LOAD-FREQUENCY CONTROL

Annual Report

2019

Publication Date: **30 September 2020**

entsoe

Executive Summary

According to Article 16 of the Commission Regulation (EU) 2017/1485 of 2 August 2017, establishing a guideline on electricity transmission system operation, transmission system operators [hereinafter TSOs] of each European Union Member State are obligated to provide ENTSO-E with the necessary data and information for the preparation and creation of the annual report on LFC [hereinafter: ALFC Report]. ENTSO-E is obligated to publish the annual report.

All ENTSO-E member TSOs agreed to provide their data and information for the preparation of the ALFC Report and its publication. The objectives of the ALFC report are to present:

(a) information (identification, graphical representation and associated monitors) for each synchronous area, LFC block and TSO of the five synchronous areas (Ireland/Northern Ireland; Great Britain; Nordic, Continental Europe and Baltic). Details are presented in Chapter 2, "Synchronous Areas, LFC Blocks and TSO Identification";

(b) results of the frequency quality evaluation criteria for each synchronous area and each LFC block. Details are presented in Chapter 3, "Frequency Quality Evaluation Criteria";

(c) description and date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations in which TSOs were involved during the preceding year. Details are presented in Chapter 3, "Frequency Quality Evaluation Criteria"; and

(d) FCR obligation and the initial FCR obligation of each TSO covering each month of the preceding two years. Details are presented in Chapter 4, "FCR Data".

The main conclusion is that for all reported data the synchronous areas frequency quality was within the defined levels. All LFC blocks and TSOs provided their data and have explained mitigation measures where applied.

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1. Introduction

Load-frequency control [hereinafter LFC] Annual Report is a requirement of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation [hereinafter SO GL].

Article 16 of SO GL sets the obligation on transmission system operators [hereinafter TSOs] of each European Union Member State to provide ENTSO-E with the necessary data and information for the preparation and creation of the annual report on LFC, and on ENTSO-E to publish the annual report.

All ENTSO-E member TSOs agreed to provide the necessary data and information for the preparation of annual LFC report and its publication. Each annual report is approved separately by System Operations Committee for publication.

The objectives of the LFC report are to represent results of the frequency quality evaluation criteria for each synchronous area and each LFC block and the FCR obligation and the initial FCR obligation of each TSO covering each month of preceding two years, as well as a description and date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations in which TSOs were involved during the last preceding year.

The annual report on load-frequency control includes the information listed in SO GL Article 16 (2) for each synchronous area, LFC block and TSO of ENTSO-E.

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2. Synchronous areas, LFC blocks and TSO identification

In this paragraph, the SO GL Article 16. 2. (a), (b) and (c) requirements are reported with the goal of identifying the LFC blocks, LFC areas and monitoring areas in the ENTSO-E. The location of each member state in relation to the European synchronous areas and LFC blocks is also reported.

The five synchronous areas included in this document are Continental Europe, Nordic, Great Britain, Ireland and Northern Ireland and Baltic as shown in Tables 1-5 and graphically in Figure 1 below. Each LFC block and LFC block monitor are reported in Tables 1-5. TSOs acronyms are explained in Appendix A. For the Baltic synchronous area data collection process is not performed. The Baltic States power system is currently asynchronously connected to Continental Europe through LitPol Link between Lithuania and Poland and to the Nordic Synchronous Area through NordBalt between Lithuania and Sweden and Estlink 1 and 2 between Estonia and Finland. The Baltic synchronisation with Continental Europe is part of the EU Energy Union strategy and will provide for the Baltic TSOs to operate their systems under the frequency of the Continental European System and under the EU rules.

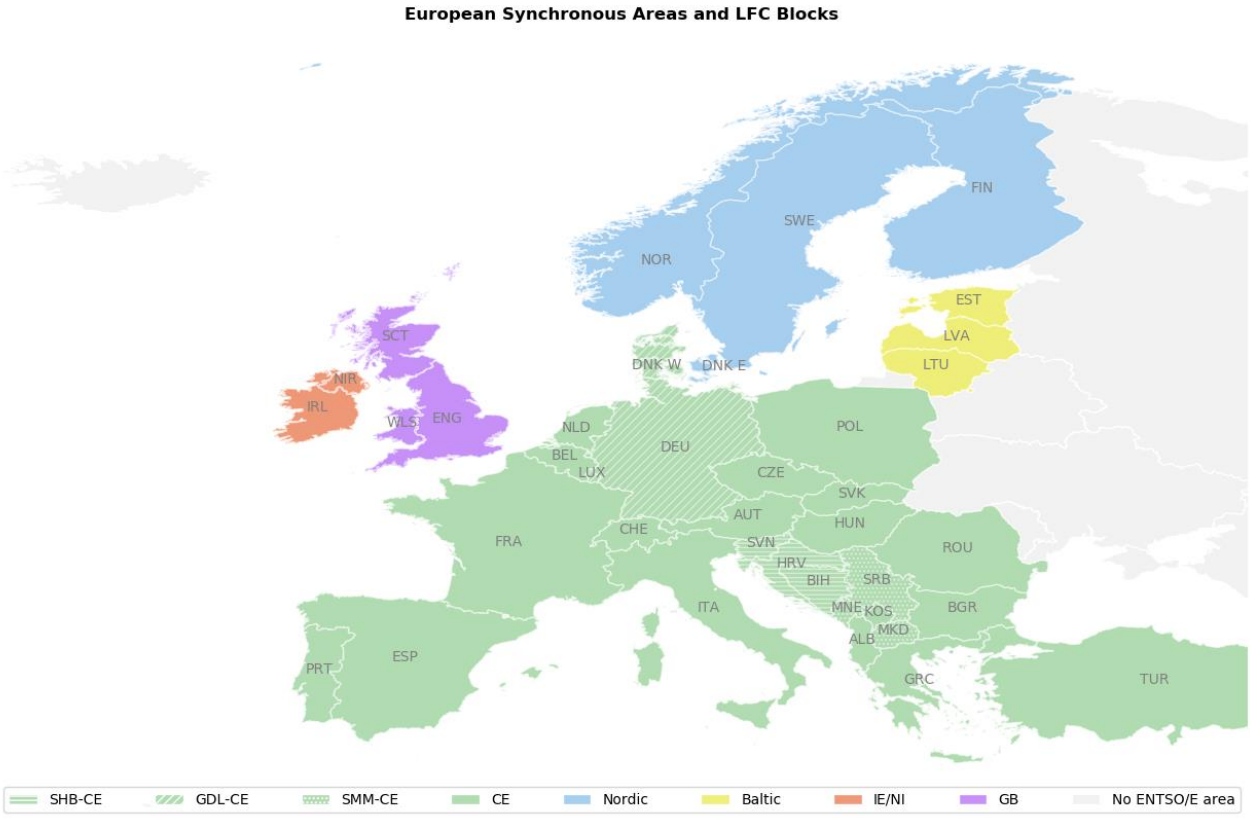

Figure 1 European Synchronous Areas and LFC Blocks

According to Article 133 of SO GL, all TSOs of a synchronous area shall appoint one TSO of that synchronous area in the synchronous area operational agreement as the synchronous area monitor. The synchronous area monitor shall implement the data collection and delivery process of the synchronous area referred to in Article 132 of SO GL, and implement the criteria application process referred to in Article 129 of SO GL.

Furthermore, the synchronous area monitor shall collect the frequency quality evaluation data of its synchronous area and perform the criteria application process, including the calculation of the frequency quality evaluation criteria, once every 3 months and within 3 months after the end of the analyzed period.

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According to Article 118 of SO GL, the following synchronous areas and associated monitors are:

- Swissgrid (south CE), Amprion (north CE),
- Statnett SF-SN (Nordic),
- National Grid ESO - NGESO (Great Britain),
- EirGrid (Ireland and Northern Ireland).

Table 1 Continental Europe SA identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
OST	OST	OST	Albania
APG	APG	APG	Austria
SHB	NOS BIH, HOPS, ELES	ELES	Bosnia and Herzegovina, Croatia, Slovenia
ELIA	ELIA	ELIA	Belgium
ESO	ESO	ESO	Bulgaria
SG	SG	SG	Switzerland
CEPS	CEPS	CEPS	Czech Republic
Germany	TNG+TTG+AMP+50HZT+EN+CREOS	Amprion	Germany, Denmark-West(EN), Luxembourg(CREOS)
REE	REE	REE	Spain
RTE	RTE	RTE	France
IPTO	IPTO	IPTO	Greece
MAVIR	MAVIR	MAVIR	Hungary
TERNA	TERNA	TERNA	Italy
SMM	CGES, MEPSO, EMS	EMS	Montenegro, North Macedonia, Serbia
TTB	TTB	TTB	The Netherlands
PSE	PSE, Western WPS	PSE	Poland
REN	REN	REN	Portugal
TEL	TEL	TEL	Romania
SEPS	SEPS	SEPS	Slovak Republic
TEIAS	TEIAS	TEIAS	Turkey

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Table 2 GB SA identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
GB	NGESO	NGESO	Great Britain

Table 3 IE/NI SA identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
EirGrid+SONI	EirGrid+SONI	EirGrid	Ireland and Northern Ireland

Table 4 Nordic identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
Nordic	NO1, NO2, NO3, NO4, NO5, SE1, SE2, SE3, SE4, DK2, FG	SN	Norway, Sweden, Finland, Denmark-East

Table 5 Baltic identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
Baltic	Baltic	Baltic	Estonia, Latvia, Lithuania

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3. Frequency quality evaluation criteria

A. Introduction and target parameters

For keeping the power system frequency within secure limits, TSOs shall maintain the balance between load and generation on a short-term basis. The first step of balancing actions is application of Frequency Containment Reserves [hereinafter FCR]. These reserves are activated fast (typically within 30s), and they stabilize the power system frequency and make sure that the frequency deviation will not further increase. The Frequency Containment Process [hereinafter FCP] will stabilize the frequency with an offset from 50 Hz, but in reality, it is the change of speed of the rotating masses, inertia, that ensures the frequency change is damped so FCR is able to contain and stabilize the frequency at a value close to 50 Hz. The second step is assigned to Frequency Restoration Reserves [hereinafter FRR] which replace FCR and restore the frequency to the target frequency. SO GL defines two type of FRR: automatic (aFRR) and manual (mFRR). FRR is activated by an automatic control device and/or by manual activation which reduces the Frequency Restoration Control Error [hereinafter FRCE] to zero value. Usually, this control device for aFRR is called Load-Frequency Controller [hereinafter LF-Controller]. The LF-Controller is physically a process computer that is implemented in the TSOs' control center systems (SCADA/EMS/AGC) and collects FRCE measurements every 4-10s and provides - in the same time cycle – automated instructions to balancing service providers that are connected by data communication links. The Frequency Restoration Process [hereinafter FRP], aFRR and/or mFRR, will restore frequency by replacing the power from the FCR. This principle is applicable for normal imbalances like the switching on of a light bulb, the start of a train or the sudden outage of a large power plant. Market behavior like the stop and start of production units at hour shift will also create a power imbalance and result in frequency deviations.

All frequency deviations are recorded carefully for further analyses. SO GL defines processes for the calculation and the evaluation of frequency data and the required parameters for each synchronous area and each LFC block (defined in SO GL in Articles 127 – 131, and in Annex III-V) are presented below in Tables 6 and 7 below.

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Table 6 Frequency quality defining parameters of synchronous areas

Data item	CE	GB	IE/NI	Nordic
Standard frequency range	± 50 mHz	± 200 mHz	± 200 mHz	± 100 mHz
Maximum instantaneous frequency deviation	800 mHz	800 mHz	1000 mHz	1000 mHz
Maximum steady-state frequency deviation	200 mHz	500 mHz	500 mHz	500 mHz
Time to recover frequency	Not used	1 minute	1 minute	Not used
Frequency recovery range	Not used	± 500 mHz	± 500 mHz	Not used
Time to restore frequency	15 minutes	15 minutes	15 minutes	15 minutes
Frequency restoration range	Not used	± 200 mHz	± 200 mHz	± 100 mHz
Alert state trigger time	5 minutes	10 minutes	10 minutes	5 minutes

Table 7 Frequency quality target parameters of synchronous areas

Data item	CE	GB	IE/NI	Nordic
Maximum number of minutes outside the standard frequency range	15 000	15 000	15 000	15 000

Taking into account above mentioned for each synchronous area during operation in normal state or alert state, on a monthly basis, for the instantaneous frequency data following values are reported:

(i) the mean value;

(ii) the standard deviation;

(iii) the 1-,5-,10-, 90-,95- and 99-percentile;

(iv) the total time in which the absolute value of the instantaneous frequency deviation was larger than the standard frequency deviation, distinguishing between negative and positive instantaneous frequency deviations;

(v) the total time in which the absolute value of the instantaneous frequency deviation was larger than the maximum instantaneous frequency deviation, distinguishing between negative and positive instantaneous frequency deviations;

(vi) the number of events in which the absolute value of the instantaneous frequency deviation of the synchronous area exceeded 200 % of the standard frequency deviation and the instantaneous frequency deviation was not returned to 50 % of the standard frequency deviation for the CE synchronous area and to the frequency restoration range for the GB, IE/NI and Nordic synchronous areas, within the time to restore frequency. The data are distinguished between negative and positive frequency deviations;

(vii) for the GB and IE/NI synchronous areas, the number of events for which the absolute value of the instantaneous frequency deviation was outside of the frequency recovery range and was not returned to the frequency recovery range within the time to recover frequency, distinguishing between negative and positive frequency deviations;

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For LFC blocks from CE and Nordic following data are reported:

(i) for a data-set containing the average values of the FRCE of the LFC block over time intervals equal to the time to restore frequency:

— the mean value,

— the standard deviation,

— the 1-,5-,10-, 90-,95- and 99-percentile,

— the number of time intervals in which the average value of the FRCE was outside the Level 1 FRCE range, distinguishing between negative and positive FRCE, and — the number of time intervals in which the average value of the FRCE was outside the Level 2 FRCE range, distinguishing between negative and positive FRCE;

(ii) for a data-set containing the average values of the FRCE of the LFC block over time intervals with a length of one minute: the number of events on a monthly basis for which the FRCE exceeded 60 % of the reserve capacity on FRR and was not returned to 15 % of the reserve capacity on FRR within the time to restore frequency, distinguishing between negative and positive FRCE (the calculation procedures of these target parameters are set in both the Nordic and the Continental Europe Synchronous Area Operational Agreements). The objective behind the Level 1 and Level 2 parameters is to provide quality targets for the individual FRCE quality of each LFC block. Since it is the responsibility of each TSO in its LFC block to keep FRCE as low as possible, the level 1 and level 2 parameters must not be exploited in order to reduce reserves or reserves activation. These parameters should rather be interpreted as an absolute warning limit that shows that quality of ACE is below the required standard and that respective countermeasures have been reported and will be implemented urgently.

For the LFC blocks of the GB and IE/NI synchronous area, during operation in normal state or alert state in accordance with Article 18(1) and (2), following data are presented; on a monthly basis and for a data-set containing the average values of the FRCE of the LFC block over time intervals with a length of one minute: the number of events for which the absolute value of the FRCE exceeded the maximum steady-state frequency deviation and the FRCE was not returned to 10 % of the maximum steady-state frequency deviation within the time to restore frequency, distinguishing between negative and positive FRCE.

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B. Performance – IE/NI

a. Ireland/Northern Ireland Synchronous Area Performance

In the following tables and figures data for 2018 and 2019 for the IE/NI synchronous area are presented. Input values for frequency are based on an instantaneous frequency values. Based on input values; mean value, standard deviation and percentiles were calculated. Moreover, time periods and events when system frequency was outside of predefined ranges were also notified. For data points when frequency was outside 200 and 1000 mHz range time is measured in minutes time scale.

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Table 8 IE/NI SA Performance for Year 2018

2018													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.0003	50.0004	49.9995	50.0005	49.9997	50.0005	50.0002	49.9998	50.0007	49.9996	50.0001	50.0003	50.00013
The standard deviation	0.0396	0.0411	0.0351	0.037	0.0354	0.0346	0.0355	0.0388	0.0402	0.0423	0.0422	0.0419	0.0386
1-percentile	49.916	49.907	49.924	49.918	49.92	49.919	49.921	49.914	49.911	49.91	49.91	49.909	49.915
5-percentile	49.938	49.933	49.943	49.941	49.943	49.943	49.941	49.937	49.936	49.933	49.934	49.935	49.938
10-percentile	49.95	49.947	49.955	49.953	49.955	49.956	49.953	49.95	49.949	49.947	49.947	49.948	49.951
90-percentile	50.051	50.052	50.045	50.049	50.044	50.044	50.045	50.05	50.052	50.056	50.056	50.055	50.05
95-percentile	50.066	50.066	50.057	50.062	50.057	50.055	50.055	50.063	50.066	50.071	50.071	50.07	50.063
99-percentile	50.093	50.093	50.081	50.086	50.083	50.077	50.077	50.088	50.091	50.096	50.097	50.097	50.088
Time > 200 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -200 mHz	3	0	0	0	0	0	0	2	1	0	3	5	14
Time > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 400 and > 200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev <-400 and < -200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev < -500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 9 IE/NI SA Performance for Year 2019

	2019												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99996	49.9998	50.0002	50.00002	50.0002	49.9999	50.0004	49.9999	50.0003	49.9998	50.0001	49.99998	50.00005
The standard deviation	0.0417	0.0417	0.0401	0.0377	0.0344	0.0348	0.0332	0.0379	0.0406	0.0395	0.0399	0.038	0.0383
1-percentile	49.907	49.909	49.912	49.914	49.923	49.922	49.924	49.918	49.913	49.918	49.911	49.917	49.916
5-percentile	49.934	49.933	49.936	49.939	49.947	49.945	49.946	49.94	49.936	49.938	49.935	49.94	49.939
10-percentile	49.948	49.946	49.95	49.952	49.957	49.956	49.958	49.952	49.949	49.95	49.949	49.953	49.952
90-percentile	50.053	50.053	50.052	50.047	50.042	50.043	50.042	50.048	50.053	50.051	50.051	50.049	50.049
95-percentile	50.07	50.068	50.067	50.062	50.055	50.056	50.054	50.063	50.067	50.066	50.064	50.064	50.063
99-percentile	50.098	50.093	50.094	50.088	50.082	50.08	50.076	50.089	50.09	50.091	50.087	50.089	50.088
Time > 200 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -200 mHz	4	0	4	0	12	2	3	1	0	8	0	0	35
Time > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 400 and > 200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev <-400 and < -200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev < -500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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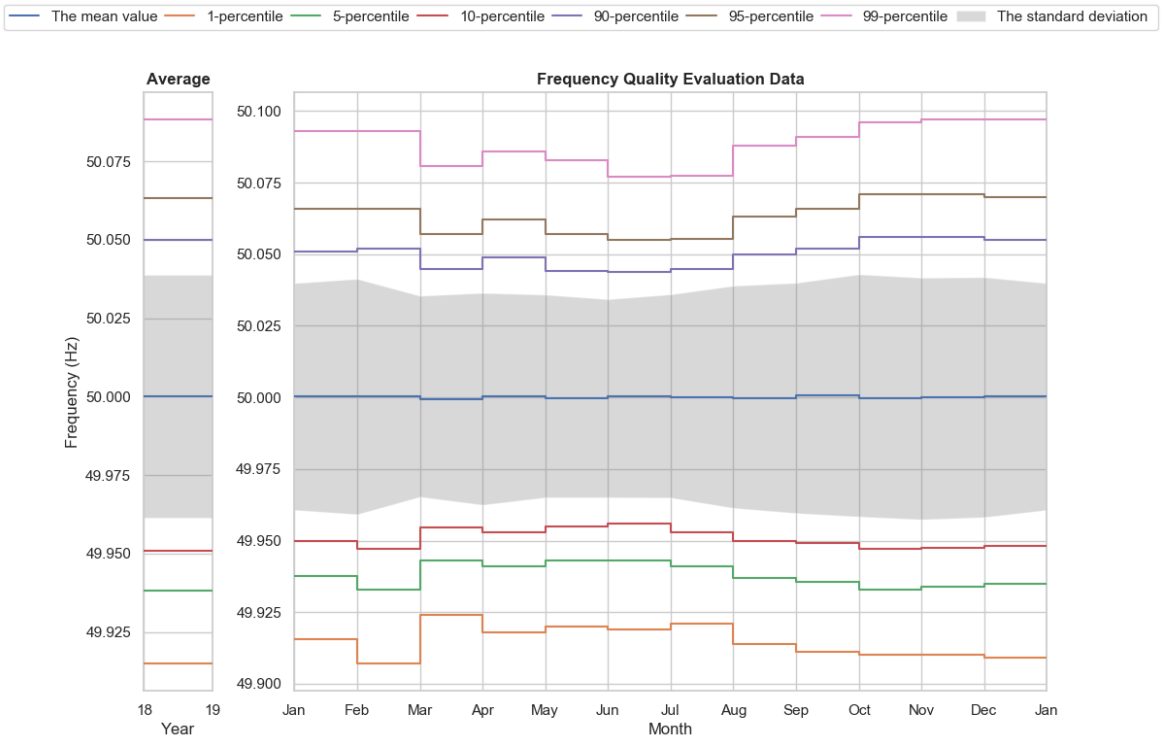

Figure 2 IE-NI SA 2018 frequency quality

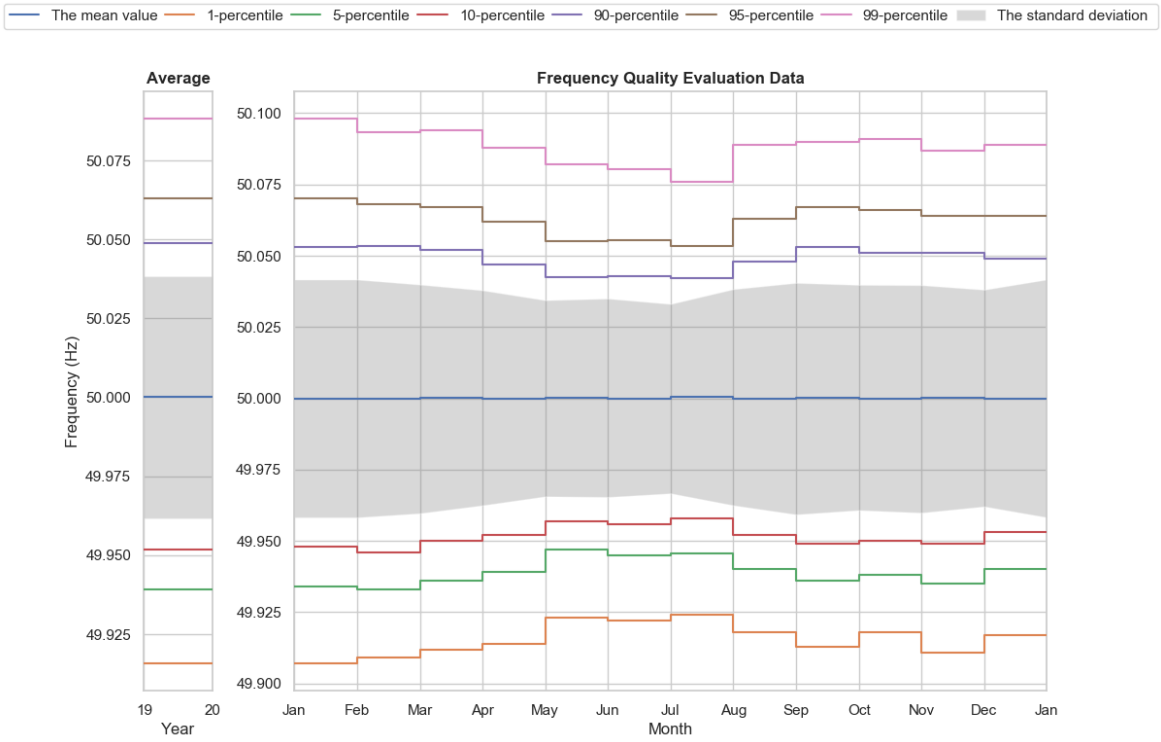

Figure 3 IE-NI SA 2019 frequency quality

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In Figures 4 and 5 accumulated minutes outside standard ranges are presented for the Years 2018 and 2019 respectively.

The red line shows the theoretical line in case of linear distribution (1/12 per month) of minutes outside standard range taking into account standard range from SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. In case that black line is higher than the red line at the end of the year this indicates that the synchronous area did not meet the required Frequency quality parameters.

The graphs in Figures 4 and 5 below show that the Frequency quality target parameters from SO GL were fulfilled for the respective years for the Synchronous Area Ireland/Northern Ireland.

