Report on the Quality of Electricity Supply

- Data for Fiscal Year 2020 -

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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 2020 fiscal year (FY 2020). 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 2020 was reviewed in this report based on the provisions of 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
The 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 6,562 points for 100 V and 6,498 points for 200 V.

Interruption
Finally, interruptions were monitored from three perspectives, 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 14,348, which was almost the same as in FY 2019.
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 19, also similar to the number of disturbances in the previous year. The number of supply disturbances caused by natural disasters was 5, which was similar to the previous year.
The final analysis was the historical monitoring of SAIFI and SAIDI values, which were both at lower levels compared with the data from the past 5 years.

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>

2024/2/2	P3	Table 7	Data from FY 2017 to 2020 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 the provisions of Article 26 of the Act. Figure 1 shows the regional service areas of the 10 general transmission and distribution companies and their standard frequency.

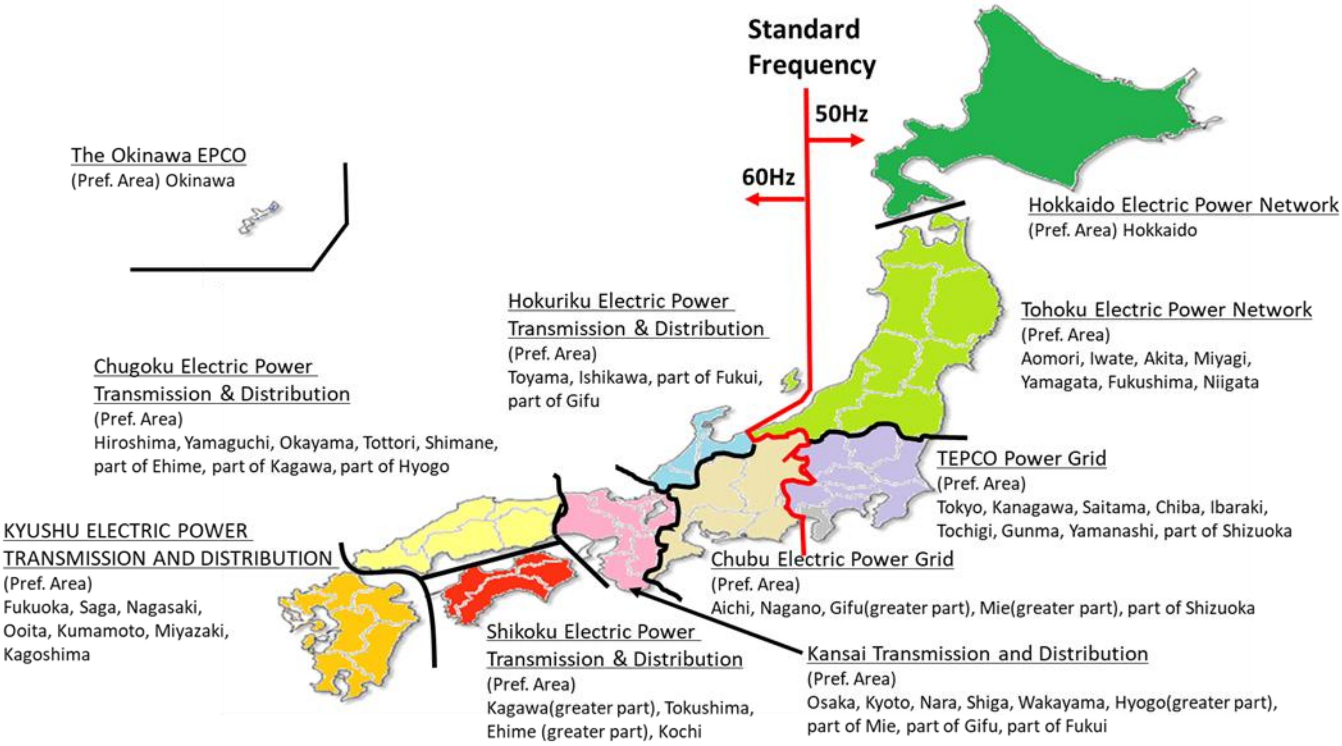

Figure 1　Regional service areas of the 10 general transmission and distribution companies and their standard frequency

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:

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

3. Frequency Control Rule [1]

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 2016–2020)

Tables 2–5 show the frequency time-kept ratio by frequency-synchronized region from FY 2016 to 2020 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 2020. In the Central and Western Japan region, the target frequency time-kept ratio within 0.1 Hz variance for FY 2020 was 98.50%, which was slightly lower than that of 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 2016–2020) [%]

Variance	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Within 0.1 Hz	99.96	99.97	99.86	99.98	99.93
Within 0.2 Hz	100.00	100.00	99.95	100.00	100.00
Within 0.3 Hz	100.00	100.00	99.98	100.00	100.00
Beyond 0.3 Hz	0.00	0.00	0.02	0.00	0.00

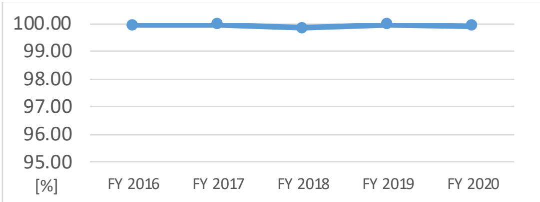

Figure 2 Frequency Time Kept Ratio within 0.1 Hz (Hokkaido, FY 2016-2020)

Table 3 Frequency Time Kept Ratio (Eastern region,[2] FY 2016–2020) [%]

Variance	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Within 0.1 Hz	99.78	99.80	99.84	99.83	99.71
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

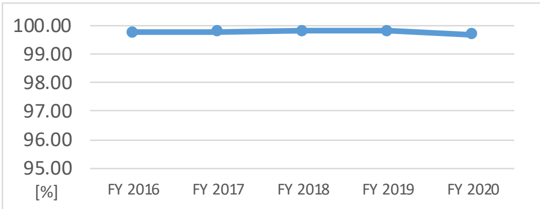

Figure 3 Frequency Time Kept Ratio within 0.1 Hz (Eastern region,[2] FY 2016-2020)

Table 4 Frequency Time Kept Ratio (Central & Western region,[3] FY 2016–2020) [%]

Variance	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Within 0.1 Hz	99.08	99.17	99.13	99.02	98.50
Within 0.2 Hz	100.00	100.00	100.00	100.00	100.00
Within 0.3 Hz	100.00	100.00	100.00	100.00	100.00
Beyond 0.3 Hz	0.00	0.00	0.00	0.00	0.00

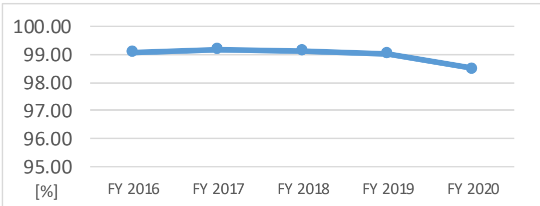

Figure 4 Frequency Time Kept Ratio (Central & Western region,[3] FY 2016–2020)

Table 5 Frequency Time Kept Ratio (Okinawa, FY 2016–2020) [%]

Variance	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Within 0.1 Hz	99.94	99.92	99.89	99.89	99.92
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

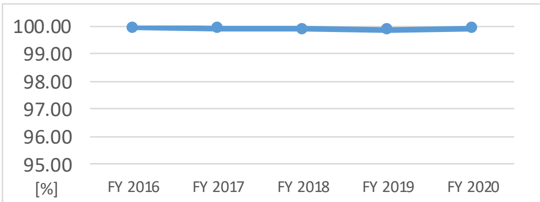

Figure 5 Frequency Time Kept Ratio (Okinawa, FY 2016–2020)

[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 the provisions of Article 26 of the Act. Table 6 shows the voltage standard and nationwide target voltage control.

