European Network of
Transmission System Operators
for Electricity

2014 ICS Annual Report

Working Group Incident Classification Scale

5 November 2015

Contents

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Introduction

The 2014 annual report of the incident classification scale is prepared according to the incident classification scale [1] developed by ENTSO-E pursuant to the Article 8(3)(a) of the Regulation (EC) 714/2009.

The incident classification scale that has been approved by ENTSO-E's System Operations Committee and Assembly was submitted to ACER for opinion pursuant to Article 9(2) of the Regulation (EC) 714/2009. The methodology was approved by the Agency on 19 September 2014.

The system operation guideline [2] is subject to comitology and formal legal approval, therefore the incident classification scale may need further improvements in order to be compliant with the final approved version of the system operation guideline.

Recording of the incidents according to the common classification enables:

- monitoring of the number of incidents and system performance during the year, comparisons with previous years;
- identifying occurrences of high risk to a breach of system security;
- identification of incident investigations to be organised; and
- analysis of the incidents and the potential to improve system operation guideline.

The harmonization has been initiated between ICS and EAS. The predefined messages of EAS are linked to the classification of the incidents detailed in the incident classification scale methodology. As a next step the data of ICS and EAS shall be compared and the opportunities for further harmonization shall be explored. The current operational security indicators mentioned in the system operation guideline are presented and commented in this annual report.

The annual report is a collation of the reports prepared by each transmission system operator, classified according to the incident classification scale methodology and aggregated at a synchronous area level. To facilitate the production of the annual report it is proposed that a process will be set up through which transmission system operators will collectively analyse the relevance of the incidents during the year. The report provides a detailed analysis of the incidents on scale 1 to 3 at a synchronous area level and a high level summary of scale 0 incidents.

The 2014 annual report of the incident classification scale covers the incident reports from 95% of the ENTSO-E members. The commitment of transmission system operators to classify and report the incidents has considerably increased compared to the previous year when 71% of the ENTSO-E members reported their incidents. This explains the significant increase in the total number of the incidents from one year to another. 460 incidents were reported more in 2014 compared to 2013, this corresponds to the increase of 58% in the number of incident reports. On the other hand, the proportion between the number of scale 1 incidents to the number of scale 0 incidents was similar in both years showing that the increase in absolute numbers is the result of more active reporting.

The analysis of the reports shows the need for further harmonization in the way the methodology and definitions are used by the transmission system operators while classifying the incidents. This issue shall be addressed during the process of updating the methodology in 2016.

The report is organized to provide three types of information:

- statistical data per synchronous area;
- analysis from the working group and other ENTSO-E bodies and recommendations to improve security of the system; and
- recommendations to improve the methodology.

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Incident classification scale

The criteria for incident classification have been defined by using definitions from system operation guideline and IEC standards. Each criterion describes factually an incident or a situation which is observable.

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 which occurred in 2014, only the incidents which meet the criteria of the incident classification scale are included.

The incident classification scale has 4 levels increasing in severity up to a general Europe wide incident. It is compliant with the definitions of the system states in the system operation guideline:

scale 0 for anomaly;

scale 1 for noteworthy disturbances;

scale 2 for extensive incidents; and

scale 3 for widespread incidents or major incidents in the control area of one transmission system operator.

Table 1. Incident classification scale

Scale 0 Anomaly		Scale 1 Noteworthy disturbance		Scale 2 Extensive incidents		Scale 3 Widespread incident or major incident	
Priority / Short definition (Criterion short code)		Priority - Short definition (Criterion short code)		Priority - Short definition (Criterion short code)		Short definition (Criterion short code)	
#17	Events on load (L0)	#9	Events on load (L1)	#2	Events on load (L2)	#1	Blackout (OB3)
#18	Disturbance leading to frequency degradation (F0)	#10	Disturbance leading to frequency degradation (F1)	#3	Disturbance leading to frequency degradation (F2)		
#19	Disturbance on transmission network equipment (T0)	#11	Disturbance on transmission network equipment (T1)	#4	Disturbance on transmission network equipment (T2)		
#20	Disturbances on Power Generating Facilities (G0)	#12	Disturbances on Power Generating Facilities (G1)	#5	Disturbances on Power Generating Facilities (G2)		
#21	Violation of standards on voltage (OV0)	#13	N-1 violation (ON1)	#6	N violation (ON2)		
		#14	Violation of standards on voltage (OV1)	#7	Separation from the grid (RS2)		
		#15	Lack of reserve (OR1)	#8	Loss of tools and facilities (LT2)		
		#16	Loss of tools and facilities (LT1)				

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Global overview

System operation review

The winter review 2013/2014 [3] shows that the temperatures across Europe were above average. As a result, the power demand was below or around seasonal average in all countries.

However in some regions winter was exceptionally stormy:

UK experienced the stormiest period of weather for the last 20 years. 12 major winter storms in the UK resulted in severe flooding in many parts;

In Ireland a winter storm caused multiple power outages across the country on 12 February, leaving around 250 000 people without power supply;

In France a winter storm caused the outage of two nuclear units in Flamanville (2 x 1300MW). The situation returned to normal within the following hours;

The HVDC link between Greece and Italy suffered a cable fault during the winter. It was available again in July 2014;

Except for faults caused by winter storms, no critical situation related to system adequacy occurred in Europe during the last winter.

In the summer review 2014 [4] the majority of countries reported an average or milder summer compared to previous years. A small number of countries reported high precipitation and flooding.

Peak demand was generally lower than what was predicted in the summer outlook report and there were no reports of unusually high demand. A number of countries reported congestion issues on parts of the network including some interconnector sites. The majority of countries did not report any system adequacy issues over the summer, only Latvia had a shortfall which resulted in congestion on its borders.

In other countries there were some reports on system security issues, such as system faults leading to boundary constraints.

Poland was affected by unscheduled flows through the system from the west to the south. The Polish transmission system operator had to activate remedial actions several times to fulfil N-1 criteria, including high volumes of bilateral redispatching. The amount of monthly energy redispatched bilaterally in July was up to 104 GWh and was almost three times higher than the historical peak from December 2013. On 22 July 2014 bilateral redispatch on the Polish transmission system operator western border reached the historically highest level of 1600 MW.

The following chapters give the statistical overview of incidents which occurred at pan-European level in 2014.

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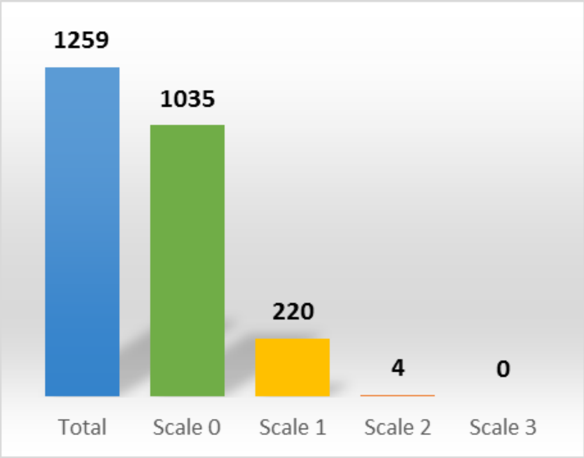
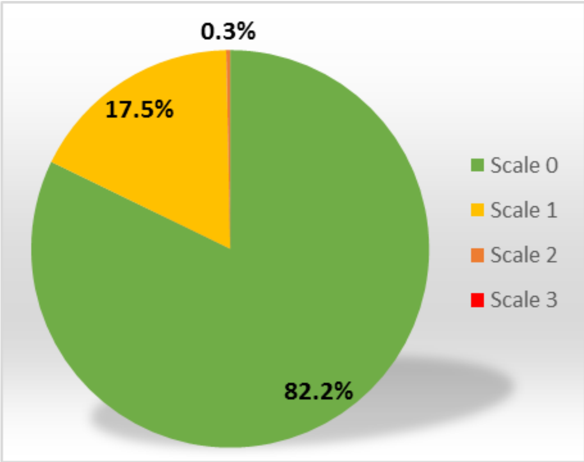
Number of classified incidents

Figure 1. Classified incidents in 2014 by scale



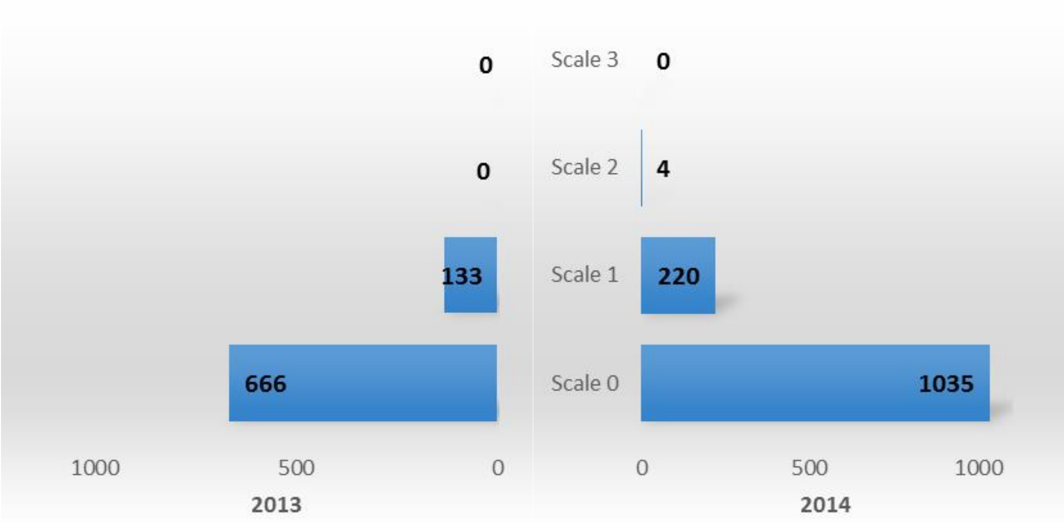
Transmission system operators recorded 1259 classified incidents in 2014.

Figure 2. Percentage of classified incidents by scale



82,2% of the reported incidents were in scale 0 and 17,5% in scale 1. Four scale 2 incidents were reported during 2014.

Figure 3. Comparison of reported incidents by scale in 2013 and 2014



The number of scale 0 incidents increased 55% from one year to another, the number of scale 1 incidents 65%. This change is the result of significantly increased number of incident reports. The proportion of the number of incidents in scale 1 to scale 0 in 2014 was similar to the previous year 2013. In both years approximately 5 times more incidents were classified as scale 0 compared to the number of scale 1 incidents.

Figure 4. Number of incidents per synchronous area

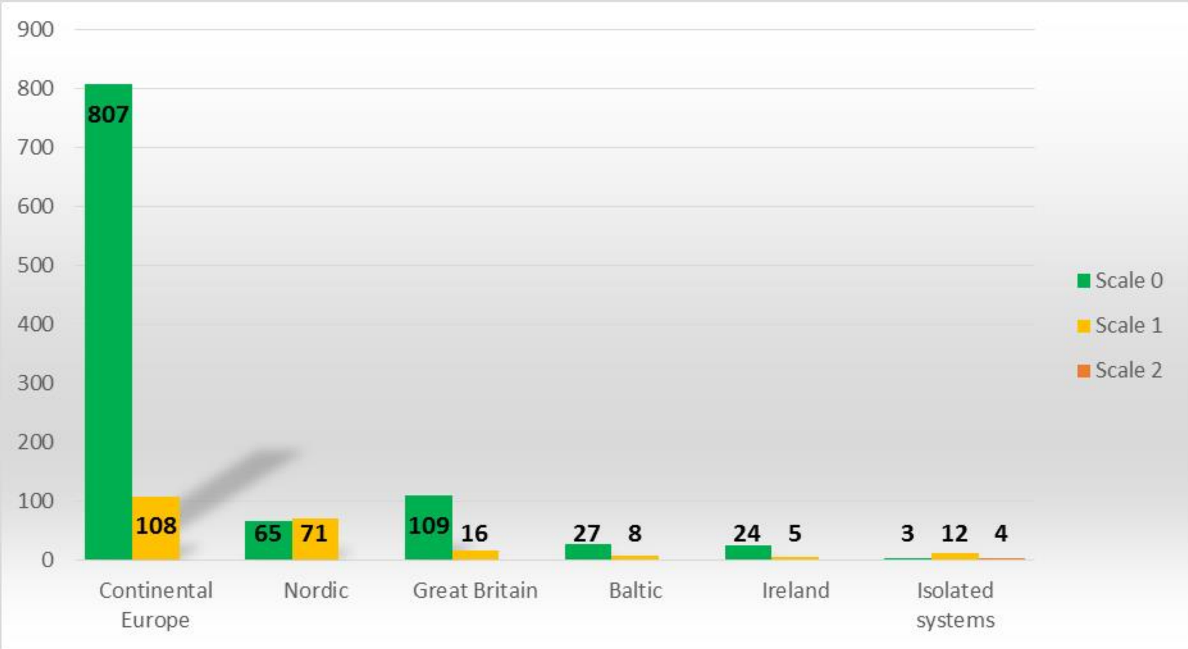
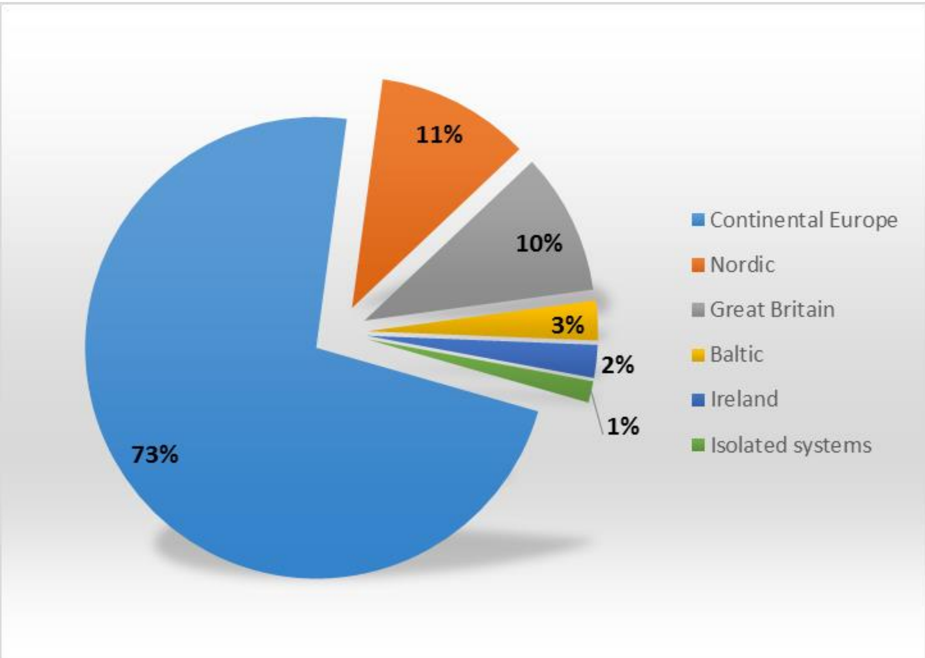


Figure 5. Distribution of incidents by synchronous areas



Incidents reported in synchronous area Continental Europe represent the largest part – 73% of all the classified incidents.

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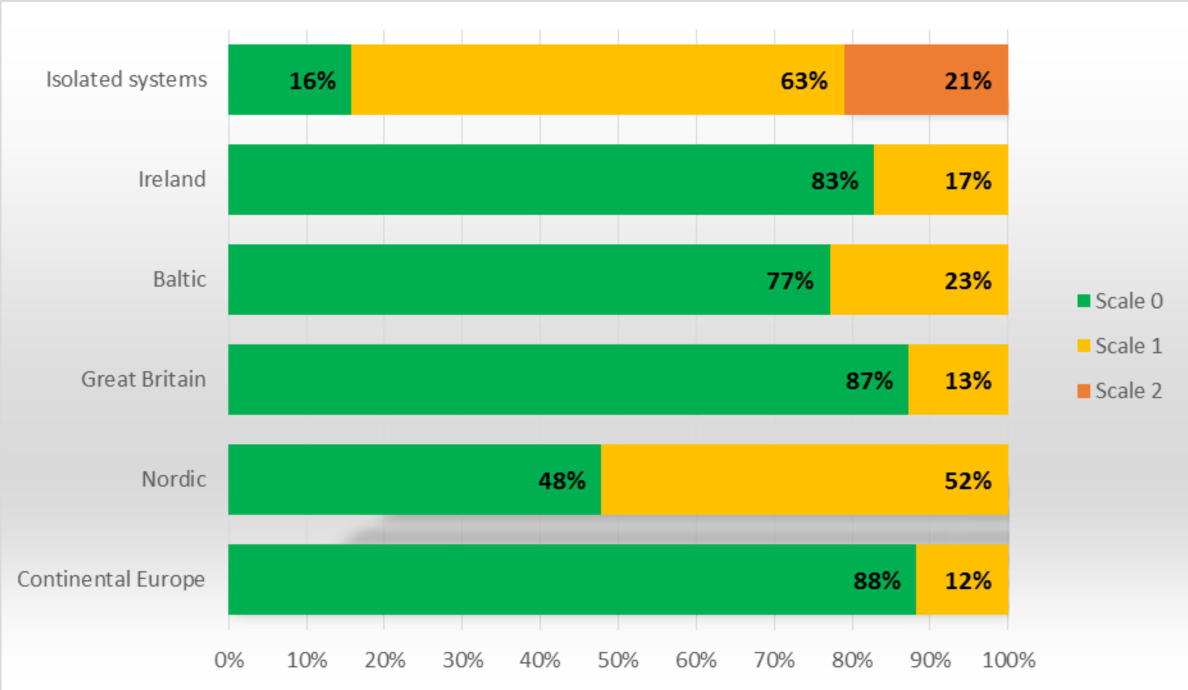
Figure 6. Proportions between scale 0, 1 and 2 incidents per synchronous area



In the Nordic synchronous area the number of reported scale 1 incidents was almost equal to the number of scale 0 incidents. There were many scale 1 incidents on HVDC interconnectors leading to the reduction of the cross-border exchange capacity.

In the isolated systems over 60% of the incidents were classified as scale 1 incidents, while the number of scale 0 incidents and the number of scale 2 incidents was similar.

In Continental Europe, Baltic area, Great Britain and Ireland the proportion between scale 0 and scale 1 incidents is alike: around 80% of the incidents are scale 0 incidents and approximately 20% scale 1 incidents.