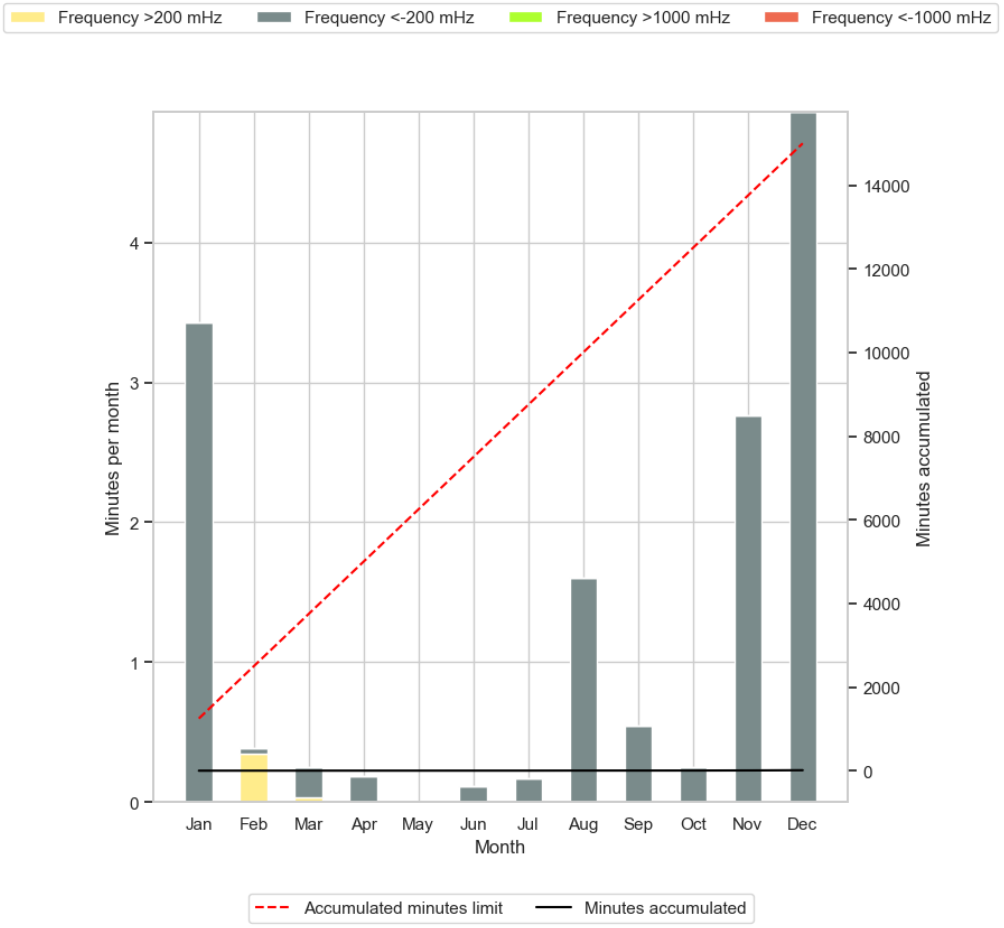

Figure 4 IE-NI SA 2018 frequency deviation

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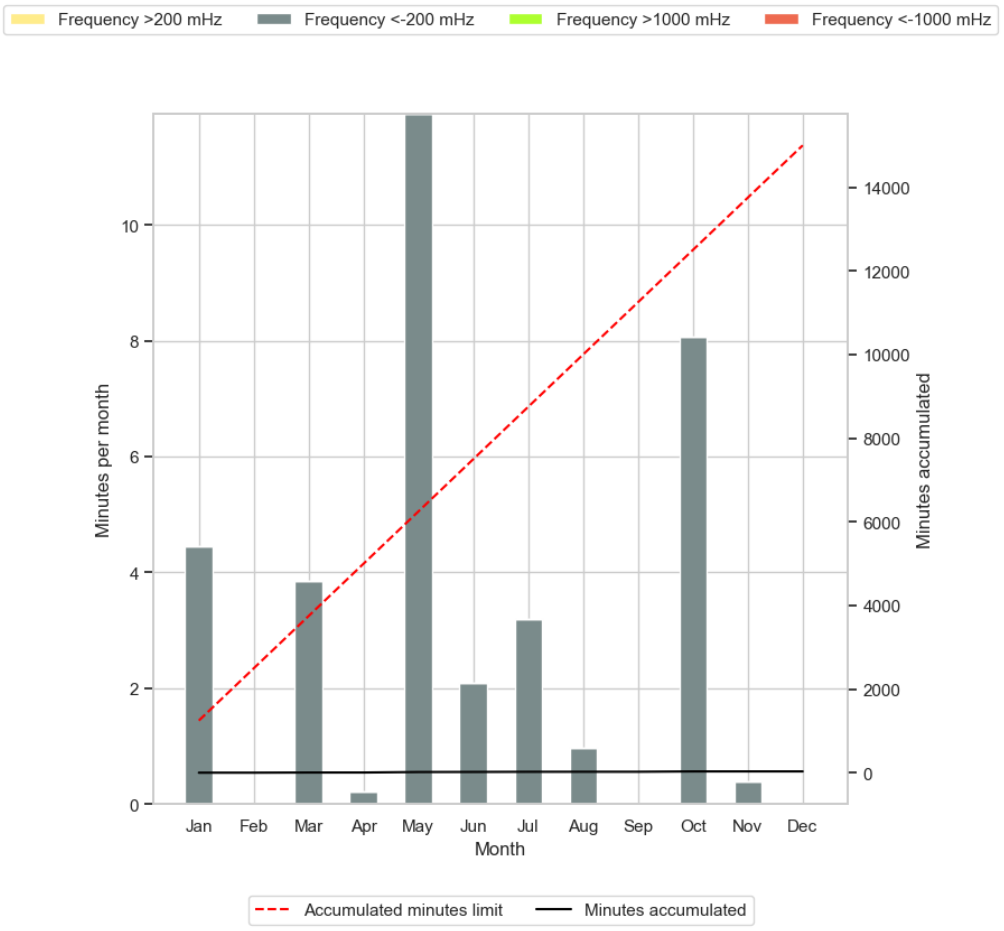

Figure 5 IE-NI SA 2019 frequency deviation

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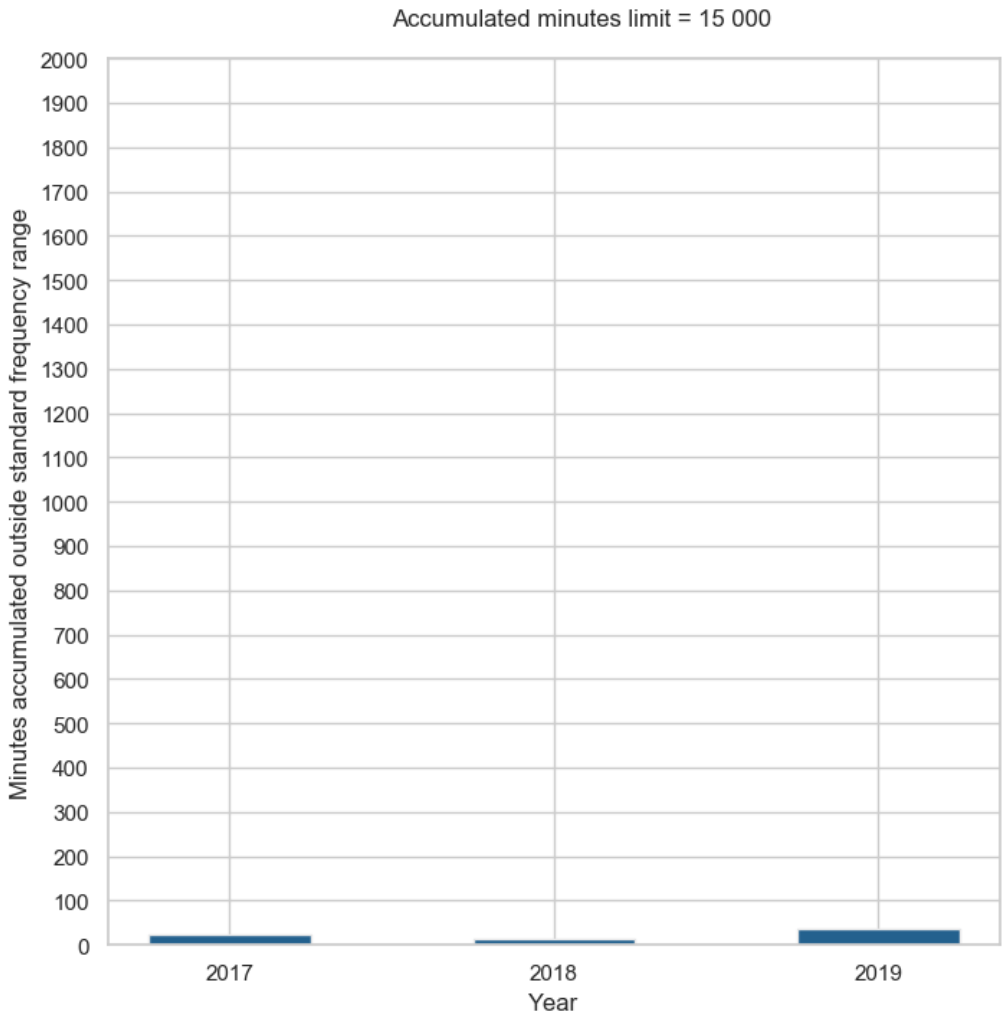

Figure 5a IE-NI SA frequency deviation trend

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b. IE/NI Synchronous Area LFC Block Performance

Tables 10 and 11 show that there were not events when FRCE values were higher than 500 mHz or lower than -500 mHz and FRCE values were not returned to 50 mHz, or -50 mHz, respectively during time to restore frequency which corresponds to 15 minutes.

Table 10 IE/NI LFC FRCE Statistic for Year 2018

2018												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of events: FRCE > 500 mHz and > 50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0
No. of events: FRCE < -500 mHz and < -50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0

Table 11 IE/NI LFC FRCE Statistic for Year 2019

2019												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of events: FRCE > 500 mHz and > 50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0
No. of events: FRCE < -500 mHz and < -50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0

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Additionally, the synchronous areas of GB and IE/NI are each required to report the number of time intervals outside Level 1 and Level 2 FRCE ranges over the course of one year which is presented in Table 12. The time intervals are aligned with SO GL, Annex III, Table 1. The number of time intervals are calculated using the following procedure:

1. Where frequency deviation is ≥ 200 mHz over a 15 minutes period or ≤ - 200 mHz over a 15 minutes period; this qualifies as a Level 1 event.

2. Where frequency deviation is ≥ 500 mHz over a 1 minute period or ≤ - 500 mHz over a 1 minute period; this qualifies as a Level 2 event.

3. The Level 1 FRCE target parameter = 3%, which is 35 040 (periods) x 0.03 = 1 051 periods.

4. The Level 2 FRCE target parameter = 1%, which is 525 600 (periods) x 0.01 = 5 256 periods.

5. The number of Level 1 periods calculated in step 1 must be less than or equal to 1 051.

6. The number of Level 2 periods calculated in step 3 must be less than or equal to 5 256.

Table 12 IE/NI LFC Number of Time Intervals Outside Range for Years 2018 and 2019

Data item	2018	2019
Number of time intervals frequency deviates outside +/- 200 mHz	0	0
Number of time intervals frequency deviates outside +/- 500 mHz	0	0

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C. Performance – GB

a. Great Britain Synchronous Area Performance

In the following tables and figures data for 2018 and 2019 for the Great Britain synchronous area are presented. Input values for frequency are based on an instantaneous frequency values. Based on input values; mean value, standard deviation and percentiles were calculated. Moreover, time periods and events when system frequency was outside of predefined ranges were also notified. For data points when frequency was outside 200 mHz and 800 mHz range, time is measured in minutes time scale.

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Table 13 GB SA Performance for Year 2018

2018													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99828	49.99904	49.99841	50.00067	49.99877	50.00058	49.99939	49.99989	49.99936	50.00064	49.99939	50.00008	49.99954
The standard deviation	0.0631	0.0666	0.0666	0.0655	0.0611	0.0651	0.0662	0.0666	0.0685	0.0692	0.0701	0.0655	0.0662
1-percentile	49.867	49.86	49.86	49.862	49.875	49.87	49.86	49.86	49.855	49.852	49.85	49.86	49.861
5-percentile	49.9	49.897	49.897	49.9	49.907	49.902	49.897	49.895	49.892	49.89	49.887	49.895	49.897
10-percentile	49.92	49.917	49.917	49.92	49.925	49.92	49.917	49.915	49.912	49.912	49.91	49.915	49.917
90-percentile	50.082	50.09	50.087	50.087	50.082	50.087	50.087	50.085	50.09	50.09	50.092	50.085	50.087
95-percentile	50.105	50.112	50.112	50.11	50.105	50.11	50.11	50.107	50.112	50.112	50.115	50.105	50.11
99-percentile	50.145	50.155	50.157	50.152	50.145	50.152	50.15	50.15	50.155	50.152	50.152	50.145	50.151
Time > 200 mHz	29	47	62	37	17	25	28	32	34	35	45	26	417
Time < -200 mHz	6	11	6	5	5	7	14	12	9	19	22	14	129
Time > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 400 and > 200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev <-400 and < -200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev < -500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 14 GB SA Performance for Year 2019

2019													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99946	49.99995	49.99917	49.99955	49.99953	49.99935	49.99951	49.99975	49.99952	49.99929	49.99975	49.9994	49.99952
The standard deviation	0.0671	0.0675	0.0648	0.0632	0.0622	0.0657	0.0631	0.061	0.0631	0.0628	0.0633	0.0657	0.0641
1-percentile	49.855	49.859	49.862	49.864	49.865	49.859	49.863	49.868	49.865	49.864	49.864	49.86	49.862
5-percentile	49.895	49.895	49.898	49.899	49.901	49.895	49.899	49.903	49.899	49.9	49.9	49.895	49.898
10-percentile	49.915	49.914	49.917	49.918	49.92	49.915	49.918	49.921	49.918	49.91	49.919	49.915	49.917
90-percentile	50.087	50.088	50.084	50.081	50.08	50.084	50.081	50.078	50.081	50.08	50.081	50.085	50.082
95-percentile	50.11	50.11	50.105	50.101	50.099	50.105	50.101	50.098	50.102	50.101	50.103	50.105	50.103
99-percentile	50.147	50.152	50.145	50.138	50.134	50.145	50.137	50.134	50.142	50.143	50.142	50.144	50.142
Time > 200 mHz	30	43	22	11	11	24	13	17	15	25	23	31	266
Time < -200 mHz	24	6	15	11	13	23	26	22	9	21	17	20	209
Time > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -800 mHz	0	0	0	0	0	0	0	2	0	0	0	0	2
No. of events freq. dev > 400 and > 200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev <-400 and < -200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev > 500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. dev < -500 mHz and > 1 min	0	0	0	0	0	0	0	1	0	0	0	0	1

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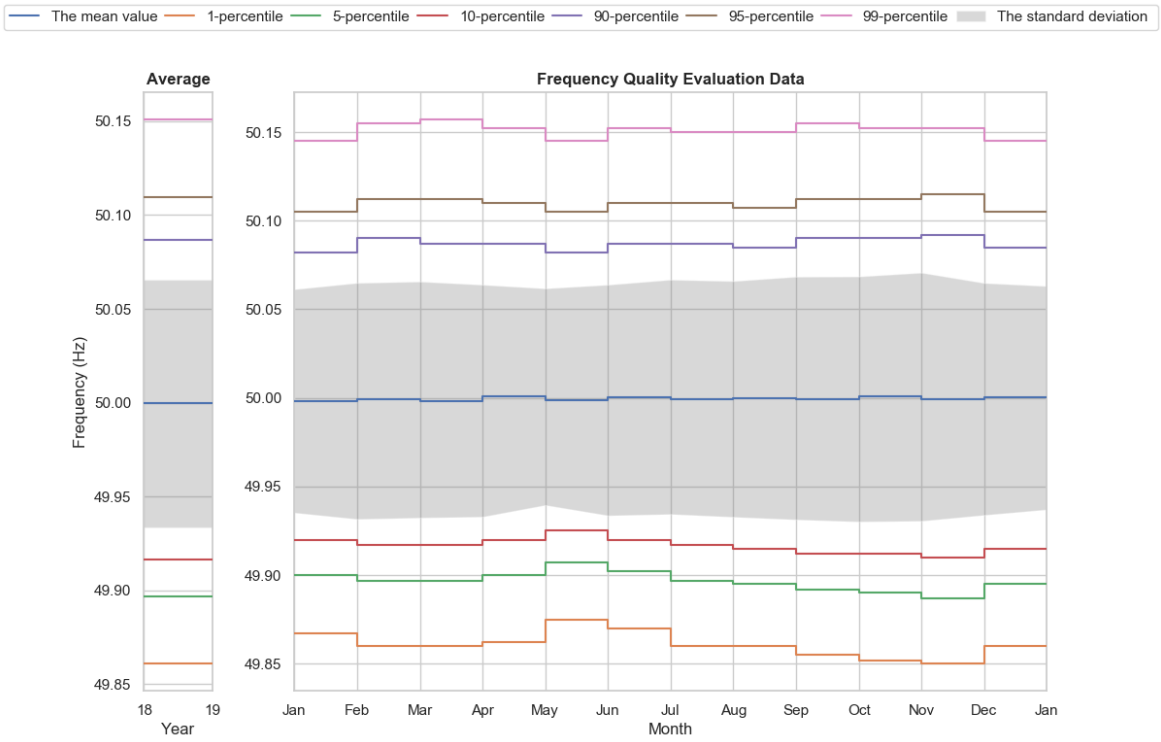

Figure 6 GB SA 2018 frequency quality

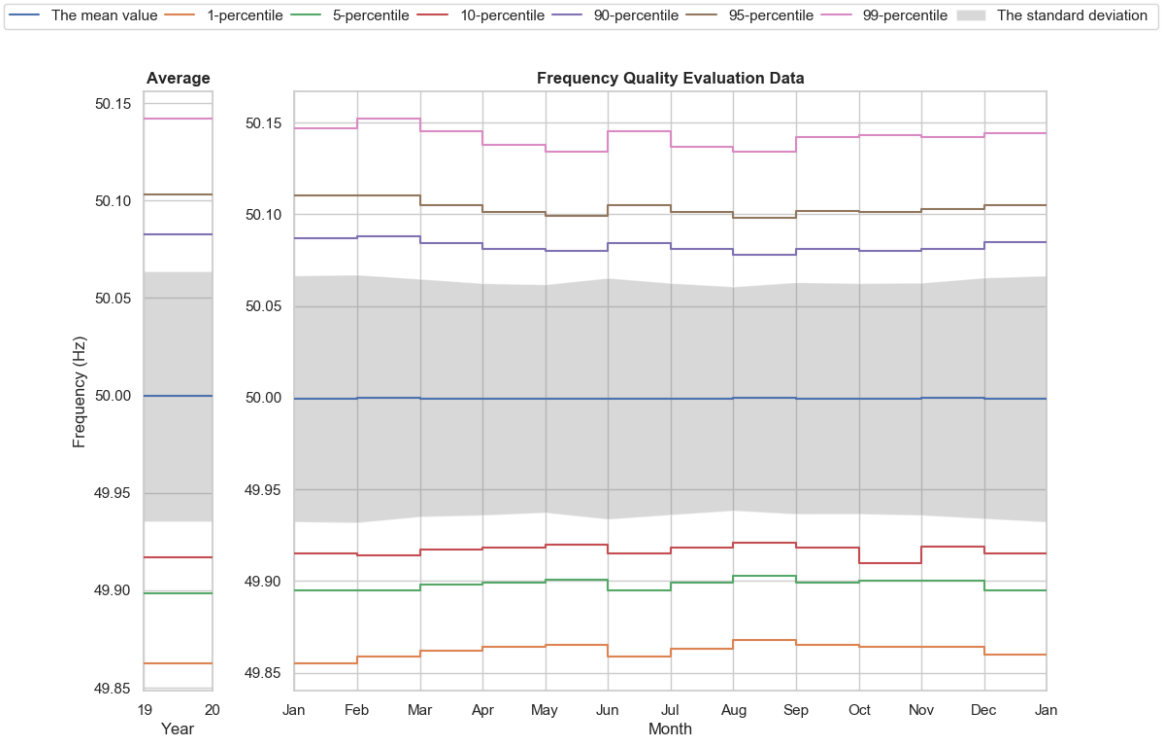

Figure 7 GB SA 2019 frequency quality

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In Figures 8 and 9 accumulated minutes outside standard ranges are presented for the years 2018 and 2019 respectively.

The red line shows the theoretical line in case of linear distribution (1/12 per month) of minutes outside standard range taking into account standard range from SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. In case that black line is higher than the red line at the end of the year this indicates that the synchronous area did not meet Frequency quality parameters.

The graphs in Figures 8 and 9 below show that the Frequency quality target parameters from SOGL were fulfilled for respective years for the Synchronous Area Great Britain.

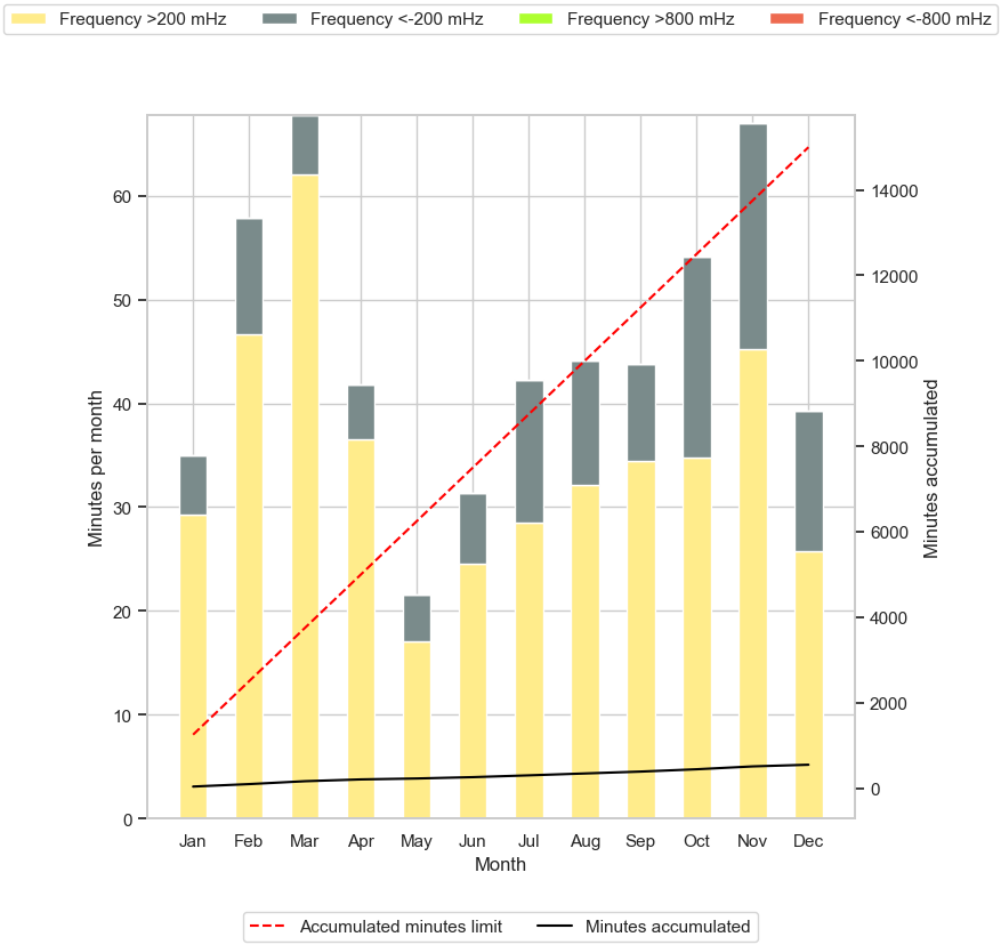

Figure 8 GB SA 2018 frequency deviation

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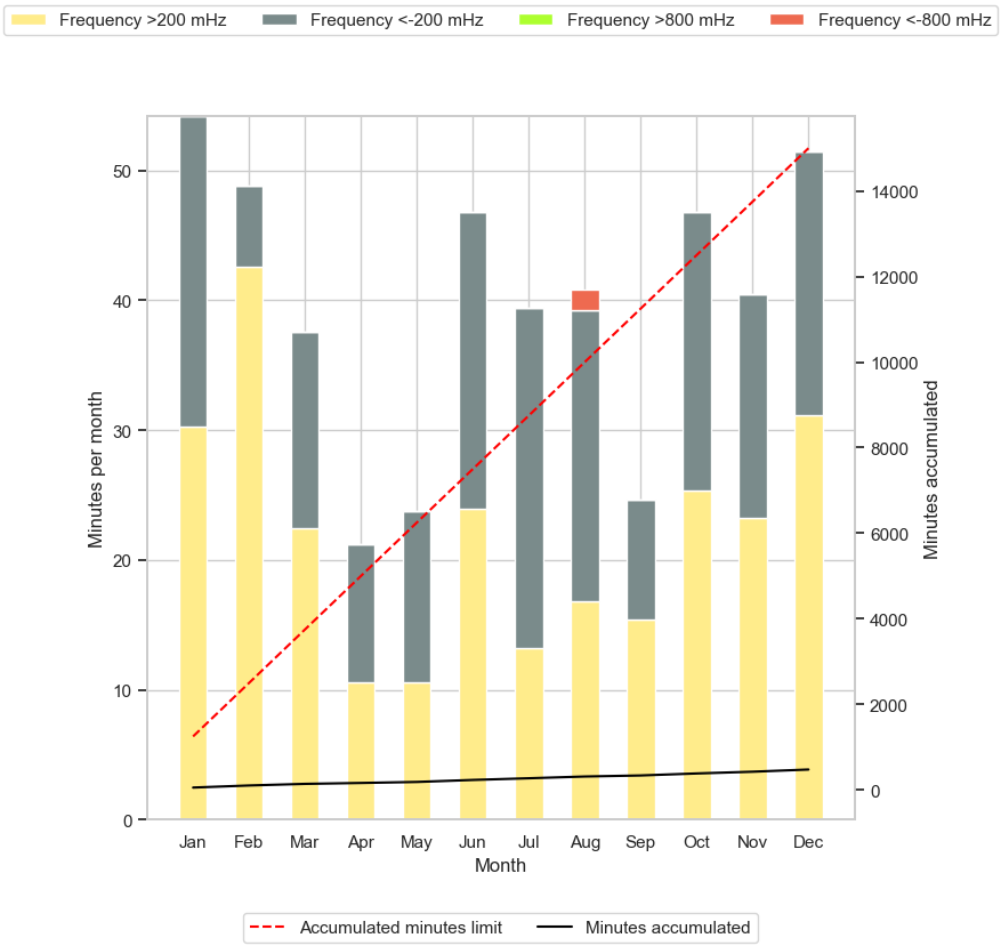

Figure 9 GB SA 2019 frequency deviation

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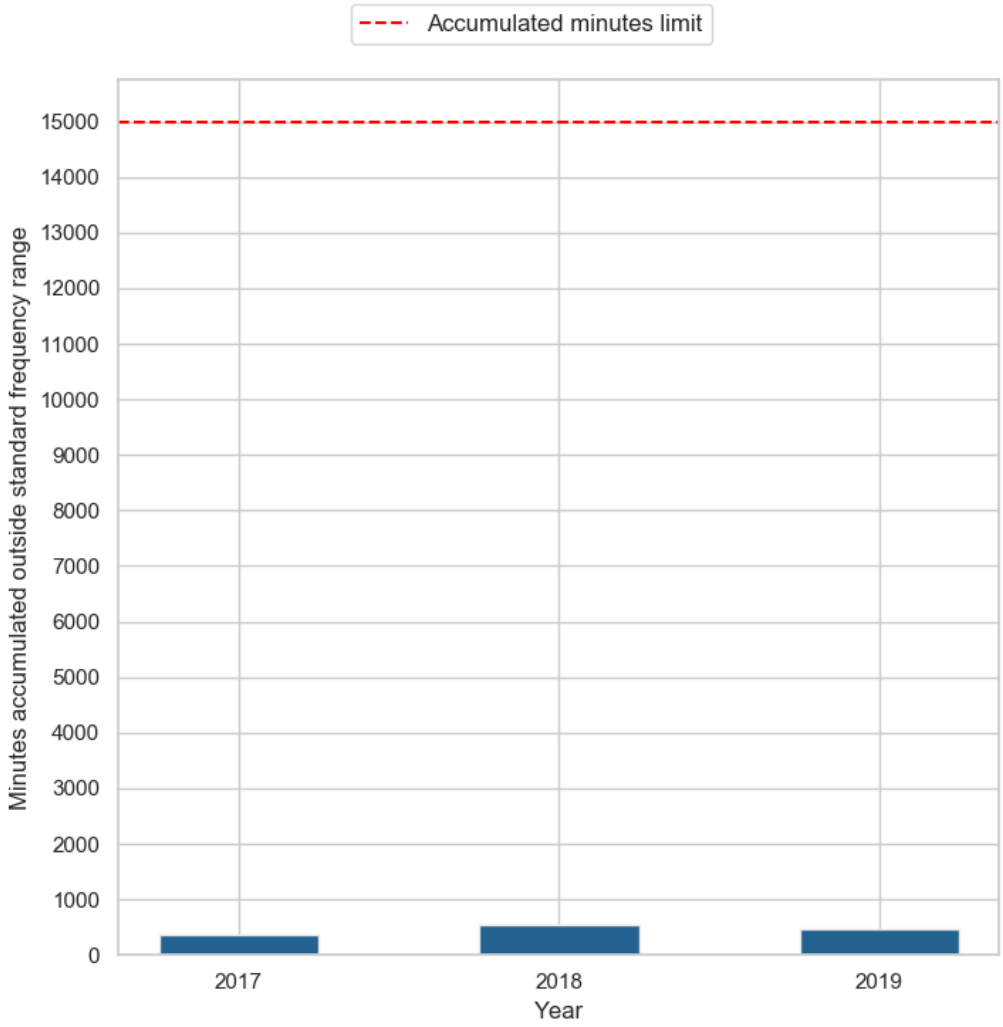

Figure 9a GB SA frequency deviation trend

In the GB synchronous area, there was one frequency deviation greater than 800 mHz event that occurred on the 9 August 2019. A lightning strike caused 400 kV circuit trip with coincidental generation loss. The event resulted in cumulative generation loss of 1878MW and system frequency dropped to 48.8 Hz. System frequency was restored to 50 Hz within 5 minutes.