Table 6 Voltage Standard and Target Voltage Control

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

2. Voltage Measurements

According to the provisions of Article 39 of the Ordinance of the Act, 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 2016–2020)

Table 7 shows the total measured points, deviated measured points, and nationwide deviation ratio from FY 2016 to 2020.

For the FY 2020 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 2016–2020) [points]

Voltage		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
100V	Total measured points	6,590	6,565	6,575	6,567	6,562
	Deviated points	0	0	0	0	0
200V	Total measured points	6,532	6,506	6,505	6,502	6,498
	Deviated points	0	0	0	0	0

III. Interruption Data

1. Data of Number of Supply Disturbances Where Interruption Originated

(1) Indices and Definition of Supply Disturbances

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

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

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[4] Electric facilities include machinery, apparatus, dams, conduits, reservoirs, electric lines, and other facilities installed for the generation, 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 on Number of Supply Disturbances Nationwide and by Regional Service Area (FY 2016–2020)

Table 8 and Figure 6 show the number of supply disturbances nationwide, where the interruptions originated in the period FY 2016–2020. 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 2020 data indicates the following points.

- The total number of supply disturbances was 14,348, which was almost the same as the number of disturbances recorded in the previous year (14,842).
- The high-voltage (HV) overhead lines in the regional service area of TEPCO PG had significant damage caused by Typhoon No. 15 (Faxai) and Typhoon No. 19 (Hagibis) in FY 2019, but supply disturbances were reduced to almost half in the area for FY 2020 as shown in Table 11. By contrast, the number of supply disturbances that occurred at HV overhead lines increased mainly in the service regional areas of Tohoku Electric Power Network and Kyushu Electric Power Transmission and Distribution. The disturbances in Tohoku area are specifically attributable to the blizzard and heavy snowfall mainly on the Japan Sea side of the area from December 2020 to January 2021,[7] and to damage caused by Fukushima offshore earthquake on February 13, 2021[8]. For the Kyushu area, the disturbances are attributable to the heavy rainfall of July 2020,[9] and damage caused by Typhoon No. 10(Haishen), which went up north on the East China Sea in September 2020.[10]

Table 8 Number of Supply Disturbances Where Interruption Originated (Nationwide, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		70	45	65	56	48	56.8
Transmission Lines & Extra High Voltage Lines	Overhead	230	278	409	246	274	287.4
	Under-ground	9	14	10	13	9	11.0
	Total	239	292	419	259	283	298.4
High Voltage Lines	Overhead	10,235	12,679	20,729	13,958	13,539	14,228.0
	Under-ground	215	216	265	227	201	224.8
	Total	10,450	12,895	20,994	14,185	13,740	14,452.8
Demand Facilities			1				0.2
Involvng Accidents		269	343	359	372	277	324.0
Total Disturbances		11,028	13,576	21,837	14,872	14,348	15,132.2

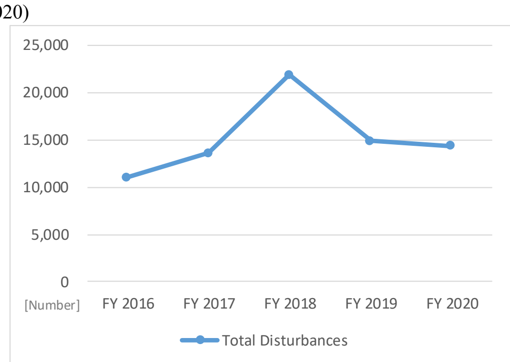

Figure 6 Transition of Supply Disturbances (Nationwide, FY 2016–2020)

[7] http://www.bousai.go.jp/updates/r2oyuki12/pdf/r2_oyuki12_05.pdf
http://www.bousai.go.jp/updates/r3oyuki01/pdf/r3_oyuki01_06.pdf

[8] http://www.bousai.go.jp/updates/r3fukushima_eq_0213/pdf/r3fukushima_eq_higai01.pdf

[9] http://www.bousai.go.jp/updates/r2_07ooame/pdf/r20703_ooame_08.pdf

[10] http://www.bousai.go.jp/updates/r2typhoon10/pdf/r2_typhoon10_08.pdf
For footnotes No.7 through No.10, see also Section 2 of Chapter 1 Disasters in FY 2020 of "White Paper on Disaster Management 2021".
http://www.bousai.go.jp/en/documentation/white_paper/pdf/2021/SF1-2.pdf

Table 9 Number of Supply Disturbances Where Interruption Originated (Hokkaido, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		1		5	2	2	2.0
Transmission Lines & Extra High Voltage Lines	Overhead	24	30	25	12	21	22.4
	Under-ground				1	1	0.4
	Total	24	30	25	13	22	22.8
High Voltage Lines	Overhead	1,289	1,144	1,139	600	801	994.6
	Under-ground	13	19	13	15	15	15.0
	Total	1,302	1,163	1,152	615	816	1,009.6
Demand Facilities							
Involvng Accidents		28	17	12	11	10	15.6
Total Disturbances		1,355	1,210	1,194	641	850	1,050.0

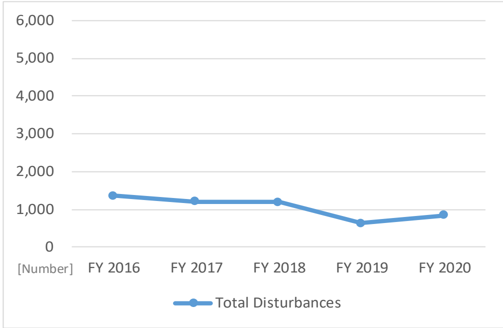

Figure 7 Transition of Supply Disturbances (Hokkaido, FY 2016–2020)

Table 10 Number of Supply Disturbances Where Interruption Originated (Tohoku, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		8	4	9	8	9	7.6
Transmission Lines & Extra High Voltage Lines	Overhead	11	16	11	16	31	17.0
	Under-ground		1				0.2
	Total	11	17	11	16	31	17.2
High Voltage Lines	Overhead	1,403	1,957	1,478	1,646	2,528	1,802.4
	Under-ground	12	5	11	7	13	9.6
	Total	1,415	1,962	1,489	1,653	2,541	1,812.0
Demand Facilities							
Involvng Accidents		22	26	20	29	17	22.8
Total Disturbances		1,456	2,009	1,529	1,706	2,598	1,859.6

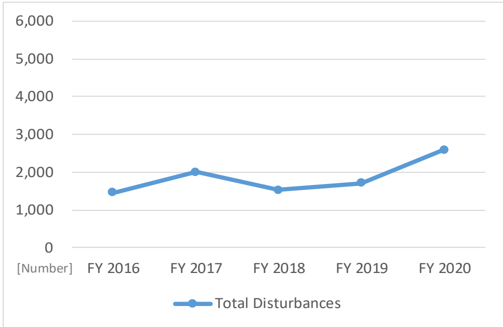

Figure 8 Transition of Supply Disturbances (Tohoku, FY 2016–2020)

