

# LOAD FREQUENCY CONTROL

## Annual Report

### 2020

Final | 30 September 2021

From: System Operations Committee

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## Executive Summary

According to Article 16 of the Commission Regulation (EU) 2017/1485 of 2 August 2017, which establishes 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 the following elements:

(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) The 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) The 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'.

(d) The FCR obligation and the initial FCR obligation of each TSO for 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 respective synchronous area's frequency quality was within the defined levels. All LFC blocks and TSOs provided their data and have explained any mitigation measures where applied.

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## INTRODUCTION

The 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 establishes an obligation for the 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 and publication of the annual LFC report. Each annual report is separately approved for publication by the ENTSO-E System Operations Committee.

The objectives of the LFC report are to present the results of the frequency quality evaluation criteria for each synchronous area and each LFC block and the FCR obligations and the initial FCR obligations of each TSO for each month of preceding two years, as well as a description and the 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.

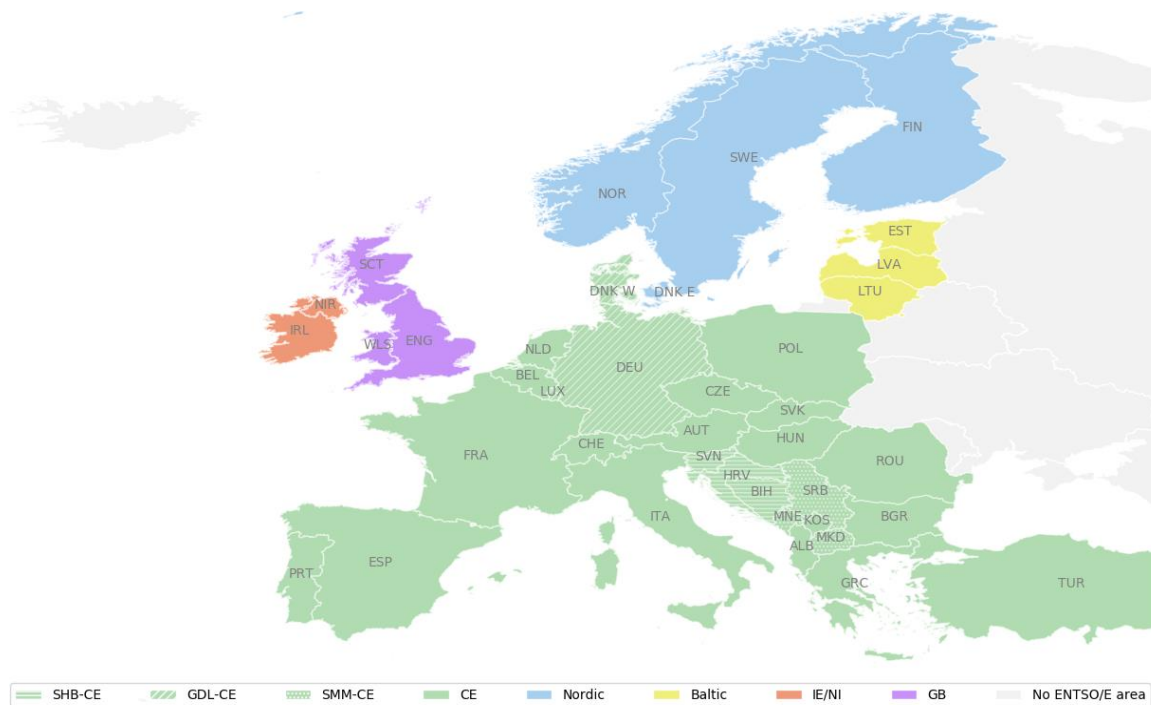
The annual report on load-frequency control includes the information listed in SO GL Article 16 (2) for each synchronous area, LFC block and TSO of ENTSO-E.

## SYNCHRONOUS AREAS, LFC BLOCKS, AND TSO IDENTIFICATION

In this paragraph, the requirements of SO GL Article 16(2)(a), (b) and (c) 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. All LFC blocks and LFC block monitors are reported in Tables 1-5. TSO acronyms are explained in Appendix A. For the Baltic Synchronous Area, the data collection process is not performed. The Baltic States power system is currently asynchronously connected to Continental Europe through the LitPol Link between Lithuania and Poland and to the Nordic Synchronous Area through the NordBalt link 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 enable the Baltic TSOs to operate their systems under the frequency of the Continental European System and under the EU rules.

European Synchronous Areas and LFC Blocks



**Figure 1 European Synchronous Areas and LFC Blocks**

According to Article 133 of SO GL, all TSOs of a synchronous area shall, in the synchronous area operational agreement, appoint one TSO of that synchronous area 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 analysed period.

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

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

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

Table 1 Continental Europe SA identification of LFC blocks

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

Table 2 GB SA identification of LFC blocks

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

Table 3 IE/NI SA identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
Nordic	FG, SN, SvK, DK-E	SN	Finland, Norway, Sweden, Denmark-East

Table 4 Nordic identification of LFC blocks

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

Table 5 Baltic identification of LFC blocks



## FREQUENCY QUALITY EVALUATION CRITERIA

### Introduction and target parameters

To maintain 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 the application of Frequency Containment Reserves [hereinafter FCR]. These reserves are activated quickly (typically within 30 s), stabilising the power system frequency and ensuring that the frequency deviation will not further increase. The Frequency Containment Process [hereinafter FCP] will stabilise the frequency with an offset from 50 Hz, but it is the change of speed of the rotating masses, inertia, that ensures the frequency change is damped so that FCR is able to contain and stabilise 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 or by manual activation, which reduces the Frequency Restoration Control Error [hereinafter FRCE] to zero. For aFRR, this control device usually is called a Load-Frequency Controller [hereinafter LF-Controller]. The LF-Controller is physically a process computer that is implemented in the TSOs' control centre systems (SCADA/EMS/AGC) and collects FRCE measurements every 4–10s, thus providing—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 mFRR, restores frequency by replacing the power from the FCR. This principle is applicable for normal imbalances such as the activation of a light bulb, the start of a train, or the sudden outage of a large power plant. Market behaviour, such as 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.

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Data item	CE	GB	IE/Nl	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 6 Frequency quality defining parameters of synchronous areas**

Data item	CE	GB	IE/Nl	Nordic
15 000	15 000	15 000	15 000	15 000

**Table 7 Frequency quality target parameters of synchronous areas**

Considering the aforementioned information for each synchronous area during operation in a normal state or an alert state, the following values are reported on a monthly basis for the instantaneous frequency data:

- (i) The mean value.
- (ii) The standard deviation.
- (iii) The 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup>, 90<sup>th</sup>, 95<sup>th</sup> and 99<sup>th</sup> percentiles.
- (iv) The total time during which the absolute value of the instantaneous frequency deviation was larger than the standard frequency deviation, distinguishing between positive and negative instantaneous frequency deviations.
- (v) The total time during which the absolute value of the instantaneous frequency deviation was larger than the maximum instantaneous frequency deviation, distinguishing between positive and negative 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/Nl and Nordic synchronous areas, within the time to restore frequency. The data distinguish between positive and negative frequency deviations.

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(vii) For the GB and IE/Nl 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 restore frequency, distinguishing between positive and negative frequency deviations.

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

(i) For a dataset containing the average values of the FRCE of the LFC block over time intervals equal to the frequency restoration time:

- the mean value,
- the standard deviation,
- the 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup>, 90<sup>th</sup>, 95<sup>th</sup> and 99<sup>th</sup> percentiles,
- the number of time intervals in which the average value of the FRCE was outside the Level 1 FRCE range, distinguishing between positive and negative FRCE, and the number of time intervals in which the average value of the FRCE was outside the Level 2 FRCE range, distinguishing between positive and negative FRCE.

(ii) For a dataset 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 positive and negative 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 to reduce reserves or reserves activation. These parameters should rather be interpreted as an absolute warning limit that shows that the ACE quality is below the required standard and that the respective countermeasures have been reported and will be implemented urgently.

For the LFC blocks of the GB and IE/Nl synchronous area, during operation in a normal state or alert state and in accordance with Article 18(1) and (2), the 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 positive and negative FRCE.

## Performance – IE/NI

### Ireland/Northern Ireland Synchronous Area Performance

In the following tables and figures, data are presented for the IE/NI synchronous area for 2019 and 2020. The input values for frequency are based on instantaneous frequency values. Based on the input values, the mean value, standard deviation and percentiles were calculated. Moreover, any time periods and events when the system frequency was outside of predefined ranges were also indicated. For data points when the frequency was outside the 200–1000 mHz range, time is measured in minutes.

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2019

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99996	49.99980	50.00020	50.00002	50.00020	49.99990	50.00040	49.99990	50.00030	49.99980	50.00010	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	0.0380	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	49.940	49.936	49.938	49.935	49.940	49.939
10-percentile	49.948	49.946	49.950	49.952	49.957	49.956	49.958	49.952	49.949	49.950	49.949	49.953	49.952
90-percentile	50.053	50.053	50.052	50.047	50.043	50.043	50.042	50.048	50.053	50.051	50.051	50.049	50.049
95-percentile	50.070	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	50.081	50.076	50.089	50.090	50.091	50.087	50.089	50.088
Time(min) > 200 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -200 mHz	4	0	4	0	12	2	3	1	0	8	0	0	35
Time(min) > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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

Table 8 IE/NI SA Performance for Year 2019

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2020

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99990	49.99990	50.00070	49.99990	50.00030	49.99980	50.00030	49.99980	50.00020	49.99970	50.00050	50.00000	50.00008
The standard deviation	0.0413	0.0393	0.0379	0.0370	0.0364	0.0390	0.0393	0.0394	0.0405	0.0399	0.0402	0.0413	0.0393
1-percentile	49.908	49.915	49.918	49.921	49.920	49.914	49.917	49.917	49.915	49.915	49.914	49.909	49.915
5-percentile	49.936	49.937	49.942	49.942	49.942	49.939	49.938	49.939	49.937	49.937	49.937	49.933	49.938
10-percentile	49.950	49.950	49.954	49.954	49.954	49.951	49.949	49.951	49.949	49.949	49.950	49.948	49.951
90-percentile	50.054	50.051	50.049	50.048	50.047	50.051	50.051	50.051	50.054	50.053	50.053	50.054	50.051
95-percentile	50.070	50.066	50.064	50.060	50.060	50.063	50.064	50.066	50.066	50.067	50.066	50.068	50.065
99-percentile	50.094	50.090	50.091	50.083	50.084	50.086	50.088	50.092	50.088	50.091	50.090	50.093	50.089
Time(min) > 200 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -200 mHz	3	0	0	0	3	2	2	0	5	0	2	0	17
Time(min) > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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

Table 9 IE/NI SA Performance for Year 2020

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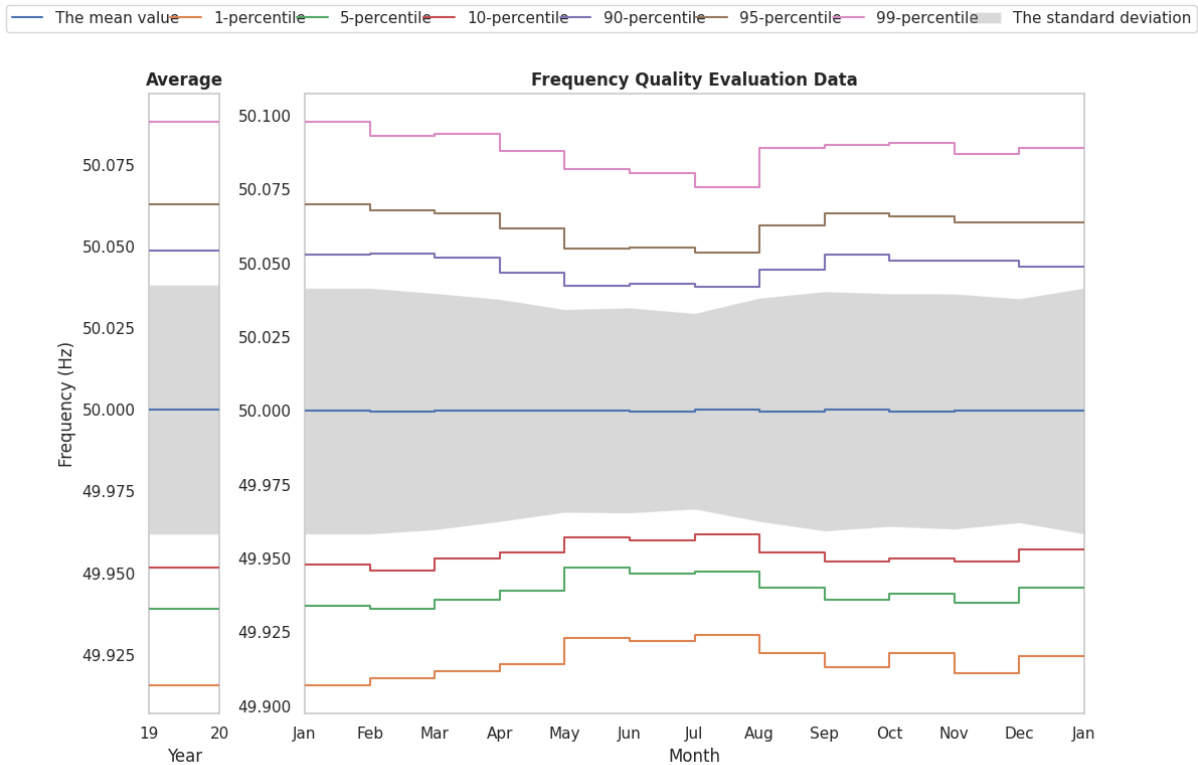


Figure 2 IE-NI SA 2019 frequency quality

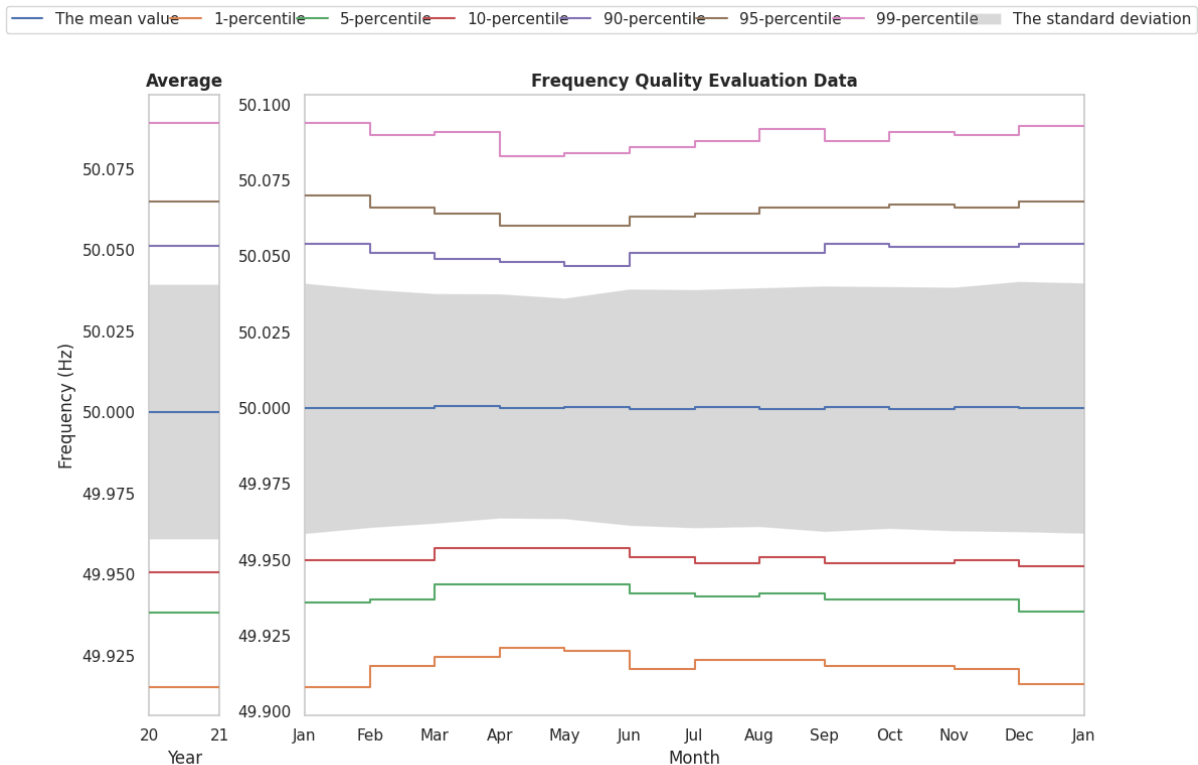


Figure 3 IE-NI SA 2020 frequency quality

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In Figures 4 and 5, the accumulated minutes outside standard ranges are presented for the years 2019 and 2020 respectively.

The red line shows the theoretical line in the case of a linear distribution (1/12 per month) of minutes outside standard ranges, considering the standard ranges from SO GL (15,000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. If 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, 5 and 5a below show that the frequency quality target parameters from SO GL were fulfilled for the respective years for the Ireland/Northern Ireland Synchronous Area.

