

2021 Load-Frequency Control Annual Report

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From: System Operations Committee

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, the 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]. Subsequently, 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 include 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 the respective synchronous area's frequency quality fit within the defined levels for all reported data. All LFC blocks and TSOs provided their data and have explained any mitigation measures where applicable.

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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, which established a guideline on electricity transmission system operation [hereinafter SO GL].

Article 16 of the SO GL requires 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. ENTSO-E is required to publish the annual report.

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

The LFC report aims to present the results of the frequency quality evaluation criteria for each synchronous area and LFC block, and the FCR obligations and initial FCR obligations of each TSO for each month of the preceding two years. Additional details include a description and the date of implementation of any mitigation measures and ramping requirements to alleviate the deterministic frequency deviations in which TSOs were involved during the 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 chapter, 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 within 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, Great Britain, Ireland and Northern Ireland, the Nordic and the 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 in accordance with EU rules.

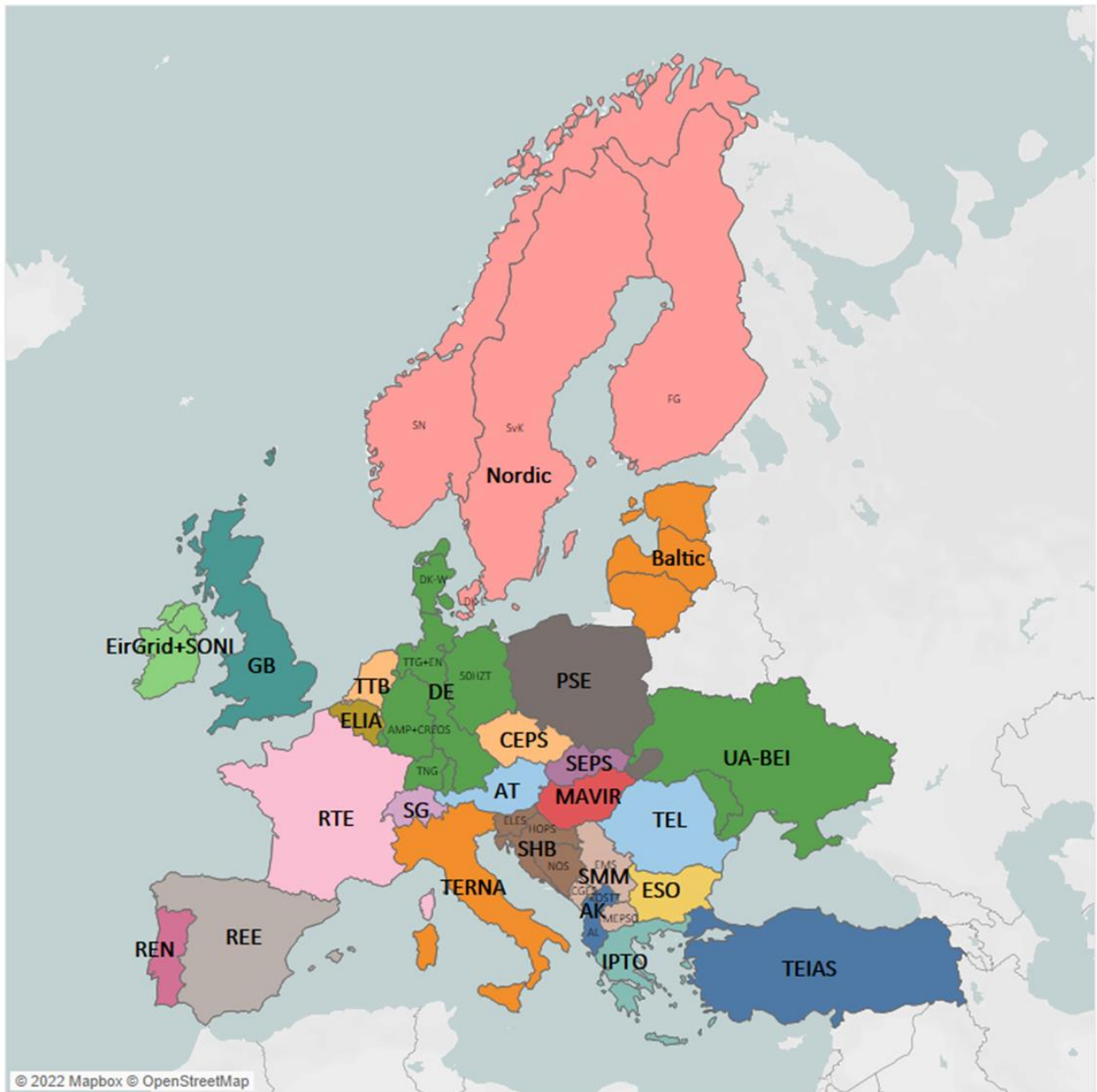


Figure 1 European LFC Blocks and Areas. The background map is provided by OpenStreetMap (openstreetmap.org/copyright).

According to Article 133 of the 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 processes of the synchronous area referred to in Article 132 of the SO GL and employ 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 three months and within three months after the end of the analysed period.

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Article 118 of the SO GL establishes 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
AK	OST, KOSTT	OST	Albania, Kosovo
APG	APG	APG	Austria
CEPS	CEPS	CEPS	Czech Republic
ELIA	ELIA	ELIA	Belgium
ESO	ESO	ESO	Bulgaria
Germany	TNG, TTG, AMP, 50HZT, EN, CREOS	AMP	Germany, Denmark-West, Luxembourg
IPTO	IPTO	IPTO	Greece
MAVIR	MAVIR	MAVIR	Hungary
PSE	PSE, Western WPS	PSE	Poland
REE	REE	REE	Spain
REN	REN	REN	Portugal
RTE	RTE	RTE	France
SEPS	SEPS	SEPS	Slovak Republic
SG	SG	SG	Switzerland
SHB	NOS BiH, HOPS, ELES	ELES	Bosnia and Herzegovina, Croatia, Slovenia
SMM	EMS, MEPSO, CGES	EMS	Serbia, North Macedonia, Montenegro
TEİAŞ	TEİAŞ	TEİAŞ	Turkey
TEL	TEL	TEL	Romania
TERNA	TERNA	TERNA	Italy
TTB	TTB	TTB	Netherlands

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 seconds), stabilising power system frequency and ensuring that the frequency deviation will not increase further. 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 that the frequency change is damped so that FCR can 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. The SO GL defines two types of FRR: automatic (aFRR) and manual (mFRR). FRR is activated by an automatic control device or manually, 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 a process computer implemented in the TSOs' control centre systems (SCADA/EMS/AGC). It collects FRCE measurements every 4–10 seconds and provides simultaneously 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 applies to 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 shifts, will also create a power imbalance and result in frequency deviations.

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

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

Table 6 Frequency Quality Defining Parameters of Synchronous Areas

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

Table 7 Frequency Quality Target Parameters of Synchronous Areas

Considering the information above for each synchronous area during operation in a normal state or an alert state, the following values are reported every month for the instantaneous frequency data:

- (i) The mean value.
- (ii) The standard deviation.
- (iii) The 1st, 5th, 10th, 90th, 95th and 99th 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

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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.

(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 1st, 5th, 10th, 90th, 95th and 99th percentiles,
- the number of time intervals in which the average value of the FRCE was outside the Level 1 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 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 every month 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 maximum 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 each TSO in the LFC block is responsible for keeping its FRCE as low as possible, the Level 1 and Level 2 parameters must not be exploited to reduce or activate reserves. These parameters should rather be interpreted as an absolute warning limit that shows that the Area Control Error (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 GB and IE/Nl, during operation in a normal state or alert state and in accordance with Article 18(1) and (2), the following data are presented monthly and 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 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

The following tables and figures display data for the IE/NI synchronous area for 2020 and 2021. The input values for frequency are based on instantaneous frequency values. The mean value, standard deviation and percentiles were calculated based on the input values. 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 200–1 000 mHz range, time is measured in minutes.

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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 8 IE/NI SA Performance for 2020

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2021

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr.
The mean value	49.99999	50.00040	50.00010	49.99990	50.00020	49.99990	50.00020	50.00040	49.99980	50.00010	50.00040	50.00000	50.00012
The standard deviation	0.0409	0.0420	0.0405	0.0414	0.0426	0.0408	0.0412	0.0404	0.0410	0.0451	0.0448	0.0496	0.0425
1-percentile	49.911	49.912	49.912	49.911	49.907	49.913	49.907	49.910	49.910	49.904	49.899	49.891	49.907
5-percentile	49.935	49.935	49.936	49.935	49.934	49.936	49.933	49.935	49.936	49.930	49.928	49.920	49.933
10-percentile	49.949	49.949	49.949	49.948	49.948	49.949	49.946	49.949	49.949	49.944	49.944	49.938	49.947
90-percentile	50.054	50.056	50.053	50.054	50.055	50.053	50.052	50.052	50.053	50.060	50.058	50.064	50.055
95-percentile	50.067	50.072	50.067	50.067	50.069	50.065	50.064	50.065	50.068	50.076	50.073	50.082	50.070
99-percentile	50.092	50.097	50.091	50.092	50.097	50.088	50.085	50.089	50.092	50.103	50.098	50.109	50.094
Time(min) > 200 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time(min) < -200 mHz	0	0	0	3	12	1	4	0	0	0	9	8	38
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 2021

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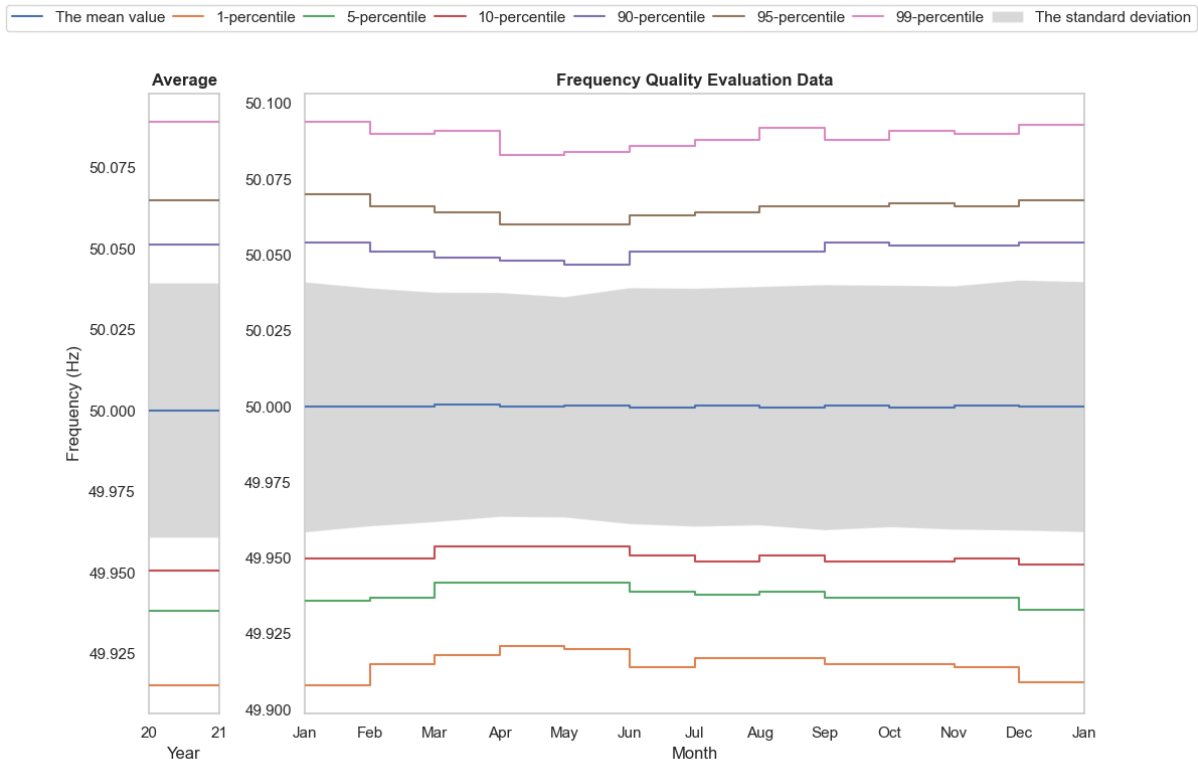


Figure 2 IE-NI SA 2020 frequency quality

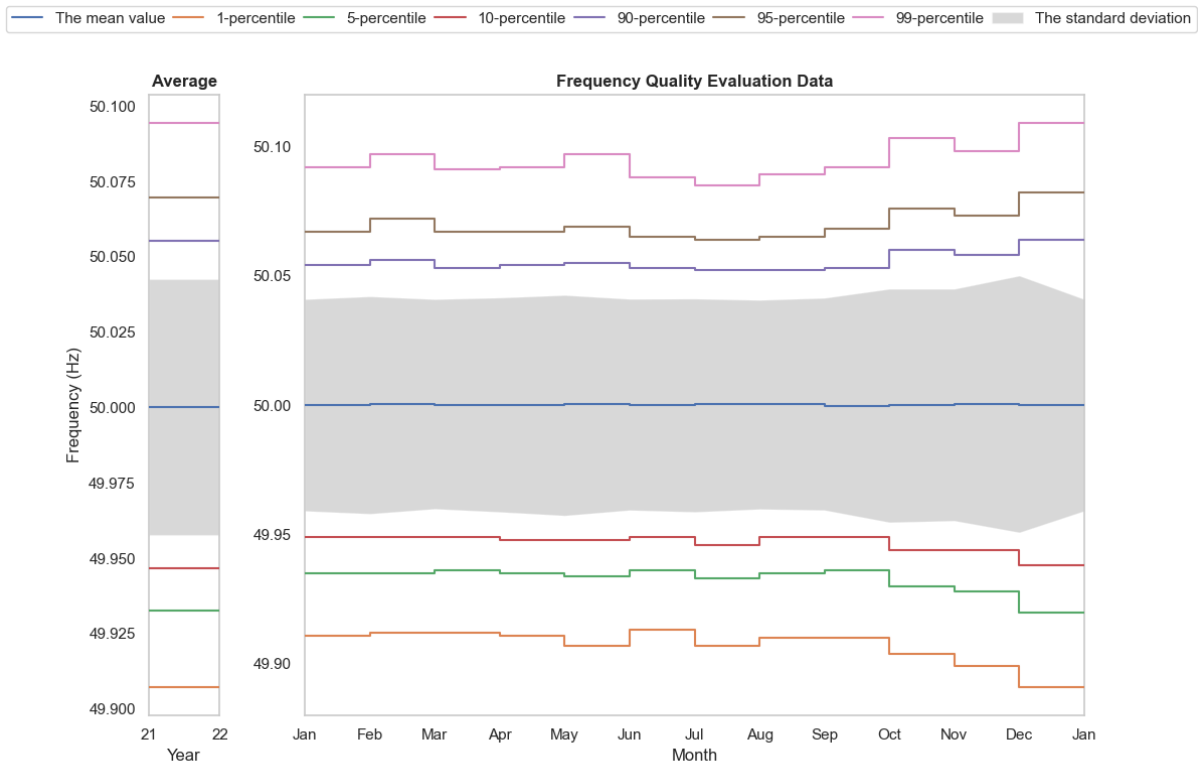


Figure 3 IE-NI SA 2021 frequency quality

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Figures 4 and 5 present the accumulated minutes outside standard ranges for 2020 and 2021, 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 the SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard monthly 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 4, 5 and 5a below demonstrate that the frequency quality target parameters from the SO GL were fulfilled for the respective years for the Ireland/Northern Ireland synchronous area.

