European Network of Transmission System Operators for Electricity

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2021 INCIDENT CLASSIFICATION SCALE ANNUAL REPORT

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2021 Incident Classification Scale Annual Report

Report rendered 29 September 2022

ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association for the cooperation of the European transmission system operators (TSOs). The 42 member TSOs, representing 35 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E brings together the unique expertise of TSOs for the benefit of European citizens by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the security of the inter-connected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first climate-neutral continent by 2050 by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system keeps consumers at its centre and is operated and developed with climate objectives and social welfare in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its legally mandated tasks, ENTSO-E's key responsibilities include the following:

› Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy; › Assessment of the adequacy of the system in different timeframes;

› Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);

› Coordination of research, development and innovation activities of TSOs;

› Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the implementation and monitoring of the agreed common rules.

ENTSO-E is the common voice of European TSOs and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

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Glossary

ALFC Annual Load-Frequency Control.

CE Continental Europe.

Contingency list "the list of contingencies to be simulated in order to test the compliance with the operational security limits" [1, p. 4].

Energy not supplied "the estimated energy which would have been supplied to end-users if no interruption and no transmission restrictions had occurred" [2, p. 18].

ENS energy not supplied.

ENTSO-E European Network of Transmission System Operators for Electricity.

Exceptional contingency "the simultaneous occurrence of multiple contingencies with a common cause" [1, p. 6].

FCR " 'frequency restoration reserves' or 'FCR' means the active power reserves available to restore system frequency to the nominal frequency and, for a synchronous area consisting of more than one LFC area, to restore power balance to the scheduled value" [1, p. 5].

FRR " 'frequency restoration reserves' or 'FRR' means the active power reserves to restore system frequency to the nominal frequency and, for a synchronous area consisting of more than one LFC area, to restore power balance to the scheduled value" [1, p. 5].

GB Great Britain.

ICS Incident Classification Scale.

ICS event An ICS event indicates the occurrence of a single ICS criteria violation.

ICS incident In the ICS Annual Report, the term incident is used to represent all related ICS events that have affected the normal operation of the electric power grid. Therefore, one ICS incident may have multiple ICS events.

IE/NI Ireland / Northern Ireland.

LFC area " 'load-frequency control area' or 'LFC area' means a part of a synchronous area or an entire synchronous area, physically demarcated by points of measurement at interconnectors to other LFC areas, operated by one or more TSOs fulfilling the obligations of load-frequency control" [1, p. 5].

OPS operational security indicator relevant to operational planning and scheduling.

Ordinary contingency "the occurrence of a contingency of a single branch or injection" [1, p. 7].

OS operational security indicator relevant to operational security.

Out-of-range contingency "the simultaneous occurrence of multiple contingencies without a common cause, or a loss of power generating modules with a total loss of generation capacity exceeding the reference incident" [1, p. 7].

PGF Power Generating Facility.

RR " 'replacement reserves' or 'RR' means the active power reserves available to restore or support the required level of FRR to be prepared for additional system imbalances, including generation reserves" [1, p. 5].

SA Synchronous Area.

SOGL System Operation Guideline, or Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation [1].

TSO Transmission System Operator.

1 Introduction

The 2021 Incident Classification Scale Annual Report has been prepared according to the Incident Classification Scale (ICS) Methodology developed by ENTSO-E according to Article 15(1) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SOGL) [1].

The latest ICS Methodology was approved on 4 December 2019 [3] and was used for the first time in the 2020 ICS Annual Report. The ICS Methodology has been updated several times since its creation in 2012. The latest changes made in 2018 and 2019 are presented in Section 2.1. The ICS aims to:

- Provide an overview of operational security indicators as specified in Article 15 of SOGL.
- Identify any improvements necessary to support sustainable and long-term operational security.
- Identify any appropriate improvements to the network operation tools required to maintain operational security and that are related to real-time operation and operational planning to support Transmission System Operators (TSOs) in their task identified in Article 55(e) of SOGL.
- Provide explanations for the reasons behind incidents at the operational security ranking scales 2 and 3 as per the ICS adopted by ENTSO for Electricity; those explanations are based on an investigation of the incidents by TSO. The process of this investigation is set out in the ICS Methodology.

The Annual Report aggregates data prepared by each TSO and provides a high-level summary of scale 0–3 ICS incidents and a detailed review of scale 2 and scale 3 incidents.

The Annual Report of the ICS covers incident reports from all of ENTSO-E's full members. Amprion provided information regarding incidents leading to frequency degradation in continental Europe (CE) for odd months, and Swissgrid provided information for even months. The frequency events in the Nordics were provided by Svenska Kraftnät.

2 Incident Classification Scale

The criteria for incident classification are defined by using definitions from SOGL and IEC standards. Each criterion factually describes an incident or an observable situation.

Only significant incidents are recorded and classified according to a scale based on severity. Therefore, this report is not a compilation of all the incidents that occurred but rather those that meet the criteria of the ICS Methodology.

The ICS has 4 levels of increasing severity, ranging from noteworthy incidents up to significant or widespread incidents. System events which are not classified as incidents are recorded in a 'Below Scale' category. The severity levels are compliant with the system state definitions listed in SOGL. The scales used in the Annual Report are:

- Below Scale[1], for anomalies and local events – the system remains in a normal state. Below scale events are only included in the calculation of operational security indicators.
- Scale 0, for noteworthy local incidents – the system remains in a normal state.
- Scale 1, for significant incidents with violation of operational security limits – the system is in an alert state.
- Scale 2, for extensive incidents involving probability of wide area incident – the system is in an emergency state.
- Scale 3, for major incidents in the control area of a single TSO – the system is in a blackout state.

Table 2.1: The Incident Classification Scale used to categorise incidents in the pan-European power system.

Below scale Anomaly		Scale 0 Noteworthy		Scale 1 Significant incident		Scale 2 Extensive incident		Scale 3 Major incident	
Priority	Short definition (Criterion short code)	Priority	Short definition (Criterion short code)	Priority	Short definition (Criterion short code)	Priority	Short definition (Criterion short code)	Priority	Short definition (Criterion short code)
		#20	Incidents on load (L0)	#11	Incidents on load (L1)	#2	Incidents on load (L2)	#1	Blackout (OB3)
#28	Incidents leading to frequency degradation (FBS)	#21	Incidents leading to frequency degradation (F0)	#12	Incidents leading to frequency degradation (F1)	#3	Incidents leading to frequency degradation (F2)		
		#22	Incidents on network elements (T0)	#13	Incidents on network elements (T1)	#4	Incidents on network elements (T2)		
#29	Incidents on power generating facilities (GBS)	#23	Incidents on power generating facilities (G0)	#14	Incidents on power generating facilities (G1)	#5	Incidents on power generating facilities (G2)		
				#15	N-1 violation (ON1)	#6	N violation (ON2)		
		#24	Separation from the grid (RS0)	#16	Separation from the grid (RS1)	#7	Separation from the grid (RS2)		
#30	Violation of standards on voltage (OVBS)	#25	Violation of standards on voltage (OV0)	#17	Violation of standards on voltage (OV1)	#8	Violation of standards on voltage (OV2)		
		#26	Reduction of reserve capacity (RRC0)	#18	Reduction of reserve capacity (RRC1)	#9	Reduction of reserve capacity (RRC2)		
		#27	Loss of tools, means and facilities (LT0)	#19	Loss of tools, means and facilities (LT1)	#10	Loss of tools, means and facilities (LT2)		

[1] Remark: The 'below Scale' level has been added to report events that are needed to calculate operational security indicators that are relevant to operational security but these events are not included in the ICS scales of 0, 1, 2 and 3. These events are considered anomalies. 'Below Scale' only exists for reporting of violations of standards of voltage, incidents on power generating facilities and incidents leading to frequency degradation. For all other criteria the ICS scales of 0, 1, 2 and 3 are sufficient to calculate the operational security indicators

2.1 Changes in the Incident Classification Scale Methodology

The current ICS Methodology has been updated several times since its introduction. The latest update in 2019 was to implement input received from ACER. This included an update of several thresholds and the addition of the new 'below scale' level. In addition, some adjustments were made to improve the quality of the ICS data. The first ICS Annual Report to use the 2019 update was the 2020 ICS Annual Report.

The Methodology was also updated in 2018 to align it with the requirements of SOGL. The update refined definitions and thresholds to improve overall data quality, make the results comparable between synchronous areas and TSO, improve analyses, and identify system operations improvements.

The updates made in 2018 and 2019 are described below. Each update has significantly changed the reported data. Therefore, the results gathered after each update cannot be directly compared to those from previous years.

As of 2018, annual workshops are being organised to ensure further high-quality and consistent reporting for all TSO.

2.1.1 ICS Methodology 2019 criteria updates

The main update in the 2019 ICS Methodology was the addition of the 'below scale' criteria for incidents on frequency degradation (FBS), incidents on power generating facilities (GBS) and violation of standards on voltage (OVBS). This addition decreases the reporting threshold for G and OV incidents sufficiently to enable the better calculation of the security indicators OS-B, OS-F1 and OS-F2. Furthermore, short frequency deviations that do not endanger the system operating condition are registered as below scale instead of scale 0. However, the below-scale events are only used when the operational security indicators are calculated.

Furthermore, definitions were clarified and the vocabulary was aligned to that used in ENTSO-E.

New ICS criteria

Incidents on load (L0) and separation from the grid (RS0) were added to the ICS criteria table. L0 incidents include disconnections of load of more than 100 MW and less than 1 % of the load in a TSO's control area (between 1–5 % in isolated systems). RS0 incidents include grid separations involving only one TSO when the asynchronous systems have a load of 1–5 % of the total load prior to the incident.

Incidents leading to frequency degradation (F)

The duration thresholds for incidents leading to frequency degradation were changed. Scale 0 duration thresholds were increased by 2–4 minutes and scale 2 duration thresholds were added as they did not previously exist. A 'below scale' level was added to collect short frequency deviations between 0–5 minutes, which would have been scale 0 events previously. See the ICS Methodology for further details.

Incidents on transmission network elements (T)

Incidents on network elements (T) were extended to also include voltage levels below 220 kV when the network elements are relevant for maintaining operational security in the TSO's control area.

Violation on standards on voltage (OV)

All thresholds for violations on standards on voltage (OV) were revised. Prior to 2020, only voltage deviations longer than 30 minutes were registered. As of 2020, voltage deviations may already be registered after 5 minutes, or 30 seconds if they are major. See the ICS Methodology for further details.

Reduction of reserve capacity (RRC)

The time threshold of 15 minutes was changed to the minimum scheduling resolution of the power generation facilities of each TSO as the scheduling resolution can vary by 5 to 30 minutes between TSO.

2.1.2 ICS Methodology 2019 security indicator updates

The operational security indicators OS-B, OS-F1, OS-F2 conditions were extended to cover 'below scale' incidents.

2.1.3 ICS Methodology 2018 criteria updates

Incidents leading to frequency degradation (F)

The 'Alert State Trigger Time' of an incident was removed in favour of defining duration thresholds for different frequency deviation magnitudes. For example, as of 2018, a scale 0 frequency incident in CE requires either a frequency deviation of 50–100 mHz that lasts 3–15 minutes or a frequency deviation of 100–200 mHz that lasts 0–5 minutes. Prior to 2018, frequency deviations had to last for at least 5 minutes to be categorised.

Incidents on transmission network elements (T)

The scale 0 threshold was updated to register all final trips of transmission network elements without any other ICS violations. The scale 1 threshold was changed to register only final trips of transmission network elements that trigger an N-1 violation. In addition, the 220–330 kV voltage range was added to the report; prior to 2018, only the 380–420 kV and 220 kV cross-border connections were included.

N and N-1 violations:

N-1 violations (ON1) without consequences to neighbouring TSOs are no longer to be registered.

Loss of tools and facilities (LT)

Scale 0 incidents (LT0) were added to the ICS criteria.

Violations of standards on voltage (OV)

The duration threshold for an OV incident was increased to 30 minutes, and the criteria changed so that scale 0 voltage violations should only affect one substation; a scale 1 incident should affect more than one substation but only one TSO, and a scale 2 voltage violation should affect more than one substation and more than one TSO. In addition, the exclusion of voltage violations exceeding 0.9–1.1 pu in the 300–400 kV range was removed.

2.1.4 ICS Methodology 2018 security indicator updates

Three new operational security indicators relevant to operational security were created, and three others were renamed in the 2018 ICS Methodology update. The changes were as follows:

- OS-D became OS-D1, and OS-D2 was created to calculate the number of individual OS-D1 occurrences.
- OS-E became OS-E1, and OS-E2 was created to calculate the number of individual OS-E1 occurrences.
- OS-F became OS-F2, and OS-F1 was created to calculate the time duration of all OS-F2 occurrences per TSO.

3 Pan-European Overview

This chapter provides a pan-European overview of the events and incidents in 2021 reported by the TSOs. The general overview per synchronous area and TSO is given in Section 3.1. Section 3.2 analyses events per circuit length and consumption and Section 3.3 illustrates the evolution of events between 2017–2021.

3.1 Number of classified events and incidents

This section presents the number of ICS events and ICS incidents that meet the ICS criteria. The numbers are shown per synchronous area and TSO and their distribution by scale or ICS criterion. The term ICS event differs from ICS incident as an incident may contain multiple events. The ICS criteria used in this report are presented in Table 2.1.This pan-European assessment does not include Great Britain (GB).

As shown in Table 3.1, TSOs reported 3894 ICS events in 2021; of which 3063 were scale 0, 814 were scale 1, and 17 were scale 2. No scale 3 events were reported. The percentage distribution of scales 0, 1 and 2 ICS events were 78.7 %, 20.9 % and 0.4 %, respectively. There were 177 more ICS events than ICS incidents. Of these, 148 were scale 0 events, 23 were scale 1 events, and 6 were scale 2 events. The similar number of ICS events and ICS incidents in the pan-European transmission grids indicates that most ICS incidents only had one ICS event.

Table 3.2 presents the total number of incidents per synchronous area and scale in 2021. Table 3.3 presents the same information but for events. Table 3.4 shows the percentage distribution of incidents meeting the ICS criteria in the pan-European power grid. Table 3.5 presents the same information but for events. Approximately 92 % of all events, as well as incidents, occurred in CE. The high percentage is due to the significantly larger synchronous area of CE than the others. However, it should be noted that in smaller synchronous areas, single incidents can have a disproportionate effect on the percentage distributions as the total number of incidents within them is small.To allow for better comparisons, Section 3.2 presents these numbers normalised by consumption and circuit length in each region.

Table 3.6 shows the number of incidents per TSO and scale; Table 3.7 gives the same overview but per event. The responsible TSO for events leading to frequency degradation is marked in most cases as 'Freq (CE)' in CE and 'Freq (Nordic)' in the Nordic synchronous area because it is rarely possible to determine which TSO is responsible for a particular frequency event. Usually, frequency events are caused by a combination of different reasons. The actual causes of many of the unknown F-events are usually deterministic frequency deviations (DFDs) caused by changes in generation and balance diagrams at the beginning and end of business hours. Incidents classified as scale 0 and scale 1 are widely distributed across most TSOs. There were zero scale 2 events in the Baltics, Nordics, Ireland and Northern Ireland (IE/NI), 16 in CE, and 1 in isolated systems. All the reported scale 2 incidents in CE were related to the three scale 2 incidents described in Chapter 4.

Table 3.9 displays the reported ICS events by criteria for each synchronous area. The most frequent events in 2021 were incidents on transmission network elements (T0) with 1446 events, incidents leading to frequency degradation (F0) with 816 events, and violations of standards on voltage (OV1) with 513 events. A significant portion occurred in CE. The newly added ICS criteria L0 and RRC0 were reported 4 times and 26 times, respectively. Although CE and the Nordic synchronous area reported 746 and 70 events leading to frequency degradation (F0), respectively, this type of incident was not reported in the Baltic area, Ireland nor the isolated systems. Violations of standards on voltage and reductions of reserve capacity are only reported in CE. Scale 2 events are widely distributed over dominating criteria but did not occur in Baltic, Nordic or Ireland. There were no scale 3 events in the ENTSO-E area in 2021.

Table 3.1: Number of ICS incidents and ICS events per scale in 2021 and their percentage (%) distribution. Great Britain is excluded from this table. An ICS event is different from ICS incident, since an incident aggregates all related events, with the ICS criteria set to the event with the highest priority according to Table 2.1.

	Number of incidents	Percentage of total	Number of events	Percentage of total
Scale 0	2 915	78.4%	3 063	78.7%
Scale 1	791	21.3%	814	20.9%
Scale 2	11	0.3%	17	0.4%
Scale 3	0	0.0%	0	0.0%
Grand Total	3 717	100.0%	3 894	100.0%

Table 3.2: Number of ICS incidents per scale and synchronous area in 2021.

	Scale 0	Scale 1	Scale 2	Scale 3	Grand Total
Baltic	36	4	-	-	40
Continental Europe	2 623	769	10	-	3 402
Great Britain	246	1	-	-	247
Ireland	22	7	-	-	29
Isolated systems	26	3	1	-	30
Nordic	208	8	-	-	216
Grand Total	3 161	792	11	-	3 964

Table 3.3: Number of ICS events per scale and synchronous area in 2021.

	Scale 0	Scale 1	Scale 2	Scale 3	Grand Total
Baltic	38	4	-	-	42
Continental Europe	2 762	791	16	-	3 569
Great Britain	251	1	-	-	252
Ireland	25	8	-	-	33
Isolated systems	26	3	1	-	30
Nordic	212	8	-	-	220
Grand Total	3 314	815	17	-	4 146

Table 3.4: Percentage distribution of ICS incidents per scale and synchronous area in 2021.

	Scale 0	Scale 1	Scale 2	Scale 3
Baltic	90.0%	10.0%	-	-
Continental Europe	77.1%	22.6%	0.3%	-
Great Britain	99.6%	0.4%	-	-
Ireland	75.9%	24.1%	-	-
Isolated systems	86.7%	10.0%	3.3%	-
Nordic	96.3%	3.7%	-	-
Grand Total	79.7%	20.0%	0.3%	-

Table 3.5: Percentage distribution of ICS events per scale and synchronous area in 2021.

	Scale 0	Scale 1	Scale 2	Scale 3
Baltic	90.5%	9.5%	-	-
Continental Europe	77.4%	22.2%	0.4%	-
Great Britain	99.6%	0.4%	-	-
Ireland	75.8%	24.2%	-	-
Isolated systems	86.7%	10.0%	3.3%	-
Nordic	96.4%	3.6%	-	-
Grand Total	79.9%	19.7%	0.4%	-

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Table 3.6: Number of ICS incidents per scale for each TSO in the pan-European transmission grid in 2021. An ICS event is different from ICS incident, since an incident aggregates all related events, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	TSO	Scale 0	Scale 1	Scale 2	Scale 3	Grand Total
Baltic	AST	7	-	-	-	7
	Elering AS	23	-	-	-	23
	Litgrid AB	6	4	-	-	10
Continental Europe	50Hertz	49	17	-	-	66
	Amprion	94	3	-	-	97
	APG	18	4	-	-	22
	CEPS	37	5	-	-	42
	ELES	5	2	-	-	7
	Elia	11	9	-	-	20
	EMS JSC	36	118	1	-	155
	Energinet (CE)	38	-	-	-	38
	ESO EAD	31	-	-	-	31
	HOPS	52	13	1	-	66
	IPTO	60	34	-	-	94
	MAVIR ZRt	274	337	-	-	611
	NOS BiH	28	-	1	-	29
	OST	23	-	-	-	23
	PSE	112	2	1	-	115
	Red Eléctrica	256	-	1	-	257
	REN	17	-	1	-	18
	RTE	224	52	1	-	277
	SEPS	15	11	-	-	26
	Swissgrid	123	15	-	-	138
	TEİAŞ	41	-	-	-	41
	TenneT DE	67	6	-	-	73
	TenneT NL	48	5	-	-	53
	TERNA	86	9	-	-	95
	Transelectrica	112	28	3	-	143
	TransnetBW	27	7	-	-	34
	Freq (CE)	739	92	-	-	831
Great Britain	National Grid ESO	246	1	-	-	247
Ireland	EirGrid	19	6	-	-	25
	SONI	3	1	-	-	4
Isolated systems	Cyprus TSO	-	-	-	-	-
	Landsnet	26	3	1	-	30
Nordic	Energinet (Nordic)	13	-	-	-	13
	Fingrid Oyj	14	-	-	-	14
	Statnett	21	3	-	-	24
	Svenska Kraftnät	90	2	-	-	92
	Freq (Nordic)	70	3	-	-	73
Grand Total		3 161	792	11	-	3 964

Table 3.7: Number of ICS events per scale for each TSO in the pan-European transmission grid in 2021. An ICS event is different from ICS incident, since an incident aggregates all related events, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	TSO	Scale 0	Scale 1	Scale 2	Scale 3	Grand Total
Baltic	AST	7	-	-	-	7
	Elering AS	23	-	-	-	23
	Litgrid AB	8	4	-	-	12
Continental Europe	50Hertz	50	17	-	-	67
	Amprion	102	3	-	-	105
	APG	18	4	-	-	22
	CEPS	39	5	-	-	44
	ELES	5	2	-	-	7
	Elia	11	9	-	-	20
	EMS JSC	37	119	1	-	157
	Energinet (CE)	38	-	-	-	38
	ESO EAD	38	-	-	-	38
	HOPS	60	16	3	-	79
	IPTO	60	34	-	-	94
	MAVIR ZRt	274	337	-	-	611
	NOS BiH	29	2	1	-	32
	OST	61	-	-	-	61
	PSE	114	3	2	-	119
	Red Eléctrica	274	1	3	-	278
	REN	18	-	2	-	20
	RTE	230	54	1	-	285
	SEPS	31	12	-	-	43
	Swissgrid	126	15	-	-	141
	TEİAŞ	41	-	-	-	41
	TenneT DE	67	6	-	-	73
	TenneT NL	48	5	-	-	53
	Terna	88	9	-	-	97
	Transelectrica	130	39	3	-	172
	TransnetBW	27	7	-	-	34
	Freq (CE)	746	92	-	-	838
Great Britain	National Grid ESO	251	1	-	-	252
Ireland	EirGrid	22	7	-	-	29
	SONI	3	1	-	-	4
Isolated systems	Cyprus TSO	-	-	-	-	-
	Landsnet	26	3	1	-	30
Nordic	Energinet (Nordic)	13	-	-	-	13
	Fingrid Oyj	14	-	-	-	14
	Statnett	25	3	-	-	28
	Svenska Kraftnät	90	2	-	-	92
	Freq (Nordic)	70	3	-	-	73
Grand Total		3 314	815	17	-	4 146

Table 3.8: ICS incidents by dominating criteria for each synchronous area in 2021. An ICS event is different from ICS incident, since an incident aggregates all related events, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	Baltic	Continental Europe	Great Britain	Ireland	Isolated systems	Nordic	Grand Total
Scale 0	Incidents leading to frequency degradation (F0)	-	739	3	-	-	70	812
	Incidents on load (L0)	-	2	-	-	-	1	3
	Incidents on network elements (T0)	19	1 190	217	8	26	100	1 560
	Incidents on power generating facilities (G0)	16	129	10	14	-	15	184
	Loss of tools, means and facilities (LT0)	1	66	16	-	-	22	105
	Reduction of reserve capacity (RRC0)	-	26	-	-	-	-	26
	Separation from the grid (RS0)	-	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	471	-	-	-	-	471
	Total	36	2 623	246	22	26	208	3 161
Scale 1	Incidents leading to frequency degradation (F1)	-	92	-	-	-	3	95
	Incidents on load (L1)	-	1	-	-	-	-	1
	Incidents on network elements (T1)	4	22	-	-	1	3	30
	Incidents on power generating facilities (G1)	-	3	-	-	2	-	5
	Loss of tools, means and facilities (LT1)	-	30	1	-	-	1	32
	N-1 violation (ON1)	-	60	-	7	-	-	67
	Reduction of reserve capacity (RRC1)	-	61	-	-	-	-	61
	Separation from the grid (RS1)	-	-	-	-	-	1	1
	Violation of standards on voltage (OV1)	-	500	-	-	-	-	500
	Total	4	769	1	7	3	8	792
Scale 2	Incidents leading to frequency degradation (F2)	-	1	-	-	-	-	1
	Incidents on load (L2)	-	2	-	-	-	-	2
	Incidents on network elements (T2)	-	3	-	-	-	-	3
	Incidents on power generating facilities (G2)	-	1	-	-	-	-	1
	Loss of tools, means and facilities (LT2)	-	-	-	-	1	-	1
	N violation (ON2)	-	1	-	-	-	-	1
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-	-
	Separation from the grid (RS2)	-	2	-	-	-	-	2
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-
	Total	-	10	-	-	1	-	11
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-
Grand Total		40	3 402	247	29	30	216	3 964

Table 3.9: ICS events by ICS criteria for each synchronous area in 2021.

Scale	ICS criterion	Baltic	Continental Europe	Great Britain	Ireland	Isolated systems	Nordic	Grand Total
Scale 0	Incidents leading to frequency degradation (F0)	-	746	3	-	-	70	819
	Incidents on load (L0)	-	2	-	-	-	2	4
	Incidents on network elements (T0)	21	1 287	218	11	26	101	1 664
	Incidents on power generating facilities (G0)	16	138	14	14	-	15	197
	Loss of tools, means and facilities (LT0)	1	68	16	-	-	22	107
	Reduction of reserve capacity (RRC0)	-	26	-	-	-	-	26
	Separation from the grid (RS0)	-	-	-	-	-	2	2
	Violation of standards on voltage (OV0)	-	495	-	-	-	-	495
	Total	38	2 762	251	25	26	212	3 314
Scale 1	Incidents leading to frequency degradation (F1)	-	92	-	-	-	3	95
	Incidents on load (L1)	-	2	-	-	-	-	2
	Incidents on network elements (T1)	4	27	-	-	1	3	35
	Incidents on power generating facilities (G1)	-	4	-	-	2	-	6
	Loss of tools, means and facilities (LT1)	-	30	1	-	-	1	32
	N-1 violation (ON1)	-	60	-	8	-	-	68
	Reduction of reserve capacity (RRC1)	-	63	-	-	-	-	63
	Separation from the grid (RS1)	-	-	-	-	-	1	1
	Violation of standards on voltage (OV1)	-	513	-	-	-	-	513
	Total	4	791	1	8	3	8	815
Scale 2	Incidents leading to frequency degradation (F2)	-	1	-	-	-	-	1
	Incidents on load (L2)	-	2	-	-	-	-	2
	Incidents on network elements (T2)	-	4	-	-	-	-	4
	Incidents on power generating facilities (G2)	-	1	-	-	-	-	1
	Loss of tools, means and facilities (LT2)	-	-	-	-	1	-	1
	N violation (ON2)	-	1	-	-	-	-	1
	Reduction of reserve capacity (RRC2)	-	1	-	-	-	-	1
	Separation from the grid (RS2)	-	6	-	-	-	-	6
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-
	Total	-	16	-	-	1	-	17
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-
Grand Total		42	3 569	252	33	30	220	4 146

3.2 Events per circuit length and energy consumption

The figures in this section present the number of ICS events in proportion to consumption or circuit length that occurred in the European synchronous areas in 2021. This pan-European assessment does not include GB.

