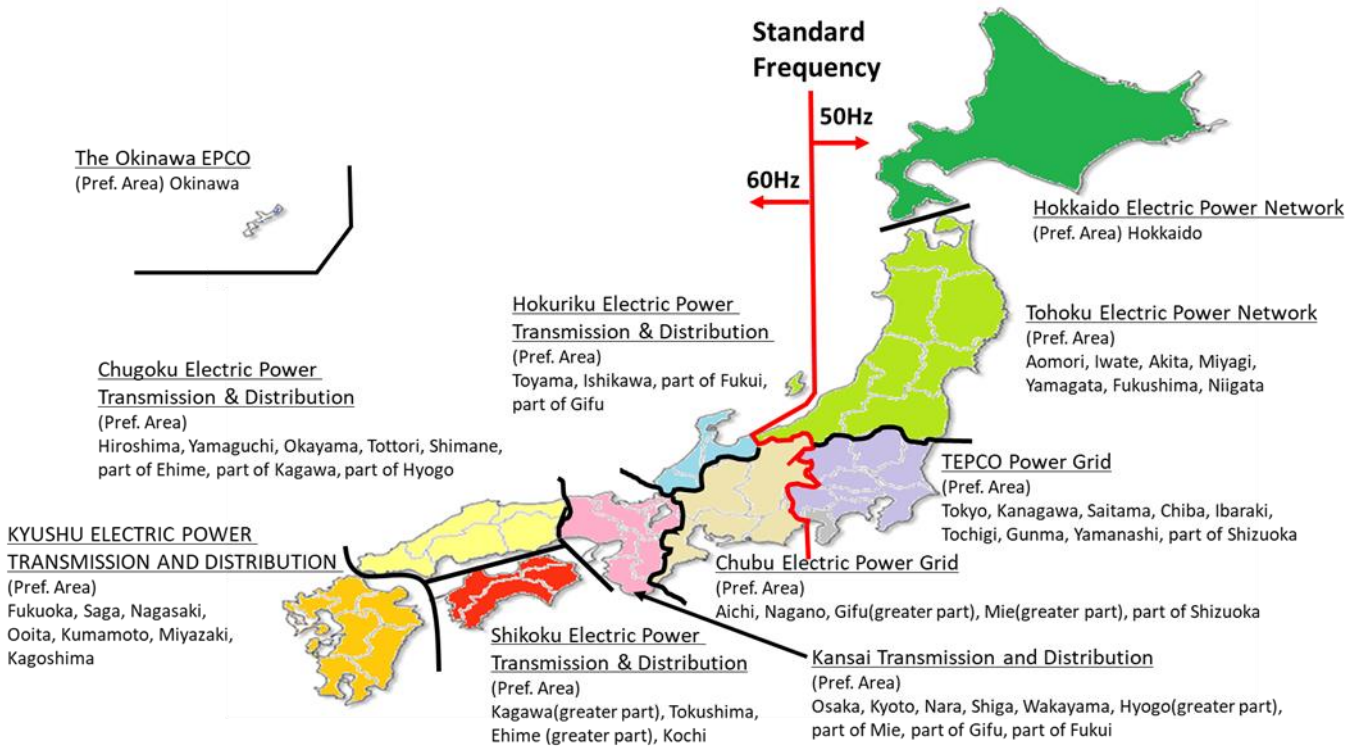

Figure 1 Regional service areas of the 10 general transmission and distribution companies and their standard frequency

2. Frequency Time-kept Ratio

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

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

3. Frequency Control Rule [1]

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

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

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

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

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

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

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

【Criteria】

Control Target ··· 100.00%

Target Time Kept Ratio within ±0.1Hz ··· 95.00% Over

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

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

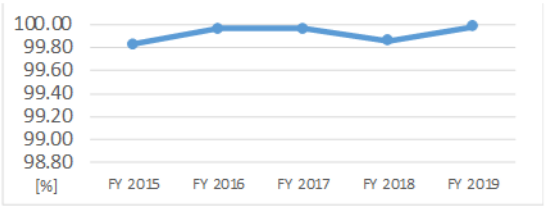

Figure 2 Frequency Time Kept Ratio within 0.1 Hz (Hokkaido, FY 2015-2019)