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b. GB Synchronous Area LFC Block Performance

Tables 15 and 16 show that there were no events when FRCE values were higher than 500 mHz or lower than -500 mHz and FRCE values were not returned to 50 mHz, or -50 mHz, respectively during time to restore frequency which corresponds to 15 minutes.

Table 15 GB LFC FRCE Statistic for Year 2018

2018												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of events: FRCE > 500 mHz and < 50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0
No. of events: FRCE < -500 mHz and < -50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0

Table 16 GB LFC FRCE Statistic for Year 2019

2019												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of events: FRCE > 500 mHz and < 50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0
No. of events: FRCE < -500 mHz and < -50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0

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Additionally, the synchronous areas of GB and IE/NI are required to report the number of time intervals outside Level 1 and Level 2 FRCE ranges over the course of one year, GB values are presented in Table 17. The time intervals are aligned with SO GL, Annex III, Table 1. The number of time intervals is calculated using the following procedure:

1. Where the frequency deviation is ≥ 200 mHz over a 15 minutes period or ≤ - 200 mHz over a 15 minutes period; this qualifies as a Level 1 event.

2. Where the frequency deviation is ≥ 500 mHz over a 1 minute period or ≤ - 500 mHz over a 1 minute period; this qualifies as a Level 2 event.

3. The Level 1 FRCE target parameter = 3%, which is 35 040 (periods) x 0.03 = 1 051 periods.

4. The Level 2 FRCE target parameter = 1%, which is 525 600 (periods) x 0.01 = 5 256 periods.

Table 17 GB LFC Number of Time Intervals Outside Range for Years 2018 and 2019

Data item	2018	2019
FRCE Level 1 Number of time intervals frequency deviates outside +/- 200 mHz	0	0
FRCE Level 2 Number of time intervals frequency deviates outside +/- 500 mHz	0	2

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D. Performance – Nordic

a. Nordic Synchronous Area Performance

In the following tables and figures data for 2018 and 2019 for the Nordic synchronous area are presented. Input values for frequency are based on an instantaneous frequency values. Based on input values; mean value, standard deviation and percentiles were calculated. Moreover, time periods and events when system frequency was outside of predefined ranges were also notified. For data points when frequency was outside 100 and 1000 mHz range time is measured in minutes time scale.

Table 18 Nordic SA Block Performance for Year 2018

2018													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00006	49.99955	49.99909	49.99955	49.99936	49.99863	49.99967	49.99946	49.99994	49.99904	49.99985	50.00041	49.99955
The standard deviation	0.0386	0.0384	0.0397	0.0398	0.0411	0.0389	0.0385	0.0402	0.0415	0.0429	0.0412	0.0415	0.0402
1-percentile	49.909	49.912	49.907	49.905	49.901	49.911	49.911	49.906	49.903	49.899	49.908	49.904	49.906
5-percentile	49.938	49.936	49.935	49.935	49.932	49.936	49.937	49.934	49.933	49.928	49.933	49.934	49.934
10-percentile	49.952	49.95	49.949	49.95	49.947	49.95	49.951	49.949	49.948	49.944	49.948	49.948	49.949
90-percentile	50.051	50.049	50.05	50.05	50.051	50.048	50.048	50.05	50.052	50.054	50.053	50.055	50.051
95-percentile	50.065	50.063	50.064	50.066	50.066	50.063	50.062	50.066	50.068	50.07	50.068	50.069	50.066
99-percentile	50.092	50.088	50.094	50.095	50.097	50.093	50.093	50.096	50.097	50.099	50.098	50.097	50.095
Time > 100 mHz	400	241	474	483	571	474	520	553	541	630	591	546	6023
Time < -100 mHz	411	305	481	508	684	342	363	485	595	763	400	608	5945
Time > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. deviation > 200 mHz and > 100 mHz within 15 minutes	0	0	0	1	1	1	2	0	0	0	1	0	6
No. of events freq. deviation < -200 mHz and < -100 mHz within 15 minutes	0	0	0	0	0	0	0	0	2	0	0	1	3

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Table 19 Nordic SA Block Performance for Year 2019

2019													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00012	49.99993	50.00041	50.00022	49.99995	49.99995	50.0003	50.0005	50	50.00022	50.00019	49.99977	50.00013
The standard deviation	0.0432	0.047	0.0465	0.0458	0.0468	0.0477	0.0415	0.0434	0.0434	0.0445	0.042	0.0445	0.0447
1-percentile	49.901	49.895	49.893	49.897	49.888	49.888	49.905	49.9	49.896	49.895	49.902	49.895	49.896
5-percentile	49.93	49.925	49.925	49.927	49.923	49.922	49.933	49.93	49.929	49.927	49.932	49.927	49.928
10-percentile	49.945	49.94	49.941	49.943	49.94	49.939	49.947	49.946	49.945	49.944	49.947	49.944	49.943
90-percentile	50.056	50.061	50.06	50.059	50.059	50.06	50.053	50.056	50.055	50.056	50.054	50.056	50.057
95-percentile	50.071	50.077	50.076	50.077	50.075	50.077	50.069	50.072	50.07	50.073	50.07	50.073	50.073
99-percentile	50.101	50.109	50.107	50.111	50.107	50.111	50.099	50.105	50.103	50.106	50.102	50.108	50.106
Time > 100 mHz	470	625	624	699	618	708	398	559	482	594	462	624	6862
Time < -100 mHz	404	506	613	489	768	750	323	436	515	557	377	573	6310
Time > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. deviation > 200 mHz and > 100 mHz within 15 minutes	0	2	0	1	0	1	0	0	0	1	0	1	6
No. of events freq. deviation < -200 mHz and < -100 mHz within 15 minutes	0	0	0	0	1	1	0	0	0	0	0	0	2

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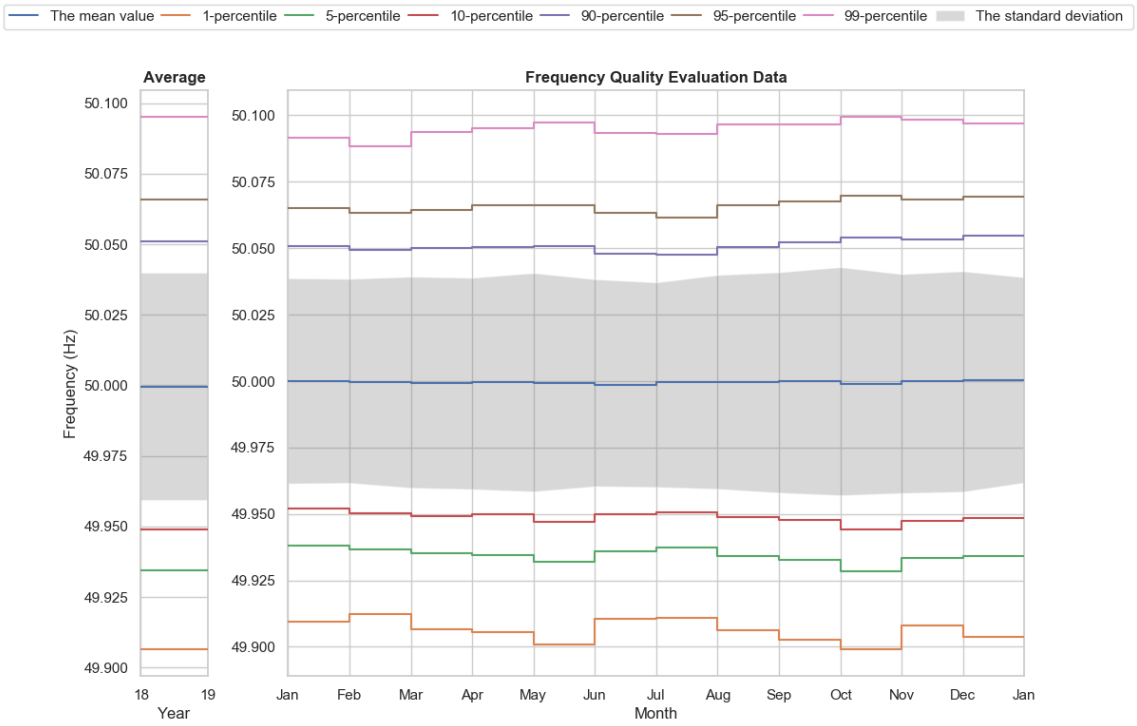

Figure 10 Nordic SA 2018 frequency quality

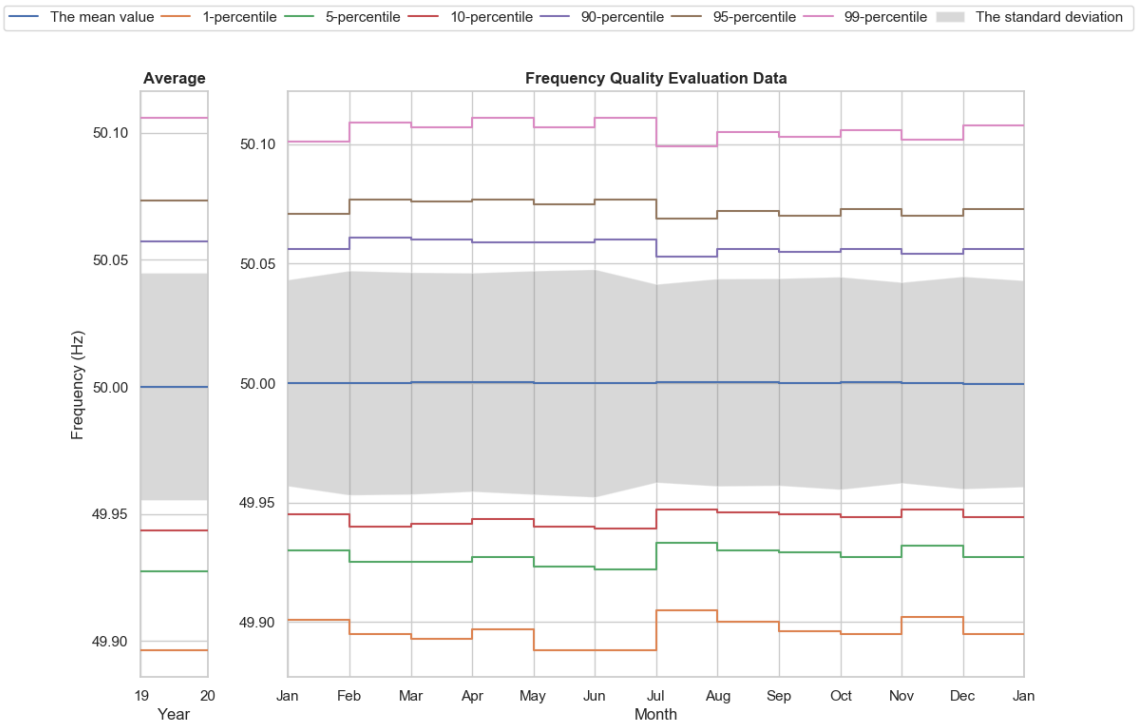

Figure 11 Nordic SA 2019 frequency quality

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In Figures 12 and 13 accumulated minutes outside standard ranges are presented for the Years 2018 and 2019.

The red line shows the theoretical line in case of linear distribution (1/12 per month) of minutes outside standard range taking into account standard range from SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. In case that black line is higher than the red line at the end of the year this indicates that the synchronous area did not meet the required Frequency quality parameters.

The graphs in Figures 12 and 13 below show that the Frequency quality target parameters from SO GL were fulfilled for the respective years for the Nordic Synchronous Area.

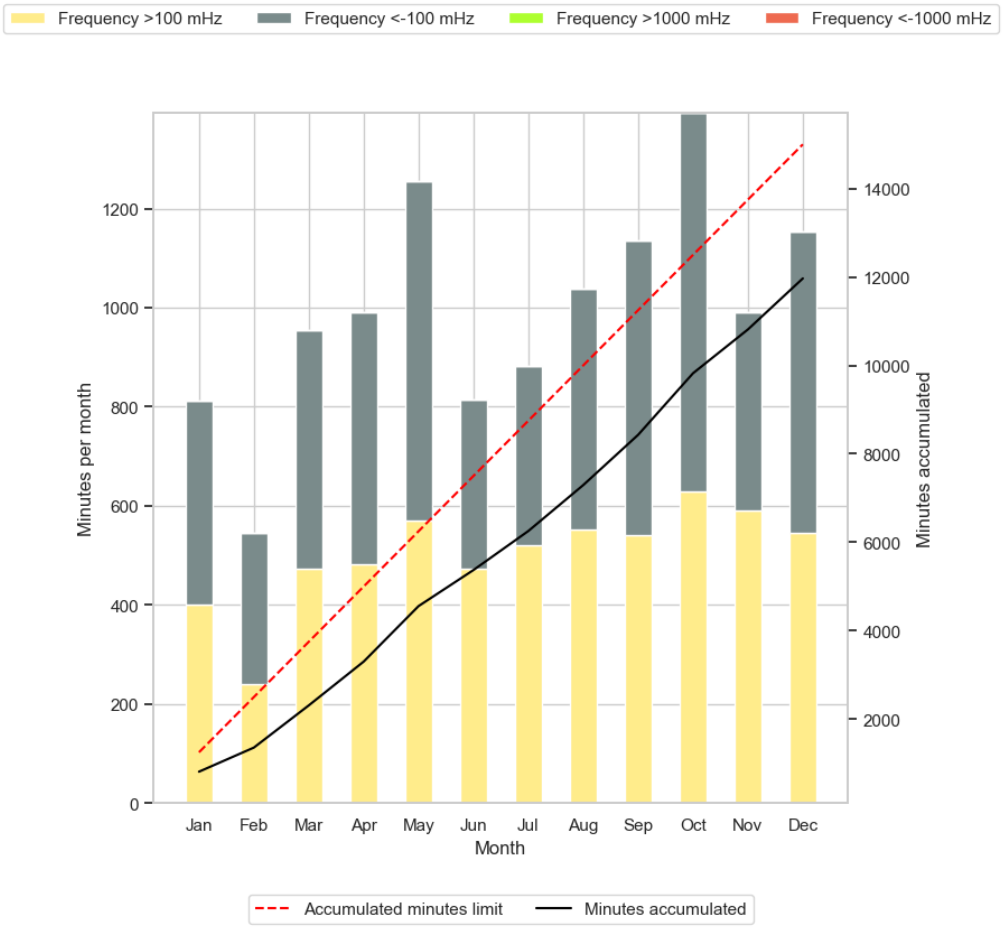

Figure 12 Nordic SA 2018 frequency deviation

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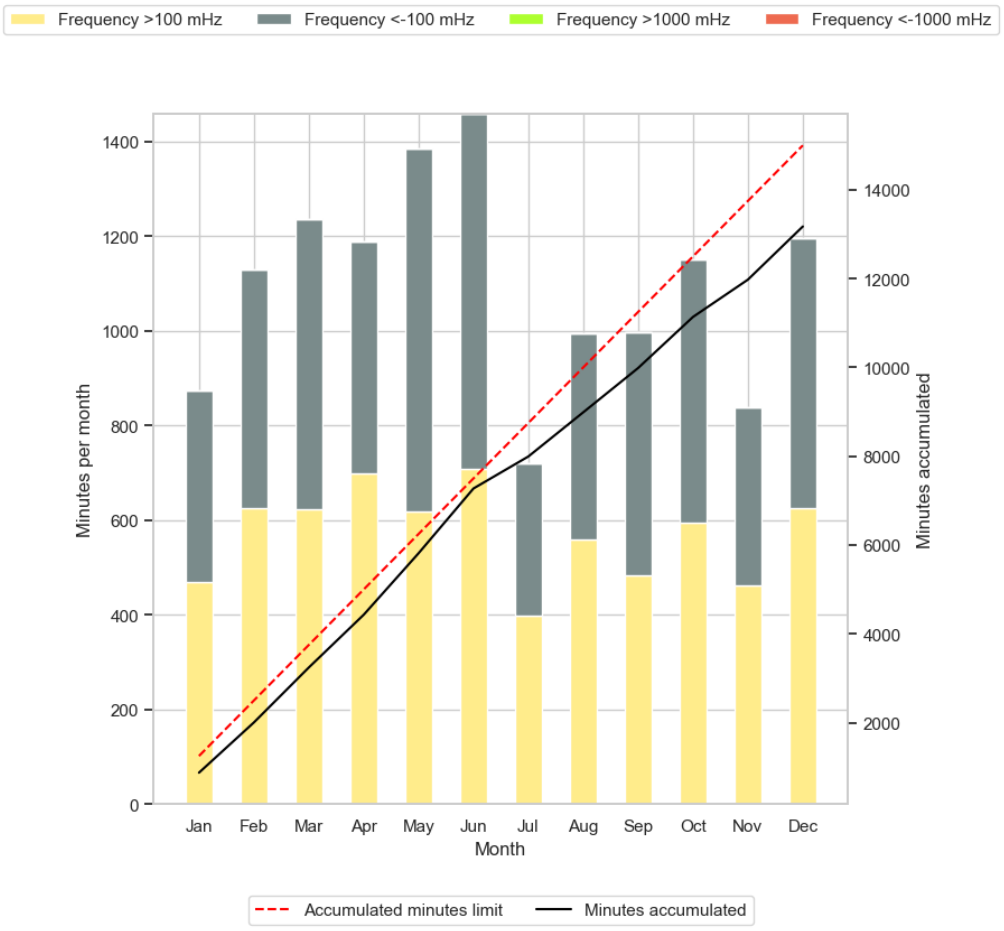

Figure 13 Nordic SA 2019 frequency deviation

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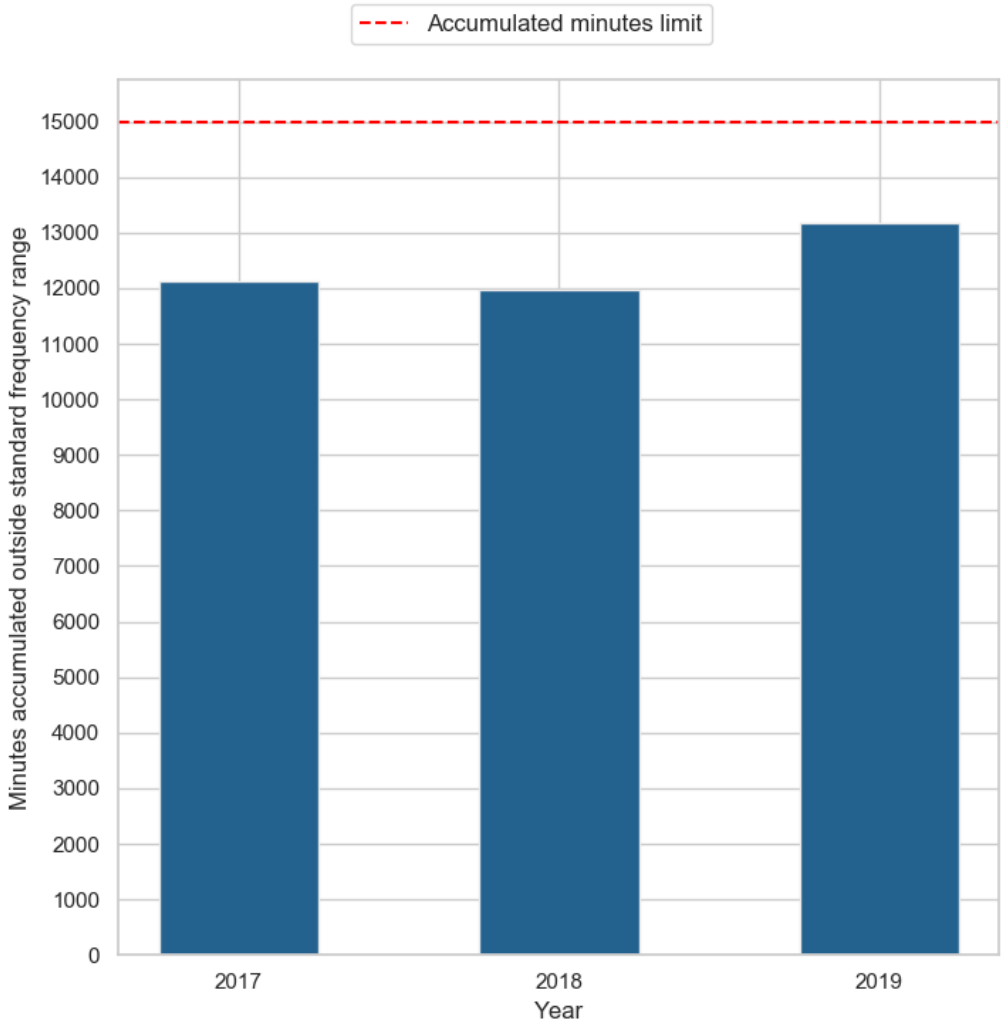

Figure 13a Nordic SA frequency deviation trend

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b. Nordic Synchronous Area LFC Block Performance

In the following table Nordic LFC block performance is presented. Level 1 and Level 2 limits are calculated according to the Methodology defined in Synchronous Area Framework Agreement. The level 1 and level 2 Frequency Restoration Control Error Target Parameters for the Nordic LFC block are presented in Table 20.

Table 20 Level 1 FRCE range and the level 2 FRCE range for the Nordic Area and targets for the number of 15 minutes time intervals per year outside the level 1 and level 2 FRCE range

FRCE target parameters	Level 1	Level 2
FRCE range	40 mHz	76 mHz
Target for the maximum number of 15 minutes time intervals per year outside the level 1 and level 2 FRCE range	30 %	5%

The methodology for calculation of these target parameters is as defined in the Nordic Synchronous Area Operational Agreement. FRCE values are calculated on a basis of 15 minutes frequency data. The percentages in Table 20 refer to 30% or 5% of the time intervals of the year. Additionally, events which indicate where FRCE exceeds 60 % of FRR used and not returned to 15 % of FRR during 15 minutes time period are reported.