The data concerning circuit length and energy consumption until 2018 is based on the discontinued ENTSO-E statistical data [4]. The consumption and circuit length after 2018 have been gathered directly from the TSOs. Whenever a TSO has not reported the latest consumption and circuit length values, the value for the previous year has been used.

Figure 3.1 shows the number of events per TWh of energy consumption, and Figure 3.2 presents the number of events per 100 km of circuit length. Figure 3.3 presents the number of events on transmission network elements (T0 and T1) per 100 km of circuit length.

When normalising the number of scale 0 events in 2021 per consumption, the Baltic area has the highest value, at 1.8 ICS events per TWh of consumption, whereas the Nordic synchronous area has the lowest value, at 0.5 events per TWh of consumption. For scale 1, the minimum value is 0.02 events per TWh in Nordic, and the maximum value is 0.3 events per TWh in CE. The number of scale 2 events per TWh of consumption is small compared to the scale 0 and scale 1 events with a maximum of 0.04 events per TWh

of consumption in Isolated Networks.

When the number of scale 0–3 events in 2021 is normalised by circuit length, 0.69 events per 100 km circuit length can be found for Isolated Networks, which is very close to the 0.68 events per 100 km circuit length for the TSOs of CE. Baltic's TSOs reported slightly more than 0.2. In all synchronous areas, scale 0 events are most common, which indicates that the transmission grids are usually in a normal state after the occurrence of an event.

Incidents on transmission network elements caused a large part of the events in the transmission grid in 2021, which can be seen in the similarities between Figure 3.2 and Figure 3.3. The largest deviation can be found for CE, where F and OV events also contributed significantly. Finally, it should be noted that TSOs may include only certain voltage level ranges in their circuit length calculations. For example, one TSO may include the whole 100–420 kV voltage range whereas another TSO uses only the 220–420 kV voltage range. The included voltage range depends usually on which voltage ranges the TSO owns or controls.

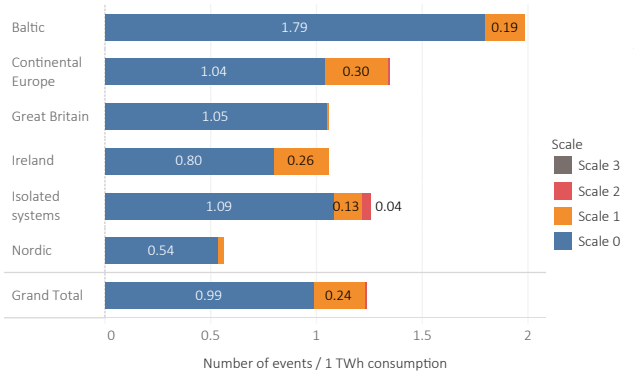

Figure 3.1: Number of ICS events per TWh of energy consumption in 2021.

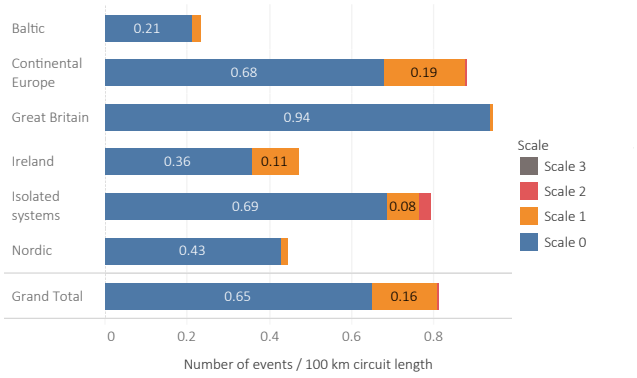

Figure 3.2: Number of ICS events per 100 km of circuit length in 2021.

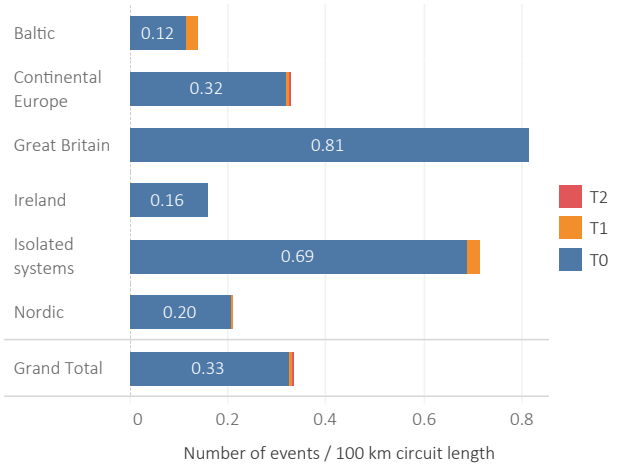

Figure 3.3: Number of ICS events on transmission network elements (T0 and T1) per 100 km of circuit length in 2021.

3.3 Evolution 2017–2021

This section presents classified events according to the ICS Methodology [3] as it developed between 2017–2021. In addition, a detailed view of the ICS criteria F, T, G, OV, RRC, LT and ON is set forth in Sections 3.3.1–3.3.7. This pan-European assessment does not include GB.

It should be noted that the 2017 data were reported according to the 2014 ICS Methodology [5]. The data for 2018–2019 were reported according to the 2018 Methodology [6], and the data for 2020 and 2021 were reported according to the Methodology updated in 2019 [3]. Therefore, the results for individual years cannot directly be compared. Furthermore, one of the important updates in 2020 was to register individual ICS events instead of aggregating related events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

The 2018 and 2019 Methodology updates are summarised in Section 2.1. It should further be noted that trends and impacts on the system must be interpreted according to specific considerations due to inherent differences in the manner networks have been designed and are operated across separate synchronous areas. The evolution of the annual number of events between 2017 and 2021 is shown in Figure 3.4 and Figure 3.5. Figure 3.4 presents the annual number of events grouped by scale, and Figure 3.5 shows the annual event scale distribution percentages. Both graphs showing annual per scale values indicate that the number of scale 0 and scale 1 events has increased significantly since 2017. However, rather than representing a substantial increase in events, the greater number of

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events is a result of the implementation of the updated ICS Methodology [3] mentioned above. The increase consists mainly of F0, T0 and OV0 events. A detailed view of these incident categories is presented in Section 3.3.1, Section 3.3.2 and Section 3.3.4, respectively. The decrease of scale 0 events since 2020 compared to 2019 is due to the updated ICS Methodology, which included changes such as updated F-criteria thresholds. The scale 0 F-criteria duration threshold was increased from 0 minutes to between 2 and 7 minutes (depending on the synchronous area), and the 'below scale' level was created to capture residual events. Therefore, the number of registered F0 events decreased from 841 in 2019 to 360 in 2020 but has risen again in 2021 to 816.

The number of scale 1 events in 2021 increased significantly compared to previous years, with 814 events in 2021 compared to 327 in 2020. This shift was mainly driven by increases in OV1 events, with an increase of 396 events. The second driver was F1 events, which increased by 88 events. A detailed view of reported ICS events per TSO is presented in Chapter 12. Figure 3.6 and Figure 3.7 present the annual number of scale 0 events by consumption and circuit length ratios. In Baltics, the number of Scale 0 events per TWh of energy consumption increased continuously since 2017. For the other synchronous areas, the numbers are more or less stable. Changes have to be viewed regarding changes in the Methodology in 2020, which added the requirement to also report tripped network elements below 220 kV that are relevant for operational security.

Figure 3.8 and Figure 3.9 present the ratios of the number of scale 1 events to consumption and the number of scale 1 events to length of circuit, respectively. The increase of Scale 1 events for Ireland and CE continued to accelerate in 2021. The number of Scale 1 events per consumption and circuit length for Isolated Systems decreased significantly in 2021. A detailed view of the annual number of ICS events, grouped by ICS criterion, is shown in Table 3.10, respectively.

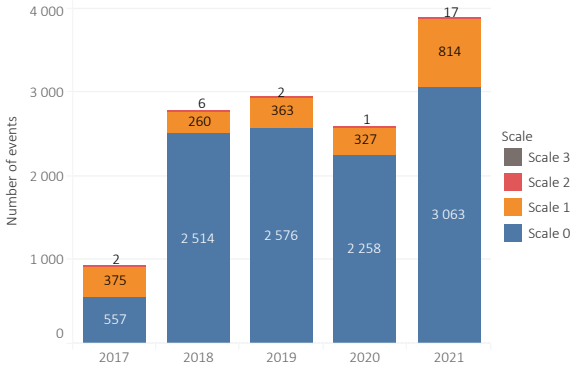

Figure 3.4: The annual number of ICS events per scale from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

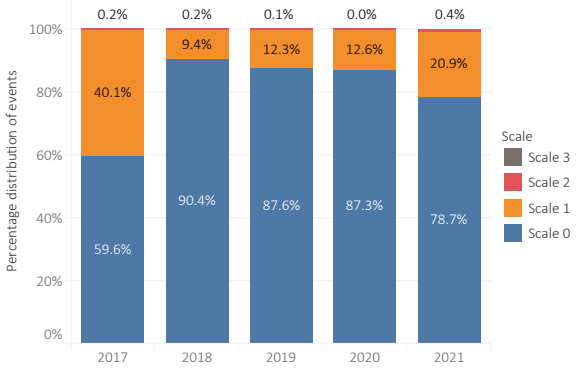

Figure 3.5: The annual percentage distribution of ICS events per scale from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

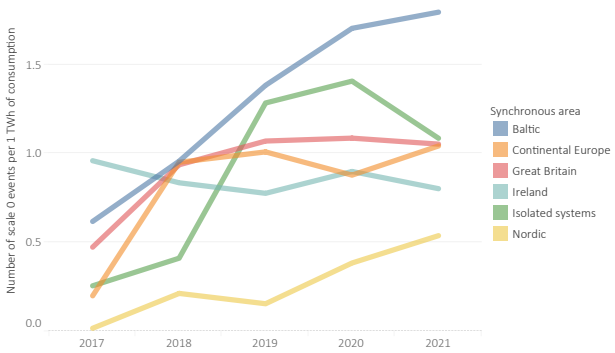

Figure 3.6: The annual number of scale 0 ICS events per TWh of energy consumption from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

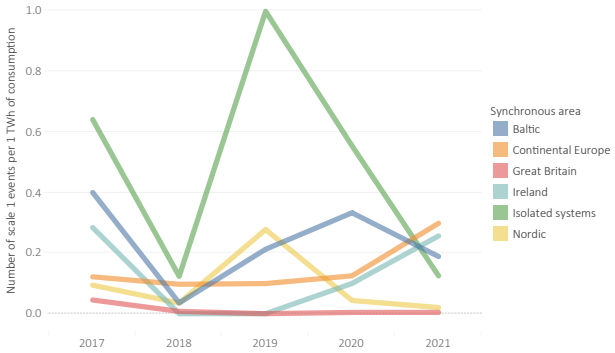

Figure 3.8: The annual number of scale 1 ICS events per TWh of energy consumption from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

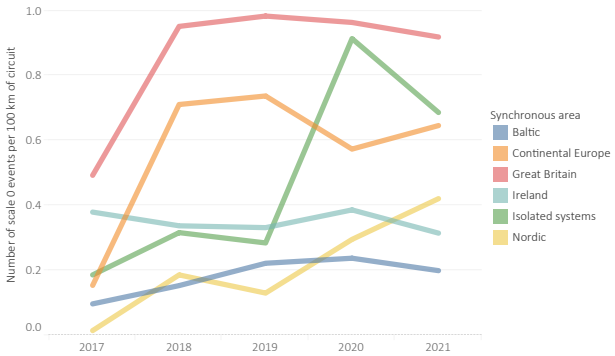

Figure 3.7: The annual number of scale 0 ICS events per 100 km of circuit length from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

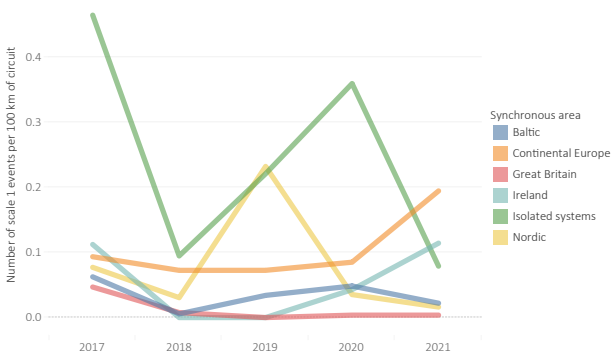

Figure 3.9: The annual number of scale 1 events per 100 km of circuit length from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Table 3.10: The annual number of ICS incidents per dominating criterion from 2017 to 2021.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	3	3
	Incidents leading to frequency degradation (F0)	11	963	763	355	809
	Incidents on network elements (T0)	409	988	1 300	1 144	1 343
	Incidents on power generating facilities (G0)	109	123	119	132	174
	Separation from the grid (RS0)	-	-	-	-	-
	Violation of standards on voltage (OV0)	27	341	286	422	471
	Reduction of reserve capacity (RRC0)	1	-	1	-	26
	Loss of tools, means and facilities (LT0)	-	99	107	109	89
	Total	557	2 514	2 576	2 165	2 915
Scale 1	Incidents on load (L1)	10	6	4	9	1
	Incidents leading to frequency degradation (F1)	-	10	114	7	95
	Incidents on network elements (T1)	242	15	32	30	30
	Incidents on power generating facilities (G1)	2	-	-	-	5
	N-1 violation (ON1)	66	33	25	57	67
	Separation from the grid (RS1)	-	-	-	1	1
	Violation of standards on voltage (OV1)	21	50	9	116	500
	Reduction of reserve capacity (RRC1)	12	118	161	66	61
	Loss of tools, means and facilities (LT1)	22	28	18	29	31
	Total	375	260	363	315	791
Scale 2	Incidents on load (L2)	2	1	-	1	2
	Incidents leading to frequency degradation (F2)	-	1	-	-	1
	Incidents on network elements (T2)	-	-	1	-	3
	Incidents on power generating facilities (G2)	-	-	-	-	1
	N violation (ON2)	-	3	1	-	1
	Separation from the grid (RS2)	-	-	-	-	2
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	1	-	-	1
	Total	2	6	2	1	11
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		934	2 780	2 941	2 481	3 717

Table 3.11: The annual number of ICS events per ICS criterion from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	4	4
	Incidents leading to frequency degradation (F0)	11	963	763	358	816
	Incidents on network elements (T0)	409	988	1 300	1 193	1 446
	Incidents on power generating facilities (G0)	109	123	119	134	183
	Separation from the grid (RS0)	-	-	-	2	2
	Violation of standards on voltage (OV0)	27	341	286	454	495
	Reduction of reserve capacity (RRC0)	1	-	1	-	26
	Loss of tools, means and facilities (LT0)	-	99	107	113	91
	Total	557	2 514	2 576	2 258	3 063
Scale 1	Incidents on load (L1)	10	6	4	9	2
	Incidents leading to frequency degradation (F1)	-	10	114	7	95
	Incidents on network elements (T1)	242	15	32	35	35
	Incidents on power generating facilities (G1)	2	-	-	1	6
	N-1 violation (ON1)	66	33	25	62	68
	Separation from the grid (RS1)	-	-	-	1	1
	Violation of standards on voltage (OV1)	21	50	9	117	513
	Reduction of reserve capacity (RRC1)	12	118	161	66	63
	Loss of tools, means and facilities (LT1)	22	28	18	29	31
	Total	375	260	363	327	814
Scale 2	Incidents on load (L2)	2	1	-	1	2
	Incidents leading to frequency degradation (F2)	-	1	-	-	1
	Incidents on network elements (T2)	-	-	1	-	4
	Incidents on power generating facilities (G2)	-	-	-	-	1
	N violation (ON2)	-	3	1	-	1
	Separation from the grid (RS2)	-	-	-	-	6
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	1
	Loss of tools, means and facilities (LT2)	-	1	-	-	1
	Total	2	6	2	1	17
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		934	2 780	2 941	2 586	3 894

3.3.1 Detailed view of events leading to frequency degradation (F)

This section presents a detailed view of scale 0–2 events leading to frequency degradation; that is, F0, F1 and F2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.12 presents the annual number of events leading to frequency degradation for each synchronous area, and Table 3.13 show the same distributed by cause for all synchronous areas combined. Figure 3.10 presents the annual number of F events normalised by the consumption in each synchronous area.

Before 2018, the scale 0 time threshold to report a frequency event was the 'alert state trigger time', which was 5 or 10 minutes depending on the synchronous area. This was changed to 0 minutes in 2018, and in 2020 it was increased to 2–7 minutes (depending on the synchronous area magnitude of the frequency deviation) to avoid reporting occurrences which do not affect system security. Another important update in use as of 2020 was to also register individual ICS events instead of aggregating related events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1. The 2018 and 2019 ICS Methodology updates are summarised in Section 2.1.

The number of incidents leading to frequency degradations (F) in 2021 is much higher than 2020 but within the range from previous years. Only for one event was a cause different than 'Unknown' provided; it was due to a previous T1 event which caused the disturbance of the CE area on 8 January 2022. Usually, frequency events are caused by a combination of different factors. The actual causes of many of the unknown F events are mainly deterministic frequency deviations (DFDs) caused by changes in generation and balance diagrams at the beginning and end of business hours.

Table 3.12: The annual number of F events from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	-	-	1	-	-
Continental Europe	11	963	766	299	839
Great Britain	-	58	79	2	3
Ireland	-	9	4	-	-
Isolated systems	-	-	-	-	-
Nordic	-	2	106	66	73
Grand Total	11	1 032	956	367	915

Table 3.13: The annual number of F events per cause from 2017 to 2021. LGF stands for "Load or generation forecasts".

Cause of event	2017	2018	2019	2020	2021
Environmental causes	-	-	1	-	-
LGF deviations	-	-	7	2	-
Loss of generation	-	10	16	1	-
Operation and maintenance	-	-	1	-	-
Other	-	-	2	1	-
Previous event	-	-	-	1	4
Tripped network element	-	12	15	-	-
Unexpected flows	-	-	2	-	-
Unknown	-	1 010	912	362	911
N/A	11	-	-	-	-
Grand Total	11	1 032	956	367	915

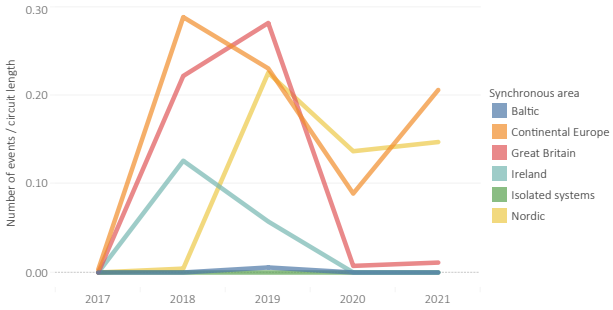

Figure 3.10: The annual number of F events per TWh of consumption in each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

3.3.2 Detailed view of events on transmission system elements (T)

This section presents a detailed view of scale 0–2 events on transmission system elements; that is, T0, T1 and T2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.14 presents the annual number of events on transmission network elements for each synchronous area, and Table 3.15 show the same distributed per cause for all synchronous areas combined. Figure 3.11 presents the annual number of T events normalised by the installed circuit length in each synchronous area. Figure 3.12 presents the number of T0 events normalised by the installed circuit length in each synchronous area, and Figure 3.13 the same but for T1 events.

As seen in Table 3.15, T events are caused mostly by technical equipment and environmental causes. Common causes include external influences, operation and maintenance and failure of infrastructure, whereas there are also a significant number of T events with an unknown cause. For the first time, Maintenance and Weather conditions have also been provided as a cause.

The increase in T events in 2018 is due to a change in the ICS Methodology [6], which added the 220–330 kV voltage range to the report. Before 2018, only 380–420 kV or 220 kV crossborder was included. Furthermore, the 2019 ICS Methodology update used as of 2020 [3] included parts of the 100–150 kV network relevant for the TSOs' operational security. Another important update in use as of 2020 was to also register individual ICS events instead of aggregating related events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1. The 2018 and 2019 Methodology updates are summarised in Section 2.1. The number of T events between 2018 and 2021 do not show any indication of a decreasing or increasing pattern, and future reports should investigate this trend further.

Table 3.14: The annual number of T events from 2017 to 2021 per synchronous area. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	28	25	31	25	25
Continental Europe	563	872	1 221	1 078	1 318
Great Britain	134	156	155	169	218
Ireland	9	9	9	8	11
Isolated systems	11	13	12	41	27
Nordic	40	84	60	76	104
Grand Total	785	1 159	1 488	1 397	1 703

Table 3.15: The annual number of T events per cause from 2017 to 2021. LGF stands for "Load or generation forecasts".

Cause of event	2017	2018	2019	2020	2021
N/A	785	-	-	-	-
Environmental causes	-	231	266	306	341
External influences	-	-	-	95	138
Failure of infrastructure	-	-	-	65	-
Failure of protection device	-	66	76	4	-
Lack of remedial actions	-	1	-	-	-
LGF deviations	-	-	1	-	-
Loss of tools or facilities	-	34	34	-	-
N-1 violation	-	-	5	-	-
Nature (animals, vegetation)	-	55	74	1	-
Operation and maintenance	-	20	36	90	165
Other	-	145	218	86	138
Previous event	-	-	-	32	50
Technical equipment	-	-	11	370	488
Tripped network element	-	523	605	53	2
Unavailability of reactive compensation	-	6	2	-	-
Unexpected flows	-	3	4	-	-
Unknown	-	75	156	295	381
Grand Total	785	1 159	1 488	1 397	1 703

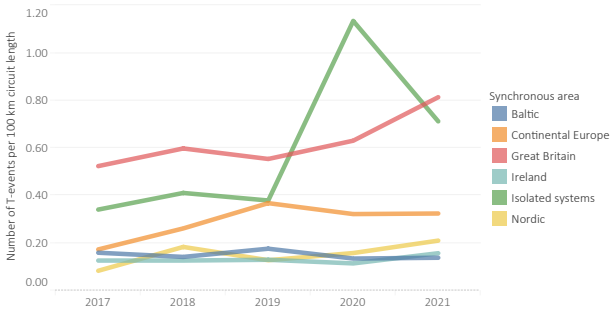

Figure 3.11: The annual number of T events per 100 km installed circuit length in each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

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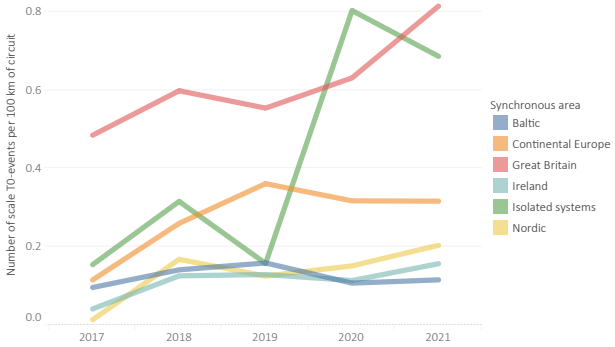

Figure 3.12: The annual number of T0 events per 100 km of circuit length from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

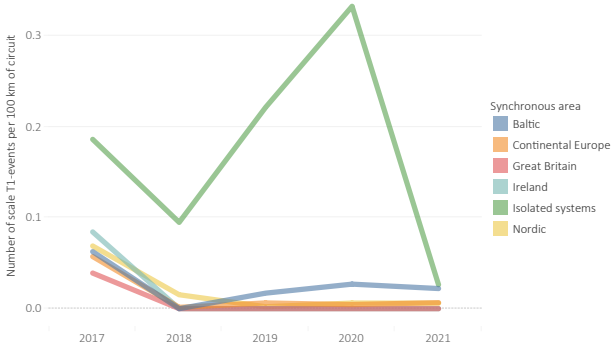

Figure 3.13: The annual number of T1 events per 100 km of circuit length from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

3.3.3 Detailed view of events on power generating facilities (G)

This section presents a detailed view of events on power generating facilities; that is, G0, G1 and G2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.16 presents the annual number of events on power generating facilities for each synchronous area, and Table 3.17 shows the same distributed per cause for all synchronous areas combined. Figure 3.14 presents the annual number of G events normalised by the consumption in each synchronous area. As seen from Table 3.17 and unlike the previous year, most G events are caused by technical issues. The second most common cause is other tripped network elements both in 2020 and 2021.

It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

As expected, most (96 %) G events were of Scale 0 and only 1 Scale 2 G event occurred (cf. Section 4.2). While Baltic reported less incidents in 2021 than 2020, the amount of G events per TWh of consumption is still the highest of all synchronous areas, with 0.76. The three synchronous areas with the highest number of G events per TWh of consumption (Baltic, Ireland and Isolated Networks) all reported decreasing event ratios, whereas the numbers for CE and Nordic increased slightly.

Table 3.16: The annual number of G events from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	-	2	11	27	16
Continental Europe	84	113	93	81	143
Great Britain	2	3	-	12	14
Ireland	24	7	10	19	14
Isolated systems	3	-	4	3	2
Nordic	-	1	1	5	15
Grand Total	113	126	119	147	204

Table 3.17: The annual number of G events per cause from 2017 to 2021. LGF stands for "Load or generation forecasts".

Cause of event	2017	2018	2019	2020	2021
Failure of infrastructure	-	-	-	24	-
Failure of protection device	-	4	1	-	-
LGF deviations	-	-	-	1	-
Loss of generation	-	102	83	6	-
Operation and maintenance	-	1	-	-	1
Other	-	8	3	2	3
Previous event	-	-	-	1	9
Technical equipment	-	-	1	73	125
Tripped network element	-	-	-	20	43
Unknown	-	11	31	18	23
N/A	113	-	-	2	-
Grand Total	113	126	119	147	204

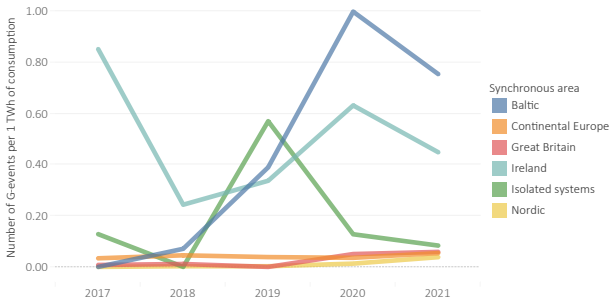

Figure 3.14: The annual number of G events per TWh of consumption for each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

3.3.4 Detailed view of violations of standards on voltage (OV)

This section presents a detailed view of events on violations of standards on voltage; that is, OV0, OV1 and OV2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.18 presents the annual number of OV events from 2017 to 2021 for each synchronous area. Table 3.19 show the same distributed by cause for all synchronous areas combined. Figure 3.15 presents the annual number of OV events normalised by the installed circuit length in each synchronous area.

As seen in Table 3.19, the number of OV events due to unavailable reactive compensation decreased significantly in 2021 compared to previous years. Instead, there are significantly more OV events caused by other or unknown causes. Most of the OV events are scale 1 events. The number of OV1 incidents increased significantly in 2021 compared to 2020. Of the 512 OV1 events, 336 were due to other causes.

The reason for the increase in reported OV1 and OV2 incidents in 2021 is not entirely clear. The 2020 and 2021 reports are based on the same methodology version. A reason for the voltage increase could be the increase of reactive power infeed, which is presumably caused by an increase in renewable energy such as solar and wind farms. It is advised that TSOs in CE investigate the reasons behind the increase in registered OV1 and OV2 events.