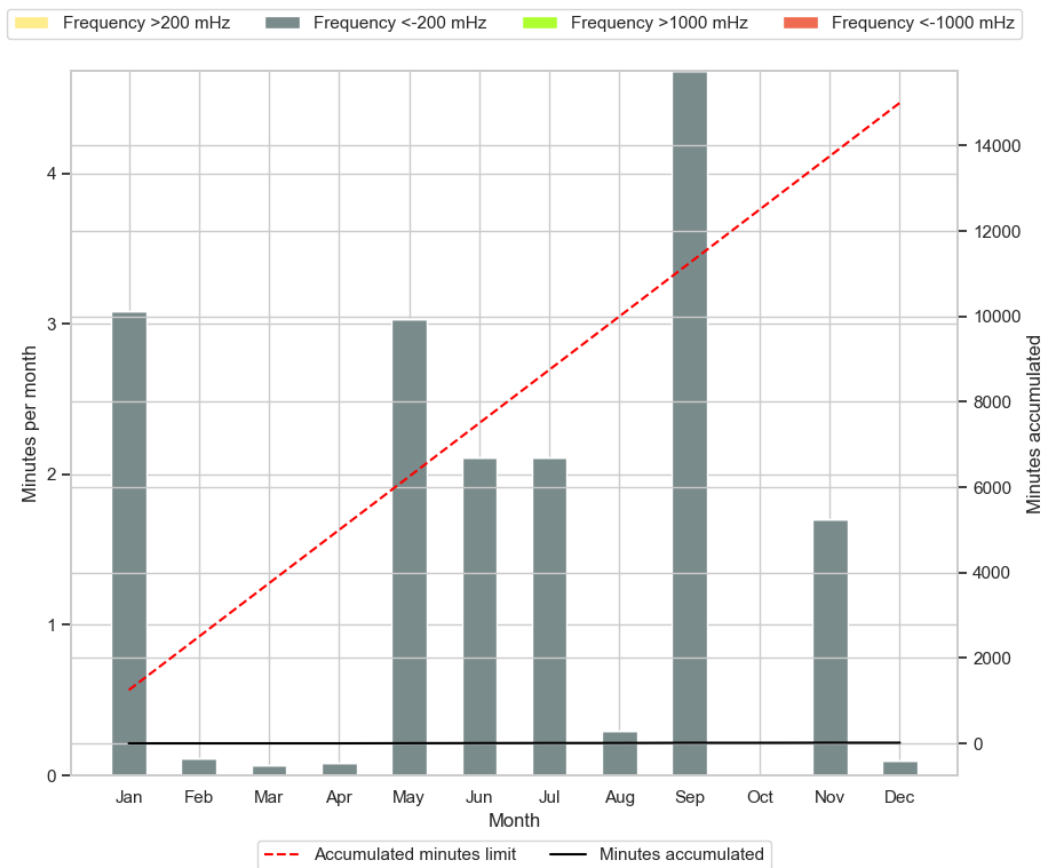


Figure 4 IE-NI SA 2020 frequency deviation

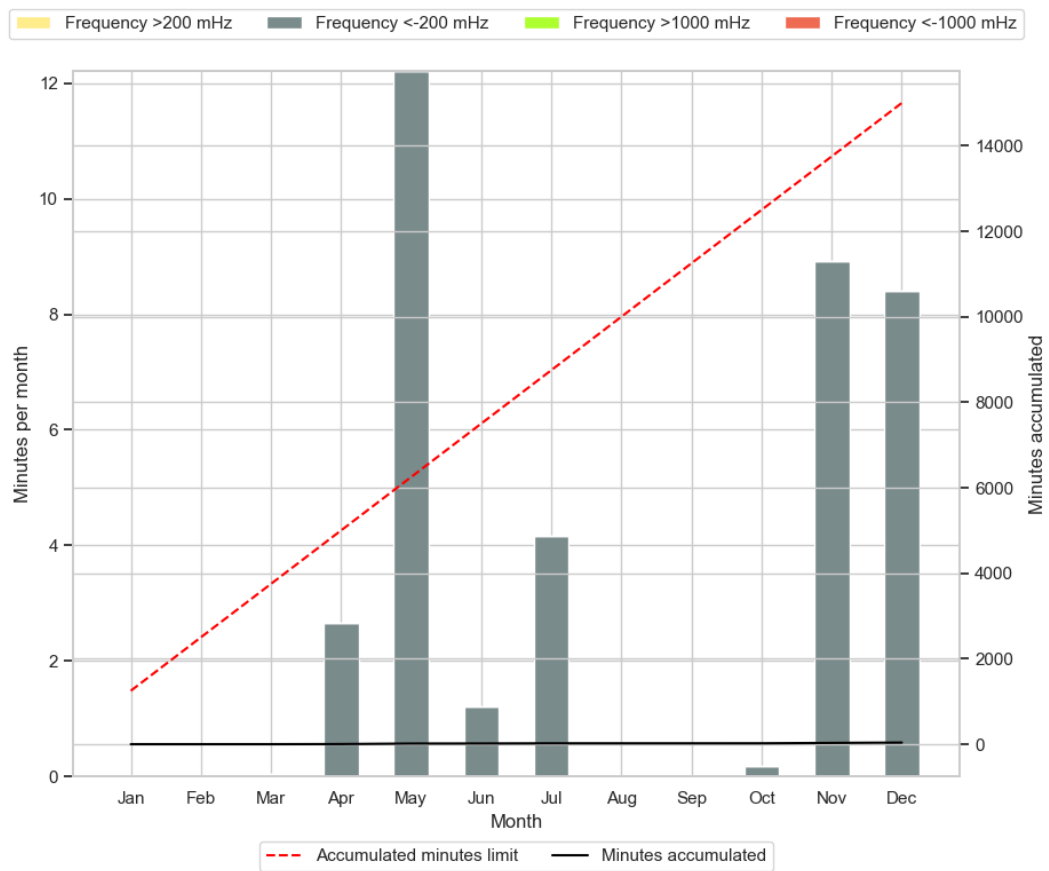


Figure 5 IE-NI SA 2021 frequency deviation

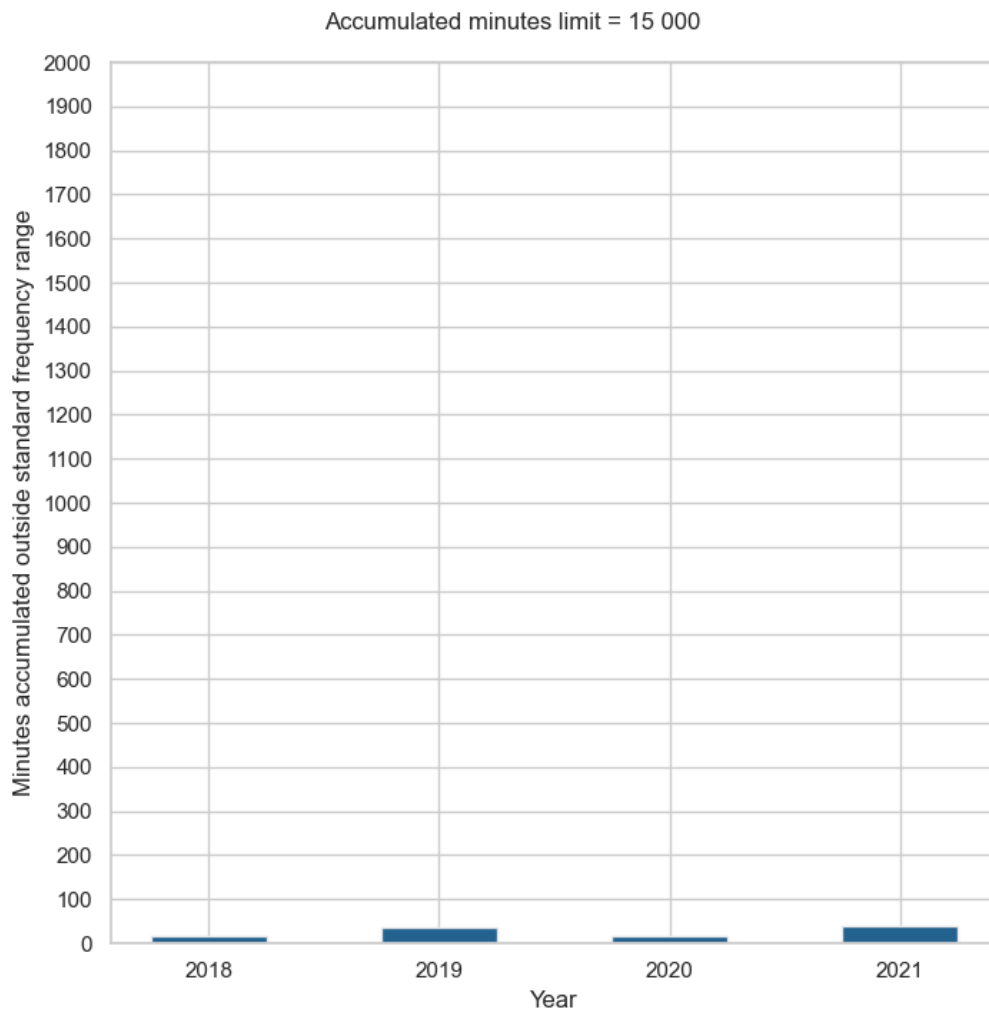


Figure 5a IE-NI SA frequency deviation trend

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 did not return to 50 mHz or -50 mHz, respectively, within the maximum time to restore frequency, which corresponds to 15 minutes.

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 10 IE/NI LFC FRCE Statistics for 2020

2021

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 Statistics for 2021

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, 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 ≥ 200 mHz over a 15 -minute period or ≤ -200 mHz over a 15-minute period, this qualifies as a Level 1 event.
2. If the frequency deviation is ≥ 500 mHz over a 1-minute period or ≤ -500 mHz over a 1-minute period, this qualifies as a Level 2 event.
3. The Level 1 FRCE target parameter = 3%, which is $35\,040$ (periods) $\times 0.03 = 1\,051$ 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	2020	2021
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 the ranges for 2020 and 2021

Performance – GB

Great Britain Synchronous Area Performance

The following tables and figures show data from 2020 and 2021 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 fell 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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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 13 GB SA Performance for 2020

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2021

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr.
The mean value	49.99895	49.99966	49.99948	49.99994	49.99915	49.99960	49.99982	49.99940	49.99974	49.99970	49.99921	49.99933	49.99950
The standard deviation	0.0653	0.0653	0.0645	0.0614	0.0618	0.0568	0.0569	0.0570	0.0595	0.0623	0.0671	0.0657	0.0620
1-percentile	49.860	49.863	49.863	49.866	49.868	49.880	49.879	49.878	49.873	49.868	49.854	49.857	49.867
5-percentile	49.896	49.898	49.897	49.902	49.901	49.910	49.910	49.910	49.906	49.902	49.893	49.894	49.902
10-percentile	49.916	49.916	49.917	49.921	49.920	49.927	49.927	49.927	49.924	49.920	49.913	49.914	49.920
90-percentile	50.084	50.085	50.083	50.079	50.079	50.074	50.074	50.073	50.077	50.081	50.085	50.083	50.080
95-percentile	50.104	50.106	50.104	50.098	50.099	50.091	50.092	50.091	50.096	50.101	50.106	50.103	50.099
99-percentile	50.141	50.145	50.142	50.136	50.136	50.125	50.124	50.125	50.131	50.139	50.145	50.141	50.136
Time(min) > 200 mHz	30	12	11	14	15	5	2	3	10	13	32	23	170
Time(min) < -200 mHz	17	21	18	12	10	5	6	3	13	14	36	34	189
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 2021

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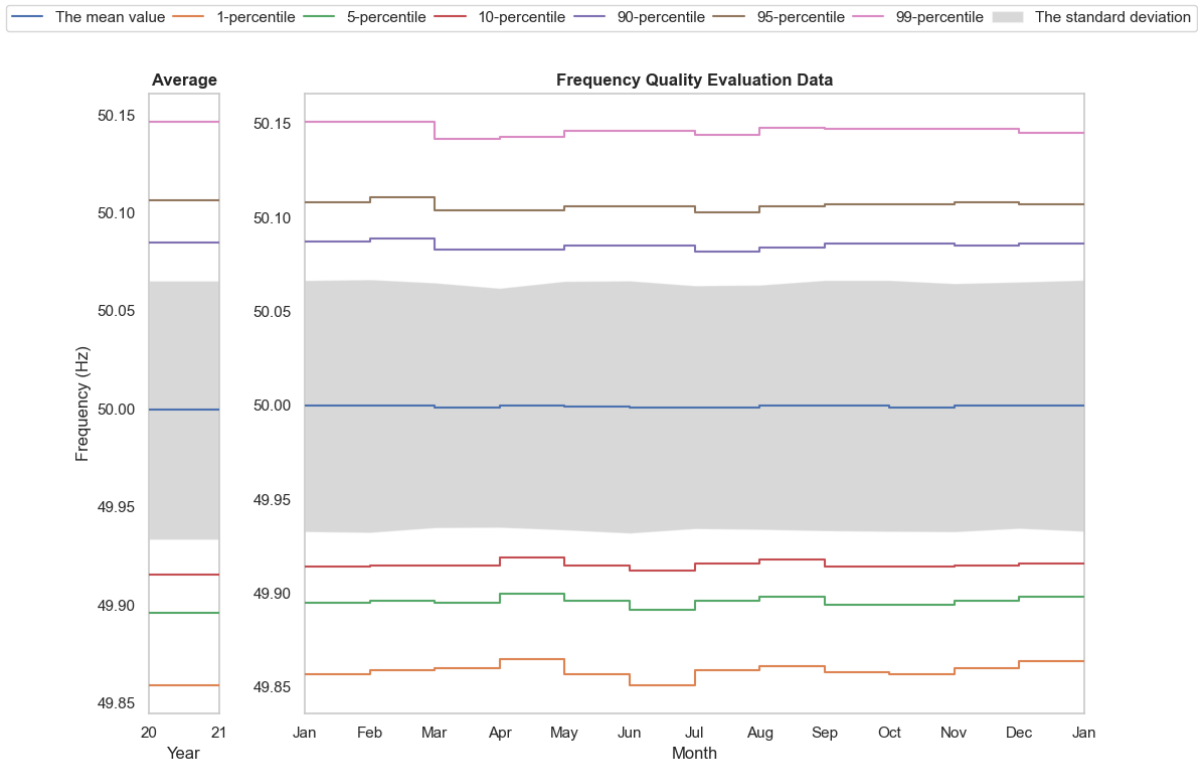


Figure 6 GB SA 2020 frequency quality

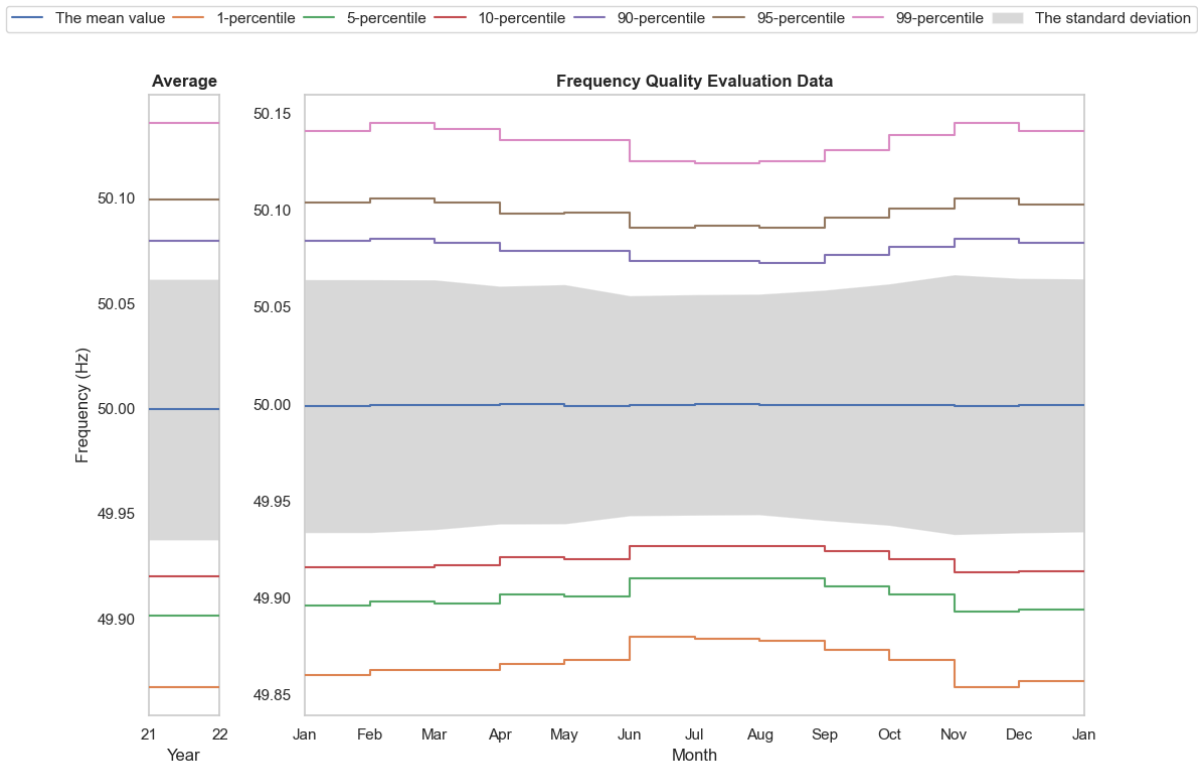


Figure 7 GB SA 2021 frequency quality

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Figures 8 and 9 illustrate the accumulated minutes outside standard ranges for 2020 and 2021, 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 the SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard monthly 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 frequency quality parameters.

The graphs in Figures 8, 9 and 9a below show that the frequency quality target parameters from the SO GL were fulfilled in the Great Britain synchronous area during the respective years.

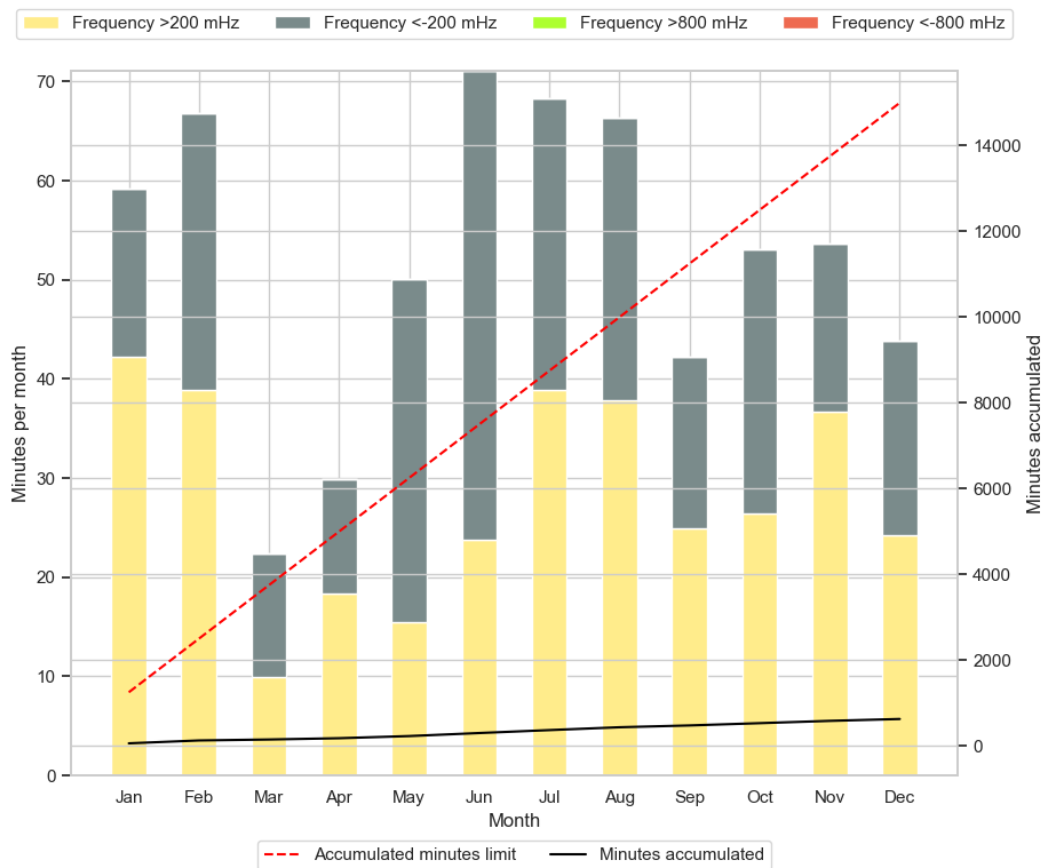


Figure 8 GB SA 2020 frequency deviation

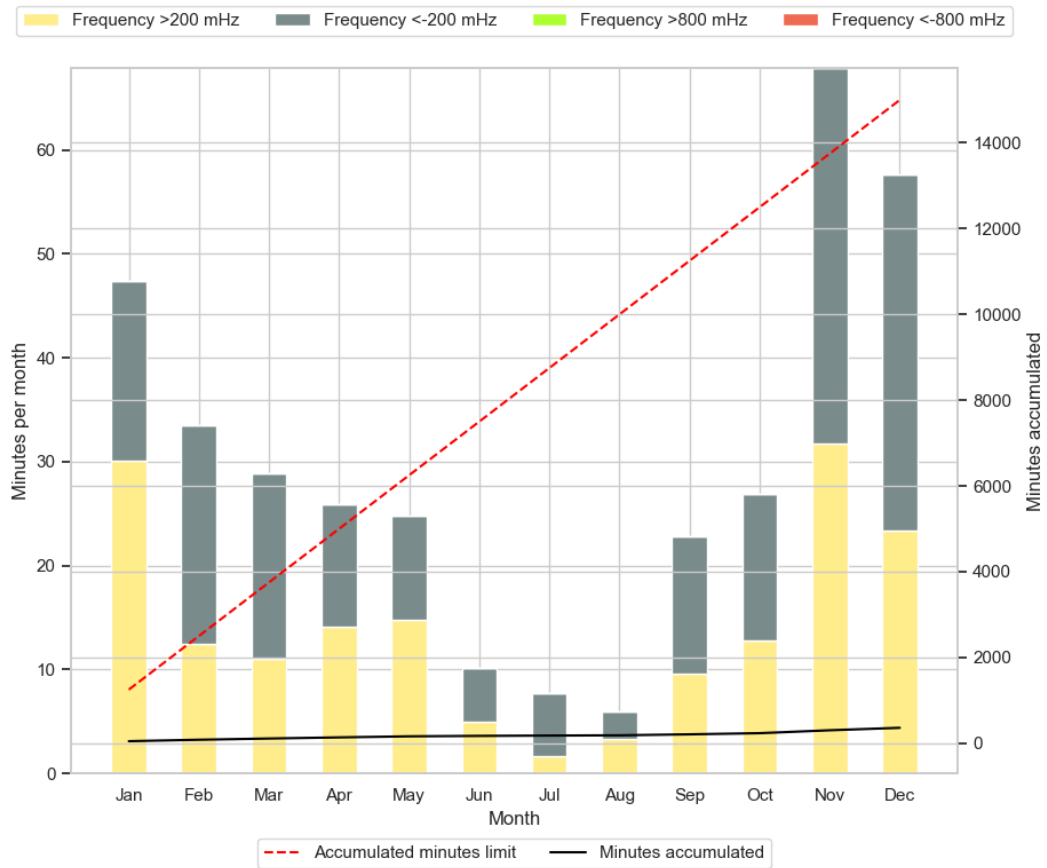


Figure 9 GB SA 2021 frequency deviation

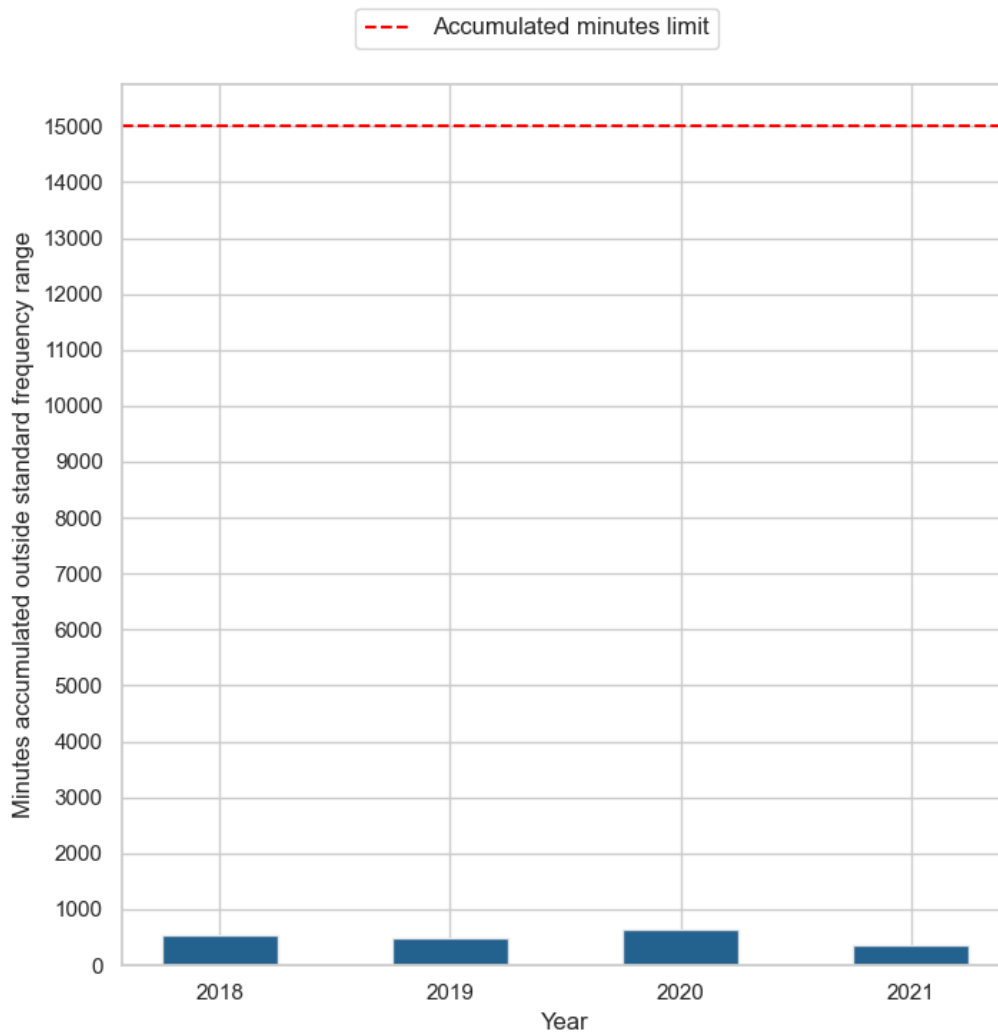


Figure 9a GB SA frequency deviation trend

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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 when FRCE values were not returned to 50 mHz or -50 mHz, respectively, during the time to restore frequency, which corresponds to 15 minutes.

