CEER

Council of European Energy Regulators

6TH CEER BENCHMARKING REPORT ON THE QUALITY OF ELECTRICITY AND GAS SUPPLY

2016

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PREFACE

European energy regulators are committed to promoting well-functioning and competitive energy markets in Europe in order to ensure that consumers receive fair prices, a wide choice of suppliers and the best quality of supply. In this Report, the Council of European Energy Regulators (CEER) focuses on monitoring the quality of electricity and gas supply, which constitutes an essential tool in the overall supervision of well-functioning energy markets.

CEER produced five Benchmarking Reports since 2001 that provide an in-depth survey and analysis of the quality of electricity supply. In addition, CEER published updates on some of the key data contained in these Reports in 2014 and 2015. In producing these Reports, CEER seeks to provide valuable information on the regulation regarding quality of electricity of supply in 28 EU Member States as well as Norway and Switzerland, with associated recommendations for good regulatory practices that could be adopted in Europe.

We are delighted to see that our work in providing an extensive analysis of quality of supply issues continues to develop. Expanding on previous Reports, this 6th CEER Benchmarking Report covers not only electricity supply indicators but also gas continuity and quality of supply covering the EU, Norway and Switzerland. Moreover, the Report presents several case studies, including case studies on the situation in Algeria and Israel. In continuing with the CEER-ECRB cooperation on improving service quality regulation, the Report also includes a dedicated annex on quality of supply in seven Energy Community contracting parties.

We hope you will find the data and analysis of interest and that the Report is useful for your work. If you would like to obtain more information about any part of the Report, please do not hesitate to contact the CEER Secretariat or your national energy regulatory authority.

The Lord Mogg
CEER President
Brussels, August 2016

EXECUTIVE SUMMARY

Since 2001 the Council of European Energy Regulators (CEER) has regularly undertaken a survey and analysis of the quality of electricity supply in its member and observer countries, the results of which are presented in its Benchmarking Reports. Over the last 15 years, CEER has produced 5 Benchmarking Reports on the quality of electricity supply, as well as updates on the key data published in February 2014 and February 2015.

In an improvement from previous years, this 6th CEER Benchmarking Report covers not only electricity supply indicators but also gas continuity and quality of supply. This Report provides information on the quality of energy supply in 28 EU Member States as well as Norway and Switzerland, with associated recommendations for good regulatory practices which could be adopted in Europe.

The CEER Report addresses 3 major aspects of quality of supply. For electricity, these are the availability of electricity (continuity of supply), its technical properties (voltage quality) and the speed and accuracy with which customer requests are handled (commercial quality). For gas, these are the supply of gas (technical operational quality), its composition (natural gas quality) and, equivalent to electricity, the speed and accuracy of handling customer requests (commercial quality).

Each chapter of the Report presents the results of the benchmarking through the following steps:

- An explanation of the quality aspect and the importance of its regulation;
- A summary of the past CEER work (for the electricity chapters);
- Specific details on which indicators are monitored as well as a review of how the specific aspects are monitored and regulated; and
- Data and results available from the monitoring and regulation with respect to the responding countries.

The overall goals of quality of supply regulation are to guarantee a good level of continuity of supply, voltage quality, quality and good services for energy consumers across Europe. These goals were considered in the Report's findings and recommendations.

Continuity of Supply

Electricity continuity of supply (CoS) is monitored in all responding countries (30); nevertheless, differences exist in the type of interruptions monitored as well as in the indicators and procedures for data collection and analysis used. The data in the Report demonstrates that 5 countries (Croatia, Greece, Hungary, Romania and Spain) experienced a decrease in the number of planned and unplanned long interruptions in the monitored years up to 2014. Overall, with respect to the number of long interruptions per year (excluding exceptional events) one can observe over recent monitored years either constant quality levels or a general tendency towards a slight increase in quality in nearly all countries. Regarding minutes lost due to planned and unplanned interruptions, large variations exist among responding countries, with the number of minutes lost ranging from 10 to 500 minutes lost per year for planned interruptions and 10 to 1,100 minutes per year for unplanned interruptions.

The chapter on CoS also explores regulatory incentive regimes implemented at system level and single-user level in the responding countries. Nearly two thirds of countries offer individual compensation to network users when standards are not met. Individual compensation is however not in place in Austria, Croatia, Cyprus, Denmark, Germany, Latvia, Luxembourg, the Slovak Republic and Switzerland. In addition to compensation for failing to meet standards, there are also schemes in Ireland and Great Britain for worst-served customers.

In order to further facilitate the comparison of national continuity data Europe-wide, CEER recommends in this Report the harmonisation of CoS indicators, data collection procedures and the methodology to calculate the values of CoS. Moreover, the monitoring of CoS should be expanded to include incidents at all voltage levels in interruption statistics in all countries, and short interruptions should be monitored across Europe. NRAs should also implement adequate incentive schemes for maintaining or improving general continuity levels at the distribution and transmission level.

Voltage quality

Given the answers from 27 countries, the Report shows that half of responding NRAs possess powers and duties to define voltage quality regulation alone or together with other competent authorities. The exact duties and powers the NRA has in voltage quality regulation has an impact on the role the NRAs takes in regulation of power quality, as well as in awareness and education.

In 6 of the reporting countries, either the DSO or the TSO has an obligation to inform end-users about past or expected future voltage quality levels. Upon receipt of a customer complaint regarding the voltage quality at the costumer's connection point, the DSO or TSO is, in several countries, obliged to perform measurements to verify the levels of all relevant voltage quality parameters. In addition, a voltage quality monitor is provided to customers wanting to monitor voltage quality at their connection point. The Report shows that in countries where smart meters have been rolled-out, they are in most cases able to monitor voltage quality.

Although the 2010 European standard EN 50160 remains the basic instrument for voltage quality assessment, some countries have implemented additional requirements in their national legislation. This is mainly due to the fact that the 2010 version of the standard does not cover extra high voltage levels and that some countries seek to implement stricter limits than the standard.

The Report also reveals that a number of countries have introduced legislation related to emissions by individual customers and have identified the concept of responsibility sharing for adequate voltage quality between the network operator, the customer and the manufacturer.

Finally, the voltage chapter includes a case study on voltage quality regulations in Israel where the EN 50160 standard is considered acceptable for the country's electrical grid.

Based on the findings, CEER recommends to accurately identify the responsibility for voltage disturbances according to the concept of responsibility sharing between the network operator, the customer and the manufacturer. Furthermore, CEER recommends publishing the monitored voltage quality data and increasing awareness of how voltage quality impacts on the network and on customers.

Gas technical operational quality

Network users expect a high continuity of supply level at an affordable price in the case of both electricity and gas. The fewer the interruptions and the shorter these interruptions are, the better the continuity is from the viewpoint of the network user. Therefore, one of the roles of network operators is to optimise the continuity performance of their distribution and/or transmission network in a cost effective manner. In the case of gas, one single interruption can lead to a high risk of safety and therefore the efforts of network operators to avoid any interruption are greater than in electricity. Indeed, the Report shows that there are considerably less interruptions in the gas sector than in electricity. Nevertheless, the gas sector experiences longer interruptions than electricity.

Technical safety plays a very important role in the gas sector; however, European countries have adopted varying approaches and regulations for networks' safety. Only 4 responding countries have introduced risk indexes, which seek to define an optimal approach to the operation and recovery of gas facilities in terms of ensuring their safe, reliable and economic operation. Nevertheless, this is not subject to regulation. Currently, a specific financial incentive scheme aimed at improving the safety of gas networks exists only in Italy.

Network losses are an inevitable consequence of transporting gas across the distribution network; nevertheless, their magnitude should be minimised. Yet, only half of responding NRAs use a methodology for computing network losses in gas networks and only half have a regulation n place aimed at reducing network losses.

CEER recommends expanding the coverage of monitoring of continuity of gas supply and safety indicators so that comparisons are possible across more countries in the future. CEER further recommends that, for the purpose of effective comparison, a definition of a basic set of indicators for gas technical operational quality is adopted.

Natural gas quality

The number of indicators monitored by NRAs demonstrates that countries pay close attention to natural gas quality. If gas quality is not met, it is important to know who is responsible in any given situation. For the majority of countries, the TSO and shipper are financially and/or legally responsible for natural gas quality. Since gas resources are exchangeable on the market, the question of shared responsibilities of transporters between 2 bordering countries is important; however, opinions among countries vary between those that consider responsibility to be at the TSO exit point and those that consider it to be shared between both TSOs on either side of an interconnection point.

The European Commission has signalled its intent to amend the Interoperability Network Code to include the European Committee for Standardisation (CEN) Standard. If the CEN standard was made binding, TSOs might need to invest in costly treatment processes in order to accept gas that would now be outside of specification. The alternative would be to refuse gas that does not meet the CEN standard, thus potentially creating future security of supply issues. CEER recommends that any attempt to harmonise gas quality firstly clarifies the problem at hand, then considers the impacts of making the standard binding, and lastly avoids having any unintended consequences on, inter alia, security of supply.

Electricity and gas commercial quality chapters

The findings of the electricity and gas commercial quality chapters are similar in that they show an increased focus by NRAs on the quality of the services provided to customers.

Looking at electricity commercial quality, performance levels have been stable or have slightly increased overall in the identified years to 2015. This is the case for the connection performance indicators, where 8 countries perform better than the overall average and others have registered an improvement in their performance. Similarly, the reported non-compliance indicators related to customer care are for most countries relatively low.

Regarding metering and billing, in general performance results are particularly good for the time for restoration of power supply following disconnection due to non-payment. The Czech Republic, Greece, Hungary, Portugal and Slovenia have performance rates over 98% for the 2010-2014 period.

The Report shows that there is room for progress especially regarding the level of gas commercial quality. Out of the responding countries, only 3 reach the value of their indicator regarding the provision of an answer to customers' queries/requests. The punctuality of operators with respect to planned appointments with customers is a major commercial quality issue, with Austria and Italy demonstrating good performances in this regard. The chapter shows that compensation paid to the customer for non-compliance exists in some countries but not on a sufficient scale. Some countries also apply automatic compensation in the case of non-compliance for certain indicators. CEER recommends that NRAs should ensure greater protection through Guaranteed Indicators with automatic compensation for customers.

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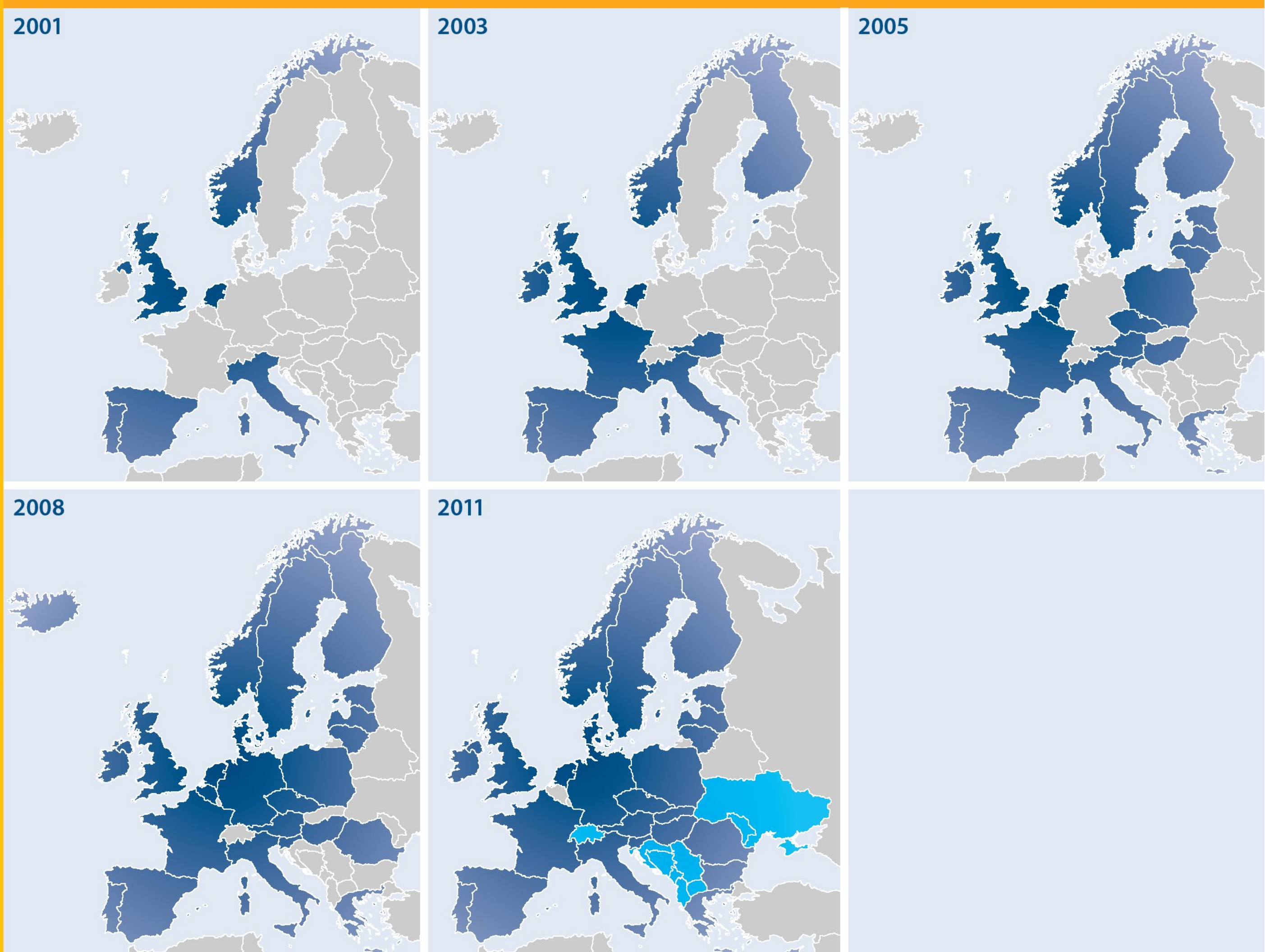
FIGURE 1.1 ACTIVE CONTRIBUTION TO THE CEER BENCHMARKING REPORTS OVER ITS 5 EDITIONS (2001-2011)



1.1. BACKGROUND

The Council of European Energy Regulators (CEER) periodically surveys and analyses the quality of electricity supply in its member and observer countries. These surveys and analyses take the form of CEER Benchmarking Reports on Quality of Electricity Supply, hereafter Benchmarking Reports. The first report was issued in 2001 [1], followed by the 2nd, 3rd, 4th and 5th editions in 2003, 2005, 2008 and 2011 respectively [2], [3], [4], [5]. Moreover, updates on the key data were published in February 2014 and 2015. For the first time, this 6th Benchmarking Report also examines and analyses the quality of gas supply.

The publication of these Reports has facilitated the availability of information on the regulation of quality of supply and its implications in each country. In addition, the Reports provide good practices for regulating the quality of supply in electricity grids, which have been adopted by many European countries. Since the first edition, the benchmarking exercise has steadily spread throughout Europe as displayed in Figure 1.1.

1.2. COVERAGE

This Benchmarking Report includes data from National Regulatory Authorities (NRAs) from EU Member States as well as Norway and Switzerland, as illustrated in Figure 1.2. In addition, a total of 7 countries from the Energy Community Regulatory Board (ECRB) – Albania, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Kosovo, Montenegro, Serbia and Ukraine – have also completed the benchmarking exercise the results of which can be found in Annex titled "Quality of Electricity Supply in the Energy Community". Lastly, to widen the geographical scope of the Report, case studies from the members of the Mediterranean Energy Regulators (MedReg), Algeria and Israel, are part of this Report.

1.3. STRUCTURE

This 6th Benchmarking Report addresses 3 major aspects of quality of supply. For electricity, these are its availability (continuity of supply), technical properties (voltage quality) and the speed and accuracy with which customer requests are handled (commercial quality). These elements are treated in Chapter 2, 3 and 4, respectively. For gas, these are its supply (technical operational quality), composition (natural gas quality) and commercial quality, which are treated in Chapter 5, 6 and 7, respectively.

Each chapter presents the benchmarking results in the following steps:

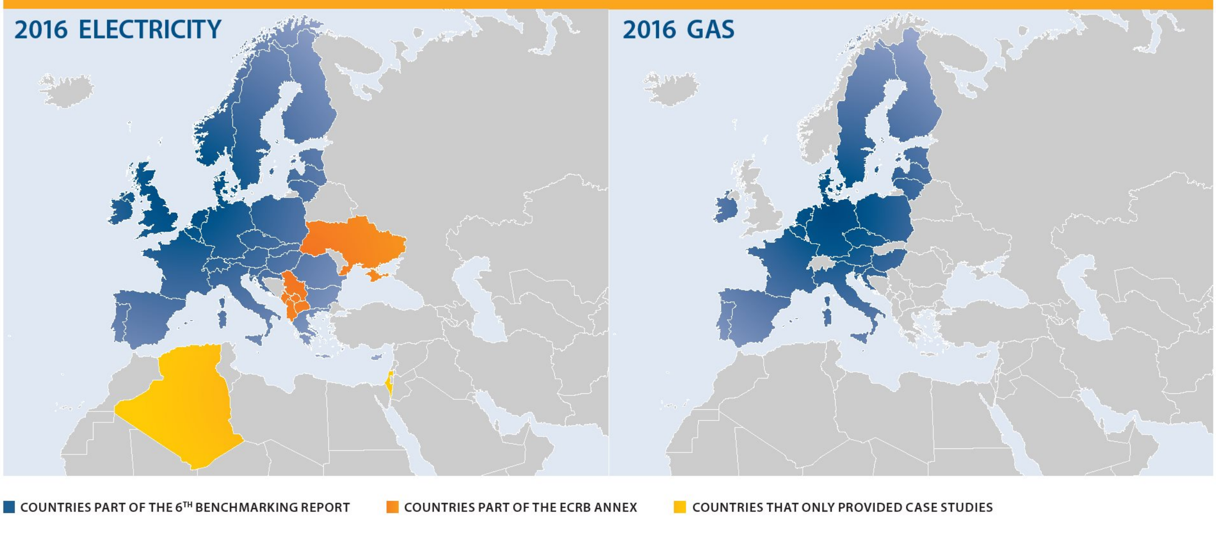
- An explanation of the quality aspect and the importance of its regulation;
- A summary of the past work (for the electricity chapters) of the European Energy Regulators;
- Specific details on the following topics:
  - A review of what is monitored;
  - A review of how the specific aspects are monitored and regulated; and
  - Actual data and results.

A more detailed analysis of practices in certain countries was included in the form of case studies, which illustrate the varying approaches to the regulation of quality of supply and reflect the conditions specific to each studied country.

1.4. CONCLUSIONS

The general goal of the quality of supply regulation is to guarantee a good level of continuity of supply, voltage quality, gas quality and good services for consumers across Europe. These goals were considered in findings and recommendations at the end of the chapters that reflect the key information and aspects concerning the covered topics. CEER members and observers as well as the additional countries included in the Report should consider the implementation of these recommendations.

FIGURE 1.2 ACTIVE CONTRIBUTION TO ELECTRICITY AND GAS CHAPTERS



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➔ ELECTRICITY – CONTINUITY OF SUPPLY

2.1. WHAT IS CONTINUITY OF SUPPLY AND WHY IS IT IMPORTANT TO REGULATE IT

Continuity of supply concerns interruptions in electricity supply and focuses on the events during which the voltage at the supply terminals of a network user drops to zero or nearly zero[1]. Continuity of supply can be described by various quality dimensions. The ones most commonly used are number of interruptions, unavailability (interrupted minutes) and energy not supplied (ENS) per year.

Network users expect a high continuity of supply[2] at an affordable price. The fewer the interruptions and the quicker the return of electricity supply, the better the continuity from the network user's point of view. Therefore, one of the roles of network operators is to optimise the continuity performance of their distribution and/or transmission network in a cost effective manner. The role of the NRAs is to ensure that this optimisation is carried out in a correct way, taking into account users' expectations and their willingness to pay.

Continuity of supply indicators are traditionally important tools for making decisions on the management of distribution and transmission networks. Regulatory instruments now mostly focus on accurately defined continuity of supply indicators of frequency of interruptions, their duration, and energy not supplied due to interruptions. These instruments normally complement incentive regulation, which (either in the form of price or revenue-cap mechanisms) is commonly used across Europe at present. Incentive regulation provides a motivation to increase economic efficiency over time. However, it also carries a risk of network operators refraining from carrying out investments and proper operational arrangements for better continuity, in order to lower their costs and increase their efficiency. To account for this drawback in incentive regulation, a large number of European NRAs adopt additional regulatory instruments to maintain or improve continuity of supply.

2.2. MAIN CONCLUSIONS FROM PAST WORK ON CONTINUITY OF SUPPLY

The 1st Benchmarking Report published in 2001 identified the 2 main features of continuity of supply regulation as:

- guaranteeing that each user can be provided with at least a minimum level of quality; and
- promoting quality improvement across the system.

The comparative analysis of available measurement and continuity of supply regulation in the 1st Benchmarking Report shows that NRAs have generally approached continuity issues by first looking at long interruptions affecting low voltage (LV) network users and treating planned and unplanned interruptions separately. In several countries, both the number and the duration of interruptions were available. However, the choice of the indicator used varies by country. Moreover, many countries record short interruptions as well as long interruptions. Different approaches to continuity of supply regulation combined with different geographical, meteorological and network characteristics, make benchmarking of actual levels of continuity of supply difficult. CEER urged NRAs in the 1st Benchmarking Report to pay attention to implementation and control issues and identified the most important of these:

- regular internal audits by distribution companies and sample audits by the NRA; and
- accuracy and precision indicators to assist in auditing and to inform decisions about sanctions.

In the 2nd Benchmarking Report, the number of countries included in the comparison was extended and the comparisons were more detailed. Distinctions were made between planned and unplanned interruptions, different voltage levels and load density areas and interruptions were classified by their cause. It was noted that further harmonisation of data and definitions between NRAs remained necessary. The 2nd Benchmarking Report also concluded the level of quality of supply had not decreased significantly in European countries even after the privatisation of utilities, increasing supply competition, price-cap regulation for monopolistic activities and legal unbundling of businesses.

1. According to EN 50160.
2. The terms "availability of electricity supply" and "reliability of supply" can be used interchangeably with continuity of supply. However, this report adopts the term "continuity of supply" as in the previous CEER Benchmarking Reports.

A number of encouraging trends were also observed in the 3rd Benchmarking Report, such as:

- The duration of unplanned interruptions showed significant improvement (downward trend) for most countries;
- The number of unplanned interruptions showed improvement (downward trend) for most countries;
- Excluding exceptional events from unplanned interruption performance figures highlighted the significant improvements made by many European countries in terms of the duration and the number of interruptions;
- Countries with previously low levels for duration and number of interruptions were able to make further improvements; and
- The number of short interruptions had generally not risen despite an increased move to automation and remote control techniques.

CEER concluded in the 2nd and 3rd Benchmarking Reports that audit procedures had been put in place in almost all countries that adopted reward/penalty schemes, as measurement rules and that audit procedures become more important when some kind of economic incentive is used for continuity of supply.

The 4th Benchmarking Report introduced precise definitions of continuity indicators in order to ensure an appropriate homogeneity between European countries. Very detailed chapters on exceptional events and a short presentation of on-site audits on continuity data were also added.

Between the 4th and the 5th Benchmarking Reports, CEER commissioned a consultancy report: "Study on estimation of costs due to electricity interruptions and voltage disturbances" elaborated by SINTEF [6] and published "Guidelines of Good Practice on Estimation of Costs due to Electricity Interruptions and Voltage Disturbances" (2010) [7]. 2 key messages emerged:

- Results from cost-estimation studies on costs due to electricity interruptions are of key importance for setting proper incentives for continuity of supply; and
- The CEER Guidelines of Good Practice (GGP) should be used as a reference when performing a nationwide cost-estimation study, always taking into account country-specific issues and needs.

CEER representatives contributed significantly to the CENELEC technical report CLC/TR 50555:2010 "Interruption indexes" [8], issued in 2010, covering guidance on how to calculate continuity of supply indices as well as recommendations on a set of indices System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) and Momentary Average Interruption Frequency Index (MAIFI) suitable for pan-European benchmarking of distribution network performances. The report recognised its shortcoming in not addressing rules on the aggregation of interruptions, in particular short interruptions and proposed to describe aggregation rules in a second version of the technical report.

In the 5th Benchmarking Report, a case study from Switzerland was included in the main document and 9 countries from the Energy Community Regulatory Board (ECRB) were included as an annex to the report. The report offered a more detailed look into the correlation between interruptions and percentage of underground cables; level of detail in the indicators; contributions to duration and frequency of interruptions based on voltage level and differences between interruptions in urban, suburban and rural areas of certain EU Member States. In addition, descriptions of quality incentive schemes were presented for many countries.

2.3. STRUCTURE OF THE CHAPTER ON CONTINUITY OF SUPPLY

The chapter on continuity of supply takes a closer look at the monitoring practices and indicators used in the responding countries. After a detailed analysis of continuity, the chapter investigates existing regulation at system level and at single-user level (including standards and incentives), and concludes with findings and recommendations on continuity of supply.

The chapter is based on input from 30 countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, the Slovak Republic, Slovenia, Spain, Sweden and Switzerland. Moreover, case studies from the Czech Republic and MedReg members, Algeria and Israel, are also included.

2.4. CONTINUITY OF SUPPLY MONITORING

Continuity of supply refers to the availability of electricity to all network users. All countries that participated in this Benchmarking Report stated that they monitor continuity of supply in their electricity networks. However, there are significant differences in monitoring across the EU Member States.

Differences arise in the type of interruptions monitored, the reported level of detail as well as the interpretation of various indicators. This section presents the methods used for monitoring in different countries.

2.4.1. Definitions and monitoring of interruptions based on duration

In the following table (Table 2.1), definitions of interruptions of different duration are reported for various countries. It is important to note that some countries do not define all types of interruptions, such as transient, while others consider transient interruptions to be included in short interruptions.

The provided definitions of short interruptions reveal that there are cases when boundaries between interruptions of different duration are blurred, as there is no clear distinction between long and short interruptions. Sometimes only interruptions above certain minimum duration are defined (e.g. 5 seconds in the Netherlands or 1 minute in Denmark) but the definition itself does not distinguish between different lengths of interruptions. Most of the countries that differentiate between long and short interruptions are in line with the EN 50160 standard regarding voltage characteristics in public distribution systems. Long interruptions are monitored in all countries that answered the questionnaire. Out of these countries, 12 also monitor short or transient interruptions.

TABLE 2.1 DEFINITIONS OF LONG, SHORT AND TRANSIENT INTERRUPTIONS

Country	Transient interruption	Short interruption	Long interruption
Austria	Not defined	1 sec<T≤3 min	T>3 min
Belgium	Same category as short	T<3 min	T≥3 min
Bulgaria	T<1 sec	T<3 min	T>3 min
Croatia	Not defined	1,5 sec≤T≤3 min	T>3 min
Cyprus	Not defined	Not defined	Not defined
Czech Republic	20 msec<T≤1 sec	1 sec<T≤3 min	T>3 min
Denmark	No distinction between long and short interruptions. An interruption has duration of at least 1 minute (1).	No distinction between long and short interruptions. An interruption has duration of at least 1 minute (1).	No distinction between long and short interruptions. An interruption has duration of at least 1 minute (1).
Estonia	Not defined	Not defined	T>3 min
Finland		T<3 min	T≥3 min
France	T<1 sec	1 sec≤T≤3 min	T>3 min (2)
Germany	T≤1 sec	1 sec< T≤3 min	T>3 min
Great Britain	Same category as short	T<3 min	T≥3 min (3)
Greece	Not defined	T≤3 min	T>3 min
Hungary	T≤1 sec	1 sec<T≤3 min	T>3 min
Ireland	Not defined	Not defined	T≥3 min (4)
Italy	T≤1 sec	1 sec<T≤3 min	T>3 min
Latvia	Not defined	T≤3 min	T>3 min
Lithuania	Not defined	T<3 min	T≥3 min
Luxembourg		T≤3 min	T>3 min
Malta	No such classification used. All interruptions are recorded.	No such classification used. All interruptions are recorded.	No such classification used. All interruptions are recorded.
The Netherlands	Not defined	No distinction between long and short interruptions. An interruption has duration of at least 5 seconds.	No distinction between long and short interruptions. An interruption has duration of at least 5 seconds.
Norway	Included in short (5)	T≤3 min	T>3 min
Poland	T<1 sec	1 sec≤T<3 min	T>3 min
Portugal	Not defined	1 sec≤T≤3 min	T>3 min
Romania	T≤1 sec	1 sec<T≤3 min	T>3 min
Slovak Republic	Not defined	T<3 min	T>3 min
Slovenia	Not defined	T≤3 min	T>3 min
Spain	Not defined	T≤3 min	T>3 min
Sweden		100 msec≤T≤3 min	T>3 min
Switzerland	T<1 sec	1 sec≤T≤3 min	T>3 min

(1) All interruptions lasting 1 minute or longer are monitored.
(2) Until 2010, it was duration ≥3 min.
(3) This excludes re-interruptions to customers that have already been interrupted during the same incident.
(4) Up to and including 2010, this definition was T≥1 minutes. For 2011 onwards, the definition was changed to T≥3 minutes.
(5) This definition is not used. Short interruptions start at zero.

2.4.2. Planned and unplanned interruptions

Most countries use separate classifications for planned (notified) and unplanned interruptions. The concept "planned interruption" is cited in EN 50160 [16] (the term "prearranged interruption" is used) as an interruption for which network users are informed in advance, typically due to the execution of scheduled works on the electricity network. Most countries consider advance notification to affected network users to be sufficient and necessary for an interruption to be classified as planned.

The majority of countries have a definition for planned interruptions. Whereas there is a general agreement on this definition, the requirement for advance notice varies strongly among countries (between 24 hours and 50 days). In some cases, the rules are less strict and depend on an agreement between the network operators and customers. Many countries with lower share of planned interruptions in the overall duration of interruptions make use of live works, portable generators and reconfiguration of networks to prevent such interruptions or mitigate their impact [9]. Definitions of planned and unplanned interruptions as well as rules for treatment of planned interruptions can be found in Table 2.2.

TABLE 2.2 PLANNED AND UNPLANNED INTERRUPTIONS – DEFINITIONS AND RULES

Country	Planned interruption	Unplanned interruption	Rules for planned interruptions
Austria	Interruptions for which the grid user has to be informed in advance.	Interruptions caused by lasting or temporary disturbances, mainly related to component malfunction or external disturbances.	The DSO has to inform the affected grid users about the start and duration at least 5 days before the planned interruption. In case of individual mutual agreements, the notification can be shorter.
Belgium	EHV / HV: the interruption planning process and notification milestones towards customers are detailed in the connection contract. The interruption is subject to customer's approval.	EHV / HV: All interruptions caused by unforeseen opening of circuit-breakers.	At the end of every year, the TSO makes a list of all planned interruptions for the following year and notifies the concerned customers at the same time. When the interruption date approaches, the TSO checks whether the interruption is still acceptable under the actual grid conditions 7 weeks before and then each week from 5 to 1 week before the planned interruption. If so, the interruption occurs in consultation with the customer.
Bulgaria	Interruptions for which the grid user has to be informed in advance.	When the customer has not been informed in advance.	For activities which are subject to planning, the company is under the obligation to inform the customer/network users about the time and duration of an electricity supply interruption through the mass media at least 14 calendar days in advance.
Croatia	Interruptions for which the grid user has to be informed in advance.	In case of force majeure or failure.	48 hour individual notice before works for users over 30 kW and 24 hour notice over mass media for users below 30 kW.
Cyprus	Interruptions for which the grid user has to be informed in advance.	An interruption due to unforeseen events like component failures, lightning strikes, excavation activities or incorrect switching actions.	Planned interruptions occur when certain work is required on the network (maintenance, upgrade, etc.) or in the event of significant deficit in generation. There is no minimum time limit for customer notification.
Czech Republic	Interruptions in electricity transmission or distribution network during performance of planned work on transmission or distribution devices according to Energy Act (mainly: maintenance, refurbishing, construction).	All interruptions in electricity transmission or distribution that are not planned (divided: failure under usual weather conditions, failure under unfavourable weather conditions, caused by third-party, forced, extraordinary, interruption outside system).	The TSO has to inform affected customers 50 days in advance, the DSO has to inform affected customers 15 days in advance.
Denmark	At least 48 hour notice to all affected customers.	When the notice is less than 48 hours.	48 hour notice.
Estonia	Planned due to construction, repairing and maintenance works on the network.	Due to unpredictable damages, faults in network.	Rules issued about notice to customers are affected with minimum time-lag requested.
Finland	Interruptions for which the grid user has to be informed in advance.	Unplanned interruptions are not notified to customers in advance.	No rules for planned interruptions by the NRA.
France	An interruption notified in advance to all affected customers with adequate notice.	An interruption not notified in advance to all affected customers or notified with inadequate notice.	On the transmissions network, there is a procedure with different steps of planning starting from 1 year (or even more for important works) to 1 month before the interruption. The last confirmation is given at least 15 days before. On the distribution network, the operator must agree with MV customer on a date for the planned interruption at least 10 days before the date (except in case of emergency). Planned interruptions are notified to small customers (<36 kVA) by press or by individualised information.

Country	Planned interruption	Unplanned interruption	Rules for planned interruptions
Germany	Interruptions with notice or arrangement in advance to the customers.	All other interruptions.	No.
Great Britain	Interruption where notification has been given to affected customers at least 48 hours before the interruption.	Interruption of supply to customer(s) for 3 minutes or longer or any occurrence on the distribution system or other connected distributed generation or transmission system that prevents a circuit or item of equipment from carrying normal load current and where notification has not been given to customers at least 48 hours before the interruption.	At least 48 hour notice should be provided to affected customers – carding customers with the expected interruption duration, etc.
Greece	48 hour notice.		No rules issued by the NRA.
Hungary	Interruptions for which the grid user has to be informed in advance.	When not all affected customers are given an adequate advance notice.	According to the Guaranteed Standards there are 2 different notification rules depending on the power capacity: • with power capacity below 200 kVA customers should be notified 15 days before the planned interruption according to the local practise, e.g. leaflet; • with power capacity of 200 kVA or above, customers should be notified 30 days before the planned interruption in a personal letter if there is no other agreement between the parties.
Ireland	Planned (prearranged) interruptions are those which are caused by the system operator interrupting supply in order to do planned maintenance or construction on the network. Normally, customers are informed in advance of planned interruptions.	In unplanned (accidental) interruptions, which are those caused by permanent (a long interruption) or transient (a short interruption) faults, mostly related to external events, equipment failures or interference, the customer is normally not informed in advance.	A minimum notice of 2 days must be provided.
Italy	An interruption notified in advance to all affected customers with adequate notice.	Any interruption that is different than planned.	Rule for distribution network operators: advance notice of 3 working days from 1 January 2016 (previously: 2 working days). Advance notice reduced to 24 hours in case of interventions after faults or during emergencies.
Lithuania	Interruption, which was informed to the customer on time and in a way set in the legal acts or agreement.	Interruption, which was not informed or informed to the customer later than the time and way set in the legal acts or agreement, except if it was done to ensure the public interests.	By law the customer has to be informed about the interruption not later than 10 days ahead.
Luxembourg	Previous notice of interruption.	No previous notice of interruption, however, if possible, provisional length of interruption has to be communicated to the affected customers.	Network operators are legally bound to inform customers about the date and time of the planned interruption prior to the interruption, as early as possible and by appropriate means.
Malta	An outage of a generating plant or of part of the distribution system other than a forced outage. In practice a planned interruption is one where the customers have been notified in advance.	An interruption where the customers have not been notified in advance.	A 3 day notice must be provided.
The Netherlands	An interruption of which the network operator has informed the affected customers at least 3 working days in advance.	An interruption that is not a planned interruption.	Yes, notice to household customers and industrial customers on the low voltage network must be given at least 3 working days in advance, but no criteria exist relating to the procedure for giving notice. Notice to industrial customers on the medium and high voltage network must be given at least 10 working days in advance and the time of the planned interruption can only be established after consultation with the customer and taking into account the interests of the customer.
Norway	Planned interruptions are called notified interruptions. An interruption is considered notified if customers are informed a reasonable amount of time prior to the interruption and the information has been provided in an appropriate manner.	Unplanned interruptions are called non-notified interruptions. An interruption is considered non-notified if it does not fulfil the requirements for a notified interruption.	The interruption must be notified minimum 24 hours prior to the interruption, but as a main rule 2 business days prior to the interruption. The information shall be provided in an appropriate manner. Trade and industry end-users must be notified individually. If the interruption is not satisfactorily notified, it shall be regarded as a non-notified interruption.

Country	Planned interruption	Unplanned interruption	Rules for planned interruptions
Poland	Classified as prearranged (planned), when network users are informed in advance, to allow for the execution of scheduled works on the distribution system.	Classified as accidental (unplanned), caused by permanent or transient faults, mostly related to external events, equipment failures or interference without notice in advance to the customers.	A minimum of 5 days of prior notice must be provided.
Portugal	Interruption with notice in accordance with the Commercial Relations Code, published by ERSE.	Interruption without notice.	Interruption with notice in accordance with the Commercial Relations Code, published by ERSE. Interruptions for reasons of public interest: the entity responsible for the network must inform, whenever possible, and with a minimum prior notice of 36 hours, the customers which may be affected by the interruption. Interruptions for service reasons: DSOs can agree with customers the best moment for the interruption. If an agreement is not possible, the interruptions must occur, preferentially, on Sundays, between 05:00 hours and 15:00 hours, with a maximum duration of 8 hours per interruption and 5 Sundays per year, per costumer affected. DSO must inform a customer with a minimum prior notice of 36 hours. Interruptions due to costumer responsibility: The supply interruption may only take place following a prior notice of interruption, with a minimum advance warning of 8 days relative to the date when it will occur. If the costumer installation emits perturbations to the network, the operator establishes, in accordance with the costumer, a time period for solving the problem.
Romania	The interruption is considered planned when the customers are informed in advance, usually with 15 calendar days and in special circumstances, critical operation conditions, can however be delayed, with 1 day (24 hours).	The interruption is considered unplanned when the customers are not informed in advance.	Usually the planned interruptions are discussed and planned with the big customers.
Slovak Republic	Not defined.	Interruption by reason of failure or force majeure.	Minimum time for giving notice is 15 days.
Slovenia	According to EN 50160:2010.	According to EN 50160:2010.	Each customer that will be affected must be informed, using written form or any other suitable form, in a timely manner. If the interruption will affect a greater number of customers, the customers must be informed by public notification (by announcement on the local radio, publication on the DSO website, notification by using messaging services (SMS, MMS) etc.) at least 48 hours before the start of the interruption.
Spain	An interruption of continuity of supply declared by Distribution firm previously (72 hours) to Regional Government, and authorised by this institution.	Any interruption not considered as planned interruption.	Planned interruptions must be announced to affected customers giving a minimum of 24 hours advance notice by the following means: a) Individualised notification using a method whereby there is a record of it having been sent to consumers shows supplies are carried out at voltages higher than 1 kV and to those establishments rendering services that are declared to be essential services, b) Advertising posters in visible spots with regard to all other consumers and by means of 2 of the most widely circulated printed media in the province.
Sweden	Interruptions for which the grid user has to be informed in advance.	Customers have not been warned in advance.	General requirements in the electricity act.
Switzerland	An interruption notified in advance to all affected customers with adequate notice.	An interruption not notified in advance to all affected customers or notified with inadequate notice.	Customers must be informed at least 24 hours in advance.

2.4.3. Voltage levels monitored

It would be very difficult to discuss the monitoring of interruptions on different voltage levels without first addressing how those voltage levels are defined. Since the terms low voltage (LV), medium voltage (MV), high voltage (HV) and extra high voltage (EHV) have quite different meanings across Europe, Table 2.3 should be consulted when referencing a specific voltage level.

Sometimes, the actual voltage level is not strictly defined or is different from its definition. In Bulgaria, the upper limit for medium voltage is defined as 75 kV while in reality the medium voltage only goes up to 35 kV. Certain voltages in Ireland are only defined nominally but their real value varies according to operating conditions. Some levels can correspond to both transmission and distribution as is the case in Belgium where grids with voltages between 30 and 36 kV are usually considered high voltage with local transmission function. Recently, however, DSOs in Belgium were allowed to build grids with voltages between 30 and 36 kV that have a distribution function. These grids are mainly developed to directly connect local generation units that are too big to the existing distribution grid.

TABLE 2.3 DEFINITIONS OF VOLTAGE LEVELS

Country	LV Network		MV Network		HV Network		EHV Network		Transmission	
	Min kV	Max kV	Min kV	Max kV	Min kV	Max kV	Min kV	Max kV	Min kV	Max kV
Austria		1	>1	36	>36	<220	220	380	110	380
Belgium	0,23	1	1	30-36 (7)	30-36 (7)	150	220	380	30	380
Bulgaria		1	1	35 (6)	110	400			110	400
Croatia	0,4	0,4	10	35	110	110	220	400	110	400
Czech Republic	0,4	0,6	6	35	110	110	220	400	110	400
Denmark	0,4	1	≥1	25	≥25	<100 (9)	100	400	100	400
Estonia	0,4	0,4	6	35	110	110	220	330	110	330
Finland	0,4	1	1	70	70	110	220	400	110	400
France		1	1	45	63	150	225	400	63	400
Germany		1	1	72,5	72,5	125	125	380	72,5	380
Great Britain		<1			1	<22	22	<132	132 (1)	400
Greece	0,4	0,4	6,6	22	66	150	400	400	66,4	400
Hungary	0,23	0,4	10	35	120	120	220	750		
Ireland	0,23	0,4	10 (2)	22,1	38 (3)	110	220	400	110	440
Italy		1	>1	35	>35	150	>150			
Latvia	0,22	0,4	6	20	110	110	330	330	110	330
Lithuania		0,4	6	35	110	330			110	330 (4)
Luxembourg	0,4	1	1	36	36	150	150	220	220	220
Malta		1	>1	33	35				(5)	(5)
The Netherlands		1	>1	36	>36	150	>150 (8)	380	110	380
Norway	0,23	1	1	22	36	132	220	420	132	420
Poland	0,23	0,4	1	60	110	110	220	750	110	750
Portugal		<1	1	<45	45	<110	110		132	400
Romania	0,4	1	1	20	110	110	220	750	220	750
Slovak Republic		1	Not defined	Not defined	1	110	110			
Slovenia	0,4	0,4	10	35	110	110	220	400	110	400
Spain	0	1	1	36	36	132	132	400	220	400
Sweden	0,4	1	1	36	36	150	220	400	220	400
Switzerland	0,22	1	1	36	36	220	220	380	220	380

(1) In England and Wales, transmission starts at 133 kV and goes up to 400 kV (lines are at 275 kV and 400 kV) In Scotland it includes the 132 kV lines.
(2) Variable according to operating conditions (nominal 10 kV).
(3) Variable according to operating conditions (nominal 38 kV).
(4) Starting in 2016, transmission lines will go up to 400 kV.
(5) No transmission system.
(6) The official definition of MV is up to 75 kV, but in practice the voltage only goes up to 35 kV.
(7) Grids with voltages between 30 and 36 kV.
(8) EHV levels are 220 and 380 kV.
(9) Before 2012 HV only went up to 70 kV.

Not all countries monitor interruptions that originate at all voltage levels, but all generate statistics for incidents at more than one voltage level as presented in Table 2.4. Interruptions originating on medium voltage (MV) level are monitored in all countries.

Incidents originating in transmission network, the definitions of which are shown in Table 2.3, are monitored in all countries except Latvia, Malta (which has no transmission system) and Romania.

TABLE 2.4 MONITORING OF VOLTAGE LEVELS WHERE INTERRUPTION ORIGINATED

Country	LV	MV	HV	EHV
Austria	X	X	X	X
Belgium		X	X	X
Bulgaria	X	X	X	X
Croatia	X	X	X	X
Cyprus	X	X	X	X
Czech Republic	X	X	X	X
Denmark	X	X	X	
Estonia		X	X	
Finland		X	X	X
France	X	X	X	X
Germany	X	X	X	X
Great Britain	X	X	X	X
Greece	X	X	X	X
Hungary	X	X	X	X
Ireland	X	X	X	
Italy	X	X	X	X
Latvia	X	X		
Lithuania	X	X	X	
Luxembourg	X	X	X	X
Malta		X	X	
The Netherlands	X	X	X	X
Norway	X	X	X	X
Poland	X	X	X	X
Portugal	X	X	X	X
Romania	X	X	X	
Slovak Republic	X	X	X	X
Slovenia		X	X	X
Spain	X	X	X	X
Sweden	X	X	X	X
Switzerland	X	X	X	X

Notes:
Portugal: LV, MV and HV levels include interruptions originated in upstream voltage levels. Interruptions are reported on a quarterly basis on all voltage levels and are reported separately for planned and unplanned interruptions, classified according with a set of causes established by the Quality of Service Code.

A presentation of voltage levels for which planned and unplanned long interruptions are monitored can be found in Table 2.5. In most cases, long interruptions are monitored on almost all voltage levels.

TABLE 2.5 VOLTAGE LEVELS FOR WHICH LONG INTERRUPTIONS ARE MONITORED

Country	Long planned interruptions voltage levels	Long unplanned interruptions voltage levels
Austria	Occurrence: all voltage levels. Customers: all voltage levels.	Occurrence: all voltage levels. Customers: all voltage levels.
Bulgaria	The data is available for MV and HV depending on the type of the 2 networks to which the customers are connected.	The data is available for MV and HV depending on the type of the 2 networks to which the customers are connected.
Croatia	HV, MV, LV	HV, MV, LV
Cyprus	HV, MV, LV	HV, MV, LV
Czech Republic	All voltage levels.	All voltage levels.
Denmark	HV, MV, LV	HV, MV, LV
Estonia	HV, MV, LV	HV, MV, LV
Finland	1-70 kV, 110 kV, 220 kV and 400 kV	1-70 kV, 110 kV, 220 kV and 400 kV
France	Customers connected to distribution networks only (MV + LV).	Available for all voltage levels, separately for each voltage level with respect to where the customer is connected.
Germany	All voltage levels.	All voltage levels.
Great Britain	All voltage levels.	All voltage levels.
Greece	MV and LV with respect to where the incident occurs.	MV and LV with respect to where the incident occurs.
Hungary	It applies to LV, MV and HV customers with respect to where the incident occurs.	It applies to all of the LV, MV, HV customers.
Ireland	Duration and number of interruptions per customer are reported to the NRA on an average (but not specific customer) basis. The information provided to the NRA for CIs and CMLs shows numbers affected with respect to where (defined by HV, MV and LV) the incident occurs. CI information shown by voltage level at which the customer was connected is also available.	Duration and number of interruptions per customer are reported to the NRA on an average (but not specific customers) basis. The information provided to the NRA for CIs and CMLs shows numbers affected with respect to where (defined by HV, MV and LV) the incident occurs. CI information shown by voltage level at which the customer was connected is also available.
Italy	All voltage levels.	All voltage levels.
Latvia	HV, MV, LV	HV, MV, LV
Luxembourg	HV, MV	HV, MV
Malta	Frequency and duration indicators of all planned interruption at 11kV substation level. Only duration data is gathered at LV and no indicators are available.	Frequency and duration indicators of all unplanned interruption at 11kV substation level. Only duration data is gathered at LV and no indicators are available.
The Netherlands	Planned interruptions are recorded at all voltage levels, but in practice only occur in the LV and MV networks. The data that is reported to the NRA makes a distinction between the voltage levels that the customers are connected to (at an aggregated level: LV, MV, HV and EHV). The NRA has no information about the location where the planned interruption takes place.	This applies to all voltage levels. The NRA only receives information concerning the voltage level that the customers are connected to. The NRA has no information regarding the location of origin of the unplanned interruption.
Norway	With respect to where the incident occurs: All voltage levels. With respect to where the customers are connected: All network IDs (1)	With respect to where the incident occurs: All voltage levels. With respect to where the customers are connected: All network IDs (1)
Poland	All voltage levels of transmission or distribution systems.	All voltage levels of transmission or distribution systems.
Portugal	All voltage levels, all customers, transmission, distribution. In practice, in transmission there is no long planned interruption. All planned interventions are done without customers' interruption.	All voltage levels, all customers, transmission, distribution.
Romania	HV, MV, LV with respect to where the customers are connected.	HV, MV, LV with respect to where the customers are connected.
Slovak Republic		TSO 220 and 400 kV, DSO HV>1 kV, LV<1 kV
Slovenia	Transmission networks: aggregated values for EHV and HV. Distribution networks: MV level (per MV substation feeder, calculated on different levels (MV feeder, distribution area, DSO). Aggregation on the distribution area (DSO) is also performed).	Transmission networks: aggregated values for EHV and HV. Distribution networks: MV level (per MV substation feeder, calculated on different levels (MV feeder, distribution area, DSO). Aggregation on the distribution area (DSO) is also performed).
Spain	All voltage levels. For interruptions at voltage levels over 1 kV, they are assigned to customers directly connected with the network. For low voltage customers (below 1 kV) the MV/LV transformer is used as the main criteria to assign incidents because the MV/LV transformers supply energy to all connected low voltage customers.	All voltage levels. For interruptions at voltage levels over 1 kV, they are assigned to customers directly connected with the network. For low voltage customers (below 1 kV) the MV/LV transformer is used as the main criteria to assign incidents because the MV/LV transformers supply energy to all connected low voltage customers.
Sweden	At all voltage levels and with respect to where the customer is connected.	At all voltage levels and with respect to where the customer is connected.
Switzerland	All voltage levels.	All voltage levels.

(1) Network ID#1: Central grid, i.e. the transmission network (HV and EHV).
Network ID#2: Regional grid, distribution network, masked configuration.
Network ID#3: Distribution grid (MV), radial configuration, more than 90% overhead lines.
Network ID#4: Distribution grid (MV), radial configuration, mixed overhead lines and cables.
Network ID#5: Distribution grid (MV), radial configuration, more than 90% cables.
Network ID#6: Distribution grid (LV), radial configuration.

2.4.4. Level of detail in indicators

Continuity of supply indicators are often captured for different categories, areas and voltage levels even within a single country. The following 2 tables (Table 2.6 and Table 2.7) provide an overview of the level of detail for which indicators are calculated and collected.

Further details, especially on monitoring the causes of interruptions, can be found in extensive footnotes.

TABLE 2.6 LEVEL OF DETAIL IN INDICATORS (1)

Country	National	System Operators	Region	Customer
Austria	X	X		
Belgium		X		X (1)
Bulgaria	X			X (2)
Croatia	X (13)	X	X (14)	
Cyprus			X (3)	
Czech Republic	X	X		
Denmark				X (4)
Estonia				X (5)
Finland		X	X (6)	
France		X		X
Germany	X	X		
Great Britain		X		X
Greece		X		
Hungary	X	X		X
Ireland	X	X (7)		
Italy		X (15)	X (15)	X (15)
Latvia		X		
Lithuania		X		X
Luxembourg		X		
Malta		X (8)		
The Netherlands	X	X		
Norway	X	X	X	X
Poland	X	X		
Portugal	X (9)	X	X (9)	X
Romania		X		
Slovak Republic	X	X		
Slovenia	X	X	X (10)	X (11)
Spain		X	X (12)	X
Sweden	X	X	X	X
Switzerland	X	X	X	

(1) EHV/HV : direct customer of TSO.
(2) At single customer level, distribution and transmission customers.
(3) Monitored at district level.
(4) All kinds of customers at aggregated and single-customer level.
(5) For all customers at single-customer level.
(6) In each network operator's geographical area of responsibility.
(7) The DSO and TSO may have further breakdowns, but the NRA does not get involved in this detail.
(8) Continuity indicators are calculated at 11 kV substation level.
(9) Only distribution is monitored at national, district and municipality level.
(10) Distribution monitored per distribution area.
(11) Monitoring on the single customer level is limited to the customers that are subject of the compensation scheme.
(12) Municipality.
(13) Transmission level only.
(14) Distribution level only.
(15) At distribution level, data are collected for "districts" (around 300 areas all over the Country) and aggregated per DSO and for the whole nation; at transmission level, data are collected at System operator level. Data per single customer are collected for each MV customer (around 100,000 customers) and in case of very long interruptions.

TABLE 2.7 LEVEL OF DETAIL IN INDICATORS (2)

Country	Voltage level	Causes	Cable/aerial
Austria	Yes	Yes (1)	No
Belgium	Yes	Yes (2)	No
Bulgaria	Yes	Yes (3)	Yes
Croatia	Yes	Yes (4)	No
Cyprus	Yes	Yes (5)	Yes
Czech Republic	Yes	Yes (6)	No
Denmark	Yes	Yes	No
Estonia	Yes	Yes (7)	No
Finland	Yes	No (8)	No
France	Yes	Yes (9)	Yes
Germany	Yes	Yes (10)	No
Great Britain	Yes	Yes (11)	Yes
Greece	Yes	Yes (12)	No
Hungary	Yes	Yes (13)	Yes
Ireland	Yes		
Italy	Yes	Yes (14)	No
Latvia	No	No	No
Lithuania	Yes	Yes (15)	Yes
Luxembourg	Yes	Yes (16)	No
Malta	Yes	Yes	Yes
The Netherlands	Yes	Yes (17)	No
Norway	Yes	Yes (18)	Yes
Poland	No	No	No
Portugal	Yes	Yes (19)	No
Romania	Yes	Yes (20)	No
Slovak Republic	Yes	No	No
Slovenia	Yes	Yes (21)	No
Spain	No	Yes (22)	Yes
Sweden	Yes (25)	Yes (23)	No
Switzerland	Yes	Yes (24)	No

(1) Planned, unplanned (force majeure, third party interference, atmospheric, system operator internal, system perturbation from other network/generation).
(2) MV/LV: only at specific voltage.
EHV/HV: Material failure, human error TSO, human error third party, human error DSO, weather, system response (interruption caused or aggravated by protection & automation system – whatever the cause), animal, fault outside grid, unknown.
(3) Planned, unplanned, third party interruptions and force majeure.
(4) Ca. 30 categories like bad maintenance, manipulation errors, technical causes, third party, force majeure, etc.
(5) Planned Interruptions (Expansion of network, maintenance, rectification of network after a fault.) Unplanned Interruptions (Operational reason, weather, related human error, equipment failure).
(6) Unplanned interruptions: Caused by failure of equipment of TSO or DSO, or during its operation, under standard weather conditions, under severe weather conditions, caused by third party interference, forced, extraordinary, caused by event outside the system.
(7) List of 60 different types of causes, 2 levels what and why happened.
(8) Recording: planned and unplanned interruptions in network operators own network.
(9) Atmospheric events (lightning, snow, wind), equipment failures (line, substation), vegetation contact, human operation cause, customer installation cause, third party cause, non-identified cause.
(10) 1. Atmospheric influence 2. Caused by third party 3. Responsibility of the network operator 4. Others (planned) 5. Feedback effects caused in other networks 6. Exchange of meter 7. Force majeure.
(11) For each recorded incident the DNOs have to record a cause code as the reason for the incident. So if there was an incident due to a branch hitting a line and causing an interruption for customers, the DNO would put the cause code in the reporting template against this incident. For the list of causes please refer to the 5th Benchmarking Report.
(12) Unplanned interruptions: 1. External (due to transmission system infeed loss, fires, floods etc.), 2. Due to exceptional weather conditions, 3. Other. Planned interruptions: 1. System development works, 2. Maintenance works, 3. Repair work.
(13) The classification of causes is made by the DSOs.
(14) For transmission, there are 4 macro-categories: lack of system adequacy, force majeure, external causes (i.e. users), TSO causes. For distribution, there are 3 macro-categories: force majeure, external causes (i.e. users), DSO causes. For transmission, there is a 2nd level classification (about 15 causes) and 3rd level classification (about 50 causes). For distribution, a 2nd level classification has been entered into force in 2012 (about 20 causes).
(15) 1. Force majeure; 2. External causes; 3. Causes attributable to system operator responsibility; 4. Non – identified causes.
(16) Atmospheric, force majeure, damage inflicted by third party internal to network, upstream network, downstream network.

(17) Manufacturer, network design, assembly, operation, aging/wear, external influence (e.g. excavation works), soil movement, moisture, weather, operational stress, internal defect, unknown.
(18) Main categories: 1. surroundings, 2. people (staff), 3. people (others), 4. operational stress, 5. technical equipment, 6. design/installation, 7. others, 8. cause unknown. These main categories are further divided into subcategories. In audits NVE emphasises the importance of trying to avoid using the category "cause unknown".
(19) Planned interruptions: for reasons of public interest, service reasons and other networks or installations.
Unplanned interruptions: (i) Exceptional events: security reasons, strikes, extreme natural conditions, odd objects in the network, fire or flood, vandalism, third party; (ii) Non-exceptional events: security reasons, strikes, extreme natural conditions, odd objects in the network, fire or flood, vandalism, third party, atmospheric conditions, maintenance, network protections, electric equipment, technical reasons, human intervention, unknown reasons, other networks or installations.
(20) a. planned; b. unplanned due to force majeure; c. unplanned due to customers; d. unplanned excluding b and c.
(21) Unplanned interruptions: 1) responsibility of system operator (DSO/TSO) 2) third party and 3) force majeure. Planned interruptions: no cause categories are applied. All interruptions must be classified into one of the categories. Unidentified causes are attributed to the DSO/TSO (responsibility of DSO/TSO). We do not categorise the cause of short interruptions.
(22) For planned interruptions: transmission and distribution. For unplanned interruptions: Third party, generation, transmission, force majeure, distribution.
(23) The DSOs decide which categories to use.
(24) Planned interruptions, unplanned interruptions (caused by other DSO, natural phenomena, human behaviour, operational cause, external cause, other cause).
(25) Indicators are presented at some voltage levels: at low voltage and high voltage (in this case high voltage means >1,000 V).

2.4.5. Measurement techniques

Roughly half of the countries use automatic logging or automatic identifications when measuring long and short interruptions (Table 2.8). About a third of the countries use both.

TABLE 2.8 MEASUREMENT TECHNIQUES FOR LONG AND SHORT INTERRUPTIONS

Country	Identification of affected network users	Automatic identification	Automatic logging
Austria	No common rules or standardised way of identifying the customers affected. The way of estimating differs from network operator to network operator.	No	No
Belgium	For EHV/HV: All the connection points of the EHV/HV grids are identified individually. These points are either connection point of individual HV-customers or connection points of distribution grids.	No	No
Bulgaria	There is no automatic identification of affected customers.	No	No
Croatia	1. Customers are allocated by substations; 2. Number of affected customers is estimated by application for network system reports (DISPO).	Yes	Yes
Cyprus	Yes there is a rule for estimating the customers affected. (Assumption is 1 customer for every 2 kVA).	Yes	No
Czech Republic	At MV and HV by SCADA system. At LV by technical scheme of the network.		No
Denmark	No common rules or standardised way of identifying the customers affected.	No	No
Estonia	Automatic identification of customers affected for interruptions on MV level, on basis of messages from customers on LV level via GIS.	Yes	Yes
Finland	Customers are identified by being sorted in different voltage levels.	No	No
France	On the transmission network, each customer's substation feeding is individually monitored. On both transmission and distribution system, network system and commercial system are connected.	Yes	Yes
Germany	There is no standardised way of identifying the affected customers. The way of estimating differs from one network operator to another.	No	No
Great Britain	Ofgem collects data at a system level for each of the 14 licensed electricity distribution businesses. Ofgem also collects disaggregated data for each MV circuit so that comparisons can be made across the distribution businesses.	Yes	Yes
Greece	For interruptions originating at MV, the number of customers affected is estimated through the interrupted MV/LV transformer installed power. For interruptions originating at LV, the number of customers affected is estimated through the rated current of the interrupted LV line fuse.	Yes	No
Hungary	At present it is allowed to estimate the number of customers affected. The NRA has already issued a resolution on determination of the number of customers affected, which will lay down the rules for estimation. The implementation of the resolution is still in progress.	No	No

Country	Identification of affected network users	Automatic identification	Automatic logging
Ireland	This level of detail is not specified by the NRA.		
Italy	For transmission, the sources of data/info include: the remote control system, the SCADA, the log of the remote control system, other recording systems, registrations by EHV-HV users, registrations by the distribution network operators. For distribution: the remote control system or other systems (SCADA for the MV network); various options are allowed for recording LV customers affected (the simplest refer to average number of customers, the most complex involves the single LV smart meters).	Yes	Yes
Latvia	The DSO can identify users affected by interruptions by using SCADA system and Geographic Information System data (GIS).	No	No
Lithuania	Automatically and manually.	Yes	
Luxembourg	HV, MV: details in DSOs system. LV: currently average number per transformer.	Yes	Yes
Malta	Until 2015 it was assumed that the number of customers supplied from a substation that experienced an outage was proportional to the rating (in kVA) of the substation transformer. From 2016 onwards, the number of customers fed from each MV/LV substation is stored in the outage reporting system that is used to record the interruption of supply to these MV/LV substations. SAIDI and CAIDI for outages on the MV network will now be based on the actual number of customers affected.	No	No
The Netherlands	Identification of affected customers mostly occurs through well-established and documented methods of estimation, which are part of a national system for the registration of interruptions.	Yes	Yes
Norway	The standardised system for reporting of interruption data (FASIT) uses data from the Customer Information System regarding exactly how many customers are connected to each of the distribution transformers affected by an interruption. The customers are divided into 36 different end-user groups, and 2 sub-groups, and the interruptions are monitored for all the 36+2 end-user groups (The 36+2 end-user groups are distributed on the 6 different customer categories), TSO/DSO network areas, counties and the country as a whole.	Yes	Yes
Poland	The customers at LV level are estimated, while at the higher levels they are all identified.	No	No
Portugal	For interruptions that affect EHV, HV and MV, TSO and DSO can identify users affected by interruptions by using SCADA system. For long interruptions with origin at LV, affected customers are identified based on phone calls.	Yes, for EHV, HV and MV through SCADA system.	No
Romania	An automatic system of calculation is in progress, until end of 2012, in order to record the interruptions for the customers of HV and MV level.		Yes
Slovak Republic	It is in competence of operator DSO and TSO.		
Slovenia	Identification is performed by the automatic binding of the number of affected customers through the entity properties in SCADA (i.e. substation, feeder properties etc.). This applies on the EHV, HV and MV levels. For LV (not yet covered) either the call-centres or AMI (Smart Grids) services will be used. Exemptions: some cases have been identified where the meta data in SCADA is not complete or not up-to-date. In such cases, operator performs manual mapping in post-processing phase (applying the data from external source).	No	Yes
Spain	Each customer is associated to a transformation centre or element in the distribution network. Each interruption in this element is associated with the customer.		Yes
Sweden	By a unique ID for each customer.	Yes (for >90% of network users) (1)	Yes (for >90% of network users) (1)
Switzerland	No common rules or standardised way of identifying the customers affected.	No	No

(1) Yes, for more than 90% of customers when the origin of the interruption is at medium voltage level; 100% of customers if the origin of the interruption is at high and extra high voltage. If the origin of interruption is at low voltage level, it is difficult to assess how many DSOs have automatic identification/logging of interruptions. Because interruptions at low voltage affect few customers, automatic identification and automatic logging is considered to be implemented for >90% of network users.

2.5. CONTINUITY OF SUPPLY INDICATORS

Different types of indicators or same indicators with different weighting methods present an obstacle to the main goal of this section, which is comparison of national continuity data across Europe. Moreover, while all countries keep track of their long interruptions, short interruptions are monitored in less than half of the countries. While Section 2.6 will analyse the values of national data, this section will examine the types of indicators used for long and short interruptions.

2.5.1. Long interruptions

Indicators used across Europe to quantify the number and duration of long interruptions are listed in Table 2.9. The definitions of these are given in the 4th Benchmarking Report for distribution and transmission systems. Please see the list of abbreviations for the meaning of individual indicators. The table also gives information on the weighting method used. SAIDI and SAIFI are commonly used whereas the weighting is regularly based on the number of network users. ENS and AIT (Average Interruption Time) are mostly used for transmission networks.

TABLE 2.9 INDICATORS FOR LONG INTERRUPTIONS

Country	Index	Weighting
Austria	SAIDI, SAIFI, ASIDI, ASIFI, CAIDI, (CML, ENS).	Weighted by both the transformer stations affected and by the number of customers.
Belgium	SAIDI, AIT.	SAIDI used for LV/MV and weighted by the number of customers. AIT used for HV/EHV and weighted by the power affected.
Bulgaria	SAIDI, SAIFI.	By the number of customers.
Croatia	SAIDI, SAIFI.	
Cyprus	SAIDI, SAIFI, per cause, per voltage, percentage indicators, lost MVA's per cause, affected consumers, faults per type, faults per location, faults per substation/ feeder, Average Time to restore supply, Time interval to restore of supply.	By the power affected.
Czech Republic	Distribution: SAIFI, SAIDI, CAIDI. Transmission: ENS, AID (sum of duration divided by number of interruptions).	Distribution: by the number of customers. Transmission: not weighted.
Denmark	SAIDI, SAIFI.	It is weighted by type of interruption, kilometres of electricity network and by the number of customers.
Estonia	SAIFI, CAIDI, total annual interruption time for each customer.	By the number of customers.
Finland	DSOs: 1-70 kV: T-SAIDI and T-SAIFI, < 1 kV: amount of interruptions; and 110 kV: amount and duration of interruptions (in total). TSO and high voltage network operators: In 400 kV, 220 kV and 110 kV: duration of interruptions and amount of interruptions (in total).	By the annual energy consumption.
France	AIT, SAIFI and ENS for transmission network, as defined SAIFI, SAIDI and "Percentage of customers with insufficient quality of supply" for distribution network. There are several versions of each of these indicators, depending on the type of disconnection (planned/ unplanned), the voltage level, and the cause (exceptional event included or not).	Depends on the indicator. For continuity indicators such as SAIDI, it is weighted by the number of delivery points affected (for HV and EHV) and by the number of customers (for LV).
Germany	SAIDI (LV), ASIDI (MV), SAIFI.	LV: Number of customers. MV: rated apparent power of the affected power.
Great Britain	The 2 main indicators are Customer Interruptions and Customer Minutes Lost. Ofgem also collects information on the number of transmission incidents and the level of energy not supplied for each incident.	By the number of customers.
Greece	SAIDI, SAIFI.	By the number of customers.
Hungary	Distribution level: the indicators used in IEEE Std. 1366-2003: SAIDI, SAIFI, CAIDI for both planned and unplanned interruptions. Transmission level: AIT (Average Interruption Time) – ENS/ES (Outage rate) is used at both distribution and transmission level.	By the number of customers.

Country	Index	Weighting
Ireland	Customer minutes lost, customer interruptions.	For distribution, the CIs and CMLs are reported on an average customer basis. For transmission, the system minutes lost indicator is related to the power affected.
Italy	Transmission: ENS (energy not supplied), ENW (energy not withdrawn), AIT (average interruption time), SAIFI. Distribution: SAIDI, SAIFI, number of customers affected by interruptions longer than 8 hours.	For distribution: by the number of users affected. For transmission: number indicators are referred to transmission users.
Latvia	SAIDI, SAIFI, CAIDI, ENS.	By the number of customers.
Lithuania	TSO: ENS, AIT. DSO: SAIDI, SAIFI.	By the number of customers. ENS, AIT – interrupted power.
Luxembourg	SAIDI, SAIFI.	By the number of customers.
Malta	SAIDI and CAIDI for each interruption but not classified as long, short and transient.	Indicators are calculated at MV level and interruptions are weighted by transformer kVA installed at MV level.
The Netherlands	SAIDI, SAIFI and CAIDI.	By the number of customers.
Norway	With reference to end-users (all voltage levels): SAIDI, SAIFI, CAIDI, CTAIDI, CAIFI, interrupted power per incident and energy not supplied (ENS). With reference to reporting points (i.e. distribution transformer or a customer connected above 1 kV): number and durations.	By the number of customers. By the amount of ENS and by the amount of interrupted power.
Poland	Distribution level according to the IEEE Std. 1366-2003: SAIDI, SAIFI. Transmission level: ENS, AIT and according to the IEEE Std. 1366-2003 SAIDI, SAIFI.	By the number of customers.
Portugal	Transmission: ENS, AIT, SAIFI, SAIDI, SARI. Distribution: SAIFI HV, SAIDI HV, END MV, AIT MV (TIEPI), SAIFI MV, SAIFI LV, SAIDI MV, SAIDI LV	SAIFI and SAIDI: weighted by delivered points (transmission, HV and MV) and by the number of customers (LV); TIE (Distribution – TIEPI) and END (distribution): weighted by installed power; ENS (transmission): estimated; TIE (transmission): energy not supplied and energy supplied.
Romania	DSO: SAIFI, SAIDI; ENS and AIT at 110 kV level. TSO: ENS and AIT for the whole country.	By the number of customers. At 110 kV (max distribution level) and TSO (220-750 kV), ENS and AIT are used; at 110 kV SAIFI and SAIDI are also used.
Slovak Republic	1. N 400 (average number of unplanned interruptions relating to the one transformer on the voltage level 400 kV). 2. N 220 (average number of unplanned interruptions relating to the one transformer on the voltage level 220 kV).	By the number of customers. By the number of transformers (TSO).
Slovenia	Distribution: SAIDI, SAIFI, CAIDI, CAIFI. Transmission: SAIDI, SAIFI (implicitly ENS, AIT, AIF, AID).	By the number of customers.
Spain	In distribution TIEPI, NIEPI, 80 Percentile of TIEPI and 80 Percentile of NIEPI at zonal level or individual level. In transmission: ENS, AIT and facility available percentage.	By the power affected.
Sweden	Since data on customer level is available regarding interruptions, NIS-tagged information, transferred energy, max effect and transferred energy of the overlying transformer, a large range of customer level and system level indicators can be calculated such as active power not supplied in kW, energy not supplied, ASIDI, ASIFI, SAIDI, SAIFI, customer experiencing multiple interruptions (CEMI), confidence interval reflecting best and worst served customers at arbitrary level, number of customer experiencing different yearly aggregated duration of interruption etc.	By the number of customers.
Switzerland	Distribution: SAIDI, SAIFI. Transmission: SAIDI, SAIFI, ENS.	By the number of customers.

2.5.2. Short and transient interruptions

Short and transient interruptions are not monitored as widely as the long ones. Less than half of the responding countries collect separate data on short or transient interruptions. These are Austria, Cyprus, the Czech Republic, Finland, France, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Slovenia and Sweden. Information on the indicators for short and transient interruptions used across Europe is summarised in Table 2.10. The number of short interruptions per year is used in almost every country listed in this table. Some give separate indicators for short and transient interruptions; some have one indicator covering both, while others exclude transient interruptions from monitoring altogether. Again, definitions of the indicators are given in the 4th Benchmarking Report.

TABLE 2.10 INDICATORS FOR SHORT AND TRANSIENT INTERRUPTIONS IN COUNTRIES THAT MONITOR THEM

Country	Short	Transient
Austria	MAIFI (DSO) (1).	None
Cyprus	SAIDI, SAIFI, per cause, per voltage, percentage indicators, lost MVA's per cause, affected consumers, faults per type, faults per location, faults per substation/ feeder, Average Time for restoration of supply, Time interval for restoration of supply.	None
Czech Republic	No specific indicator. Distribution system operators monitor them at the chosen points according the technical report CENELEC TR 50555.	No specific indicator. Distribution system operators monitor them at the chosen points according the technical report CENELEC TR 50555.
Finland	In MV amount of short interruptions (high speed automatic reclosing and delayed automatic reclosing) which are proportional to the annual amount of energy.	
France	MAIFI for transmission network, MAIFI and percentage of customers with “insufficient quality of supply” for distribution network.	None
Hungary	Distribution level: indicators used in IEEE Std. 1366-2003: MAIFI (for MV networks). Transmission level: no indicator.	Distribution level: indicators used in IEEE Std. 1366-2003: MAIFI (for MV networks). Transmission level: no indicator.
Italy	For transmission: ENS (energy not supplied), ENW (energy not withdrawn), AIT (average interruption time), MAIFI. For distribution: MAIFI, separately for short and transient interruptions.	For transmission: number of transient interruptions. For distribution: number of transient interruptions.
Latvia	MAIFI	
Lithuania	MAIFI (DSO)	
Norway	With reference to end-users (all voltage levels): SAIDI, SAIFI, CAIDI, CTAIDI, CAIFI, interrupted power per incident and energy not supplied (ENS). With reference to reporting points (i.e. distribution transformer or a customer connected above 1 kV): number and durations.	Included in short interruptions.
Poland	Distribution level according to the IEEE Std. 1366-2003: MAIFI. Transmission level: no indicator.	
Portugal	MAIFI (EHV, HV and MV).	None
Slovenia	Distribution and transmission: MAIFI. Distribution: MAIFI-E.	
Sweden	MAIFI-E.	

(1) Published on DSO level.

2.5.3. Discussion of indicators

From the tables presented, it is clear that a wide range of indicators is implemented across Europe. The use of multiple indicators to quantify the continuity of supply has resulted in a greater availability of information and possibilities to observe trends.