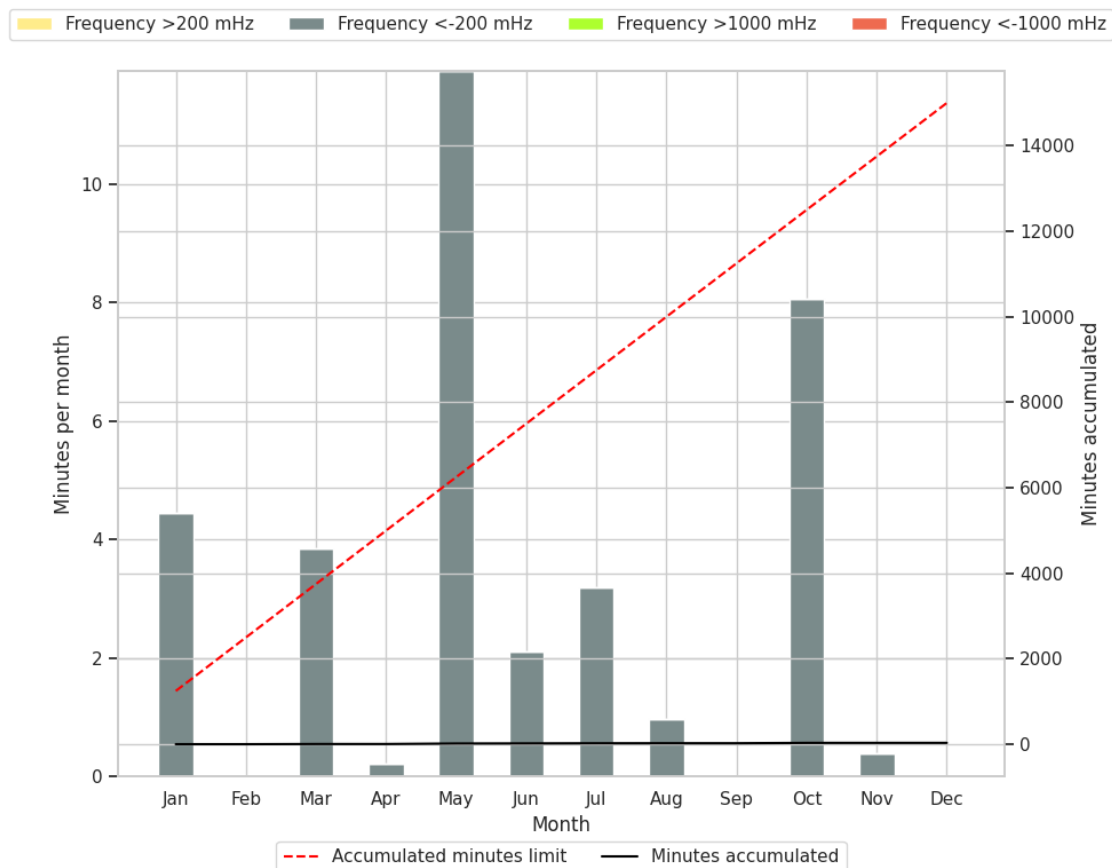


Figure 4 IE-NI SA 2019 frequency deviation



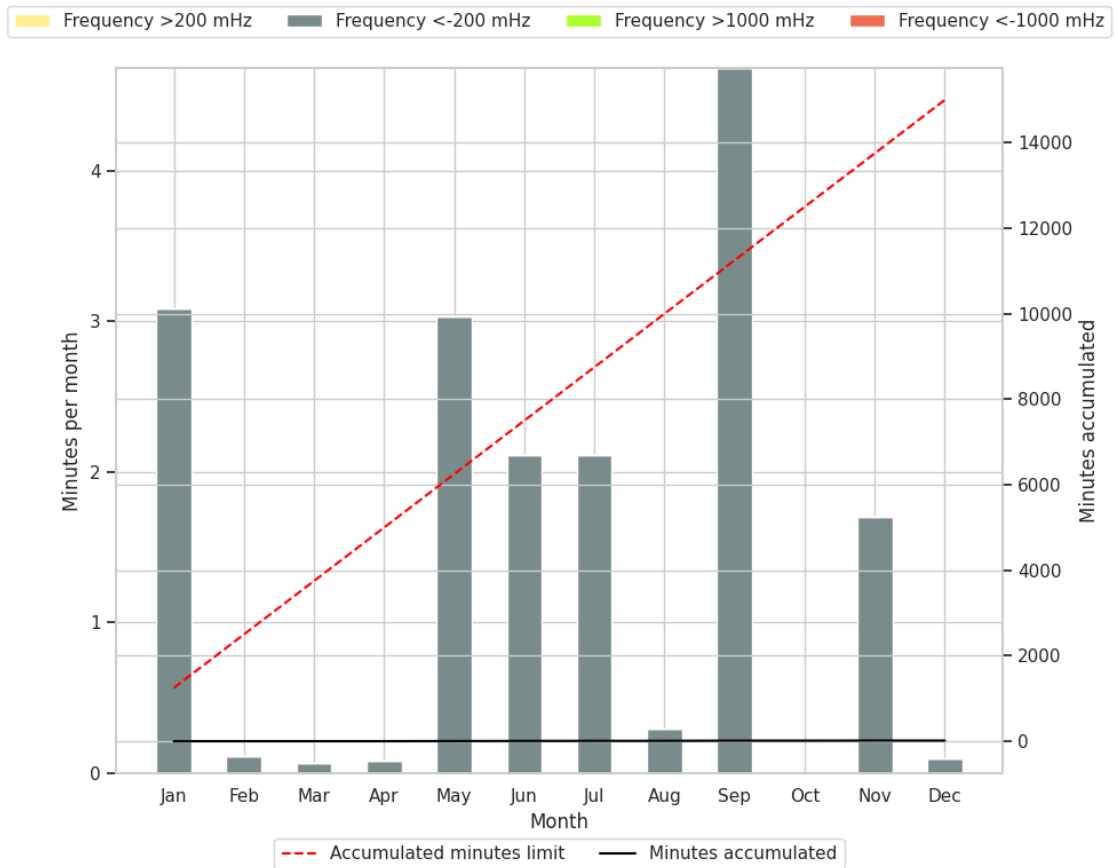


Figure 5 IE-NI SA 2020 frequency deviation

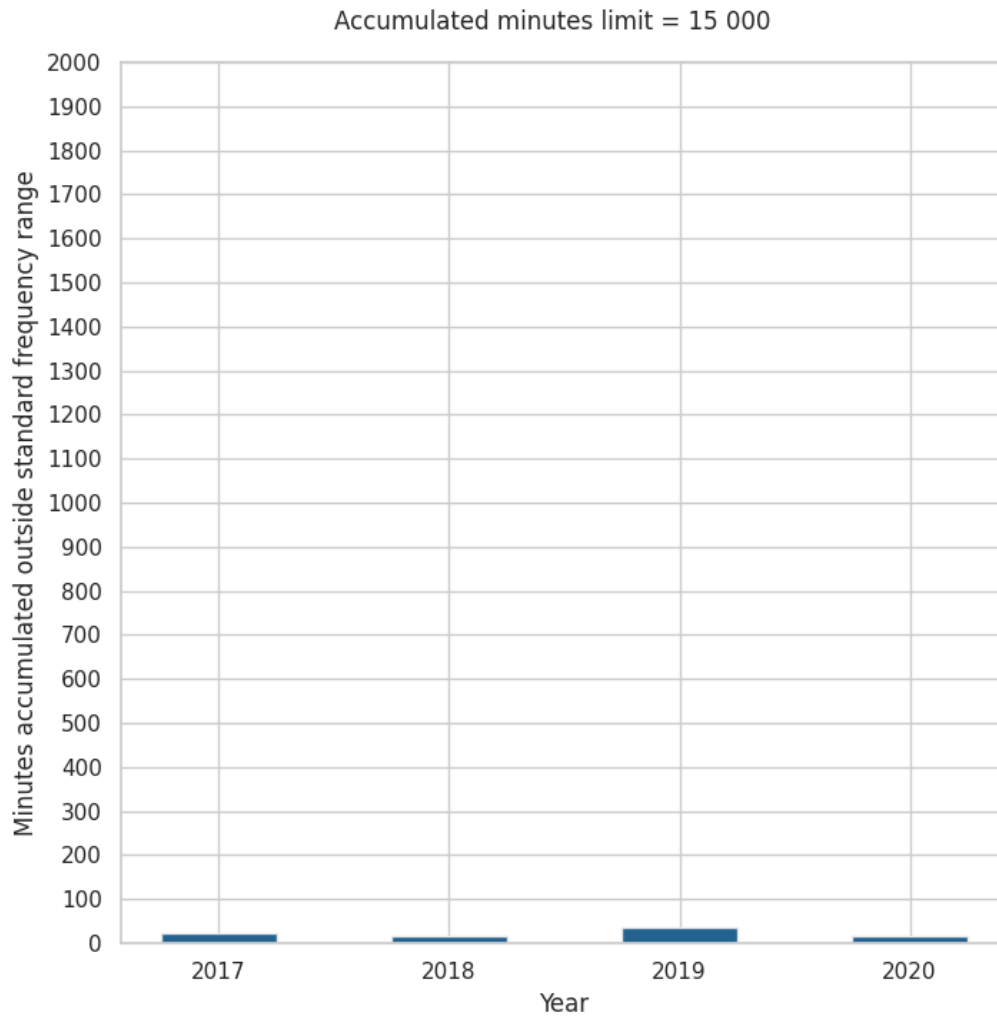


Figure 5a IE-NI SA frequency deviation trend

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## IE/NI Synchronous Area LFC Block Performance

Tables 10 and 11 show that there were no events where 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 the time to restore frequency, which corresponds to 15 minutes.

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

**Table 10 IE/NI LFC FRCE Statistic for Year 2019**

2020

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 2020**

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 is calculated using the following procedure:

1. If the frequency deviation is  $\geq 200$  mHz over a 15 -minute period or  $\leq -200$  mHz over a 15-minutes period, this qualifies as a Level 1 event.
2. If the frequency deviation is  $\geq 500$  mHz over a 1-minute period or  $\leq -500$  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)  $\times 0.03 = 1\,051$  periods.
4. The Level 2 FRCE target parameter = 1%, which is  $525\,600$  (periods)  $\times 0.01 = 5\,256$  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.

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Data item	2019	2020
Number of time intervals frequency deviates outside +/- 200 mHz	0	0
Number of time intervals frequency deviates outside +/- 500 mHz	0	0

Table 12 IE/NI LFC Number of Time Intervals Outside Range for Years 2019 and 2020

## Performance – GB

# GREAT BRITAIN SYNCHRONOUS AREA PERFORMANCE

In the following tables and figures, data are presented from 2019 and 2020 for the Great Britain synchronous area. Input values for frequency are based on instantaneous frequency values. Based on the input values, mean value, standard deviation and percentiles were calculated. Moreover, any time periods and events where the system frequency was outside of predefined ranges were also indicated. For data points where the frequency was outside of the 200 mHz–800 mHz range, time is measured in minutes.

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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	49.99940	49.99952
The standard deviation	0.0671	0.0675	0.0648	0.0632	0.0622	0.0657	0.0631	0.0610	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	49.860	49.862
5-percentile	49.895	49.895	49.898	49.899	49.901	49.895	49.899	49.903	49.899	49.900	49.900	49.895	49.898
10-percentile	49.915	49.914	49.917	49.918	49.920	49.915	49.918	49.921	49.918	49.910	49.919	49.915	49.917
90-percentile	50.087	50.088	50.084	50.081	50.080	50.084	50.081	50.078	50.081	50.080	50.081	50.085	50.083
95-percentile	50.110	50.110	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(min) > 200 mHz	30	43	22	11	11	24	13	17	15	25	23	31	266
Time(min) < -200 mHz	24	6	15	11	13	23	26	22	9	21	17	20	209
Time(min) > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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

Table 13 GB SA Performance for Year 2019

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2020

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	49.99971	50.00011	49.99877	49.99993	49.99921	49.99911	49.99907	49.99996	49.99978	49.99884	50.00016	49.99987	49.99954
The standard deviation	0.0669	0.0674	0.0652	0.0637	0.0662	0.0672	0.0647	0.0651	0.0667	0.0669	0.0661	0.0656	0.0660
1-percentile	49.857	49.859	49.860	49.865	49.857	49.851	49.859	49.861	49.858	49.857	49.860	49.864	49.859
5-percentile	49.895	49.896	49.895	49.900	49.896	49.891	49.896	49.898	49.894	49.894	49.896	49.898	49.896
10-percentile	49.914	49.915	49.915	49.919	49.915	49.912	49.916	49.918	49.914	49.914	49.915	49.916	49.915
90-percentile	50.087	50.089	50.083	50.083	50.085	50.085	50.082	50.084	50.086	50.086	50.085	50.086	50.085
95-percentile	50.108	50.111	50.104	50.104	50.106	50.106	50.103	50.106	50.107	50.107	50.108	50.107	50.106
99-percentile	50.151	50.151	50.142	50.143	50.146	50.146	50.144	50.148	50.147	50.147	50.147	50.145	50.146
Time(min) > 200 mHz	42	39	10	18	15	24	39	38	25	26	37	24	338
Time(min) < -200 mHz	17	28	12	12	35	47	29	28	17	27	17	20	289
Time(min) > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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

Table 14 GB SA Performance for Year 2020

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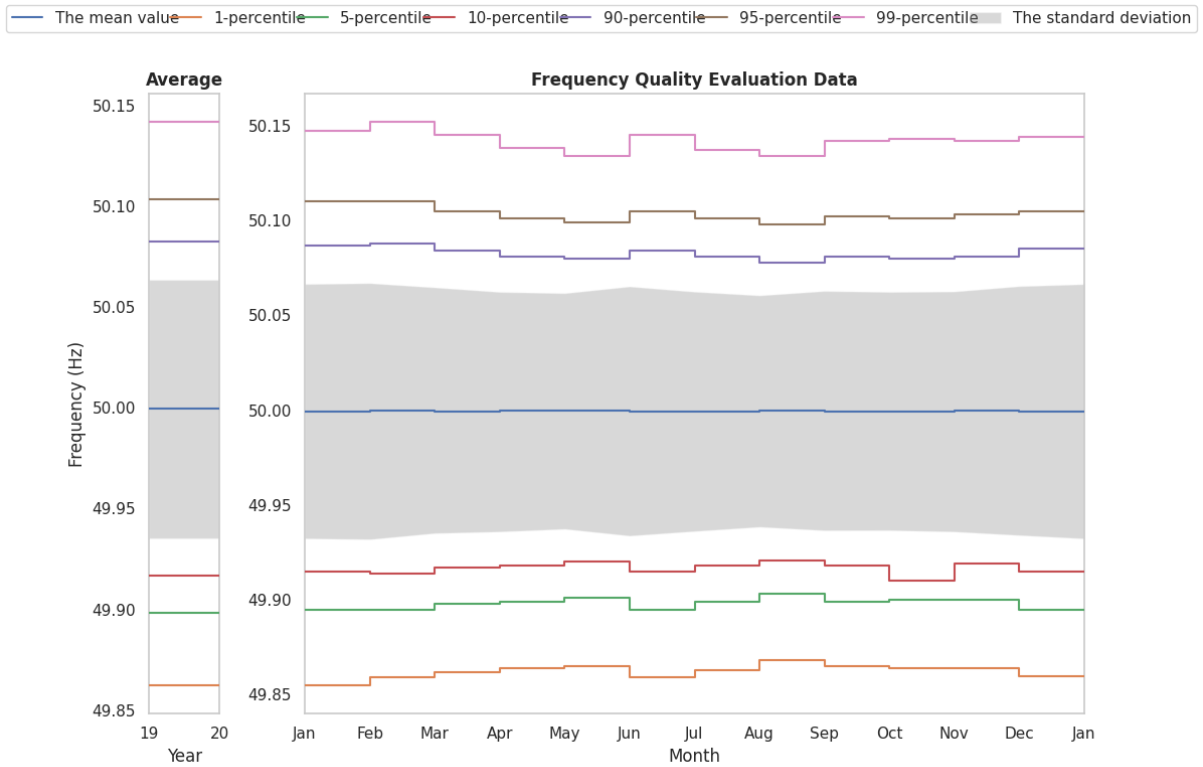


Figure 6 GB SA 2019 frequency quality

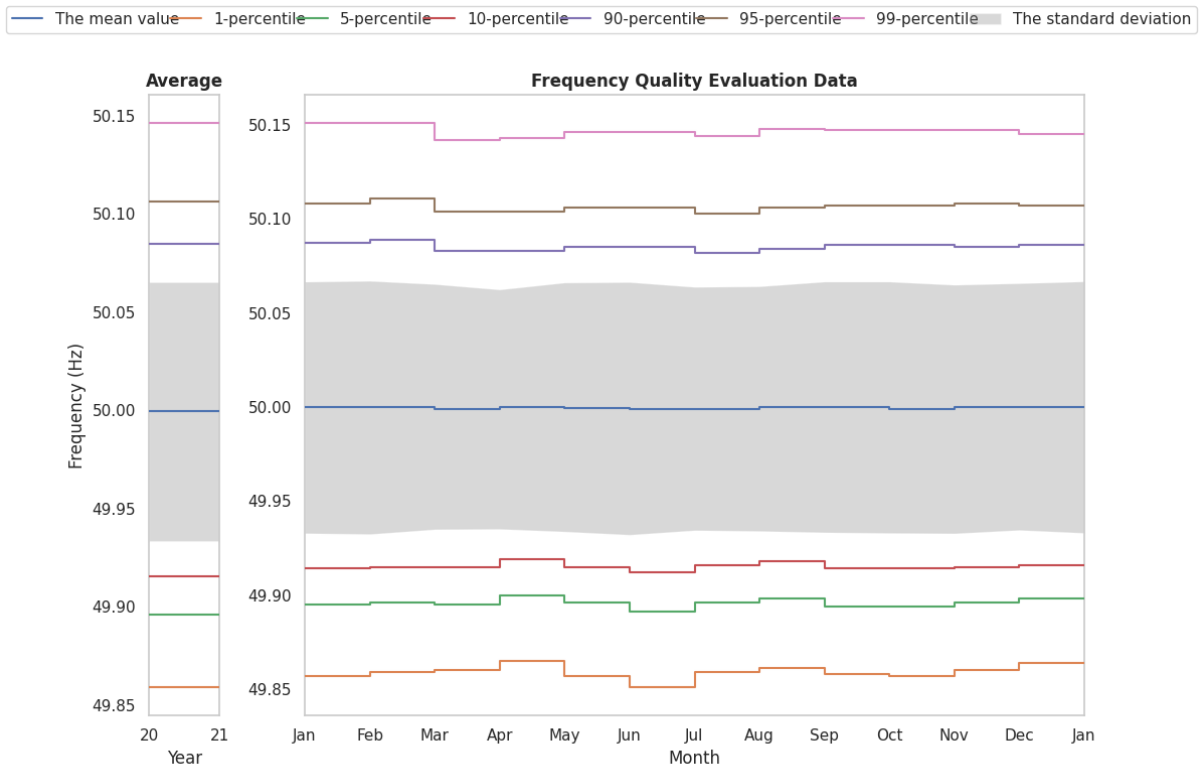


Figure 7 GB SA 2020 frequency quality



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In Figures 8 and 9, the accumulated minutes outside standard ranges are presented for the years 2019 and 2020, respectively.

The red line shows the theoretical line in the case of a linear distribution (1/12 per month) of minutes outside standard ranges, considering the standard ranges from SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. If the 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, 9 and 9a below show that the frequency quality target parameters from SO GL were fulfilled in the Great Britain Synchronous Area during the respective years.

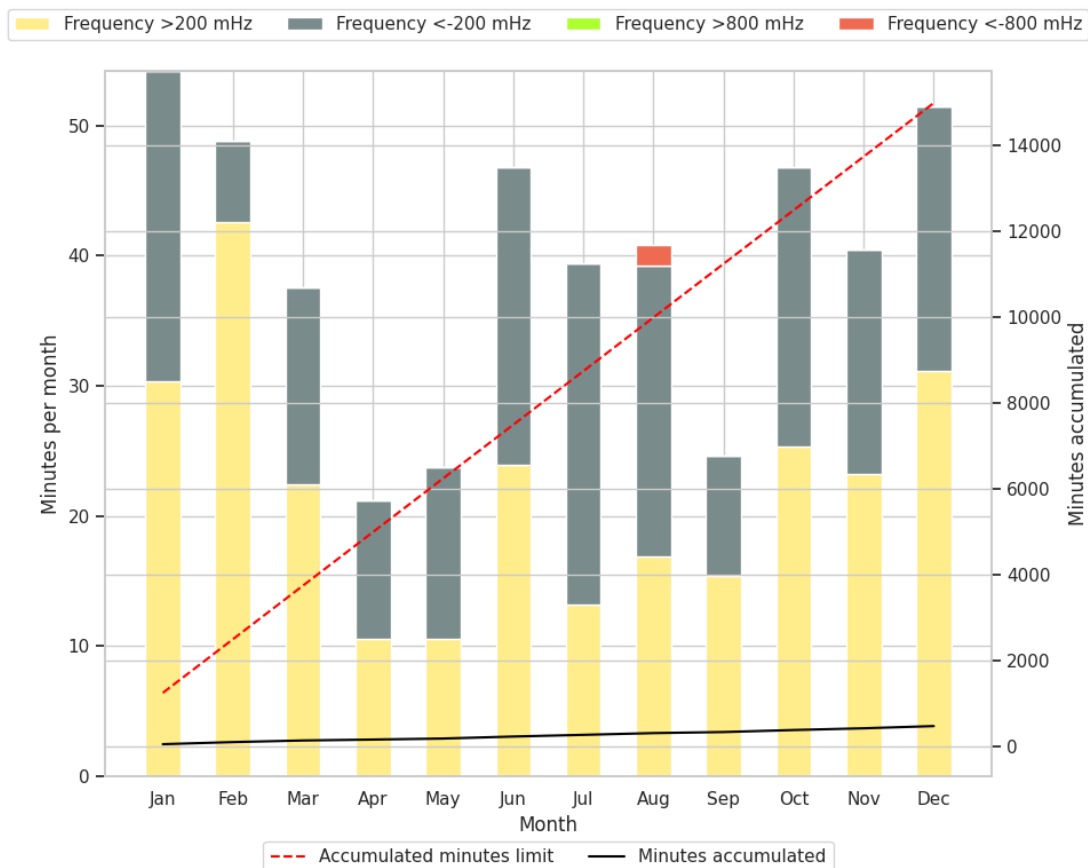


Figure 8 GB SA 2019 frequency deviation

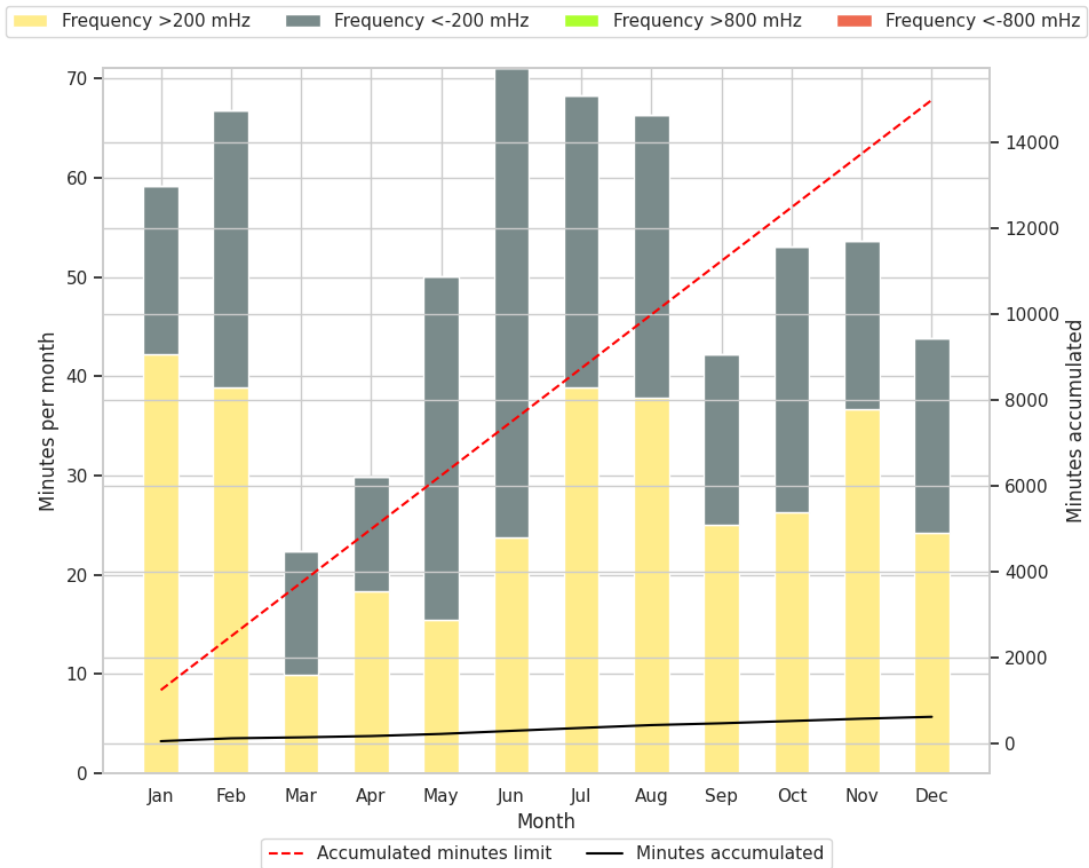


Figure 9 GB SA 2020 frequency deviation

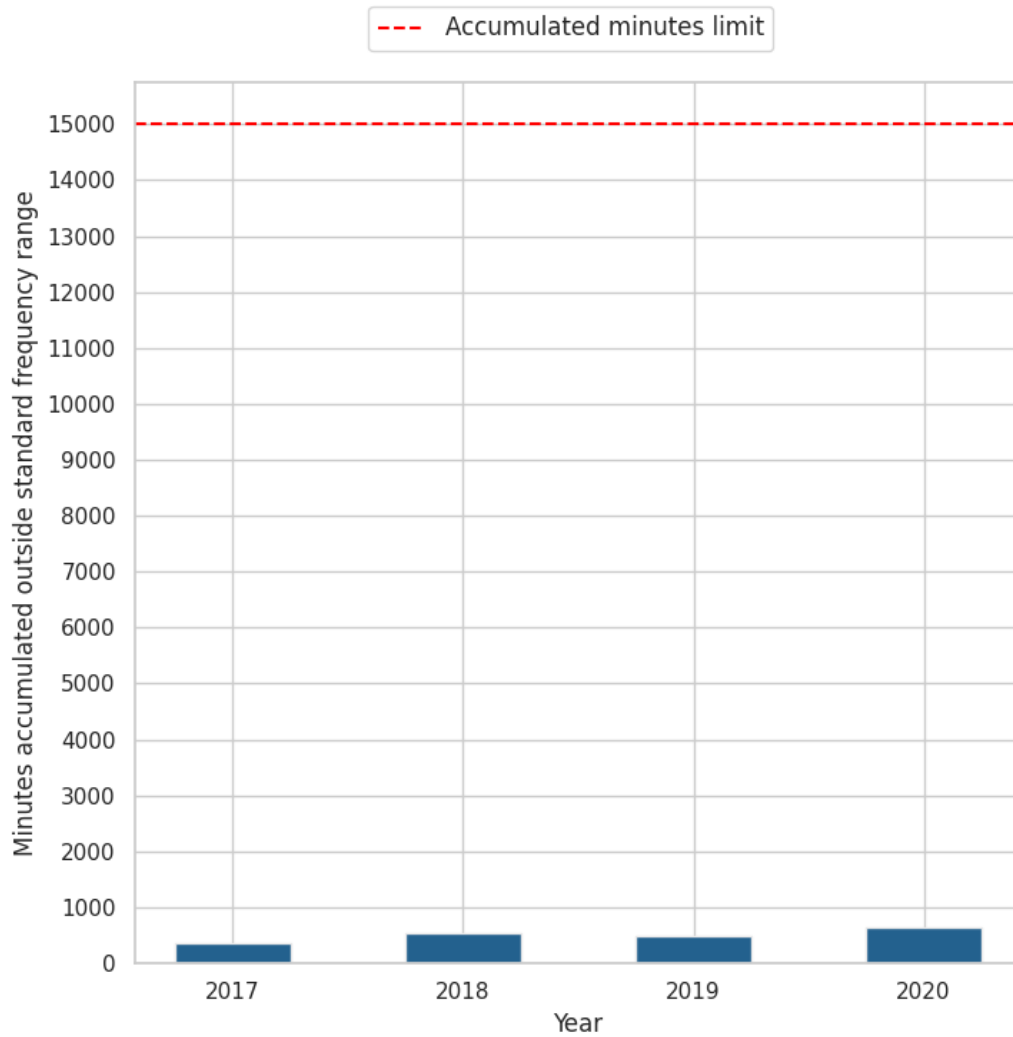


Figure 9a GB SA frequency deviation trend

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## GB Synchronous Area LFC Block Performance

Tables 15 and 16 show that there were no events in which the 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 the time to restore frequency, which corresponds to 15 minutes.