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Table 21 Nordic LFC Block Performance

2018												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The mean value	50.00006	49.99955	49.99909	49.99955	49.99936	49.99863	49.99967	49.99946	49.99994	49.99904	49.99985	50.00041
The standard deviation	0.0386	0.0384	0.0397	0.0398	0.0411	0.0389	0.0385	0.0402	0.0415	0.0429	0.0412	0.0415
1-percentile	49.909	49.912	49.907	49.905	49.901	49.911	49.911	49.906	49.903	49.899	49.908	49.904
5-percentile	49.938	49.936	49.935	49.935	49.932	49.936	49.937	49.934	49.933	49.928	49.933	49.934
10-percentile	49.952	49.95	49.949	49.95	49.947	49.95	49.951	49.949	49.948	49.944	49.948	49.948
90-percentile	50.051	50.049	50.05	50.05	50.051	50.048	50.048	50.05	50.052	50.054	50.053	50.055
95-percentile	50.065	50.063	50.064	50.066	50.066	50.063	50.062	50.066	50.068	50.07	50.068	50.069
99-percentile	50.092	50.088	50.094	50.095	50.097	50.093	50.093	50.096	50.097	50.099	50.098	50.097
No. of time intervals: average FRCE > Level 1 positive	401	351	390	352	375	319	348	390	415	440	424	459
No. of time intervals: average FRCE < Level 1 negative	353	343	397	361	429	376	404	430	404	478	416	400
No. of time intervals: average FRCE > Level 2 positive	47	45	51	57	63	51	50	54	54	72	55	72
No. of time intervals: average FRCE < Level 2 negative	42	38	48	45	56	30	31	41	53	80	44	59
No. of time intervals: FRCE > 60 % FRR capacity+ and < 15 % FRR capacity+ after 15 min	0	0	0	2	7	2	1	0	0	0	0	1
No. of time intervals: FRCE < -60 % FRR capacity+ and <- 15 % FRR capacity+ after 15 min	0	1	0	0	0	0	0	0	0	0	0	0

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Table 22 Nordic LFC Block Performance

2019												
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
The mean value	50.00012	49.99993	50.00041	50.00022	49.99995	49.99995	50.00031	50.0005	50	50.00022	50.00019	49.99977
The standard deviation	0.0432	0.047	0.0465	0.0458	0.0468	0.0477	0.0415	0.0434	0.0434	0.0445	0.042	0.0445
1-percentile	49.901	49.895	49.893	49.897	49.888	49.888	49.905	49.9	49.896	49.895	49.902	49.895
5-percentile	49.93	49.925	49.925	49.927	49.923	49.922	49.933	49.93	49.929	49.927	49.932	49.927
10-percentile	49.945	49.94	49.941	49.943	49.94	49.939	49.947	49.946	49.945	49.944	49.947	49.944
90-percentile	50.056	50.061	50.06	50.059	50.059	50.06	50.053	50.056	50.055	50.056	50.054	50.056
95-percentile	50.071	50.077	50.076	50.077	50.075	50.077	50.069	50.072	50.07	50.073	50.07	50.073
99-percentile	50.101	50.109	50.107	50.111	50.107	50.111	50.099	50.105	50.103	50.106	50.102	50.108
No. of time intervals: average FRCE > Level 1 positive	439	450	495	436	404	417	330	373	346	389	371	406
No. of time intervals: average FRCE < Level 1 negative	427	427	448	365	413	436	310	327	345	376	331	405
No. of time intervals: average FRCE > Level 2 positive	52	77	75	68	45	56	38	53	40	58	60	76
No. of time intervals: average FRCE < Level 2 negative	53	66	68	42	54	53	25	34	48	51	44	65
No. of time intervals: FRCE > 60 % FRR capacity+ and < 15 % FRR capacity+ after 15 min	0	1	0	4	0	1	0	1	0	2	0	0
No. of time intervals: FRCE < -60 % FRR capacity+ and <- 15 % FRR capacity+ after 15 min	0	0	0	0	0	0	0	0	0	0	0	0

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I. Level 1/Level 2 statistics

In following Figures 14-17 monthly distribution of FRCE time intervals outside Level 1 range and Level 2 range for positive and negative time intervals per month and Year is presented. If the maximum numbers of intervals exceed 10512 for Level 1 or 1752 for level 2 then mitigation measures have to be proposed and taken.

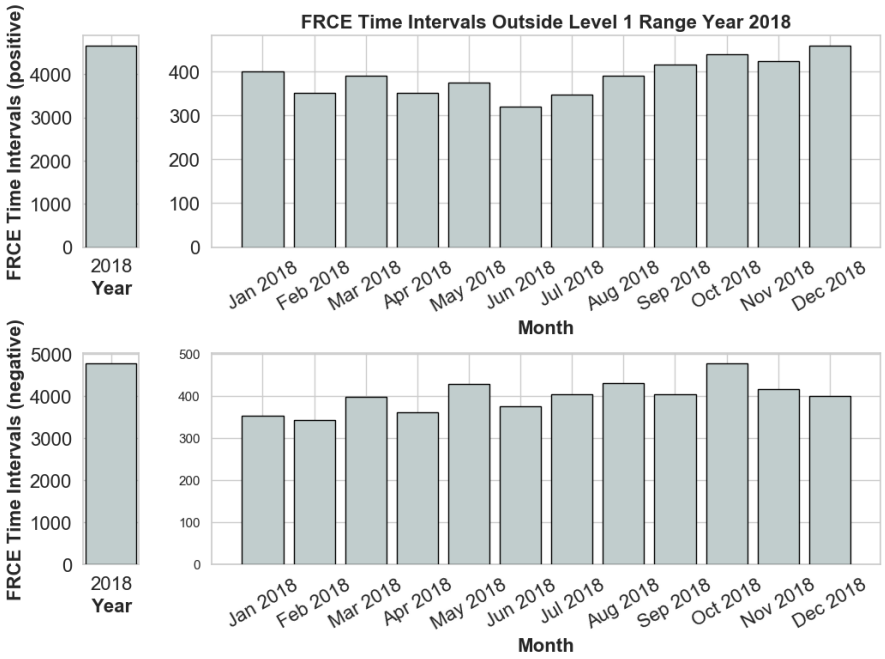

Figure 14 Nordic LFC 2018 FRCE Time Intervals Outside Level 1 Range

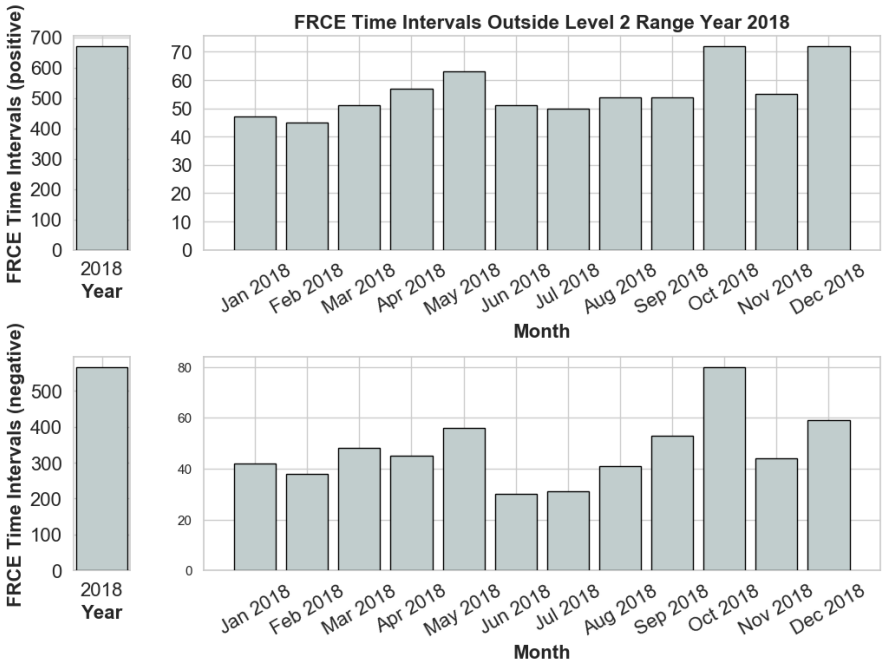

Figure 15 Nordic LFC 2018 FRCE Time Intervals Outside Level 2 Range

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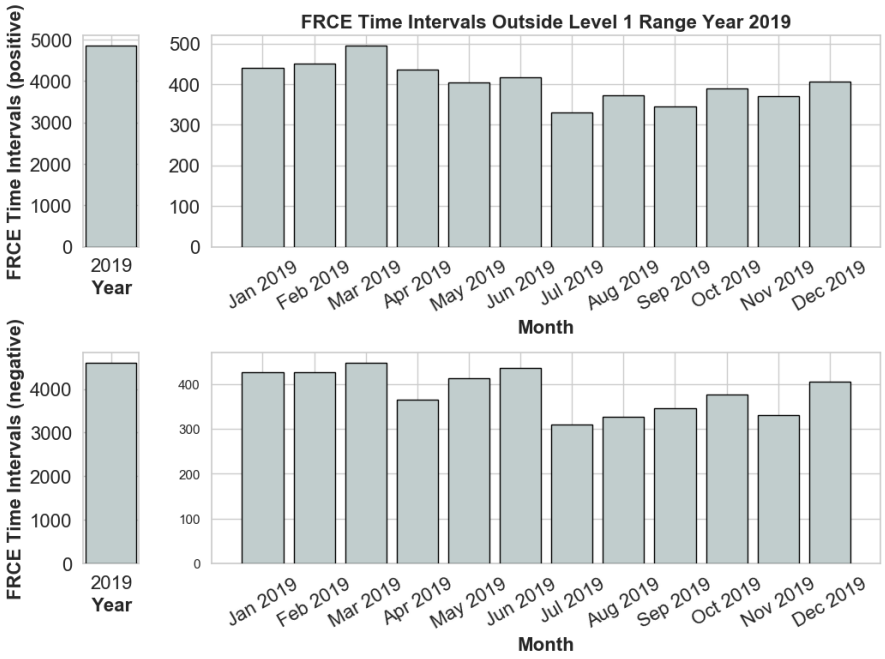

Figure 16 Nordic LFC 2019 FRCE Time Intervals Outside Level 1 Range

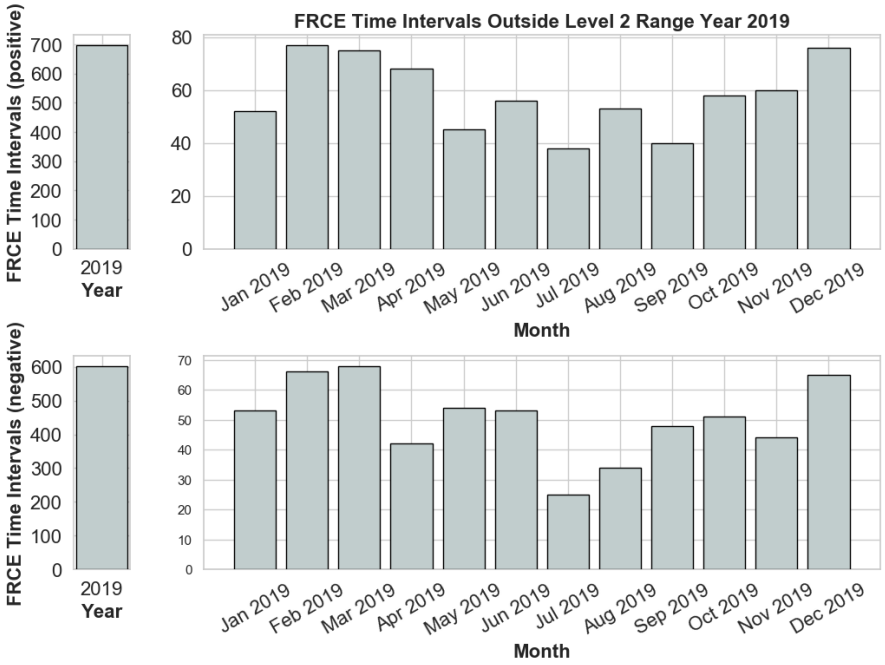

Figure 17 Nordic LFC 2019 FRCE Time Intervals Outside Level 2 Range

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II. FRCE vs. FRR

Ability of LFC block to regulate its own FRCE is presented by comparing reserve capacity on FRR and FRCE value according to SO GL. Reserve capacity on FRR is defined as FRR capacity from the dimensioning process (SO GL, Art. 157). If a TSO in dedicated time interval had more FRR (e.g. from free energy bids) this can also be included in the calculation. FRR is considered separately, this means a positive FRR (referred as FRR+ in this document) for negative FRCE, and a negative FRR (referred as FRR- in this document) for positive FRCE. FRCE values includes all correction signals, for TSOs part of an Imbalance Netting Initiative, and is the value after the adjustment process for TSOs part of an FRR activation process. The values taken into account are the one minute average values. The granularity of FRCE instantaneous values (used to calculate the 1 minute average) is 10 seconds or lower.

Reported number of events indicate occurrence of large imbalances in LFC block (60 % of FRR) and an insufficient capability of LFC blocks to solve them during time to restore frequency.

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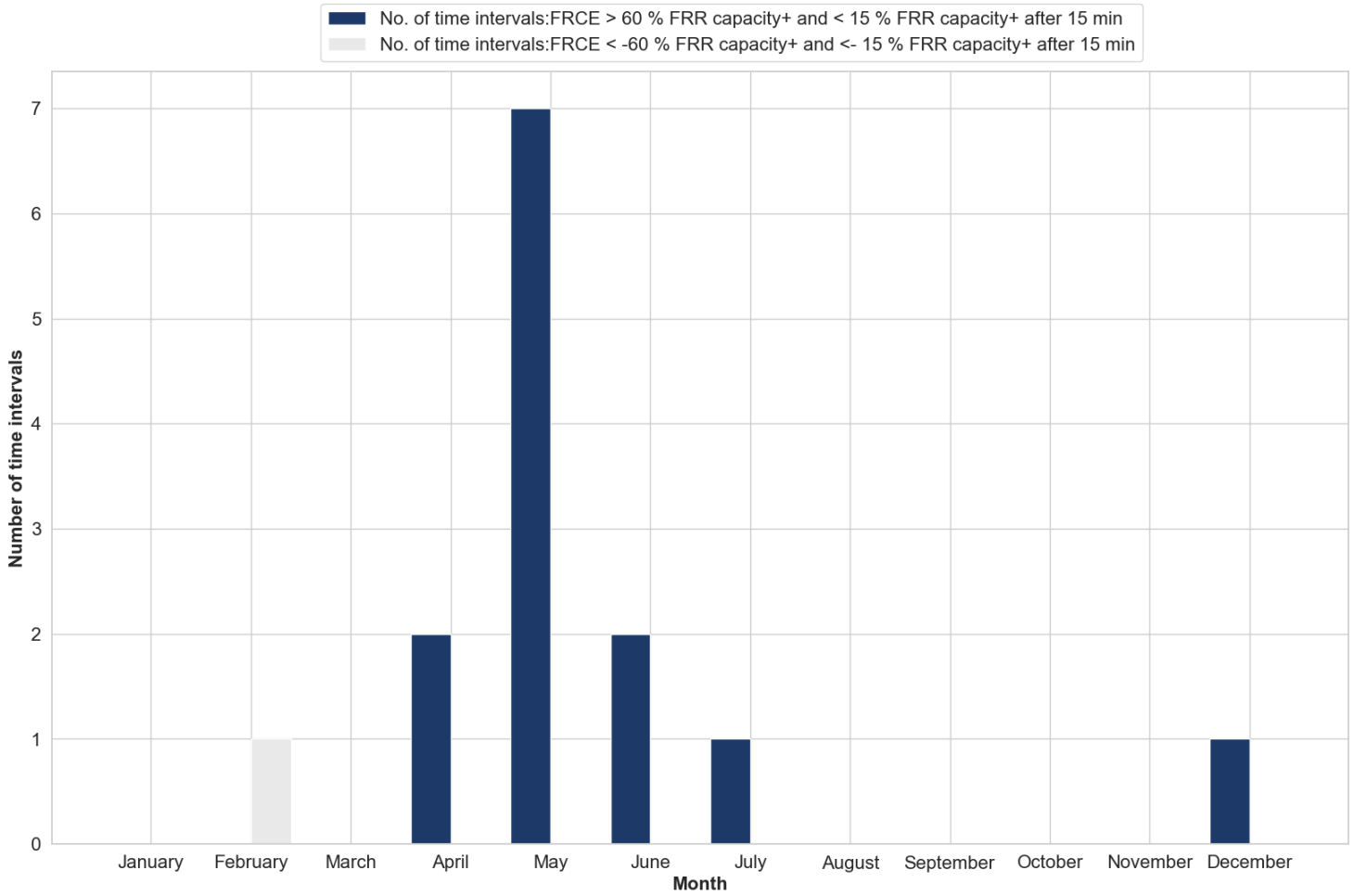

Figure 18 Nordic LFC 2018 FRCE Outside FRR Capacity within 15 minutes

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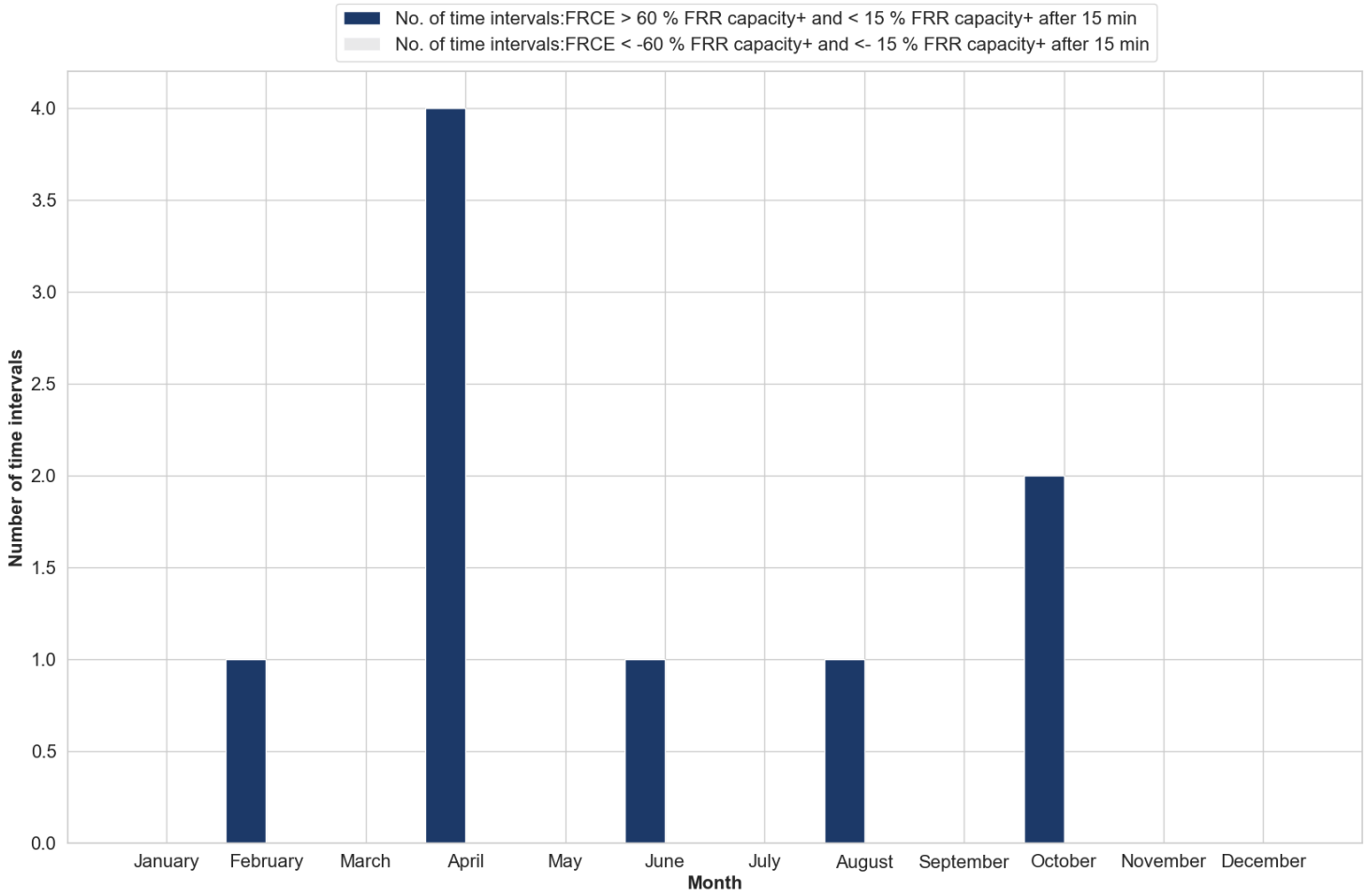

Figure 19 Nordic LFC 2019 FRCE Outside FRR Capacity within 15 minutes

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c. Frequency quality evaluation

I. Mitigation Measures Analysis

Annual report on load-frequency control provides a description and date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations taken in the previous calendar year in accordance with SO GL Articles 137 and 138, in which TSOs were involved.

In accordance to Article 138., when the values calculated for the period of one calendar year concerning the frequency quality target parameters are outside the targets set for the synchronous area, all TSOs of the relevant synchronous area should provide analysis and mitigation measures.

In accordance to Article 138., when the values calculated for the period of one calendar year concerning FRCE target parameters are outside the targets set for the LFC block, all TSOs of the relevant LFC block should provide analysis and mitigation measures.

According to SO GL Article 138, information contains:

(a) analysis whether the frequency quality target parameters or the FRCE target parameters will remain outside the targets set for the synchronous area or for the LFC block and in case of a justified risk that this may happen, analyse the causes and develop recommendations; and

(b) description of developed mitigation measures to ensure that the targets for the synchronous area or for the LFC block can be met in the future.

For the reporting period, Year 2018 and Year 2019, in line with Figures 14-17 following analysis and mitigation measures were reported from Nordic LFC Block:

Mitigation measures for year 2018:

There were no mitigation measures applied.

Mitigation measures for year 2019:

Analysis:
The Level 2 Negative FRCE target of 76 mHZ excursions was exceeded in 2019. The trend over the period 2017-2019 shows a deterioration trend , with the number of excursions increasing (approximately 0.75 per month).
Mitigation measures:
The Nordic LFC Block is increasing the volume of aFRR contracted and the extending the number of hours it is contracted to mitigate for this deteriorating trend.

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E. Performance – CE

a. Continental Europe Synchronous Area Performance

In the following tables and figures data for 2018 and 2019 for Continental Europe synchronous area are presented. Input values for frequency are based on an instantaneous frequency values. Based on input values; mean value, standard deviation and percentiles were calculated. Moreover, time periods and events when system frequency was outside of predefined ranges were also notified. For data points when frequency was outside 50 and 800 mHz range, time is measured in minutes time scale.

Table 23 CE SA Performance for Year 2018

2018													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99941	49.99478	50.00401	50.00194	49.99959	50.00038	50.00009	50.00072	50.00017	50.00018	49.99969	50.00051	50.00012
The standard deviation	0.0208	0.0225	0.0241	0.0234	0.0199	0.0195	0.0189	0.019	0.0205	0.0222	0.0213	0.0202	0.0201
1-percentile	49.947	49.936	49.943	49.95	49.953	49.954	49.953	49.956	49.949	49.943	49.945	49.95	50.05
5-percentile	49.967	49.96	49.965	49.967	49.97	49.971	49.971	49.972	49.968	49.966	49.967	49.969	50.05
10-percentile	49.975	49.969	49.974	49.974	49.976	49.977	49.977	49.978	49.976	49.974	49.975	49.977	50.05
90-percentile	50.024	50.021	50.033	50.031	50.024	50.023	50.023	50.023	50.025	50.026	50.025	50.025	50.05
95-percentile	50.032	50.029	50.042	50.041	50.031	50.031	50.029	50.03	50.032	50.035	50.033	50.032	50.05
99-percentile	50.053	50.052	50.062	50.063	50.049	50.05	50.046	50.049	50.05	50.056	50.053	50.051	50.05
Time > 50 mHz	525	450	1116	1062	396	414	285	398	414	699	526	470	6755
Time < - 50 mHz	551	973	725	409	328	297	340	296	454	692	607	445	6117
Time > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < - 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. deviation > 100 mHz and not < 25 mHz	1	0	0	1	0	1	0	0	0	0	0	0	3
No. of events freq. deviation < - 100 mHz and not < -25 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0

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Table 24 CE SA Performance for Year 2019

2019													
Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00009	50.00037	50.0004	50.00003	50.00034	49.99986	50.00019	49.99969	50.00002	49.99975	50.0005	49.99989	50.00009
The standard deviation	0.022	0.0208	0.0215	0.0206	0.0199	0.0197	0.0184	0.0182	0.0198	0.0204	0.0206	0.0196	0.0201
1-percentile	49.943	49.948	49.946	49.948	49.951	49.951	49.954	49.954	49.95	49.947	49.949	49.95	49.949
5-percentile	49.965	49.967	49.966	49.967	49.969	49.969	49.972	49.972	49.97	49.967	49.969	49.969	49.969
10-percentile	49.974	49.975	49.974	49.975	49.976	49.976	49.978	49.978	49.977	49.975	49.976	49.976	49.976
90-percentile	50.026	50.025	50.026	50.025	50.024	50.024	50.022	50.022	50.023	50.024	50.025	50.023	50.024
95-percentile	50.033	50.032	50.033	50.032	50.031	50.03	50.029	50.028	50.03	50.031	50.032	50.03	50.031
99-percentile	50.053	50.052	50.052	50.049	50.049	50.046	50.045	50.044	50.049	50.05	50.051	50.048	50.049
Time > 50 mHz	540	457	513	370	403	256	277	222	363	423	445	360	4629
Time < - 50 mHz	733	444	563	491	368	389	328	317	408	523	445	437	5446
Time > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < - 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq. deviation > 100 mHz and not < 25 mHz	0	0	1	0	1	0	0	0	0	0	0	0	2
No. of events freq. deviation < - 100 mHz and not < -25 mHz	0	0	0	0	0	1	0	0	0	0	0	0	1

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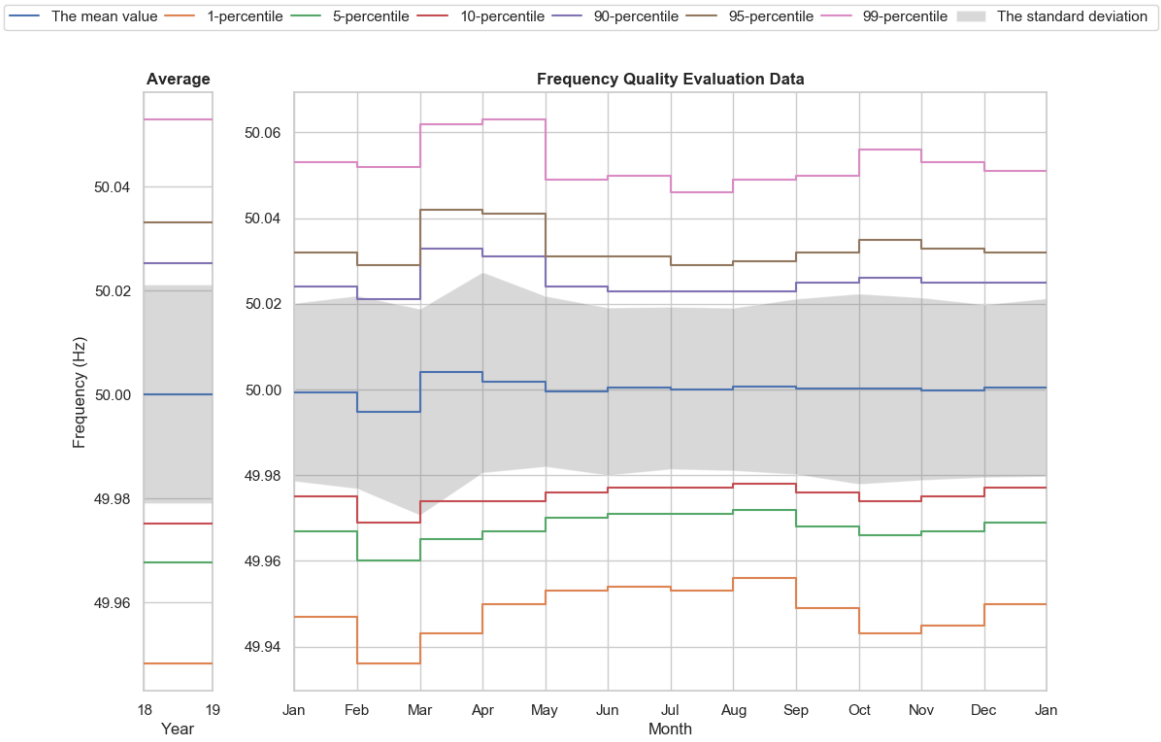

Figure 20 CE SA 2018 frequency quality

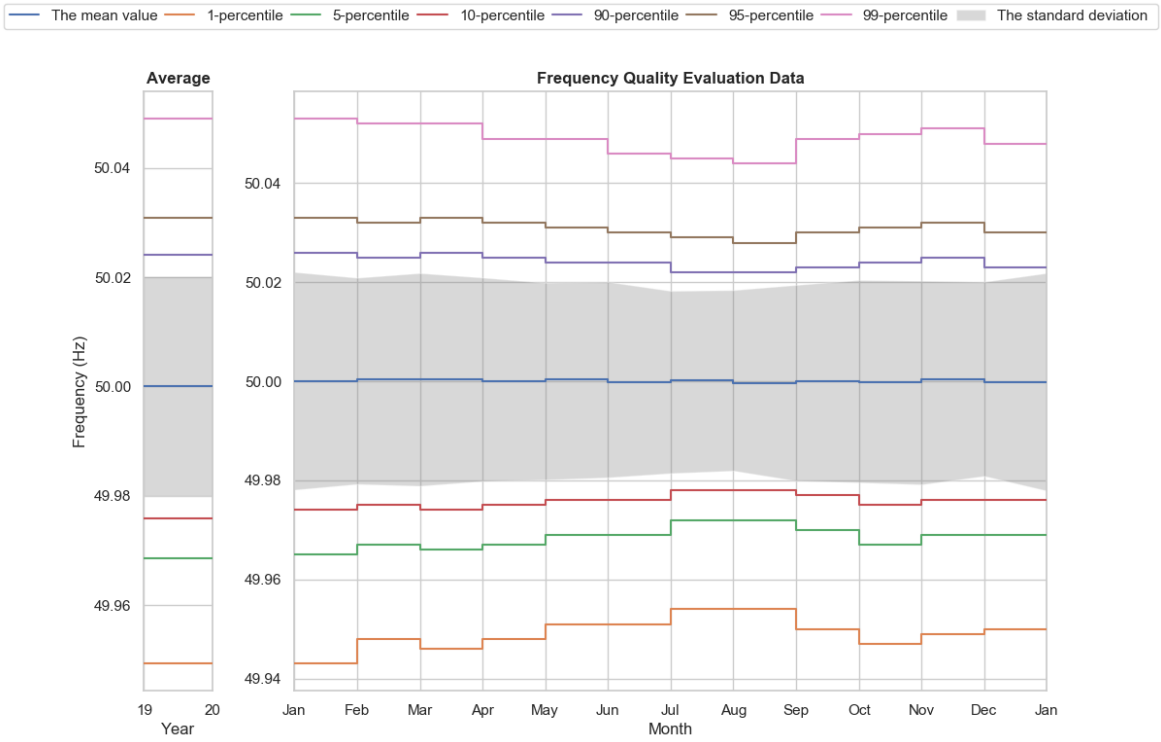

Figure 21 CE SA 2019 frequency quality

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In Figures 22 and 23 accumulated minutes outside standard ranges are presented for the Years 2018 and 2019 respectively.