Table 3.18: The annual number of OV events from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	-	-	-	1	-
Continental Europe	48	386	295	570	1 008
Great Britain	-	-	-	-	-
Ireland	-	-	-	-	-
Isolated systems	-	-	-	-	-
Nordic	-	5	-	-	-
Grand Total	48	391	295	571	1 008

Table 3.19: The annual number of OV events per cause from 2017 to 2021. LGF stands for “Load or generation forecasts”.

Cause of event	2017	2018	2019	2020	2021
Environmental causes	-	1	-	-	-
LGF deviations	-	-	-	-	1
Operation and maintenance	-	-	-	2	-
Other	-	132	30	229	770
Previous event	-	-	-	1	22
Technical equipment	-	-	-	2	1
Too low Mvar absorption	-	-	-	3	-
Tripped network element	-	-	-	1	-
Unavailability of reactive compensation	-	167	221	40	-
Unexpected flows	-	4	1	-	-
Unknown	-	87	43	293	214
N/A	48	-	-	-	-
Grand Total	48	391	295	571	1 008

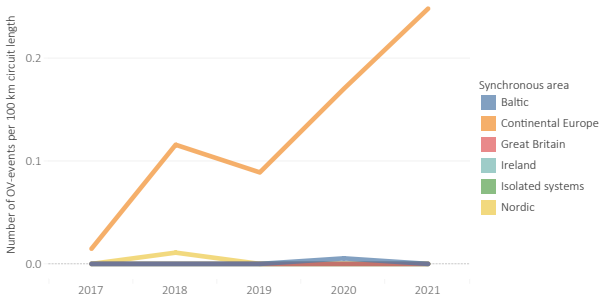

Figure 3.15: The annual number of OV events per 100 km of installed circuit length in each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

3.3.5 Detailed view of events involving a reduction of reserve capacity (RRC)

This section presents a detailed view of scale 0–2 events involving a reduction of reserve capacity; that is, RRC0, RRC1 and RRC2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.20 presents the annual number of RRC events for each synchronous area, and Table 3.21 show the same distributed per cause for all synchronous areas combined. Figure 3.16 presents the annual number of RRC events per 100 km of installed length in each synchronous area from 2017 to 2021.

All RRC events have been reported by 6 TSOs located in the synchronous area CE. Of the 90 events reported, 26 were of scale 0 (RRC0), 63 of scale 1 (RRC1) and one of scale 2 (RRC2). Most of the RRC events were caused by unexpected discrepancies from load or generation forecasts.

It should be noted that the recorded values for 2017–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Table 3.20: The annual number of RRC events from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	-	-	-	-	-
Continental Europe	13	118	162	66	90
Great Britain	-	-	-	-	-
Ireland	-	-	-	-	-
Isolated systems	-	-	-	-	-
Nordic	-	-	-	-	-
Grand Total	13	118	162	66	90

Table 3.21: The annual number of RRC events per cause from 2017 to 2021. LGF stands for "Load or generation forecasts".

Cause of event	2017	2018	2019	2020	2021
External influences	-	-	-	1	-
Lack of reserves	-	117	159	64	-
LGF deviations	-	-	2	-	62
Loss of generation	-	1	1	-	4
Other	-	-	-	-	10
Previous event	-	-	-	-	2
Unknown	-	-	-	-	12
N/A	13	-	-	1	-
Grand Total	13	118	162	66	90

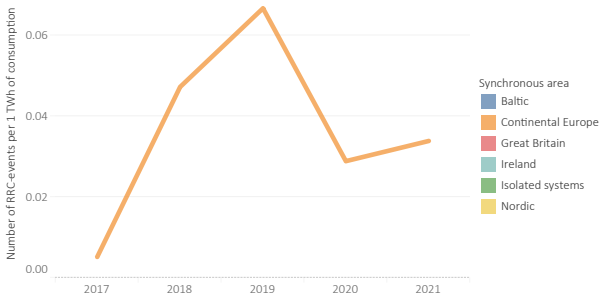

Figure 3.16: The annual number of RRC events per TWh of consumption in each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

3.3.6 Detailed view of events involving loss of tools, means or facilities (LT)

This section presents a detailed view of events involving loss of tools or facilities, that is, LT0, LT1 and LT2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.22 presents the annual number of LT events for each synchronous area, and Table 3.23 shows the same distributed by cause for all synchronous areas combined. Figure 3.17 presents the annual number of LT events per TWh of consumption for each synchronous area.

Compared to 2020, the number of LT events has decreased from 219 to a total of 140.

Table 3.22: The annual number of LT events from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	-	1	-	-	1
Continental Europe	18	124	124	125	98
Great Britain	2	31	42	77	17
Ireland	2	-	-	-	-
Isolated systems	-	1	-	1	1
Nordic	2	2	1	16	23
Grand Total	24	159	167	219	140

Table 3.23: The annual number of LT events per cause from 2017 to 2021. LGF stands for "Load or generation forecasts".

Cause of event	2017	2018	2019	2020	2021
Environmental causes	-	-	-	1	-
Failure of infrastructure	-	-	-	89	48
LGF deviations	-	-	-	1	-
Loss of tools or facilities	-	147	134	25	1
Operation and maintenance	-	1	-	7	7
Other	-	7	33	70	55
Previous event	-	-	-	4	-
Technical equipment	-	-	-	5	1
Unknown	-	4	-	17	28
N/A	24	-	-	-	-
Grand Total	24	159	167	219	140

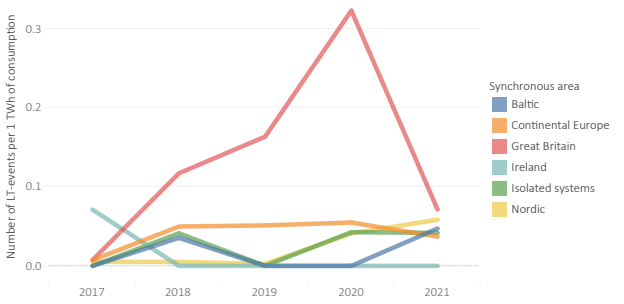

Figure 3.17: The annual number of LT events per TWh of consumption for each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

3.3.7 Detailed view of N- and N-1 violations (ON)

This section presents a detailed view of events involving N and N-1 violations, that is, ON0, ON1 and ON2 events. If the main or primary cause of an event was not reported prior to 2018, N/A (not available) was substituted.

Table 3.24 presents the annual number of ON1 and ON2 violation events for each synchronous area. Table 3.25 shows the same distributed by cause for all synchronous areas combined. Figure 3.18 presents the annual number of ON events per 100 km of installed length in each synchronous area.

In 2021 ON violations were only reported in the synchronous area CE and Ireland.

Most ON events during 2018 and 2019 were caused by unexpected flows, whereas in 2020 and 2021 they mostly were due to unexpected discrepancies from load or generation forecasts. These causes are very similar in nature, and improving load flow and generation forecasts could drastically reduce the number of ON events. This improvement is of critical importance as each ON event degrades the TSO's operating state to alert or emergency.

In the synchronous area CE, TSO RTE has the most reported ON1 events. It concerns almost half (31) of the registered ON1 events in CE.

It should be noted that the recorded values for 2017–2019 aggregate all related ICS events into ICS incidents, with the

ICS criteria set to the event with the highest priority according to Table 2.1.

Table 3.24: The annual number of ON events from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Synchronous area	2017	2018	2019	2020	2021
Baltic	-	-	-	1	-
Continental Europe	66	34	26	56	61
Great Britain	-	2	-	-	-
Ireland	-	-	-	3	8
Isolated systems	-	-	-	-	-
Nordic	-	2	-	2	-
Grand Total	66	38	26	62	69

Table 3.25: The annual number of ON events per cause from 2017 to 2021. LGF stands for "Load or generation forecasts".

Cause of event	2017	2018	2019	2020	2021
Environmental causes	-	2	-	-	-
Failure of protection device	-	1	-	-	-
LGF deviations	-	2	-	39	44
Operation and maintenance	-	1	-	3	-
Other	-	3	3	9	10
Previous event	-	-	-	6	9
Technical equipment	-	-	-	1	1
Tripped network element	-	3	-	1	-
Unexpected flows	-	26	23	2	-
Unknown	-	-	-	1	5
N/A	66	-	-	-	-
Grand Total	66	38	26	62	69

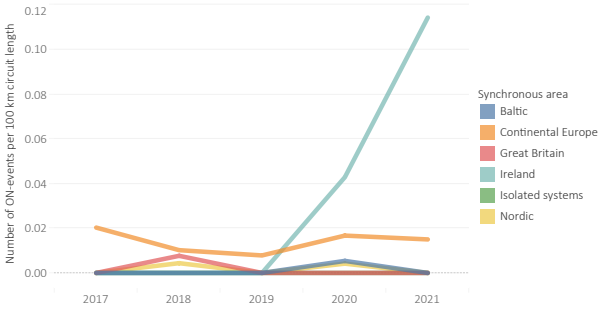

Figure 3.18: The annual number of ON events per 100 km of installed circuit length in each synchronous area from 2017 to 2021. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

4 A detailed view of scale 2 and scale 3 incidents

This chapter gives a detailed view of scale 2 and scale 3 incidents that occurred in the synchronous areas of CE, GB, Nordic, IE/NI or Baltic in 2021, as required by SOGL Article 15(5) [1] . There were 17 scale 2 incidents in total, of which 16 occurred in CE and one in Iceland. All of the scale 2 incidents in CE were related to the scale 2 incidents described in this chapter. No scale 3 ICS incidents were recorded in 2021.

4.1 The scale 2 incident in CE on 8 January

On Friday, 8 January 2021 at 14.05 CET, the CE Synchronous Area was separated into two areas (the north-west area and the south-east area) due to cascaded trips of several transmission network elements. This cascade of trips was initiated by the busbar coupler in the Croatian substation Ernestinovo. The substation was exposed to a high load flow, caused by a large flow pattern running from South-East to North-West Europe. That flow pattern totalled approximately 5.8 GW across the separation line at the time when the initial event took place. However, this high load flow, particularly on the busbar coupler, was not correctly forecasted in the security calculations.

Directly after the initial trip at 14.04, overcurrent protection tripped additional network elements due to redirected power flows. Post-incident investigations concluded that the power system was already on the verge of angular instability before the initial event. Thus, the system became unstable after the first trips and caused additional cascading trips. Finally, 43 seconds after the initial event at 14.05, the CE Power System was divided into two asynchronous areas. Due to the load flow pattern before the event, the north-west area had a power deficit of 5.8 GW, while the south-east area coped with the according surplus of power. This led to frequency gradients, peaking at 49.746 Hz in the north-west area and 50.6 Hz in the south-east area.

Based on the large frequency deviations in both areas, the automatic frequency containment reserves started to contribute power shortly after the system separation and thus stabilised the frequency soon afterwards. This was also a result of the further application of frequency support by automatic interruptible loads in France and Italy as well as through HVDC lines from the Nordic and GB power systems. Shortly after the separation, the affected TSOs as well as the coordination centres advised all TSOs with the guidance of EAS. The frequency leaders Amprion (for the north-west area) as well as EMS (for the south-east area) then further coordinated the return of the frequency to 50 Hz. As this was obtained after approx. an hour, the resynchronisation process was started immediately by the affected TSOs, so that the CE Power System was resynchronised at 15.08.

Further investigations regarding the influence on the market do not reveal any impact. The markets continued to operate as planned before, during and after the incident. Market schedules did not exceed the agreed NTC values.

4.2 Local Incident in Rogowiec (Poland) substation on 17 May 2021

On Monday 17 May 2021 at 16.34 CET an incident occurred in Poland's Rogowiec substation that tripped ten generation units in the Bełchatów power plant and caused a loss of 3322 MW of generation. The Polish Power System (PPS) was operating within security limits and with the required level of reserves before the incident. The active power reserve amounted to 3379 MW, whereas the required minimum is at 1748 MW and was available on centrally dispatched thermal and hydro Power Generating Modules (PGM).

The incident began during the switching of the 400 kV Rogowiec-Ołtarzew (ROG4-OLT4) line into a bypass busbar. As a result of a human error, a switching operation was performed in the incorrect local drive cabinet that controls the earth switch instead of the disconnector. Due to workmanship defects and material deterioration of the grounding net since the commissioning, the short-circuit current flowed also leaked to secondary circuits and resulted in numerous induced undesirable impulses. Protection devices, unaffected by undesirable impulses, correctly separated the affected busbar section of the substation. Consequently, the Switch On The Fault (SOTF) function, that is a standard function of long-distance protections in transmission substations, switched off the circuit breakers on both ends of the lines to 10 working PGMs in the Bełchatów Power Plant. The amount of disconnected generation was 3322 MW.

Due to the incident, a dynamic frequency deviation of

-158 mHz was recorded in CE SA (frequency drop to 49.842 Hz). The frequency deviation in CE returned to levels below 100 mHz at 16.43, below 50 mHz at 16.49, and finally to normal values at 16.56. A sudden increase of exchange balance at the synchronous profile was observed immediately after the incident. The increase reached 4.5 GW in the import direction, which was 2.3 GW more than the offered Net Transfer Capacity (NTC) for that hour. The increased power flow did not cause any N violations in PPS. N-1 situations occurred at the western border or nearby, and were resolved by PSE in cooperation with 50Hertz (Germany) by simultaneous tap changes of PSTs in Mikułowa and Vierraden. N-1 criteria for connected systems were fulfilled approximately 20 minutes after the incident. At the same time, PSE ordered selected PGMs to operate at the maximum possible capacity. PSE also ordered to start all hydro PGMs in the PPS.

Considering the activation of the whole available reserve in PPS to compensate for power loss in the Rogowiec substation and upcoming evening peak of demand, emergency import (peaking at 1.4 GW) from neighbouring TSOs were activated between 17.15 and 23.00. Normal operation in 400 kV and 220 kV switchyards (except 400 kV line Rogowiec-Ołtarzew) was resumed 3.5 hours after the incident. The Bełchatów PP PGMs were resynchronised with the PPS within 30 hours.

4.3 The scale 2 incident in CE on 24 July

On Saturday 24 July 2021 at 16.36 CET, the CE synchronous area was separated into two areas (the north-east area and the south-west area) due to cascaded trips of several transmission network elements. This cascade of trips was caused by a forest fire in the vicinity of the two-circuit 400 kV Baixas-Gaudière transmission line in France. The fire began around 13.30 CET and a request should have been made to RTE to disconnect the two circuits because of their proximity to the fire. In this case, due to the extreme environmental conditions which hampered communications, this request was unfortunately not made and so the two circuits remained in service. At 16.33.11, the fire caused a two-phase short-circuit on circuit 2 approximately 8 km from the Gaudière substation. The protection system detected the fault and responded correctly by opening the circuit breaker and tripping the line at 16.33.12. Five seconds after this first trip, an unsuccessful automatic reclosure attempt was made, after which circuit 2 remained out of service. At 16.35.23, circuit 1 experienced a similar fault and tripped. The automatic reclosure was again unsuccessful leaving both circuits of the 400 kV Baixas-Gaudière transmission line out of service.

Before the tripping, the two 400 kV Baixas-Gaudière circuits were transporting 612 MW each from France to Spain. Due to the separation of the Baixas substation from the rest of the French transmission system, these two trips resulted in the loss of the eastern interconnection between Spain and France. The Baixas substation remained supplied from Spain. The loss of the eastern corridor overloaded the western and central France-Spain interconnection corridors. These overloads tripped in turn the Argia-Cantegrit 400 kV line 73.2 seconds after the second tripping. This third trip caused a loss of synchronism between the French and Spanish systems, which subsequently led to the complete loss of interconnections between the two systems.

It should be noted that this sequence of events reflects only the tripping of transmission lines in the high and extra high voltage transmission system. In addition, on the French side, ten 63 kV lines tripped during the event, due to distance and loss of synchronism protections.

After circuit 2 tripped, RTE and Red Eléctrica immediately decided to reduce by 1.3 GW the power flows from France to Spain. Unfortunately, circuit 1 tripped before this reduction could impact the load flow situation. Automatic frequency restoration reserves were correctly activated in Spain and Portugal, together with manual frequency restoration in Spain. Shortly after the separation, the affected TSOs as well as the CCs Amprion and Swissgrid informed all TSOs of the incident via the EAS. Red Eléctrica as the frequency leader, with support from Amprion, as SAM, then coordinated the return of the frequency to 50 Hz in the Iberian Peninsula. The CE Power System was resynchronised at 17.09.

Further investigations regarding the influence on the market do not reveal any impact. The markets continued to operate as planned before, during and after the incident. Market schedules did not exceed the agreed NTC values.

From the perspective of regional security coordination, it can be concluded that the operational situation was consistent with the forecast and within the limits of usually expected deviations. Given the 3 hour time span between the identification of the fire breakout and the system split, it is obvious that the risk assessment could have been effectively supported by TSOs in the event the information on the fire and updated contingency lists was made available in time. Subsequently, necessary remedial actions could presumably have been aligned between RTE and Red Eléctrica and the system split might have been prevented.

5 Operational Security Indicators

This chapter presents the operational security indicators relevant to operational security (OS) and planning and scheduling (OPS), as required by SOGL Article 15(3) and 15(4).

5.1 Operational security indicators relevant to operational security

This section presents the operational security indicators relevant to operational security (OS). For convenience, each security indicator, along with its abbreviation, description and calculation method, is presented in Table 5.1.

Most security indicators are calculated with scale 0–3 ICS incidents. However, the OS-indicators OS-B, OS-F1 and OS-F2 also use the reported 'Below Scale' ICS events. OS-F1 and OS-F2 use OVBS reported by TSOs, and OS-B use GBS events retrieved from the ENTSO-E Transparency Platform. The GBS events from the Transparency Platform are not fully in line with the ICS requirements because the provided 'Unavailability of Production and Generation Units 15.1' data also include forced outages of power generating facilities not connected to the grid. This leads to higher than expected calculated values of the operational security indicator OS-B. More filtering was done for the 2021 GBS data; however, more work is needed to improve the results.

Table 5.2 shows the calculated values for each security indicator for the year 2021.

Table 5.1: The operational security indicators relevant to operational security

Abbr.	Description of the operational security indicator	Calculation method
OS-A	Number of tripped transmission system elements per year per TSO – SOGL Article 15(3)(a) [1, p. 19].	Add up the number of transmission system elements tripped reported for all the incidents on scale 0, 1, 2 and 3.
OS-B	Number of tripped power generation facilities per year per TSO – SOGL Article 15(3)(b) [1, p. 19].	Add up the number of power generation facilities tripped reported for all the events/incidents on 'Below Scale' and Scale 0, 1, 2 and 3. The number of tripped generation facilities collected for the 'Below Scale' category will be taken from the ENTSO-E transparency platform [7].
OS-C	Energy not supplied due to unscheduled disconnection of demand facilities per year per TSO – SOGL Article 15(3)(c) [1, p. 19].	Add up the energy not supplied reported for all incidents on scale 0, 1, 2 and 3 due to unscheduled disconnection of demand facilities.
OS-D1	Time spent of being in alert and emergency states per year per TSO – SOGL Article 15(3)(d) [1, p. 19].	Add up the time being in alert and emergency states reported for all incidents on scale 0, 1, 2 and 3.
OS-D2	Number of instances of being in alert and emergency states per year per TSO – SOGL Article 15(3)(d) [1, p. 19].	Add up the number of incidents on scale 0, 1, 2 and 3 if an alert or emergency state was reported.
OS-E1	Time duration within which there was a lack of reserve identified per year per TSO – SOGL Article 15(3)(e) [1, p. 19].	Add up the duration of incidents reported under the criteria RRC0, RRC1 and RRC2; and the duration of all other incidents on scale 0, 1, 2 and 3 if the reduction of reserve capacity is reported.
OS-E2	Number of events within which there was a lack of reserve identified per year per TSO – SOGL Article 15(3)(e) [1, p. 19].	Add up the number of incidents reported under the criteria RRC0, RRC1 and RRC2; and the number of all other incidents on scale 0, 1, 2 and 3 if the reduction of reserve capacity is reported.
OS-F1	Time duration of voltage deviations exceeding the ranges from Tables 1 and 2 of SOGL Annex II per year per TSO – SOGL Article 15(3)(f) [1, p. 19].	Add up the duration of events/incidents reported under the criteria OV 'Below Scale' and Scale OV1 and OV2; and add up the duration of all other incidents on the 'Below Scale', Scale 0, 1, 2 and 3 if voltage deviations are reported which exceed the ranges from SOGL Annex II [1, p. 115].
OS-F2	Number of voltage deviations exceeding the ranges from Tables 1 and 2 of SOGL Annex II [1, p. 115] per year per TSO – SOGL Article 15(3)(f) [1, p. 19].	Add up the number of events/incidents reported under the criteria OV 'Below Scale' and Scale OV0, OV1 and OV2; and add up the number of events/incidents of all other incidents on the 'Below Scale', Scale 0, 1, 2 and 3 if voltage deviations are reported which exceed the ranges from SOGL Annex II [1, p. 115].
OS-G1	Number of minutes outside the standard frequency range per year per synchronous area – SOGL Article 15(3)(g) [1, p. 19].	Annual Load-Frequency Control Reporting (ALFC) [8] will provide data for number of minutes outside the standard frequency range.
OS-G2	Number of minutes outside the 50 % of maximum steady-state frequency range per year per synchronous area – SOGL Article 15(3)(g) [1, p. 19].	Annual Load-Frequency Control reporting [8] will provide data for number of minutes outside the 50 % of maximum steady state frequency deviation.
OS-H	Number of system-split separations or local blackout states per year – SOGL Article 15(3)(h) [1, p. 19].	Add up the number of incidents reported under the criteria RS1 and RS2.
OS-I	Number of blackouts involving two or more TSOs per year – SOGL Article 15(3)(i) [1, p. 19].	Add up the number of incidents reported under the criteria OB3, if two or more TSOs are involved.

Table 5.2: Operational security indicators relevant to operational security per synchronous area. PGF means Power Generating Facility. All security indicators except OS-B, OS-F1 and OS-F2 are calculated using scale 0–3 ICS incidents. OS-B also uses GBS events retrieved from the ENTSO-E Transparency Platform [7], and OS-F1 and OS-F2 also uses OVBS events reported by the TSOs. National Grid ESO in Great Britain reported their GBS events themselves.

	Synchronous area						
	Baltic	Continental Europe	Great Britain	Ireland	Isolated systems	Nordic	ENTSO-E
OS-A [tripped elements/TSO]	13.3	62.9	274.0	5.5	33.0	39.3	57.4
OS-B [tripped PGF/TSO]	5.3	12.2	96.0	7.0	6.5	20.0	14.1
OS-C [MWh/TSO]	0.0	73.5	0.0	0.0	27.9	108.5	63.2
OS-D1 [minutes/TSO]	20.0	2 940.7	0.0	0.0	46.0	24.8	2 018.6
OS-D2 [incidents/TSO]	1.3	16.3	0.0	0.0	1.0	1.0	11.4
OS-E1 [minutes/TSO]	0.0	502.2	0.0	0.0	0.0	0.0	343.6
OS-E2 [incidents/TSO]	0.0	3.4	0.0	0.0	0.0	0.0	2.3
OS-F1 [minutes/TSO]	0.0	5 667.6	0.0	0.0	0.0	22.5	3 880.2
OS-F2 [incidents/TSO]	0.0	47.8	0.0	0.0	0.0	2.3	32.9
OS-G1 [minutes]	0.0	11 281.3	359.4	37.8	0.0	10 618.0	22 296.5
OS-G2 [minutes]	0.0	242.3	49.3	0.0	0.0	0.0	291.6
OS-H [incidents]	0.0	2.0	0.0	0.0	0.0	1.0	3.0
OS-I [incidents/TSO]	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5.1.1 Evolution of operational security indicators relevant to operational security, 2017–2021

Figure 5.1 through Figure 5.12 show the annual calculated values for the OS indicators OS-A to OS-H for the period 2017–2021. The OS indicator OS-I has been omitted from this section as no scale 3 events were recorded in the ENTSO-E area from 2017 to 2021.

The substantial increases in the OS indicators for 2018 are a result of the updated 2018 ICS Methodology [7], which was introduced for the 2018 Annual Report. Furthermore, some increases in 2020 are due to the updates in the 2019 ICS Methodology. The 2018 and 2019 updates are summarised in Section 2.1.

However, not all changes are due to the Methodology updates. The indicator OS-B decreased compared to 2020 because more filtering was done on the GBS events retrieved from the ENTSO-E Transparency Platform [7]. The indicator OS-C also decreased compared to 2020. Both OS-B and OS-C do fluctuate depending on the occurrence of noteworthy incidents. The indicators OS-D1 and OS-D2 increased compared to 2020, which means that there were more events that triggered alert or emergency states than before. Comparing OS-D1 and OS-D2 also shows that the number of incidents is not proportional to their combined duration and that CE is mainly affected.

The security indicators OS-E1 and OS-E2, which measure the availability of reserve capacity, and OS-F1 and OS-F2, which measure the duration and number of OV events, are mostly seen by a few TSOs in CE. In 2021, voltage violations (OS-F1 and OS-F2) were only seen in CE and TSOs should investigate the reasons behind this evolution.

The increase in reported OS-G1 and OS-G2 minutes in 2020 is prompted by the greater detail of frequency reporting in the ALFC Report.

OS-H, which calculates the number of grid separation incidents (RS1 and RS2), is rarely recorded in the pan-European power systems. OS-H was registered once in 2020 (RS1) and three times in 2021 (two RS2 events in CE and one RS1 event in Nordics).

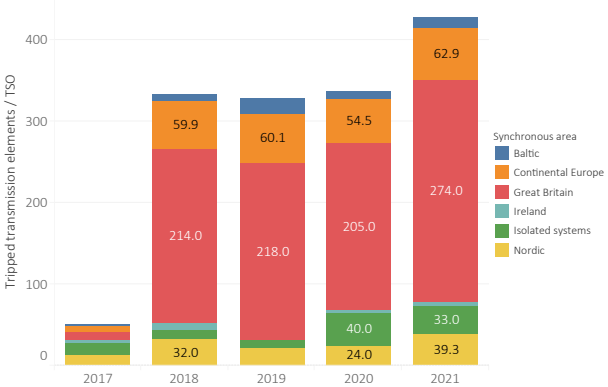

Figure 5.1: Operational security indicator OS-A from 2017 to 2021. It is calculated by adding up the number of tripped transmission system elements reported for all scale 0–3 incidents, and dividing by the number of TSOs in the synchronous area.

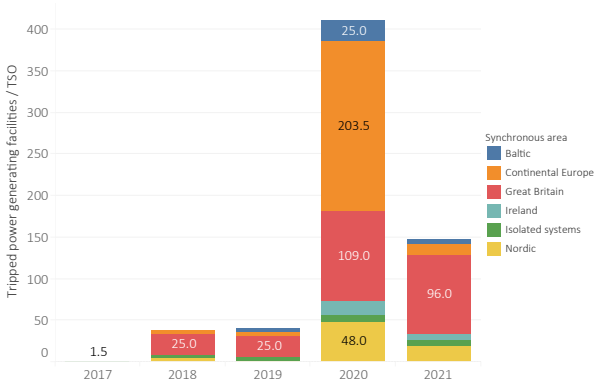

Figure 5.2: Operational security indicator OS-B from 2017 to 2021. It is calculated by adding up the number of tripped power generation facilities reported for below scale and scale 0–3 incidents and dividing by the number of TSOs in the synchronous area. The GBS events are retrieved from the Transparency Platform [7]. National Grid ESO in Great Britain reported their own GBS events.