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 15 GB LFC FRCE Statistic for 2020

2021

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 2021

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 ≥ 200 mHz over a 15-minute period or ≤ -200 mHz over a 15-minute period, this qualifies as a Level 1 event.
2. If the frequency deviation is ≥ 500 mHz over a 1-minute period or ≤ -500 mHz over a 1-minute period, this qualifies as a Level 2 event.
3. The Level 1 FRCE target parameter = 3%, which is $35\,040$ (periods) $\times 0.03 = 1\,051$ periods.
4. The Level 2 FRCE target parameter = 1%, which is $525\,600$ (periods) $\times 0.01 = 5\,256$ periods.

Data item	2020	2021
Number of time intervals frequency deviates outside +/- 200 mHz	0	0
Number of time intervals frequency deviates outside +/- 500 mHz	0	0

Table 17 GB LFC Number of time intervals outside the ranges for 2020 and 2021

Performance – Nordic

Nordic Synchronous Area Performance

The following tables and figures present data from 2020 and 2021 for the Nordic synchronous area. The input values for frequency are based on instantaneous frequency values. The mean value, standard deviation and percentiles were calculated based on the input values. Moreover, any time periods and events where the system frequency occurred outside of predefined ranges were also indicated. For data points where the frequency was outside the 100–1 000 mHz range, time is measured in minutes.

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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.dev > 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.dev < -200 mHz and < -100 mHz within 15 minutes	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 18 Nordic SA Block Performance for 2020

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2021

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr.
The mean value	50.00026	49.99983	49.99995	49.99979	50.00021	50.00010	49.99981	50.00020	49.99993	50.00012	49.99987	49.99992	50.00000
The standard deviation	0.0388	0.0428	0.0435	0.0450	0.0436	0.0420	0.0388	0.0423	0.0413	0.0442	0.0422	0.0390	0.0420
1-percentile	49.911	49.900	49.902	49.892	49.899	49.901	49.909	49.902	49.906	49.897	49.900	49.908	49.902
5-percentile	49.937	49.932	49.931	49.927	49.930	49.931	49.937	49.932	49.934	49.929	49.931	49.937	49.932
10-percentile	49.951	49.948	49.946	49.944	49.946	49.947	49.951	49.947	49.949	49.945	49.947	49.951	49.948
90-percentile	50.050	50.055	50.056	50.057	50.056	50.053	50.049	50.053	50.053	50.056	50.053	50.050	50.053
95-percentile	50.066	50.072	50.074	50.075	50.073	50.069	50.064	50.070	50.069	50.074	50.070	50.065	50.070
99-percentile	50.094	50.106	50.109	50.110	50.106	50.100	50.095	50.107	50.101	50.111	50.105	50.096	50.103
Time(min) > 100 mHz	290	535	670	667	606	416	311	585	448	710	524	336	6098
Time(min) < -100 mHz	193	385	380	607	456	397	255	375	287	503	415	268	4521
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 > 200 mHz and > 100 mHz within 15 minutes	0	39	28	0	18	0	0	0	16	0	24	0	125
No. of events freq.dev < -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 2021

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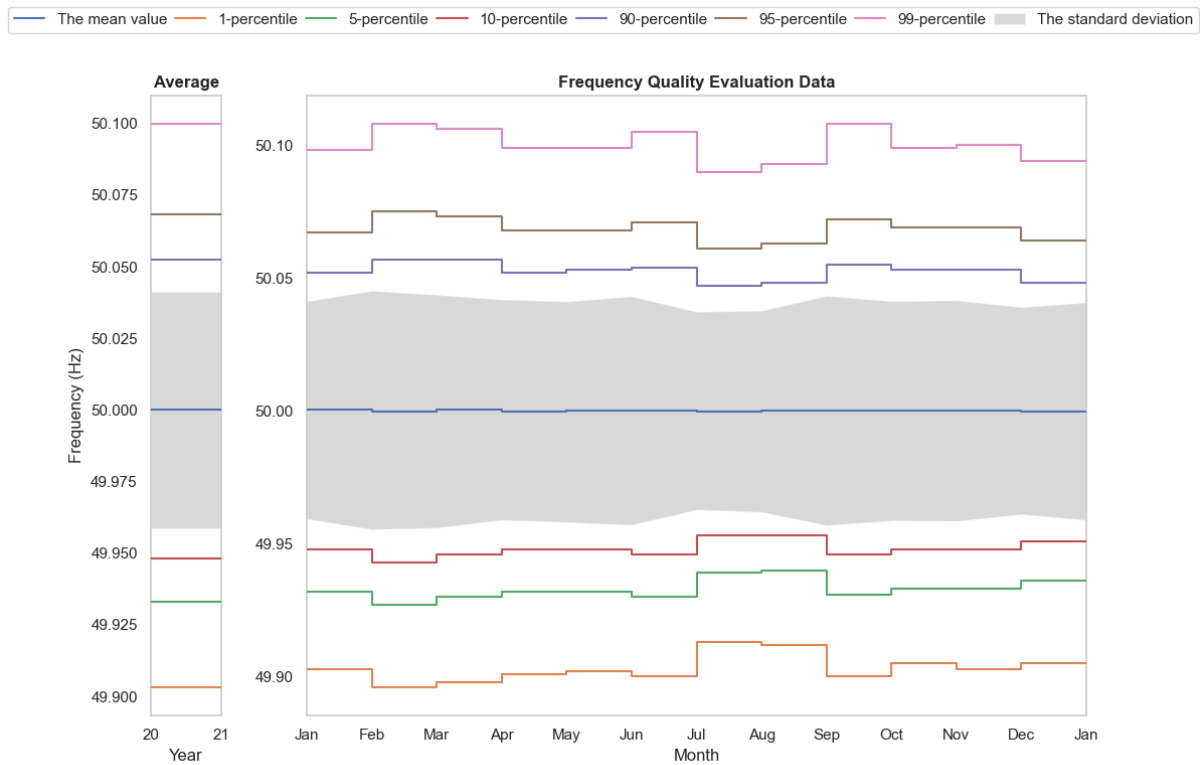


Figure 10 Nordic SA 2020 frequency quality

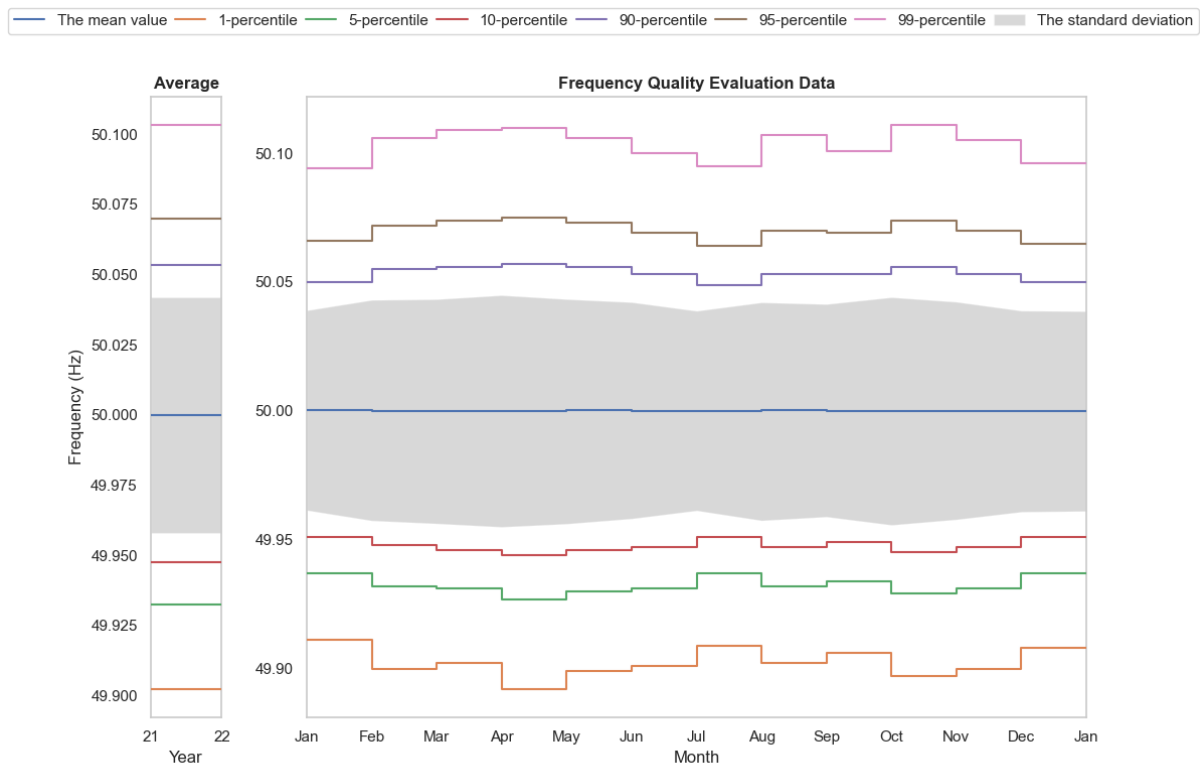


Figure 11 Nordic SA 2021 frequency quality

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Figures 12 and 13 illustrate the accumulated minutes outside standard ranges for 2020 and 2021.

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 the SO GL (15 000 minutes).

The black line shows the accumulated monthly minutes 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 the SO GL were fulfilled during the respective years in the Nordic synchronous area.

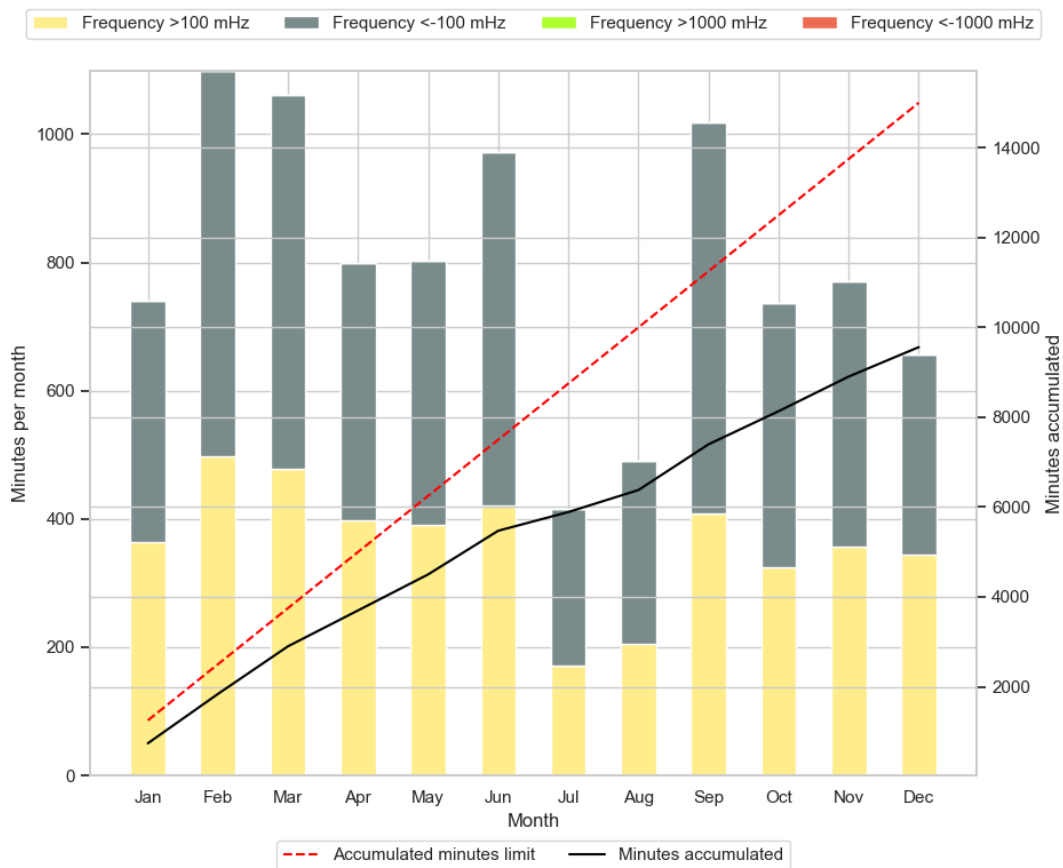


Figure 12 Nordic SA 2020 frequency deviation

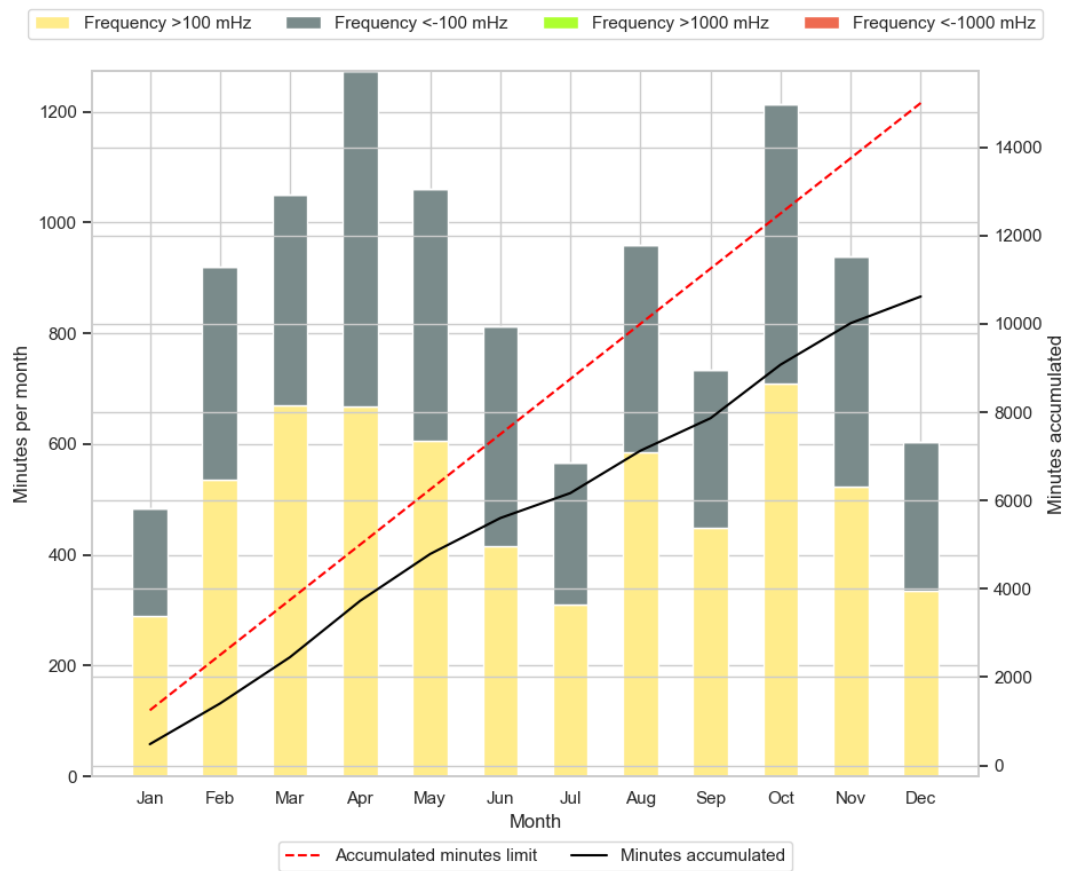


Figure 13 Nordic SA 2021 frequency deviation

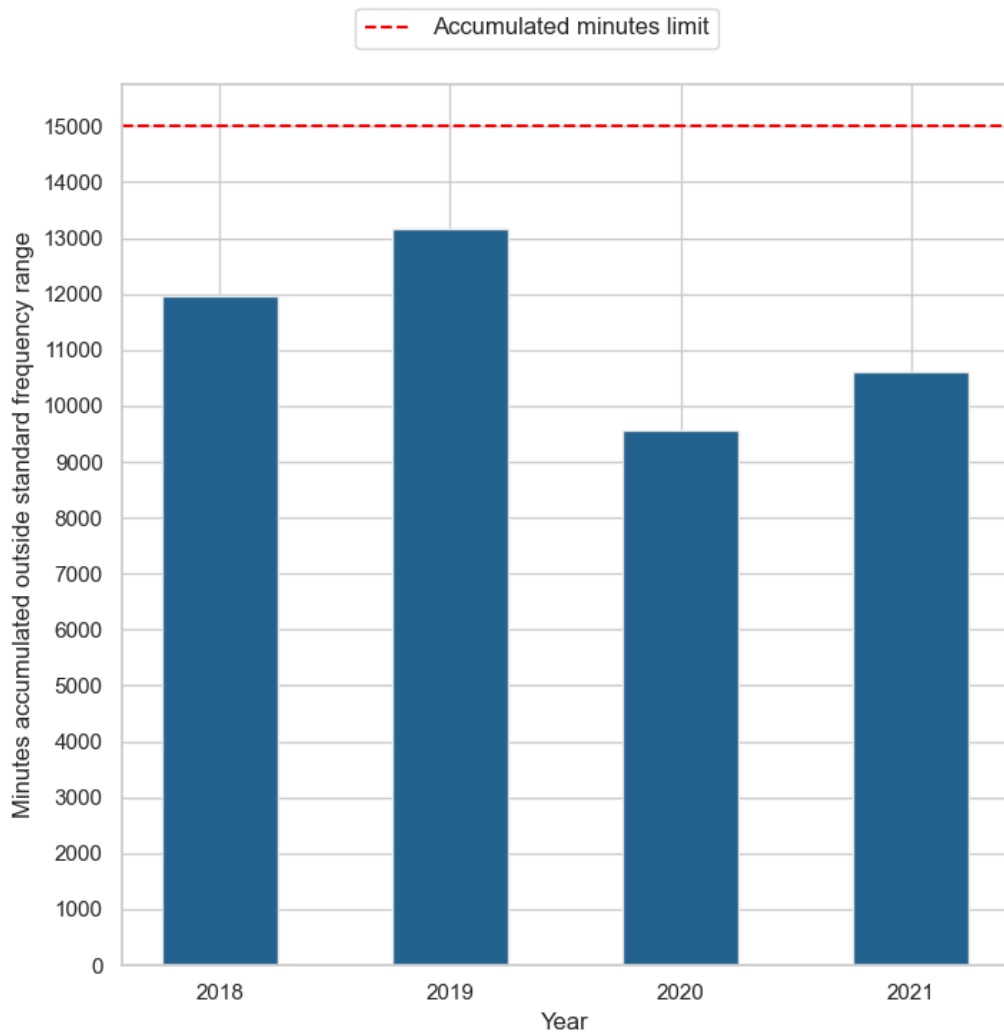


Figure 13a Nordic SA frequency deviation trend

Nordic Synchronous Area LFC Block Performance

The following table shows the Nordic LFC block performance. 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-minute time intervals per year outside the Level 1 and Level 2 FRCE range	30%	5%

Table 20 Level 1 and Level 2 FRCE Ranges for the Nordic Area and Targets for the Number of 15-minute Time Intervals per Year Outside the Level 1 and Level 2 FRCE Ranges

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

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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
No. of time intervals: average FRCE > Level 1 positive	301	385	427	321	335	333	217	248	323	319	328	285	3822
No. of time intervals: average FRCE < Level 1 negative	311	372	358	272	280	306	185	187	300	295	265	261	3392
No. of time intervals: average FRCE > Level 2 positive	42	72	66	38	46	69	22	30	61	46	38	30	560
No. 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 21 Nordic LFC Block Performance for 2020

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2021

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr.
The mean value	50.00026	49.99983	49.99995	49.99979	50.00021	50.00010	49.99981	50.00020	49.99993	50.00012	49.99987	49.99992	50.00000
The standard deviation	0.0388	0.0428	0.0435	0.0450	0.0436	0.0420	0.0388	0.0423	0.0413	0.0442	0.0422	0.0390	0.0420
1-percentile	49.911	49.900	49.902	49.892	49.899	49.901	49.909	49.902	49.906	49.897	49.900	49.908	49.902
5-percentile	49.937	49.932	49.931	49.927	49.930	49.931	49.937	49.932	49.934	49.929	49.931	49.937	49.932
10-percentile	49.951	49.948	49.946	49.944	49.946	49.947	49.951	49.947	49.949	49.945	49.947	49.951	49.948
90-percentile	50.050	50.055	50.056	50.057	50.056	50.053	50.049	50.053	50.053	50.056	50.053	50.050	50.053
95-percentile	50.066	50.072	50.074	50.075	50.073	50.069	50.064	50.070	50.069	50.074	50.070	50.065	50.070
99-percentile	50.094	50.106	50.109	50.110	50.106	50.100	50.095	50.107	50.101	50.111	50.105	50.096	50.103
No. of time intervals: average FRCE > Level 1 positive	350	378	397	384	349	253	236	263	263	325	326	316	3840
No. of time intervals: average FRCE < Level 1 negative	289	298	342	333	280	233	223	232	176	279	293	275	3253
No. of time intervals: average FRCE > Level 2 positive	47	64	82	72	54	22	35	49	37	55	59	40	616
No. of time intervals: average FRCE < Level 2 negative	31	51	39	65	30	30	14	21	13	30	43	29	396
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	1	1	1	0	0	1	1	0	0	0	0	5

Table 22 Nordic LFC Block Performance for 2021

I. Level 1/Level 2 Statistics

Figures 14–17 show the monthly distribution of FRCE time intervals outside the Level 1 and Level 2 ranges for positive and negative time intervals by month and year. If the maximum number of intervals exceeds 10 512 for Level 1 or 1 752 for Level 2, then mitigation measures must be proposed and taken.