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

**Table 15 GB LFC FRCE Statistic for Year 2019**

2020

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 2020**

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

1. If the frequency deviation is  $\geq 200$  mHz over a 15-minutes period or  $\leq -200$  mHz over a 15-minute period, this qualifies as a Level 1 event.
2. If the frequency deviation is  $\geq 500$  mHz over a 1-minute period or  $\leq -500$  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)  $\times 0.03 = 1\,051$  periods.
4. The Level 2 FRCE target parameter = 1%, which is  $525\,600$  (periods)  $\times 0.01 = 5\,256$  periods.

Data item	2019	2020
Number of time intervals frequency deviates outside +/- 200 mHz	0	0
Number of time intervals frequency deviates outside +/- 500 mHz	2	0

**Table 17 GB LFC Number of Time Intervals Outside Range for Years 2019 and 2020**

## Performance – Nordic

### Nordic Synchronous Area Performance

In the following tables and figures, data are presented from 2019 and 2020 for the Nordic synchronous area. Input values for frequency are based on instantaneous frequency values. Based on the input values, the mean value, standard deviation and percentiles were calculated. Moreover, any time periods and events where the system frequency was outside of predefined ranges were also indicated. For data points where the frequency was outside the 100–1000 mHz range, time is measured in minutes.

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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	50.00031	50.00050	50.00000	50.00022	50.00019	49.99977	50.00013
The standard deviation	0.0432	0.0470	0.0465	0.0458	0.0468	0.0477	0.0415	0.0434	0.0434	0.0445	0.0420	0.0445	0.0447
1-percentile	49.901	49.895	49.893	49.897	49.888	49.888	49.905	49.900	49.896	49.895	49.902	49.895	49.896
5-percentile	49.930	49.925	49.925	49.927	49.923	49.922	49.933	49.930	49.929	49.927	49.932	49.927	49.928
10-percentile	49.945	49.940	49.941	49.943	49.940	49.939	49.947	49.946	49.945	49.944	49.947	49.944	49.943
90-percentile	50.056	50.061	50.060	50.059	50.059	50.060	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	50.070	50.073	50.070	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(min) > 100 mHz	470	625	624	699	618	708	398	559	482	594	462	624	6863
Time(min) < -100 mHz	404	506	613	489	768	750	323	436	515	557	377	573	6311
Time(min) > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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

Table 18 Nordic SA Block Performance for Year 2019

# LFC ANNUAL REPORT 2020



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2020

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00033	49.99985	50.00046	49.99964	50.00012	50.00008	49.99983	50.00014	50.00000	50.00009	50.00008	49.99986	50.00004
The standard deviation	0.0409	0.0449	0.0438	0.0415	0.0415	0.0430	0.0372	0.0379	0.0432	0.0413	0.0415	0.0390	0.0413
1-percentile	49.903	49.896	49.898	49.901	49.902	49.900	49.913	49.912	49.900	49.905	49.903	49.905	49.903
5-percentile	49.932	49.927	49.930	49.932	49.932	49.930	49.939	49.940	49.931	49.933	49.933	49.936	49.933
10-percentile	49.948	49.943	49.946	49.948	49.948	49.946	49.953	49.953	49.946	49.948	49.948	49.951	49.948
90-percentile	50.052	50.057	50.057	50.052	50.053	50.054	50.047	50.048	50.055	50.053	50.053	50.048	50.052
95-percentile	50.067	50.075	50.073	50.068	50.068	50.071	50.061	50.063	50.072	50.069	50.069	50.064	50.068
99-percentile	50.098	50.108	50.106	50.099	50.099	50.105	50.090	50.093	50.108	50.099	50.100	50.094	50.100
Time(min) > 100 mHz	364	497	479	397	391	421	172	206	409	325	357	344	4362
Time(min) < -100 mHz	376	602	582	402	411	551	244	284	609	412	414	312	5199
Time(min) > 1000 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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	0	0	0	0	0	2	0	0	0	2
No.of events freq.deviation < -200 mHz and < -100 mHz within 15 minutes	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 19 Nordic SA Block Performance for Year 2020

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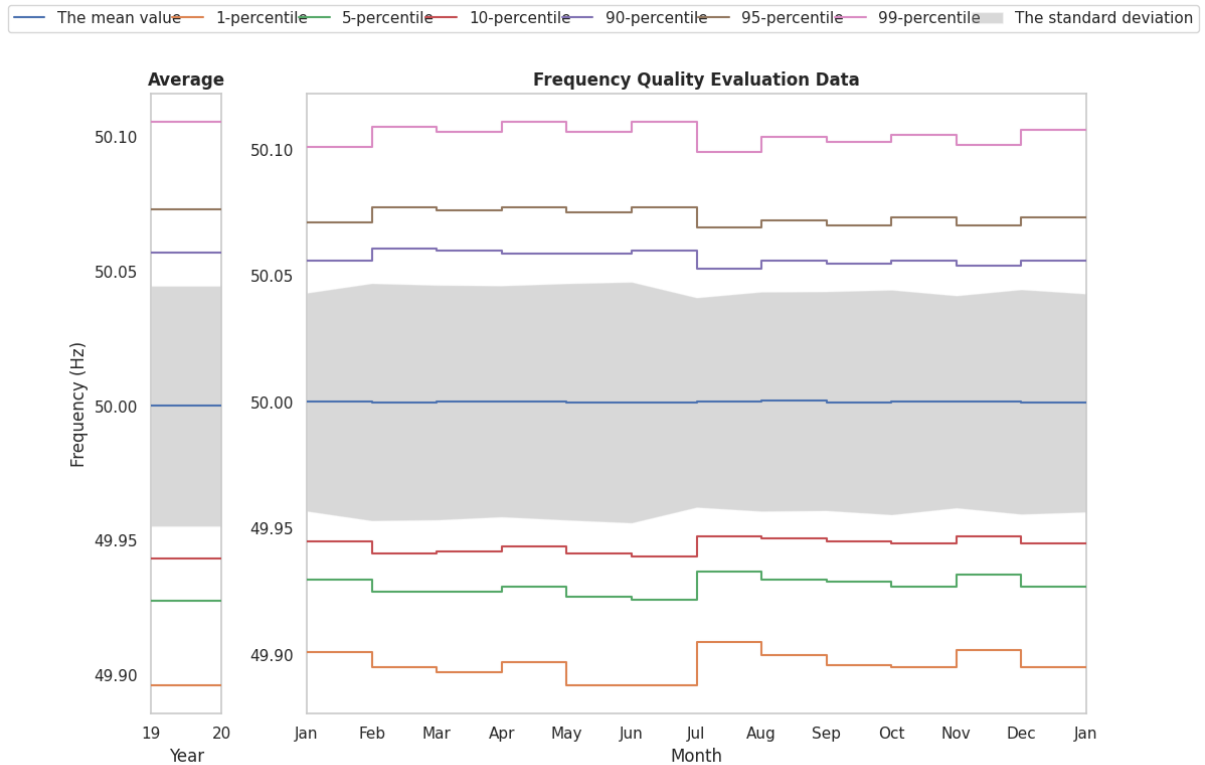


Figure 10 Nordic SA 2019 frequency quality

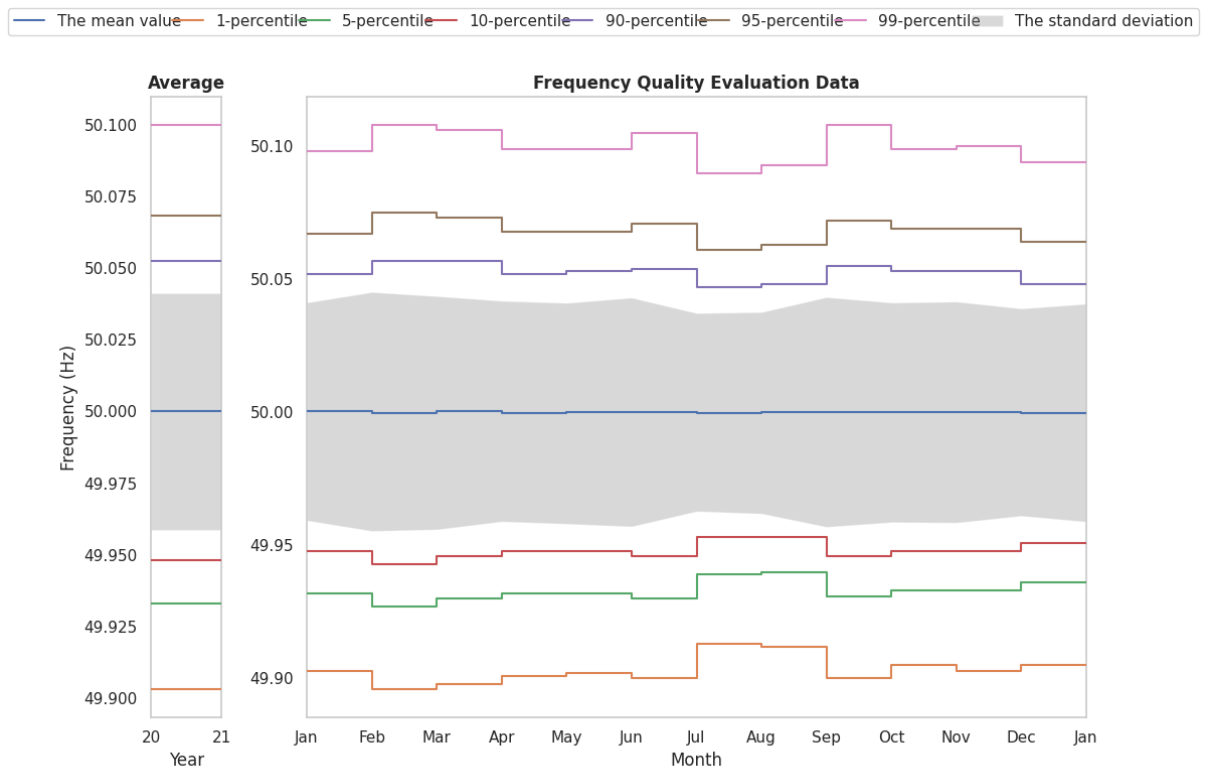


Figure 11 Nordic SA 2020 frequency quality



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In Figures 12 and 13, the accumulated minutes outside standard ranges are presented for the years 2019 and 2020.

The red line shows the theoretical line in the case of a linear distribution (1/12 per month) of minutes outside standard ranges, considering the standard ranges from SO GL (15 000 minutes).

The black line shows the accumulated minutes per month outside standard ranges for the synchronous area. If the 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, 13 and 13a below show that the frequency quality target parameters from SO GL were fulfilled during the respective years in the Nordic Synchronous Area.

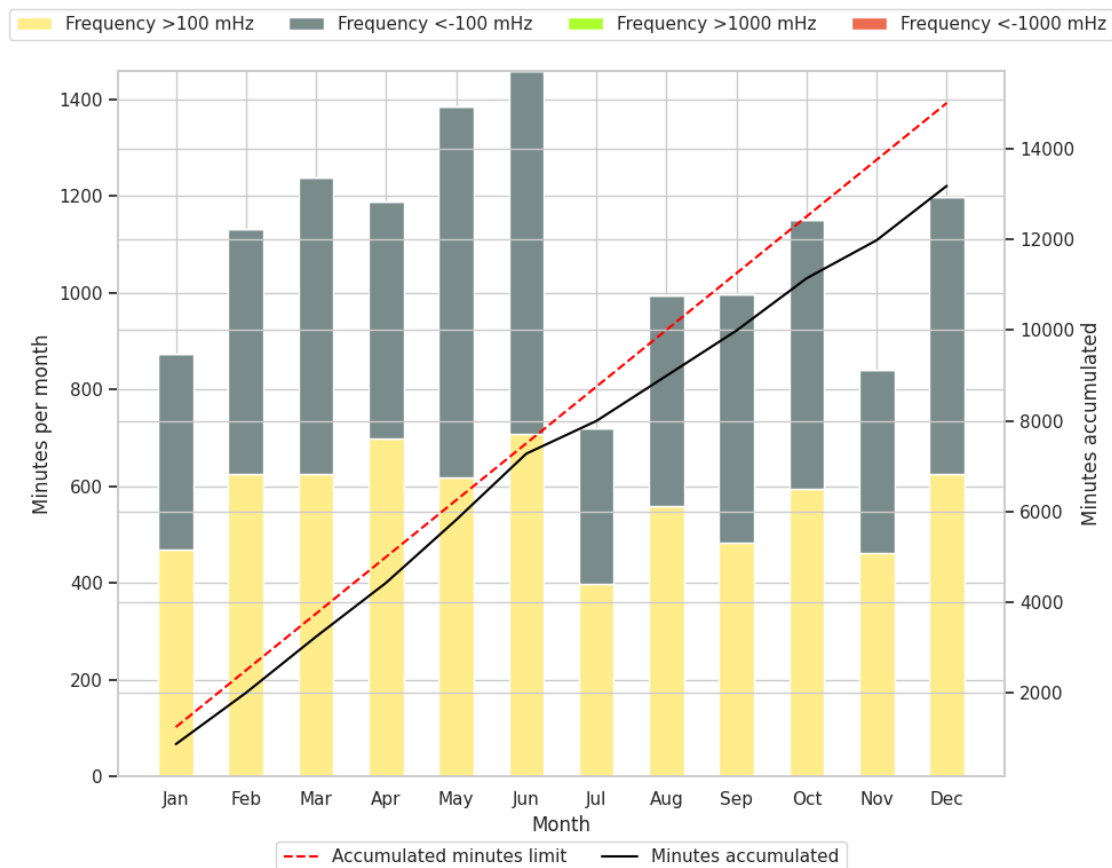


Figure 12 Nordic SA 2019 frequency deviation

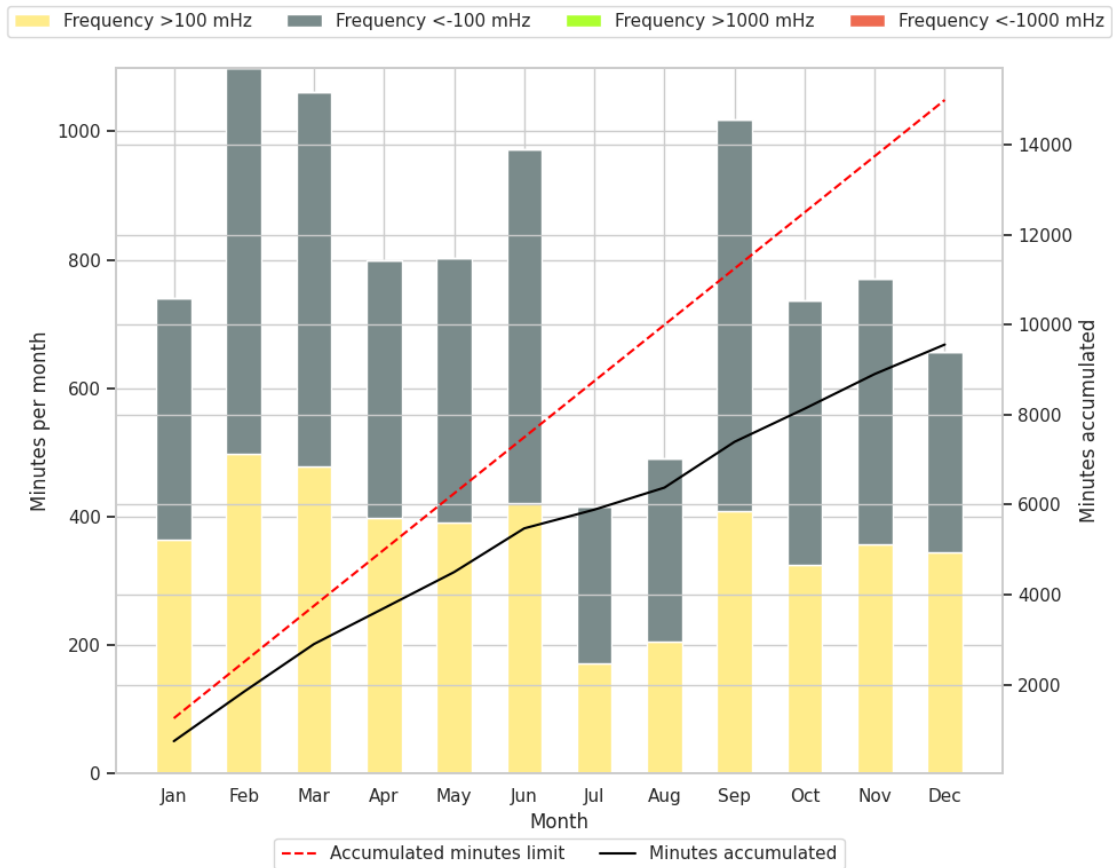


Figure 13 Nordic SA 2020 frequency deviation

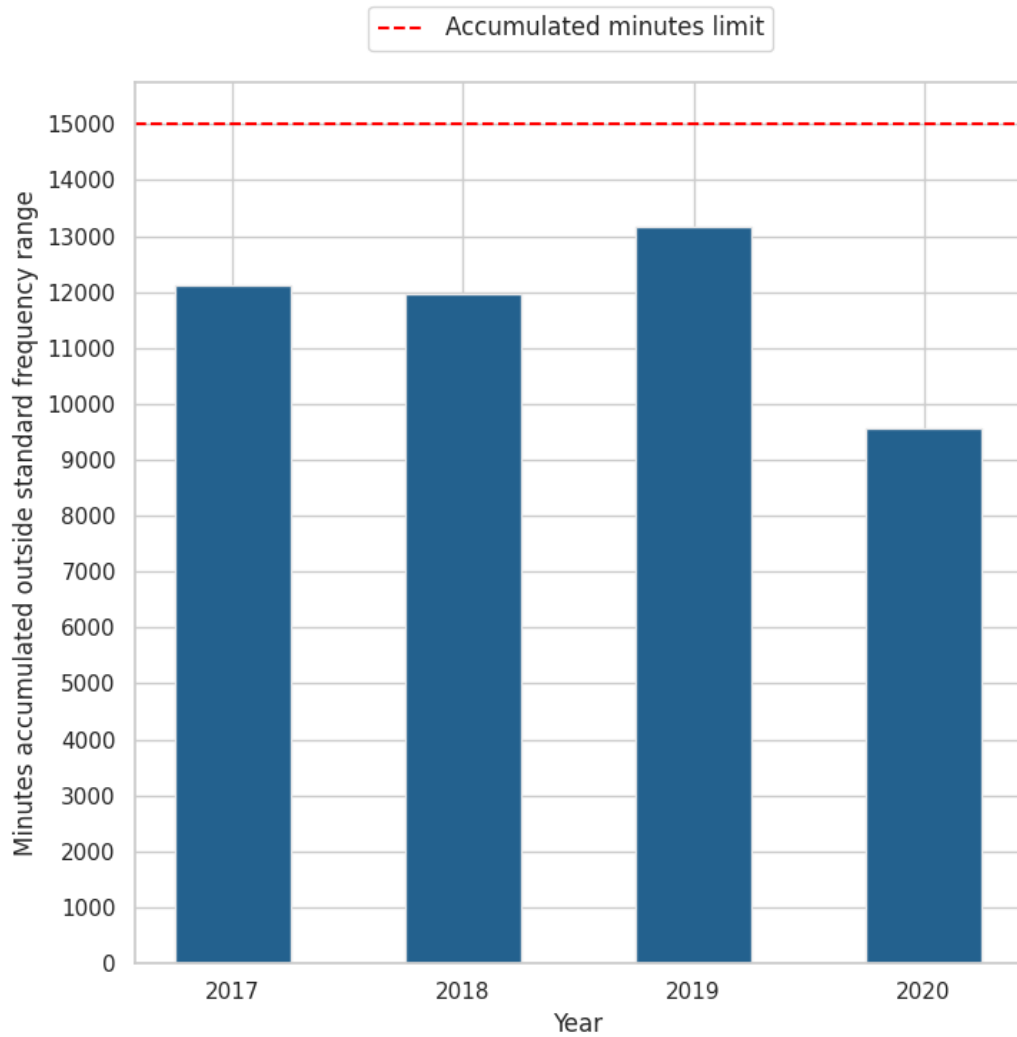


Figure 13a Nordic SA frequency deviation trend

## Nordic Synchronous Area LFC Block Performance

In the following table, the Nordic LFC block performance is presented. The Level 1 and Level 2 limits are calculated according to the methodology defined in the 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.