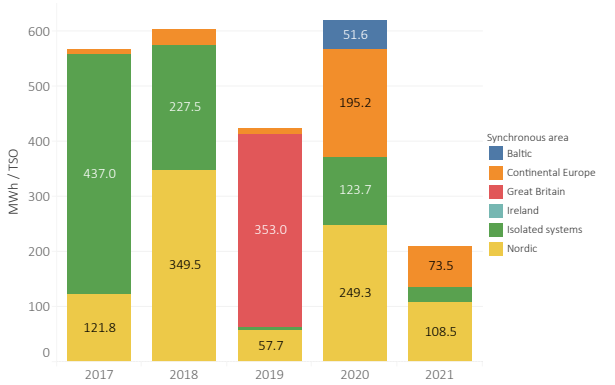

Figure 5.3: Operational security indicator OS-C from 2017 to 2021. It is calculated by adding up the reported energy not supplied (ENS) due to unscheduled disconnection of demand facilities for all scale 0–3 incidents, and dividing by the number of TSOs in the synchronous area.

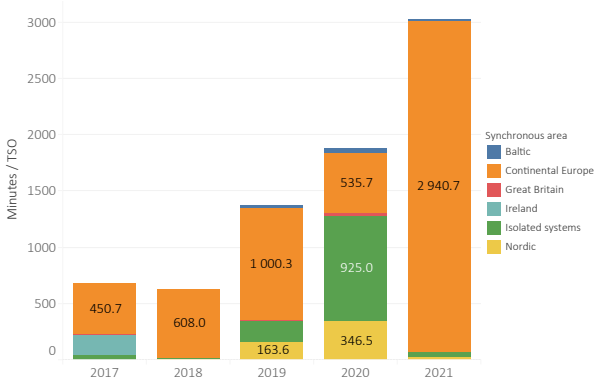

Figure 5.4: Operational security indicator OS-D1 from 2017 to 2021. It is calculated by adding up the number of minutes in alert and emergency states of all reported scale 0–3 incidents, and dividing by the number of TSOs in the synchronous area.

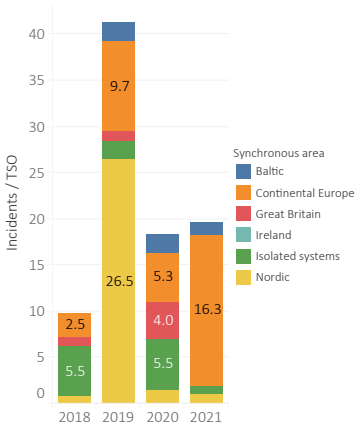

Figure 5.5: Operational security indicator OS-D2 from 2018–2021. It is calculated by counting the number of scale 0–3 incidents in which an alert or emergency state was reported, and dividing by the number of TSOs in the synchronous area. The security indicator OS-D2 was created in 2018. Comparing OS-D1 and OS-D2 shows that the number of incidents is not directly proportional to their combined duration.

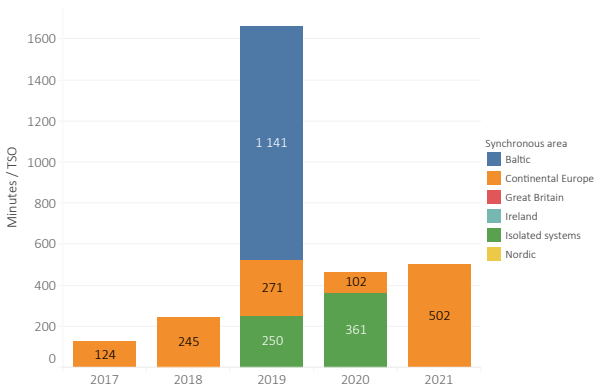

Figure 5.6: Operational security indicator OS-E1 from 2017 to 2021. It is calculated by adding up the duration of RRC0, RRC1 and RRC2 incidents and the duration of all other scale 0–3 incidents if a reduction of reserve capacity is reported, and dividing by the number of TSOs in the synchronous area.

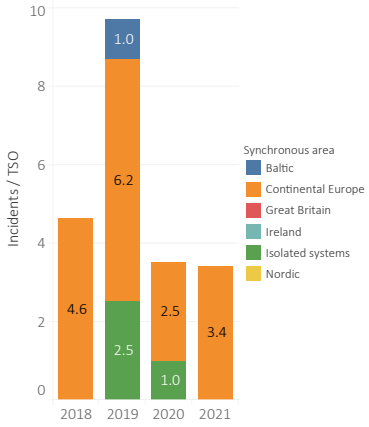

Figure 5.7: Operational security indicator OS-E2 from 2018 to 2021. It is calculated by counting the number RRC0, RRC1 and RRC2 incidents and the number of all other scale 0–3 incidents if a reduction of reserve capacity is reported, and dividing by the number of TSOs in the synchronous area. The security indicator OS-E2 was created in 2018. Comparing OS-E1 and OS-E2 shows that incidents do not usually affect reserves, but when they do, they tend tend to be longer. In continental Europe, this is mainly due to the minimum power scheduling resolution being 30 minutes in most market areas. However, the amount of minutes is minimal on a yearly basis.

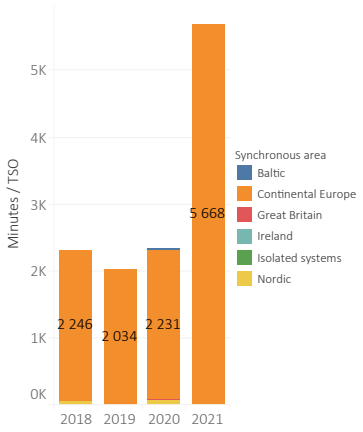

Figure 5.8: Operational security indicator OS-F1 from 2018 to 2021. It is calculated by adding up the duration of OVBS, OV0, OV1 and OV2 incidents and the duration of all other incidents on below scale and scale 0–3 where voltage deviations exceeding the ranges from SOGL Annex II [1, p. 115] are reported, and dividing by the number of TSOs in the synchronous area. The security indicator OS-F1 was created in 2018.

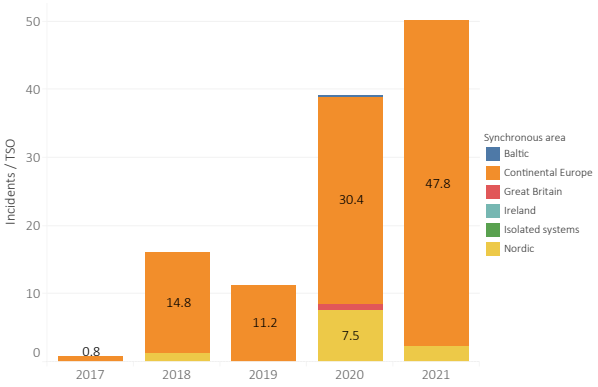

Figure 5.9: Operational security indicator OS-F2 from 2017 to 2021. It is calculated by counting the number of violation of standards of voltage incidents (OVBS, OV0, OV1 and OV2) and the number of all other below scale and scale 0–3 incidents in which the voltage standards are violated, and dividing by the number of TSOs in the synchronous area.

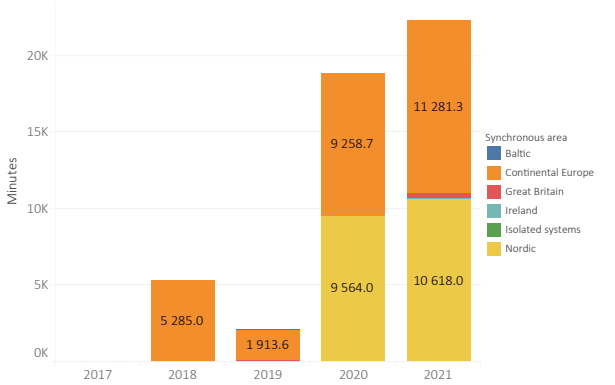

Figure 5.10: Operational security indicator OS-G1 from 2017 to 2021. It is calculated by adding up the number of minutes outside the standard frequency range for all scale 0–3 incidents. SOGL Article 127(4) [1, p. 76] sets a frequency quality target parameter for the maximum number of minutes for each synchronous area. The threshold is 15 000 minutes, and each specified synchronous area passed the threshold in 2020. The number of minutes for 2020 and 2021 were provided by the Annual Load-Frequency Control (ALFC) Report.

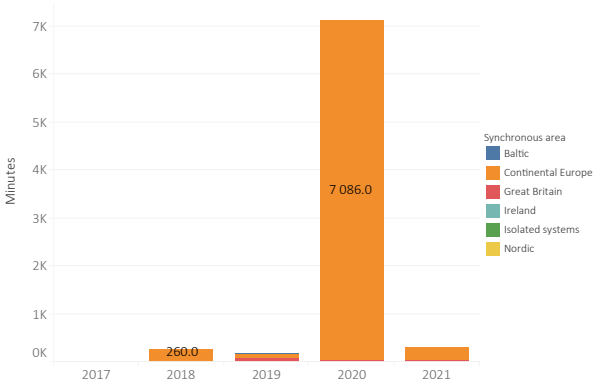

Figure 5.11: Operational security indicator OS-G2 from 2017 to 2021. It is calculated by adding up the number of minutes outside the 50 % of the maximum steady-state frequency deviation for all scale 0–3 incidents. The number of minutes for 2020 and 2021 were provided by the Annual Load-Frequency Control (ALFC) Report.

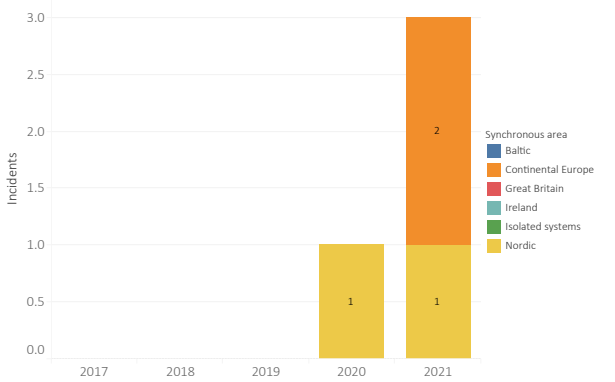

Figure 5.12: Operational security indicator OS-H from 2017 to 2021. It is calculated by counting the number of grid separation incidents (RS1 and RS2).

5.2 Operational security indicators relevant to operational planning and scheduling

The operational security indicators relevant to operational planning and scheduling (OPS) are presented in table 5.3. Table 5.4 presents the calculated value of each OPS indicator for the year 2021.

The OPS indicators mainly track the occurrences of contingencies from the contingency list. OPS-A tracks the occurrences of single contingencies from the list, and OPS-B records whether the OPS-A occurrences were due to unexpected discrepancies from load and generation forecasts. OPS-C is similar to OPS-A; however, it tracks exceptional contingencies – that is, the simultaneous occurrence of multiple contingencies from the contingency list that share a common cause. OPS-D records OPS-C incidents caused by unexpected discrepancies from load and generation forecasts.

The indicator OPS-E tracks the number of scale 0, 1, 2 and 3 incidents where active power reserves was reported as the cause of the incident.

Table 5.3: The operational security indicators relevant to operational planning and scheduling

Abbr.	Description of the operational security indicator	Calculation method
OPS-A	Number of events in which an incident contained in the contingency list led to a degradation of the system operation state – SOGL Article 15(4)(a) [1, p. 19].	Sum the number of incidents on scale 0, 1, 2 and 3 if degradation of system operation state is reported and if the cause of the incident is a contingency from contingency list.
OPS-B	Number of events counted by indicator OPS-A (events in which an incident contained in the contingency list led to a degradation of the system operation state), in which a degradation of system operation conditions occurred as a result of unexpected discrepancies from load or generation forecasts – SOGL Article 15(4)(b) [1, p. 19].	Add up the number of incidents counted by indicator OPS-A if unexpected discrepancies from load and generation forecasts were reported as the cause of the incident.
OPS-C	Number of events in which there was a degradation in system operation conditions due to an exceptional contingency – SOGL Article 15(4)(c) [1, p. 19].	Sum the number of incidents on scale 0, 1, 2 and 3 if degradation of system operation state is reported and if the cause of the incident is an exceptional contingency.
OPS-D	Number of events counted by indicator OPS-C (events in which there was a degradation in system operation conditions due to an exceptional contingency), in which a degradation of system operation conditions occurred as a result of unexpected discrepancies from load or generation forecasts – SOGL Article 15(4)(d) [1, p. 19].	Add up the number of incidents counted by indicator OPS-C if unexpected discrepancies from load and generation forecasts were reported as the cause of the incident.
OPS-E	Number of events leading to a degradation in system operation conditions due to lack of active power reserves – SOGL Article 15(4)(e) [1, p. 19].	Sum the number of incidents on scale 0, 1, 2 and 3 if lack of active power reserves was reported as the cause of the incident.

Table 5.4: Operational security indicators relevant to operational planning and scheduling for each synchronous area.

	Synchronous area						
	Baltic	Continental Europe	Great Britain	Ireland	Isolated systems	Nordic	ENTSO-E Total
OPS-A [incidents]	4	156	0	0	4	4	168
OPS-B [incidents]	0	45	0	0	0	0	45
OPS-C [incidents]	0	4	0	0	3	0	7
OPS-D [incidents]	0	1	0	0	0	0	1
OPS-E [incidents]	0	0	0	0	0	0	0

5.2.1 Evolution of operational security indicators relevant to operational planning and scheduling, 2017–2021

This section presents the operational security indicators relevant to operational planning and scheduling (OPS) for 2017–2021. Figures 5.13–5.16 show the annual calculated values for the OPS indicators OPS-A, OPS-B, OPS-C and OPS-E, respectively. The indicator OPS-D is omitted from this section because only one OPS-D incident was recorded in 2020 and 2021, respectively (both in CE).

OPS-A decreased slightly compared to 2020 and OPS-C remained the same. OPS-B is approximately 30 % as large as OPS-A. This indicates that a third of incidents that were caused by contingencies in the contingency list (OPS-A) could be prevented by improving the accuracy of load and generation forecasts in CE.

The indicator OPS-E decreased to zero in 2021 because no events, not even RRC events, were caused by reduced reserve capacity.

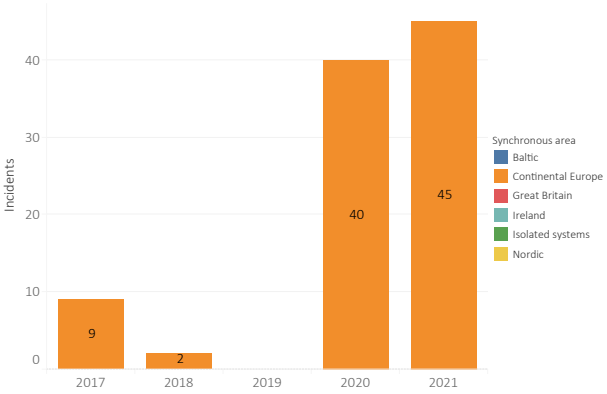

Figure 5.14: Operational security indicator OPS-B from 2017 to 2021. The indicator is calculated by counting the number of OPS-A indicators where the cause was unexpected discrepancies from load and generation forecasts.

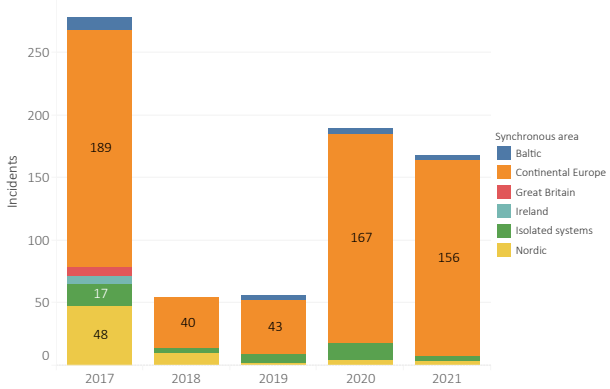

Figure 5.13: Operational security indicator OPS-A from 2017 to 2021. The indicator is calculated by counting the number of scale 0–3 incidents where a contingency from the contingency list degraded the system operation state. Most of the OPS-A incidents are due to ordinary contingencies, and only a few are due to exceptional contingencies or out-of-range contingencies.

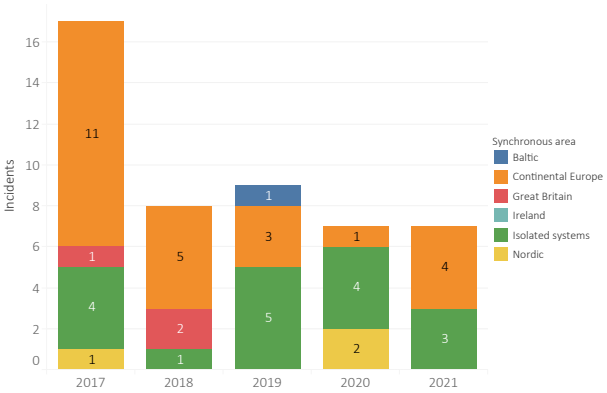

Figure 5.15: Operational security indicator OPS-C from 2017 to 2021. The indicator is calculated by counting the number of scale 0–3 incidents where an exceptional contingency degraded the system operation state.

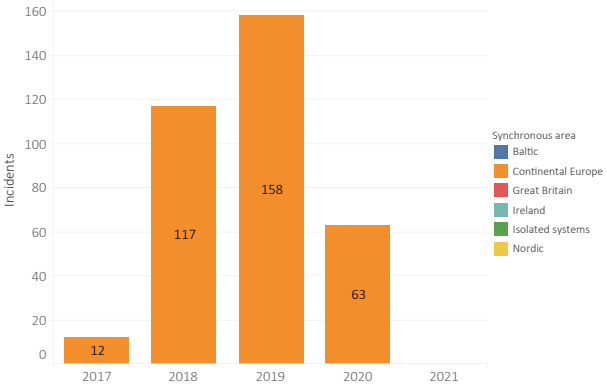

Figure 5.16: Operational security indicator OPS-E from 2017 to 2021. The indicator is calculated by counting the number of scale 0–3 incidents caused by lack of active power reserves.

6 Events in continental Europe

6.1 Overview of 2021

This section presents an overview of scale 0–3 ICS events in CE in 2021. The scale 0-3 ICS events are organised by ICS criterion and further grouped by month and duration in Table 6.1 and Table 6.2, respectively.

As Table 6.1 shows, a total of 3568 ICS events meeting the ICS criteria were reported by TSOs in CE in 2021. Together, these events formed 3402 ICS incidents, meaning that most events only involved one ICS criteria violation. Approximately 77.5 % of all scale 0–3 events were scale 0 events, approximately 22 % of all scale 0–3 events were scale 1 events and 0.5 % of all scale 0–3 events were scale 2 events. All the reported scale 2 incidents were related to the three scale 2 incidents described in Chapter 4. No Scale 3 events were reported.

Events on transmission network elements (T0) accounted for 36 % of all events, violations on standards of voltage (OV0) for 28 %, and frequency degradations (F0) for 21 % of the events. Combined, these three ICS categories accounted for 85 % of all events. The number of T0 events was higher during the winter and summer and lower during spring and autumn. The number of OV0 and OV1 events were higher during spring and summer, and ON1 events were mostly reported during the first half of the year.

As shown in Table 6.2, approximately 62 % of all scale 0 events, 22 % of all scale 1 and 38 % of all scale 2 were resolved within less than an hour. All frequency deviations in scale 0 (F0) and almost all violations of standards on voltage (OV0) events were cleared in less than an hour. However, T and G events were particularly likely to be resolved in more than 24 hours. The duration of T and G events depended mainly on the underlying cause of the trip. LT, OV and RRC events had a more diverse duration distribution, but approximately 74 % were resolved within less than two hours. For most TSOs, 30 minutes is the minimum scheduling resolution of power generation. As such, in the 2018 ICS Methodology, RRC incidents that last for more than 30 minutes are automatically classified as scale 1 events. RRC0 events are, therefore, unusual in CE.

Table 6.1: Number of ICS events by ICS criteria distributed per month in 2021 in continental Europe.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	1	-	-	-	-	-	1	-	-	-	-	2
	Incidents leading to frequency degradation (F0)	29	33	206	25	121	13	28	13	72	32	146	28	746
	Incidents on network elements (T0)	129	106	62	74	77	181	161	101	110	97	76	113	1 287
	Incidents on power generating facilities (G0)	11	9	14	7	6	8	12	14	19	12	9	17	138
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	24	22	35	50	80	43	49	68	67	31	11	15	495
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	12	8	6	26
	Loss of tools, means and facilities (LT0)	5	2	5	3	7	7	4	5	13	9	5	3	68
	Total	198	173	322	159	291	252	254	202	281	193	255	182	2 762
Scale 1	Incidents on load (L1)	1	-	-	-	-	-	-	1	-	-	-	-	2
	Incidents leading to frequency degradation (F1)	2	-	4	-	10	2	-	-	4	2	68	-	92
	Incidents on network elements (T1)	6	4	4	2	1	1	-	-	-	3	6	-	27
	Incidents on power generating facilities (G1)	-	1	-	-	-	1	1	-	-	-	-	1	4
	N-1 violation (ON1)	10	5	6	7	3	13	-	1	7	3	3	2	60
	Separation from the grid (RS1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	34	22	21	66	84	38	56	67	88	12	7	17	512
	Reduction of reserve capacity (RRC1)	11	2	5	2	5	4	7	7	9	1	2	8	63
	Loss of tools, means and facilities (LT1)	4	3	4	3	-	3	2	1	1	3	3	3	30
	Total	68	37	44	80	103	62	66	77	109	24	89	31	790
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	2	-	-	-	-	-	2
	Incidents leading to frequency degradation (F2)	1	-	-	-	-	-	-	-	-	-	-	-	1
	Incidents on network elements (T2)	2	-	-	-	-	-	2	-	-	-	-	-	4
	Incidents on power generating facilities (G2)	-	-	-	-	1	-	-	-	-	-	-	-	1
	N violation (ON2)	1	-	-	-	-	-	-	-	-	-	-	-	1
	Separation from the grid (RS2)	4	-	-	-	-	-	2	-	-	-	-	-	6
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	1	-	-	-	-	-	-	-	1
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	8	-	-	-	2	-	6	-	-	-	-	-	16
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		274	210	366	239	396	314	326	279	390	217	344	213	3 568

Table 6.2: Cumulative Number of ICS events by ICS criteria and duration in 2021 in continental Europe.

		2021					
Scale	ICS criterion	<1h	<2h	<5h	<10h	<24h	Total
Scale 0	Incidents on load (L0)	-	1	1	2	2	2
	Incidents leading to frequency degradation (F0)	746	746	746	746	746	746
	Incidents on network elements (T0)	406	548	780	930	1 060	1 287
	Incidents on power generating facilities (G0)	25	35	53	75	95	138
	Separation from the grid (RS0)	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	493	495	495	495	495	495
	Reduction of reserve capacity (RRC0)	22	26	26	26	26	26
	Loss of tools, means and facilities (LT0)	25	46	59	67	68	68
	Total	1 717	1 897	2 160	2 341	2 492	2 762
Scale 1	Incidents on load (L1)	-	-	1	1	2	2
	Incidents leading to frequency degradation (F1)	70	88	92	92	92	92
	Incidents on network elements (T1)	6	10	13	16	24	27
	Incidents on power generating facilities (G1)	3	3	3	3	3	4
	N-1 violation (ON1)	38	46	54	59	60	60
	Separation from the grid (RS1)	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	14	222	396	491	505	512
	Reduction of reserve capacity (RRC1)	34	38	54	57	63	63
	Loss of tools, means and facilities (LT1)	8	11	22	29	30	30
	Total	173	418	635	748	779	790
Scale 2	Incidents on load (L2)	1	2	2	2	2	2
	Incidents leading to frequency degradation (F2)	-	1	1	1	1	1
	Incidents on network elements (T2)	2	3	4	4	4	4
	Incidents on power generating facilities (G2)	-	-	-	-	1	1
	N violation (ON2)	1	1	1	1	1	1
	Separation from the grid (RS2)	2	6	6	6	6	6
	Violation of standards on voltage (OV2)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	1	1	1	1	1
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-
	Total	6	14	15	15	16	16
Scale 3	Blackout (OB3)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Grand Total		1 896	2 329	2 810	3 104	3 287	3 568

6.2 Evolution 2017–2021

This section presents the annual number of ICS events in CE from 2017 to 2021, distributed by scale and dominating criterion. The dominating criteria used in this report are presented in Table 2.1. It should be noted that the recorded values for 2017–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

As shown in Table 6.3, scale 0 events in 2021 increased by 760 (+38 %) compared to 2020 and by 318 (+13 %) compared to 2019. Comparison with the year 2017 can be misleading because of the substantial 2018 ICS Methodology change that was introduced for the 2018 Annual Report. One of the important updates for 2020 and 2021 were to register individual ICS events instead of aggregating related events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1. The 2018 and 2019 Methodology updates are summarised in Section 2.1.

The number of scale 1 events increased by 505 (+177 %) over 2020 and 549 (+228 %) over 2019. The largest changes in the number of scale 1 events are seen in violations of standards on voltage (OV1) and incident leading to frequency degradation (F1). OV1 events increased from 116 events in 2020 to 512 events in 2021, F1 events increased from 3 events in 2020 to 92 events in 2021. All other scale 1 categories show similar numbers to previous

years.

The number of scale 2 events increased from 0 events in 2020 to 16 events in 2021 and from 2 events in 2019 to 16 events in 2021. The largest changes in the number of scale 2 events are seen in separation from the grid (RS2) and incidents on network elements (T2). RS2 events increased from 0 event in 2020 to 6 events in 2021 and T2 events increased from 0 events in 2020 to 4 events in 2021. All other scale 2 categories show similar numbers or increased slightly comparing to previous years. All the reported scale 2 incidents were related to the three scale 2 incidents described in Chapter 4.

No scale 3 events were reported in CE in 2021.

Table 6.3: The annual number of ICS events by ICS criterion from 2017 to 2021 in continental Europe. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	4	2
	Incidents leading to frequency degradation (F0)	11	953	759	296	746
	Incidents on network elements (T0)	377	867	1 199	1 063	1 287
	Incidents on power generating facilities (G0)	84	113	93	81	138
	Separation from the grid (RS0)	-	-	-	2	-
	Violation of standards on voltage (OV0)	27	336	286	454	495
	Reduction of reserve capacity (RRC0)	1	-	1	-	26
	Loss of tools, means and facilities (LT0)	-	99	106	102	68
	Total	500	2 368	2 444	2 002	2 762
Scale 1	Incidents on load (L1)	1	3	-	6	2
	Incidents leading to frequency degradation (F1)	-	10	7	3	92
	Incidents on network elements (T1)	186	5	21	15	27
	Incidents on power generating facilities (G1)	-	-	-	-	4
	N-1 violation (ON1)	66	31	25	56	60
	Separation from the grid (RS1)	-	-	-	-	-
	Violation of standards on voltage (OV1)	21	50	9	116	512
	Reduction of reserve capacity (RRC1)	12	118	161	66	63
	Loss of tools, means and facilities (LT1)	18	25	18	23	30
	Total	304	242	241	285	790
Scale 2	Incidents on load (L2)	-	-	-	-	2
	Incidents leading to frequency degradation (F2)	-	-	-	-	1
	Incidents on network elements (T2)	-	-	1	-	4
	Incidents on power generating facilities (G2)	-	-	-	-	1
	N violation (ON2)	-	3	1	-	1
	Separation from the grid (RS2)	-	-	-	-	6
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	1
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	Total	-	3	2	-	16
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		804	2 613	2 687	2 287	3 568

6.3 Analysis of significant changes in trends

In 2021, 3568 events were reported in CE; an increase of 56 % compared to 2020 and an increase of 33 % compared to 2019. This increase appears to be significant, and is mainly due to the increase in the number of reported T0 and OV1 events. The increase of OV events was due to the increase of OV1 events in MAVIR (Hungary TSO). Furthermore, a decrease in RRC1 events compared to 2019 and 2018 was observed, like in year 2020.