Table 11 Number of Supply Disturbances Where Interruption Originated (Tokyo, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		14	17	16	17	5	13.8
Transmission Lines & Extra High Voltage Lines	Overhead	16	24	38	21	10	21.8
	Under-ground	2	4		4	3	2.6
	Total	18	28	38	25	13	24.4
High Voltage Lines	Overhead	2,204	2,311	3,841	5,186	2,472	3,202.8
	Under-ground	75	65	100	97	75	82.4
	Total	2,279	2,376	3,941	5,283	2,547	3,285.2
Demand Facilities							
Involvng Accidents		93	96	107	134	74	100.8
Total Disturbances		2,404	2,517	4,102	5,459	2,639	3,424.2

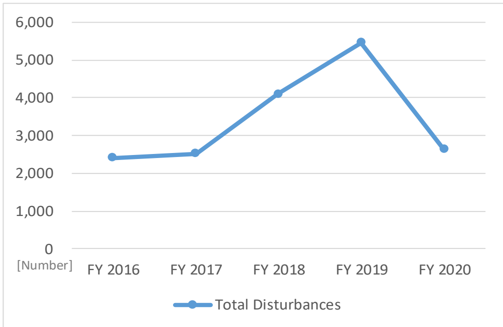

Figure 9 Transition of Supply Disturbances (Tokyo, FY 2016–2020)

Table 12 Number of Supply Disturbances Where Interruption Originated (Chubu, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		6	3	6	10	4	5.8
Transmission Lines & Extra High Voltage Lines	Overhead	16	9	26	19	15	17.0
	Under-ground					1	0.2
	Total	16	9	26	19	16	17.2
High Voltage Lines	Overhead	1,069	1,607	4,053	1,570	1,359	1,931.6
	Under-ground	5	11	39	6	4	13.0
	Total	1,074	1,618	4,092	1,576	1,363	1,944.6
Demand Facilities							
Involvng Accidents		40	49	66	60	71	57.2
Total Disturbances		1,136	1,679	4,190	1,665	1,454	2,024.8

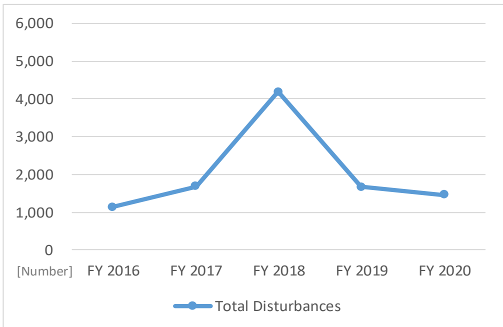

Figure 10 Transition of Supply Disturbances (Chubu, FY 2016–2020)

Table 13 Number of Supply Disturbances Where Interruption Originated (Hokuriku, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		3	1		2	3	1.8
Transmission Lines & Extra High Voltage Lines	Overhead	7	4	7	2	3	4.6
	Under-ground			2	2		0.8
	Total	7	4	9	4	3	5.4
High Voltage Lines	Overhead	303	542	385	199	444	374.6
	Under-ground	10	5	3	1	4	4.6
	Total	313	547	388	200	448	379.2
Demand Facilities							
Involvng Accidents		17	15	21	10	10	14.6
Total Disturbances		340	567	418	216	464	401.0

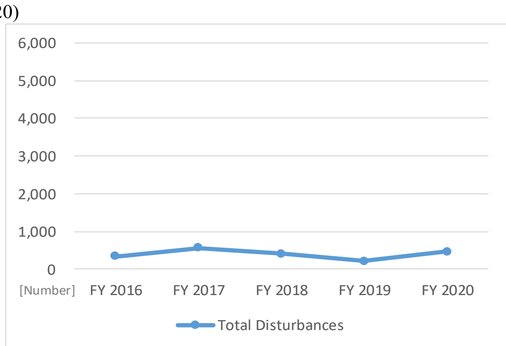

Figure 11 Transition of Supply Disturbances (Hokuriku, FY 2016–2020)

Table 14 Number of Supply Disturbances Where Interruption Originated (Kansai, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		13	9	8	3	6	7.8
Transmission Lines & Extra High Voltage Lines	Overhead	80	102	190	82	84	107.6
	Under-ground	3	7	6	3	4	4.6
	Total	83	109	196	85	88	112.2
High Voltage Lines	Overhead	1,171	1,695	5,270	1,300	1,254	2,138.0
	Under-ground	63	48	56	50	50	53.4
	Total	1,234	1,743	5,326	1,350	1,304	2,191.4
Demand Facilities							
Involvng Accidents			65	70	64	44	48.6
Total Disturbances		1,330	1,926	5,600	1,502	1,442	2,360.0

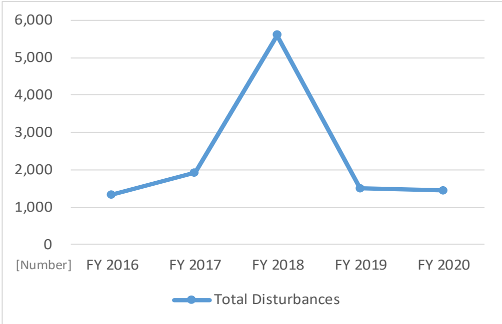

Figure 12 Transition of Supply Disturbances (Kansai, FY 2016–2020)

Table 15 Number of Supply Disturbances Where Interruption Originated (Chugoku, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		7	2	8	6	3	5.2
Transmission Lines & Extra High Voltage Lines	Overhead	16	16	14	17	11	14.8
	Under-ground		1	1	1		0.6
	Total	16	17	15	18	11	15.4
High Voltage Lines	Overhead	960	1,066	1,172	1,015	1,163	1,075.2
	Under-ground	13	24	20	16	12	17.0
	Total	973	1,090	1,192	1,031	1,175	1,092.2
Demand Facilities			1				0.2
Involvng Accidents		25	33	31	35	32	31.2
Total Disturbances		1,021	1,143	1,246	1,090	1,221	1,144.2

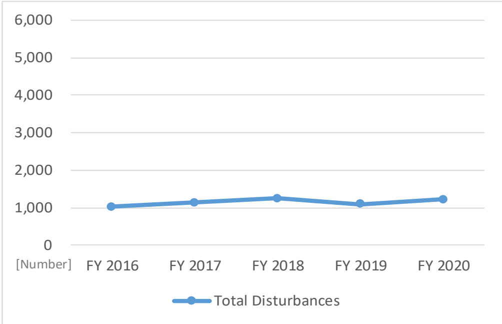

Figure 13 Transition of Supply Disturbances (Chugoku, FY 2016–2020)

Table 16 Number of Supply Disturbances Where Interruption Originated (Shikoku, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations			6	4	2	5	3.4
Transmission Lines & Extra High Voltage Lines	Overhead	5	3	4	4	1	3.4
	Under-ground						
	Total	5	3	4	4	1	3.4
High Voltage Lines	Overhead	357	630	616	439	447	497.8
	Under-ground	4	9	8	6	6	6.6
	Total	361	639	624	445	453	504.4
Demand Facilities							
Involvng Accidents		6	5	5	7	6	5.8
Total Disturbances		372	653	637	458	465	517.0