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

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

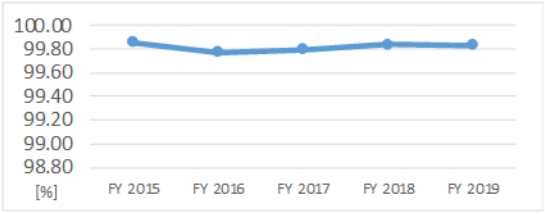

Figure 3 Frequency Time Kept Ratio within 0.1 Hz (Eastern region,[2] FY 2015-2019)

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

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

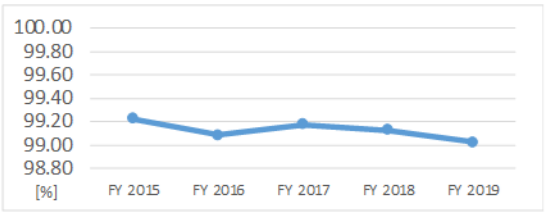

Figure 4 Frequency Time Kept Ratio (Central & Western region,[3] FY 2015–2019)

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

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

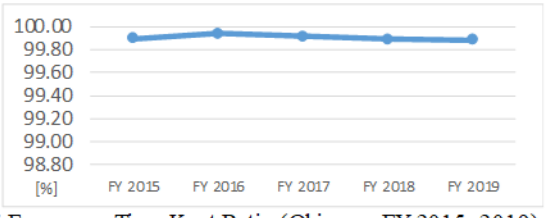

Figure 5 Frequency Time Kept Ratio (Okinawa, FY 2015–2019)

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

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

II. Voltage Data

1. Japanese Voltage Standard

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

Table 6 Voltage Standard and Target Voltage Control

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

2. Voltage Measurements

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

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

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

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

Table 7 Voltage deviation measurement (Nationwide, FY 2015–2019) [points]

Voltage		FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
100V	Total measured points	6,554	6,590	6,565	6,575	6,567
	Deviated points	0	0	0	0	0
200V	Total measured points	6,508	6,532	6,506	6,505	6,502
	Deviated points	0	0	0	0	0

III. Interruption Data

1. Data of Number of Supply Disturbances Where Interruption Originated

(1) Indices and Definition of Supply Disturbances

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

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

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

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

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

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

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

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

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

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

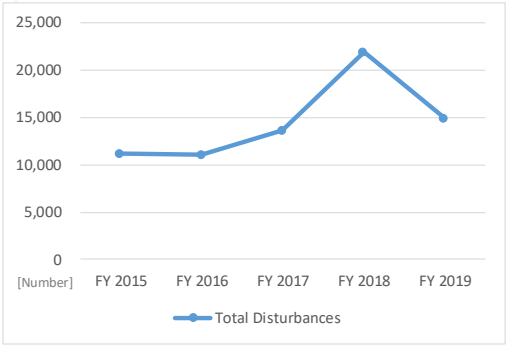

Figure 6 Transition of Supply Disturbances (Nationwide, FY 2015–2019)

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

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

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

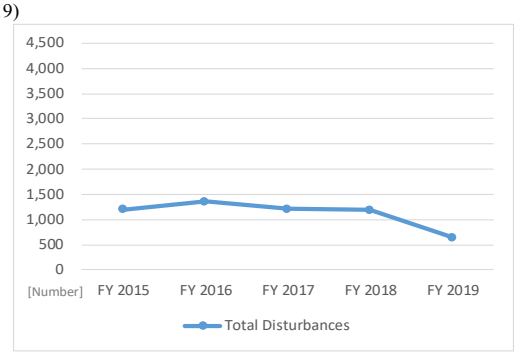

Figure 7 Transition of Supply Disturbances (Hokkaido, FY 2015–2019)