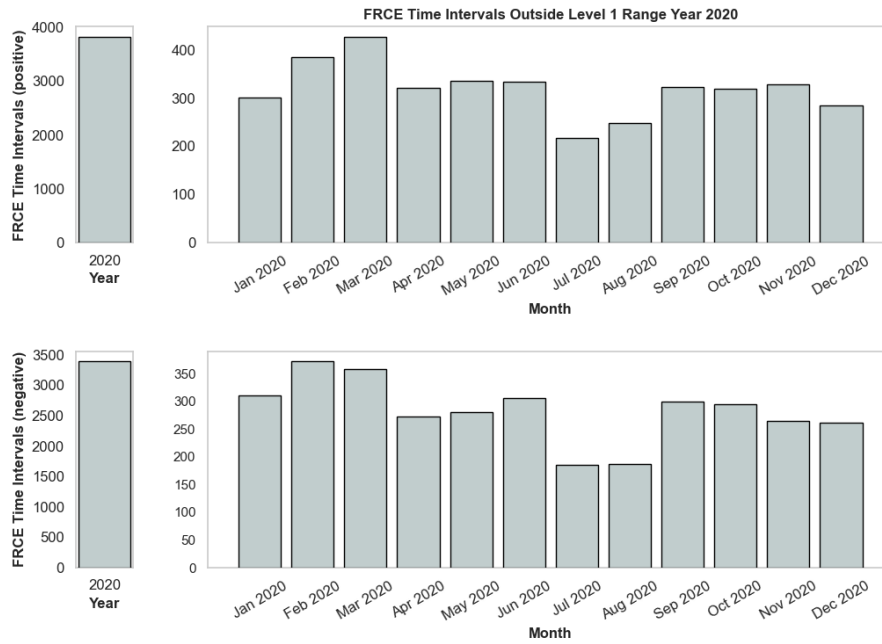


Figure 14 Nordic LFC 2020 FRCE time intervals outside Level 1 range

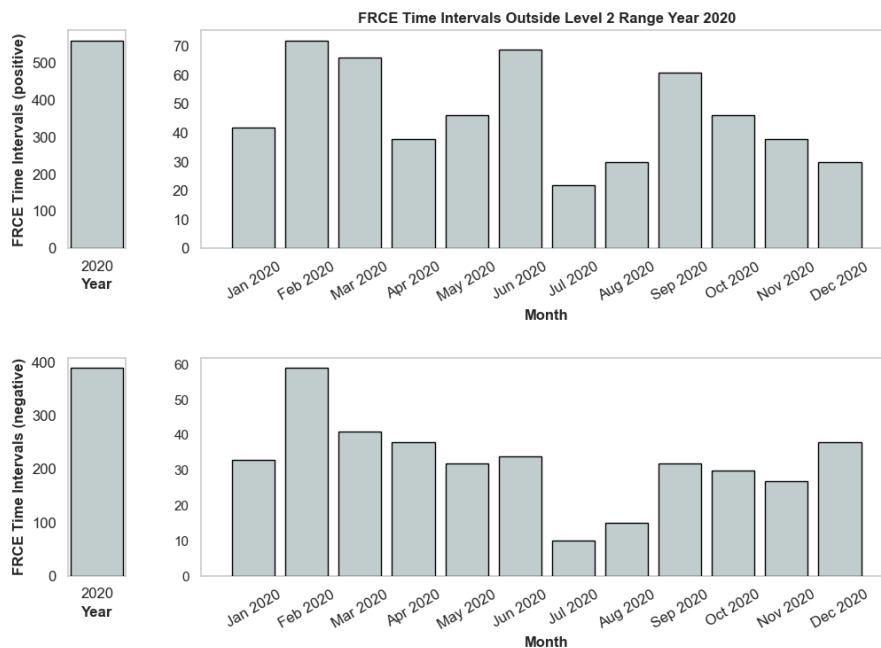


Figure 15 Nordic LFC 2020 FRCE time intervals outside Level 2 range

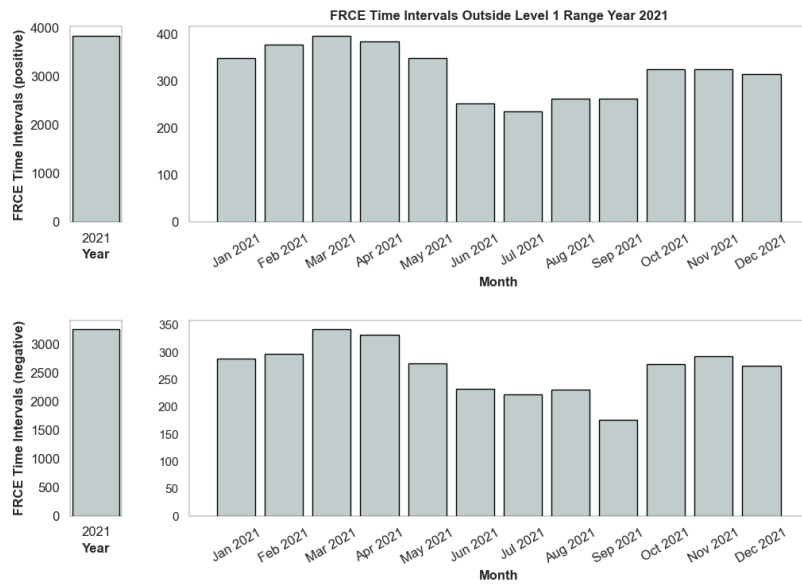


Figure 16 Nordic LFC 2021 FRCE time intervals outside Level 1 range

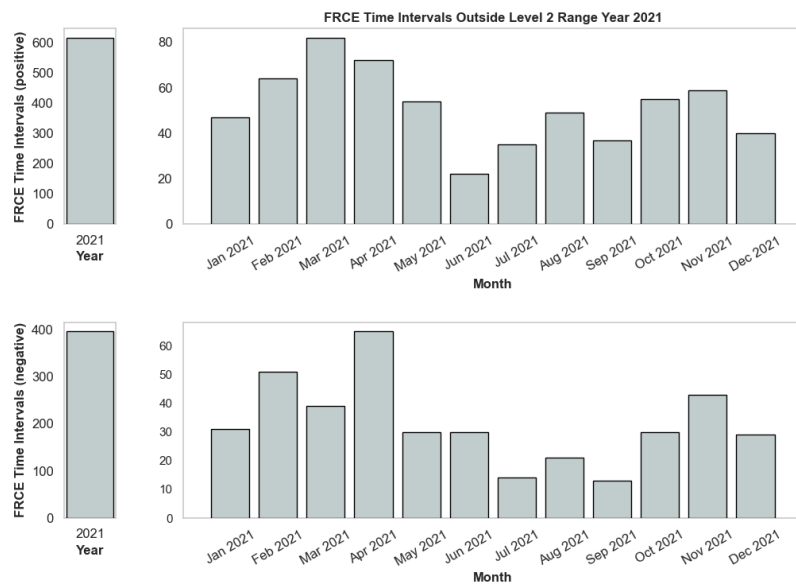


Figure 17 Nordic LFC 2021 FRCE time intervals outside Level 2 range

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 the 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 to as FRR+ in this document) for negative FRCE and a negative FRR (referred to as FRR- in this document) for a positive FRCE. FRCE is the value after the adjustment process for TSOs' part of an FRR activation process. The values include all correction signals for TSOs' part of the Imbalance Netting 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 within the maximum time to restore frequency.

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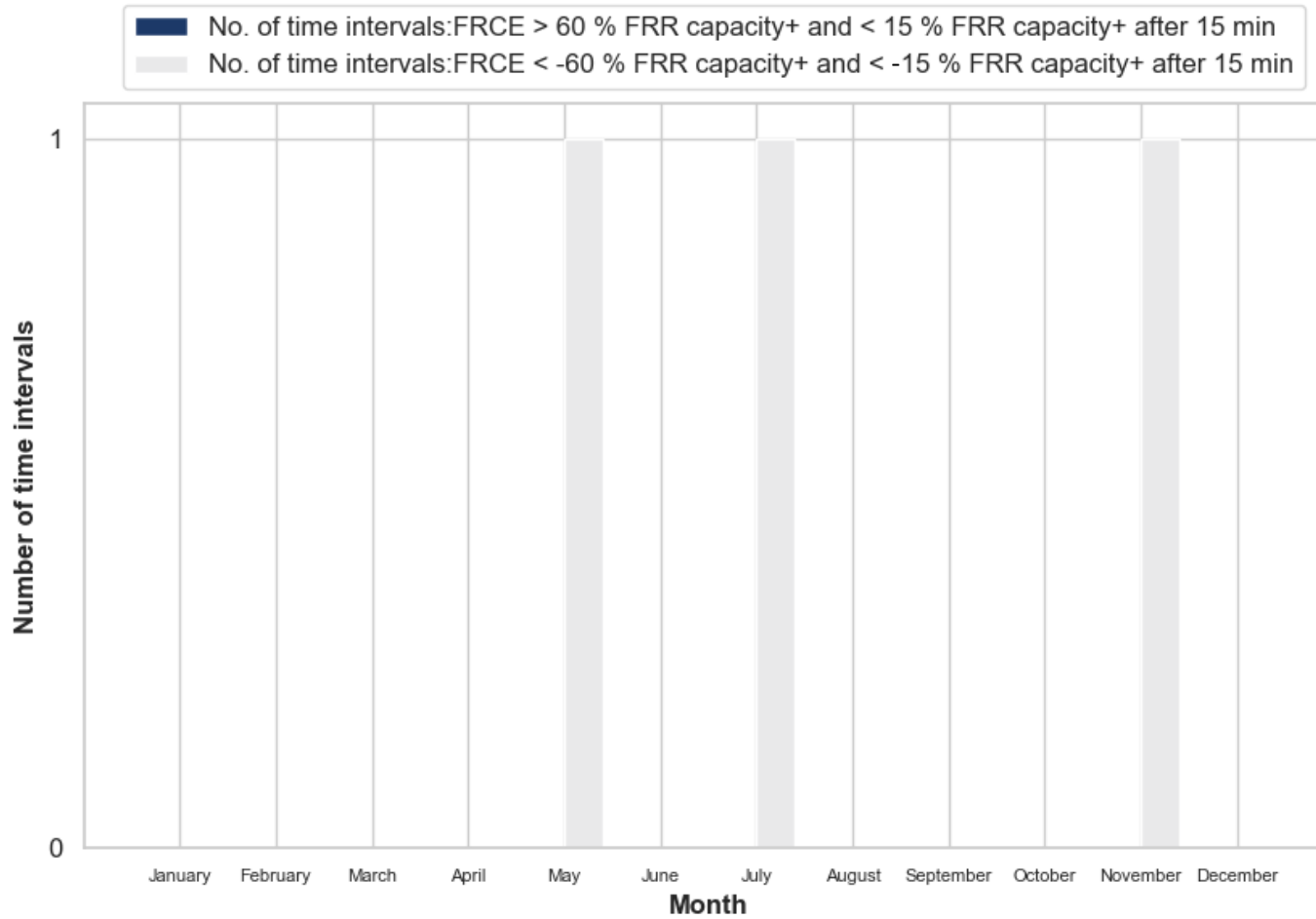


Figure 18 Nordic LFC 2020 FRCE outside FRR capacity within 15 minutes

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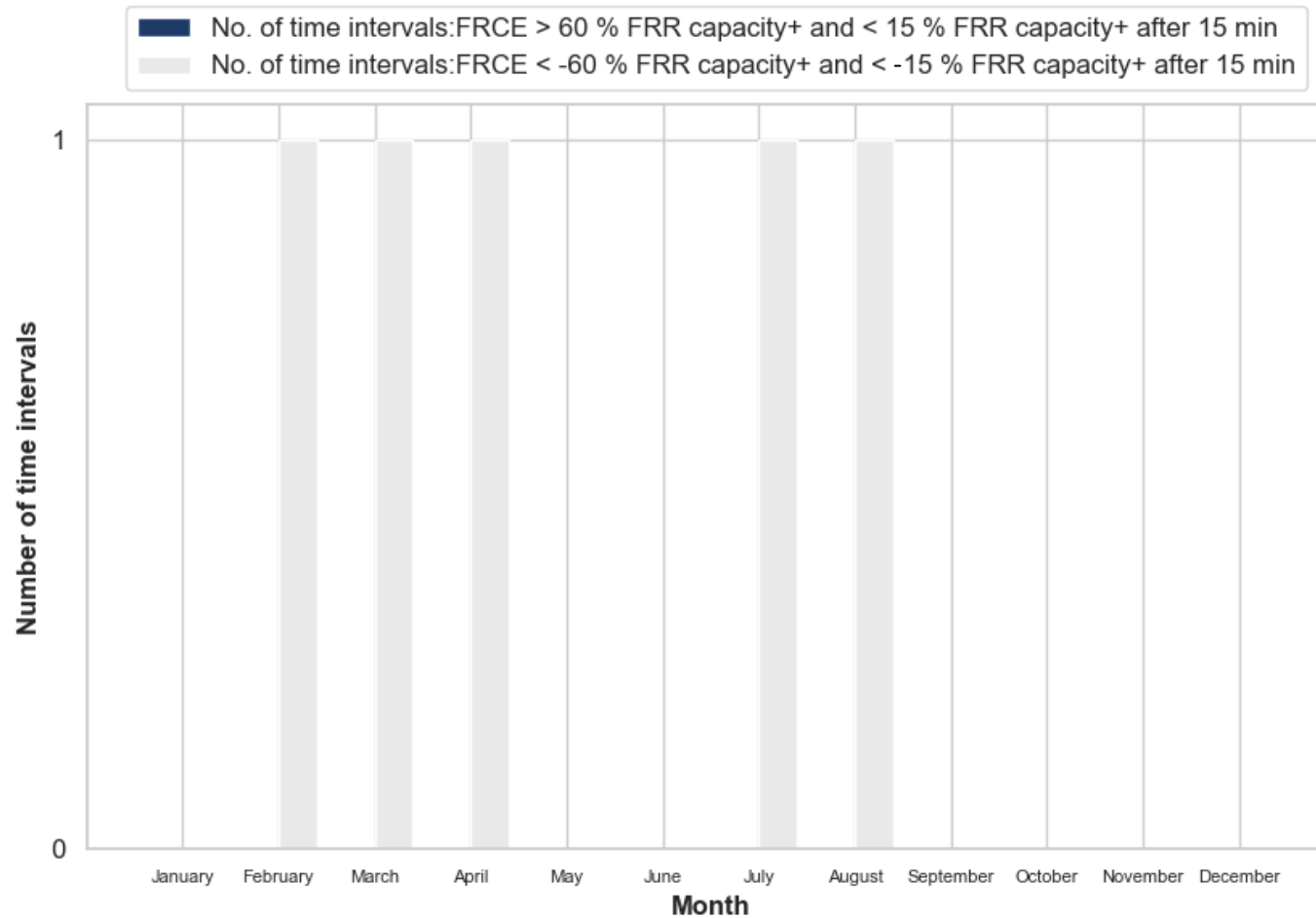


Figure 19 Nordic LFC 2021 FRCE outside FRR capacity within 15 minutes

Frequency Quality Evaluation

I. Mitigation Measures Analysis

The annual report on load-frequency control provides a description and date of implementation for 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 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 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, the information contains:

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

For the reporting period, which included the years 2020 and 2021, in line with Figures 14–17, the following analysis and mitigation measures were reported from the Nordic LFC Block:

Mitigation measures for 2020:

No mitigation measures were applied as FRCE performance was within the required range.

Mitigation measures for 2021:

No mitigation measures were applied as FRCE performance was within the required range.

Performance – CE

Continental Europe Synchronous Area Performance

The following tables and figures present data from 2020 and 2021 for the Continental Europe synchronous area. Input values for frequency are based on instantaneous frequency values. The mean value, standard deviation and percentiles were calculated based on the input values. Moreover, any time periods and events where the system frequency appeared 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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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	0.0189	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.dev > 100 mHz and not < 25 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev < -100 mHz and not < -25 mHz	0	0	0	0	0	0	2	1	0	0	0	0	3

Table 23 CE SA Performance for 2020

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Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr.
The mean value	49.99965	50.00142	49.99940	50.00029	50.00066	49.99953	50.00086	49.99993	50.00007	49.99960	50.00049	50.00076	50.00022
The standard deviation	0.0200	0.0211	0.0212	0.0204	0.0210	0.0188	0.0181	0.0184	0.0202	0.0221	0.0212	0.0209	0.0203
1-percentile	49.948	49.947	49.942	49.946	49.946	49.950	49.956	49.953	49.947	49.942	49.947	49.944	49.947
5-percentile	49.968	49.968	49.966	49.968	49.967	49.970	49.973	49.971	49.969	49.964	49.967	49.966	49.968
10-percentile	49.976	49.976	49.974	49.976	49.976	49.977	49.979	49.978	49.976	49.973	49.975	49.975	49.976
90-percentile	50.023	50.026	50.024	50.023	50.025	50.022	50.022	50.022	50.024	50.025	50.025	50.025	50.024
95-percentile	50.030	50.033	50.031	50.030	50.033	50.028	50.029	50.028	50.031	50.032	50.032	50.031	50.031
99-percentile	50.047	50.053	50.052	50.051	50.054	50.044	50.046	50.046	50.049	50.053	50.051	50.048	50.050
Time(min) > 50 mHz	336	466	499	440	588	232	304	277	395	518	454	350	4860
Time(min) < -50 mHz	497	486	728	562	577	421	269	354	517	798	537	675	6422
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	1	1
No. of events freq.deviation < -100 mHz and not < -25 mHz	1	0	1	1	1	3	0	0	0	2	0	0	9

Table 24 CE SA Performance for 2021

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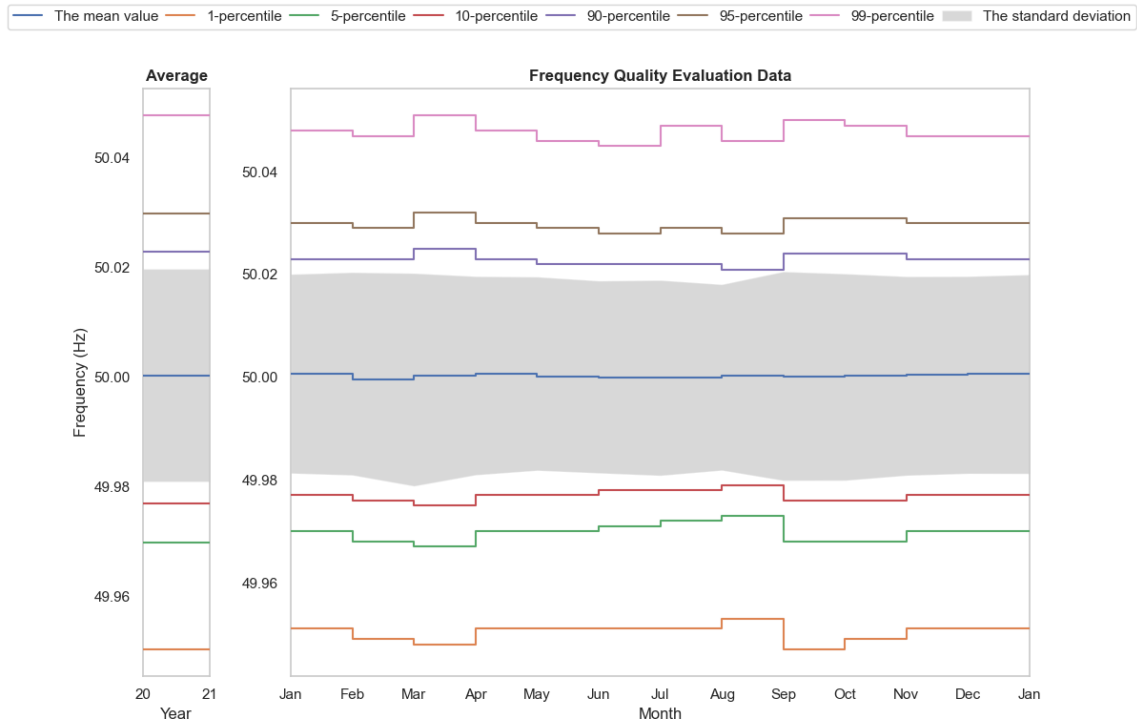