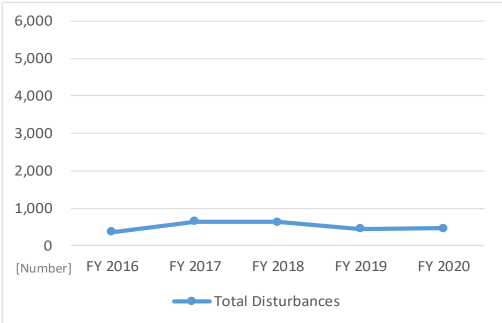

Figure 14 Transition of Supply Disturbances (Shikoku, FY 2016–2020)

Table 17 Number of Supply Disturbances Where Interruption Originated (Kyushu, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		15	3	1	4	7	6.0
Transmission Lines & Extra High Voltage Lines	Overhead	21	32	42	38	42	35.0
	Under-ground	4		1			1.0
	Total	25	32	43	38	42	36.0
High Voltage Lines	Overhead	1,237	1,349	1,888	1,547	2,614	1,727.0
	Under-ground	18	30	15	22	17	20.4
	Total	1,255	1,379	1,903	1,569	2,631	1,747.4
Demand Facilities							
Involvng Accidents		20	23	16	19	13	18.2
Total Disturbances		1,315	1,437	1,963	1,630	2,693	1,807.6

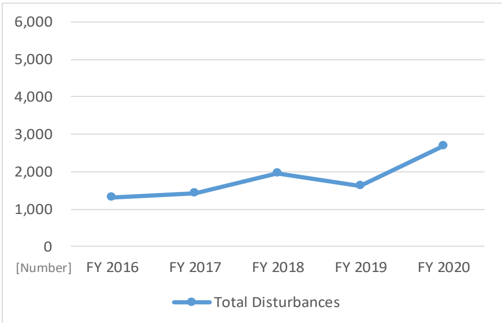

Figure 15 Transition of Supply Disturbances (Kyushu, FY 2016–2020)

Table 18 Number of Supply Disturbances Where Interruption Originated (Okinawa, FY 2016–2020)

Occurrence in		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years average
Disturbance of General Transmission & Distribution Companies' Facilities							
Substations		3		8	2	4	3.4
Transmission Lines & Extra High Voltage Lines	Overhead	34	42	52	35	56	43.8
	Under-ground		1		2		0.6
	Total	34	43	52	37	56	44.4
High Voltage Lines	Overhead	242	378	887	456	457	484.0
	Under-ground	2			7	5	2.8
	Total	244	378	887	463	462	486.8
Demand Facilities							
Involvng Accidents		18	14	11	3		9.2
Total Disturbances		299	435	958	505	522	543.8

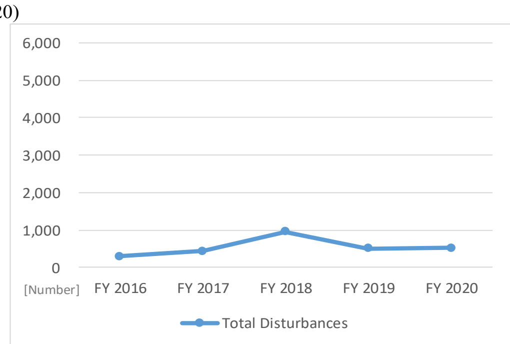

Figure 16 Transition of Supply Disturbances (Okinawa, FY 2016–2020)

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

(1) Data on Supply Disturbances over a Certain Scale

For the data on 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 these causes.

A supply disturbance over a certain scale applies 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 2020[11]. The columns in the table was left blank if value was zero or data are unavailable. It should be noted that supply disturbances that was caused by blackout are not included in the statistics.

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

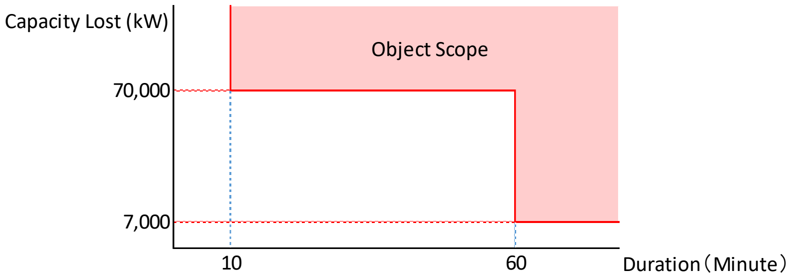

Figure 20 Image of Supply Disturbances over a Certain Scale

Table 19 Number of Supply Disturbances Where Interruption Originated by Scale of Interruption (Nationwide, FY 2020) [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		1	1			4
Transmission Lines & Extra High Voltage Lines	Overhead					7			6			13
	Under-ground								2			2
	Total					7			8			15
High Voltage Distribution Lines	Overhead											
	Under-ground											
	Total											
Demand Facilities												
Involved Accidents												
Total Disturbance						9		1	9			19

[11] 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) Number and Causes of Supply Disturbances over a Certain Scale (FY 2016–2020)

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 2016–2020.[12,13]

For the FY 2020 data, the number and the causes of supply disturbances over a certain scale were analyzed. Nationwide, there were 19 cases of supply disturbance over a certain scale, which was similar to 18 cases in the previous year, and to the 5-year average of 21.8.

Table 21 Causes of Disturbances over a Certain Scale (Nationwide, FY 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
Fault of Facility or Maintenance						
Facility Fault	2	1	4	1	1	1.8
Maintenance fault	1	4	1	1	1	1.6
Accident/Malice	1	1	1	4	4	2.2
Physical contact	4	2	2	5	6	3.8
Involved accident	1		1	1		0.6
Electric shock(worker)						
Subtotal	9	8	9	12	12	10.0
Natural Disaster						
Thunderbolt	3	2	1	2	2	2.0
Rainstorm	3	3	17			4.6
Snowstorm	2	2				0.8
Earthquake	6			3	3	2.4
Dust/Gas	2		2			0.8
Subtotal	16	7	20	5	5	10.6
Unknown				1	1	0.4
Miscellaneous	1		2	1	1	1.0
Total Disturbances	26	15	31	18	19	21.8

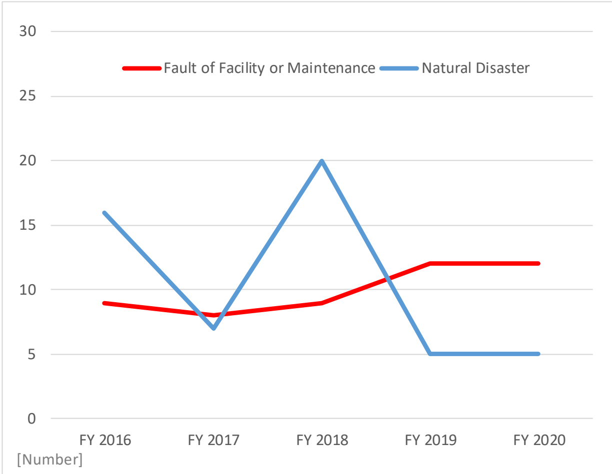

Figure 18 Transition of Disturbances by Causes (Nationwide, FY 2015–2019)