The red line shows the theoretical line in case of linear distribution (1/12 per month) of minutes outside standard range taking into account standard range from SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. In case that black line is higher than the red line at the end of the year this indicates that the synchronous area did not meet the required Frequency quality parameters.

The graphs in Figures 22 and 23 below show that the Frequency quality target parameters from SO GL were fulfilled for the respective years for the Synchronous Area Continental Europe.

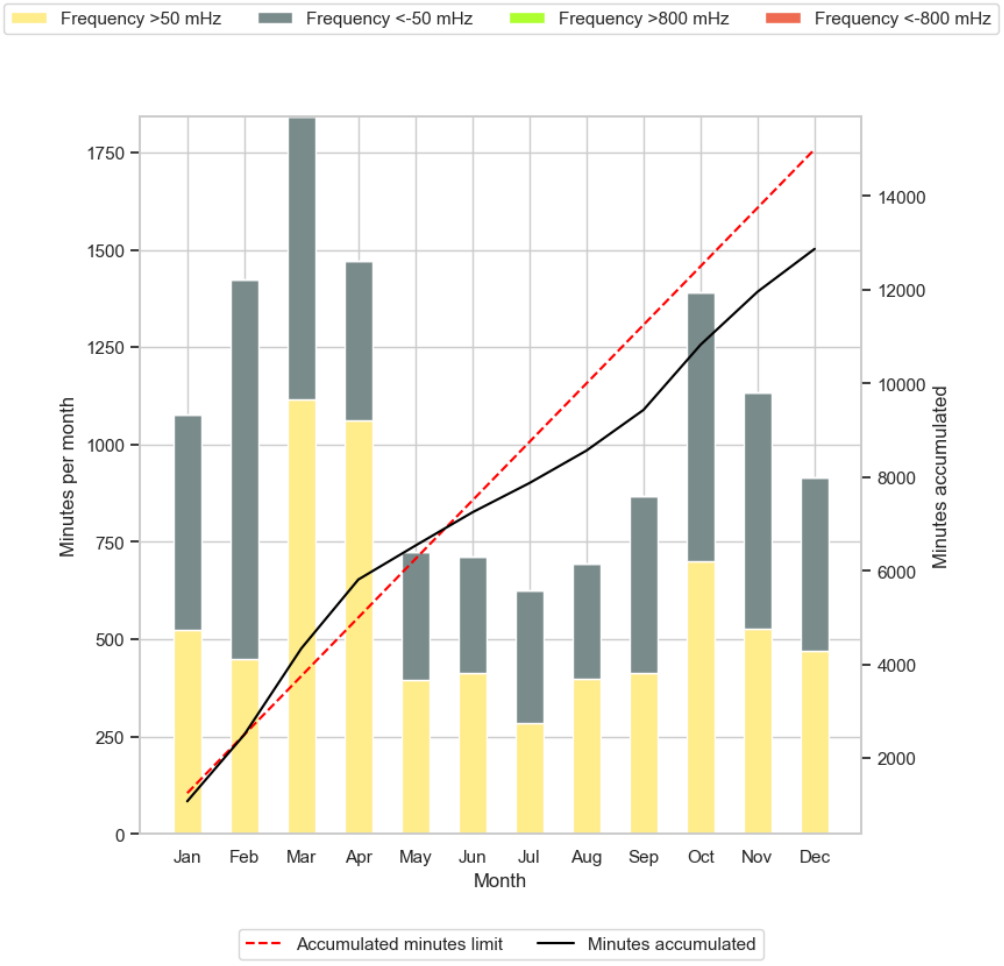

Figure 22 CE SA 2018 frequency deviation

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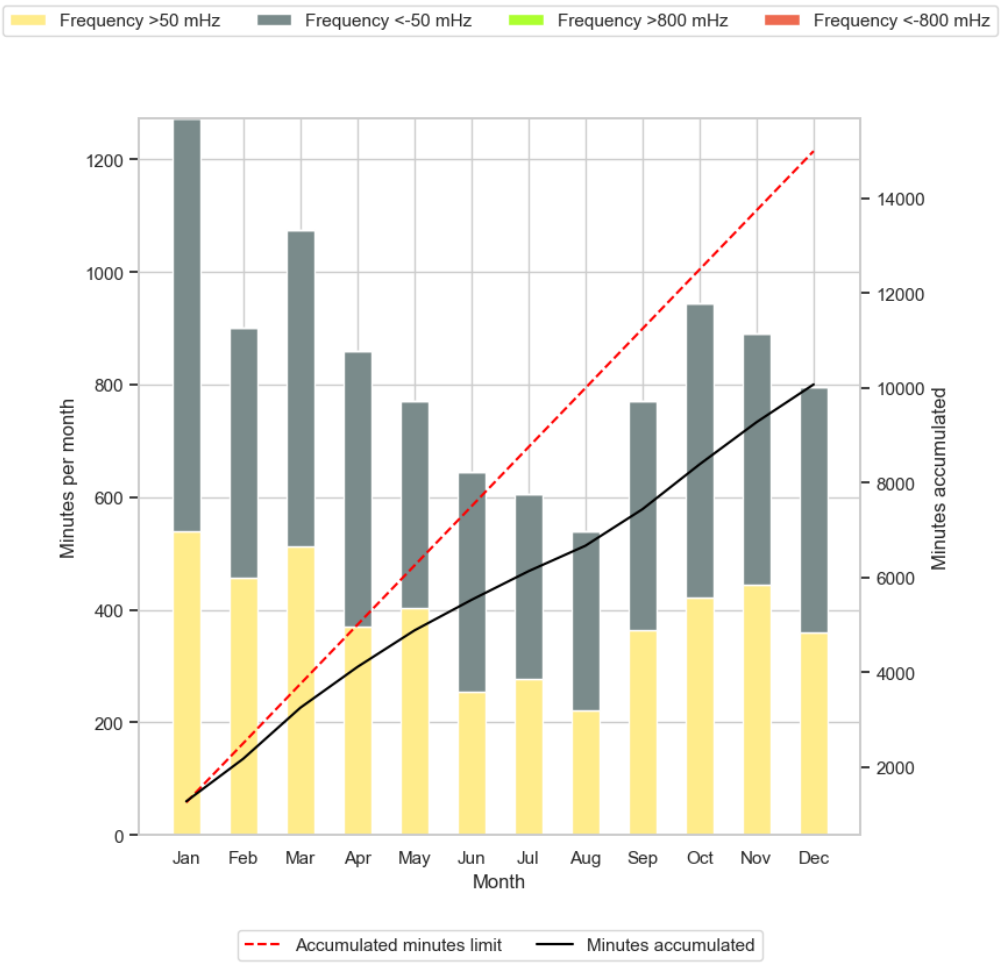

Figure 23 CE SA 2019 frequency deviation

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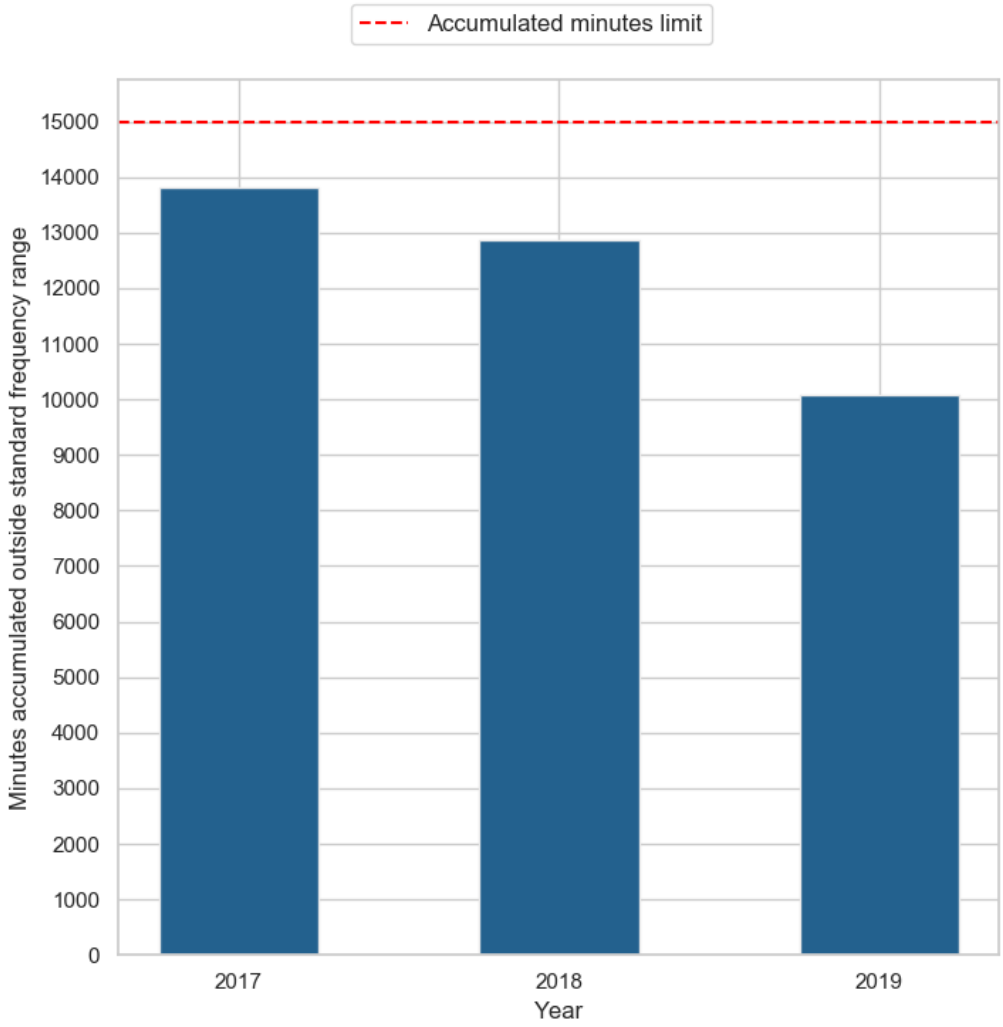

Figure 23a CE SA frequency deviation trend

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b. Continental Europe Synchronous Area LFC Blocks Performance

In this chapter Continental Europe Frequency Quality Evaluation Criteria for LFC blocks is presented. Limits for Level 1 and Level 2 are calculated retroactively in line with Synchronous Area Framework Agreement for Continental Europe, whose entry into force was 14th of April 2019. FRCE values are calculated on a basis of 15 min Area Control Error (ACE) data. Additionally, events which indicate where FRCE exceeds 60 % of FRR used and not returned to 15 % of FRR during 15 minutes time period are reported. Complete list of data provided by LFC blocks is shown in Appendix B.

I. Level 1/Level 2 statistics

In the following graphs, monthly distribution of FRCE time intervals outside Level 1 and Level 2 ranges is presented, separately for positive and negative time intervals, for every month for reporting Years for each LFC block in Continental Europe Synchronous Area. Number of time intervals in which average FRCE was higher than Level 1 positive is shown with dots, while for the opposite direction with x. The level 1 and level 2 Frequency Restoration Control Error Target Parameters for the Continental Europe LFC blocks are presented in Tables 25 and 26 for respective years and measured in MW.

Table 25 Level 1 FRCE range and the level 2 FRCE range for the Continental Europe Synchronous Area and targets for the number of 15 minutes time intervals per year outside the level 1 and level 2 FRCE range for 2018

LFC Block	Level 1	Level 2
APG	78.234	147.954
CEPS	86.08	162.79
ELIA	87.887	166.208
ESO	62.775	118.717
Germany	243.62	460.726
IPTO	63.851	120.752
MAVIR	52	98.34
OST	25.285	47.817
PSE	121.606	229.976
REE	187.236	354.093
REN	73.253	138.533
RTE	225.851	427.12
SEPS	38.305	72.441
SG	76.883	145.398
SHB	64.015	121.062
SMM	69.358	131.167
TEIAS	161.771	305.934
TEL	76.336	144.363
TERNA	158.993	300.682
TTB	102.579	193.993
Target for the maximum number of 15 minutes time intervals per year outside the Level 1 and Level 2 FRCE range	10512	1752

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Table 26 Level 1 FRCE range and the level 2 FRCE range for the Continental Europe Synchronous Area and targets for the number of 15 minutes time intervals per year outside the level 1 and level 2 FRCE range for 2019

LFC Block	Level 1	Level 2
APG	79.942	151.183
CEPS	88.22	166.838
ELIA	87.861	166.159
ESO	62.634	118.451
Germany	245.734	464.722
IPTO	66.314	125.411
MAVIR	52.864	99.975
OST	20.018	37.858
PSE	126.649	239.515
REE	188.49	356.466
REN	72.396	136.913
RTE	225.597	426.64
SEPS	49.993	94.546
SG	76.917	145.462
SHB	62.381	117.972
SMM	67.105	126.906
TEIAS	168.585	318.821
TEL	75.881	143.504
TERNA	162.469	307.254
TTB	103.562	195.852
Target for the maximum number of 15 minutes time intervals per year outside the Level 1 and Level 2 FRCE range	10512	1752

The methodology for calculation of these target parameters is as defined in the Continental Europe Synchronous Area Operational Agreement.

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Figure 24 CE LFCs 2018 FRCE Time Intervals outside Level 1 Range

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Figure 25 CE LFCs 2018 FRCE Time Intervals outside Level 2 Range

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Figure 26 CE LFCs 2019 FRCE Time Intervals outside Level 1 Range

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Figure 27 CE LFCs 2019 FRCE Time Intervals outside Level 2 Range

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II. FRCE vs. FRR

Ability of LFC blocks to regulate its own FRCE is presented by comparing reserve capacity on FRR and FRCE value according to SO GL. Reserve capacity on FRR is defined as FRR capacity from the dimensioning process (SO GL, Art. 157). If a TSO in dedicated time interval had more FRR (e.g. from free energy bids) this can also be included in the calculation. FRR is considered separately, this means a positive FRR (referred as FRR+ in this document) for negative FRCE, and a negative FRR (referred as FRR- in this document) for positive FRCE. FRCE values includes all correction signals (e.g. for TSOs part of an Imbalance Netting Process), and is the value after the adjustment process for TSOs part of an FRR activation process. The values taken into account are the one minute average values. The granularity of FRCE instantaneous values (used to calculate the 1 minute average) is 10 seconds or lower.

Reported number of events indicate occurrence of large imbalances in LFC blocks (60 % of FRR) and an insufficient capability of LFC blocks to solve them during time to restore frequency.

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Figure 28 CE LFCs 2018 FRCE Outside FRR Capacity within 15 minutes

Figure 29 CE LFCs 2019 FRCE Outside FRR Capacity within 15 minutes

c. Frequency quality evaluation

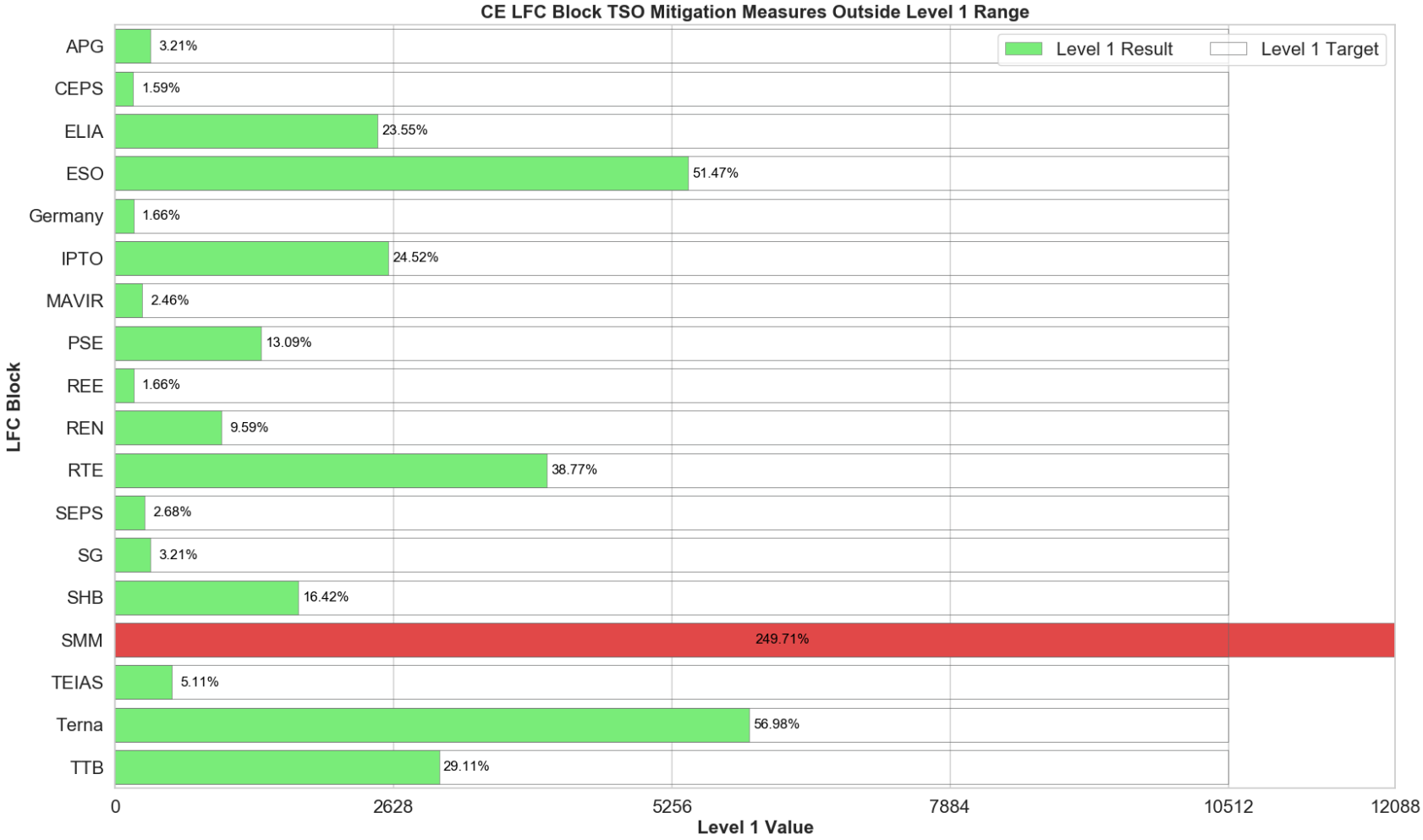

Figure 30 CE LFC Blocks 2018 TSO time Intervals with average FRCE outside Level 1 target

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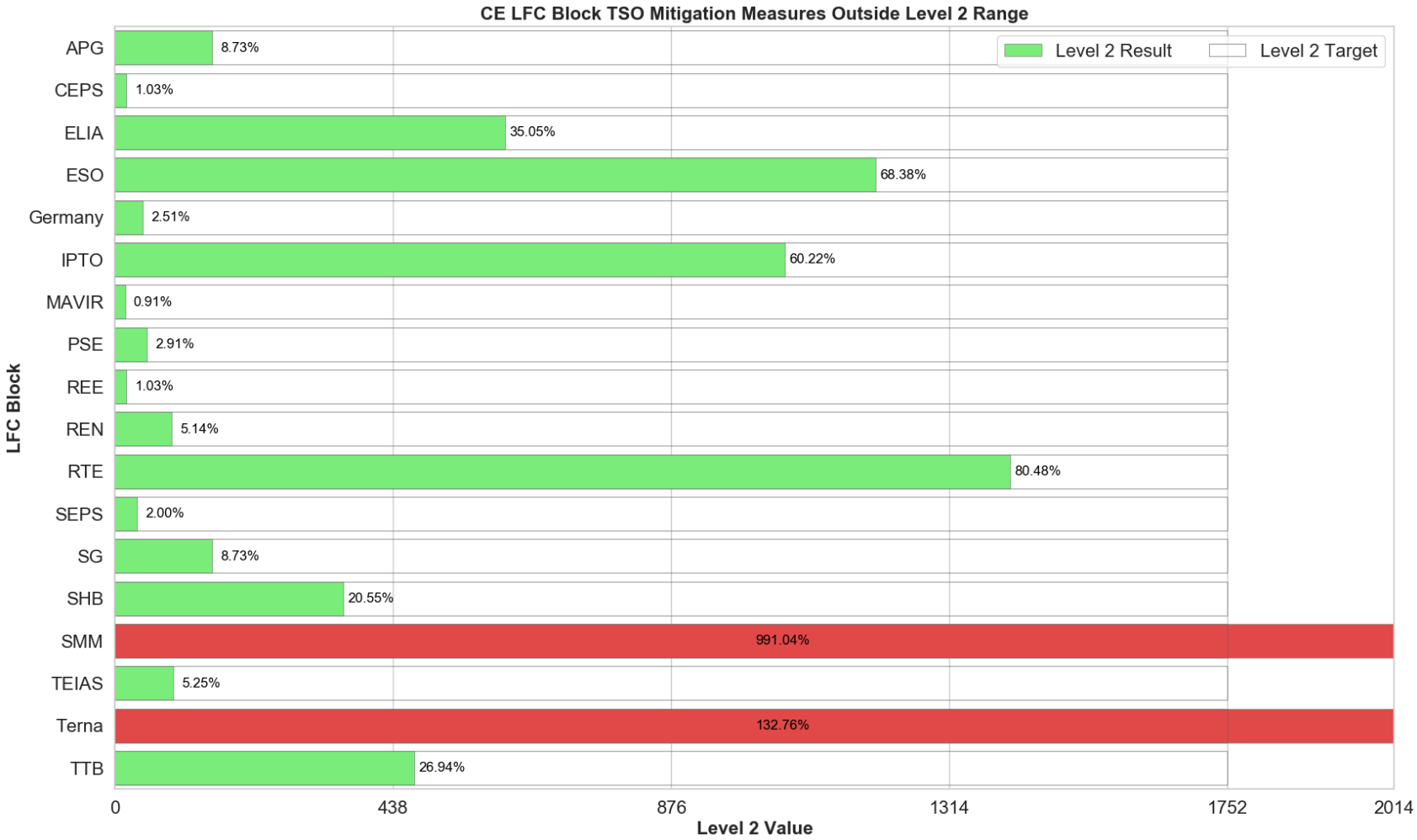

Figure 31 CE LFC Blocks 2018 TSO time Intervals with average FRCE outside Level 2 target