SAIDI and SAIFI are the basic indicators reported in almost all countries, albeit under different names and with different methods for weighting the interruptions.

The method of weighting impacts the results and leads to different biases towards different types of network users. When weighting is based on the number of network users, users are treated equally regardless of their size and consumption levels.

When weighting is based on interrupted power or energy not supplied (ENS), an interruption gets a higher weighting whenever the total interrupted power is higher. This might happen when network users with larger demand are interrupted or when the interruption takes place during a period of higher consumption. Weighting based on contracted power, rated power or annual power consumption makes the contribution of an incident during high load the same as in the case of an incident during low load.

Any weighting based on power and energy is biased towards network users with larger demand. As these users typically suffer fewer and shorter interruptions, this is expected to result in lower values for frequency and duration of interruptions than weighting based on number of network users.

It is important to remember that both SAIDI and SAIFI can be presented with or without exceptional events. In this report, more than two thirds of the countries have a definition of exceptional events, which mostly includes natural causes such as strong winds, snowstorms, floods and earthquakes. The individual definitions, however, are far from harmonised. Non-natural causes include among others, wars, sabotage, acts of terrorism and embargos.

Sometimes the assumptions are a simplification of the actual consequences of interruptions. A good example of this is ENS that gives the total amount of energy that would have been supplied to the interrupted customers if there would not have been any interruption [4]. The fact that there is no energy consumption during the interruption makes it impossible to exactly measure this indicator.

The indicators such as Customer Average Interruption Frequency Index (CAIFI) and Customer Total Average Interruption Duration Index (CTAIDI) give a better impression of the continuity of supply as experienced by those network users that are affected by at least one interruption. The differences in value between SAIFI and CAIFI, and between SAIDI and CTAIDI, give an impression of the spread in the number of interruptions between different network users. The distribution of number of interruptions experienced by each individual user gives this information in a more direct way, but results in more indicators, making comparisons and trend analysis more complicated. CTAIDI is currently only used by Norway, while CAIFI is used by both Norway and Slovenia. CEMI [10] [11], a similar indicator that measures percentage of customers experiencing more than one interruption, is used by Sweden.

2.6. ANALYSIS OF CONTINUITY BY NATIONAL DATA

European countries use different indicators and different weighting methods when evaluating interruptions. Two main groups of indicators – "*minutes lost per year*" [SAIDI, Customer Minutes Lost (CML), Average System Interruption Duration Index (ASIDI), Transformer System Average Interruption Duration Index (T-SAIDI) or "Equivalent interruption time related to the installed capacity" (TIEPI)] and "*number of interruptions per year*" [SAIFI, Customer interruptions (CI), Average System Interruption Frequency Index (ASIFI), Transformer System Average Interruption Frequency Index (T-SAIFI), or "Equivalent number of interruptions related to the installed capacity" (NIEPI)] – are collected by countries and partly presented in this chapter. Their values are compared over a number of years.

In addition to the monitoring of duration and frequency of interruptions, one can also examine whether the interruptions were planned or unplanned. For more information, please refer to Section 2.4.2 where the definitions of planned and unplanned interruptions are listed by country, as well as the rules issued on the notice to the affected network user for planned interruptions (minimum time-requested, procedures for giving notice, etc.). Which occurrences are considered as exceptional events can be determined in different ways. Some countries have a more statistical approach, while others focus their definition on the causes of exceptional events. More information on this topic can be found in the Annex A to Chapter "Electricity – Continuity of supply" on Continuity of Supply data.

When interpreting the results and especially when comparing between countries, one should consider the differences in calculation of the indices and in the voltage levels at which incidents are monitored. For example, Slovenia specified that while all voltage levels are monitored, only the MV data is used due to unavailability of LV data and a different weighting method for calculating SAIDI and SAIFI on the EHV/HV level; Finland reports T-SAIDI or Transformer SAIDI (SAIDI weighted by the annual energy consumption); Norway's data since 2014 includes also incidents at LV; and Malta calculates at 11 kV and includes interruptions on this level or upstream. Despite the difference in names and calculation methods between countries, the results are shown in the same diagrams.

It should also be noted that indicators representing the number of interruptions, for example SAIFI, are not always easily comparable among countries. The reason for this is that the aggregation rules for interruptions differ across Europe. In some countries, all interruptions occurring during a specific defined time period are considered as a single interruption.

The system indicators ("minutes lost per year" and "number of interruptions per year") for the different countries and years are compared in Figure 2.1 and Figure 2.3, which illustrate the overall indicators of planned and unplanned long interruptions. More specific indicators are addressed in subsequent sections. Since a wide spread of indicators makes the reading of the lower half of some graphs more difficult, certain figures such as Figure 2.2 and Figure 2.4 show only the countries where the worst values over the observed period (2002-2014) do not exceed the limit chosen in any of the observed years. This presentation has no effect on data and was only done for visibility reasons.

FIGURE 2.1 OVERALL PLANNED AND UNPLANNED LONG INTERRUPTIONS (MINUTES LOST PER YEAR)

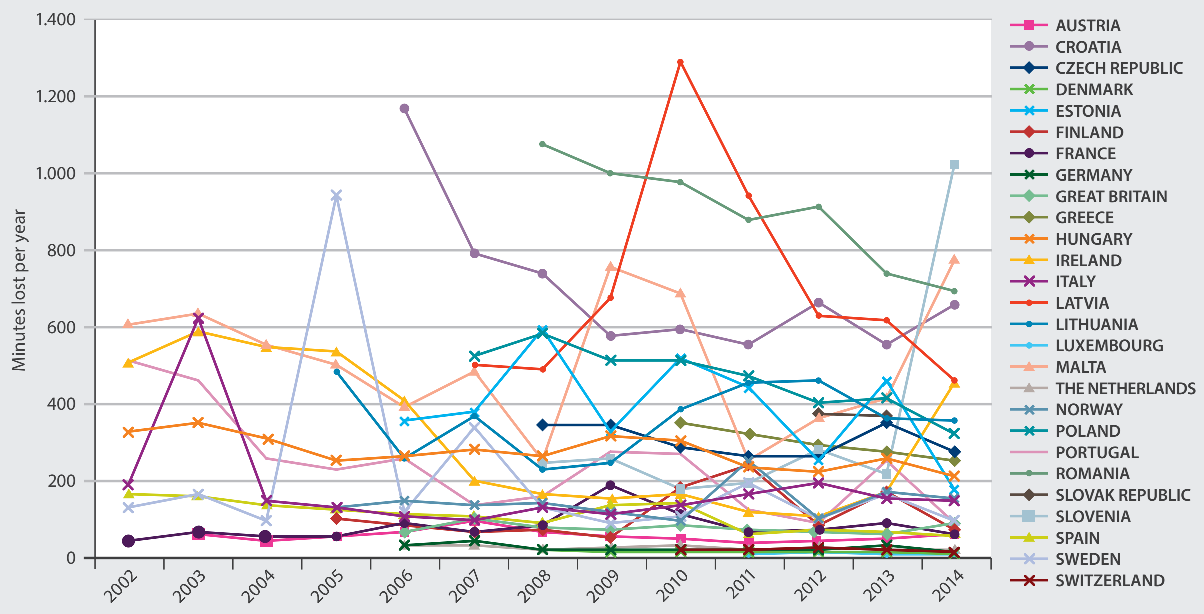
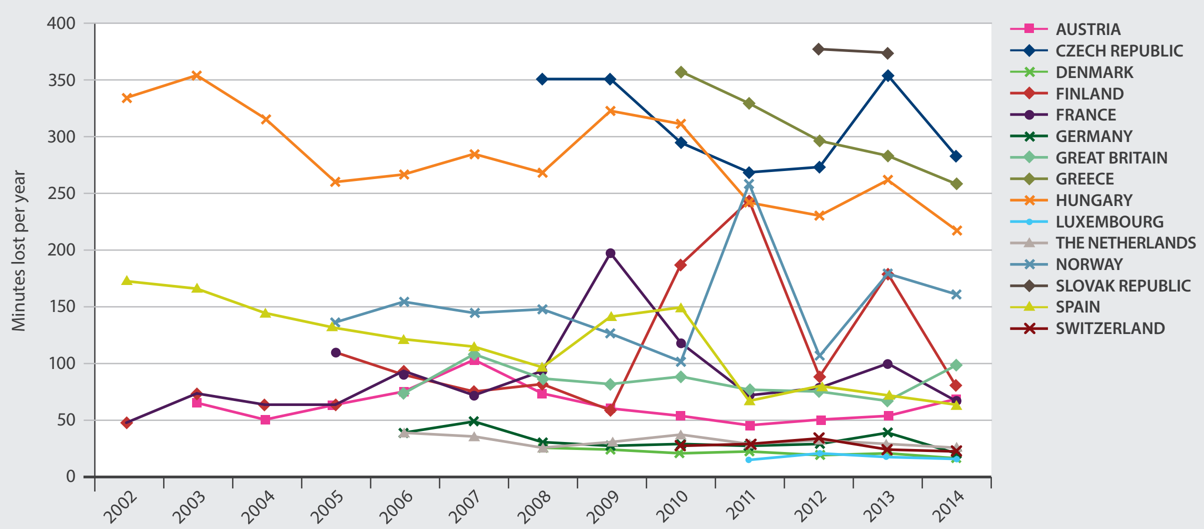


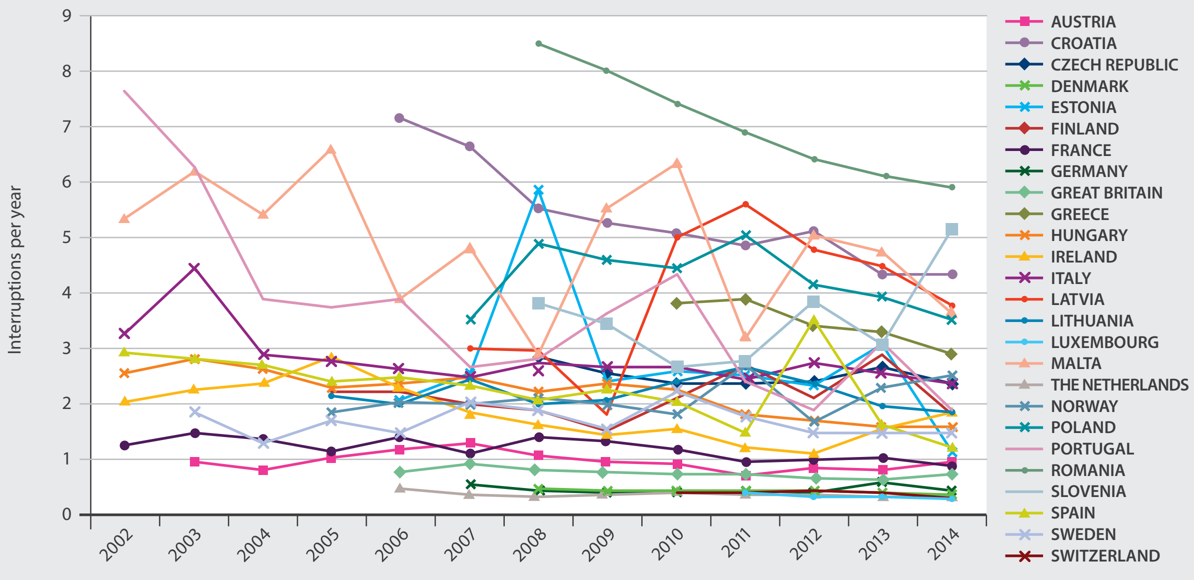
Figure 2.1 represents the overall planned and unplanned long interruptions as minutes lost per year and shows a very wide range of the indicators (15 -1,300 minutes). No trends are visible and values vary over time. The reason is that the overall indicators include all interruptions (planned and unplanned) as well as exceptional events.

FIGURE 2.2 OVERALL PLANNED AND UNPLANNED LONG INTERRUPTIONS (MINUTES LOST PER YEAR); ONLY COUNTRIES NOT EXCEEDING 400 MINUTES



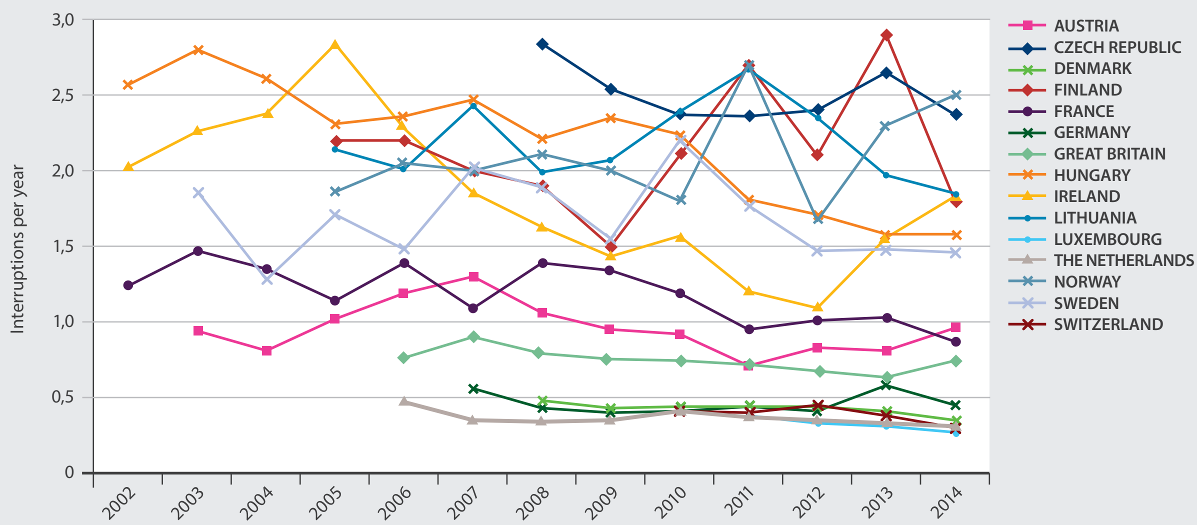
A better view of the countries with lower values of this indicator can be seen in Figure 2.2. This figure shows the same data as Figure 2.1, but the values are limited to 400 minutes lost per year with everything above (worse continuity values) excluded. In this case it is easier to observe the countries with very low indicators and relatively stable course which do not exceed 50 minutes lost per year (Denmark, Germany, Luxembourg, the Netherlands and Switzerland). These countries can also be characterised as those with high proportion of cable circuits at MV networks. Technical characteristics of electricity networks across Europe can be found in Section 2.6.6.

FIGURE 2.3 OVERALL PLANNED AND UNPLANNED LONG INTERRUPTIONS (NUMBER OF INTERRUPTIONS PER YEAR)



The overall planned and unplanned long interruptions as number of interruptions per year are shown in Figure 2.3. There is also a wide range and variability of the indicators, except for the countries with very low indicators mentioned above. It cannot be said that there is a trend in all the countries, but 5 show decreasing values (Croatia, Greece, Hungary Romania and Spain).

FIGURE 2.4 OVERALL PLANNED AND UNPLANNED LONG INTERRUPTIONS (NUMBER OF INTERRUPTIONS PER YEAR); ONLY COUNTRIES NOT EXCEEDING 3 INTERRUPTIONS

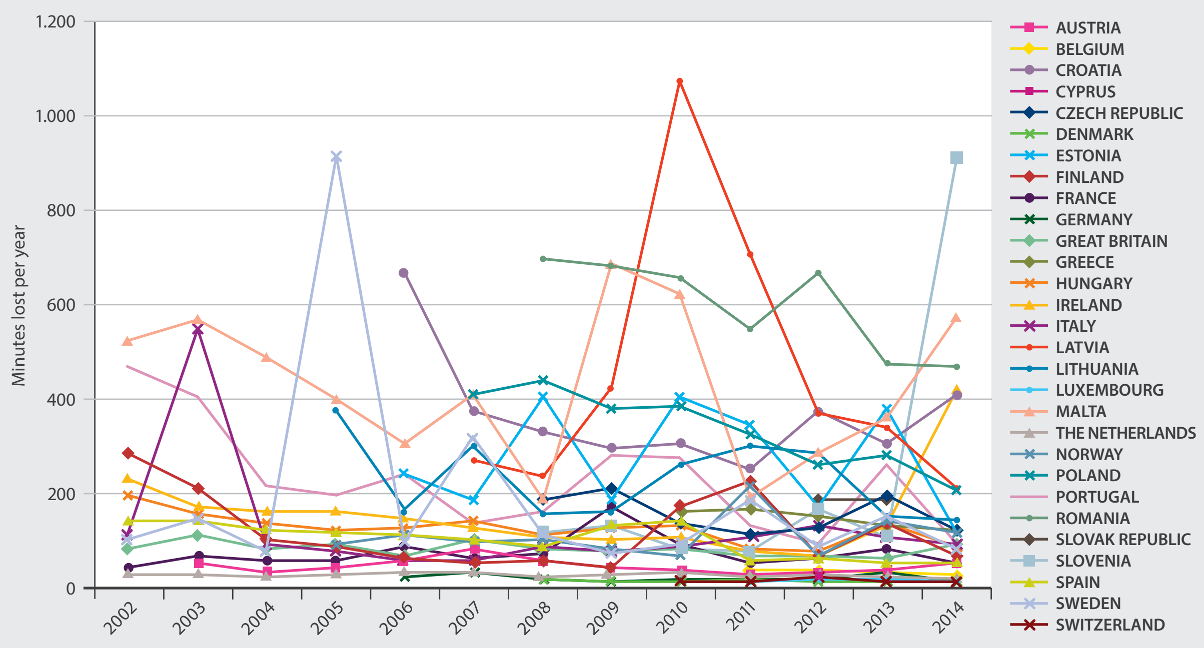


Again, a better view of countries with lower values of this indicator is in Figure 2.4, which shows only countries that do not exceed the limit of 3 interruptions per year during the observed period. Relatively stable numbers of interruptions (lower than 1 per year) are in Denmark, Germany, Great Britain, Luxembourg, the Netherlands and Switzerland.

2.6.1. Unplanned long interruptions, all events

Taking planned interruptions out, Figure 2.5 presents the minutes lost per year during unplanned long interruptions including all events. Due to extreme weather situations that have occurred in many European countries over recent years the values show a lot of variations. Therefore the clean values (without exceptional events) are presented in next section (Section 2.6.2). In general, the minutes lost over the 29 countries that contributed data, ranges between 10 and 1,100 minutes per year.

FIGURE 2.5 UNPLANNED LONG INTERRUPTIONS INCLUDING ALL EVENTS (MINUTES LOST PER YEAR)



Countries not exceeding 200 minutes lost per year are presented in Figure 2.6 and while there are countries with some minor reduction, the values still vary a lot. Apart from Romania and Poland from the figure above, the reduction in the recent years is also visible in Greece.

FIGURE 2.6 UNPLANNED LONG INTERRUPTIONS INCLUDING ALL EVENTS (MINUTES LOST PER YEAR); ONLY COUNTRIES NOT EXCEEDING 200 MINUTES

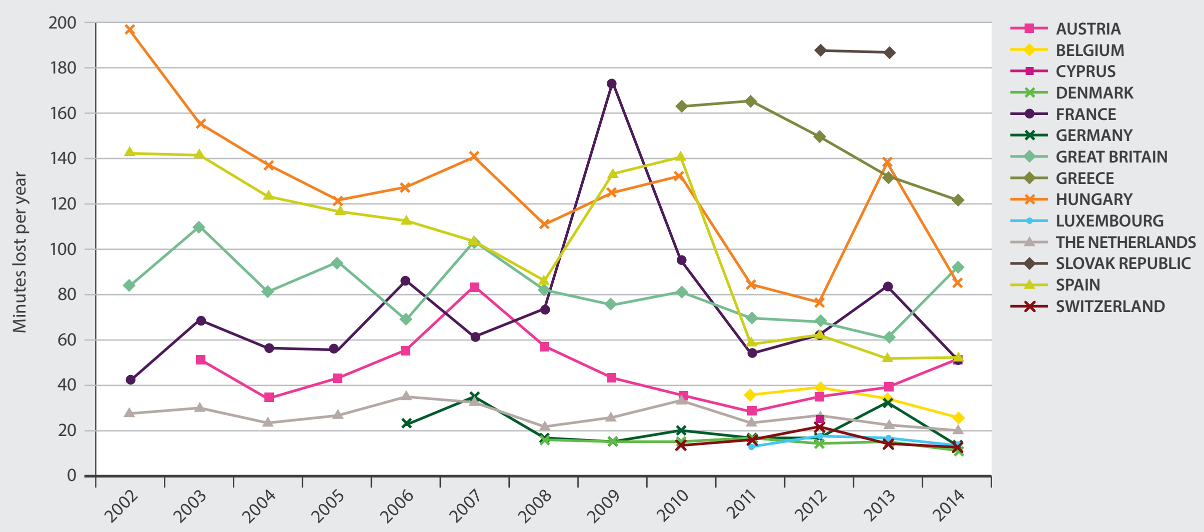
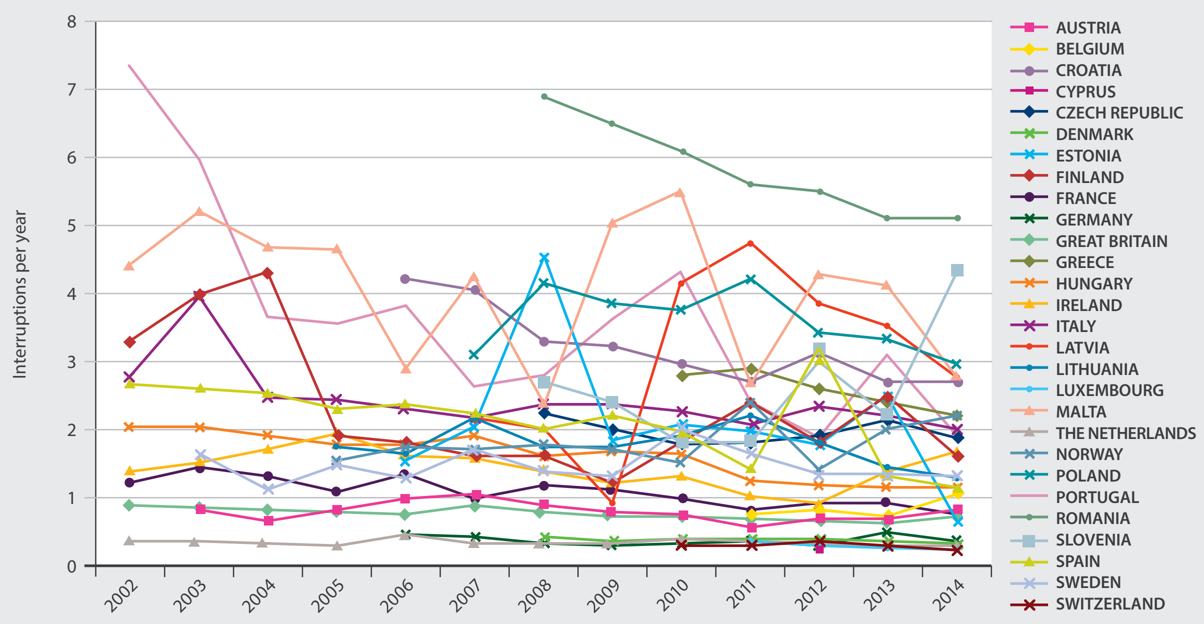


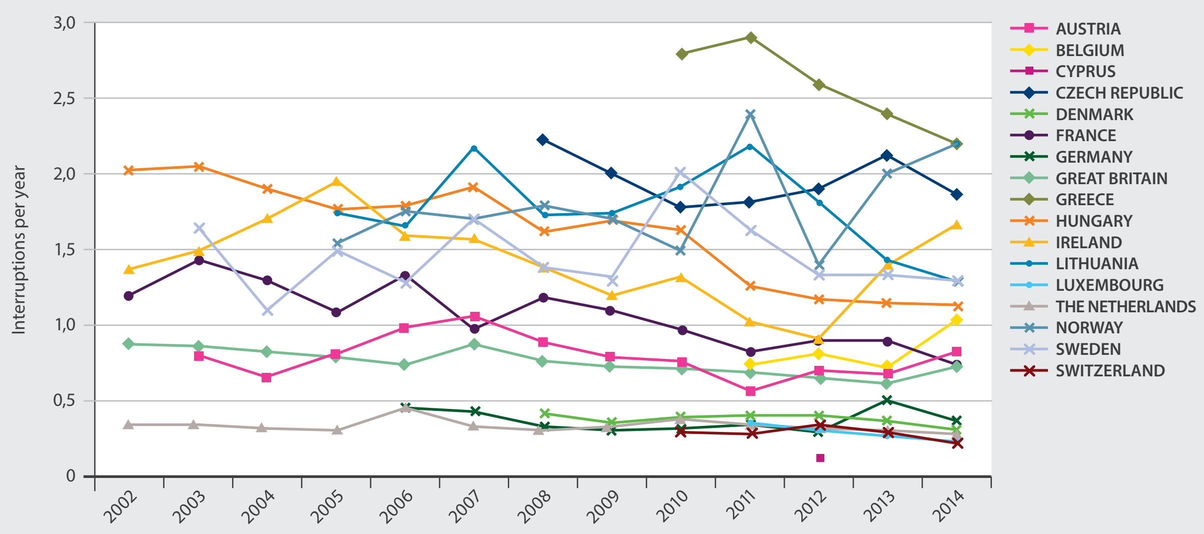
Figure 2.7 shows the number of interruptions per year, with unplanned long interruptions including all events. The year-to-year variation in the number of interruptions is less than the variation for the minutes lost. This is because extreme events (e.g. blackout) more often result in lower number of long interruptions than higher number of short interruptions. By way of example, the number of interruptions in 2003 in Italy is about one interruption higher than the value in preceding and subsequent years (because the blackout on 28 September 2003 affected almost all of Italy); however, the minutes lost are 450 minutes higher than in preceding and subsequent years.

FIGURE 2.7 UNPLANNED LONG INTERRUPTIONS INCLUDING ALL EVENTS (NUMBER OF INTERRUPTIONS)



By limiting the worst values of the number of unplanned long interruptions including all events to 3 interruptions per year, an improvement in Hungary, France and partly in Lithuania can be seen in Figure 2.8.

FIGURE 2.8 UNPLANNED LONG INTERRUPTIONS INCLUDING ALL EVENTS (NUMBER OF INTERRUPTIONS); ONLY COUNTRIES NOT EXCEEDING 3 INTERRUPTIONS



2.6.2. Unplanned long interruptions, excluding exceptional events

Data was also obtained for the continuity of supply indicators excluding exceptional events. When comparing the values without exceptional events between countries, significant care has to be taken as every country has its own methodology for determining what constitutes an exceptional event, which renders a direct comparison more difficult.

Figure 2.9 shows the minutes lost per year for unplanned interruptions, excluding exceptional events. The filtered values display less year-to-year variations than the values in Figure 2.7 where all interruptions are included. The countries are now roughly divided into 2 groups: one with relatively high and variable values (Bulgaria, Croatia, Malta, Poland and Romania); and another with relatively low and stable values, that are better visible in Figure 2.10. The curves in this figure show continuously decreasing trend in nearly all countries.

FIGURE 2.9 UNPLANNED LONG INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS (MINUTES LOST PER YEAR)

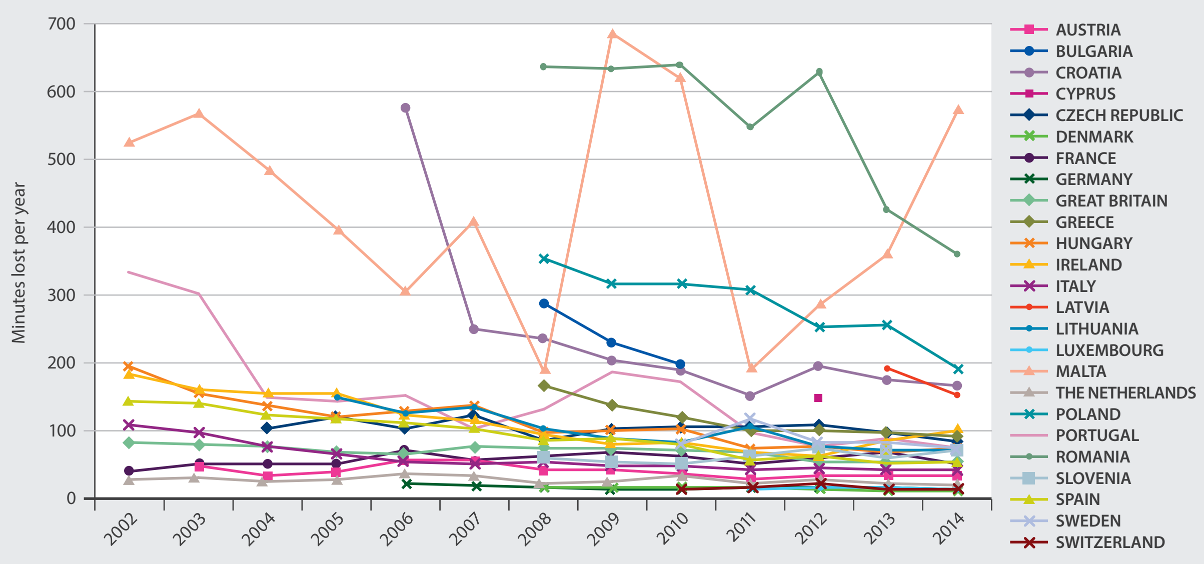


FIGURE 2.10 UNPLANNED LONG INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS (MINUTES LOST PER YEAR); ONLY COUNTRIES NOT EXCEEDING 200 MINUTES

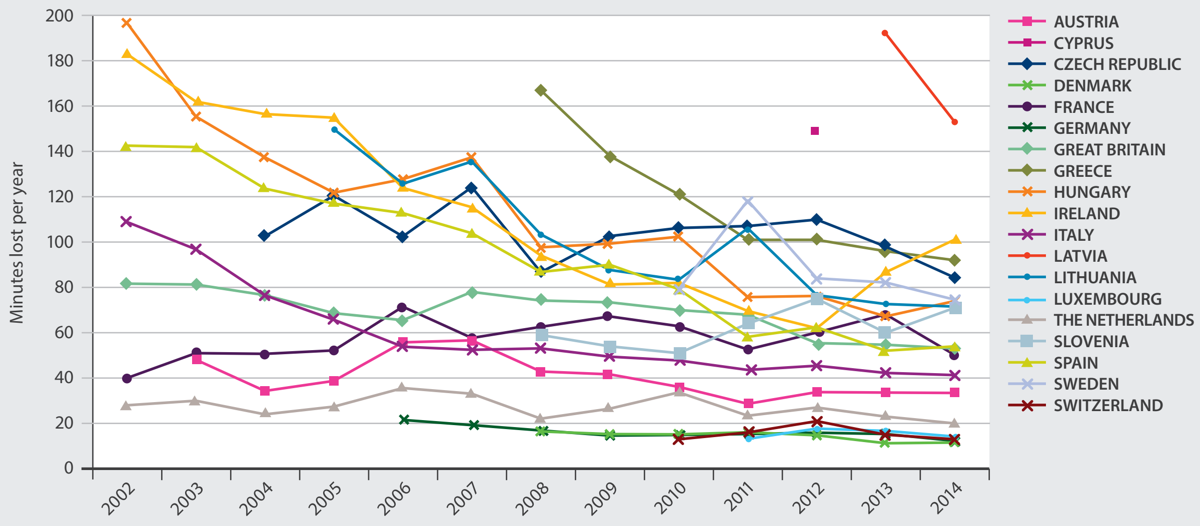


FIGURE 2.11 UNPLANNED LONG INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS (NUMBER OF INTERRUPTIONS)

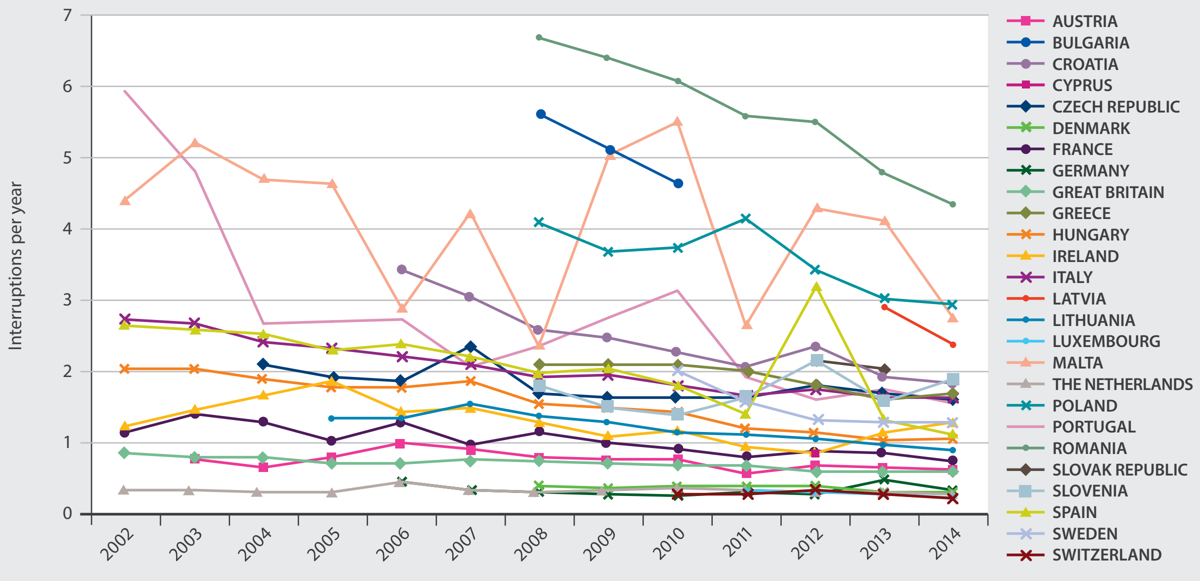


FIGURE 2.12 UNPLANNED LONG INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS (NUMBER OF INTERRUPTIONS); ONLY COUNTRIES NOT EXCEEDING 3 INTERRUPTIONS

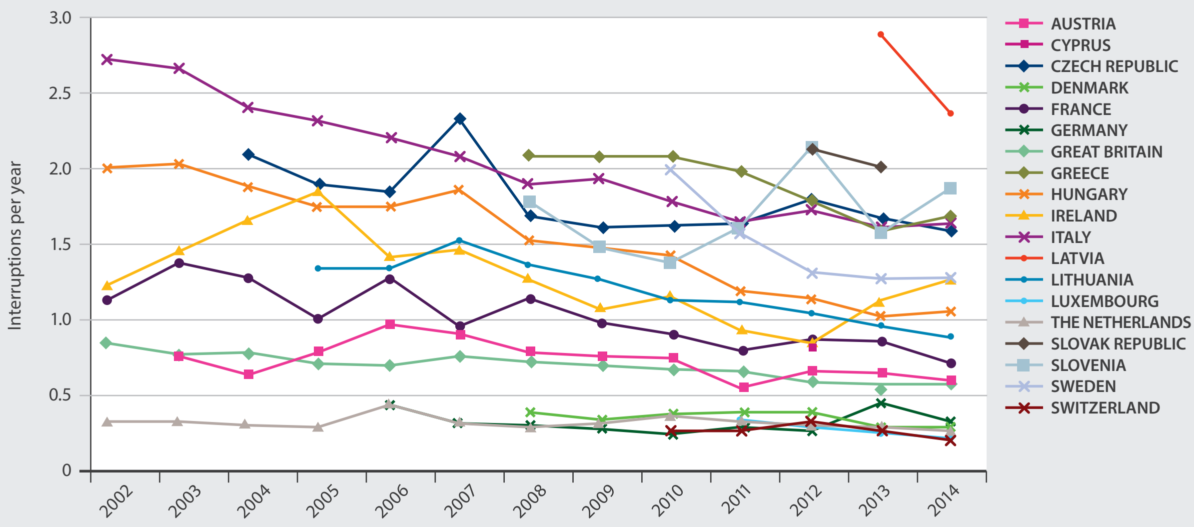


Figure 2.11 shows the number of long interruptions per year, excluding exceptional events. Considering the data reported for the years since the publication of the 5th Benchmarking Report (2011, 2012, 2013 and 2014), we can observe either constant quality levels or a smooth general tendency for an increase in quality in nearly all countries.

2.6.3. Planned (notified) interruptions

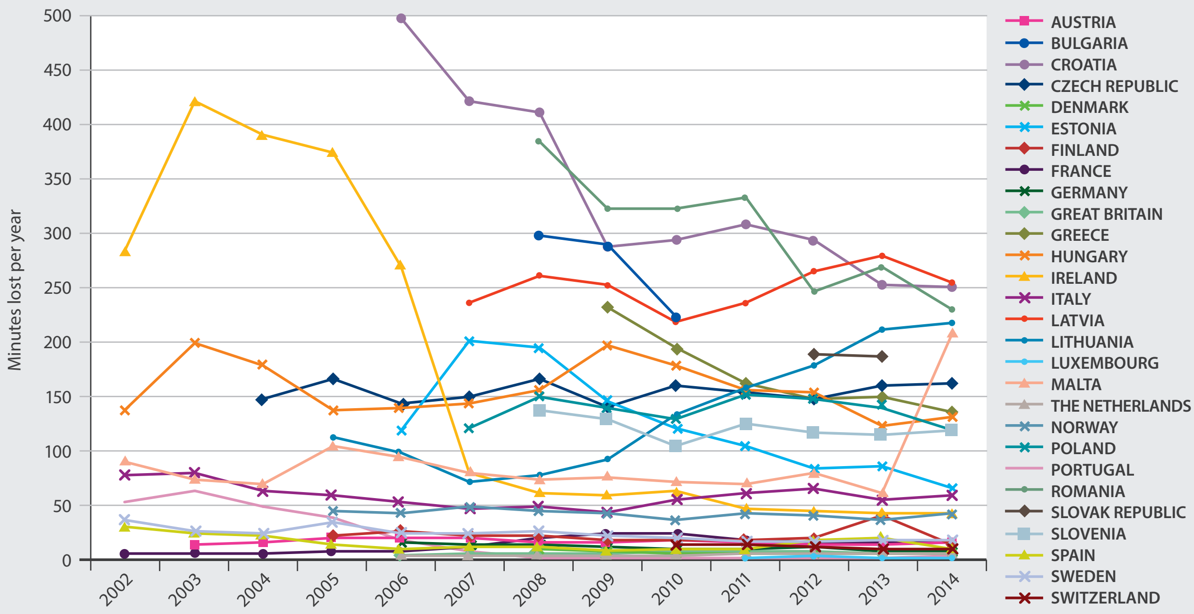
Planned interruptions relate to those minutes without supply experienced by network users who were given prior notice about the interruption. The general and national rules related to definition and treatment of this kind of interruption can be found in Section 2.4.2.

The minutes lost per year due to planned interruptions are presented in Figure 2.13 for the countries that reported the data. The value shows a very wide spread between the countries, from less than 10 minutes to over 500 minutes per year. No trends are visible in the figure; the minutes lost due to planned interruptions remain more or less constant during the observation period, although some countries show a minor reduction (Croatia, Greece, Estonia and Romania). Nevertheless, there are also exceptions, for example Lithuania's minutes lost significantly increased from 2007 to 2014.

The differences between countries may be due to variations in the design of the distribution network (with or without redundant supply paths) and the amount of maintenance and building in the distribution network. A temporary high level of planned interruptions could be a sign of high investment in the distribution networks, aiming at reducing the number of unplanned interruptions in the future. High levels of planned interruptions can also be due to replacement and repair of components that were provisionally restored after a major storm and due to a widespread replacement of energy meters.

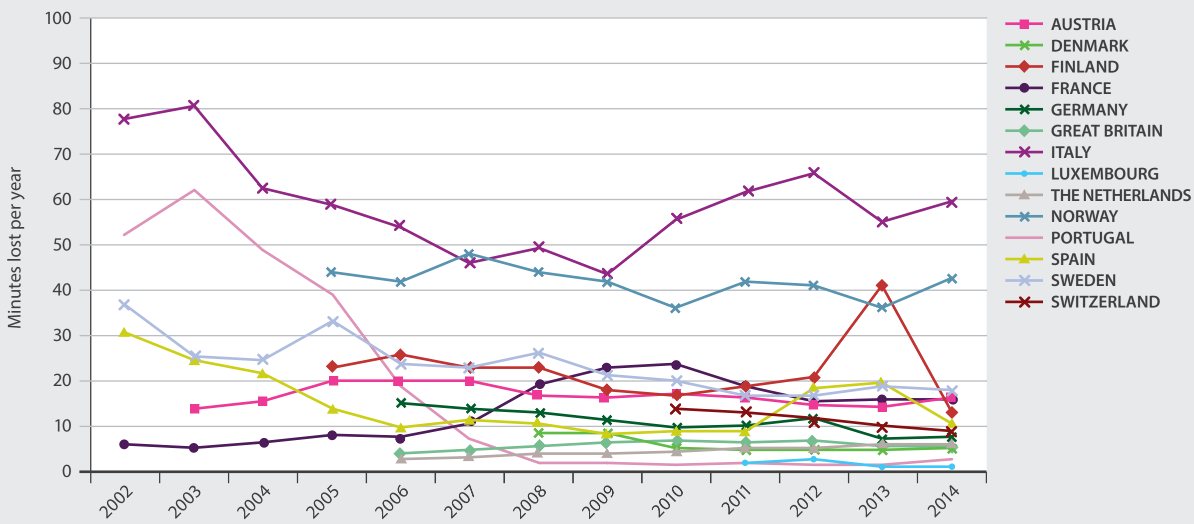
Not all countries include interruptions due to planned maintenance at LV in their statistics. Radial networks without redundancy, where planned interruptions are necessary for maintenance, are more common at low-voltage levels. Not including incidents at LV may significantly underestimate the number and duration of planned interruptions.

FIGURE 2.13 PLANNED LONG INTERRUPTIONS (MINUTES LOST PER YEAR)



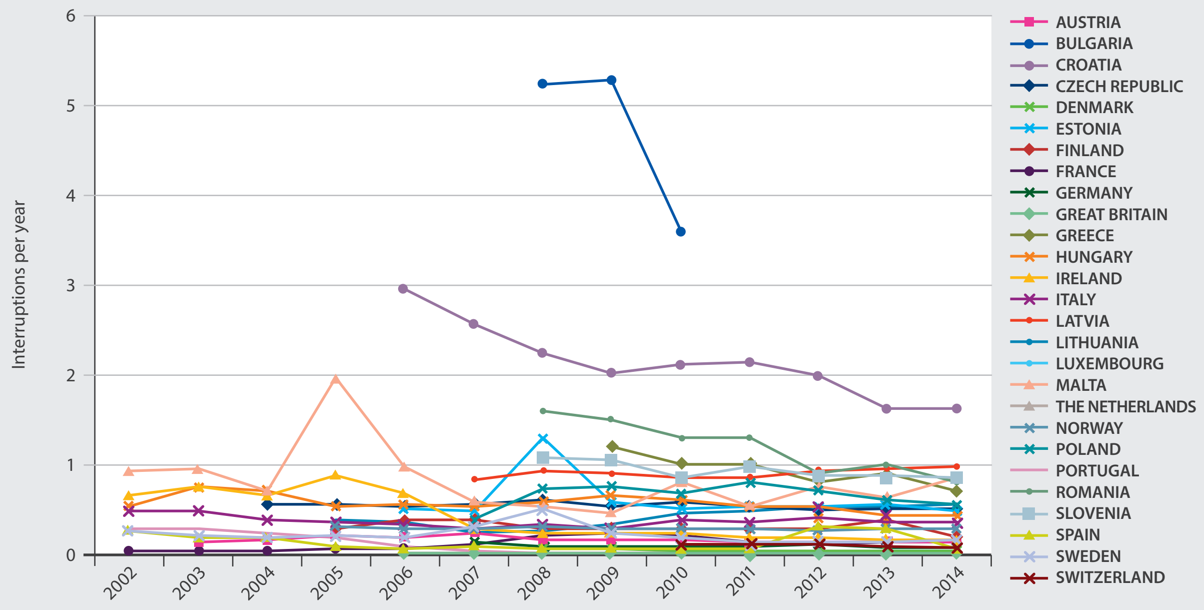
The values in Figure 2.13 are difficult to observe for countries with very few minutes lost per year during planned long interruptions. Therefore, Figure 2.14 shows only countries not exceeding a limit of 100 minutes lost per year. No trends are visible, except minor reduction in Germany, Norway and Switzerland and a minor increase in the Netherlands.

FIGURE 2.14 PLANNED LONG INTERRUPTIONS (MINUTES LOST PER YEAR); ONLY COUNTRIES NOT EXCEEDING 100 MINUTES



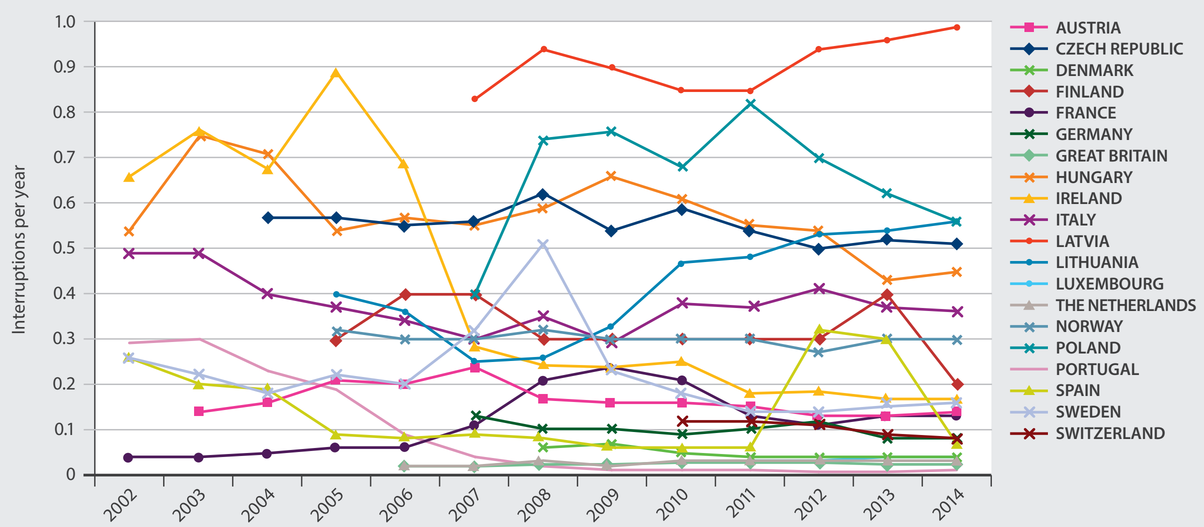
The number of planned interruptions per year is shown in Figure 2.15. As with minutes lost, the number of interruptions also varies significantly between countries and there is no visible trend; except for Croatia, Romania and Greece, where the duration of interruptions for the years reported has been decreasing.

FIGURE 2.15 PLANNED LONG INTERRUPTIONS (NUMBER OF INTERRUPTIONS)



Because of the significant variation between countries (Bulgaria reported very high values), only countries with values limited to 1 interruption per year are presented in Figure 2.16. Except for some countries with relatively stable values, it is hard to find trends.

FIGURE 2.16 PLANNED LONG INTERRUPTIONS (NUMBER OF INTERRUPTIONS); ONLY COUNTRIES NOT EXCEEDING 1 INTERRUPTION



2.6.4. Short interruptions

As previously illustrated, about half of the countries make no distinction between long and short interruptions. Additionally, few countries differentiate between interruptions lasting less than 1 second (or similar values), known as transient interruptions, and those lasting longer than 1 second and less than 3 minutes, which is the definition of a short interruption in most countries.

As discussed in Section 2.5, nearly all countries use the indicator for the average number of times per year that the supply to a network user is interrupted for 3 minutes or less (usually called MAIFI).

When calculating MAIFI, the time-aggregation rules are very important. Multiple interruptions during a 3 minute period, due to automatic reclosing actions, may be counted as one event for MAIFI or as multiple events. This choice could significantly impact the value of MAIFI. In fact, MAIFIE (Momentary average interruption event frequency index, according to the term used in CENELEC TR 50555) is used in practice in most countries for the average frequency of momentary interruptions. In addition, when calculating MAIFIE, the aggregation rules used for counting short interruption sequences are very important and can greatly affect the calculated values.

2.6.5. Interruptions on the transmission networks

As mentioned in Section 2.5.1, the most common indicators for measuring continuity of supply in transmission networks are ENS and AIT. ENS gives the total amount of energy that would have been supplied to the interrupted users if there had not been any interruption. AIT is expressed in minutes per year and calculated as 60 times the ENS (in MWh) divided by the average power supplied by the system (in MW). CEER's data survey aimed to collect ENS and AIT indices for both long and short interruptions[3]. Table 2.11 reports the ENS data available from 11 countries. The AIT data available are presented in Table 2.12. Even though the number of countries is similar (10), there are differences in responding countries between these 2 tables.

The definition of the transmission network can significantly affect comparisons. Whereas in most countries the transmission network includes EHV and HV, the transmission network in the Czech Republic (plus selected 110 kV lines), Great Britain, Hungary, Norway (plus selected 132 kV lines), Romania, the Slovak Republic, Spain and Sweden mostly corresponds to EHV. For exact definitions, please refer to Table 2.3 in Section 2.4.3.

TABLE 2.11 UNPLANNED ENERGY NOT SUPPLIED (ENS) IN MWH DUE TO INTERRUPTIONS IN TRANSMISSION NETWORKS (EXCLUDING EXCEPTIONAL EVENTS)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Cyprus											202.8		
Czech Republic								52	7	161.3	4.5	167.5	231
France	1,753	3,211	1,891	1,598	1,416	1,815	3,563	5,089	2,429	1,374	1,864	2,499	2,150
Greece									1,245	2,070.7			
Italy					3,477	8,465	2,430	2,372	2,175	3,131	3,886	2,839	1,593
Latvia											2,533	1,395	1,144
Lithuania				57.04	157.55	133.89	15.39	26.32	52.95	51.18	18.79	13.89	37.35
Portugal	75.9	141.78	496	40.2	262.59	75.9	130.16	42.09	116.2	27.00	0	8.6	1.8
Romania			247	387	106	80	167	55	267.9	98.804	102.71	30.89	82.51
Slovenia		2.33	94.54	2.54	156.76	34.02	1.34	7.69	67.94	9.71	8.85	25.69	0.82
Spain	802.69	466.23	1,249.65	548.79	935.8	757.16	573.54	437.5	1,569.47	2,590	113	1,126	204

Notes:
France: since 2008, ENS & AIT include load shedding. Includes big incidents in south-east of France in 2008 and 2009.
Latvia: This is only for MV and LV together. NRA does not hold information for transmission system.
Portugal: interruptions not attributable to force majeure or exceptional events. The 2006 value considers the interruptions due to the European event of 4th November (204.5 MWh).
Slovenia: does not comprise the interruptions attributable to a third party. Interruptions on EHV and HV are counted in.
Spain: only for Spanish peninsular system.

3. ENS can be applied to both long and short interruptions in the countries where these interruption types are defined. This is different to the computation of the SAIDI indicator for distribution networks, which normally refers only to long interruptions. The different definition can be associated to the meshed nature of transmission networks, which normally leads to shorter interruption times compared to those of interruptions in radial distribution networks. As a consequence of shorter interruption times, the impact of short interruptions in ENS and AIT indicators tends to be greater than their impact in the SAIDI index.

TABLE 2.12 UNPLANNED AVERAGE INTERRUPTION TIME (AIT) IN SYSTEM MINUTE PER YEAR DUE TO INTERRUPTIONS IN TRANSMISSION NETWORKS (EXCLUDING EXCEPTIONAL EVENTS)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Belgium							3.02	1.35	4.25	1.67	2.18	1.77	3.47
Cyprus											1,433		
Czech Republic								5.3	5	15.4	4	18.3	15.8
Estonia						234	1,209.8	1,068	2,972.32	2,983.33	1,756	2,719	410.3
France	2.4	4.2	2.4	2	1.8	2.3	4.4	6.4	2.9	1.7	2.3	3.0	2.8
Lithuania				1.62	5.11	3.98	0.64	0.78	2.22	2.31	0.87	0.65	1.75
Portugal	1.07	2.02	6.68	0.52	0.78	0.81	1.35	0.44	1.16	0.28	0	0.09	0.02
Romania			3	4.4	1.2	0.86	1.8	0.81	3.1	1.06	1.19	0.35	0.82
Slovenia		0.1	4.03	0.11	6.33	1.35	0.06	0.36	2.95	0.4	0.37	1.08	0.03
Spain	2.006	1.095	2.798	1.176	1.939	1.523	1.147	0.91	3.17	0.42	0.18	0.24	0.441

Notes:
Belgium: only refers to the interruptions for which the responsibility is linked to the TSO.
Czech Republic: Average interruption time of one interruption.
France: since 2008, ENS & AIT include load shedding. Includes big incidents in south-east of France in 2008 and 2009.
Portugal: interruptions not attributable to force majeure or exceptional events. The 2006 value considers the interruptions duo to the European event of 4th November (2.75 min).
Slovenia: does not comprise the interruptions attributable to "third party". Interruptions on EHV and HV are counted in
Spain: only for Spanish peninsular system. Data for 2014 are provisional data pending audit.

2.6.6. Technical characteristics of electricity networks

European networks are designed in various ways, which can be explained by different factors such as the population density, the country's topology, climate and the history behind the construction and evolution of the electricity networks. There is a large variety of parameters for the definition of the technical state of networks. These may vary widely in different countries and may have an impact on continuity of supply.

Figure 2.17 and Figure 2.18 below and Table 2.13 show the length of circuits in European countries in a year when the latest data for all voltage levels was available (for most countries this is 2014). For low and medium voltage, in addition to total length of circuits, the respective lengths of cables and overhead lines are also included. Again, voltage levels often have different meanings across countries and Table 2.3 should always be consulted.

TABLE 2.13 LENGTH OF CIRCUITS IN EUROPEAN COUNTRIES IN KM

	LV				MV				HV	EHV
Country	Total length of circuits	Length of cable circuits	Length of overhead lines	Percentage of underground cables	Total length of circuits	Length of cable circuits	Length of overhead lines	Percentage of underground cables	Total length of circuits	Total length of circuits
Austria, 2014	170,663	135,337	35,326	79.3%	68,684	41,146	27,538	59.906%	11,275	6,729
Belgium, 2014	128,120	79,044	49,076	61.695%	75,286	69,532	5,754	92.357%	9,604	1,761
Bulgaria, 2010	88,937	26,044	62,893	29.28%	63,946	14,354	49,592	22.447%	15,213	
Croatia, 2014	95,174	27,521.6	67,652.4	28.917%	40,600	16,637	23,963	40.978%	6,401	1,247
Cyprus, 2012	14,924	5,366	9,558	35.96%	9,304	3,608	5,696	38.78%	1,621	
Czech Republic, 2014	149,759	85,071	64,688	56.805%	76,815	17,865	58,950	23.257%	14,101	5,503
Denmark, 2011	95,797	92,431	3,366	96.49%	72,237	64,017	8,220	88.62%	2,992	
Estonia, 2014	36,781	10,531	26,250	28.63%	31,348	8,798	22,550	28.066%	3,547	1,945

	LV				MV				HV	EHV
Country	Total length of circuits	Length of cable circuits	Length of overhead lines	Percentage of under-ground cables	Total length of circuits	Length of cable circuits	Length of overhead lines	Percentage of under-ground cables	Total length of circuits	Total length of circuits
Finland, 2014	239,960	97,817	142,143	40.76%	141,290	23,166	118,124	16.4%	16,134	7,378
France, 2014	706,106	302,556	403,550	42.85%	626,836	288,208	338,628	45.978%	55,221	49,687
Germany, 2013	1,156,785	1,029,542	127,243	89.0%	509,866	398,232	111,634	78.105%	96,308	34,797
Great Britain, 2014	389,663	328,850	60,813	84.39%	326,714	158,763	167,951	48.59%		72,938
Greece, 2014	124,575	78,507	46,068	63.02%	110,750	11,920	98,830	10.763%	12,733	4,699
Hungary, 2014	88,700	23,841	64,859	26.878%	67,400	13,480	53,920	20.0%	6,520	4,855
Ireland, 2014	70,460	12,362	58,098	17.54%	92,326	9,526	82,800	10.318%	7,266	6,500
Italy, 2014	857,977	320,578	537,399	37.364%	388,762	173,660	215,102	44.67%	46,575	21,931
Latvia, 2014	58,960	21,482	37,478	36.435%	35,647	6,456	29,191	18.11%	3,963	1,394
Lithuania, 2014	71,078	16,867	54,211	23.73%	56,004	12,516	43,488	22.35%	6,792	
Luxembourg, 2014	6,069	5,724	345	94.315%	3,705	2,612	1,093	70.5%	536	156
Malta, 2014	3,028.2	951.2	2,077	31.41%	1,380.4	1,295.5	84.9	93.85%	61	0
The Netherlands, 2014	145,712	145,712	0	100%	105,181	105,181	0	100%	10,559	2,974
Norway, 2013	199,074	106,030	93,044	53.26%	100,481	40,859	59,622	40.66%	22,159	8,261
Poland, 2014	424,540	179,613	244,927	42.31%	294,998	71,491	223,507	24.234%	33,103	13,688
Portugal, 2014	141,829	33,243	108,586	23.44%	72,319	14,135	58,184	19.545%	9,375	8,630
Romania, 2014	183,279	50,562	132,717	27.587%	120,038	29,023	91,015	24.178%	22,300	8,721
Slovak Republic, 2013	52,863	13,396	39,467	25.34%					32,720	9,663
Slovenia, 2014	46,272	18,272	28,000	39.49%	17,391	5,448	11,943	31.33%	2,705	997
Spain, 2014	443,764	189,273	254,491	42.65%	248,756	92,855	155,901	37.33%	28,277	42,601
Sweden, 2014	314,786	250,149	64,637	79.47%	199,104	116,289	82,815	58.41%	30,404	15,314
Switzerland, 2014	136,200	125,900	10,300	92.44%	44,000	32,800	11,200	25.45%	9,000	6,750

Notes:
Great Britain: Medium voltage is not defined in Great Britain. High voltage starts at 1 kV and goes up to (but not including) 22 kV. In this table, the voltage defined as HV in Table 2.13 is included as MV since the voltage level roughly corresponds to other MV systems in Europe. The HV value was left blank.

The following 2 figures illustrate the length of low and medium voltage circuits in European countries corresponding to the years listed in Table 2.13. They are ordered by the total length of LV and MV circuits in descending order. Germany, France and Italy are the top 3 countries in both cases.

FIGURE 2.17 LENGTH OF LV CIRCUITS (KM)

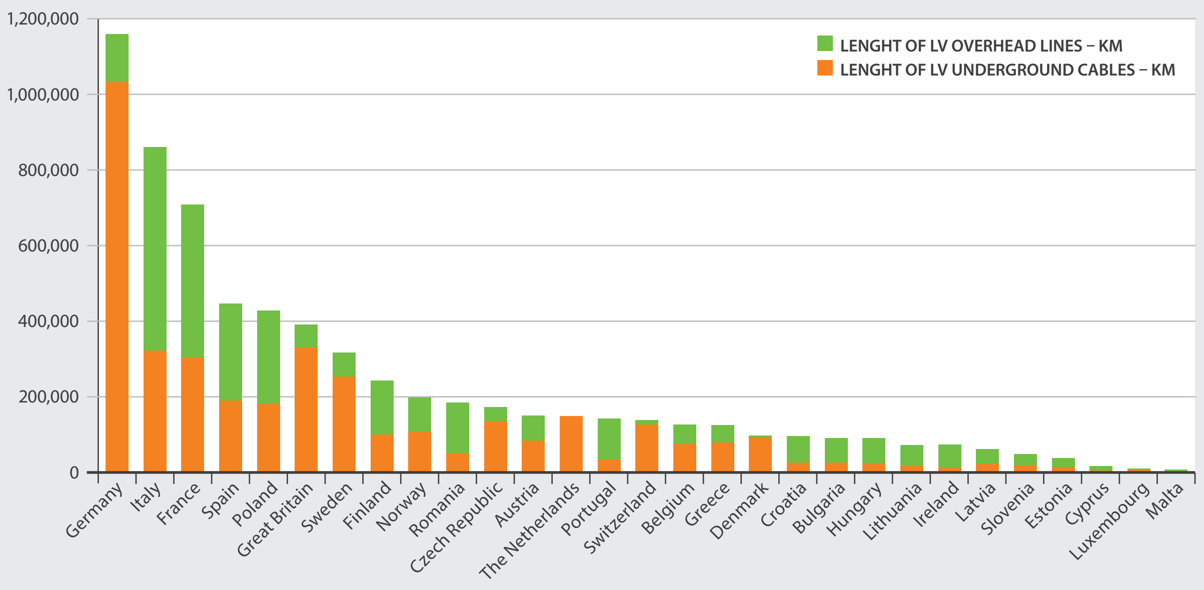


FIGURE 2.18 LENGTH OF MV CIRCUITS (KM)

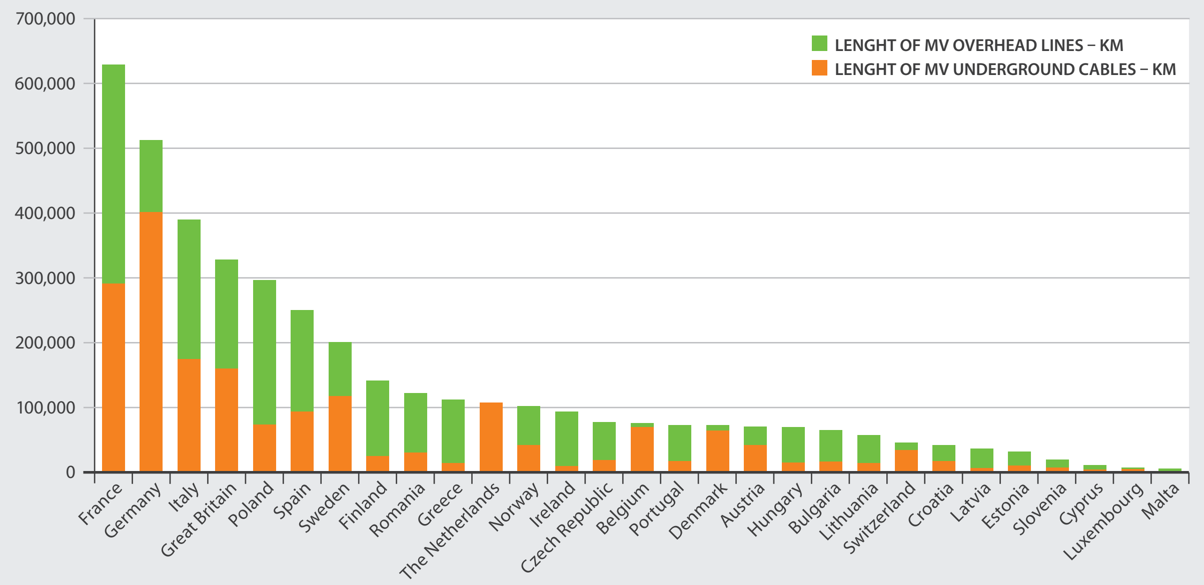


Figure 2.20 graphically illustrates the percentage of the share of cable lines at MV and LV. Groups of countries that have similar network characteristics may make it easier to compare the values of their indicators. The proportion of cable circuits has direct impact on continuity of supply indicators. Generally speaking, the countries that have high percentage of cable circuits (especially at MV) have lower values of the corresponding interruption indicators. This is obvious when rates of underground cables from Figure 2.19 and Figure 2.20 are compared to the values of indicators in Section 2.6.

FIGURE 2.19 RATE OF LV AND MV UNDERGROUND CABLES (1)

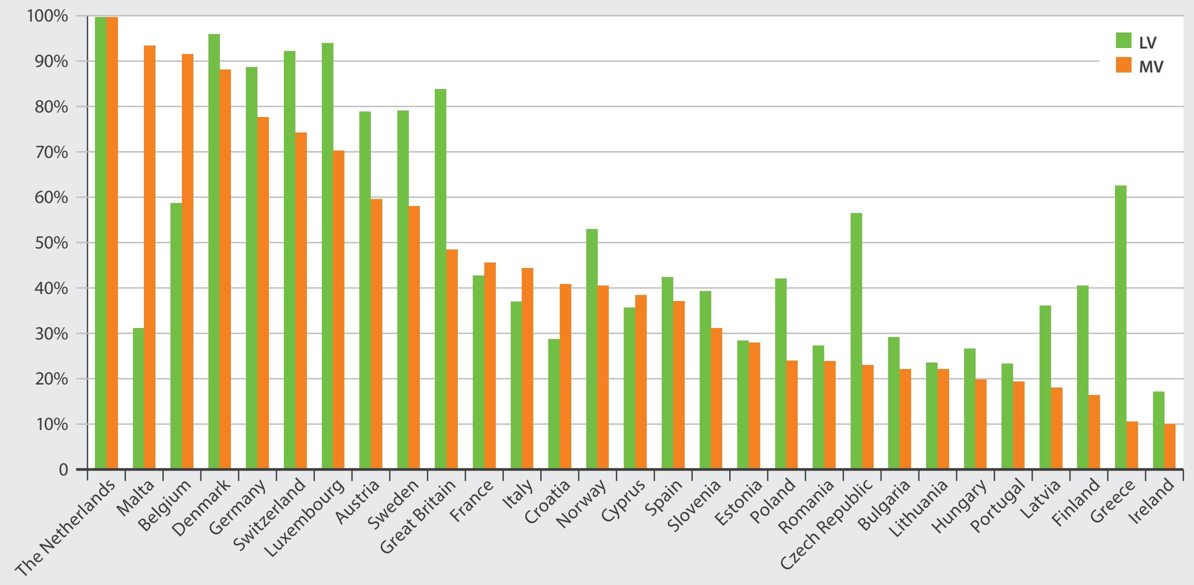
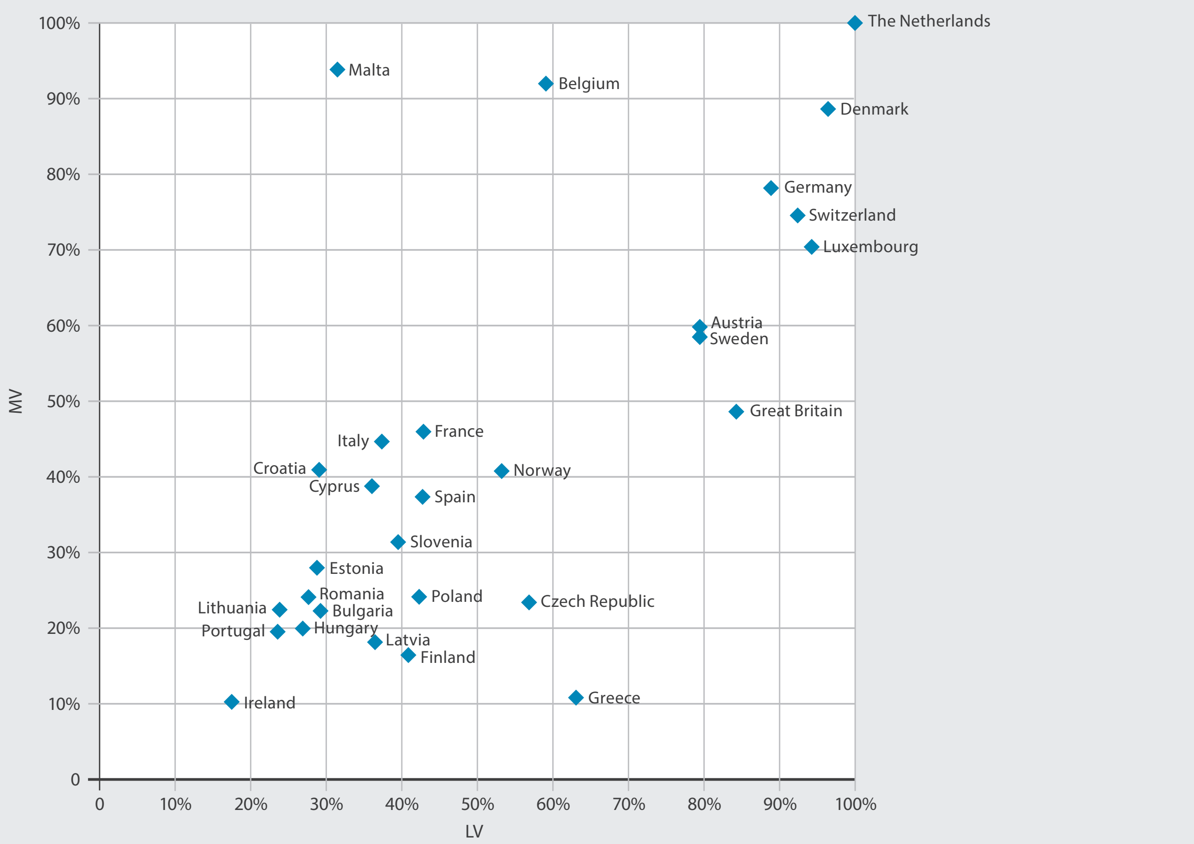


FIGURE 2.20 RATE OF LV AND MV UNDERGROUND CABLES (2)



2.7. STANDARDS AND INCENTIVES IN CONTINUITY OF SUPPLY REGULATION

2.7.1. Introduction

This section provides an overview of the existing quality regulation frameworks in European countries, for electricity distribution as well as for transmission networks. Financial incentives discussed in this chapter relate to continuity of supply. For economic penalties and compensations in the field of commercial quality, see Chapter 4.

A performance-based regulation comprises the following main aspects:

- **Continuity measurement** – a prerequisite for setting standards and reward/penalty regimes. Here, robust and reliable data is needed in terms of the actual continuity levels as well as the level perceived by the network users;

- **Maintenance and improvement of general continuity levels** – the investment decisions of network operators influence current and future quality levels. Depending on the actual quality level, the NRA must make sure that the current status is either maintained (if continuity of supply has already reached good levels) or improved (if continuity of supply is not yet satisfactory). Preferred regulatory actions to reach these goals include publishing continuity data and implementing reward/penalty schemes. Regulatory approaches for general continuity levels are addressed in Section 2.7.3; and

- **Continuity ensured for each network user** – the focus is placed on individual users. Minimum standards for quality levels accompanied by associated payments will guarantee that single users will be compensated if the standard is not met by the network operator. Regulatory approaches on individual continuity levels are discussed in Section 2.7.4.

2.7.2. Measurement of quality levels: a prerequisite for quality regulation

The measurement of actual continuity levels through indicators and standards constitutes the basis for regulating continuity and quality of supply as a whole. In general, the actual measurement of continuity can be performed on 2 different levels, namely system level and user-specific level. While the measurement at system level is usually done on an aggregate basis, measurement at user level is often based on surveys asking customers about their satisfaction, expectations, willingness to pay for high quality or willingness to accept low quality levels. As is to be expected, private households and business or industrial consumers can have diverging interests and therefore will probably also have diverging views regarding the required quality of electricity supply. The implementation of adequate measurement systems is essential for setting standards and incentives at both measurement levels.

The most common indicators for measuring duration and frequency of continuity of supply are SAIDI and SAIFI for distribution networks and ENS and AIT for transmission networks. The measurement of interruptions should cover all network levels.

2.7.3. Regulation at system level and reward/penalty regimes

The following section provides an overview of the existing quality incentive schemes across Europe. It also illustrates which indicators and standards are used in this regard. In addition, the economic effects and outcomes of the regulatory actions are addressed.

General reward or penalty schemes or incentives to optimise continuity of supply levels have been introduced in 17 of the 26 countries that provided feedback: Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Ireland, Italy, the Netherlands, Norway, Portugal, Slovenia, Spain and Sweden. However, the use of rewards, penalties and a combination of those differs among countries and is also applied differently to the transmission and the distribution levels. Penalties are usually coupled with rewards and can be applied to distribution or transmission networks or both. Table 2.14 reveals that countries do not use the same indicators. Most of the countries that have not yet implemented a continuity of supply scheme either consider, plan or have intentions to introduce such a regime (e.g. Austria, Greece, Luxembourg and Romania).

Quality as a regulatory element has been implemented in several regimes across Europe, with incentive schemes being the most common ones. The main intention is to keep quality levels at a socio-economically acceptable level. As such, maintaining or improving the existing levels might be on the NRA's radar. Nevertheless, the input-output relationship has to be considered: if the quality level is already very high, then a further improvement might be very costly for the consumer. Existing schemes are reviewed below. The analysis focuses on transmission and distribution networks separately.