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

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

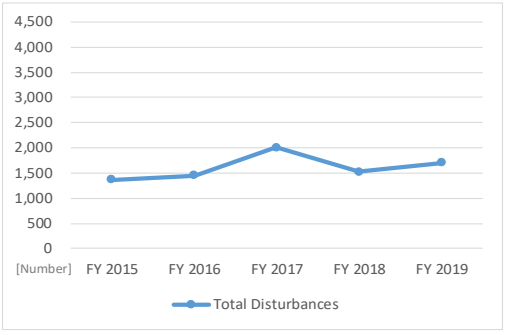

Figure 8 Transition of Supply Disturbances (Tohoku, FY 2015–2019)

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

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

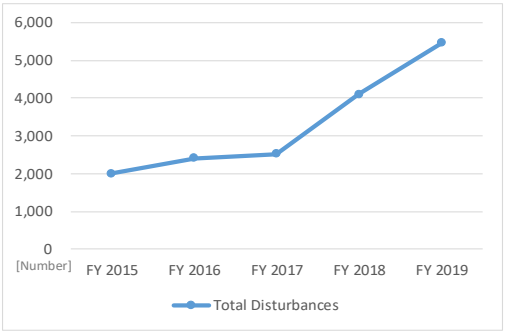

Figure 9 Transition of Supply Disturbances (Tokyo, FY 2015–2019)

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

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

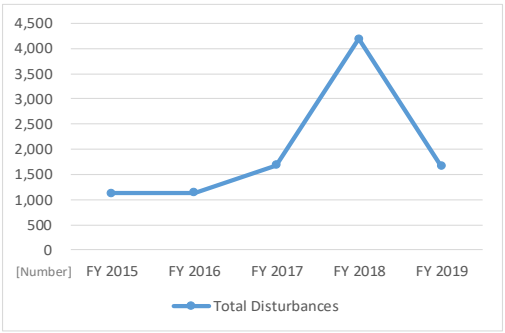

Figure 10 Transition of Supply Disturbances (Chubu, FY 2015–2019)

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

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

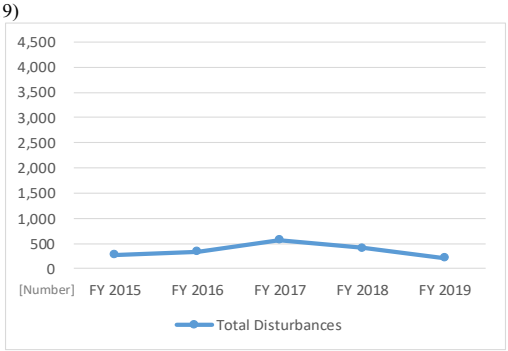

Figure 11 Transition of Supply Disturbances (Hokuriku, FY 2015–2019)

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

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

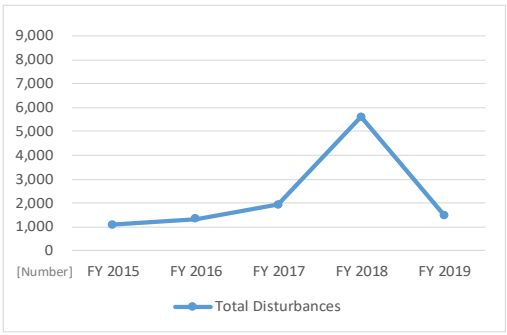

Figure 12 Transition of Supply Disturbances (Kansai, FY 2015–2019)

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

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

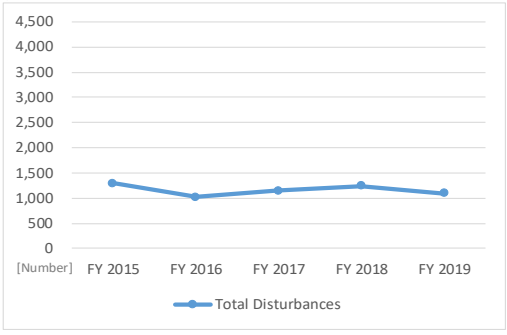

Figure 13 Transition of Supply Disturbances (Chugoku, FY 2015–2019)