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The table below contains a global overview of the pan-European number and type of incidents which occurred in 2014.

Table 2. Incidents by criteria

Criteria scale 0	Number of incidents	Criteria scale 1	Number of incidents	Criteria scale 2	Number of incidents
Total number of classified scale 0 incidents	**1035**	**Total number of classified scale 1 incidents**	**220**	**Total number of classified scale 2 incidents**	**4**
Events on load: disconnection of 1-5% of actual load of TSO before the incident	21	Events on load: disconnection of 5-10% of actual load of TSO before the incident (5-15% for isolated systems)	11	Events on load: disconnection of 10-50% of actual load of TSO before the incident (15-70% for isolated systems)	4
Disturbance leading to frequency degradation	5				
Disturbance on transmission network equipment: final tripping of equipment with no violations of operational security limits and no effect on available cross-border transmission capacity	820	Disturbance on transmission network equipment: final tripping of equipment causing violations of operational security limits or/and with effect on available cross-border transmission capacity	120		
Disturbance on generation facilities: loss of generation according to scale 0 thresholds	129	Disturbance on generation facilities: loss of generation according to scale 1 thresholds	3		
		N-1 violation	45		
Violation of standards on voltage from 5 to 15 minutes	60	Violation of standards on voltage for more than 15 minutes	11		
		Lack of reserve: lack of more than 20% of frequency restoration reserve for at least 30 minutes	2		
		Loss of tools and facilities: loss of one or more tools or facilities for more than 30 minutes	28		

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Table 3. Summary of scale 1 incidents by synchronous area

	Criteria	Continental Europe	Nordic	Great Britain	Baltic	Ireland	Isolated systems
1	**Events on load (L1)**	1					10
2	**Disturbance on transmission network equipments (T1)**	36	63	6	8	5	2
3	**Disturbance on generation facilities (G1)**	3					
4	**N-1 violation (ON1)**	45					
5	**Violation of standards on voltage (OV1)**		4	7			
6	**Lack of reserve (OR1)**	2					
7	**Loss of tools and facilities (LT1)**	21	4	3			

Incidents per length of circuit and energy consumption

The figures below show the ratio between the number of incidents and the annual consumption and the ratio between number of incidents and length of circuit.

Information about the length of circuits on 31 December 2014 and the energy consumption in 2014 is taken from ENTSO-E data portal [5].

Figure 7. Number of incidents per 1 TWh of energy consumption

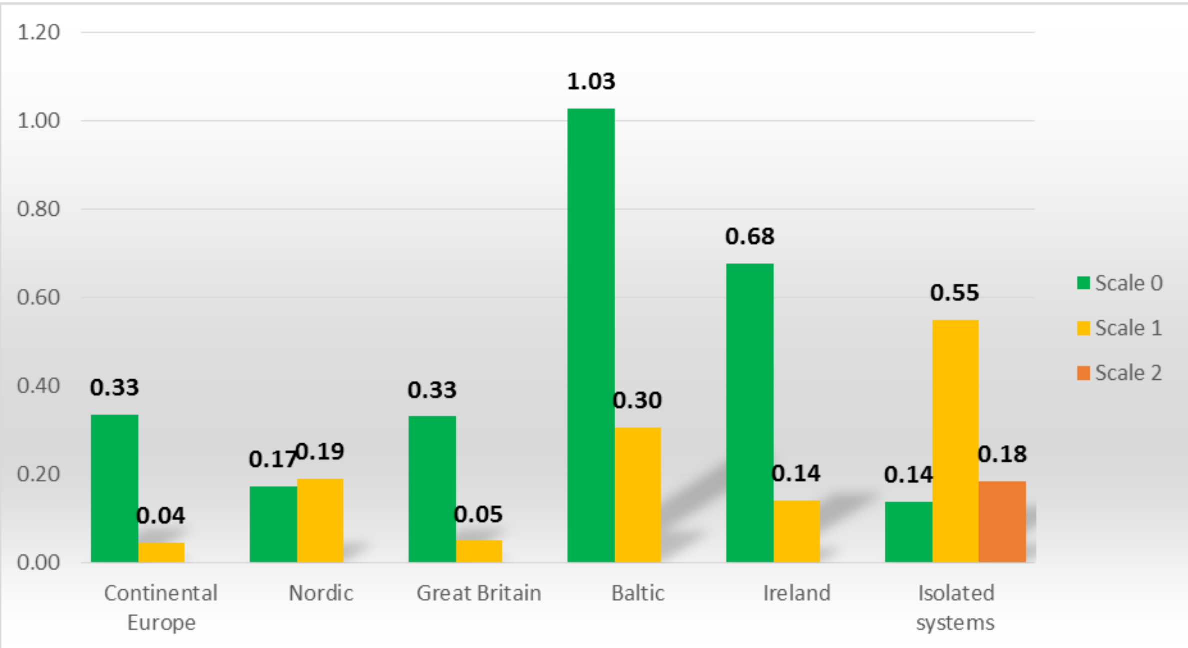

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Figure 8. Number of incidents per 100 km of circuit

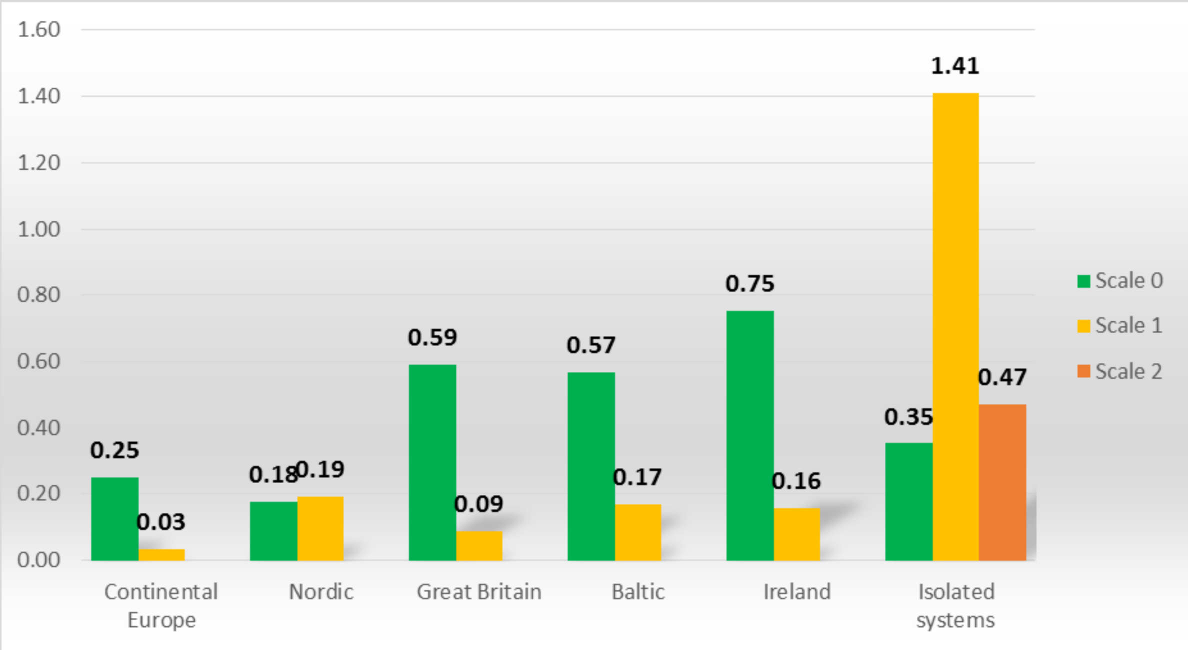
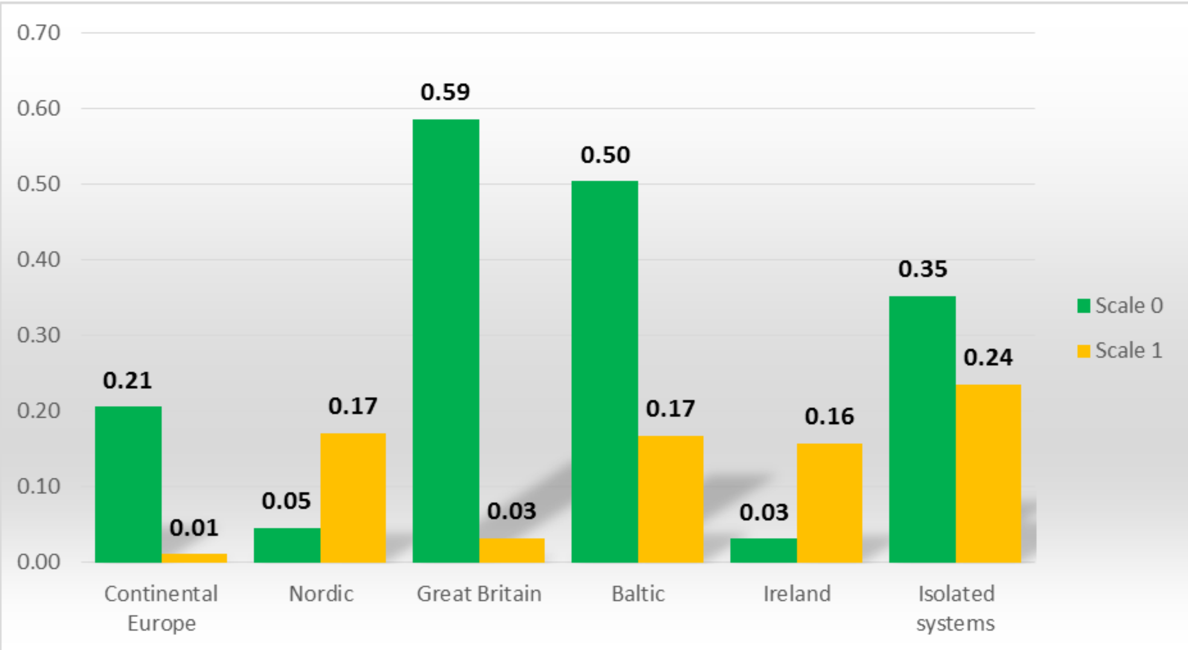


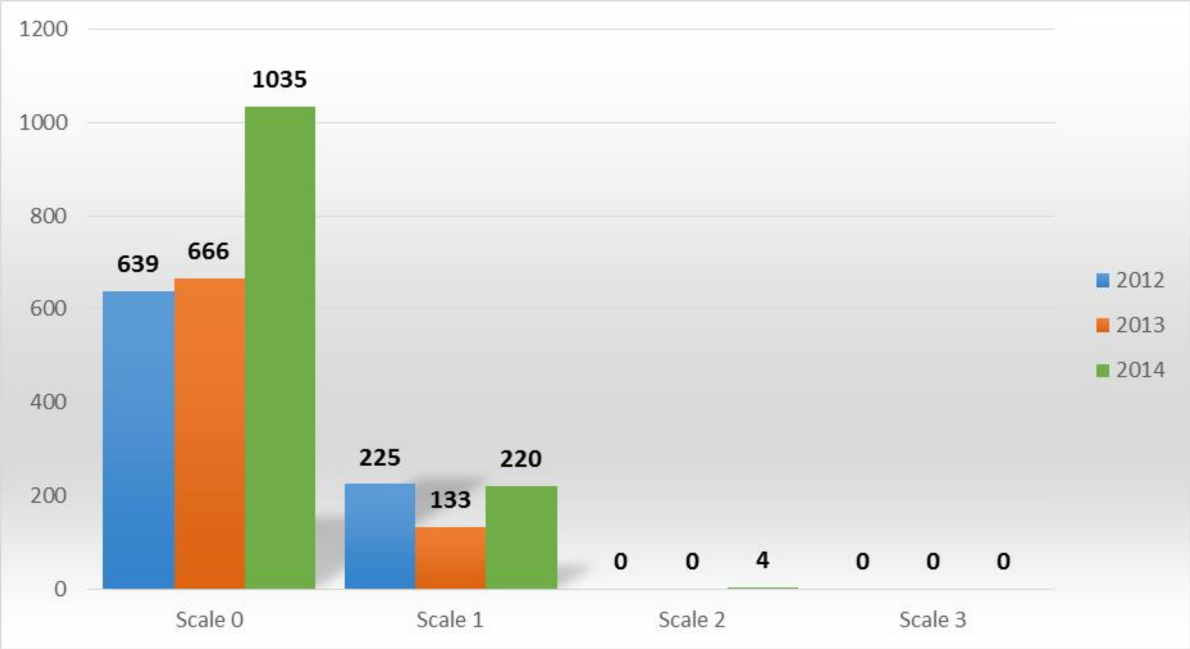
Figure 9. Number of incidents resulting in final tripping of transmission network equipment per 100 km of circuit:



Evolution from 2012 to 2014

The number of scale 0 incidents increased significantly between 2012 and 2014 – 639 in 2012, to 1035 in 2014. The number of scale 1 incidents was similar in 2012 and 2014, while in 2013 less scale 1 incidents were reported.

Figure 10. Incidents by scale from 2012 to 2014



For Continental Europe the indicators per 100 km of circuit and per 1 TWh of energy consumption are similar during all three years. For the other areas one or more indicators have changed significantly from 2012 to 2014.

Figure 11. Number of scale 0 incidents per 100 km of circuit

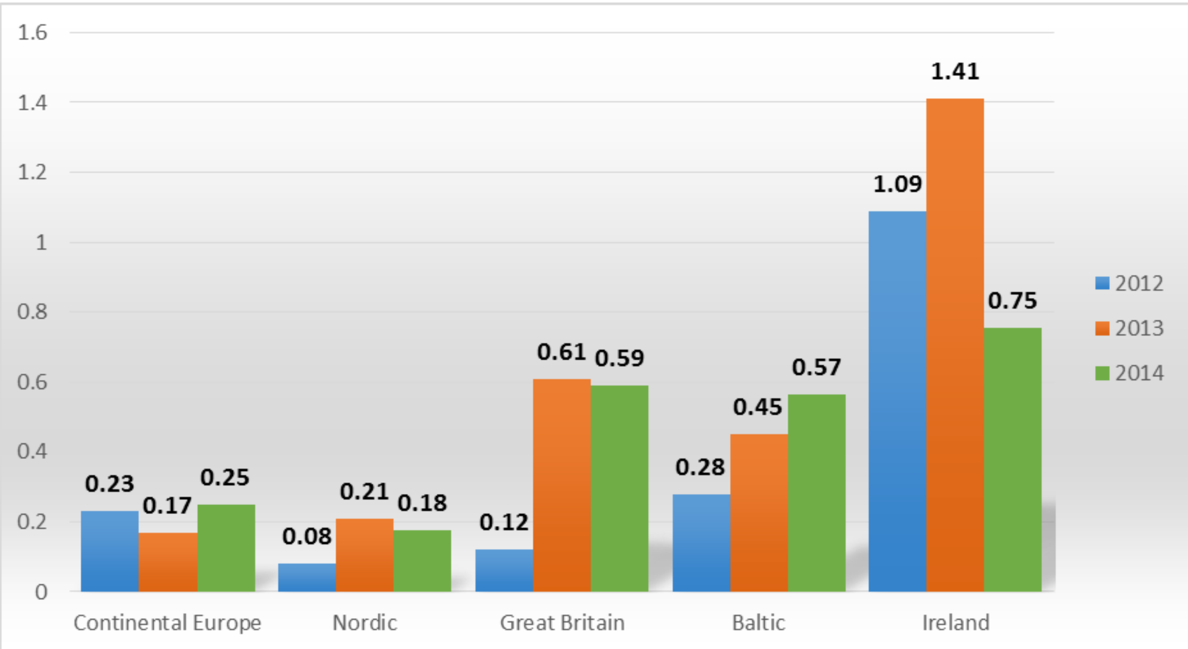


Figure 12. Number of scale 0 incidents with transmission network equipment per 100 km of circuit

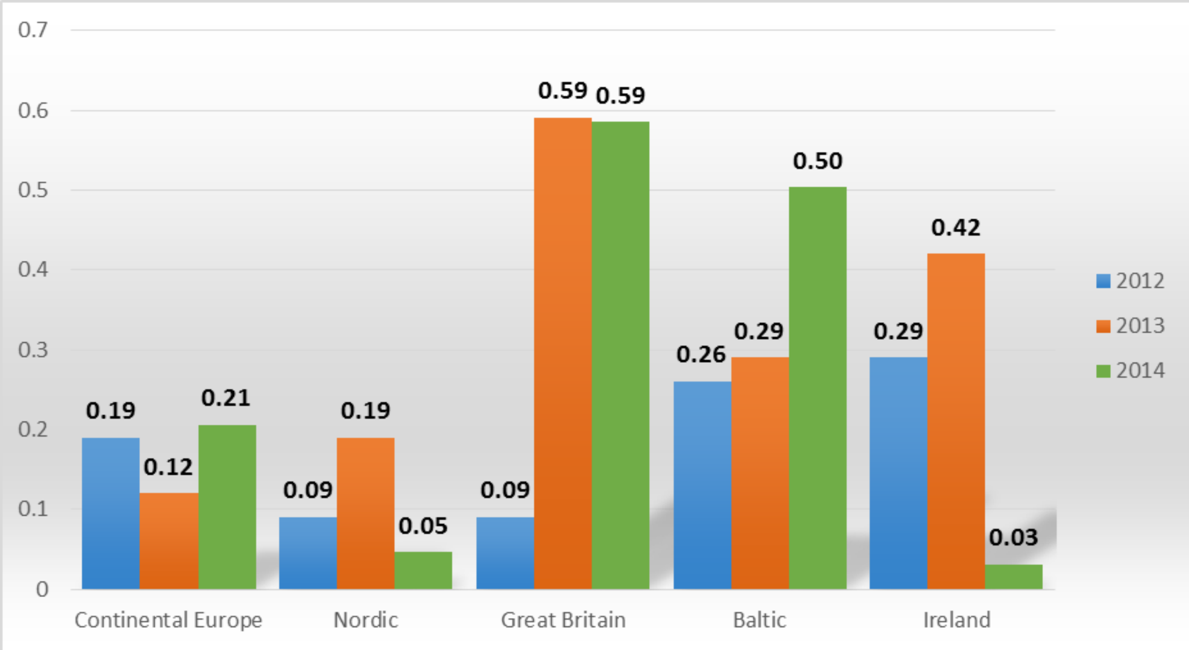


Figure 13. Number of scale 0 incidents per 1 TWh of energy consumption

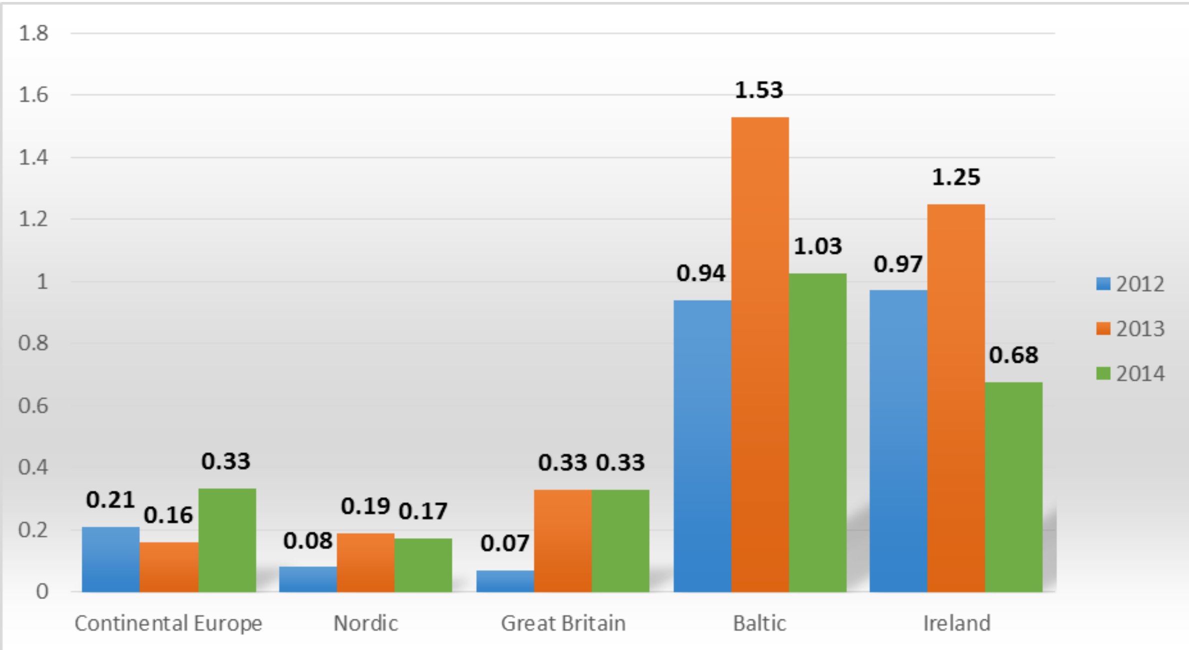


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Figure 14. Number of scale 1 incidents per 100 km of circuit