Table 22 Causes of Disturbances over a Certain Scale (Hokkaido, FY 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
Fault of Facility or Maintenance						
Facility Fault			1		1	0.4
Maintenance fault	1		1			0.4
Accident/Malice						
Physical contact			1			0.2
Involved accident						
Electric shock(worker)						
Subtotal	1		3		1	1.0
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	2.0

Table 23 Causes of Disturbances over a Certain Scale (Tohoku, FY 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	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)						
Subtotal	3					0.6
Natural Disaster						
Thunderbolt				1		0.2
Rainstorm						
Snowstorm		1				0.2
Earthquake					3	0.6
Dust/Gas						
Subtotal		1		1	3	1.0
Unknown						
Miscellaneous						
Total Disturbances	3	1		1	3	1.6

12 Causes of the disturbances that did not occur in the period FY 2016–2020 are omitted from the tables.
13 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 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
Fault of Facility or Maintenance						
Facility Fault	1	1				0.4
Maintenance fault						
Accident/Malice			1	1	2	0.8
Physical contact	1	1	1	1	1	1.0
Involved accident						
Electric shock(worker)						
Subtotal	2	2	2	2	3	2.2
Natural Disaster						
Thunderbolt	1	1	1	2	2	1.4
Rainstorm				3	3	1.2
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal	1	1	1	5	5	2.6
Unknown					1	0.2
Miscellaneous			1		1	0.4
Total Disturbances	3	3	4	7	5	4.4

Table 25 Causes of Disturbances over a Certain Scale (Chubu, FY 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	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)						
Subtotal				2	1	0.6
Natural Disaster						
Thunderbolt	1				1	0.4
Rainstorm			1			0.2
Snowstorm	2					0.4
Earthquake						
Dust/Gas			2			0.4
Subtotal	3		3		1	1.4
Unknown						
Miscellaneous				1		0.2
Total Disturbances	3		3	3	2	2.2

Table 26 Causes of Disturbances over a Certain Scale (Hokuriku, FY 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	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 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
Fault of Facility or Maintenance						
Facility Fault			3			0.6
Maintenance fault		3			1	0.8
Accident/Malice		1			1	0.4
Physical contact		1		2	4	1.4
Involved accident	1		1			0.4
Electric shock(worker)						
Subtotal	1	5	4	2	6	3.6
Natural Disaster						
Thunderbolt				1	1	0.4
Rainstorm	1	3	10	1		3.0
Snowstorm						
Earthquake						
Dust/Gas						
Subtotal	1	3	10	2	1	3.4
Unknown						
Miscellaneous						
Total Disturbances	2	8	14	4	7	7.0

Table 28 Causes of Disturbances over a Certain Scale (Chugoku, FY 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	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 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	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 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	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 2016–2020) [Number]

	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
Fault of Facility or Maintenance						
Facility Fault						
Maintenance fault						
Accident/Malice						
Physical contact					1	0.2
Involved accident						
Electric shock(worker)						
Subtotal					1	0.2
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	1	1.0

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 one year.

System Average Interruption Frequency Index (SAIFI/number)

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

System Average Interruption Duration Index (SAIDI/minute)

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

Table 32 shows the definitions of terms relating to outage.

Table 32 Definition of Outage-related Terms

Term	Definition
Forced outage	Supply interruption occurred to end-use customers by accident, such as the malfunction of the electric facility, excluding resumption of electricity supply by automatic reclosing.[14][15]
Planned outage	Electric power company interrupts its electricity supply in planned manner to construct, improve, and maintain its electric facility.

[14] See footnote 5 for definitions.
[15] See footnote 6 for definitions.

(2) Data on System Average Interruption Nationwide and by Regional Service Area (FY 2016–2020)

Table 33 and Figure 19 show the nationwide data for system average interruptions for FY 2016–2020. 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 2020.[16]

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

・Regarding the nationwide SAIFI and SAIDI, data for FY 2020 were lower compared with both data from the previous year and the average for the previous 5 years. This was attributable to the reduced formation of typhoons. In FY 2020, 7 typhoons approached Japan, with the climatological average being 11.4 for a normal year.[17] In addition, no typhoon has made landfall on Japan proper in the 12 years since 2008, with the climatological average being 2.7 for a normal year.[18]

・Regarding the data by regional service area, the Tohoku Network area and Kyushu Transmission and Distribution area suffered damage from natural disasters. For the Tohoku area, such damage was specifically attributable to the blizzard and heavy snowfall mainly on the Japan Sea side of the area from December 2020 to January 2021, and damage caused by Fukushima offshore earthquake on February 13, 2021. For the Kyushu area, such damage is attributable to the heavy rainfall of July 2020, and Typhoon No. 10(Haishen), which went up north on the East China Sea in September 2020.

Table 33 Indices of System Average Interruption (Nationwide, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.14	0.11	0.28	0.19	0.13	0.17
	Planned	0.03	0.03	0.03	0.04	0.04	0.03
	Total ●	0.18	0.14	0.31	0.23	0.17	0.21
SAIDI [Minute]	Forced	21	12	221	82	24	72
	Planned	4	3	4	3	3	3
	Total ●	25	16	225	86	27	76

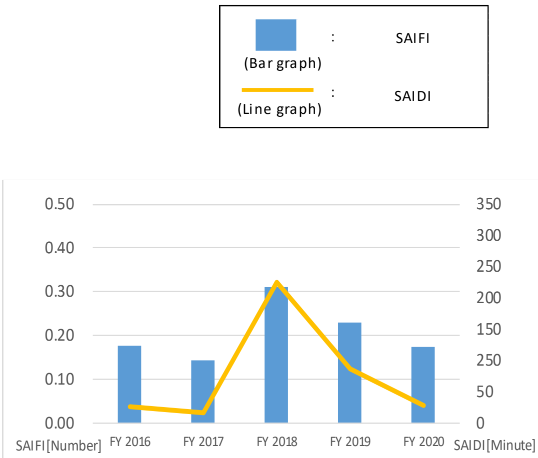

Figure 19 System Average Interruption Indices of LV Customers (Nationwide, FY 2016–2020)

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

[17] https://www.data.jma.go.jp/fcd/yoho/typhoon/statistics/accession/accession.html

[18] https://www.data.jma.go.jp/fcd/yoho/typhoon/statistics/landing/landing.html
Also see Figure 3.3 of "Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2020".
https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/AnnualReport/2020/Text/Text2020.pdf

Table 34 Indices of System Average Interruption (Hokkaido, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.17	0.13	1.19	0.11	0.09	0.34
	Planned	α	0.01	α	α	α	0.01
	Total	0.17	0.14	1.19	0.11	0.09	0.34
SAIDI [Minute]	Forced	35	10	2,154	4	5	441
	Planned	1	α	α	α	α	1
	Total	36	10	2,154	4	5	442

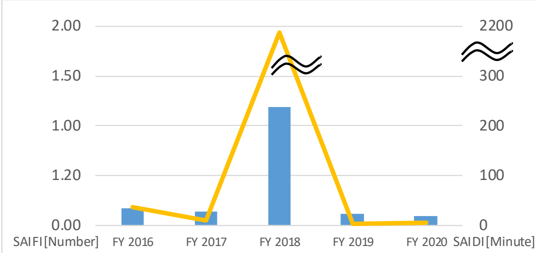

Figure 20 System Average Interruption Indices of LV Customers (Hokkaido, FY 2016–2020)