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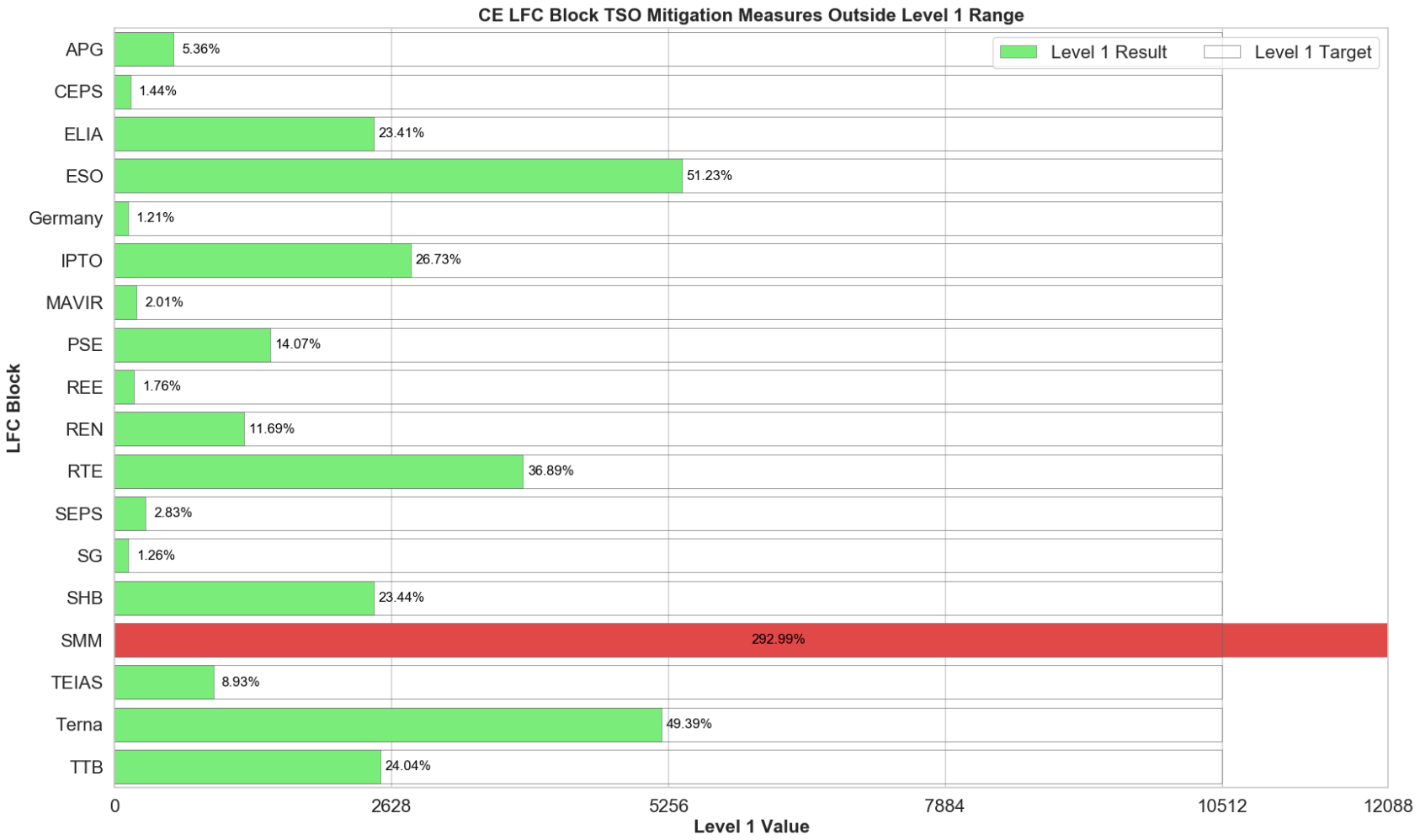

Figure 32 CE LFC Blocks 2019 TSO time Intervals with average FRCE outside Level 1 target

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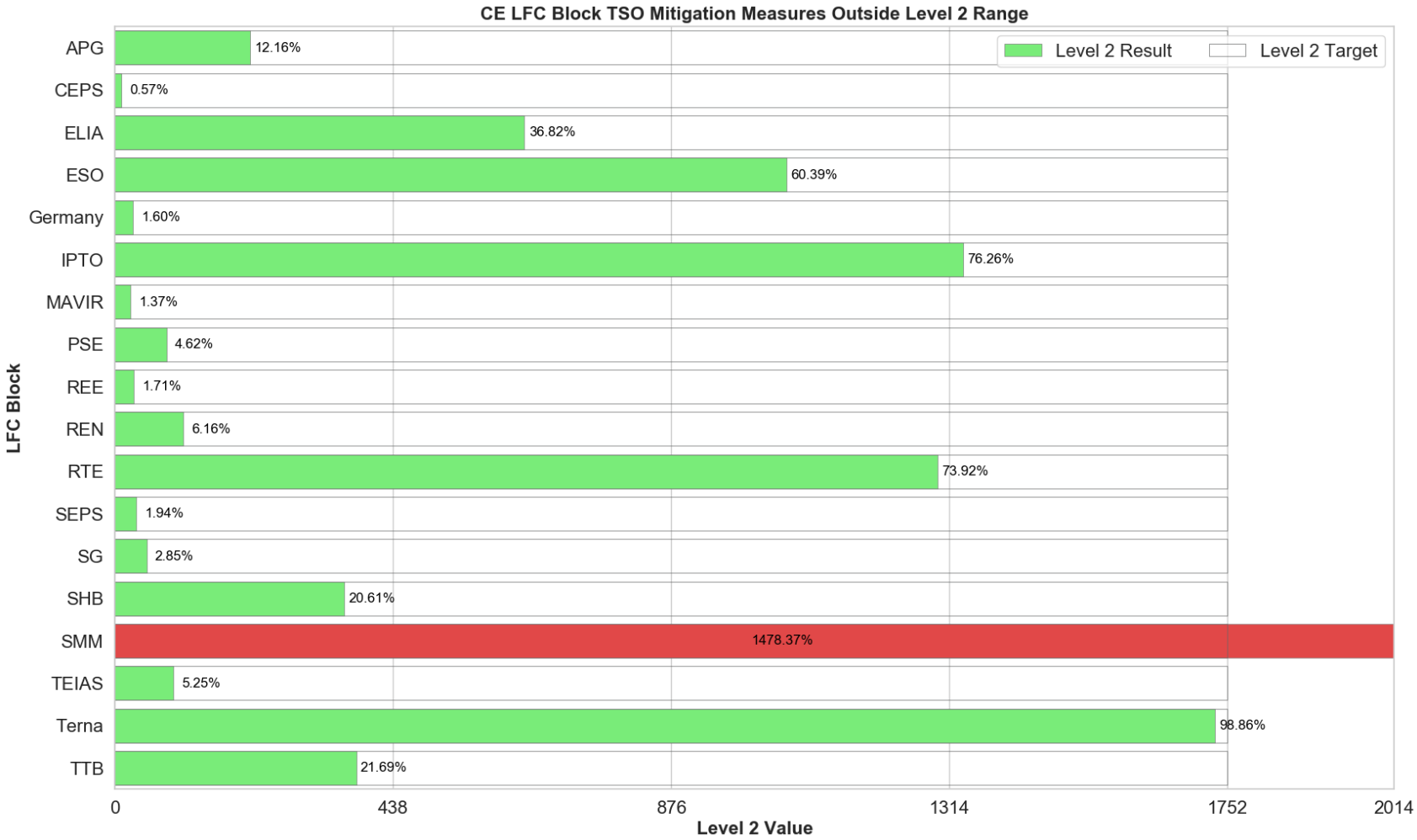

Figure 33 CE LFC Blocks 2019 TSO time Intervals with average FRCE outside Level 2 target

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I. Mitigation Measures Analysis

Annual report on load-frequency control provides a description and date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations taken in the previous calendar year in accordance with SO GL Articles 137 and 138, in which TSOs were involved.

In accordance to Article 138., when the values calculated for the period of one calendar year concerning the frequency quality target parameters are outside the targets set for the synchronous area, all TSOs of the relevant synchronous area should provide analysis and mitigation measures.

In accordance to Article 138., when the values calculated for the period of one calendar year concerning FRCE target parameters are outside the targets set for the LFC block, all TSOs of the relevant LFC block should provide analysis and mitigation measures.

According to SO GL Article 138, information contains:

(a) analysis whether the frequency quality target parameters or the FRCE target parameters will remain outside the targets set for the synchronous area or for the LFC block and in case of a justified risk that this may happen, analyse the causes and develop recommendations; and

(b) description of developed mitigation measures to ensure that the targets for the synchronous area or for the LFC block can be met in the future.

For the reporting period, Year Write(Model.year[0]) and Write(Model.year[1]), in line with Figures 35-38 following analysis and mitigation measures were reported from LFC blocks in Continental Europe:

Mitigation measures for year 2018:

SMM LFC Block
Analysis:
The FRCE quality for the SMM CB was very low due to a dispute in the SMM CB.
Mitigation measures:
EMS was covering partially the imbalance and discussions were ongoing to resolve this dispute.

Terna LFC Block
Analysis:
The statistic shown is not representative of the real performance of Italian electrical system for years 2017 and 2018, as Terna as LFC Block monitor is implementing Art. 157 (FRR dimensioning rules) and Art. 137 (Ramping restrictions for active power output) in compliance with SO GL implementation process of Art. 119 (LFC Block Operational Agreement), fulfilling the timeline prescribed in Art. 119 and Art. 6. Calculation of Level 1 and Level 2 parameters is defined in accordance with Art. 118, whose entry into force was 14th April 2019 (Synchronous Area Framework Agreement); therefore Level 1 and Level 2 targets and results for years 2017 and 2018 did not exist.

Mitigation measures for year 2019:

SMM LFC Block
Analysis:
The FRCE quality for the SMM CB was very low due to a dispute in the SMM CB
Mitigation measures:
EMS was covering partially the imbalance and discussions were ongoing to resolve this dispute.
Connection agreement between transmission system operator of Kosovo and the ENTSO-E has been signed in the Year 2020 and it is expected that there will be no future impact on frequency quality target parameters.

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4. FCR data

A. Introduction

The annual report on load-frequency control provides information for the FCR obligation and the initial FCR obligation of each TSO, covering each month of at least two previous calendar years. In spite of that, SO GL requests to report two separate values regarding FCR with following definitions:

- FCR obligation means the part of all of the FCR that falls under the responsibility of a TSO; and
- Initial FCR obligation means the amount of FCR allocated to a TSO on the basis of a sharing key.

Initial FCR obligation is reported on a monthly basis as an average value of FCR in MWs for reported month. For TSOs which have the same value of initial FCR obligation for the whole Year, TSO reports the same value for all months for reported Year. Otherwise, if initial FCR obligation is not constant during a time, the TSO reports an average value of FCR on a monthly level for reported Year.

IE/NI and GB TSOs

In Tables 27 to 30 below the FCR is presented from January (I) to December (XII) for 2018 and 2019. The FCR requirement for the Synchronous Area of IE/NI and GB is dynamic and it varies over a day therefore it is represented as a historical monthly MW average. In calculating the "Average monthly FCR" the record spot FCR values are averaged over the monthly period. The amount of FCR obtained inside the area of TSO is also given as a percentage.

Nordic TSOs

In Figures 34 and 35 FCR is pictured for every Nordic TSO from January (I) to December (XII) for 2018 and 2019, respectively. The initial determined initial capacity for each TSO covers is the capacity for FCR-D, Frequency containment reserve for disturbance Frequency deviations < 49.9 Hz. These capacities are insured by each TSO with combinations of mandatory requirement, internal markets and a common market.

Continental Europe TSOs

In Figures 36 and 37 FCR is pictured for every for every Continental Europe TSO from January (I) to December (XII) for 2018 and 2019, respectively. If more than one TSO is operating inside the Member State (e.g. Germany) the provided value per TSO is summarized for the Member State to enable comparability. The determined value describes the amount of initial FCR obligation inside the respective TSO, divided through the amount of procured FCR inside the TSO. This value is calculated in percentage. Values higher than 100 % indicate that respective TSO exported percentage amount of FCR to other TSOs, while if reported value is lower than 100 % means that respective TSO import part of FCR from other TSOs (Part of its initial FCR obligation is contracted outside its responsibility area). If value is equal to 100 %, this mean that all FCR is ensured inside TSO responsibility area. For the case of missing or not (timely) provided data the entry shows N/A.

The following tables and figures show FCR per TSOs separately for each Synchronous Area presented in this report.

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B. TSO data

I. IE/NI TSO

Table 27 IE/NI TSO FCR Statistic Year 2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average Monthly FCR [MW]	281	301	280	274	302	313	313	303	289	294	278	284
FCR obtained inside the area of TSO [%]	69%	72%	84%	71%	73%	67%	66%	67%	70%	72%	71%	76%

Table 28 IE/NI TSO FCR Statistic Year 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average Monthly FCR [MW]	305	262	288	294	300	298	319	292	294	289	305	274
FCR obtained inside the area of TSO [%]	77%	71%	72%	69%	67%	70%	72%	74%	72%	70%	73%	73%

II. GB TSO

Table 29 GB TSO FCR Statistic Year 2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average Monthly FCR [MW]	728	736	814	855	890	861	849	870	957	1005	1026	1034
FCR obtained inside the area of TSO [%]	74%	77%	81%	80%	86%	88%	89%	89%	91%	84%	86%	91%

Table 30 GB TSO FCR Statistic Year 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average Monthly FCR [MW]	939	1016	1077	1107	1084	1079	1048	1045	1014	1059	979	980
FCR obtained inside the area of TSO [%]	90%	92%	95%	97%	99%	98%	91%	92%	94%	91%	95%	96%

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III. Nordic TSOs

	Obligation	Month I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
DK-E	176.5 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
FG	258.8 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
SN	352.9 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
SvK	411.8 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
Nordic	1200 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %

Figure 34 Nordic LFCs 2018 TSO FCR Statistics

	Obligation	Month I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
DK-E	143 MW	73.00 %	73.00 %	73.00 %	73.00 %	73.00 %	72.00 %	71.00 %	64.00 %	57.00 %	74.00 %	71.00 %	71.00 %
FG	320 MW	80.00 %	82.00 %	83.00 %	81.00 %	100.00 %	95.00 %	82.00 %	85.00 %	104.00 %	83.00 %	89.00 %	86.00 %
SN	359 MW	316.00 %	304.00 %	278.00 %	270.00 %	223.00 %	226.00 %	253.00 %	272.00 %	314.00 %	270.00 %	279.00 %	297.00 %
SvK	320 MW	113.00 %	134.00 %	135.00 %	128.00 %	117.00 %	118.00 %	128.00 %	137.00 %	140.00 %	124.00 %	126.00 %	132.00 %
Nordic	1162 MW	166.00 %	163.00 %	156.00 %	152.00 %	142.00 %	142.00 %	148.00 %	155.00 %	172.00 %	151.00 %	156.00 %	162.00 %

Figure 35 Nordic LFCs 2019 TSO FCR Statistics

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IV. CE TSOs

	Obligation	Month I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
APG	64 MW	140.23 %	115.63 %	115.00 %	129.30 %	112.50 %	94.38 %	120.31 %	128.44 %	137.89 %	123.44 %	106.56 %	99.61 %
CEPS	78 MW	109.47 %	109.54 %	110.17 %	109.81 %	110.14 %	108.55 %	109.51 %	109.54 %	109.62 %	109.79 %	110.13 %	110.13 %
ELIA	81 MW	52.61 %	37.04 %	34.14 %	37.33 %	49.90 %	34.40 %	33.17 %	55.56 %	42.65 %	43.65 %	40.04 %	39.35 %
ESO	41 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
Amprion	225 MW	63.70 %	59.38 %	71.46 %	72.49 %	61.79 %	51.72 %	53.59 %	65.91 %	64.79 %	67.89 %	69.13 %	65.94 %
TenneT DE	189 MW	55.50 %	57.22 %	54.12 %	51.80 %	28.38 %	44.36 %	51.36 %	50.20 %	57.83 %	61.80 %	58.17 %	61.84 %
TransnetBW	80 MW	267.74 %	246.43 %	308.67 %	274.56 %	282.46 %	249.38 %	163.99 %	198.47 %	225.88 %	223.02 %	251.71 %	253.99 %
50Hertz	126 MW	187.02 %	207.20 %	215.72 %	223.44 %	227.62 %	228.70 %	193.83 %	211.24 %	218.60 %	229.34 %	211.43 %	194.01 %
Germany	620 MW	112.59 %	112.90 %	126.10 %	122.92 %	113.78 %	110.95 %	95.66 %	107.76 %	114.71 %	118.86 %	118.26 %	114.98 %
2019	43 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
MAVIR	28 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
PSE	155 MW	112.47 %	110.84 %	113.04 %	111.35 %	110.94 %	110.92 %	111.66 %	111.36 %	112.12 %	111.51 %	111.09 %	110.39 %
REE	368 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
REN	56 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
RTE	536 MW	93.00 %	99.00 %	92.00 %	95.00 %	96.00 %	100.00 %	111.00 %	91.00 %	89.00 %	92.00 %	95.00 %	91.00 %
SEPS	26 MW	70.70 %	70.58 %	72.93 %	81.51 %	81.90 %	79.18 %	73.31 %	72.51 %	79.39 %	76.16 %	71.32 %	71.22 %
SG	62 MW	158.00 %	170.00 %	97.00 %	76.00 %	161.00 %	212.00 %	221.00 %	249.00 %	207.00 %	157.00 %	160.00 %	187.00 %
HOPS	11 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
NOS BiH	16 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
ELES	15 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
EMS	43 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
CGES	3 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
MEPSO	5 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
SMM	51 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
TEIAS	275 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
Terna	265 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
TTB	111 MW	44.41 %	31.15 %	31.04 %	31.47 %	31.85 %	30.81 %	31.07 %	32.05 %	31.05 %	30.63 %	31.14 %	31.36 %

Figure 36 CE LFCs 2018 TSO FCR Statistics

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	Obligation	Month I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
APG	68 MW	62.28 %	81.72 %	94.81 %	107.60 %	118.31 %	100.59 %	122.21 %	109.21 %	112.40 %	123.63 %	102.16 %	96.54 %
CEPS	81 MW	111.11 %	111.11 %	110.73 %	111.35 %	109.78 %	109.78 %	113.80 %	108.52 %	109.54 %	110.64 %	110.80 %	111.04 %
ELIA	80 MW	40.24 %	39.87 %	39.60 %	38.26 %	43.09 %	40.29 %	41.33 %	42.83 %	48.45 %	51.61 %	45.54 %	38.02 %
ESO	41 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
Amprion	223 MW	54.76 %	71.83 %	73.25 %	72.02 %	69.41 %	65.64 %	80.11 %	79.92 %	75.71 %	77.78 %	70.70 %	75.63 %
TenneT DE	182 MW	59.50 %	66.27 %	64.84 %	52.22 %	54.52 %	61.06 %	55.55 %	62.58 %	66.98 %	73.41 %	63.35 %	76.85 %
TransnetBW	78 MW	287.49 %	244.92 %	191.48 %	292.95 %	252.40 %	206.37 %	108.35 %	166.42 %	239.74 %	220.39 %	153.42 %	114.64 %
50Hertz	122 MW	189.12 %	214.61 %	234.64 %	189.43 %	204.68 %	185.66 %	182.07 %	188.89 %	185.25 %	185.38 %	192.54 %	148.70 %
Germany	605 MW	113.34 %	121.26 %	118.51 %	118.22 %	115.80 %	106.61 %	96.92 %	107.83 %	116.32 %	116.55 %	103.72 %	95.76 %
2019	46 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
MAVIR	29 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
PSE	157 MW	114.86 %	111.03 %	108.86 %	109.56 %	109.52 %	109.81 %	110.71 %	109.92 %	110.91 %	111.21 %	113.95 %	112.96 %
REE	368 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
REN	54 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
RTE	527 MW	106.00 %	91.00 %	94.00 %	94.00 %	96.00 %	100.00 %	105.00 %	94.00 %	86.00 %	87.00 %	105.00 %	118.00 %
SEPS	26 MW	71.27 %	70.95 %	70.72 %	81.87 %	75.68 %	76.28 %	71.89 %	75.47 %	73.36 %	82.10 %	68.85 %	71.08 %
SG	61 MW	166.00 %	182.00 %	166.00 %	157.00 %	154.00 %	233.00 %	239.00 %	243.00 %	218.00 %	190.00 %	180.00 %	174.00 %
HOPS	11 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
NOS BiH	15 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
ELES	15 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
EMS	39 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
CGES	2 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
MEPSO	5 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
SMM	46 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
TEIAS	294 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
Terna	274 MW	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
TTB	111 MW	30.83 %	35.01 %	34.41 %	34.20 %	32.96 %	33.69 %	41.85 %	41.03 %	40.00 %	39.96 %	47.36 %	43.82 %

Figure 37 CE LFCs 2019 TSO FCR Statistics

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A. Appendix

Country	TSO (full company name)	TSO (short name)
Austria	Austrian Power Grid AG	APG
Belgium	Elia System Operator SA	Elia
Bosnia and Herzegovina	Nezavisni operator sustava u Bosni i Hercegovini	NOS BiH
Bulgaria	Electroenergien Sistemen Operator EAD	ESO
Croatia	HOPS d.o.o.	HOPS
Czech Republic	ČEPS a.s.	ČEPS
Denmark	Energinet	EN
Estonia	Elering AS	Elering AS
Finland	Fingrid Oyj	Fingrid
France	Réseau de Transport d'Electricité	RTE
Germany	TransnetBW GmbH	TransnetBW
Germany	TenneT TSO GmbH	TenneT DE
Germany	Amprion GmbH	Amprion
Germany	50Hertz Transmission GmbH	50Hertz
UK (Great Britain)	National Grid Electricity System Operator Limited	NGESO (National Grid ESO)
UK (Northern Ireland)	System Operator for Northern Ireland Ltd	SONI
Greece	Independent Power Transmission Operator S.A.	IPTO
Hungary	MAVIR Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság	MAVIR ZRt.
Ireland	EirGrid plc	EirGrid
Italy	Terna - Rete Elettrica Nazionale SpA	Terna
Latvia	AS Augstsprieguma tīkls	AST
Lithuania	Litgrid AB	Litgrid
Luxembourg	Creos Luxembourg S.A.	CREOS
Montenegro	Crnogorski elektroprenosni sistem AD	CGES
Netherlands	TenneT TSO B.V.	TenneT NL
Norway	Statnett SF	Statnett
Poland	Polskie Sieci Elektroenergetyczne S.A.	PSE S.A.
Portugal	Rede Eléctrica Nacional, S.A.	REN
Republic of North Macedonia	Transmission System Operator of the Republic of North Macedonia	MEPSO
Romania	C.N. Transelectrica S.A.	Transelectrica
Serbia	Joint Stock Company Elektromreža Srbije	EMS
Slovak Republic	Slovenská elektrizačná prenosová sústava, a.s.	SEPS
Slovenia	Sistemski operater prenosnega elektroenergetskega omrežja Republike Slovenije	ELES
Spain	Red Eléctrica de España S.A.	REE
Sweden	Svenska Kraftnät	SVENSKA KRAFTNÄT, SVK
Switzerland	Swissgrid AG	Swissgrid
Turkey	TEİAŞ	TEİAŞ

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Abbreviation	Meaning
FCR	Frequency Containment Reserves
aFRR	Automatic Frequency Restoration Reserves
mFRR	Manual Frequency Restoration Reserves
TSO	Transmission System Operator
CE	Continental Europe
IE/NI	Ireland and Northern Ireland
FRCE	Frequency Restoration Control Error
StG	Steering Group Operations
SOC	System Operations Committee
TO	Transmission owner
GB	Great Britain

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B. Appendix – CE LFC Block data

APG

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6.3	5.7	0.7	5	-4.2	5.6	4.2	6.5	11	13.2	11	10.4	6.3
The standard deviation	63	69	69	63	61	59	49	58	62	63	62	61	62
1-percentile	-172	-193	-193	-188	-201	-151	-116	-150	-173	-143	-150	-141	-164
5-percentile	-95	-102	-104	-84	-96	-73	-69	-82	-81	-84	-79	-83	-86
10-percentile	-62	-68	-71	-57	-67	-49	-48	-53	-56	-56	-57	-54	-58
90-percentile	79	79	76	74	59	67	60	72	85	89	87	78	76
95-percentile	109	114	108	102	81	94	84	99	113	114	114	110	103
99-percentile	178	207	177	174	146	163	163	169	171	189	180	200	176
No. of intervals: Avg. FRCE > Level 1 +	172	165	166	140	86	111	108	141	186	209	190	176	1850
No. of intervals: Avg. FRCE < Level 1 -	132	134	156	101	122	75	54	91	89	92	79	85	1210
No. of intervals: Avg. FRCE > Level 2 +	21	34	19	21	15	20	15	15	15	25	25	32	257
No. of intervals: Avg. FRCE < Level 2 -	19	27	30	26	32	15	4	15	17	12	11	7	215
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	1	1	1	0	0	0	1	0	0	1	5

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-5.1	-1	-0.4	0.9	1.1	1.2	1.9	2.6	3.5	0.8	-0.5	0	0.4
The standard deviation	24	20	21	22	21	21	25	21	23	21	19	16	21
1-percentile	-203	-129	-138	-117	-107	-106	-130	-96	-116	-110	-121	-95	-124
5-percentile	-80	-57	-62	-57	-52	-47	-56	-44	-57	-51	-56	-43	-55
10-percentile	-45	-36	-38	-37	-32	-31	-37	-28	-38	-33	-35	-26	-35
90-percentile	33	32	37	37	33	31	37	33	45	34	34	26	34
95-percentile	51	49	57	56	52	48	58	52	69	51	51	41	53
99-percentile	109	112	122	123	116	114	172	138	168	102	95	89	121
No. of intervals: Avg. FRCE > Level 1 +	19	11	24	20	25	21	55	30	50	13	10	9	287
No. of intervals: Avg. FRCE < Level 1 -	94	23	35	16	9	14	29	7	11	9	20	9	276
No. of intervals: Avg. FRCE > Level 2 +	5	3	11	10	15	11	24	18	17	5	2	5	126
No. of intervals: Avg. FRCE < Level 2 -	37	2	13	2	2	5	9	4	3	2	5	3	87
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	1	1	7	2	5	6	10	7	6	1	0	0	46
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	8	0	4	0	0	1	2	1	0	1	2	1	20