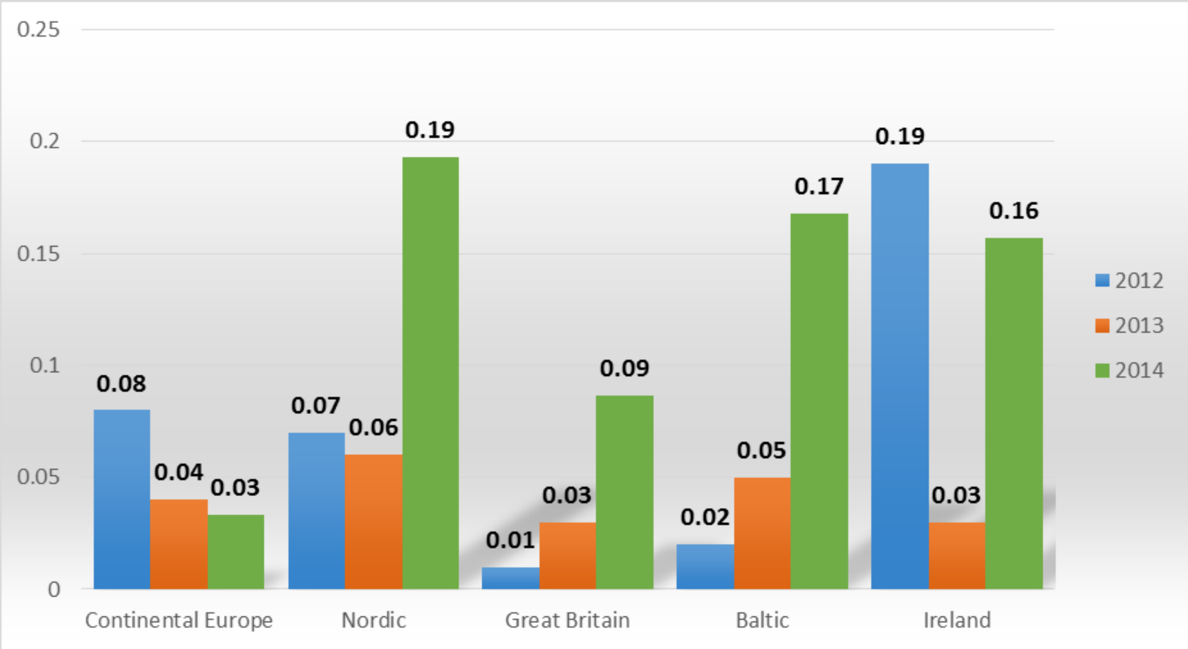

Figure 15. Number of scale 1 Incidents on transmission network per 100 km of circuit

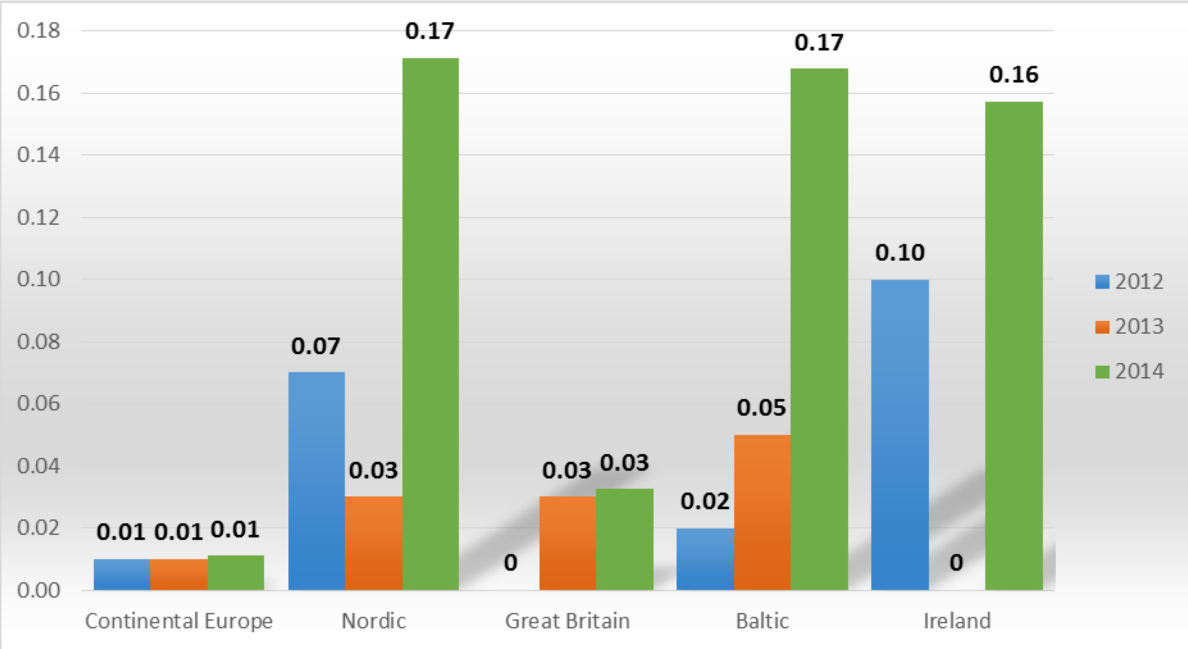

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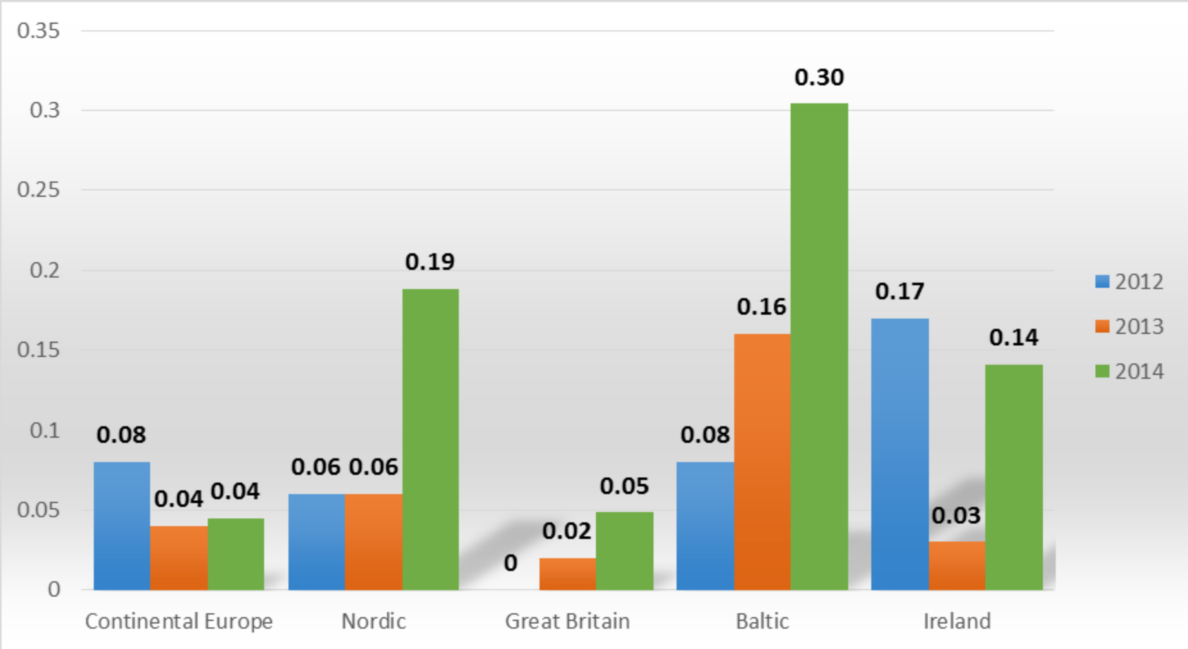
Figure 16. Number of scale 1 incidents per 1 TWh of energy consumption



The data for synchronous areas is not directly comparable because the network design is adapted to the specificity of the countries, the energy mix and the operational conditions (for example weather) are very different from one synchronous area to another. ICS methodology is also not designed to compare synchronous areas.

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Operational security indicators

List of operational security indicators

Article 10 of the system operation guideline states that each TSO shall contribute to the yearly report of the incidents classification scale.

The operational security indicators relevant for operational security are the following:

OS-A: number of tripped transmission system elements per year; it is calculated adding up all transmission network elements tripped in any incident in scale 1, 2 or 3.

OS-B: number of tripped power generation facilities per year; it is calculated adding up all power generation facilities tripped in any incident in scale 1, 2 or 3 with dominating or subsidiary criterion G1 or G2.

OS-C: energy not supplied per year due to unscheduled disconnection of demand facilities; it is calculated adding up all energy not supplied in any incident in scale 1, 2 or 3 with dominating or subsidiary criterion L1 or L2.

OS-D: time duration of being in operational states other than normal state; it is calculated adding up all the time that a transmission system operator has declared to have been in alert, emergency, blackout or restoration state. If two or more transmission system operators have been in an operational state other than normal state at the same time, the time is considered separately for each transmission system operator.

OS-E: time duration within which there was a lack of reserves identified; it is calculated adding up all the time with lack of reserves identified in any incident in scale 1, 2 or 3 with dominating or subsidiary criterion OR1.

OS-F: the number of voltage deviations exceeding the voltage thresholds for normal state; it is calculated by adding up the number of incidents in scale 1, 2 or 3 with dominating or subsidiary criteria OV1.

OS-G1: number of events within which there was a frequency deviation per Synchronous Area; it is calculated by adding up all the incidents in scale 1, 2 or 3 with dominating or subsidiary criteria F1 or F2. The incidents are calculated once per synchronous area. In case two transmission system operators have reported frequency deviation at the same time it is counted once.

OS-G2: time duration within which there was a frequency deviation per synchronous area; it is calculated by adding up all the time with frequency deviation in any incident in scale 1, 2 or 3 with dominating or subsidiary criteria F1 or F2. The incidents are calculated once per synchronous area. In case two transmission system operators have reported frequency deviation at the same time it is counted once.

OS-H: number of system-split, separations or local blackouts; it is calculated by adding up all the incidents in scale 2 or 3 with dominating or subsidiary criteria RS2.

OS-I: number of blackouts involving two or more transmission system operators; it is calculated by adding up all the incidents with criteria OB3.

According to this calculation methodology for the operational security performance indicators, the values for each synchronous area for the year 2014 are as follows:

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Table 4. Operational security indicators relevant for operational security for each synchronous area

	Indicator	Continental Europe	Nordic	Great Britain	Baltic	Ireland	Isolated systems
1	**OS-A [Tripped Elements]**	60	67	13	8	5	35
2	**OS-B [Tripped PGF]**	4	0	1	0	0	1
3	**OS-C [Energy not Supplied MWh]**	152	0	0	0	0	807
4	**OS-D [minutes]**	209 040	144 979	2 890	59 424	514	252
5	**OS-E [minutes]**	97	0	0	0	0	0
6	**OS-F [Incidents]**	0	4	7	0	0	0
7	**OS-G1 [Incidents]**	0	0	0	0	0	1
8	**OS-G2 [minutes]**	0	0	0	0	0	45
9	**OS-H [Incidents]**	0	0	0	0	0	0
10	**OS-I [Blackouts]**	0	0	0	0	0	0

The operational security indicators relevant for operational planning and scheduling are the following:

OPS-1A: the number of events in which an incident contained in the contingency list led to a degradation of system operation conditions; it is calculated adding up all incidents in scale 1, 2 or 3, with a dominating or subsidiary criteria with loss of one transmission system element.

OPS-1B: the number of events counted by indicator OPS-1A in which a degradation of system operation conditions occurred as a result of unexpected discrepancies of demand or generation forecast; it is calculated adding up all incidents in scale 1, 2 or 3 with dominating or subsidiary criteria OR1 and loss of one transmission system element.

OPS-2A: the number of events in which there was a degradation in system operation conditions due to an out-of-range contingency; it is calculated adding up all incidents in scale 1, 2 or 3, with any dominating or subsidiary criteria with loss of more than one transmission system element.

OPS-2B: the number of events counted by indicator OPS-2A in which a degradation of system operation conditions occurred as a result of unexpected discrepancies of demand or generation forecast; it is calculated adding up all incidents in scale 1, 2 or 3 with dominating or subsidiary criteria OR1 and loss of more than one transmission system element.

OPS-3: the number of events leading to a degradation in system operation conditions due to lack of active power reserves; it is calculated adding up all incidents with lack of reserves identified in any incident in scale 1, 2 or 3 with dominating or subsidiary criteria OR1.

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Table 5. Operational security indicators relevant for operational planning and scheduling for each synchronous area

	Indicator	Continental Europe	Nordic	Great Britain	Baltic	Ireland	Isolated systems
1	**OPS-1A [Incidents]**	28	59	4	8	5	6
2	**OPS-1B [Incidents]**	0	0	0	0	0	0
3	**OPS-2A [Incidents]**	10	4	2	0	0	9
4	**OPS-2B [Incidents]**	0	0	0	0	0	0
5	**OPS-3 [Incidents]**	2	0	0	0	0	0

The reference for the operational security indicators is the draft system operation guideline submitted to European Commission in August 2015. The calculation of the indicators OPS-1B and OPS-2B needs to be updated in order to take into account the unexpected discrepancies of demand or generation forecast instead of lack of reserve.

Comparison between 2013 and 2014

The following figures show, as far as possible, the comparison between the values calculated for 2013 and 2014. The values for 2013 can be considered as the starting point to analyse trends in following years, therefore 2013 and 2014 values can be compared.

The following figures represent the non-zero comparisons.