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%

**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**

The methodology for the calculation of these target parameters is as defined in the Nordic Synchronous Area Operational Agreement. FRCE values are calculated on a basis of 15-minute 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 is not returned to 15% of FRR during a 15-minute time period are reported.

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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	50.00031	50.00050	50.00000	50.00022	50.00019	49.99977	50.00013
The standard deviation	0.0432	0.0470	0.0465	0.0458	0.0468	0.0477	0.0415	0.0434	0.0434	0.0445	0.0420	0.0445	0.0447
1-percentile	49.901	49.895	49.893	49.897	49.888	49.888	49.905	49.900	49.896	49.895	49.902	49.895	49.896
5-percentile	49.930	49.925	49.925	49.927	49.923	49.922	49.933	49.930	49.929	49.927	49.932	49.927	49.928
10-percentile	49.945	49.940	49.941	49.943	49.940	49.939	49.947	49.946	49.945	49.944	49.947	49.944	49.943
90-percentile	50.056	50.061	50.060	50.059	50.059	50.060	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	50.070	50.073	50.070	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
Number of time intervals: average FRCE > Level 1 positive	439	450	495	436	404	417	330	373	346	389	371	406	4856
Number of time intervals: average FRCE < Level 1 negative	427	427	448	365	413	436	310	327	345	376	331	405	4610
Number of time intervals: average FRCE > Level 2 positive	52	77	75	68	45	56	38	53	40	58	60	76	698
Number of time intervals: average FRCE < Level 2 negative	53	66	68	42	54	53	25	34	48	51	44	65	603
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	9
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

Table 21 Nordic LFC Block Performance for Year 2019

# LFC ANNUAL REPORT 2020



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2020

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00033	49.99985	50.00046	49.99964	50.00012	50.00008	49.99983	50.00014	50.00000	50.00009	50.00008	49.99986	50.00004
The standard deviation	0.0409	0.0449	0.0438	0.0415	0.0415	0.0430	0.0372	0.0379	0.0432	0.0413	0.0415	0.0390	0.0413
1-percentile	49.903	49.896	49.898	49.901	49.902	49.900	49.913	49.912	49.900	49.905	49.903	49.905	49.903
5-percentile	49.932	49.927	49.930	49.932	49.932	49.930	49.939	49.940	49.931	49.933	49.933	49.936	49.933
10-percentile	49.948	49.943	49.946	49.948	49.948	49.946	49.953	49.953	49.946	49.948	49.948	49.951	49.948
90-percentile	50.052	50.057	50.057	50.052	50.053	50.054	50.047	50.048	50.055	50.053	50.053	50.048	50.052
95-percentile	50.067	50.075	50.073	50.068	50.068	50.071	50.061	50.063	50.072	50.069	50.069	50.064	50.068
99-percentile	50.098	50.108	50.106	50.099	50.099	50.105	50.090	50.093	50.108	50.099	50.100	50.094	50.100
Number of time intervals: average FRCE > Level 1 positive	301	385	427	321	335	333	217	248	323	319	328	285	3822
Number of time intervals: average FRCE < Level 1 negative	311	372	358	272	280	306	185	187	300	295	265	261	3392
Number of time intervals: average FRCE > Level 2 positive	42	72	66	38	46	69	22	30	61	46	38	30	560
Number of time intervals: average FRCE < Level 2 negative	33	59	41	38	32	34	10	15	32	30	27	38	389
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	1	0	1	0	0	0	1	0	3

Table 22 Nordic LFC Block Performance for Year 2020

## I. Level 1/Level 2 statistics

In following Figures (14–17), the monthly distribution of FRCE time intervals outside the Level 1 range and Level 2 range for positive and negative time intervals is presented by month and year. If the maximum number of intervals exceeds 10512 for Level 1 or 1752 for Level 2, then mitigation measures must be proposed and taken.

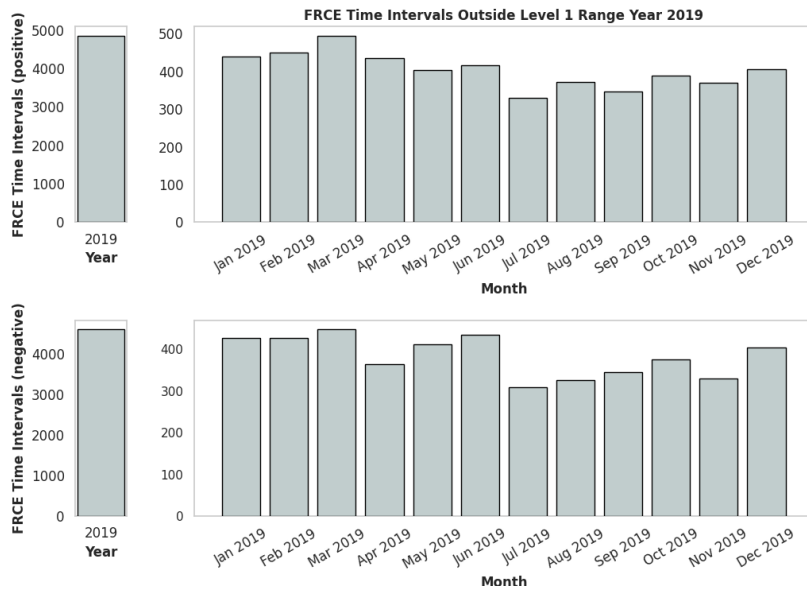


Figure 14 Nordic LFC 2019 FRCE Time Intervals Outside Level 1 Range

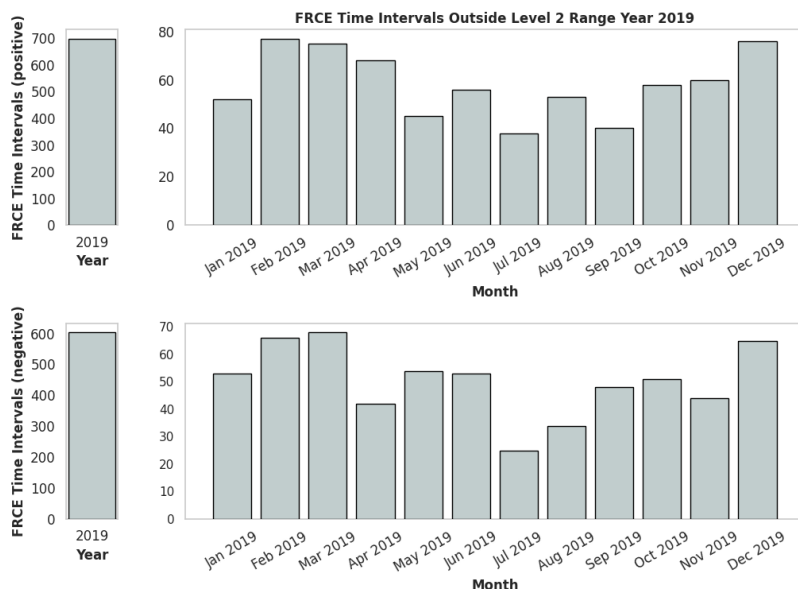


Figure 15 Nordic LFC 2019 FRCE Time Intervals Outside Level 2 Range

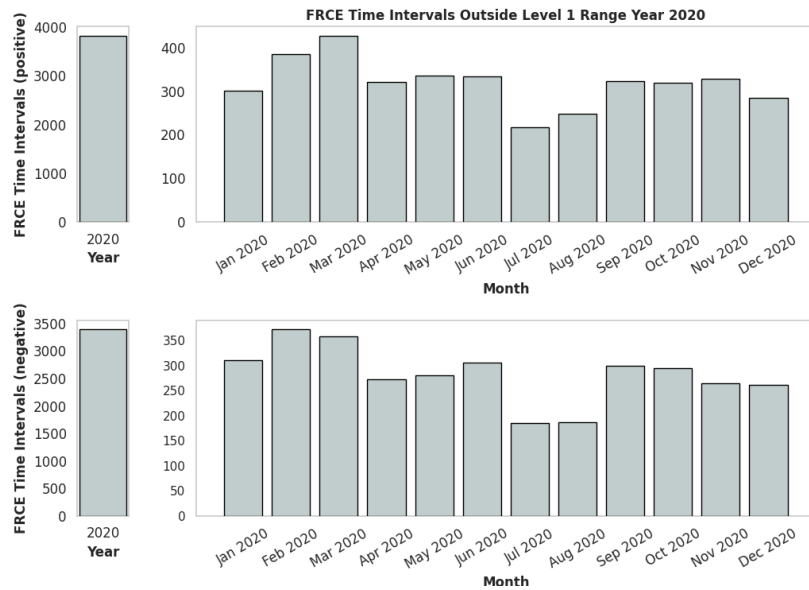


Figure 16 Nordic LFC 2020 FRCE Time Intervals Outside Level 1 Range

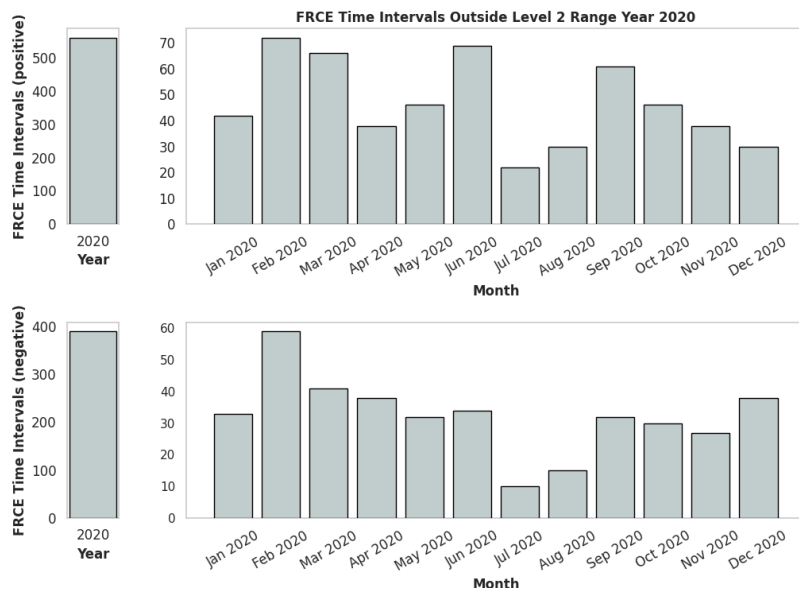


Figure 17 Nordic LFC 2020 FRCE Time Intervals Outside Level 2 Range



## II. FRCE vs. FRR

The ability of an LFC block to regulate its own FRCE is presented by comparing its reserve capacity on FRR and its FRCE value according to SO GL. Reserve capacity on FRR is defined as FRR capacity from the dimensioning process (SO GL, Art. 157). If during a dedicated time interval a TSO 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 include 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 used are the 1-minute average values. The granularity of the instantaneous FRCE values (used to calculate the 1-minute average) is 10 seconds or lower.

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

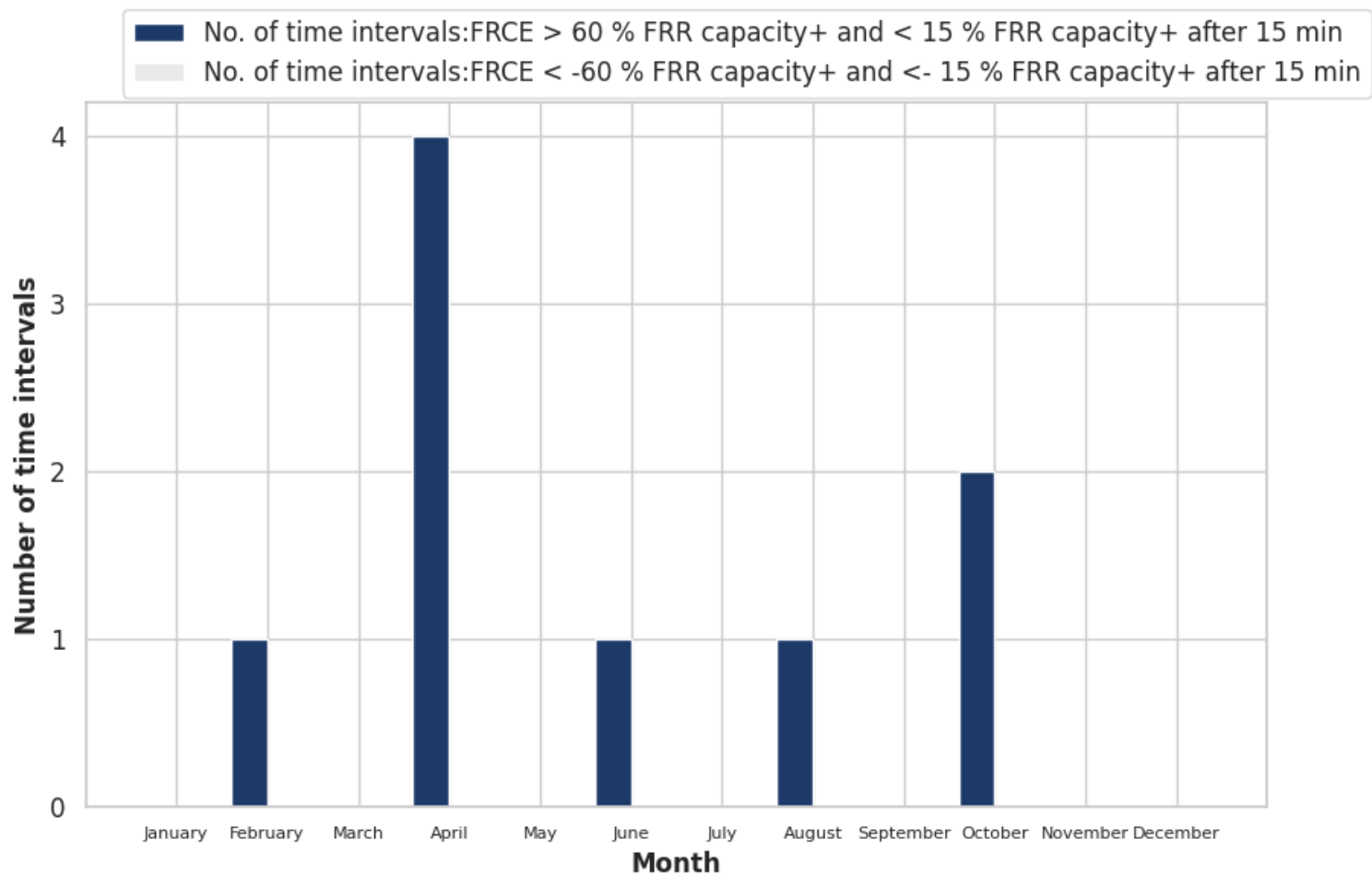


Figure 18 Nordic LFC 2019 FRCE Outside FRR Capacity within 15 minutes

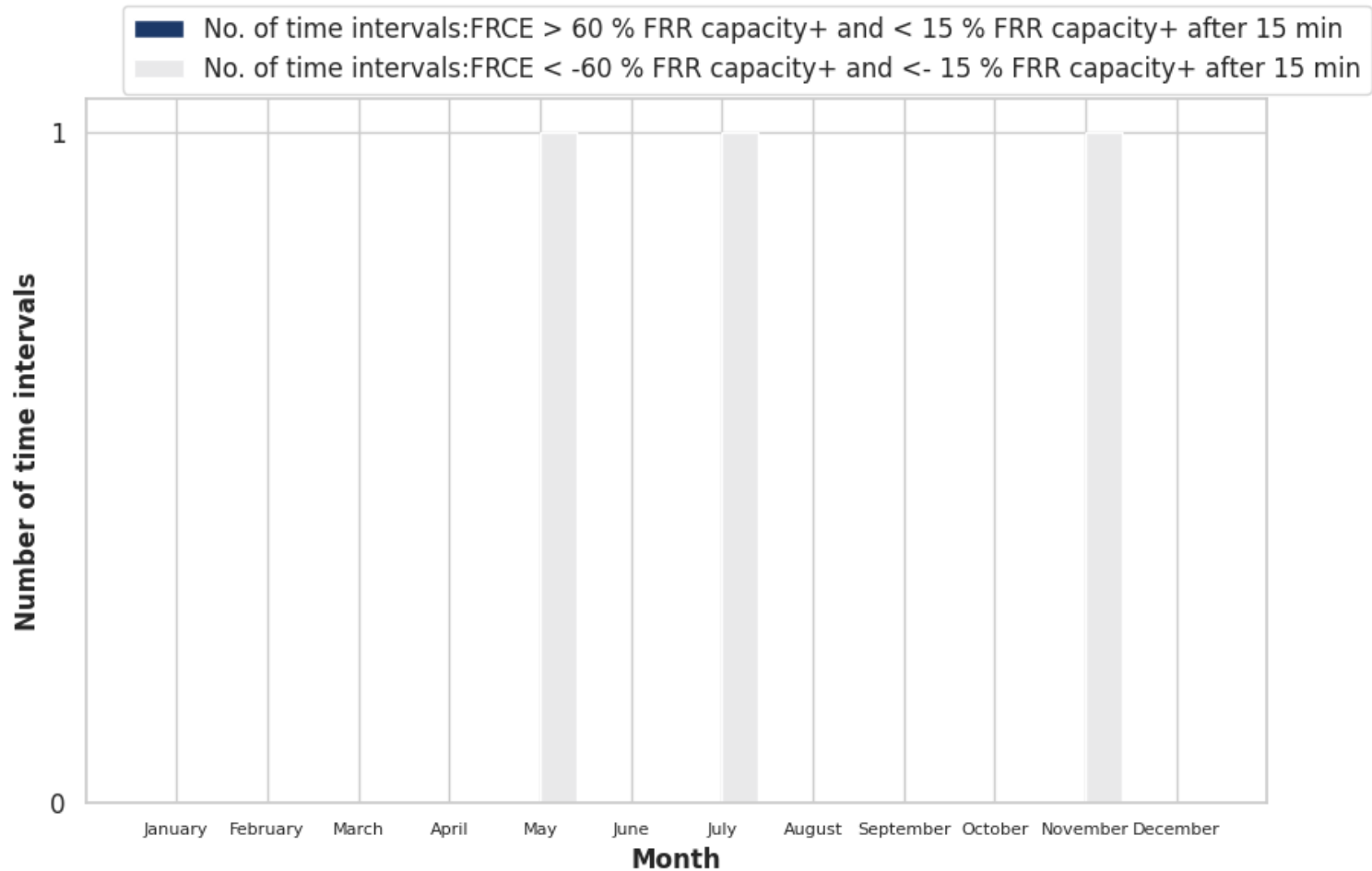


Figure 19 Nordic LFC 2020 FRCE Outside FRR Capacity within 15 minutes

### I. Mitigation Measures Analysis

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

In accordance with Article 138, when the values of the FRCE target parameters calculated for the period of one calendar year 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 of 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, an analysis of the causes and a set of recommendations; and

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

For the reporting period, which included the years 2019 and 2020, in line with Figures 14–17, the following analysis and mitigation measures were reported from the Nordic LFC Block:

#### Mitigation measures for the year 2019:

Nordic LFC Block

Analysis:

The Level 2 Negative FRCE target of 76 mHZ excursions was exceeded in 2019. The trend over the period 2017–2019 shows deterioration, 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 extending the number of hours it is contracted to compensate for this deteriorating trend.

#### Mitigation measures for the year 2020:

There were no mitigation measures applied, since FRCE performance was in the required range.

## Performance – CE

### Continental Europe Synchronous Area Performance

In the following tables and figures, data from 2019 and 2020 for the Continental Europe synchronous area are presented. Input values for frequency are based on instantaneous frequency values. Based on the input values, the mean value, standard deviation and percentiles were calculated. Moreover, any time periods and events where the system frequency was outside of predefined ranges were also indicated. For data points where the frequency was outside the 50 and 800 mHz range, time is measured in minutes.