Figure 20 CE SA 2020 frequency quality

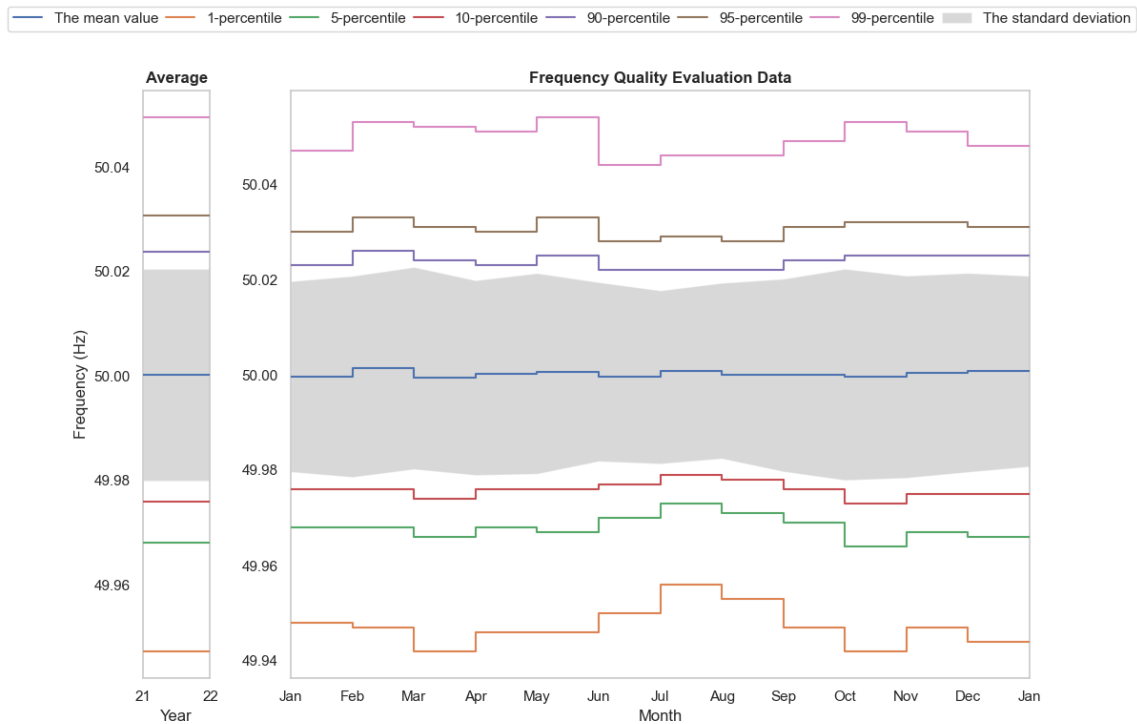


Figure 21 CE SA 2021 frequency quality

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Figures 22 and 23 present the accumulated minutes outside standard ranges for 2020 and 2021, 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 the SO GL (15 000 minutes).

The black line shows the accumulated minutes outside standard monthly 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 22, 23 and 23a below show that the frequency quality target parameters from the SO GL were fulfilled for the respective years for the Synchronous Area of Continental Europe.

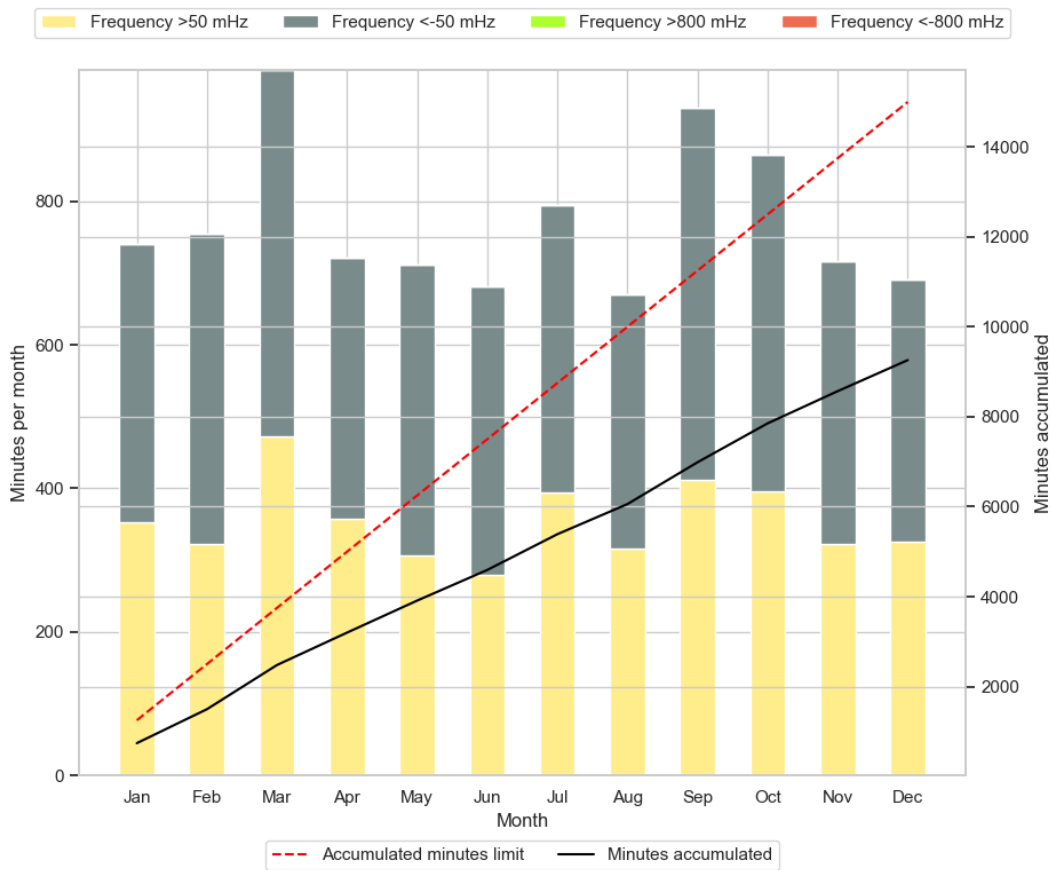


Figure 22 CE SA 2020 frequency deviation

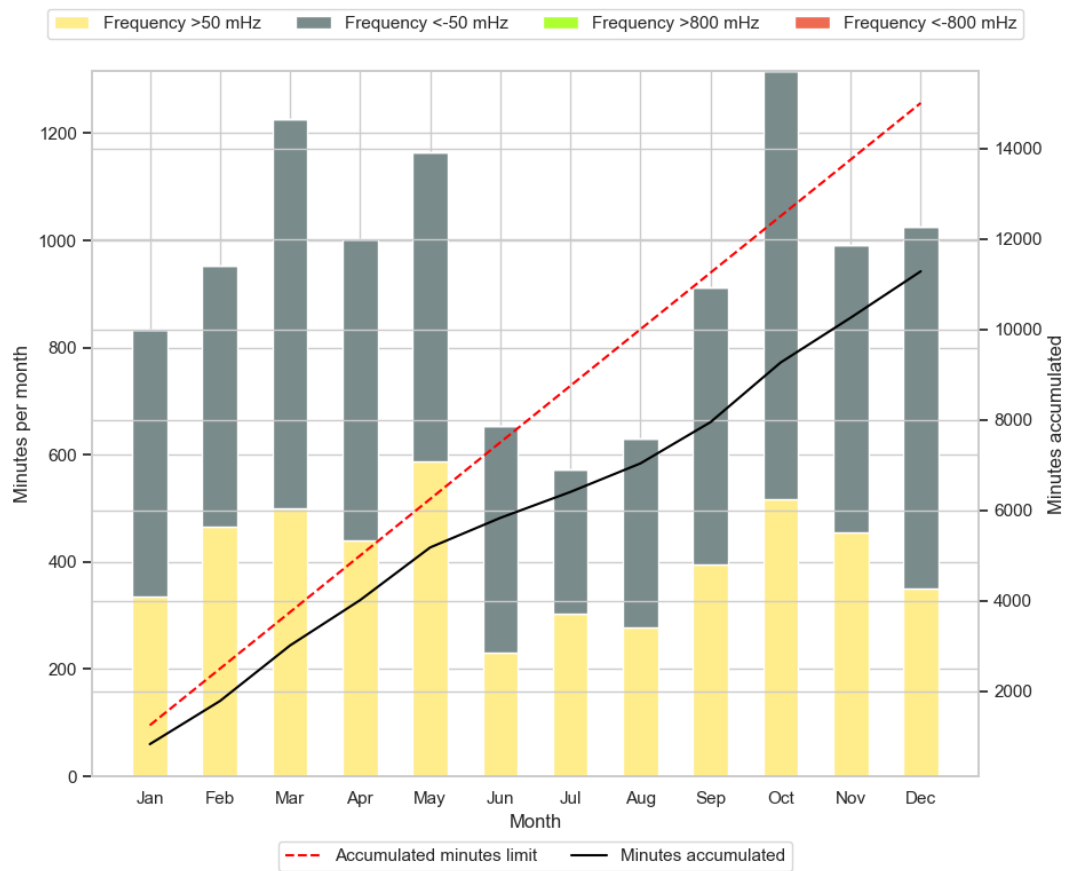


Figure 23 CE SA 2021 frequency deviation

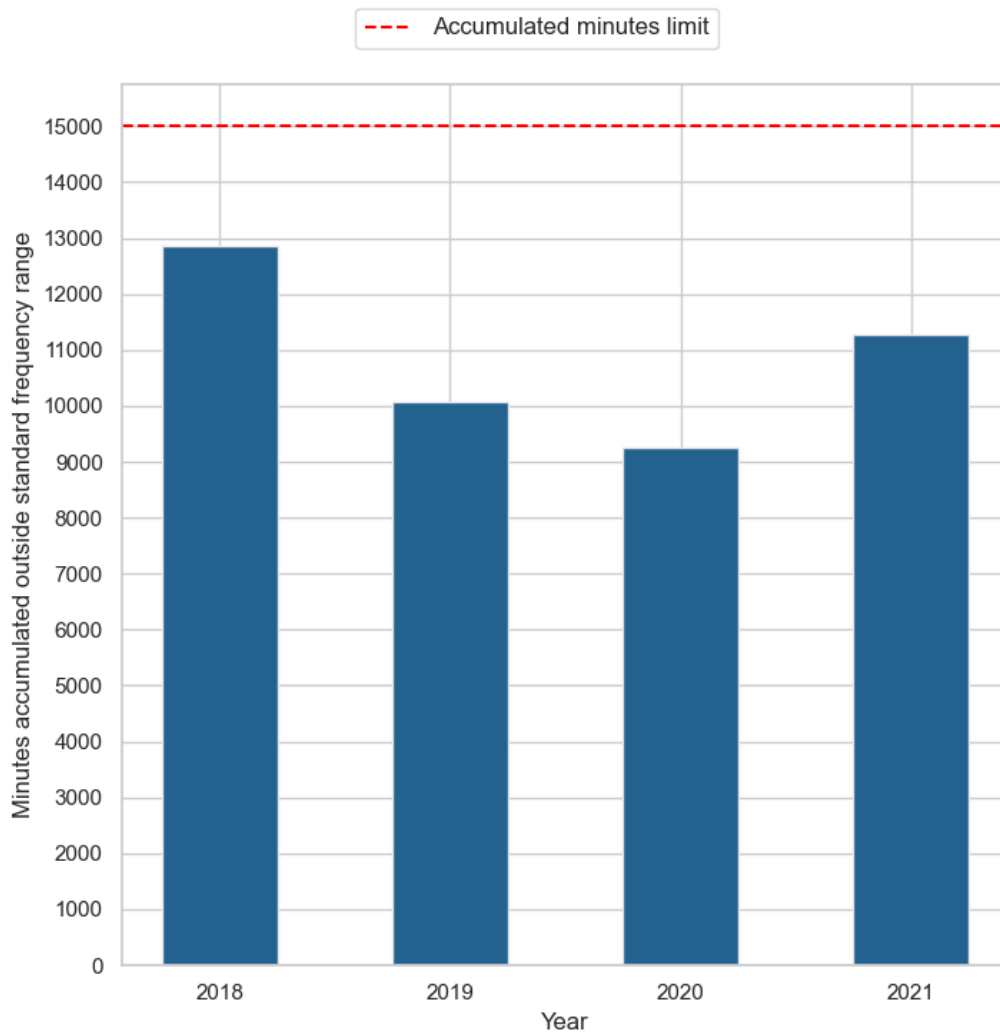


Figure 23a CE SA frequency deviation trend

Continental Europe Synchronous Area LFC Blocks Performance

This section provides an overview of the Continental Europe Frequency Quality Evaluation Criteria for LFC Blocks. Limits for Level 1 and Level 2 are calculated retroactively in line with the Synchronous Area Framework Agreement for Continental Europe, whose entry into force was 14 April 2019. FRCE values are calculated based on 15 min Area Control Error (ACE) data. Additionally, events that indicate where FRCE exceeds 60% of FRR used and not returned to 15% of FRR during a 15-minute time period are reported. A 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 the 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	87	164
CEPS	91	172
ELIA	93	175
ESO	65	123
Germany	256	485
IPTO	60	113
MAVIR	63	119
OST	29	55
PSE	137	258
REE	205	388
REN	77	145
RTE	239	452
SEPS	54	103
SG	85	161
SHB	71	133
SMM	74	140
TEİAŞ	183	346
TEL	81	154
TERNA	181	341
TTB	112	212
Target for the maximum number of 15-minute time intervals per year outside the Level 1 and Level 2 FRCE ranges	10512	1752

Table 25 Level 1 and Level 2 FRCE Ranges for the Continental Europe Synchronous Area and Targets for the Number of 15-minute Time Intervals per Year Outside the Level 1 and Level 2 FRCE Ranges for 2020

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LFC Block	Level 1	Level 2
AK	36	69
APG	89	168
CEPS	91	172
ELIA	98	186
ESO	64	121
Germany	255	481
IPTO	73	137
MAVIR	64	121
PSE	135	256
REE	206	389
REN	74	141
RTE	238	450
SEPS	55	104
SG	86	163
SHB	69	131
SMM	74	140
TEİAŞ	184	348
TEL	80	151
TERNA	181	342
TTB	113	213
Target for the maximum number of 15-minute time intervals per year outside the Level 1 and Level 2 FRCE ranges	10512	1752

Table 26 Level 1 and Level 2 FRCE Ranges for the Continental Europe Synchronous Area and Targets for the Number of 15-minute Time Intervals per Year Outside the Level 1 and Level 2 FRCE Ranges for 2021

The Continental Europe Synchronous Area Operational Agreement defines the methodology for calculating these target parameters.

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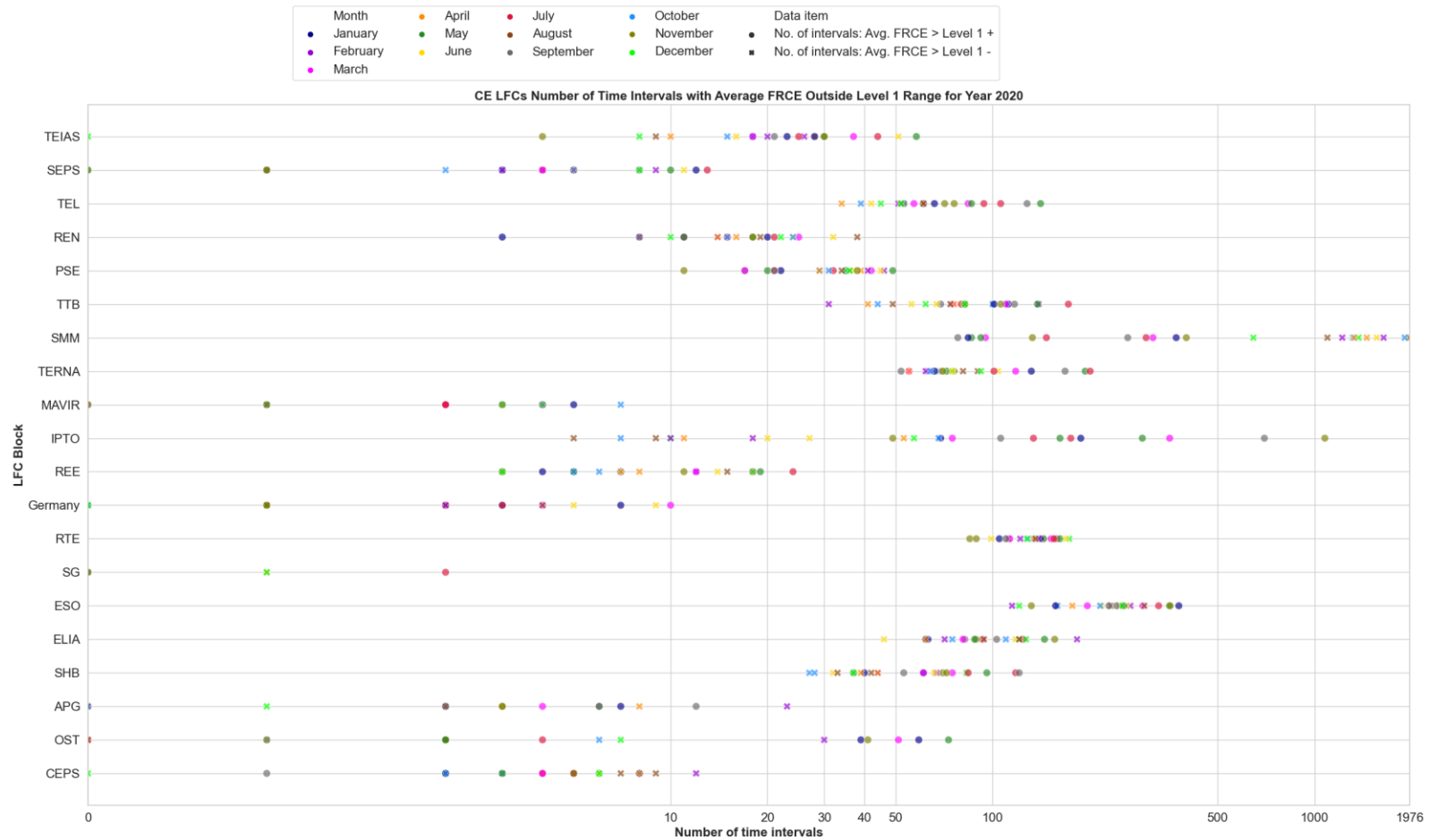


Figure 24 CE LFCs 2020 FRCE time intervals outside Level 1 range

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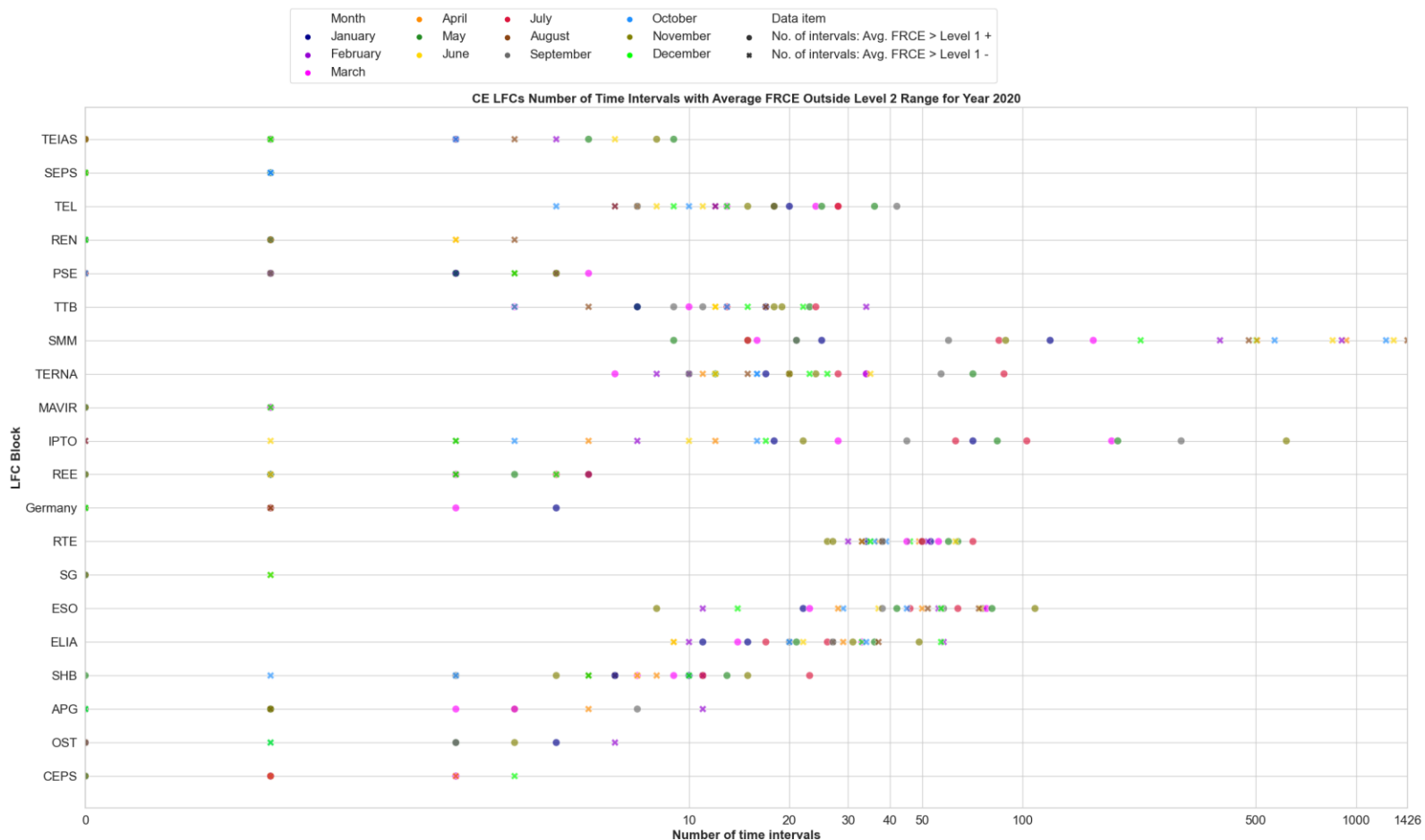