Figure 17: Operational security indicator OS-A 2013-2014

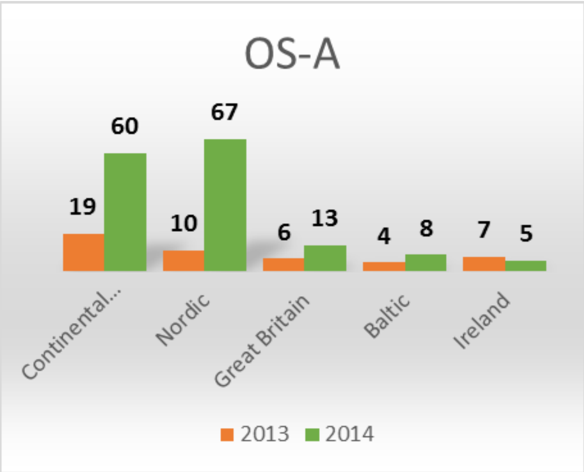


Figure 18: Operational security indicator OS-C 2013-2014

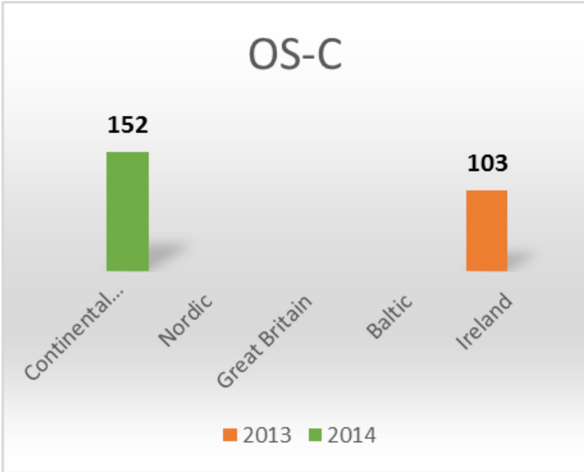


Figure 19: Operational security indicator OS-D 2013-2014

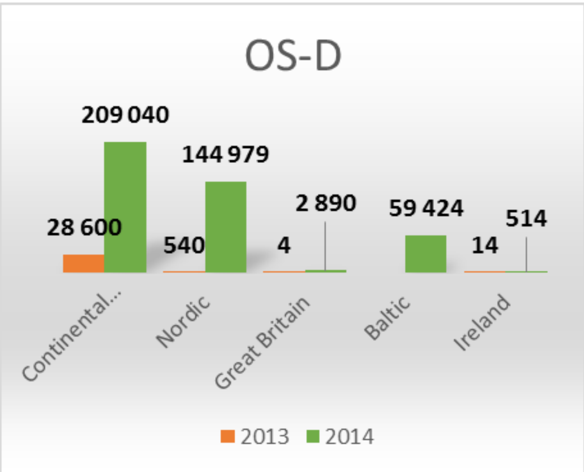


Figure 20: Performance Indicator OPS-1A-2013-2014

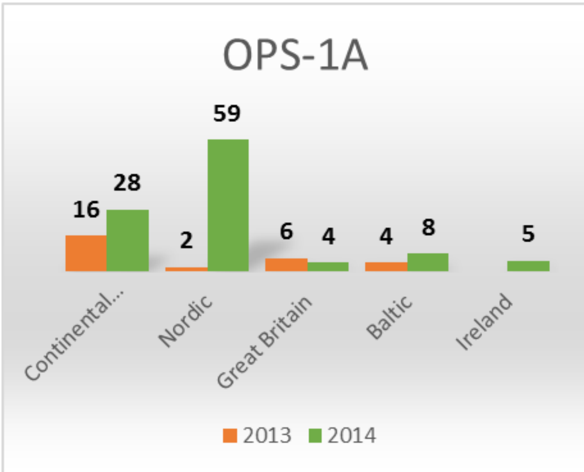


Figure 21: Operational security indicator OPS-2A 2013-2014

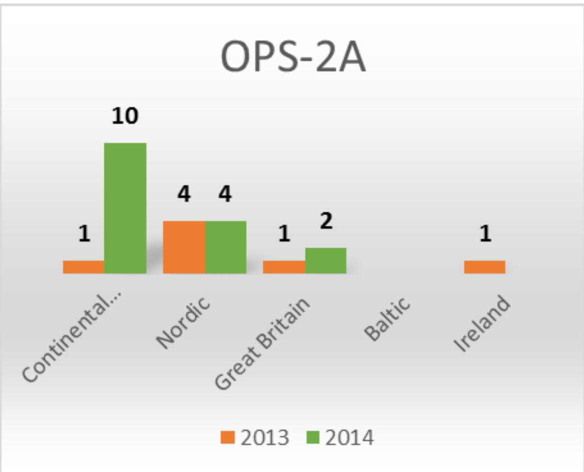
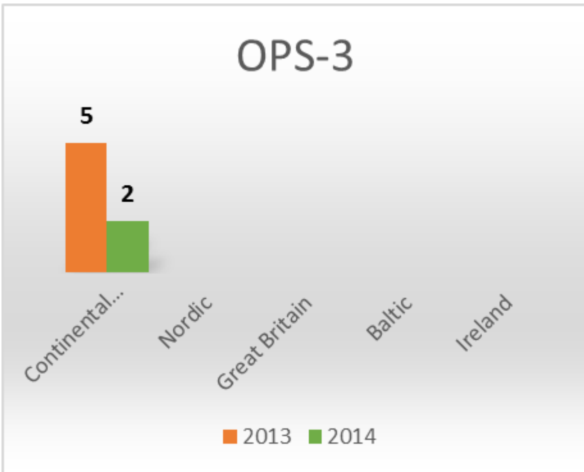


Figure 22: Operational security indicator OPS-3 2013-2014



Scale 0 incidents

Overview

In 2014 disturbances on transmission network equipment made up the largest part, 79% in average, of the incidents classified as scale 0 incidents – similarly to year 2013 when the percentage was 74% in average.

The next largest group of incidents were the disturbances on power generating facilities that made up 12% of the scale 0 incidents, in 2013 the percentage was 19%.

Figure 23. Scale 0 incidents by criteria for each synchronous area

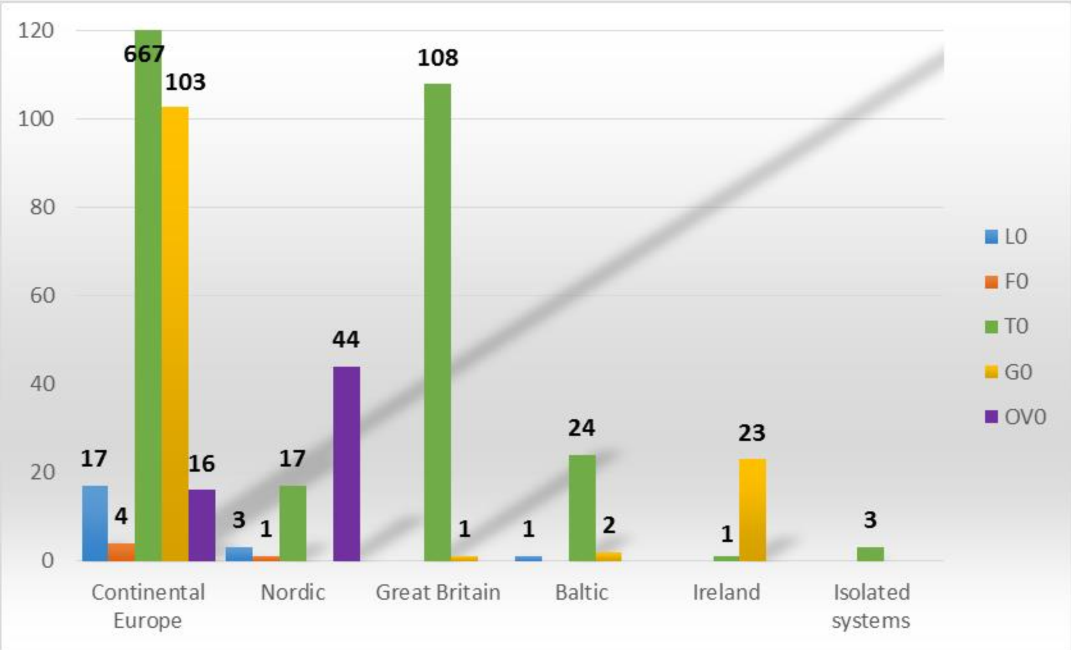


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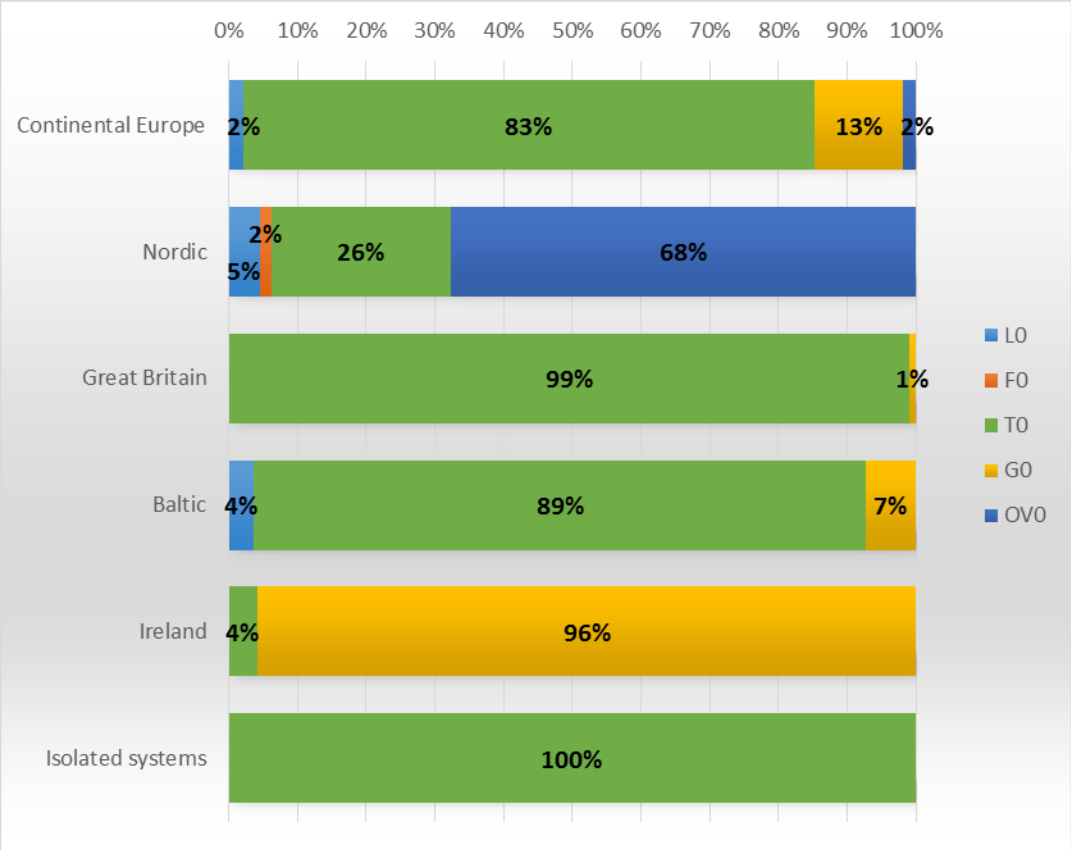
Figure 24. Scale 0 incidents: the percentage of the occurrence of incidents by criteria



The majority, 92% of the scale 0 incidents were:

- final tripping of equipment; or
- loss of generation.

Synchronous area Ireland is not directly comparable with other synchronous areas. The Irish system (comprising Ireland and Northern Ireland) has a relatively small number of generators but the thresholds for classifying an incident on power generating facility as scale 0 incident are large compared to overall system demand.

Therefore most generator trips in the Irish system are qualified as scale 0 events, whereas this would not be the case in larger power systems with more interconnection. For this reason also the number of scale 0 events per 100 km of circuit and 1 TWh of consumption for the Irish system are also not directly comparable with those of other systems. It is notable that main problems in Irish system were disturbances on generation facilities – 96% of scale 0 incidents.

Comparison between 2013 and 2014

Figure 25. Events on load (L0)

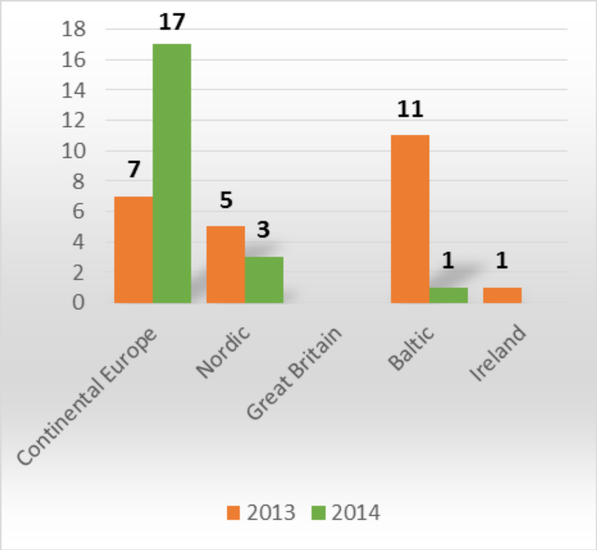


Figure 26. Disturbances leading to frequency degradation (F0)

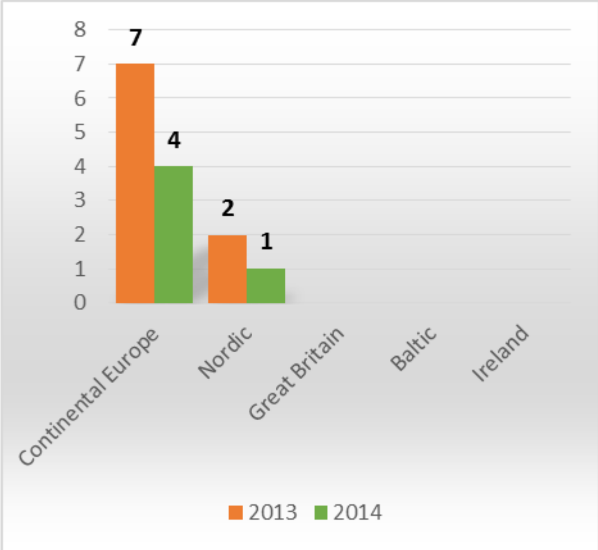


Figure 27. Disturbances on transmission network equipment (T0)

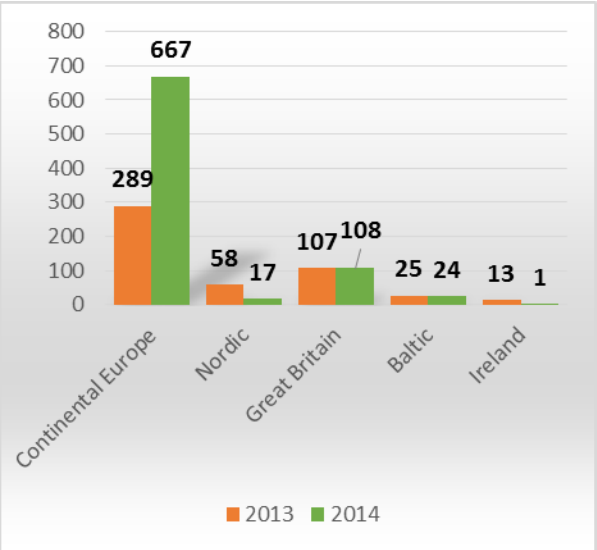


Figure 28. Disturbances on power generating facilities (G0)

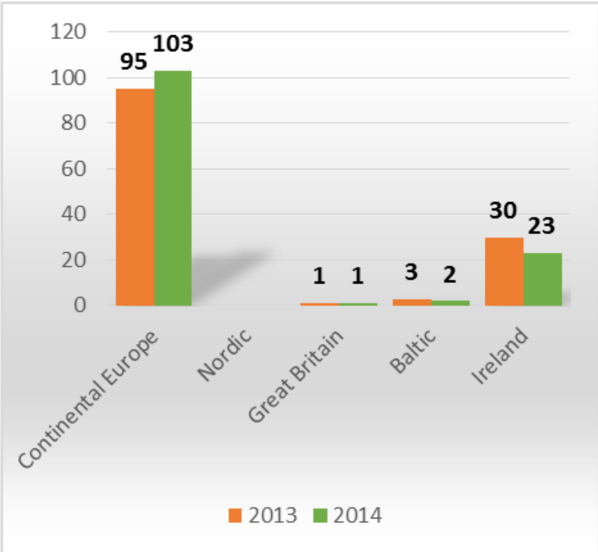


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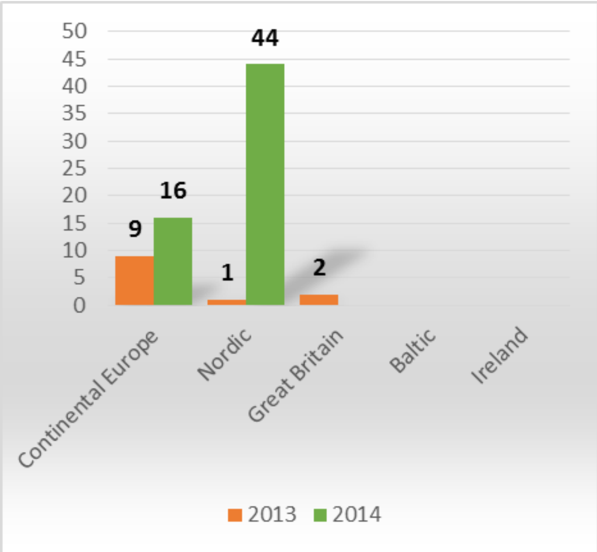
Figure 29. Violation of standards on voltage (OV0)



Scale 1 incidents

Overview

In 2014, 220 scale 1 incidents were reported by 26 TSOs, in comparison 133 incidents were reported in 2013. The disparity in the number of incidents is primarily due to more active reporting by TSOs, developments of the ICS methodology and clarifications of what constitutes as a scale 1 incident versus a scale 0 incident. Thus, direct comparison of 2013 and 2014 is not completely meaningful.

No disturbances leading to frequency degradation in scale 1 occurred in 2014.