TABLE 2.14 CONTINUITY OF SUPPLY REGULATION AT SYSTEM LEVEL

System	Rewards	Penalties	Combination	Continuity indicators used
Distribution		DK, HU	BG, CZ, DE, ES, FI, FR, GB, IE, IT, NL, NO, PT, SI, SE	BG (SAIDI, SAIFI), CZ (SAIFI, SAIDI), FI (outage costs based on planned and unplanned long interruptions), FR (SAIDI), DE (SAIDI for LV, ASIDI for MV), GB (customer interruptions and customer minutes lost), HU (SAIDI, SAIFI, outage rate), IE (customer minutes lost, customer interruptions), IT (SAIDI and SAIFI+MAIFI), NO (interrupted power at a specific time, duration, time of occurrence, planned, unplanned), PT (END), SI (SAIDI, SAIFI), ES (TIEPI, NIEPI), SE (ENS, PNS, SAIDI, SAIFI, CEMI4)
Transmission	BE, ES	HU	DE, FI, FR, IE, IT, NO, PT, SE	BE (AIT), FI (outage costs based on planned and unplanned long and short interruptions), FR (AIT and SAIFI+MAIFI), DE (SAIDI for LV, ASIDI for MV), HU (outage rate, AIT), IE (system minutes lost), IT (ENS), NO (interrupted power at a specific time, duration, time of occurrence, planned, unplanned), PT (TCD: Combined average availability rate in %), ES (availability of facilities), SE (ENS, PNS)
No existing CoS scheme	AT, CH, CY, EE, EL, LT, LU, MT, PL, SK			
Intentions/plans for implementation	AT (details under consideration), EL (penalty and reward scheme on basis of SAIFI and SAIDI indicators), LU (Q factor currently under discussion), RO (implementation under consideration)			

Belgium introduced for the period 2016-2019 an incentive to improve the continuity of supply of the transmission system. The TSO can obtain a bonus up to 2 million €/year based on the AIT of the transmission system. The formula that will be applied to calculate the bonus is:

$$Bonus = \min\left(2\,M€, 1.2 + \log\left(\frac{AITref}{AIT(y)}\right) * AITref * IR(y)\right)$$

Where:
$AITref$ is the reference AIT (set at 2.55);
and $AIT(y)$ is an incentive rate that is a function of the energy offtake of the grid for a given year.

Bulgaria uses a combination of penalties and incentives for continuity regulation for distribution companies (no existing scheme for the transmission level) on the basis of SAIFI and SAIDI indicators. The scheme is based on cost estimation survey and an optimal continuity level has been estimated. Each year, the level of the performance indicators is determined according to a standardised calculation method which is the same for the whole country. However, the indicators are different for each company. Calculated company values are then compared to determined target indicators. The scheme requires a minimum improvement which is calculated according to the following formula:

$$K = \frac{(RV - TV)}{TV}$$

The correction ratio for the performance of the indicators (K) is determined as the ratio of the difference between the reached value for the reference year (RV) and the target value (TV) divided by the respective target value. A maximum value is determined for each company based on a comparative analysis of EU countries' practices for reached indicators in similar energy companies. Moreover, the NRA takes into account the realised investments of the relevant companies. The continuity scheme is linked to the revenue-cap formula and the incentive is funded by all customers.

The Czech Republic relies on a combination of rewards and penalties for continuity regulation for distribution companies on the basis of SAIDI and SAIFI (only events which can be influenced by the DSOs, i.e. those under standard weather conditions and planned interruptions). An analysis of the dependency between costs and quality was made and the company specific target value of SAIFI, SAIDI for given price control period is set on the basis of this analysis. A minimum improvement is foreseen, as otherwise the Q-element, which is linked with the regulatory formula, will result in a penalty. Furthermore, the scheme involves a dead band which is set as a percentage from the required value of the indicator and a 2 year moving average, whereby the goal is to eliminate year to year fluctuations. In this sense, the incentive formula uses a linear dependence between quality and reward/penalty with the dead band and the maximum reward/penalty limit, whereby the target which was set in advance is compared with average value of actual performance indicators in the past 2 years. Target values are updated at the beginning of the regulatory period, but the comparison happens on an annual basis. The financial result is set to +/- 2% of DSO's profit for each indicator and the maximal value of the reward or penalty is set as a percentage of the requested value of the indicator. The incentive scheme is funded by customers of DSOs which are entitled to incentives. More information can be found in a case study at the end of the chapter on continuity of supply, in Section 2.9.1.

While **Denmark** does not monitor the TSO, it uses a regime which exclusively focuses on penalties for DSOs. The Danish NRA did not conduct a cost estimation survey or estimation of an optimal continuity level. The implemented scheme does not foresee a minimum improvement or dead band. It is not based on a cost estimation survey or estimation of a socioeconomic or optimal continuity level, but the desired continuity level is set at 83%. An individual threshold (IT) value for each network company is calculated on an annual basis. If the interruption frequency or duration is higher than the IT, the company gets a penalty. The penalty is calculated as the minimum of the 2 values – 10% of the excess of the IT or 1% of the susceptible costs. The company can get a penalty for both frequency and duration. The maximum penalty is 2% of the susceptible costs, whereby there are caps of 1% for both frequency and duration to prevent too high penalties.

The scheme in **Finland** is based on a combination of rewards and penalties which provide incentives to optimise future continuity of supply levels on the transmission as well as on the distribution level. The indicators used are planned and unplanned long term interruptions for transmission companies and planned and unplanned long and short term interruptions for distribution networks. Corresponding outage costs are taken into account.

In 2009, the Finnish NRA conducted 2 different cost estimation surveys which form the basis for the design of the continuity scheme of electricity TSOs. The first survey was made by Tampere and Lappeenranta University of Technology and the other survey was made by Pöyry Management Engineering. These surveys were mainly based on interviews and the analysis of industrial data. For electricity DSOs, an initial survey was made in 2005. The research was made by Helsinki and Tampere University of Technology and it was mainly based on a postal inquiry and telephone interviews. Another survey was made in 2014 which affirmed that the results from the previous survey are still accurate enough to be used in regulation. The actual continuity of supply level of each network operator (TSOs and DSOs), which is calculated from historical values, is compared to a set reference level, whereby no area difference is taken into account. If the actual level is better than the reference, the network operator will get a lower adjustment of the profit (reward); otherwise it will be penalised. While the incentive scheme for TSOs involves the use of a dead band in which the economic effect is set to zero, there is no dead band for DSOs. Moreover, there is a symmetric structure of maximum levels (cap and floor) used for penalties and rewards.[4]

As in many other countries, **France** uses a combination of rewards and penalties for both distribution and transmission network continuity regulation. While AIT and SAIFI+MAIFI are the continuity indicators used for the transmission level, SAIDI is addressed at distribution level. No cost estimation surveys or estimations of optimal levels were carried out for the development of the continuity scheme. The expected level of continuity is estimated in line with the investment program of the distribution and transmission companies and past values of indicators considered in the incentive scheme. No difference is made between rural and urban areas. While the incentive scheme does not require a minimum improvement of continuity at TSO level, it is required for distribution companies. For the transmission company, the expected level of continuity, i.e. the level that corresponds to no penalty and no reward, is set at 2.4 minutes for the period between 2009 and 2012. For distribution companies, the expected level of continuity (i.e. the level that corresponds to no penalty and no reward) is set at 68 minutes for 2014, 67 minutes for 2015, 66 minutes for 2016 and 65 minutes for 2017. No tolerance/dead band is implemented for either the DSO or TSO level. The incentive rate for TSO and DSOs is calculated according to formulas 1 and 2 respectively:

$$(1)\quad I_N = -10{,}4 \times AIT_{ref} \times \ln\left(\frac{AIT_N}{AIT_{ref}}\right) + 72 \times (SAIFI + MAIFI)_{ref} \times \ln\left(\frac{(SAIFI + MAIFI)_N}{(SAIFI + MAIFI)_{ref}}\right)$$

$$(2)\quad I_N = -4{,}3 \times \left(SAIDI_{N\,ref} - 34\right) \times \ln\left(\frac{SAIDI_N - 34}{SAIDI_{N\,ref} - 34}\right)$$

4. Further details for the TSO and DSO schemes can be found in the following 2 documents:
http://www.energiavirasto.fi/documents/10179/0/Appendix_1-Confirmation_decision_Methods_of_determining_reasonable_return_2012-2015_TSO.pdf
http://www.energiavirasto.fi/documents/10179/0/Appendix_1-Confirmation_decision_Methods_of_determining_reasonable_return_2012-2015_DSOs_+revised-29112013.pdf

Where:

I_N	is the incentive of the year N (reward if positive; penalty if negative);
AIT_N	is the system average interruption time for the year N (excluding planned interruptions and exceptional events);
AIT_{ref}	is the reference system average interruption time set at 2.4 minutes;
$SAIFI+MAIFI_N$	is the system average number of times per year that the supply to a customer is interrupted (including short and long interruptions);
$SAIFI+MAIFI_{ref}$	is the reference average number of times that the supply to a customer is interrupted and is set to 0.6; $SAIDI_N$ is the system average interruption duration index for the year N (including interruptions for works); and
$SAIDI_{N\,ref}$	is the reference system average interruption duration index for the year N set at 68 minutes for 2014, 67 minutes for 2015, 66 minutes for 2016 and 65 minutes for 2017.

Moreover, while the incentive for TSOs is €10.4M/min and €72.0M/interruption, the incentive of €4.3M/min for DSOs corresponds to a value of loss load of about €6/kWh. For TSOs, both penalties and rewards are capped at €30M. For DSOs, the cap for both penalties and rewards is set at €54.2M.

In **Germany**, quality regulation was implemented with the beginning of the year 2012. For the time being this system is valid just for electricity distribution system operators on LV (low voltage level) and MV (medium voltage level) with more than 30,000 customers although there is no exact legal distinction between DSOs and TSO. That means in general this system is valid for the TSO as well. One reason why it is not applied to the TSO is because there is no reliable data available concerning continuity level on high voltage level and extra high voltage level. The system is an addition to the incentive-based regulation, which was implemented in 2009. No cost estimation surveys or estimations of an optimal continuity level were conducted. Network operators are able to get a reward or a penalty which is dependent on their overall performance concerning continuity of supply in comparison to the other network operators. Overall performance of the network operator is measured by SAIDI on LV and ASIDI on MV. Each network operator is benchmarked against an individual reference level (SAIDIi*). Structural differences in overall reliability are taken into account when calculating the reference value. Therefore load density which is the ratio of peak load and geographic area is used. As a result of a regression analysis a load density-dependent reference value for each network operator is calculated. The difference between the continuity reference level and the network operator's current SAIDI level is transformed into a monetary amount – reward as well as penalty – by multiplication with a price of quality per unit and the number of customers connected to the network operator's grid. The cap and floor for rewards and penalties is set to a fixed percentage of allowed revenues. Thus, the continuity scheme is explicitly linked with the general revenue-cap formula and the amount of rewards and penalties are funded by redistribution of the revenues. The existing revenue-caps increase or decrease with quality of supply. The overall amount of revenues is not affected. The rewards and penalties are calculated according to the formula:

$$\text{REWARD/PENALTY} = (\text{SAIDI}_{i*} - \text{SAIDI}_{i}) \times \text{CUSTOMERS}_{i} \times \text{PRICE OF QUALITY}$$

Both the operator's continuity level and the continuity reference level are calculated as a mean of continuity indicators for the past 3 years to control for stochastic influences in network reliability. The price of quality is estimated by using a macroeconomic approach which is used to estimate the value of lost load (VoLL). Data will be taken from the national accounting. For each year belonging to the first regulation period the price of quality was set to €0.18 per minute of interruption per customer. No predetermined minimum improvement is required and no dead band is addressed. Improving or worsening quality is an optimization decision taken by the network operator. The aim of the quality regulation system in Germany is to achieve a socio-economically acceptable level of continuity of supply which is not set by the NRA.

Incentive rates in **Great Britain** are used to reward or penalise distribution companies based on their performance regarding continuity standards. The continuity indicators considered in the incentive scheme are customer interruptions (CI) and customer minutes lost (CML), but exceptional events are excluded. Respective cost estimations are conducted during the price control process and companies have to reach targets set during the price control process which are valid for 8 years. Each distribution network operator's (DNO) performance in comparison to their customer interruptions and customer minutes lost targets provides their resulting penalty or reward, whereby there is a limit to the penalty and reward (2.5% of Return on Regulatory Equity). Furthermore, the system does not involve a dead band.

The continuity regulation system in **Hungary** is exclusively based on penalties for transmission as well as for distribution companies. For the transmission level, the outage rate (the availability of energy, which is the ratio of ENS to available energy) and the availability indicator for transmission lines are used as the availability indicators of the network. In addition to the outage rate, SAIDI and SAIFI indicators are considered for distribution companies. No cost estimation survey or estimation of an optimal continuity level was carried out. The expected continuity level is calculated on a historical basis for each company. While the individual requirements for improvement of continuity levels are determined for each DSO, the TSOs do not have to achieve minimum levels of improvement. Penalties are limited and depend on the actual performance level and the standard (which was not fulfilled). DSOs have to pay 1-2% of the amount of network charges to customers. The actual performance of continuity standards is considered in the next year's price-cap calculation.

In **Ireland**, the continuity scheme is based on a combination of rewards and penalties and is comparable for transmission and distribution companies. There is a single transmission and a single distribution company operating in the region. While the indicator used for the TSO is the system minutes lost (SML), the indicators on the DSO level are the customer minutes lost (SAIDI) and the number of customer interruptions (SAIFI). At the TSO level, the targets for the SML incentive are set through reviewing outturn SML results and discussions with the TSO on expected SML results for the forthcoming year. While there is a dead band but no minimum improvement foreseen for TSOs, DSOs have to improve their continuity level on an annual basis (without a dead band), whereby targets have been set up to 2015 (there is no differentiation between urban and rural)[5]. The level of the reward depends on the amount by which the TSO or DSO has beaten the foreseen target. Each % over/under achievement is rewarded by a fixed amount. On the TSO level, the most recent incentive period (2009/2010) had a central target of 3.5 SML with an upper (maximum) value of 5.5 SML. If the TSO had gone above 5.5 SML it would have had to pay the full penalty amount. For DSOs, the annual payment/penalty for customer interruptions is limited to 1.5% of total annual DSO revenue. This limit is set at a level to ensure the payment is sufficient to incentivise the DSO, while also ensuring the reward/penalty is not overly onerous on either the DSO or its customers. The quality schemes for both TSO and DSO are linked to the respective revenue-caps, whereby the annual payment/penalty is calculated each year and netted off (or added to) the annual revenue the company can collect from its customers.

Incentive (reward/penalty) regulation for continuity of supply was introduced in **Italy** on distribution level in 2000 and is regularly updated every 4 years. In the beginning, only SAIDI was considered but since 2008, regulation based on SAIDI was complemented by rewards and penalties for SAIFI+MAIFI as well. Transmission quality has also been regulated with rewards and penalties since 2008. A survey for estimating customer interruption costs was carried out in 2003 and the results have been embedded for valuating both rewards and penalties. At distribution level, continuity targets are set at "district level" starting from the actual level reached in the previous regulatory period (for each district separately) and targeting a nation-wide reference level to be reached in 3 regulatory periods (4-years each) for SAIDI and in 4 regulatory periods for SAIDI+MAIFI. Nation-wide reference targets are differentiated only according to territorial density (i.e. nation-wide reference targets are the same for all districts having the same territorial density of which 3 levels are defined: urban, suburban, and rural areas). Planned interruptions and interruptions attributable to exceptional events are excluded from reward/penalty regulation. This also applies to interruptions generated in transmission grid which are excluded from interruptions considered for DSO reward/penalty mechanism. Penalties are used to reduce distribution tariff, whilst rewards imply a limited increase in distribution tariff. There is a cap for rewards and floor for penalties in order to reduce risk. A similar reward/penalty mechanism is applied to the TSO at system level for interruption generated in the transmission grid. Furthermore, a "mitigation" mechanism economically incentivises DSOs to provide help to the TSO (when interruptions occur in the Transmission grid) through MV reconfiguration in order to back-feed interrupted customers via a non-standard network scheme until the supply is restored in the transmission system.

In **Lithuania**, rewards or penalties (no distinction between urban and rural areas) are linked to a price-cap formula via a quality factor and are adjusted every 3 years. Thus, the incentive is funded by all customers via network tariffs.

While in **the Netherlands** there is no quality regulation implemented on the transmission level, the distribution level has a scheme based on the combination of rewards and penalties. Each DSO is compared to the average valuation of the quality level of supply and receives a reward or penalty depending on whether it performed better or worse than the average. The scheme is based on SAIFI and CAIDI indicators and provides an incentive to each DSO to deliver the optimal level of continuity of supply. A cost estimation survey was conducted in 2004 amongst household customers and small and medium-sized companies in the Netherlands. In 2009 the results of this survey have been updated. This update realigned key variables with current economic developments. It did not include a new customer survey. These results are used to determine the value of the quality level of supply, given a certain level of SAIFI and CAIDI. The survey results indicated that for certain levels of delivered quality there was no compensation required by the customers. For example: If households were to experience an interruption more often than once in the 8-year period, lasting less than 21 minutes in total, no compensation would be required. Each DSO receives a reward or penalty at the height of the difference between the actual company specific performance level (the valuation of the quality level of the DSO) and the average continuity level achieved by all DSOs, i.e. the average is used as a standard for the quality factor.[6]

5. Details in Section 9.1 of the CER decision on DSO revenue for the 2011 to 2015 period: http://www.cer.ie/en/electricity-distribution-network-decision-documents.aspx?article=0b278e96-80f5-43e1-80ab- b23423c3c34c.

6. For further details, please see the "Guidelines of Good Practice on Estimation of Costs due to Electricity Interruptions and Voltage Disturbances".

Thus, no minimum improvement of the continuity level is demanded as such. Furthermore, no distinction is made between urban and rural areas. In this sense, no optimal continuity level is estimated as the regulation as such, but the incentive scheme should result in and optimal level of continuity of supply. The incentive is capped at 5% of the total income of the DSO. However, this cap has not been reached yet. The quality incentive scheme is linked to the price control formula, since the efficiency factor and the quality factor are both in the same formula to determine the total income of the DSOs. The efficiency factor is derived by considering the average costs of all DSOs as efficient and the quality factor is derived by considering the average value of quality as the standard. This way each DSO has to balance between efficiency and quality in such a way so that the optimal level of quality will be reached.

The **Norwegian** financial incentive-based regulation on continuity of supply (CENS) gives the network companies (TSO and DSO level) economic motivation to ensure an optimal resource allocation when all minimum requirements are complied with. The objective is to achieve the most optimal level of continuity of supply for the society as a whole. The customers' costs related to interruptions are detected through nationwide surveys and will vary between different customer groups, when the interruptions occur etc. The costs related to investments to reduce the extent of interruptions will on the other hand depend significantly on the location of the customers' connection to the power system, including network topology, geography, climate etc. From the NRA's point of view it is important that decisions influencing the continuity of supply are also based on cost-benefit analyses.[7] Thus, the costs related to decreasing the extent of interruptions must be lower than the future decrease in customers' interruption costs due to the investment. Incentives to optimise the continuity of supply levels, should take into account all cost elements. Consequently, for some customers this may imply reduced, increased or maintained CoS levels. No minimum requirements and no caps or floor are addressed in the schemes. For both TSOs and DSOs, the indicators used include interrupted power at a specific reference time, duration, time of occurrence (during the day, during the week, calendar month), whether the interruption was notified in advance or not.

Portugal defined 2 incentive schemes (for the TSO and DSO responsible for HV and MV) based on rewards and penalties. Dead bands are used to avoid the activation of the incentives when small performance improvement or deterioration is experienced. The incentive for the TSO has the objective of increasing the availability of network equipment, where the relevant indicator corresponds to the combined average availability rate (TCD), expressed in (%), which results from the weight of the average availability rate of line circuits and power transformers. The incentive for the DSO intends to improve the continuity of supply of the MV customers. This incentive consists of 2 components with different objectives: (1) to improve the overall continuity of supply; and (2) to improve the continuity of supply of the worst-served 5% of customers. The parameters of the 2 incentive schemes (TSO and DSO) are defined for each regulatory period (every 3 years), while the values of the incentives (rewards or penalties) are calculated on an annual basis.

While there is no quality scheme for TSOs in **Slovenia**, there is a scheme on the distribution levels, which uses a combination of rewards and penalties for continuity regulation. The scheme is fully flexible regarding the indicators used, the levels of penalties and rewards, quality classes, dead bands, etc. In general, the parameters and indicators are specified for one regulatory period. For the actual regulatory period, the indicators considered are SAIDI and SAIFI values, which are separated for rural and urban. The NRA performed 2 surveys to assess customer interruption costs (2007 and 2010). However, the utilisation of both studies in terms of design of the incentive scheme was limited. Furthermore, the NRA is currently working on the estimation of an optimal continuity level to update the incentive scheme for the next regulatory period. Within the scheme, there is a long-term reference (target) value for SAIDI and SAIFI in each regulatory period set. In addition, it is defined and applied separately for each distribution area in a particular area type (rural, urban). It is defined using the reference standards calculated each year applying the requested improvement on the initial (starting) level of continuity of supply using SAIDI and SAIFI. A minimum improvement of the continuity level is demanded according to the initial starting level: if the long term reference level has already been reached, there is no consequence; if it has not been reached, then an improvement is demanded on a yearly basis. The current scheme uses a dead band to avoid strong effects on the tariff (optimizing the administrative costs) caused by non-structural changes in level of continuity of supply (i.e. stochastic variations around the reference). The Slovenian incentive structure is partly linear and partly constant in a sense that a certain constant band (constant economic effect) is applied for each quality class and a linear function is defined in the range between the quality classes. This is introduced for the same reason as in case of so called dead-band: to avoid the effect on the tariff (optimizing the administrative costs) of non-structural changes in level of continuity of supply (i.e. stochastic variations around the reference of a certain class). Rewards and penalties are capped and also floored (to the certain percentage of controlled costs for O&M). Capping is applied since the NRA has not yet completely verified/validated the customer information on the marginal valuation of quality. The continuity scheme is linked to the regulatory formula, which corresponds to a mix of revenue and price-cap regulation and is funded by all customers via regulated tariffs.

7. See CIRED paper no 494 and CEER GGP C10-EQS-41-03 for further details.

Spain applies a scheme that uses rewards for TSOs and incentives for DSOs. While the availability of facilities is considered at the TSO level, the continuity indicators which are used for DSOs include TIEPI and NIEPI which are similar to ASIDI and ASIFI. While no cost estimation survey was conducted for TSOs, cost estimation was used within the reference network model to calibrate incentives when minimum continuity requirements were established for DSOs. However, no estimation of an optimal continuity level was conducted. For DSOs, the incentive is calculated separately for different areas. The scheme is based on target values, which are considering the average between specific DSO data indexes in each area in the previous 3 years, and national average data indexes in that area. The incentive scheme does neither involve a dead band nor a minimum improvement of the continuity level. Although the time scale is yearly, it considers previous quality values for establishing future targets. The incentives (rewards, penalties, others) are not proportional to the difference between the actual performance level and the standard (or target). The quality incentives vary between -3% and 3% of the distribution company's total remuneration.

Sweden uses a combination of rewards and penalties for the TSO as well as for the DSO level. While continuity indicators used for TSOs include ENS and PNS, ENS, PNS / SAIDI, SAIFI, CEMI4 are used for DSOs. The NRA conducted a cost estimation survey to set an incentive rate for the continuity of supply (CoS) indicators. By setting an incentive rate based on data from customer surveys ("bottom up"), the quality regulation aims to give to incentives for a socioeconomic level of CoS. An explicit Q-element is calculated using the mentioned CoS-indicators, whereby the target for DSOs (there is no target and no minimum improvement determined for TSOs) is set using a benchmarking method where DSOs with similar customer density are exposed to a similar target. The target is not an "optimal" level but the mean value of the relevant CoS indicators, i.e. it is calculated based on the mean value of all DSO CoS-indicators (per customer group) as a function of customer density. That target is predefined during the regulatory period and has to be reached within 4 years. Afterwards it is updated for the next period. The scheme does not involve the use of a dead band. Incentives are calculated as follows:

(1) $Q_{TSO} = (ENS_{Target} - ENS_{result}) \times \cos t$ (2) $Q_{DSO} = (SAIDI_{Target} - SAIDI_{result}) / 60 \times P_{mean} \times \cos t$

For both TSOs and DSOs, the scheme is linked to the overall revenue-cap model while quality incentives are capped with 5% of total (capped) revenues. The scheme is funded only by costumers of areas/companies which are entitled to incentives.

2.7.4. Regulation at single-user level and economic compensation

Various countries employ incentives on single-user level, as presented in Table 2.15. For historic evolution of incentive regimes please refer to Section 2.8.5 of the 5th Benchmarking Report on the quality of electricity supply [5].

Nearly two thirds of countries offer individual compensation to network users when standards are not met. Individual compensation is not in place in Austria, Croatia, Cyprus, Denmark, Germany, Latvia, Luxembourg, the Slovak republic and Switzerland. Greece has introduced compensation scheme since the 5th Benchmarking Report.

In most cases, economic compensation has to do with individual duration of long unplanned interruptions. How long a customer would have to be out of power depends not only on a country, but sometimes also on connected capacity, voltage level and even weather conditions. In this compensation scheme, the minimum duration of an interruption eligible for compensation varies between 1 hour (in the Netherlands, but this depends on capacity and voltage level, see Table 2.16) and 24 hours (in Ireland). Additionally, Estonia and Romania offer compensation for planned interruptions if they exceed certain threshold.

A different compensation scheme has to do with aggregated values in a year: total duration or total number of interruptions. Spain, Portugal and Slovenia employ both these programmes. In addition, Poland offers compensation for total duration of interruptions while Hungary reimburses customers if a total number of interruptions in a year exceeds a set limit. In Italy such a mechanism is applied for MV customers only in case of exceeding maximum number of short and long interruptions in a year.

Compensation is not received automatically in every country. Of 17 countries that remunerate customers if various interruption standards are not met, only 11 offer automatic compensation: Estonia, Finland, France (one standard), Great Britain (priority service register only), Greece, Hungary, Italy, the Netherlands, Portugal, Spain and Sweden. Even in these countries compensation is not automatic in every case. In France, automatic compensation applies to one standard while in Great Britain only customers on the priority service register receive automatic compensation. In most countries customers have to ask for reimbursement. In Norway, for example, system operators are obligated to annually inform their customers on how to request compensation and to have a standard request form available. In Slovenia, customers may issue the request for compensation for each calendar year by providing required data (own interruption register) to DSO. This means that customers should already have the appropriate measuring equipment installed.

When considering the minimum guaranteed standards, exceptional events are included except in the Czech Republic, Greece, Poland, Portugal, Slovenia and Sweden. Compensation per customer per year is limited in these countries: Bulgaria, Finland, Great Britain, Norway (only for cabins, for other customers there is no limit), Portugal, Romania, Slovenia and Spain.

TABLE 2.15 STANDARDS FOR WHICH ECONOMIC COMPENSATION APPLIES

Type of standard	Country adopting the standard	Standard value	Automatic compensation
Individual duration of long unplanned interruption	CZ, EE, EL (1), FI, FR, GB, HU, IE, LT, NL, NO, RO, SE	8h for the capital – Prague, 12h elsewhere (CZ) (2), >12h (EL), >6h (FR), >12h (FI), >12h (GB) (7), >24h (IE), >8 urban, >12 suburban and rural (IT), >12h, >1h (NL) (5), >12h (NO), >12h (SE)	EE, EL, FI, FR, GB (only customers on the priority service register), HU, NL, SE
Individual duration of long planned interruptions	RO, EE		EE
Total duration of long interruptions (planned or unplanned or both) in a year	ES, PL (3), PT (8), SI	45min<T<17h (PT) (6), >9h (SI) (4)	ES, PT
Total number of interruptions (long or short or both) in a year	ES, HU (short), IT (1) (long and short), PT (8), SI	6-9-10 long+short, according to territorial density (IT), 3<n<20 (PT)	ES, IT (1), PT
Single-user advance notice for planned interruptions	IE	2 days	

(1) Applies to MV customers only.
(2) Applies to LV.
(3) Poland differentiates between planned and unplanned interruptions.
(4) Individual customers (LV and MV).
(5) Depends on voltage level and capacity of the connected customer.
(6) EHV starts at 45 minutes.
(7) If a customer is without supply for 12 continuous hours under normal weather conditions, then they are eligible for a payment. If there is "severe weather" (determined by there being at least 8 times the daily average number of faults at HV (1 kV+) and above in a 24 hour period), then a customer must be without supply for at least 24 continuous hours.
(8) For comparison with standards, only long unplanned interruptions are considered.

The level of compensation can be set as a percentage of yearly network tariffs (the Czech Republic, Finland, Sweden), determined through customer research (Great Britain), based on international comparison (Hungary, Italy), on estimated costs of interruptions (the Netherlands, Portugal, Romania, Slovenia) or on the cost of energy during the period of interruption (Poland).

The following paragraphs offer more insight into the level and limits of reimbursement in several countries:

- In Bulgaria, customers experiencing no electricity supply for more than 24 hours receive compensation in the amount of 30 BGN with 20 BGN added for every subsequent period of 12 hours without electricity.

- In the Czech Republic, reimbursement is similarly set at 10 % of yearly payment for network tariffs and limited to €250 at low voltage, €500 at medium voltage and €5,000 at high voltage.

- In Finland, economic compensation is defined by Finnish Electricity Market Act and capped at €2,000. The rates are as follows: 10% of yearly network tariff for outages lasting 12-24h, 25% of yearly network tariff for outages lasting 24-72h, 50% of yearly network tariff for outages lasting 72-120h, 100% of yearly network tariff for outages lasting 120-192h, 150% of yearly network tariff for outages lasting 192-288h and 200% of yearly network tariff for outages lasting longer than 288h.

- France offers reimbursement to customers if single unplanned interruptions are longer than 6 hours (including exceptional events but excluding interruptions attributable to customers). The compensation from TSOs is 2% on the fixed part of the network tariff for every full 6-hour period of interruption. From DSOs, customers are entitled to 20% of the annual amount of the fixed part of tariff for interruptions longer than 6 hours and additional 20% for every additional 6-hour period. In other words, compensation for interruptions between 6 and 12 hours is 20% of the yearly fixed tariff, for interruptions between 12 and 18 hours it is 40% etc. Fixed part of the tariff is what is paid by customer for the connected power capacity. There are no differences according to type of customer except for DSOs which are customers of TSOs and can either choose the standard payment from TSOs (2% for 6 hours) or TSO's participation in the compensation payments to DSO's own customers. In case of exceptional events, the main distribution system operator ERDF has to re-energize more than 90% of its customers within 5 days.

- In Great Britain, where the compensation level has been set through customer research, rates differ for domestic and business customers and are capped at £700 per customer per year. Domestic customers are entitles to £75, while business customers receive £150 for the first 12 hours, then £35 for every 12th hour. This 12-hour standard applies under normal weather conditions. If the interruption was due to an exceptional event, then the customer must be without power for a minimum of 24 hours, or 48 hours for large events.

- Medium voltage customers in Greece are entitled to €150 if an interruption exceeds 12 hours.

- In Italy, automatic reimbursement applies for all customers involved in long interruptions. Threshold currently still depends upon territorial density but in 2016 a convergence process has been started at the end of which (2020) the same threshold will be applied (8 hours). The amount of automatic reimbursement for LV customers starts from €30 at the threshold level and increases by €15 every 4 hours up to a maximum of €300. Interruptions for exceptional events are also included in this protection scheme. For MV only, a further scheme is also applied. Customers on MV level suffering too many interruptions in a single year (considering both long and short ones) receive an automatic reimbursement provided that they are compliant with proper technical requirement for connection.

Compensation levels in the Netherlands distinguish between the voltage levels where the interruption was caused and between customers' connected capacity. These are presented in Table 2.16 in detail.

TABLE 2.16 COMPENSATION LEVELS IN THE NETHERLANDS

Type of standard	Interruption caused by a failure in the network with a voltage <= 1 kV	Interruption caused by a failure in the network with a voltage > 1 kV and < 35 kV	Interruption caused by a failure in the network with a voltage >= 35 kV
For each connection <= 3 x 25 A in a network with a voltage <= 1 kV	€35 for an interruption of 4 to 8 hours, plus €20 for each subsequent unbroken period of 4 hours	€35 for an interruption of 4 to 8 hours, plus €20 for each subsequent unbroken period of 4 hours	€35 for an interruption of 4 to 8 hours, plus €20 for each subsequent unbroken period of 4 hours
For each connection > 3 x 25 A in a network with a voltage <= 1 kV	€195 for an interruption of 4 to 8 hours, plus €100 for each subsequent unbroken period of 4 hours	€195 for an interruption of 2 to 8 hours, plus €100 for each subsequent unbroken period of 4 hours	€195 for an interruption of 1 to 8 hours, plus €100 for each subsequent unbroken period of 4 hours
For each connection in a network with a voltage > 1 kV and < 35 kV		€910 for an interruption of 2 to 8 hours, plus €500 for each subsequent unbroken period of 4 hours	€910 for an interruption of 1 to 8 hours, plus €500 for each subsequent unbroken period of 4 hours
For each connection in a network with a voltage > 35 kV			€0.35 per contracted kW for an interruption of 1 to 8 hours, plus €0.20 per contracted kW for each subsequent unbroken period of 4 hours

Compensation levels are based on estimated customer costs caused by interruptions. A customer survey to establish costs of interruptions for households and small business customers was conducted in 2004. An update of this study from 2009 is currently used as a basis for quality regulation. Payments to customers are not required if the interruption of the transmission service is the result of automatic or manual load shedding, if the network operator can demonstrate that due to an extreme situation it was unable to repair an interruption within the restoration times or if an interruption is caused in HV or EHV networks.

In Norway, the NRA sets the compensation level but does not differentiate according to the type of customer. All conditions are eligible as long as the power outage is at least 12 hours long. The amounts are: NOK 600 for interruptions between 12 and 24 hours, NOK 1,400 for interruptions between 24 and 48 hours and NOK 2,700 for interruptions between 48 and 72 hours. For interruptions longer than 72 hours, the compensation is NOK 1,300 per each 24- hour period. The only differentiation for customers applies to cabins, for which a cap is set at the expected value for the annual grid tariff. There is no cap for other customers. In addition, customers having more than one connection point are not entitled to more than one compensation for one interruption.

The levels of compensation in Portugal are defined by the concept of the Value of Lost Load. A limit of 100% of customer's annual network tariff (for the previous year) was defined as a result of benchmarking with other European countries and was introduced in 2014. Before 2014, the total amount of compensation was limited to 10% of the annual energy bill of a consumer. Since the standards are differentiated by voltage level and geographic area, the compensation level is also differentiated by these 2 characteristics.

Slovenia sets their level of compensation according to result of an internal assessment of industrial customer interruption costs. The compensation for industrial customers (MV level) is determined by the connected load (≤250 kW or >250 kW) as well as the extent of a breach of particular standard (duration or number of interruptions).

Compensations are also available for individual customers on low or medium voltage level who suffered extremely long interruptions: more than 9 hours due to planned or unplanned interruptions (excluding exceptional events and third party responsibility) or more than 18 hours due to unplanned interruptions for which only the DSO is responsible.

In Sweden, for an outage period between 12 and 24 hours, compensation is set as 12.5% of consumer's estimated annual network cost. For outages longer than 24 hours, further compensation of 25% of consumer's annual cost shall be paid for each 24h period commenced thereafter. For one outage period, compensation is limited to 300% of consumer's annual network cost. However, electricity consumers are not entitled to compensation for outages if the outage is attributable to a fault in a cable network with voltage of 200 kV or above, if the outage is customer's fault or if the transmission of electrical power is discontinued in order to take measures to maintain good operational or supply security and the outage does not last longer than the measure requires.

In addition to compensations for failing to meet standards, there exist also schemes in Ireland and Great Britain for worst-served customers. In Great Britain, while not considered a specific regulation or standard, funding is available for DNOs who are trying to improve the performance experience for those customers meeting the criteria for being considered worst-served. Funding is available at a rate of £1,000 per customer per scheme. In Ireland, the NRA has made an allowance of 2 million Euro per year within the DSO revenue, which the DSO can use to improve services to worst-served customers. The details of this scheme have not been finalised yet. Similar allowances for TSOs are not in use.

2.8. FINDINGS AND RECOMMENDATIONS ON ELECTRICITY CONTINUITY OF SUPPLY

Finding 1
Continuity of supply is monitored in all responding countries.

All countries that participated in CEER's survey stated that they monitor continuity of supply in their electricity networks. In addition, most ECRB countries that were featured in the ECRB Annex of this Report monitor continuity of supply. So do Israel and Algeria that provided input for case studies.

The monitoring usually covers long interruptions (see Table 2.2 for definitions of duration) and differentiates between planned and unplanned outages. Short interruptions are monitored by a minority of countries.

About two thirds of responding countries keep track of interruptions on all voltage levels. Those that do not, usually omit what they consider low or extra high voltage. It should be kept in mind that voltage level definitions are not standardised.

Finding 2
Continuity of supply indicators and procedures for data collection and analysis vary across countries.

Diverse indicators and weighting methods are employed when evaluating interruptions in various countries. The use of multiple indicators enables the collection of more information and offers more possibilities to observe trends. The most commonly used indicators are SAIDI and SAIFI with most countries using weighting by the number of users. Many countries that monitor short interruptions keep track of the yearly number of those interruptions and use MAIFI or MAIFIE as indicators. Even the use of the same indicator does not guarantee easy comparison. For example, aggregation rules for counting short interruption sequences vary across Europe and can greatly affect the values of an indicator, in this case MAIFIE. Indicators such as ENS and AIT are frequently used to monitor continuity of supply in transmission networks. Certain indicators are presented with and without exceptional events with countries having their own interpretation of what constitutes an exceptional event.

The level of detail being monitored is not harmonised either (as presented in Table 2.6 and Table 2.7). Most countries collect some information on the cause of interruptions. If collected in detail, this provides NRAs with important information and can be used as an essential part of the improvement of continuity of supply.

Finding 3
Calculation of continuity of supply indicators varies across countries.

As already mentioned above, various continuity of supply indicators are used across countries. It can be assumed from the obtained data that even in case of using the same indicators (e.g. SAIFI, SAIDI), different approach to calculating these parameters exists. One of the differences, for example, is including or excluding each specific cause of interruption (force majeure, exceptional events etc.). Concurrently, each country can have different approach to calculation of complicated causes where lots of sequences of interruptions with different duration (long or short) and different numbers of affected customers occur. The same approach in each country and the whole EU is a basic assumption for a correct evaluation and comparison.

Finding 4
There is a different approach to exceptional events across countries.

Based on the data analysis, it is obvious that the share of exceptional events has serious impact on the values of continuity of supply indicators. Table A.13 in Annex A illustrates the different definitions and approaches to exceptional events. One of the reasons for the difference could be that lots of countries defined exceptional events with respect to their historical experiences or geographic reasons. Some countries have no definition in place. As a result, it is not clear what types of interruptions are considered in exceptional events. Therefore, the comparison of continuity of supply indicators among European countries must take into account this diversity in the definitions of exceptional events.

Finding 5
Incentive schemes are used to regulate continuity of supply in distribution and transmission networks.

General reward or penalty schemes or incentives to optimise the continuity of supply on a system level are applied in more than half of the countries that responded. A total of 3 new countries have introduced incentive schemes since the last report was published.

Most countries use a combination of rewards and penalties in both distribution and transmission while several countries have regimes that focus exclusively on penalties (Denmark, Hungary) or rewards (Belgium, Spain). Austria, Greece, Luxembourg and Romania are considering implementing a regulation of continuity of supply on system level. The incentive schemes are often based on benchmarking or on network operator's historical level of actual continuity of supply.

Finding 6
Incentive schemes for individual continuity levels are used in many countries and have different formulations.

Compensation schemes at single-user level are applied in more than half of the countries. The schemes mostly correspond to reimbursement of customers based on duration of individual long interruptions (planned or unplanned), although total duration and total number of interruptions in a year are also used. The minimum outage duration necessary for compensation vary from 1 to 24 hours. This, as well as the level of compensation, differs not only by country but also by voltage level, connected capacity, type of customer (business or domestic) and even weather conditions. In most countries, exceptional events are included when considering the minimum guaranteed standards.

The level of compensation can be set as a percentage of yearly network tariffs (the Czech Republic, Finland, Sweden), determined through customer research (Great Britain), based on international comparison (Hungary, Italy), on estimated costs of interruptions (the Netherlands, Portugal, Romania, Slovenia) or on the cost of energy during the period of interruption (Poland).

RECOMMENDATION 1

EXPAND THE MONITORING OF CONTINUITY OF SUPPLY.

It is recommended to include incidents at all voltage levels in interruption statistics in all responding countries. Moreover, monitoring of short interruptions should be extended to those countries that currently monitor only long interruptions. Monitoring of transient interruptions could be introduced in as many countries as possible. A decision at national level is needed on automatic methods for determining the duration and number of affected users for incidents at LV. The costs of such a scheme should be considered in that decision.

RECOMMENDATION 2

HARMONISE CONTINUITY OF SUPPLY INDICATORS AND DATA COLLECTING PROCEDURES.

In order to enable easier comparison and benchmarking between countries, CEER recommends standardisation of data collecting procedures with a single scheme tied to the duration and frequency of long interruptions (SAIDI and SAIFI), the frequency of short interruptions (MAIFIE) and to ENS due to interruptions in transmission networks. Common rules for aggregation of short interruptions should be investigated and pursued by CEER, before more countries begin to use short interruption indicators. Common weighting methods should also be employed for easier comparison of indicators between countries.

CEER confirms its recommendation that any publication of continuity of supply data should include information on the interruptions that are excluded and included.

RECOMMENDATION 3

HARMONISE CALCULATION OF CONTINUITY OF SUPPLY INDICATORS.

In order to have comparable data, CEER recommends harmonising the methods of calculation such as aggregation rules and weighting of the continuity of supply indicators in use. In connection with this recommendation, there is a case study in Section 2.9.2 as an example of calculation of continuity indicators SAIDI and SAIFI with focus on complicated causes that usually happen in practice. At the same time it is very important to mention that the uniformity of this methodology is significantly important mainly for grid operators (TSO and DSO) which log all details of each specific event or calculate the indicators.

RECOMMENDATION 4

ESTABLISH AND HARMONISE DEFINITION OF EXCEPTIONAL EVENTS.

CEER recommends establishing the definition of exceptional events in each country. Concurrently, it is also important to harmonise these definitions at the EU level in order to achieve comparable data. The characterisation of exceptional events is also essential for unbiased evaluation of continuity of supply indicators because it is assumed that extreme events, which would distort statistics, will be excluded. At the same time, this definition should eliminate the grid operators' responsibility, because they do not have any possibility to influence exceptional events.

RECOMMENDATION 5

IMPLEMENT AN INCENTIVE SCHEME FOR MAINTAINING OR IMPROVING GENERAL CONTINUITY LEVELS.

CEER recommends that NRAs implement adequate incentive schemes in order to maintain continuity of supply levels or improve them, if economically viable on both the distribution and the transmission levels.

CEER confirms its past recommendation that the results from cost-estimation studies on customer costs due to electricity interruptions are of key importance in order to be able to set proper incentives for continuity of supply.

RECOMMENDATION 6

IMPLEMENT COMPENSATION PAYMENTS FOR NETWORK USERS AFFECTED BY VERY LONG INTERRUPTIONS.

CEER recommends that the monitoring of interruptions is extended to a customer survey at single-user level to provide the basis for individual compensation schemes.

CEER recommends the standardisation of payments among the European countries. However, compensation payments should depend on the respective connection level.

2.9. CASE STUDIES

2.9.1. Case study: Incentive-based regulation of the quality of electricity supply in the Czech Republic

The following part describes the historical development of the regulation of the quality of electricity supply in the Czech Republic. The description is set out in the frame of "regulatory periods", i.e. predefined periods of time in which the principle of regulation in place is kept unchanging, with only certain parameters adjusted year-to-year.

In 2001, the Energy Regulatory Office (ERO) promulgated its first public notice [i.e. statutory instrument] on the quality of electricity supply. It specified the basic standards of the quality of electricity supply and related services. However, this public notice did not contain any repressive measures on the part of the NRA, which would have permitted to penalise the breach of the standards. Due to the insufficient empowerment in the Energy Act, the issue of the quality of electricity supply was not addressed any further during the first regulatory period (2002-2004).

In the second regulatory period (2005-2009), ERO promulgated a new public notice, number 540/2005 on the quality of electricity supply and related services in the electricity industry, which introduced standards defining levels of quality that had to be kept in each individual case, i.e., it laid down the minimum level of quality for each of the customers. It also laid down the amounts of compensation for breach of the required standards, the time limits for claiming such compensation, and the procedures for reporting on the keeping of the quality of supply and services. No other requirements for quality were introduced in the second regulatory period.

During the third regulatory period (2010-2015), incentive-based quality regulation was introduced in the Czech Republic; its purpose was to set the required level of the quality of provided services in relation to the price of the services. The purpose of this mechanism was to improve the quality of electricity supply throughout the system, or in each of the distribution systems, unlike the quality public notice that had primarily focused on each individual customer. The formula for calculating allowed revenues was extended to include a term adjusting the value of allowed revenues by a penalty or bonus for the quality level achieved. At the beginning of the third regulatory period, a sufficiently long time series of continuity indicators was not available in the Czech Republic, and the incentive-based quality regulation was therefore only implemented in practice as of 2013.

For the fourth regulatory period (2016-2018), ERO maintains in place a combination of the above mentioned regulatory mechanisms, i.e. the public notice (standards) and incentive-based regulation. In the case of incentive-based quality regulation there is a difference compared with the preceding regulatory period, in that some new features have been introduced on the basis of the experience gained with the implementation of incentive-based regulation. The purpose is a gradual improvement in the quality of electricity supply, specifically reductions in the number and duration of long interruptions in electricity distribution, both unplanned and planned ones. More details about the mechanism of incentive-based quality regulation for the fourth regulatory period are contained in the following text.

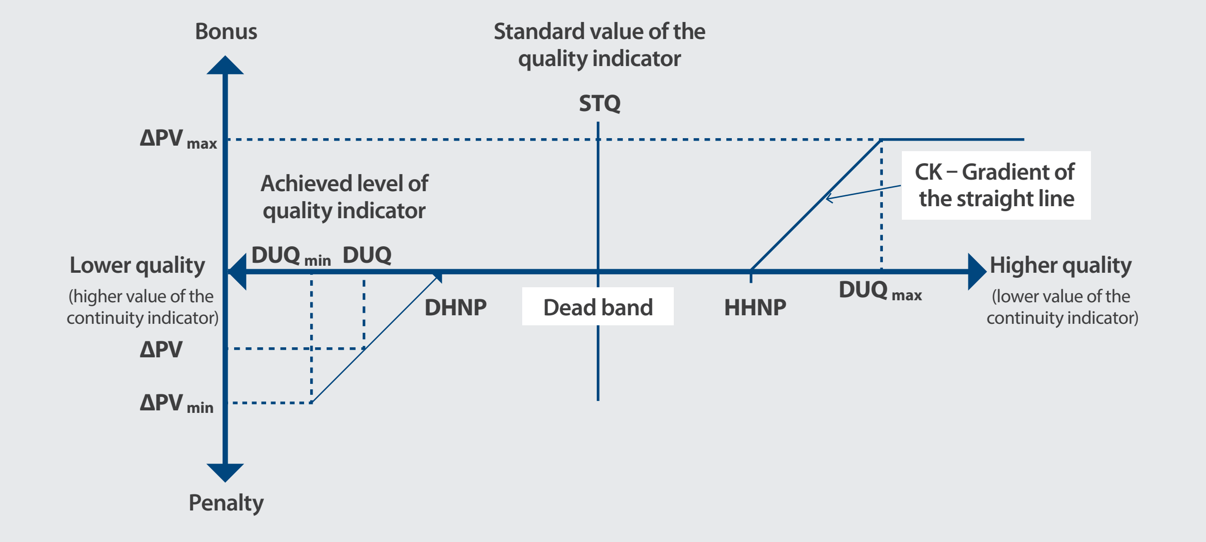
Mechanism of incentive-based quality regulation in the Czech Republic

The Czech Republic's incentive-based quality regulation applies only to electricity distribution. In the Czech Republic, only one company provides electricity transmission and ERO does not regard the quality of electricity in the transmission system problematic, because only a few interruptions per year occur. Electricity transmission is therefore presently not subject to incentive-based regulation.

The quality of network services in distribution is evaluated using a combination of SAIFI and SAIDI (continuity indicators). The calculation of the continuity indicators is set out in quality public notice number 540/2005.

Individual parameters of the quality indicator are set for each of the regional distribution system operators. The required values of SAIFIQ and SAIDIQ are "whole-system" indices, i.e. indices for the respective system operator's entire distribution system without differentiating between voltage levels. The amount of the penalty or bonus for the quality level achieved in electricity distribution is calculated on the basis of the achieved values of the continuity indicators in electricity distribution as against the required values set by the ERO. Together with the required quality parameters, upper and lower limits are set, beyond which the maximum value of the bonus or penalty are applied. A "dead band" is also used, within which no bonuses or penalties are applied. This feature helps to partly eliminate the probable year-to-year fluctuations in the achieved values of continuity indicators. The mechanism of incentive-based quality regulation is shown in the following diagram.

FIGURE 2.21 INCENTIVE-BASED QUALITY REGULATION DIAGRAM



Where:

ΔPV_t	bonus/penalty for the quality achieved, expressed in financial terms
t	order number of the regulated year
DUQ	the achieved value of the quality indicator in the period relevant for assessing service quality for the respective year of the regulatory period
CK	unit price of quality
ΔPV_{max}	maximum bonus for service quality achieved
ΔPV_{min}	maximum penalty for service quality achieved
DHNP	lower limit of the dead band
HHNP	upper limit of the dead band
STQ	the required value of the quality indicator ($SAIDI_Q$ and $SAIFI_Q$)
DUQ_{max}	limit value of the quality indicator, from which the maximum bonus for achieved service quality is applied
DUQ_{min}	limit value of the quality indicator, from which the maximum penalty for achieved service quality is applied

New features of incentive-based quality regulation for the fourth regulatory period

1 Clear-cut definition of the input indicators:

Incentive-based quality regulation only includes such events in the calculation of $SAIFI_Q$ and $SAIDI_Q$, which are within the system operator's control. This principle was also applied in the third regulatory period but it was not set out in the relevant methodology. Due to this fact, the calculation of continuity indicators includes only the following interruption categories under Annex 4 to public notice number 540/2005:

- Unplanned failure-related interruptions in electricity distribution caused by failures originating in the installations of the system operator's distribution system or in the operation thereof under usual weather conditions; and
- Planned interruptions in electricity distribution.

On the other hand, the following interruption categories are not included in the calculation of $SAIFI_Q$ and $SAIDI_Q$:

- Unplanned failure-related interruptions in electricity distribution caused by failures originating in the installations of the system operator's distribution system or in the operation thereof under unfavourable weather conditions;
- Unplanned failure-related interruptions in electricity distribution caused by third-party interference or action;
- Forced unplanned interruptions in electricity distribution (during imminent danger of one's life, health or property and during liquidation of these states);
- Extraordinary unplanned interruptions in electricity distribution (during emergency states or prevention of emergency states); and
- Unplanned interruptions in electricity distribution caused by events outside the system operator's system and at the generator.

2 Setting the required values for the whole regulatory period:

Since the development and extensive refurbishments of distribution systems are time and cost intensive activities that have to be planned for a long time in advance, setting the required targets for a longer period of time, i.e. determining the achievable level of the quality of electricity supply is necessary for incentive-based quality regulation to work. This step makes it possible for the particular companies to make, well in advance, the necessary preparations for implementing the measures that will help to improve electricity supply quality parameters. For this reason, the required values of $SAIFI_Q$ and $SAIDI_Q$ are set for the whole regulatory period. In the third regulatory period, the required values were set every year.

A new feature is the fact that for the fourth regulatory period, the required values of continuity indicators have been set on the basis of an analysis of the relationship between the possible measures for reducing continuity indicators and the costs spent by the particular distribution system operators. The purpose of this analysis was to identify the relationship between costs and quality on an individual basis for each of the distribution system operators. Specifically, it was based on the calculation (simulation) of reliability using real data for selected distribution network feeders. The principle of the analysis is described in a paper delivered at the CIRED 2015 conference in Lyon (Paper 1078).

3 Implementing a two-year moving average:

Another new feature implemented beginning the fourth regulatory period is the two-year moving average. The feature has been introduced in order to smooth out the year-to-year changes in continuity indicators even more. Values of $SAIFI_Q$ and $SAIDI_Q$ for individual years will no longer enter the calculation of the quality factor Q; their average values for the last 2 years will be used instead.

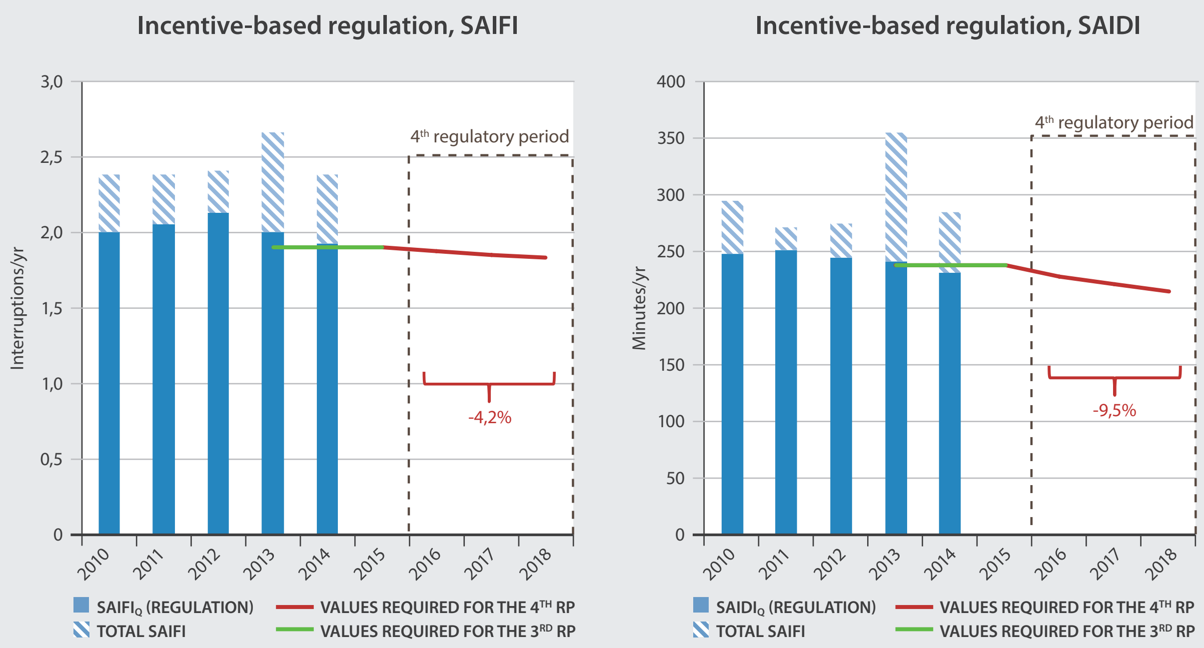
When two-year moving averages are used, attention must be paid to the way of setting the required values of continuity indicators. Should the year-to-year tightening of the indices (in percentage terms) be higher than half of the dead band (the band within which the bonus and penalty are zero) the principle of moving average would work as another tightening feature. This undesirable effect might cause considerable complications for the utilities in achieving the required values.

Quality indicator parameters set for the fourth regulatory period

The purpose of incentive-based quality regulation is to provide sufficient incentives to distribution system operators to improve the quality of electricity supply for final customers. For the fourth regulatory period, the ERO also wanted to accentuate quality within the entire regulatory mechanism. The ERO has therefore increased the maximum amount of the bonuses/penalties from ±3% (in the third regulatory period) to ±4% of the utility's profit. The limits of the dead band have been set as in the preceding years, i.e. at ±5% of the required value, and the value of the maximum bonus/penalty has been set at ±15% of the required value. In the case of the distribution company that operates the system in the country's capital (Prague), different values have been set (±10% and ±25% respectively) due to the different nature of its networks compared with other utilities in the Czech Republic (a small number of interruptions with heavy impacts on overall indicators).

The specific required values of $SAIFI_Q$ and $SAIDI_Q$ (STQ) have been set individually for each distribution company on the basis of an analysis of the relationship between quality and costs that was made for each company. The following charts show the reflection of required values of $SAIFI_Q$ and $SAIDI_Q$ for each of the distribution company on the level of the whole Czech Republic for the 3rd and 4th regulatory periods (calculation is made on the basis of the STQ values and the number of customers of each distribution company).

FIGURE 2.22 REQUIRED VALUES OF CONTINUITY INDICATORS



2.9.2. Case study: Examples of calculation of SAIFI, SAIDI continuity indicators in distribution systems in the Czech Republic

The following chapter provides examples of calculation of basic continuity indicators (SAIFI, SAIDI) in distribution systems, as it became apparent that the approach to continuity indicators calculation might be different in individual countries. Simultaneously, it is important to realise that different approach (or perception) may occur even among individual operators of distribution systems who are responsible (in many countries) for calculation of indicators or for reporting data necessary for such calculation. Nevertheless, the unification calculation method is the key prerequisite for further analyses or for comparison of individual companies or states. For these reasons this chapter intends to present instruction for calculation of basic continuity indicators (SAIFI, SAIDI) on the selected model example.

Model example of calculation

The presented example describes the procedure for calculation of the SAIDI, SAIFI indicators in more complicated cases where the operation steps during failure localisation usually interrupt electricity distribution to different groups of customers in the system for the period exceeding 3 minutes. At the same time, we have to emphasise that the example aims to facilitate unified understanding of indicators calculation and is not intended as a means for comparing advantages brought by different types of switching elements.

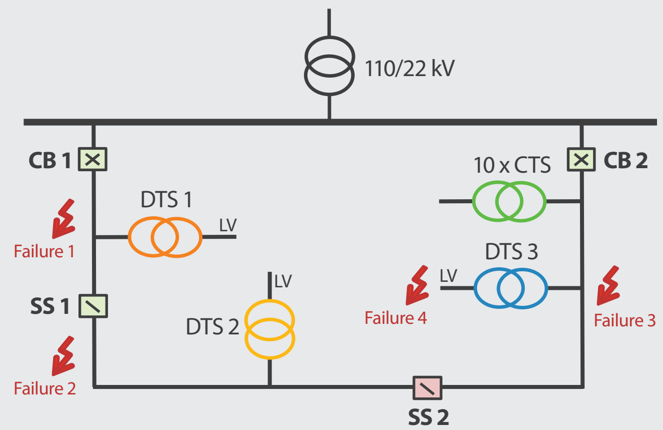
The model example encompasses 4 different failures in different parts of a distribution system. To allow for presenting calculation of not only the system indicators but also the voltage level indicators, the customers are connected to the LV – low voltage and MV – medium voltage levels. At the same time, the stated transformer stations (TS) are not interconnected on the LV side, hence the substitute feeding cannot be provided through operation on the LV level (utilised mainly in urban cable networks).

The example is provided for 2 alternatives of switching elements in the line (section switch and remotely controlled section switch). It is presumed that the first dispatcher's operation could not be executed in less than 3 minutes, regardless of the switching element type. We anticipate that the operations done by dispatcher in order to reconfigure the system into the pre-failure state would be finalised within 3 minutes, as in such case the dispatcher is ready for these operation steps and can carry them out in immediate sequence. Although in real operation the remotely controlled section switches can be used for operation also when the line is energised the operations within the example are considered only for no voltage state, i.e. after the feeder circuit-breaker was switched off.

To illustrate this point, individual alternatives are supplemented with graphical courses of interruption evaluation, including the method for detecting the failure location. Only the long- term interruptions, i.e. with the duration exceeding 3 minutes are used for calculation of the SAIFI, SAIDI indicators. The hatched areas of these courses are not included into the calculation, as their duration is shorter or equal to 3 minutes. Such interruptions would be potentially used for calculation of indicators that evaluate short-term interruptions (e.g. MAIFI), where the way of calculation applied would be similar to the one for SAIFI indicator.

Alternative with section switch (SS)

FIGURE 2.23 DISTRIBUTION SYSTEM DIAGRAM



Distribution transformer station (DTS)
Customer transformer station (CTS)

DTS 1 = 150 customers at LV
DTS 2 = 50 customers at LV
DTS 3 = 100 customers at LV
10 x CTS = 10 customers at MV

$N_{SLV} = 150 + 50 + 100 = 300$
$N_{SMV} = 10$
$N_S = N_{SLV} + N_{SMV} = 310$

CB – power circuit-breaker
SS – section switch

Switched on
Switched off

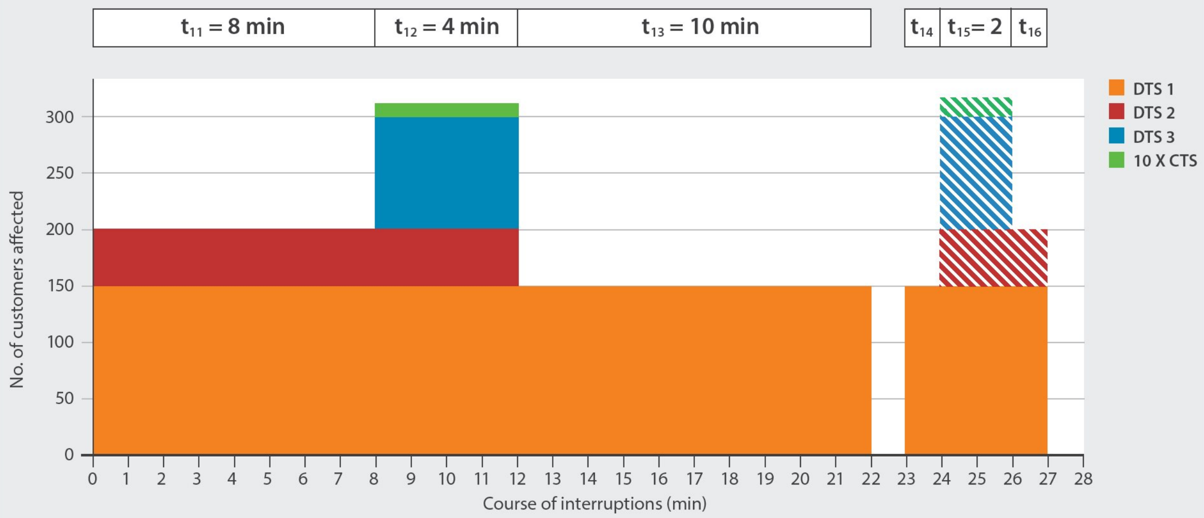
Failure 1

Course of operations in case of failure 1

TABLE 2.17 COURSE OF OPERATIONS IN CASE OF FAILURE 1

Process	Time elapsed from failure (min)
Triggering the CB 1 protection	t = 0
Switching off the SS 1, switching on the CB 1, triggering the CB 1 protection – detecting the location of failure	t = 6
Switching off the CB 2, switching on SS 2	t = 8
Switching on the CB 2 – partial restoration of supply	t = 12
Switching on the CB 1 – failure reparation finished	t = 22
Switching off the CB 1 – operations in order to reconfigure the system into the pre-failure state	t = 23
Switching off the CB 2, switching off the SS 2, switching on the SS 1	t = 24
Switching on the CB 2	t = 26
Switching on the CB 1	t = 27

FIGURE 2.24 GRAPHIC COURSE OF INTERRUPTIONS IN CASE OF FAILURE 1



Calculation of indicators

System indicators

$$SAIFI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j n_{jh}}{N_S} = \frac{n_{1LV} + n_{1MV}}{N_S} = \frac{(150+50+100)+(10)}{310} = 1 \; [1/\text{year}]$$

$$SAIDI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j t_{sj}}{N_S} = \frac{\sum_{h=(LV,MV,...)} \sum_j \sum_i t_{ji} \cdot n_{jhi}}{N_S} = \frac{t_{s1LV} + t_{s1MV}}{N_S} =$$

$$= \frac{(t_{11}.n_{1LV1} + t_{12}.n_{1LV2} + t_{13}.n_{1LV3} + t_{14}.n_{1LV4} + t_{15}.n_{1LV5} + t_{16}.n_{1LV6}) + (t_{12}.n_{1MV2})}{N_S} =$$

$$= \frac{[8 \cdot (150+50) + 4 \cdot (150+50+100) + 10 \cdot 150 + 1 \cdot 150 + 2 \cdot 150 + 1 \cdot 150] + [4 \cdot 10]}{310} = 15.94 \; [\text{min/year}]$$

Where:

h indicates the voltage level (low voltage = LV, medium voltage = MV,…),

j indicates the event (failure),

n_{jh} is the total number of customers directly fed from the voltage level *h*, who were affected by interruption of electricity distribution as a result of the *j* event,

t_{sj} is the total duration of all electricity distribution interruptions resulting from the *j* event at individual customers directly fed from the voltage level *h*, for whom the electricity distribution was interrupted,

t_{ji} is the duration of the *i* operation step within the *j* event,

n_{jhi} is the number of customers directly fed from the voltage *h*, who were affected by interruption of the electricity distribution in the given category in the *i* operation step of the *j* event,

i is the sequence number of the operation step within the *j* event.