The number of OV1 incidents increased by over 340 % relative to 2020. The number of N-1 violations increased from 56 in 2020 to 60 in 2021, and is similar to the numbers in 2017. The changes in the number after the year 2019 of reported OV and RRC events is due to the recent methodology change in 2020.

The trend of scale 1 events shifting to scale 0 events observed in 2018 continued in 2019, 2020 and 2021. This shift is due to clarifications and better alignment of the ICS Methodology with the SOGL. The recent ICS Methodology updates are summarised in Section 2.1.

The number of scale 2 events is significantly higher compared to previous years. No scale 3 events were reported in CE.

7 Events in the Nordic synchronous area

7.1 Overview of 2021

This section presents an overview of ICS events in the Nordic synchronous area in 2021. The events are presented by ICS criterion and grouped by month and duration in Table 7.1 and Table 7.2, respectively. In 2021, 221 scale 0–3 ICS events were reported in the Nordic synchronous area, of which 214 were scale 0 events, and seven scale 1 events.

As shown in Table 7.1, T0 and F0 were the most common type with 101 events and 70 events in 2021, respectively. These T0 events on network elements were mainly due to tripped HVDC links and HVAC elements because of faults in operation and maintenance or technical equipment. Furthermore, all events were moderately spread throughout the year.

As shown in Table 7.2, 55 % of the events were resolved in less than an hour, and 90 % of all events were resolved in less than 24 hours.

All incidents leading to frequency degradation (F0 and F1) and separation from the grid (RS1) were resolved within an hour. Other incidents took longer to resolve. Some (T0), (G0) and one (T1) incident took more than 24 h.

Table 7.1: Number of ICS events by ICS criteria distributed per month in 2021 in the Nordic synchronous area.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	-	-	-	2	-	2
	Incidents leading to frequency degradation (F0)	3	13	8	15	2	-	-	6	3	11	6	3	70
	Incidents on network elements (T0)	7	8	7	6	6	12	11	10	6	7	15	6	101
	Incidents on power generating facilities (G0)	-	-	-	-	1	2	-	1	5	1	-	5	15
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	1	-	1	-	2
	Violation of standards on voltage (OV0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	4	3	3	-	1	-	2	4	3	2	-	-	22
	Total	14	24	18	21	10	14	13	21	18	21	24	14	212
Scale 1	Incidents on load (L1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	2	1	-	-	-	-	-	-	-	-	-	3
	Incidents on network elements (T1)	-	-	-	-	-	-	1	-	1	-	1	-	3
	Incidents on power generating facilities (G1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-	1	-	-	-	-	-	1
	Violation of standards on voltage (OV1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	1	-	-	-	-	-	-	-	-	-	-	-	1
	Total	1	2	1	-	-	-	2	-	1	-	1	-	8
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		15	26	19	21	10	14	15	21	19	21	25	14	220

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Table 7.2: Cumulative number of ICS events by ICS criteria and duration in 2021 in the Nordic synchronous area.

		2021					
Scale	ICS criterion	<1h	<2h	<5h	<10h	<24h	Total
Scale 0	Incidents on load (L0)	1	1	2	2	2	2
	Incidents leading to frequency degradation (F0)	70	70	70	70	70	70
	Incidents on network elements (T0)	35	51	67	76	85	101
	Incidents on power generating facilities (G0)	3	4	5	8	9	15
	Separation from the grid (RS0)	-	-	1	2	2	2
	Violation of standards on voltage (OV0)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	7	12	18	22	22	22
	Total	116	138	163	180	190	212
Scale 1	Incidents on load (L1)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	3	3	3	3	3	3
	Incidents on network elements (T1)	-	-	1	2	2	3
	Incidents on power generating facilities (G1)	-	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	-	-
	Separation from the grid (RS1)	1	1	1	1	1	1
	Violation of standards on voltage (OV1)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	1	1	1	1	1
	Total	4	5	6	7	7	8
Scale 2	Incidents on load (L2)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Grand Total		120	143	169	187	197	220

7.2 Evolution 2017–2021

This section presents the annual number of ICS events in the Nordic synchronous area from 2017–2021, distributed by scale and dominating criterion. The dominating criteria used in this report are presented in Table 2.1 It should be noted that the recorded values for 2017–2021 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

As mentioned in Chapter 1, the ICS Methodology has been changed several times, preventing direct comparison of annual reporting results. Nevertheless, it is useful to examine recent incident reporting to identify potential trends. The update of the ICS Methodology has refined the definitions and thresholds to align with SOGL to improve the overall data quality, make results comparable between synchronous areas and TSOs, and to ease the analysis and identification of improvements to system operations. One of the important updates as of 2020 was to also register individual ICS events instead of aggregating related events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1. The Methodology updates are summarised in Section 2.1.

As seen in Table 7.3, the number of scale 0 events in 2021 compared to 2020 and 2019 has clearly increased, by 43 % compared to 2020 and by 251 % compared to 2019. There was a big increase in F0, T0, G0 and LT0. Nordic had first two events in L0 and RS0. The number of scale 1 events decreased by 65 %.

Table 7.3: The annual number of ICS events by ICS criterion from 2017 to 2021 in the Nordic synchronous area. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	2
	Incidents leading to frequency degradation (F0)	-	2	-	62	70
	Incidents on network elements (T0)	7	77	59	73	101
	Incidents on power generating facilities (G0)	-	1	1	5	15
	Separation from the grid (RS0)	-	-	-	-	2
	Violation of standards on voltage (OV0)	-	5	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	1	10	22
	Total	7	85	61	150	212
Scale 1	Incidents on load (L1)	2	3	2	1	-
	Incidents leading to frequency degradation (F1)	-	-	106	4	3
	Incidents on network elements (T1)	33	7	1	3	3
	Incidents on power generating facilities (G1)	-	-	-	-	-
	N-1 violation (ON1)	-	2	-	2	-
	Separation from the grid (RS1)	-	-	-	1	1
	Violation of standards on voltage (OV1)	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	2	2	-	6	1
	Total	37	14	109	17	8
Scale 2	Incidents on load (L2)	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	Total	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		44	99	170	167	220

7.3 Analysis of significant changes in trends

In 2021, 220 scale 0 and 1 events were reported in the Nordic synchronous area, representing an increase of 53 events compared to 2020 and an increase of 50 events compared to 2019.

An increasing trend can be seen in T0, G0 and LT0.

8 Events in Great Britain

8.1 Overview of 2021

This section presents an overview of ICS events in GB in 2021. The events are presented by ICS criterion and further grouped by month and duration in Table 8.1 and Table 8.2, respectively.

The National Grid Electricity System Operator (NGESO) of GB reported 252 ICS events (247 ICS incidents) in 2021, of which, 251 events (245 incidents) were scale 0 and 1 event (1 incident) were scale 1.

There were five ICS incidents in which two ICS events were registered.

- In four incidents, the event on network element(T0) resulted in generation loss(G0)
- In one incident, the event on a network element (T0) was suppressed by a concurrent event with a higher priority (F0).

There was one scale 1 ICS event due to loss of tools, means or facilities (LT1).

Of the 251 scale 0 ICS events, 218 events were related to transmission network elements (T0), 16 events were due to loss of tools, means or facilities (LT0), 14 events were on power generating facilities (G0), and 3 events were frequency degradations (F0). All transmission events were secured by applying curative remedial actions within appropriate timescales. Disturbances on transmission network elements (T0), loss of tools, means and facilities (LT0) and power generating facilities (G0) accounted for a significant portion of the reported ICS events, as shown in Table 8.1 and Table 8.2. Most of the events on transmission system elements (T0) were caused by primary system faults that resulted in the automatic operation of circuit breakers following the detection of primary system fault current. The system remained secure following all events.

As shown in Table 8.1, the reported ICS events were spread out over the year, with peaks in some months but no specific trend.

As shown in Table 8.2, 24 % of the reported ICS events were resolved within one hour and 34 % of the reported events lasted longer than 24 hours. Thorough site investigations were initiated, and mitigating actions were deployed in most instances to ensure that the network elements were reconditioned and maintained before re-energisation resulting in longer restoration times.

Around 62 % (135) of the 218 events on transmission network elements (T0) and 94 % (32) of the 34 events involving loss of tools, means and facilities (LT0) were resolved within 24 hours.

Table 8.1: Number of ICS events by ICS criteria distributed per month in 2021 in Great Britain.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	1	-	-	1	-	-	-	-	1	-	-	-	3
	Incidents on network elements (T0)	25	30	10	20	18	16	22	16	22	9	21	9	218
	Incidents on power generating facilities (G0)	1	2	1	2	1	1	1	1	1	-	-	3	14
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	3	-	1	2	-	-	-	1	1	1	3	4	16
	Total	30	32	12	25	19	17	23	18	25	10	24	16	251
Scale 1	Incidents on load (L1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-	-	1	-	-	-	-	1
	Total	-	-	-	-	-	-	-	1	-	-	-	-	1
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		30	32	12	25	19	17	23	19	25	10	24	16	252

Table 8.2: Cumulative number of ICS events by ICS criteria and duration in 2021 in Great Britain.

		2021					
Scale	ICS criterion	<1h	<2h	<5h	<10h	<24h	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	3	3	3	3	3	3
	Incidents on network elements (T0)	44	65	92	117	135	218
	Incidents on power generating facilities (G0)	4	6	6	9	12	14
	Separation from the grid (RS0)	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	10	12	15	16	16	16
	Total	61	86	116	145	166	251
Scale 1	Incidents on load (L1)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-
	Incidents on network elements (T1)	-	-	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	1	1	1	1
	Total	-	-	1	1	1	1
Scale 2	Incidents on load (L2)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Grand Total		61	86	117	146	167	252

8.2 Evolution 2017–2021

This section presents the annual number of ICS events in GB from 2017 to 2021, distributed by scale and ICS criterion. The ICS criteria used in this report are presented in Table 2.1. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

NGESO from GB recorded 252 scale 0–3 ICS events (247 ICS incidents) in comparison to 260 ICS events (259 ICS incidents) in 2020, 276 incidents in 2019, 250 in 2018. In 2021, there were 251 scale 0 ICS events, one scale 1 events and no scale 2–3 events.

Table 8.3 shows that yearly numbers of ICS events from 2018 to 2021 are quite similar.

The large number of scale 0 incidents emerging in 2018 to 2021 are attributed to the change in the ICS Methodology. The sizeable increase in the number of incidents reported from 2017 to 2018 was due to the reporting scale change for frequency degradation (F0) and loss of tools and facilities (LT0).

If F0 and LT0 events are excluded, the number of incidents is similar to those reported between 2016 and 2017. The ICS Methodology updates are summarised in Section 2.1.

In 2021, Great Britain recorded one scale 1 ICS events similar to one in 2020 and compared to zero in 2019, two in 2018, 12 in 2017 and 10 in 2016. The first scale 2 incident

in Great Britain, recorded in 2019, was an incident leading to frequency degradation (F2). Details of the scale 2 incident can be found in the 2019 ICS Annual Report.

Table 8.3: The annual number of ICS events by ICS criterion from 2017 to 2021 in Great Britain. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	58	78	2	3
	Incidents on network elements (T0)	124	156	155	169	218
	Incidents on power generating facilities (G0)	2	3	-	12	14
	Separation from the grid (RS0)	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	31	42	76	16
	Total	126	248	275	259	251
Scale 1	Incidents on load (L1)	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-
	Incidents on network elements (T1)	10	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	-
	N-1 violation (ON1)	-	2	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	2	-	-	1	1
	Total	12	2	-	1	1
Scale 2	Incidents on load (L2)	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	1	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	Total	-	-	1	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		138	250	276	260	252

8.3 Analysis of significant changes in trends

In 2021, 252 scale 0–3 ICS events (247 ICS incidents) were reported in Great Britain's synchronous area, which is similar to the number of incidents reported in 2019 and 2020. The dominant ICS criteria in 2021 were incidents on transmission system elements (T0) and loss of tools and facilities (LT0).

The number of scale 0 incidents in 2021 decreased slightly compared to 2020, whereas scale 1 incidents were similar in number to previous years (one in 2021, one in 2020, zero in 2019 and two in 2018).

There were no scale 2 events in 2021, unlike in 2019, when the first scale 2 incident in GB was recorded. The dominating ICS criterion of the scale 2 incident in 2019 was incidents leading to frequency degradation (F2).

The increased reporting of ICS incidents is primarily attributed to the ICS Methodology update in 2018 [6]. This evolving trend requires a follow-up when the methodology has stabilised.

9 Events in the Baltic Area

9.1 Overview of 2021

This section presents an overview of ICS events in the Baltic area in 2021. The events are presented by ICS criterion and further grouped by month and duration in Table 9.1 and Table 9.2, respectively. In 2021, 42 ICS events were reported in the Baltic area. Of these, 38 were scale 0, 4 were scale 1. No scale 2 and 3 incidents were reported in 2021.

Incidents on transmission network elements (T0) and incidents on power generating facilities (G0) were the most frequent types of incidents, as shown in Table 9.1. Furthermore, the number of incidents recorded in 2021 has a uniform distribution during the year with a slight concentration of incidents in June. In 2021, there were 16 incidents on power generating facilities (G0) compared with 11 in 2019 and 23 in 2020. The G0 incidents relate to repeating issues at one generating facility. The distribution of incidents by duration shown in Table 9.2 indicates that 5 of the 42 events in 2021 were resolved in less than an hour, and 10 events took more than 24 hours to resolve. Approximately 76 % of all events were resolved within 24 hours.

Table 9.1: Number of ICS events by ICS criteria distributed per month in 2021 in the Baltic area.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T0)	2	1	2	2	-	6	2	2	1	-	1	2	21
	Incidents on power generating facilities (G0)	1	1	1	1	2	1	2	2	-	2	2	1	16
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	1	-	-	-	-	-	-	-	-	-	1
	Total	3	2	4	3	2	7	4	4	1	2	3	3	38
Scale 1	Incidents on load (L1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T1)	1	-	2	-	-	-	-	-	-	-	-	1	4
	Incidents on power generating facilities (G1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	1	-	2	-	-	-	-	-	-	-	-	1	4
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		4	2	6	3	2	7	4	4	1	2	3	4	42

Table 9.2: Cumulative number of ICS events by ICS criteria and duration in 2021 in the Baltic area.

		2021					
Scale	ICS criterion	<1h	<2h	<5h	<10h	<24h	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-	-
	Incidents on network elements (T0)	5	8	10	14	16	21
	Incidents on power generating facilities (G0)	-	-	6	10	11	16
	Separation from the grid (RS0)	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	1	1	1	1	1
	Total	5	9	17	25	28	38
Scale 1	Incidents on load (L1)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-
	Incidents on network elements (T1)	2	3	3	4	4	4
	Incidents on power generating facilities (G1)	-	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-
	Total	2	3	3	4	4	4
Scale 2	Incidents on load (L2)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Grand Total		7	12	20	29	32	42

9.2 Evolution 2017–2021

This section presents the annual number of ICS events in the Baltic area power system from 2017 to 2021, distributed by scale and dominating criterion. The dominating criteria used in this report are presented in Table 2.1. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

The number of reported events shows a slight annual decrease, as seen in Table 9.3. Twenty-three of the 26 G0 events in 2020 and 15 of the 16 G0 events in 2021 occurred in Elering's power grid. These events should be followed up on in the future. The most common type of event is incidents on network elements (T0).

Table 9.3: The annual number of ICS events by ICS criterion from 2017 to 2021 in the Baltic area. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-
	Incidents on network elements (T0)	17	25	28	20	21
	Incidents on power generating facilities (G0)	-	2	11	26	16
	Separation from the grid (RS0)	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	1
	Total	17	27	39	46	38
Scale 1	Incidents on load (L1)	-	-	2	1	-
	Incidents leading to frequency degradation (F1)	-	-	1	-	-
	Incidents on network elements (T1)	11	-	3	5	4
	Incidents on power generating facilities (G1)	-	-	-	1	-
	N-1 violation (ON1)	-	-	-	1	-
	Separation from the grid (RS1)	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	1	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	1	-	-	-
	Total	11	1	6	9	4
Scale 2	Incidents on load (L2)	-	-	-	1	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	Total	-	-	-	1	-
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		28	28	45	56	42

9.3 Analysis of significant changes in trends

In 2021, a total of 42 scale 0–3 events were reported in the Baltic area. They were mostly caused by T0 incidents and G0 incidents. Although the number of T0 events was stable, the number of G0 events fluctuates from year to year.

The number of reported scale 1 events was lower in 2021 compared to 2020. They were mostly caused by events on transmission network elements (T1). Small differences in other criteria are more connected to the small size of the Baltic area and the probability of uncommon events.

10 Events in Ireland

10.1 Overview of 2021

This section presents an overview of ICS events in Ireland in 2021. The events are presented by ICS criterion and further grouped by month and duration in Table 10.1 and Table 10.2, respectively.

In 2021, 33 ICS events were reported in Ireland, of which 25 were of scale 0 and 8 of scale 1. No scale 2 or scale 3 incidents were reported. Out of all ICS events in Ireland, 42 % were incidents on power generating facilities (G0), 33 % were incidents transmission network elements (T0), and the remaining 24 % were N-1 violations (ON1), as can be seen in Table 10.1. 'Tripped network elements caused all G0 events and 'Technical equipment' was the cause of most of the T0 events. The events did not show any nonuniform monthly distribution during the year.

61 % (20) of the 33 ICS events were cleared in under 24 hours, as seen in Table 10.2. The remaining 13 lasted 24 hours or longer.

Table 10.1: Number of ICS events by ICS criteria distributed per month in 2021 in Ireland.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T0)	-	1	1	-	-	4	1	-	2	1	1	-	11
	Incidents on power generating facilities (G0)	-	-	-	1	-	-	2	-	-	2	5	4	14
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	1	1	1	-	4	3	-	2	3	6	4	25
Scale 1	Incidents on load (L1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N-1 violation (ON1)	1	-	-	1	1	-	-	-	4	1	-	-	8
	Separation from the grid (RS1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	1	-	-	1	1	-	-	-	4	1	-	-	8
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		1	1	1	2	1	4	3	-	6	4	6	4	33

Table 10.2: Cumulative number of ICS events by ICS criteria and duration in 2021 in Ireland.

		2021				
Scale	ICS criterion	<1h	<5h	<10h	<24h	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-
	Incidents on network elements (T0)	4	4	4	4	11
	Incidents on power generating facilities (G0)	-	3	6	8	14
	Separation from the grid (RS0)	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	-
	Total	4	7	10	12	25
Scale 1	Incidents on load (L1)	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-
	Incidents on network elements (T1)	-	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	-
	N-1 violation (ON1)	-	3	6	8	8
	Separation from the grid (RS1)	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-
	Total	-	3	6	8	8
Scale 2	Incidents on load (L2)	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	Total	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		4	10	16	20	33

10.2 Evolution 2017–2021

This section presents the annual number of ICS events in Ireland from 2017 to 2021, distributed by scale and ICS criterion. The ICS criteria used in this report are presented in Table 2.1. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

The number of scale 0 ICS events reported in 2021 is similar to the four previous years, as seen in Table 10.3. Eight scale 1 ICS events were reported in 2021, 3 in 2020 and none in 2019.A stable trend of reported scale 0 events can be seen over the years; however, the number of ON1 events (N-1 violations) is almost triple the number compared to 2020 (3 vs 8).

No scale 2 or scale 3 incidents were reported in Ireland in 2021. The previous scale 2 incident was in 2018, and it was caused by a frequency deviation mainly due to a loss of generation.

Table 10.3: The annual number of ICS events by ICS criterion from 2017 to 2021 in Ireland. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	8	4	-	-
	Incidents on network elements (T0)	3	9	9	8	11
	Incidents on power generating facilities (G0)	24	7	10	19	14
	Separation from the grid (RS0)	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	-
	Total	27	24	23	27	25
Scale 1	Incidents on load (L1)	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-
	Incidents on network elements (T1)	6	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	-
	N-1 violation (ON1)	-	-	-	3	8
	Separation from the grid (RS1)	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	2	-	-	-	-
	Total	8	-	-	3	8
Scale 2	Incidents on load (L2)	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	1	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	Total	-	1	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		35	25	23	30	33

10.3 Analysis of significant changes in trends

In 2021, a total of 33 ICS events were reported in IE/NI. The number is the highest since 2018 but still lower than in 2017, when 35 events were reported.

The dominant criteria in 2021 were events on power generating facilities (G0) and events involving transmission network elements (T0). The remaining 8 were N-1 violations (ON1).

The continuing trend of G0 and T0 events can still be seen in IE/NI. However, in 2021 there were many scale 1 N-1 violations (ON1). The number of scale 1 incidents was zero in 2018 and 2019, when the ICS Methodology was updated. The 2018 and 2019 Methodology updates are summarised in Section 2.1.

No scale 2 or scale 3 events were reported in 2021, which means that the reported ICS events were low impact and did not affect normal operating conditions.

11 Incidents in isolated systems

11.1 Overview of 2021

This section presents an overview of ICS events in isolated systems in 2021. The events are presented by ICS criterion and further grouped by month and duration in Table 11.1 and Table 11.2, respectively.

In 2021, a total of 30 ICS events were reported for the isolated systems of Iceland and Cyprus. All the events occurred in Iceland. One of the events was a scale 2 LT event, whereas the other events where of scale 0 and 1. The LT2 event was due to the energy management system losing connectivity to its remote terminal units, causing a loss of control and monitoring capability for the control centre. Other systems were operable during this time, but the control and monitoring potential was greatly reduced.

Most of the reported ICS events were events on transmission network elements (T0), as shown in Table 11.1. T0 events were primarily due to technical equipment and environmental causes. Two scale 1 events on power generating facilities (G1) and one event on load (L1) were also reported. Only a third of the events took longer than 24 hours to resolve as seen in Table 11.2.

Table 11.1: Number of ICS events by ICS criteria distributed per month in 2021 in isolated systems.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T0)	5	3	2	3	-	1	-	-	7	1	3	1	26
	Incidents on power generating facilities (G0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	5	3	2	3	-	1	-	-	7	1	3	1	26
Scale 1	Incidents on load (L1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T1)	-	-	-	-	-	-	-	-	-	-	-	1	1
	Incidents on power generating facilities (G1)	-	1	-	-	-	-	-	-	-	-	-	1	2
	N-1 violation (ON1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	1	-	-	-	-	-	-	-	-	-	2	3
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-	1	-	-	-	-	-	-	1
	Total	-	-	-	-	-	1	-	-	-	-	-	-	1
Scale 3	Blackout (OB3)	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
Grand Total		5	4	2	3	-	2	-	-	7	1	3	3	30

Table 11.2: Cumulative number of ICS events by ICS criteria and duration in 2021 in isolated systems.

		2021					
Scale	ICS criterion	<1h	<2h	<5h	<10h	<24h	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-	-
	Incidents on network elements (T0)	2	5	9	12	16	26
	Incidents on power generating facilities (G0)	-	-	-	-	-	-
	Separation from the grid (RS0)	-	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	-	-
	Total	2	5	9	12	16	26
Scale 1	Incidents on load (L1)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-	-
	Incidents on network elements (T1)	1	1	1	1	1	1
	Incidents on power generating facilities (G1)	-	2	2	2	2	2
	N-1 violation (ON1)	-	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-
	Total	1	3	3	3	3	3
Scale 2	Incidents on load (L2)	-	-	-	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	1	1	1	1
	Total	-	-	1	1	1	1
Scale 3	Blackout (OB3)	-	-	-	-	-	-
	Total	-	-	-	-	-	-
Grand Total		3	8	13	16	20	30

11.2 Evolution 2017 to 2021

This section presents the annual number of incidents in the isolated systems from to 2017 to 2021, distributed by scale and ICS criterion. The ICS criteria used in this report are presented in Table 2.1. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

The number of scale 0 ICS events reported in 2020 is significantly higher than that from 2016 to 2019, as seen in Table 11.3. This increase in T0 events in 2020 is a result of the recent ICS Methodology update, which included tripped 100–150 kV network elements which impact operational security. All other ICS criteria remained approximately on the same levels.

There was one scale 2 (LT) event, in isolated systems in 2021. No scale 3 events have been reported from 2017 to 2021.

All ICS events during 2017–2021 in the isolated systems were reported by Landsnet in Iceland, except for four L1 events and one L2 event in 2017 that occurred in Cyprus.

Table 11.3: The annual number of ICS events by ICS criterion from 2017 to 2021 in isolated systems. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	-
	Incidents leading to frequency degradation (F0)	-	-	-	-	-
	Incidents on network elements (T0)	5	10	5	29	26
	Incidents on power generating facilities (G0)	1	-	4	3	-
	Separation from the grid (RS0)	-	-	-	-	-
	Violation of standards on voltage (OV0)	-	-	-	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	-	-	1	-
	Total	6	10	9	33	26
Scale 1	Incidents on load (L1)	7	-	-	1	-
	Incidents leading to frequency degradation (F1)	-	-	-	-	-
	Incidents on network elements (T1)	6	3	7	12	1
	Incidents on power generating facilities (G1)	2	-	-	-	2
	N-1 violation (ON1)	-	-	-	-	-
	Separation from the grid (RS1)	-	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	-
	Total	15	3	7	13	3
Scale 2	Incidents on load (L2)	2	1	-	-	-
	Incidents leading to frequency degradation (F2)	-	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	1	-	-	1
	Total	2	2	-	-	1
Scale 3	Blackout (OB3)	-	-	-	-	-
	Total	-	-	-	-	-
Grand Total		23	15	16	46	30

11.3 Analysis of significant changes in trends

In 2021, a total of 30 ICS events were reported in isolated systems by Landsnet in Iceland. All incidents were mainly events on transmission network elements (T); however, there is no clear visible trend over the last few years. In addition, the data must be interpreted cautiously as the overall number of events is low, and the isolated systems are only represented by two TSO, Landsnet in Iceland and TSO-Cyprus in Cyprus, which have very different operating environments.

The number of scale 0, Scale 1 and scale 2 events is not sufficiently significant to make a relevant comparison with previous years.

The recent ICS Methodology update in for 2020, that included tripped 100–150 kV network elements which impact operational security, can be seen as the reason for the increased number of reported events after 2019. Most of the events in the isolated systems occurred in Landsnet's transmission network, and the only finding that can be made is that overall, the number of scale 2 events is sporadic and that the year 2020 was a year without any scale 2 events.

12 Overview of events per TSO

This chapter presents detailed information about each TSO that reported data according to the Incident Classification Scale Methodology [3]. In total, 40 TSOs contributed data to the 2021 ICS report. The TSOs in each synchronous area are listed below.

TSOs were asked to comment on trends and out of average values. When comments have been received, they are presented in this report.