Figure 30. Scale 1 incidents by criteria

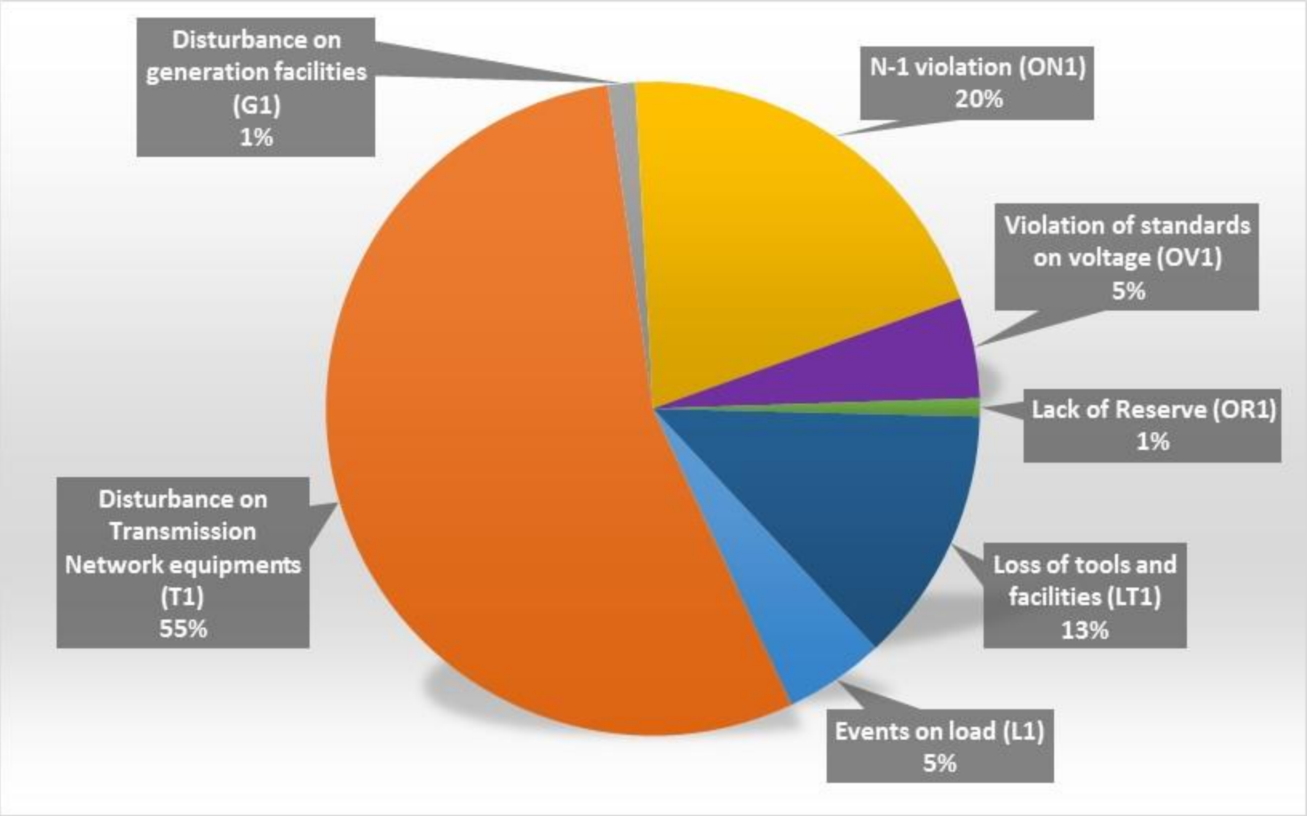
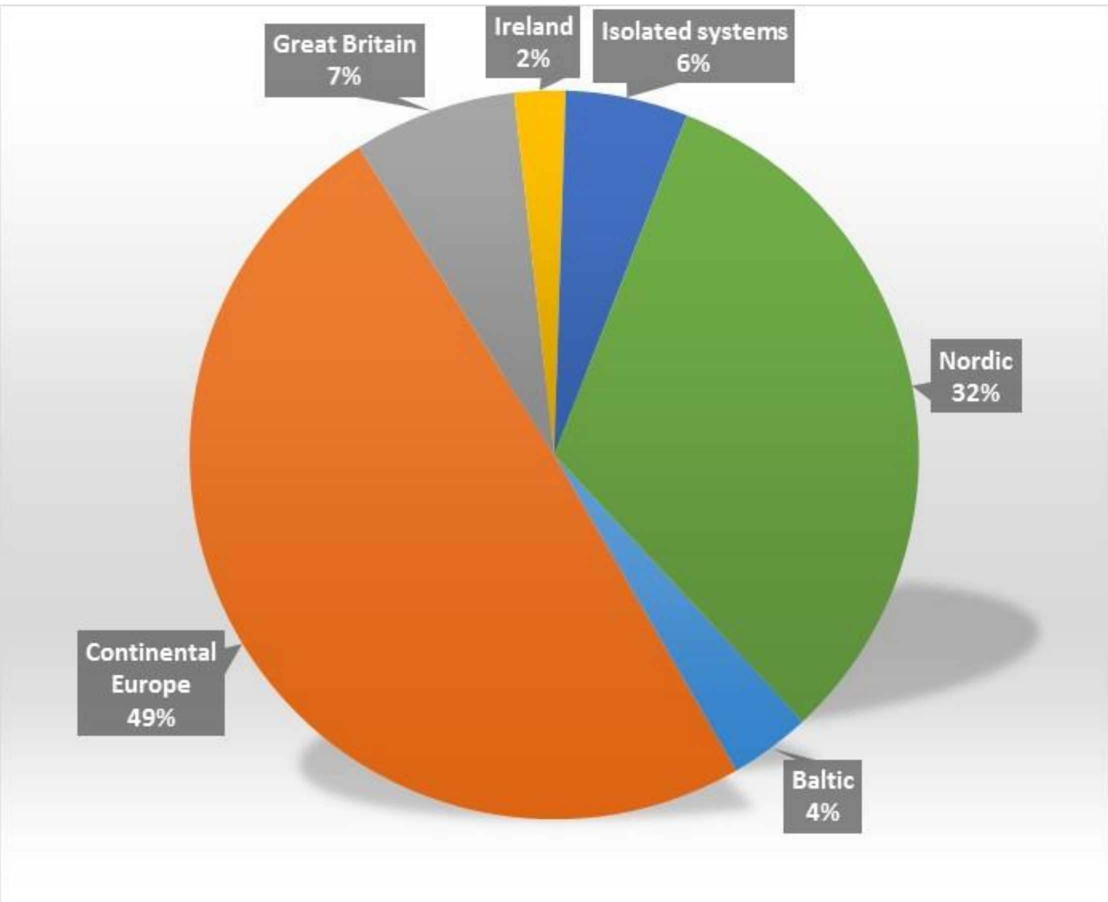


Table 6. Scale 1 incidents by criteria in each synchronous area

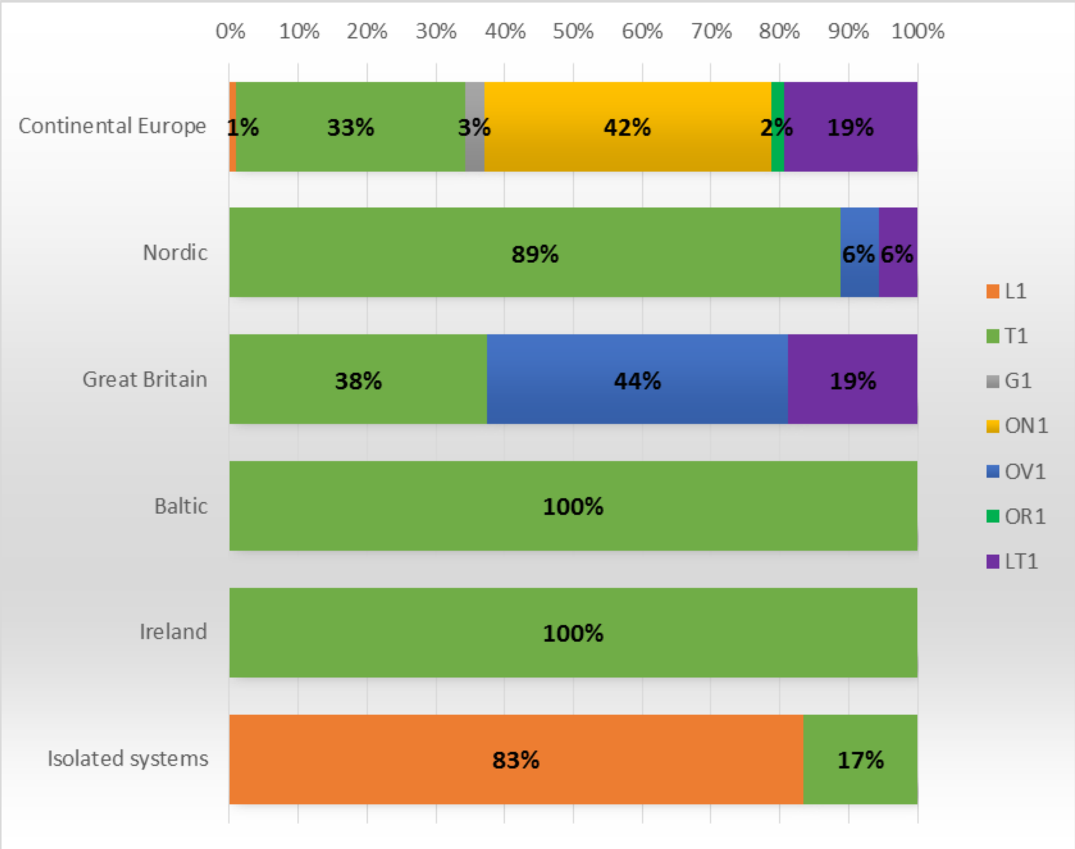
	Continental Europe	Nordic	Great Britain	Baltic	Ireland	Isolated systems	Grand Total
Events on load (L1)	1					10	**11**
Disturbance on transmission network equipment (T1)	36	63	6	8	5	2	**120**
Disturbance on power generating facilities (G1)	3						**3**
N-1 violation (ON1)	45						**45**
Violation of standards on voltage (OV1)		4	7				**11**
Lack of reserve (OR1)	2						**2**
Loss of tools and facilities (LT1)	21	4	3				**28**
Grand Total	**108**	**71**	**16**	**8**	**5**	**12**	**220**

Figure 31. Distribution of scale 1 incidents by synchronous areas



The majority of the reported scale 1 incidents (179 of 220) occurred in the Continental Europe and Nordic synchronous areas.

Figure 32. Percentage of the recorded scale 1 incidents by synchronous area



In the Baltic and Ireland synchronous areas all scale 1 incidents were disturbances on transmission network equipment (T1).

Monthly distribution of scale 1 incidents

The following figure shows the number of scale 1 incidents recorded in each month of 2014.

The largest number of incidents occurred in February, May, June and July. The month with the highest number of incidents was June, 41% of the recorded incidents were N-1 violations and 30% were disturbances on transmission network elements. On average, there were 18 incidents per month recorded in 2014.

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Figure 33. Monthly distribution of scale 1 incidents

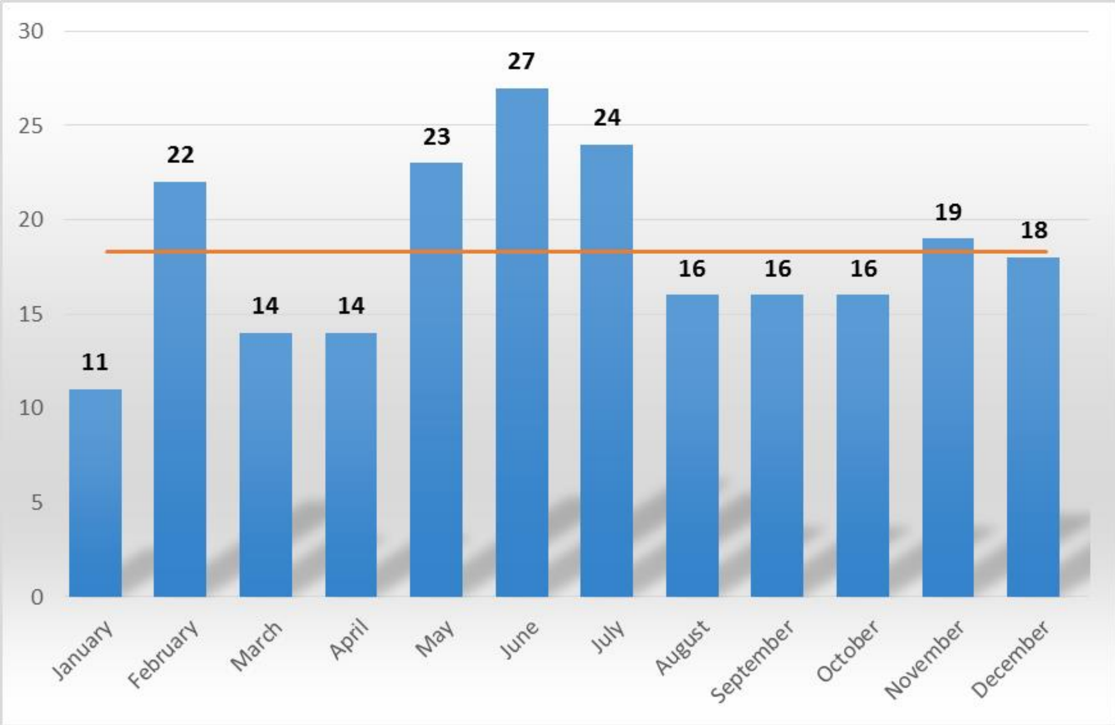
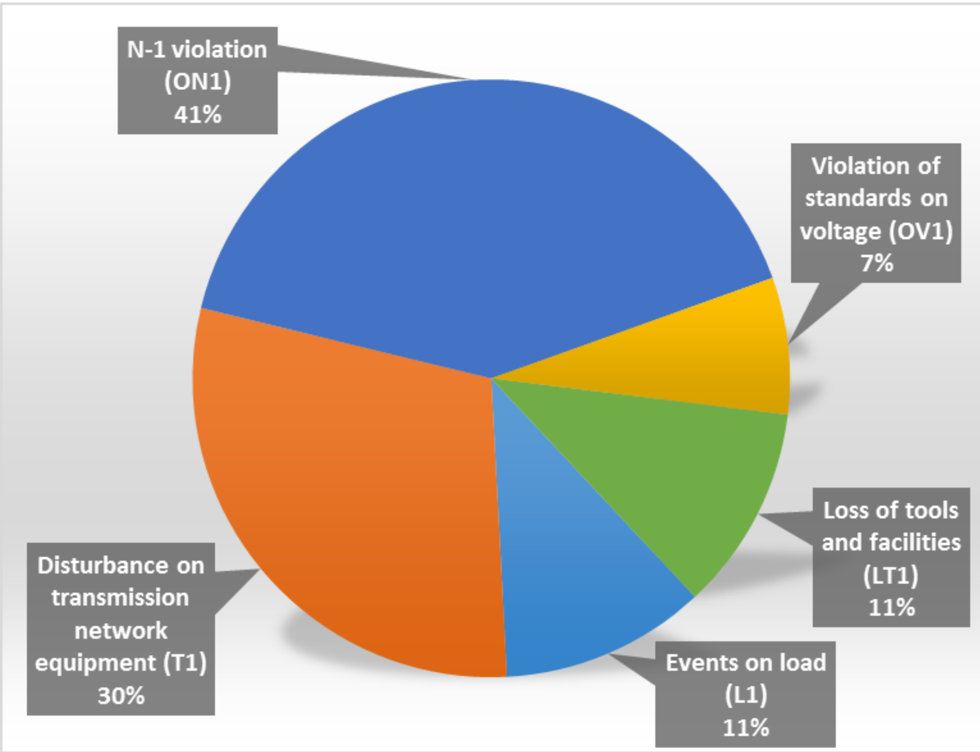


Figure 34. Breakdown of scale 1 incidents recorded in June 2014, the month with most incidents reported



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Duration of incidents

As in previous years the duration of scale 1 incidents has a wide range. 40% of incidents lasted less than 1 hour, while 31% of incidents had duration longer than 5 hours.

Figure 35. Duration of scale 1 incidents

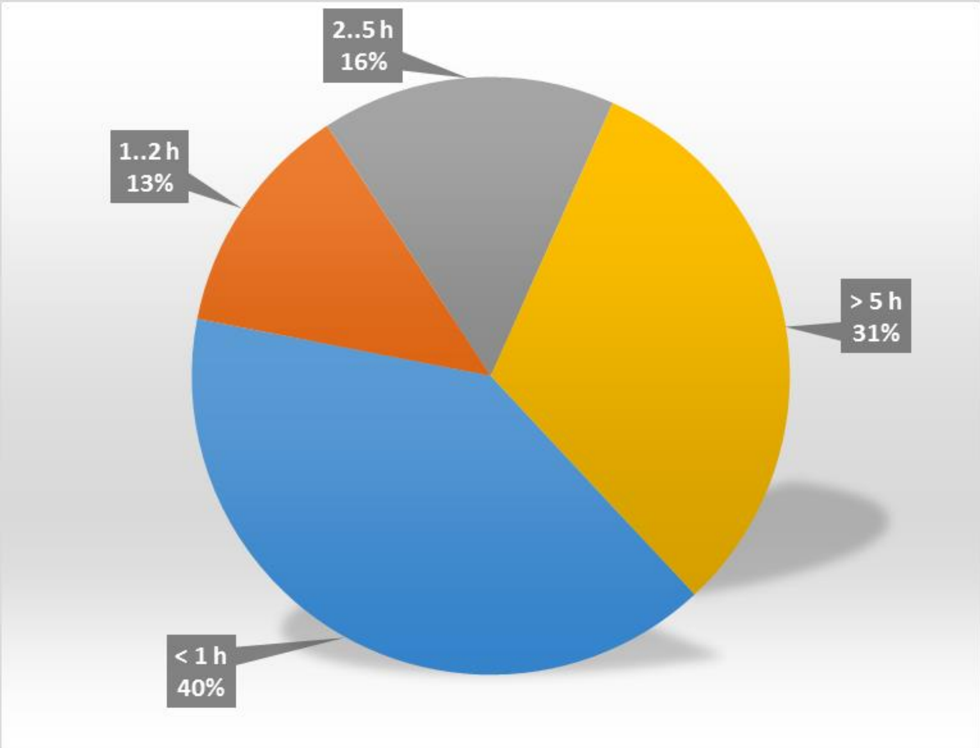
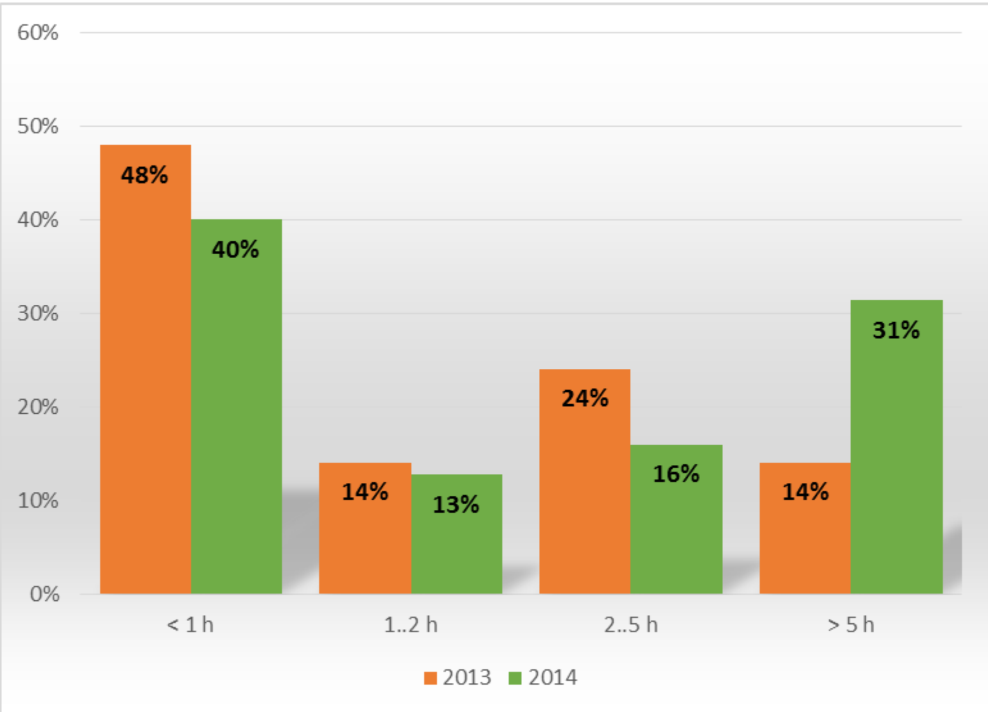


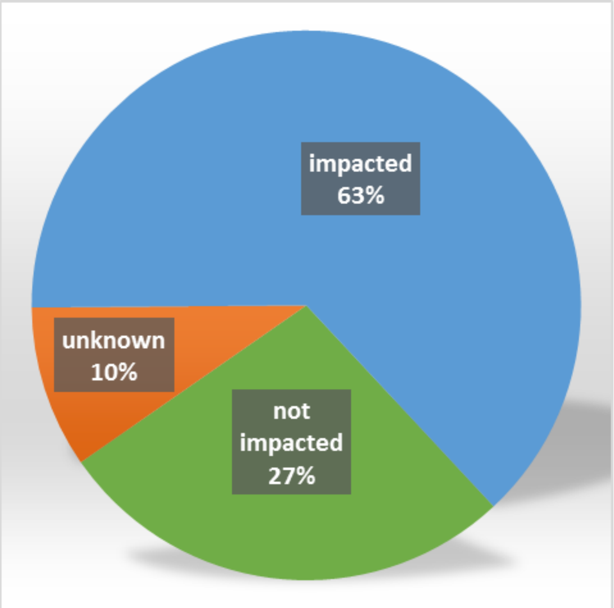
Figure 36. Comparison of scale 1 incident duration between 2013 and 2014



Impact on other transmission system operators

63% of reported scale 1 incidents impacted one or more transmission system operators in control areas other than the control area where the incident occurred, for 27% of incidents there was no impact identified outside the transmission system operator control area. For the rest of the reported incidents the impact on other transmission system operators was unknown.