Table 35 Indices of System Average Interruption (Tohoku, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.11	0.13	0.09	0.11	0.16	0.12
	Planned	0.03	0.02	0.02	0.02	0.02	0.02
	Total	0.14	0.15	0.11	0.12	0.18	0.14
SAIDI [Minute]	Forced	24	10	7	15	25	16
	Planned	4	3	2	2	4	3
	Total	28	13	10	17	29	19

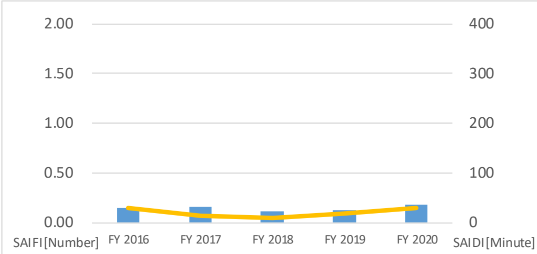

Figure 21 System Average Interruption Indices of LV Customers (Tohoku, FY 2016–2020)

Table 36 Indices of System Average Interruption (Tokyo, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.13	0.09	0.13	0.33	0.11	0.16
	Planned	0.02	0.01	0.01	0.03	0.06	0.02
	Total	0.15	0.10	0.14	0.36	0.17	0.18
SAIDI [Minute]	Forced	7	6	19	200	7	48
	Planned	1	1	3	1	1	1
	Total	8	7	22	201	8	49

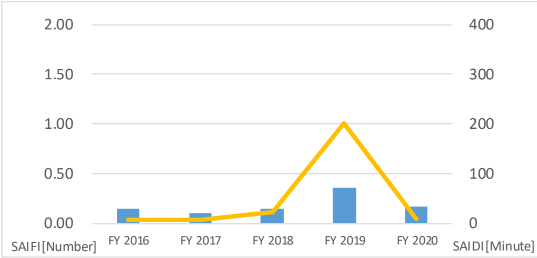

Figure 22 System Average Interruption Indices of LV Customers (Tokyo, FY 2016–2020)

Table 37 Indices of System Average Interruption (Chubu, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.17	0.08	0.39	0.11	0.07	0.16
	Planned	0.06	0.06	0.06	0.06	0.05	0.06
	Total	0.23	0.14	0.45	0.17	0.13	0.22
SAIDI [Minute]	Forced	5	10	348	32	6	80
	Planned	7	7	8	8	7	7
	Total	12	17	356	40	12	87

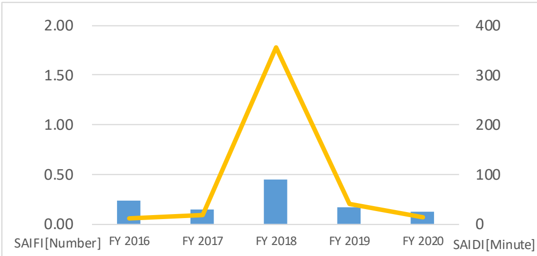

Figure 23 System Average Interruption Indices of LV Customers (Chubu, FY 2016–2020)

Table 38 Indices of System Average Interruption (Hokuriku, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.06	0.09	0.06	0.03	0.06	0.06
	Planned	0.10	0.09	0.09	0.09	0.08	0.09
	Total	0.16	0.17	0.15	0.13	0.14	0.15
SAIDI [Minute]	Forced	4	11	9	3	7	7
	Planned	17	15	15	16	15	15
	Total	21	26	24	19	22	22

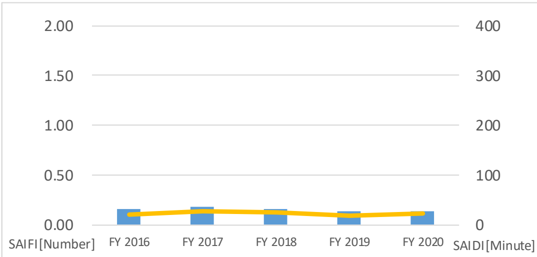

Figure 24 System Average Interruption Indices of LV Customers (Hokuriku, FY 2016–2020)

Table 39 Indices of System Average Interruption (Kansai, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.07	0.12	0.40	0.10	0.09	0.15
	Planned	0.01	0.01	0.01	0.01	0.01	0.01
	Total	0.09	0.13	0.41	0.11	0.10	0.17
SAIDI [Minute]	Forced	4	14	396	5	7	85
	Planned	1	1	1	1	1	1
	Total	5	15	397	6	8	86

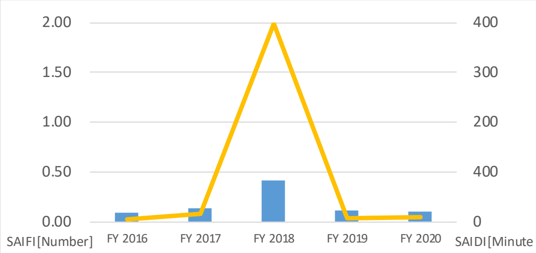

Figure 25 System Average Interruption Indices of LV Customers (Kansai, FY 2016–2020)

Table 40 Indices of System Average Interruption (Chugoku, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.15	0.12	0.14	0.13	0.15	0.14
	Planned	0.11	0.11	0.09	0.09	0.10	0.10
	Total	0.26	0.23	0.23	0.21	0.25	0.24
SAIDI [Minute]	Forced	6	7	24	10	20	13
	Planned	12	12	10	9	11	11
	Total	18	19	33	19	31	24

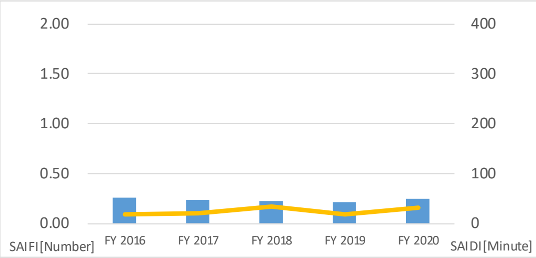

Figure 26 System Average Interruption Indices of LV Customers (Chugoku, FY 2016–2020)

Table 41 Indices of System Average Interruption (Shikoku, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.09	0.19	0.20	0.13	0.14	0.15
	Planned	0.18	0.16	0.14	0.14	0.14	0.15
	Total	0.27	0.36	0.34	0.27	0.28	0.30
SAIDI [Minute]	Forced	6	21	32	8	10	15
	Planned	20	17	15	15	15	16
	Total	26	38	47	23	24	32

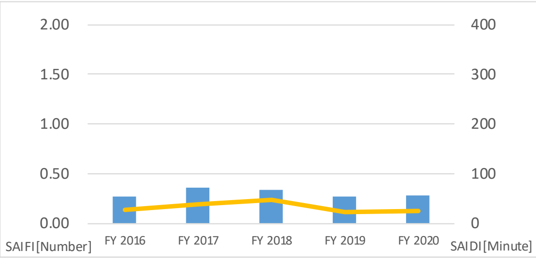

Figure 27 System Average Interruption Indices of LV Customers (Shikoku, FY 2016–2020)

Table 42 Indices of System Average Interruption (Kyushu, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.24	0.08	0.14	0.08	0.21	0.15
	Planned	0	0	0	0	0	0
	Total	0.24	0.08	0.14	0.08	0.21	0.15
SAIDI [Minute]	Forced	128	25	103	15	139	82
	Planned	0	0	0	0	0	0
	Total	128	25	103	15	139	82