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

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

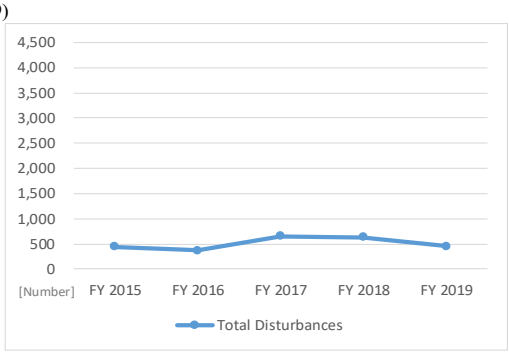

Figure 14 Transition of Supply Disturbances (Shikoku, FY 2015–2019)

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

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

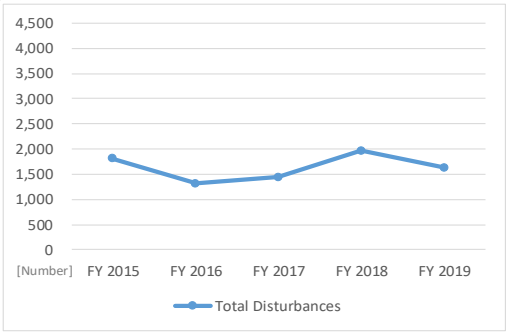

Figure 15 Transition of Supply Disturbances (Kyushu, FY 2015–2019)

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

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

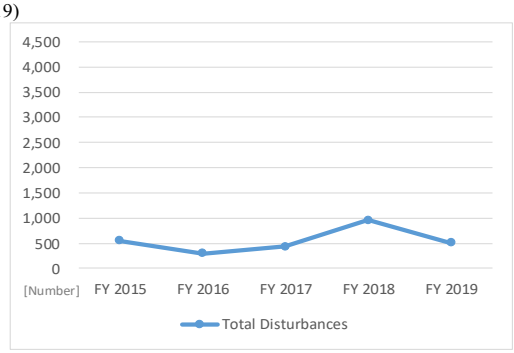

Figure 16 Transition of Supply Disturbances (Okinawa, FY 2015–2019)

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

(1) Data for Supply Disturbances over a Certain Scale

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

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

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

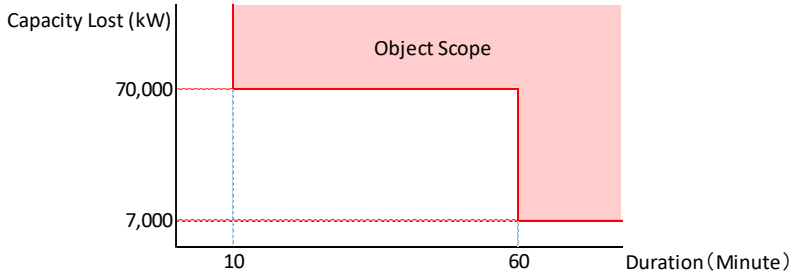

Figure 20 Image of Supply Disturbances over a Certain Scale

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

Scale of Disturbance / [Duration & Capacity lost] / Occurrence at		10 min. till 30 min.		30 min. till 1 hour		1hour till 3 hours			Longer than 3 hours			Total Disturbance
		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			2			2		1	1			6
Transmission Lines & Extra High Voltage Lines	Overhead	1	2			3			5		1	12
	Under-ground											
	Total	1	2			3			5		1	12
High Voltage Distribution Lines	Overhead											
	Under-ground											
	Total											
Demand Facilities												
Involved Accidents												
Total Disturbance		1	4			5		1	6		1	18

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

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

Table 20 classifies and describes the causes of supply disturbances.