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2019

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00009	50.00037	50.00040	50.00003	50.00034	49.99986	50.00019	49.99969	50.00002	49.99975	50.00050	49.99989	50.00009
The standard deviation	0.0220	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	49.950	49.947	49.949	49.950	49.949
5-percentile	49.965	49.967	49.966	49.967	49.969	49.969	49.972	49.972	49.970	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	50.030	50.029	50.028	50.030	50.031	50.032	50.030	50.031
99-percentile	50.053	50.052	50.052	50.049	50.049	50.046	50.045	50.044	50.049	50.050	50.051	50.048	50.049
Time(min) > 50 mHz	540	457	513	370	403	256	277	222	363	423	445	360	4629
Time(min) < -50 mHz	733	444	563	491	368	389	328	317	408	523	445	437	5446
Time(min) > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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

Table 23 CE SA Performance for Year 2019

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2020

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
The mean value	50.00069	49.99954	50.00032	50.00071	50.00007	49.99989	49.99999	50.00024	50.00004	50.00026	50.00046	50.00061	50.00024
The standard deviation	0.0194	0.0198	0.0207	0.0193	0.0188	0.0187	0.0190	0.0181	0.0203	0.0201	0.0194	0.0192	0.0194
1-percentile	49.951	49.949	49.948	49.951	49.951	49.951	49.951	49.953	49.947	49.949	49.951	49.951	49.950
5-percentile	49.970	49.968	49.967	49.970	49.970	49.971	49.972	49.973	49.968	49.968	49.970	49.970	49.970
10-percentile	49.977	49.976	49.975	49.977	49.977	49.978	49.978	49.979	49.976	49.976	49.977	49.977	49.977
90-percentile	50.023	50.023	50.025	50.023	50.022	50.022	50.022	50.021	50.024	50.024	50.023	50.023	50.023
95-percentile	50.030	50.029	50.032	50.030	50.029	50.028	50.029	50.028	50.031	50.031	50.030	50.030	50.030
99-percentile	50.048	50.047	50.051	50.048	50.046	50.045	50.049	50.046	50.050	50.049	50.047	50.047	50.048
Time(min) > 50 mHz	352	323	472	358	307	280	394	316	411	395	323	325	4256
Time(min) < -50 mHz	389	432	511	363	405	401	401	354	519	470	393	366	5004
Time(min) > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -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	0	0	0	0	0	0	0	0	0	0	0
No.of events freq.deviation < -100 mHz and not < -25 mHz	0	0	0	0	0	0	2	1	0	0	0	0	3

Table 24 CE SA Performance for Year 2020

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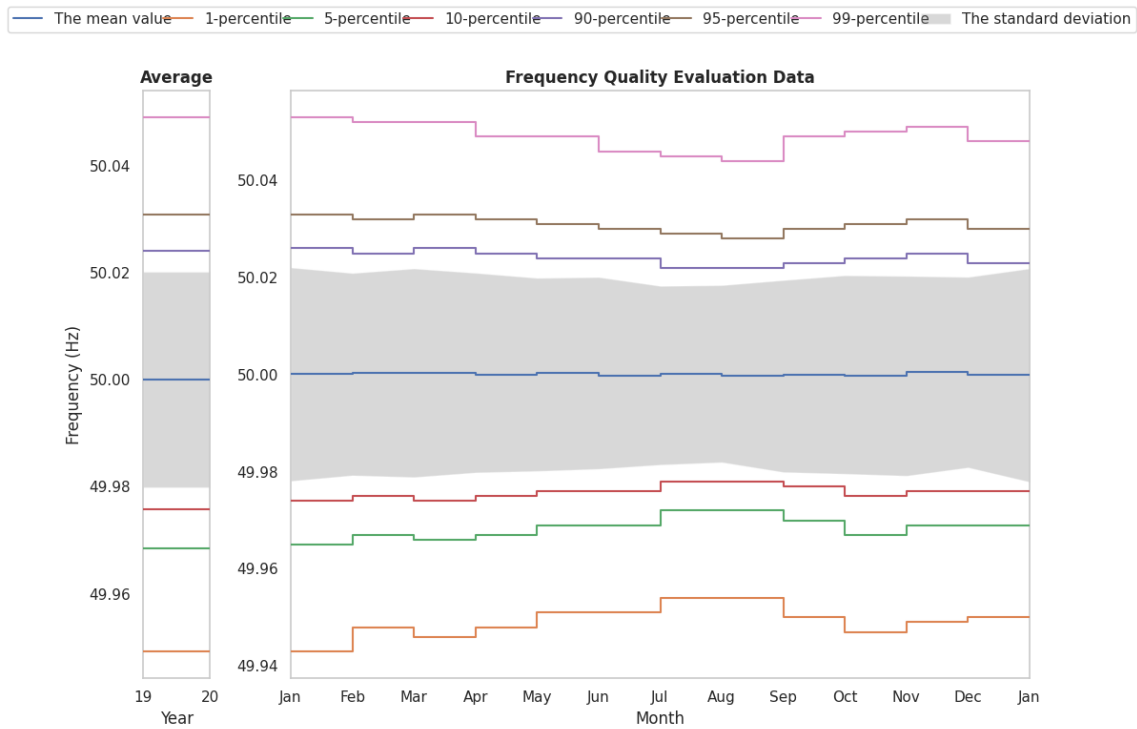


Figure 20 CE SA 2019 frequency quality

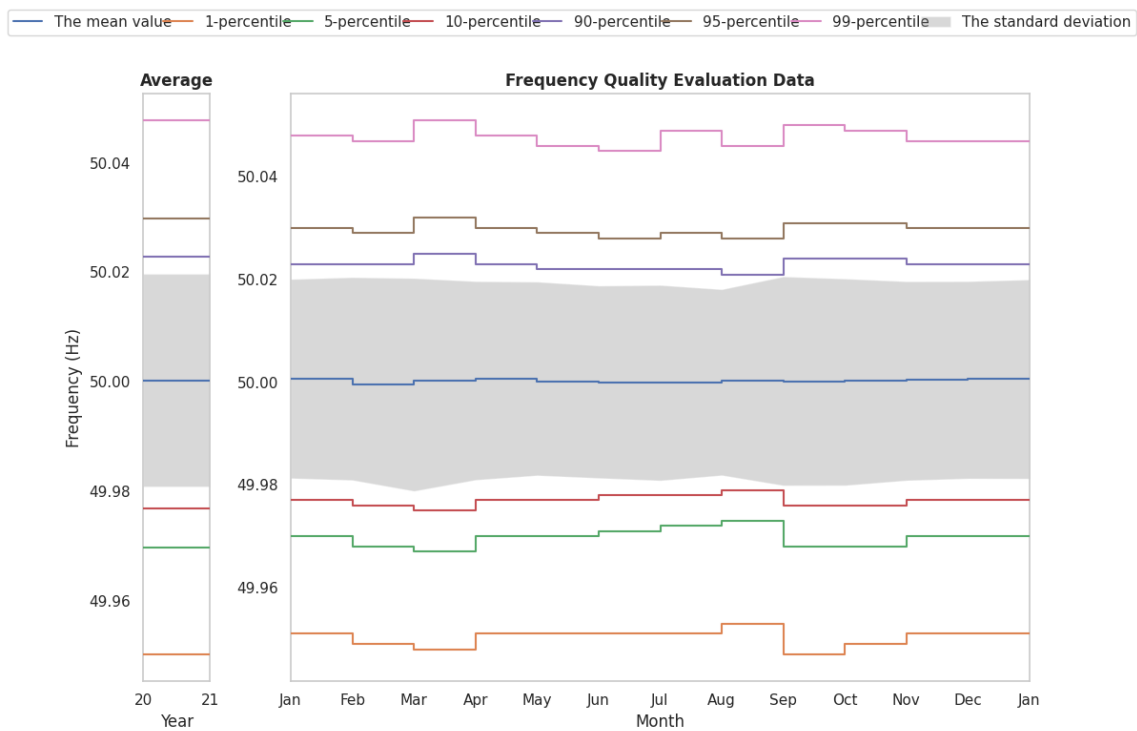


Figure 21 CE SA 2020 frequency quality



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In Figures 22 and 23, the accumulated minutes outside standard ranges are presented for the years 2019 and 2020, respectively.

The red line shows the theoretical line in the case of a linear distribution (1/12 per month) of minutes outside standard ranges, considering standard ranges from SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard ranges per month for the synchronous area. If the 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, 23 and 23a below show that the frequency quality target parameters from SO GL were fulfilled for the respective years for the Synchronous Area of Continental Europe.

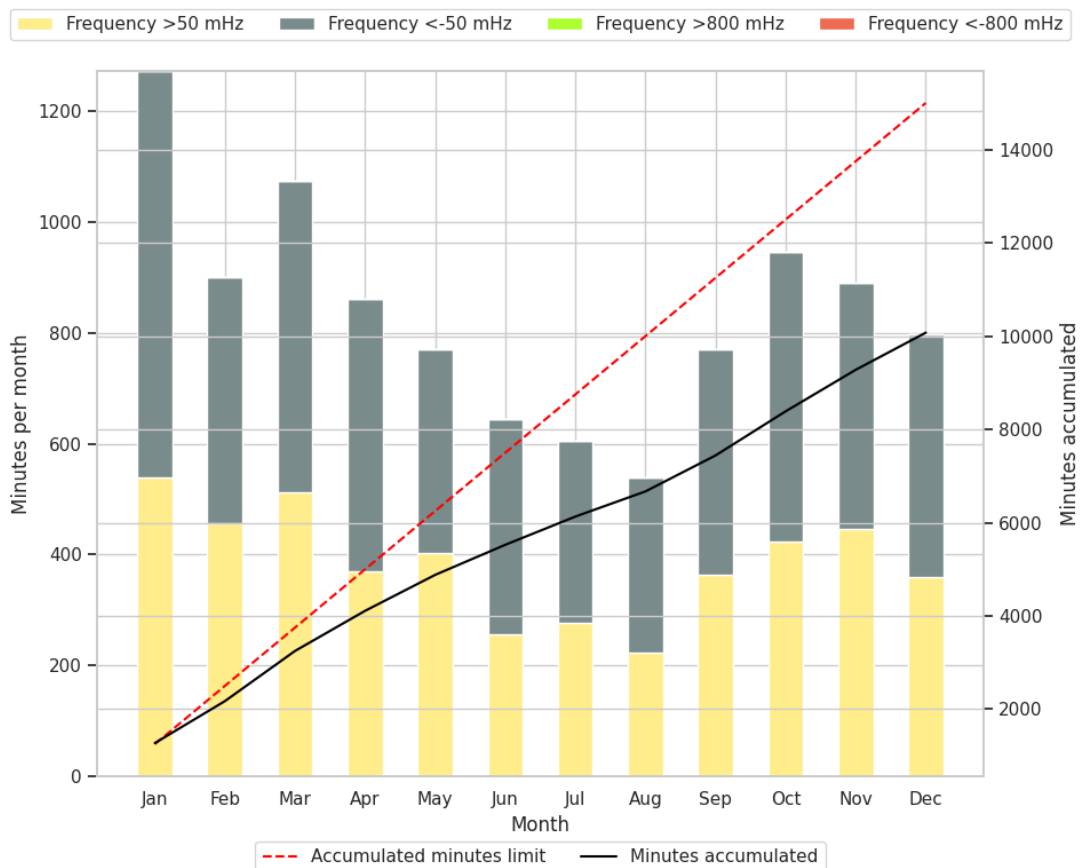


Figure 22 CE SA 2019 frequency deviation

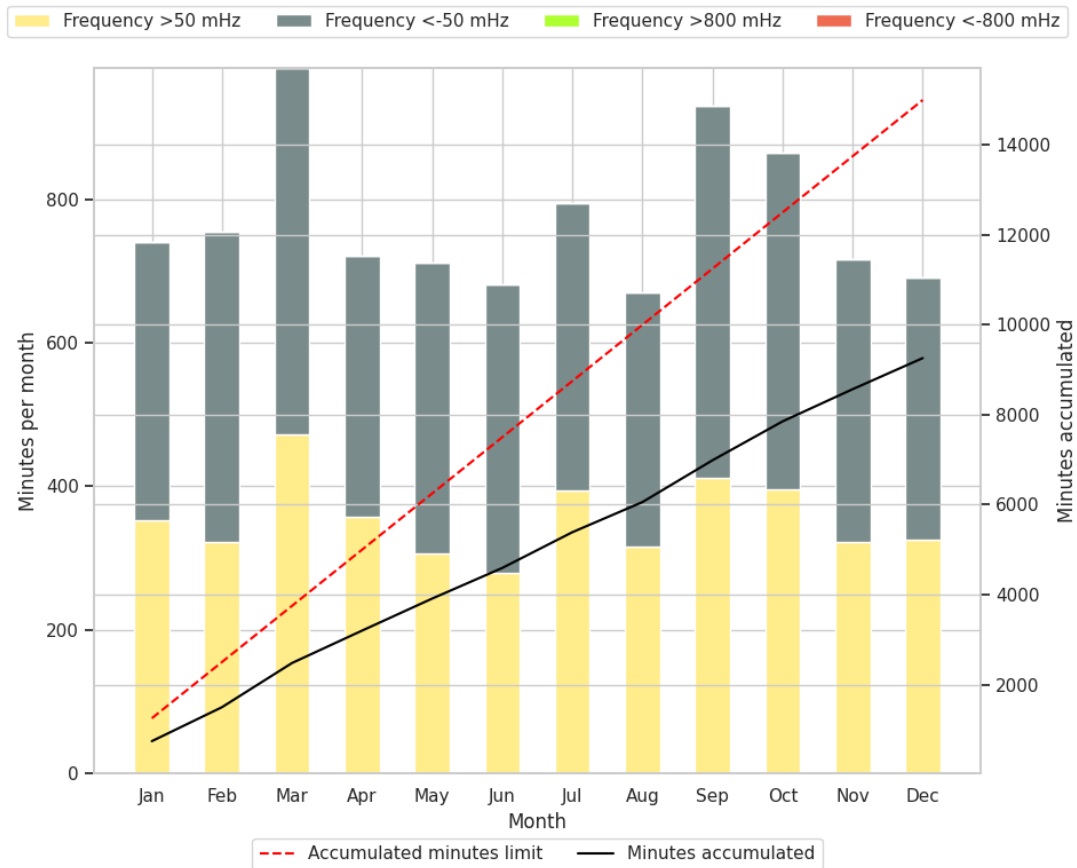


Figure 23 CE SA 2020 frequency deviation

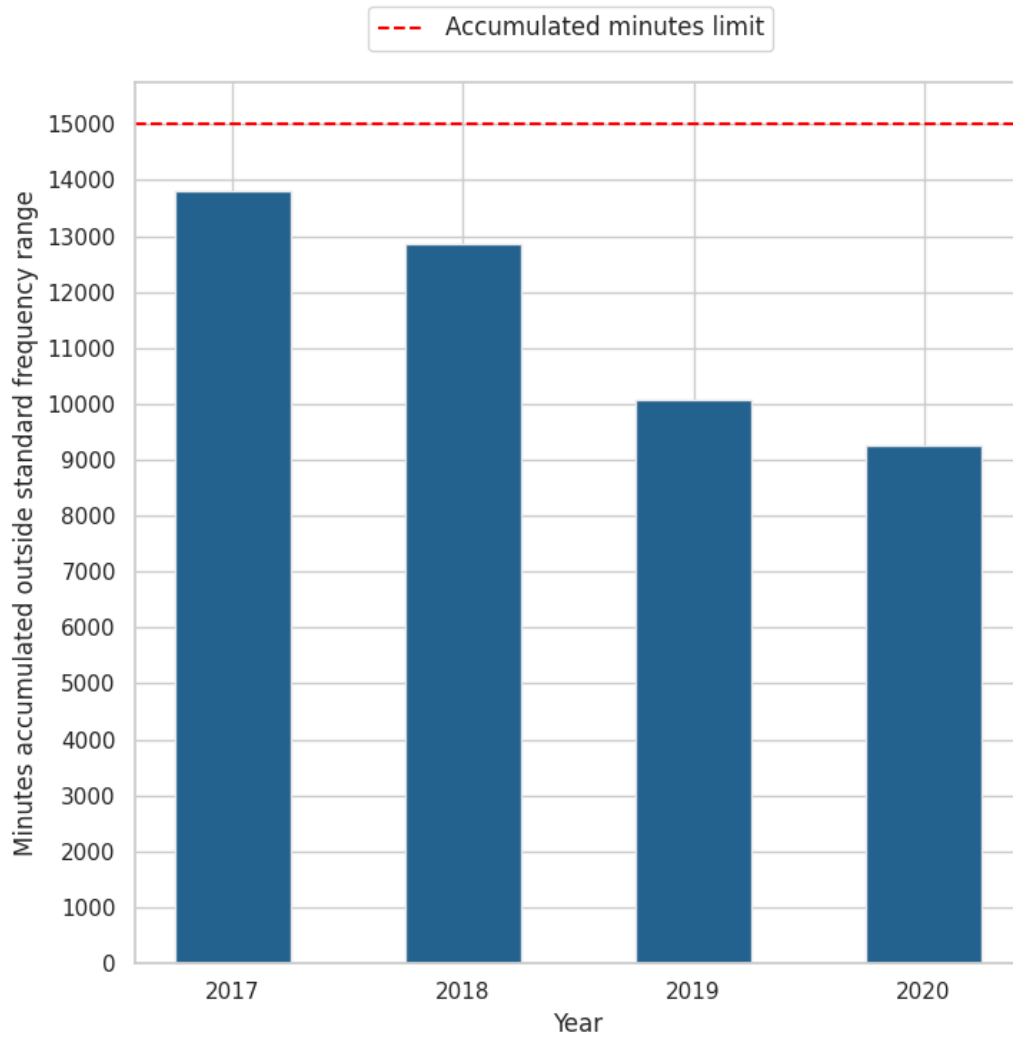


Figure 23a CE SA frequency deviation trend

## 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, the 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 and for reporting years from each LFC block in the Continental Europe Synchronous Area. The number of time intervals in which average FRCE was higher than Level 1 is shown with dots, while for the opposite direction it is denoted by the symbol 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 the respective years and measured in MW.

LFC Block	Level 1	Level 2
APG	80	151
TEIAS	169	319
SEPS	50	95
TEL	76	144
REN	72	137
PSE	127	240
TTB	104	196
SMM	67	127
TERNA	162	307
MAVIR	53	100
RTE	226	427
OST	20	38
SHB	62	118
ELIA	88	166
ESO	63	118
IPTO	66	125
CEPS	88	167
Germany	246	465
REE	188	356
SG	77	145
Target for the maximum number of 15 minutes time intervals per year outside the Level 1 and Level 2 FRCE range	10512	1752

**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 2019**

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LFC Block	Level 1	Level 2
APG	87	164
TEIAS	183	346
SEPS	54	103
TEL	81	154
REN	77	145
PSE	137	258
TTB	112	212
SMM	74	140
TERNA	181	341
MAVIR	63	119
RTE	239	452
OST	29	55
SHB	71	133
ELIA	93	175
ESO	65	123
IPTO	60	113
CEPS	91	172
Germany	256	485
REE	205	388
SG	85	161
Target for the maximum number of 15 minutes time intervals per year outside the Level 1 and Level 2 FRCE range	10512	1752

**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 2020**

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



Figure 24 CE LFCs 2019 FRCE Time Intervals outside Level 1 Range



Figure 25 CE LFCs 2019 FRCE Time Intervals outside Level 2 Range



Figure 26 CE LFCs 2020 FRCE Time Intervals outside Level 1 Range





Figure 27 CE LFCs 2020 FRCE Time Intervals outside Level 2 Range

## II. FRCE vs. FRR

The ability of LFC blocks to regulate their 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 during a dedicated time interval had more FRR (e.g., from free energy bids) this can also be included in the calculation. FRR is considered separately, which 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 include 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 used are the 1-minute average values. The granularity of the FRCE values (used to calculate the 1-minute average) is 10 seconds or lower.