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CEPS

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.4	0.2	-0.1	-0.2	0	-0.1	-0.1	0.2	-0.2	0.1	-0.1	0	0
The standard deviation	45	49	46	46	40	39	32	33	42	51	46	42	43
1-percentile	-136	-144	-134	-138	-115	-109	-90	-91	-114	-158	-134	-120	-124
5-percentile	-59	-63	-60	-57	-50	-51	-44	-45	-56	-64	-59	-54	-55
10-percentile	-39	-41	-39	-37	-33	-36	-30	-30	-38	-43	-40	-37	-37
90-percentile	37	41	38	36	33	36	30	30	37	44	40	37	37
95-percentile	60	66	62	57	51	54	45	46	57	69	62	58	57
99-percentile	145	164	153	155	127	118	95	102	133	172	151	136	138
No. of intervals: Avg. FRCE > Level 1 +	10	7	4	10	5	4	1	0	7	16	10	5	79
No. of intervals: Avg. FRCE < Level 1 -	5	11	11	10	7	2	0	5	6	20	6	5	88
No. of intervals: Avg. FRCE > Level 2 +	1	0	0	1	0	0	0	0	2	2	1	1	8
No. of intervals: Avg. FRCE < Level 2 -	0	1	1	0	1	0	0	3	0	4	0	0	10
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	1	0	1	0	2
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.1	-0.1	-0.1	0.1	-0.2	-0.2	-0.1	-0.1	0	-0.3	-0.4	-0.3	-0.1
The standard deviation	47	45	46	46	41	35	35	37	46	48	45	45	43
1-percentile	-136	-130	-134	-125	-116	-95	-97	-109	-133	-146	-138	-128	-124
5-percentile	-61	-59	-60	-58	-54	-47	-46	-49	-59	-60	-60	-57	-56
10-percentile	-41	-40	-40	-39	-36	-32	-31	-32	-39	-39	-39	-39	-37
90-percentile	41	39	38	39	35	32	29	31	37	38	38	38	36
95-percentile	65	61	61	61	54	48	46	50	60	62	61	61	58
99-percentile	155	145	163	149	125	101	109	124	156	162	144	142	140
No. of intervals: Avg. FRCE > Level 1 +	10	6	11	13	1	1	3	2	13	10	8	6	84
No. of intervals: Avg. FRCE < Level 1 -	4	3	5	3	4	4	0	3	2	13	7	7	55
No. of intervals: Avg. FRCE > Level 2 +	1	1	1	1	0	0	0	0	2	0	1	1	8
No. of intervals: Avg. FRCE < Level 2 -	0	0	0	0	2	1	0	0	0	0	2	0	5
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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ELIA

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.6	0.4	-3.4	1.7	-4.9	-3	-4.4	-2.2	1.6	-2.6	-4.4	-2.4	-1.9
The standard deviation	49	52	54	47	41	38	36	37	46	58	51	57	48
1-percentile	-182	-168	-196	-149	-161	-143	-145	-134	-136	-192	-183	-173	-167
5-percentile	-68	-81	-97	-73	-77	-58	-55	-51	-62	-98	-93	-90	-76
10-percentile	-36	-44	-51	-36	-42	-33	-30	-26	-33	-58	-52	-47	-40
90-percentile	42	43	41	41	24	23	17	18	38	48	37	33	33
95-percentile	76	79	72	79	46	43	31	39	74	84	69	63	63
99-percentile	161	182	168	169	121	116	87	107	158	174	141	174	150
No. of intervals: Avg. FRCE > Level 1 +	119	112	104	116	50	54	29	47	111	132	91	94	1059
No. of intervals: Avg. FRCE < Level 1 -	110	114	170	102	124	75	85	76	80	177	150	154	1417
No. of intervals: Avg. FRCE > Level 2 +	25	32	30	30	17	4	8	10	24	34	16	32	262
No. of intervals: Avg. FRCE < Level 2 -	36	27	48	21	28	16	25	13	17	48	42	31	352
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-8.8	2.3	2.1	-0.1	0.7	-1.2	0.6	1.3	4.8	1	-0.7	1.9	0.3
The standard deviation	54	58	52	46	46	54	39	37	40	52	51	62	50
1-percentile	-198	-169	-155	-165	-146	-182	-129	-127	-112	-183	-180	-205	-166
5-percentile	-102	-80	-77	-62	-52	-76	-46	-50	-44	-79	-75	-79	-70
10-percentile	-60	-42	-40	-31	-27	-37	-21	-22	-22	-41	-42	-41	-35
90-percentile	30	49	44	32	26	32	23	27	38	45	39	48	36
95-percentile	57	85	86	65	55	64	47	53	64	80	71	90	68
99-percentile	120	179	180	148	147	176	129	135	146	161	166	197	159
No. of intervals: Avg. FRCE > Level 1 +	62	125	145	93	82	89	63	81	88	124	103	156	1211
No. of intervals: Avg. FRCE < Level 1 -	183	122	118	94	75	121	71	62	46	121	110	127	1250
No. of intervals: Avg. FRCE > Level 2 +	15	33	36	17	20	31	11	14	21	26	27	49	300
No. of intervals: Avg. FRCE < Level 2 -	58	29	22	27	20	33	10	9	9	37	34	57	345
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	1	1	1	0	0	0	0	1	4
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	2	0	0	0	0	0	0	0	0	0	0	0	2

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ESO

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	2.7	2.9	-1.6	4.3	0.5	1.8	2.1	0.5	-1.2	-0.6	-1.5	-1.9	0.6
The standard deviation	62	68	65	53	40	41	39	34	43	43	46	44	49
1-percentile	-161	-182	-180	-129	-108	-103	-99	-94	-126	-128	-136	-129	-140
5-percentile	-102	-110	-111	-77	-66	-62	-61	-57	-71	-77	-79	-80	-80
10-percentile	-69	-74	-80	-52	-46	-45	-43	-40	-51	-52	-54	-55	-54
90-percentile	73	78	72	61	46	48	48	39	47	47	46	49	54
95-percentile	106	111	103	87	67	66	65	56	67	67	72	68	78
99-percentile	180	192	169	168	110	118	113	94	112	117	123	111	141
No. of intervals: Avg. FRCE > Level 1 +	376	370	364	270	162	157	166	113	166	165	176	169	2654
No. of intervals: Avg. FRCE < Level 1 -	335	350	412	212	168	139	144	122	189	225	225	236	2757
No. of intervals: Avg. FRCE > Level 2 +	111	121	110	74	21	27	27	9	22	29	35	20	606
No. of intervals: Avg. FRCE < Level 2 -	99	117	127	36	18	16	14	8	38	39	41	39	592
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	57	57	52	22	10	10	7	6	9	10	16	6	262
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	4	12	7	3	0	1	1	0	1	0	2	3	34

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.1	1.5	7	2.4	-0.2	0.6	2.3	-0.2	1.1	0.6	0.7	1.9	1.6
The standard deviation	53	54	72	54	41	40	43	40	46	45	47	50	50
1-percentile	-143	-146	-154	-127	-106	-106	-110	-110	-121	-126	-135	-140	-130
5-percentile	-88	-86	-91	-82	-70	-64	-63	-65	-76	-76	-77	-80	-77
10-percentile	-60	-59	-66	-57	-51	-46	-42	-47	-52	-50	-50	-54	-53
90-percentile	57	62	76	60	47	47	51	47	54	50	49	59	55
95-percentile	83	87	108	89	68	66	73	63	78	71	76	82	78
99-percentile	146	148	247	154	107	112	119	102	125	125	136	138	137
No. of intervals: Avg. FRCE > Level 1 +	258	263	386	265	176	158	210	154	232	200	209	260	2771
No. of intervals: Avg. FRCE < Level 1 -	279	252	329	237	189	162	150	162	205	215	200	234	2614
No. of intervals: Avg. FRCE > Level 2 +	56	59	126	69	18	22	30	18	31	36	43	62	570
No. of intervals: Avg. FRCE < Level 2 -	60	60	77	43	21	16	24	20	32	34	43	58	488
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	25	22	44	27	11	10	14	7	15	13	22	19	229
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	9	2	5	1	1	1	1	1	0	3	2	6	32

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Germany

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	64.7	48.9	24.4	36.5	13.9	-4.5	14	-3.3	16	27.4	3.5	2.6	20.3
The standard deviation	61	51	70	65	78	55	41	61	75	67	84	62	64
1-percentile	-80	-94	-117	-117	-152	-140	-84	-132	-136	-138	-231	-143	-130
5-percentile	-24	-41	-75	-66	-116	-91	-50	-90	-81	-81	-119	-90	-77
10-percentile	-1	-15	-54	-43	-94	-70	-35	-72	-57	-51	-80	-66	-53
90-percentile	118	106	109	108	100	59	63	63	89	100	93	73	90
95-percentile	137	122	136	128	120	79	79	93	114	128	130	105	114
99-percentile	200	172	194	184	163	124	117	169	169	202	232	174	175
No. of intervals: Avg. FRCE > Level 1 +	16	2	11	9	3	2	1	11	12	15	24	11	117
No. of intervals: Avg. FRCE < Level 1 -	1	0	3	2	5	3	0	3	6	3	24	3	53
No. of intervals: Avg. FRCE > Level 2 +	9	0	4	1	0	0	0	1	2	2	1	1	21
No. of intervals: Avg. FRCE < Level 2 -	0	0	0	0	2	0	0	0	2	1	6	1	12
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	1	0	2	1	0	0	0	0	1	0	0	0	5
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	2	0	0	1	3

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	10	19	22	2	7	1	0	9	6	2	8	9	7.9
The standard deviation	63	64	62	61	55	93	53	53	50	59	46	50	59
1-percentile	-188	-116	-129	-135	-138	-192	-124	-122	-126	-125	-96	-104	-133
5-percentile	-85	-66	-71	-82	-76	-83	-81	-72	-71	-81	-63	-63	-74
10-percentile	-58	-48	-45	-58	-55	-58	-64	-52	-49	-64	-46	-45	-54
90-percentile	74	85	87	60	67	66	62	71	69	69	66	62	70
95-percentile	102	110	115	85	95	92	85	95	87	92	90	85	94
99-percentile	175	182	194	171	156	186	146	144	130	156	134	144	160
No. of intervals: Avg. FRCE > Level 1 +	7	9	10	12	6	12	3	2	4	14	3	8	90
No. of intervals: Avg. FRCE < Level 1 -	16	2	0	5	5	21	3	2	0	4	0	2	60
No. of intervals: Avg. FRCE > Level 2 +	0	0	5	1	0	3	0	0	0	0	0	1	10
No. of intervals: Avg. FRCE < Level 2 -	1	1	0	2	0	12	1	1	0	0	0	0	18
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	1	0	0	0	0	0	0	1
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	1	0	0	0	0	0	0	1

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IPTO

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	15.4	16.6	21.5	12	13	9.1	8.1	10.6	5.3	4.2	7.2	15.6	11.5
The standard deviation	44	46	54	45	34	28	27	36	24	23	32	47	38
1-percentile	-64	-54	-68	-53	-22	-15	-34	-43	-55	-46	-38	-38	-43
5-percentile	-13	-11	-14	-13	-8	-7	-9	-11	-13	-23	-10	-9	-21
10-percentile	-7	-6	-7	-7	-5	-4	-5	-6	-7	-12	-5	-5	-6
90-percentile	62	64	100	43	43	24	27	42	22	33	25	50	40
95-percentile	107	112	163	87	82	60	56	79	38	65	57	111	84
99-percentile	180	207	215	191	165	137	124	178	93	99	140	240	174
No. of intervals: Avg. FRCE > Level 1 +	291	271	406	207	208	138	129	195	69	77	125	242	2358
No. of intervals: Avg. FRCE < Level 1 -	30	24	32	20	2	2	11	22	25	19	18	15	220
No. of intervals: Avg. FRCE > Level 2 +	105	118	232	91	76	41	36	68	18	16	39	136	976
No. of intervals: Avg. FRCE < Level 2 -	15	12	9	6	0	1	5	7	8	5	8	3	79
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	148	116	131	83	94	61	75	91	44	40	71	107	1061
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	5	7	0	1	0	0	2	2	1	3	2	2	25

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	18.9	9.8	22	21.5	17.4	8.2	12.3	6.8	4.9	12.1	12.1	22	14
The standard deviation	50	32	53	51	49	30	51	35	30	42	40	66	46
1-percentile	-28	-36	-38	-37	-45	-16	-27	-52	-52	-44	-29	-49	-45
5-percentile	-9	-9	-12	-8	-17	-6	-7	-9	-11	-20	-11	-13	-20
10-percentile	-5	-5	-6	-5	-8	-4	-5	-5	-6	-12	-7	-7	-6
90-percentile	69	32	78	76	68	18	26	16	16	75	38	76	45
95-percentile	121	71	138	133	149	43	94	54	35	166	76	139	100
99-percentile	234	147	241	247	185	169	237	173	119	203	210	312	215
No. of intervals: Avg. FRCE > Level 1 +	310	148	335	318	363	110	179	123	79	192	169	339	2665
No. of intervals: Avg. FRCE < Level 1 -	10	7	8	13	5	2	13	19	21	18	9	20	145
No. of intervals: Avg. FRCE > Level 2 +	141	50	173	158	178	47	105	68	26	92	73	181	1292
No. of intervals: Avg. FRCE < Level 2 -	4	2	1	2	1	0	6	8	5	6	1	8	44
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	132	74	127	120	57	42	55	46	33	77	73	114	950
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	1	1	2	0	0	0	2	5	2	2	1	3	19

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MAVIR

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.1	0.1	1.2	0.6	0.3	0.6	1.2	1.4	0.7	-0.1	0	-0.3	0.5
The standard deviation	19	18	18	17	16	17	15	16	16	16	18	17	17
1-percentile	-36	-38	-38	-40	-38	-39	-33	-33	-36	-34	-36	-37	-36
5-percentile	-26	-26	-26	-26	-25	-25	-23	-24	-24	-25	-26	-26	-25
10-percentile	-22	-21	-20	-20	-18	-19	-17	-18	-18	-20	-20	-20	-20
90-percentile	24	22	24	21	19	20	20	21	20	21	22	21	21
95-percentile	34	30	33	29	27	28	26	28	29	29	32	29	29
99-percentile	52	48	49	47	44	43	41	40	43	46	52	45	46
No. of intervals: Avg. FRCE > Level 1 +	30	19	23	15	13	14	6	10	9	16	31	18	204
No. of intervals: Avg. FRCE < Level 1 -	1	2	6	8	13	10	3	1	1	3	1	6	55
No. of intervals: Avg. FRCE > Level 2 +	2	0	0	1	0	3	1	1	0	0	1	1	10
No. of intervals: Avg. FRCE < Level 2 -	0	1	1	1	0	1	0	1	0	0	0	1	6
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	1	0	0	0	0	0	0	1
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.3	-0.8	-0.4	0.5	-0.4	0.5	1.7	1.4	1.3	0.7	-0.2	-0.1	0.3
The standard deviation	18	17	18	17	15	17	16	16	17	18	17	17	17
1-percentile	-35	-35	-39	-35	-33	-37	-34	-36	-38	-35	-35	-37	-36
5-percentile	-26	-27	-27	-24	-24	-25	-23	-24	-24	-25	-25	-26	-25
10-percentile	-20	-21	-22	-19	-19	-20	-18	-18	-19	-19	-20	-21	-20
90-percentile	23	22	22	21	18	19	20	19	23	22	21	21	21
95-percentile	31	30	30	28	25	25	27	26	31	31	30	29	29
99-percentile	49	47	46	44	40	42	43	42	47	50	49	47	45
No. of intervals: Avg. FRCE > Level 1 +	17	13	16	13	5	12	10	13	18	24	20	14	175
No. of intervals: Avg. FRCE < Level 1 -	0	1	9	3	7	5	2	2	2	2	3	0	36
No. of intervals: Avg. FRCE > Level 2 +	1	0	0	1	2	5	2	2	0	4	1	1	19
No. of intervals: Avg. FRCE < Level 2 -	0	0	2	0	1	1	0	1	0	0	0	0	5
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	1	1	1	0	0	0	0	0	3
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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OST

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.2	-5.7	2.2	3.2	0.4	0.6	0.1	0.1	0	0.2	0.7	0.3	0.2
The standard deviation	4	16	19	10	4	4	3	4	3	4	6	5	7
1-percentile	-11	-63	-68	-22	-11	-9	-9	-10	-10	-12	-12	-11	-21
5-percentile	-7	-39	-30	-8	-6	-5	-5	-6	-5	-6	-6	-6	-11
10-percentile	-5	-29	-18	-5	-4	-3	-4	-4	-4	-4	-4	-4	-7
90-percentile	4	6	24	14	5	5	4	4	4	4	6	5	7
95-percentile	6	9	31	25	6	6	6	5	6	6	9	8	10
99-percentile	11	17	45	40	10	11	9	10	10	11	28	15	18
No. of intervals: Avg. FRCE > Level 1 +	1	3	273	142	0	1	0	1	0	6	35	5	467
No. of intervals: Avg. FRCE < Level 1 -	2	313	206	17	3	1	0	0	0	6	1	2	551
No. of intervals: Avg. FRCE > Level 2 +	0	0	17	4	0	0	0	0	0	0	4	0	25
No. of intervals: Avg. FRCE < Level 2 -	0	60	77	1	2	0	0	0	0	0	0	0	140
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.3	0.8	0.4	1.4	1.5	0.2	0.3	0.1	0.4	0.2	-0.3	-0.4	0.4
The standard deviation	5	6	6	6	7	3	2	2	3	3	4	2	4
1-percentile	-12	-11	-17	-14	-11	-9	-5	-7	-8	-9	-14	-8	-10
5-percentile	-7	-5	-7	-6	-5	-4	-2	-3	-4	-4	-5	-4	-5
10-percentile	-5	-4	-4	-4	-3	-2	-1	-2	-2	-2	-3	-2	-3
90-percentile	5	5	6	8	8	2	2	2	3	2	2	1	4
95-percentile	8	8	9	13	16	4	3	3	5	4	5	3	7
99-percentile	16	32	19	23	26	9	7	8	9	9	15	9	15
No. of intervals: Avg. FRCE > Level 1 +	15	53	24	61	93	1	0	1	0	1	14	2	265
No. of intervals: Avg. FRCE < Level 1 -	7	3	15	6	8	1	0	2	1	2	12	0	57
No. of intervals: Avg. FRCE > Level 2 +	0	16	4	2	8	0	0	0	0	0	0	0	30
No. of intervals: Avg. FRCE < Level 2 -	0	0	4	0	5	0	0	1	0	0	0	0	10
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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PSE

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	3.2	3.9	2.4	1.7	1.9	1	0.5	0.4	0.2	0.7	0.1	0.9	1.4
The standard deviation	57	57	57	58	56	56	59	60	62	61	60	57	58
1-percentile	-134	-140	-137	-140	-135	-141	-137	-143	-154	-159	-151	-151	-144
5-percentile	-89	-87	-90	-89	-90	-90	-93	-93	-107	-98	-99	-92	-93
10-percentile	-63	-66	-67	-69	-67	-68	-70	-72	-75	-72	-71	-68	-69
90-percentile	73	75	73	72	69	69	73	75	76	75	70	70	73
95-percentile	96	100	95	96	91	94	97	103	103	100	94	94	97
99-percentile	144	150	153	151	142	137	159	154	153	157	146	143	149
No. of intervals: Avg. FRCE > Level 1 +	55	64	56	52	48	52	73	84	67	73	54	52	730
No. of intervals: Avg. FRCE < Level 1 -	43	40	44	50	44	42	50	49	82	78	71	53	646
No. of intervals: Avg. FRCE > Level 2 +	4	1	0	2	4	2	1	3	2	0	3	0	22
No. of intervals: Avg. FRCE < Level 2 -	3	0	2	2	1	3	2	1	4	5	2	4	29
No. of time intervals: FRCE > 60 % FRR* capacity+** and < 15 % FRR* capacity+** after 15 min	3	1	0	1	2	0	0	0	1	0	1	0	9
No. of time intervals: FRCE < -60 % FRR* capacity+** and <- 15 % FRR* capacity+** after 15 min	1	0	1	0	0	0	1	1	1	0	0	1	6

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.3	0.7	1.7	1.3	0.2	-0.6	0.8	0.7	1.2	1	0.9	0.9	0.8
The standard deviation	61	60	64	60	57	59	60	60	58	61	60	59	60
1-percentile	-159	-165	-167	-155	-149	-165	-159	-149	-158	-164	-164	-157	-159
5-percentile	-101	-100	-104	-95	-95	-102	-97	-94	-93	-98	-100	-91	-97
10-percentile	-73	-70	-75	-69	-68	-73	-71	-70	-68	-71	-72	-70	-71
90-percentile	73	75	78	73	69	69	75	73	69	74	69	72	72
95-percentile	97	101	105	98	91	93	97	95	93	98	95	95	97
99-percentile	161	147	163	152	146	144	149	146	147	147	152	152	150
No. of intervals: Avg. FRCE > Level 1 +	70	56	85	59	49	55	55	59	50	66	59	51	714
No. of intervals: Avg. FRCE < Level 1 -	70	58	80	60	52	68	71	60	57	67	66	56	765
No. of intervals: Avg. FRCE > Level 2 +	3	1	6	3	2	0	2	5	4	2	2	3	33
No. of intervals: Avg. FRCE < Level 2 -	3	3	5	4	3	6	3	5	6	5	0	5	48
No. of time intervals: FRCE > 60 % FRR* capacity+** and < 15 % FRR* capacity+** after 15 min	3	0	7	2	1	1	0	4	2	3	0	3	26
No. of time intervals: FRCE < -60 % FRR* capacity+** and <- 15 % FRR* capacity+** after 15 min	4	1	1	2	2	4	3	1	0	0	0	2	20

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REE

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.9	2.5	2	-10.8	-10	-4.3	-0.4	-9.8	-6.7	-3.5	-6.6	-8.3	-4.6
The standard deviation	48	52	50	46	40	39	38	38	44	49	49	38	45
1-percentile	-116	-142	-135	-121	-120	-112	-99	-104	-111	-120	-142	-105	-120
5-percentile	-66	-81	-80	-78	-68	-61	-60	-68	-72	-74	-74	-68	-71
10-percentile	-50	-56	-55	-60	-54	-47	-44	-52	-55	-54	-57	-51	-53
90-percentile	50	57	54	39	32	40	42	33	40	49	45	35	43
95-percentile	69	74	75	58	47	53	55	46	53	69	63	52	60
99-percentile	129	122	123	121	83	87	85	80	107	124	135	92	110
No. of intervals: Avg. FRCE > Level 1 +	14	8	5	11	3	1	1	2	12	10	11	3	81
No. of intervals: Avg. FRCE < Level 1 -	6	14	10	8	5	9	6	3	8	10	13	1	93
No. of intervals: Avg. FRCE > Level 2 +	3	1	1	0	1	0	0	0	1	0	1	0	8
No. of intervals: Avg. FRCE < Level 2 -	1	2	2	1	1	0	0	1	1	1	0	0	10
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	2	1	0	3	1	0	0	0	2	2	3	1	15
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	1	0	0	0	0	0	0	2	1	1	0	0	5

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-8.5	-1	30.4	18.9	17.5	14.9	10.1	13.3	10.3	7.7	10.9	9.2	11.2
The standard deviation	42	42	82	48	44	39	39	36	49	46	54	47	50
1-percentile	-121	-113	-87	-114	-113	-100	-100	-84	-111	-137	-134	-117	-112
5-percentile	-73	-65	-37	-51	-48	-43	-47	-42	-55	-64	-71	-57	-56
10-percentile	-56	-48	-20	-31	-27	-29	-31	-26	-37	-44	-44	-37	-38
90-percentile	40	46	75	67	61	58	53	52	57	57	62	56	58
95-percentile	58	62	92	87	79	72	66	65	75	74	87	72	76
99-percentile	102	105	140	145	137	101	99	102	152	110	162	117	122
No. of intervals: Avg. FRCE > Level 1 +	5	3	15	11	12	2	2	4	20	2	22	7	105
No. of intervals: Avg. FRCE < Level 1 -	1	3	5	10	8	4	7	2	8	10	11	8	77
No. of intervals: Avg. FRCE > Level 2 +	0	0	5	2	0	1	0	1	2	1	2	2	16
No. of intervals: Avg. FRCE < Level 2 -	0	1	1	0	0	0	1	0	2	3	2	4	14
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	2	1	5	4	6	1	0	1	4	1	5	2	32
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	1	0	2	2	2	0	1	1	2	1	12

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REN

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-1.8	-1.4	-2	-0.7	-0.9	-0.3	-1	-0.2	0.1	-1.5	0.6	2.7	-0.5
The standard deviation	24	20	21	20	18	27	29	29	33	39	38	34	29
1-percentile	-79	-69	-69	-64	-59	-80	-72	-71	-75	-111	-90	-82	-80
5-percentile	-43	-35	-35	-31	-29	-44	-50	-46	-50	-64	-60	-44	-46
10-percentile	-25	-20	-20	-18	-16	-27	-37	-33	-37	-47	-42	-32	-31
90-percentile	18	16	15	14	13	26	35	35	39	42	45	39	30
95-percentile	33	26	24	25	23	42	48	50	55	60	64	56	46
99-percentile	66	55	58	57	53	83	75	81	94	106	102	113	84
No. of intervals: Avg. FRCE > Level 1 +	25	12	13	16	17	46	35	47	69	94	91	75	540
No. of intervals: Avg. FRCE < Level 1 -	40	18	28	19	15	39	28	28	32	103	76	42	468
No. of intervals: Avg. FRCE > Level 2 +	2	1	1	1	3	5	3	1	5	11	8	20	61
No. of intervals: Avg. FRCE < Level 2 -	1	1	4	0	1	2	0	1	5	5	2	7	29
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	26	9	21	12	12	11	3	2	2	15	5	25	143
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	15	10	8	8	8	27	6	5	14	26	13	9	149