Table 20 Classification and Description of the Causes of Supply Disturbances

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

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

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

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

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

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

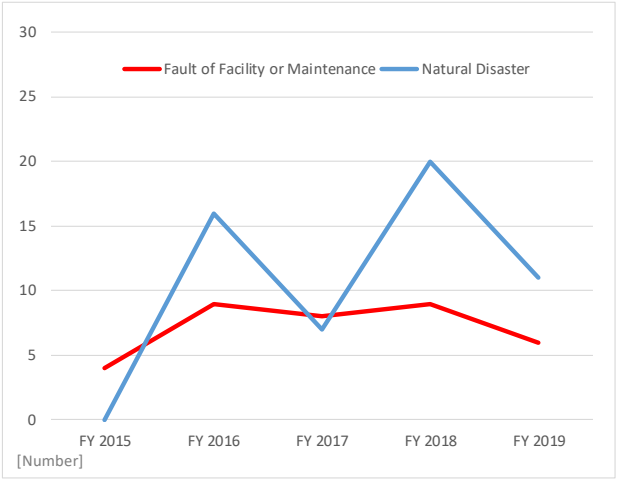

Figure 18 Transition of Disturbances by Causes (Nationwide, FY 2015–2019)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. Data of Interruptions for LV Customers

(1) Indices of System Average Interruption for LV Customers

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

$$\text{System Average Interruption Frequency Index (SAIFI/number)} = \frac{\text{Low voltage customers affected by interruption}}{\text{Low voltage customers served at the beginning of the fiscal year}}$$

$$\text{System Average Interruption Duration Index (SAIDI/minute)} = \frac{\text{Interruption duration (min)} \times \text{Low voltage customers affected by interruption}}{\text{Low voltage customers served at the beginning of the fiscal year}}$$

Table 32 shows the definitions of terms relating to outage.

Table 32 Definition of Outage-related Terms

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

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

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

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

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

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

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

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

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

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

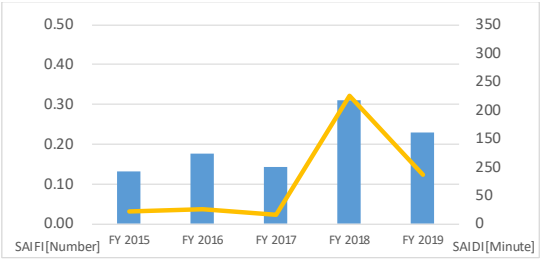

Figure 19 System Average Interruption Indices of LV Customers (Nationwide, FY 2015–2019)

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

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

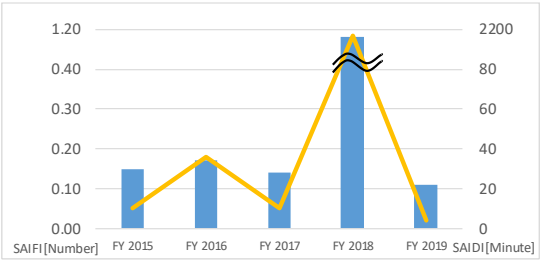

Figure 20 System Average Interruption Indices of LV Customers (Hokkaido, FY 2015–2019)

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

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

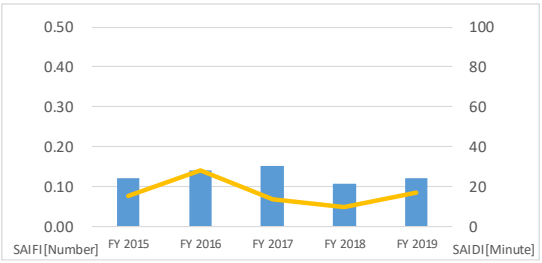

Figure 21 System Average Interruption Indices of LV Customers (Tohoku, FY 2015–2019)

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

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

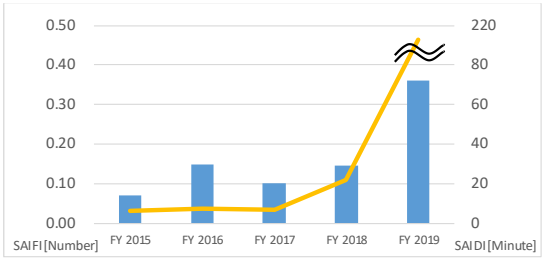

Figure 22 System Average Interruption Indices of LV Customers (Tokyo, FY 2015–2019)

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

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

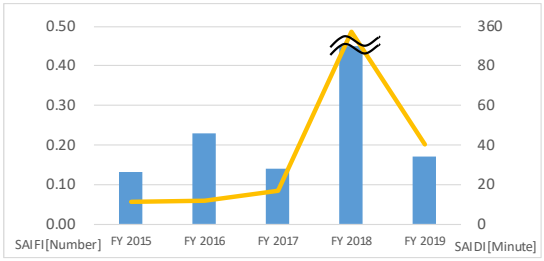

Figure 23 System Average Interruption Indices of LV Customers (Chubu, FY 2015–2019)