TSOs in continental Europe

- 50Hertz
- Amprion GmbH
- Austrian Power Grid AG (APG)
- CEPS
- CGES
- ELES
- Elia
- EMS JSC
- Energinet (CE)
- ESO EAD
- HOPS
- IPTO
- MAVIR ZRt
- MEPSO
- NOS BiH
- OST
- PSE
- Red Eléctrica
- REN
- RTE
- SEPS
- Swissgrid
- TenneT TSO B.V.
- TenneT TSO GmbH
- TEİAŞ
- TERNA
- Transelectrica
- TransnetBW GmbH

Nordic TSOs

- Energinet (Nordic)
- Fingrid Oyj
- Statnett
- Svenska Kraftnät

TSO in Great Britain

- National Grid ESO

Baltic TSOs

- AS Augstsprieguma tīkls (AST)
- Elering AS
- Litgrid AB

TSOs in Ireland

- EirGrid
- SONI

TSOs in the isolated systems

- TSO-Cyprus
- Landsnet

12.1 Overview of events per TSOs in continental Europe

12.1.1 Events reported by 50Hertz

This section presents events for 50Hertz, one of the TSOs in Germany. Table 12.1 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.2 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.1 presents the number of events grouped by duration in 2021.

Table 12.1: Monthly distribution of ICS events by ICS criterion in 2021 for 50Hertz.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	1	-	-	-	-	1
	Incidents on network elements (T0)	1	3	2	-	3	4	7	8	6	3	-	3	40
	Incidents on power generating facilities (G0)	-	-	1	-	-	1	4	1	-	1	-	-	8
	Loss of tools, means and facilities (LT0)	-	-	-	-	-	-	-	-	-	1	-	-	1
Scale 1	N-1 violation (ON1)	2	-	2	2	-	-	-	-	1	1	1	-	9
	Loss of tools, means and facilities (LT1)	-	2	1	2	-	-	1	-	-	1	1	-	8
Grand Total		3	5	6	4	3	5	12	10	7	7	2	3	67

Table 12.2: The annual number of ICS events by ICS criterion from 2017 to 2021 for 50Hertz. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	1
	Incidents on network elements (T0)	17	30	24	29	40
	Incidents on power generating facilities (G0)	1	-	2	9	8
	Loss of tools, means and facilities (LT0)	-	-	6	2	1
Scale 1	Incidents on network elements (T1)	1	-	-	-	-
	Loss of tools, means and facilities (LT1)	1	-	3	9	8
	N-1 violation (ON1)	16	5	3	-	9
Grand Total		36	35	38	49	67

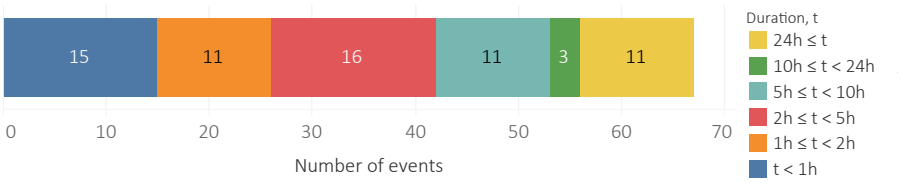

Figure 12.1: Number of events grouped by duration in 2021 for 50Hertz.

12.1.2 Events reported by Amprion GmbH

This section presents events for Amprion GmbH, one of the TSOs in Germany. Table 12.3 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.4 presents the annual number of ICS events by ICS criterion from 2017 to 2021.

Table 12.3: Monthly distribution of ICS events by ICS criterion in 2021 for Amprion GmbH.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	5	9	8	7	12	13	5	9	4	1	3	3	79
	Incidents on power generating facilities (G0)	2	3	-	1	2	1	-	1	1	1	3	4	19
	Loss of tools, means and facilities (LT0)	-	-	1	1	-	-	-	2	-	-	-	-	4
Scale 1	N-1 violation (ON1)	-	-	1	-	-	1	-	-	1	-	-	-	3
Grand Total		7	12	10	9	14	15	5	12	6	2	6	7	105

Table 12.4: The annual number of ICS events by ICS criterion from 2017 to 2021 for Amprion GmbH. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	25	47	31	35	79
	Incidents on power generating facilities (G0)	19	13	7	9	19
	Loss of tools, means and facilities (LT0)	-	-	6	3	4
Scale 1	Incidents on network elements (T1)	4	1	-	-	-
	Loss of tools, means and facilities (LT1)	4	6	-	-	-
	N-1 violation (ON1)	9	7	3	4	3
	Reduction of reserve capacity (RRC1)	-	-	1	-	-
Grand Total		61	74	48	51	105

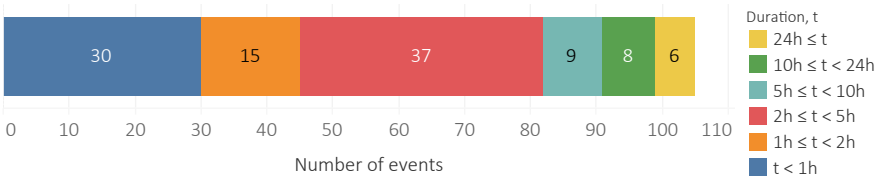

Figure 12.2: Number of events grouped by duration in 2021 for Amprion GmbH.

12.1.3 Events reported by Austrian Power Grid AG (APG)

This section presents events for Austrian Power Grid AG (APG), the TSO in Austria. Table 12.5 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.6 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.3 presents the number of events grouped by duration in 2021.

Table 12.5: Monthly distribution of ICS events by ICS criterion in 2021 for Austrian Power Grid AG.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	4	-	3	-	4	3	-	1	1	1	-	17
	Loss of tools, means and facilities (LT0)	-	-	1	-	-	-	-	-	-	-	-	-	1
Scale 1	N-1 violation (ON1)	1	-	-	-	-	1	-	1	1	-	-	-	4
Grand Total		1	4	1	3	-	5	3	1	2	1	1	-	22

Table 12.6: The annual number of ICS events by ICS criterion from 2017 to 2021 for Austrian Power Grid AG. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	24	10	24	24	17
	Loss of tools, means and facilities (LT0)	-	-	-	1	1
Scale 1	Incidents on network elements (T1)	3	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	2	2	-
	N-1 violation (ON1)	-	-	1	3	4
Grand Total		27	10	27	30	22

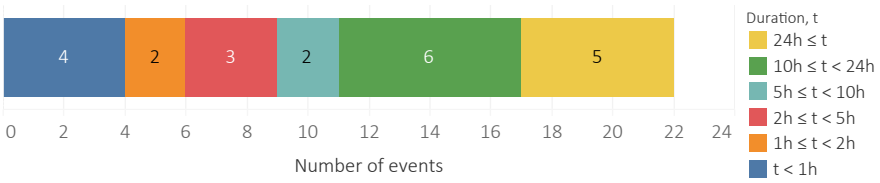

Figure 12.3: Number of events grouped by duration in 2021 for Austrian Power Grid AG.

12.1.4 Events reported by CEPS

This section presents events for CEPS, the TSO in the Czech Republic. Table 12.7 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.8 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.4 presents the number of events grouped by duration in 2021.

Table 12.7: Monthly distribution of ICS events by ICS criterion in 2021 for CEPS.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	1	3	1	1	4	2	1	5	2	6	1	2	29
	Incidents on power generating facilities (G0)	-	-	-	-	-	2	-	1	2	-	-	1	6
	Violation of standards on voltage (OV0)	-	1	1	-	-	-	-	1	-	-	-	-	3
	Loss of tools, means and facilities (LT0)	1	-	-	-	-	-	-	-	-	-	-	-	1
Scale 1	Incidents on load (L1)	-	-	-	-	-	-	-	1	-	-	-	-	1
	Violation of standards on voltage (OV1)	-	2	-	-	-	-	-	-	1	-	-	-	3
	Loss of tools, means and facilities (LT1)	1	-	-	-	-	-	-	-	-	-	-	-	1
Grand Total		3	6	2	1	4	4	1	8	5	6	1	3	44

Table 12.8: The annual number of ICS events by ICS criterion from 2017 to 2021 for CEPS. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	1	-
	Incidents on network elements (T0)	12	2	11	18	29
	Incidents on power generating facilities (G0)	-	2	6	3	6
	Loss of tools, means and facilities (LT0)	-	-	5	1	1
	Separation from the grid (RS0)	-	-	-	2	-
	Violation of standards on voltage (OV0)	-	31	19	-	3
Scale 1	Incidents on load (L1)	-	-	-	-	1
	Incidents on network elements (T1)	3	-	2	4	-
	Loss of tools, means and facilities (LT1)	3	1	1	2	1
	N-1 violation (ON1)	3	6	-	2	-
	Reduction of reserve capacity (RRC1)	2	-	-	-	-
	Violation of standards on voltage (OV1)	-	7	3	5	3
Grand Total		23	49	47	38	44

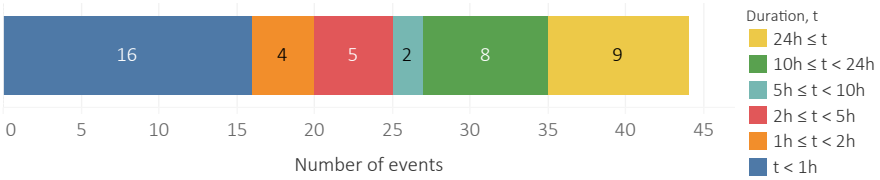

Figure 12.4: Number of events grouped by duration in 2021 for CEPS.

12.1.5 Events reported by CGES

This section presents events for CGES, the TSO in Montenegro. Table 12.9 presents the annual number of ICS events by ICS criterion from 2017 to 2021. CGES did not report any ICS events in 2021.

Table 12.9: The annual number of ICS events by ICS criterion from 2017 to 2021 for CGES. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	22	84	71	-	-
Scale 1	Incidents on network elements (T1)	52	-	-	-	-
Grand Total		74	84	71	-	-

12.1.6 Events reported by ELES

This section presents events for ELES, the TSO in Slovenia. Table 12.10 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.11 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.5 presents the number of events grouped by duration in 2021.

Table 12.10: Monthly distribution of ICS events by ICS criterion in 2021 for ELES.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	1	-	1	-	-	-	1	1	-	1	-	-	5
Scale 1	N-1 violation (ON1)	1	-	-	-	-	-	-	-	-	-	-	-	1
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	1	-	-	-	-	-	-	1
Grand Total		2	-	1	-	-	1	1	1	-	1	-	-	7

Table 12.11: The annual number of ICS events by ICS criterion from 2017 to 2021 for ELES. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	5	4	4	-	5
Scale 1	Incidents on network elements (T1)	2	-	-	2	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	1
	N-1 violation (ON1)	-	-	-	2	1
	Violation of standards on voltage (OV1)	-	-	1	5	-
Scale 2	N violation (ON2)	-	-	1	-	-
Grand Total		7	4	6	9	7

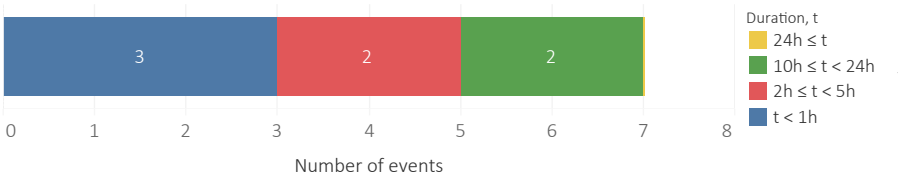

Figure 12.5: Number of events grouped by duration in 2021 for ELES.

12.1.7 Events reported by Elia

This section presents events for Elia, the TSO in Belgium. Table 12.12 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.13 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.6 presents the number of events grouped by duration in 2021.

Table 12.12: Monthly distribution of ICS events by ICS criterion in 2021 for Elia.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	2	-	-	-	4	1	-	-	1	1	-	9
	Incidents on power generating facilities (G0)	-	-	-	1	-	-	-	-	-	-	-	-	1
	Violation of standards on voltage (OV0)	-	-	-	-	1	-	-	-	-	-	-	-	1
Scale 1	Incidents on network elements (T1)	-	-	2	-	-	-	-	-	-	-	1	-	3
	N-1 violation (ON1)	-	1	-	-	-	-	-	-	-	-	-	1	2
	Loss of tools, means and facilities (LT1)	1	-	-	-	-	-	-	-	-	1	-	2	4
Grand Total		1	3	2	1	1	4	1	-	-	2	2	3	20

Table 12.13: The annual number of ICS events by ICS criterion from 2017 to 2021 for Elia. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	2	-
	Incidents on network elements (T0)	1	5	6	12	9
	Incidents on power generating facilities (G0)	6	1	2	-	1
	Loss of tools, means and facilities (LT0)	-	-	4	3	-
	Violation of standards on voltage (OV0)	-	1	1	-	1
Scale 1	Incidents on network elements (T1)	1	-	-	-	3
	Loss of tools, means and facilities (LT1)	3	4	-	-	4
	N-1 violation (ON1)	3	1	8	4	2
	Reduction of reserve capacity (RRC1)	3	-	1	-	-
	Violation of standards on voltage (OV1)	-	-	-	3	-
Grand Total		17	12	22	24	20

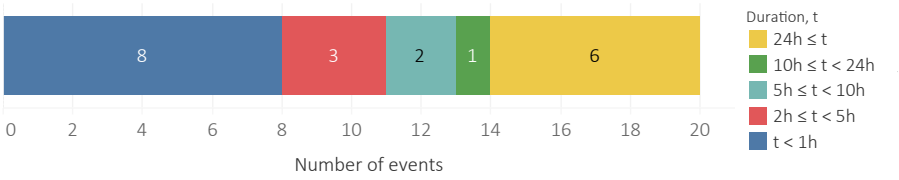

Figure 12.6: Number of events grouped by duration in 2021 for Elia.

12.1.8 Events reported by EMS JSC

This section presents events for EMS JSC, the TSO of Serbia. Table 12.14 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.15 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.7 presents the number of events grouped by duration in 2021.

Table 12.14: Monthly distribution of ICS events by ICS criterion in 2021 for EMS JSC.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	1	-	-	3	2	7	5	9	1	1	-	2	31
	Incidents on power generating facilities (G0)	1	-	-	-	-	-	-	-	-	-	-	1	2
	Violation of standards on voltage (OV0)	-	-	2	1	-	1	-	-	-	-	-	-	4
Scale 1	Incidents on network elements (T1)	2	-	-	-	-	1	-	-	-	1	-	-	4
	Violation of standards on voltage (OV1)	3	4	5	19	30	15	7	8	14	1	-	3	109
	Reduction of reserve capacity (RRC1)	-	-	-	-	-	-	-	-	-	-	-	4	4
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-	-	-	-	1	1	-	2
Scale 2	Separation from the grid (RS2)	1	-	-	-	-	-	-	-	-	-	-	-	1
Grand Total		8	4	7	23	32	24	12	17	15	4	1	10	157

Table 12.15: The annual number of ICS events by ICS criterion from 2017 to 2021 for EMS JSC. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	4	4	8	24	31
	Incidents on power generating facilities (G0)	-	28	-	-	2
	Loss of tools, means and facilities (LT0)	-	-	1	-	-
	Violation of standards on voltage (OV0)	12	-	-	-	4
Scale 1	Incidents on load (L1)	1	-	-	1	-
	Incidents on network elements (T1)	3	-	3	3	4
	Loss of tools, means and facilities (LT1)	-	-	-	1	2
	Reduction of reserve capacity (RRC1)	1	-	-	-	4
	Violation of standards on voltage (OV1)	-	-	-	-	109
Scale 2	Separation from the grid (RS2)	-	-	-	-	1
Grand Total		21	32	12	29	157

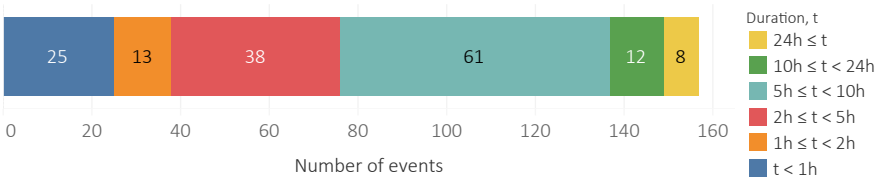

Figure 12.7: Number of events grouped by duration in 2021 for EMS JSC.

12.1.9 Events reported by Energinet (CE)

This section presents events for Energinet (CE), the TSO in Denmark. Table 12.16 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.17 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.8 presents the number of events grouped by duration in 2021.

Table 12.16: Monthly distribution of ICS events by ICS criterion in 2021 for Energinet (CE).

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	2	2	1	2	2	4	5	1	2	2	5	7	35
	Violation of standards on voltage (OV0)	-	-	-	-	-	1	-	-	-	-	-	-	1
	Loss of tools, means and facilities (LT0)	-	-	-	-	-	-	-	-	-	1	-	1	2
Grand Total		2	2	1	2	2	5	5	1	2	3	5	8	38

Table 12.17: The annual number of ICS events by ICS criterion from 2017 to 2021 for Energinet (CE). It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	1	6	15	15	35
	Loss of tools, means and facilities (LT0)	-	-	4	3	2
	Violation of standards on voltage (OV0)	-	-	-	-	1
Scale 1	Incidents on network elements (T1)	6	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	1	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	1	-
Grand Total		7	6	20	19	38

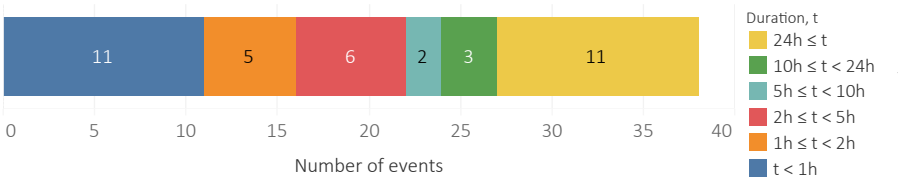

Figure 12.8: Number of events grouped by duration in 2021 for Energinet (CE).

12.1.10 Events reported by ESO EAD

This section presents events for ESO EAD, the TSO in Bulgaria. Table 12.18 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.19 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.9 presents the number of events grouped by duration in 2021.

Table 12.18: Monthly distribution of ICS events by ICS criterion in 2021 for ESO EAD.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	4	4	2	2	1	9	9	-	5	1	-	1	38
Grand Total		4	4	2	2	1	9	9	-	5	1	-	1	38

Table 12.19: The annual number of ICS events by ICS criterion from 2017 to 2021 for ESO EAD. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	25	29	38	40	38
	Incidents on power generating facilities (G0)	-	-	2	-	-
Scale 1	Incidents on network elements (T1)	11	-	-	-	-
Grand Total		36	29	40	40	38

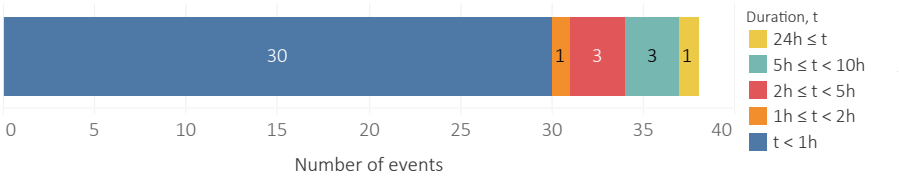

Figure 12.9: Number of events grouped by duration in 2021 for ESO EAD.

12.1.11 Events reported by HOPS

This section presents events for HOPS, the TSO in Croatia. Table 12.20 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.21 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.10 presents the number of events grouped by duration in 2021.

Table 12.20: Monthly distribution of ICS events by ICS criterion in 2021 for HOPS.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	4	2	1	5	6	4	10	10	2	3	1	1	49
	Loss of tools, means and facilities (LT0)	2	-	-	1	2	2	-	-	4	-	-	-	11
Scale 1	Incidents on network elements (T1)	2	-	-	-	-	-	-	-	-	-	-	-	2
	Reduction of reserve capacity (RRC1)	8	-	-	-	3	1	-	-	-	-	-	-	12
	Loss of tools, means and facilities (LT1)	-	1	1	-	-	-	-	-	-	-	-	-	2
Scale 2	Incidents on network elements (T2)	1	-	-	-	-	-	-	-	-	-	-	-	1
	Separation from the grid (RS2)	2	-	-	-	-	-	-	-	-	-	-	-	2
Grand Total		19	3	2	6	11	7	10	10	6	3	1	1	79

Table 12.21: The annual number of ICS events by ICS criterion from 2017 to 2021 for HOPS. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1. HOPS did not have any events from 2015–2016.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	6	31	31	49
	Loss of tools, means and facilities (LT0)	-	-	-	1	11
Scale 1	Incidents on network elements (T1)	-	-	-	-	2
	Loss of tools, means and facilities (LT1)	-	-	-	-	2
	N-1 violation (ON1)	11	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	12
Scale 2	Incidents on network elements (T2)	-	-	-	-	1
	Separation from the grid (RS2)	-	-	-	-	2
Grand Total		11	6	31	32	79

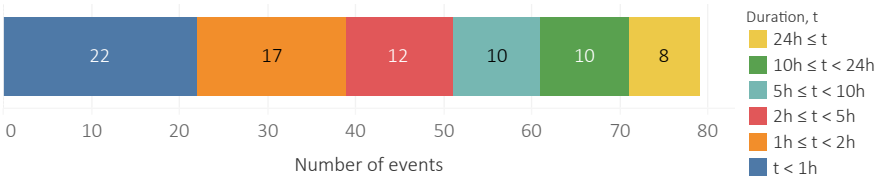

Figure 12.10: Number of events grouped by duration in 2021 for HOPS.

12.1.12 Events reported by IPTO

This section presents events for IPTO, the TSO in Greece. Table 12.22 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.23 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.11 presents the number of events grouped by duration in 2021.

Table 12.22: Monthly distribution of ICS events by ICS criterion in 2021 for IPTO.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	2	1	2	1	3	4	1	11	1	3	1	5	35
	Incidents on power generating facilities (G0)	1	-	-	-	-	-	-	-	-	-	-	-	1
	Violation of standards on voltage (OV0)	-	4	1	1	4	1	-	-	-	-	1	2	14
	Loss of tools, means and facilities (LT0)	-	1	-	-	3	1	-	-	4	1	-	-	10
Scale 1	Violation of standards on voltage (OV1)	1	6	3	7	6	5	-	-	1	1	-	4	34
Grand Total		4	12	6	9	16	11	1	11	6	5	2	11	94

Table 12.23: The annual number of ICS events by ICS criterion from 2017 to 2021 for IPTO. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	8	22	17	23	35
	Incidents on power generating facilities (G0)	-	-	-	-	1
	Loss of tools, means and facilities (LT0)	-	-	-	-	10
	Violation of standards on voltage (OV0)	-	2	2	14	14
Scale 1	Incidents on load (L1)	-	1	-	-	-
	Incidents on network elements (T1)	17	-	3	1	-
	Violation of standards on voltage (OV1)	-	1	1	26	34
Grand Total		25	26	23	64	94

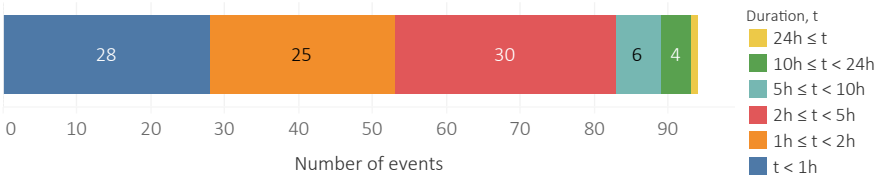

Figure 12.11: Number of events grouped by duration in 2021 for IPTO.

12.1.13 Events reported by MAVIR ZRt

This section presents events for MAVIR ZRt, the TSO in Hungary. Table 12.24 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.25 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.12 presents the number of events grouped by duration in 2021.

The RRC events registered by MAVIR ZRt were mostly caused by reaching the technical maximum ramping rate of the power plants.

Table 12.24: Monthly distribution of ICS events by ICS criterion in 2021 for MAVIR ZRt.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Violation of standards on voltage (OV0)	12	5	14	26	19	18	33	35	55	20	5	7	249
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	11	8	6	25
Scale 1	Incidents on network elements (T1)	-	3	2	2	1	-	-	-	-	2	5	-	15
	Violation of standards on voltage (OV1)	21	7	12	31	37	10	43	34	69	9	7	7	287
	Reduction of reserve capacity (RRC1)	3	1	5	-	1	3	7	7	8	-	-	-	35
Grand Total		36	16	33	59	58	31	83	76	132	42	25	20	611

Table 12.25: The annual number of ICS events by ICS criterion from 2017 to 2021 for MAVIR ZRt. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	72	52	6	-
	Reduction of reserve capacity (RRC0)	-	-	1	-	25
	Violation of standards on voltage (OV0)	-	77	43	292	249
Scale 1	Incidents on network elements (T1)	-	-	-	-	15
	Loss of tools, means and facilities (LT1)	-	-	1	-	-
	N-1 violation (ON1)	-	1	-	-	-
	Reduction of reserve capacity (RRC1)	3	112	155	63	35
	Violation of standards on voltage (OV1)	-	-	-	-	287
Grand Total		3	262	252	361	611

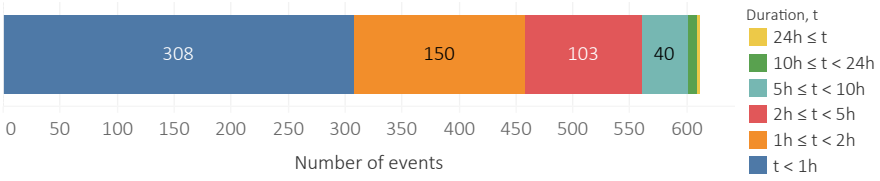

Figure 12.12: Number of events grouped by duration in 2021 for MAVIR ZRt.

12.1.14 Events reported by MEPSO

This section presents events for MEPSO, the TSO in Macedonia. Table 12.26 presents the annual number of ICS events by ICS criterion from 2017 to 2021. MEPSO did not report any ICS events in 2021.

Table 12.26: The annual number of ICS events by ICS criterion from 2017 to 2021 for MEPSO. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	4	-	-	-
Scale 1	Incidents on network elements (T1)	4	-	5	-	-
Grand Total		4	4	5	-	-

12.1.15 Events reported by NOS BiH

This section presents events for NOS BiH, the TSO in Bosnia and Herzegovina. Table 12.27 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.28 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.13 presents the number of events grouped by duration in 2021.

Table 12.27: Monthly distribution of ICS events by ICS criterion in 2021 for NOS BiH.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	2	-	1	-	1	9	2	3	3	2	3	2	28
	Incidents on power generating facilities (G0)	1	-	-	-	-	-	-	-	-	-	-	-	1
Scale 1	Incidents on network elements (T1)	2	-	-	-	-	-	-	-	-	-	-	-	2
Scale 2	Incidents leading to frequency degradation (F2)	1	-	-	-	-	-	-	-	-	-	-	-	1
Grand Total		6	-	1	-	1	9	2	3	3	2	3	2	32

Table 12.28: The annual number of ICS events by ICS criterion from 2017 to 2021 for NOS BiH. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	5	80	20	27	28
	Incidents on power generating facilities (G0)	-	-	-	-	1
Scale 1	Incidents on network elements (T1)	-	-	-	-	2
Scale 2	Incidents leading to frequency degradation (F2)	-	-	-	-	1
Grand Total		5	80	20	27	32

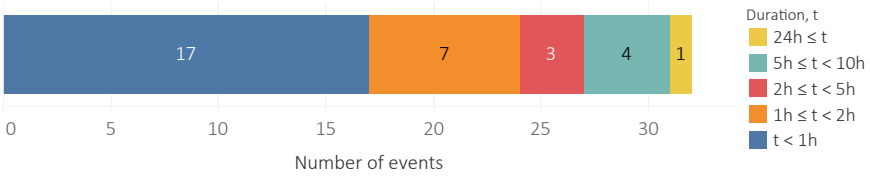

Figure 12.13: Number of events grouped by duration in 2021 for NOS BiH.