Figure 37. Impact on other transmission system operators



75% of scale 1 incidents which impacted control areas of other transmission system operators were caused by disturbances on transmission network equipment (T1), 24% of incidents mentioned above were caused by N-1 violation (ON1).

The rest (1%) of the incidents impacting other transmission system operators were caused by loss of tools and facilities (LT1).

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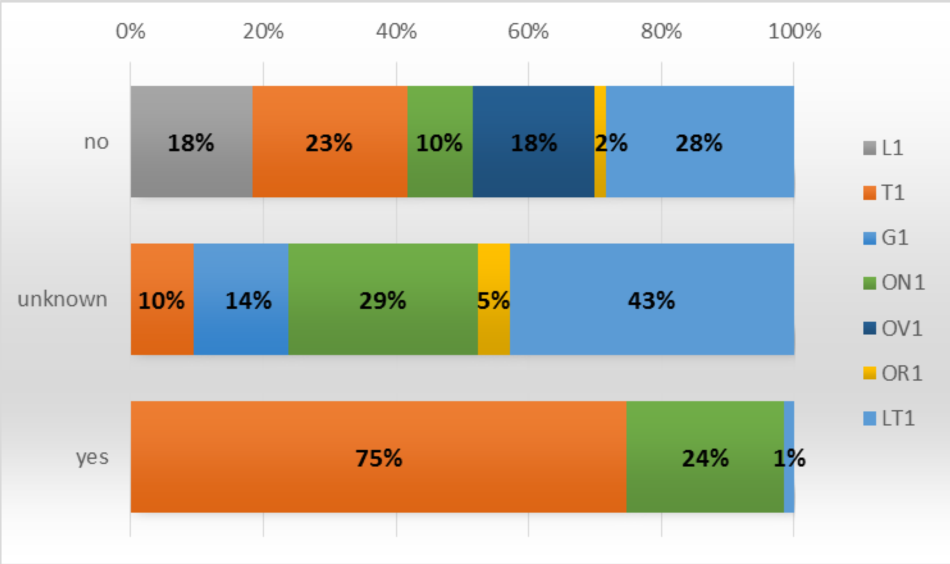
Figure 38. Causes of the incidents by impact on other transmission system operators



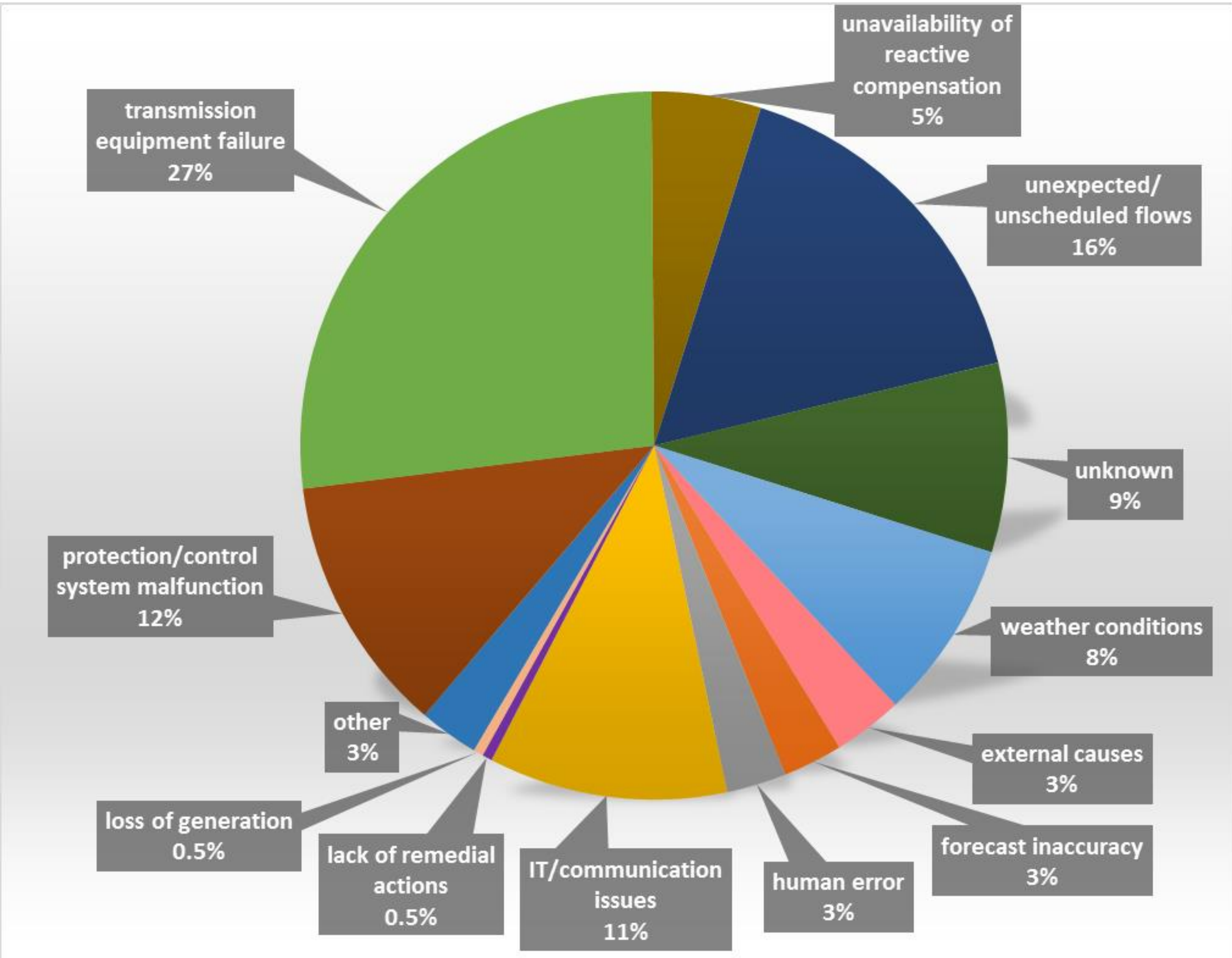
Causes of the incidents

The main cause of the 220 reported scale 1 incidents was transmission equipment failure – this was mainly the cause of disturbances on transmission network equipment.

Other frequent causes for incident were unexpected/unscheduled flows (only for N-1 violations), protection/control system malfunction (mainly causing disturbances on transmission network equipment) and IT/communication issues (resulting in loss of tools and facilities).

9% of the scale 1 incidents had an unknown cause.

Figure 39. Causes of the incidents



N-1 violations

45 N-1 violations were recorded in 2014. The largest number of N-1 violations occurred in June and July. In June temperatures along Europe were higher than normal and in this month many transmission system operators did maintenance works on generating facilities and transmission system equipment.

In July the temperatures were lower than average with the consequence of low consumption. Also increased precipitation in many European countries led to high hydro production. Another constraining element for the system operation is the continuously increasing installation of wind and solar power plants with inflexible generation and inaccurate forecasts.

For all the reasons mentioned above in July many transmission system operators were faced with imbalance of energy that was not easy to manage due to cross-border exchange limitations. On the other hand exchanged energy depends on market programs with the limits imposed.

Despite the difficulties described in 2014 the reduction of N-1 violations was notable compared to 2012 and 2013.

Figure 40. N-1 violations 2012-2014

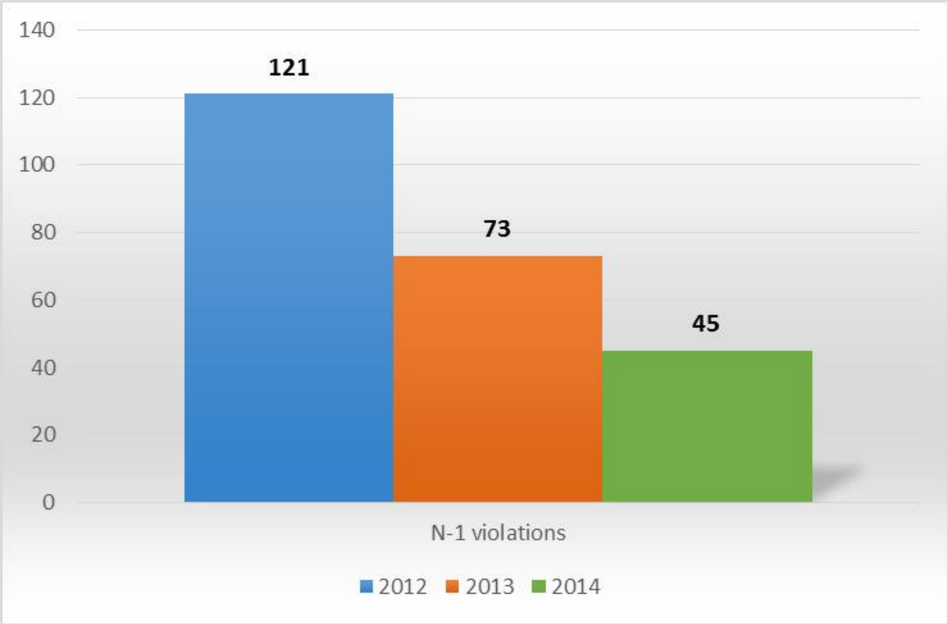


Figure 41. Monthly occurrence of reported N-1 violations

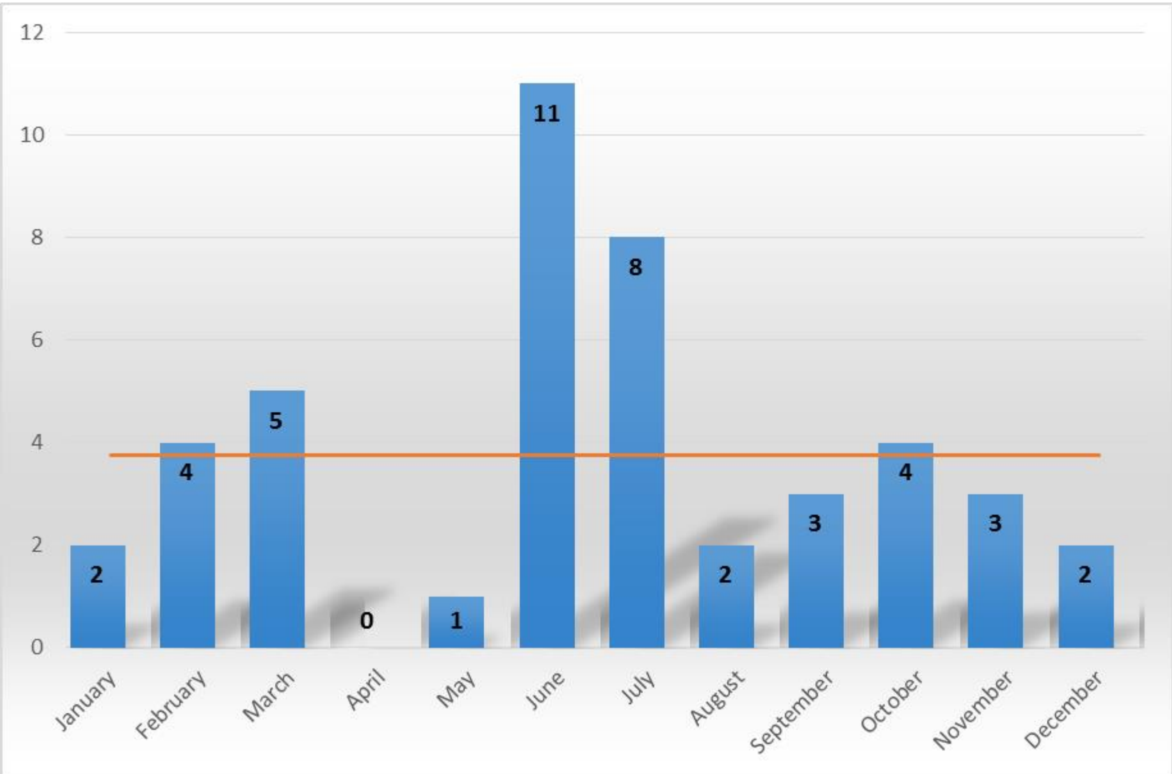
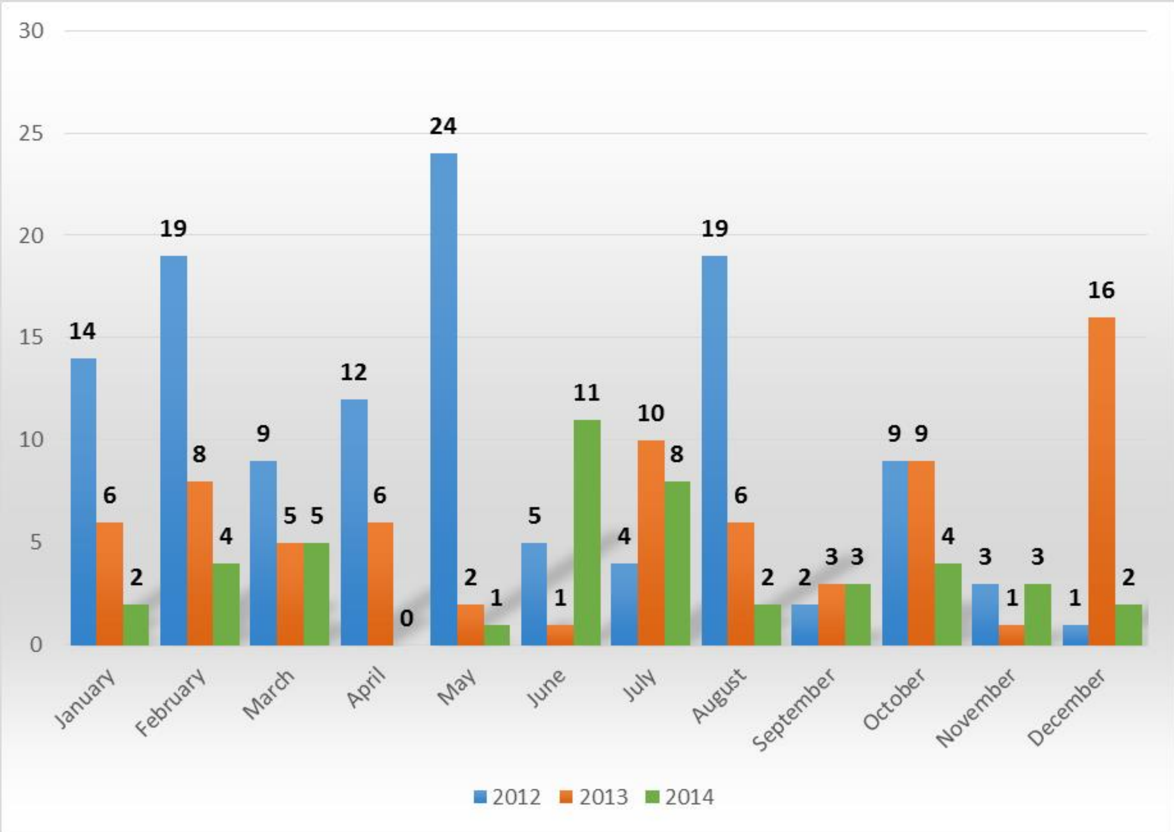


Figure 42. Monthly occurrence of reported N-1 violations – comparison 2012-2014



Even if a direct comparison between the years is not possible due to differences in the incident classification scale-methodology, a notable reduction of N-1 violations is recorded from 2012 to 2014. More specifically, the 45 scale 1 N-1 violations in 2014 represent a reduction of 38% in comparison with the previous year. This was achieved due to the application of preventive and curative remedial actions – redispatching, activation of frequency restoration reserves, network reconfiguration, adjustments of virtual and real phase shifting transformers and better coordination between transmission system operators are some of them.

N-1 violations lasted from 10 minutes to 16,5 hours. Two-thirds of the N-1 violations lasted less than 5 hours while 15 N-1 violations (33%) were longer than 5 hours. The average duration of the N-1 violations was 4,5 hours.