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.1	-0.8	-2.5	-1.4	-1.1	0.2	2.7	0.9	0.8	1.2	1.8	4.9	0.6
The standard deviation	17	18	64	22	22	24	31	32	36	37	40	36	32
1-percentile	-51	-61	-63	-74	-72	-66	-80	-87	-91	-95	-99	-83	-77
5-percentile	-22	-30	-26	-37	-35	-37	-43	-49	-51	-60	-62	-46	-41
10-percentile	-14	-16	-15	-22	-22	-24	-30	-33	-37	-42	-45	-32	-28
90-percentile	15	14	13	18	18	25	39	38	40	45	48	45	30
95-percentile	24	24	21	30	29	39	54	52	62	63	69	67	44
99-percentile	52	55	47	61	60	75	89	88	103	95	113	119	80
No. of intervals: Avg. FRCE > Level 1 +	10	13	5	18	19	34	71	63	101	103	129	116	682
No. of intervals: Avg. FRCE < Level 1 -	16	14	24	31	29	23	47	62	71	90	89	51	547
No. of intervals: Avg. FRCE > Level 2 +	0	0	0	0	3	0	6	5	13	10	11	15	63
No. of intervals: Avg. FRCE < Level 2 -	2	1	4	1	4	2	2	2	7	8	5	7	45
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	10	6	7	28	16	4	18	7	5	8	10	20	139
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	5	8	7	11	24	8	17	20	13	16	17	5	151

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RTE

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	9.5	14.2	22.8	31.1	17	20.3	2.5	6.4	11	15	10.3	8.2	14
The standard deviation	164	173	198	206	187	180	159	170	178	197	182	162	180
1-percentile	-484	-459	-464	-465	-493	-397	-476	-483	-476	-515	-523	-427	-467
5-percentile	-222	-221	-237	-225	-224	-197	-232	-222	-247	-269	-243	-237	-232
10-percentile	-143	-146	-154	-142	-138	-137	-146	-139	-157	-169	-166	-152	-149
90-percentile	148	161	185	194	155	151	134	134	172	188	162	146	159
95-percentile	235	270	342	382	312	258	201	227	284	312	275	229	282
99-percentile	540	654	744	907	781	701	615	591	635	708	637	591	678
No. of intervals: Avg. FRCE > Level 1 +	158	173	250	251	214	164	135	150	196	232	186	150	2259
No. of intervals: Avg. FRCE < Level 1 -	139	128	159	143	146	125	151	146	164	196	165	155	1817
No. of intervals: Avg. FRCE > Level 2 +	58	62	107	118	98	82	60	59	82	89	71	60	946
No. of intervals: Avg. FRCE < Level 2 -	38	32	39	34	41	16	43	48	40	55	49	29	464
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	57	54	89	90	77	80	55	48	72	71	63	65	822
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	2	3	2	4	3	1	1	1	2	3	3	4	29

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.2	11.9	12.9	6.3	10.3	4.6	1.2	9.3	6	6.7	-3.2	6.1	6
The standard deviation	167	165	198	183	166	161	159	158	168	183	173	178	172
1-percentile	-507	-444	-552	-548	-466	-491	-509	-479	-500	-532	-586	-555	-502
5-percentile	-263	-235	-251	-261	-220	-220	-238	-206	-243	-270	-278	-263	-244
10-percentile	-168	-159	-169	-166	-134	-138	-133	-125	-156	-169	-169	-159	-155
90-percentile	139	164	167	151	135	131	127	137	154	161	146	158	148
95-percentile	219	261	297	270	210	214	208	209	245	281	232	268	247
99-percentile	548	593	748	594	623	574	517	542	583	595	498	572	583
No. of intervals: Avg. FRCE > Level 1 +	144	165	220	174	138	136	131	130	163	183	147	192	1923
No. of intervals: Avg. FRCE < Level 1 -	181	142	179	175	139	138	159	124	160	193	181	184	1955
No. of intervals: Avg. FRCE > Level 2 +	50	61	86	74	55	51	47	53	60	79	46	68	730
No. of intervals: Avg. FRCE < Level 2 -	50	28	55	50	37	37	52	33	49	49	64	61	565
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	47	60	66	66	49	46	49	49	54	60	56	73	675
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	2	3	2	4	1	2	1	1	2	2	7	4	31

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SEPS

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.7	-0.7	-0.6	-0.4	-0.4	-0.7	-0.3	0	-0.2	0.1	-0.3	0.1	-0.3
The standard deviation	15	15	16	16	15	14	13	13	15	15	15	16	15
1-percentile	-41	-41	-39	-39	-42	-38	-33	-35	-39	-42	-43	-41	-39
5-percentile	-25	-25	-25	-25	-25	-22	-21	-20	-21	-24	-25	-24	-23
10-percentile	-17	-18	-18	-18	-17	-15	-15	-14	-15	-17	-17	-17	-17
90-percentile	19	18	19	18	18	17	15	14	16	17	17	16	17
95-percentile	24	24	26	25	24	23	21	20	22	22	23	22	23
99-percentile	39	40	42	46	43	36	32	34	40	37	36	35	38
No. of intervals: Avg. FRCE > Level 1 +	14	9	15	22	15	11	5	7	14	6	7	10	135
No. of intervals: Avg. FRCE < Level 1 -	11	9	14	10	11	7	6	6	14	16	18	21	143
No. of intervals: Avg. FRCE > Level 2 +	1	0	1	1	0	3	0	0	0	0	1	0	7
No. of intervals: Avg. FRCE < Level 2 -	0	0	0	0	0	0	0	0	4	1	0	2	7
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.1	-0.7	-0.7	0.5	-0.6	-0.6	-0.6	-0.4	0	-0.1	-0.6	-0.4	-0.4
The standard deviation	16	14	15	10	11	10	9	9	13	15	12	13	12
1-percentile	-39	-33	-42	-29	-31	-33	-28	-28	-36	-44	-37	-39	-35
5-percentile	-22	-21	-24	-15	-14	-16	-13	-11	-16	-18	-18	-17	-17
10-percentile	-17	-16	-17	-9	-9	-11	-10	-8	-11	-12	-12	-12	-12
90-percentile	19	16	16	9	9	10	8	7	11	10	9	10	11
95-percentile	27	22	23	14	13	13	11	11	16	16	14	16	16
99-percentile	45	35	40	35	26	26	25	23	41	52	43	37	36
No. of intervals: Avg. FRCE > Level 1 +	21	8	14	12	9	4	4	5	19	34	25	17	172
No. of intervals: Avg. FRCE < Level 1 -	10	7	15	5	11	8	4	12	14	19	8	12	125
No. of intervals: Avg. FRCE > Level 2 +	2	0	0	0	1	1	0	0	4	8	3	4	23
No. of intervals: Avg. FRCE < Level 2 -	0	0	1	0	3	0	0	0	1	4	0	2	11
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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SG

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.2	0	-0.2	0	0	-0.5	-0.1	0.2	-0.1	-0.1	0.1	0	0
The standard deviation	8	8	8	8	8	8	8	8	8	8	8	8	8
1-percentile	-13	-12	-12	-11	-9	-8	-9	-10	-12	-12	-10	-11	-11
5-percentile	-8	-7	-7	-6	-5	-5	-5	-5	-6	-7	-7	-6	-6
10-percentile	-5	-5	-5	-4	-4	-3	-3	-4	-4	-5	-4	-4	-4
90-percentile	5	5	5	4	3	3	3	4	4	5	4	4	4
95-percentile	7	6	6	6	5	4	4	5	6	6	6	6	6
99-percentile	11	11	10	10	8	7	7	8	10	11	10	9	9
No. of intervals: Avg. FRCE > Level 1 +	4	1	0	0	0	0	0	3	0	0	4	1	13
No. of intervals: Avg. FRCE < Level 1 -	0	0	4	0	0	2	0	0	1	0	1	0	8
No. of intervals: Avg. FRCE > Level 2 +	2	0	0	0	0	0	0	2	0	0	1	0	5
No. of intervals: Avg. FRCE < Level 2 -	0	0	2	0	0	2	0	0	0	0	0	0	4
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	1	0	0	0	0	1
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.3	0	-0.1	0	-0.2	0	-0.1	0	0	0	-0.1	-0.2	-0.1
The standard deviation	7	7	7	7	7	7	7	7	7	7	7	7	7
1-percentile	-12	-12	-12	-11	-15	-16	-17	-19	-20	-20	-20	-20	-17
5-percentile	-7	-7	-7	-6	-8	-10	-9	-10	-12	-12	-11	-11	-9
10-percentile	-4	-5	-5	-4	-5	-6	-6	-7	-7	-8	-7	-7	-6
90-percentile	4	5	4	4	5	6	5	7	7	8	7	7	6
95-percentile	6	6	6	5	7	9	8	9	10	10	9	9	8
99-percentile	11	11	10	10	13	13	12	14	16	16	16	15	14
No. of intervals: Avg. FRCE > Level 1 +	1	0	0	1	0	0	0	0	2	0	0	0	4
No. of intervals: Avg. FRCE < Level 1 -	4	0	1	0	2	0	0	0	1	0	1	2	11
No. of intervals: Avg. FRCE > Level 2 +	1	0	0	0	0	0	0	0	0	0	0	0	1
No. of intervals: Avg. FRCE < Level 2 -	2	0	0	0	1	0	0	0	0	0	0	2	5
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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SHB

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.9	2.5	2	-10.8	-9.9	-4.3	-0.4	-9.8	-6.7	-3.5	-6.5	-8.3	-4.6
The standard deviation	48	52	50	46	40	39	38	38	44	49	49	38	45
1-percentile	-116	-142	-135	-121	-120	-112	-99	-104	-111	-120	-142	-105	-120
5-percentile	-66	-81	-80	-78	-68	-61	-60	-68	-72	-74	-74	-68	-71
10-percentile	-50	-56	-55	-60	-54	-47	-44	-52	-55	-54	-57	-51	-53
90-percentile	50	57	54	39	32	40	42	33	40	49	45	35	43
95-percentile	69	74	75	58	47	53	55	46	53	69	63	52	60
99-percentile	129	122	123	121	83	87	85	80	107	124	135	92	110
No. of intervals: Avg. FRCE > Level 1 +	14	8	5	11	3	1	1	2	12	10	11	3	81
No. of intervals: Avg. FRCE < Level 1 -	6	14	10	8	5	9	6	3	8	10	13	1	93
No. of intervals: Avg. FRCE > Level 2 +	3	1	1	0	1	0	0	0	1	0	1	0	8
No. of intervals: Avg. FRCE < Level 2 -	1	2	2	1	1	0	0	1	1	1	0	0	10
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	2	1	0	3	1	0	0	0	2	2	3	1	15
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	1	0	0	0	0	0	0	2	1	1	0	0	5

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6	9.6	7	9.1	9.7	11.7	-3	9.3	1.1	2.3	4.5	-0.9	5.5
The standard deviation	37	33	34	32	32	31	36	39	35	38	34	39	35
1-percentile	-110	-83	-94	-87	-83	-86	-109	-100	-103	-115	-100	-114	-99
5-percentile	-60	-40	-45	-44	-39	-37	-59	-48	-55	-64	-53	-58	-50
10-percentile	-35	-22	-26	-24	-23	-20	-40	-28	-38	-41	-32	-35	-30
90-percentile	42	42	39	39	39	43	34	48	37	40	39	30	39
95-percentile	58	63	53	55	55	58	52	71	55	58	55	44	57
99-percentile	94	114	102	89	93	97	102	127	104	101	94	88	100
No. of intervals: Avg. FRCE > Level 1 +	114	132	100	101	99	115	93	166	104	122	109	74	1329
No. of intervals: Avg. FRCE < Level 1 -	129	64	77	71	58	57	117	79	106	149	105	123	1135
No. of intervals: Avg. FRCE > Level 2 +	14	23	17	8	12	12	19	33	19	11	9	11	188
No. of intervals: Avg. FRCE < Level 2 -	22	8	6	10	8	8	20	15	9	28	12	27	173
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	6	1	2	1	1	3	7	8	2	2	2	1	36
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	1	0	0	0	0	0	0	0	0	0	0	1	2

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SMM

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-188.2	-380.6	-152.9	-15.3	-57.7	-154.1	-121.4	-86.5	-129	-74	-110.4	-146.8	-133.1
The standard deviation	148	107	241	115	89	88	90	83	75	82	77	89	107
1-percentile	-458	-701	-399	-347	-275	-492	-447	-366	-401	-289	-321	-369	-403
5-percentile	-386	-600	-451	-201	-191	-350	-270	-240	-254	-209	-241	-301	-306
10-percentile	-348	-530	-260	-150	-161	-247	-231	-196	-218	-179	-209	-266	-248
90-percentile	21	-257	-107	132	62	-57	-5	19	-32	43	-1	-22	-15
95-percentile	81	-224	2	187	95	-24	27	52	0	74	36	19	29
99-percentile	334	-143	197	322	206	49	85	120	76	147	105	104	136
No. of intervals: Avg. FRCE > Level 1 +	168	0	565	596	234	9	29	65	18	119	45	33	1881
No. of intervals: Avg. FRCE < Level 1 -	2393	2685	1746	894	1512	2625	2189	1725	2384	1670	2110	2436	24369
No. of intervals: Avg. FRCE > Level 2 +	83	0	351	276	49	0	2	11	9	24	7	7	819
No. of intervals: Avg. FRCE < Level 2 -	2213	2673	1480	339	573	1780	1360	791	1504	796	1266	1769	16544
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	3	0	43	31	3	0	0	3	1	2	1	3	90
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	58	11	24	10	7	20	25	12	15	8	18	40	248

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-171.2	-244.1	-378	-127.3	-78.7	-119.9	-175.4	-132.3	-204.5	-297.7	-326.6	-325.1	-215.1
The standard deviation	86	106	165	134	78	119	160	137	69	108	127	105	116
1-percentile	-329	-495	-781	-471	-251	-411	-762	-450	-363	-592	-758	-564	-519
5-percentile	-292	-411	-673	-392	-198	-277	-453	-285	-311	-471	-503	-489	-396
10-percentile	-270	-376	-607	-322	-173	-239	-278	-249	-287	-422	-453	-455	-344
90-percentile	-60	-106	-175	22	18	10	-64	-11	-114	-162	-173	-185	-83
95-percentile	-26	-64	-122	48	53	63	-16	68	-87	-119	-138	-144	-40
99-percentile	38	-7	-39	97	118	203	186	466	-44	-46	-27	-78	73
No. of intervals: Avg. FRCE > Level 1 +	23	2	7	64	104	134	87	150	3	2	5	0	581
No. of intervals: Avg. FRCE < Level 1 -	2632	2545	2919	1735	1720	2098	2651	2385	2810	2929	2841	2953	30218
No. of intervals: Avg. FRCE > Level 2 +	11	0	4	9	28	61	69	109	1	1	1	0	294
No. of intervals: Avg. FRCE < Level 2 -	2185	2319	2815	1244	776	1439	2089	1789	2504	2807	2760	2880	25607
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	2	0	0	2	3	7	8	5	1	0	0	0	28
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	53	53	49	19	9	45	35	24	49	62	45	51	494

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TEIAS

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	10.4	6.8	8.6	-1.9	8.2	16.6	7.7	5.5	8.4	15.3	7	16.7	9.1
The standard deviation	93	95	87	85	95	94	82	92	92	87	89	98	91
1-percentile	-215	-208	-188	-190	-216	-206	-193	-205	-201	-181	-202	-253	-205
5-percentile	-113	-120	-117	-128	-124	-108	-111	-121	-116	-107	-118	-110	-116
10-percentile	-83	-90	-88	-99	-92	-79	-81	-91	-88	-80	-88	-79	-87
90-percentile	109	107	109	95	112	119	103	104	107	114	107	120	109
95-percentile	147	146	142	129	154	155	140	140	146	151	143	159	146
99-percentile	287	276	249	234	288	281	241	270	284	263	250	290	268
No. of intervals: Avg. FRCE > Level 1 +	42	34	27	17	32	34	14	27	31	26	19	36	339
No. of intervals: Avg. FRCE < Level 1 -	25	17	13	4	18	20	11	22	11	7	16	34	198
No. of intervals: Avg. FRCE > Level 2 +	6	4	3	1	4	6	2	7	9	3	1	5	51
No. of intervals: Avg. FRCE < Level 2 -	6	4	2	0	2	5	1	5	2	3	3	8	41
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	4	0	1	2	0	2	0	2	2	0	0	2	15
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	2	0	0	0	0	2	1	1	0	1	0	0	7

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	10.5	15.5	6.9	17.9	22.1	12.8	3.3	2.4	5	8.3	-2.7	-1.2	8.4
The standard deviation	95	103	98	100	102	97	91	88	86	84	86	87	93
1-percentile	-223	-243	-216	-217	-236	-211	-232	-205	-195	-199	-214	-209	-217
5-percentile	-113	-127	-133	-125	-119	-124	-129	-122	-118	-115	-134	-133	-124
10-percentile	-85	-91	-101	-91	-85	-91	-95	-91	-88	-85	-101	-101	-92
90-percentile	110	129	117	135	139	122	107	100	103	106	97	100	114
95-percentile	147	172	161	178	186	168	147	136	138	142	131	136	153
99-percentile	284	315	296	295	313	304	253	242	227	226	229	232	268
No. of intervals: Avg. FRCE > Level 1 +	63	97	71	74	87	69	44	38	35	58	35	18	689
No. of intervals: Avg. FRCE < Level 1 -	15	31	10	20	40	20	24	13	17	21	30	9	250
No. of intervals: Avg. FRCE > Level 2 +	9	13	9	7	6	6	2	6	4	6	1	1	70
No. of intervals: Avg. FRCE < Level 2 -	3	3	2	2	8	0	4	0	0	0	0	0	22
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	1	1	0	1	0	0	0	0	1	1	0	0	5
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	1	0	1	0	1	0	1	0	1	0	0	0	5

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TERNA

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	25.9	16.2	22.2	56.2	28.3	14.2	7.3	21.4	15.8	12	18.8	18.3	N/A
The standard deviation	167	158	164	191	157	136	130	124	131	153	141	168	N/A
1-percentile	-381	-453	-394	-343	-371	-377	-395	-308	-332	-429	-348	-454	N/A
5-percentile	-194	-197	-200	-158	-181	-166	-159	-113	-141	-219	-177	-216	N/A
10-percentile	-125	-138	-139	-110	-106	-88	-93	-70	-83	-134	-115	-139	N/A
90-percentile	186	174	177	276	193	129	107	134	134	168	164	185	N/A
95-percentile	303	285	302	443	321	243	223	264	258	268	269	307	N/A
99-percentile	640	545	621	766	600	507	484	474	518	494	480	591	N/A
No. of intervals: Avg. FRCE > Level 1 +	360	301	356	501	371	239	213	267	240	322	302	365	3837
No. of intervals: Avg. FRCE < Level 1 -	217	202	234	140	178	155	147	102	120	237	177	244	2153
No. of intervals: Avg. FRCE > Level 2 +	149	116	150	261	167	108	92	114	113	117	122	152	1661
No. of intervals: Avg. FRCE < Level 2 -	56	63	58	41	55	51	58	31	45	81	45	81	665
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	90	76	102	149	125	85	66	92	74	80	80	94	1113
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	51	44	55	37	53	46	49	27	30	61	37	60	550

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	13.4	35.2	31.8	27.8	26.9	19.2	27.3	35.6	27.4	5.6	8.8	17.3	23
The standard deviation	150	158	157	157	158	152	146	141	136	94	95	119	139
1-percentile	-399	-361	-374	-346	-359	-384	-293	-253	-263	-229	-230	-260	-313
5-percentile	-200	-180	-177	-184	-175	-192	-157	-133	-151	-127	-123	-128	-160
10-percentile	-133	-117	-117	-125	-118	-121	-109	-95	-112	-92	-87	-87	-109
90-percentile	161	209	206	184	181	177	177	199	171	101	104	119	166
95-percentile	267	332	326	297	315	287	273	312	271	143	156	182	263
99-percentile	510	599	562	592	598	534	561	548	525	285	301	523	512
No. of intervals: Avg. FRCE > Level 1 +	292	362	387	344	347	315	337	373	318	113	128	185	3501
No. of intervals: Avg. FRCE < Level 1 -	216	164	169	185	166	194	135	91	117	88	76	90	1691
No. of intervals: Avg. FRCE > Level 2 +	118	152	162	133	155	122	115	153	120	22	26	73	1351
No. of intervals: Avg. FRCE < Level 2 -	59	42	46	40	48	53	24	11	13	13	12	20	381
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	6	2	8	13	12	9	3	5	3	0	0	2	63
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	2	1	1	1	1	0	1	0	0	0	0	0	7

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TEL

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.4	1.1	2.1	2.9	0.9	0.8	0.5	1.1	1.1	1.3	1.1	1.1	N/A
The standard deviation	35	37	42	45	30	32	27	27	31	35	32	35	N/A
1-percentile	-99	-106	-146	-120	-86	-118	-84	-73	-97	-103	-87	-111	N/A
5-percentile	-45	-48	-51	-47	-41	-40	-32	-30	-38	-39	-38	-40	N/A
10-percentile	-29	-30	-30	-26	-25	-25	-21	-19	-24	-25	-26	-25	N/A
90-percentile	30	33	38	35	28	29	23	20	26	30	26	27	N/A
95-percentile	48	54	61	66	43	44	33	33	42	51	40	45	N/A
99-percentile	119	119	145	153	104	100	81	100	111	109	102	114	N/A
No. of intervals: Avg. FRCE > Level 1 +	73	68	106	126	60	49	37	42	54	75	52	67	809
No. of intervals: Avg. FRCE < Level 1 -	67	59	86	74	38	56	39	24	44	58	43	64	652
No. of intervals: Avg. FRCE > Level 2 +	16	14	32	34	9	9	9	12	14	12	13	17	191
No. of intervals: Avg. FRCE < Level 2 -	11	12	30	21	11	13	7	5	10	12	12	16	160
No. of time intervals: FRCE > 60 % FRR capacity+ and < 15 % FRR capacity+ after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of time intervals: FRCE < -60 % FRR capacity+ and <- 15 % FRR capacity+ after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.3	2.5	4.6	3.4	3.6	3.7	3.1	2.8	2.5	1.5	2.3	1.9	N/A
The standard deviation	38	39	43	39	44	38	44	40	34	28	39	33	N/A
1-percentile	-118	-128	-126	-107	-131	-115	-152	-125	-93	-83	-92	-92	N/A
5-percentile	-44	-41	-50	-42	-40	-36	-39	-44	-39	-30	-33	-37	N/A
10-percentile	-28	-26	-29	-26	-25	-22	-23	-23	-23	-20	-22	-22	N/A
90-percentile	31	33	42	36	33	33	32	32	29	24	27	26	N/A
95-percentile	48	59	74	60	64	56	59	59	49	38	42	47	N/A
99-percentile	123	143	162	142	159	134	146	151	100	91	127	128	N/A
No. of intervals: Avg. FRCE > Level 1 +	71	95	141	96	116	94	102	100	62	44	64	85	N/A
No. of intervals: Avg. FRCE < Level 1 -	66	57	76	62	70	52	79	82	39	34	44	44	N/A
No. of intervals: Avg. FRCE > Level 2 +	20	22	47	28	37	23	31	33	13	6	19	19	N/A
No. of intervals: Avg. FRCE < Level 2 -	20	13	20	19	25	18	31	19	13	7	8	13	N/A
No. of time intervals: FRCE > 60 % FRR capacity+ and < 15 % FRR capacity+ after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	N/A
No. of time intervals: FRCE < -60 % FRR capacity+ and <- 15 % FRR capacity+ after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	N/A

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TTB

2018

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6.3	5.7	0.7	5	-4.2	5.6	4.2	6.5	11	13.2	11	10.4	6.3
The standard deviation	63	69	69	63	61	59	49	58	62	63	62	61	62
1-percentile	-172	-193	-193	-188	-201	-151	-116	-150	-173	-143	-150	-141	-164
5-percentile	-95	-102	-104	-84	-96	-73	-69	-82	-81	-84	-79	-83	-86
10-percentile	-62	-68	-71	-57	-67	-49	-48	-53	-56	-56	-57	-54	-58
90-percentile	79	79	76	74	59	67	60	72	85	89	87	78	76
95-percentile	109	114	108	102	81	94	84	99	113	114	114	110	103
99-percentile	178	207	177	174	146	163	163	169	171	189	180	200	176
No. of intervals: Avg. FRCE > Level 1 +	172	165	166	140	86	111	108	141	186	209	190	176	1850
No. of intervals: Avg. FRCE < Level 1 -	132	134	156	101	122	75	54	91	89	92	79	85	1210
No. of intervals: Avg. FRCE > Level 2 +	21	34	19	21	15	20	15	15	15	25	25	32	257
No. of intervals: Avg. FRCE < Level 2 -	19	27	30	26	32	15	4	15	17	12	11	7	215
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	0	0	1	1	1	0	0	0	1	0	0	1	5

2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-5.4	7.1	-0.3	-3.1	-1.7	-6.8	2.5	2.2	11.4	8.8	8.6	10.7	2.8
The standard deviation	69	59	56	54	55	55	47	46	58	63	59	64	57
1-percentile	-222	-167	-161	-177	-166	-188	-119	-125	-125	-154	-158	-161	-160
5-percentile	-120	-81	-88	-92	-85	-93	-62	-69	-77	-88	-80	-81	-85
10-percentile	-81	-55	-59	-61	-56	-68	-43	-47	-51	-60	-52	-55	-57
90-percentile	65	70	59	55	54	49	51	54	79	83	76	83	65
95-percentile	95	101	85	80	81	73	77	82	108	114	104	113	93
99-percentile	169	174	153	133	139	126	144	144	182	192	186	201	162
No. of intervals: Avg. FRCE > Level 1 +	120	121	107	64	80	51	84	76	151	184	147	185	1370
No. of intervals: Avg. FRCE < Level 1 -	199	89	96	111	100	109	43	60	70	101	90	89	1157
No. of intervals: Avg. FRCE > Level 2 +	19	16	9	5	5	11	5	8	20	27	23	34	182
No. of intervals: Avg. FRCE < Level 2 -	43	17	18	21	18	26	10	2	5	10	12	16	198
Number of events: FRCE > 60 % FRR capacity- and not < 15 % FRR capacity- within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60 % FRR capacity+ and not >- 15 % FRR capacity+ within 15 min	1	0	0	1	1	0	3	0	0	1	0	4	11

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