Voltage level indicators

$$SAIFI_{LV} = \frac{\sum_j n_{jLV}}{N_{SLV}} = \frac{n_{1LV}}{N_{SLV}} = \frac{(150+50+100)}{300} = 1 \; [1/year]$$

$$SAIDI_{LV} = \frac{\sum_j t_{sj}}{N_{SLV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jLVi}}{N_{SLV}} = \frac{t_{s1LV}}{N_{SLV}} = \frac{(t_{11}.n_{1LV1} + t_{12}.n_{1LV2} + t_{13}.n_{1LV3} + t_{14}.n_{1LV4} + t_{15}.n_{1LV5} + t_{16}.n_{1LV6})}{N_{SLV}} =$$

$$= \frac{8 \cdot (150+50) + 4 \cdot (150+50+100) + 10 \cdot 150 + 1 \cdot 150 + 2 \cdot 150 + 1 \cdot 150}{300} = 16.33 \; [min/year]$$

$$SAIFI_{MV} = \frac{\sum_j n_{jMV}}{N_{SMV}} = \frac{n_{1MV}}{N_{SMV}} = \frac{10}{10} = 1 \; [1/year]$$

$$SAIDI_{MV} = \frac{\sum_j t_{sj}}{N_{SMV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jMVi}}{N_{SMV}} = \frac{t_{s1MV}}{N_{SMV}} = \frac{t_{12}.n_{1MV2}}{N_{SMV}} = \frac{4 \cdot 10}{10} = 4 \; [min/year]$$

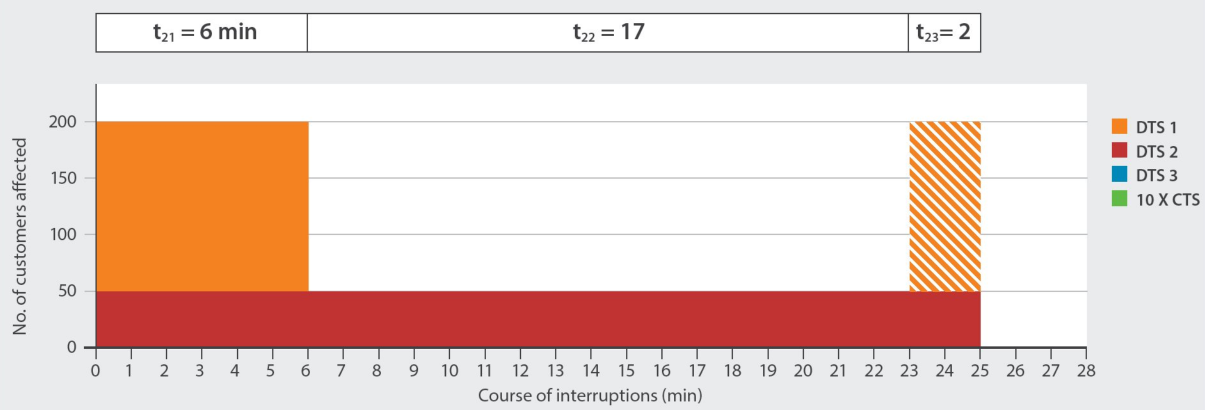
Failure 2

Course of operations in case of failure 2

TABLE 2.18 COURSE OF OPERATIONS IN CASE OF FAILURE 2

Process	Time elapsed from failure (min)
Triggering the CB 1 protection	t = 0
Switching off SS 1, switching on CB 1 – **detecting the location of failure**	t = 6
Switching off CB 1, switching on SS 1 – **operations in order to reconfigure the system into the pre-failure state**	t = 23
Switching on the CB 1	t = 25

FIGURE 2.25 GRAPHIC COURSE OF INTERRUPTIONS IN CASE OF FAILURE 2



Calculation of indicators

System indicators

$$SAIFI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j n_{jh}}{N_S} = \frac{n_{2LV}}{N_S} = \frac{150+50}{310} = 0.65 \ [1/\text{year}]$$

$$SAIDI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j t_{sj}}{N_S} = \frac{\sum_{h=(LV,MV,...)} \sum_j \sum_i t_{ji} \cdot n_{jhi}}{N_S} = \frac{t_{s2LV}}{N_S} = \frac{t_{21}.n_{2LV1} + t_{22}.n_{2LV2} + t_{23}.n_{2LV3}}{N_S} =$$

$$= \frac{6 \cdot (150+50) + 17 \cdot 50 + 2 \cdot 50}{310} = 6.94 \ [\text{min/year}]$$

Voltage level indicators

$$SAIFI_{LV} = \frac{\sum_j n_{jLV}}{N_{SLV}} = \frac{n_{2LV}}{N_{SLV}} = \frac{150+50}{300} = 0.67 \ [1/\text{year}]$$

$$SAIDI_{LV} = \frac{\sum_j t_{sj}}{N_{SLV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jLVi}}{N_{SLV}} = \frac{t_{s2LV}}{N_{SLV}} = \frac{t_{21}.n_{2LV1} + t_{22}.n_{2LV2} + t_{23}.n_{2LV3}}{N_{SLV}} =$$

$$= \frac{6 \cdot (150+50) + 17 \cdot 50 + 2 \cdot 50}{300} = 7.17 \ [\text{min/year}]$$

Failure 3

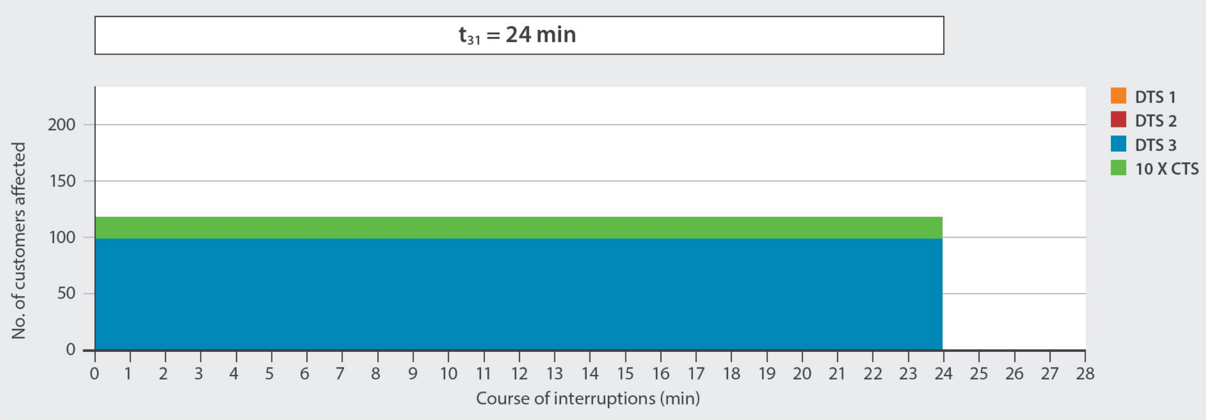
Course of operations in case of failure 3

TABLE 2.19 COURSE OF OPERATIONS IN CASE OF FAILURE 3

Process	Time elapsed from failure (min)
Triggering the CB 2 protection	t = 0
Switching on CB 2 – **failure reparation finished**	t = 24

Graphic course of interruptions in case of failure 3

FIGURE 2.26 GRAPHIC COURSE OF INTERRUPTIONS IN CASE OF FAILURE 3



Calculation of indicators

System indicators

$$SAIFI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j n_{jh}}{N_S} = \frac{n_{3LV} + n_{3MV}}{N_S} = \frac{100+10}{310} = 0.35 \; [1/\text{year}]$$

$$SAIDI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j t_{sj}}{N_S} = \frac{\sum_{h=(LV,MV,...)} \sum_j \sum_i t_{ji} \cdot n_{jhi}}{N_S} = \frac{t_{s3LV} + t_{s3MV}}{N_S} = \frac{t_{31} . n_{3LV1} + t_{31} . n_{3MV1}}{N_S} =$$
$$= \frac{24 \cdot 100 + 24 \cdot 10}{310} = 8.52 \; [\text{min/year}]$$

Voltage level indicators

$$SAIFI_{LV} = \frac{\sum_j n_{jLV}}{N_{SLV}} = \frac{n_{3LV}}{N_{SLV}} = \frac{100}{300} = 0.33 \; [1/\text{year}]$$

$$SAIDI_{LV} = \frac{\sum_j t_{sj}}{N_{SLV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jLVi}}{N_{SLV}} = \frac{t_{s3LV}}{N_{SLV}} = \frac{t_{31} . n_{3LV1}}{N_{SLV}} = \frac{24 \cdot 100}{300} = 8 \; [\text{min/year}]$$

$$SAIFI_{MV} = \frac{\sum_j n_{jMV}}{N_{SMV}} = \frac{n_{3MV}}{N_{SMV}} = \frac{10}{10} = 1 \; [1/\text{year}]$$

$$SAIDI_{MV} = \frac{\sum_j t_{sj}}{N_{SMV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jMVi}}{N_{SMV}} = \frac{t_{s3MV}}{N_{SMV}} = \frac{t_{31} . n_{3MV1}}{N_{SMV}} = \frac{24 \cdot 10}{10} = 24 \; [\text{min/year}]$$

Failure 4

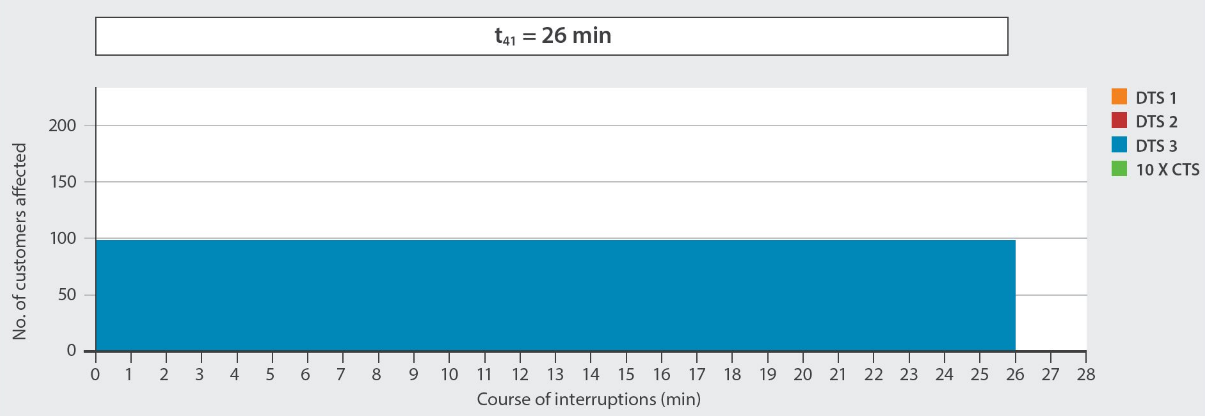
Course of operations in case of failure 4

TABLE 2.20 COURSE OF OPERATIONS IN CASE OF FAILURE 4

Process	Time elapsed from failure (min)
Triggering the DTS 3 protection	t = 0
Switching on the DTS 3 – **failure reparation finished**	t = 26

Graphic course of interruptions in case of failure 4

FIGURE 2.27 GRAPHIC COURSE OF INTERRUPTIONS IN CASE OF FAILURE 4



Calculation of indicators

System indicators

$$SAIFI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j n_{jh}}{N_S} = \frac{n_{4LV}}{N_S} = \frac{100}{310} = 0.32\ [1/\text{year}]$$

$$SAIDI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j t_{sj}}{N_S} = \frac{\sum_{h=(LV,MV,...)} \sum_j \sum_i t_{ji} \cdot n_{jhi}}{N_S} = \frac{t_{s4LV}}{N_S} = \frac{t_{41} \cdot n_{4LV1}}{N_S} = \frac{26 \cdot 100}{310} = 8.39\ [\text{min/year}]$$

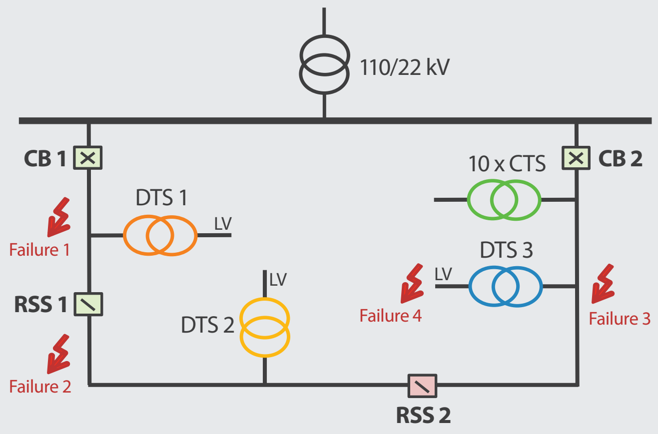
Voltage level indicators

$$SAIFI_{LV} = \frac{\sum_j n_{jLV}}{N_{SLV}} = \frac{n_{4LV}}{N_{SLV}} = \frac{100}{300} = 0.33\ [1/\text{year}]$$

$$SAIDI_{LV} = \frac{\sum_j t_{sj}}{N_{SLV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jLVi}}{N_{SLV}} = \frac{t_{s4LV}}{N_{SLV}} = \frac{t_{41} \cdot n_{4LV1}}{N_{SLV}} = \frac{26 \cdot 100}{300} = 8.67\ [\text{min/year}]$$

Alternative with remotely controlled section switch (RSS)

FIGURE 2.28 DISTRIBUTION SYSTEM DIAGRAM (WITH RSS)



Distribution transformer station (DTS)
Customer transformer station (CTS)

DTS 1 = 150 customers at LV
DTS 2 = 50 customers at LV
DTS 3 = 100 customers at LV
10 x CTS = 10 customers at MV

$N_{SLV} = 150 + 50 + 100 = 300$
$N_{SMV} = 10$
$N_S = N_{SLV} + N_{SMV} = 310$

CB – power circuit-breaker
RSS – remotely controlled section switch

Switched on
Switched off

Failure 1

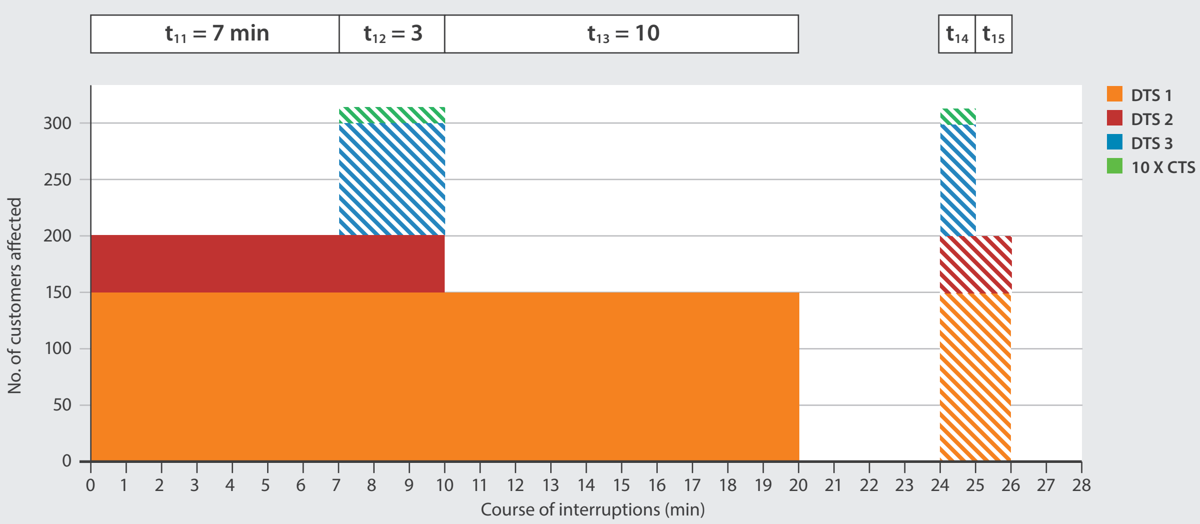
Course of operations in case of failure 1

TABLE 2.21 COURSE OF OPERATIONS IN CASE OF FAILURE 1 (WITH RSS)

Process	Time elapsed from failure (min)
Triggering the CB 1 protection	t = 0
Switching off RSS 1, switching on CB 1, triggering the CB 1 protection – **detecting the location of failure**	t = 4
Switching off CB 2, switching on RSS 2	t = 7
Switching on CB 2 – **partial restoration of supply**	t = 10
Switching on CB 1 – **failure reparation finished**	t = 20
Switching off CB 1, switching off CB 2, switching off RSS 2, switching on RSS 1 – **operations in order to reconfigure the system into the pre-failure state**	t = 24
Switching on CB 2	t = 25
Switching on CB 1	t = 26

Graphic course of interruptions in case of failure 1

FIGURE 2.29 GRAPHIC COURSE OF INTERRUPTIONS IN CASE OF FAILURE 1 (WITH RSS)



Calculation of indicators

System indicators

$$SAIFI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j n_{jh}}{N_S} = \frac{n_{1LV}}{N_S} = \frac{150+50}{310} = 0.65\ [1/\text{year}]$$

$$SAIDI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j t_{sj}}{N_S} = \frac{\sum_{h=(LV,MV,...)} \sum_j \sum_i t_{ji} \cdot n_{jhi}}{N_S} = \frac{t_{s1LV}}{N_S} = \frac{t_{11}.n_{1LV1} + t_{12}.n_{1LV2} + t_{13}.n_{1LV3}}{N_S} =$$

$$= \frac{7 \cdot (150+50) + 3 \cdot (150+50) + 10 \cdot 150}{310} = 11.29\ [\text{min/year}]$$

Voltage level indicators

$$SAIFI_{nn} = \frac{\sum_j n_{jLV}}{N_{SLV}} = \frac{n_{1LV}}{N_{SLV}} = \frac{(150+50)}{300} = 0.67\ [1/\text{year}]$$

$$SAIDI_{nn} = \frac{\sum_j t_{sj}}{N_{SLV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jLVi}}{N_{SLV}} = \frac{t_{s1LV}}{N_{SLV}} = \frac{t_{11}.n_{1LV1} + t_{12}.n_{1LV2} + t_{13}.n_{1LV3}}{N_{SLV}} =$$

$$= \frac{7 \cdot (150+50) + 3 \cdot (150+50) + 10 \cdot 150}{300} = 11.67\ [\text{min/year}]$$

Failure 2

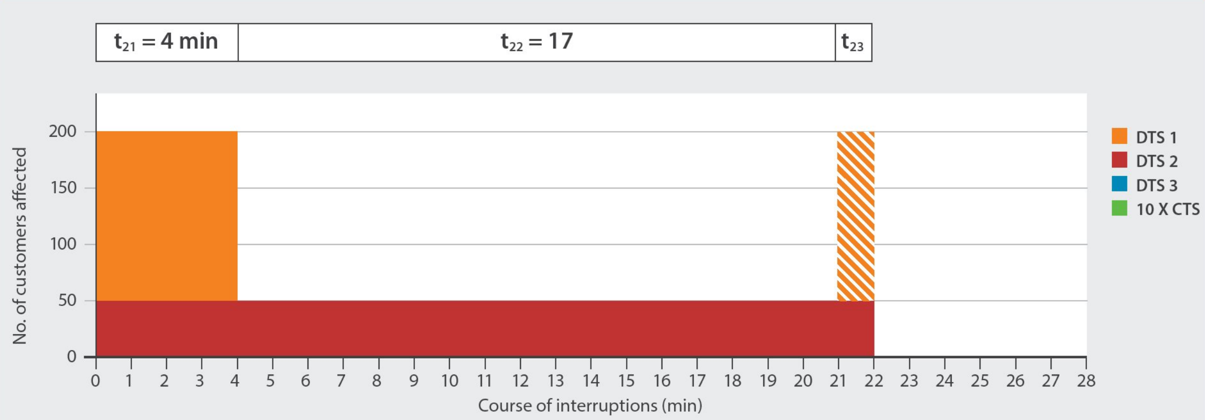
Course of operations in case of failure 2

TABLE 2.22 COURSE OF OPERATIONS IN CASE OF FAILURE 2 (WITH RSS)

Process	Time elapsed from failure (min)
Triggering the CB 1 protection	t = 0
Switching off RSS 1, switching on CB 1 – **detecting the location of failure**	t = 4
Switching off CB 1, switching on RSS 1 – **operations in order to reconfigure the system into the pre-failure state**	t = 21
Switching on CB 1	t = 22

Graphic course of interruptions in case of failure 2

FIGURE 2.30 GRAPHIC COURSE OF INTERRUPTIONS IN CASE OF FAILURE 2 (WITH RSS)



Calculation of indicators

System indicators

$$SAIFI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j n_{jh}}{N_S} = \frac{n_{2LV}}{N_S} = \frac{150+50}{310} = 0.65\ [1/\text{year}]$$

$$SAIDI_S = \frac{\sum_{h=(LV,MV,...)} \sum_j t_{sj}}{N_S} = \frac{\sum_{h=(LV,MV,...)} \sum_j \sum_i t_{ji} \cdot n_{jhi}}{N_S} = \frac{t_{s2LV}}{N_S} = \frac{t_{21}.n_{2LV1} + t_{22}.n_{2LV2} + t_{23}.n_{2LV3}}{N_S} =$$

$$= \frac{4 \cdot (150+50) + 17 \cdot 50 + 1 \cdot 50}{310} = 5.48\ [\text{min/year}]$$

Voltage level indicators

$$SAIFI_{LV} = \frac{\sum_j n_{jLV}}{N_{SLV}} = \frac{n_{2LV}}{N_{SLV}} = \frac{150+50}{300} = 0.67\ [1/\text{year}]$$

$$SAIDI_{LV} = \frac{\sum_j t_{sj}}{N_{SLV}} = \frac{\sum_j \sum_i t_{ji} \cdot n_{jLVi}}{N_{SLV}} = \frac{t_{s2LV}}{N_{SLV}} = \frac{t_{21}.n_{2LV1} + t_{22}.n_{2LV2} + t_{23}.n_{2LV3}}{N_{SLV}} =$$

$$= \frac{4 \cdot (150+50) + 17 \cdot 50 + 1 \cdot 50}{300} = 5.67\ [\text{min/year}]$$

Failure 3 and 4

Switching elements RSS 1 and RSS 2 applied in this alternative do not influence the course of interruptions in case of failures 3 and 4. For this reason the failures 3 and 4 have the same course as in the first alternative with section switches (SS).

2.9.3. Case study: Electricity continuity of supply indicators and monitoring in Algeria

General information

The Law 02-01 on electricity and gas distribution by pipeline, and its implementing provisions mandates the Regulation Commission for Electricity and Gas (CREG) to:

- Propose general and specific standards for the quality of supply and customer service as well as the control measures;
- Approve TSO's development plans and monitor their implementation. In these plans, the TSO is committed to improve the continuity of supply and set targets for the whole period;
- Monitor and evaluate the performance of the obligations of public service: Distribution of electricity is a public service activity which guarantees the supply of electricity, under the best conditions of safety, quality, price and compliance with technical and environmental requirements;
- Provide an opinion on the 5 year engagement of the distributor's performance improving plan, before approval by the Ministry of Energy. These plans cover aspects related to the quality and continuity of energy supply and in relationship with customers; and
- Set up the remuneration of distribution and transmission activities. The determination of remuneration should integrate the incentive mechanism aiming at cost reduction as well as the improvement of the quality of service.

In Algeria, transmission electricity network is operated by a single operator (GRTE) who is in charge of operation, maintenance and development of the network.

The transmission network is composed of an interconnected network in the north and an insulated network in the south part of the country.

The interconnected electricity network has an aerial predominance (99% of grid length). In 2014, the length of lines which are available in (400 kV, 220 kV and 60 kV) had reached 26,500 km and the number of substations was 390. The installed capacity has exceeded 51,160 MVA. In the same year, the number of industrial clients connected to the transmission grid was 110.

The insulated network included approximately 680 km of lines available in 220 kV and 7 substations EHV/MV. The installed capacity exceeded 500 MVA, for the same year.

The electricity distribution is also a regulated activity, nevertheless it is subjected to concession regime. There are 4 DSOs, each holding a number of concessions. In total, there are 48 electricity concessions.

DSOs are responsible for network management activities (building, operation, maintenance, development) and retail activity (notes, billing, and customer advice and handling complaints).

Distribution network operates at 10,000 V and 30,000 V, known as "MV networks", and at 400 V for 3-phase current and at 230 V for single-phase current, known as "LV network". In 2014, their cumulated length was about 291,000 km. The interface between MV networks and LV network is composed of more than 90,000 substations. The number of LV and MV customers has reached respectively 8,041,635 and 50,590 customers. The electricity consumption has reached 49.2 TWh.

Indicators and data collected for transmission & distribution grid

For transmission grid, 5 indicators are used by CREG for monitoring continuity of supply: number of incidents that occur on the transmission grid resulting in a loss of supply to end consumers, ENS, AIT, SAIDI and SAIFI. These indicators are calculated according to formulas as described in the 4th Benchmarking Report.

For the indicators SAIFI (number/year/customer) and SAIDI (min/year/customer), "customer" refers to industrial customer's substations and transformers HV/MV and EHV/MV (substations interface with distribution grid).

These indicators are collected separately for:

- Interconnected network and insulated network;
- National and regional interconnected network;
- By origin of interruption (distribution, transmission, generation, third party);
- With and without exceptional event;
- Planned and unplanned interruptions; and
- The number of incidents occurred on the transmission system which result in a loss of supply to end consumers is collected by cause (DSO, generation, cable rupture by third party, customer installation, weather conditions, human fault on operation, fault on lines or cables operated by the TSO, fault on TSO's substation).

For distribution grid, 2 main indicators are used by CREG for monitoring continuity of supply: SAIDI and SAIFI as described in the 4th Benchmarking Report, and "customer" refers to MV customer's substation and public distribution substations (MV/LV).

These indicators are collected for each concession, without exceptional event, separately for MV customers and public distribution substation (MV/LV), and determined separately for planned and unplanned interruptions. Only long interruptions (lasting more than 3 min), at MV level, attributable to distribution network are taken into account for indicators determination.

The reports on indicators' achievements are submitted to CREG on a quarterly basis. These reports specify achievements for each indicator according to guidelines document approved by CREG after consultation with the operator.

An annual report is submitted as well, stating the annual achievements of the indicators. This report contains information such as arguments regarding non-achievement of targets and list of all interruptions that occurred on the transmission grid following exceptional events and / or major events (ENS > 50 MWh) giving date, origin and impact (ENS).

On the basis of the received information, CREG performs and submits an annual report to the Minister of Energy. The report gives an overview of the achievement of the indicators in comparison to annual approved targets as well as CREG's opinion on the operator's performance.

CREG has also set up a database on the transmission and distribution grid indicators in order to compare performance at a regional level and provide information that can be used for incentive-based regulation and for investment decisions.

The following table gives an overview of the transmission grid's achievements for the period 2011-2014. These results include all long unplanned interruptions (>3 min), without exceptional events that fall under the responsibility of the TSO.

TABLE 2.23 VALUES OF INDICATORS IN ALGERIA

Indicator (unit)	2011	2012	2013	2014
SAIFI (number/year/customer)	1.82	2.3	1.8	1.4
SAIDI (min/year/customer)	81	77	59	45
AIT (min)	47	77	45	39

Future challenges

CREG expects to implement audit procedures to check data reliability and application of the indicators' determination guidelines.

The continuity data provided by the DSOs has to be improved on a global scale (including all interruptions sources).

2.9.4. Case study: Israel's network

General Overview

Israel's population is about 8 million people, residing on total area of about 21,000 km^2. Israel Electric Corporation is a governmentally owned, vertically integrated monopoly, regulated body, serving about 2.5 million consumers. Until early 2013, 98% of total energy consumed by electricity consumers, used to be manufactured by Israel Electric Corporation. Since early 2013 new large and small Independent Power Producers (IPPs) were introduced to the electricity market, reducing Israel Electric Corporation's market share in the production segment to about 75%. This course is due to continue until IPPs will produce about 40% of the annual national energy level.

IPPs can sell the energy they produce directly to the grid or through bilateral contracts mainly to large private consumers. Electricity and financial transactions are inspected and monitored by the System Operator, which is in charge of the electricity market. Currently the System Operator is a unit within Israel Electric Corporation and not an independent entity as it is the case in countries that underwent comprehensive electricity market reform.

At the end of 2014, Israel Electric Corporation held capacity of 13,617 MW and Independent Power Producers held additional 3,800 MW. Total Installed Capacity in Israel is hence, 17,417 MW. Production by Israel Electric Corporation is 51 TWh and 10 TWh by IPPs. Total energy consumption by Israel Electric Corporation's consumers is 49 TWh and 9 TWh by IPPs' consumers. In the summer of 2015 peak load reached 12,900 MW. Electricity market growing demand is about 2.5% annually. Israeli grid is an "Electricity Island", which means that no back up is available from surrounding countries.

In 2014, AIT in the production sector reached a level of 3 min/year while a 5-year average was 4.1 min/year. Residential Consumption in Israel is about 32% of total consumption. Industrial consumption is about 18% and commercial 32%.

Since the Israeli electricity market is partially competitive, the Public Utility Authority (PUA) defines most of the costs of produced electricity either ex ante or ex post.

The PUA was established by law enacted in 1996 and its 4 main roles are as follows:

1. Setting tariffs for all electricity sectors: production, transmission, distribution and supply (excluding bilateral agreements in the free market between IPPs and private consumers);
2. Setting regulation rules for regulated bodies;
3. Resolving conflicts between consumers/producers and regulated bodies; and
4. Issuing licenses to all players.

Currently, electricity sector reform is debated in Israel and negotiations between the government and the Israel Electric Corporation are still in place.

It should be noted that for historical reasons there are about 220 very small privately owned distribution entities mainly in the kibbutzim communities. Every such community is serving between 100-400 residential consumers and some industrial facilities. The reliability data shown below do not include these distributors. Currently, PUA is taking measures to regulate their activities.

It addition, consumers in East Jerusalem are being served by JDECO, a distribution company serving about 68,000 consumers with total energy consumption of 380 GWh. JDECO's reliability data are not included in this report. Finally, Israel is providing about 6% of its produced energy to the Palestinian Authority and the Gaza strip.

Transmission grid

Transmission grid consists of 3 different voltage levels: 400 kV with 741 km of circuit lines, 161 kV with about 4,594 km of circuit lines, and 115 kV with about 115 km of circuit lines. It should be noted that in the past 2 decades Israel Electric Corporation is slowly replacing the 115 kV grid with a 161 kV grid. The number of substations held by Israel Electric Corporation (public) is 151 units with total capacity of 16,847 MW. Private Substations of private large consumers are 45 with total capacity of 4,500 MW.

Reliability of the transmission grid

The following indicators are usually used in the Israeli system in order to monitor and regulate the transmission grid. These indicators are based on international practices:

AIT = 8,760 * 60 * *ENS / AD*

Where:
AIT Average Interruption Time
ENS Energy Not Supplied
AD Average Demand.

SAIDI – System Average Interruption Duration Index calculated as follows:

$$\bar{U} = \frac{\sum Installed\ Capacity\ Interrupted\ \text{X}\ Calculatd\ time\ of\ intrruption}{Total\ Installed\ Capacity\ in\ the\ system}$$

SAIFI – System Average Interruption Frequency Index, calculated as follows:

$$\lambda = \frac{\sum Installed\ Capacity\ Interrupted}{Total\ Installed\ Capacity\ in\ the\ system}$$

CAIDI – Customer Average Interruption Duration Index, calculated as follows:

$$r = \frac{\bar{U}}{\lambda}$$

Table 2.24 below provides data on long interruptions on transmission grid during 2014 as well as data about the number of cases that the grid failed to meet N-1 and N-2 criteria. Table 2.26 provides results of reliability standards such as AIT, frequency of interruptions and unsupplied minutes on the transmission grid. Table 2.25 presents the total system demand, ENS of the system and AIT.

TABLE 2.24 N-1 & N-2 CRITERIA & LONG INTERRUPTIONS ON TRANSMISSION GRID IN 2014

Index	Value	Five-year average	Comments
Number of cases that N-1 Criteria not met	10	7	
Number of cases that N-2 Criteria not met	1	2	
Number of long interruptions in 400 kV lines per 100 km	0	0	No ENS Impact
Number of long interruptions in 161 kV lines per 100 km	1,404	0,536	No ENS Impact
Number of long interruptions in 115 kV lines per 100 km	1,739	1,355	No ENS Impact
Number of long interruptions in 400 kV lines per 100 km	0,809	0,921	ENS Impact
Number of long interruptions in 161 kV lines per 100 km	0,602	1,566	ENS Impact
Number of long interruptions in 115 kV lines per 100 km	0,87	1,014	ENS Impact

TABLE 2.25 AIT, FREQUENCY INDEX (SAIFI) AND UNSUPPLIED MINUTES (SAIDI) IN THE TRANSMISSION GRID

System	115 kV		161 kV		Total	
	2014	5-year average	2014	5-year average	2014	5-year average
AD – average demand (GWh)	147	288	50.624	54.540	50.624	54.807
ENS (MWh)	1	14	68	115	435	598
AIT (min)	3,6	36,8	0,7	1,1	4,5	5,7

TABLE 2.26 RELIABILITY INDICATORS FOR TRANSMISSION GRID

Index	5-year average	Value
AIT for total transmission system	5.69	4.52
AIT for Israel Electric Corporation consumers	0.87	0.00
Frequency of interruptions 161 kV	0.09	0.00
Frequency of interruptions 115 kV	0.07	0.00
Minutes not supplied	0.02	0.00

MV distribution grid

MV distribution grid consists mostly voltage levels of 33 kV, 22 kV, 12 kV. The grid is controlled by Israel Electric Corporation. About 3,000 consumers are connected directly to MV lines. The rest of the consumers are connected via LV lines. Total length of MV lines is approximately 25,000 km. About 40% of them are installed underground. This is a result of a directive set by the Ministry of Energy in 2002 ordering Israel Electric Corporation to install all new distribution lines in urban areas underground. Reliability indices for MV lines are registered and calculated in 2 separate forms. The first form relates to MV lines that are mainly serving MV consumers and the second form relates to MV lines mainly serving LV consumers. The table below provides technical data for 2014 on the MV lines in both forms:

TABLE 2.27 TECHNICAL DATA OF MV LINES IN 2014

MV lines Serving mostly MV consumers	Total	OH	Mixed	UG
Number of Lines	449	45	146	258
Number of transformers	1,285	163	586	536
Installed capacity (MVA)	4,428	481	1,597	2,349
Length (km)	2,182.9	560.5	829.5	792.9
ENS (MWh)	2,850	858	1,513	479
MV lines Serving mostly LV consumers	**Total**	**OH**	**Mixed**	**UG**
Number of Lines	1,804	159	1,046	599
Number of transformers	46,422	5,888	33,220	7,314
Installed capacity (MVA)	28,031	3,010	19,628	5,391
Length (km)	24,226.6	5,251.9	15,934.5	3,040.2
ENS (MWh)	11,669	2,522	8,119	1,028

Reliability indicators for MV lines

Reliability standards such as SAIDI, SAIFI, are measured based on international standards. Tables 2.28 to 2.30 present reliability indices of SAIFI and SAIDI and short interruptions since 2006. It should be noted that short interruptions are defined in Israel as an interruption greater than 20 ms and shorter than 3 minutes.

TABLE 2.28 SAIDI OF MV LINES (MINUTES)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
MV lines serving mainly MV consumers	92,2	68,7	63,1	68,8	73,1	69,9	98,9	224,8	102,1
MV lines serving mainly LV consumers	178,7	133,5	123,6	121,3	144,9	132,2	171,6	234,3	159,4

TABLE 2.29 SAIFI OF MV LINES (NUMBER)

	2006	2007	2008	2009	2010	2011	2012	2013	2014
MV lines serving mainly MV consumers	1,7	1,2	1,2	1,3	1,8	1,7	1,9	2,4	1,8
MV lines serving mainly LV consumers	4,0	2,7	2,6	2,6	3,2	2,7	3,7	4,6	3,1

TABLE 2.30 SHORT INTERRUPTIONS PER 100 KM OF MV LINES

	2006	2007	2008	2009	2010	2011	2012	2013	2014
MV lines serving mainly MV consumers	156,5	162,2	137,1	61,9	96,3	71,5	101,2	65,8	66,0
MV lines serving mainly LV consumers	30,5	35,5	28,9	26,5	30,2	25,7	29,3	35,0	25,2

LV lines (supply)

LV lines consist of a total of 22,000 kilometres of which about 60% of them are installed underground. As mentioned above since 2002 Israel Electric Corporation is not allowed to install overhead lines in urban areas. Table 2.31 presents reliability data for 2011-2014. The average number minutes not supplied per consumer, average interruptions per consumer, average rehabilitation duration and the total consumers affected to the interruptions.

TABLE 2.31 LV GRID RELIABILITY IN 2010-2014

Year	Minutes Not Supplied (SAIDI) (Minutes)	Number of interruptions per consumer (SAIFI)	Average Rehabilitation Duration (CAIDI) (minutes)	Total number of interrupted consumers (for LV only)
2014	11,5	0,072	160	186.765
2013	33,7	0,132	255	336.580
2012	16,7	0,127	132	318.755
2011	11	0,086	129	213.675

Consumer compensation regulation for reliability of supply

In the following cases, a distributer must compensate the consumer with a sum of €0.5/kWh of estimated unsupplied energy due to a long interruption:

1. When an LV consumer experiences an interruption longer than:
   a. 24 hours on single interruption event.
   b. 48 hours of accumulated interruption vents over 1 year.
2. When an MV consumer experiences an interruption longer than:
   a. 20 hours in single event.
   b. 40 hours of accumulated interruption vents over 1 year.

It should be noted that for consumers connected to the transmission grid, the transmission owner must reach an agreement with individual HV consumers regarding acceptable level of interruptions during a year.

03

ELECTRICITY – VOLTAGE QUALITY

3.1. WHAT IS VOLTAGE QUALITY AND WHY IS IT IMPORTANT TO REGULATE IT

Voltage quality (VQ) covers a wide range of voltage disturbances and deviations in voltage magnitude or waveform from the optimum values. In this Benchmarking Report, voltage quality is used to refer to all disturbances in the supply of electricity, excluding interruptions that are covered in Chapter 2. Disturbances to voltage quality could occur as a consequence of the operation of the power grid and/or of units connected to the grid. Examples of voltage disturbances are supply voltage variations that, for instance, could accrue in case of large load changes at the costumer level; voltage dips that could be caused by short-circuits in the grid; or rapid voltage changes that could be caused by changes in production. We do not include details of frequency variations in this report as these are deemed to be mainly a system operation issue.

Everyone connected to the power grid could influence the quality of the voltage delivered at his/her own connection point or in other connection points throughout the power grid. Any voltage quality regulation must consider both the cost for specific customers as a result of equipment malfunctioning or damage and any direct or indirect increased cost of improving the grid, which could lead to increased tariffs for all customers. Whereas interruptions affect all network users, voltage disturbances do not affect all customers in the same way.

Voltage quality is becoming an increasingly important issue due to, among other things, the increasing susceptibility of end-user equipment and industrial installations to voltage disturbances. At the same time, increased emissions of voltage disturbances by end-user equipment could be predicted. This increase of emissions could be expected, amongst others, as a result of the use of energy-efficient equipment that could include rapid load switching. Future developments, such as growing amounts of distributed generation, could result in further increases in voltage disturbances.

3.2. MAIN CONCLUSIONS FROM CEER'S PREVIOUS WORK ON VOLTAGE QUALITY

The 1st and 2nd Benchmarking Reports on Quality of Electricity Supply [1] [2] devoted their attention to continuity of supply and commercial quality. CEER began addressing voltage quality in 2005, when preparing the 3rd Benchmarking Report [3]. In 2006, CEER cooperated on voltage quality with the European standardisation organisation CENELEC in order to revise the European standard EN 50160 [16], which gives an overview of all voltage quality disturbances and sets limits or indicative values for many of them[8].

The 3rd Benchmarking Report discussed how a good knowledge of actual voltage quality levels is a first step towards any kind of regulatory intervention. In 2005, there were on-going processes in many countries for voltage quality monitoring. In general, network users were entitled to get a verification of actual voltage quality levels at their point of connection. The recommendations from the 3rd Benchmarking Report were to exploit monitoring and publication of most critical voltage quality performances and do further research on power quality contracts.

In 2006, a handbook developed as a joint effort by CEER and the Florence School of Regulation on "Service quality regulation in electricity distribution and retail" [12] mapped the limited practices of voltage quality regulation into 4 regulatory instruments:

- Publication of data;
- Minimum requirements/standards;
- Reward-penalty schemes attached to standards; and
- The adoption of power quality contracts.

Before adopting any of these instruments, the handbook commented on the availability of reliable measurements as a very critical issue, especially in the area of voltage quality.

In 2008, the 4th Benchmarking Report [4] assessed the monitoring schemes for voltage quality in 11 countries. The report concluded that the monitoring programmes suffered from lack of harmonisation. Measurements by all available meters can provide important information on voltage deviations and can offer preliminary information for further measurements. The 4th Benchmarking Report recommended that countries should consider continuous monitoring of voltage quality, publish results and disseminate experiences. Furthermore, it was recommended that all countries should adopt the obligation for system operators to provide individual verification of voltage quality upon request by end-user, and that countries should investigate whether it is feasible to use smart meters for measuring voltage quality parameters in an efficient way.

In 2009, CEER in cooperation with Eurelectric organised a joint workshop on "Voltage Quality Monitoring", following the recommendation on disseminating experiences of voltage quality monitoring (VQM). The workshop concluded that there was a need for clear responsibility sharing between the relevant stakeholders, increased awareness and participation among network users, and for the relevant stakeholders to remain involved in international expert groups like those sponsored by International Council on Large Electric Systems (CIGRE) and International Conference and Exhibition on Electricity Distribution (CIRED).

8. In this chapter the term "standard" refers to a technical specification for repeated or continuous application, with which compliance is not compulsory, and which can be an international standard, a European standard, a harmonised standard on the basis of a request by the European Commission or a national standard. The rules for individual voltage parameters are usually referred to as "limits" or "requirements" when they relate to voltage quality (whereas they are normally called "standards" when relating to continuity of supply or commercial quality).

In 2010, CEER commissioned a consultancy report on "Estimation of Costs due to Electricity Interruptions and Voltage Disturbances", focusing on the problems and costs of voltage quality disturbances [13]. The consultancy report found that activity in this area was at different levels of development across European countries. Results from cost-estimation studies on customer costs due to voltage disturbances are important for determining the consequences of various voltage disturbances when deciding where to focus regulation. Following the consultancy report, CEER published "Guidelines of Good Practice on Estimation of Costs due to Voltage Quality Disturbances", and encouraged NRAs to perform nationwide cost-estimation studies on electricity interruptions and voltage disturbances.

In 2012, the 5th Benchmarking Report [5] focused on the improvements made to the new 2010 version of the EN 50160 standard. Some of the major changes to the standard were: a division of continuous phenomena and voltage events, improved definitions and standardisations of voltage dips and voltage swells. Description of additional changes and further recommendations for the EN 50160 standard were included in the report.

Key findings of the 5th Benchmarking Report on Quality of Electricity Supply:

- Voltage characteristics are regulated through EN 50160 in combination with stricter national requirements;
- Verification of actual voltage levels at individual connection points is guaranteed in most countries;
- Regulation of emission levels of network users varies across countries;
- Many countries have voltage quality monitoring systems;
- Differences exist between countries in the choice of monitored voltage quality parameters and in the reported voltage dip data; and
- Voltage quality data is publicly available in some European countries.

Recommendations of the 5th Benchmarking Report on Quality of Electricity Supply:

- Further improve EN 50160 as a harmonised instrument for voltage quality regulation, as it is expected that the need for proper regulation of voltage quality will increase with implementation of distributed generation;
- Perform cost-estimation studies of voltage disturbances, for a better input of where the regulation should focus;
- Ensure individual voltage quality verification in all countries, keep statistics on complaints and verification result, and if possible correlate these results with results from continuous monitoring programs; and
- Set reasonable emission limits for network users to maintain the voltage disturbance levels below the voltage quality requirements without excessive costs for other costumers.

In 2012, the CEER/ECRB report "Guidelines of Good Practice on the Implementation and Use of Voltage Quality Monitoring Systems for Regulatory Purposes" [14] was published. The GGP highlight several different applications and drivers for launching a voltage quality monitoring programme; see also the list in Chapter 3.6. A VQM is a useful tool for further understanding the relations between network properties and voltage disturbances and for verifying compliance. Moreover, a VQM programme facilitates the collection of data for benchmarking, education and for improving technical standards. Regarding the specific location for monitoring, the GGP recommend implementing VQM at all EHV/HV, EHV/MV, HV/MV substations and a selection of MV/LV substations. The GGP also recommend implementing VQM at connection points for EHV and HV customers and at other connection points where voltage disturbances may be expected. In LV networks VQM is recommended at a random selection of connection points. The GGP also suggest making the use of smart meters part of VCM in the future.

The main work of CEER on voltage quality is listed in Annex B.

3.3. STRUCTURE OF THE CHAPTER ON VOLTAGE QUALITY

This chapter first describes how voltage quality is regulated in Europe, the standards that apply for voltage quality and national rules, which differ from EN 50160. Second, the chapter looks at individual verification and information of voltage quality at the customer's connection point, as well as emission limits of voltage disturbances. Third, data and description of voltage monitoring systems are presented; including publication of voltage quality data and voltage dip characteristics. A further section about awareness of voltage quality was introduced for the first time in this edition of the report, and at the end of the chapter a case study about voltage quality in Israel is presented. Actual data on voltage dips from 4 countries are presented in Annex B.

This chapter is based on data provided from the following 27 countries: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain and Sweden. It should be noted that not all countries have submitted answers to all questions.

3.4. HOW IS VOLTAGE QUALITY REGULATED

Voltage quality is the most technically complex part of quality of electricity supply. Measurement issues, the choice of appropriate indicators, and the setting of limits require detailed monitoring of every single disturbance. Moreover, multiple stakeholders determine the disturbance level and the consequences of high disturbance levels. This often makes it difficult to lay the responsibility with one particular stakeholder, whether it is the network operator or one of the connected end-users. For this reason, voltage quality regulation must consider both the cost for customers as a result of equipment malfunctioning or damage and any direct or indirect increase in tariffs due to improvements made in the grid.

3.4.1. Responsibilities for regulation of voltage quality

The impact of different types of voltage disturbances can vary for different individual users. Whereas there is a need for harmonisation as regards the limits on voltage disturbances (as end-user equipment is the same throughout Europe), the emphasis on regulation is likely to be different between European countries.

In Table 3.1, the responsibility of voltage quality regulation is presented for each reporting country. About half of the responding NRAs have powers/duties to define voltage quality regulation alone or together with other competent authorities. The exact duties and powers the NRA has in voltage quality regulation would influence the role that different NRAs take in regulation of power quality, as well as in awareness and education. For most countries, the power for regulating voltage quality is within the ministry, delegated to the NRA from the ministry, or given to the industry or authorities for national standardisation with approval procedures from the NRA.

TABLE 3.1 RESPONSIBILITY FOR VOLTAGE QUALITY REGULATION

Country	Does the NRA have exclusive powers/duties to define voltage quality regulation?	Does the NRA have powers/duties to define voltage quality regulation together with other competent authorities?		Has the NRA issued regulatory orders regarding voltage quality?	Has the NRA issued public consultations regarding voltage quality?
Austria	Yes	No		Yes	No
Belgium	No	No		No	No
Bulgaria	Yes	No		Yes	Yes
Czech Republic	Yes	Yes	NRA has partially powers/duties delegated from Ministry of Energy and Trade.		
Denmark	No	No		Yes	Yes
Estonia	No	No		No	No
Finland	No	No		No	No
France	Yes	Yes	NRA has partially powers/duties delegated from Ministry.	No	No
Germany	No	No			
Great Britain	No	No	Department of Energy and Climate Change has the powers.IDEM !!!	Yes	Yes
Greece	Yes	Yes	Ministry for Environment, Energy and Climate Change.	No	No
Hungary	Yes	No			
Iceland	No	Yes	Ministry.	Yes	Yes
Ireland	No	Yes	Industry. NRA approves codes and standards.		
Italy	Yes	No		No	Yes
Latvia	Yes	Yes	Ministry of Economics.	Yes	Yes
Lithuania	Yes	Yes		Yes	No
Luxembourg	Yes	No		No	No
Malta	No	Yes	Competent Authority for National Standards.	Yes	Yes
The Netherlands	Yes	No	Competition Authority.	No	No
Norway	Yes	Yes	NRA has powers/duties delegated from Ministry.	Yes	No
Poland	No	No	The Ministry of Economy has the powers.	No	Yes
Portugal	Yes	No			No
Slovak Republic	Yes	No		Yes	No
Slovenia	No	Yes	DSO, TSO.	Yes	Yes
Spain	No	No		No	No
Sweden	Yes	No		Yes	Yes

In Bulgaria, each distribution company carries out persistent monitoring and internal control of the voltage quality indicators, and provides the results to the NRA, the State Energy and Water Regulatory Commission (SEWRC), each year or at its request. When the target quality indicators are not fulfilled, SEWRC adjusts the revenue requirements of the companies through a pricing methodology. Procedurally this takes place within a public discussion.

In the Czech Republic, the NRA has the powers to define voltage quality regulations partially with the Ministry of Industry and Trade, which delegates to the NRA powers via the Energy Act. The NRA issues public consultations regarding voltage quality in the process of issue or amendment of the public notice on the quality of electricity supplies and other services in the electricity industry.

In France, the NRA, Commission de Régulation de l'Energie (CRE), gives advice on decrees and technical texts including those dealing with voltage quality. CRE does not have competence for approving or defining the standards regarding voltage quality. The ministries define these standards. However, since 2008 CRE approves the models for transport grid access contracts, including the voltage quality commitments. During the approval process of the model of access contract for consumer users connected to transport grid, CRE issues public consultations including on voltage quality, and specifically on voltage dips. The models for distribution grid access contracts are notified to CRE, but not approved. The Standing Committee for disputes and sanctions (CoRDiS) was created by the French law passed on 2 December 2006 in relation to the energy sector. CoRDiS is competent regarding disputes between an end-user and TSO or DSO on voltage quality, interpretation of access to the grid contracts signed by the end-users and the system operators and enforcement of access to the grid contracts.

In Great Britain, the Department of Energy and Climate Change has the powers and duties to define voltage quality regulation. As part of the recent distribution price control review the NRA conducted customer research on "Expectation of DNOs and willingness to pay for improvements in service".

In Greece, the NRA has the powers and duties to define voltage quality regulation together with the Ministry for Environment, Energy and Climate Change. The NRA has issued public consultations regarding voltage quality regulation instruments, minimum quality standards, overall quality standards, incentive regulation and premium quality contracts.

In Hungary, the NRA has issued a guidance regarding voltage quality monitoring.

In Iceland, European Standard EN 50160 Voltage Characteristics in Public Distribution Systems is stipulated in the government regulation.

In Ireland, the technical standards that the network utilities must comply with are detailed in the network utilities' codes and planning standards. Industry members sit on the review panels for the codes, and these panels review proposed modifications to the codes. The NRA has final approval on both the codes and planning standards.

In Italy, the NRA has only exclusive powers and duties. The NRA has issued public consultations regarding mainly implementation of VQM (EHV-HV-MV) including through smart meters (LV), voltage dips (MV), supply voltage variations (LV), individual verification of supply voltage variations (MV-LV) and expected levels of VQ (EHV-HV).

In Luxembourg, the NRA has issued public consultations on voltage quality criteria and monitoring methodologies.

In the Netherlands the NRA, the Netherlands Competition Authority (NMa), is solely responsible for defining voltage quality regulation. The process through which legislation is defined involves all electricity network operators drafting the legislation and, after consultation with affected parties, the NMa makes a decision upon the proposed legislation.

In Norway, the NRA has sole power to define voltage quality regulation within the legal framework provided by the Ministry of Petroleum and Energy.

In Portugal, a public consultation was issued before the publication, in 2013, of the new Quality of Service Code. This new code includes a chapter on voltage quality. The main changes in this topic referred to the adaption to version 2010 of the standard EN 50160.

In Sweden, the NRA has issued public consultations regarding regulatory orders of voltage quality.

3.4.2. Voltage quality standardisation (EN 50160)

The European standard EN 50160 gives an overview of all voltage quality disturbances and sets limits or indicative values for many of them. This document has become an important basis for voltage quality regulation throughout Europe. A further important contribution came in the form of the standard on power quality measurements, EN 61000-4-30 [15] which has resulted in common methods for VQM.

The 2010 version of the standard EN 50160 had been translated and applied in 24 countries. In 4 countries, Cyprus, Hungary, Romania and the Slovak Republic, the 2007 version of the standard is still in force.

In most European countries (17), the application of the standard is defined in the regulation codes. In 8 countries there are references to the EN 50160 standard in national legislation. In the case of Romania and Estonia, the standard is implemented on a voluntary basis. In Spain, although a description of the standard is published in the

Royal Decree, it is implemented on a voluntary basis. In the Czech Republic, a reference to the translated version of the standard exists in the Transmission and Distribution codes. In France, there is a national decree dealing with Transmission network granting specifications that requires the TSO to guarantee sufficient voltage quality to allow DSOs to fulfil the EN 50160 standard. It also states that the TSO shall make precise contractual commitments on 4 indicators of voltage quality: (slow) supply voltage variations, flicker, power frequency and voltage unbalance.

The limits set by EN 50160 for voltage disturbances are presented in Table 3.2. In the case of supply voltage variations, limits are set only for LV and MV networks.

TABLE 3.2 STANDARD EN 50160 – SUMMARY FOR CONTINUOUS PHENOMENA

Voltage disturbance	Voltage level	Voltage quality index (limit)
Supply voltage variations	LV	• 95% of the 10 minute mean r.m.s values for 1 week (± 10% of nominal voltage)
		• 100% of the 10 minute mean r.m.s values for 1 week (+ 10% / - 15% of nominal voltage)
	MV	• 99% of the 10 minute mean r.m.s values for 1 week below +10% of reference voltage and 99% of the 10 minute mean r.m.s values for 1 week above -10% of reference voltage
		• 100% of the 10 minute mean r.m.s values for 1 week (± 15% of reference voltage)
Flicker	LV, MV, HV	• 95% of the P_{lt} values for 1 week, should be less than or equal to 1
Unbalance	LV, MV, HV	• 95% of the 10 minute mean r.m.s values of the negative phase sequence component divided by the values of the positive sequence component for 1 week, should be within the range 0% to 2%
Harmonic voltage	LV, MV	• 95% of the 10 minute mean r.m.s values for 1 week lower than limits provided by means of a table
		• 100 % of the THD values for 1 week (£ 8%)
	HV	• 95% of the 10 minute mean r.m.s values for 1 week lower than limits provided by means of a table
Mains signalling voltages	LV, MV	• 99% of a day, the 3 second mean value of signal voltages less than limits presented in graphical format

3.4.3. National legislation and regulations that differ from EN 50160

Standard EN 50160 remains the basic instrument for voltage quality assessment in the reporting countries. However, in some countries, different requirements are implemented in national legislation. The reasons for the existence of such differences vary from country to country and are usually related to the fact that the 2010 version of the standard still does not cover extra high voltage levels and because stricter limits have been used at national level compared to those established by the standard.

France reports that for HV networks limits are generally the same as in EN 50160 version 2010, but with time restriction of 100% (as opposed to 95% in EN 50160). In Great Britain, the Electricity Safety Quality and Continuity Regulations 2002 preceded EN 50160, and, since some voltage limits were narrower than EN 50160, they are still in force. A similar situation occurs in Ireland, where slow voltage variations range that applies for MV was set by the DSO long before EN 50160 was introduced. In Malta, there are differences in the tolerance limits for certain voltage quality characteristics between the Network Code and EN 50160. The Network Code is prepared by the DSO and approved by the NRA after stakeholder consultation.

In Netherlands, it is assumed that the voltage quality is better than in the standard EN 50160. Consequently, strict requirements were defined and some limits for voltage dips were implemented and others are currently under development. This was the case of the limits for voltage dips in high and extra high voltage networks, included in the Network Code in 2013. In the meantime, network operators submitted a proposal to update those limits, which is currently being assessed by the regulatory authority. Network operators are also working on limits for voltage dips in medium voltage networks. These regulations should take effect before the start of 2018.

Also in Norway it is assumed that the standard EN 50160 has some important and crucial weaknesses and hence is not satisfactorily usable for public regulation of quality of electricity supply in the Norwegian power system. The most important issues are that for several areas the standard only defines limits that apply for 95% of the time. Furthermore, it only defines limits to some of the quality parameters. For some of the parameters the standards only describe what can be expected in Europe. In the NRA's opinion it is not acceptable that in a modern society the electricity quality delivered to the grid customers lacks limit values for 8 hours every week for several important parameters.

In Sweden, the same definitions as in EN 50160 are used but the limits should not be exceeded for 100% of time. In addition, the NRA has introduced limits for voltage dips (see case study in the 5th Benchmarking Report [5]).

Countries with different requirements are presented in Table 3.3, Table 3.4 and Table 3.5. Voltage quality indicators different from the indicators used in EN 50160 are also shown in these tables. More details are given in Annex B.

TABLE 3.3 VOLTAGE QUALITY REGULATION DIFFERING FROM EN 50160 – SUPPLY VOLTAGE VARIATIONS

Voltage disturbances	Indicator	Integration period	Time	Limit	Country (voltage level)
Supply voltage variations	r.m.s. voltage	1 min	100%	±10% of U_N	SE (HV, MV, LV)
	r.m.s. voltage	1 min	100%	+10% / -6% of U_N	GB (LV)
	r.m.s. voltage	1 min	100%	±10% of U_N	NO (LV)
	r.m.s. voltage	10 min	100%	±5% of U_N	FR (MV) MT (MV) [11 kV]
	r.m.s. voltage	10 min	100%	±6% of U_N	MT (HV), GB (HV, MV)
	r.m.s. voltage	10 min	100%	+9% / -5% of U_N	IE (MV)
	r.m.s. voltage	10 min	100%	+5% / -10% of U_N	MT (MV) [3 kV]
	r.m.s. voltage	10 min	100%	±10% of U_N	FR (LV), MT (LV) GB (EHV)
	r.m.s. voltage	10 min	100%	+13.16% / -8.42% of U_N	IE (HV)
	r.m.s. voltage	10 min	100%	+10% / -15% of U_N	NL (MV, LV)
	r.m.s. voltage	10 min	99.9%	±10% of U_N	NL (EHV, HV)
	r.m.s. voltage	10 min	95%	±5% of U_N	PT (EHV)
	r.m.s. voltage	10 min	95%	±10% of U_N	NL (MV, LV)

(1): EHV is not covered by the EN 50160: 2010.
(2): For HV no supply voltage variations limits are given by the EN 50160: 2010.
(3): The measurement period for all the above requirements is 1 week.

TABLE 3.4 VOLTAGE QUALITY REGULATION DIFFERING FROM EN 50160 – OTHER VARIATIONS

Voltage disturbances	Indicator	Integration period	Time	Limit	Country (voltage level)
Flicker	Pl_t	-	100%	≤ 0.5	MT (MV, LV)
	P_{lt}	-	100%	≤ 0.8	NO (EHV, HV)
	P_{lt}	-	100%	≤ 1	NO (MV, LV), PT (EHV)
		-	100%	≤ 5	NL (EHV, HV)
	P_{lt}	-	95%	≤ 1	NL (EHV, HV)
		-	100%	≤ 0.7	MT (MV, LV)
	P_{st}	-	100%	≤ 1	PT (EHV)
	P_{st}	-	95%	≤ 1	NO (EHV, HV)
	P_{st}	-	95%	≤ 1.2	NO (MV, LV)
Voltage unbalance	V_{un}	10 min	100%	≤ 2%	NO (EHV, HV, MV, LV), SE (HV, MV, LV)
	V_{un}	10 min	100%	≤ 3%	NL (MV, LV)
	V_{un}	10 min	99.9%	≤ 1%	NL (EHV, HV)
	V_{un}	10 min	95%	≤ 2%	NL (MV, LV) PT (EHV)
	V_{un}	-	-	≤ 1.3%	MT (LV)

Voltage disturbances	Indicator	Integration period	Time	Limit	Country (voltage level)
Harmonic voltage	THD	-	-	≤ 1.5%	MT (MV) [33 kV]
	THD	-	-	≤ 2%	MT (MV) [11 kV]
	THD	-	-	≤ 2.5%	MT (LV)
	THD	10 min	100%	≤ 8%, 0,23 ≤ U ≤ 35 kV ≤ 3%, 35 ≤ U ≤ 245 kV < 2%, U > 245 kV	NO (EHV, HV, MV, LV)
	THD	10 min	99.9%	≤ 6%	NL (EHV)
	THD	10 min	99.9%	≤ 7%	NL (HV)
	THD	10 min	99.9%	≤ 12%	NL (MV)
	THD	10 min	95%	≤ 4%	PT (EHV)
	THD	10 min	95%	≤ 5%	NL (EHV)
	THD	10 min	95%	≤ 6%	NL (HV)
	THD	10 min	95%	≤ 8%	NL (MV)
	THD	1 week	100%	≤ 5%	NO (MV, LV)
	Individual	10 min	100%	Table	NO (HV, MV, LV)
	Individual	10 min	100%	Table (as in EN 50160)	SE (HV, MV, LV)
	Individual	10 min	95%	Table	PT (EHV)

(1): The measurement period for all the above requirements is 1 week.

TABLE 3.5 VOLTAGE QUALITY REGULATION DIFFERING FROM EN 50160 – EVENTS

Voltage disturbances	Indicator	Integration period	Time	Limit	Country (voltage level)
Voltage dips	The dip-table is divided in the 3 areas A, B and C. Dips with a duration and severity that puts them in area A is regarded a normal part of the operation of the network. Dips within area B need to be investigated and dips in area C are not allowed. The borders between the areas are slightly different for voltages above and below 45 kV. (see case study in the 5th Benchmarking Report).				SE (HV, MV, LV)
	A sudden reduction of the voltage to a value between 90% and 1% of the declared voltage followed by a voltage recovery after a short period of time.				MT (MV, LV)
Voltage swells	The swell-table is divided in the 3 areas A, B and C. Swells with a duration and severity that puts them in area A is regarded a normal part of the operation of the network. Swells within area B need to be investigated and swells in area C are not allowed. (see case study in the 5th Benchmarking Report).				SE (HV, MV, LV)
Single rapid voltage change	Number of voltage changes per 24 hours			$\Delta U_{steady\ state} \geq 3\%$: ≤ 24 0.23 ≤ U ≤ 35 kV ≤ 12 35 kV < U $\Delta U_{max} \geq 5\%$: ≤ 24 0.23 ≤ U ≤ 35 kV ≤ 12 35 kV < U	NO (HV, MV, LV)

3.5. VOLTAGE QUALITY AT CUSTOMER LEVEL

The 5th Benchmarking Report found that verification of actual voltage quality levels at individual connection points is guaranteed or a common practice in most countries, and the report recommended that this practice be adopted by all countries. Additionally, it was recommended that network operators should give detailed description of their practice so that all relevant information is available to the customer.

Another recommendation of the 5th Benchmarking Report is that the NRA or the network operator keep statistics on complaints and verification results and correlate these with the results from continuous voltage quality monitoring.

As mentioned in Section 3.2, the handbook developed jointly by CEER and the Florence School of Regulation in 2006 on "Service quality regulation in electricity distribution and retail" [12], lists power quality contracts as 1 out of 4 regulatory instruments. In the Czech Republic and Norway it is possible to arrange individual contracts regarding voltage quality, nevertheless these are not commonly used in practice. In Norway, if private agreements concerning quality of supply other than stipulated by the regulations are agreed upon, the TSO or DSOs shall provide an explicit account of the consequences this will have for the grid customer. It is however a premise that no other customers, who are not part of the contract, get poorer quality because of such a contract. In Latvia, the TSO has specified individual contracts. However, in several other countries there is no option of agreements or contracts to additional VQ guarantees in exchange of fees.

3.5.1. Individual information on voltage quality

In a few of the reporting countries, the network operators are obliged to inform customers about the actual voltage quality levels (in practice, the measured levels from the recent past). Table 3.6 shows an overview of the obligations for the DSO/TSO to present information to the costumers on request. The type of information provided will depend on the request. For description of the information provided to end-users in Slovenia and Norway, please see the case studies in the 5th Benchmarking Report.

TABLE 3.6 OBLIGATIONS FOR DSOs/TSOs TO INFORM END-USERS ABOUT THE PAST (OR EXPECTED FUTURE) VOLTAGE QUALITY LEVELS

	DSO	TSO	No obligation	Comment
Austria			X	
Belgium			X	No specific obligation but the DSO must do the necessary work to reach the standards.
Bulgaria			X	
Croatia			X	
Cyprus			X	
Czech republic			X	Only basic information on VQ – voltage level is common for new customers, new sensitive customers can ask for detailed information about voltage harmonics, dips/swells.
Denmark			X	
Estonia			X	
Finland			X	
France			X	There is no obligation, but there are optional service packages that include information about the past years.
Germany			X	
Great Britain			X	
Greece			X	
Hungary			X	
Ireland	X		X	The DSO must provide information upon request of a customer. The information is not defined in detail it would depend on the customer request. The TSO is not obliged to inform end-users about voltage quality levels.
Italy	X	X		Regarding EHV and HV end-users, TSO is obliged to publish/inform maximum and minimum short circuit power. Regarding MV end-users, DSO are obliged to inform about maximum levels of short circuit power. The communication of voltage dips to MV end-users will be from 2016.
Latvia			X	
Lithuania			X	Company before making a reconstruction inform their clients about the possible voltage quality disorders.

	DSO	TSO	No obligation	Comment
Luxembourg			X	
Malta	X			Network Code obliges the DSO to provide certain information on the local network conditions to end-users on request.
The Netherlands			X	If there is a measuring unit installed at a particular connection point, then that particular customer is entitled to information about the measured data.
Norway	X	X		At the request of a current or future network customer, the TSO/DSOs shall provide information within one month about voltage quality in their own installations.
Poland			X	
Portugal	X	X		The parameters established in the Quality of Service Code; Frequency; Supply voltage variations; Voltage unbalance; Flicker severity; Harmonic voltage; Voltage dips; Voltage swells.
Slovak republic			X	
Slovenia	X	X		DSO/TSO is obliged to provide the information on harmonized set of parameters for the past levels (annually).
Spain			X	
Sweden			X	Obligation is restricted to the continuity of supply issues.

3.5.2. Individual voltage quality verification

3.5.2.1 By costumer complaint

If a customer complains about the voltage quality at the costumer's connection point the DSO or TSO is, in several countries, obliged to perform measurements to verify the levels of all relevant voltage quality parameters.

The cost for performing voltage quality measurements upon receiving a complaint of the voltage quality is in general covered in 2 ways:

- The cost is borne by TSO/DSO (the Czech Republic, Estonia, Germany, Lithuania, Luxembourg, Norway); and
- The cost is borne by TSO/DSO if the quality does not conform to national legislation or EN 50160. The customer pays if the quality voltage level meets the standard, or when it is not justified (Belgium, Bulgaria, Latvia, Portugal).

Some countries allow for the end-user to install his/her own voltage quality recorder when results are to be used in a dispute between the end-user and the DSO/TSO. Several countries have specific regulations regarding the technical measurements of the voltage parameters for verification of the voltage quality itself, although it is not common for specific regulations of whether it is allowed for end-user to perform the measurements.

In several countries (Belgium, Finland, Hungary, Poland and Norway) the legislation allows cases where the end-user wants to install his/her own voltage quality recorder, as long as the installed device is approved by the DSO/TSO and/or both the end-user and the DSO/TSO agree upon the installation.

In Slovenia, the executive legislation does not explicitly regulate such cases, so it is possible and performed only on the basis of agreement between the end-user and the DSO/TSO, since the DSO/TSO has an exclusive responsibility to declare its voltage quality. The supervision of the voltage quality monitoring with the installed end-user's equipment in parallel is however possible and applied in some particular cases by some particular big and very sensitive customers. No conditions are defined for accepting the end-user's measurements. The results of the measurements performed by the end-user can be used as an indication of poor quality only. In the dispute, usually the independent expert would be assigned to perform the measurements for the reference.

In Italy, end-users of HV and MV can install their own voltage quality recorder, but there are no rules regarding the use of the measurements in disputes as this is up to the court to decide.

In Germany, the end-user can install his/her own voltage quality recorder in his/her electrical customer installation, but illegal reactions of the system on the network must be excluded. To ensure this, the customer installation is to be allowed to construct, advance, modify and maintain only by the Low Voltage Access Regulation, by other applicable statutory provisions and governmental regulations plus by the generally accepted rules of technology. These operations must be carried out by the network operator or an installation company registered with the network operator. Whether the data can be used in a dispute between the end-user and the DSO/TSO, must be decided by a civil court.

In Latvia, end-users certified to make voltage quality measurements can install their own voltage quality recorder, or the end-user can ask other companies to make such measurements if those companies are certified to do such services.

In Lithuania, end-users must provide a measuring accuracy certificate for the voltage quality recorder for the measurements to be accepted in disputes with the DSO. The certificate must be issued by a testing laboratory from Lithuania. The testing laboratory must at the same time be accredited according to ISO/IEC 17025 to carry out meter testing. However, up to this date, the DSO in Lithuania has not had any cases where the end-user has used data from certified own voltage quality meter as a proof in disputes.

In Portugal, according to the Quality of Service Code, the results of measurement are accepted in a dispute if the recorder has been calibrated and locked. However, it is under discussion which entity has the ability to verify if the monitoring device is calibrated and locked.

Monetary penalties applied to grid operator customer compensations with respect to individual voltage quality issues were described in the 5th Benchmarking Report.

3.5.2.2 On request by costumer

In some countries, if a customer wants to monitor voltage quality at his/her own connection point, the DSO/TSO is compelled to provide a voltage quality monitor. For the rest of the reporting countries, it appears that VQM is performed even if the DSO/TSO is not legally obliged to do so. In situations not referring to complaints on the general voltage quality, the end-user usually pays for this measurement. Most commonly there is no pre-defined payment for this service. In Malta, as an exception, a voltage quality recorder provided by the DSO is free of charge.

In France, the customer may subscribe to an optional service package (€2,000 a year on the transmission network and from €270 to several thousand depending on the type of monitoring on the distribution network) including monitoring system, disturbance analysis, information and reports. On distribution networks, customers are reimbursed provided the records show that (slow) voltage variations exceed the standard.

In Poland, the DSO/TSO is compelled to provide a voltage quality recorder to end-users, but only temporarily and there is no pre-defined payment by customer for this service. When the monitoring results show that the poor voltage quality at the customer's end is caused by the network operator, the customer does not pay for this service. The voltage quality recorder is being understood as a measuring device having the technical function of data storage and its further elaboration for the assessment of power quality.

In Ireland, the DSO is not compelled to provide a voltage quality monitor upon request by the costumer, but the DSO usually provides this free of charge. The TSO is not compelled to provide a voltage quality recorder but it is the TSO's policy to have sufficient recorders available on the system to provide adequate monitoring of the power system, connected generators and demand customers and to have the capability to deliver relevant data to customers as required. If a specific issue arises that requires additional recording facilities this can be achieved in a timely manner with portable equipment. Customers can also install their own recorders on their side of the connection point. There are no pre-defined payments by the customer for this service.

In Sweden, voltage quality measurement can only be ordered by the NRA. However, the Swedish NRA recommends that network operators comply with customer requests.

3.5.2.3 Requirements regarding VQ monitoring instruments

To verify whether the supplied voltage complies with the legislation or standards, it is crucial to have a standardised method for monitoring the different voltage quality parameters. Most commonly, if there are national requirements regarding VQM, these requirements are to follow the EN 61000-4-30 standard, or national legislation based on the EN 61000-4-30. In a few countries standards are adopted or developed by national standardisation organisations.

For example, EN 61000-4-30 is used as the reference for the requirements of VQM in Bulgaria, Croatia, Italy, Portugal, Norway and Sweden. In the Czech Republic, voltage quality specifications are contained in the national distribution code, and derived from EN 61000-4-30. The national distribution code is approved by NRA.

National guidelines on VQM, including requirements of the measuring units are developed in Hungary and Slovenia. The requirements in Slovenia existed before the creation of the Slovenian NRA. In Italy, a TSO grid-code document, which is approved by the NRA, specifies the following features for the voltage quality monitoring: voltage measurement on the 3 phases; precision EN 61000-4-30 class A; and avoiding double-counting in 2 different parameters of the same disturbance. The specifications of the equipment for VQM for MV networks are defined by the NRA. In Bulgaria, technical means used to control the quality must be traceably metrological calibrated and must meet the standards adopted by the Bulgarian Standardisation Institute. In Lithuania, the NRA has indicated what would be recommended devices. Devices must comply with the Republic of Lithuania Law on metrology requirements.

In the Netherlands, the VQM instruments have to comply with the standards set in the "Measurement Guide for Voltage characteristics" written by UNIPEDE (now Eurelectric). IEC 61000-4-30 will in the near future be included in the Network Code, as the process of changing the code is currently taking place.

3.5.3. Emission limits

The voltage quality in the grid and at the end-user's connection point could potentially be influenced depending on: how the grid is operated by the grid operator, how the grid is dimensioned by the grid owner, as well as on the design and use of all units connected to the grid. Since both the source of the voltage disturbances and the solution to reduce the voltage disturbances could be in the grid or the unit connected to the grid, CEER has identified responsibility sharing as an important principle for voltage quality regulation. This concerns, among other things, the setting of maximum levels of voltage disturbances at the point of delivery between the network operator and its customers and emission limits for installations. Emissions from individual customers need to be limited to keep the voltage disturbance levels within the requirements. The 5th Benchmarking Report recommended that limits are set at a reasonable level for both the customers and the network operator. Violations of these limits should not for example be due to low short-circuit levels (weak grid).

It is important to ensure that the functioning of equipment is not impacted by voltage disturbances coming from the grid. The probability of malfunctioning due to voltage disturbances from the grid is kept low in Europe through a set of standards on electromagnetic compatibility issued by the International Electrotechnical Commission (IEC) and taken over by the European Committee for Electrotechnical Standardisation (CENELEC) as European harmonised standards. The Electromagnetic Compatibility (EMC) Directive [16] limits electromagnetic emissions from equipment in order to ensure that, when used as intended, such equipment does not disturb other equipment. These documents regulate the emission of disturbances by individual devices as well as by installations, and regulate the immunity of individual devices to any disturbances. Although the spread of disturbances across the electricity network is taken into consideration when setting the various limits, additional regulation of network operators in terms of voltage quality is necessary.

In order to regulate the impact that customers have on the voltage quality of the networks, a number of countries have introduced legislation on emissions by individual customers. Penalties for customers in case of violation of maximum levels of disturbance are foreseen in these countries: Austria, Bulgaria, Croatia, the Czech Republic, Finland, France, Great Britain, Ireland, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Portugal and Slovenia. These penalties can be disconnection from the grid or consumers connected to the grid can be required to take the necessary measures to avoid violating the maximum levels of disturbances.

In the 5th Benchmarking Report [5] the roles of stakeholders with respect to emission limits for costumers and penalties were treated more in detail, as well as a case study of maximum current emissions for harmonics in France.

The concept of responsibility sharing between the stakeholders has been identified along the following lines:

- Good voltage quality at the customer's bus is the network operator's responsibility;
- Good quality for load current drawn from the bus is the customer's responsibility; and
- Developing and supplying equipment with adequate tolerance to power quality and cost-effective power conditioning devices with appropriate technology are the manufacturer's responsibility.

Ensuring an efficient balance of these 3 responsibilities is the role of the NRAs.

In the questionnaire, which this report is based upon, the different NRAs were asked to give their comments on how these responsibilities were allocated among different stakeholders for improving overall voltage quality and/or for rectifying situations when experiencing voltage disturbances.

The sharing of responsibility between the different stakeholders according to the 3 bullet points listed above is the common understanding of the answers from the 19 NRAs that responded to this question: the system operator has the overall responsibility of keeping a good voltage quality of the system, however, if the sources of poor voltage quality is due to emissions of a grid user, the responsibility is with that grid user. This implies that grid users also have a responsibility to use appropriate devices.

Another principle used among the NRAs is to allocate the responsibility of taking mitigating measures to reduce the voltage disturbances according to source of the problem.

An aspect that was mentioned was that it is the network operator's responsibility to ensure that any normal load currents do not cause problems with voltage quality. The extent to which a device could create voltage disturbance will depend on the characteristics of the device and the short-circuit levels at the connection point.

It has also been pointed out that the network operator has a responsibility to monitor the emissions from the customer side and enforce emission limits. In addition, the network operator could have a responsibility to provide the necessary information to the customer in order for the grid user to be able to select and tune the conditioning devices.

3.5.3.1 Case study: Responsibility sharing among stakeholders in Latvia

In Latvia, the responsibility of voltage quality is shared among the grid companies and the grid users by regulation. In this case study, some main elements of the responsibility sharing regulation will be presented.

The operator's responsibilities for good VQ are stated in the Latvian regulation. The system operator shall continuously provide the system services to the user within the limits of the permitted peak load determined in the system services contract or in the trade of electricity contract, though there are some exceptions to the duty. However, the grid users also have some responsibilities.

Responsibilities for the grid system operators

The regulation states that the system operator has the duty to ensure a conforming quality of the system services. If the user is not ensured the quality of services of the electricity system conforming to the quality requirements laid down in laws and regulations, and the standards determined the characteristics of the quality of voltage, the following applies:

The distribution system operator shall apply a lowered tariff of services of the electricity system. A lowered tariff of services of the electricity system shall be calculated, applying the coefficient 0.5 to the electricity transmission component of the tariff of services of the electricity system determined for the relevant group of users. Payment for the amount of current of the input protection appliance and the permitted load shall remain unchanged. The procedures for applying a lowered tariff of services of the electricity system shall be drawn up by the distribution system operator and published on its website.

The TSO shall reimburse to the user losses which have arisen due to providing a poor-quality service of the electricity system.

Responsibilities for the grid users

The user is responsible for connecting his/her electrical installations and electrical appliances, their technical state and qualified servicing in conformity with the laws and regulations that determine the requirements for the technical operation of electrical installations and safety equipment.

The user whose electrical installations do not tolerate discontinuations in supply of electricity, voltage dips and overvoltage shall take additional measures in order to achieve the necessary safety of supply of electricity. A reserve connection, an independent power supply and appliances stabilising voltage, as well as automated switching equipment shall be installed and arranged on the account of the user.

Additionally, the user is prohibited from transporting reactive energy to the network of the system operator. If the system operator establishes the transfer of reactive energy into the system, the users whose electrical installations are connected to voltage of at least 6 kV with the permitted load of 100 kW and more or other users with an input protection appliance, the amount of current of which is 200 A and more, have a duty to pay for all the reactive energy transferred into the network of the system operator in accordance with the payment €0.013/kVArh.

3.6. VOLTAGE QUALITY MONITORING SYSTEMS AND DATA

Since the 5th Benchmarking Report, more countries have begun to monitor voltage quality at different voltage levels. The national approaches have differed in their conception due to local conditions, with no harmonised requirements to direct them in a common direction. In particular, the reasons behind their use have varied, leading to different choices in terms of what is monitored, which (and how many) network points and voltage levels are concerned and what types of monitoring are applied.

In this 6th Benchmarking Report, when referring to voltage quality monitoring (VQM) we should keep in mind the various applications and drivers given in the Guidelines of Good Practice from 2012 [14]. The variety of drivers makes it somewhat complex to compare data from the different European countries:

- Compliance monitoring
- System performance monitoring
- Specific site monitoring
- Benchmarking
- Network development and investment approval
- Reporting and publishing of VQM results
- Further development of VQ regulation
- Remedial and mitigation measures
- Network operators and end-users awareness
- Verification of compliance by network users
- Transition to smart grids
- Research and education

Nevertheless, this chapter will summarise the status for VQM among the European countries, and do some comparisons where possible.

Out of CEER countries, 18 are in the process of rolling out smart meters, or have already done so. In this chapter the status of VQM by smart meters is presented. In several countries VQM by smart meters is possible, or partly possible.

3.6.1. Development of voltage quality monitoring systems

Voltage quality monitoring systems were reported to be operating in 18 of 27 responding countries. Table 3.7 below provides a summary of the monitoring systems in operation, how long the systems have been running for and the number of monitoring units, differentiated by voltage level. However, this does not imply that there are no VQM systems present in other countries.

As also commented in the 5th Benchmarking Report, a Eurelectric survey in 2009 reported that 82% of the surveyed DSOs carry out voltage quality monitoring on a continuous basis [17]. In this report, the focus is on permanent voltage quality monitoring systems as opposed to occasional voltage quality measurements, which result for example from complaints made by customers.