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

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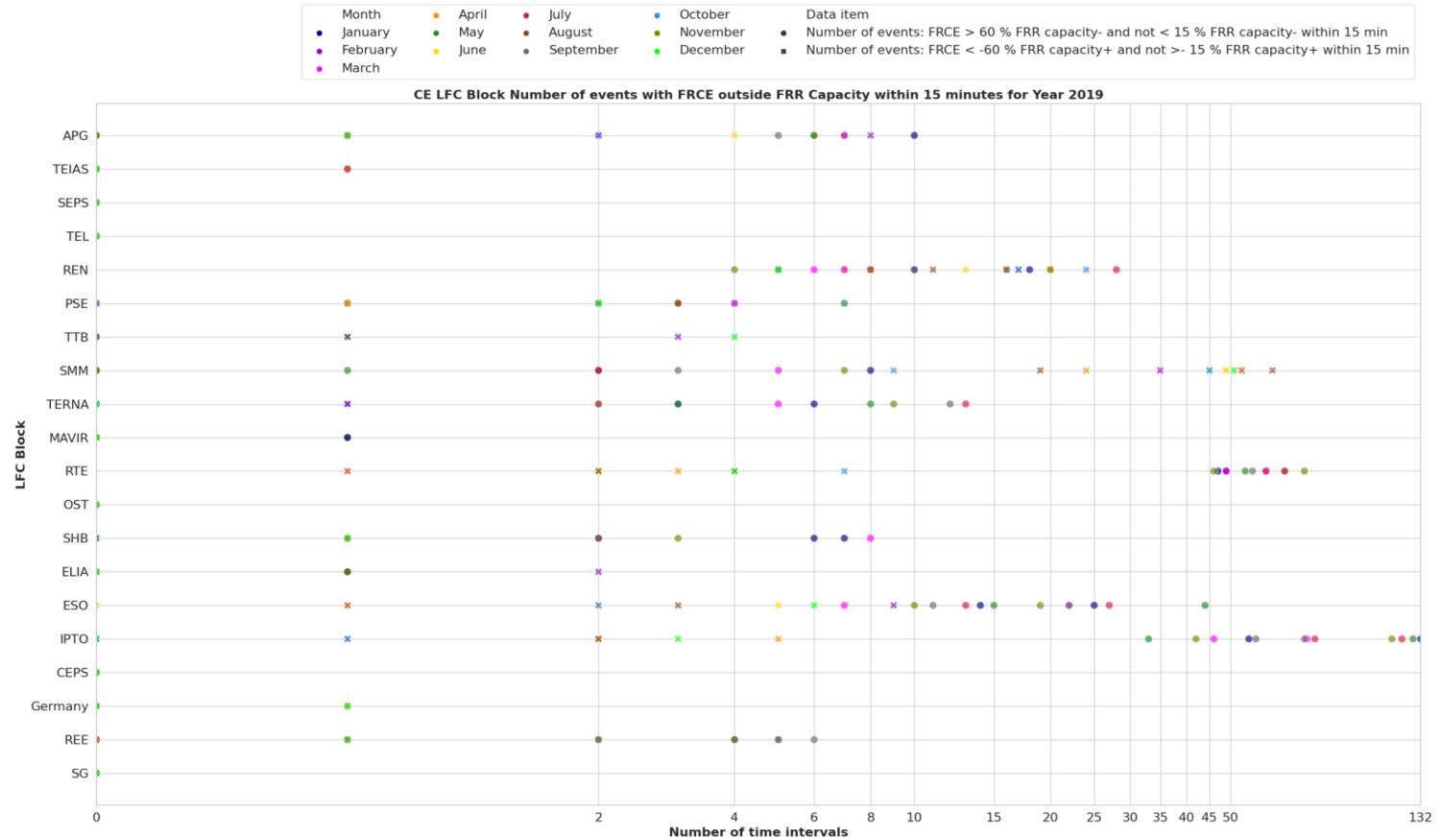


Figure 28 CE LFC Blocks 2019 FRCE Outside FRR Capacity within 15 minutes

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Figure 29 CE LFC Blocks 2020 FRCE Outside FRR Capacity within 15 minutes

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## Frequency quality evaluation

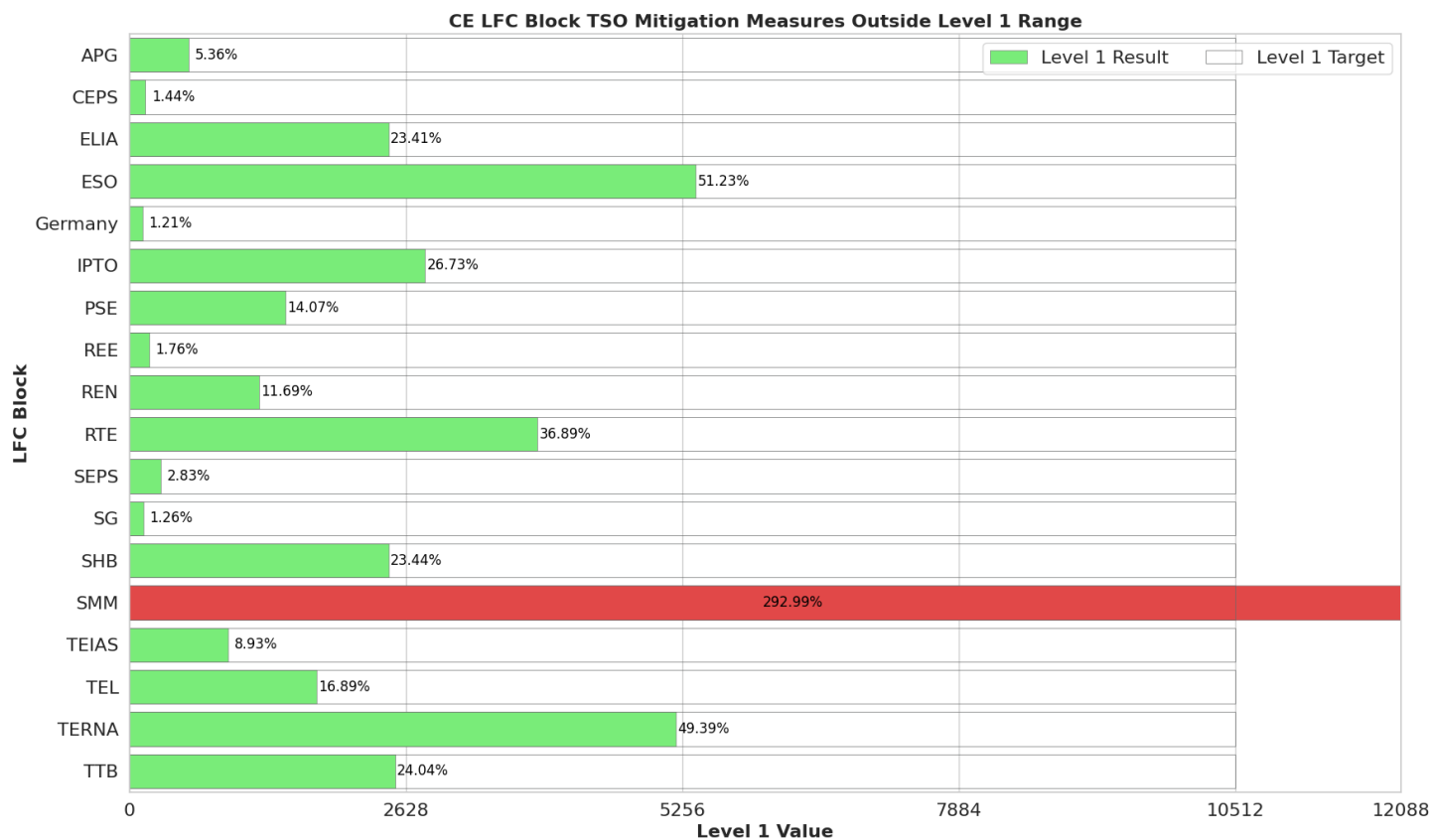


Figure 30 CE LFC Blocks 2019 TSO time Intervals with average FRCE outside Level 1 target

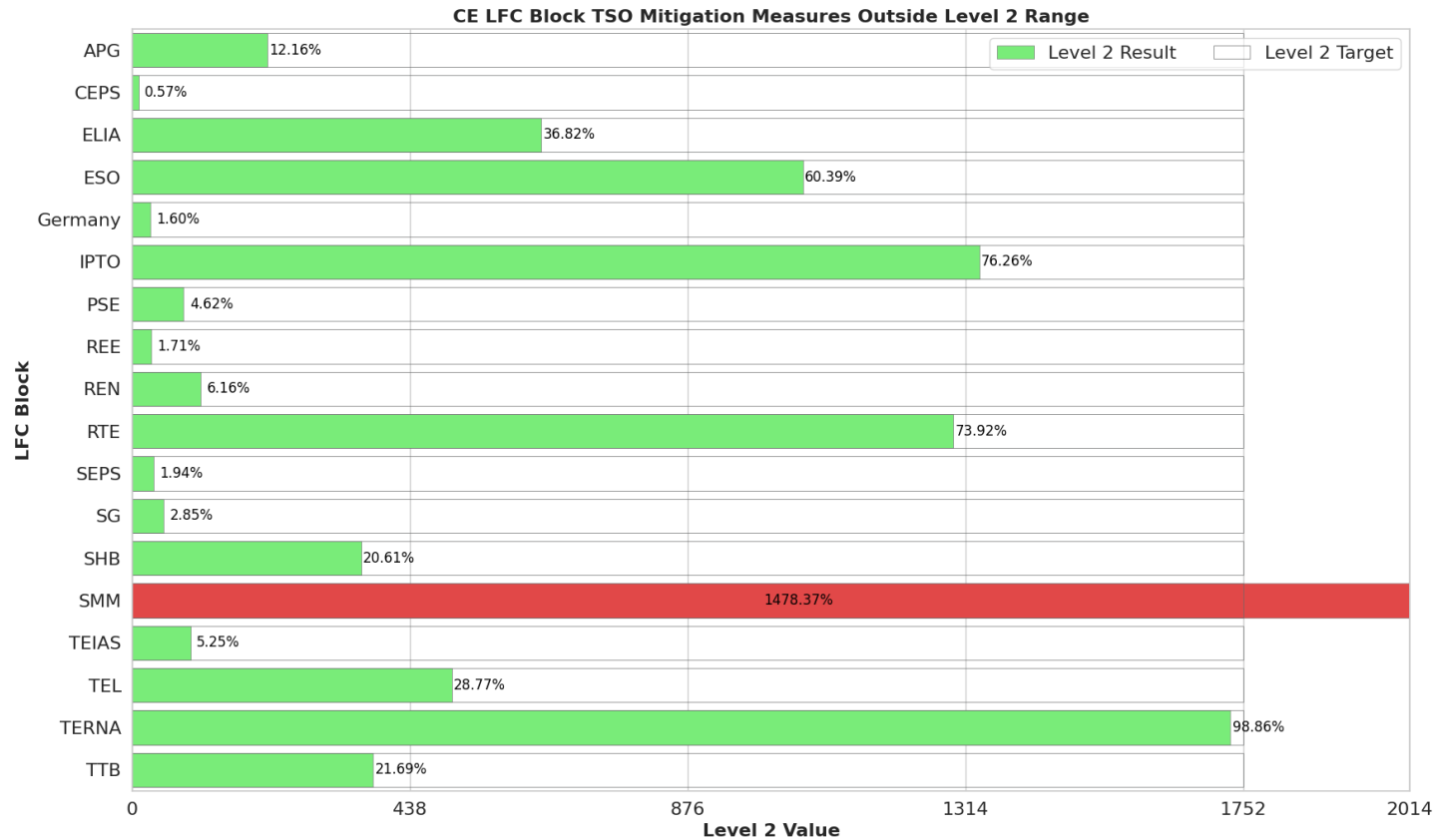


Figure 31 CE LFC Blocks 2019 TSO time Intervals with average FRCE outside Level 2 target

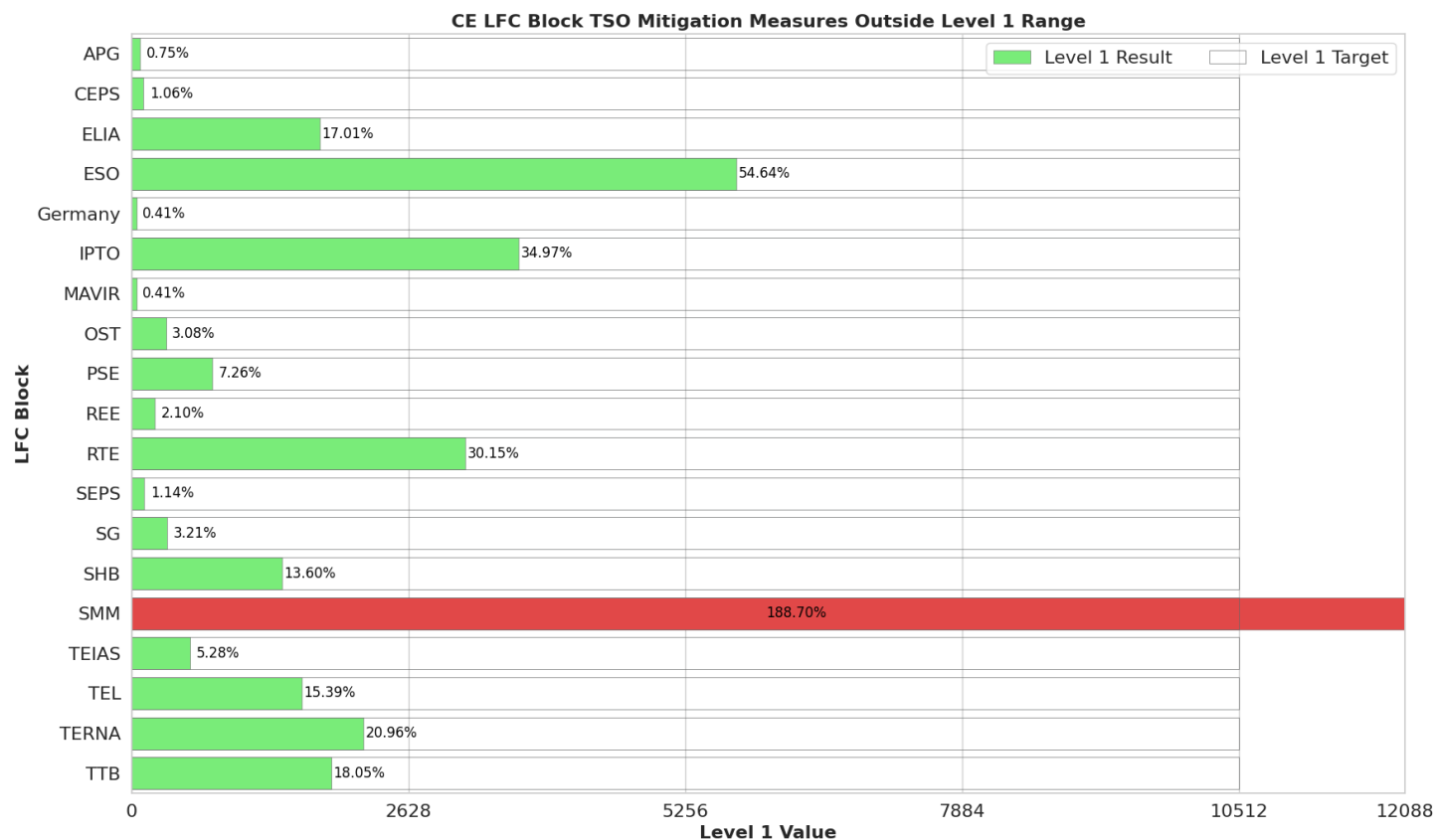


Figure 32 CE LFC Blocks 2020 TSO time Intervals with average FRCE outside Level 1 target

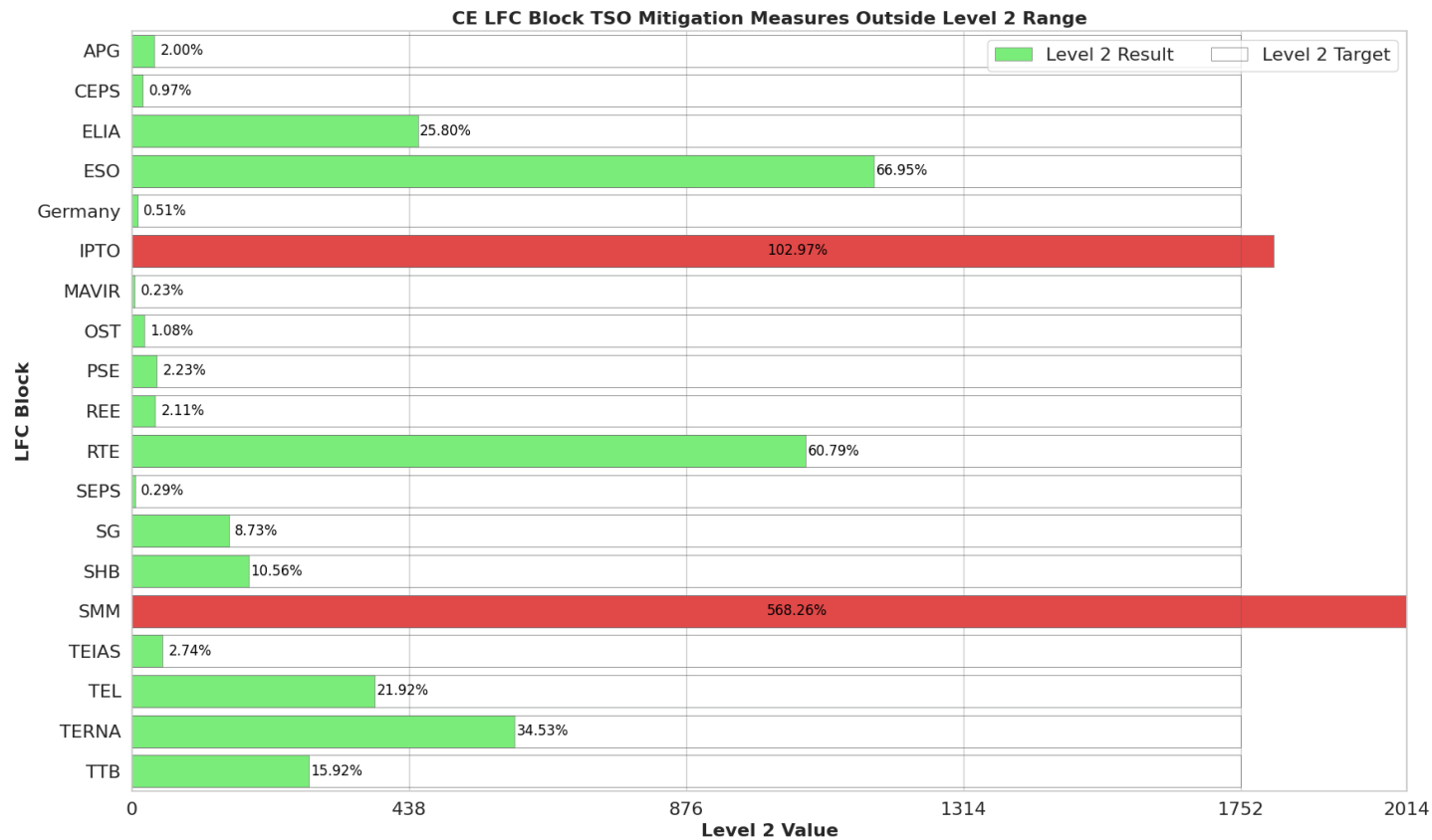


Figure 33 CE LFC Blocks 2020 TSO time Intervals with average FRCE outside Level 2 target



## I. Mitigation Measures Analysis

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

In accordance with Article 138, when the values calculated for the period of one calendar year with respect to 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 with Article 138, when the values calculated for the period of one calendar year with respect to the 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, this information should contain:

(a) analysis of 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, analysis of the causes and a set of recommendations; and

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

For the reporting period, encompassing the years 2019 and 2020, in line with Figures 30–33, the following analysis and mitigation measures were reported from LFC blocks in Continental Europe:

### 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 partially covering the imbalance and discussions were ongoing to resolve this dispute. A connection agreement between the 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.

### Mitigation measures for year 2020:

#### SMM LFC Block

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##### Mitigation measures:

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#### IPTO LFC Block

##### Analysis:

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On November 1st, 2020, the Greek wholesale electricity market model changed (towards target model requirements). As is depicted in the detailed monthly sheet, the number of time intervals where the average FRCE > Level 1 during these two months was 1901 (that is more than 50% of the yearly number) while the number of time intervals where the average FRCE > Level 2 was 950 (that is also more than 50% of the yearly number). The market's operation was evidently immature during the first few months but its behaviour is satisfying during Q1 2021.

## FCR DATA

### Introduction

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

FCR obligation refers to the portion of all the FCR that falls under the responsibility of a TSO; and

Initial FCR obligation refers to 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 the reported month. For TSOs that have the same value of initial FCR obligation for the whole year, TSO reports the same value for all months for the reported year. Otherwise, if the initial FCR obligation is not constant during a period, the TSO reports an average value of the FCR on a monthly level for the reported year.

#### IE/NI and GB TSOs

In Tables 27 to 30 below, the FCR is presented from January (I) to December (XII) for 2019 and 2020. 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 31 and 32, the FCR is pictured for every Nordic TSO from January (I) to December (XII) for 2019 and 2020, respectively. The initial determined initial capacity for each TSO is the capacity for FCR-D, frequency containment reserve for disturbance with frequency deviations < 49.9 Hz. These capacities are ensured by each TSO with combinations of mandatory requirements, internal markets, and a common market.

#### Continental Europe TSOs

In Figures 33 and 34, the FCR is given for every Continental Europe TSO from January (I) to December (XII) for 2019 and 2020, respectively. If more than one TSO is operating inside the Member State (e.g., Germany) the provided value per TSO is summarised for the Member State to enable comparability. The determined value describes the amount of initial FCR obligation inside the respective TSO, divided by the amount of procured FCR inside the TSO. This value is calculated as a percentage. Values higher than 100% indicate that respective TSO exported a percentage amount of FCR to other TSOs, while if the reported value is lower

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than 100 %, this means that the TSO imported part of its FCR from other TSOs (Part of its initial FCR obligation is contracted outside its responsibility area). If the value is equal to 100%, this mean that all FCR is ensured inside the TSO’s area of responsibility. For the case of missing data or data that was not provided in a timely manner, the entry shows N/A.