Figure 43. Total duration of N-1 violations by month

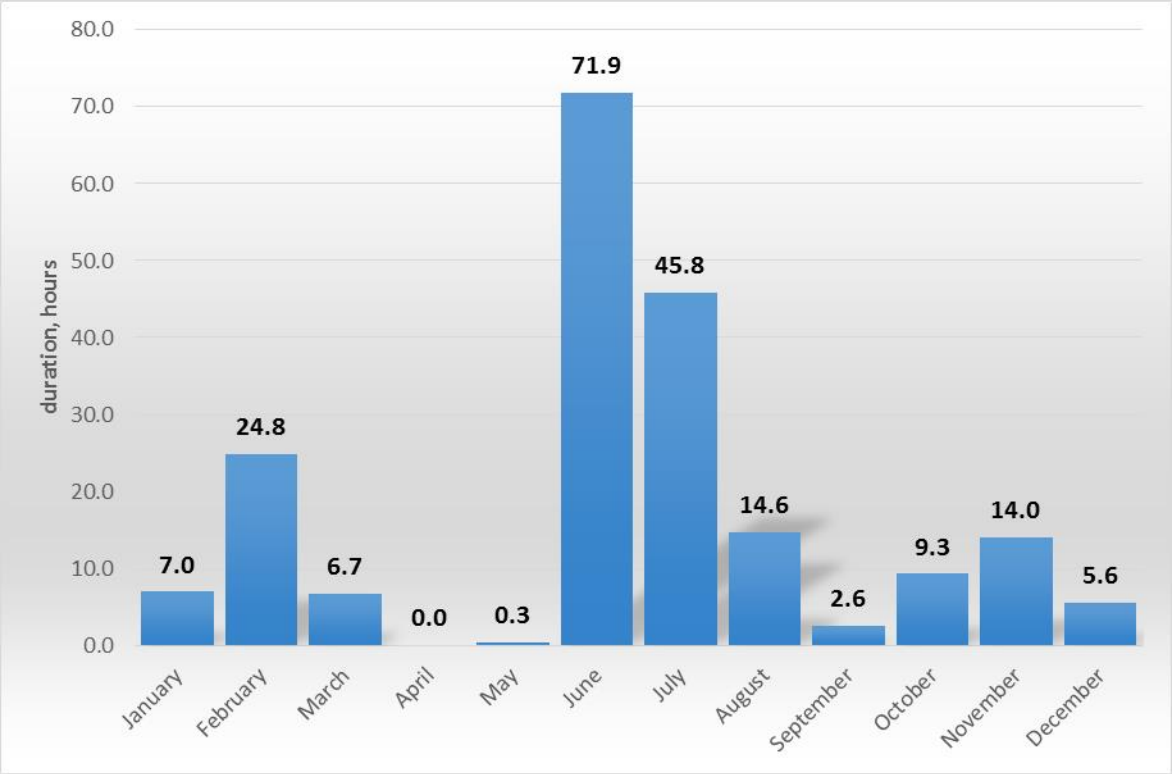
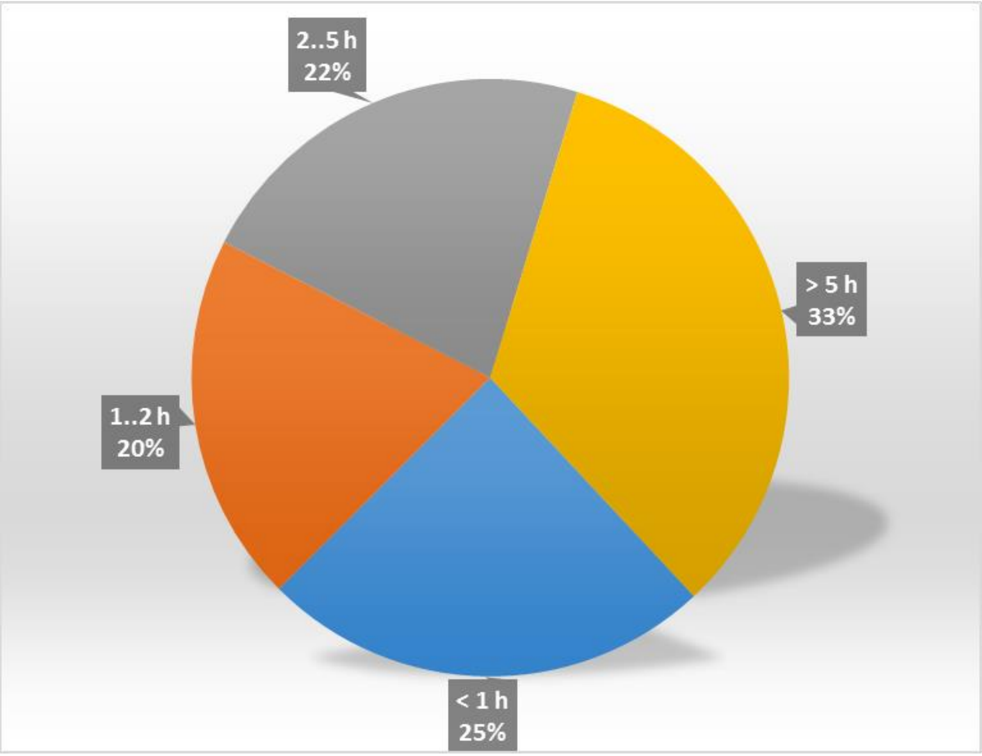


Figure 44. Duration of N-1 violations



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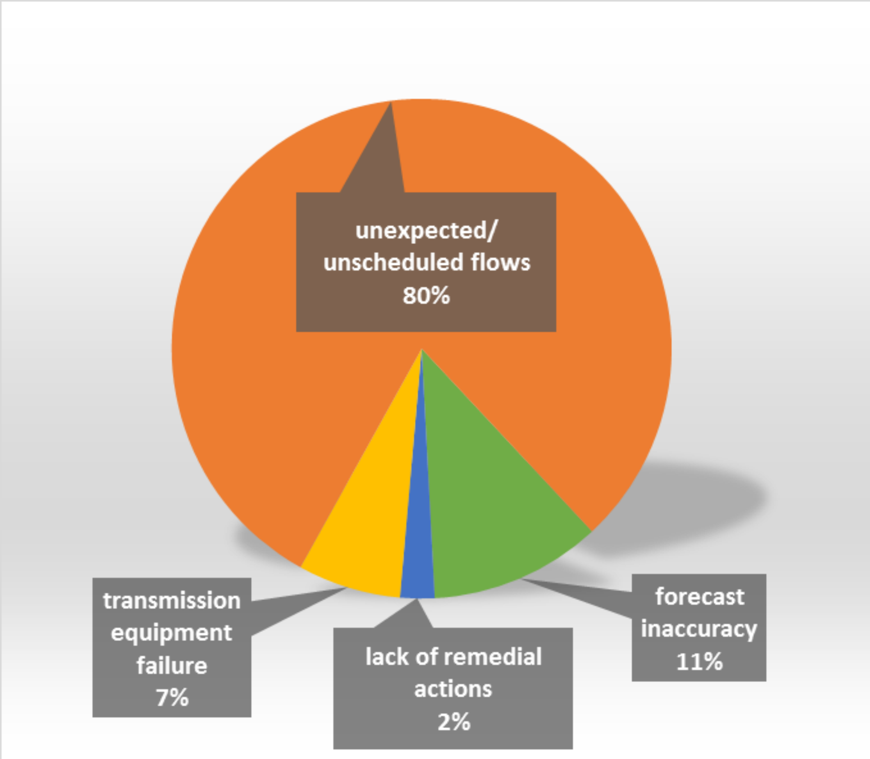
Unexpected/unscheduled flows were the predominant cause of those incidents (80%). Other N-1 violations were caused by forecast inaccuracy (11%), transmission equipment failure (7%) and lack of remedial actions (2%).

Figure 45. Causes of N-1 violations



The share of N-1 violations that lasted more than 5 hours increased compared to the previous year (from 22% to 33%). The causes for those N-1 violations were analysed to identify the ways to reduce the duration and occurrence of this kind of violations in the future.

14 out of the 15 prolonged N-1 violations were caused by unexpected/unscheduled flows, one N-1 violation that lasted more than 5 hours was caused by transmission equipment failure. In each N-1 violation case all available remedial actions were used to return the system to normal state.

Unexpected/unscheduled flows are the result of a combination of different reasons that raise the level of uncertainty in all of the operational planning stages – increasing shares of variable renewable energy sources, complex interdependencies between the different transmission systems and shorter market time intervals combined with changes on the market closer to real-time (intraday market trades). As a consequence it is more challenging to forecast the physical flows and transmission system operators have little time to assess and coordinate the remedial actions necessary to avoid or resolve N-1 violations.

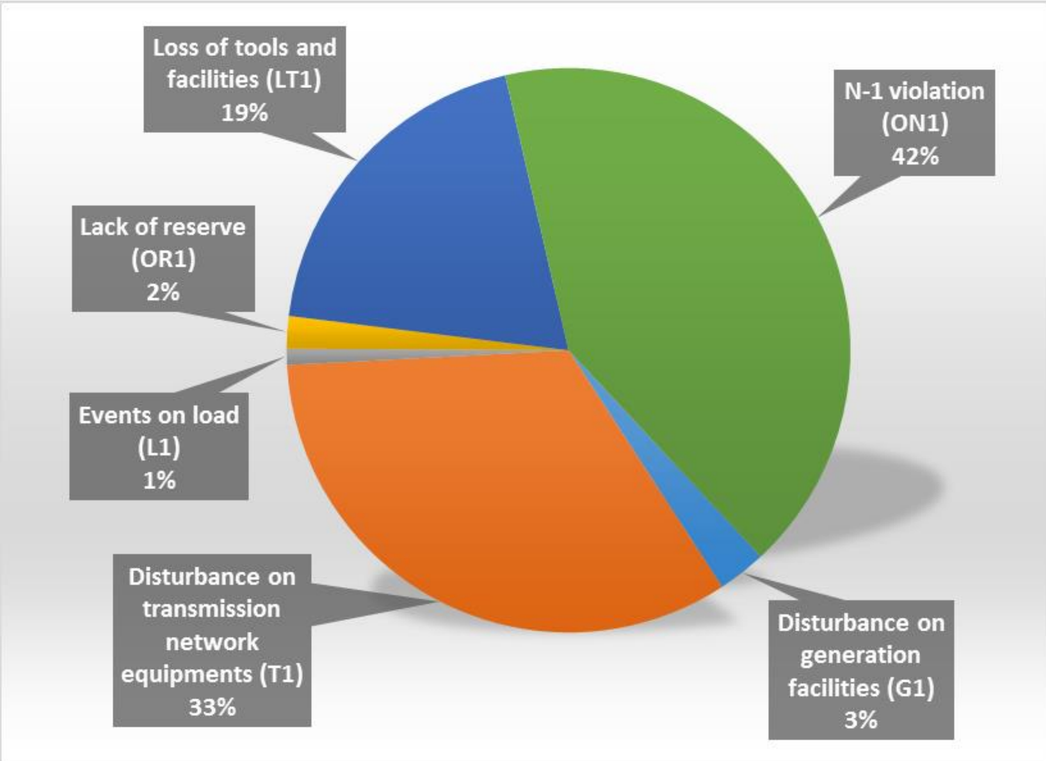
Reducing the occurrence of unexpected/unscheduled flows requires higher level of coordination between transmission system operators in all operational planning phases but especially in intraday and access to more accurate forecasts and schedules.

Regional overview

Incidents in Continental Europe

49% of all the scale 1 incidents were recorded in Continental Europe. All of the scale 1 disturbances on power generating facilities, lack of reserve cases and N-1 violations were recorded in Continental Europe.

Figure 46. Scale 1 incidents in Continental Europe by criteria



For the first time in three years, a scale 1 incident on load was reported in 2014: 6% of the load in the control area of a transmission system operator was disconnected. The incident was caused by the explosion of a circuit breaker during a severe thunderstorm. Pieces of the exploded circuit breaker caused the loss of two bus bars and 5 autotransformers. 50% of the load was restored after 5 minutes, after 15 minutes 90% of the load was restored.

No disturbances leading to frequency degradation and no violations of standards on voltage were reported in 2014. In 2013 also no violations of standards on voltage were recorded and one disturbance leading to frequency degradation was recorded.

36 scale 1 disturbances on transmission network equipment were recorded in 2014 – this is twice the number of incidents that was reported in 2013. Compared to the previous year the number of weather related incidents has increased – in 2013 two incidents were caused by weather while in 2014 weather conditions were recorded as the cause of the incident in 13 cases.

Figure 47. Causes of incidents with transmission system elements

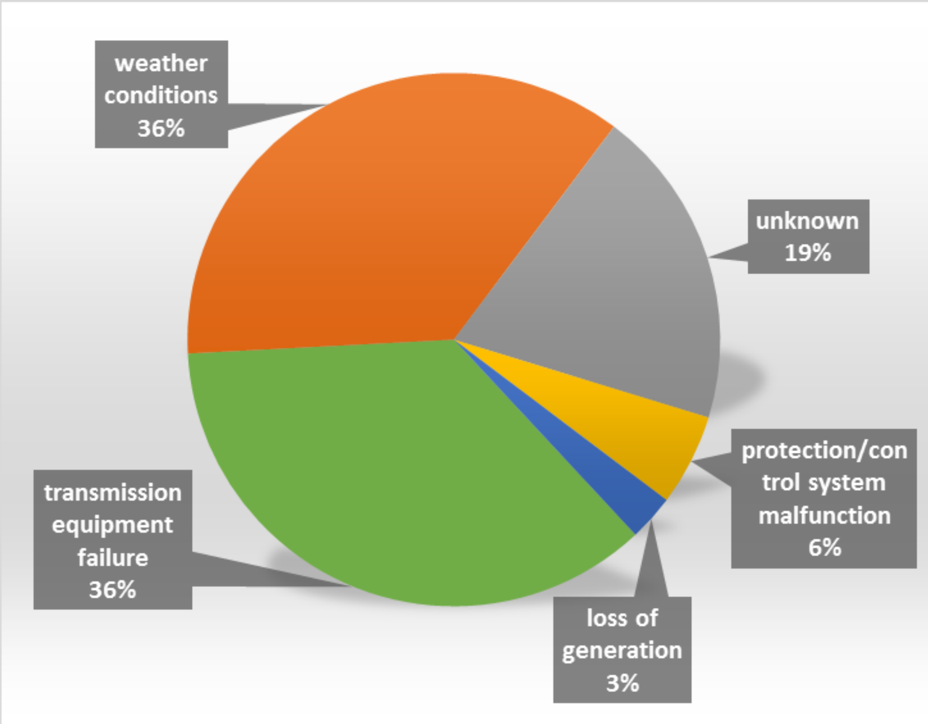


Figure 48. Disturbances on transmission network equipment – number of incidents per month

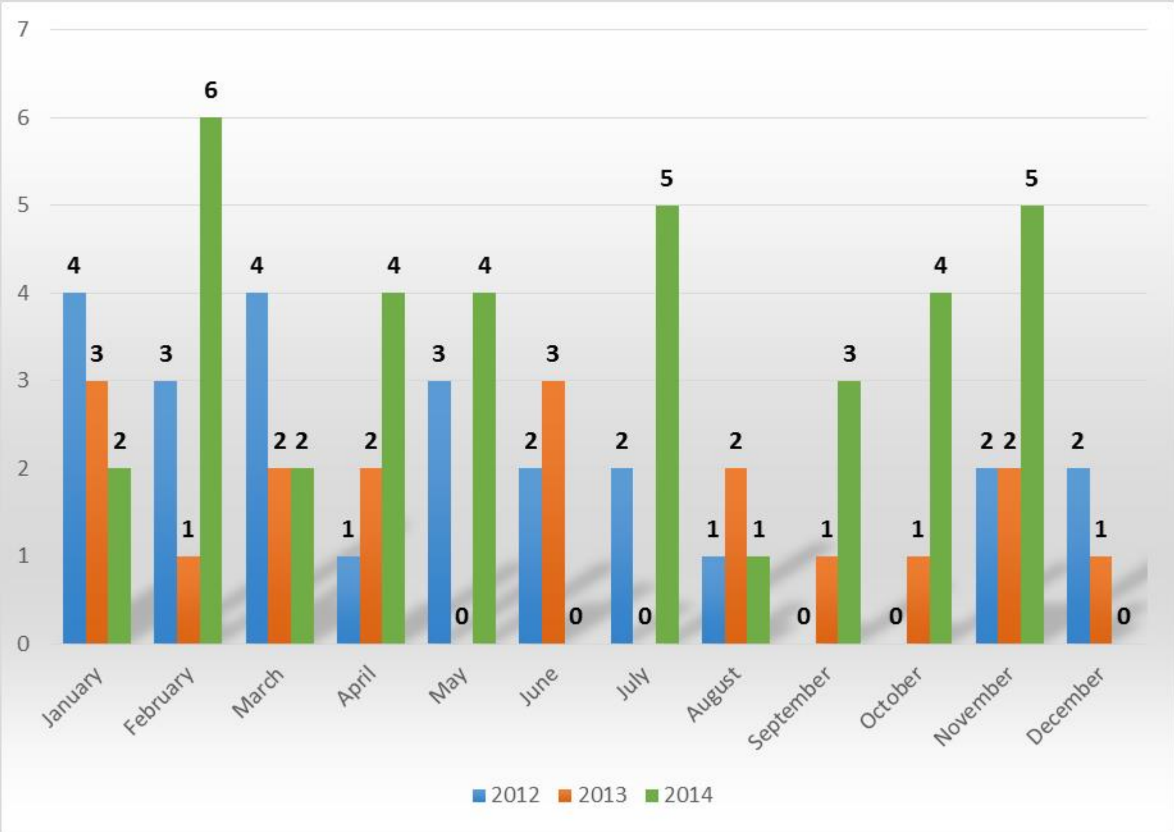
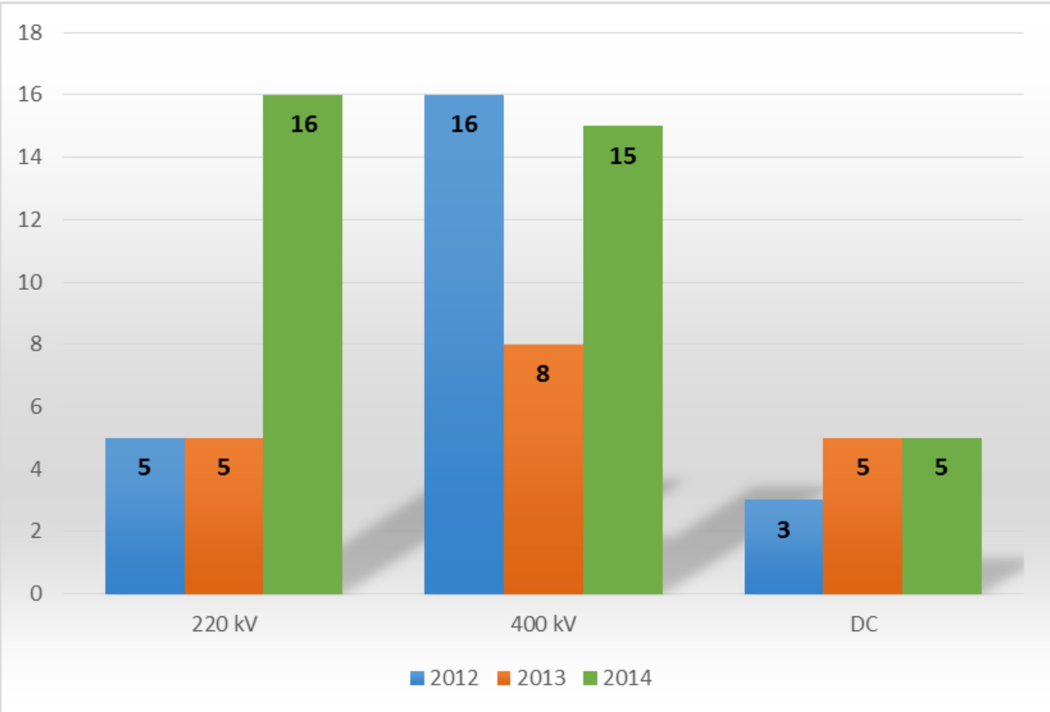


Figure 49. Disturbances on transmission network equipment – number of incidents per voltage level



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Comparison with 2012 and 2013 shows a smaller number of N-1 violations in 2014. The number of N-1 violations was reduced by 30% compared with 2013.