12.1.16 Events reported by OST

This section presents events for OST, the TSO in Albania. Table 12.29 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.30 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.15 presents the number of events grouped by duration in 2021.

Table 12.29: Monthly distribution of ICS events by ICS criterion in 2021 for OST.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	15	12	1	3	4	3	5	-	6	3	4	5	61
Grand Total		15	12	1	3	4	3	5	-	6	3	4	5	61

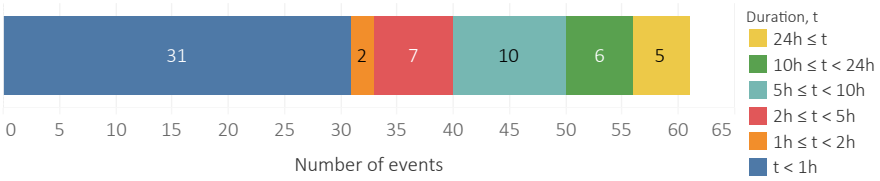

Figure 12.14: Number of events grouped by duration in 2021 for OST.

12.1.17 Events reported by PSE

This section presents events for PSE, the TSO in Poland. Table 12.29 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.30 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.14 presents the number of events grouped by duration in 2021.

The number of reported events by PSE has been consistent after 2017. Most of the events have been either incidents on network elements (T0) or incidents on power generating facilities (G0). However, other types of ICS events (LT0, ON1 and RRC1) have occasionally occurred.

Table 12.30: Monthly distribution of ICS events by ICS criterion in 2021 for PSE.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	6	7	4	4	5	8	32	6	5	10	6	7	100
	Incidents on power generating facilities (G0)	1	1	5	1	2	1	-	-	3	-	-	-	14
Scale 1	Reduction of reserve capacity (RRC1)	-	-	-	-	1	-	-	-	-	-	-	-	1
	Loss of tools, means and facilities (LT1)	1	-	-	-	-	-	-	-	-	-	1	-	2
Scale 2	Incidents on power generating facilities (G2)	-	-	-	-	1	-	-	-	-	-	-	-	1
	Reduction of reserve capacity (RRC2)	-	-	-	-	1	-	-	-	-	-	-	-	1
Grand Total		8	8	9	5	10	9	32	6	8	10	7	7	119

Table 12.31: The annual number of ICS events by ICS criterion from 2017 to 2021 for PSE. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	40	86	89	76	100
	Incidents on power generating facilities (G0)	-	14	10	13	14
	Loss of tools, means and facilities (LT0)	-	-	1	2	-
Scale 1	Incidents on network elements (T1)	5	-	-	-	-
	Loss of tools, means and facilities (LT1)	-	-	-	-	2
	N-1 violation (ON1)	-	-	-	1	-
	Reduction of reserve capacity (RRC1)	-	-	1	-	1
Scale 2	Incidents on power generating facilities (G2)	-	-	-	-	1
	Reduction of reserve capacity (RRC2)	-	-	-	-	1
Grand Total		45	100	101	92	119

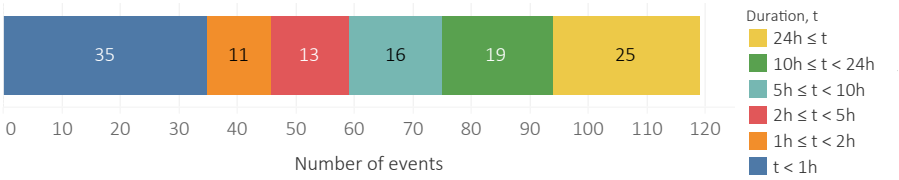

Figure 12.15: Number of events grouped by duration in 2021 for PSE.

12.1.18 Events reported by Red Eléctrica

This section presents events for Red Eléctrica, the TSO in Spain. Table 12.32 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.33 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.16 presents the number of events grouped by duration in 2021.

The ICS Methodology update in 2018 caused the number of events that Red Eléctrica reported in 2019 to increase significantly in comparison to the previous years. As the same criteria were used for 2019, 2020 and 2021, the difference between the number of events reported for these years is minimal. The overwhelming majority of the events that RE reported in 2021 were related to scale 0 incidents on network elements, which represent more than 98 % of the grand total. One scale 1 incident and three scale 2 incidents were reported in Spain during 2021, all of them related to the incident that occurred on 24 July. More information can be found in Chapter 4.3.

January was the month in which more incidents were reported by RE in 2021 (50) when compared to the rest of months, mainly because of strong weather conditions. The weather, together with concomitant fires, made June and September the second and third month with the highest number of T0 reported incidents (38 and 33, respectively). The rest of the year, the monthly number of events registered by the Spanish TSO was kept between 10 and 30.

Table 12.32: Monthly distribution of ICS events by ICS criterion in 2021 for Red Eléctrica.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	50	21	19	15	13	38	17	10	33	11	17	30	274
Scale 1	Incidents on power generating facilities (G1)	-	-	-	-	-	-	1	-	-	-	-	-	1
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	1	-	-	-	-	-	1
	Incidents on network elements (T2)	-	-	-	-	-	-	1	-	-	-	-	-	1
	Separation from the grid (RS2)	-	-	-	-	-	-	1	-	-	-	-	-	1
Grand Total		50	21	19	15	13	38	21	10	33	11	17	30	278

Table 12.33: The annual number of ICS events by ICS criterion from 2017 to 2021 for Red Eléctrica. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	90	235	258	274
	Incidents on power generating facilities (G0)	2	-	-	-	-
	Loss of tools, means and facilities (LT0)	-	1	2	5	-
Scale 1	Incidents on load (L1)	-	1	-	1	-
	Incidents on network elements (T1)	14	-	-	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	1
	Loss of tools, means and facilities (LT1)	1	1	-	-	-
Scale 2	Incidents on load (L2)	-	-	-	-	1
	Incidents on network elements (T2)	-	-	-	-	1
	Separation from the grid (RS2)	-	-	-	-	1
Grand Total		17	93	237	264	278

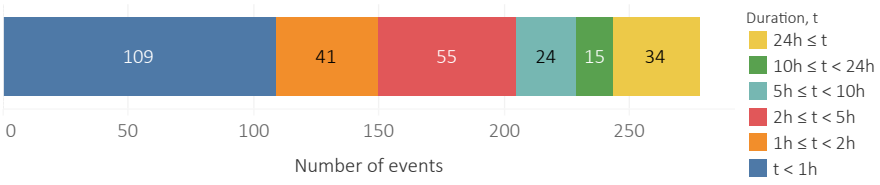

Figure 12.16: Number of events grouped by duration in 2021 for Red Eléctrica.

12.1.19 Events reported by REN

This section presents events for REN, the TSO in Portugal. Table 12.34 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.35 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.17 presents the number of events grouped by duration in 2021.

Table 12.34: Monthly distribution of ICS events by ICS criterion in 2021 for REN.

		2021											
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Scale 0	Incidents on network elements (T0)	3	-	-	1	2	1	1	1	4	2	2	17
	Incidents on power generating facilities (G0)	-	-	-	-	-	-	1	-	-	-	-	1
Scale 2	Incidents on load (L2)	-	-	-	-	-	-	1	-	-	-	-	1
	Separation from the grid (RS2)	-	-	-	-	-	-	1	-	-	-	-	1
Grand Total		3	-	-	1	2	1	4	1	4	2	2	20

Table 12.35: The annual number of ICS events by ICS criterion from 2017 to 2021 for REN. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	38	15	10	11	17
	Incidents on power generating facilities (G0)	-	1	-	-	1
	Loss of tools, means and facilities (LT0)	-	1	1	2	-
Scale 1	Incidents on network elements (T1)	2	-	-	-	-
Scale 2	Incidents on load (L2)	-	-	-	-	1
	Separation from the grid (RS2)	-	-	-	-	1
Grand Total		40	17	11	13	20

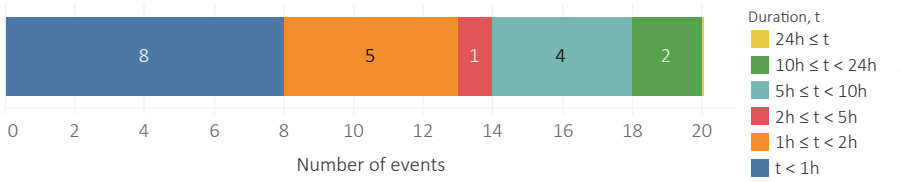

Figure 12.17: Number of events grouped by duration in 2021 for REN.

12.1.20 Events reported by RTE

This section presents events for RTE, the TSO in France. Table 12.36 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.37 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.18 presents the number of events grouped by duration in 2021.

Events on transmission networks elements (T0) are mainly due to weather conditions, particularly thunderstorms during the summer period. However, the system state did not degrade after those events. The change on the ON1-criteria in the 2019 ICS Methodology [3] explains the increase in ON1 events in 2020.

Table 12.36: Monthly distribution of ICS events by ICS criterion in 2021 for RTE.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	1	-	-	-	-	-	-	-	-	-	-	1
	Incidents on network elements (T0)	11	9	5	5	2	27	17	9	14	23	18	19	159
	Incidents on power generating facilities (G0)	-	-	1	1	-	-	-	3	10	6	1	8	30
	Violation of standards on voltage (OV0)	1	2	1	3	9	4	7	10	1	-	-	1	39
	Loss of tools, means and facilities (LT0)	-	-	-	-	1	-	-	-	-	-	-	-	1
Scale 1	Incidents on power generating facilities (G1)	-	1	-	-	-	1	-	-	-	-	-	-	2
	N-1 violation (ON1)	6	4	2	4	1	10	-	-	1	1	1	1	31
	Violation of standards on voltage (OV1)	-	-	-	1	5	-	2	10	-	-	-	-	18
	Reduction of reserve capacity (RRC1)	-	1	-	1	-	-	-	-	-	-	-	-	2
	Loss of tools, means and facilities (LT1)	-	-	-	-	-	1	-	-	-	-	-	-	1
Scale 2	Incidents on network elements (T2)	-	-	-	-	-	-	1	-	-	-	-	-	1
Grand Total		18	18	9	15	18	43	27	32	26	30	20	29	285

Table 12.37: The annual number of ICS events by ICS criterion from 2017 to 2021 for RTE. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents leading to frequency degradation (F0)	11	-	-	-	-
	Incidents on load (L0)	-	-	-	1	1
	Incidents on network elements (T0)	38	75	270	154	159
	Incidents on power generating facilities (G0)	32	30	19	29	30
	Loss of tools, means and facilities (LT0)	-	14	29	4	1
	Violation of standards on voltage (OV0)	3	68	10	15	39
Scale 1	Incidents on network elements (T1)	21	4	3	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	2
	Loss of tools, means and facilities (LT1)	-	8	7	1	1
	N-1 violation (ON1)	-	4	-	30	31
	Reduction of reserve capacity (RRC1)	1	5	1	2	2
	Violation of standards on voltage (OV1)	1	38	2	18	18
Scale 2	Incidents on network elements (T2)	-	-	-	-	1
Grand Total		107	246	341	254	285

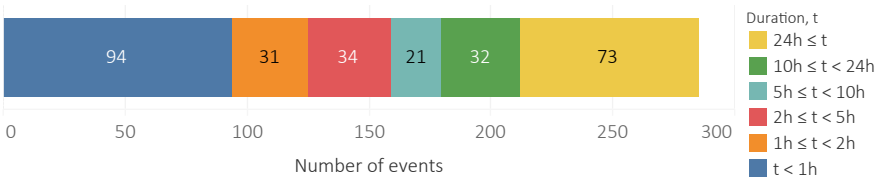

Figure 12.18: Number of events grouped by duration in 2021 for RTE.

12.1.21 Events reported by SEPS

This section presents events for SEPS, the TSO in Slovakia. Table 12.38 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.39 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.19 presents the number of events grouped by duration in 2021.

Table 12.38: Monthly distribution of ICS events by ICS criterion in 2021 for SEPS.

		2021											
Scale	ICS criterion	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	-	3	-	2	-	3	-	-	-	-	8
	Violation of standards on voltage (OV0)	1	-	-	7	4	4	7	-	-	-	-	23
Scale 1	Violation of standards on voltage (OV1)	-	-	-	-	5	1	6	-	-	-	-	12
Grand Total		1	-	3	7	11	5	16	-	-	-	-	43

Table 12.39: The annual number of ICS events by ICS criterion from 2017 to 2021 for SEPS. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	6	2	4	8
	Violation of standards on voltage (OV0)	-	-	15	49	23
Scale 1	Incidents on network elements (T1)	2	-	-	3	-
	Loss of tools, means and facilities (LT1)	-	-	-	1	-
	N-1 violation (ON1)	2	-	-	1	-
	Reduction of reserve capacity (RRC1)	1	-	-	-	-
	Violation of standards on voltage (OV1)	-	-	2	11	12
Grand Total		5	6	19	69	43

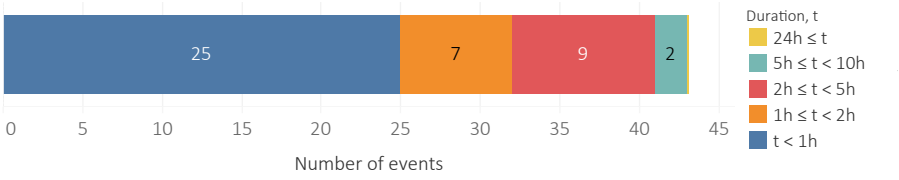

Figure 12.19: Number of events grouped by duration in 2021 for SEPS.

12.1.22 Events reported by Swissgrid

This section presents events for Swissgrid, the TSO in Switzerland. Table 12.40 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.41 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.20 presents the number of events grouped by duration in 2021.

Table 12.40: Monthly distribution of ICS events by ICS criterion in 2021 for Swissgrid.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	3	4	1	3	1	6	9	-	1	4	1	-	33
	Incidents on power generating facilities (G0)	-	-	-	-	-	-	-	-	-	-	2	-	2
	Violation of standards on voltage (OV0)	-	6	6	9	23	1	2	13	6	6	5	1	78
	Loss of tools, means and facilities (LT0)	1	1	1	-	1	4	-	2	1	1	-	1	13
Scale 1	Violation of standards on voltage (OV1)	-	-	1	1	2	-	-	8	-	-	-	-	12
	Loss of tools, means and facilities (LT1)	-	-	2	-	-	-	-	1	-	-	-	-	3
Grand Total		4	11	11	13	27	11	11	24	8	11	8	2	141

Table 12.41: The annual number of ICS events by ICS criterion from 2017 to 2021 for Swissgrid. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents leading to frequency degradation (F0)	-	-	1	-	-
	Incidents on network elements (T0)	7	12	31	37	33
	Incidents on power generating facilities (G0)	2	1	6	2	2
	Loss of tools, means and facilities (LT0)	-	5	16	21	13
	Violation of standards on voltage (OV0)	1	-	-	72	78
Scale 1	Incidents leading to frequency degradation (F1)	-	-	2	-	-
	Incidents on load (L1)	-	1	-	1	-
	Incidents on network elements (T1)	2	-	4	2	-
	Loss of tools, means and facilities (LT1)	1	-	-	2	3
	N-1 violation (ON1)	3	1	2	1	-
	Reduction of reserve capacity (RRC1)	1	-	2	-	-
	Violation of standards on voltage (OV1)	-	-	-	27	12
Scale 2	Incidents on network elements (T2)	-	-	1	-	-
	N violation (ON2)	-	3	-	-	-
Grand Total		17	23	65	165	141

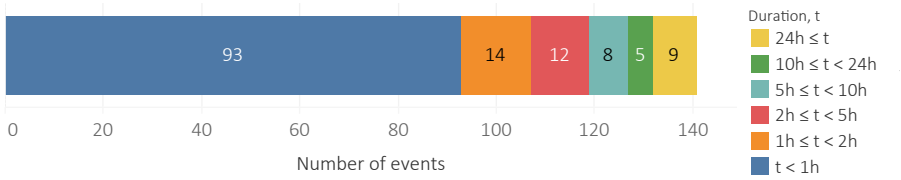

Figure 12.20: Number of events grouped by duration in 2021 for Swissgrid.

12.1.23 Events reported by TenneT TSO B.V.

This section presents events for TenneT TSO B.V., the TSO in the Netherlands. Table 12.42 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.43 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.21 presents the number of events grouped by duration in 2021.

Table 12.42: Monthly distribution of ICS events by ICS criterion in 2021 for TenneT TSO B.V.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	3	-	1	-	-	2	-	2	1	2	-	5	16
	Incidents on power generating facilities (G0)	-	1	-	-	1	1	2	1	2	1	-	2	11
	Loss of tools, means and facilities (LT0)	1	-	1	1	-	-	2	1	4	5	5	1	21
Scale 1	Incidents on power generating facilities (G1)	-	-	-	-	-	-	-	-	-	-	-	1	1
	N-1 violation (ON1)	-	-	-	-	1	-	-	-	3	-	-	-	4
Grand Total		4	1	2	1	2	3	4	4	10	8	5	9	53

Table 12.43: The annual number of ICS events by ICS criterion from 2017 to 2021 for TenneT TSO B. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	4	13	14	13	16
	Incidents on power generating facilities (G0)	16	19	12	6	11
	Loss of tools, means and facilities (LT0)	-	68	23	49	21
	Violation of standards on voltage (OV0)	11	-	-	-	-
Scale 1	Incidents on network elements (T1)	4	-	1	-	-
	Incidents on power generating facilities (G1)	-	-	-	-	1
	Loss of tools, means and facilities (LT1)	-	3	1	1	-
	N-1 violation (ON1)	1	3	6	1	4
	Violation of standards on voltage (OV1)	19	-	-	-	-
Grand Total		55	106	57	70	53

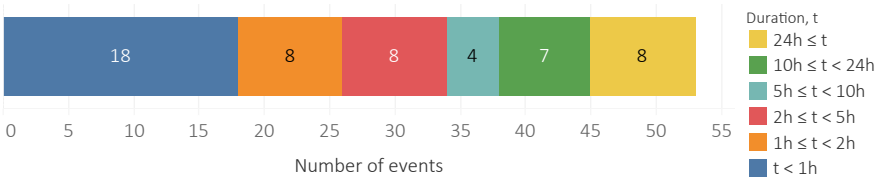

Figure 12.21: Number of events grouped by duration in 2021 for TenneT TSO B.V.

12.1.24 Events reported by TenneT TSO GmbH

This section presents events for TenneT TSO GmbH, one of the TSOs in Germany. Table 11.45 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 11.46 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 11.22 presents the number of events grouped by duration in 2021.

The changes in yearly numbers are stable for consistent ICS Methodologies. Only the T events increased slightly due to grid expansion measures. The variance during the year 2021 is insignificant. Although the overall grid security is maintained, it is expected that the number of events might increase due to grid expansion and more frequent severe weather conditions.

Table 12.44: Monthly distribution of ICS events by ICS criterion in 2021 for TenneT TSO GmbH.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	3	10	5	9	8	2	5	3	7	3	5	4	64
	Loss of tools, means and facilities (LT0)	-	-	1	-	-	-	2	-	-	-	-	-	3
Scale 1	Incidents on network elements (T1)	-	1	-	-	-	-	-	-	-	-	-	-	1
	N-1 violation (ON1)	-	-	-	1	1	-	-	-	-	1	-	-	3
	Loss of tools, means and facilities (LT1)	1	-	-	-	-	1	-	-	-	-	-	-	2
Grand Total		4	11	6	10	9	3	7	3	7	4	5	4	73

Table 12.45: The annual number of ICS events by ICS criterion from 2017 to 2021 for TenneT TSO GmbH. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	26	24	53	54	64
	Incidents on power generating facilities (G0)	2	-	-	1	-
	Loss of tools, means and facilities (LT0)	-	10	5	5	3
	Violation of standards on voltage (OV0)	-	-	-	1	-
Scale 1	Incidents on network elements (T1)	2	-	-	-	1
	Loss of tools, means and facilities (LT1)	3	-	-	2	2
	N-1 violation (ON1)	13	1	2	6	3
	Violation of standards on voltage (OV1)	1	4	-	-	-
Grand Total		47	39	60	69	73

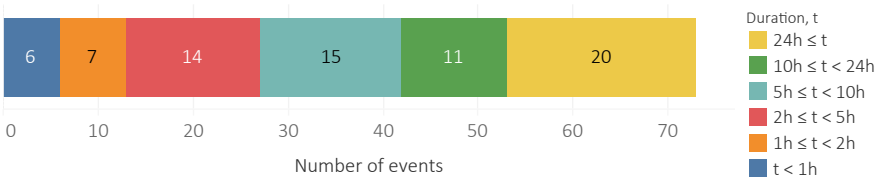

Figure 12.22: Number of events grouped by duration in 2021 for TenneT TSO GmbH.

12.1.25 Events reported by TEİAŞ

This section presents events for TEİAŞ, the TSO in Turkey. Table 12.46 presents the monthly distribution of ICS events by ICS criterion in 2021. Figure 12.23 presents the number of events grouped by duration in 2021. TEİAŞ has not reported ICS events prior to 2021.

Table 12.46: Monthly distribution of ICS events by ICS criterion in 2021 for TEİAŞ.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	1	2	-	1	3	1	-	2	-	-	1	11
	Incidents on power generating facilities (G0)	3	2	3	1	-	1	2	3	1	-	-	-	16
Scale 1	N-1 violation (ON1)	-	-	1	-	-	1	-	-	-	-	1	-	3
	Loss of tools, means and facilities (LT1)	-	-	-	1	-	-	1	-	1	-	-	1	4
Grand Total		3	3	6	2	1	5	4	3	4	-	1	2	34

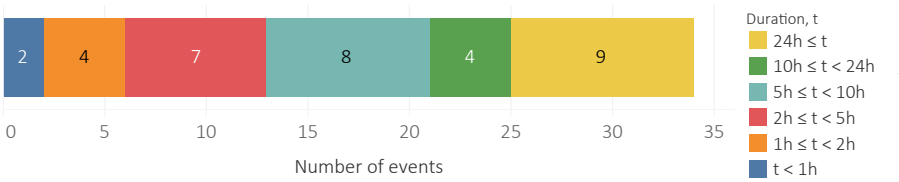

Figure 12.23: Number of events grouped by duration in 2021 for TEİAŞ.

12.1.26 Events reported by TERNA

This section presents events for TERNA, the TSO in Italy. Table 12.47 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.48 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.24 presents the number of events grouped by duration in 2021.

Table 12.47: Monthly distribution of ICS events by ICS criterion in 2021 for TERNA.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	10	9	4	3	3	8	6	5	6	6	5	10	75
	Violation of standards on voltage (OV0)	-	1	1	3	5	-	-	-	-	2	-	-	12
	Reduction of reserve capacity (RRC0)	-	-	-	-	-	-	-	-	-	1	-	-	1
Scale 1	Reduction of reserve capacity (RRC1)	-	-	-	1	-	-	-	-	1	1	2	4	9
Grand Total		10	10	5	7	8	8	6	5	7	10	7	14	97

Table 12.48: The annual number of ICS events by ICS criterion from 2017 to 2021 for TERNA. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	63	83	66	75
	Loss of tools, means and facilities (LT0)	-	-	3	-	-
	Reduction of reserve capacity (RRC0)	-	-	-	-	1
	Violation of standards on voltage (OV0)	-	-	-	-	12
Scale 1	Incidents on network elements (T1)	17	-	-	-	-
	Reduction of reserve capacity (RRC1)	-	-	-	-	9
Grand Total		17	63	86	66	97

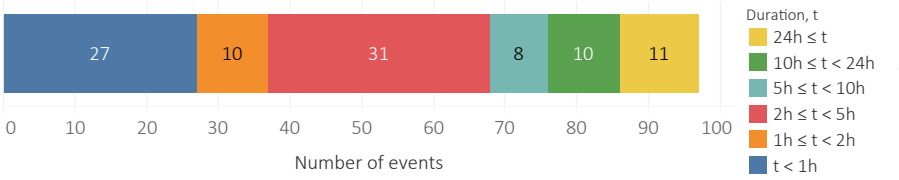

Figure 12.24: Number of events grouped by duration in 2021 for TERNA.

12.1.27 Events reported by Transelectrica

This section presents events for Transelectrica, the TSO in Romania. Table 12.49 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.50 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.25 presents the number of events grouped by duration in 2021.

Table 12.49: Monthly distribution of ICS events by ICS criterion in 2021 for Transelectrica.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	5	9	8	7	12	13	5	9	4	1	3	3	79
	Incidents on power generating facilities (G0)	2	3	-	1	2	1	-	1	1	1	3	4	19
	Loss of tools, means and facilities (LT0)	-	-	1	1	-	-	-	2	-	-	-	-	4
Scale 1	N-1 violation (ON1)	-	-	1	-	-	1	-	-	1	-	-	-	3
Grand Total		7	12	10	9	14	15	5	12	6	2	6	7	105

Table 12.50: The annual number of ICS events by ICS criterion from 2017 to 2021 for Transelectrica. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	25	47	31	35	79
	Incidents on power generating facilities (G0)	19	13	7	9	19
	Loss of tools, means and facilities (LT0)	-	-	6	3	4
Scale 1	Incidents on network elements (T1)	4	1	-	-	-
	Loss of tools, means and facilities (LT1)	4	6	-	-	-
	N-1 violation (ON1)	9	7	3	4	3
	Reduction of reserve capacity (RRC1)	-	-	1	-	-
Grand Total		61	74	48	51	105

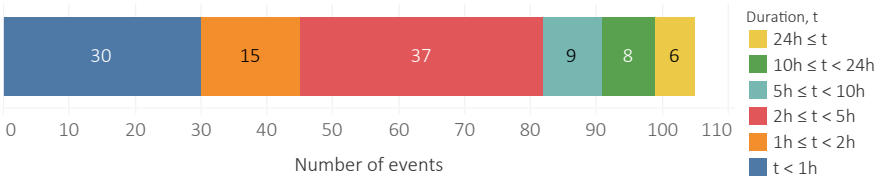

Figure 12.25: Number of events grouped by duration in 2021 for Transelectrica.

12.1.28 Events reported by TransnetBW GmbH

This section presents events for TransnetBW GmbH, one of the TSOs in Germany. Table 12.51 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.52 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.26 presents the number of events grouped by duration in 2021.