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

## TSO data

### I. IE/NI TSO

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%

Table 27 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]	274	233	265	304	290	281	289	287	294	289	280	285
FCR obtained inside the area of TSO [%]	75%	71%	75%	74%	68%	69%	69%	70%	70%	70%	70%	72%

Table 28 IE/NI TSO FCR Statistic Year 2020

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## II. GB TSO

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%

**Table 29 GB TSO FCR Statistic Year 2019**

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average Monthly FCR [MW]	985	988	1023	1042	1102	1159	1207	1150	1147	1072	1070	1019
FCR obtained inside the area of TSO [%]	95%	96%	94%	95%	96%	96%	96%	96%	95%	94%	94%	95%

**Table 30 GB TSO FCR Statistic Year 2020**

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## III. Nordic TSOs

2019

Name	Initial obligation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energinet (Nordic)	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 %
Fingrid	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 %
Statnett	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 %
Svenska kraftnät	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 %

Table 31 Nordic TSO FCR Statistic Year 2019

2020

Name	Initial obligation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energinet (Nordic)	38 MW	111.00 %	101.00 %	106.00 %	105.00 %	102.00 %	79.00 %	105.00 %	106.00 %	106.00 %	106.00 %	106.00 %	107.00 %
Fingrid	271 MW	102.00 %	97.00 %	101.00 %	100.00 %	100.00 %	93.00 %	100.00 %	107.00 %	101.00 %	104.00 %	101.00 %	100.00 %
Statnett	489 MW	210.00 %	209.00 %	205.00 %	195.00 %	225.00 %	156.00 %	169.00 %	197.00 %	195.00 %	213.00 %	202.00 %	175.00 %
Svenska kraftnät	530 MW	93.00 %	88.00 %	86.00 %	102.00 %	113.00 %	118.00 %	116.00 %	105.00 %	97.00 %	94.00 %	92.00 %	83.00 %

Table 32 Nordic TSO FCR Statistic Year 2020

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## IV. CE TSOs

2019

Name	Initial obligation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
APG	68 MW	62.28 %	81.72 %	94.81 %	107.6 %	118.31 %	100.59 %	122.21 %	109.21 %	112.4 %	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 %
50Hertz	122.77 MW	189.12 %	214.61 %	234.64 %	189.43 %	204.68 %	185.66 %	108.35 %	188.89 %	185.25 %	185.38 %	192.54 %	148.70 %
Amprion	223.39 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	183.35 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	78.39 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 %
IPTO	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 %
OST	6 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 %	109.82 %	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 %
Swissgrid	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 %
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 %
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 %
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 %
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 %
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 %
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 %
Transelectrica	60 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 %
TenneT NL	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 %

Table 33 Central Europe TSO FCR Statistic Year 2019

# LFC ANNUAL REPORT 2020



Final | 30 September 2021

2020

Name	Initial obligation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
APG	68 MW	93.45 %	83.68 %	110.51 %	118.19 %	117.6 %	102.9 %	120.74 %	129.15 %	141.01 %	139.97 %	139.16 %	124.53 %
CEPS	83 MW	113.20 %	114.07 %	112.59 %	114.37 %	113.70 %	113.24 %	113.25 %	113.39 %	114.17 %	113.29 %	110.93 %	112.18 %
Elia	81 MW	42.41 %	43.81 %	46.32 %	50.29 %	48.04 %	44.61 %	30.11 %	30.75 %	31.21 %	30.83 %	30.12 %	29.88 %
ESO	38 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 %
50Hertz	116 MW	170.10 %	130.86 %	148.69 %	138.79 %	147.72 %	157.87 %	167.05 %	178.61 %	196.43 %	178.96 %	185.57 %	204.58 %
Amprion	211 MW	73.05 %	79.34 %	80.08 %	79.21 %	76.50 %	75.81 %	78.63 %	80.01 %	78.27 %	81.59 %	74.23 %	71.16 %
TenneT DE	172 MW	83.03 %	80.83 %	77.63 %	79.22 %	72.02 %	66.00 %	65.95 %	70.82 %	72.8 %	76.49 %	67.7 %	77.09 %
TransnetBW	74 MW	67.58 %	87.88 %	55.45 %	107.3 %	64.95 %	68.47 %	78.74 %	108.06 %	99.32 %	48.37 %	43.93 %	42.47 %
IPTO	32 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	36 MW	100.00 %	100.96 %	100.30 %	100.00 %	100.27 %	100.10 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %	100.00 %
OST	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 %
PSE	160 MW	108.37 %	108.10 %	107.25 %	106.43 %	107.42 %	107.71 %	106.98 %	107.50 %	107.78 %	108.72 %	106.80 %	106.95 %
REE	379 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	53 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	516 MW	120.16 %	120.35 %	122.48 %	117.25 %	121.90 %	122.48 %	111.63 %	103.10 %	100.19 %	114.92 %	118.02 %	116.28 %
SEPS	27 MW	70.4 %	74.1 %	72.6 %	75.7 %	71.2 %	76.4 %	73.7 %	74.4 %	76.7 %	76.2 %	80.1 %	70.8 %
Swissgrid	67 MW	172.00 %	202.00 %	162.00 %	155.00 %	174.00 %	186.00 %	227.00 %	213.00 %	208.00 %	164.00 %	180.00 %	168.00 %
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 %
HOPS	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 %
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 %
CGES	4 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	40 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	6 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 %
TEİAŞ	302 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 %
Transelectrica	60 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	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 %
TenneT NL	113 MW	33.80 %	37.14 %	36.99 %	39.31 %	38.15 %	36.40 %	37.70 %	38.41 %	39.29 %	39.39 %	37.51 %	37.35 %

Table 34 Central Europe TSO FCR Statistic Year 2020

## APPENDIX

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



Abbreviation	Meaning
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
SOC	System Operations Committee
TO	Transmission owner
GB	Great Britain
StG Op	Steering Group Operations

## APPENDIX – CE LFC BLOCK DATA

### APG

#### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-5.1	-1.0	-0.4	0.9	1.1	1.2	1.9	2.6	3.5	0.8	-0.5	0.0	0.4
The standard deviation	25	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	-122
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	122
Number of time intervals: average FRCE > Level 1 positive	19	11	24	20	25	21	55	30	50	13	10	9	287
Number of time intervals: average FRCE < Level 1 negative	94	23	35	16	9	14	29	7	11	9	20	9	276
Number of time intervals: average FRCE > Level 2 positive	5	3	11	10	15	11	24	18	17	5	2	5	126
Number of time intervals: average FRCE < Level 2 negative	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

#### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-1.0	0.0	1.0	0.0	2.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.3
The standard deviation	40	36	36	37	45	31	29	30	26	27	28	32	33
1-percentile	-135	-110	-112	-112	-108	-88	-89	-81	-83	-84	-87	-100	-99
5-percentile	-58	-52	-53	-57	-53	-46	-45	-42	-34	-42	-44	-51	-48
10-percentile	-36	-32	-32	-37	-33	-29	-28	-25	-19	-25	-27	-31	-30
90-percentile	33	33	34	36	34	29	28	25	20	26	27	32	30
95-percentile	51	51	56	55	56	45	43	41	35	42	42	48	47
99-percentile	101	100	115	110	119	90	85	84	86	82	84	92	96
Number of time intervals: average FRCE > Level 1 positive	7	6	6	2	12	3	0	4	0	0	2	3	45
Number of time intervals: average FRCE < Level 1 negative	23	8	0	2	0	0	0	0	0	0	0	1	34
Number of time intervals: average FRCE > Level 2 positive	1	2	1	0	7	3	0	3	0	0	0	1	18
Number of time intervals: average FRCE < Level 2 negative	11	5	0	1	0	0	0	0	0	0	0	0	17
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	0	1	1	0	2	1	0	1	0	0	0	0	6
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	4	0	0	0	0	0	0	0	0	0	0	0	4

## CEPS

### 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	-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
Number of time intervals: average FRCE > Level 1 positive	10	6	11	13	1	1	3	2	13	10	8	6	84
Number of time intervals: average FRCE < Level 1 negative	4	3	5	3	4	4	0	3	2	13	7	7	55
Number of time intervals: average FRCE > Level 2 positive	1	1	1	1	0	0	0	0	2	0	1	1	8
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.1	-0.2	-0.1	0.0	-0.1	-0.1	-0.1	0.0	0.1	-0.2	-0.2	-0.4	-0.1
The standard deviation	50	46	48	46	41	37	33	38	43	46	46	48	44
1-percentile	-139	-137	-141	-129	-122	-99	-89	-104	-121	-137	-130	-144	-124
5-percentile	-61	-59	-62	-58	-51	-47	-45	-48	-55	-60	-58	-61	-55
10-percentile	-41	-39	-41	-38	-34	-32	-31	-32	-37	-40	-39	-41	-37
90-percentile	42	38	39	36	33	32	30	31	35	40	38	40	36
95-percentile	66	61	63	58	52	48	46	49	56	62	61	64	57
99-percentile	154	148	164	157	130	109	101	123	143	147	157	155	141
Number of time intervals: average FRCE > Level 1 positive	11	12	8	2	5	3	3	3	1	8	6	14	76
Number of time intervals: average FRCE < Level 1 negative	13	4	13	14	7	3	1	9	12	12	14	10	112
Number of time intervals: average FRCE > Level 2 positive	2	1	2	0	0	0	0	0	0	0	1	1	7
Number of time intervals: average FRCE < Level 2 negative	2	0	2	1	0	0	0	0	1	2	2	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	0	0	1	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	1	0	0	1

## ELIA

### 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	-0.7	1.9	0.3
The standard deviation	54	58	52	46	46	54	39	37	40	52	51	62	49
1-percentile	-198	-169	-155	-165	-146	-182	-129	-127	-112	-183	-180	-205	-162
5-percentile	-102	-80	-77	-62	-52	-76	-46	-50	-44	-79	-75	-79	-69
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	157
Number of time intervals: average FRCE > Level 1 positive	62	125	145	93	82	89	63	81	88	124	103	156	1211
Number of time intervals: average FRCE < Level 1 negative	183	122	118	94	75	121	71	62	46	121	110	127	1250
Number of time intervals: average FRCE > Level 2 positive	15	33	36	17	20	31	11	14	21	26	27	49	300
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

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	-0.7	1.9	0.3
The standard deviation	54	58	52	46	46	54	39	37	40	52	51	62	49
1-percentile	-198	-169	-155	-165	-146	-182	-129	-127	-112	-183	-180	-205	-162
5-percentile	-102	-80	-77	-62	-52	-76	-46	-50	-44	-79	-75	-79	-69
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	157
Number of time intervals: average FRCE > Level 1 positive	62	125	145	93	82	89	63	81	88	124	103	156	1211
Number of time intervals: average FRCE < Level 1 negative	183	122	118	94	75	121	71	62	46	121	110	127	1250
Number of time intervals: average FRCE > Level 2 positive	15	33	36	17	20	31	11	14	21	26	27	49	300
Number of time intervals: average FRCE < Level 2 negative	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

## ESO

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.1	1.5	7.0	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	49
1-percentile	-143	-146	-154	-127	-106	-106	-110	-110	-121	-126	-135	-140	-127
5-percentile	-88	-86	-91	-82	-70	-64	-63	-65	-76	-76	-77	-80	-76
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	79
99-percentile	146	148	247	154	107	112	119	102	125	125	136	138	138
Number of time intervals: average FRCE > Level 1 positive	258	263	386	265	176	158	210	154	232	200	209	260	2771
Number of time intervals: average FRCE < Level 1 negative	279	252	329	237	189	162	150	162	205	215	200	234	2614
Number of time intervals: average FRCE > Level 2 positive	56	59	126	69	18	22	30	18	31	36	43	62	570
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	5.9	3.5	5.6	2.4	5.3	0.6	1.7	1.7	1.6	2.1	2.9	6.5	3.3
The standard deviation	56	56	58	52	49	38	39	44	50	58	49	59	51
1-percentile	-151	-140	-158	-139	-122	-99	-100	-122	-127	-162	-139	-141	-134
5-percentile	-86	-88	-90	-82	-67	-62	-58	-70	-78	-93	-78	-86	-78
10-percentile	-61	-61	-61	-58	-47	-44	-43	-49	-55	-65	-53	-58	-55
90-percentile	75	67	72	61	59	45	46	53	61	69	57	73	61
95-percentile	100	96	101	86	81	62	66	75	87	92	83	107	86
99-percentile	152	157	165	145	153	100	115	116	130	154	129	196	143
Number of time intervals: average FRCE > Level 1 positive	379	293	354	254	243	132	157	197	256	328	230	356	3179
Number of time intervals: average FRCE < Level 1 negative	268	248	261	233	159	121	115	177	218	296	216	253	2565
Number of time intervals: average FRCE > Level 2 positive	76	78	81	46	58	8	22	23	42	64	38	109	645
Number of time intervals: average FRCE < Level 2 negative	56	50	75	52	29	14	11	28	37	74	45	57	528
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	39	41	49	21	22	4	9	9	24	42	24	39	323
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	6	2	4	1	1	0	0	0	3	4	5	2	28

## Germany

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	10.0	19.0	22.0	2.0	7.0	1.0	0.0	9.0	6.0	2.0	8.0	9.0	7.9
The standard deviation	63	64	62	61	55	93	53	53	51	59	46	51	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	-75
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
Number of time intervals: average FRCE > Level 1 positive	7	9	10	12	6	12	3	2	4	14	3	8	90
Number of time intervals: average FRCE < Level 1 negative	16	2	0	5	5	21	3	2	0	4	0	2	60
Number of time intervals: average FRCE > Level 2 positive	0	0	5	1	0	3	0	0	0	0	0	1	10
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	8.0	7.0	-11.0	-12.0	-10.0	-31.0	-27.0	-10.0	-8.0	-1.0	2.0	-4.0	-8.1
The standard deviation	51	53	55	47	40	49	53	53	53	55	49	41	50
1-percentile	-115	-125	-138	-162	-117	-159	-129	-108	-157	-106	-100	-96	-126
5-percentile	-68	-76	-86	-78	-72	-109	-90	-77	-83	-70	-67	-66	-79
10-percentile	-50	-56	-67	-59	-57	-87	-74	-62	-65	-54	-54	-52	-61
90-percentile	71	68	45	40	39	28	22	45	56	54	66	49	49
95-percentile	94	93	65	59	58	51	44	67	79	73	102	69	71
99-percentile	138	149	109	111	94	110	104	111	116	112	131	106	116
Number of time intervals: average FRCE > Level 1 positive	3	4	2	2	0	0	7	10	1	3	0	1	33
Number of time intervals: average FRCE < Level 1 negative	0	1	5	4	0	1	2	0	9	1	0	0	23
Number of time intervals: average FRCE > Level 2 positive	0	0	1	0	0	0	4	2	0	1	0	0	8
Number of time intervals: average FRCE < Level 2 negative	0	0	0	0	0	0	0	0	0	1	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
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

## IPTO

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	18.9	9.8	22.0	21.5	17.4	8.2	12.3	6.8	4.9	12.1	12.1	22.0	14.0
The standard deviation	50	32	53	51	49	30	51	35	30	42	40	66	44
1-percentile	-28	-36	-38	-37	-45	-16	-27	-52	-52	-44	-29	-49	-38
5-percentile	-9	-9	-12	-8	-17	-6	-7	-9	-11	-20	-11	-13	-11
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	49
95-percentile	121	71	138	133	149	43	94	54	35	166	76	139	102
99-percentile	234	147	241	247	185	169	237	173	119	203	210	312	206
Number of time intervals: average FRCE > Level 1 positive	310	148	335	318	363	110	179	123	79	192	169	339	2665
Number of time intervals: average FRCE < Level 1 negative	10	7	8	13	5	2	13	19	21	18	9	20	145
Number of time intervals: average FRCE > Level 2 positive	141	50	173	158	178	47	105	68	26	92	73	181	1292
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	9.7	21.6	21.4	10.7	6.2	3.3	4.3	4.0	8.6	8.5	38.5	58.0	16.2
The standard deviation	33	63	68	42	30	20	19	23	42	37	63	82	44
1-percentile	-36	-93	-48	-18	-17	-31	-30	-32	-59	-33	-104	-92	-50
5-percentile	-9	-23	-14	-6	-6	-10	-9	-12	-18	-13	-30	-28	-15
10-percentile	-5	-10	-8	-4	-4	-6	-5	-7	-10	-7	-15	-13	-8
90-percentile	31	86	68	20	11	11	13	13	27	19	117	170	49
95-percentile	76	143	143	80	37	20	28	26	74	55	158	216	88
99-percentile	168	305	354	218	149	101	101	113	193	179	268	320	206
Number of time intervals: average FRCE > Level 1 positive	188	355	292	175	106	49	69	75	162	134	699	1077	3381
Number of time intervals: average FRCE < Level 1 negative	18	53	20	9	7	10	10	11	27	5	68	57	295
Number of time intervals: average FRCE > Level 2 positive	71	185	193	103	45	22	18	28	84	63	299	618	1729
Number of time intervals: average FRCE < Level 2 negative	7	12	1	2	3	2	0	5	10	0	16	17	75
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	71	103	77	47	36	17	22	26	43	44	246	326	1058
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	1	2	2	1	2	2	1	4	2	0	0	2	19

## MAVIR

### 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
Number of time intervals: average FRCE > Level 1 positive	17	13	16	13	5	12	10	13	18	24	20	14	175
Number of time intervals: average FRCE < Level 1 negative	0	1	9	3	7	5	2	2	2	2	3	0	36
Number of time intervals: average FRCE > Level 2 positive	1	0	0	1	2	5	2	2	0	4	1	1	19
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.9	-0.5	-0.1	0.6	-0.5	0.3	1.2	1.0	0.3	-0.4	-1.5	-1.6	-0.2
The standard deviation	17	17	17	17	16	14	14	15	14	14	14	15	15
1-percentile	-35	-37	-37	-35	-39	-34	-34	-36	-34	-34	-35	-36	-35
5-percentile	-26	-26	-26	-25	-26	-22	-22	-23	-22	-21	-25	-24	-24
10-percentile	-21	-21	-21	-20	-20	-17	-17	-17	-16	-15	-19	-19	-19
90-percentile	22	21	22	22	19	18	19	18	19	16	18	17	19
95-percentile	30	29	30	29	25	24	25	25	25	23	25	24	26
99-percentile	45	45	44	41	38	37	39	44	37	39	36	36	40
Number of time intervals: average FRCE > Level 1 positive	5	2	0	2	1	0	4	4	3	2	0	1	24
Number of time intervals: average FRCE < Level 1 negative	0	1	3	1	7	1	0	0	0	1	1	4	19
Number of time intervals: average FRCE > Level 2 positive	1	0	0	0	0	0	0	1	0	0	0	0	2
Number of time intervals: average FRCE < Level 2 negative	0	0	1	0	0	0	0	0	0	0	0	1	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
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



## OST

### 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
Number of time intervals: average FRCE > Level 1 positive	15	53	24	61	93	1	0	1	0	1	14	2	265
Number of time intervals: average FRCE < Level 1 negative	7	3	15	6	8	1	0	2	1	2	12	0	57
Number of time intervals: average FRCE > Level 2 positive	0	16	4	2	8	0	0	0	0	0	0	0	30
Number of time intervals: average FRCE < Level 2 negative	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	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	2.3	4.6	3.4	0.6	0.6	0.2	1.0	0.3	0.5	0.2	0.2	1.0	1.2
The standard deviation	8	10	9	5	4	3	10	2	3	4	4	7	6
1-percentile	-11	-19	-14	-14	-12	-9	-30	-5	-11	-10	-12	-17	-14
5-percentile	-5	-10	-7	-6	-5	-4	-13	-2	-4	-5	-5	-7	-6
10-percentile	-2	-5	-4	-3	-3	-2	-5	-1	-2	-3	-3	-4	-3
90-percentile	14	18	17	5	5	3	9	1	3	4	4	7	7
95-percentile	20	23	24	7	8	5	15	2	6	7	7	13	11
99-percentile	36	32	36	16	14	11	33	5	12	20	13	33	22
Number of time intervals: average FRCE > Level 1 positive	59	51	73	2	0	2	39	0	2	4	1	41	274
Number of time intervals: average FRCE < Level 1 negative	0	1	1	2	1	1	30	0	1	0	6	7	50
Number of time intervals: average FRCE > Level 2 positive	0	2	2	0	0	0	4	0	0	0	0	3	11
Number of time intervals: average FRCE < Level 2 negative	0	0	0	0	0	0	6	0	0	0	1	1	8
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

## PSE

### 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	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
Number of time intervals: average FRCE > Level 1 positive	70	56	85	59	49	55	55	59	50	66	59	51	714
Number of time intervals: average FRCE < Level 1 negative	70	58	80	60	52	68	71	60	57	67	66	56	765
Number of time intervals: average FRCE > Level 2 positive	3	1	6	3	2	0	2	5	4	2	2	3	33
Number of time intervals: average FRCE < Level 2 negative	3	3	5	4	3	6	3	5	6	5	0	5	48
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	3	0	7	2	1	1	0	4	2	3	0	3	26
Number of events: FRCE < -60 % FRR capacity + and not > -15 % FRR capacity + within 15 min	4	1	1	2	2	4	3	1	0	0	0	2	20

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.6	1.1	2.8	1.4	0.1	-0.3	0.3	-0.2	0.1	-0.4	0.4	1.2	0.6
The standard deviation	59	61	61	54	49	48	51	48	51	50	48	54	53
1-percentile	-153	-160	-153	-147	-134	-142	-154	-135	-146	-143	-142	-146	-146
5-percentile	-100	-98	-95	-86	-80	-80	-82	-79	-90	-84	-78	-84	-86
10-percentile	-72	-72	-70	-61	-57	-56	-59	-58	-61	-62	-55	-59	-62
90-percentile	72	74	74	65	58	54	59	55	59	60	56	60	62
95-percentile	96	96	103	87	79	79	82	78	84	79	79	86	86
99-percentile	142	152	164	139	121	118	131	118	125	127	132	150	135
Number of time intervals: average FRCE > Level 1 positive	35	42	49	32	17	11	22	17	20	21	21	38	325
Number of time intervals: average FRCE < Level 1 negative	46	39	45	36	29	35	41	29	37	34	31	36	438
Number of time intervals: average FRCE > Level 2 positive	1	5	4	2	1	0	2	1	0	0	1	4	21
Number of time intervals: average FRCE < Level 2 negative	0	1	3	3	1	2	4	0	0	1	0	3	18
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	1	4	2	1	1	1	0	0	0	0	1	4	15
Number of events: FRCE < -60 % FRR capacity + and not > -15 % FRR capacity + within 15 min	0	0	2	1	1	0	0	0	2	2	0	4	12