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

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

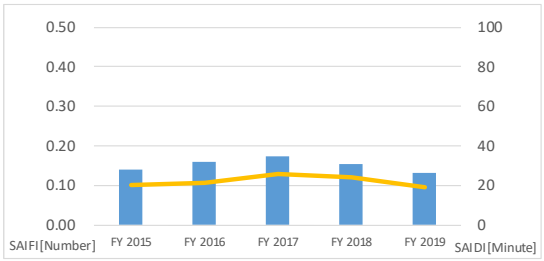

Figure 24 System Average Interruption Indices of LV Customers (Hokuriku, FY 2015–2019)

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

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

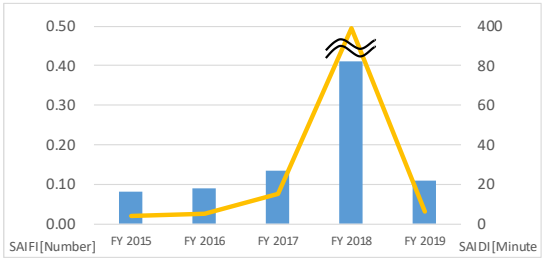

Figure 25 System Average Interruption Indices of LV Customers (Kansai, FY 2015–2019)

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

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

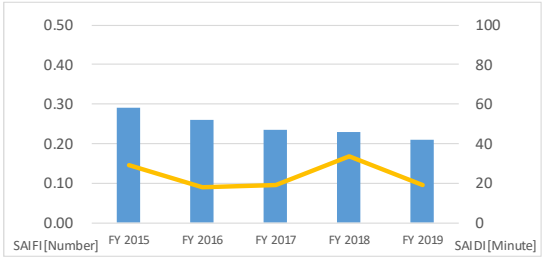

Figure 26 System Average Interruption Indices of LV Customers (Chugoku, FY 2015–2019)

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

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

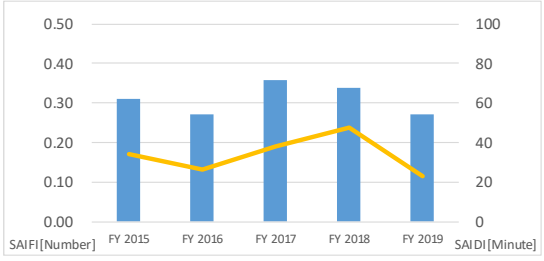

Figure 27 System Average Interruption Indices of LV Customers (Shikoku, FY 2015–2019)

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

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

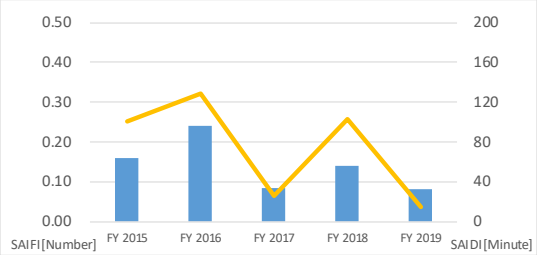

Figure 28 System Average Interruption Indices of LV Customers (Kyushu, FY 2015–2019)

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

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

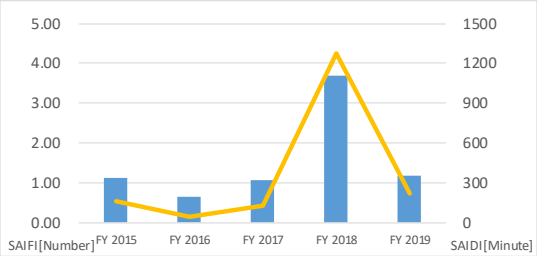

Figure 29 System Average Interruption Indices of LV Customers (Okinawa, FY 2015–2019)