Table 12.51: Monthly distribution of ICS events by ICS criterion in 2021 for TransnetBW GmbH.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	1	2	-	1	3	1	-	2	-	-	1	11
	Incidents on power generating facilities (G0)	3	2	3	1	-	1	2	3	1	-	-	-	16
Scale 1	N-1 violation (ON1)	-	-	1	-	-	1	-	-	-	-	1	-	3
	Loss of tools, means and facilities (LT1)	-	-	-	1	-	-	1	-	1	-	-	1	4
Grand Total		3	3	6	2	1	5	4	3	4	-	1	2	34

Table 12.52: The annual number of ICS events by ICS criterion from 2017 to 2021 for TransnetBW GmbH. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	28	14	16	29	11
	Incidents on power generating facilities (G0)	1	-	27	8	16
Scale 1	Incidents on network elements (T1)	4	-	-	-	-
	Loss of tools, means and facilities (LT1)	2	2	2	2	4
	N-1 violation (ON1)	5	2	-	1	3
Grand Total		40	18	45	40	34

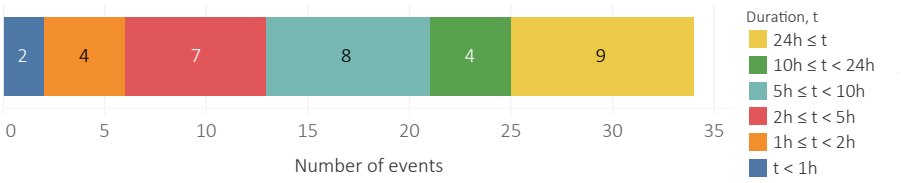

Figure 12.26: Number of events grouped by duration in 2021 for TransnetBW GmbH.

12.2 Overview of events per TSOs in the Nordic synchronous area

12.2.1 Events reported by Energinet (Nordic)

This section presents events for Energinet (Nordic), the TSO in Denmark. Table 12.53 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.54 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.27 presents the number of events grouped by duration in 2021.

Table 12.53: Monthly distribution of ICS events by ICS criterion in 2021 for Energinet (Nordic).

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	1	2	3	2	-	-	2	1	2	-	-	-	13
Grand Total		1	2	3	2	-	-	2	1	2	-	-	-	13

Table 12.54: The annual number of ICS events by ICS criterion from 2017 to 2021 for Energinet (Nordic). It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	1	2	5	15	13
Scale 1	Incidents on network elements (T1)	3	1	1	-	-
	Loss of tools, means and facilities (LT1)	-	2	-	2	-
	Separation from the grid (RS1)	-	-	-	1	-
Grand Total		4	5	6	18	13

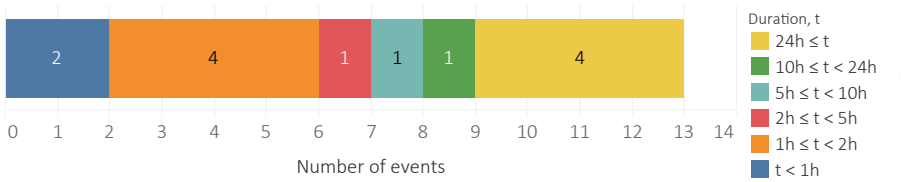

Figure 12.27: Number of events grouped by duration in 2021 for Energinet (Nordic).

12.2.2 Events reported by Fingrid Oyj

This section presents events for Fingrid Oyj, the TSO in Finland. Table 12.55 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.56 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.28 presents the number of events grouped by duration in 2021.

Table 12.55: Monthly distribution of ICS events by ICS criterion in 2021 for Fingrid Oyj.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	2	-	-	-	3	-	1	-	3	4	-	13
	Loss of tools, means and facilities (LT0)	-	-	-	-	-	-	-	-	1	-	-	-	1
Grand Total		-	2	-	-	-	3	-	1	1	3	4	-	14

Table 12.56: The annual number of ICS events by ICS criterion from 2017 to 2021 for Fingrid Oyj. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	-	4	6	4	13
	Incidents on power generating facilities (G0)	-	1	-	1	-
	Loss of tools, means and facilities (LT0)	-	-	1	-	1
	Violation of standards on voltage (OV0)	-	5	-	-	-
Scale 1	Incidents on network elements (T1)	4	3	-	-	-
Grand Total		4	13	7	5	14

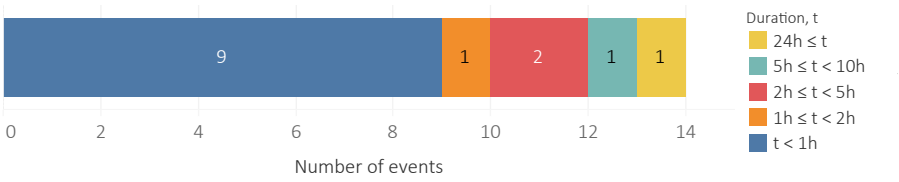

Figure 12.28: Number of events grouped by duration in 2021 for Fingrid Oyj.

12.2.3 Events reported by Statnett

This section presents events for Statnett, the TSO in Norway. Table 12.57 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.58 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.29 presents the number of events grouped by duration in 2021.

Table 12.57: Monthly distribution of ICS events by ICS criterion in 2021 for Statnett.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on load (L0)	-	-	-	-	-	-	-	-	-	-	2	-	2
	Incidents on network elements (T0)	-	2	-	1	1	3	3	-	-	1	6	2	19
	Incidents on power generating facilities (G0)	-	-	-	-	-	1	-	-	1	-	-	-	2
	Separation from the grid (RS0)	-	-	-	-	-	-	-	-	1	-	1	-	2
Scale 1	Incidents on network elements (T1)	-	-	-	-	-	-	-	-	1	-	1	-	2
	Separation from the grid (RS1)	-	-	-	-	-	-	1	-	-	-	-	-	1
Grand Total		-	2	-	1	1	4	4	-	3	1	10	2	28

Table 12.58: The annual number of ICS events by ICS criterion from 2017 to 2021 for Statnett. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on load (L0)	-	-	-	-	2
	Incidents on network elements (T0)	2	23	12	14	19
	Incidents on power generating facilities (G0)	-	-	1	2	2
	Loss of tools, means and facilities (LT0)	-	-	-	1	-
	Separation from the grid (RS0)	-	-	-	-	2
Scale 1	Incidents on load (L1)	2	3	2	1	-
	Incidents on network elements (T1)	9	2	-	2	2
	Loss of tools, means and facilities (LT1)	2	-	-	-	-
	N-1 violation (ON1)	-	2	-	2	-
	Separation from the grid (RS1)	-	-	-	-	1
Grand Total		15	30	15	22	28

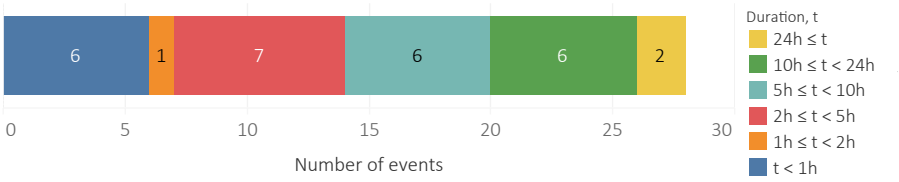

Figure 12.29: Number of events grouped by duration in 2021 for Statnett.

12.2.4 Events reported by Svenska Kraftnät

This section presents events for Svenska Kraftnät, the TSO in Sweden. Table 12.59 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.60 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.30 presents the number of events grouped by duration in 2021.

Table 12.59: Monthly distribution of ICS events by ICS criterion in 2021 for Svenska Kraftnät.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	6	2	4	3	5	6	6	8	4	3	5	4	56
	Incidents on power generating facilities (G0)	-	-	-	-	1	1	-	1	4	1	-	5	13
	Loss of tools, means and facilities (LT0)	4	3	3	-	1	-	2	4	2	2	-	-	21
Scale 1	Incidents on network elements (T1)	-	-	-	-	-	-	1	-	-	-	-	-	1
	Loss of tools, means and facilities (LT1)	1	-	-	-	-	-	-	-	-	-	-	-	1
Grand Total		11	5	7	3	7	7	9	13	10	6	5	9	92

Table 12.60: The annual number of ICS events by ICS criterion from 2017 to 2021 for Svenska Kraftnät. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents leading to frequency degradation (F0)	-	2	-	-	-
	Incidents on network elements (T0)	4	48	36	40	56
	Incidents on power generating facilities (G0)	-	-	-	2	13
	Loss of tools, means and facilities (LT0)	-	-	-	9	21
Scale 1	Incidents on network elements (T1)	17	1	-	1	1
	Loss of tools, means and facilities (LT1)	-	-	-	4	1
Grand Total		21	51	36	56	92

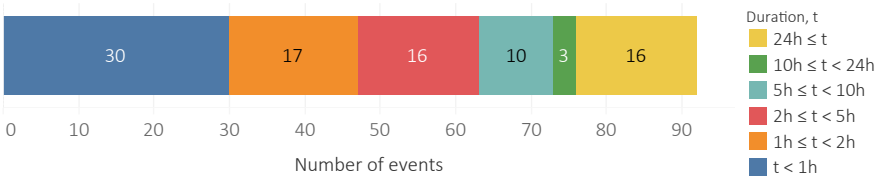

Figure 12.30: Number of events grouped by duration in 2021 for Svenska Kraftnät.

12.3 Overview of events per TSOs in Great Britain

12.3.1 Events reported by National Grid ESO

This section presents events for National Grid ESO, the TSO in Great Britain. Table 12.61 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.62 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.31 presents the number of events grouped by duration in 2021.

Table 12.61: Monthly distribution of ICS events by ICS criterion in 2021 for National Grid ESO.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents leading to frequency degradation (F0)	1	-	-	1	-	-	-	-	1	-	-	-	3
	Incidents on network elements (T0)	25	30	10	20	18	16	22	16	22	9	21	9	218
	Incidents on power generating facilities (G0)	1	2	1	2	1	1	1	1	1	-	-	3	14
	Loss of tools, means and facilities (LT0)	3	-	1	2	-	-	-	1	1	1	3	4	16
Scale 1	Loss of tools, means and facilities (LT1)	-	-	-	-	-	-	-	1	-	-	-	-	1
Grand Total		30	32	12	25	19	17	23	19	25	10	24	16	252

Table 12.62: The annual number of ICS events by ICS criterion from 2017 to 2021 for National Grid ESO. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents leading to frequency degradation (F0)	-	58	78	2	3
	Incidents on network elements (T0)	124	156	155	169	218
	Incidents on power generating facilities (G0)	2	3	-	12	14
	Loss of tools, means and facilities (LT0)	-	31	42	76	16
Scale 1	Incidents on network elements (T1)	10	-	-	-	-
	Loss of tools, means and facilities (LT1)	2	-	-	1	1
	N-1 violation (ON1)	-	2	-	-	-
Scale 2	Incidents leading to frequency degradation (F2)	-	-	1	-	-
Grand Total		138	250	276	260	252

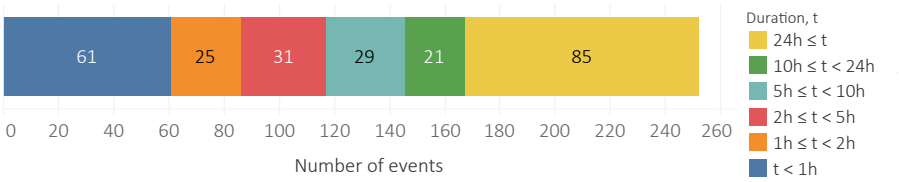

Figure 12.31: Number of events grouped by duration in 2021 for National Grid ESO.

12.4 Overview of events per TSOs in the Baltic area

12.4.1 Events reported by AS Augstsprieguma tīkls (AST)

This section presents events for AS Augstsprieguma tīkls (AST), the TSO in Latvia. Table 12.63 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.64 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.32 presents the number of events grouped by duration in 2021.

Table 12.63: Monthly distribution of ICS events by ICS criterion in 2021 for AS Augstsprieguma tīkls.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	1	-	-	-	3	-	1	-	-	-	1	6
	Incidents on power generating facilities (G0)	-	-	-	-	-	-	-	-	-	-	-	1	1
Grand Total		-	1	-	-	-	3	-	1	-	-	-	2	7

Table 12.64: The annual number of ICS events by ICS criterion from 2017 to 2021 for AS Augstsprieguma tīkls. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	6	7	6	4	6
	Incidents on power generating facilities (G0)	-	-	1	-	1
Scale 1	Incidents leading to frequency degradation (F1)	-	-	1	-	-
	Incidents on network elements (T1)	-	-	-	1	-
	Incidents on power generating facilities (G1)	-	-	-	1	-
	Loss of tools, means and facilities (LT1)	-	1	-	-	-
	N-1 violation (ON1)	-	-	-	1	-
	Violation of standards on voltage (OV1)	-	-	-	1	-
Scale 2	Incidents on load (L2)	-	-	-	1	-
Grand Total		6	8	8	9	7

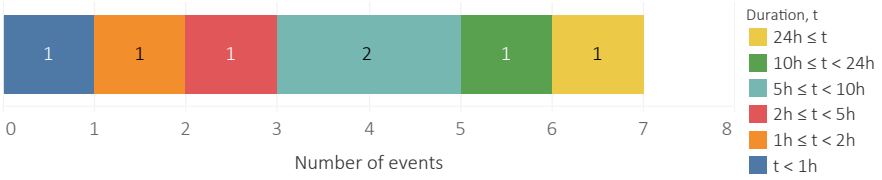

Figure 12.32: Number of events grouped by duration in 2021 for AS Augstsprieguma tīkls.

12.4.2 Events reported by Elering AS

This section presents events for Elering AS, the TSO in Estonia. Table 12.65 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.66 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.33 presents the number of events grouped by duration in 2021.

Table 12.65: Monthly distribution of ICS events by ICS criterion in 2021 for Elering AS.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	1	-	1	2	-	2	-	1	-	-	1	-	8
	Incidents on power generating facilities (G0)	1	1	1	1	2	1	2	2	-	2	2	-	15
Grand Total		2	1	2	3	2	3	2	3	-	2	3	-	23

Table 12.66: The annual number of ICS events by ICS criterion from 2017 to 2021 for Elering AS. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	5	6	14	7	8
	Incidents on power generating facilities (G0)	-	1	10	23	15
Scale 1	Incidents on network elements (T1)	3	-	-	-	-
Grand Total		8	7	24	30	23

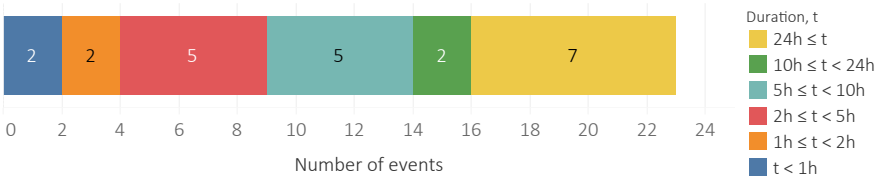

Figure 12.33: Number of events grouped by duration in 2021 for Elering AS.

12.4.3 Events reported by Litgrid AB

This section presents events for Litgrid AB, the TSO in Lithuania. Table 12.67 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.68 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.34 presents the number of events grouped by duration in 2021.

Table 12.67: Monthly distribution of ICS events by ICS criterion in 2021 for Litgrid AB.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	1	-	1	-	-	1	2	-	1	-	-	1	7
	Loss of tools, means and facilities (LT0)	-	-	1	-	-	-	-	-	-	-	-	-	1
Scale 1	Incidents on network elements (T1)	1	-	2	-	-	-	-	-	-	-	-	1	4
Grand Total		2	-	4	-	-	1	2	-	1	-	-	2	12

Table 12.68: The annual number of ICS events by ICS criterion from 2017 to 2021 for Litgrid AB. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	6	12	8	9	7
	Incidents on power generating facilities (G0)	-	1	-	3	-
	Loss of tools, means and facilities (LT0)	-	-	-	-	1
Scale 1	Incidents on load (L1)	-	-	2	1	-
	Incidents on network elements (T1)	8	-	3	4	4
Grand Total		14	13	13	17	12

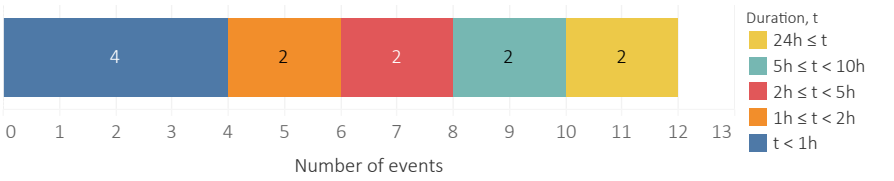

Figure 12.34: Number of events grouped by duration in 2021 for Litgrid AB.

12.5 Overview of events per TSOs in Ireland

12.5.1 Events reported by EirGrid

This section presents events for EirGrid, the TSO in Ireland. Table 12.69 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.70 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.35 presents the number of events grouped by duration in 2021.

Table 12.69: Monthly distribution of ICS events by ICS criterion in 2021 for EirGrid.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	1	1	-	-	2	1	-	1	1	1	-	8
	Incidents on power generating facilities (G0)	-	-	-	1	-	-	2	-	-	2	5	4	14
Scale 1	N-1 violation (ON1)	1	-	-	1	1	-	-	-	3	1	-	-	7
Grand Total		1	1	1	2	1	2	3	-	4	4	6	4	29

Table 12.70: The annual number of ICS events by ICS criterion from 2017 to 2021 for EirGrid. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents leading to frequency degradation (F0)	-	7	4	-	-
	Incidents on network elements (T0)	3	8	9	6	8
	Incidents on power generating facilities (G0)	23	7	8	19	14
Scale 1	Incidents on network elements (T1)	2	-	-	-	-
	Loss of tools, means and facilities (LT1)	2	-	-	-	-
	N-1 violation (ON1)	-	-	-	3	7
Scale 2	Incidents leading to frequency degradation (F2)	-	1	-	-	-
Grand Total		30	23	21	28	29

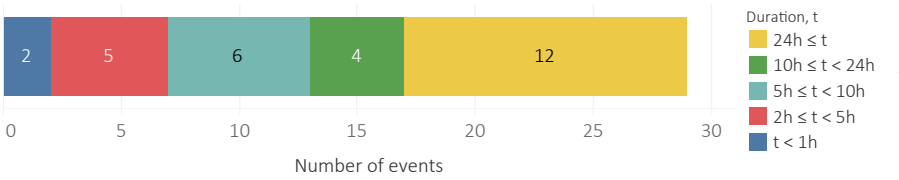

Figure 12.35: Number of events grouped by duration in 2021 for EirGrid.

12.5.2 Events reported by SONI

This section presents events for SONI, the TSO in Northern Ireland. Table 12.71 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.72 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.36 presents the number of events grouped by duration in 2021.

Table 12.71: Monthly distribution of ICS events by ICS criterion in 2021 for SONI.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	-	-	-	-	-	2	-	-	1	-	-	-	3
Scale 1	N-1 violation (ON1)	-	-	-	-	-	-	-	-	1	-	-	-	1
Grand Total		-	-	-	-	-	2	-	-	2	-	-	-	4

Table 12.72: The annual number of ICS events by ICS criterion from 2017 to 2021 for SONI. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents leading to frequency degradation (F0)	-	1	-	-	-
	Incidents on network elements (T0)	-	1	-	2	3
	Incidents on power generating facilities (G0)	1	-	2	-	-
Scale 1	Incidents on network elements (T1)	4	-	-	-	-
	N-1 violation (ON1)	-	-	-	-	1
Grand Total		5	2	2	2	4

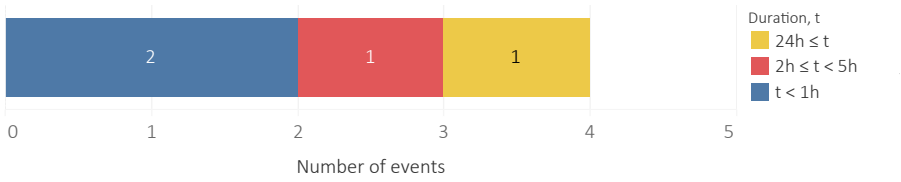

Figure 12.36: Number of events grouped by duration in 2021 for SONI.

12.6 Overview of events per TSOs in isolated systems

12.6.1 Events reported by TSO-Cyprus

This section presents events for TSO-Cyprus, the TSO in Cyprus. Table 12.73 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Cyprus TSO has not had any events since 2017.

Table 12.73: The annual number of ICS events by ICS criterion from 2017 to 2021 for TSO-Cyprus. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Reduction of reserve capacity (RRC0)	-	-	-	-	-
Scale 1	Incidents on load (L1)	4	-	-	-	-
Scale 2	Incidents leading to frequency degradation (F2)	-	-	-	-	-
	Incidents on load (L2)	1	-	-	-	-
	Incidents on network elements (T2)	-	-	-	-	-
	Incidents on power generating facilities (G2)	-	-	-	-	-
	Loss of tools, means and facilities (LT2)	-	-	-	-	-
	N violation (ON2)	-	-	-	-	-
	Reduction of reserve capacity (RRC2)	-	-	-	-	-
	Separation from the grid (RS2)	-	-	-	-	-
	Violation of standards on voltage (OV2)	-	-	-	-	-
Scale 3	Blackout (OB3)	-	-	-	-	-
Grand Total		5	-	-	-	-

12.6.2 Events reported by Landsnet

This section presents events for Landsnet, the TSO in Iceland. Table 12.74 presents the monthly distribution of ICS events by ICS criterion in 2021, and Table 12.75 presents the annual number of ICS events by ICS criterion from 2017 to 2021. Figure 12.37 presents the number of events grouped by duration in 2021.

Table 12.74: Monthly distribution of ICS events by ICS criterion in 2021 for Landsnet.

		2021												
Scale	ICS criterion	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Scale 0	Incidents on network elements (T0)	5	3	2	3	-	1	-	-	7	1	3	1	26
Scale 1	Incidents on network elements (T1)	-	-	-	-	-	-	-	-	-	-	-	1	1
	Incidents on power generating facilities (G1)	-	1	-	-	-	-	-	-	-	-	-	1	2
Scale 2	Loss of tools, means and facilities (LT2)	-	-	-	-	-	1	-	-	-	-	-	-	1
Grand Total		5	4	2	3	-	2	-	-	7	1	3	3	30

Table 12.75: The annual number of ICS events by ICS criterion from 2017 to 2021 for Landsnet. It should be noted that the recorded values for 2016–2019 aggregate all related ICS events into ICS incidents, with the ICS criteria set to the event with the highest priority according to Table 2.1.

Scale	ICS criterion	2017	2018	2019	2020	2021
Scale 0	Incidents on network elements (T0)	5	10	5	29	26
	Incidents on power generating facilities (G0)	1	-	4	3	-
	Loss of tools, means and facilities (LT0)	-	-	-	1	-
Scale 1	Incidents on load (L1)	3	-	-	1	-
	Incidents on network elements (T1)	6	3	7	12	1
	Incidents on power generating facilities (G1)	2	-	-	-	2
Scale 2	Incidents on load (L2)	1	1	-	-	-
	Loss of tools, means and facilities (LT2)	-	1	-	-	1
Grand Total		18	15	16	46	30

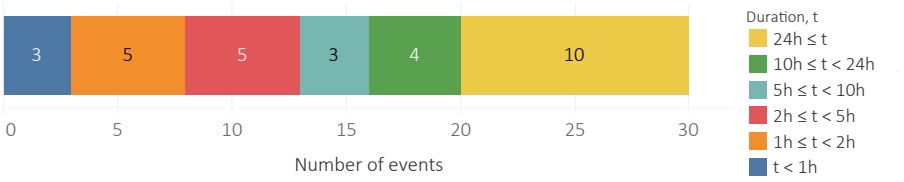

Figure 12.37: Number of events grouped by duration in 2021 for Landsnet.

13 Conclusion

The ENTSO-E ICS Methodology has been revised multiple times since its initial publication in 2014. The 2021 ICS Annual Report follows the most recent version, the 2019 ICS Methodology [3]. The 2021 Annual Report provides a clear overview of the incidents that took place within each TSO. This pan-European assessment does not include GB.

The ENTSO-E Members reported a total of 3893 ICS events for the year 2021, of which 3063 were scale 0, 812 were scale 1 and 17 were scale 2. No scale 3 incidents were reported. There were 177 more events than incidents. The similar number of ICS events and ICS incidents in the pan-European transmission grids indicates that most ICS incidents only had one ICS event. The term ICS event differs from ICS incident as an incident may contain multiple events.

Approximately 87 % of all ICS events took place in CE, which is expected as 27 of the 39 TSOs reside there. The region dominated the number of incidents at all scales. 16 of the 17 scale 2 ICS events in 2021 took place in CE. All the reported scale 2 incidents in CE were related to the three scale 2 incidents described in Chapter 4. The number of reported ICS events on all scales reached an all-time high in 2021, with more than double the number of scale 1 and 2 events registered compared to 2020. Increases are mainly seen in F0, T0, F1, OV1 events on scale 0 and 1. No scale 2 criteria cannot be singled out as the reason behind the increase because many were triggered in 2021.

13.1 Recommendations from the ICS Subgroup

As required by the SOGL [1], the ICS Subgroup should provide recommendations to improve operational security in the European power grids. The ICS subgroup has identified a high increase in ICS events due to violations of standards on voltage (OV0 and OV1), frequency degradation (F0 and F1) and trips of network elements (T0). All voltage violations were registered in CE, and F and T events were mainly registered in CE but also occurred in other synchronous areas.

The ICS Subgroup strongly recommends TSOs that registered voltage violations to investigate the reason behind these events and find ways to prevent these in the future. The subgroup also advocates TSOs who registered many T events to analyse if there are any actions available to prevent the increase from continuing. Methods to mitigate frequency impacts are covered in the Annual Load-Frequency Report, also published by ENTSO-E.

Finally, approximately 30 % of the incidents due to contingencies from the contingency-list are due to causes other than unexpected discrepancies from load and generation forecasts, as seen from the OS indicators relevant to OPS in Section 5.2. This indicates that this number could be decreased significantly by improving the accuracy of load and generation forecasts in CE.

References

[1] European Commission, "COMMISSION REGULATION (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation," Aug 2017.

[2] ENTSO-E, "ENTSO-E Grid Disturbance Definitions for the Power System above 100 kV." https://www.entsoe.eu/publications/system-operations-reports/#entso-e-grid-disturbance-definitions-for-the-power-system-above-100-kv, June 2021.

[3] Incident Classification Scale Subgroup, "Incident Classification Scale Methodology." https://eepublicdownloads.entsoe.eu/clean-documents/SOC%20documents/Incident_Classification_Scale/200629_Incident_Classification_Scale_Methodology_revised_and_in_use_as_of_2020.pdf, December 2019.

[4] ENTSO-E, "ENTSO-E Power Statistics." https://www.entsoe.eu/data/power-stats/, September 2019. [Online; accessed 30.09.2019. Discontinued in November 2019.].

[5] Incident Classification Scale Subgroup, "Incident Classification Scale Methodology." https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/SOC%20documents/Incident_Classification_Scale/2014_ICS_Methodology.pdf, May 2014.

[6] Incident Classification Scale Subgroup, "Incident Classification Scale Methodology." https://doc-store.entsoe.eu/Documents/SOC%20documents/Incident_Classification_Scale/180411_Inci-dent_Classification_Scale.pdf, April 2018.

[7] ENTSO-E, "ENTSO-E Transparency Platform." https://transparency.entsoe.eu/, September 2019. [Online; accessed 9.7.2021].

[8] ENTSO-E, "Load-Frequency Control Annual Reporting." https://www.entsoe.eu/network_codes/sys-ops/annual-reports/#load-frequency-control, September 2022.