TABLE 3.7 MONITORING SYSTEMS IN OPERATION

Country	Start of monitoring	Voltage levels monitored			Number of instruments installed	Duration of monitoring
		EHV / HV	MV	LV		
Austria	2011		X	X		3 weeks, rolling
Belgium	2005	X	X			
Bulgaria	2010	X	X	X	Fixed: 250 Portable: 53	Continuous, rolling
Cyprus	2010 Transmission 2000 Distribution	X	X	X	Fixed: 1 Portable: 15	Permanent: Continuous Portable: 1 week
Czech Republic	2006	X	X	X	Fixed: 15,379 Portable: 400	Permanent: Continuous Portable: 1 week
France	1998 EHV and HV 2010 LV	X	X	X	Fixed EHV: 670 Portable EHV: 14 Fixed HV/MV: 3,000 Fixed LV: 270,000	Continuous
Greece	2008			X	Fixed: 500	Continuous for 1 year
Hungary	2009		X	X		Continuous and limited period. Average duration 90 days.
Ireland		X	X		Fixed: 308 Portable: 10	Continuous
Italy	2006 EHV, HV and MV	X	X	X	Fixed EHV/HV: 180 Fixed MV: 4,000 Fixed LV: 35 million	EHV, HV, MV: Continuous (1)
Latvia	1999		X	X	Portable: 20	1 week
Lithuania		X	X	X	Fixed: 13,000 Portable: 80	Continuous
Malta				X	Portable: 8	15 days (2)
The Netherlands	1996	X	X	X		Continuous (voltage dip) 1 week, rolling (PQ)
Norway	2006	X	X		Fixed: 250	Continuous
Portugal	2001	X	X	X	Fixed EHV/HV: 27 Portable EHV/HV: 7 Fixed MV/LV:47	EHV/HV : 1 year MV: 1 year LV: 3 months
Romania	2008	X	X	X	Fixed: 150 Portable: 150	Continuous and rolling Minimum 1 year period
Slovenia		X	X		Fixed: Portable:	Continuous

(1) LV network is subjected to monitoring on a sample, over the period of adjustment or every X years. This is under consultation.
(2) In a survey carried out by the NRA most of the sites were monitored for 15 days.

In the 5th Benchmarking Report the monitoring programmes in the different countries were presented. The number of countries performing voltage quality monitoring have increased to 18 compared to the 5th Benchmarking Report (14 countries), whereby Belgium, Ireland and Lithuania, have been added to the list. In addition, Malta has performed a one-time survey, a summary of which is given in case study 3.2. As seen in Table 3.7 some countries perform monitoring on all voltage levels (Bulgaria, Cyprus, the Czech Republic, France, Italy, Lithuania, the Netherlands, Portugal and Romania). The results show that 5 countries do not perform monitoring on EHV/HV-level (Austria, Greece, Hungary, Malta and Latvia), and 4 countries do not perform monitoring on LV-level (Belgium, Ireland, Norway and Slovenia). Greece and Malta do not perform monitoring on MV-level.

There are also some differences in the period of the monitoring: 13 countries perform monitoring continuously, while the others have other durations of monitoring, or a combination of continuous and rolling monitoring.

3.6.1.1 Network points monitored

For the 6th Benchmarking Report all countries were asked to give the type and number of network points, and the number of these points that are monitored. The replies are given in Table 3.9.

Table 3.8 presents the monitoring of HV/MV substations in the representative countries. Many network operators have access to voltage quality monitoring instruments for their own use and several even have a permanent monitoring system with many instruments in operation. Nonetheless, these systems are often for use by the network operator only. Though only a few of the countries have reported the percentage of busbars that is being monitored, monitoring of current and voltage levels on busbars on higher voltage levels usually is a key part of operating the grid. However, there could be differences in how the term "monitoring" is interpreted in the answers. In this chapter "monitoring" is mainly focusing on monitoring the different voltage quality parameters, as presented in Table 3.10.

TABLE 3.8 MONITORING OF HV/MV SUBSTATIONS

	AT	BE	BG	CY	CZ	EL	FR	HU	IE	IT	LT	LV	NO	PT	RO	SI
MV busbars in HV/MV substations are monitored	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Percentage of busbars being monitored	10			20	100	60			3,6	100	100	10		18,5		100

In Table 3.9 the number of different network points monitored in the respective countries are presented. Some differences between the choices of measuring points are identified.

TABLE 3.9 NETWORK POINTS MONITORED

Country	Type of network point	Total number of points	Points monitored (total number and percentage	
Austria	MV/LV	4,300	400	
Bulgaria	HV substation	165	165	100 %
	HV end-user site	330	330	100 %
	MV end-user site	124	124	100 %
	MV busbar in HV/MV substations	1,252	1,252	100 %
Czech republic	Delivery points TS/DS	62	62	100%
	MV busbars in HV/MV substations	694	694	100%
	LV busbars in MV/LV DT		14,525	
	Delivery points at 110 kV customers		98	
France	EHV/HV end-user sites	1,72	208	12 %
	MV busbars in HV/MV	5,000	3,000	60%
	MV end-user sites	96,000	48,000	50 %
	LV end-user sites		270,000	1 %
	Various other network points			
	HV/MV substations			
Greece	Interconnected Urban		285	
	Interconnected Rural		107	
	Non-Interconnected Islands		108	

Country	Type of network point	Total number of points	Points monitored (total number and percentage	
Hungary	MV busbar in HV/MV substations + MV end-user site		157	
	LV busbar in MV/LV transformers + LV end-user site		2,758	
Ireland	38kV Bus at 110/38kV Substation (TSO/DSO)	81	69	85 %
	38kV generator	60	60	100 %
	MV Generator	121	121	100 %
	LV Generator >300kW	5	5	100 %
Italy	380 kV busbar/substation		17	
	220 kV busbar/substation		25	
	HV busbar/substation		138	
	MV busbar in HV/MV substations	4,000	4,000	100 %
	MV busbar in MV/LV substations		130	
	MV end-user site	100,000	70	0.07 %
	LV end-user site (smart meters)	35,000,000	35,000,000	100 %
Portugal	HV busbar delivery point	80	34	42.5 %
	MV busbars in HV/MV	416	77	18.5 %
	LV busbar in MV/LV transformers	66,719	168	0.25 %
Slovenia	EHV/HV	187	187	100 %
	HV/MV	87	87	100 %
	MV/MV	219	219	100 %

By comparing the replies in Table 3.8 and Table 3.9 it can be noticed that the number of instruments given in Table 3.8 differs from the number of network points monitored given in Table 3.9. Out of 18 countries, 15 have deviations in their replies. Only the Czech Republic, Italy and Greece gave numbers of monitoring instruments corresponding to the number of network points monitored.

Out of 18 countries, 7 did not provide information in Table 3.9 about which type of network point VQM is being performed: Belgium, Cyprus, Latvia, Malta, the Netherlands, Norway and Romania. Moreover, Austria, Bulgaria, and Romania indicate that their instrument location is rolling, which means that one instrument may cover several network points over time. Greece indicates 1 year duration of monitoring, which also means that one instrument over several years can cover several network points.

The substations between the transmission and distribution network are measured in the majority of the countries which have responded. The placement is both for monitoring the input energy parameters between the grids as well as for separate customers equipped with the necessary devices. In the Czech Republic all delivery points at the transmission system/distribution system at 110 kV and outputs of all 110 kV/HV stations have to monitor according to the Czech Distribution Code. Also in Ireland and Bulgaria the quality indicators measurement points are placed at the property borders between the transmission and distribution network. In Belgium, the TSO installs a monitoring instrument in its substations in the transmission grid, where at least one customer is connected, or where the transmission grid is connected with other TSOs. Exceptions are substations connecting the railway, the subway and DSO substations.

The placement of the voltage quality monitoring units in several countries is done on the basis of experience of the grid conditions by the system operators. In Latvia, the monitoring is performed at the weakest grid point. In Poland, the measured network points are chosen by the TSO selected by the criterion of balancing energy for metering and billing.

In Norway, all TSO/DSOs are obliged to continuously carry out monitoring on characteristic areas of their MV, HV and EHV network. Important elements to consider when dividing the network into different characteristic areas are underground cables versus aerial lines, system earthing, extension of the network, customer categories connected, climatic differences, short circuit power. The TSO/DSOs must decide by themselves how many instruments are necessary in order to create trustworthy statistics. Each network company must have at least one instrument installed in each different characteristic area. The monitoring instruments are installed in the high voltage network, and must therefore be connected to measuring transformers.

In Romania, the network operators set points of monitoring, taking into account different criteria, such as representative substations, connection points between TSO and DSO, potential disturbances in the substation and for instance production, like wind power plants.

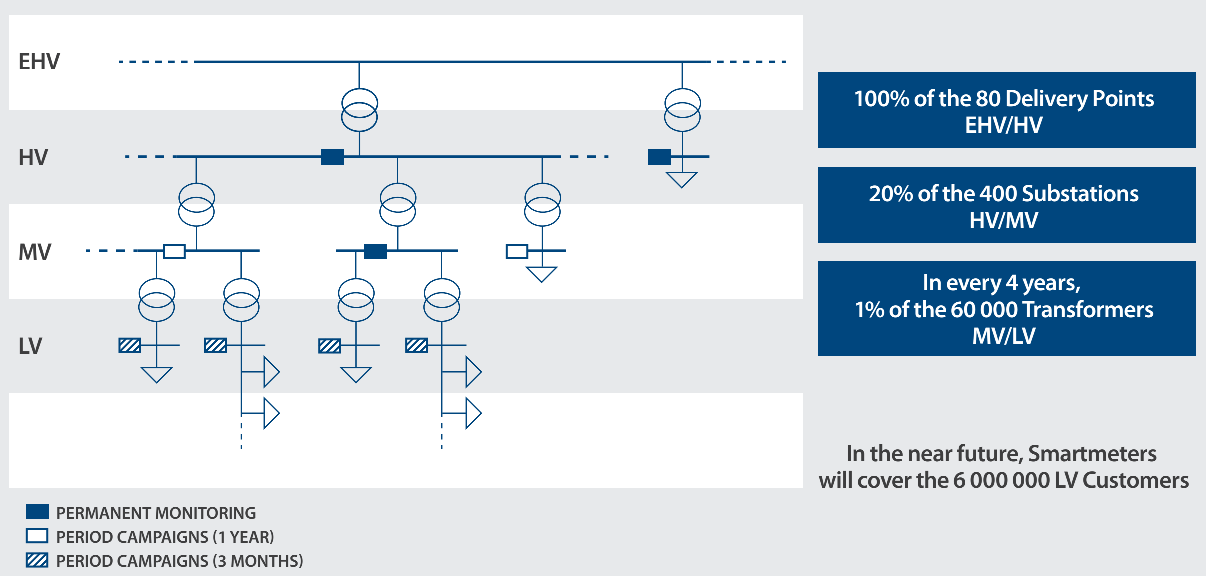
The production unit is another criteria used for determining the placement of voltage monitoring. In Ireland, all generator sites with maximum export capacity greater than 300 kW are monitored. In Cyprus, the connection points of independent producers at the transmission level are measured with a permanent unit. Connection points of independent renewable generators at the distribution level are measured with portable units. In the near future, permanent units will also be provided in transmission substations, and portable units at MV substations.

Measuring units are also installed randomly in 3 countries: Austria, Hungary and the Netherlands. In Austria, the detailed information about measuring points and measurement strategy is operated by DSOs. The points measured are chosen based on statistical considerations and methods. The metering-points are chosen from a list of potential points and have to be agreed with the regulatory authority. In Hungary, the present monitoring devices are installed randomly at LV and MV level. In the near future, the MV side of HV/MV substations will be equipped with VQ monitoring devices. The criteria for the selection are chosen by the DSOs. In the Netherlands, there are 2 systems of points being measured: voltage dips are measured at 200 locations at MV since 2015 onwards, 14 locations at HV and 17 locations at EHV. Additionally, power quality measurements with duration of 1 week are performed on all voltage levels, where the locations are chosen randomly. At LV, MV, HV and EHV respectively 266, 266, 1,265 and 650 measurements are performed (2015).

In France, for EHV and HV, 31% of the devices are located at connection points for customers with optional service packages, as described in Section 3.5. The other 69% of the measuring points are located so that the network is sufficiently covered with a minimum of devices. About 50%, or 48,000, of the MV customers are equipped with a monitoring device which monitors voltage variations. This yields especially for customers larger than 250 kVA. The only other monitoring devices on distribution networks are located in HV/MV substations. At LV only end-user sites are monitored.

In Portugal, a new revision of the quality of electricity supply code was finalised in 2013. In this revised code, the network operators must develop voltage quality monitoring programmes every 2 years, based on permanent monitoring and periodic campaigns. Those bi-annual programmes must be submitted to the regulatory authority for approval. In the code, it is established that all delivery points of the transmission network, about 80 EHV/HV substations, shall be equipped with fixed monitoring units. The code also establishes the minimum number of network points that must be covered by the voltage quality monitoring program in each voltage level. Until 2017, some portable equipment is used in 1 year duration campaigns. The location of the portable equipment is defined by the TSO in coordination with the DSO. The Portuguese quality of service code establishes that in a period of 4 years at least 2 MV/LV power transformation stations of each municipality must be monitored. The architecture of the voltage quality monitoring program in Portugal is presented in Figure 3.1.

FIGURE 3.1 ARCHITECTURE OF THE PORTUGUESE VOLTAGE QUALITY MONITORING PROGRAM FOR 2017



Source: S. Faias and J. Esteves, "Guidelines for Publication of Voltage Quality Monitoring Results in Portugal: A Regulatory Perspective"

3.6.1.2 Voltage disturbances monitored

Voltage quality parameters monitored in the different countries are presented in Table 3.10.

TABLE 3.10 VOLTAGE QUALITY PARAMETERS MONITORED

	Supply voltage variations	Flicker	Voltage dips	Voltage swells	Transient over-voltages	Voltage unbalance	Harmonic voltage	Inter-harmonic voltage	Mains signalling voltage	Single rapid voltage change	Other, please specify
Austria	X	X	X			X	X				
Belgium	X	X	X	X	X	X	X	X	X	X	EN 50160
Bulgaria	X	X	X	X	X	X	X	X	X	X	
Cyprus	X	X	X	X			X			X	
Czech republic	X	X	X	X		X	X		X		
France	X	X	X	X	X	X	X				Frequency
Greece	X	X	X	X		X	X				
Hungary	X		X	X		X	X				
Ireland	X	X	X	X		X	X			X	
Italy	X	X	X	X		X	X			X	Frequency
Latvia	X	X	X	X		X	X				
Lithuania (1)											
Malta (2)	X	X	X	X	X	X	X	X		X	THD, Frequency
The Netherlands	X	X	X (3)	X	X	X	X			X	
Norway		X	X	X						X	THD
Poland	X	X	X	X			X		X	X	
Portugal	X	X	X	X		X	X				THD, Frequency
Romania	X	X	X	X	X	X	X			X	Frequency
Slovenia	X	X	X	X	X	X	X	X	X	X	Frequency

(1) In Lithuania, all the monitoring parameters in the table above are measuring when the company gets complain from a consumer.
(2) In Malta, the voltage disturbances were monitored for 15 days in a monitoring campaign, see details in case study.
(3) In the Netherlands, dips measured only for EHV and HV, but from 2015 onwards dips will be measured also for MV.

Regarding voltage events, 18 out of 19 countries are monitoring voltage dips, 17 countries are monitoring voltage swells and 11 countries are monitoring rapid voltage changes. For these parameters, which occur stochastically, it is an advantage to monitor continuously in order to get the total picture of such voltage disturbances.

Regarding continuous voltage phenomena, 17 out of 19 countries are monitoring supply voltage variations, flicker and individual voltage harmonics. A total of 15 countries are monitoring voltage unbalance and 7 transient overvoltage. Less than one third of the countries monitor mains signalling voltages, inter-harmonic voltages and THD.

Out of 19 countries, 6 are monitoring power frequency. The need to monitor frequency at many locations is limited in a traditional interconnected power system, as this is already continuously monitored by the TSO in every country as part of the operation of the system. However, with the increase in distributed generation both controlled and non-controlled island operation of parts of the system might become more common, so the need to continuously monitor power frequency will also increase.

3.6.1.3 Responsibility and purpose of the monitoring programmes

Table 3.11 shows the body which promoted the initiative for the monitoring scheme, for example the NRA, the Ministry, TSOs or DSOs along with the purpose for monitoring. Compared to the similar table from the 5th Benchmarking Report, Belgium, Bulgaria, Ireland and Malta are added on the list in this report.

TABLE 3.11 INITIATIVES AND PURPOSES FOR VQ MONITORING (WHEN NOT DUE TO COMPLAINTS)

Country	Initiative	Purposes
Austria	Other authorities	Statistics
Belgium	NRA	
Bulgaria	NRA, TSOs, DSOs	Services quality enhancement and diminishing technical losses
Cyprus	TSOs	Statistics, regulation, research
Czech Republic	TSOs and DSOs	Statistics, regulation, research, network development
France	EHV/HV: TSOs MV: DSOs LV: NRA, other authorities	Statistics, information to customers and to ensure that standards in legislation and contracts to individual customers are fulfilled
Greece	NRA	Statistics
Hungary	NRA	Statistics, competition by comparison
Ireland	DSOs	Statistics, monitoring, research
Italy	NRA	Statistics, research, information, regulation, publication, definition of expected VQ levels
Latvia	DSOs	Statistics
Lithuania	TSOs and DSOs	Monitoring, ensure and maintain electricity quality.
Malta	NRA	One time survey for statistics on current supply quality level. Survey designed mainly on the ECRB guidelines
The Netherlands	TSOs and DSOs	Statistics, regulation
Norway	NRA	Statistics, regulation, monitoring
Portugal	NRA	Statistics, regulation
Romania		Statistics, regulation, research and development
Slovenia	NRA and other authorities	Statistics, regulation, research and development

In Italy, the voltage quality monitoring scheme at all voltage levels was initiated by the NRA with the following objectives:

- statistics (knowledge and publication of statistical data), research (correlation analysis between voltage quality parameters and network characteristics), information (improve awareness of network users), regulation (basis for possible future regulation / review of existing technical rules)
- definition of expected VQ levels, publication of statistical data
- statistics (knowledge of statistical data), regulation (basis for possible future regulation), understanding the voltage impact of LV distributed generation

In Norway, the regulation requires the TSO and DSOs to perform continuous monitoring of voltage quality in their networks. Upon request from a customer they need to be able to provide explanations for historical quality values in their network and to be able to estimate the future quality in their network. Further, upon request by an individual customer, they must provide relevant voltage quality information and explanations for the historical quality performance of their networks and estimate the future quality in their networks.

Table 3.12 shows who bears the cost of voltage quality monitoring in the different countries. This includes the costs of the installation, maintenance and operation of the monitoring system.

TABLE 3.12 RESPONSIBILITY FOR VOLTAGE QUALITY MONITORING COSTS

Country	Pre-defined tariffs	Responsible for payment of monitoring costs
Austria	No	DSOs, covered via grid tariffs to all connected customers
Bulgaria	No	DSOs, covered via grid tariffs to all connected customers
Croatia		DSOs
Cyprus	No	TSO, DSO and independent producers
Czech Republic	No	DSO, covered via grid tariffs to all connected customers
France	Yes	All customers through grid tariffs
Greece	No	NRA
Hungary	No	DSO
Ireland	No	DSO, covered via grid tariffs to all connected customers or charges on generators
Italy	No	TSO, covered via transmission tariffs to all connected customers National research funds for distribution voltage quality instruments DSOs, covered via tariffs to all users (for LV smart meters)
Latvia	Yes	DSO
Lithuania	Yes	Voltage quality measurements are made from the funds of the TSO/DSO company
The Netherlands	No	TSO / DSOs, covered via grid tariffs to all connected customers
Norway	No	TSO / DSOs
Poland		TSO / DSO
Portugal	No	TSO / DSO, covered via grid tariffs to all connected customers
Romania	Yes	TSO / DSO. Wind power stations above 10 MW are obliged to monitor voltage quality in the connection point and the producer pays the cost of this monitoring
Slovenia	Yes	TSO / DSOs, covered via grid tariffs to all connected customers

In France, for EHV, HV and MV, customers who subscribe to optional service packages pay for their own delivery point(s). Possible differences between payments from customers and actual costs of monitoring (as there are pre-defined tariffs) are passed on grid tariffs. The costs of global monitoring are paid by all customers through grid tariffs.

In Italy, the DSO receives a socialised contribution of the cost of each unit by the tariff. This contribution is excluded from the return on investments achieved by the tariff. The system is paid by the TSO and covered through transmission tariffs.

In Norway, the TSO/DSOs who are obliged to perform the continuous monitoring of voltage quality must also cover the costs for installation, maintenance and operation of the system.

In Portugal, customers pay the VQM programme. The cost of the programme is included in the network tariffs.

In Romania, the network operators (TSO/DSO) are required to monitor a number of substations, according to the performance standards developed by the NRA. The costs are included in the grid tariff. Additionally, wind power stations above 10 MW have obligations to monitor the voltage quality in the connection point and pay for this monitoring. A customer can also install, at his/her expense, his/her own power quality analyser/recorder.

In Slovenia, costs for monitoring are incorporated into network tariffs for transmission and distribution. Final customers on transmission and distribution pay network charge.

3.6.1.4 Case Study 6: Electrical Supply Voltage Quality Survey in Malta 2013-2014

In Malta, the NRA carried out a survey on voltage quality for the period 2013-2014. The survey was performed to obtain a sample of data on all voltage characteristics, in order to gain an idea of the existing supply quality level. The survey was designed mainly based on the ECRB guidelines and it was financed by the NRA.

The survey involved low voltage service connection points rated at 230V/400V (+/- 10%) and with current rating capacity not exceeding 60Amps/phase. The low voltage single phase supplies in Malta are rated at 40 Amps. The 4 wire system is used for 3 phase supplies. In the case of connection points served with a 3 phase supply, only those rated up to 60Amps/phase were considered in the survey. The survey was carried out over a timeframe of 12 months. The measurement points for gathering the necessary data required for the survey were located in the premises of a selection customers connected to the low voltage part of the distribution system. The measurement points were stratified randomly to involve different localities as much as possible.

Measuring points

In total, 106 low voltage customers were involved in the survey out of which 104 served with a single phase supply and 2 with a 3 phase supply. The single phase points were each monitored continuously for 15 days and the two 3 phase supplies were monitored continuously for 12 months. For each one of the monitored points monitored for 15 days, supply voltage variations, flicker, voltage unbalance (for 3 phase), harmonic voltage, inter harmonic voltage, total harmonic distortion and mains signaling were measured. For the two 3 phase locations, additionally frequency, voltage swells, voltage dips, single rapid voltage changes and transient over voltages were monitored.

Technical standards for the measurements

Voltage quality measurements in each one of the monitored sites and analysis of the voltage quality data collated from the monitored sites as specified were carried out in compliance with EN 61000-4-30 Class S or better and EN 50160 latest versions. In general the contractor was also expected to refer to CEER's 2012 "Guidelines of Good Practice on the implementation and use of VQM systems for regulatory purposes". Familiarity with the CEER Benchmarking Reports on quality of supply is also expected. The equipment used to take voltage quality measurements had to be compliant with EN 61326 in terms of EMC. For the single phase monitoring the Metrel Power Q4 Plus MI2792 equipment was used and for the 3 phase monitoring the Fluke 435 Series II equipment was used.

Reporting

Both the interim reports and a final report that covered all the sites monitored during the survey and included the results were produced. In the reports, monitoring data was presented with amongst others deviations and number of events that exceeded given values for the different voltage quality parameters monitored.

3.6.2. Smart meters and voltage quality monitoring

The 2013 CEER report "Status Review of Regulatory Aspects of Smart Metering" [18] summarises the regulation and status of roll-out of smart meters in CEER member countries. According to this report, 18 countries had rolled out smart meters, or were planning to do so in 2013.

Some countries plan to use smart meters to monitor voltage quality aspects alongside the measurement of the quantities of electricity consumed. In order to measure voltage quality aspects with smart meters, it is important to know whether the measurements are performed in accordance with international standards and/or good engineering practice. Otherwise the measurements will be of limited value and their interpretation will be difficult in many cases.

Table 3.13 gives an overview of the countries in which smart meters are currently installed and the extent to which these meters can monitor aspects of voltage quality. There may be differences in the way the different countries have defined their "smart meters" when answering the questionnaire, which may influence the answers.

TABLE 3.13 SMART METERS AND VOLTAGE QUALITY MONITORING

Country	Smart meters?	Voltage quality monitoring possible?	Which parameters are (or can be) monitored?
Austria	Yes(1)	Voluntary, ongoing projects	
Belgium	Yes	No	
Bulgaria	No	No	
Croatia	Yes	Yes	Voltage outages, THD.
Cyprus	No (2)		
Czech Republic	Yes	Ongoing projects	Voltage.
Finland	Yes	Partly	Majority of meters can monitor voltage level, voltage drops.
France	Yes	Partly	New meters currently tested for monitoring of slow supply voltage variations (from 10 min intervals to 1 min intervals).
Greece	No	Partly	Meters of MV customers can monitor voltage dips and swells.
Hungary	No		
Italy	Yes	Yes	Supply voltage variations.
Latvia	Yes	Yes	Supply voltage variations, voltage dips, swells, harmonics.
Lithuania	Yes	Partly	Frequency, voltage (3).
Malta	Yes		
The Netherlands	Yes	No	
Norway	Yes (4)	Voluntary	
Poland	Yes		
Portugal	Yes	No	
Romania	Yes	Partly (5)	
Sweden	Yes	Partly	66% of the meters in Sweden can collect information on supply voltage variations.

(1) Austria: Voluntary. There are open legal questions regarding data protection issues. There is no nation-wide smart metering in place yet, but a number of ongoing projects.
(2) Cyprus: Smart metering to be installed in the near future.
(3) Lithuania: EPQS type meters records periods when the average frequency and voltage value did not meet the limits specified. EPQS meters represent 0,19% of all exploited meters.
(4) Norway: Installation of smart meters for energy metering purposes will be compulsory for all end-users from 2019. Depending on the choice of meter and auxiliaries voltage quality metering will also become possible.
(5) Romania: Some (large) customers have smart meters, of various/ different types, that allow monitoring.

Table 3.13 shows that there are variations regarding whether the smart meters are able to monitor voltage quality. In Croatia, Finland, Italy, Latvia, Lithuania and Sweden smart meters, or some of the smart meters, are able to monitor voltage quality. From the questionnaire, it is not known if it is compulsory in these countries to perform the voltage quality monitoring. Additionally, Austria, the Czech Republic, France and Norway responded that the monitoring of voltage quality parameters is voluntary or only undergoing testing. In Greece and Romania larger customers or customers on higher voltages have the possibility to monitor voltage quality.

For countries where smart meters are able to measure voltage quality, supply voltage variations is the most common parameter being monitored. Measurement of voltage dips and/or swells by smart meters are also included in some countries.

In the 4th Benchmarking Report, it was recommended to exploit the possibility offered by smart meters without excessive price increase for costumers, although CEER does not deem it necessary to monitor all voltage quality phenomena thought smart meters for all LV users.

The last Benchmarking Report described the development of monitoring of voltage quality by smart meters in France, Italy and the Netherlands.

Since the last report, 10 additional countries have responded to the question of smart meters and voltage quality measurements. Of these 10 countries, Belgium, Croatia, the Czech Republic, Malta, Norway, Poland and Romania have installed, or are in the process of installing smart meters. In Croatia, it is possible to monitor voltage quality, while it is voluntary in Norway and there is an ongoing project in the Czech Republic.

3.6.2.1 Case Study 7: Norwegian research project on monitoring power quality in low-voltage network with smart meters

In a traditional power network, without prosumers, the power flow is one-directional and the voltages at the customers connection points are easy to estimate. In a "smarter" network however, with distributed generation and possibilities of feeding power from electrical vehicles and other batteries, the power flow is no longer one-directional. This will make it more complicated to estimate the voltage in the connection points. Moreover, the usage of electricity is changing to more energy-efficiency but power-demanding apparatus are used in the network and this may lead to voltage disturbances such as voltage dips, rapid voltage changes, flicker, harmonics, voltage unbalance, etc. Therefore the trend is that it is becoming more and more important for DSOs to have appropriate tools and methods for monitoring the quality

SINTEF Energy Research published in 2010 a report [19] presenting the possibilities to take advantage of smart meters for monitoring and controlling voltage quality in the low voltage grid. The report focuses on the use of voltage measurements in cases of customer complaints, for analysing and planning of the network and gives examples on usage for network management.

SINTEF claims that DSOs can take more advantage of smart meters than measurements of energy consumption alone and challenges DSOs to make future-oriented decisions when investing in the low-voltage network. The DSOs in Norway are about to make a large investment in smart meters at customers' connection points. It will be wise to consider if smart meters should be applied for monitoring power quality or if such monitoring should be done by alternative methods.

Examples for usage of data from smart meters

Available voltage and power measurements from smart meters are useful to achieve better comprehension and control in the low-voltage network. They will also make it possible to automatize management processes in the network. In a network planning process, access to actual quality data makes it easier to identify places in the grid where upgrading is necessary:

- Makes it possible to establish better presumptions for investment analysis with better overview on production and consumption of active and reactive power;
- Allows for analysis of load- and production with better data on the actual load-and production conditions;
- Provides possibilities for load-control at customers and control of transformer- points;
- Safety evaluation by monitoring voltage at the customers;
- Better in-data in technical analysis of alternative solutions; and
- Better establishment of costs and more correct calculation of loss in the network and better accuracy in load-flow analysis.

The SINTEF report shows several possible ways to present the voltage quality data graphically, that makes it easier to gather information about the condition in the network, i.e. at locations in the network where a smart meter is registration voltage data.

Use of "use-case" to describe usage of voltage quality monitoring with smart meters

"Use-case" is a standardised method [20] for describing functionality in a system and how a desired goal for the system can be achieved. The method gives an overview of the system and over the different actors that are relevant for the goal achievement. The SINTEF report has used the method to describe several concrete examples on how to use the measured voltage quality data:

- Confirm whether the voltage variations is too low or too high;
- Verify rapid voltage changes, dips and swells;
- Locate the source of rapid voltage changes, dips and swells;
- Verify voltage conditions at high and low-load periods;
- Present voltage margins in the low-voltage network;
- Verify network documentation;
- Get notifications at high or low voltages;
- Verify whether the voltage is acceptable after re-connections in the network; and
- Alarm in case of faults in the network.

3.6.3. Actual data on voltage dips

Clear and consistent definitions of voltage dip indicators are necessary for interpreting the results from measurement campaigns and for effectively enforcing limits. The calculation of voltage dip indicators consists of 3 stages:

- Calculation of the "dip characteristics" (also known as "single-event indicators") from the sampled voltage waveform. This calculation is often performed by the monitoring instrument;
- Calculation of the "site indicators", typically the number of dips per year with certain characteristics; and
- Calculation of the "system indicators", for example the average number of dips per year per site.

These 3 levels of indicators, including their definition in international standards and similar documents, were discussed extensively in the 5th Benchmarking Report. The main points are recreated in Annex B.

Annex B also provides an overview of the voltage quality data that countries have provided in response to the internal questionnaire for the 6th Benchmarking Report. The responding countries for this annex include France, Portugal and Slovenia. The voltage quality data provided is voltage dips, reported accordingly to the classification of voltage dips recommended in EN 50160.

A description of the standard definitions of voltage dips according to EN 50160 is given in the same annex.

3.6.4. Publication of voltage quality data

Reporting and publishing VQM results, as a simple regulatory instrument, is recommended in different CEER publications as a first step towards VQ regulation.

A total of 15 countries responded to the question regarding publication of voltage quality data. Their answers to the questions are given in Table 3.14. In addition, 6 countries are added to the table compared to the 5th Benchmarking Report: Cyprus, the Czech Republic, Latvia, Lithuania, Poland and Romania. For the countries that responded in the 5th Benchmarking Report, no great changes are identified for the 6th Benchmarking Report.

The 5th Benchmarking Report concluded that countries monitoring voltage quality are recommended to publish results regularly. Additionally, the Report recommended storing as much data as feasible in an easily accessible format to facilitate future queries that cannot yet be foreseen.

Table 3.14 shows that in all the countries except in the Czech Republic, voltage quality data is available for the NRA at an aggregated level, and in several countries, the individual data is also available for the NRA. In the Czech Republic, individual data is available to the relevant end-users. In about half of the countries the voltage quality data is stored in a central computer.

Most commonly, the publication of voltage quality data is either done as available data on the website of DSO/TSOs, separate reports on voltage quality, or as part of annual reports to NRA on operation of the grid from TSOs.

TABLE 3.14 PUBLICATION OF VOLTAGE QUALITY DATA

Country	Is voltage quality stored in a central database?	Publicly available voltage quality data	Aggregated data available to regulator	Individual data available to regulator	Individual data available to end-users	Party responsible for publication	Regularity for publishing of data
Austria	No	Yes	Yes	Yes	Yes		
Cyprus	Yes	No	Yes	Yes	Yes		
Czech Republic	Yes	No	No	No	Yes		
France	Yes	Yes	Yes		Yes	TSO / DSOs	
Hungary	No	Yes	Yes	Yes	No	Regulator	
Ireland		Yes	Yes	Yes	No		
Italy	Yes	Yes	Yes	Yes		Research centre / TSO	
Latvia	No	No	Yes	Yes	Yes		
Lithuania	No	No	Yes		Yes	NRA	Annually
The Netherlands	No (1)	Yes	Yes	No	Yes, HV and EHV connections	Consultant company	
Norway	Yes	Yes	Yes	Yes	Yes	NRA / TSO	Annually (2)
Poland		No	Yes	Yes	Yes		
Portugal	No	Yes	Yes	Yes	Yes	Regulator	Annually
Romania						TSO / DSO	
Slovenia	Yes	No	Yes		Yes	TSO / DSO / regulator	Annually

(1) Data is not available for the NRA.
(2) Voltage quality has been reported to the NRA since 2014. Publishing of data is not yet effectuated, but will be in the future.

In France, the number of voltage dips in the transmission network is published in annual reports on the TSO website using the EN 50160 cells standards. Individual information is available by subscription and additional information can be found on the internet.

In Hungary, data aggregated nationally and per DSO is published on HEO's website. DSOs aggregate data for LV and MV level separately, and report them annually to the NRA. The NRA aggregates data on national level for publication purposes. Each DSO collects data in its own central computer. Individual VQ data is available upon request of the NRA, e.g. in case of complaint.

In Ireland, the DSO provides information on voltage quality to the individual customer upon request about their own connection. No aggregated data is published for the distribution networks.

In Italy, aggregated data is published on the internet and in a TSO report. The data is available aggregated by region, province, type of network points, status of neutral earthling, type of MV lines (overhead/mixed/cable), length of MV lines, size of HV/MV transformer power and MV busbar nominal voltage. It is a minimum level of aggregation of at least 4 monitored sites.

In Lithuania, voltage quality is reported in an annual report on power system reliability, which is published on the internet.

In the Netherlands, aggregated data for voltage quality measurements in all networks is published on the internet. The publication lists the number of times the monitoring units measured a violation of the requirements on voltage quality in the Network Code. Voltage quality data is available on a map at the website of the Association of Energy Network Operators in the Netherlands[9]. No data about the performance of individual network operators is publicly available.

In Norway, the grid code was reviewed in 2014, introducing changes to the reporting of voltage quality data. Since 2014 the TSO and all DSOs are obliged to report 5 specified VQ parameters, along with some key information about the measurement points, such as the name of the measurement location, GPS coordinates for the measurement location, name of county and municipality for the measurement location, nominal voltage at the measurement location, short circuit current for the measurement location, grid type at the measurement location, EHV, HV, MV (overhead lines, combination or cables) as well as earthing system at the measurement location (Insulated, Peterson-coil, directly earthed). The TSO publishes results from VQ monitoring as a part of an annual report on the operation of the transmission power system. The NRA plans to publish a report on voltage statistics for the first time in 2016.

In Portugal, the TSO, DSO and the NRA publish annual quality of service reports on their respective websites. For transmission, for each measured point and each characteristic the representative value and the worst value is published. The situations where there has been no fulfilment of the limits are publicised. For distribution the situations where the limits were not fulfilling are quantified. See the case study below for more details on publication of voltage quality in Portugal.

In Slovenia, the TSO and DSO are required to publish voltage quality data and upload the voltage quality of the continuous voltage monitoring are included in yearly reports of quality of service. Aggregation of the data is performed by both the utilities, DSO/TSO and the NRA.

3.6.4.1 Case Study: Guidelines for publication of voltage quality data in Portugal

One of the main components of a VQM programme is the reporting and publishing of the results. For this purpose, the internet seems to be a common and powerful platform for the publication of data. In addition to NRAs' websites, the results should be published on the respective websites of network operators [14].

In Portugal, the quality of electricity supply code, published in November 2013, imposes the obligation of network operators to publish the VQM results on their websites. Consequently, the Portuguese system operators have already started to publish the monitoring results on their websites. However, since the quality of electricity supply code does not define any guidelines for the publication of such results, different practices have been adopted by each operator.

Transmission System Operator

The TSO, as required by the quality of electricity supply code, publishes the results of VQM programme on its website. This publication includes a list of the delivery points covered by the monitoring and the respective reports with the results [21].

Each report includes the identification of the delivery point, the voltage level of the monitored bus or buses, the measuring period and the results for the different voltage characteristics. For the continuous phenomena, as presented in Figure 3.2, the results are published per week according to a colour labelling system.

FIGURE 3.2 PUBLICATION OF RESULTS FOR CONTINUOUS PHENOMENA IN EHV/HV DELIVERY POINTS

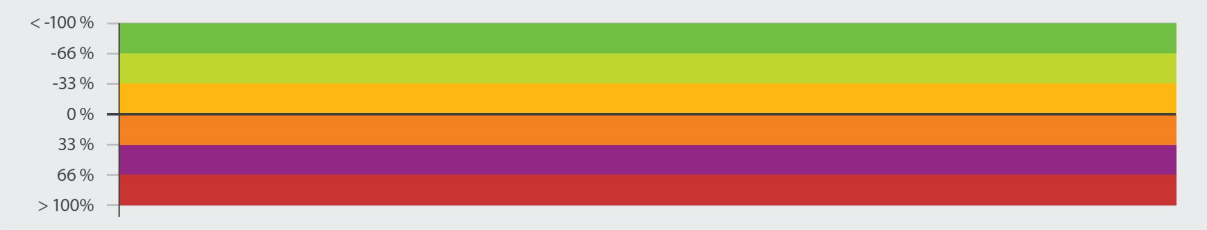
Year 2014								
Features/ Week	1	2	3	4	5	6	7	8
Amplitude								
Unbalance								
Harmonics								
Frequency								
Flicker								

9. Voltage quality data in the Netherlands is presented geographically at the website www.uwspanningskwaliteit.nl.

The labelling system used by the operator comprises 6 different colours and has the objective of making the analysis as understandable as possible. This characterisation system was initially developed by CIRED [22] [23], taking its inspiration from the labels used for the energy efficiency characterisation of domestic electrical devices.

As presented in Figure 3, the colours vary from dark green (very good quality) to red (bad quality) according to the value of a voltage quality index.

FIGURE 3.3 LABELLING SYSTEM DEVELOPED BY THE OPERATOR TO CHARACTERISE CONTINUOUS PHENOMENA



The colour of the label depends on the value of the voltage quality index i(p,l,f), used to characterise each one of the continuous phenomena. The calculation of this index is presented in the following formula:

$$i_{(p,l,f)}(\%) = \left(\frac{n_{(p,l,f)}}{l_{(p)}} - 1\right) \times 100$$

Where n(p,l,f) corresponds to the level of the voltage characteristic p, at phase l of bus b, and l(p) corresponds to the limits established for the characteristic p by the quality of electricity supply code.

For harmonic voltages, the voltage quality index is determined based on the THD characteristic.

The main disadvantage of this methodology is that, for voltage characteristics that have upper and lower regulatory limits, there is no information about which one of those limits is imposing the colour of the label.

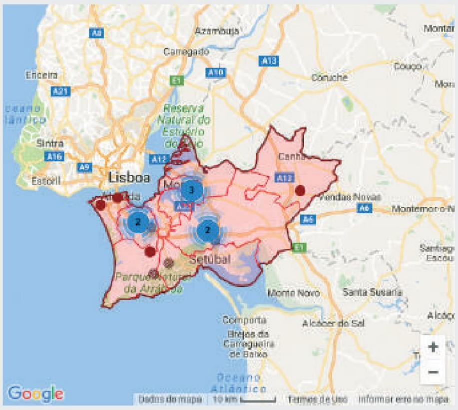
Regarding voltage events, since no regulatory limits are established, this labelling system is not applied. The results of the voltage events monitoring are published based on the tables defined by the Portuguese code (adopted from standard EN 50160: 2010), which aggregate the events according to the maximum deviation from the declared voltage and the duration of the events.

Distribution System Operator

The main Portuguese DSO (HV, MV and LV networks), which supplies more than 99% of the 6 million LV customers, implemented a system for the publication of the VQM results based on an interactive map. As presented in Figure 3.4, the map identifies all the network points covered by the monitoring programme. It allows the user to select any point and to access the results of the measurements [24].

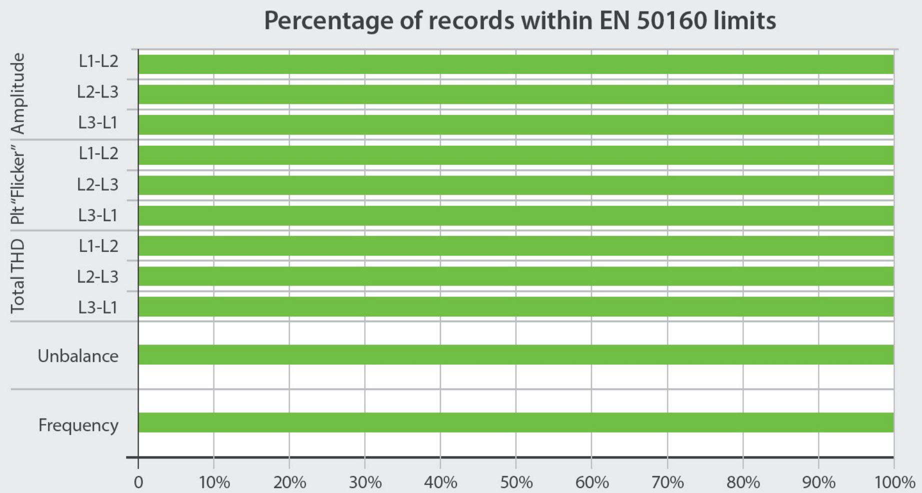
The report available for each network point includes the identification of the delivery point, the voltage level of the monitored bus or buses, the measuring period and the results for the different voltage characteristics.

FIGURE 3.4 MAP WITH LOCATION OF NETWORK POINTS COVERED BY THE VOLTAGE QUALITY MONITORING PROGRAM



For continuous phenomena, the results for each voltage characteristic are presented in a bar chart (see Figure 3.5) with the percentage of the 10 min records that are in compliance with the limits established by EN 50160: 2010.

FIGURE 3.5 EXAMPLE OF RESULTS PUBLICATION FOR CONTINUOUS PHENOMENA IN HV/MV DELIVERY POINTS AND MV/LV TRANSFORMERS



Despite the reference to EN 50160:2010, this solution for continuous phenomena publication is not completely aligned with the standard. The approach used in the standard is based on the "week in compliance" with the limits and not based on the compliance of each 10 min records.

Moreover, publication of results only based on the compliance with the standard may not be sufficient for network users. For instance, a given voltage characteristic can be in compliance with the standard, but very close to the limit. According to the approach used by the DSO, that information is not made available to the customers. Additionally, with this approach, it is not possible to follow the evolution of the voltage characteristics along the year.

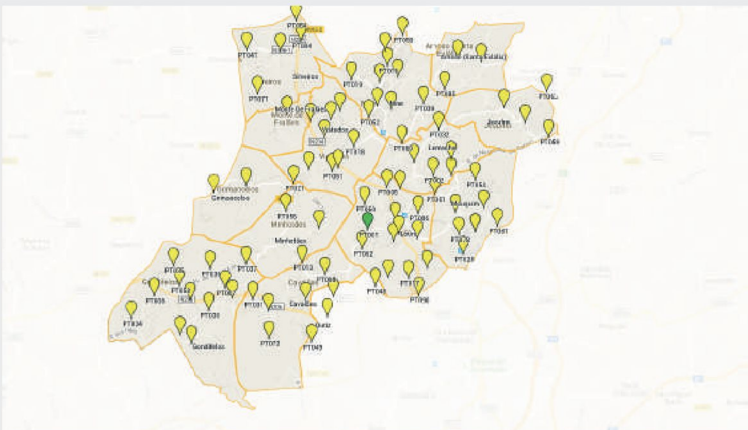
For the publication of the voltage events, the approach is the same as the one used by the TSO, based on the EN 50160: 2010 tables for voltage dips and swells.

Distribution System Operators exclusively in LV

In mainland Portugal, besides the largest DSO, there are 10 smaller companies operating exclusively LV networks. From those, CEVE is the one supplying more customers, approximately 9,000.

As presented in Figure 3.6, CEVE operates exclusively in LV and has also implemented a map on its website with the identification of the network points covered by the respective VQM programme [25].

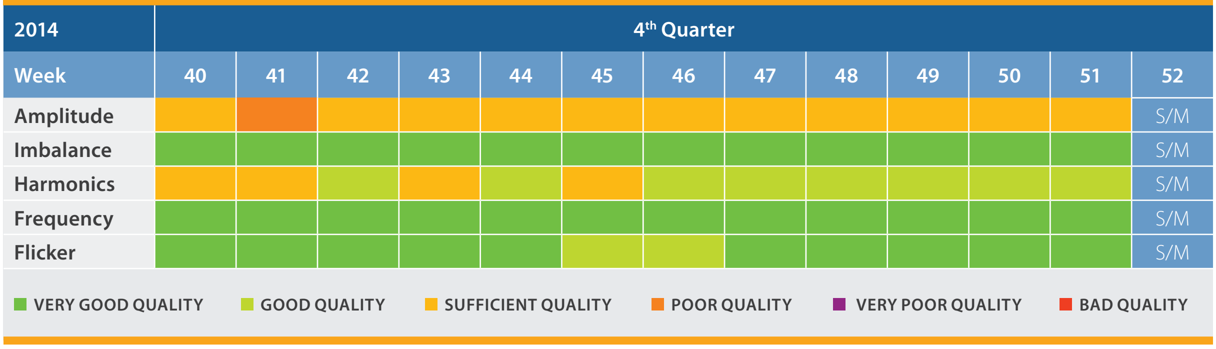
FIGURE 3.6 MAP WITH LOCATION OF THE MV/LV TRANSFORMERS COVERED BY THE VOLTAGE QUALITY MONITORING PROGRAM



As presented in Figure 3.7, the results of monitoring are reported with a labelling system based on a scale of 6 colours, from red (bad quality) to dark green (very good quality), equivalent to the one developed by the TSO.

Since the Portuguese quality of electricity supply code does not impose the monitoring of voltage events for LV networks, such data is not reported by this network operator.

FIGURE 3.7 PUBLICATION OF RESULTS FOR CONTINUOUS PHENOMENA IN MV/LV TRANSFORMERS



Some Guidelines for Publication of the Monitoring Results

The main objective of publishing the VQM results is to make performance data of the grid available to its users, especially to industrial customers. This data is important for present users of the grid to better understand voltage perturbations that are affecting their installations. Yet, it is also essential for future grid users when they need to select the location and the connection point for their installation and design protection tools that protect such installations from the most frequent perturbations.

Given the objective of making the monitoring results more useful for grid users, some guidelines for their publication are under development by the Portuguese NRA [26].

3.7. AWARENESS ON VOLTAGE QUALITY

As mentioned in Section 3.4, the impact and the frequency with which voltage quality issues accrue could vary between different customers and between different grid areas. For this reason, the emphasis in regulation is likely to be different across European countries. Nevertheless, voltage disturbance is expected to be an increasingly important part of electricity quality of supply and information and awareness on voltage quality could reduce inconveniences arising from voltage disturbances.

There are differences among the NRAs in the extent of emphasis on voltage quality. This could also be seen in reference to where the responsibility of voltage quality regulation is placed in the different countries, as described in Section 3.4.

One way of disseminating knowledge on voltage quality is to have good information on the internet. Voltage quality is mainly discussed in sessions or at conferences for industry organisations, DSOs and experts working with power quality in the Czech Republic, Ireland, the Netherlands and Norway.

In Ireland, there is no mandated work on education on voltage quality by the NRA or the DSOs, but a private company provides a half-day training course on power quality in electrical networks for the utilities, industrial and renewable energy sectors. Participants in this course would typically be engineering managers, maintenance managers, and facility engineers.

In the Netherlands, the branch organisation for energy suppliers, Energie Nederland and the network user association for industrial customers, VEMW are represented in a voltage quality session every half year. At this session, the progress on the VQM programme is presented.

In Norway, the energy industry organisation Energi Norge, which represents about 270 companies involved in the production, distribution and trading of electricity in Norway, arranges 2 seminars annually, 1 on voltage quality and 1 on continuity of supply. The seminars are open for both members of Energi Norge and other stakeholders. The NRA participates in planning of the seminars and gives lectures on miscellaneous topics within the regulation. In addition, Sintef Energy offers courses for the stakeholders on voltage quality.

In Portugal, the NRA coordinates a stakeholder group dedicated to the topic of the quality of service. In this stakeholder group, representatives of the TSO, DSO, suppliers, domestic and industrial network users associations, national engineers associations, national committee of CENELEC, universities, electrical equipment suppliers, and national association of municipalities participate. The NRA, in cooperation with the other members of the stakeholder group, developed materials for an awareness campaign[10]. The associations represented in the stakeholders group are responsible to disseminate the information materials by their members, and the suppliers are responsible to disseminate the materials by their MV customers.

10. http://campanhaqualidadeservico.erse.pt/

3.8. CASE STUDY: VOLTAGE QUALITY REGULATIONS IN ISRAEL

Following a brief description of the Israel VQM programme, some of the main results of the programme will be presented as well as a description of the customers' compensation mechanism, used in cases of poor voltage quality results.

Voltage Quality Monitoring Programme

In 2005, cooperation between the Israeli Electric Corporation (IEC) and the Israeli Electricity Market Regulatory Authority (PUA) initiated a Voltage Quality Monitoring Programme. This project included installation of monitors (smart meters) for all the 48 HV customers and additional 200 monitors on MV lines. Since then, the HV and MV grid is rigorously monitored and all data is accumulated. VQ in LV lines were not part of the project.

In 2011, the Standards Israeli Institution (SII) adopted the European EN 50160 standard as an acceptable standard for the Israeli electrical grid. As a result, PUA adopted this standard to be applied by regulated entities. The table below presents quality of supply data since 2010:

TABLE 3.15 RESULTS OF THE VOLTAGE QUALITY MONITORING PROGRAM: 2010-2014 IN ISRAEL

1-52 kV		2010	2011	2012	2013	2014
voltage dip (pu)	high value	967	561	308	386	295
	average	133.1	65.6	82.5	90.7	66
voltage swell (pu)	high value	-	1734	748	493	225
	average	-	31.2	14-sept	6-août	3-août
supply interruption (pu)	high value	61	34	78	61	40
	average	6-juin	5-juin	6-mai	7-mars	5-juil
thd v (%)	high value	6-mars	5-févr	6	8-août	6-juin
	average	3-mars	3-janv	3-févr	3	3
voltage unbalance (%)	high value	1-mai	2	2-août	2	2-mars
	average	0.6	0.6	0.7	0.6	0.6
P_{lt} (pu)	high value	1-sept	2	3-mars	2-août	2
	average	0.7	0.7	0.7	0.8	0.7
frequency (Hz)	max	50.1	50.1	50.1	50.1	50.1
	min	49.9	50	49.9	49.9	49.9
supply voltage variation 95% (%)	max	-8.1\9.2	-8.2\8.9	-10.4\9	-6.1\9.1	-6.8\9.6
	min	0.4\5.3	0.3\5.2	0.3\5.4	0.4\5.3	0.3\5.4
supply voltage variation 99% (%)	max	-	-	-11.1\9.9	-7.2\9.4	-7.3\10
	min	-	-	-0.8\6.1	-0.9\6.1	-1\6.2
52-161 kV		**2010**	**2011**	**2012**	**2013**	**2014**
voltage dip (pu)	high value	305	176	196	215	176
	average	137.8	47.4	79.5	79.3	57
voltage swell (pu)	high value		39	36	14	25
	average		1-mars	1-avr	0.5	1
supply interruption (pu)		3	2	-	2	1
THD v (%)	high value	2-août	3-avr	2-avr	3	3
	average	2-janv	2-janv	1-juil	1-juil	1-juil
voltage unbalance (%)	high value	1-avr	1-janv	0.9	0.9	1-févr
	average	0.5	0.5	0.5	0.4	0.5
P_{lt} (pu)	High value	1-mai	1-févr	1-févr	1-avr	3-févr
	average					
frequency (Hz)	high value	50.1	50.1	50.1	50.1	50.1
	average	49.9	50	49.9	49.9	49.9
supply voltage variation 95% (%)	high value	-6.2\4.5	-4.7\5.7	-5.8\4.7	-3.7\4.5	-4.5\4.6
	average	-2.1\3.3	-1.8\3.4	1.8\3.4	-1.5\3.3	-1.5\3.3

In the Table 3.15 the number for "high value" for voltage dips or swells references a site where the highest number of voltage dips/swells was measured. The number for "average" represents the total number of events measured by the monitoring system divided by the number of sites monitored. The number for "high value" for interruptions references a site where the highest number of voltage interruptions was measured in accordance with EN 50160. Interruptions are classified as "short" for a duration of 1 sec to 3 min and as "long" for a duration over 3 min. The results above only refer to short interruptions.

Customer compensation regulation for voltage quality

According to new regulations, the transmission grid owner or the distribution grid owner must investigate any customer complaint about voltage quality and provide the consumer with a report. If the failure to meet quality of supply standards is caused by the grid, the grid owner must compensate the consumer only for direct damage to electric devices. If the consumer has a private monitoring system that meets IEC standards, the measured values registered by the monitor is acceptable for compensation.

3.9. FINDINGS AND RECOMMENDATIONS ON VOLTAGE QUALITY

Finding 1

Voltage quality regulation:

From the responding NRAs, 15 have powers and duties to define voltage quality regulation and have issued regulatory orders regarding voltage quality. The term "regulation" includes setting standards, rules, and minimum requirements, implementing rewards, monetary penalties and other sanctions, publishing and setting obligations for voltage quality monitoring.

Finding 2

Voltage quality at customer level:

A number of countries have introduced legislation regarding emissions by individual customers. The concept of responsibility sharing for adequate voltage quality between the network operator, the customer and the manufacturer is identified. Of the responding NRAs, 16 foresee penalties for customers in the case of violation of disturbance limits.

Finding 3

Voltage quality monitoring:

A total of 18 countries are monitoring voltage quality. There are, however, some differences in the number of measurement instruments installed, the duration of monitoring and the monitored voltage levels. The data and aggregated data are available for most of the countries' NRAs. In some countries, data is also available for end-users. Only a few countries publish statistics based on the data: 4 countries provided tables with classification of voltage dips. Portugal provides a web-service with information about voltage quality at the substation level.

Finding 4

Awareness about voltage quality:

Of the responding NRAs, 5 informed that courses, seminars and information material is provided among stakeholders through branch organisations, research companies or other stakeholder groups. Only a few countries have replied that information on voltage quality is shared on the internet, in dedicated meetings/ workshops and such.

RECOMMENDATION 1

VOLTAGE QUALITY AT CUSTOMER LEVEL

Further investigations should be made in order to identify the responsibility for voltage disturbances according to the concept of responsibility sharing described in this report. In order to verify whether the network operator, the customer or the manufacturer is responsible, it is necessary to describe the factors that should be taken into account when identifying the responsible party.

RECOMMENDATION 2

VOLTAGE QUALITY MONITORING

It is recommended to publish the monitored voltage quality data or statistics that are based on the monitored data.

RECOMMENDATION 3

AWARENESS ABOUT VOLTAGE QUALITY

Education and awareness about how voltage quality issues might affect the network and the customers connected to the network will contribute to reducing inconveniences due to voltage disturbances. It is recommended that more countries increase the awareness and education on voltage quality in order to be prepared to deal with voltage quality issues.

RECOMMENDATION 4

MORE RESEARCH

It is recommended to perform more investigations on the use of smart meters for voltage quality monitoring. It is also recommended to do further investigations on the way voltage quality is influenced by distributed generation and prosumers.

04

➔ ELECTRICITY – COMMERCIAL QUALITY

4.1. WHAT IS COMMERCIAL QUALITY AND WHY IS IT IMPORTANT TO REGULATE IT

In a liberalised electricity market, the customer has either a single contract with the supplier (SP) or separate contracts with the supplier and the distribution system operator (DSO), according to the existing national regulations. In both cases, commercial quality is an important issue.

Commercial quality is directly associated with transactions between electricity companies (either DSOs or suppliers, or both) and customers. Commercial quality covers not only the supply and sale of electricity, but also various forms of contacts established between electricity companies and customers. New connections, disconnections, meter reading and verification, repairs and elimination of voltage quality problems, claims processing, etc. are all services that involve some commercial quality aspect. The most frequent commercial quality aspect is the timeliness of services requested by customers. From a customer perspective, these services often represent the customers' first interaction with the energy market. The CEER-BEUC 2020 Vision for Europe's Energy Customers identifies 4 Reliability, Affordability, Simplicity, Protection and Empowerment (RASPE) principles, which must underpin energy markets that engage with and understand the diverse needs of customers and which deliver services that meet those needs. Reliability is characterised as continuous and reliable supply as well as reliable customer service. Hence, commercial quality services are considered to be highly important for customer satisfaction and positive engagement with energy markets.

Where it concerns the need for commercial quality indicators, a distinction should be made between the deregulated energy market and the regulated market of network operation. The energy NRA normally does not intervene in the deregulated market, as competition between retailers is expected to result in the sufficient quality. However, in some cases, a certain level of customer protection is needed. The need for such protection differs among different types of customers.

Network operators (i.e. the regulated market) are natural monopolies, free or almost free from competition. Commercial quality indicators help ensure sufficient levels of quality for services provided by network operators. In some countries, a regulatory framework based on financial incentives (e.g. a bonus/penalty system) has been set: if the operator's performance reaches the quality level expected, it can get a bonus equal to or higher than zero, and if not, it will have to pay a penalty and/or compensation to the affected customer. Numerous commercial quality aspects (e.g. times for connections) in the deregulated electricity market are also related to distribution networks and therefore, given their monopolistic nature, should still be regulated.

EU legislation provides a framework for commercial quality measures. Directive 2009/72/EC and Directive 2009/73/EC require that Member States shall take appropriate measures to protect final customers, to ensure that they:

- Have a right to a contract with their electricity service provider that specifies: the services provided, the service quality levels offered, as well as the time needed for the initial connection; any compensation and the refund arrangements which apply if contracted service quality levels are not met, including inaccurate and delayed billing; and information relating to customer rights, including on the complaint handling and all of the information referred to in this point, clearly communicated through billing or website; and
- Benefit from transparent, simple and inexpensive procedures for dealing with their complaints. In particular, all customers shall have the right to a good standard of service and complaint handling by their electricity/gas service provider.

Based on these Directives, NRAs have a duty to monitor the time taken by TSOs and DSOs to make connections and repairs. While these requirements concern the regulated part of energy markets, their functioning is essential for retail markets as a whole. Therefore, it is important to monitor these key network services and their timely provision by DSOs so as to provide a full picture of market functioning from a customer perspective.

4.2. MAIN CONCLUSIONS FROM CEER'S PREVIOUS WORK ON COMMERCIAL QUALITY

Commercial quality has been an integral part of all CEER's Quality of Supply Benchmarking Reports over the past 15 years. The regulation of commercial quality mainly concerns the quality of the relationship between a supplier or a network operator (DSO, TSO) and a network user. In the 1st Benchmarking Report (in 2001), definitions of Overall Indicators (OI) and Guaranteed indicators (GI) were introduced in order to categorise the regulatory methods. In the 1st and 4 subsequent Benchmarking Reports these were referred to as "guaranteed standards" (GS) and "overall standards" (OS). The main difference between the 2 types of (now called) indicators is that the customer is reimbursed when the GI is not fulfilled (but not in the case of the OI). This 6th Benchmarking Report refers (also retrospectively), to Overall Indicators and Guaranteed Indicators as opposed to standards, with a distinction made between "standards" (which refer to the minimum level of service quality) and "indicators" (which measure service quality) as explained below.

The internal questionnaire, which was prepared for the **1st Benchmarking Report** (2001) was completed by 6 countries. As a result, the evaluation and the processing of the data did not cause significant difficulties. The 25 indicators evaluated were organised around concrete topics (e.g. access to the network, complaints, etc.). OS and GS existed in 4 of the 6 countries, with 1 country having only GSs while another country used individual indicators without any compensation. The scale of compensation (€15-33) to be paid automatically or by request in case of non-fulfilling the standards – was also presented.

The **2nd Benchmarking Report** (2003) pointed out that the number of regulations for suppliers has decreased in countries with fully opened markets but it forecasted the opposite for the DSO. The questionnaire results showed that many countries were already using the indicators. In 4 countries the total number of OS and GS was above 15. From the 25 indicators that were involved in the survey, 9 indicators were applied in more than 5 countries. In most of the countries, the compensation was paid automatically.

The **3rd Benchmarking Report** (2005) aimed to measure whether commercial quality regulation was applied widely. The CEER questionnaire originally listed 24 indicators and also allowed countries to identify any additional indicators specific to them. As a result, 19 countries provided data for 48 indicators altogether as well as data for the actual level of application of 42 indicators. The 14 most frequently used indicators were evaluated in 5 groups. For the first time, the survey also evaluated data of TSOs. The survey results showed a rate shift in favour of GS and the compensation to be paid automatically. Furthermore, regulatory authorities closely monitored the level of the service quality with significantly different sets of indicators, different contents and implementation levels.

For the **4th Benchmarking Report** (2008), CEER adjusted the list of indicators by reformulating the titles of some indicators and including a new indicator about the "Time from notice-to-pay until disconnection". The 15 indicators that were most frequently used in 21 countries were evaluated into 4 groups. It was clear that the majority of the commercial quality regulations related to DSOs. In addition to the 2 types of indicators of the previous reports (GS and OS), a new one was introduced: "other available requirements" (OAR) as a form of regulation. In this 4th Benchmarking Report, CEER recommended: (1) that countries consider the usefulness of GS tied to automatic compensation for non-compliance with the quality parameters, or other regulatory requirements, with the possibility to impose sanctions, whenever it is possible; and (2) that NRAs consider developing procedures able to measure the performance of call centres and monitor the performance of the licensees.

The **5th Benchmarking Report** (2011) was completed by 17 countries. The classification of the indicators into 4 groups was kept and a total of 17 indicators evaluated. The number of indicators applied as GS and OS varied between 1 and 14 in each single country. Based on the list of the most commonly used standards and recommendations from past CEER work some refinements were made to the standards: for example, the "response time to customer complaints" became the "response time to customer complaints and enquiries", subdivided into voltage complaints and interruption complaints. In addition, new standards were included such as the "time for disconnection upon customer's request" and the "time until the restoration of supply in case of unplanned interruption".

The key recommendations of the 5th Benchmarking Report were: to periodically review the national regulations of commercial quality, to enforce GS to better protect customers, to prioritise properly the national regulations of commercial quality, to maximise the benefits of high tech development for customers, and to develop the regulation of customer relations. The main points underlined in this report were:

- A widespread use of commercial quality indicators in European countries;
- A trend for increasing the adoption of GS;
- A priority of having access to electricity;
- Proven opportunities of high tech developments for improving quality for customers; and
- New trends in regulating customer relations.

The 5th Benchmarking Report and the best practices identified therein served as an important basis for the development of 2014 CEER Advice on the Quality of Electricity and Gas Distribution, which proposed 16 recommendations on quality levels of DSO services provided to household consumers. This advice presented a first step towards a European-wide harmonised view of which DSO services within connection, disconnection and maintenance would benefit from being defined and monitored by NRAs.

4.3. STRUCTURE OF THE CHAPTER ON ELECTRICITY COMMERCIAL QUALITY

As for the previous reports, the current 6th Benchmarking Report is focused more on the commercial quality performance of the DSOs than on the performance of the operators of the deregulated electricity market. The impact of market opening on commercial quality is not discussed in this edition.

Regarding commercial quality, the 6th Benchmarking Report adopts the same structure as the 5th Benchmarking Report. First, it presents the main aspects of commercial quality and categorises indicators into 4 groups. Then it provides the list of indicators and the approaches for regulating commercial quality.

The contents of this chapter on commercial quality are based on answers provided by 23 CEER countries: Austria, Belgium, Croatia, the Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Slovenia, Sweden and Great Britain. Germany provided some additional information but without any detailed data. The results of the benchmarking are presented in Section 4.5, organised by main groups of commercial quality aspects. In Section 4.5.6 attention is paid to the level of compensation to the customers. Section 4.7 presents the levels of commercial quality since 2008 (average percentage of non-compliance of the CEER countries). A summary of the results is provided in Section 4.8.

4.4. MAIN ASPECTS OF ELECTRICITY COMMERCIAL QUALITY

Commercial transactions between electricity companies and customers are traditionally classified as follows:

- **Pre-contract transactions**, such as information on connection to the network and prices associated with the supply of electricity. These actions occur before the supply contract comes into force and incorporate actions by both the DSO and the supplier. Generally, customer rights with regard to such actions are set out in codes (such as Connection Agreements and the General Conditions of Supply Contracts) and are approved by the regulatory authority or other governmental authorities; and
- **Transactions during the contract period**, such as billing, payment arrangements and responses to customers' complaints. These transactions occur regularly, like billing and meter readings or occasionally (e.g. when the customer contacts the company with a query or a complaint).

The quality of service during these transactions can be measured by the time the company needs to provide a proper reply. These transactions could relate to the DSO, the supplier/universal supplier (USP) or to the meter operator (MO) and could be regulated according to the regulatory framework of the particular country.

This chapter focuses on residential customers with a connection to the LV network because this is the largest group of customers and because small domestic customers often need more protection.

4.4.1. Main groups of commercial quality aspects

In order to simplify the approach to such a complex matter as commercial quality, indicators relating to commercial quality have been classified into 4 main groups:

- Connection (Group I);
- Customer Care (Group II);
- Technical Service (Group III); and
- Metering and Billing (Group IV).

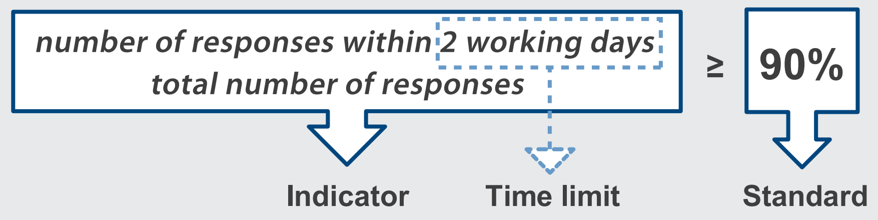
4.4.2. Commercial quality indicators and their definitions

The commercial quality questionnaires of the 6th Benchmarking Report differ from past editions. These changes resulted from the need to use a uniform set of more precise terms and definitions, in accordance with those currently in use in energy regulation literature. Hence, in this 6th Benchmarking Report, "standard" refers to the minimum levels of service quality, as defined by the NRAs, that a company is expected to deliver to its customers. Indicators are defined as a way to measure dimensions of service quality. NRAs can define standards for indicators or they can define indicators without standards and just publish the indicator values of the companies. Therefore, what is "overall" or "guaranteed" are the indicators, not the standards, because "overall" and "guaranteed" refers to the nature of the indicator. A standard is a limit, a value (e.g. a percentage). Thus, this report includes 3 types of indicators: guaranteed indicators, overall indicators, and other requirements. Following this need, the terms used in previous editions of the BR were substituted as described in the following table and example:

TABLE 4.1 EXAMPLES OF USE OF NEW TERMS

Terms used in the 5th BR	New term	Example m	Example n
Indicator no.		m	n
Description		~~Standard~~ indicator (guaranteed ~~standard~~ indicator) ~~number m~~	~~Standard~~ indicator (overall ~~standard~~ indicator) ~~number n~~
Standard	Type of indicator	GI	OI
Quantity of standard	Time limit	5	20
Unit of measurement	Unit of measurement of the limit	work days	days
% cases	Standard value	NA	90%
Actual performance 2010	Number of cases for which the limit was fulfilled	5.000	10.000
Actual % cases	Value of the indicator	99.5%	93.5%
Average performance time		3 work days	13 days
Compensation for non-performance of GS (euro)	Compensation for non-compliance	€ 20	NA
Compensation – payment method		Automatic	NA
Penality or consequence		NA	Sanction €20,000 when less than 85%
Company it refers to	Type of company	DSO	DSO
LV or MV	Voltage levels	LV	LV

FIGURE 4.1 EXAMPLE OF A COMMERCIAL QUALITY INDICATOR



For example, as illustrated in Figure 4.1 below, for the overall indicator "time taken to respond to a customer request for a new grid connection", the time taken should not exceed 2 working days in country A. The response should inform the customer of the process, the estimated schedule and requests for information required from the customer, including contact details. The time taken to respond to a customer request for a connection to the grid should not exceed 2 working days in 90% of the cases.

Based on the list of the most commonly used indicators and recommendations from past CEER work on commercial quality (4th and 5th Benchmarking Reports), a questionnaire was prepared so as to aid the comparability of the data.

Minor adjustments were made compared to the 5th Benchmarking Report. A new indicator was created in the Connection Indicators (Group I): "Time for a switching of supplier". One standard, namely the "Response time to customer complaints and enquiries" was divided into 2 indicators: "Response time to customer complaints"; and "Response time to customer enquiries". Additional 3 indicators have been included in the Customer Care Indicators Group (Group II) concerning call and customer centres (e.g. "Call Centres average holding time").

Table 4.2 shows the commercial quality indicators included in the survey and their definitions for the purposes of this 6th Benchmarking Report.

TABLE 4.2 COMMERCIAL QUALITY INDICATORS SURVEYED

Group	Indicator	Definition
I. Connection	I.1 Time for response to the customer's claim for network connection	Time period between the receipt of the customer's written claim for connection and the written response of the Licensee (date of dispatch), if no intervention is necessary on the public network.
	I.2 Time for the cost estimation for simple works	Time period between the receipt of the customer's written claim for connection and the written response of the Licensee including a cost estimation of works (date of dispatch), if connection can be executed by simple works* (*connection that requires no more than 1 day of work at the customer's premises).
	I.3 Time for connecting new customers to the network	Time period between the receipt of the customer's written claim for connection and the date the customer is connected to network, if no intervention is required in the network.
	I.4 Time for disconnection upon customer's request	Time period between the receipt of the customer's written request for disconnection (de-activation) until the date the customer is disconnected. See also de-activation of supply.
	I.5 Time for a switching of supplier	Time period between the receipt of the customer's written request for a switching of supplier until the date the switching is effective.

Group	Indicator	Definition
II. Customer care	II.1 Punctuality of appointments with customers	The personnel of Licensee appears on the customer's site within the time range (period of hours) previously agreed with the customer.
	II.2 Response time to customer complaints	Time period between the registration of a customer complaint and the date of the response to it.
	II.3 Response time to customer enquiries	Time period between the registration of a customer enquiry and the date of the response to it.
	II.4 Response time to customer voltage and/or current complaints	Time period between the registration of a customer's voltage and/or current complaint and the date of the response to it.
	II.5 Response time to customer interruption complaints	Time period between the registration of a customer's interruption complaints and the date of the response to it.
	II.6 Response time to questions in relation to costs and payments (excluding connection)	Time period between the receipt of the customer's questions (excluding cost estimation for connection) and the answer to it.
	II.7 Call Centers average holding time	Time period between the receipt of the customer's call and the answer given to that call by the Call Center regarding specifically emergency and/or failure calls.
	II.8 Call Centers service level	Time period between the receipt of customer's call and the answer given to that call by the Call Center.
	II.9 Waiting time in case of personal visit at client centers	Time period between the arrival of customers and the answer given by the operator.
	II.10 Percentage of customers with a waiting time below the limit in call centres	Percentage of customers that waited less than the regulatory time limit before their calls where answered .
	II:11 Percentage of customers with a waiting time below the limit in customer centres	Percentage of customers that waited less than the regulatory time limit before their where attended by a customer centre employee.
	II.12 Percentage of customers' requests answered within the time limit	-
	II.13 Average response time to customer complaints and/or requests	-
III. Technical Service	III.1 Time between the date of the answer to the VQ complaint and the elimination of the problem	Time period between the answer to the complaint and the elimination of the voltage disturbance.
	III.2 Time until the start of restoration of supply following failure of a fuse of a DSO	Time period between the failure of a DSO fuse and the start of fuse repairs.
	III.3 Time for giving information in advance of a planned interruption	Time period between the advance notice of a planned interruption and the beginning of the planned interruption.
	III.4 Time until the restoration of supply in case of unplanned interruption	Time period between the beginning of an unplanned interruption and the restoration of supply to the individual customer affected.
IV. Metering and Billing	IV.1 Time for meter inspection in case of meter failure	Time period between the meter problem notified by the customer and the inspection of the meter.
	IV.2 Time from the notice to pay until disconnection	Time period between the notice to pay / notice of disconnection after missing payments and the disconnection of the customer.
	IV.3 Time for restoration of power supply following disconnection due to non-payment	Time period between the payment of debts by the customer and the restoration of supply to the customer.
	IV.4 Yearly number of meter readings by the designated company	The number of actually performed meter readings by the designated meter operator (readings by the customer are excluded).
	IV.5 Percentage of meter readings made within less than a certain amount of time after the last one	Percentage of meter readings that were made before a certain amount of time, e.g. 92 days, has passed since the previous reading of the same meter.