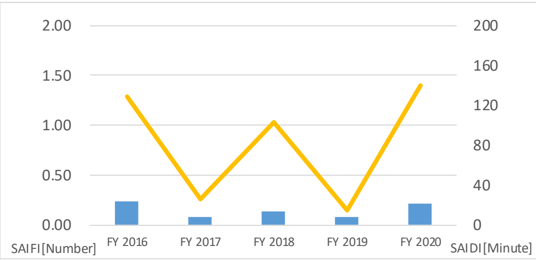

Figure 28 System Average Interruption Indices of LV Customers (Kyushu, FY 2016–2020)

Table 43 Indices of System Average Interruption (Okinawa, FY 2016–2020)

		FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	5-years Average
SAIFI [Number]	Forced	0.57	0.98	3.62	1.11	1.12	1.48
	Planned	0.08	0.07	0.07	0.05	0.06	0.07
	Total	0.65	1.05	3.69	1.17	1.18	1.55
SAIDI [Minute]	Forced	35	117	1,269	215	90	345
	Planned	8	7	6	6	11	8
	Total	43	124	1,275	221	101	353

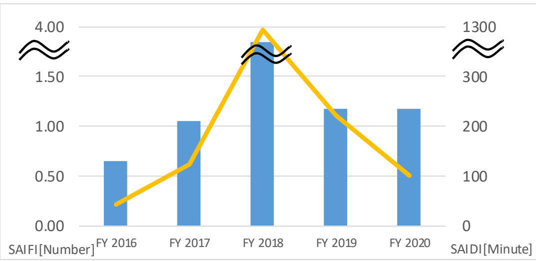

Figure 29 System Average Interruption Indices of LV Customers (Okinawa, FY 2016–2020)

Table 44 System Average Disturbances where Interruptions Were Caused by Outages (Nationwide, FY 2020)[19,]

			Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa	Nationwide
SAIFI [Number]	Forced Outage												
		Generators	0.02	0.02	0.06	0.01	0.01	0.03	0.02	0.02	0.01	0.19	
		HV Lines	0.06	0.14	0.05	0.06	0.05	0.06	0.12	0.11	0.20	0.92	
		LV Lines	α	α	α	α	α	α	α	α	α	0.01	
		Subtotal	0.09	0.16	0.11	0.07	0.06	0.09	0.15	0.14	0.21	1.12	0.13
	Planned Outage												
		Generators	α	α	α	0.00	α	α	α	0.00	0.00	α	
		HV Lines	α	0.02	0.05	0.04	0.07	0.01	0.08	0.09	0.00	0.02	
		LV Lines	α	α	α	0.01	0.01	0.01	0.02	0.05	0.00	0.04	
		Subtotal	α	0.02	0.06	0.05	0.08	0.01	0.10	0.14	0.00	0.06	0.04
	Total Outage												
		Generators	0.02	0.02	0.06	0.01	0.01	0.03	0.02	0.02	0.01	0.19	
		HV Lines	0.06	0.16	0.10	0.10	0.12	0.06	0.20	0.20	0.20	0.94	
		LV Lines	α	0.01	α	0.02	0.02	0.01	0.02	0.06	α	0.05	
		Total	0.09	0.18	0.17	0.13	0.14	0.10	0.25	0.28	0.21	1.18	0.17
SAIDI [Minute]	Forced Outage												
		Generators	1	4	4	α	α	1	1	α	1	7	
		HV Lines	4	20	4	5	6	5	18	8	137	79	
		LV Lines	α	1	α	1	1	α	1	1	1	4	
		Subtotal	5	25	7	6	7	7	20	10	139	90	24
	Planned Outage												
		Generators	α	α	α	0	α	α	α	0	0	α	
		HV Lines	α	3	1	5	13	1	10	11	0	8	
		LV Lines	α	1	α	1	1	α	1	3	0	3	
		Subtotal	α	4	1	7	15	1	11	15	0	11	3
	Total Outage												
		Generators	1	4	4	α	α	1	1	α	1	7	
		HV Lines	4	23	4	10	19	6	28	20	137	87	
		LV Lines	α	2	α	2	3	1	2	4	1	7	
		Total	5	29	8	12	22	8	31	24	139	101	27

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

[19] 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 2020 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 2020.

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 2020, the total number of supply disturbances nationwide was similar to the previous year. The TEPCO PG area, which had significant supply disturbances on overhead HV lines caused by natural disasters such as Typhoon No.15 and No.19 in the previous year, saw its number of supply disturbances reduced to the half, however, the supply disturbances on overhead HV lines for the Tohoku Network area and the Kyushu Transmission and Distribution area were significantly increased. For the Tohoku area, they were specifically attributable to the blizzard and heavy snowfall mainly on the Japan Sea side of the area from December 2020 to January 2021, and damage caused by the Fukushima offshore earthquake on February 13, 2021. For the Kyushu area, it is attributable to the heavy rainfall of July 2020, and damage caused by Typhoon No. 10(Haishen), which went up north on the East China Sea in September 2020.

The number of supply disturbances over a certain scale for FY 2020 was 19, which was similar to the previous year of 18 and almost at the same level as 21.8 average for the past 5 years. There was no area that recorded a significant number.

Considering the data on interruptions for LV customers, the SAIFI and SAIDI data nationwide for FY 2020 were significantly improved from the previous year. Some areas suffered damage caused by natural disasters such as earthquakes, heavy rainfall, and typhoons, though, this improvement is largely attributable to there being no typhoon landfalls in FY 2020.

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 2020. OCCTO will continue to collect and publish information on the quality of electricity in the future.

<Reference > Comparison of Average System Interruptions in Japan with Various Countries and US States for 2016–2020

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 2016–2020. The data for EU countries are cited from the report[20] of the Council of European Energy Regulators; those for major US states are from the report[21] of the Public Utilities Commission in each state. These data were aggregated and analyzed by OCCTO.[22]

The monitoring conditions, such as observed voltage, annual monitoring period (whether starting from January or April),[23] and data including/excluding natural disasters, 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 means other than the LV network, it is estimated that interruptions of such customers would have only a marginal effect on the interruption data.

Data for California and EU countries were not available at the time of preparing this report, as their dates of publication were reported as "to be determined."

[20] 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.

[21] 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

[22] 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.)