## REE

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-8.5	-1.0	30.4	18.9	17.5	14.9	10.1	13.3	10.3	7.7	10.9	9.2	11.1
The standard deviation	42	42	82	48	44	39	39	36	49	46	54	47	47
1-percentile	-121	-113	-87	-114	-113	-100	-100	-84	-111	-137	-134	-117	-111
5-percentile	-73	-65	-37	-51	-48	-43	-47	-42	-55	-64	-71	-57	-54
10-percentile	-56	-48	-20	-31	-27	-29	-31	-26	-37	-44	-44	-37	-36
90-percentile	40	46	75	67	61	58	53	52	57	57	62	56	57
95-percentile	58	62	92	87	79	72	66	65	75	74	87	72	74
99-percentile	102	105	140	145	137	101	99	102	152	110	162	117	123
Number of time intervals: average FRCE > Level 1 positive	5	3	15	11	12	2	2	4	20	2	22	7	105
Number of time intervals: average FRCE < Level 1 negative	1	3	5	10	8	4	7	2	8	10	11	8	77
Number of time intervals: average FRCE > Level 2 positive	0	0	5	2	0	1	0	1	2	1	2	2	16
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	14.1	35.7	23.7	26.9	24.4	13.7	-2.0	-1.3	-0.1	11.7	10.1	8.2	13.8
The standard deviation	50	45	54	48	47	53	44	50	47	62	42	43	49
1-percentile	-132	-88	-124	-92	-101	-146	-115	-138	-125	-147	-99	-107	-118
5-percentile	-56	-35	-54	-40	-38	-57	-66	-72	-72	-81	-55	-55	-57
10-percentile	-35	-13	-30	-20	-20	-37	-48	-51	-52	-53	-33	-37	-36
90-percentile	64	83	76	70	67	61	43	51	51	70	54	53	62
95-percentile	80	99	94	87	80	75	58	68	67	91	72	72	79
99-percentile	128	136	168	143	119	124	102	115	106	178	111	110	128
Number of time intervals: average FRCE > Level 1 positive	7	5	19	18	5	11	4	12	5	24	3	3	116
Number of time intervals: average FRCE < Level 1 negative	12	5	14	7	6	18	7	8	7	15	5	3	107
Number of time intervals: average FRCE > Level 2 positive	5	1	3	4	1	2	1	2	1	5	0	0	25
Number of time intervals: average FRCE < Level 2 negative	0	0	0	0	2	4	1	0	1	2	0	2	12
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	4	0	7	3	2	1	2	4	2	5	0	1	31
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	2	1	2	0	2	6	1	3	3	3	0	1	24

## REN

### 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
Number of time intervals: average FRCE > Level 1 positive	10	13	5	18	19	34	71	63	101	103	129	116	682
Number of time intervals: average FRCE < Level 1 negative	16	14	24	31	29	23	47	62	71	90	89	51	547
Number of time intervals: average FRCE > Level 2 positive	0	0	0	0	3	0	6	5	13	10	11	15	63
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.8	0.9	0.3	-0.6	-0.6	0.2	-0.8	-1.1	-2.5	-2.1	-1.4	-0.7	-0.5
The standard deviation	20	21	22	20	18	17	17	19	22	25	19	21	20
1-percentile	-58	-65	-69	-67	-57	-53	-55	-60	-77	-83	-67	-70	-65
5-percentile	-23	-26	-33	-31	-29	-27	-29	-33	-39	-46	-31	-34	-32
10-percentile	-13	-16	-19	-18	-18	-16	-16	-20	-23	-27	-18	-19	-19
90-percentile	19	20	20	16	16	17	15	17	16	20	15	17	17
95-percentile	32	32	33	28	26	26	26	27	26	33	25	29	28
99-percentile	70	71	66	64	55	52	51	55	57	67	50	68	60
Number of time intervals: average FRCE > Level 1 positive	20	25	18	15	11	11	3	11	11	21	8	18	172
Number of time intervals: average FRCE < Level 1 negative	14	16	24	19	15	10	8	14	32	38	24	22	236
Number of time intervals: average FRCE > Level 2 positive	1	1	1	1	0	0	0	0	0	1	0	1	6
Number of time intervals: average FRCE < Level 2 negative	0	2	1	1	1	0	0	1	2	3	1	0	12
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	17	22	9	31	13	12	5	13	6	36	7	25	196
Number of events: FRCE < -60 % FRR capacity + and not > -15 % FRR capacity + within 15 min	3	4	19	12	12	5	17	12	12	6	5	17	124

## RTE

### 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	6.0	6.7	-3.2	6.1	6.0
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	-514
5-percentile	-263	-235	-251	-261	-220	-220	-238	-206	-243	-270	-278	-263	-246
10-percentile	-168	-159	-169	-166	-134	-138	-133	-125	-156	-169	-169	-159	-154
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	243
99-percentile	548	593	748	594	623	574	517	542	583	595	498	572	582
Number of time intervals: average FRCE > Level 1 positive	144	165	220	174	138	136	131	130	163	183	147	192	1923
Number of time intervals: average FRCE < Level 1 negative	181	142	179	175	139	138	159	124	160	193	181	184	1955
Number of time intervals: average FRCE > Level 2 positive	50	61	86	74	55	51	47	53	60	79	46	68	730
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	4.1	13.2	15.4	4.2	2.8	-9.0	1.1	1.0	-0.2	7.8	1.5	-2.6	3.3
The standard deviation	175	177	170	160	161	152	168	154	190	168	150	142	164
1-percentile	-588	-514	-475	-512	-463	-526	-540	-501	-582	-531	-490	-484	-517
5-percentile	-234	-198	-187	-232	-207	-282	-229	-222	-272	-227	-219	-218	-227
10-percentile	-149	-132	-128	-139	-132	-152	-132	-137	-169	-147	-134	-136	-141
90-percentile	145	144	138	147	122	123	132	132	159	154	129	122	137
95-percentile	240	248	249	230	180	178	230	196	265	243	189	174	219
99-percentile	579	623	653	512	471	433	572	530	627	571	524	421	543
Number of time intervals: average FRCE > Level 1 positive	152	144	158	135	105	85	141	113	162	155	110	89	1549
Number of time intervals: average FRCE < Level 1 negative	143	99	112	136	122	173	139	134	169	136	129	128	1620
Number of time intervals: average FRCE > Level 2 positive	56	64	71	50	34	26	53	45	60	50	38	27	574
Number of time intervals: average FRCE < Level 2 negative	49	33	33	39	30	46	52	37	63	38	36	35	491
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	53	51	62	63	36	34	59	41	60	55	47	44	605
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	7	4	3	4	3	2	7	3	7	1	4	4	49

## SEPS

### 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	-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
Number of time intervals: average FRCE > Level 1 positive	21	8	14	12	9	4	4	5	19	34	25	17	172
Number of time intervals: average FRCE < Level 1 negative	10	7	15	5	11	8	4	12	14	19	8	12	125
Number of time intervals: average FRCE > Level 2 positive	2	0	0	0	1	1	0	0	4	8	3	4	23
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.1	-0.3	-0.2	0.0	-0.5	-0.6	0.0	-0.2	-0.5	0.2	-0.3	-0.3	-0.2
The standard deviation	11	9	13	12	9	7	7	8	8	7	7	9	9
1-percentile	-34	-29	-37	-32	-28	-18	-20	-23	-29	-19	-20	-28	-27
5-percentile	-15	-13	-21	-18	-13	-10	-10	-11	-12	-10	-10	-12	-13
10-percentile	-9	-9	-14	-13	-8	-6	-7	-7	-7	-6	-6	-8	-8
90-percentile	9	8	13	12	8	5	7	7	7	7	6	7	8
95-percentile	14	11	19	18	12	8	10	10	11	10	9	11	12
99-percentile	33	28	35	37	26	19	21	21	20	20	17	23	25
Number of time intervals: average FRCE > Level 1 positive	12	4	10	13	8	5	3	4	0	5	1	1	66
Number of time intervals: average FRCE < Level 1 negative	9	0	11	4	2	1	3	5	5	1	5	8	54
Number of time intervals: average FRCE > Level 2 positive	1	0	1	0	0	0	0	0	0	0	0	0	2
Number of time intervals: average FRCE < Level 2 negative	1	0	0	0	1	0	0	0	0	0	1	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
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

## SG

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.3	0.0	-0.1	0.0	-0.2	0.0	-0.1	0.0	0.0	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	-16
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	13
Number of time intervals: average FRCE > Level 1 positive	1	0	0	1	0	0	0	0	2	0	0	0	4
Number of time intervals: average FRCE < Level 1 negative	4	0	1	0	2	0	0	0	1	0	1	2	11
Number of time intervals: average FRCE > Level 2 positive	1	0	0	0	0	0	0	0	0	0	0	0	1
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.2	-0.1
The standard deviation	7	7	7	5	5	5	7	7	7	7	7	9	7
1-percentile	-20	-21	-21	-18	-17	-15	-15	-18	-19	-20	-17	-19	-18
5-percentile	-13	-13	-12	-11	-8	-8	-8	-10	-12	-12	-10	-10	-11
10-percentile	-8	-8	-8	-7	-5	-5	-5	-6	-7	-7	-7	-7	-7
90-percentile	8	8	7	7	5	5	5	6	7	7	6	6	6
95-percentile	10	11	11	9	8	8	7	9	10	10	9	8	9
99-percentile	16	16	18	14	14	12	11	14	15	16	15	14	15
Number of time intervals: average FRCE > Level 1 positive	0	0	0	0	0	0	0	0	0	2	0	0	2
Number of time intervals: average FRCE < Level 1 negative	0	0	0	0	0	0	0	1	0	0	0	1	2
Number of time intervals: average FRCE > Level 2 positive	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of time intervals: average FRCE < Level 2 negative	0	0	0	0	0	0	0	1	0	0	0	1	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
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

## SHB

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6.0	9.6	7.0	9.1	9.7	11.7	-3.0	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
Number of time intervals: average FRCE > Level 1 positive	114	132	100	101	99	115	93	166	104	122	109	74	1329
Number of time intervals: average FRCE < Level 1 negative	129	64	77	71	58	57	117	79	106	149	105	123	1135
Number of time intervals: average FRCE > Level 2 positive	14	23	17	8	12	12	19	33	19	11	9	11	188
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6.0	8.9	11.5	12.1	15.2	4.4	-4.4	0.3	-3.0	12.4	11.3	10.4	7.1
The standard deviation	33	34	30	32	32	33	29	29	28	29	26	29	30
1-percentile	-79	-84	-71	-74	-70	-96	-98	-82	-97	-77	-70	-78	-81
5-percentile	-39	-39	-32	-34	-33	-53	-53	-42	-49	-31	-30	-31	-39
10-percentile	-24	-23	-17	-18	-20	-33	-36	-28	-34	-15	-16	-16	-23
90-percentile	35	44	42	46	52	39	21	29	25	41	38	39	38
95-percentile	50	60	60	65	67	52	38	44	40	55	52	55	53
99-percentile	90	95	96	119	115	91	76	88	79	98	81	104	94
Number of time intervals: average FRCE > Level 1 positive	61	75	96	118	121	70	40	61	37	84	53	72	888
Number of time intervals: average FRCE < Level 1 negative	44	44	32	33	27	83	67	39	66	42	28	37	542
Number of time intervals: average FRCE > Level 2 positive	10	9	13	23	11	4	6	7	0	11	2	15	111
Number of time intervals: average FRCE < Level 2 negative	7	8	7	6	1	10	11	5	7	5	2	5	74
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	3	2	6	6	3	1	1	2	0	3	1	2	30
Number of events: FRCE < -60 % FRR capacity + and not > -15 % FRR capacity + within 15 min	0	1	0	1	0	2	0	0	0	0	0	0	4



## SMM

### 2019

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-171.2	-244.1	-378.0	-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	72
Number of time intervals: average FRCE > Level 1 positive	23	2	7	64	104	134	87	150	3	2	5	0	581
Number of time intervals: average FRCE < Level 1 negative	2632	2545	2919	1735	1720	2098	2651	2385	2810	2929	2841	2953	30218
Number of time intervals: average FRCE > Level 2 positive	11	0	4	9	28	61	69	109	1	1	1	0	294
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-44.4	-93.7	-116.9	-46.4	-57.2	-64.9	-92.3	-63.0	-85.8	-123.6	-151.5	-11.2	-79.2
The standard deviation	101	123	103	100	97	83	121	79	101	119	170	87	107
1-percentile	-308	-368	-356	-295	-271	-251	-398	-238	-327	-447	-692	-233	-349
5-percentile	-191	-305	-280	-220	-208	-198	-254	-189	-234	-305	-581	-159	-260
10-percentile	-152	-261	-243	-174	-181	-168	-214	-164	-203	-263	-412	-126	-213
90-percentile	91	54	21	77	67	45	23	37	30	39	-2	89	48
95-percentile	133	104	51	116	100	72	49	61	56	74	36	119	81
99-percentile	205	182	112	170	167	123	122	115	122	122	122	204	147
Number of time intervals: average FRCE > Level 1 positive	372	315	86	300	263	133	84	95	92	147	78	400	2365
Number of time intervals: average FRCE < Level 1 negative	1220	1454	1951	1097	1317	1371	1640	1330	1562	1976	1907	646	17471
Number of time intervals: average FRCE > Level 2 positive	121	163	9	85	60	15	25	16	21	15	21	89	640
Number of time intervals: average FRCE < Level 2 negative	391	935	1297	477	570	502	906	505	851	1426	1230	226	9316
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	0	0	0	0	1	0	3	0	2	0	0	6	12
Number of events: FRCE < -60 % FRR capacity + and not > -15 % FRR capacity + within 15 min	63	26	3	36	39	60	39	45	39	2	1	2	355

## TEIAS

### 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	5.0	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
Number of time intervals: average FRCE > Level 1 positive	63	97	71	74	87	69	44	38	35	58	35	18	689
Number of time intervals: average FRCE < Level 1 negative	15	31	10	20	40	20	24	13	17	21	30	9	250
Number of time intervals: average FRCE > Level 2 positive	9	13	9	7	6	6	2	6	4	6	1	1	70
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	7.5	0.9	1.3	7.8	0.4	-1.5	1.1	2.4	10.2	11.8	13.6	15.9	5.9
The standard deviation	84	92	106	87	86	49	86	73	86	81	90	85	84
1-percentile	-184	-218	-244	-192	-204	-155	-204	-185	-189	-176	-191	-181	-194
5-percentile	-111	-135	-152	-118	-131	-82	-127	-109	-114	-106	-113	-110	-117
10-percentile	-82	-102	-114	-87	-98	-45	-95	-79	-85	-80	-84	-81	-86
90-percentile	109	107	118	107	100	33	100	89	110	110	118	120	102
95-percentile	145	147	168	147	140	73	135	123	147	146	156	156	140
99-percentile	225	256	323	260	243	159	227	205	242	234	247	245	239
Number of time intervals: average FRCE > Level 1 positive	23	37	58	44	18	4	28	18	30	25	21	30	336
Number of time intervals: average FRCE < Level 1 negative	20	28	51	18	18	0	26	10	16	9	15	8	219
Number of time intervals: average FRCE > Level 2 positive	0	2	9	1	2	8	0	0	5	0	1	0	28
Number of time intervals: average FRCE < Level 2 negative	2	0	6	3	0	0	4	1	1	0	2	1	20
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	0	0	2	0	0	0	0	0	0	0	0	0	2
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	0	0	0	1	0	0	1	0	0	1	0	0	3

## TERNA

### 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	23.0
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
Number of time intervals: average FRCE > Level 1 positive	292	362	387	344	347	315	337	373	318	113	128	185	3501
Number of time intervals: average FRCE < Level 1 negative	216	164	169	185	166	194	135	91	117	88	76	90	1691
Number of time intervals: average FRCE > Level 2 positive	118	152	162	133	155	122	115	153	120	22	26	73	1351
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	13.0	8.7	13.5	18.4	13.3	1.3	2.3	-0.7	0.2	4.6	-2.1	-2.3	5.8
The standard deviation	100	102	136	131	114	96	84	78	88	109	84	100	102
1-percentile	-238	-275	-368	-290	-268	-312	-240	-227	-248	-291	-262	-327	-279
5-percentile	-122	-131	-152	-140	-135	-125	-128	-119	-134	-142	-131	-141	-133
10-percentile	-84	-86	-101	-91	-92	-80	-82	-83	-91	-94	-91	-98	-89
90-percentile	108	104	131	139	117	86	86	76	87	102	82	84	100
95-percentile	168	168	210	241	196	127	130	119	126	155	115	125	157
99-percentile	362	355	533	512	444	301	254	224	261	337	221	288	341
Number of time intervals: average FRCE > Level 1 positive	132	118	194	201	168	76	66	55	72	101	52	70	1305
Number of time intervals: average FRCE < Level 1 negative	63	69	104	90	68	75	62	55	75	81	64	92	898
Number of time intervals: average FRCE > Level 2 positive	34	34	71	88	57	24	17	6	12	28	10	20	401
Number of time intervals: average FRCE < Level 2 negative	10	12	35	20	16	23	8	11	12	15	16	26	204
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	127	109	379	577	490	99	48	10	57	169	33	32	2130
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	18	74	168	212	132	127	10	29	74	55	50	143	1092

## TEL

### 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	2.8
The standard deviation	38	39	43	39	44	38	44	40	34	28	39	33	38
1-percentile	-118	-128	-126	-107	-131	-115	-152	-125	-93	-83	-92	-92	-113
5-percentile	-44	-41	-50	-42	-40	-36	-39	-44	-39	-30	-33	-37	-39
10-percentile	-28	-26	-29	-26	-25	-22	-23	-23	-23	-20	-22	-22	-24
90-percentile	31	33	42	36	33	33	32	32	29	24	27	26	31
95-percentile	48	59	74	60	64	56	59	59	49	38	42	47	55
99-percentile	123	143	162	142	159	134	146	151	100	91	127	128	134
Number of time intervals: average FRCE > Level 1 positive	71	95	141	96	116	94	102	100	62	44	64	85	1070
Number of time intervals: average FRCE < Level 1 negative	66	57	76	62	70	52	79	82	39	34	44	44	705
Number of time intervals: average FRCE > Level 2 positive	20	22	47	28	37	23	31	33	13	6	19	19	298
Number of time intervals: average FRCE < Level 2 negative	20	13	20	19	25	18	31	19	13	7	8	13	206
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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	2.0	2.5	6.5	4.2	5.8	3.6	2.3	2.7	4.1	4.0	2.1	2.4	3.5
The standard deviation	34	40	43	39	42	36	37	31	37	37	30	35	37
1-percentile	-98	-127	-103	-111	-103	-109	-113	-96	-103	-102	-100	-113	-106
5-percentile	-34	-39	-43	-41	-46	-33	-34	-29	-37	-37	-34	-37	-37
10-percentile	-22	-26	-25	-24	-26	-21	-19	-18	-23	-22	-21	-23	-22
90-percentile	25	30	42	33	42	29	25	25	30	32	25	29	31
95-percentile	44	54	76	64	74	53	45	40	59	56	42	45	54
99-percentile	122	138	166	151	161	124	125	110	144	148	118	125	136
Number of time intervals: average FRCE > Level 1 positive	61	84	141	106	128	76	66	57	86	94	53	71	1023
Number of time intervals: average FRCE < Level 1 negative	52	61	53	61	53	45	51	34	42	52	39	52	595
Number of time intervals: average FRCE > Level 2 positive	20	24	36	28	42	15	18	13	25	28	7	18	274
Number of time intervals: average FRCE < Level 2 negative	6	12	11	12	10	9	12	7	8	6	4	13	110
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

## TTB

### 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
Number of time intervals: average FRCE > Level 1 positive	120	121	107	64	80	51	84	76	151	184	147	185	1370
Number of time intervals: average FRCE < Level 1 negative	199	89	96	111	100	109	43	60	70	101	90	89	1157
Number of time intervals: average FRCE > Level 2 positive	19	16	9	5	5	11	5	8	20	27	23	34	182
Number of time intervals: average FRCE < Level 2 negative	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

### 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.3	4.1	5.3	2.7	1.6	-3.1	8.4	9.6	9.6	14.8	12.4	7.1	6.1
The standard deviation	78	56	52	56	56	63	49	51	61	59	55	60	58
1-percentile	-223	-164	-147	-163	-159	-186	-112	-122	-152	-141	-120	-145	-153
5-percentile	-107	-83	-81	-82	-96	-89	-65	-65	-85	-77	-71	-74	-81
10-percentile	-70	-54	-53	-56	-59	-62	-41	-43	-51	-50	-45	-45	-52
90-percentile	70	69	62	60	63	52	68	69	81	86	77	70	69
95-percentile	99	93	89	84	89	79	97	100	110	118	102	100	97
99-percentile	180	143	145	167	183	147	169	172	187	201	173	176	170
Number of time intervals: average FRCE > Level 1 positive	112	75	82	80	69	82	101	110	138	172	117	106	1244
Number of time intervals: average FRCE < Level 1 negative	139	76	56	74	100	82	31	41	67	49	44	62	821
Number of time intervals: average FRCE > Level 2 positive	17	3	7	13	9	19	7	10	23	24	11	18	161
Number of time intervals: average FRCE < Level 2 negative	34	12	12	17	13	22	3	3	12	5	3	15	151
Number of events: FRCE > 60 % FRR capacity - and not < 15 % FRR capacity - within 15 min	0	0	0	1	6	1	1	0	0	1	0	0	10
Number of events: FRCE < -60 % FRR capacity + and not > - 15 % FRR capacity + within 15 min	18	6	2	7	9	13	10	13	23	13	8	25	147