Figure 25 CE LFCs 2020 FRCE time intervals outside Level 2 range

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Figure 26 CE LFCs 2021 FRCE time intervals outside Level 1 range

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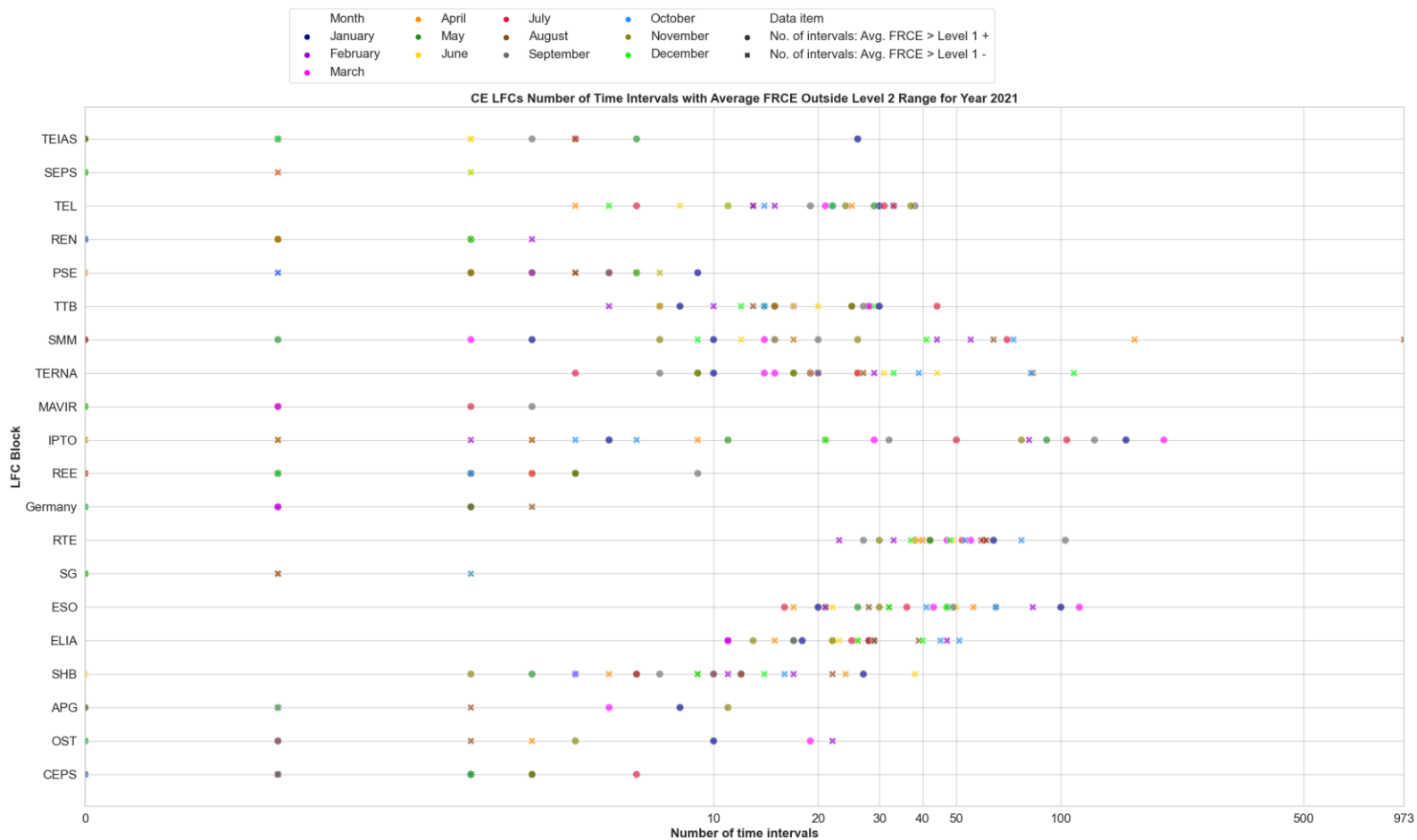


Figure 27 CE LFCs 2021 FRCE time intervals outside Level 2 range

II. FRCE vs FRR

The ability of LFC blocks to regulate their own FRCE is presented by comparing reserve capacity on FRR and FRCE values according to the 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 could also be included in the calculation. FRR is considered separately, which means a positive FRR (referred to as FRR+ in this document) for a negative FRCE and a negative FRR (referred to as FRR- in this document) for a positive FRCE. FRCE is the value after the adjustment process for TSOs' part of an FRR activation process. The values include all correction signals for TSOs' part of the Imbalance Netting 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 within the maximum time to restore frequency.

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Figure 28 CE LFC Blocks 2020 FRCE outside FRR capacity within 15 minutes

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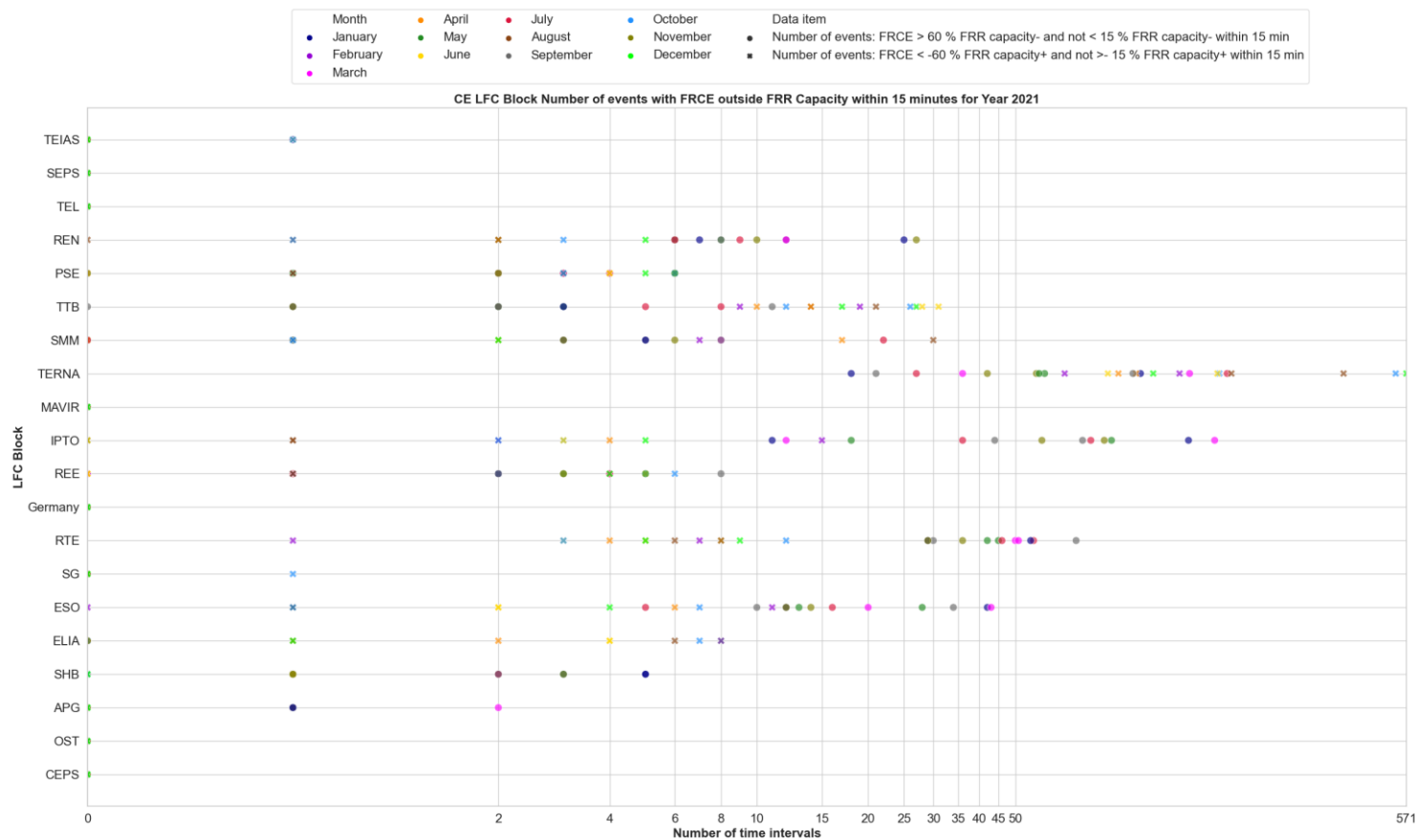


Figure 29 CE LFC Blocks 2021 FRCE outside FRR capacity within 15 minutes

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Frequency Quality Evaluation

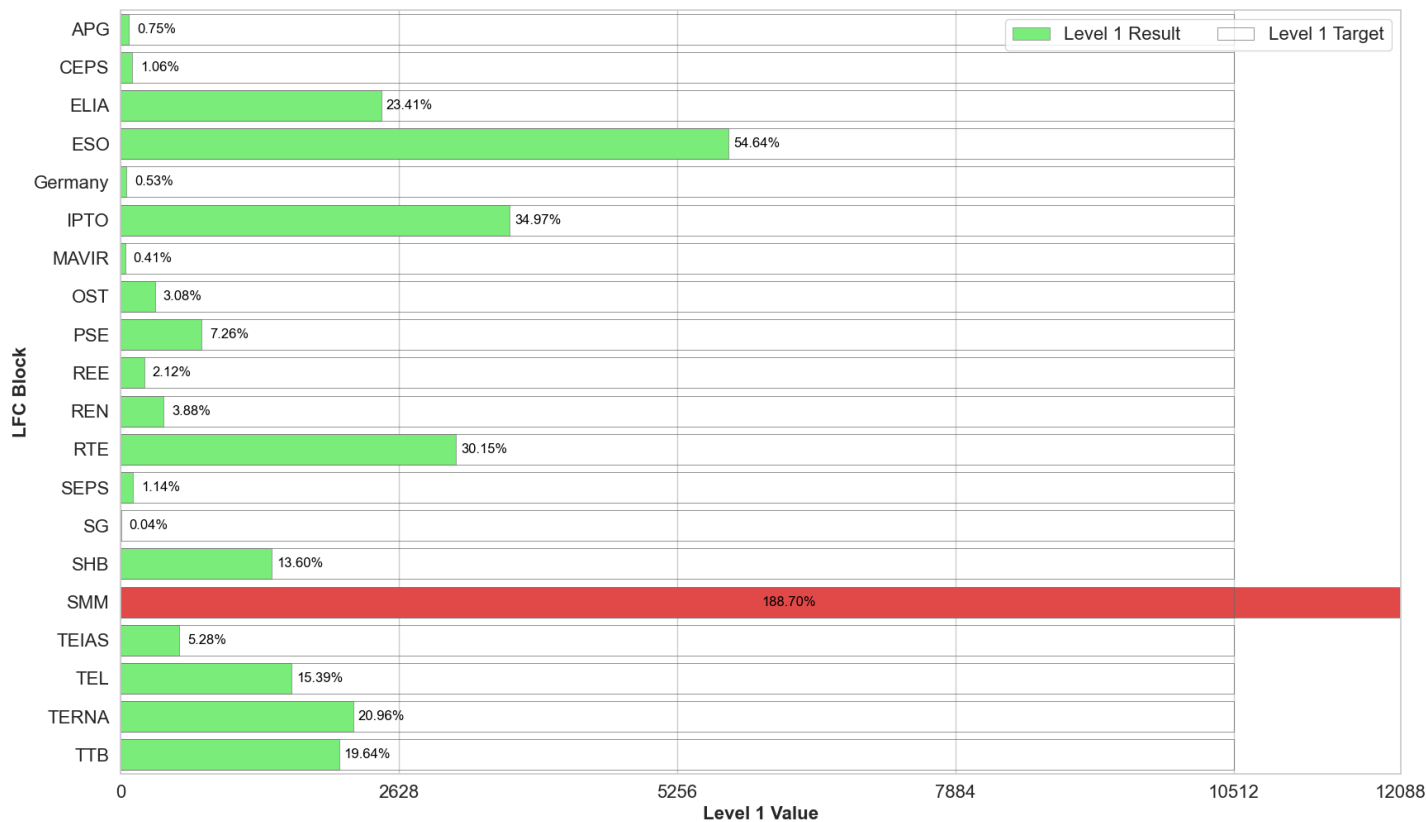


Figure 30 CE LFC Blocks 2020 TSO time intervals with average FRCE outside the Level 1 target

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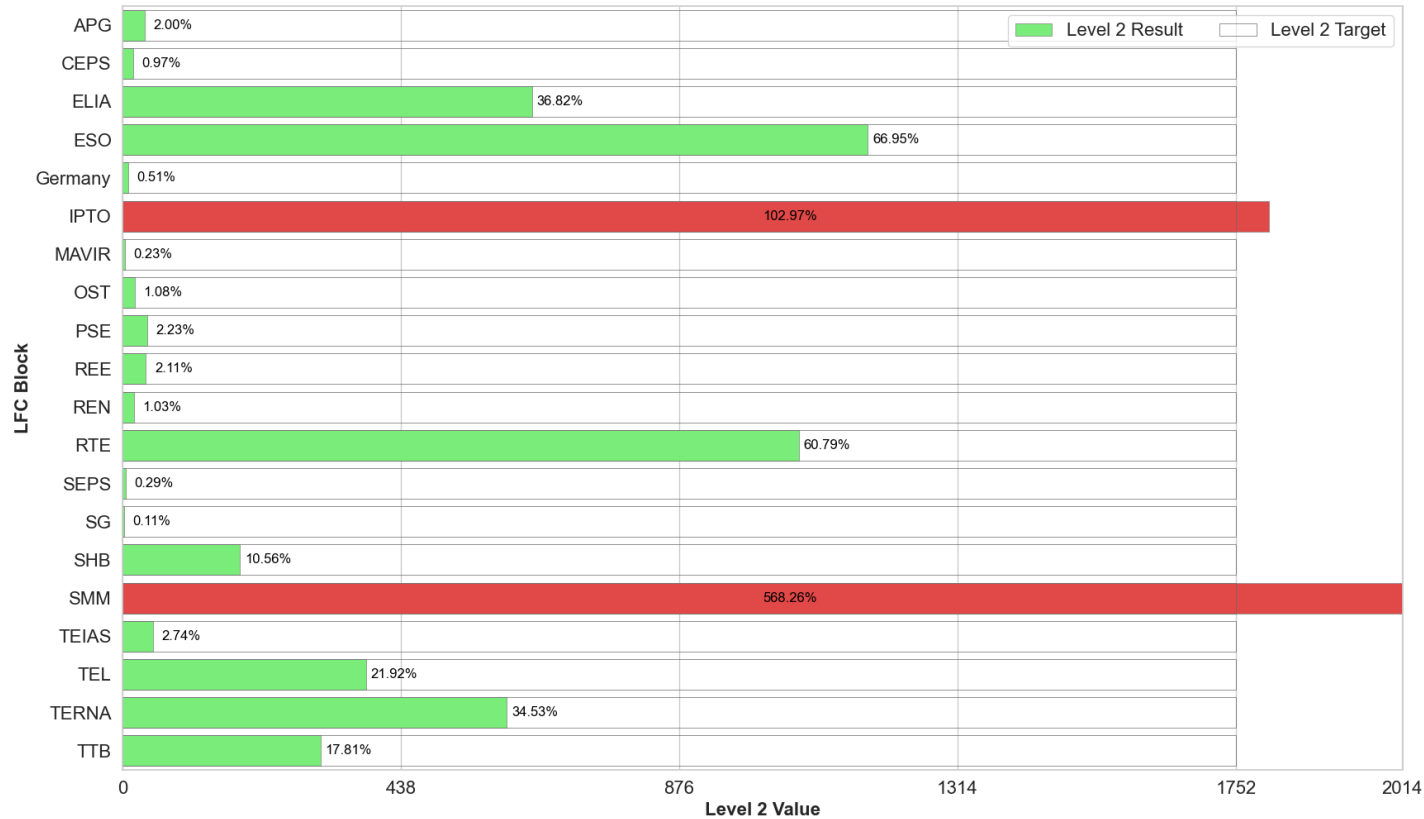


Figure 31 CE LFC Blocks 2020 TSO time intervals with average FRCE outside the Level 2 target

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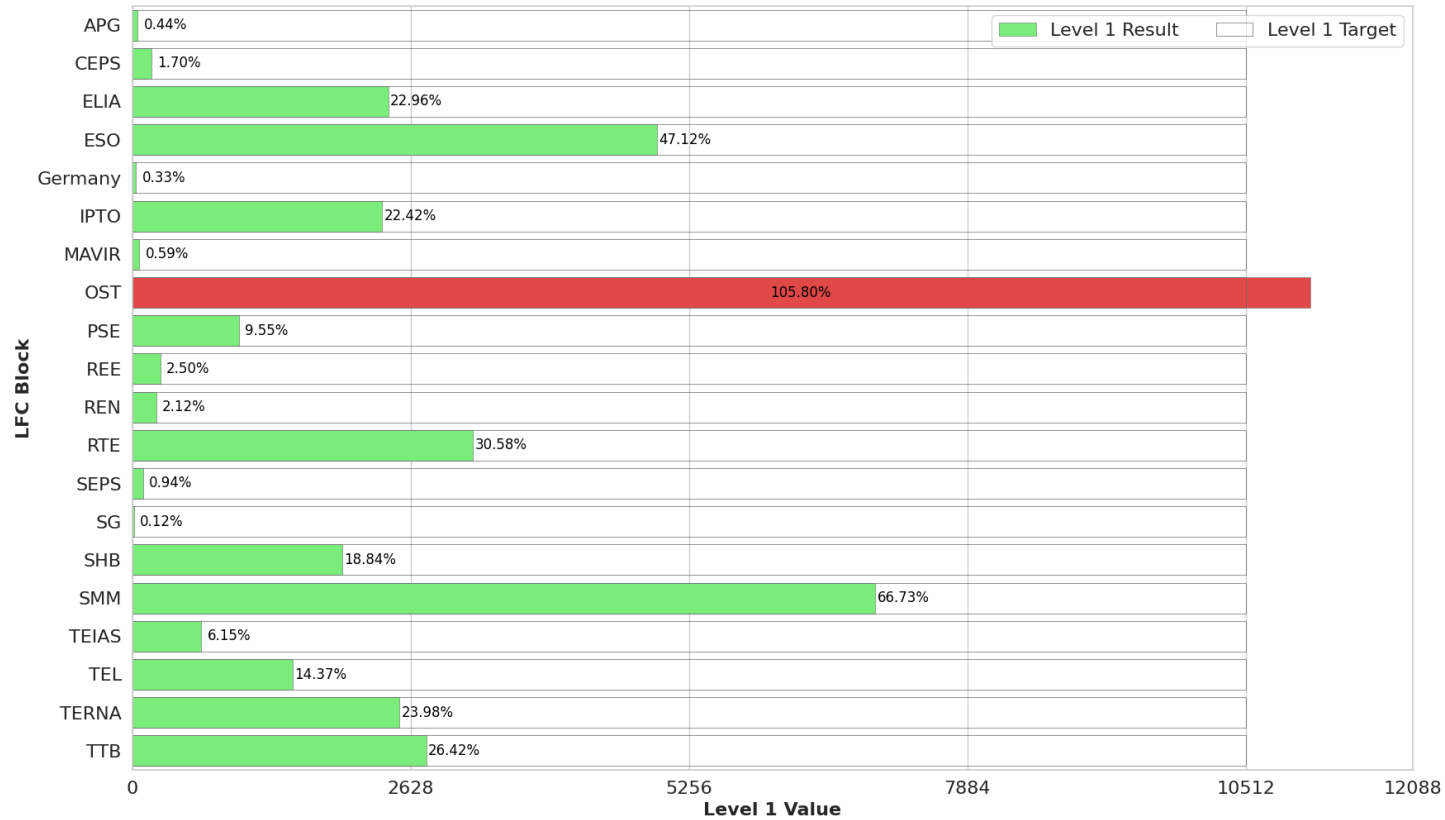