[23] 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 2016–2020 by Forced and Planned Outages

(Minutes/Year: Customer)

			Year					Condition		
Country/State			2016	2017	2018	2019	2020	Event of	Observed Voltage	Natural Disaster
JAPAN			25	16	225	86	76	except auto re-closing	LV	Include
		Forced	21	12	221	82	72			
		Planned	4	3	4	3	3			
U.S.A.	California		219	308	266	737	-	5 minutes and longer	All	Include
		Forced	124	244	201	690	-			
		Planned	95	64	65	48	-			
	Texas		214	522	175	335	356			
		Forced	205	509	158	319	343			
		Planned	9	13	17	15	13			
	New York		137	270	409	228	538			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			
EU	Germany		24	-	-	-	-	3 minutes and longer	All	Include
		Forced	13	-	-	-	-			
		Planned	10	-	-	-	-			
	Italy		144	-	-	-	-		All	Include
		Forced	65	-	-	-	-			
		Planned	79	-	-	-	-			
	France		71	-	-	-	-		All	Include
		Forced	53	-	-	-	-			
		Planned	18	-	-	-	-			
	Spain		66	-	-	-	-		All	Include
		Forced	54	-	-	-	-			
		Planned	12	-	-	-	-			
	UK		55	-	-	-	-		All	Exclude
		Forced	47	-	-	-	-			
		Planned	8	-	-	-	-			
	Sweden		94	-	-	-	-		All	Include
		Forced	76	-	-	-	-			
		Planned	19	-	-	-	-			
	Finland		81	-	-	-	-		except LV	Include
		Forced	68	-	-	-	-			
		Planned	13	-	-	-	-			
	Norway		129	-	-	-	-		All	Include
		Forced	88	-	-	-	-			
		Planned	41	-	-	-	-			

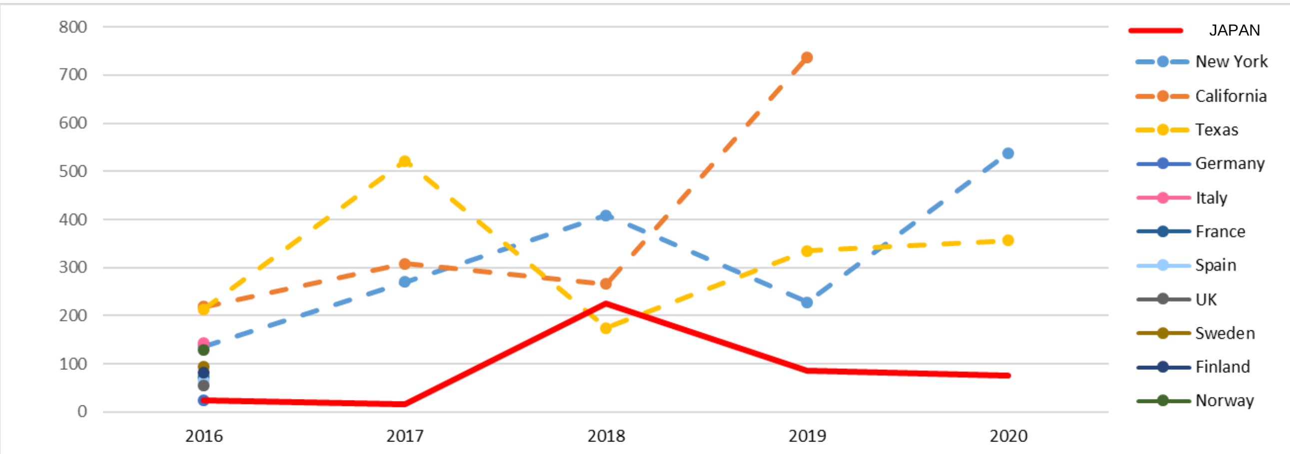

Figure 30 SAIDI of Japan and Various Countries/US States for FY 2016–2020 (Minutes/Year: Customer)

Table 48 SAIFI of Japan and Various Countries/US States for FY 2016–2020 by Forced and Planned Outages

(Number/Year: Customer)

Country/State			2016	2017	2018	2019	2020	Event of	Observed Voltage	Natural Disaster
JAPAN			0.18	0.14	0.31	0.23	0.21	except auto re-closing	LV	Include
		Forced	0.14	0.11	0.28	0.19	0.17			
		Planned	0.03	0.03	0.03	0.04	0.03			
U.S.A.	California		1.31	1.46	1.45	1.53	-	5 minutes and longer	All	Include
		Forced	1.05	1.26	0.94	1.37	-			
		Planned	0.26	0.20	0.50	0.16	-			
	Texas		1.55	1.61	1.54	1.82	1.69			
		Forced	1.48	1.51	1.40	1.68	1.57			
		Planned	0.07	0.15	0.13	0.14	0.12			
	New York		0.79	0.85	1.01	0.88	1.06			
		Forced	-	-	-	-	-			
		Planned	-	-	-	-	-			
EU	Germany		0.59	-	-	-	-	3 minutes and longer	All	Include
		Forced	0.51	-	-	-	-			
		Planned	0.08	-	-	-	-			
	Italy		2.17	-	-	-	-		All	Include
		Forced	1.76	-	-	-	-			
		Planned	0.41	-	-	-	-			
	France		0.22	-	-	-	-		All	Include
		Forced	0.08	-	-	-	-			
		Planned	0.14	-	-	-	-			
	Spain		1.18	-	-	-	-		All	Include
		Forced	1.09	-	-	-	-			
		Planned	0.09	-	-	-	-			
	UK		0.57	-	-	-	-		All	Exclude
		Forced	0.53	-	-	-	-			
		Planned	0.04	-	-	-	-			
	Sweden		1.33	-	-	-	-		All	Include
		Forced	1.17	-	-	-	-			
		Planned	0.16	-	-	-	-			
	Finland		1.58	-	-	-	-		except LV	Include
		Forced	1.42	-	-	-	-			
		Planned	0.15	-	-	-	-			
	Norway		1.89	-	-	-	-		All	Include
		Forced	1.59	-	-	-	-			
		Planned	0.30	-	-	-	-			

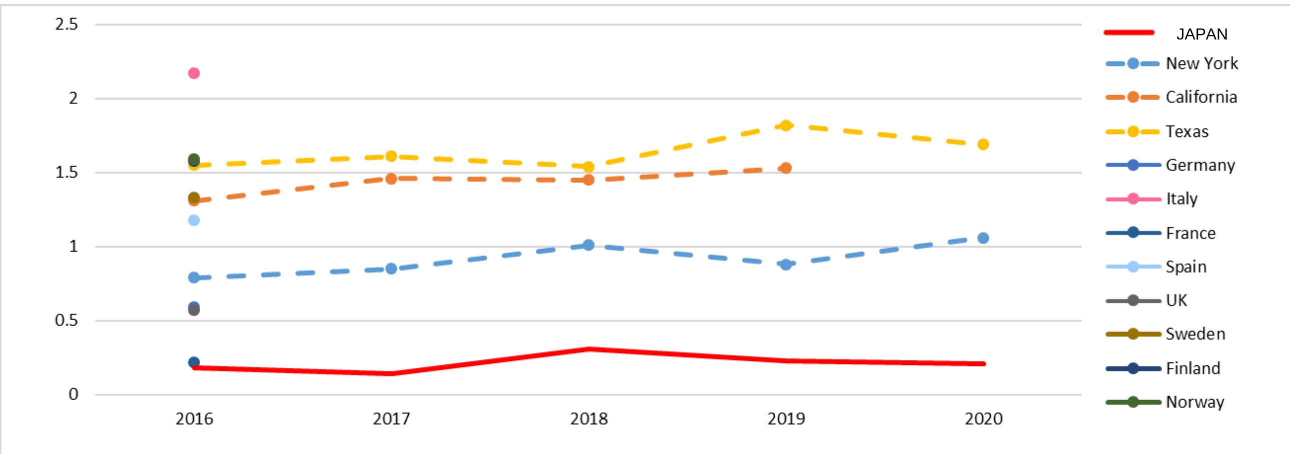

Figure 31 SAIFI of Japan and Various Countries/US States for FY 2016–2020 (Number/Year: Customer)

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