The main results of the benchmarking are described in Section 4.5 distinguishing between the 4 main groups. The results on commercial quality should be interpreted with prudence, as some elements can be measured in different ways and data was not always available in every country. Importantly, as each country has its own regulatory system (with specific time limits, standards, compensation levels and penalty amounts), the performances of the operators in each country are not comparable.

4.4.3. How to regulate commercial quality

For this 6th Benchmarking Report, there are **3 types of requirements** for commercial quality:

- **Guaranteed Indicators** (GIs) refer to service quality levels that must be met in each individual case. If the company fails to provide the service level required, the customer affected must receive ***compensation***, subject to certain exemptions. The definition of GIs includes the following features:
  - performance covered by the standards (e.g. estimation of the costs for the connection);
  - maximum time before execution of the performance (response or fulfilment time);
  - economic compensation to be paid to the customer in case of non-compliance.

- **Overall Indicators** (OIs) refer to a given set of cases (e.g. all customer requests in a given region for a given transaction) and must be met with respect to the whole population in that set. A ***penalty*** has to be paid in case of non-compliance with the indicator. OIs are defined as follows:
  - performance covered (e.g. connection of a new customer to the network);
  - minimum level of performance (commonly in % of cases), which has to be met in a given period (e.g. 90% of new customers have to be connected to the distribution network within 15 working days).

- **Other Requirements** (ORs). In addition to GIs and OIs, NRAs (and/or other competent parties) can issue requirements to achieve a certain quality level of service. These quality levels can be set as the NRA wants, e.g. a minimum level which must be met by all customers at all times. If the requirements set by the NRAs are not met, the NRA can impose sanctions (e.g. financial penalties) in most of the cases.

4.5. MAIN RESULTS OF BENCHMARKING COMMERCIAL QUALITY INDICATORS

4.5.1. Commercial quality indicators applied

Table 4.3 shows whether a country monitors and/or applies a requirement (GI, OI or OR) for the different commercial quality aspects. In the last column, the total number of countries where an indicator is in effect is shown. The most common indicators are the ones concerning connection (Group I) and customer care (Group II) issues. The results show that 16 responding countries apply some type of indicator regarding the time for response to the customer's claim for network connection (I.1) and the time for connecting customers to the network (I.3). A total of 12 countries have 10 or more indicators: Austria, Belgium, Croatia, the Czech Republic, Estonia, France, Greece, Hungary, the Netherlands, Norway, Portugal and Slovenia.

TABLE 4.3 SUMMARY OF COUNTRIES WHICH ADOPT COMMERCIAL QUALITY INDICATORS

Group	Indicator	AT	BE	CZ	EE	EL	FI	FR	GB	HR	HU	IE	IT	LT	LU	LV	MT	NL	NO	PL	PT	SE	SI	Total
I. Connection	I.1 Time for response to customer claim for network connection	X	X	X	X					X	X		X	X	X	X	X	X	X		X	X	X	**16**
	I.2 Time for cost estimation for simple works	X				X		X			X		X		X	X			X				X	**9**
	I.3 Time for connecting new customers to the network	X	X	X		X	X	X		X	X			X	X			X	X		X	X	X	**15**
	I.4 Time for disconnection upon customer's request		X		X	X		X								X			X					**6**
	I.5 Time for a switching of supplier	X	X	X	X	X	X	X		X	X			X	X				X	X		X		**14**
II. Customer care	II.1 Punctuality of appointments with customers	X		X				X			X										X			**5**
	II.2 Response time to customer complaints		X		X	X		X		X	X			X		X		X	X	X	X			**12**
	II.3 Response time to customer enquiries	X	X		X	X					X					X		X	X		X		X	**10**
	II.4 Response time to customer voltage and/or current complaints		X	X		X		X		X	X							X	X	X			X	**10**
	II.5 Response time to customer interruption complaints		X		X			X		X								X	X	X				**7**
	II.6 Response time to questions in relation with costs and payments (excluding connection)			X				X										X		X				**4**
	II.7 Call Centers average holding time										X													**1**
	II.8 Call Centers service level							X			X								X				X	**4**
	II.9 Waiting time in case of personal visit at client centers										X								X					**2**
	II.10 Percentage of customers with a waiting time below the limit in call centres																				X			**1**
	II.11 Percentage of customers attended within the waiting time limit in customer centres																				X			**1**
	II.12 Percentage of customers' requests answered within the time limit																				X			**1**
	II.13 Average response time to customer complaints and/or requests																				X			**1**
III. Technical Service	III.1 Time between the date of the answer to the VQ complaint and the elimination of the problem		X	X		X		X	X		X											X	X	**8**
	III.2 Time until the start of restoration of supply following failure of fuse of DSO		X	X		X			X	X	X							X			X		X	**9**
	III.3 Time for giving information in advance of a planned interruption	X	X	X	X				X	X	X			X		X		X					X	**11**
	III.4 Time until the restoration of supply in case of unplanned interruption	X	X	X	X				X	X	X			X		X		X				X		**11**
IV. Metering and Billing	IV.1 Time for meter inspection in case of meter failure		X	X	X	X			X	X	X	X		X			X		X				X	**12**
	IV.2 Time from the notice to pay until disconnection	X	X	X		X				X							X	X				X		**8**
	IV.3 Time for restoration of power supply following disconnection due to non-payment	X		X	X					X	X				X						X			**7**
	IV.4 Yearly number of meter readings by the designated company	X	X	X			X	X		X	X	X						X				X		**10**
	IV.5 Percentage of meter readings made within less than a certain amount of time after the last one																				X			**1**
Total number of indicators per country		**11**	**15**	**14**	**10**	**11**	**3**	**12**	**5**	**13**	**18**	**2**	**2**	**7**	**5**	**7**	**3**	**12**	**12**	**5**	**12**	**7**	**10**	**196**

In Table 4.4, the number of various commercial quality indicators is shown together with the type of company they refer to (DSO, Supplier, USP, MO and TSO). The largest numbered of indicators are for connections (Group I) and customer care (Group II).

TABLE 4.4 NUMBER OF COMMERCIAL QUALITY INDICATORS (GI, OI, OR) PER GROUP AND COMPANY TYPE

Group	Indicator	DSO	SP/ USP	MO	TSO	Total
I. Connection	I.1 Time for response to customer claim for network connection	13	1	1	1	**16**
	I.2 Time for cost estimation for simple works	9	2	2	1	**14**
	I.3 Time for connecting new customers to the network	10	1			**11**
	I.4 Time for disconnection upon customer's request	5				**5**
	I.5 Time for a switching of supplier	7	5			**12**
II. Customer care	II.1 Punctuality of appointments with customers	4				**4**
	II.2 Response time to customer complaints	8	4	1	2	**15**
	II.3 Response time to customer enquiries	7	3		2	**12**
	II.4 Response time to customer voltage and/or current complaints	9			1	**10**
	II.5 Response time to customer interruption complaints	5			1	**6**
	II.6 Response time to questions in relation with costs and payments (excluding connection)	4			1	**5**
	II.7 Call Centres average holding time	2	1			**3**
	II.8 Call Centres service level	1	2			**3**
	II.9 Waiting time in case of personal visit at client centres	1	2			**3**
	II.10 Percentage of customers with a waiting time below the limit in call centres	1	1			**2**
	II.11 Percentage of customers attended within the waiting time limit in customer centres	1	1			**2**
	II.12 Percentage of customers' requests answered within the time limit	1	1			**2**
	II.13 Average response time to customer complaints and/or requests				1	**1**
III. Technical Service	III.1 Time between the date of the answer to the VQ complaint and the elimination of the problem	4				**4**
	III.2 Time until the start of restoration of supply following failure of fuse of DSO	7				**7**
	III.3 Time for giving information in advance of a planned interruption	13			3	**16**
	III.4 Time until the restoration of supply in case of unplanned interruption	7				**7**
IV. Metering and Billing	IV.1 Time for meter inspection in case of meter failure	8		1		**9**
	IV.2 Time from the notice to pay until disconnection	4				**4**
	IV.3 Time for restoration of power supply following disconnection due to non-payment	9	1	1	1	**12**
	IV.4 Yearly number of meter readings by the designated company	6		1		**7**
	IV.5 Percentage of meter readings made within less than a certain amount of time after the last one	1				**1**
Total		**147**	**25**	**7**	**14**	**193**

Table 4.5 shows the number of commercial quality indicators per country, distinguishing between GIs, OIs and ORs. It is evident that NRAs make more use of GIs than OIs. However, in many countries requirements applicable to each single transaction are applied as well, albeit without compensation to the customer in case of non-compliance. From the customer protection point of view, the most efficient regulation is based on GIs, or minimum requirements set by the NRA where sanctions can be issued.

TABLE 4.5 NUMBER OF COMMERCIAL QUALITY INDICATORS SURVEYED

Countries	OI	GI	OR	Total
Austria	11	0	2	**13**
Belgium	0	0	12	**12**
Croatia	4	1	6	**11**
Czech Republic	0	10	3	**13**
Estonia	7	0	3	**10**
Finland	0	0	1	**1**
France	2	4	8	**14**
Great Britain	0	5	0	**5**
Greece	0	8	1	**9**
Hungary	2	16	4	**22**
Ireland	0	0	1	**1**
Italy	1	2	1	**4**
Latvia	0	0	8	**8**
Lithuania	6	0	0	**6**
Luxembourg	5	0	0	**5**
Malta	1	1	1	**3**
The Netherlands	0	6	0	**6**
Norway	0	0	6	**6**
Poland	1	0	0	**1**
Portugal	7	3	1	**11**
Slovenia	4	5	1	**10**
Sweden	0	0	5	**5**
Total	**51**	**61**	**64**	**176**

Importantly, results from the 5th and 6th Benchmarking Reports are not comparable as they relate to different sets of countries and the questionnaires were different. Most of the countries use GIs and ORs. The Czech Republic, Great Britain, Greece, and the Netherlands use GIs. Other countries (Austria, Belgium, Finland, Ireland, Latvia and Norway) use ORs. In Estonia and Austria, the NRA monitors a set of requirements and sets OIs. Croatia, France, Hungary, Italy, Malta and Slovenia, make use of all the 3 types of indicators.

4.5.2. Group I: Connection

This group concerns commercial quality indicators that are applicable only to DSOs and are applied by a large number of NRAs. The reason for this is two-fold: on the one hand, both speedy clarification of the network access conditions and timeliness of concrete connections are of high priority to customers, and on the other hand, connection is mainly related to distribution and is therefore strictly related to the regulation of a monopoly activity (although in a few countries this activity can be performed by independent companies).

Table 4.6 contains data for household customer connections to the LV network: countries are grouped by the type of applied indicators, descriptive values of the standards and compensation. Several countries provided data for indicators for customers connected to different voltage levels (MV or HV). The table shows a synthesis of the commercial quality indicators for connection-related activities. Some particularities can be pointed out from the results.

TABLE 4.6 COMMERCIAL AND QUALITY INDICATORS FOR CONNECTION-RELATED ACTIVITIES RELATED TO LV CUSTOMERS

Quality indicators (Group I)	Countries grouped by types of indicators			Time limit (median value and range)	Compensation (median value and range)	Company involved
	OI	GI	OR			
I.1 Time for response to customer claim for network connection	AT, EE, HR, IT, LT, LU, MT, PT, SI	CZ, HU, IT, MT, NL	BE, HU, LV, NO	15 days (range 8-30)	€20 (range 16-25)	DSO
I.2 Time for cost estimation for simple works	AT, FR, LU	EL, HU, IT, SI	HU, LV	14 days (range 8-30)	€20 (range 15-70)*	DSO
I.3 Time for connecting new customers to the network	AT, HR, LT, LU, PT, SI	CZ, EL, HU, NL	BE, FI, FR, HU, SE	11 days (range 2 working days – 18 weeks)	€16 (range 15-250)	DSO
I.4 Time for disconnection upon customer's request	EE	EL	BE, FR, LV	5 working days (range 3-5)	€15 Only one country	DSO
I.5 Time for a switching of supplier	AT, EE, HU, LT	-	BE, CZ, EL, FI, FR, HR, LU, NO	21 days (range 2-42)	-	DSO

* including LV non-domestic customer (Italy).

As **connection-related activities** are closely interrelated, some countries reported that some indicators of the CEER questionnaire are not entirely identical with the ones they apply. For example, in Hungary, the indicators I.1 ("Time for response to customer claim for network connection") and I.2 ("Time for cost estimation for simple works") are identical. Sweden (1) does not monitor an indicator related to the "time for response to customer claim for network connection", but the network operators are bound to respond to connection requests (if they do not, the Energy Markets Inspectorate can request an explanation of why they have failed to respond and if necessary, demand the operator to respond to the connection request); (2) the operators are bound by law to have a plan for handling customer complaints; and (3) no indicator exists for the "time for connecting new customers to the network" (I.3), but the law says that the connecting customer shall be offered "reasonable terms" (the Energy Markets Inspectorate can examine all terms (e.g. time or cost) of a connection to see if they are reasonable, and if not, the network operators will have to change them).

As regards the "time for response to customer claim for network connection" (I.1), in Hungary, over the past 5 years, actual performance levels have been relatively stable (approximately equal to 98.68%) and the average performance time has been decreasing from 2010 (3.84 days) to 2014 (1.3 day), with a time limit of 8 days and a standard of 100%. The Czech Republic achieved a stable performance from 2010 (99.44%, with an average performance time of 9 days) to 2014 (99.95%, with an average performance time of 7 days, and a time limit of 30 days for LV customers). In Slovenia, the performance has slightly improved since 2010: from 82.24% (in 2010, with an average performance time of 14.5 days) to 86.25% (in 2014, with an average performance time of 15.4 days and a time limit of 20 working days). Portugal had an annual performance of 72.61%.

The "time for cost estimation for simple works" (I.2) indicator exists in 9 countries, mainly as a guaranteed indicator. In Portugal, there is no indicator corresponding to "time for cost estimation for simple works" (I.2) since 2013. Greece achieved a good and slightly increasing quality level from 2010 to 2014: an average performance time decreasing from 6.49 days to 6.15 days (with a time limit of 15 working days), and an annual average performance increasing from 98.32% to 99.21%. In Hungary, the performances decreased slightly from 2010 to 2014: the average performance time decreased from 1.13 days to 2.51 days (time limit of 8 days), and average performance decreased by approximately 1 point of percentage from 99.40% to 98.30%; this slight drop can be explained by an increase of the number customer requests for cost estimation from 2010 to 2014 (+34.70%).

TABLE 4.7 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE INDICATOR "TIME FOR COST ESTIMATION FOR SIMPLE WORKS" IS MONITORED

Country	Criteria / types of customer	Obligation	Standard that must be met	Compensation
Austria	LV	14 days	95%	"Administrative offence – fined up to €75,000 "
	MV	30 days	95%	"Administrative offence – fined up to €75,000"
Croatia	LV	20 days		
Greece	LV	15 working days		€15
Hungary	LV	8 days	100%	€16
Italy	LV domestic	20 working days		€35
	LV non-domestic	20 working days		€70
	MV	40 working days		€105
Slovenia		10 working days	100%	€20

The "time for connecting new customers to the network" (I.3) is monitored by 15 countries, through the 3 types of indicators (OIs, GIs and ORs). In Portugal, this is measured by the indicator "percentage of connections of new customers made within 2 working days" and it is only applied for simple works, having a standard of 90%. In 2014, the country achieved an average performance of 68.50% (for a total of 292,972 requests).

The "time for a switching of supplier" (I.5) is a new indicator of the CEER 2014 questionnaire. It is monitored as an OR indicator for most countries and as an OI for 3 countries (Estonia, Hungary and Lithuania). A total of 7 countries reported existing numerical time limits. In Portugal, 2 overall indicators exist for the switching of supply: the average switching time with preferential date (customer asks for a specific date) and the average switching time without preferential date (customer doesn´t express his wish for a specific date). In Malta, supplier switching is not possible as the supply market is not open to competition.

Time limits for connection-related activities often have a complex structure, depending upon the complexity of the work to be done. In some countries, the services are achieved in the agreed lead times. For example, in France, the time for connecting a new customer to the network (I.3) is agreed with the customer.

TABLE 4.8 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE SUBJECT "CONNECTION OF NEW CUSTOMERS TO THE NETWORK" IS MONITORED

Country	Criteria / types of customer	Obligation	Standard that must be met	Compensation	Compensation payment method
Austria	LV	14 days	95%	"Administrative offence – fined up to €75,000"	
	MV	30 days	95%	"Administrative offence – fined up to €75,000"	
Czech Republic	LV	5 working days		max €250	Upon claim
	MV	5 working days		max €500	Upon claim
	HV	5 working days		max €500	Upon claim
France	Date agreed with the customer	-			
Greece	LV	20 working days		€15	Automatic
Hungary	LV	8 days	100%	€16	Automatic
Lithuania	MV	20 working days			
The Netherlands	LV	126 days			
Portugal	LV	2 working days	90%		
Slovenia		20 working days	85%		

The differences in interpreting what "complex work" means probably explains why a rather large range of time limits and compensation values can be observed (see Table 4.8): from 8 to 30 days, with a median value of 15 days. In France, (1) the time to respond to a cost estimation for simple works has to be 10 working days maximum (8.4 days in 2010); (2) since 2014, due to a large number of applications, the main DSO has established a new connection procedure that allows it to anticipate studies (it contacts the customer when a building permit is submitted and proposes the customer to anticipate the studies), thus, the indicator is no longer appropriate because it records the time taken to carry out the study from an anticipated date to the date agreed with the customer.

There is also a broad range of time limits for LV customers considering the "time for connecting new customer to the network" (I.3), from 2 working days (in Portugal) to 126 days (in the Netherlands), with a median value of 11 days. Concerning the disconnections, the results do not show a wide disparity between the time limits: from 3 working days to 5 working days, with a median value of 5 working days. Of note for this indicator is that in Greece, the limit was set to 3 working days in April 2014 (it was 2 working days in previous years).

Compensation in case of non-compliance with the guaranteed indicators can also have a complex structure. In many countries, compensation depends upon voltage level or the types of customer (household or business customer). The requirements for indicators of Group I have been defined according to different criteria. The expected levels of quality can be determined by the connection capacity or the complexity of the project, but in most countries, it depends on the voltage level (low, medium or high voltage). The diversity of regulation is clearly shown in Tables 4.7 and 4.8.

For all the guaranteed indicators related to connection in Slovenia, values for compensations at the guaranteed indicators stand as follows: €20 for households, €40 for other LV customers and €100 for MV customers. In Italy, costs estimation for simple works are subject to GI and the limit differs according to the voltage level: the limit is 20 working days for the LV customers (compensation is €35 for a LV domestic customer and €70 for a LV non-domestic customer), and 40 working days for MV customers (compensation is €105).

There is not a wide range of compensations for LV customers for the indicator "Time for response to customer claim for network connection" (I.1): the amounts paid by the DSO vary from €16 (in Hungary) to €25 in (the Czech Republic), with a median value of €20. However, there is a broad range of compensation amounts for LV customers considering the "Time for cost estimation for simple works" (I.2): from €15 to €70. In Greece, the main improvement that has been made related to guaranteed services adopted by the DSO was the implementation of a new policy method: the automatisation of the compensation payment.

4.5.3. Group II: Customer care

While the indicators in Group I (Connection) refer exclusively to DSOs, in Group II, they apply mostly to DSOs but also to suppliers and TSOs. Also for the indicators in Group II, some responding countries have indicated that certain indicators cannot be unambiguously interpreted. Most of the indicators related to **customer care** are guaranteed indicators with payment of compensation to the customer in case of non-compliance.

Regarding the indicator "Punctuality of appointment with customers" (II.1), Hungary registers an increasing performance from 2010 (96.30%) to 2014 (98.74%). In Portugal, besides the "Punctuality of appointment with customers" (II.1), (1) the operators have other obligations regarding appointments with customers: USP and MO are responsible for the payment of compensations to the customer or to the DSO, when applicable; (2) the customers, the DSO and the USP can cancel the appointment without having to pay compensation if the cancelation is done until 5pm of the day before the appointment. Until 2014, only performed appointments (not all the requested) data were available for Portugal: data about punctuality from customers before 2014 was not reliable because it included situations of cancelation not due to the client; therefore, it was not reported.

Considering the "response to customer complaints", the TSO in Portugal has an overall indicator for the annual average time of answer to customer complaints. The 15 working days limit only applies to the DSO and the USP. Each SP has to define a time limit for answering to complaints and a compensation value, and include them in the contract with the customer. Before 2014, there were 3 quality of service codes: one for Mainland Portugal, another for the Azores and another for Madeira autonomous regions. Each had different demands regarding customer complaints. The time limit in Portugal to respond to customer complaints is 15 working days. In 2014, it registers an average performance time of 8 days and a performance of 91.96% (no standard value for this indicator).

For the "customer voltage and/or current complaints" (II.4), in Portugal, the DSO must either explain to the customer the reasons for the lack of quality, or pay a visit to the customer installation to identify the causes for the lack of quality. If the lack of quality is the responsibility of the customer, then the customer has to pay to the DSO the cost of the verification performed by the DSO. In Sweden, there is no indicator related to "response time to customer voltage and/or current complaints" (II.4), but if there are problems with voltage or current that is not solved, the customer can contact the Energy Markets Inspectorate and report the problem.

In France, the indicator related to the time to response to customer's voltage complaints (II.5) and for interruption (II.6) is the same.

TABLE 4.9 COMMERCIAL AND QUALITY INDICATORS FOR CUSTOMER CARE RELATED ACTIVITIES

Quality indicators (Group II)	Countries grouped by types of indicators			Time limit (median value and range)	Compensation (median value and range)	Company involved
	OI	GI	OR			
II.1 Punctuality of appointments with customers	AT	CZ, FR, HU, PT	-	2.5 hours (range 1-4)	€25 (range 16-100)	DSO
II.2 Response time to customer complaints	FR, HU, PT	EL, FR, HU, PT	BE, EE, HR, LV, NO	15 days (range 5 working days-30)	€20 (range 15-30)	USP/SP, DSO, TSO
II.3 Response time to customer enquiries	AT, HU	EL, HU, PT, SI	BE, EE, FR, LV, NO	15 days (range 5 working days-30)	€16 (range 15-20)	USP/SP, DSO, TSO
II.4 Response time to customer voltage and/or current complaints	SI	CZ, EL, FR, HU	HR, NO	30 days (range 10-60)	€23 (range 15-50)	DSO, TSO
II.5 Response time to customer interruption complaints	-	FR	BE, EE, HR, NO	30 days (range 24 hours-30 days)	€30 Only one country	DSO, TSO
II.6 Response time to questions in relation with costs and payments (excluding connection)	PL	CZ	FR	14 days (range 5-30)	€25 Only one country	DSO, TSO

As regards the **time limits**, an important issue is that of appointments with customers since some operations (for example, access to the premises) require the presence of the customer. NRAs can impose standards (mainly GIs for DSOs) in order to ensure punctuality of appointments with customers. As shown in Table 4.9, many countries apply indicators for this quality aspect. The median value of the time limit related to punctuality of appointments with customers is 2.5 hours, varying from 1 hour to 4 hours depending on the country. The Czech Republic's performance decreased slightly from 2011 (1.1 hour) to 2014 (2.2 hours).

Concerning the response time to customer complaints (II.2) and enquiries (II.3), the median value of the time limit is 15 days, and the ranges vary from 10 working days (Belgium) to 30 days (Estonia, Latvia) for LV customer's complaints, and from 5 working days to 30 days for customer's enquiries. In Portugal, all enquiries made to call centres must be answered within 3 working days. In 2013, Lithuania and Latvia registered an average performance time of approximately 13 days.

Compensations, when the standard related to punctuality of appointments (II.1) is not met, are due in almost all countries that monitor this indicator (mostly a GI). The level of the compensation payments for this quality aspect varies from €16 (in Hungary) to €100 (in the Czech Republic). The compensation payment is automatic in Hungary and Portugal and upon claim in the Czech Republic and France. Concerning the response time to customer complaints and enquiries, the median value is equal to €20 for complaints and €16 for enquiries.

Very few countries monitor the "response time to customer interruption complaints" (France, with a compensation of €30 if the standard of 100% in 30 days is not met) and the "response time to questions in relation with costs and payments" (the Czech Republic, with a compensation of €25 above 15 days) as a GI.

Additional obligations exist in Portugal, regarding customer centres, in addition to the indicators reported in this report: from 2014, companies must report all visits by customers in all customer centres, regardless of whether it is a centre with verification of the waiting time or not. Furthermore, the data reported by companies must be from a set of centres that have represented, at least, 40% of the visits in the previous year.

TABLE 4.10 EXAMPLE FOR THE REGULATION OF CUSTOMER CONTACTS OTHER THAN IN WRITING

Country	Call centers' average holding time*	Call centers' average service level	Waiting time in case of personal visit at client centres
Hungary	GI for DSO. Requirement: 75% of the cases must be answered within 30 seconds, actual value in 2014 is 35.21 seconds (782,379 calls presented) and annual performance is 78.62%.	GI for USP. Requirement: 80% of the cases must be answered within 30 seconds, actual value in 2014 is 28 seconds (1,780,745 calls presented) and annual performance is 79.65%.	GI for USP. Requirement: 80% of the cases must be answered within 10 minutes, actual value in 2014 is 6.42 minutes (1,711,701 visits).

*including LV non-domestic customer (Italy).

4.5.4. Group III: Technical Service

Group III includes indicators that are related to **technical service**. All indicators relate to distribution and/or transmission activities and therefore the standards of Group III refer exclusively to DSOs and TSOs. Handling voltage complaints normally involves 2 steps: the first step is to verify, through performing measurements, whether any regulation or norm has been violated; the second step of the remedy is the correction of voltage problems through appropriate works on the networks. It is important that any customer complaint related to voltage disturbance is rectified without undue delay. The exact time needed to rectify the problem or to implement temporary solutions will vary a lot and will depend upon the complexity of the given situation.

The indicator III.1 "Time between the date of the answer to the VQ complaint and the elimination of the problem" exists since the 5th Benchmarking Report. The aim of the question on voltage quality in the 4th Benchmarking Report was to evaluate the regulations in relation to the first step of solving the problem (customer complaint, measurements, verify the problem, response to the customer), while in the 5th and the 6th Benchmarking Reports, the requirements for both steps (response to the customer (indicator II.4) and correction of the voltage problem) are investigated. Only Belgium, the Czech Republic, Slovenia and Hungary reported existing numerical time limits.

The Czech Republic, Great Britain and Hungary are monitoring a guaranteed indicator, whereas in Slovenia, it is an overall indicator. NRAs in Belgium, Finland and France issue requirements to achieve a certain quality level of service. In Sweden: (1) there is no indicator for that issue but if there are problems which are not solved, the customers can contact the NRA and report the problem; (2) according to the Electricity Act, a network concessionaire is required to remedy deficiencies with the transmission of electricity to the extent that the costs to remedy the deficiencies are reasonable in proportion to the inconvenience for the electricity consumers that are associated with the deficiencies, and (3) electricity suppliers and network concessionaires must have established procedures for handling complaints from consumers.

TABLE 4.11 COMMERCIAL AND QUALITY INDICATORS FOR TECHNICAL CUSTOMER SERVICE

Quality indicators (Group III)	Countries grouped by types of indicators			Time limit (median value and range)	Compensation (median value and range)	Company involved
	OI	GI	OR			
III.1 Time between the date of the answer to the VQ complaint and the elimination of the problem	SI	CZ, GB, HU	BE, FR, SE	1 month (range 6 days-24 months)	€43 (range 16-50)	DSO
III.2 Time until the start of restoration of supply following failure of fuse of DSO	-	CZ, EL, GB, HU, NL, PT, SI	BE, FR	4 hours (range 3-6)	€20 (range 15-100)	DSO
III.3 Time for giving information in advance of a planned interruption	AT, EE, LT	GB, HU, NL	BE, CZ, HR, LV, SI	3 days (range 1-15)	€30 (range 16-43)	DSO
III.4 Time until the restoration of supply in case of unplanned interruption	AT, EE, LT	CZ, GB, HU, NL	BE, HR, LV, SE	12 hours (range 4-24)	€106 (range 100-250)	DSO

The "time until the start of the restoration of supply following failure of a fuse of the DSO" (III.2), is mainly monitored as a GI. The Czech Republic, Greece, Hungary and Portugal register an average performance above 98% since 2010. In addition, the Czech Republic achieved a stable performance time of 0.07 days (that is 2 hours) since 2012. In Greece, (1) the obligation refers to both MV and LV voltage levels; (2) the starting time is defined by the receipt of a blown fuse notice, if the call is made during working hours of the respective DSO service, otherwise it is set at opening of business for said service on the following day.

The "time of giving information on the planned interruption" (III.3) is used as an indicator by 11 reporting countries. The aim of notifying a customer about an interruption in advance is to give the end-user the possibility to implement proper measures in order to reduce the negative consequences of the interruption. In Poland, there is no overall indicator but for failing, at least 5 days in advance of the dates and duration of planned interruptions, for every day of delay, consumer is entitled to compensation in the amount of 1/50 of the average wage in the national economy.

The "time until the restoration of supply in case of unplanned interruptions" (III.4) is used as an indicator by 11 reporting countries. In Belgium, Croatia, Latvia and Sweden, existing requirements are expected to achieve a certain level of quality in case of unplanned interruptions. In Austria, immediate measures are to be taken to provide information to customers about the expected duration of the interruption. In Sweden, no indicator exists but according to the Electricity Act, the electricity supply shall be of good quality, which implies a prompt restoration of supply following an unplanned interruption.

Concerning **time limits**, the "time between the date of the answer to the VQ complaint and the elimination of the problem" (III.1), there is a wide range of time limits amongst countries: from 6 days, to 24 months, with a median value of 1 month. In fact, in the Czech Republic, different time limits applied depending on the type of the problem: 1 month for a simple measure, 6 months in case of building measures, and a very long deadline of 24 months when building permits are needed. In Hungary, the time limit for LV customers is a long delay of 12 months, as was the case in 2010.

One of the most commonly applied GIs of Group III is the "time until the start of the restoration of supply following failure of a fuse of the DSO" (III.2). In some countries (the Czech Republic, Portugal and Hungary), the time limits depend on the customer's geographic location, the voltage level, the time of the call (day or night) or the type of customer. The range of the time limits varies from 3 hours in Great Britain (if the failure occurs on a working day) and Portugal (for priority consumers), to 12 hours (mostly if the failure occurs on periphery of municipalities) in Slovenia.

TABLE 4.12 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE INDICATOR III.2 "TIME UNTIL THE START OF THE RESTORATION OF SUPPLY" IS MONITORED

Country	Criteria / types of customer	Obligation	Compensation
Belgium	LV,MV,HV	6 hours	€100
Czech Republic	In Prague (LV,MV,HV)	4 hours	€50
	Elsewhere (LV,MV,HV)	6 hours	€50
Great Britain		3 hours (working day) 4 hours (otherwise)	€43
Hungary	More than 50,000 inhabitants, on week days	4 hours	€16
	More than 50,000 inhabitants, on weekends, and between 5,000 and 50,000 inhabitants, on working days	6 hours	
	Between 5,000 and 50,000 inhabitants at weekends, and less than 5,000, on working days	8 hours	
	Less than 5,000 inhabitants, at weekends and on the periphery of municipalities	12 hours	
	On periphery of municipalities	12 hours	
Portugal	For priority consumers	3 hours	€20
	LV	4 hours	

Notes:
Great Britain: Where a distributor is informed by a telephone call, text message, or email made by a customer whose premises are directly connected to that distributor's distribution system that, or of circumstances suggesting that, the distributor's fuse has operated so as to disconnect the supply to those premises. Where an appropriate person fails to attend (within 3 hours on a working day and 4 hours on any other day) the premises where the distributor's fuse is situated for the purpose of replacing or reinstating that fuse and restoring the supply, the distributor must, except in certain circumstances, pay the customer £30.

The necessary "time of giving information on the planned interruption" (III.3) will vary between different types of customer (i.e. industrial versus residential). The negative consequences of an interruption will also vary a lot between the groups of type of customers (LV, MV and HV). In almost all responding countries, some requirements for a deadline have been applied. In a few countries, the deadline for providing customers with information on planned interruptions is very long: in the Czech Republic (15 days for the DSOs, 50 days for the TSOs), in Hungary (15 days) and in Lithuania (10 days). In contrast, in most of the other countries a deadline between 1 and 5 days is applied. In a few cases, this deadline differs depending on the type of work requiring the planned interruption or the affected voltage level: for example, in Croatia, the time limit is 1 working day for end-users whose consumption is < 30 kW, and it is 2 working days for end-users whose consumption is > 30 kW. Despite the importance to customers of being informed about planned interruptions ahead of time, only 3 countries apply compensation in the case of non-fulfilment.

Regarding the "time until the restoration of supply in case of unplanned interruptions" (III.4), as expected, time limits are diverse (from 4 hours to 24 hours, with a median value of 12 hours) and depend on the voltage level and the location of the interruption. In the Czech Republic, the time limits are: 8 hours for MV and HV customers in Prague, 12 hours for LV customers in Prague and MV and HV customers that are elsewhere, and 18 hours for LV customers that are elsewhere. In Hungary, in case of a single interruption, the time limit is 12 hours, and in case of multiple simultaneous interruptions, it is 18 hours. In the Netherlands, an unplanned interruption should be solved within 4 hours for LV customers (lower or equal to 1 kV), within 2 hours for MV customers (between 1 kV and 35 kV), within 1 hour (higher or equal to 35 kV).

TABLE 4.13 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE INDICATOR "III.4 TIME UNTIL THE RESTORATION OF SUPPLY IN CASE OF UNPLANNED INTERRUPTION" IS MONITORED

Country	Criteria / types of customer	Time limit	Compensation
Czech Republic	In Prague (LV)	12 hours	10 % of the customer's annual payment for distribution (max. 250) upon claim
	Elsewhere (LV)	18 hours	
	In Prague (MV)	8 hours	10 % of the customer's annual payment for distribution (max. 500) upon claim
	Elsewhere (MV)	12 hours	
	In Prague (HV)	8 hours	10 % of the customer's annual payment for distribution (max. 5,000) upon claim
	Elsewhere (HV)	12 hours	
Great Britain	Automatic for customers on the Priority Services Register, upon claim for all others. (LV, MV, HV)	12 hours	€106.5 (domestic customers) €213 (non domestic customers)
Hungary	In case of a single interruption	12 hours	
	In case of multiple simultaneous interruptions	18 hours	
Lithuania	There are 3 categories of restoration of supply, depending on customer request	Automated	
		2.5 hours	
		24 hours	

Notes:
Great Britain: Where the supply to a customer's premises is interrupted as a result of a failure of, fault in or damage to that distributor's distribution system (except where the standard relating to the distributor's fuse applies). Supply is not restored within 12 hours, the distributor must pay the customer £75 (£150 for non-domestic customers), and a further £35 for each succeeding period of 12 hours without supply.

As regards the "time between the date of the answer to the VQ complaint and the elimination of the problem" (III.1), the **compensation** range varies from €16 to €50, with a median value of €43. In the Czech Republic, the level of the compensation is €50 (upon claim) for LV customers since 2010, with a maximum amount of €2,500. In Great Britain, the compensation is €43 and is also upon claim, contrary to Hungary, for which an amount of €16 is automatically paid in case of non-compliance.

There is a broad range of levels of compensations for the "time until the start of the restoration of supply following failure of a fuse of the DSO" (III.2): from €15 (in Greece), to €100 (in Belgium), with a median value of €20 (Slovenia, Portugal). In Great Britain, the level of the compensation increased from 2010 (€22) to 2014 (€43), and the customer must be compensated -except in certain cases- (1) when a distributor is informed by a telephone call, text message, or e-mail made by a customer that the distributor's fuse has operated so as to disconnect the supply to those premises, and (2) when an appropriate person fails to attend within the time limit, the installations where the distributor's fuse is situated for the purpose of replacing or reinstating that fuse and restoring the supply.

Concerning the "time of giving information on the planned interruption" (III.3), the levels of compensation varies from €16 to €43 for LV domestic customers. In Great Britain, the amount depends on the type of customers: it costs €43 for a domestic customer and €85 for a non-domestic customer. Despite the importance to customers of being informed about planned interruptions ahead of time, only 2 countries apply compensation in the case of non-fulfilment.

4.5.5 Group IV: Metering and billing

Group IV includes a set of commercial quality indicators related to metering and billing. Table 4.14 summarises responses on commercial quality indicators of Group IV, which refer mainly to DSOs. In some countries (such as Ireland), the indicators are also set for MOs. In general, only few NRAs dictate indicators in connection with meters. As regards the indicators related to **metering and billing**, all 3 types of indicators are used. Compensation in case of non-performance is applied in a small number of responding countries.

TABLE 4.14 COMMERCIAL AND QUALITY INDICATORS FOR METERING AND BILLING SERVICE

Quality indicators (Group IV)	Countries grouped by types of indicators			Time limit (median value and range)	Compensation (median value and range)	Company involved
	OI	GI	OR			
IV.1 Time for meter inspection in case of meter failure	EE, HR, LT	CZ, EL, GB, HU, SI	BE, IE, NO	6.5 days (range 3-20)	€20 (range 15-31)	DSO
IV.2 Time from the notice to pay until disconnection	AT, EE, HR	NL	BE, CZ, GB, SE	15 days (range 10-45)	NA	DSO
IV.3 Time for restoration of power supply following disconnection due to non-payment	AT, EE, LT, LU	CZ, EL, HU, SI, PT	HR, LV	2 days (range 0.5-5)	€20 (range 15-50)	DSO
IV.4 Yearly number of meter readings by the designated company	AT, FR	HR, NL	BE, CZ, HU, LV, SE	5 months (range 1-12)	NA	DSO, MO
IV.5 Percentage of meter readings made within less than a certain amount of time after the last one	PT			96 days since the last reading	NA	DSO

Regarding the "time for meter inspection of a meter failure" (IV.1), the typical indicators in use are relatively heterogeneous. There are guaranteed indicators in the Czech Republic, Great Britain, Greece, Hungary and Slovenia. In Ireland, (1), the DSO has cyclical inspection regimes for major metering, depending on the meter type and voltage (MV and HV); (2) the DSO has policies around inspections which can be every 2, 3 or 6 years; (3) at LV (i.e. domestic meters), the DSO has no policy for regular inspections but if a customer or supplier request that the metering is checked a call is logged and a meter test visit is scheduled, and similarly, the DSO will replace any faulty meters it finds during other duties. In Norway, the DSOs are responsible for all the meters, and must replace the meters in cases of meter failure. In Greece, the definition of the "time for meter inspection of a meter failure" is slightly different: it is considered as a meter inspection following written request by a customer or its supplier. Greece had an average performance of 91.74% in 2014.

Time limits for the "time from notice to pay until disconnection" (IV.2) typically vary between 10 working days and 6 weeks. Furthermore, there are several examples where NRAs apply country-specific considerations. In Austria, in the case of separate bills, the DSO has to send at least 2 payment reminders with at least 2 weeks deadline, that is, a minimum 4 week deadline before the customer is disconnected.

Concerning the "time for restoration of power supply following disconnection due to non-payment" (IV.3), 11 countries apply time limits, but only 5 allow compensation (as a guaranteed indicator) in case of non-compliance. In Poland, there is no indicator but the energy firm is obliged to restore the power supply immediately. In Austria, the DSO has to reconnect during the next working day.

The situations of non-compliance by the customer that may lead to disconnection of power supply vary from country to country. For example, in Croatia, the TSO/DSO may discontinue electricity supply to a customer, having first submitted the reminder, in different cases: for example, if a customer or a producer does not reduce the use of power within the limits of approved connecting power, if no supply contract and the network use agreement have been concluded; etc. In Hungary, different situations also exist that may lead to disconnection of the power supply such as non-payment of charges or a breach of the contract.

The "yearly number of meter readings by the designated company" (IV.4) is monitored as an OR in 5 countries: Belgium, the Czech Republic, Hungary, Latvia and Slovenia. In Austria, the operator has to inform customer 14 days in advance in case of a meter reading. In Latvia, DSO has to check meters at least once a year. In Sweden, there is no indicator but requirements on meter readings are set out in the Electricity Act.

Considering **time limits**, as regards the "time for meter inspection of a meter failure" (IV.1), 8 countries reported existing numerical time limits applied for LV customers. There is not a wide range of time limits: from 3 days (in Belgium) to 20 working days (in Greece), with a median value of 6.5 days. In the Czech Republic, the limits are 15 days for answering and 60 days for meter inspection. In Hungary (time limit of 15 days), Lithuania (time limit of 5 working days), and Slovenia (time limit of 8 working days), the standard is 100%.

The time limit regarding the "time to restore the power supply following disconnection due to non-payment" (IV.3) attracted the most attention among the responding NRAs. It is closely linked to the availability of the service. Customers who have settled their debts and paid all fees in connection with the disconnection can request to be reconnected to the electricity network as soon as possible. For more than one third of the reporting countries, reconnection of customers must be performed by the DSO within one day. NRAs intend to incentivise DSOs to complete the reconnection as soon as possible through a burden of paying an increasing amount of compensation (see Table 4.15). Hence, there is a small range of time limits for this indicator: from 0.5 days to 5 working days, and the median value is 2 days. In Portugal, (1) the time limit is 8 hours for non-LV customers; (2) customers (of any voltage level) can choose urgent restoration (for which the time limit is 4 hours) by paying an additional fee; (3) time until deadlines is not counted between 24h00 and 8h00; and (4) time limits only apply to simple operations.

TABLE 4.15 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE INDICATOR IV.3 "TIME FOR RESTORATION OF POWER SUPPLY FOLLOWING DISCONNECTION DUE TO NON-PAYMENT" IS MONITORED

Country	Criteria / types of customer	Obligation	Compensation
Czech Republic	LV, MV, HV	2 days	max. €1,250
Estonia	LV	5 working days	
Greece	LV, MV, HV	2 working days	€15
Hungary	LV	1 day	€16
Lithuania	LV, MV, HV	2 working days	
Portugal	LV	12 hours	€20
	MV, HV	8 hours	
	For urgent restorations	4 hours	
Slovenia		3 days	€20

The statements in CEER's previous Benchmarking Reports concerning the typical values for the maximum time between meter readings ("yearly number of meter readings by the designated company" (IV.4)) are becoming somewhat outdated since smart meters are being installed in many countries. Different standard are in force depending on the country. For example, in Portugal, 92% of the readings must be made before 96 days (approximately 13 weeks) pass since the last reading. In France, 94.8% of the readings cannot be carried out in more than 1 year. In Ireland, the standards applied depend on the hourly basis (quarter hourly or non-quarter hourly meter readings): (1) for non-quarter hourly meters: 100% of premises should have a scheduled read visit 2 times per year; 97% of premises should have a scheduled read visit 4 times per year; 80% of visits should result in an actual meter read; 98% of meters should have 1 reading (DSO or customer) per year; and 99% of meters will not have back to back block estimates; (2) quarter hourly meters are polled daily; the DSO endeavours to address communication problems within a specified time frame but there are no formal Service Level Agreements (SLAs) for these.

Concerning **compensations**, for the "time for meter inspection of a meter failure" (IV.1) the range of values varies from €15 (in Greece) to €31 (in Great Britain). For the "time to restore the power supply following disconnection due to non-payment" (IV.3), the range varies from €15 (in Greece) to €50 (in the Czech Republic).

4.5.6 Compensations to customers

Table 4.16 shows that there is a great variety of payment methods in case of compensations to customers when GIs are not fulfilled in the reporting countries. Indicators can be classified by the type of payment.

TABLE 4.16 COMPENSATIONS DUE IF COMMERCIAL QUALITY GUARANTEED INDICATORS ARE NOT FULFILLED

Country	Payment method	
	Automatic	Upon claim
Belgium		X
Czech Republic		X
France	X	X
Great Britain		X
Greece	X	
Hungary	X	
Ireland		
Italy	X	
Poland		X
Portugal	X	
Slovenia		**X**

Automatic compensation is preferable in order to guarantee effective customer protection. Detailed information on the amount of compensation is available later in this chapter. This amount can vary, according to each country, by the customer sector (residential, non-residential), or by the voltage level (LV, MV and HV) or depending upon the delay in executing the transaction beyond the standard.

In Italy, the automatic compensation doubles and triples depending on the types of customer when the required time limit of the performance is exceeded: for example, regarding the "time for cost estimation for simple works", for LV domestic customer, the compensation is €35, for LV non-domestic customers, the compensation doubles (€70) and for a MV customer, the initial amount triples (€105). Compensation sums in the Czech Republic are among the highest ones across the CEER countries: in fact, (1) for the "time for restoration of power supply following disconnection due to non-payment", the compensation can reach a maximum amount of €1,250; (2) for the "time for connecting new customers to the network", for LV customer, the compensation is €250, while for MV and HV customers, the compensation doubles (€500).

In general, it can be concluded that penalties are not frequently used compared with compensations. In Belgium and Luxembourg, the indicators named ORs are legal obligations/sanctions; therefore any penalty may only be applied subsequent to a public administration procedure.

4.6 CASE STUDIES: THE ACTIVATION RATES IN THE AGREED LEAD TIMES IN FRANCE

In France, the French energy NRA (CRE) set the commercial quality indicators and the performance objectives, after discussion with the DSOs (mainly ERDF in electricity and GRDF in gas). CRE evaluates the performances achieved and assigns bonus (if the performance is above the target objective) or penalties (if the performance is below the basic objective).

Activation is carried out at the initiative of the customer that moved in, and who has, beforehand, chosen an energy supplier. Activations in gas and electricity are ensured by the same technical teams. ERDF monitors the activation (with intervention) rate in the agreed lead times, that corresponds to the number of activations on existing installation achieved in the agreed lead times with respect to the total number of activation requests.

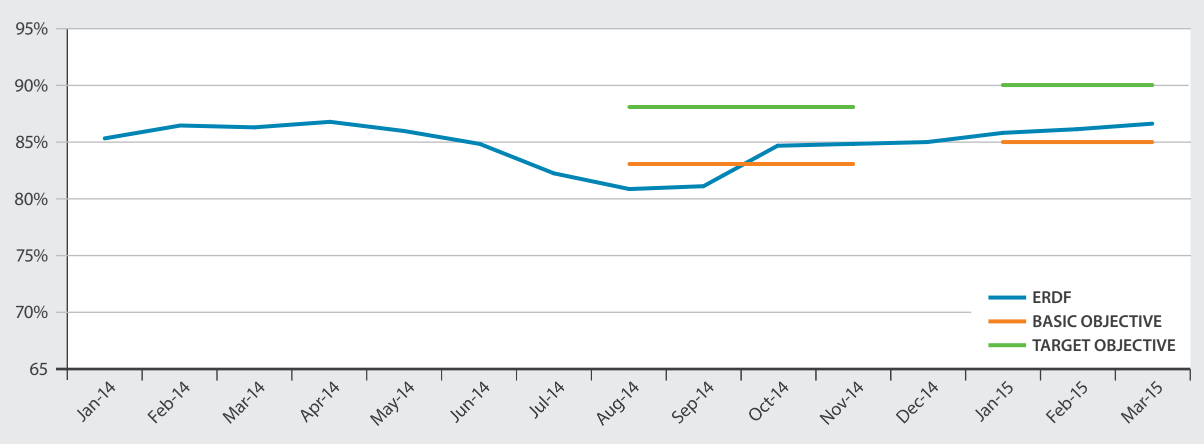
This indicator has financial incentives since 1 January 2014:

- A penalty of €40,000 per calendar year if the monthly rate is strictly lower than the basic objective of 83%;
- A bonus of €40,000 per calendar year if the biannual rate is higher or equal than the target objective of 88%.

Since 1 January 2015, financial incentives have evolved to improve the performance of the network operator.

Figure 4.2 represents the performance in % (number of activations in the agreed deadlines over the total number of activations).

FIGURE 4.2 ERDF ACTIVATION RATES (WITH INTERVENTION) IN THE AGREED LEAD TIMES



In 2014, the average activation (with intervention) rate in the agreed lead times is 84.3%, which is higher than the basic objective (83%) but lower than the target objective (88%). ERDF did not gain any bonus, or pay any penalty. According to ERDF, this slight decline of the performance during the third trimester can be explained by a summer period during which the availability of resources was lower than the average and a higher volume of activation requests compared to the average level. However, there is still room for improvement.

4.7. ACTUAL LEVELS OF COMMERCIAL QUALITY

There are 2 ways to monitor the actual level of commercial quality:

- Monitoring the **average value of the indicator** (e.g. the average time for making a new connection);
- Monitoring the **percentage of cases for which the company complies with the time limit** set by the NRA, i.e. the percentage of cases for which the limit was met (over the total number of cases) is below or above the standard (90% for example).

It is important to note that the first way of measuring the actual quality level does not depend upon the standards and is therefore comparable between countries (assuming that requirements of the same type are considered). The second way of measuring, also called **compliance percentages**, is only meaningful for comparison if the time limits to which it refers are the same, even if the standards are not, otherwise, it cannot be compared between countries. For example, the percentage of customers complaints responded within 15 days (time limit) is 99% in country A (country A has a standard of 80%) and 90% in country B (which has as standard of 95%), then these values can be compared if country B also has a time limit of 15 days.

In the 4th Benchmarking Report, insufficient data was provided on the actual performance levels of the quality indicators, therefore cross-country comparisons were not feasible. For the 5th Benchmarking Report, respondents were asked to report data for the period 2008- 2010, and for the 6th Benchmarking Report, data from 2010 to 2014 was requested. In this report, the analysis focuses on the 2010-2014 results.

A larger amount of information became available for the current 6th Benchmarking Report, possibly due to NRAs' growing attention to commercial quality standards. In Table 4.17 below, a small selection of indicators from each of the 4 main groups is shown (e.g. for the group I "Connection", data for the first 4 indicators has been included). The figures were calculated by averaging the non-compliance figures within the main group: Connection, Customer care, Technical service, and Metering and billing. Although the values are not weighted by the importance of the questions included in the groups, it still provides a reliable impression of the direction of the improvements. However, this analysis, based on data from a period of 4 years, has to be considered with caution, as the database was partially scarce (not all the countries responded to all the indicator values).

Furthermore, the average performances should not be compared across countries, the only purpose of it is to provide a view into the actual levels of commercial quality, at a glance.

TABLE 4.17 AVERAGE NON-COMPLIANCE PERCENTAGE BY COUNTRIES

Average non-compliance percentage	I. Connection					II. Customer care				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Austria					4.00%					2,3%
Belgium										
Croatia					30.00%					
Czech Republic	0.29%	0.19%	0.14%	0.10%	0.03%	1.94%	0.46%	0.22%	0.50%	0.26%
France					1.05%					6.15%
Greece	2.04%	3.02%	3.65%	2.39%	1.12%		0.49%	0.30%	0.25%	0.10%
Hungary	6.04%	5.16%	4.06%	5.61%	5.95%	10.66%	14.00%	10.90%	18.88%	16.87%
Ireland										
Latvia				0.11%	0.0%				7.90%	3.23%
Lithuania		0.35%	0.85%	3.55%	4.75%					
The Netherlands										
Portugal					29.45%	2.95%	3.54%	3.52%	3.39%	10.90%
Slovenia		7.99%	7.64%	6.74%	7.22%		31.92%	24.57%	21.06%	55.24%
Average	**2.79%**	**3.34%**	**3.27%**	**3.08%**	**8.36%**	**5.19%**	**10.08%**	**7.91%**	**8.66%**	**13.25%**

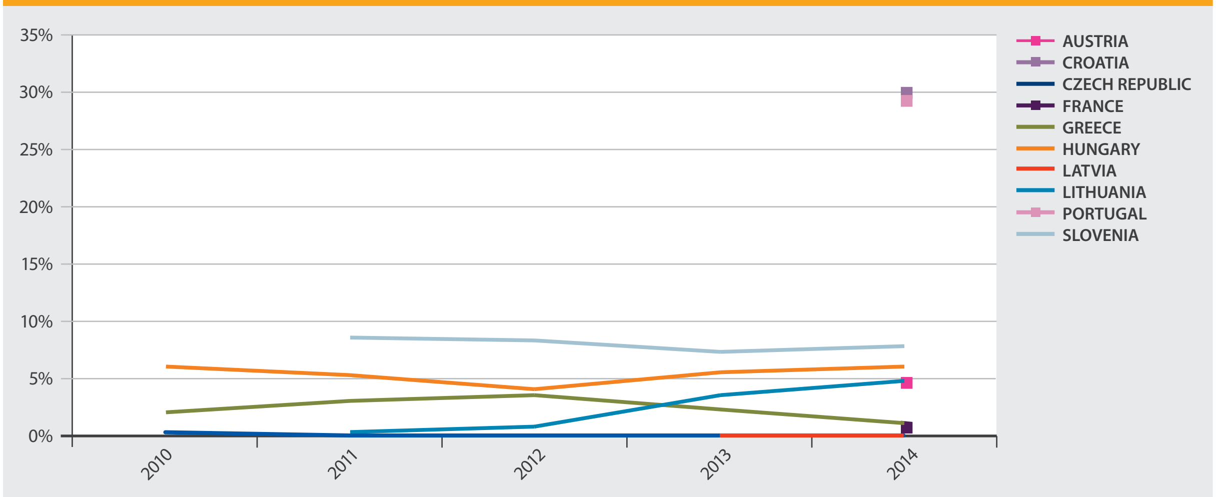
Average non-compliance percentage	III. Technical service					IV. Metering and billing				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Austria										
Belgium										
Croatia										5.00%
Czech Republic	4.09%	7.23%	6.03%	5.87%	5.24%	0.14%	0.39%	0.61%	0.04%	2.35%
France										
Greece	1.50%	1.48%	1.56%	1.77%	0.46%	1.58%	1.58%	1.58%	1.80%	4.41%
Hungary	17.22%	19.01%	6.28%	15.92%	12.52%	2.54%	4.025%	4.025%	3.71%	5.645%
Ireland										
Latvia				0.0%	0.0%					
Lithuania										
The Netherlands										
Portugal	1.57%	0.14%	0.16%	0.36%	0.58%	0.61%	0.26%	0.20%	0.35%	7.17%
Slovenia		31.02%	36.50%	32.82%	36.52%		1.25%	3.75%	14.43%	3.76%
Average	**6.10%**	**11.78%**	**10.10%**	**9.45%**	**9.22%**	**1.22%**	**1.50%**	**2.03%**	**4.07%**	

The growing number of countries collecting data is encouraging. However, not all the countries responded to the questionnaire because they do not monitor the indicator required or because the indicator they monitor does not correspond exactly to the indicator's definition in the CEER questionnaire.

4.7.1 Connection

Connection performance indicators (Group I) are the most monitored commercial quality indicators. Most countries made noticeable progress in the past few years. The average non-compliance percentage for the Czech Republic decreased from 0.29% (in 2010) to 0.03% (in 2014). Greece achieved a good and relatively stable performance since 2010: from 2.05% (in 2010) to 1.12% (in 2014). In Hungary, since 2010, the country registered an average non-compliance percentage of 5.36% over 5 years. In 2014, 8 countries (Austria, the Czech Republic, France, Greece, Hungary and Latvia) are below the overall average of non-compliance of 8.36%.

FIGURE 4.3 AVERAGE NON-COMPLIANCE PERCENTAGE BY COUNTRIES FOR CONNECTION ACTIVITIES



The overall average time for connecting new customer to the network (I.3) is 7.89 days in 2014 (including the Czech Republic, France, Greece, Hungary, Lithuania, Portugal and Slovenia results). For most of the countries, the overall trend is positive (average percentages of compliance higher than 90%). In 2014, Croatia and Portugal registered average non-compliance percentages of 30.0% for Croatia and 29.45% for Portugal. In fact, in Croatia the time limit (15 days) to response to customer claim for network connection (I.1) is respected in 70% of the cases. And in Portugal, the time limit (15 working days) to response to customer claim for network connection (I.1) is respected in 72.61% of the cases, for a total number of 9,355 requests.

4.7.2 Customer care

Similarly to connection (Group I), the reported non-compliance indicators related to **customer care** (Group II) for most countries are also relatively low and homogeneous on the 2010-2014 period: the percentages are lower than 10% for Austria, the Czech Republic, France, Greece, Portugal (except in 2014) and Latvia.

In Portugal, from 2010 to 2013, non-performance percentages were lower than 4%: a particularly good performance has been observed concerning the response time to customer complaints (II.2). In 2014, it reached 10.90%: this higher non-compliance percentage can be explained by a lower performance achieved for the "punctuality of appointments with customers" (88.77%).

Slovenia and Hungary are the 2 countries whose non-compliance results are above the overall average since 2011. Since 2010, Hungary shows non-performance from 10.66% to 16.87%: the percentages of compliance for the indicator "response time to customer voltage and/or current complaints" (II.3) are pulling down the average percentage of compliance related to customer care: the operators achieved a performance lower than 50% in 2013 and 2014 for this indicator. The highest non-performance percentages related to customer care are observed in Slovenia: in particular, improvements should be provided to the time to response to customer enquiries (II.3) and customer voltage and/or current complaints (II.4).

4.7.3 Technical service

The indicators of **technical service** (Group III) remained either about the same or improved slightly during the period of 2010-2014 for the Czech Republic, Greece, Hungary, and Portugal. Most results are below the overall average percentage of non-compliance (9.22%) in 2014. Slovenia registered high levels of non-compliance (between 31% and 36.52%) on the 2011-2014 period. Particularly, the percentages of compliance for the time between the date of the answer to the VQ complaint and the elimination of the problem (III.1) from 2011 to 2014 are low (34.11%).

Concerning the time between the date of the answer to the VQ complaint and the elimination of the problem (III.1), Hungary registered very heterogeneous percentages of compliance on the period 2010-2014 (e.g. 24.41% in 2011, 75.75% in 2012 and 51.22% in 2014). Regarding the time until the start of restoration of supply following failure of fuse of DSO (III.2), the percentages of compliance from 2010 to 2014 are good (> 96%) for the Czech Republic, Greece, Hungary, Portugal and Slovenia.

4.7.4 Metering and billing

Performance indicators for **metering and billing** (Group IV) were the least monitored commercial quality indicators in the previous 5th Benchmarking Report. For the 6th Benchmarking Report, 6 countries provided their metering and billing indicators performance. All the countries registered non-compliance percentages lower than 8% on the 2010-2014 period. In 2014, the overall average of non-performance reaches 4.72% and 3 countries are slightly above the average: Croatia (5.00%), Hungary (5.65%) and Portugal (7.17%). The non-compliance percentages are slightly increasing on the 2010-2014 period but the overall picture is relatively homogeneous. Quite large differences are observed for Portugal (i.e. 0.61% in 2010 and 7.17% in 2014).

Performance results are particularly good for the time for restoration of power supply following disconnection due to non-payment (IV.3), for which the percentages of compliance of the Czech Republic, Greece, Hungary, Portugal and Slovenia are above 98% on the 2010- 2014 period. The average performance time for restoration of power supply following disconnection due to non-payment (IV.3) has decreased from 2011 to 2014 for the Czech Republic (from 0.9 days to 0.8 days, with a time limit of 2 days), Lithuania (from 1.87 days to 1.5 days, with a time limit of 2 working days) and Slovenia (from 3 to 1.1 days, with a time limit of 3 days).

4.8. SUMMARY OF BENCHMARKING RESULTS

Tables 4.18 and 4.19 on the next page synthesise the results according to the indicators (see also Section 4.5.1). Indicators for DSOs account for 147 out of 193 national indicators (as per Table 4.4).

TABLE 4.18 TOTALS OF APPLIED INDICATORS BY TYPE

Totals of applied indicators by type	OI	GI	OR	Total
I. CONNECTION				
I.1 Time for response to customer claim for network connection	8	4	5	**17**
I.2 Time for cost estimation for simple works	1	4	4	**9**
I.3 Time for connecting new customers to the network	5	4	6	**15**
I.4 Time for disconnection upon customer's request	1	1	3	**5**
I.5 Time for a switching of supplier	3	0	9	**12**
TOTAL FOR CONNECTION INDICATORS	**18**	**13**	**27**	**58**
II. CUSTOMER CARE				
II.1 Punctuality of appointments with customers	0	4	1	**5**
II.2 Response time to customer complaints	3	4	5	**12**
II.3 Response time to customer enquiries	2	4	5	**11**
II.4 Response time to customer voltage and/or current complaints	1	4	2	**7**
II.5 Response time to customer interruption complaints	0	1	4	**5**
II.6 Response time to questions in relation with costs and payments (excluding connection)	1	1	1	**3**
II.7 Call Centres average holding time	0	1	0	**1**
II.8 Call Centres service level	0	0	0	**0**
II.9 Waiting time in case of personal visit at client centres	0	0	0	**0**
TOTAL FOR CUSTOMER CARE INDICATORS	**7**	**19**	**18**	**44**
III. TECHNICAL SERVICE				
III.1 Time between the date of the answer to the VQ complaint and the elimination of the problem	1	3	3	**7**
III.2 Time until the start of restoration of supply following failure of fuse of DSO	0	6	2	**8**
III.3 Time for giving information in advance of a planned interruption	2	3	6	**11**
III.4 Time until the restoration of supply in case of unplanned interruption	2	4	5	**11**
TOTAL FOR TECHNICAL SERVICE INDICATORS	**5**	**16**	**16**	**37**
IV. METERING AND BILLING				
IV.1 Time for meter inspection in case of meter failure	3	5	3	**11**
IV.2 Time from the notice to pay until disconnection	2	1	5	**8**
IV.3 Time for restoration of power supply following disconnection due to non-payment	3	4	3	**10**
IV.4 Yearly number of meter readings by the designated company	1	2	6	**9**
TOTAL FOR METERING AND BILLING INDICATORS	**9**	**12**	**17**	**38**

According to Table 4.18, there are 58 indicators for connection activities (Group I). The most monitored indicators are the time for response to customer claim for network connection (I.1), the time for connecting new customers to the network (I.3), and the time for a switching of supplier (I.5), which was introduced as a new commercial quality performance in the 5th benchmarking report. The average number of indicators whose type is specified is 12 ("standards/activity", that is "(18+13+27)/5") in the connection (Group I). This figure is the highest among the other groups, meaning that connection to the network in the countries surveyed is of primary importance. Customer care (Group II) is the lowest group of indicators, with an average value of 6 indicators/activity.

Technical service (Group III) (with an average value of 9 indicators/activity) and metering and billing (Group IV) (with an average value of 10 indicators/activity) are more or less regulated to the same extent. Of note is that much attention is paid to the quickest possible restoration of supply, irrespective of whether the loss of supply was caused by faults, missing payments and information on notice for planned interruptions. This confirms the priority in energy regulation to ensuring the availability of supply.

There are considerable differences in the average number of indicators per activity group. ORs are the most frequently applied for regulation of connection, customer care, technical service and billing and metering issues.

In some important cases GIs, OIs and ORs are used in parallel by the countries. OI are frequently applied for connection group activities. A lot of GIs are applied for customer care, technical service, and metering and billing issues. Table 4.19 shows the indicators applied in the countries, per group and per type.

TABLE 4.19 COMMERCIAL QUALITY INDICATORS APPLIED BY THE CEER COUNTRIES PER TYPE OF INDICATOR AND GROUPS

Countries	I. Connection			II. Customer care			III. Technical service			IV. Metering and billing		
	OI	GI	OR	OI	GI	OR	OI	GI	OR	OI	GI	OR
Austria	X			X			X			X		
Belgium			X			X			X			X
Croatia	X		X			X			X	X	X	
Czech Republic		X	X		X			X			X	X
Estonia	X					X	X			X		
Finland			X									
France			X	X	X	X			X	X		
Great Britain								X			X	X
Greece		X	X		X			X			X	
Hungary	X	X	X	X	X			X			X	X
Italy	X	X										
Latvia			X			X			X			X
Lithuania	X						X			X		
Luxembourg	X		X							X		
Malta	X	X										
The Netherlands		X						X			X	
Norway			X			X						X
Portugal	X		X	X	X			X		X	X	
Slovenia	X	X		X	X		X	X	X		X	
Sweden			X						X			X

4.9. FINDINGS AND RECOMMENDATIONS ON COMMERCIAL QUALITY OF ELECTRICITY

It is important to recall that the results on commercial quality should be interpreted with caution as some elements can be measured in different ways and data is not yet available in every country. This may reflect differences in measurement. For example, some indicators do not differentiate between simple and complex work. Furthermore, the performances of the operators are not comparable across countries since each country has its own regulatory system (with specific time limits, standards, compensation levels, penalty amounts, etc.).

Finding 1
An increased focus by NRAs on the quality of the services provided to customers.

The first finding, in line with the conclusions from CEER's past Benchmarking Reports, is that NRAs devote significant attention to the commercial quality of the services provided. A total of 22 responding countries reported 177 national commercial quality indicators referring to 22 performances requested by customers.

Finding 2
A broad, but increasingly harmonised, range of commercial quality indicators are monitored.

There are significant differences concerning the nature and the number of indicators monitored across countries. Although the set of activities and the expected goals of the regulation are similar, in some countries the regulations are not clearly defined or are less enforced than specific quality indicators (e.g. "within reasonable time", "in reasonable terms"). The regulation of a given service can be achieved in many different ways such as time limits, standards, compensation levels, penalty levels. NRAs should set the commercial quality regulations taking into account their national, political, cultural and economic specificities. At the same time, progresses in harmonisation have been achieved compared with the previous CEER Benchmarking Reports. At the time of the 3rd Benchmarking Report (in 2005), the commercial quality parameters were rarely regulated in the same way across CEER Members, whilst the 6th Benchmarking Report reveals that the number of identical or partially identical regulations concerning these indicators has grown considerably.

Finding 3
Requirements and compensations vary a lot depending on the customer type.

Commercial quality concerns different types of customers: the difference in the amount of consumption is also important from a regulation point of view. Their classification (location, voltage levels) varies from country to country and from network operator to network operator. In a given country, requirements may vary a lot depending on whether the customer concerned is a LV customer or a HV customer. In general, commercial quality is mainly focused on residential customers with a connection to the LV network because they represent the largest group and because small domestic customers often need more protection.

Finding 4
The move towards more Guaranteed Indicators (with compensation) is again confirmed.

Some definitions and names related to commercial quality requirements have changed from past editions, e.g. "standards" are now referred to as "indicators". The data collected shows that commercial quality indicators can be used by NRAs in 3 ways:

- To define OIs, either without any economic consequence for the DSO or supplier upon non-compliance or including economic sanctions. NRAs are entitled to impose sanctions such as penalties;
- To set GIs by which customers receive direct compensation if standards are not met; or
- To apply OR, and in the case of non-compliance, sanctions can be imposed by the NRA.

The analysis of the results confirms that there is a general trend over time to move away from Overall Indicators (OIs) to Guaranteed Indicators (GIs). This trend was already identified by the 4th and the 5th Benchmarking Reports. This 6th Benchmarking Report reports 60 GIs compared to 39 OIs currently being applied. Automatisation of compensation payment is being developed: some countries already apply automatic compensation in the case of non-compliance for certain indicators (France, Greece, Hungary, Italy and Portugal).

Finding 5
Commercial quality is mainly focused on the DSO's relationship with customers.

In countries where competition works well, the NRAs are focused more on monitoring the DSOs' commercial quality obligations (rather than those of the suppliers) as the distribution activities are closely linked to customers (connection to the grids, activations, etc.). In fact, 147 (out of a total of 193 indicators) relate to DSOs and 25 indicators relate to suppliers / USP.

Finding 6
Network connection and customer care remain as key considerations.

From a consumer perspective, connections, activations, and maintenance are very relevant processes, as, in some cases, they represent the consumer's first interaction with the energy market. If these processes are well designed and function efficiently, they will help to improve consumer's perception of the energy market. The survey stresses that priority is given to the standards for connection of customers to the network and customer care like the response time to complaints. In fact, out of a total of 177 indicators, 58 indicators are monitored for connection to the network activities and 44 for customer care services.

Finding 7
Smart meters impact on commercial quality regulation.

Having accurate billing based on the actual, measured consumption is becoming more and more important both for customers and licensees. All parties expect a more detailed picture of consumption habits (profiles) on the basis of which they would be able to plan network maintenances, energy purchases or eventual changes in the daily consumption practices. Recognising this need, many countries aim to collect monthly (or even more frequent) meter data with meter readings through the roll-out of smart meter programmes. Smart meters facilitate a more accurate picture of electricity consumption, of grid status and can ease and shorten both the procedure of supplier switching and the process of deactivation and reactivation due to unpaid bills.

Finding 8
The focus needs to be wider than DSO's written responses to consumers.

In addition to the customer's expectation to be connected or reconnected as quickly as possible, there is a noticeable need for a substantive response from the DSO/supplier to any customer request within a reasonable limit of time. The data reveals that the current emphasis is placed on DSO's performance with regard to written forms of communication. This results in an incomplete picture of the quality of responses to customer requests for 2 different reasons: (1) non-written forms of communication like telephone (fixed and cell-phone) and internet (website) have developed significantly and are widespread; (2) in some countries, the more traditional approach of visiting local customer centres continues. In some countries, oral claims are still not taken into account and only written complaints are counted.

RECOMMENDATION 1

PERFORM REGULAR REVIEWS OF NATIONAL REGULATIONS.

It is important for CEER (and NRAs) to regularly review the commercial quality indicators, taking into account the development of national conditions (e.g. the development of smart grids) and the expectations of the customers. Monitoring the actual level of commercial quality (average values of the indicators and percentages of fulfilment) has an important role in such reviews. The most important factor in this process is the availability of wide and realistic data. Therefore, it is necessary to examine in detail (including questioning stakeholders about) the commercial quality regulations in place to know if other indicators or requirements are monitored, or to understand the specificities of each country surveyed. In addition, the number of indicators surveyed by CEER should be limited to make the data analysis manageable. It is recommended to treat the actual performances for MV and HV customers separately, in order to avoid distorting the median value.

RECOMMENDATION 2

PURSUE THE HARMONISATION OF COMMERCIAL QUALITY INDICATORS DEFINITIONS.

Harmonising the definitions[11] facilitates significant results from European countries and a more consistent and understandable database. Comparisons are difficult to make between Member States, as the regulation of a given activity can be achieved in many different ways depending on the country. A clear framework and harmonised parameters can help the analysis of the results and thus the identification of further improvements and recommendations.

RECOMMENDATION 3

ENSURE GREATER PROTECTION THROUGH GUARANTEED INDICATORS WITH AUTOMATIC COMPENSATION FOR CUSTOMERS.

It is recommended that NRAs should apply GIs with automatic compensation, or OIs or ORs associated with the option of sanctioning. For the most important indicators (e.g. for connection activities), a combination of OI with economic sanctions (like penalties) and GIs is recommended, in order both to improve the average performances and to protect customers from worst service conditions. This recommendation is targeted mainly at DSOs given their important relationship with customers. In addition, the automatisation of the compensation payment, which is increasingly applied, should be extended to every country.

RECOMMENDATION 4

NRAs SHOULD MONITOR INDICATORS IN ALL FORMS OF COMMUNICATION FOR MORE ACCURATE PERFORMANCE LEVELS.

Most of the indicators take into account only written forms of communication, which is an incomplete picture of the commercial quality. Non-written forms of communication like telephone (fixed and cell-phone) and internet (website) should also be considered. For example, not all the countries monitor oral and written complaints. CEER recommends that NRAs should also regulate the performance of the service level provided to customer through communications such as phone, e-mail and online (e.g. website/apps), and visits to customer centres. In particular, the performances of DSOs and USPs in the increasingly important field of phone contacts should be monitored. Attention should be paid not only to a rapid response but also to a thorough and useful response. All types of responses should be taken into account in the commercial quality regulation: oral, internet-based and written complaints.

11. 2014 CEER-ACER report on the results of monitoring the internal electricity and natural gas markets.

RECOMMENDATION 5

ENSURE THE AVAILABILITY OF THE SERVICES, IN PARTICULAR REGARDING CONNECTION AND CUSTOMER CARE.

CEER recommends that countries and their NRAs evaluate customer priorities before creating new regulatory frameworks.

RECOMMENDATION 6

FURTHER DEVELOP THE REGULATION OF CUSTOMER RELATIONS.

To further develop the commercial quality regulation, satisfaction surveys -although costly- could be implemented to have qualitative elements (in addition to the quantitative elements the CEER questionnaire provides), since it could help in assessing how the customers actually perceive the service achieved by the operator.