Figure 32 CE LFC Blocks 2021 TSO time intervals with average FRCE outside the Level 1 target

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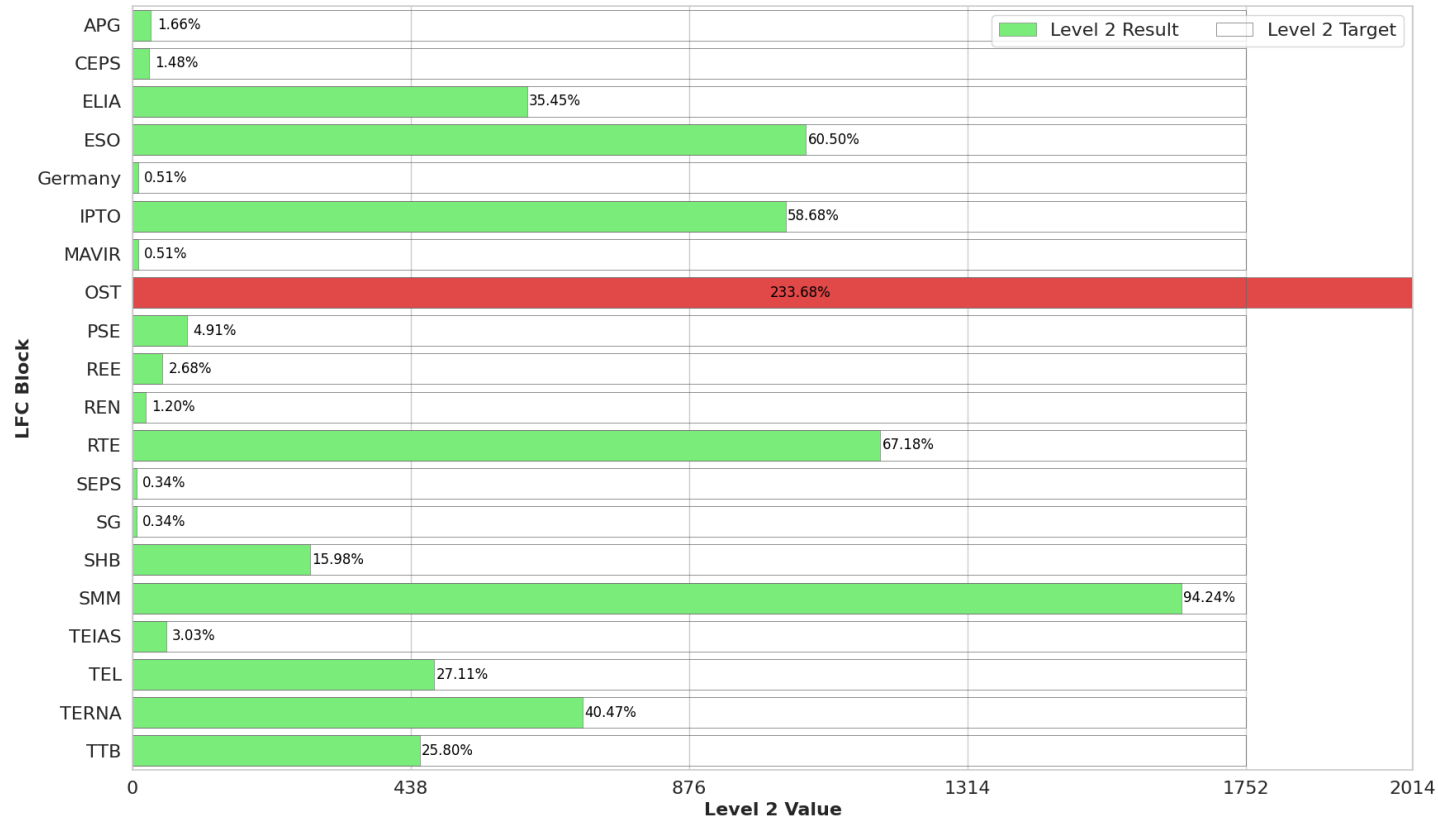


Figure 33 CE LFC Blocks 2021 TSO time intervals with average FRCE outside the Level 2 target

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

For the reporting period, encompassing the years 2020 and 2021, in line with Figures 30–33, the following analysis and mitigation measures were reported from LFC blocks in Continental Europe:

Mitigation measures for 2020:

SMM LFC Block

Analysis:

The FRCE quality for the SMM CB was very low due to an internal dispute.

Mitigation measures:

EMS partially covered the imbalance, and discussions were ongoing to resolve this dispute. The connection agreement between the transmission system operator of Kosovo and the ENTSO-E was signed in 2020, and it is expected that there will be no future impact on frequency quality target parameters.

IPTO LFC Block

Analysis:

On 1 November 2020, the Greek wholesale electricity market model changed (towards target model requirements). As depicted in the detailed monthly sheet, the number of time intervals where the average FRCE > Level 1 during these two months was 1 901 (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 obviously was immature during the first couple of months, but its behaviour improved during Q1 2021.

Mitigation measures for 2021:

AK LFC Block

Analysis:

In December 2021, KOSTT units in KosovaB tripped, which led to high ACE in the KOSTT Control Area and in respective Control Block AK (CB AK). The outage of units lasted several days; hence, the CB AK ACE surpassed Level 1 and Level 2 limits. Within the CB AK, mFRR reserves in the OST Control Area were activated, but due

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to low hydrology in that period, the amount of mFRR was insufficient to cover the whole imbalance.

Mitigation measures:

As the root cause was a combination of several uncontrollable events by TSOs (low hydrology, outage of the largest unit, disruptions in the energy market), OST will take measures to prevent this from happening again.

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. The SO GL requests that companies report two distinct 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.

The initial FCR obligation is reported monthly as an average value of FCR in MW for the reported month. This value is the same for each month if the value of a TSO's initial FCR obligation is constant for the whole year. 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

Tables 27 to 30 below present the FCR from January (I) to December (XII) for 2020 and 2021. The FCR requirement for the synchronous areas 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 TSO area is also given as a percentage.

Nordic TSOs

Figures 31 and 32 depict the FCR for every Nordic TSO from January (I) to December (XII) for 2020 and 2021, respectively. The initial FCR obligation for each TSO is the FCR-D capacity, i.e., the frequency containment reserve used to limit frequency deviations 49.5 Hz or 50.5 Hz during disturbances. Each TSO ensures these capacities with a combination of mandatory requirements, internal markets and a common market.

Continental Europe TSOs

Figures 33 and 34 show the FCR for every Continental Europe TSO from January (I) to December (XII) for 2020 and 2021, 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 area. This value is calculated as a percentage. Values higher than 100% indicate that the respective TSO exported a percentage amount of FCR to other TSOs, and values lower than 100% indicate that the TSO imported part of its FCR from other TSOs (i.e. part of its initial FCR obligation is contracted outside of its responsibility area). If the value is equal to 100 all FCR was ensured inside the TSO's responsibility area. If data is missing or 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.

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TSO data

I. IE/NI TSO

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 27 IE/NI TSO FCR Statistics Year 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average monthly FCR [MW]	289	265	285	314	312	312	341	305	291	267	277	261
FCR obtained inside the area of TSO [%]	77%	78%	79%	80%	82%	80%	88%	87%	81%	83%	83%	84%

Table 28 IE/NI TSO FCR Statistics Year 2021

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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]	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 29 GB TSO FCR Statistics Year 2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Average monthly FCR [MW]	1026	1027	1044	1121	1047	908	903	904	909	891	1230	1189
FCR obtained inside the area of TSO [%]	95%	95%	95%	92%	95%	95%	95%	95%	94%	94%	96%	96%

Table 30 GB TSO FCR Statistics Year 2021

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III. Nordic TSOs

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 31 Nordic TSO FCR Statistics Year 2020

2021

Name	Initial obligation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energinet (Nordic)	40 MW	41.00%	41.00%	41.00%	41.00%	40.71%	38.17%	39.84%	39.94%	40.00%	40.00%	38.67%	38.71%
Fingrid	288 MW	299.82%	298.81%	298.89%	299.00%	295.24%	286.05%	287.47%	289.64%	290.18%	290.32%	288.07%	288.84%
Statnett	566 MW	861.57%	891.58%	899.10%	925.15%	891.12%	953.15%	989.41%	879.96%	909.70%	897.94%	921.46%	896.40%
Svenska Kraftnät	556 MW	454.85%	449.64%	477.85%	536.62%	570.38%	583.25%	586.52%	566.11%	562.96%	594.29%	541.98%	506.32%

Table 32 Nordic TSO FCR Statistics Year 2021

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IV. CE TSOs

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%	117.60%	102.90%	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%	72.80%	76.49%	67.70%	77.09%
TransnetBW	74 MW	67.58%	87.88%	55.45%	107.30%	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%	100.09%	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	70.40%	74.10%	72.60%	75.70%	71.20%	76.40%	73.70%	74.40%	76.70%	76.20%	80.10%	70.80%
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%
TEIAS	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 33 Continental Europe TSO FCR Statistics Year 2020

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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%	117.60%	102.90%	120.74%	129.15%	141.01%	139.97%	139.16%	124.53%
CEPS	74 MW	109.46%	109.46%	109.46%	109.46%	109.46%	108.12%	109.46%	109.46%	109.46%	101.35%	101.35%	101.35%
Elia	87 MW	32.48%	37.41%	32.15%	32.04%	33.02%	31.95%	32.59%	31.73%	32.04%	32.21%	31.77%	31.35%
ESO	37 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	114 MW	229.35%	213.00%	204.33%	230.30%	188.86%	199.08%	219.26%	241.00%	263.68%	233.06%	248.30%	251.12%
Amprion	209 MW	77.60%	80.89%	81.99%	83.05%	81.98%	71.03%	69.43%	76.15%	70.30%	76.06%	74.55%	75.08%
Energinet (CE)	20 MW	100.00%	100.00%	100.00%	100.00%	100.00%	96.77%	97.01%	100.00%	100.00%	100.00%	100.00%	94.04%
TenneT DE	170 MW	79.37%	88.78%	88.67%	93.58%	92.61%	90.94%	94.42%	96.88%	101.80%	99.04%	99.32%	107.94%
TransnetBW	73 MW	34.55%	31.27%	35.09%	43.09%	12.29%	31.48%	81.37%	81.74%	68.94%	59.60%	61.05%	52.89%
IPTO	47 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	37 MW	100.00%	100.00%	100.00%	100.00%	100.79%	100.00%	104.01%	100.00%	100.00%	100.78%	100.18%	100.00%
KOSTT	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%
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	109.60%	109.38%	110.22%	109.89%	110.92%	110.06%	109.42%	109.74%	109.98%	111.18%	110.87%	109.14%
Western WPS	8 MW	96.77%	100.00%	80.11%	93.61%	100.00%	100.00%	100.00%	71.91%	95.14%	100.00%	98.33%	100.00%
REE	380 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	50 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	508 MW	115.00%	121.00%	120.00%	109.00%	118.00%	116.00%	94.00%	93.00%	91.00%	94.00%	97.00%	99.00%
SEPS	27 MW	70.20%	76.50%	72.00%	78.00%	73.10%	71.50%	71.90%	69.70%	72.90%	75.40%	68.10%	65.90%
Swissgrid	67 MW	157.00%	148.00%	146.00%	143.00%	163.00%	194.00%	224.00%	191.00%	157.00%	154.00%	143.00%	110.00%
ELES	15 MW	60.00%	4.00%	5.00%	17.00%	8.00%	6.00%	27.00%	21.00%	26.00%	52.00%	41.00%	32.00%
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	13 MW	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
CGES	3 MW	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
EMS	34 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	304 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	57 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	295 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	114 MW	36.78%	36.94%	36.73%	36.64%	42.64%	43.25%	55.57%	56.37%	53.10%	59.08%	56.90%	63.27%

Table 34 Continental Europe TSO FCR Statistics Year 2021

It should be noted that (for 2021) eleven TSOs participate in the FCR Cooperation to procure their FCR. Therefore, the value of procured FCR can be different from the initial FCR obligation due to export and import. These TSOs are from Austria (APG), Belgium (Elia), Switzerland (Swissgrid), Germany (50Hertz, Amprion, TenneT DE, TransnetBW), Slovenia (ELES), Western Denmark (Energinet), France (RTE) and the Netherlands (TenneT NL). More information about the FCR Cooperation can be found at https://www.entsoe.eu/network_codes/eb/fcr/.

APPENDIX

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

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Abbreviation Meaning

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

APPENDIX – CE LFC BLOCK DATA

APG

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.0	0.0	0.0	0.0	0.2	1.7	1.2	0.7	0.1	0.0	0.0	0.0	0.3
The standard deviation	31	38	30	26	29	40	35	32	25	30	30	25	31
1-percentile	-99	-118	-90	-79	-87	-83	-79	-80	-76	-91	-92	-77	-88
5-percentile	-52	-60	-50	-41	-46	-44	-43	-43	-41	-47	-46	-39	-46
10-percentile	-31	-37	-32	-26	-31	-29	-28	-27	-26	-31	-30	-24	-29
90-percentile	31	38	31	25	30	29	28	28	25	31	30	23	29
95-percentile	49	58	46	39	45	45	43	42	38	46	44	35	44
99-percentile	90	108	83	73	83	89	81	80	70	82	81	66	82
Number of time intervals: average FRCE > Level 1 positive	0	2	1	0	2	12	10	6	0	0	0	0	33
Number of time intervals: average FRCE < Level 1 negative	1	0	0	3	0	0	0	1	1	3	3	1	13
Number of time intervals: average FRCE > Level 2 positive	0	1	0	0	0	11	8	5	0	0	0	0	25
Number of time intervals: average FRCE < Level 2 negative	1	0	0	2	0	0	0	0	0	0	0	1	4
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	1	0	1	0	1	2	0	0	0	0	5
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	1	0	0	0	0	0	0	0	0	1

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CEPS

2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.1	-0.2	-0.5	-0.2	-0.3	-0.1	0.0	0.0	0.1	-0.1	0.1	0.0	-0.1
The standard deviation	48	43	46	42	39	33	37	36	40	40	37	39	40
1-percentile	-135	-118	-135	-117	-111	-93	-103	-95	-111	-113	-103	-107	-112
5-percentile	-59	-57	-61	-54	-52	-43	-47	-46	-51	-51	-49	-50	-52
10-percentile	-40	-38	-41	-37	-35	-28	-32	-32	-35	-35	-32	-34	-35
90-percentile	39	36	39	35	33	28	31	30	35	34	33	34	34
95-percentile	62	57	61	55	52	43	47	46	53	53	51	53	53
99-percentile	150	141	148	134	127	99	116	112	126	128	118	119	127
Number of time intervals: average FRCE > Level 1 positive	8	4	6	4	2	2	2	4	3	5	1	5	46
Number of time intervals: average FRCE < Level 1 negative	12	3	4	9	3	0	5	8	6	7	2	6	65
Number of time intervals: average FRCE > Level 2 positive	2	0	1	1	1	0	0	2	0	1	0	0	8
Number of time intervals: average FRCE < Level 2 negative	2	1	0	0	0	0	0	2	1	0	0	3	9
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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	0.0	0.1	0.1	0.3	0.2	0.4	0.2	0.4	1.3	2.2	3.4	4.0	1.0
The standard deviation	37	37	39	40	34	36	34	36	44	48	48	48	40
1-percentile	-106	-102	-108	-110	-90	-96	-89	-94	-120	-133	-128	-115	-108
5-percentile	-51	-52	-53	-53	-47	-48	-45	-49	-54	-60	-61	-58	-53
10-percentile	-35	-36	-36	-37	-34	-34	-33	-35	-37	-39	-41	-40	-36
90-percentile	35	35	36	37	33	35	33	35	40	46	51	50	39
95-percentile	53	53	54	55	48	50	47	51	62	75	82	80	59
99-percentile	113	117	120	130	107	105	98	112	147	171	170	174	130
Number of time intervals: average FRCE > Level 1 positive	1	3	3	6	0	6	5	5	16	31	40	45	161
Number of time intervals: average FRCE < Level 1 negative	2	2	2	2	0	1	0	0	3	3	1	2	18
Number of time intervals: average FRCE > Level 2 positive	0	3	0	2	0	2	1	0	2	3	3	6	22
Number of time intervals: average FRCE < Level 2 negative	0	2	1	0	0	1	0	0	0	0	0	0	4
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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ELIA

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-7.8	1.1	0.4	-2.5	-1.2	-5.9	2.4	-1.5	-2.6	-1.7	-11.1	-4.9	-2.9
The standard deviation	59	60	55	67	66	45	38	42	48	59	58	59	55
1-percentile	-208	-184	-175	-204	-224	-177	-119	-148	-177	-186	-223	-204	-186
5-percentile	-110	-97	-79	-93	-89	-67	-45	-62	-72	-82	-113	-105	-85
10-percentile	-66	-55	-45	-54	-43	-36	-27	-33	-39	-47	-68	-63	-48
90-percentile	43	53	45	49	42	21	33	30	33	42	35	46	39
95-percentile	68	90	78	82	81	34	57	49	56	72	61	78	67
99-percentile	161	187	185	188	185	110	146	123	158	172	138	166	160
Number of time intervals: average FRCE > Level 1 positive	78	111	107	102	118	34	57	46	68	90	62	98	971
Number of time intervals: average FRCE < Level 1 negative	184	133	109	130	134	90	48	67	96	113	171	168	1443
Number of time intervals: average FRCE > Level 2 positive	18	28	28	28	29	13	11	11	17	25	17	22	247
Number of time intervals: average FRCE < Level 2 negative	47	26	23	39	45	26	11	15	22	29	51	40	374
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	1	4	6	7	8	8	2	4	0	0	1	42

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ESO

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	3.5	7.5	2.2	-0.7	2.0	-1.5	0.5	3.9	0.4	-2.2	0.5	-3.6	1.0
The standard deviation	66	62	50	46	54	44	37	41	42	40	52	47	48
1-percentile	-181	-150	-148	-129	-154	-122	-108	-101	-113	-119	-131	-143	-133
5-percentile	-92	-84	-79	-80	-82	-74	-57	-54	-63	-73	-77	-84	-75
10-percentile	-60	-57	-55	-53	-55	-53	-40	-37	-44	-50	-57	-58	-52
90-percentile	72	75	57	50	60	49	43	48	44	41	53	45	53
95-percentile	103	109	82	71	85	68	64	72	68	60	77	70	78
99-percentile	186	210	138	127	150	107	111	137	117	106	145	130	139
Number of time intervals: average FRCE > Level 1 positive	350	332	234	188	268	169	151	191	155	135	205	163	2541
Number of time intervals: average FRCE < Level 1 negative	275	225	231	215	236	203	117	117	139	197	228	229	2412
Number of time intervals: average FRCE > Level 2 positive	100	113	47	36	65	21	20	43	26	16	49	30	566
Number of time intervals: average FRCE < Level 2 negative	83	56	50	32	65	32	21	17	22	28	41	47	494
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	42	43	28	16	34	14	12	20	13	5	10	12	249
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	11	6	2	1	7	1	0	1	2	1	1	4	37

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Germany

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-2.0	-1.0	-13.0	-5.0	-4.0	-10.0	-3.0	-5.0	10.0	-14.0	-13.0	-9.0	-5.8
The standard deviation	44	43	43	46	44	38	37	47	55	45	47	48	45
1-percentile	-111	-102	-115	-112	-89	-105	-94	-86	-132	-115	-112	-113	-107
5-percentile	-72	-62	-76	-74	-58	-67	-63	-53	-53	-76	-76	-74	-67
10-percentile	-53	-46	-59	-56	-44	-50	-46	-40	-37	-61	-60	-57	-51
90-percentile	52	51	36	52	44	32	43	35	64	36	36	43	44
95-percentile	71	71	58	72	62	48	58	52	87	56	63	63	63
99-percentile	118	115	106	119	95	92	94	91	144	101	136	115	111
Number of time intervals: average FRCE > Level 1 positive	1	2	0	0	3	1	0	0	3	1	5	5	21
Number of time intervals: average FRCE < Level 1 negative	0	0	2	3	0	0	0	4	0	4	1	0	14
Number of time intervals: average FRCE > Level 2 positive	0	0	0	0	2	0	0	0	1	1	0	2	6
Number of time intervals: average FRCE < Level 2 negative	0	0	0	0	0	0	0	3	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
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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IPTO