In 33 cases out of 45 N-1 violations in 2014 the number of impacted TSOs was equal to or greater than 2. This is an indication that most N-1 violations occur at or near the border between TSO's. Further reinforcement of interconnections might reduce the number of N-1 violations.

Figure 50. N-1 violations in Continental Europe 2012-2014

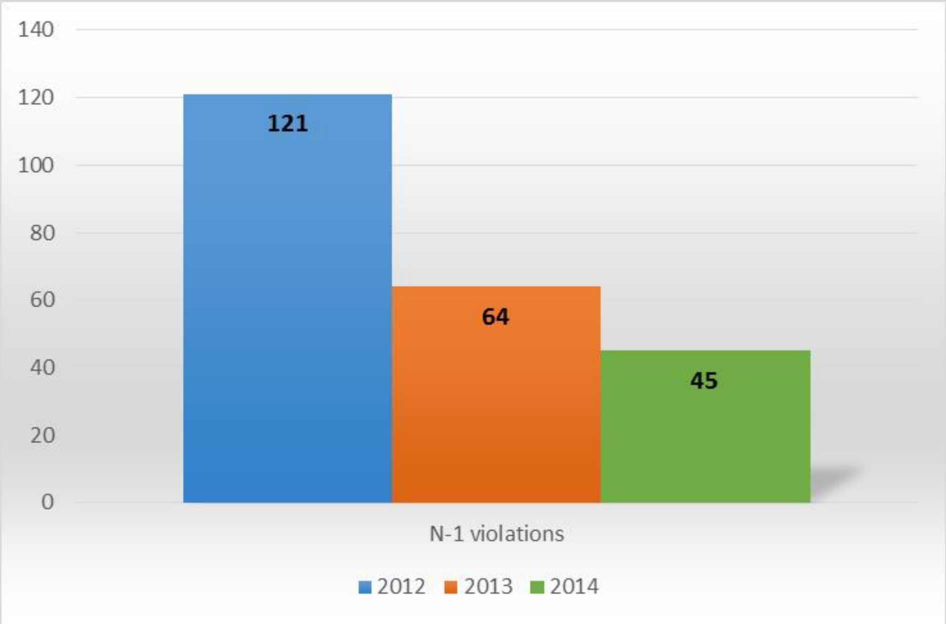
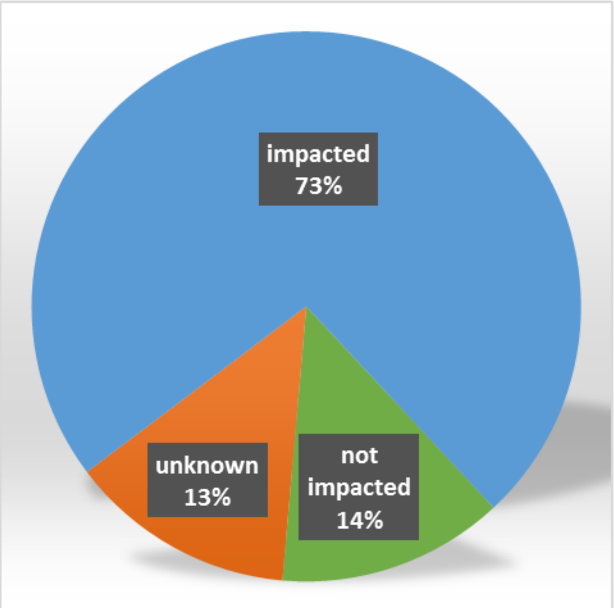


Figure 51. Impact of N-1 violations on other transmission system operators



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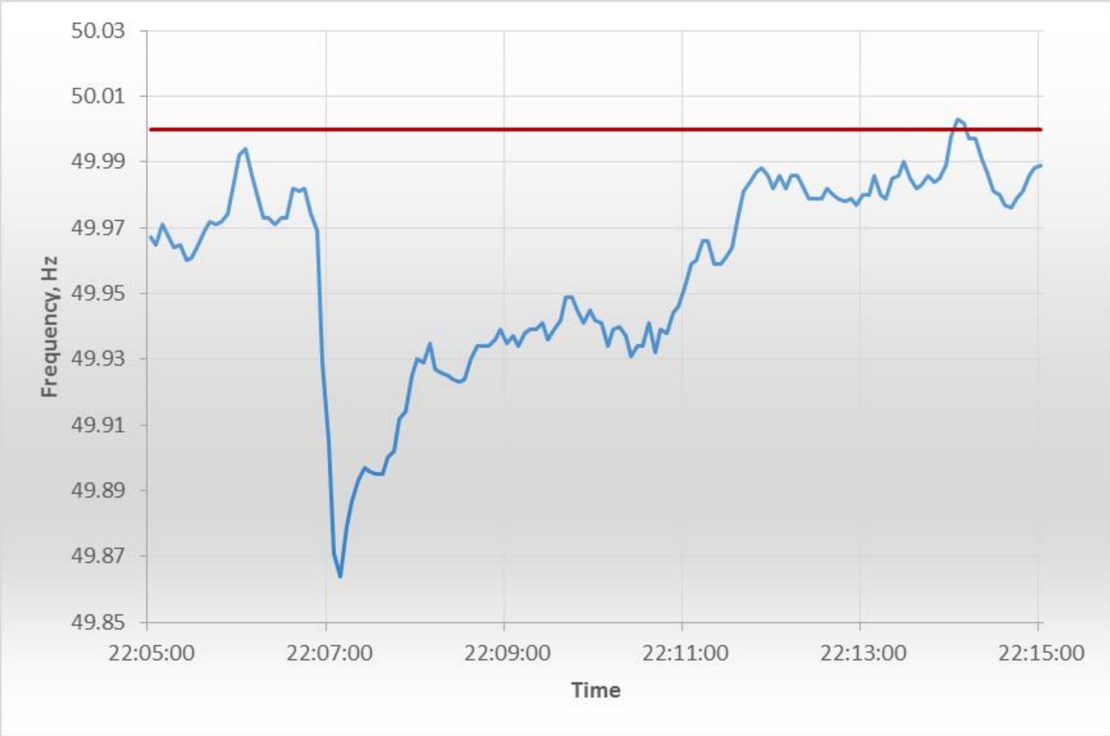
In 2014, three incidents were reported on power generating facilities. For Continental Europe, an incident qualifies as a level 1 incident if the loss of generation is between 1500 and 3000 MW.

Two incidents were caused by the simultaneous tripping of two nuclear units on the same site. Another incident was caused by flooding because of high river water level.

The most serious incident was the loss of 2 nuclear units of 1300 MW. However, the frequency dropped to a minimum value of 49.87 Hz and was restored quickly (4 minutes before reaching 49.95 Hz).

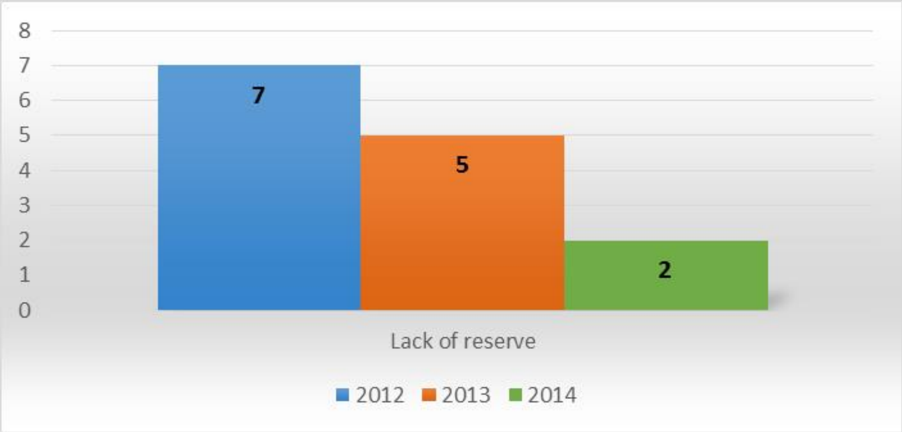
This incident shows that the reference incident for primary reserve dimensioning is realistic (3000 MW compared to 2600 MW).

Figure 52. Frequency response after largest loss of generation (2600 MW)



Two incidents were reported with lack of reserve criterion. This is a large reduction compared to the 5 incidents in 2013. In 2013 all reported incidents were caused by wind forecasting deviation, compared to 2014 when no incident was caused by wind forecasting deviation. This might indicate an improvement in wind forecasting quality.

Figure 53. Incidents resulting in lack of reserves



In 2014, 21 cases of loss of tools and facilities were reported in Continental Europe. This cannot be compared with previous years since loss of tools and facilities is a new criterion introduced in the incident classification scale methodology.

Incidents in Nordic area

The Nordic synchronous area experienced 71 scale 1 incidents. The majority (63 incidents – 89%) of the incidents were classified as disturbances on transmission network equipment. From the rest of the incidents half were classified as violations of standards on voltages and the other half as loss of tools and facilities.

All the 63 disturbances on transmission network equipment led to the reduction in the cross-border exchange capacity. For the HVDC part of these incidents were preventing 1.2 TWh of potential energy transmission. Approximately half of the energy transmission was lost due to three incidents lasting longer than two weeks each with the longest lasting 50 days.

Violation of standards on voltages was reported on four occasions in the Nordic area. Most of these violations happened during HVDC ramping and were a consequence of low load and low overnight reactive power demand in Denmark. Additionally there were 43 scale 0 violations of standards on voltage with the same cause in Denmark.

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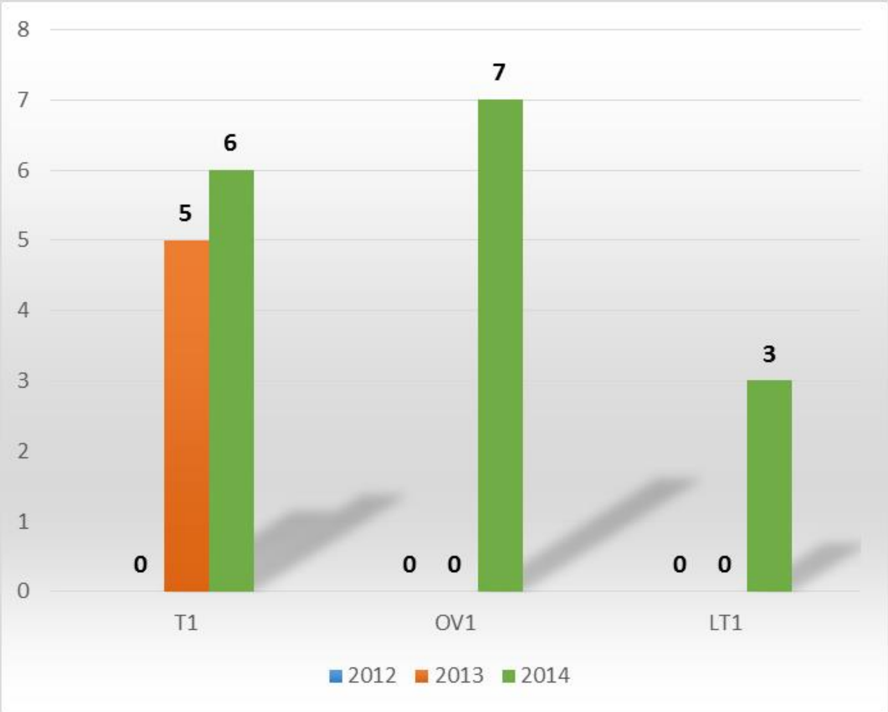
Incidents in Great Britain

16 scale 1 incidents were recorded in Great Britain in 2014.

Figure 54. Scale 1 incidents by dominating criterion 2012-2014



Great Britain synchronous area experienced six scale 1 incidents associated with the disturbances on transmission network equipment criterion. All of these incidents led to the reduction of the cross-border exchange capacity of the HVDC interconnectors between Great Britain and France (IFA) or Great Britain and Northern Ireland (Moyle). There were four instances when Moyle HVDC interconnector tripped due to a fault on the Scottish Power network. IFA HVDC interconnector tripped twice due to the final tripping of equipment.

Violation of standards on voltages was reported on seven occasions in Great Britain. Six of these violations were a consequence of low overnight reactive power demand while one occurred due to a disturbance on transmission equipment. All violations were observed on 400kV substations.

Three scale 1 incidents were recorded in GB under the loss of tools and facilities (LT1) category. The average duration of the incidents resulting in loss of tools and facilities was 7,4 hours.

Incidents in Baltic area

There were 8 incidents in scale 1 recorded in Baltic area. All incidents were classified as disturbances on transmission network equipment, 5 incidents involved the HVDC interconnectors between Estonia and Finland.

One of the incidents did not cause a reduction of exchange capability because it lasted less than hour, other incidents resulted in reduced transmission capacity on Finnish or Latvian border. Half of the incidents were caused by transmission equipment failure, 2 incidents were the result of relay protection malfunction and 2 other incidents had external causes.

Compared to 2013 there were 2 times more incidents classified as scale 1 incidents.

Incidents in Ireland

There were five recorded scale 1 incidents in Ireland in 2014. This compares with one such incident in 2013 and six in 2012.

Four incidents involved the tripping of the West-East (EWIC) interconnector between Ireland and the United Kingdom and one incident involved the tripping of the Moyle interconnector between Northern Ireland and United Kingdom. These are reported as scale 1 incidents due to the reduction in transfer capacity between the United Kingdom and Ireland.

Incidents in the isolated systems

In Iceland there were three scale 2 incidents in Iceland in 2014:

Trip of power intensive industry load causing the system protection scheme to split the transmission system into two islands. In both islands relay protection schemes and WACS (wide area control system) balanced the load after some production units tripped.

Preventive actions: None, islanding of the transmission system was intentional and the risk was mitigated as planned.

An event caused by a database update in the EMS system. Wrong setpoints were written into the AGC (Automatic Generation Control). The AGC sent these incorrect setpoints to individual production units resulting in a large change in power flow between areas. This activated automatic system protection schemes, tripping power transformers. This resulted in energy not served to power intensive customers.

Preventive actions: Improved procedure when implementing database changes into EMS. AGC made inactive and put in action after inspection of all setpoints.

During ramp down of load in power intensive industry, production units were not ramped down at the same speed. This resulted in overload of power transformers, which caused them to trip. The system protection scheme then tripped the rest of the load of the industrial plant. Because of under frequency in the whole system some other customers automatically ramped fast down.

Preventive actions: Training the event in DTS in the upcoming seasonal training period.

Cyprus reported one incident in 2014 – a scale 2 incident on load with subsidiary criteria F2.

The incident involved the loss of two generating units (including the largest unit 130 MW plus another unit of 75 MW). Disconnection of the generating units caused frequency deviation of 1130 mHz and the disconnection of 147 MW of load.

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Conclusion

Significant figures describing the year 2014:

1259 – in the third year of data collection and reporting the total number of reported incidents increased by 58% from 2013 to 2014.

1035 – the total number of scale 0 incidents in 2014 is higher than the number of scale 0 incidents in 2013 (666), the proportion between scale 0 and scale 1 incidents is similar with the previous year. Around 79% of the scale 0 incidents are disturbances on transmission network equipment while 12% of incidents are disturbances on generation facilities. For all scale 0 incidents the system remained in the normal state (based on the system design criteria) during and after the incident. This was also the case in 2013.

220 – the number of scale 1 incidents increased significantly from 2013 (133 incidents) to 2014. As in the previous year, the number of N-1 violations continues to decrease year after year notably thanks to the improvement of coordination between transmission system operators.

4 – the number of scale 2 incidents in isolated systems. No incidents classified in scales 2 and 3 were reported for the other synchronous areas. This is an indication that overall the security of electricity supply was satisfactory throughout Europe.

The year 2014 has not been very disturbed by weather conditions or tense situations (except in Serbia with flooding caused by rain and except the Belgium adequacy situation in winter which required a thorough preparation) and yet has seen an increase of the number of incidents recorded. One possible explanation is the increased commitment of transmission system operators to trace incidents and improve the reliability of the system.

The new tool for recording the incidents – EDICT (ENTSO-E Disturbance and Incident Classification Tool) to be commissioned before the end of 2015 will take the reporting and analysis of the incident data even a step further.

To conclude, in 2014 the transmission system operators demonstrated high levels of coordination and cooperation enabling a highly stressed system with high cross-border flows and internal system constraints to be managed securely and efficiently.

ENTSO-E recommends a continuation of the development of closer cooperation between the transmission system operators in order to improve transmission system operation and security.

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References

[1] ENTSO-E – Incident Classification Scale – Methodology, 13 November 2013

[2] ENTSO-E – System Operation Guideline

[3] ENTSO-E - Summer Outlook Report 2014 and Winter Review 2013/2014

[4] ENTSO-E - Winter Outlook Report 2014/2015 and Summer Review 2014

[5] ENTSO-E – ENTSO-E data portal, www.entsoe.eu/data/data-portal/

Contact
ENTSO-E AISBL

Avenue de Cortenbergh 100
1000 Brussels – Belgium

Tel +32 2 741 09 50
Fax +32 2 741 09 51

info@entsoe.eu
www.entsoe.eu