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

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

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

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

IV. Conclusion

Frequency

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

Voltage

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

Supply Disturbances and Interruption for LV Customers

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

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

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

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

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

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

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

・Number of Supply Disturbances Indicating Where Interruptions Originated

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

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

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

・System Average Interruption Nationwide

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

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

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

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

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

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

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

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

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

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

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

(Minutes/Year: Customer)

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

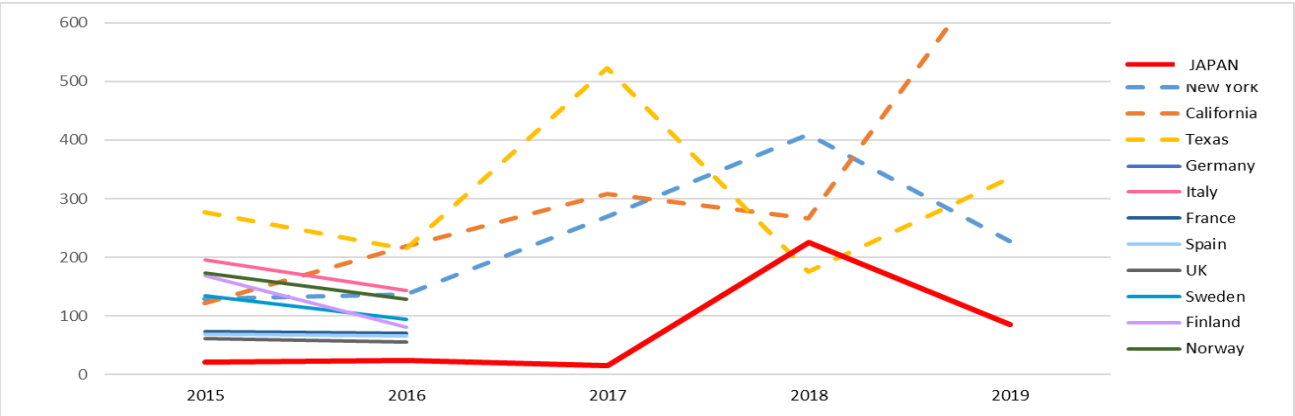

Figure 30 SAIDI of Japan and Various Countries/US States for FY 2015–2019 (Minutes/Year: Customer)

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

(Number/Year: Customer)

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

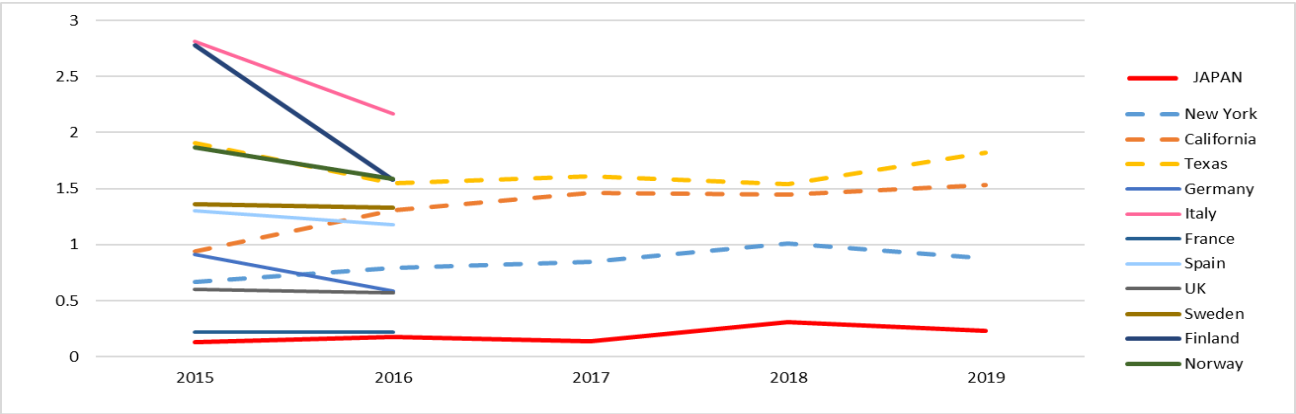

Figure 31 SAIFI of Japan and Various Countries/US States for FY 2015–2019 (Number/Year: Customer)

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