05

GAS – TECHNICAL OPERATIONAL QUALITY

5.1. INTRODUCTION

For the first time, this CEER Benchmarking Report also covers the gas sector. Although in general the quality of supply regulation of gas networks does not differ from the approaches used in electricity networks, the underlying objective is entirely different. Since gas is a natural resource its quality and composition is of particular importance, especially in an international context (see the natural gas quality indicators in Chapter 6).

Moreover, technical safety is of much higher importance than in the electricity since an interruption of gas delivery may give rise to physical danger and in the worst case with fatalities. This is why an extensive set of gas technical standards and rules have been established for gas internationally. In addition, the ability of gas to be stored leads to a very high quality of supply concerning gas continuity.

In this part, the dimensions "Technical operational quality", "Natural gas quality", and "Commercial quality" will be covered respectively in the following chapters. Each of these chapters contains a brief description of relevant quality factors, initial benchmarking of current quality levels, and standards introduced by NRAs.

The following countries have generously answered questions for gas quality: Austria, Belgium, Croatia, the Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Slovenia, Spain and Sweden.

5.2. STRUCTURE OF THE CHAPTER ON TECHNICAL OPERATIONAL QUALITY

This chapter gives a brief overview on Continuity of Supply indicators used and regulation that is applied in CEER countries. Firstly, this chapter gives an overview of the structure of the gas networks. Secondly, continuity of supply indicators provided by these countries are presented. Finally, this will be followed by an overview of the regulation in force dealing with Continuity of Supply and safety.

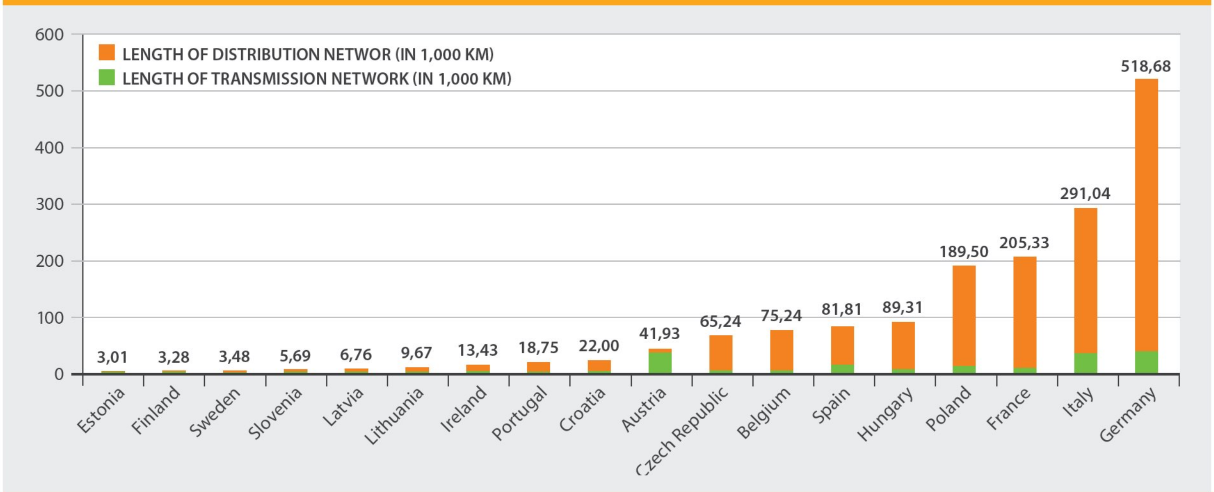
In general, this chapter is based on input from 19 CEER countries: Austria, Belgium, Croatia, the Czech Republic, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Slovenia, Spain, and Sweden. However, the overall availability of data and information differs noticeably from question to question and hence it is not always possible to compare the answers of all participating countries.

5.3. STRUCTURE OF GAS NETWORKS

At first, it might be helpful to get an overview of the technical structure of gas networks across the Member States. Therefore the definition of pressure levels and the length of the gas networks are shown and compared.

5.3.1 Network length

FIGURE 5.1 LENGTH OF THE GAS NETWORK (IN 1,000 KM) IN 2014



5.3.2 Measurement Points

TABLE 5.1 NUMBER OF MEASUREMENT POINTS

Country	Year	- with remote control	- without remote control	- with compliant measurements to technical standards
Belgium	2010	1,05	30,984	10,361
	2011	1,05	31,95	10,876
	2012	1,05	32,119	10,862
	2013	1,05	29,917	10,271
	2014	1,05	28,858	9,877
Czech Republic	2010	0	4,318	4,318
	2011	0	4,318	4,318
	2012	0	4,328	4,328
	2013	0	4,471	4,471
	2014	0	4,347	4,347
Estonia	2010	3		
	2011	3		
	2012	3		
	2013	3		
	2014	3		
France	2010			
	2011			
	2012			
	2013			
	2014	174,874		
Hungary	2010	620		620
	2011	620		620
	2012	625		625
	2013	630		630
	2014	636		636
Ireland	2010	153	3,1	400
	2011	153	3,2	300
	2012	153	3,2	290
	2013	153	3,3	290
	2014	153	3,477	275
Italy	2010	32,063	98,064	
	2011	33,438	96,73	
	2012	36,438	98,528	
	2013	38,701	97,111	
	2014	42,582	93,465	
Latvia	2010			
	2011			
	2012			
	2013			
	2014	456	8,381	4,624
Portugal	2010	12		12
	20 11	12		12
	2012	12		12
	2013	12		12
	2014	12		12
Slovenia	2010			
	2011			419
	2012			444
	2013			452
	2014			451

5.3.3 Pressure regulated and metering gas stations

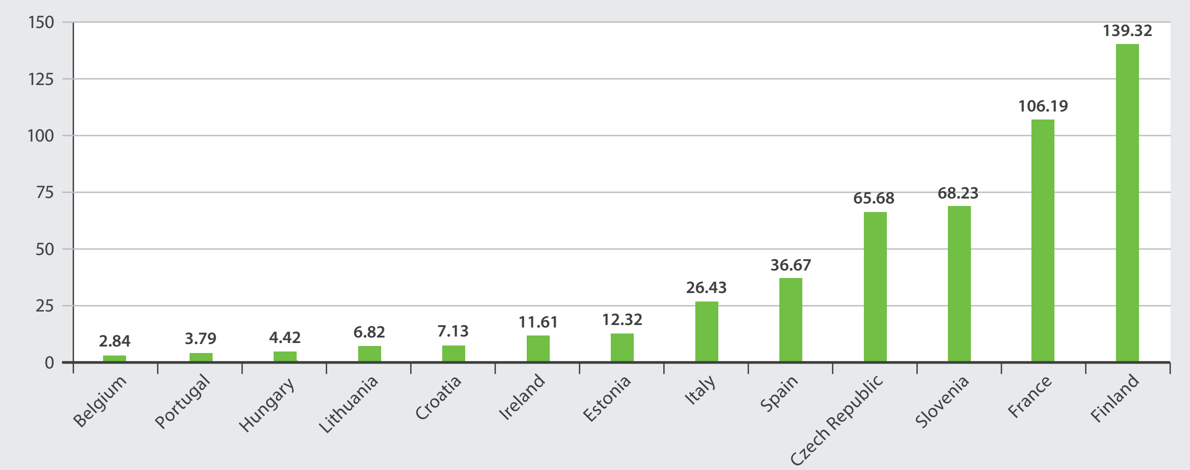
Grid structure and complexity can be shown by the number of pressure regulated and metering gas stations.

Since absolute numbers are not very powerful, the ratio of transformer stations and net length is shown in the next figure. It can be seen that the ratio varies noticeably across countries from a ratio of 2.84 up to a ratio of 139.32.

TABLE 5.2 NUMBER OF PRESSURE REGULATED AND METERING GAS STATIONS

Country	2010	2011	2012	2013	2014
Belgium	213	213	214	214	214
Croatia	159	158	156	157	157
Czech Republic			4,313	4,299	4,285
Estonia		37	37	37	37
Finland	439	454	463	477	456
France	22,626	22,466	22,26	22,045	21,803
Hungary	393	394	395	395	395
Ireland	150	151	151	152	156
Italy	7,563	7,593	7,565	7,596	7,692
Latvia					20,236
Lithuania	65	65	65	66	66
The Netherlands	683	688	685	687	686
Portugal	68	69	71	71	71
Slovenia		350	359	378	388
Spain					3
Sweden	49	49	50	50	

FIGURE 5.2 NUMBER OF PRESSURE REGULATED AND METERING GAS STATIONS PER LENGTH OF THE GAS NETWORK (IN 1,000 KM) IN 2014



5.3.4 Pressure levels

The definition of pressure levels in use varies widely throughout the reporting countries. In some countries more definitions are in use, for example in Ireland, where higher pressure levels are used for onshore and subsea transmission systems.

More interestingly, not only the pressure levels are defined in these countries but also the accepted variations in pressure are regulated in 10 countries that have reported an answer to that question.

TABLE 5.3 PRESSURE LEVELS IN USE

Country	High pressure	Definition	Medium pressure	Definition	Low pressure	Definition	Other
Austria	✓	All transmission pipeline systems are listed in ANNEX 2 of Natural Gas Act 2011	✓	Higher than 6 bar	✓	Lower than 6 bar	
Croatia	✓	In distribution system > 5 bar, whole transmission system	✓	In distribution system > 0.1 bar ≤ 5 bar	✓	In distribution system ≤ 0.1 bar	Transmission system consist of 75 bar and 50 bar working pressure pipelines
Czech Republic	✓	1.6 MPa – 3.9 MPa (16 bar – 39 bar) [1]	✓	5 kPa – 0.4 MPa (0.05 bar – 4 bar)	✓	up to 5 kPa (0.05 bar)	
Estonia	✓	exceeds 16 bar	✓	lower than 16 bar	✓	lower than 16 bar	
France	✓	pressure between 40 and 70 bar	✓	3 types: MPC: pressure between 4 and 25 bar MPB: pressure between 0.4 and 4 bar MPA: pressure between 0.05 and 0.4 bar	✓	pressure <= 50 mbar	
Germany	✓	> 1 bar	✓	> 0.1 bar – ≤ 1 bar	✓	≤ 0.1 bar	
Hungary	✓	MOP > 25 bar	✓	100 mbar < MOP ≤ 4 bar	✓	MOP ≤ 100 mbar	High-medium: 4 bar < MOP ≤ 25 bar
Ireland	✓	Max operating pressure 70 bar	✓	Max. operating pressure 40 bar	✓	Max. operating pressure 19 bar	Distribution system (MOP 16 barg-millibar) Subsea Transmission System MOP =148 barg [2] South West Scotland Onshore System MOP = 85 barg
Italy	✓	It is the gauge pressure of the gas exceeding 5 bar	✓	It is the gauge pressure of the gas exceeding 0.04 bar and not exceeding 5 bar	✓	It is the gauge pressure of the gas not exceeding 0.04 bar	
Latvia	✓	Above 0.4 MPa up to 1.6 MPa (including) (4 bar – 16 bar)	✓	Above 0.005 MPa up to 0.4 MPa (including (0.05 bar – 4 bar)	✓	Up to 0.005 MPa (including) (0.05 bar)	
Lithuania	✓	All gas transmission network pipelines operate at pressure from 16 bar. As regards to gas distribution network, such pipelines are regarded to operate at high pressure if they operate at pressure from 5 to 16 bar.	✓	Distribution network pipelines are considered medium pressure if they operate at pressure from 0.1 to 5 bar. Moreover, medium pressure is divided into 2 sub-categories in the medium level: Category I : from 2 to 5 bar; Category II: from 0.1 to 2 bar.	✓	Distribution network pipelines are considered low pressure if they operate at pressure below 0.1 bar.	
The Netherlands	✓	The pressure of the high pressure network varies from 40 bar to 80 bar. This network is maintained by the TSO. Levels: 40 bar 67 bar	✓	The medium pressure network is maintained by the DSO. P > 200 mbar (high pressure DSO) Levels: 1 bar 2 bar 4 bar 8 bar	✓	The pressure of the low pressure network is smaller than or equal to 200 mbar. The low pressure network is maintained by the DSO. P ≤ 200 mbar (low pressure DSO) Levels: 100 mbar 30 mbar	

Country	High pressure	Definition	Medium pressure	Definition	Low pressure	Definition	Other
Poland	✓	Exceeding 1.6 MPa (16 bar)	✓	Between 10.0 kPa and 0.5 MPa inclusive (0.1 bar – 5 bar)	✓	Up to and including 10.0 kPa (0.1 bar)	Increased medium pressure gas pipelines: between 0.5 MPa and 1.6 MPa inclusive (5 bar and 16 bar)
Portugal	✓	> 20 bar	✓	between 4 and 20 bar	✓	< 4 bar	
Slovenia	✓	For the purpose of answering the questionnaire we will divide the network in this way: > 1 bar	✓	For the purpose of answering the questionnaire we will divide the network in this way: between 100 mbar and 1 bar	✓	For the purpose of answering the questionnaire we will divide the network in this way: < 100 mbar	At the moment there is not a clear definition which divide gas network in different pressure levels. For building the network there are rules which divide network on the network for pressure higher than 16 bars and the network for pressure lower than 16 bars.
Spain	✓	Up to 4 bar (rel) of maximum operation pressure	✓	From 0,05 up to 4 bar of maximum operation pressure	✓	Bellow 0,05 bar (rel) of max operation pressure	

[1] 1 Pa = 1 x 10-5 bar
[2] Bar(a)" and "bara" are sometimes used to indicate absolute pressures and "bar(g)" and "barg" for gauge pressures.

TABLE 5.4 ALLOWED VARIATIONS IN PRESSURE GAS NETWORKS

Country	What variations in pressure are allowed in gas networks?
Austria	1.022 bar to 91 bar (also depending on the pipeline)
Croatia	In transmission system allowed pressure variation are 70 – 75 bar and 45 – 50 bar, with respect to working pressure
Czech Republic	Within the category
France	If it is the MIP ≥ 10 % on the network: see EN 12186 § 9 and guide Gesip [1] § 6: The pressure control system shall maintain the pressure in the downstream system within the required limits and shall ensure that this pressure does not exceed the permitted level.
Hungary	In case of high pressure pipeline system the allowed variations is between 25 bar and 75 bar.
Ireland	8 bar off the 19 bar system 19 bar off the 70 bar system 50 bar of the SUB/SEA offtake
Latvia	Distribution system: low pressure 0.002 MPa; medium pressure 0.01 MPa, 0.4 MPa; high pressure 0.6 MPa, 1.2 MPa, 1.6 MPa
Lithuania	For system of 0.1 – 2 bar pressure variations can be up to 12.5 percent. For system of 2 – 5 bar pressure variations can be up to 7.5 percent. For system of 5 – 16 bar pressure variations can be up to 5 percent.
The Netherlands	This is not regulated
Poland	Transmission system: The pressures at which gaseous fuel is delivered for transmission at physical entry points or off-taken at physical exit points shall be posted on the TSO's website. The change of the value of gaseous fuel pressure published on the TSO's website shall be done in agreement with the proper Interoperating System Operator (ISO) or Customer connected at the physical exit point. In order to assure security of operation of the transmission system and security of supply of gaseous fuel to Customers, the Network User shall be obliged to deliver gaseous fuel for transmission at physical entry points to the transmission system while conforming to the quality parameters required under in the Transmission Network Code (TNC), and maintaining the pressure within the ranges specified in accordance with above mentioned provision. Upon a request from a Customer connected directly to the transmission system, as submitted directly to the TSO, the TSO shall adjust, twice a year, the pressure at the physical exit point where such final Customer off-takes gaseous fuel, to the extent that technical capabilities for pressure adjustment exist at such point. The procedure of pressure adjustment at the physical exit points shall be specified in the technical annexes to the relevant contracts or agreements executed with the ISOs or Customers. In the event of failing to maintain the minimum delivery pressure at a physical entry point to the transmission system, the TSO is entitled to a charge from the Network User on this account.
Portugal	There are no limits.
Spain	Type Maximum Operation Pressure (Minimum granted pressure) High pressure B (APA) P > 16 bar (16 bar) High pressure A (APA) 4 bar < P ≤ 16 bar (3 bar) Medium pressure B (MPB) 0.4 bar < P ≤ 4 bar (0.4 bar) Medium pressure A (MPA) 0.05 bar < P ≤ 0.4 bar (50 mbar) Low pressure (BP) P ≤ 0.05 bar (18 mbar)

5.4. CONTINUITY OF SUPPLY OF GAS NETWORKS

Continuity of supply concerns interruptions in gas supply. In other words, it focusses on the events during which there is no gas at the supply terminals of a network user or the pressure drops below a specific level. Continuity of supply can be described by various quality dimensions. The most commonly used ones are the number of interruptions per year or the unavailability measured by interrupted minutes per year.

In general, it can be assumed that network users expect a high continuity of supply level at an affordable price. The fewer the interruptions and the shorter these interruptions are, the better the continuity is from the viewpoint of the network user. Therefore, one of the roles of network operators is to optimise the continuity performance of their distribution and/or transmission network in a cost effective manner.

Continuity of supply indicators are traditionally important tools for making decisions on the management of distribution and transmission networks. However, in the case of gas networks, safety is of much greater importance than in the electricity branch since unavailability or interruption of supply in many cases may correspond to some danger.

Indicators covering continuity of supply are mainly transferred from the electricity sector, although they cannot be applied and interpreted like in that sector. Since there is the possibility of storage in the grid and because of the very high technical requirements, continuity of supply is not one main scope for decisions for the network operator. Nevertheless, the usually used interruption-indicators are good candidates if one wants to describe and compare continuity of supply internationally.

Many countries who participated to this survey stated that continuity of supply is monitored within their networks country-wide. This monitoring is done in different ways across countries. Differences vary from the kind of interruptions monitored and the level of detail being reported to the interpretation and highlighting of various indicators.

In comparison with electricity, it can be seen that not only interruptions are monitored in the participating countries, but also the causes of interruptions. Moreover, as it can be seen from the following tables, these interruption indicators are also calculated separately for those causes, although not in every country.

5.4.1 Systematic between incidents, leaks, interruptions and emergency

When describing indicators on continuity of supply it is worth mentioning that within the gas sector the quality of supply is not only expressed by continuity indicators but also through incidents that precede an interruption, like incidents or leaks.

As mentioned before, technical safety of gas networks plays an important role when analysing continuity of supply. In contrast to the electricity sector, in gas there exist different types of events that have different consequences for network users and network operators and which therefore need to be handled differently when analysing technical and operational gas quality.

An **incident** can and does happen in every running system. But the existance of incidents is not necessarily an indicator for an interruption since that is dependant on other factors. Incidents may lead to **interruptions** but in many cases, an incident can be fixed without any effect on the supply of customers at all. In some cases there might be interruptions without any incident at all, for example due to maintanance of the grid.

Leaks are a direct indicator for the technical quality of the infrastructure. It means that gas unwantedly leaves the closed system due to corrosion, a pipe burst or some security leaks. The consequences with respect to continuity of supply can differ, since not every leak inevitably entails an interruption for the customer. Leaks may be repaired in due time when observed close to buildings but there is some room for action for the network operator if the leak is observed far away from buildings or populated area.

An **accident** (damage) is the worst of all incidents, where gas is inflamed and physical damage appears.

It is worth mentioning that incidents might rise the risk of leaks, interruptions or damages, but that it is not a necessarily consequence. Moreover, there is some room for action for the network operators especially with respect to failure management.

When monitoring these data it is necessary to have clear definitions of these events that are sufficient to separate between these situations.

In the following tables the different definitions of incidents, leaks, interruptions and damages are presented to give an overview of the varying definitions across countries.

TABLE 5.5 IS THERE A DEFINITION OF GAS INCIDENT?

Country	Is there a definition of gas incident?	If yes, please describe	Answer relates to: Transmission	Answer relates to: Distribution
Austria	Yes	"Failure" means an incident related to a gas pipeline system which can jeopardise the life and health of persons or damage property or another unintended interference with the proper functioning of a natural gas pipeline system; "Interruption" means an interruption of a consumer's supply with natural gas or a restriction of injection capacity due to insufficient pipeline capacity or other technical reasons relating to the transmission or distribution system.		✓
Croatia	No			
Czech Republic	Yes	Random accident is caused by damage to gas facilities, which has resulted in the immediate loss of life, injury or loss of life or gas leaks associated with the subsequent explosion and fire.	✓	✓
Estonia	No		✓	✓
Finland	No		✓	✓
France	Yes	Accidental release of gas, 3 different leak sizes puncture (diameter ≤ 12 mm), hole (12 mm < diameter ≤ 70 mm) and rupture (diameter > 70 mm).	✓	
Germany	Yes	E.g. unwanted gas release.	✓	✓
Hungary	No		✓	✓
Italy	Yes	It is defined as incident from a gas event involving the gas distributed through networks, which interests any part of the distribution and / or installations of end customers, including such apparatus for use, and that results in the death or injury serious people or damage to property with a value not less than € 5,000.00 and is caused by one of the following causes: a) a dispersion of gas (voluntary or not); b) an uncontrolled combustion in an apparatus of use of the gas; c) poor combustion in an apparatus of use of the gas, including that due to insufficient aeration; and d) an inadequate evacuation of the combustion products in an apparatus of use of the gas.		✓
Latvia	Yes	The incident is defined as the damage to the natural gas system, explosion, ignition etc. caused by a technical defect, incorrect exploitation or other unforeseen factors, which endanger health and life of human beings, and environment or causes material losses.		✓
Lithuania	Yes	Regulation of Energy equipment accidents and incidents investigating and accounting, adopted by Ministry of Energy of the Republic of Lithuania (13.03.2010 administrative order No. 1-80) containing precise list.	✓	✓
The Netherlands	Yes	See Table 5.6.		
Slovenia	Yes	Crises (incident) are every unplanned event because of which the operation of gas system is interrupt.	✓	✓
Spain	No			

TABLE 5.6 UNDER WHAT CRITERIA ARE INCIDENTS CLASSIFIED?

Country	DSO respon-sibility	Exceptional event	Force majeure	Third parties	Other	Answer relates to: Transmission	Answer relates to: Distribution
Austria	✓				Planned, unplanned		✓
Czech Republic	✓	✓	✓	✓	a) an imminent danger to life and health, injury or loss of life; b) gas leaks associated with the subsequent explosion and fire; c) damage to gas facilities PDS sudden external intervention when the damage exceeds 500,000,- CZK; d) limitation or interruption of gas distribution to more than 500 supply points; e) the emergence of a situation that could have or has the effect of declaring a state of emergency; and f) Unplanned interruption of gas distribution customers VO with the contracted annual gas consumption over 15 miles per m³ per supply point. This will ord. at his request, 2 x a year provided by the respective customer lists VO leader contractual sales capacity.	✓	✓
Estonia	✓		✓	✓		✓	✓
France	✓	✓	✓	✓		✓	
Germany	✓		✓	✓	Atmospheric influence, feedback effects caused in other networks, others (planned), exchange of meter.	✓	✓
Hungary						✓	
Italy	✓	✓	✓	✓			✓
Latvia	✓	✓	✓	✓			✓
Lithuania	✓		✓	✓	Also according to the termination type: planned and unplanned.	✓	✓
The Netherlands					Category 1: Deadly victims, more than one seriously injured person; loss of more than € 0.5 million to property; major damage to the environment (e. g. buildings or environment); need for coordinated mobilization of emergency services; public concern in the area. Category 2: Potential effects on or off the site (outflow of liquids and gas). For example, more than 0.1 % of the applied outflow quantities in the security calculations); Serious risks to soil pollution, groundwater pollution, air pollution or contamination; surface water as a consequence of an outflow; Risks to humans and animals; The need to switch on emergency services; Need to implement procedural, organisational or technical changes; Repair costs exceed € 0.25 million.		
Slovenia		✓	✓			✓	✓
Spain					Incidents in gas are not classified.		

TABLE 5.7 IS THERE A DEFINITION OF GAS LEAK?

Country	Is there a definition of gas leak?	If yes, please provide the definition	Answer relates to: Transmission	Answer relates to: Distribution
Austria	No			
Belgium	No		✓	
Croatia	No			
Czech Republic	Yes	Gas leaks or is uncontrolled. Unmetered loss of gas from the gas facility, technical rules for gas TPG 905 01.	✓	✓
Estonia	No		✓	✓
Finland	No			
France	Yes	Any unintentional release of gas.	✓	
Germany	Yes	Unwanted gas release.	✓	✓
Hungary	No		✓	
Italy	Yes	Gas leak calculation is detailed and defined for gas transmission system in Gas Network Code and for balancing equation. Gas leak or "dispersion" is the uncontrolled release of gas from the distribution system.	✓	✓
Latvia	Yes	Uncontrolled gas outflow from the gas network into environment, when it is required to perform specific activities in order to ensure safe operation of the facility.		✓
Lithuania	No			
The Netherlands	Yes	Unintended outflow of gas, caused by a failure of a component of the gas distribution network (NEN 7244-9).		✓
Slovenia	No			

TABLE 5.8 WHAT KIND OF CLASSIFICATION IS AVAILABLE FOR GAS LEAKS?

Country	Technical classification based on a degree of dangerousness	Localised after planned inspections	Reported by third parties (1)	Gas leaks per km of network	Gas leaks per number of final customers	Other	Answer relates to: Transmission	Answer relates to: Distribution
Czech Republic	✓	✓	✓				✓	✓
France	✓	✓	✓	✓	✓		✓	✓
Germany	✓	✓	✓	✓			✓	✓
Hungary		✓	✓				✓	
Italy	✓	✓	✓	✓				✓
Latvia	✓	✓	✓	✓	✓			✓
The Netherlands	✓			✓	✓	The DSOs also have data about the other 2 classifications (Localised after planned inspections, Reported by third parties). This data is not available at the NRA.		✓
Slovenia	✓	✓	✓				✓	✓

(1) E.g. via prompt intervention telephone number.

TABLE 5.9 IS THERE A DEFINITION OF EMERGENCY?

Country	Is there a definition of emergency?	If yes, please provide the definition
Austria	No	
Belgium	Yes	See AR16/02/2006 "plans d'urgence et d'intervention", art. 6 § 2
Czech Republic	Yes	A state of emergency is a situation that arose on the gas system or its part as a result of natural disasters, actions of state bodies under a state of emergency, state of emergency or a state of war, accidents on facilities for production, transport, distribution and storage of gas, outstanding balance of the gas system, or in part, terrorist act, or an uncontrolled drop in operating pressure in the high-pressure part of the distribution system (even locally) under 0.8 MPa, which causes a significant shortage of gas or compromising the integrity of the gas system, its safety and reliability throughout the national territory, a defined territory or a portion there of.
Estonia	Yes	An emergency is an event or a chain of events which endangers the life or health of many people or causes major proprietary damage or major environmental damage or severe and extensive disruptions in the continuous operation of vital services and resolving of which requires the prompt coordinated activities of several authorities or persons involved by them.
Finland	No	
France	Yes	
Germany	Yes	
Hungary	Yes	Council Directive 96/82/EC, European Parliament and Council Directive 2012/18/EU.
Italy	Yes	DSO: Emergency is defined as an event that can produce serious effects and / or large-scale safety and continuity of service distribution and causing one or more of the following conditions: a) Unplanned unavailability of delivery points or interconnection points; b) Unplanned unavailability of networks AP or MP or BP that results in the interruption without notice the gas flow to one or more end-users; c) Gas dispersion with interruption without notice of the gas distribution to one or more end customers; and d) Disruption caused by excess or lack of pressure in the network compared to the values required by applicable technical standards. It also defines any emergency event that results in the termination without notice of the gas to at least 250 end-users and for which the gas supply is not activated at all end-users involved present within 24 hours of the start of interruption, with the exception of end-users who are not reactivated when the first attempt to reactivate. TSO: a) Unplanned unavailability of pipelines, total or partial; b) Unplanned unavailability of line installations, total or partial; and c) Unplanned unavailability of compressor stations, total or partial.
Latvia	Yes	National emergency, regional emergency, local emergency.
Lithuania	Yes	The emergency is defined in Low on Civil Security of Republic of Lithuania. It defines 2 aspects of emergency: - emergency event: natural, technological, ecological or social event which corresponds, achieves or exceeds set criteria and also which puts lives, health, social conditions, assets or environment of the citizens in danger; and - emergency situation: situation formed due to emergency event which can cause sudden and great danger for the lives, health, assets, environment of citizens or citizens' death, injury, or other harm.
The Netherlands	No	
Slovenia	Yes	A crisis (incident) is an every unplanned event because of which the operation of gas system is interrupt. Emergency is also defined regarding EU Regulation 994/2010.

TABLE 5.10 UNDER WHAT CRITERIA ARE EMERGENCIES CLASSIFIED?

Country	DSO responsibility	Exceptional event	Force majeure	Third parties	Other	Answer relates to: Transmission	Answer relates to: Distribution
Belgium						✓	
Czech Republic					According to the Public Notice 344/2012	✓	✓
Estonia	✓		✓	✓	TSO responsibility	✓	✓
France		✓	✓	✓	Classification of the accident (leak/rupture) Urbanisation Emergency Plan	✓	
Germany	✓		✓	✓		✓	✓
Italy	✓	✓	✓	✓		✓	✓
Latvia							✓
Lithuania					Extreme situations are classified into 2 levels: - national, - municipal.		
Poland	✓	✓	✓	✓		✓	✓
Slovenia	✓	✓	✓	✓		✓	✓

TABLE 5.11 ARE CAUSES OF INTERRUPTIONS RECORDED?

Country	Are causes of interruptions recorded?	If yes, according to what classification? [1]	Answer relates to: Transmission	Answer relates to: Distribution
Austria	Yes	Network operator, third parties.		✓
Belgium	Yes			
Croatia	Yes	Network operator.	✓	✓
Czech Republic	Yes		✓	✓
Estonia	Yes	Planned and unplanned interruption.	✓	✓
Finland	No		✓	✓
France	Yes	For TSO: Network operator or force majeure. For DSO: DSO (GrDF) operate a data system to classify causes of interruptions recorded.	✓	✓
Germany	Yes	1. Atmospherically influence 2. Caused by third party 3. Responsibility of the network operator 4. Others (planned) 5. Feedback effects caused in other networks 6. Exchange of meter 7. Force majeure	✓	✓

Country	Are causes of interruptions recorded?	If yes, according to what classification? [1]	Answer relates to: Transmission	Answer relates to: Distribution
Hungary	Yes	Force majeure, third parties.	✓	
Italy	Yes	The causes of the interruptions are recorded with reference to: 1. Force majeure, understood as acts of public authorities, unusual natural events for which was declared a state of emergency by the competent authority, strikes, failure to obtain the authorisations; 2. External causes, defined as damage caused by third parties, emergencies and accidents from gas for reasons not attributable to the DSO and TSO; and 3. Other causes, studied come all other causes not included under the previous, including the causes not ascertained.	✓	✓
Latvia	Yes	Planned and unplanned gas supply interruptions, network operator or third party.		✓
Lithuania	Yes	Unplanned interruptions are classified into 3 main categories: Force majeure, third parties and network operator.	✓	✓
The Netherlands	Yes	Vandalism / theft; construction error (in the past); installation error; product error; soil; congealment; customer; pollution; wearing/aging; operation error; internal defect; unknown; other causes.		✓
Portugal	Yes	Force majeure Third parties Network operator Public interest reasons Security reasons		✓
Slovenia	Yes	Planned maintenance, inspections, reconstructions, tests, control measurements, enlargement of network, force majeure, third parties.	✓	✓
Spain	Yes	Situation of transport grid Normal grid operation conditions SOE 0 Situation of exceptional operative condition level 0 SOE 1 Situation of exceptional operative condition level 1 SOE 2 Situation of exceptional operative condition level 2 Situation of Emergency Can only be declared by the Government	✓	
Sweden	No			

5.4.2 Continuity of Supply Indicators

A total of 10 countries use indicators to monitor continuity of supply indicators, both frequency and duration and for both planned and unplanned interruptions.

From the tables shown, it becomes clear that in most countries, where continuity of supply is monitored, the indicators SAIDI, ASIDI, SAIFI, and CAIDI are in use. The use of more than just one indicator to quantify continuity of supply, results in more information being available and more possibilities to compare the results among different countries.

SAIDI and SAIFI are the basic indicators, reported in almost all participating countries, albeit under different names and with different methods for weighting the interruptions. The method of weighting impacts the results and leads to different biases towards different types of network users.

When weighting is based on the number of network users, each user is treated equally, independent of its size and independent of their consumption levels. Whereas when weighting is based on interrupted or contracted power, an interruption gets a higher weighting when the total interrupted power is higher.

Again, it should be noticed, that one single interruption in gas can lead to a high risk of safety and therefore the efforts of network operators to almost completely avoid such an interruption might be greater than in electricity. In general, this might be one reason for having considerably fewer interruptions than in electricity. Another reason for fewer interruptions is that most of the pipelines are below ground level and therefore are less vulnerable than overhead power lines. However, most interruptions last much longer than in electricity.

TABLE 5.12 WHAT RELIABLE INDEXES ARE AVAILABLE AS FAR AS GAS NETWORKS ARE CONCERNED?

Country	SAIDI	ASIDI	SAIFI	CAIDI	Other	Answer relates to: Transmission	Answer relates to: Distribution
Austria	✓ SAIDI = (sum of all customer interruption durations) / (total number of customers served)		✓ SAIFI = (total number of customer interruptions) / (total number of customers served)	CAIDI = (sum of all customer interruption durations) / (total number of customer interruptions) = SAIDI / SAIFI			✓
Croatia					✓ Duration of all interruptions of gas supplies in relation to the number of all end customers which gas supply has been interrupted.		✓
Czech Republic						✓	✓
France		✓	✓	✓			
Germany	✓ SAIDI = Σ(Ni * ri) / Nt N_i - number of customers interrupted by each incident, N_t - total Number of customers in the system for which the index is calculated, r_i - restoration time for each incident (< 100 mbar)	✓ ASIDI = Σ(Li * ri) / Lt N_i - contracted power interrupted by each incident, N_t - total contracted power in the system for which the index is calculated, r_i - restoration time for each incident (< 100 mbar)	✓ SAIFI = Σ(Ni) / Nt (< 100mbar) SAIFI = $\Sigma(L_i) / L_t$ (≥ 100 mbar)	CAIDI = Σ(Ni * ri) / Ni (< 100 mbar) CAIDI = Σ(Li * ri) / Li (≥ 100 mbar)	No	✓	✓
Italy	✓ The number of interruptions for the end customer is defined by means of the following formula: Number of interruptions for customer = $\Sigma C_i / C_{tot}$ where the sum is extended to all n interruptions occurred in the calendar year, and where: • C_i is the number of end-users involved in the i-th interruption considered; • C_{tot} is the total number of end customers served by the distribution company at the end of the calendar year.		✓ The overall duration of interruption for the end customer is defined by means of the following formula: Total duration of interruption for customer = $\Sigma C_i \times t_i$ / Ctot where the sum includes all n outages occurred in the calendar year, and where: • C_i is the number of end-users involved in the i-th interruption considered; • t_i it is the corresponding duration of the interruption for customers Ci; • C_{tot} is the total number of end customers served by the distribution company at the end of the calendar year.				✓

Country	SAIDI	ASIDI	SAIFI	CAIDI	Other	Answer relates to: Trans-mission	Answer relates to: Distri-bution
Lithuania	✓ It is average disruption duration for one customer, calculated as: Sum of all customers who encountered planned or not planned disruption times the length of duration (minutes) in the numerator and total number of customers in the denominator.		✓ It is average number of disruption for one customer, calculated as: sum of all customers for who encountered gas distribution disruption in the numerator and total number of customers in the denominator.				✓
The Netherlands	✓ Sum of all customer interruption durations / Total amount of consumers served		✓ Total number of customer interruptions / Total amount of customers served	✓ Sum of all customer interruption durations / Total number of customer interruptions			✓
Poland	✓	✓	✓	✓		✓	✓
Portugal	✓ Average duration of interruptions per exit point (min/exit point): the quotient of the overall duration of interruptions at the exit points over a specific period and the total number of exit points at the end of the period considered.		✓ Average number of interruptions per exit point: quotient of the total number of interruptions at the exit points over a specific period and the total number of exit points at the end of the period considered.		✓ AIT: Average duration of the interruption (min/interruption): Quotient of the overall duration of interruptions at the exit points and the total number of interruptions at the exit points over the period considered.	✓	

TABLE 5.13 AVAILABILITY OF SUB-INDICATORS

Country	Planned/unplanned interruptions	For causes of interruptions	For origins of interruptions	Answer relates to: Transmission	Answer relates to: Distribution
Austria	✓		✓		✓
Croatia	✓				
Czech Republic	✓	✓	✓		✓
France	✓	✓	✓		✓
Germany	✓	✓	✓	✓	✓
Italy	✓	✓			✓
Lithuania	✓	✓			✓
The Netherlands	✓				✓
Poland	✓	✓	✓	✓	✓
Portugal	✓	✓		✓	

TABLE 5.14 CONTINUITY OF SUPPLY INDICATORS IN 2013

Editor	SAIDI	ASIDI	SAIFI	CAIDI	Other	Answer relates to: Transmission	Answer relates to: Distribution
Austria (1)	1.83		0.0057	323.00			✓
Czech Republic						✓	✓
Germany	0.573	0.072				✓	✓
Lithuania	26.9702 (planned) 1.5283 (unplanned)		0.2643 (planned) 0.0045 (unplanned)				✓
The Netherlands	5.10 (planned) 1.01 (unplanned)		0.027 (planned) 0.0067 (unplanned)	195.64 (planned) 122.5 (unplanned)			✓
Poland						✓	✓
Portugal	0.00		0		AIT: 0	✓	
Slovenia	NAP						

(1) Values in 2014: SAIDI: 1.68, SAIFI: 0.0050, CAIDI: 335.

5.5. REGULATION OF CONTINUITY OF SUPPLY AND SAFETY ISSUES

Technical quality of gas networks is mainly a result of operating and maintaining the gas networks by the network operator. In this area, network operators have to follow technical rules and standards with the aim to guarantee a mostly uninterrupted distribution of gas in sufficient quantity and quality and the required pressure.

This section provides an overview of the different regulation frameworks for technical gas quality and safety issues which exist in CEER countries. Since the topic of regulation of technical gas quality is manifold, it is subject to many different indicators. To mention just a few, this section covers the handling of planned interruptions, rules and incentives for safety, whether or not there are rules in force for the restoration of networks in case of an unplanned interruption and if there are any obligations for odorising gas.

5.5.1 Standards in technical gas quality regulation

Continuity of supply refers to the availability of gas to all network users. All reporting countries stated that continuity of supply is monitored within their gas networks country-wide. This monitoring is done in differently ways across different countries. Differences vary from the kind of interruptions monitored and the level of detail being reported to the interpretation and highlighting of various indicators. The methods used for monitoring in the different countries are presented in this section.

Since technical safety is much more important in the gas sector than in the electricity sector, it is covered by accepted technical rules and standards, which are in many cases not subject to direct regulation but it is assumed that network operators follow those rules.

5.5.2 Case Study: The role of technical rules and standardisation for the gas sector in Germany

The general concept of the German energy policy is shaped by market principles. Energy is in principle a matter for the private sector and energy companies act on their own authority. Nonetheless, due to the importance of energy availability to public welfare and to the economy, it is subject to state supervision within a clear legal framework. Putting it briefly, the safety and operation of the German gas supply system is based on a self-administration principle with a minimum of state supervision.

The energy authority within the Federal Ministry of Economic Affairs and Energy, and additional offices in the federal states are responsible for technical safety in gas. According to the principle of self-administration, the Energy Authority normally observes the gas sector and intervenes only if deficits or critical incidents show up. Nonetheless, there is a continuous communication and information exchange between the authorities and the gas sector.

Energy Industry Act ensures safety by self-administration of the gas sector

In Germany, the Energy Industry Act (EnWG: 2005) builds the legal framework for the gas sector, which also implements the European Directives in the field of energy, e.g. the directive for the common gas market 2003/55/EC, replaced now by the new edition 2009/73/EC, and the related EC Regulation No 715 on the gas transmission network access. Regarding the technical functioning of gas infrastructure, the Energy Industry Act is limited to the stipulation of general aims: provision of gas has to be managed in a safe, economic and environment friendly way.

As a specialty, the Energy Industry Act requires in section 49 that energy companies (that means facilities that produce, transmit, distribute, and deliver gas) have to operate their system according to the generally recognised technical rules. Especially according to this section, it is assumed that the generally recognised technical rules have been observed when the technical rules of the German Technical and Scientific Association for Gas and Water (DVGW e. V.)[12] have been adhered to. This means that the German law does not define the features which constitute for example technical safety, but it assumes that, with respect to technical safety, it should be sufficient if an energy company builds and operates according to the generally accepted technical rules.

In addition to the Energy Industry Act, only few additional ordinances refer to technical aspects of the gas infrastructure such as:

- Ordinance for general requirements for connection to and the use of a low pressure network, which directs the contract between the gas network operator and the gas consumer;
- Ordinance for access to gas network, which governs the conditions for which network operators have to admit non-discriminatory access to the network, including biogas injection and capacity allocation; and
- Ordinance for high pressure pipelines, which applies for construction and operation of pipelines with operating pressure over 16 bar as a part of gas transmission systems designated for provision of public with gas or designated for provision of industrial enterprises but outside of the site of this enterprise.

All of these ordinances are referring to the Energy Industry Act section 49, to the quoted DVGW codes of practices as well as to DVGW certification and quality marks.

As a consequence, technical rules serve as additional elements to state regulation. Precondition is the democratic legitimation of these rules provided by comprehensive involvement of all relevant parties – sector, science, administration, politics and society. This precondition leads to the approach of self-administration of the gas techniques:

- The sector builds a representative technical and scientific association and provides expertise (for the gas sector, the DVGW e. V);
- The association obliges itself in statutes and in organisation to guarantee transparency, openness, participation of all interested parties and consensus in the procedures of setting codes of practices. Certainly, the resulting set of technical rules has to be coherent and without conflicts in itself or with view to legislation and national and European standards; and
- Easy availability of the resulting technical rules has to be granted.

The documents developed according to this approach shall give the liberty to choose different solutions and shall be open to the available and innovative technologies in order not to create innovation barriers.

The principles of self-administration are well-proven and advantageous for all parties involved in the gas sector, including the responsible state authorities. Respecting all changes on European and national level, it is also the approach of the future.

The role of the German Technical and Scientific Association for Gas and Water in the German gas sector

As a non-profit organisation German Technical and Scientific Association for Gas and Water (DVGW e. V.) promotes the technological developments of the gas and water sectors and contributes to the effective implementation of new technologies and legislation in practice. In this regard, the DVGW bases its activities on the current requirements of gas and water sector and on the objectives declared in the statutes, i.e. safety, environmental and consumer protection, precautionary principles, hygiene and quality aspects, while taking efficiency and cost-effectiveness into consideration.

As shown previously, German legislation mandates the DVGW to set technical requirements on which the practical work in the gas and water branch is therefore based. These are stipulated in different kinds of DVGW deliverables in descending order of importance: codes of practice, technical guidelines and recommendations. Together these documents build the “DVGW Set of Technical Rules” for gas. This set applies to the design, construction, operation and maintenance as well as to the use of installations, systems and products intended for the public provision of gas, including quality of gas and the qualification requirements for companies and persons involved in the gas sector. In general, it defines primarily the technical safety, environmental and organisational requirements for the provision and use of gas.

Through this, the DVGW essentially provides the yardstick for achieving compliance with safety requirements. Compliance is the final responsibility of the applying companies. All activities of the non-profit association aim at supporting companies in this duty. In this regard, the DVGW follows the described principles of self-administration and acts as an autonomous body, free of the influence of special interests. In addition, the continuous and interactive co-operation between the DVGW, energy authorities and other related authorities contributes significantly to the proper completion of the task. In this context, the DVGW also has a constructive dialogue with BNetzA, focussed on the technical safety

12. http://www.dvgw.de/english-pages/dvgw/

as an important aspect in regulation. For example the well-proven Technical Safety Management System of DVGW's supporting companies qualification, organisation and procedures, could build a good basis for a common approach with the German NRA.

The application of DVGW codes of practice is voluntary in a formal respect but de facto, they are stipulating the obligatory level of safety and technology to be respected by all parties involved in the German gas industry and they are recognised as such by legislation. If other rules and procedures are followed, in the case of incidents and/or accidents, users have to prove that the applied rules and procedures are offering the same safety level as the DVGW codes of practice do.

Procedure of setting DVGW codes of practices

The work of drafting codes of practices, technical guidelines and recommendations follows the same principles and similar procedures as formal standardisation (e.g. DIN, CEN and others), including involvement of all interested parties, enquiries and public hearings. It is carried out by DVGW technical committees which are composed of experts delegated voluntarily for this purpose by gas network operators, utilities, product manufacturers, pipe-construction companies, etc. Approximately 400 gas experts are contributing expertise and experience to the DVGW committees. Thus, the committee elaborates the rules for the sector and ensures hereby a high level of quality, technical safety and reliability.

The procedure of setting codes of practices, technical guidelines and recommendations is laid down in the terms and conditions for DVGW technical bodies and for the elaboration of the "DVGW Set of Technical Rules" (GW 100:2015).[13]

One example demonstrating the interaction of DVGW activities is the introduction of the Technical Safety Management Gas (DVGW TSM). This branch specific system aims at supporting gas network operators to verify, optimise and monitor the internal operational, organisational structure and qualification of the company in line with the gas technical and legal framework. By introducing the DVGW TSM, companies demonstrate conformity in general and in case of incidences with gas.

Based on the DVGW code of practice G 1000 "Requirements related to the qualification and organisation of companies operating facilities for the pipe-bounded supply of the public with gas"[14], a questionnaire has been elaborated covering all relevant gas technical, organisational and legal issues for appropriate organisation and qualification of a gas network operator. For the company, the internal introduction of TSM is a continuous process, starting with the internal self-verification during which the company checks itself whether all requested requirements are fulfilled. Following to this, DVGW experts verify the compliance with the questionnaire and the related requirements in detailed dialogues and give approval by certificate or relaunch the self-verification process. Assuming no major changes, verification and approval is repeated every 5 years.

DVGW TSM is highly appreciated by the energy authorities. In some federal states of Germany, e.g. Bavaria, the proof of DVGW TSM system provides basis for the permission to transport and distribute natural gas according to the Energy Industry Act section 3 requiring the appropriate staff, technical and economic capacities to guarantee the permanent provision of consumers with gas. Additionally, BNetzA as the NRA accepts the value of DVGW TSM for the technical safety and has agreed to take it into account for a future configuration of the quality regulation.

5.5.3 Planned interruptions

A total of 15 of the reporting countries have obligations for giving advance notice of planned interruptions. The time for that advance notice varies clearly between 36 hours in Portugal and almost a year in Hungary, where all planned interruptions for the following year have to be published by the 15 January of each year.

13. A comprehensive overview of new technical standards issued by the DVGW is available on the Internet at www.dvgw-regelwerk.de. Furthermore, an electronic newsletter informs regularly about the publication of new DVGW deliverables and related events. (www.dvgw.de/english-pages/services/standardisation/newsletter).

14. The DVGW codes of practice are accessible via the webpage of DVGW.

TABLE 5.15 IS THERE AN OBLIGATION FOR OPERATORS TO GIVE AN ADVANCE NOTICE FOR PLANNED INTERRUPTIONS?

Country	Obligations for advance notice for planned interruptions	If yes, how long in advance	Answer relates to: Transmission	Answer relates to: Distribution
Austria	Yes	"Planned interruptions and restrictions of injection capacity shall be announced to system users and their suppliers in a suitable manner at least 5 days in advance, and such announcement shall include information about the planned duration of the interruption or restriction. Shorter lead times are permitted subject to the agreement of system users in each individual case."		✓
Belgium	Yes			
Croatia	Yes	Minimum 30 days		✓
Czech Republic	Yes	42 days in advance	✓	✓
Estonia	No	No direct obligation		
Finland	Yes	Not regulated	✓	✓
France	Yes	5 days		✓
Germany	Yes		✓	✓
Hungary	Yes	Until 15 January of every year the planned interruptions have to be published for the calendar year.	✓	
Italy	Yes	As regards the gas distribution the minimum time of notice in cases of scheduled interruption is equal to 3 working days.	✓	(i)
Latvia	Yes	5 working days before planned interruption.		✓
Lithuania	Yes	42 calendar days.	✓	✓
The Netherlands	Yes	At least 3 days in advance.		✓
Poland	**Yes**	Network operators are obliged to give an advice notice to all gas system users about the dates and duration of planned interruptions in delivery of gaseous fuels by press, Internet, radio or television announcements or by any other means customarily adopted in the given location, at least: a) 7 days before the day of planned interruption for customers classified as Connection Group B, subgroup I (i.e. customers who declare off-takes of gaseous fuel in an amount no more than 10 m^3/h of high-methane gas or no more than 25 m^3/h of low-methane gas). b) 14 days before the day of planned interruption for other customers.	✓	✓
Portugal	**Yes**	36 hours	✓	
Slovenia	**Yes**	1 month in advance	✓	✓
Spain	**Yes**	Except for emergency situations, the DSO will proceed to inform in due time for the affected users on the intention to supply disruption, trying in all cases to minimize the impact that the interruption would cause users affected. The DSO will include in such information, the cause that originates the interruption and expected date to resume the supply.		✓

(i) As regards the transport gas the minimum time of notice in cases of scheduled interruption it is equal to 7 working days of delivery points or interconnection and 3 working days on points of redelivery.

5.5.4 Rules and incentives for safety

Since safety issues are much more important in gas networks, different types of regulations or rules are in force. Some countries have introduced a sort of "risk index" and it is the network operator's task to provide these indicators to the public. Although monitored and published, it is not subject to regulation.

TABLE 5.16 IS ANY TYPE OF "RISK INDEX" OF DISTRIBUTION NETWORKS INTRODUCED TO REVEAL NETWORKS' SAFETY STATUS, TO MAKE NETWORKS MORE SECURE OR TO IDENTIFY PIPES REPLACEMENT PRIORITIES?

Country	Is any type of a "risk index" of distribution networks introduced to reveal networks' safety status, to make networks more secure or to identify pipes replacement priorities?	Description	Is this monitored?	Answer relates to: Transmission	Answer relates to: Distribution
Austria	No		No		
Croatia	No		No		
Czech Republic	Yes	In the Czech Republic there is a methodology for evaluating the condition of gas equipment for the purpose of ensuring their operation (TPG 905 01) as well as the methodology for ensuring recovery facility (TPG 700 02, TPG 700 04). These methodologies incorporate both technical insight and depending riskiness of the operation of the device. The purpose of these regulations is to define the optimal approach to the operation and recovery of gas facilities in terms of ensuring their safe, reliable and economic operation.	Yes		✓
Estonia	No		No		
Finland	No		No		
France	No		No		✓
Germany	No		No	✓	✓
Italy	Yes	The distribution company annually prepares the "Annual Report on the risks of gas emission" for each distribution system, considering the number of gas leaks reported by third parties during the reference year and the year prior to reference, specifying for each distribution system material type and the class of the pipeline pressure and road, as required by Technical Specification UNI / TS 11297 Evaluation procedures against gas leakages risks.	Yes		✓
Latvia	No		No	✓	✓
Lithuania	Yes	Regulated companies' competence.	No		
The Netherlands	Yes	The DSO's introduced a kind of risk index (veiligheids indicator). However this is not regulated by the NRA.			
Slovenia	No		No		
Spain	No		No		

Moreover, from all reporting countries, only Italy has adopted a specific financial incentive scheme aimed at improving safety of gas networks which is described as follows:

"The adjustment of the quality of service of the gas distribution provides, inter alia, a mechanism of incentives and penalties based on indicators measured at the level of gas distribution plant which make reference to 2 components (odorisation and gas dispersion). The incentive regulation of odorant is asymmetrical and only reward. The incentive regulation of the reduction of conventional localised disturbances reported by third parties includes both awards that penalty, through a mechanism trend levels (defined ex-ante) and comparing the trend levels and the actual levels (ex-post); it is asymmetrical in caps."

When it comes to financial compensation in situations where technical supply standards are not met, 4 of the reporting countries (the Czech Republic, the Netherlands, Slovenia and Spain) impose network operators to pay such compensations.

5.5.5 Restoration of networks

A total of 8 countries report that the time for restoration after an unplanned interruption is regulated by the NRA. In some countries this rule is set by law (Estonia), some countries use individual rules (France, Italy), and in other countries there is only the obligation to restore gas supply as soon as possible (Austria, Hungary, Latvia). Please see the following table for more information.

TABLE 5.17 IS THE TIME FOR THE RESTORATION OF SUPPLY IN CASE OF UNPLANNED INTERRUPTIONS SUBJECT TO ANY PARTICULAR REGULATION?

Country	Is the time for the restoration of supply for unplanned interruptions subject to any particular regulation (1)	If yes, please describe	Answer relates to: Transmission	Answer relates to: Distribution
Austria	Yes	Ordinance on Gas System Service Quality: "In cases of failures that interfere with supply or injection, system operators shall immediately start repair works, conclude the absolutely necessary repair works as quickly as possible and inform the affected system users of the planned or actual duration of the failure in a suitable manner."		✓
Croatia	Yes	Network codes of gas distribution system.		✓
Czech Republic	No			✓
Estonia	Yes	Natural Gas Act – The consecutive duration of an interruption of gas supply caused by failures may not exceed 72 hours and the total duration of interruptions per year may not exceed 130 hours.	✓	✓
Finland	No			
France	Yes	For GrDF: unless longer period agreed with the customer, the first trip comes within 4 hours when the call is received before 9 pm and the next morning before noon when the call is received during the night between 9 pm and 8 am.		✓
Germany	No		✓	✓
Hungary	Yes	As soon as possible.	✓	
Italy	Yes	1. Specific standard on the maximum number of days of reduction / interruption of capacity at redelivery points due to maintenance operations: it is expected that the TSO, exceeded the maximum number of 3 days, on an annual basis, of interruptions / reductions in capacity (days equivalent to entire capacity) as a result of maintenance activities that impact on the capacity available to a delivery point (net of those provided by the contractual conditions of interruptible and those arising from emergency service), matches an automatic compensation related to the allocated capacity not made available over on the 3rd day equivalent, until the 6th. For compensation, a maximum factor of risk containment for TSO is expected. 2. Specific standard on the maximum number of supply disruptions in the delivery points: with the same purposes of the preceding paragraph, it is provided that the TSO, exceeded the maximum number of interruptions, 0 (excluding emergencies derived from interruptions of service for reasons not attributable to the transport undertaking interruptions with notice and those set by contract terms interruptible) in which, in the reporting year, a delivery point has been involved, an automatic compensation corresponds to the number of interruptions in excess the specific level (up to a maximum of 3). There will also be a maximum value and a minimum compensation for each compensable interruption.	✓	
Latvia	No	Gas supply is restored as soon as possible.		✓
Lithuania	Yes	SAIDI index.		✓
The Netherlands	No			
Portugal	No		✓	
Slovenia	No			
Spain	Yes	Discount on access charges (the discount does not affect the energy component). 1 interruption of less than 5 hours: No discount. 2 interruptions of less than 5 hours in a month: 10 % discount. 1 Interruption from 5 to 24 hours: 10 % discount. For every additional 2 days of interruption: Additional 10 % discount.	✓	✓

(1) E.g. Standard, automatic compensations.

5.5.6 Obligations for odorising natural gas

TABLE 5.18 IS THERE AN OBLIGATION TO ODORISE NATURAL GAS?

Country	Is there an obligation to odorise natural gas?	Odori-sation at trans-portation level:	Odori-sation at distri-bution level:	Are there types of consumers for whom odorisation is not mandatory?	Do DSOs have obligations as far as gas odorisation is concerned?	Please, describe.	Is this monitored	Answer relates to: Trans-mission	Answer relates to: Distri-bution
Austria	Yes		✓	Yes			No		
Croatia	Yes		✓	No	Yes	DSO is obliged to odorise gas and to monitor the effectiveness of odorisation in accordance with the provisions of special laws, regulations, standards, codes of practice and internal technical acts of the DSO regulating the technical conditions of the odorisation.	Yes		
Czech Republic	Yes		✓	Yes	Yes	RWE GasNet used on its grid system combined central and local odorising so that odorisation secured safely and efficiently. It is used as an odorant substance Spot leak 1424 (a mixture of substances TBM and DMS). On a limited scale network is used based on customer requirements (technological consumption VO) sulphur-free odorant S GASODOR free.	Yes		✓
Estonia	Yes		✓						
Finland	Yes		✓	Yes	No	Gas safety is responsibility of Finnish Safety and Chemicals Agency (Tukes). http://www.tukes.fi/en/	No		
France	Yes	✓	✓	No	Yes	In France, gas is odorised by the TSO.	No	✓	✓
Germany	Yes		✓	No	Yes		No	✓	✓
Hungary	Yes	✓		Yes	No	Odorisation is the obligation of TSO. In specific cases the producer, who injects natural gas to the distribution system or the supplier of an island distribution system is responsible for the odorisation.	Yes	✓	
Italy	Yes	✓	✓	Yes	Yes	Odorisation at transportation level is required when the gas delivered is used for domestic or similar use. The distribution company is required to make an annual minimum number of measurements of the level of odorisation of gas per thousand end customers served. Such measures must be carried out in a distributed fashion throughout the year at the critical points of the network in accordance with the provisions of the applicable technical standards (UNI-CIG 7133-2 edition 2014 Gas odorisation for domestic and uses. Part 2: Requirements, check and management).	Yes		✓

Country	Is there an obligation to odorise natural gas?	Odori-sation at trans-portation level:	Odori-sation at distri-bution level:	Are there types of consumers for whom odorisation is not mandatory?	Do DSOs have obligations as far as gas odorisation is concerned?	Please, describe.	Is this monitored	Answer relates to: Trans-mission	Answer relates to: Distri-bution
Latvia	Yes		✓	No	Yes	In particular points according the standards.	Yes	✓	✓
Lithuania	Yes	✓		No			Yes		
The Netherlands	Yes	✓			Yes	DSOs monitor whether the gas is odorised properly. If not, the TSO is warned.			
Poland	Yes		✓	No	Yes	Gas odorisation parameters and the intensity of the odorisation for the low-pressure and the medium-pressure pipelines are contained in secondary law.	Yes		
Slovenia	Yes		✓	Yes	Yes	He is obliged to do the odorisation of gas in distribution system at the entry point of distribution system.	No		
Spain	Yes	✓	✓	No	Yes	DSO is also responsible for the gas odorisation.			
Sweden	Yes	✓		No					

5.5.7 Network losses

In general, losses are defined as the absolute difference between the volume of gas entering the system (metered or estimated at the point of entry) and the customer related amount of gas exiting the system (metered or estimated at the point of exit). The specific definition of network losses varies across countries.

To be able to compare losses across countries in the future, the adoption of a common standard for the expression of losses might be worth considering. Although losses are defined as listed below, additional inaccuracies in their measurement might occur, for example because of the time-lag between measuring input and output.

Moreover, some countries have implemented regulatory rules aimed in reducing losses.

TABLE 5.19 IS THERE A METHODOLOGY TO COMPUTE NETWORK LOSSES IN GAS NETWORKS?

Country	Answer	Is there any methodology to compute network losses in gas networks?
Austria	No	
Belgium	No	
Croatia	Yes	Annual gas losses are determined as difference of the total amount of gas that is taken into the distribution system and the total amount of gas that is delivered from the distribution system to end customers. The total amount of gas that is delivered to the distribution system is calculated as the total measured amount of gas entering the distribution system for a period of 6 hours of June 30 last year to 6 pm on June 30 of the year in which annual gas losses are determined.
Czech Republic	Yes	According to the Public Notice 195/2014.
Estonia	No	
Finland	No	
France	Yes	The Gas Losses and Diverse Discrepancies (LDD) of GrDF equals to the difference between: • Quantity of energy injected by the TSOs at the entrance of the DSO (Removals from the TSOs); and • Quantity of energy metered by GrDF to its customers (metered energy to the customers). Real GrDF LDD = ∑ (Removals from the TSOs – metered energy to the customers) To estimate this, we use: • The daily allocations = energy breakdown among customers supplied by GrDF of "Removals from the TSOs – LDD bought by GrDF" in which "LDD bought by GrDF" is the quantity of energy bought every day by GrDF to compensate its average LDD (2.4 TWh per year); and • Distribution spread account (DSA): calculated after each reading, they equal for each customer to the difference between its quantity of metered energy and the quantity of energy which was allocated to him/her during the same period. DSA = metered quantities – allocated quantities Then we have: ∑ DSA = ∑ (metered quantities – allocated quantities) = ∑ metered quantities – ∑ (Removals from the TSOs – LDD bought by GrDF) = ∑ (metered quantities – Removals from the TSOs) + ∑ LDD bought by GrDF = ∑ LDD bought by GrDF – Real GrDF LDD and Real GrDF LDD = ∑ LDD bought by GrDF – ∑ DSA Example: in 2013, the LDD bought by GrDF equaled 2,414 GWh and S DSA -656 GWh. It then came Real GrDF LDD =3,070 GWh.
Germany	No	
Hungary	Yes	High pressure system: the TSO measures continuously the entry and exit volumes. The metering differences and the transmission losses are defined in a balance sheet form on a daily basis, taking into account the transmission system operator's own consumption and change in its line pack, as well as the input to and off-take from the system. Medium and low pressure system: the losses are computed with the help of an expert model which defines several subcategories of loss.
Ireland	Yes	GNI calculates gas shrinkage losses on a monthly basis across the network. Shrinkage gas includes both fuel gas usage in compressor stations and water bath heaters on the transmission network as well as UAG.
Italy	Yes	High pressure system: gas transmission network codes define losses (measured, calculated and estimated). Balancing equation takes into consideration losses. Tariff regulations recognise average losses.
Latvia	Yes	JSC "Latvijas Gaze" uses 5 methodologies: methodology for technological losses calculation in distribution system, methodology for technological losses in transmission system, methodology for technological losses calculation for Incukalns UGS, methodology of technological losses calculation in user's gas supply system, methodology for calculation of non-balance of technological losses.
The Netherlands	No	
Portugal	No	
Slovenia	No	
Spain	Yes	Yearly balancing among entries and exits to the transport and distribution grids.
Sweden	Yes	Annual gas losses are determined as difference of the total amount of gas that is taken into the distribution system and the total amount of gas that is delivered from the distribution system to end customers.

TABLE 5.20 IS THERE ANY REGULATION IN FORCE AIMED AT REDUCING LOSSES?

Country	Answer	Is there any regulation in force aimed at reducing losses?
Austria	No	
Belgium	No	
Croatia	Yes	The methodology of determining the amount of tariff items for gas distribution prescribing that gas losses are within OPEX which includes the cost of purchasing gas for covering allowed losses of gas amounting to a maximum of 3 % of the total amount of gas entering the distribution system.
Czech Republic	No	
Estonia	No	
Finland	No	
France	Yes	Ministerial order on multi-fluids of 05/03/2014 (article 6) aims at reducing the vented gas in planned works on the transmission network. Use of reduction venting technics is mandatory if the estimation of losses reaches 40 t CH4. If the utilisation of such mitigation measure is not possible, the transporter has to justify it.
Germany	No	
Hungary	Yes	The accepted loss level is determined by the NRA and its level is under the actual loss level to incentivise the system operators to cut their losses.
Ireland	Yes	Incentive to reduce this.
Latvia	Yes	Every year JSC "Latvijas Gaze" elaborates and submits to the Public Utility Commission the plan of decrease of natural gas losses for the next year and the report on performance in the previous year in reference to the plan.
Lithuania	Yes	NCC confirmed the methodology for price calculation which indicates that technical losses projected for the regulatory period (5 years) must be proved by operators when setting the prices-cap. They should also prove any changes in technical losses each year when adjusting price-cap.
The Netherlands	No	
Portugal	No	
Slovenia	Yes	There is a regulative limit of 2%.
Spain	Yes	TSO and DSO have an economic incentive to reduce losses, as they can keep half of the value of the gas if the losses are less than the standard losses recognised by the regulation: Standard losses Distribution grids (≤ 4 bar) 1 % Distribution grids (4 to 16 bar) real losses up to a maximum of 0.39 % Transport grids (> 16 bar) 0.2%
Sweden	No	

5.6. FINDINGS AND RECOMMENDATIONS ON GAS TECHNICAL OPERATIONAL QUALITY

Finding 1
The availability of continuity of supply indicators and safety indicators for gas varies noticeably across all reporting countries.

Although one can observe a general availability of information on continuity of supply indicators, the level of detail varies markedly across the reporting countries.

RECOMMENDATION 1

EXPAND THE COVERAGE OF MONITORING OF CONTINUITY OF SUPPLY INDICATORS AND SAFETY INDICATORS.

It is recommended to extend the reported indicators across the reporting countries so that comparisons are possible across more countries in the future. Consequently, the definition of a basic set of indicators might be useful.

06

NATURAL GAS QUALITY

6.1. INTRODUCTION

Depending on its origin, the composition of natural gas can differ. Gas can be supplied to a country from different sources such as indigenous production, imports from neighbouring countries at interconnection points, or Liquefied Natural Gas (LNG) imports through LNG terminals. As a result of the varying supply mixes and appliance populations, each country has developed its own gas quality standards. This chapter proposes to compare the different standards across the European countries.

This benchmarking analysis is also relevant since European regulations such as the Interoperability Network Code [27] are to be implemented from May 2016 with the aim to facilitate efficient gas trading and transmission across gas systems within the European Union, and thereby moving towards greater internal market integration. Furthermore, work is being carried out by CEN, ENTSOG and other stakeholders to examine the impact of harmonising gas quality across Europe.

6.2. STRUCTURE OF THE CHAPTER ON NATURAL GAS QUALITY

In this chapter, the results allow comparisons of the standards relating to technical parameters applicable in each country and their monitoring frequency. The second part presents the actors who assume the responsibilities and financial risks resulting in gas quality. Finally, CEER provides its findings and observations on natural gas quality.

In total 17 countries responded to this questionnaire. Among these countries, Austria and Germany did not provide technical data given that parameters are defined by technical associations for gas (OVGW for Austria and DVGW for Germany) which set binding guidelines and technical rules according to their national legislation. This means that in Austria and Germany quality requirements for injecting and transporting gas that are set in the General Terms and Conditions for the distribution network, shall comply with OVGW or DVGW regulation, respectively. Therefore, the requested parameters are not monitored by the NRA.

6.3. ANALYSIS OF TECHNICAL PARAMETERS MONITORED BY COUNTRIES

6.3.1 Overview of technical parameters

In the benchmarking questionnaire, NRAs were asked to provide data on several parameters. Some of these parameters represent the chemical composition of natural gas (methane, sulphur, carbon dioxide, etc.). Other parameters such as Wobbe index, Relative Density or Water/Hydrocarbon Dew Point, etc. are considered as important quality parameters, sometimes stipulated in contractual specifications and enforced throughout the natural gas supply chain, from producers through processing, transmission and distribution companies to final end-users.

Table 6.1 presents an overview of the technical parameters monitored by each country. The definitions and characteristics of the main parameters are given in Section 6.3.2.

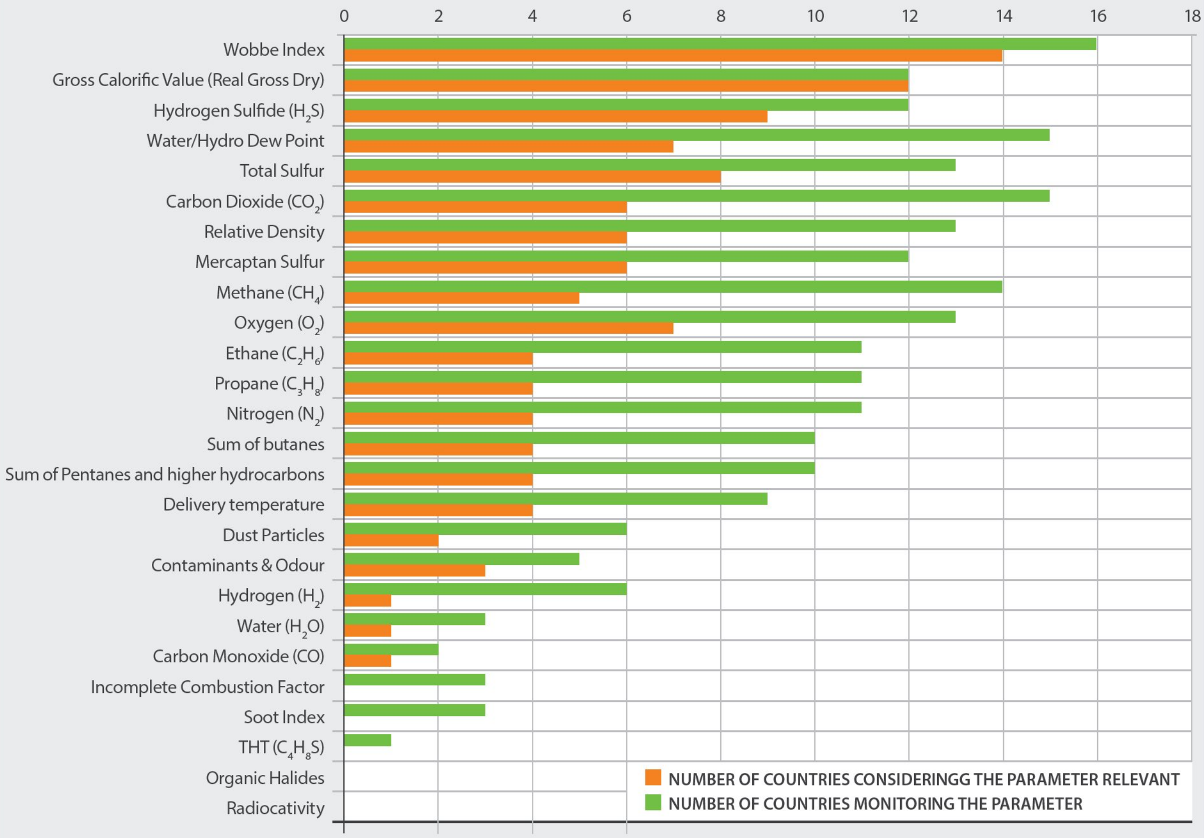
TABLE 6.1 OVERVIEW OF THE PARAMETERS MONITORED BY EACH COUNTRY

Parameters	BE	CZ	EE	ES	FR	GB	HR	HU	IE	IT	LT	LV	NL	PL	PT	SI
Wobbe Index	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Gross Calorific Value	x	x		x	x		x	x		x	x	x		x	x	x
Hydrogen Sulfide (H_2S)	x	x			x	x	x	x	x	x	x	x		x	x	
Water/Hydrocarbon Dew Point	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
Total Sulphur	x	x	x	x	x	x	x	x	x	x	x			x	x	
Carbon Dioxide (CO_2)	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x
Relative density		x	x	x	x		x	x	x	x	x	x		x	x	x
Mercaptan Sulphur	x	x	x	x	x		x	x		x	x	x		x	x	
Methane		x	x	x	x		x	x	x	x	x	x	x	x	x	x
Oxygen	x	x	x	x	x	x	x	x	x	x	x	x			x	
Ethane		x	x		x		x	x	x	x	x	x		x		x
Propane		x	x		x		x	x	x	x	x	x		x		x
Nitrogen		x	x		x		x	x	x	x	x	x		x		x
Sum of butanes		x	x		x			x	x	x	x	x		x		x
Sum of Pentanes		x	x		x			x	x	x	x	x		x		x
Delivery temperature	x		x		x			x			x	x	x	x		x
Dust particles				x	x			x			x	x	x			
Contaminants & Odour					x	x		x	x			x				
Hydrogen (H_2)				x	x	x			x		x		x			
Water (H_2O)					x			x			x					
Carbon Monoxide (CO)					x								x			
Incomplete Combustion Factor						x			x							x
Soot Index						x			x							x
THT								x								
Organic Halides																
Radioactivity																
Total parameters monitored by country	**9**	**15**	**14**	**11**	**21**	**9**	**13**	**20**	**16**	**15**	**19**	**17**	**8**	**15**	**10**	**14**

Most countries monitor over 10 parameters related to gas quality, while Lithuania, Hungary and France monitor nearly 20, which demonstrates that countries are attentive to gas quality.

However, some countries consider that some parameters are more important than others as shown in Figure 6.1.

FIGURE 6.1 OVERVIEW OF THE PARAMETERS MONITORED BY EACH COUNTRY



In the remainder of this chapter, results for the parameters considered relevant by countries are presented while other results are available in Annex D.

6.3.2 Definitions and characteristics of the main parameters

This section seeks to allow any reader to understand the links between the various parameters and the characteristics of the main parameters.

Gross Calorific Value: The amount of heat evolved by the complete combustion of a unit certain volume of gas with air [28]

Relative Density: The density of gas in relation to the density of air, when both are at the same reference conditions [28]

Wobbe Index: Wobbe Index (WI) is the main indicator of the interchangeability of fuel gases and is frequently defined in the specifications of gas supply and transport utilities. WI is used to compare the combustion energy output with different composition of fuel gases. If 2 fuels have identical WIs at a given pressure and valve setting, then the energy output will be identical. WI is a critical factor in minimising the impact of fluctuations in fuel gas supply and can therefore be used to increase the efficiency of burner or gas turbine applications [28].