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6.6	30.1	15.6	15.8	17.8	7.5	0.9	4.0	2.1	6.3	5.7	8.4	10.1
The standard deviation	85	68	46	52	58	31	17	30	29	41	31	49	45
1-percentile	-185	-80	-43	-42	-47	-34	-45	-30	-42	-56	-45	-115	-64
5-percentile	-107	-23	-19	-21	-22	-18	-17	-12	-16	-18	-15	-28	-26
10-percentile	-66	-11	-11	-12	-13	-11	-11	-8	-10	-12	-10	-15	-16
90-percentile	88	117	52	48	54	27	12	11	13	18	19	41	42
95-percentile	146	165	104	103	119	54	19	18	20	40	42	88	76
99-percentile	258	294	214	263	292	124	50	138	70	199	148	199	188
Number of time intervals: average FRCE > Level 1 positive	347	415	200	204	232	93	14	58	25	86	81	175	1930
Number of time intervals: average FRCE < Level 1 negative	262	28	11	8	13	4	9	2	14	17	14	45	427
Number of time intervals: average FRCE > Level 2 positive	154	198	91	104	125	21	5	29	11	50	32	77	897
Number of time intervals: average FRCE < Level 2 negative	81	9	1	1	4	0	2	0	3	3	6	21	131
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	147	173	91	80	76	59	11	12	18	36	44	87	834
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	15	4	2	1	3	0	2	0	3	1	2	5	38

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MAVIR

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	0.4	-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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.9	-0.5	-0.1	-1.2	-1.1	0.0	1.2	1.0	0.3	-1.2	-1.2	-0.8	-0.4
The standard deviation	17	17	17	17	15	16	14	15	14	18	18	15	16
1-percentile	-35	-37	-37	-40	-36	-37	-34	-36	-34	-37	-35	-39	-36
5-percentile	-26	-26	-26	-26	-24	-25	-22	-23	-22	-28	-25	-24	-25
10-percentile	-21	-21	-21	-21	-20	-19	-17	-17	-16	-22	-21	-18	-19
90-percentile	22	21	22	21	18	20	19	18	19	22	21	17	20
95-percentile	30	29	30	27	24	26	25	25	25	31	29	25	27
99-percentile	45	45	44	41	38	42	39	44	37	47	43	42	42
Number of time intervals: average FRCE > Level 1 positive	3	2	0	3	3	7	3	4	3	11	6	5	50
Number of time intervals: average FRCE < Level 1 negative	0	1	3	2	1	3	0	0	0	1	1	0	12
Number of time intervals: average FRCE > Level 2 positive	1	0	0	0	1	0	0	1	0	2	3	0	8
Number of time intervals: average FRCE < Level 2 negative	0	0	1	0	0	0	0	0	0	0	0	0	1
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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AK

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	3.3	4.0	1.4	0.6	1.5	0.6	1.1	1.3	2.1	1.1	0.5	-2.6	1.2
The standard deviation	14	11	4	5	5	5	5	7	5	7	8	13	7
1-percentile	-43	-24	-12	-14	-10	-14	-12	-18	-11	-19	-21	-36	-19
5-percentile	-19	-9	-4	-5	-4	-5	-7	-10	-5	-11	-12	-26	-10
10-percentile	-10	-4	-1	-2	-2	-2	-3	-6	-2	-6	-8	-20	-5
90-percentile	21	17	5	4	6	5	8	11	9	9	10	12	10
95-percentile	30	24	7	6	9	9	12	15	12	14	15	18	14
99-percentile	42	46	13	13	21	18	18	22	18	25	28	33	25
Number of time intervals: average FRCE > Level 1 positive	212	116	3	6	16	1	4	9	3	27	32	62	491
Number of time intervals: average FRCE < Level 1 negative	90	20	4	13	0	3	3	2	0	6	5	145	291
Number of time intervals: average FRCE > Level 2 positive	10	19	0	1	0	0	0	0	0	0	1	4	35
Number of time intervals: average FRCE < Level 2 negative	22	3	0	2	0	0	0	0	0	0	0	0	27
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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PSE

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.0	1.0	-0.2	0.5	-1.6	-0.2	0.5	0.0	-0.2	0.6	0.0	0.0	0.1
The standard deviation	54	55	53	57	65	47	54	54	61	55	53	55	55
1-percentile	-144	-153	-153	-148	-156	-143	-153	-164	-192	-149	-150	-158	-155
5-percentile	-87	-92	-89	-90	-87	-77	-90	-88	-99	-89	-89	-91	-89
10-percentile	-59	-63	-60	-63	-58	-53	-60	-59	-67	-62	-60	-61	-60
90-percentile	59	63	60	63	55	53	62	61	65	60	60	60	60
95-percentile	91	94	85	88	79	76	88	88	90	84	84	85	86
99-percentile	153	156	134	157	135	130	145	149	170	143	138	143	146
Number of time intervals: average FRCE > Level 1 positive	43	41	29	49	29	23	43	41	47	37	32	36	450
Number of time intervals: average FRCE < Level 1 negative	41	49	46	42	50	30	41	51	67	44	46	47	554
Number of time intervals: average FRCE > Level 2 positive	9	3	2	5	5	2	2	3	6	6	3	2	48
Number of time intervals: average FRCE < Level 2 negative	2	0	2	4	7	2	1	2	7	4	1	6	38
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	3	3	1	4	2	0	2	2	6	3	2	2	30
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	1	0	4	3	6	3	2	2	4	1	3	5	34

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REE

2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	14.1	35.7	23.8	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	-34	-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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	18.1	23.2	11.9	22.4	22.9	5.5	9.6	16.8	16.7	10.5	-4.4	1.4	12.9
The standard deviation	52	56	49	50	68	42	44	42	50	53	55	53	51
1-percentile	-121	-116	-115	-112	-179	-103	-112	-87	-93	-135	-183	-148	-125
5-percentile	-54	-46	-51	-51	-67	-53	-45	-35	-39	-57	-84	-73	-55
10-percentile	-31	-26	-30	-30	-36	-33	-29	-22	-24	-34	-58	-48	-33
90-percentile	73	79	63	80	85	50	58	68	74	66	44	48	66
95-percentile	92	105	86	96	107	73	79	93	97	93	68	67	88
99-percentile	155	192	134	132	188	128	128	144	180	174	146	141	153
Number of time intervals: average FRCE > Level 1 positive	9	21	11	2	27	8	5	4	19	19	12	11	148
Number of time intervals: average FRCE < Level 1 negative	6	5	10	8	25	5	4	3	3	9	21	16	115
Number of time intervals: average FRCE > Level 2 positive	2	2	2	1	9	0	1	0	4	3	1	4	29
Number of time intervals: average FRCE < Level 2 negative	4	1	3	1	4	1	1	0	0	0	2	1	18
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	4	3	1	8	0	2	0	5	4	2	3	32
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	1	2	5	2	2	1	1	0	0	1	6	4	25

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REN

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.3	3.6	2.0	1.0	0.7	0.3	1.0	0.9	0.3	-0.1	0.4	1.7	0.9
The standard deviation	19	15	13	13	15	12	12	12	13	14	13	16	14
1-percentile	-67	-27	-24	-37	-42	-38	-27	-32	-35	-47	-40	-44	-38
5-percentile	-25	-10	-10	-14	-18	-13	-10	-12	-14	-14	-15	-12	-14
10-percentile	-13	-6	-7	-9	-9	-8	-6	-7	-8	-8	-9	-7	-8
90-percentile	13	15	11	11	11	9	9	9	9	9	10	12	11
95-percentile	24	26	16	17	18	13	13	13	14	14	16	21	17
99-percentile	60	59	48	42	50	40	33	40	38	35	41	62	46
Number of time intervals: average FRCE > Level 1 positive	19	13	10	11	16	4	5	10	8	5	9	17	127
Number of time intervals: average FRCE < Level 1 negative	24	4	6	2	5	7	3	5	19	9	4	8	96
Number of time intervals: average FRCE > Level 2 positive	0	1	2	1	2	0	2	0	0	0	0	1	9
Number of time intervals: average FRCE < Level 2 negative	3	1	1	0	0	0	0	1	2	2	0	2	12
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	25	12	6	9	12	10	7	12	8	6	8	27	142
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	6	2	1	0	3	1	1	1	2	2	1	5	25

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RTE

2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	4.0	13.0	15.0	4.0	3.0	-9.0	1.0	1.0	0.0	8.0	1.0	-3.0	3.2
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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-1.1	9.3	3.7	-3.6	10.2	-1.5	12.3	8.4	5.4	-2.6	-9.5	-8.4	1.9
The standard deviation	187	170	178	178	226	159	161	165	159	186	154	149	173
1-percentile	-465	-527	-544	-586	-685	-508	-418	-527	-554	-551	-541	-527	-536
5-percentile	-242	-221	-240	-276	-290	-229	-198	-196	-223	-265	-257	-229	-239
10-percentile	-150	-135	-150	-173	-165	-136	-126	-128	-142	-168	-152	-138	-147
90-percentile	118	139	136	145	159	122	135	140	144	137	111	105	133
95-percentile	170	234	221	259	305	180	218	216	229	230	171	156	216
99-percentile	494	564	648	566	921	534	651	629	565	666	449	448	595
Number of time intervals: average FRCE > Level 1 positive	82	132	128	155	198	100	125	130	131	142	74	72	1469
Number of time intervals: average FRCE < Level 1 negative	149	115	150	179	189	140	110	118	122	175	163	136	1746
Number of time intervals: average FRCE > Level 2 positive	38	47	60	52	103	42	64	55	42	60	27	30	620
Number of time intervals: average FRCE < Level 2 negative	33	39	49	59	77	37	23	40	38	61	53	48	557
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	29	50	42	56	73	36	55	51	45	46	30	29	542
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	7	5	8	8	12	9	1	4	3	6	3	5	71

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SEPS

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.4	-0.4	-0.2	-0.2	-0.4	-1.3	-0.9	-0.5	-1.0	-1.0	-1.2	-0.6	-0.7
The standard deviation	7	6	6	6	7	9	8	8	12	11	11	8	8
1-percentile	-20	-20	-19	-18	-25	-31	-25	-26	-52	-43	-41	-30	-29
5-percentile	-10	-9	-8	-8	-9	-12	-11	-10	-18	-19	-18	-12	-12
10-percentile	-6	-6	-5	-5	-6	-8	-7	-7	-10	-10	-10	-7	-7
90-percentile	6	5	5	5	6	6	5	6	9	8	8	7	6
95-percentile	9	8	7	8	9	9	8	9	14	13	13	10	10
99-percentile	16	14	16	15	17	19	20	21	28	28	28	21	20
Number of time intervals: average FRCE > Level 1 positive	0	0	0	1	0	3	5	0	1	6	7	2	25
Number of time intervals: average FRCE < Level 1 negative	1	0	1	2	1	3	8	3	26	13	12	4	74
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	1	0	0	0	0	2	0	1	2	0	0	0	6
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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SG

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-0.1	0.0	-0.2	0.0	0.1	0.0	0.0	0.0	0.0	-0.1	-0.4	0.0	-0.1
The standard deviation	6	7	7	7	7	5	6	6	6	9	9	9	7
1-percentile	-20	-21	-21	-20	-19	-17	-16	-16	-19	-19	-20	-18	-19
5-percentile	-12	-13	-13	-12	-10	-9	-9	-9	-10	-12	-12	-10	-11
10-percentile	-7	-8	-8	-8	-7	-5	-6	-6	-6	-7	-8	-6	-7
90-percentile	7	8	8	7	7	5	5	6	6	7	7	6	7
95-percentile	10	11	11	10	10	7	8	8	9	10	10	9	9
99-percentile	16	17	17	17	18	13	14	13	15	15	17	13	15
Number of time intervals: average FRCE > Level 1 positive	0	0	0	0	2	0	0	3	0	0	0	0	5
Number of time intervals: average FRCE < Level 1 negative	0	0	2	0	0	0	0	2	0	1	3	0	8
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	2	0	0	0	0	1	0	1	2	0	6
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	1	0	1

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SHB

2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	6.0	8.9	11.6	12.1	15.2	4.4	-4.5	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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	1.1	2.0	5.4	3.2	12.7	4.2	-0.5	7.8	9.0	-0.3	4.6	13.9	5.2
The standard deviation	42	35	37	35	29	31	38	35	29	39	37	39	35
1-percentile	-86	-128	-150	-101	-85	-100	-99	-83	-72	-123	-110	-103	-103
5-percentile	-38	-52	-48	-51	-31	-47	-59	-43	-39	-69	-60	-51	-49
10-percentile	-24	-32	-26	-35	-16	-31	-38	-27	-23	-46	-39	-31	-31
90-percentile	27	36	38	39	44	34	31	42	39	38	43	57	39
95-percentile	42	53	52	55	58	47	51	58	53	58	56	72	55
99-percentile	99	91	81	100	90	83	124	108	93	97	99	108	98
Number of time intervals: average FRCE > Level 1 positive	69	68	63	79	86	49	91	102	67	103	73	170	1020
Number of time intervals: average FRCE < Level 1 negative	55	87	101	79	50	62	101	51	34	150	99	91	960
Number of time intervals: average FRCE > Level 2 positive	12	4	3	10	7	2	27	12	6	6	10	12	111
Number of time intervals: average FRCE < Level 2 negative	11	24	38	9	4	14	17	5	0	22	16	9	169
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	5	0	0	3	2	1	5	2	3	2	2	1	26
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	1	0	1	0	0	0	0	0	0	0	0	0	2

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SMM

2020

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-44.0	-94.0	117.0	-46.0	-57.0	-65.0	-92.0	-63.0	-86.0	124.0	151.0	-11.0	-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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-28.8	-33.9	-14.2	15.0	0.8	21.7	-14.3	-10.6	-18.7	134.3	-17.3	-21.6	-21.4
The standard deviation	73	81	46	103	60	51	64	53	49	104	70	60	68
1-percentile	-202	-283	-146	-471	-118	-86	-180	-163	-146	-396	-221	-186	-217
5-percentile	-121	-186	-93	-85	-60	-49	-120	-111	-101	-317	-141	-114	-125
10-percentile	-94	-133	-69	-58	-43	-33	-91	-78	-77	-272	-101	-89	-95
90-percentile	43	52	38	105	52	81	63	50	36	-5	61	45	52
95-percentile	67	77	57	135	73	106	87	67	52	20	87	70	75
99-percentile	116	153	92	231	127	164	137	107	92	72	147	125	130
Number of time intervals: average FRCE > Level 1 positive	105	127	57	512	120	293	181	86	51	24	166	107	1829
Number of time intervals: average FRCE < Level 1 negative	411	584	210	157	64	41	391	284	250	1994	430	370	5186
Number of time intervals: average FRCE > Level 2 positive	3	14	0	70	20	26	10	2	1	0	15	7	168
Number of time intervals: average FRCE < Level 2 negative	55	163	12	64	17	9	44	17	15	973	73	41	1483
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	3	8	0	22	5	6	5	1	1	0	8	3	62
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	7	17	0	2	1	0	2	0	2	30	1	2	64

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TEIAS

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	2.5	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	-83	-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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	9.9	8.9	13.4	14.4	9.4	4.2	21.9	9.3	11.8	11.1	11.1	6.5	11.0
The standard deviation	90	87	86	88	90	91	103	88	86	87	92	90	90
1-percentile	-208	-194	-187	-192	-202	-218	-222	-211	-206	-205	-227	-228	-208
5-percentile	-122	-123	-113	-115	-124	-129	-121	-123	-115	-116	-124	-127	-121
10-percentile	-90	-93	-83	-86	-93	-96	-85	-90	-83	-86	-90	-93	-89
90-percentile	116	115	118	120	116	110	135	114	113	115	118	113	117
95-percentile	155	152	155	158	156	149	176	149	149	150	156	147	154
99-percentile	252	243	241	250	259	244	320	235	228	232	247	237	249
Number of time intervals: average FRCE > Level 1 positive	38	17	35	36	36	17	63	12	19	24	29	28	354
Number of time intervals: average FRCE < Level 1 negative	21	14	34	19	23	27	21	21	34	23	30	26	293
Number of time intervals: average FRCE > Level 2 positive	0	0	6	4	1	0	26	0	0	1	3	0	41
Number of time intervals: average FRCE < Level 2 negative	0	0	2	0	0	0	1	1	2	4	1	1	12
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	0	0	0	0	1	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	1	0	0	0	1	0	1	0	3

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TERNA

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	-2.4	-3.4	-3.0	-0.9	-5.4	-4.5	-7.7	0.6	-11.7	-20.6	-23.8	-27.4	-9.2
The standard deviation	106	105	104	118	108	103	100	99	111	130	130	136	113
1-percentile	-310	-342	-347	-335	-409	-368	-340	-298	-398	-502	-535	-580	-397
5-percentile	-161	-160	-151	-161	-172	-152	-160	-139	-187	-254	-244	-282	-185
10-percentile	-109	-113	-106	-106	-111	-99	-104	-90	-119	-156	-138	-163	-118
90-percentile	91	103	95	95	102	86	91	90	92	96	76	82	92
95-percentile	132	142	142	146	138	126	124	137	129	133	110	122	132
99-percentile	278	285	294	328	300	283	209	288	239	232	205	212	263
Number of time intervals: average FRCE > Level 1 positive	75	79	80	90	77	60	52	74	54	57	39	55	792
Number of time intervals: average FRCE < Level 1 negative	109	111	102	115	132	102	106	82	154	248	205	263	1729
Number of time intervals: average FRCE > Level 2 positive	19	14	17	26	20	17	10	15	9	4	7	9	167
Number of time intervals: average FRCE < Level 2 negative	20	26	31	27	39	33	29	19	44	83	82	109	542
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	109	36	60	187	104	57	18	148	58	27	21	42	867
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	68	106	89	192	178	118	139	95	176	386	534	571	2652

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TEL

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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	4.5	2.3	1.9	4.1	7.0	3.6	0.3	2.5	2.1	-3.2	0.7	1.8	2.3
The standard deviation	54	43	36	38	40	37	36	31	31	36	35	43	38
1-percentile	-112	-142	-107	-101	-93	-86	-104	-67	-93	-157	-116	-140	-110
5-percentile	-40	-42	-41	-30	-28	-33	-35	-24	-30	-47	-39	-48	-36
10-percentile	-24	-23	-25	-20	-19	-20	-20	-15	-18	-25	-24	-23	-21
90-percentile	31	30	27	28	34	25	19	17	23	21	25	28	26
95-percentile	60	59	45	52	67	45	30	33	38	30	40	55	46
99-percentile	150	159	146	161	164	142	114	128	114	84	114	162	136
Number of time intervals: average FRCE > Level 1 positive	94	95	73	92	119	81	54	63	45	32	49	96	893
Number of time intervals: average FRCE < Level 1 negative	57	69	53	45	38	34	48	22	35	84	53	80	618
Number of time intervals: average FRCE > Level 2 positive	30	33	29	31	38	24	22	21	11	6	19	37	301
Number of time intervals: average FRCE < Level 2 negative	15	25	8	13	11	5	13	4	11	33	14	22	174
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

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TTB

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	-113	-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	101	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

2021

Data item	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yr.
The mean value	8.2	6.1	3.9	8.1	4.1	-1.6	15.6	14.3	10.4	13.6	10.3	10.6	8.6
The standard deviation	58	67	59	67	65	66	60	59	62	71	71	70	65
1-percentile	-147	-201	-180	-213	-182	-212	-130	-136	-157	-175	-175	-150	-171
5-percentile	-78	-94	-85	-95	-95	-93	-66	-65	-79	-88	-100	-90	-86
10-percentile	-53	-62	-55	-57	-58	-63	-38	-44	-49	-58	-66	-60	-55
90-percentile	75	78	69	78	70	61	83	85	83	97	95	90	80
95-percentile	101	113	98	104	100	95	122	122	113	131	129	126	113
99-percentile	162	185	164	177	190	179	214	206	190	249	210	207	194
Number of time intervals: average FRCE > Level 1 positive	104	135	99	122	116	90	181	173	143	206	202	200	1771
Number of time intervals: average FRCE < Level 1 negative	67	86	90	102	113	104	47	41	68	88	110	90	1006
Number of time intervals: average FRCE > Level 2 positive	8	17	7	15	25	15	30	28	14	44	27	25	255
Number of time intervals: average FRCE < Level 2 negative	10	25	20	28	17	29	5	7	17	13	14	12	197
Number of events: FRCE > 60% FRR capacity - and not < 15% FRR capacity - within 15 min	1	2	3	5	11	2	3	2	2	8	0	1	40
Number of events: FRCE < -60% FRR capacity + and not > -15% FRR capacity + within 15 min	9	10	31	14	12	27	19	14	28	21	26	17	228