Wobbe Index is defined as:

$$Wobbe\ Index = \frac{Gross\ Calorific\ Value}{\sqrt{Relative\ density}}$$

Water and Hydrocarbon Dew Point: Hydrocarbon Dew Point is the temperature (at a given pressure) at which the hydrocarbon components of any hydrocarbon-rich gas mixture, such as natural gas, will start to condense out of the gaseous phase. Hydrocarbon Dew Point is a function of the gas composition as well as the pressure. The Hydrocarbon Dew Point of gas is a different concept from that of Water Dew Point, the latter being the temperature (at a given pressure) at which water vapour present in a gas mixture will condense from the gas [29].

Hydrogen Sulphide and Mercaptan Sulphur: are composed of sulphur which, when present in sufficient volumes, can lead to serious problems such as increased corrosion rates. Odorants added for safety reasons often also contain sulphur which may explain why sulphur content can be very different if a country has odorised its gas on the transmission network.

6.3.3 Wobbe Index, Gross Calorific Value and Relative Density

Wobbe Index is intrinsically linked to Gross Calorific Value and Relative Density, which means that all are considered as significant by countries. The tables and figure below present the standards usually used by countries, the frequency of measurement and the publication of these values at the entry point of the transmission network.

Due to the different gas supply portfolios and gas system configurations, some countries are used to a relatively narrow Wobbe Index bandwidth near 1 kWh/m³, while in other regions the actual distributed gases have a relatively wide Wobbe Index bandwidth near 3 kWh/m³.

Among countries that monitor this parameter, most of them measure the Wobbe Index on a daily basis.

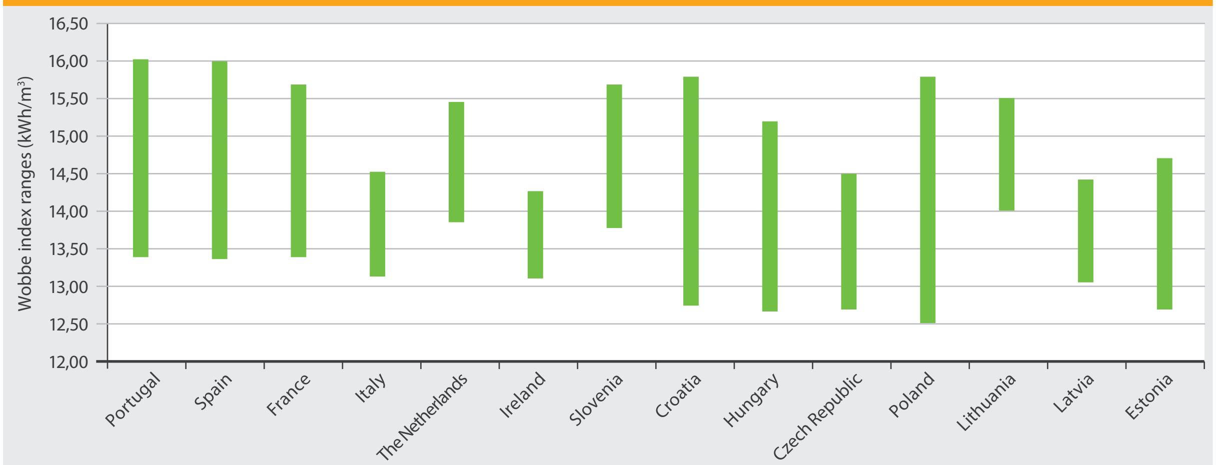
In Figure below, some countries have been classified, side by side, to compare different Wobbe Index ranges between neighbouring countries. Belgium has not been considered in this figure given that different reference conditions have been used in calculating the Wobbe Index.

TABLE 6.2 WOBBE INDEX RANGE AND MONITORING FREQUENCY

Wobbe Index	Min	Max	Unit	Measurement frequency	Frequency of information published
Belgium	12.2	13.02	kWh/m³ (1)	5 minutes	Hourly
Croatia	12.75	15.81	kWh/m³ (2)	Twice per month	Twice per month
Czech Republic	12.7	14.5	kWh/m³	5 minutes	Montlhy
Estonia	12.7	14.7	kWh/m³	5 minutes	Monthly
France	13.4	15.7	kWh/m³	5 minutes	Not published
Hungary	12.68	15.21	kWh/m³ (3)	4 minutes	Daily
Ireland	13.1	14.28	kWh/m³ (3)	Monthly	Yearly
Italy	13.14	14.54	kWh/m³ (3)	Hourly	Monthly
Latvia	13.06	14.44	kWh/m³ (3)	In real time	Monthly
Lithuania	14.02	15.51	kWh/m³	In real time	Daily
The Netherlands	13.86	15.47	kWh/m³ (3)		
Poland	12.5	15.806	kWh/m³	In real time	Monthly
Portugal	13.38	16.02	kWh/m³ (3)	In real time	Monthly
Slovenia	13.79	15.7	kWh/m³	Hourly	Daily
Spain	13.368	16.016	kWh/m³	In real time	Daily

(1) Based on normal reference condition 25°C /0°C while the others values are based on standard reference condition 15°C/15°C.
(2) Values have been converted from MJ/m³ to kWh/m³ which is the standard unit in the Interoperability Network Code.
(3) Values have been converted from kcal/m³ to kWh/m³ which is the standard unit in the Interoperability Network Code.

FIGURE 6.2 WOBBE INDEX RANGE



Portugal, Spain and France have very similar Wobbe Index ranges possibly due to their geographical proximity. However, this is not always the case for other neighbouring countries.

Although the CEN standard has proposed the harmonisation of several parameters relating to natural gas quality, a common Wobbe Index range could not be defined because of different regulations in CEN Member States and limited knowledge of the influence of broadening Wobbe Index range on integrity, efficiency and safe use of appliances in some countries.

Table 6.3 and Table 6.4 present Gross Calorific Value and Relative Density standards used by countries and their monitoring frequency.

TABLE 6.3 GROSS CALORIFIC VALUE RANGE AND MONITORING FREQUENCY

Gross Calorific Value (Real Gross Dry)	Min	Max	Unit	Measurement frequency	Frequency of information published
Belgium (1)	9.53	10.74	kWh/m³	5 minutes	Hourly
Croatia (2)	10.28	12.75	kWh/m³	Twice per month	Twice per month
Czech Republic	9.4	11.8	kWh/m³	5 minutes	Monthly
France	10.7	12.8	kWh/m³	5 minutes	Daily
Hungary (2)	8.6	12.58	kWh/m³	4 minutes	Daily
Italy (2)	9.71	12.58	kWh/m³	Hourly	Monthly
Latvia (3)	9.69		kWh/m³	In real time	Monthly
Lithuania	10.4	12.21	kWh/m³	In real time	Daily
Poland	10.56		kWh/m³	In real time	Daily
Portugal	no value	no value	kWh/m³	In real time	Monthly
Slovenia	10.7	12.8	kWh/m³	Hourly	Daily
Spain	10.23	13.23	kWh/m³	In real time	Daily

(1) based on normal reference condition 25°C /0°C while the others values are based on standard reference condition 15°C/15°C.
(2) Values have been converted from MJ/m³ to kWh/m³ which is the standard unit in the Interoperability Network Code.
(3) values have been converted from kcal/m³ to kWh/m³ which is the standard unit in the Interoperability Network Code.

TABLE 6.4 RELATIVE DENSITY AND MONITORING FREQUENCY

Relative Density	Min	Max	Unit	Measurement frequency	Frequency of information published
Croatia	0.56	0.7	No unit	Twice per month	Twice per month
Czech Republic	0.56	0.7	No unit	5 minutes	Monthly
Estonia	0.555	0.7	No unit	5 minutes	Monthly
France	0.555	0.7	No unit	5 minutes	Not published
Hungary	no limit	no limit	No unit	4 minutes	Daily
Ireland				Monthly	Yearly
Italy	0.555	0.8	No unit	Hourly	Monthly
Latvia	0.55	0.7	No unit	In real time	month, 10 d
Lithuania	0.55	0.63	No unit	In real time	Once per day
Poland				In real time	Monthly
Portugal	0.555	0.700	No unit	In real time	Monthly
Slovenia	0.555	0.7	No unit	Hourly	Daily
Spain	0.555	0.7	No unit	In real time	Daily
CEN standard	**0.555**	**0.7**	**No unit**		

(1) based on normal reference condition 25°C /0°C while the others values are based on standard reference condition 15°C/15°C.
(2) Values have been converted from MJ/m³ to kWh/m³ which is the standard unit in the Interoperability Network Code.
(3) values have been converted from kcal/m³ to kWh/m³ which is the standard unit in the Interoperability Network Code.

Since the relative density range is almost the same in all countries and nearly in line with the standard 0.555 to 0.7 advocated by the CEN standard, a similar spread of values for Gross Calorific Value to that of the Wobbe Index might be observed. This is because the Gross Calorific Value is equal to the Wobbe Index multiplied by the square root of the relative density (see Wobbe Index definition in Section 6.3.1).

6.3.4 Water and Hydrocarbon Dew Point

In the compressed air industry dew point is always a measurement of water content. However, in the natural gas industry, dew point often refers to Hydrocarbon Dew Point.

Table 6.5 and Table 6.6 present the maximum limit of these 2 parameters for each country and the CEN standard's recommendations [30].

In these tables we can notice that all countries that monitor Hydrocarbon Dew Point also monitor Water Dew Point. However, some countries are only monitoring Water Dew Point, which seems to be the most important parameter among these two.

Regarding the results, the maximum limits in Belgium are higher than the CEN standards recommendations for both parameters. The same applies to Lithuania in the case of Water Dew Point. On the contrary, Spain is the only country to have positive maximum limits for these 2 parameters, which seems to be far from the CEN standards recommendations.

Yet, these results should be taken with caution as the maximum allowable temperature may vary according to the time of year or pressure as stated by Poland in Table 6.5 (see footnote).

TABLE 6.5 WATER DEW POINT AND MONITORING FREQUENCY

Water Dew Point	Min	Max	Unit	Measurement frequency	Publication frequency
Belgium	-58	-15.5	°C	In real time	Not published
Croatia		-8	°C	Twice per month	Twice per month
Czech Republic		-7	°C	In real time	Not published
Estonia		-8	°C	In real time	NA
France		-5	°C		
Hungary		-8	°C	Twice per month	Twice per month
Italy		-5	°C	In real time	NA
Lithuania		-10	°C	Monthly	Not published
The Netherlands		-8	°C		
Poland		-5/3.7 (1)	°C	In real time	Monthly
Spain		2	°C	NA	NA
CEN standard		**-8**	**°C**		

(1) based on normal reference condition 25°C /0°C while the others values are based on standard reference condition 15°C/15°C.

TABLE 6.6 HYDROCARBON DEW POINT AND MONITORING FREQUENCY

Hydro Dew Point	Min	Max	Unit	Measurement frequency	Publication frequency
Belgium	-15	-6	°C	10 minutes	Not published
Croatia		-2	°C	Twice per month	Twice per month
Estonia		-2	°C	In real time	NA
France		-2	°C	5 minutes	Not published
Hungary		-2	°C	Twice per month	Twice per month
Italy		0	°C	Monthly	NA
Lithuania		-2	°C	Monthly	Not published
Poland		0	°C	In real time	Monthly
Spain		5	°C	NA	NA
CEN standard		**-2**	**°C**		

6.3.5 Chemical content

Gas usually contains a small amount of sulphur as a result of decaying organic substances. This can be as hydrogen sulphide, carbonyl sulphide, mercaptans, and/or other kind of sulphides, depending on the origin of the gas and its treatment.

Furthermore, the majority of artificial odorants contain strong sulphur organic compounds. These odorants are added to nearly all distribution grids and also to some transmission grids to give gas a smell for the purpose of leak detection.

In some gas storage facilities, higher sulphur contents can lead to serious problems such as increased corrosion rates, degradation of glycol, disposal of produced water and higher sulphur dioxide content in exhaust gases.

Table 6.7 presents the maximum acceptable Sulphur content for each country.

TABLE 6.7 TOTAL SULPHUR MAXIMUM VALUE

Total Sulphure	Max	Unit	Measurement frequency	Frequency of information published
Belgium	30.0	mg/m^3	10 minutes	Not published
Croatia	30.0	mg/m^3	Twice per month	Twice per month
Czech Republic	30.0	mg/m^3	5 minutes	Monthly
Estonia	30.0	mg/m^3		Yearly
France	150.0	mg/m^3	5 minutes	Daily
Great Britain	50.0	mg/m^3		
Hungary	100.0	mg/m^3	20 minutes	Daily
Ireland	50.0	mg/m^3	Monthly	Yearly
Italy	150.0	mg/m^3	Defined by TSO	Defined by TSO
Lithuania	30.0	mg/m^3	Quarterly	Not published
Poland	40.0	mg/m^3	In real time	Monthly
Portugal	50.0	mg/m^3	In real time	Monthly
Spain	50.0	mg/m^3	In real time	
CEN standard	**20.0**	**mg/m^3**		

As recommended by the CEN standard, the maximum acceptable sulphur content for conveyance should be 20 mg/m^3, which is current practice according to CEN in high-pressure networks non-odorised gas. However, with respect to transmission of odorised gas between high-pressure networks, a higher sulphur content value up to 30 mg/m^3 may be accepted.

None of the above countries are within the 20mg/m^3 set by the CEN standard. France, Hungary, Ireland and Latvia indicated that the gas is odorised at the transmission level which explains some very high sulphur values. For these countries, the amount of odorant added to the gas is provided in Table 6.8 below.

TABLE 6.8 ODORANT

Odorant	Min	Max	Unit
France	15	40	mg/m^3
Hungary	13	25	mg/m^3
Ireland	3	10	mg/m^3
Latvia	8		mg/m^3

Table 6.9 and Table 6.10 present the maximum Hydrogen Sulphide and Mercaptan Sulphur values applicable by countries.

Some high values for Hungary, Italy, Latvia, Lithuania, Poland and Spain may also be due to gas odorisation at the transmission level.

TABLE 6.9 HYDROGEN SULPHIDE (H_2S) MAXIMUM VALUE

Hydrogen sulphide (H_2S)	Max	Unit	Measurement frequency	Publication frequency
Belgium	5.0	mg/m^3	5 minutes	Not published
Croatia	6.0	mg/m^3	Twice per month	Twice per month
Czech Republic	6.0	mg/m^3	In real time	Monthly
France	5.0	mg/m^3	5 minutes	Daily
Great Britain	5.0	mg/m^3		
Hungary	20.0	mg/m^3	20 minutes	Daily
Ireland			Monthly	Yearly
Italy	6.6	mg/m^3	Defined by TSO	Defined by TSO
Latvia	7.0	mg/m^3	10 days	Monthly, 10 days
Lithuania	7.0	mg/m^3	Monthly	Not published
Poland	7.0	mg/m^3	In real time	Monthly
Portugal	5.0	mg/m^3	In real time	Monthly
Spain	15.0	mg/m^3	In real time	
CEN standard	**5.0**	**mg/m^3**		

TABLE 6.10 MERCAPTAN SULPHUR MAXIMUM VALUE

Mercaptan Sulphur maximum value	Max	Unit	Measurement frequency	Publication frequency
Belgium	6.0	mg/m^3	1 minute	Not published
Croatia	6.0	mg/m^3	Twice per month	Twice per month
Czech Republic	5.0	mg/m^3	In real time	Monthly
Estonia	6.0	mg/m^3		
France	6.0	mg/m^3	5 minutes	Daily
Hungary	No limit	mg/m^3	20 minutes	Daily
Italy	15.5	mg/m^3	Defined by TSO	Defined by TSO
Latvia	16.0	mg/m^3	10 days	Monthly, 10 days
Lithuania	16.0	mg/m^3	Monthly	Not published
Poland	16.0	mg/m^3	In real time	Monthly
Portugal		mg/m^3	In real time	Monthly
Spain	17.0	mg/m^3	In real time	
CEN standard	**6.0**	**mg/m^3**		

6.4. RESPONSIBILITIES REGARDING NATURAL GAS QUALITY

6.4.1 Responsibilities between TSO and Shipper

If gas quality is not met, it is important to know who is responsible in any given situation. The legal and financial responsibilities are presented in Figure 6.3 and in Table 6.11 listed by country.

For 8 countries the TSO and the shipper are responsible from a legal point of view while 5 other countries consider that both parts are also financially responsible. However, Table 6.11 brings further clarification on the shared responsibilities between the TSO and the shipper.

FIGURE 6.3 RESPONSIBILITIES BETWEEN THE TRANSPORTER (TSO) AND THE SHIPPER ACCORDING TO THE COUNTRIES

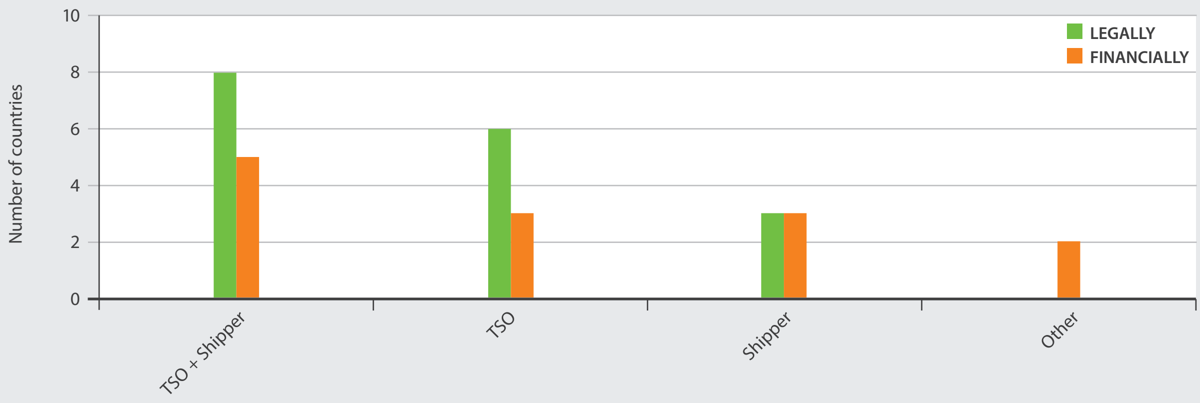


TABLE 6.11 FURTHER CLARIFICATION ON THE RESPONSIBILITIES BETWEEN TSO AND SHIPPER

Countries	Responsibilities	Further clarification
Austria	TSO (legally) Shipper (financially)	The TSO is entitled to refuse acceptance of off-spec gas at the entry point. The system user (shipper) shall be liable to the TSO for costs incurred by the TSO in connection with the cleaning and overhauling of the transmission system and the recovery of full operational performance, and shall indemnify and hold harmless the transmission system operator including towards third parties on whatever legal grounds.
Estonia	TSO (legally)	TSO determines the composition of natural gas entering the transmission network and based on this compiles the average composition of natural gas delivered during the accounting month. Quality of natural gas must be in accordance of TSO standard.
France	TSO + shipper (legally and financially)	TSO has the responsibilities to control gas quality. Shippers are responsible to provide gas within the maximum permissible limits.
Great Britain		The TSO is entitled to refuse acceptance of off-spec gas at the entry point and is legally liable if it conveys off-spec gas in its network. The system user (shipper) is responsible for delivering compliant gas to the TSO's system which it enacts via the upstream party.
Hungary	Shipper (legally and financially)	The shippers are responsible for the quality of the injected natural gas. TSO controls the quality parameters and in case of off-spec gas calls the Shipper for renomination. If the shipper nominates other than 0 volume then it takes the responsibilities.
Ireland	TSO + shipper (legally) Shipper (financially)	TSO has responsibilities to maintain system gas quality but can recover costs from shippers.
Poland	TSO (legally and financially)	National System: according to point 3.2.1. of the Transmission Network Code (TNC), the risk related to the transported gaseous fuel shall pass on the TSO upon the delivery of the gaseous fuel to the transmission system at the physical entry point specified in point 3.1.4. of the TNC. According to point 3.2.2. the risk related to the transported gaseous fuel shall pass on the system user upon the off-take of the gaseous fuel at the physical exit points from the transmission system specified in point 3.1.5. of the TNC.
Slovenia	Shipper (legally)	TSO has an inspection body for gas meters in volume conversion devices. Inspection body is accredited by Slovenian Accreditation (SA). Appointment of inspection body depends on the Metrology institute of the Republic of Slovenia.
Spain	TSO + shipper (legally and financially)	The shipper/trader that introduces the gas into the system (or brings an LNG cargo) is responsible for the quality of the gas introduced to the system (until the moment of the introduction at the system). Once the gas is in the system, LSO, TSO and DSO are responsible for keeping the gas quality inside their facilities.

6.4.2 Cross border responsibilities

Since gas resources are exchangeable on the market, the question of shared responsibilities of transporters between 2 bordering countries is important. As shown in Figure 6.4 and Table 6.12, countries have different views on this subject.

A total of 5 countries consider that the responsibilities have to be at the TSO exit while 6 other countries state the responsibilities have to be shared between both TSOs on either side of the interconnection point.

Table 6.12 gives further clarification on this notion of shared responsibilities at the interconnection point in 2 countries.

FIGURE 6.4 SHARED RESPONSIBILITIES OF TRANSPORTERS BETWEEN 2 BORDERING COUNTRIES

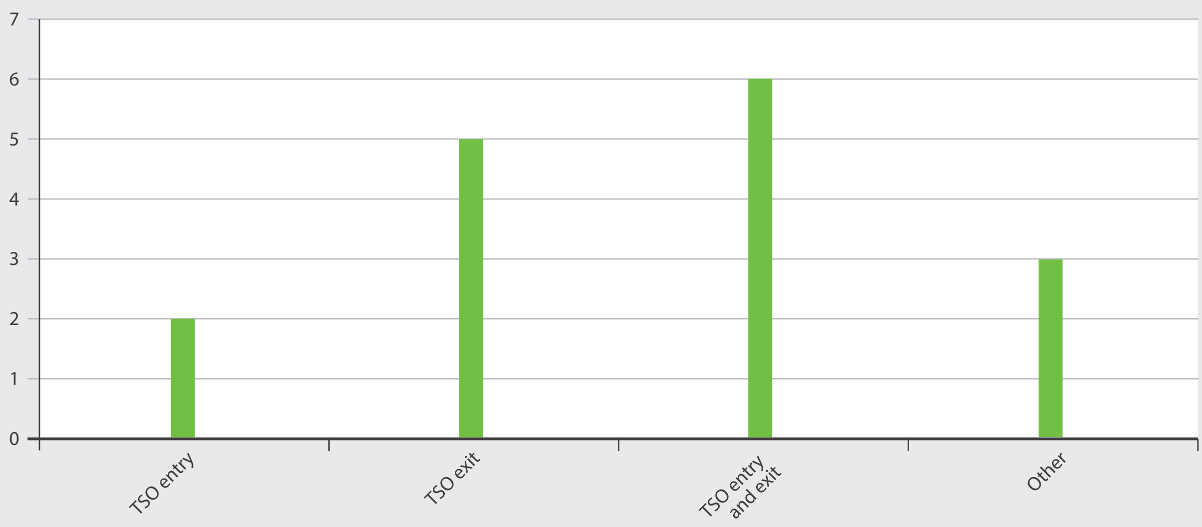


TABLE 6.12 FURTHER CLARIFICATION ON THE SHARED RESPONSIBILITIES BETWEEN TRANSPORTERS

Countries	Responsibilities	Further clarification
Austria	Other	In the interconnection point agreements gas quality is just included regarding which of the adjacent TSOs is responsible for the installation, operation and maintenance of the measurement equipment (including gas quality). Breaches of natural gas quality are handled on both sides of the interconnection point in a TSO-shipper relationship that governs the responsibilities for refusing off-spec gas.
France	TSO entry	Upstream TSO must inform downstream TSO of any breaches. Downstream TSO decides or not to accept gas and in which condition.

TABLE 6.13 PROCEDURES BETWEEN TSOs

Countries	Procedures between TSOs	Further clarification
Austria	No	NA
Belgium	Yes	Some Interconnection agreements foresee that receiving party takes all reasonable endeavours to accept the off-spec gas (i.e., if it is able to lend it with other gas flows to make it in-spec again).
Croatia	No	NA
Czech Republic	Yes	Specified in interconnection agreements.
Estonia	No	NA
France	No	NA
Germany	Yes	NA
Great Britain		Specified in interconnection agreements.
Hungary	Yes	Specified in interconnection agreements.
Ireland	No	NA
Italy		NA
Latvia	Yes	Contracts with TSOs provide for physical – chemical characteristics of gas agreed between parties. When gas quality characteristics do not comply with what is specified in the contract, cross-border gas supply is stopped until the supplier renews gas supply that matches the specification.
Lithuania	Yes	TSO cannot accept the natural gas if quality is below their requirements.
The Netherlands	Yes	Specified in interconnection agreements.
Poland	Yes	There are procedures described in the interconnection agreements concluded between the adjacent TSOs. Each agreement describes specific procedure applied to the given interconnection point at both national systems. Flow breaches of natural gas quality specification at the Polish Section of Yamal Pipeline are also subject to intergovernmental agreement between the Republic of Poland and Russian Federation.
Portugal	No	NA
Slovenia	No	NA
Spain	No	NA

Certain countries have also set up procedures or agreements at the interconnection point between 2 TSOs from 2 bordering countries as described in Table 6.13

As required in the Interoperability Network Code (Chapters II and IV) [30], these agreements which would allow clear rules for cross border exchange should be set up by all TSOs by 1 May 2016.

6.4.3 Findings on Natural Gas Quality

The European Commission has signalled its intent to amend the Interoperability Network Code to include the CEN Standard. ENTSOG has been asked to carry out a detailed analysis on the impact of making the standard binding and based on the evidence, to submit a draft code amendment by June 2017. Due to differing views between the European Commission and certain Member States regarding the possible amendment of the Interoperability Network Code, no conclusions can be drawn at the moment. However, the tables above show that a number of national parameters are outside of what is allowed by the CEN standard.

If the CEN standard was made binding, TSOs might need to invest in costly treatment processes in order to accept gas that would now be outside of specification. The alternative would be to refuse gas that does not meet the CEN standard, thus potentially creating future security of supply issues. Nevertheless, if the standard is implemented by the Commission, it may – in the long term – contribute to reducing restrictions in cross border gas flows and commercial market efficiency.

It is therefore vital that any attempts to harmonise gas quality undertake the following:

- Set out the problem that they are trying to solve (and why the current arrangements are not sufficient);
- Be a proportionate response to the issue, having considered the impacts on the gas value chain of making the standard binding; and
- Do not have any unintended consequences on; inter alia, security of supply.

07

GAS – COMMERCIAL QUALITY

7.1. WHAT IS COMMERCIAL QUALITY AND WHY IS IT IMPORTANT TO REGULATE IT

In a liberalised natural gas market, the customer has either a single contract with the supplier (SP) or separate contracts with the supplier and the distribution system operator (DSO), depending on the national regulations. In both cases, commercial quality is an important issue.

Commercial quality is directly associated with transactions between gas companies (either DSOs or suppliers, or both) and customers. Commercial quality covers not only the supply and sale of gas, but also various forms of contacts established between gas companies and customers. New connections, disconnection upon customer's request, meter reading and verification, repairs and elimination of pressure problems, claims processing are all services that involves some commercial quality aspect. The most frequent commercial quality aspect is the timeliness of services requested by customers.

Where it concerns the need for commercial quality indicators, a distinction should be made between the deregulated market of natural gas energy and the regulated market of network operation. The energy NRA normally does not intervene in the deregulated market, as competition between retailers is expected to result in the sufficient quality. However, in some cases, a certain level of customer protection is needed. The need for such protection differs among different types of customers.

Network operators (i.e. the regulated market) are natural monopolies, free or almost free from competition. Commercial quality indicators help ensure a sufficient level of quality of service by network companies. In some countries, a regulatory framework based on financial incentives (e.g. a bonus/penalty system) has been set: if the operator's performance reaches the quality level expected, it can get a bonus equal to or higher than zero, and if not, it will have to pay a penalty and/or compensation to the affected customer. Numerous commercial quality aspects (e.g. times for connections) in the deregulated market of natural gas energy are also related to distribution networks and therefore, given their monopolistic nature, should still be regulated.

EU legislation provides a framework for commercial quality measures. Directive 2009/72/EC and Directive 2009/73/EC require that Member States shall take appropriate measures to protect final customers, to ensure that they:

- Have a right to a contract with their gas service provider that specifies: the services provided, the service quality levels offered, as well as the time needed for the initial connection; any compensation and the refund arrangements which apply if contracted service quality levels are not met, including inaccurate and delayed billing; and information relating to customer rights, including on the complaint handling and all of the information referred to in this point, clearly communicated through billing or website.
- Benefit from transparent, simple and inexpensive procedures for dealing with their complaints. In particular, all customers shall have the right to a good standard of service and complaint handling by their electricity/natural gas service provider.

Based on these Directives, the national authorities have a duty to monitor the time taken by TSOs and DSOs to make connections and repairs. While these requirements concern the regulated part of energy markets, their functioning is essential for retail markets as a whole. Therefore, it is important to monitor these key services and their timely provision by DSOs so as to provide a full picture of market functioning from a customer perspective.

7.2. STRUCTURE OF THE CHAPTER ON GAS COMMERCIAL QUALITY

The 6th Benchmarking Report is the first CEER Benchmarking Report that includes a part devoted to gas. The Gas commercial quality chapter adopts a largely similar structure as the 5th Benchmarking Report for the commercial quality part for electricity. First, it presents the main aspects of commercial quality and categorises indicators into 6 groups (compared to 4 for electricity), then it provides the list of indicators and the approaches for regulating gas commercial quality.

The contents of this chapter on commercial quality are based on answers provided by 17 CEER countries: Austria, Belgium, Croatia, the Czech Republic, Estonia, France, Hungary, Ireland, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, Slovenia, Spain and Sweden. The results of the benchmarking are presented in Section 7.4, organised by main groups of commercial quality aspects. A summary of the benchmarking results is provided in Section 7.6.

7.3. MAIN ASPECTS OF GAS COMMERCIAL QUALITY

Like in electricity, commercial transactions between gas companies and customers are traditionally classified as follows:

- Pre-contract transactions, such as information on connection to the network and prices associated with the supply of gas. These actions occur before the supply contract comes into force and incorporate actions by both the DSO and the supplier. Generally, customer rights with regard to such actions are set out in codes (such as Connection Agreements and the General Conditions of Supply Contracts) and are approved by the NRA or other governmental authorities;
- Transactions during the contract period, such as billing, payment arrangements and responses to customers' complaints. These transactions occur regularly like billing and meter readings or occasionally (e.g. when the customer contacts the company with a query or a complaint).

The quality of service during these transactions can be measured by the time the company needs to provide a proper reply. These transactions could relate to the DSO, the supplier/universal supplier (USP) or to the meter operator (MO) and could be regulated according to the regulatory framework of the particular country.

An issue is which customer class (pressure level) the regulation should focus upon. As the database for this section was short, this chapter focuses on all types of customers with a connection to the low pressure, medium pressure and high pressure networks.

7.3.1 Main groups of gas commercial quality indicators

In order to simplify the approach to such a complex matter as commercial quality, indicators relating to commercial quality have been classified into 6 main groups:

- Customer information (Group I)
- Customer Care (Group II)
- Grid access (Group III)
- Activation, Deactivation, and Reactivation of supply (Group IV)
- Metering (Group V)
- Invoices (Group VI).

7.3.2 Commercial quality indicators and their definitions

For the first time, the quality of gas is evaluated in a CEER Benchmarking Report. In this 6th Benchmarking report, "standard" refers to the minimum levels of service quality, as defined by the NRAs, that a company is expected to deliver to its customers. Indicators are defined as a way to measure dimensions of service quality. NRAs can define standard for indicators or they can define indicators without standards and just publish the indicator values of the companies. Therefore, what is "overall" or "guaranteed" are the indicators, not the standards, because "overall" and "guaranteed" refers to the nature of the indicator. A standard is a limit, a value (e.g. a percentage). This report includes 3 types of indicators: the guaranteed indicators (GIs), the overall indicators (OIs), and the other requirements (ORs).

For example, as illustrated in Figure 7.1 below, for the overall indicator "time take to respond to a customer request for a new grid connection", the time taken to respond to a household customer request for a connection to the grid should not exceed 2 working days in country A. The response should inform the customer of the process, the estimated schedule and requests for information required from the customer, including contact details. The time taken to respond to a customer request for a connection to the grid should not exceed 2 working days in 90% of the cases.

FIGURE 7.1 EXAMPLE OF A COMMERCIAL QUALITY INDICATOR

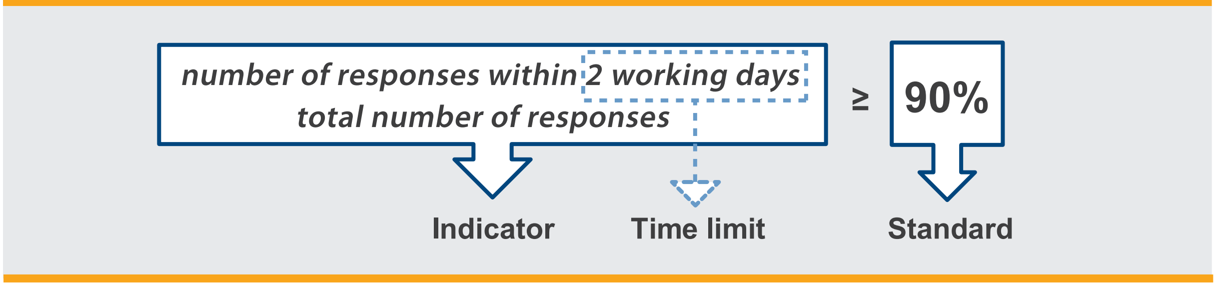


Table 7.1 shows the commercial quality indicators included in the survey of the CEER countries and the definitions for the purpose of this 6th Benchmarking Report.

TABLE 7.1 COMMERCIAL QUALITY INDICATORS SURVEYED

Group	Indicator	Definition
I. Customer information	Time of response to the customer request and/or complaints	Time period between the receipt of the customer request or complaint and the written response of the [market operator].
	Average response time to the customer request and/or complaints	-
	Number of customer requests and/or complaints	-
	Percentage of responses to customer complaints and/or requests in written form within a given time period	-
	Percentage of market participants who display the gas emergency number on invoices, homepage, customer magazine, etc.	-
	Number of market participants who display the quality of supply standards on invoices, homepage, etc.	-
	Time of availability of a market participant's call centre	Time period during which the market participant's call centre is available.
	Time of availability of a network operator's website accessible to providers	Time period during which the network operator website is accessible to providers.
II. Customer care	Punctuality of market participants regarding appointments with customers	The personnel of the Licensee arrives at the customer site within the time range (period of hours) previously agreed with the customer.
	Punctuality of customers regarding appointments with market participants	The customer is present on the customer site when the personnel of the licensee appears, within the time range (period of hours) previously agreed.
	Time limit for market participants/clients to cancel an appointment	-
	Time limit for waiting in customer centres	-
	Percentage of customers with a waiting time below the limit in customer centres	-
	Time limit for waiting in call centres	-
	Target call answer time in call centres	Target time period to reach between the receipt of the customer's call and the answer given to that call by the call centre (telephone contact).
	Percentage of dropped calls in the call centres	Percentage of calls in the call centres for which the customer hangs up before the call is answered.
	Percentage of customers with a waiting time below the limit in call centres	-
	Other performance indicators or targets for different customer issues in call centres (telephone contact)	-
	Obligation for DSO regarding response time for emergency situations	-
III. Grid access	Number of customer requests for technical grid access	-
	Average response time of a DSO to customer requests for technical grid access	Sum of all time periods between the registrations of customers' requests for technical grid access and the dates of the responses to them, divided by the number of those requests.
	Number of customer requests for cost estimations for connecting customers to the network	-
	Time for providing a cost estimation of connecting customers to the network	Time period between the receipt of the customer's written request for connection and the written response of the Licensee including a cost estimation of the works.
	Time of execution of customers' connections to the network	Time period between the receipt of the customer's written claim for connection and the date the customer is connected to network.

Group	Indicator	Definition
IV. Activation, deactivation, reactivation of supply	Number of activations of supply / deactivations of supply due to late payment/reactivations of supply after payment (for bad payer previously disconnected) carried out	-
	Time of response to customer request for activation	Time period between the receipt of the customer's request for activation and the written response of Licensee (date of dispatch).
	Time of activation of supply following a request	Time period between the receipt of the customer's request for activation and the date the customer's connection to network is activated.
	Time of deactivation of supply following a request	Time period between the receipt of the customer's request for deactivation and the date the customer's housing is deactivated (disconnected) from the network.
	Success rate of deactivation of supply on the first request	Percentage of success for deactivation of supply at the first request from the customer.
	Number of calls required to successfully deactivate a customer's connection	-
	Time of reactivation of supply after payment (for bad payers previously disconnected)	Time period between the receipt of the customer's payment for reactivation (for bad payers previously disconnected) and the date the customer's connection to network is reactivated.
	Time of disconnection of a customer following deactivation for non-payment	Time period between the procedure of deactivation for non-payment and the date the customer's housing is deactivated to network.
V. Meters	Number of installed ga3s meters	-
	Number of gas meters not installed in due time	-
	Time for meter verification	Time for the inspection of the meter.
	Time of replacement of the meter (when found out of order after verification)	Time period between the meter problem was notified after the verification of the meter and the replacement of the meter.
	Number of network customers who were informed about meter readings in absentia	-
	Number of market participants who offer the possibility of online meter data reading (self service)	-
	Number of customers receiving real time meter data	-
	Percentage of meter reading successfully transmitted by customers through a dedicated IVR call centre number	-
	Times a year the meter is read by type of customers	Number of meter readings actually performed by the designated meter operator (readings by the customer are excluded) for industrial / commercial / household customers.
	Minimum period of reading the meter	Minimum period between 2 meter readings.
	Regulation value of the readings made by the customers and by DSO or suppliers	-
	Percentage of meter readings made within a certain amount of time after the last one	Percentage of meter readings that were made before a certain amount of time, e.g. 96 days, has passed since the previous reading of the same meter.
VI. Invoices	Percentage of invoices submitted in due time	Number of invoices submitted in due time with respect to the total number of invoices.
	Percentage of corrected invoices submitted in due time	Number of corrected invoices submitted in due time with respect to the total number of corrected invoices.
	Number of customers who have requested settlement data	-
	Number of settlement data not transmitted in due time	-
	Number of DSOs who offer the possibility of cash payment	-
	Number of DSOs who provide settlement data online to their network customers	-
	Time to change provider on customer request	Time period between the receipt of customer's written request for a switching of supplier until the date the switching is effective.

7.3.3 How to regulate commercial quality

For this 6th Benchmarking Report, there are 3 types of requirements for commercial quality:

- **Guaranteed Indicators** (GIs) refer to service quality levels which must be met in each individual case. If the company fails to provide the level of service required by the GI for a specific service, the customer affected is entitled to a ***compensation***. Usually, a GI includes the following features:
  - a performance standard, which sets the expected level of service for each case (e.g. 5 working days); and
  - economic compensation to be paid to the customer in case of failure to comply with the requirements (e.g. €20).

- **Overall Indicators** (OIs) refer to a given set of cases (e.g. all customer requests in a given region for a specific service) and are used as a metric with respect to the whole population in that set. In some cases a penalty has to be paid whenever companies' performances are not up to a standard set for a given indicator. OIs usually include the following features:
  - a time limit that sets the reasonable period for the completion of the specific service (e.g. 20 working days); and
  - a performance standard (commonly a given percentage of cases), which has to be met for a whole set of customers (e.g. 90% of new customers have to be connected to the distribution network within 20 working days).

- **Other Requirements** (ORs). In addition to GIs and OIs, NRAs (or other competent parties) can issue requirements in order to achieve a certain quality level of service that are not easily classified as either GI or OI. These quality levels can be set as the NRA wants, e.g. a minimum set of information that must be given to customers when they are connected. If the requirements set by the NRAs are not met, the NRA can impose sanctions (e.g. financial penalties) in most of the cases.

7.4. MAIN RESULTS OF BENCHMARKING COMMERCIAL QUALITY INDICATORS

7.4.1 Commercial quality indicators applied

Responses are included in Table 7.2, in accordance with the survey structure.

Table 7.2 shows whether a country monitors or applies a requirement (GI, OI or OR) for the different commercial quality aspects. In the last column, the total number of countries where an indicator is in effect is shown. The most common indicators among the NRAs are the ones concerning customer information (Group II) and metering (Group V) issues. In total 13 of the responding countries apply some types of indicator regarding the time for response to customer request and/or complaints (indicator I.1) and the number of customer requests and/or complaints (indicator I.2); and 9 countries monitor a minimum period for reading the meter (V.10). A total of 10 countries have more than 10 indicators: Austria, Belgium, Croatia, the Czech Republic, France, Hungary, Italy, Latvia, Lithuania and Portugal.

TABLE 7.2 SUMMARY OF COUNTRIES WHICH ADOPT COMMERCIAL QUALITY INDICATORSS

Group	Indicator	AT	BE	CZ	EE	ES	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	SE	SI	Total
I. Customer information	I.1 Time for response to the customer request and/or complaints	X	X	X	X		X	X	X	X		X	X	X	X	X			13
	I.2 Number of customer requests and/or complaints	X	X	X			X	X	X	X		X	X	X	X	X		X	13
	I.3 Percentage of responses to customer complaints and/or requests in written form within a given time period				X		X	X			X	X	X			X			7
	I.4 Percentage of market participants who display the gas emergency number on invoices, homepage, etc.	X	X	X		X	X	X					X						7
	I.5 Number of market participants who display the quality of supply standards on invoices, homepage, etc.	X					X	X											3
	I.6 Time of availability of a market participant's call centre		X				X						X			X			4
	I.7 Time of availability of a network operator's website accessible to providers						X		X				X						3
	I.8 Average response time to customer request and/or complaints															X			1
II. Customer care	II.1 Punctuality of market participants regarding appointments with customers	X					X	X	X		X					X			6
	II.2 Punctuality of customers regarding appointments with market participants								X							X			2
	II.3 Time limit for market participants / for clients to cancel an appointment						X												1
	II.4 Time limit for waiting in customer centers								X										1
	II.5 Percentage of customers attended within the waiting time limit in customer centers								X							X			2
	II.6 Time limit for waiting in call centers								X										1
	II.7 Target call answer time in call centers								X				X						2
	II.8 Percentage of dropped calls in the call centers		X				X		X			X							4
	II.9 Other performance indicators or targets for different customer issues in call centers (telephone contact)								X				X			X			3
	II.10 Obligation for DSO regarding response time for emergency situations							X	X				X			X			4
	II.11 Percentage of customers with a waiting time below the limit in call centres															X			1
III. Grid access	III.1 Number of customer requests for technical grid access	X	X	X				X				X						X	6
	III.2 Average response time of a DSO to customer requests for technical grid access	X						X	X			X						X	5
	III.3 Number of customer requests for cost estimations for connecting customers to the network	X	X								X	X						X	5
	III.4 Time for providing a cost estimation of connecting customers to the network	X					X				X	X	X						5
	III.5 Time for execution of connecting customers to the network						X	X	X		X	X	X						6

Group	Indicator	AT	BE	CZ	EE	ES	FR	HR	HU	IE	IT	LT	LV	NL	PL	PT	SE	SI	Total
IV. Activation, deactivation, reactivation of supply	IV.1 Number of activations of supply / deactivations of supply due to late payment/reactivations of supply after payment (for bad payer previously disconnected) carried out						X	X	X		X	X	X						**9**
	IV.2 Time of response to customer request for activation	X							X										**2**
	IV.3 Time for activation of supply following a request			X			X		X		X		X			X			**6**
	IV.4 Time for deactivation of supply following a request		X	X			X		X		X								**5**
	IV.5 Success rate for deactivation of supply on the first request			X					X										**2**
	IV.6 Number of calls required to successfully deactivate a customer																		**0**
	IV.7 Time of reactivation of supply after payment (for bad payers previously disconnected)	X		X				X	X		X		X			X			**7**
	IV.8 Time for disconnection of a customer following deactivation for non-payment		X						X						X				**3**
V. Meters	V.1 Number of installed gas meters	X	X	X				X				X	X		X				**7**
	V.2 Number of gas meters not installed in due time	X		X															**2**
	V.3 Time for meter verification			X			X	X	X		X	X	X					X	**8**
	V.4 Time for replacement of the meter (when found out of order after verification)			X			X		X		X								**4**
	V.5 Number of network customers who were informed about meter readings in absentia	X							X										**2**
	V.6 Number of market participants who offer the possibility of online meter data announcement (self service)	X					X		X				X						**4**
	V.7 Number of customers receiving real time meter data		X					X	X										**3**
	V.8 Percentage of meter reading successfully transmitted by customers through a dedicated IVR call centre number															X			**1**
	V.9 Times a year the meter is read by type of customers (Industrial / Commercial / Household)		X	X			X	X	X			X	X				X		**8**
	V.10 Minimum period for reading the meter	X	X	X				X	X			X	X			X	X		**9**
	V.11 Regulation value of the readings made by the customers and by DSO or suppliers	X	X	X				X	X				X				X		**7**
	V.12 Percentage of meter readings made within a certain amount of time after the last one																	X	**1**
VI. Invoices	VI.1 Percentage of invoices submitted in due time	X	X						X				X						**4**
	VI.2 Percentage of corrected invoices submitted in due time	X						X	X				X						**4**
	VI.3 Number of customers who have requested settlement data	X																	**1**
	VI.4 Number of settlement data not transmitted in due time	X																	**1**
	VI.5 Number of DSOs who are offering the possibility of cash payment	X											X		X				**3**
	VI.6 Number of DSOs who are providing settlement data online to their network customers	X							X				X						**3**
	VI.7 Time for changing provider on customer request			X			X	X	X						X				**5**
Total number of indicators per country		**24**	**16**	**17**	**2**	**1**	**19**	**19**	**33**	**2**	**11**	**14**	**24**	**2**	**6**	**16**	**3**	**7**	**216**

In Table 7.3, the number of various commercial quality indicators is shown together with the type of company they refer to (DSO, Supplier, USP and MO). The largest number of indicators is for customer information (Group I) and customer care (Group II).

TABLE 7.3 NUMBER OF COMMERCIAL QUALITY INDICATORS (GI, OI, OR) IN FORCE PER GROUP AND PER COMPANY TYPE

Group	Indicator	DSO	SP/ USP	MO	TSO	Total
I. Customer information	I.1 Time for response to customer request and/or complaints	8	6	1	6	**21**
	I.2 Number of customer requests and/or complaints	9	4	2	5	**20**
	I.3 Percentage of responses to customer complaints and/or requests in written form within a given time period	4	1	2	1	**8**
	I.4 Percentage of market participants who display the gas emergency number on invoices, homepage, etc.	5	2		1	**8**
	I.5 Number of market participants who display the quality of supply standards on invoices, homepage, etc.	3	1		1	**5**
	I.6 Time of availability of a market participant's call centre	5	3		1	**9**
	I.7 Time of availability of a network operator's website accessible to providers	3			2	**5**
	I.8 Average response time to customer request and/or complaints				1	**1**
II. Customer care	II.1 Punctuality of market participants regarding appointments with customers	8	2	1	2	**13**
	II.2 Punctuality of customers regarding appointments with market participants	5	2		2	**9**
	II.3 Time limit for market participants / clients to cancel an appointment	4	1		2	**7**
	II.4 Time limit for waiting in customer centres	4	3	1	2	**10**
	II.5 Percentage of customers attended within the waiting time limit in customer centres	3	1		2	**6**
	II.6 Time limit for waiting in call centres	3	1		2	**6**
	II.7 Target call answer time in call centres	3	2		2	**7**
	II.8 Percentage of dropped calls in the call centres	4	2		2	**8**
	II.9 Other performance indicators or targets for different customer issues in call centres (telephone contact)					**0**
	II.10 Obligation for DSO regarding response time for emergency situations	5	1		3	**9**
	II.11 Percentage of customers with a waiting time below the limit in call centres	1	1			**2**
III. Grid access	III.1 Number of customer requests for technical grid access					**0**
	III.2 Average response time of a DSO to customer requests for technical grid access	6	1		1	**8**
	III.3 Number of customer requests for cost estimations for connecting customers to the network					**0**
	III.4 Time for providing a cost estimation of connecting customers to the network	5		1	1	**7**
	III.5 Time for execution of connecting customers to the network	7	1	1	1	**10**

Group	Indicator	DSO	SP/ USP	MO	TSO	Total
IV. Activation, Deactivation, Reactivation of supply	IV.1 Number of activations of supply / deactivations of supply due to late payment/reactivations of supply after payment (for bad payer previously disconnected) carried out					**0**
	IV.2 Time of response to customer request for activation	3	1		1	**5**
	IV.3 Time for activation of supply following a request	6	1	1	1	**9**
	IV.4 Time for deactivation of supply following a request	6	2	1	1	**10**
	IV.5 Success rate for deactivation of supply on the first request					**0**
	IV.6 Number of calls required to successfully deactivate a customer					**0**
	IV.7 Time of reactivation of supply after payment (for bad payers previously disconnected)	7	4	2	2	**15**
	IV.8 Time for disconnection of a customer following deactivation for non-payment	4	2	1	1	**8**
V. Meters	V.1 Number of installed gas meters					0
	V.2 Number of gas meters not installed in due time	4	1		2	7
	V.3 Time for meter verification	6	1	1	3	11
	V.4 Time for replacement of the meter (when found out of order after verification)	6	1	1	2	10
	V.5 Number of network customers who were informed about meter readings in absentia	4	1		1	6
	V.6 Number of market participants who offer the possibility of online meter data announcement (self service)					0
	V.7 Number of customers receiving real time meter data					0
	V.8 Percentage of meter reading successfully transmitted by customers through a dedicated IVR call centre number	1				1
	V.9 Times a year the meter is read by type of customers (Industrial / Commercial / Household)					0
	V.10 Minimum period for reading the meter	5			2	7
	V.11 Regulation value of the readings made by the customers and by DSO or suppliers					0
	V.12 Percentage of meter readings made within a certain amount of time after the last one	1				1
VI. Invoices	VI.1 Percentage of invoices submitted in due time	5	3	1	2	11
	VI.2 Percentage of corrected invoices submitted in due time	4	2		2	8
	VI.3 Number of customers who have requested settlement data					0
	VI.4 Number of settlement data not transmitted in due time	3	1	1	1	6
	VI.5 Number of DSOs who offer the possibility of cash payment					0
	VI.6 Number of DSOs who provide settlement data online to their network customers					0
	VI.7 Time for changing provider on customer request	5	4	1	2	12
Total		**165**	**59**	**19**	**63**	**306**

Table 7.4 shows the number of commercial quality indicators per country, distinguishing between GIs, OIs and ORs. The results show that NRAs make more use of OIs (112 in total) and GIs (78 in total) than ORs. However, in many countries requirements applicable to each single transaction are applied as well, albeit without compensation to the customer in case of non-compliance. From the customer protection point of view, the most efficient regulation is based on GIs, or OIs with minimum requirements set by the NRA where sanctions can be issued.

Austria, Belgium, Lithuania, the Czech Republic, Hungary, Italy, Latvia, Lithuania and Portugal use OIs, and GIs or ORs. Estonia and the Netherlands use only OIs while Poland uses only GIs. Croatia, Hungary and Latvia make use of all 3 types of indicators (GIs, OIs, ORs).

All customer types (low pressure, medium pressure and high pressure) are taken into account in this chapter.

TABLE 7.4 NUMBER OF COMMERCIAL QUALITY INDICATORS SURVEYED

Countries	GI	OI	OR	Total
Austria	0	11	2	**13**
Belgium	0	3	3	**6**
Croatia	5	4	8	**17**
Czech Republic	9	26	0	**35**
Estonia	0	1	0	**1**
Finland	0	0	0	**0**
France	5	0	12	**17**
Germany	0	0	0	**0**
Hungary	24	24	7	**55**
Ireland	0	0	0	**0**
Italy	8	2	0	**10**
Latvia	19	22	11	**52**
Lithuania	0	6	3	**9**
The Netherlands	0	2	0	**2**
Poland	3	0	0	**3**
Portugal	5	11	0	**16**
Slovenia	0	0	3	**3**
Spain	0	0	1	**1**
Total	78	112	50	**240**

7.4.2 Group I: Customer information and requests/complaints

Customer information is an important aspect of commercial quality. It is essential that market participants keep the customer informed via invoices, their homepage or customer communications material about issues such as gas emergency numbers. The time for availability of a network operator's call centre or website is also important from both the customer's and the supplier's point of view. In addition, **complaints and requests** are an important tool to take into account the customers' expectations.

A claim is a written or oral expression of a discontentment from a network user. The analysis of the customers' complaints (cause, frequency, volume, etc.) or requests can allow the apprehension of the quality of the services perceived by the customer and to improve them. The time to treat a complaint/request and the quality of response are a major issue in commercial quality.

For this section, most of the countries answered to the question regarding the "Response to customer requests and/or complaints", therefore, the analysis will be focused on this point.

TABLE 7.5 TYPES OF INDICATORS USED ON "RESPONSE TO CUSTOMER REQUESTS AND/OR COMPLAINTS"

Subject	Countries grouped by types of indicators in 2014			Time limit (median value and range)	Compensation (median value and range)	Company involved
	GI	OI	OR	2014	2014	
Response to customer requests and/or complaints	CZ, FR, LV, PL, PT	AT, CZ, EE, HR, HU, LT, LV, NL, PT	-	23 days (range 5 working days-30 days)	€23 (range 20-25)	DSO, USP/SP, MO, TSO

Response to customer requests and/or complaints is measured with overall indicators in 9 countries [Austria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, the Netherlands and Portugal (average time)] and with guaranteed indicators in 5 countries [the Czech Republic, France, Latvia, Poland and Portugal (complaints)]. In Belgium, this subject is monitored by the supplier and is neither a GI nor an OI.

Most of the countries monitor both complaints and requests (Austria, Croatia, Hungary, Latvia, Lithuania and Poland). Some countries monitor the response time only for complaints (Belgium, the Czech Republic, Estonia and France). Portugal monitors the response time separately for complaints and requests.

In 2014, Austria had a good annual performance of 99.98% with a standard of 95% and a time limit of 5 working days. The Czech Republic had 100% performance record with a standard of 100% and a time limit of 30 days to answer. Lithuania also registered a good performance of 100% of the requests and complaints answered within the time limit of 30 days.

TABLE 7.6 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE RESPONSE TO CUSTOMER REQUEST AND/OR COMPLAINT IS MONITORED

Country	Limit	Standard that must be met	Number of cases for which the limit was fulfilled	Value of the indicator	Compensation for non-compliance	Penalty or other consequences	Pressure levels	Request / complaint
Austria	5 working days	95%	1.205.016	99,98%	None	administrative offence – fined up to €75,000	LP, MP	Requests & complaints
Belgium	10 working days							Complaints
Croatia	10 working days	90%						Requests & complaints
Czech Republic	30 days	100%	20.813 requests 11.651 complaints	100%	NA	0	LP, MP, HP	Complaints
France	30 calendar days	100%		90,60%	€25	None	LP, MP	Complaints
Hungary	30 days	100%	19				HP	Requests & complaints
Latvia	30 days	100%					LP, MP, HP	Requests & complaints
Lithuania	30 days	100%	134	100%	None		HP	Requests & complaints
Portugal	15 working days	98% DSO 90% USP/SP	11.863 221.234	96% 53%	NA	NA	LP, MP, HP	Requests

Concerning the **percentage of market participants who display the gas emergency number on invoices, their homepage, customer magazines and others** (I.4), Austria, the Czech Republic and France registered a performance of 100%. In the Czech Republic, the objective is that 100% of the invoices include an emergency number. Regarding the **number of market participants who display the quality of supply standards on invoices, homepage and others** (I.5), this indicator is being monitored in 3 countries (Austria, Croatia and France).

In Belgium, under the current Walloon legislation, suppliers are required to provide a range of detailed information to their customers. Fulfilment of these obligations is controlled by the regional NRA, as legal obligations, through on-the-spot periodic monitoring (at least every 2 years).

As concerns **the time for availability of a market participant's call centre** (I.6), Latvia had a performance of 100%, with a standard of 100% and a time limit of 5 working days. In Portugal, (1) call centres must allow customers to leave their contact and purpose of the call in case the waiting time is expected to be over 60 seconds; in such cases, companies have to call back those customers within 2 working days; (2) assistance and emergency numbers are monitored separately from commercial calls.

Concerning the time for response to customer request and/or complaints (I.1), the time limits vary from 5 working days (in Austria) to 30 days (in the Czech Republic, Estonia, Hungary, Latvia, Lithuania), with a median value of 23 days. There is no compensation for the non-compliance of the standard for the time for response to customer request and/or complaints (I.1) in Austria (but there is an administrative offence fine of up to €75,000) and Lithuania. The compensation for complaints is €25 in France and €20 in Portugal.

7.4.3 Group II: Customer care

The punctuality of operators with respect to planned appointments with customers is a major commercial quality issue. It is essential that the customer does not wait too long before getting a response in customer centres and on phone calls. In this section, all the indicators concern the punctuality of appointments, and the time limits related to the customer centres and call centres. The most monitored indicator is the punctuality of market participants regarding appointments with customers (II.1). It is monitored as a GI in Croatia, France, Hungary, Italy, Latvia and Portugal, and as an OI in Austria, the Czech Republic, Hungary and Latvia.

TABLE 7.7 TYPES OF INDICATORS USED ON PUNCTUALITY OF MARKET PARTICIPANTS REGARDING APPOINTMENTS WITH CUSTOMERS

Subject	Countries grouped by types of indicators in 2014			Time limit (median value and range)	Compensation (median value and range)	Company involved
	GI	OI	OR	2014	2014	
Punctuality of market participants regarding appointments with customers	FR, HR, HU, IT, LV, PT	AT, CZ, HU, LV	-	2.3 hours (range 2-3)	€33 (range 20-35	DSO, USP/SP, MO, TSO

In 2014, Austria achieved a good performance (99.50%) above the standard (95%), with a 2-hour-time window as a time limit and a total amount of 313,166 appointments. In Italy, the performance is also good (99.6%), with a total amount of 1,658,352 appointments and a time limit of 2 hours.

TABLE 7.8 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE PUNCTUALITY OF MARKET PARTICIPANTS REGARDING APPOINTMENTS WITH CUSTOMERS IS MONITORED

Country	Limit	Standard that must be met	Number of cases for which the limit was fulfilled	Value of the indicator	Compensation for non-compliance	Penalty or other consequences	Pressure levels
Austria	2-hour time window	95%	313.166	99,50%	None	administrative offence – fined up to €75,000	LP, MP
Croatia	3 hours						
France			11.488		€33	penalty of €27.46 (+ VAT is paid to the supplier)	LP, MP
Italy	2 hours		1.658.352	99,60%	€35		LP
Portugal	within a 2.5 hours interval agreed with the customer		112.691		€20		LP, MP, HP

In France, as part of the incentive regulation scheme, appointments that the DSO has not met are monitored (in number, not in percentage). It includes planned appointments that require the customer's presence but where the intervention was not performed because of the DSO. For each case, a penalty of €27.46 (excluding tax) is charged to the supplier. GRDF (the main French DSO) faced a penalty of €311,884 in 2014 because of 11,488 missed appointments. The detection of missed appointments is processed automatically by the grid operator since July 2013 (before this date, it was the supplier or the customer).

In Portugal, appointments are made between the customer and the supplier (USP/SP). If the DSO does not arrive within the 2.5 hours interval set with the customer, then the customer must receive €20 compensation from either the USP/SP or DSO, depending on whose fault it was. If customers are not present when the DSO arrives, then the DSO has the right to receive €20 compensation. Cancelation of the visits is possible, by either part, up to 12 hours before the appointment hour.

As regards the **percentage of dropped calls in the call centres** (II.8), France monitors an OR and registered a performance of 93.4% in 2014. In Portugal, there is an overall indicator for commercial themed calls, another for emergency and assistance calls (the standard is that 85% of the calls must not have a waiting time of more than 60 seconds) and another for meter readings. By law, in Portugal, call backs to clients must be made within 2 working days after the client -having waited more than 60 seconds- has left his contact details and stated the purpose of the call.

Concerning the **obligations for DSO on response times for emergency situations** (II.10), Portugal responded to 93% of the requests related to emergency situations within 60 minutes (with a standard of 85%). In France, "emergency situations" are seen from the customer's need (e.g. a customer has an urgent need to activate the gas supply for his home) and not "emergency situations" from a safety point of view (because this questionnaire is focused on commercial quality and not on safety issues). When a customer needs quicker service than standards allow, GRDF's service catalogue provides options for quicker activation of supply (beginning of contract) and for quicker reactivation of supply (after deactivation for non-payment).

For the **"Punctuality of market participants regarding appointments with customers"** (II.1) the time limits vary from 2 hours (in Italy, Austria) to 3 hours (in Croatia), with a median value of 2.3 hours. The compensation for non-compliance is €33 in France, €35 in Italy and €20 in Portugal.

7.4.4 Group III: Grid access

Connection to the gas network is one of the most important commercial quality issues. When a customer moves in a new housing, the customer expects that the time limit to be connected to the network to be respected. Among the indicators of Group III, only 3 indicators provided sufficient results for analysis: the average response time of a DSO to customer requests for technical grid access (III.2); the time for providing a cost estimation of connecting customers to the network (III.4); and time for execution of connecting customers to the network (III.5) (see the results in Table 7.9).

TABLE 7.9 TYPES OF INDICATORS USED TO MONITOR INDICATORS IN GROUP III

Subject	Countries grouped by types of indicators in 2014			Time limit (median value and range)	Compensation (median value and range)	Company involved
	GI	OI	OR	2014	2014	
III.2 Average response time of a DSO to customer requests for technical grid access	HR, HU	AT, CZ, HU, LT	SI	25 days (range 14-30)	-	DSO, SP/USP, TSO
III.4 Time for providing a cost estimation of connecting customers to the network	IT	AT, CZ, LT	FR	14 days for simple works (range 8 work days-30 days) 30 days for complex works (range 14-30)	€35 Only one country)	DSO, MO, TSO
III.5 Time for execution of connecting customers to the network	HR, HU, IT	CZ, HU, IT, LT	FR	10 days for simple works (range 5 work days-20 work days) 35 days for complex works (range 10 work days-60 work days)	€35 (Only one country)	DSO, SP/USP, MO, TSO

Concerning the **average response time of a DSO to customer requests for technical grid access** (III.2), only 2 countries monitor a GI (Croatia and Hungary) while the majority of the countries monitor an OI (Austria, the Czech Republic, Hungary and Lithuania). Only Slovenia monitors an OR. In 2014, Austria registered a good performance of 99.8%, with a standard of 95% and a time limit of 14 days. Lithuania had a 100% performance record in 2014, with a time limit of 30 days in 100% of the cases.

The **time for providing a cost estimation of connecting customers to the network** (III.4) is mainly monitored as an OI (by Austria, the Czech Republic and Lithuania). In some countries, time for providing cost estimation depends on the types of work: simple or complex work. All the performances reported are above 98.8%: Austria's was 99.58% for complex and simple works; Italy had a performance of 99.1% for simple works and 98.8% for complex works.

The **time for execution of connecting customers to the network** (III.5), Italy had a performance of 98.10% for simple works (with 117,074 cases for which the limit was fulfilled and a time limit of 10 working days) and 98.8% for complex works (with 2,956 cases for which the limit was fulfilled and a time limit of 60 working days and a standard of 90%). Lithuania had a performance of 99.58% for both simple and complex works.

TABLE 7.10 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE INDICATOR III.4 "TIME FOR PROVIDING A COST ESTIMATION OF CONNECTING CUSTOMERS TO THE NETWORK" IS MONITORED

Country	Type of work	Limit	Standard that must be met	Number of cases for which the limit was fulfilled	Value of the indicator	Compensation for non-compliance	Penalty or other consequences	Pressure levels
Austria	For simple and complex works	14 days	95%	6.171	99,58%		administrative offence – fined up to €75,000	LP, MP
Italy	For simple works	15 working days		159.334	99,10%	€35	doubles after 30 working days, triples after 45 working days	LP
	For complex works	30 working days		5.085	98,80%		doubles after 60 working days, triples after 90 working days	
Lithuania	For simple and complex works	30 days	100%					

The **time limit** for the average response time of a DSO to customer requests for technical grid access (III.2) varies from 14 days (Austria) to 30 days (Latvia and Lithuania), with a median value of 25 days, but only 4 countries provided their time limits.

Regarding the time for providing a cost estimation of connecting customers to the network (III.4) and the time for execution of connecting customers to the network (III.5), in most of the countries, time limits depend on whether it is a simple or a complex work. For example, in Italy, the limit time for providing a cost estimation of connecting customers to the network is 15 working days for simple works, and 30 working days for complex work. For this indicator, the time limits vary from 8 working days to 30 days for simple work, and from 14 days to 30 days for complex work.

Only Italy provided the amount (€35) of the **compensation** for non-compliance of the time for providing cost estimation of connecting customers to the network (III.4) and of the time for execution of connecting customers to the network (III.5). Regarding the time for providing a cost estimation of connecting customers to the network (III.4) in Italy, compensation for simple works doubles after 30 working days and triples after 45 working days; and for complex works, it doubles after 60 working days and triples after 90 working days. In Belgium, besides commercial quality indicators, grid access is also ensured by a compensation regime. The Walloon gas decree defines a set of conditions under which aggrieved customers may receive flat-rate compensation from DSO. Once a year, the DSO must report customers' compensation requests to the Walloon energy regulatory authority (e.g. for late connection).

7.4.5 Group IV: Activation, Deactivation and Reactivation

Interventions with customers such as activation or deactivation are a major issue for gas network operators, particularly at the distribution level. Activation consists of linking a connection and estimation point to the scope of the transportation contract of a gas supplier when an occupant arrives in his premises. If the premises are not served by gas and unoccupied, the activation will require an intervention. A deactivation consists of separating a connection and estimation point to the scope of the transportation contract of a gas supplier when an occupant leaves his premises, at the time of the cancellation of its supply contract. The DSO often intervenes and reads the consumption data if the DSO has access to the gas meter.

In this section, the analysis focuses on the 3 indicators for which countries provided the highest number of responses: the **time period for activation of supply following request** (IV.3), the **time period for deactivation of supply following a request** (IV.4), the **time period for reactivation of supply after payment (for bad payers previously disconnected)** (IV.7). These indicators are mostly monitored as guaranteed indicators, particularly by the Czech Republic, France, Hungary, Italy and Latvia. The number of activations, deactivations, reactivations and customer requests for activation of supply is also monitored by numerous countries (see Figure 7.2).

FIGURE 7.2 NUMBER OF CUSTOMER REQUESTS FOR ACTIVATION, ACTIVATIONS OF SUPPLY, DEACTIVATIONS OF SUPPLY DUE TO LATE PAYMENT/REACTIVATIONS OF SUPPLY AFTER PAYMENT (FOR BAD PAYER PREVIOUSLY DISCONNECTED) CARRIED OUT

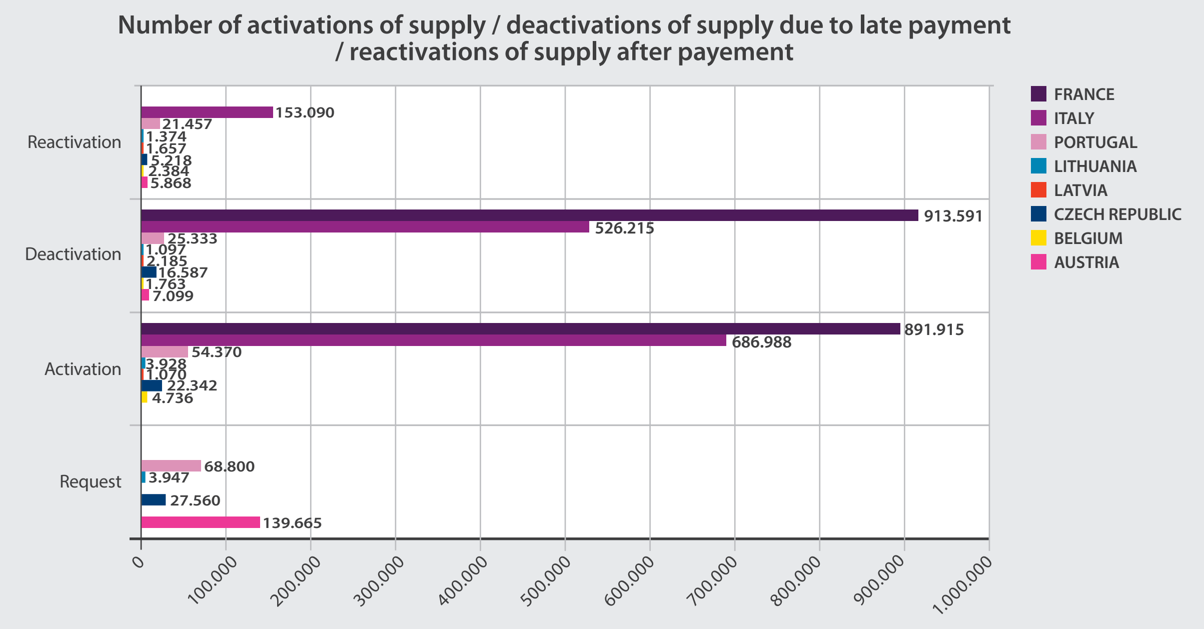


TABLE 7.11 TYPES OF INDICATORS USED IN GROUP IV

Subject	Countries grouped by types of indicators in 2014			Time limit (median value and range)	Compensation (median value and range)	Company involved
	GI	OI	OR	2014	2014	
IV.3 Time period for activation of supply following request	CZ, FR, HU, IT, PT	HU	LT	5 working days (range 2 work days-10 work days)	€27 (range 20-35)	DSO, SP/USP, MO, TSO
IV.4 Time period for deactivation of supply following a request	CZ, FR, HU, IT, LV	HU, LV	BE, LV, LT	5 working days (range 2 work days-45 work days)	€35 (Only one country)	DSO, SP/USP, MO, TSO
IV.7 Time period for reactivation of supply after payment (for bad payers previously disconnected)	CZ, HR, HU, IT, LV, PT	AT, HU	-	2 days (range 0.5-5)	€27 (20-35)	DSO, SP/USP, MO, TSO

The **time period for activation of supply following a request** (IV.3) is monitored as a GI by the Czech Republic, France, Italy and Portugal. In Hungary it is monitored as a GI and an OI. In Lithuania, it is monitored as an OR. The Czech Republic and Latvia had a 100% a performance rate, with a standard of 100% and a time limit of 5 days for the Czech Republic and 5 working days for Latvia. France had a performance of 92.2%, slightly above the standard (92%) (See case study).

For the **time period for deactivation of supply following a request** (IV.4), in Italy: 99.2% of the deactivations have been performed within 5 working days. In France, 95.8% of the deactivations have been realised in the agreed lead times with the customer, which is above the standard of 94% (see case study).

TABLE 7.12 EXAMPLES OF CRITERIA AND OBLIGATIONS BY WHICH THE INDICATOR IV.4 "TIME PERIOD FOR DEACTIVATION OF SUPPLY FOLLOWING A REQUEST" IS MONITORED

Country	Limit	Standard that must be met	Number of cases for which the limit was fulfilled	Value of the indicator	Compensation for non-compliance	Penalty or other consequences	Pressure levels
Belgium	2 to 45 working days						
Czech Republic	5 days						LP, MP, HP
France	in the agreed lead times	94%		95,80%		€100,000 / year	LP, MP
Italy	5 working days		522.040	99,20%	€35	doubles after 10 working days, triples after 15 working days	LP
Latvia	2 working days						LP, MP, HP
Lithuania	15 working days						

Concerning **the time period for reactivation of supply after payment** (IV.7), in the Czech Republic and Latvia, 100% of the reactivations (for bad payers previously disconnected) have been performed within 5 days in Latvia (1,657 cases) and 5 working days in the Czech Republic.

There is not a wide range of **time limits for the time period for activation of supply following request** (IV.3): it varies from 2 working days (Belgium) to 10 working days (Italy), while most of the countries have a time limit of approximately 5 working days. In France, the indicator is monitored in the agreed lead times with the customers; but standard lead times exist in the service catalogue of the main French DSO: 5 working days or 21 working days when the meter has to be installed (see case study).

There is a larger range of values for the **time period for deactivation of supply following a request** (IV.4). The time limits vary from 2 working days (in Belgium and Latvia) to 45 working days (it can vary from 2 to 45 working days in Belgium) but the median value is rather low (5 working days). In France, as for the activation rate, the indicator related to deactivation is monitored in the agreed lead times with the customer; even though standard lead times exist in the network operator's service catalogue: the time limit is 5 working days when requested by customer, and 10 working days when requested by the supplier.

In Belgium, in the Brussels-Capital Region, the supplier is allowed to disconnect consumers solely after a court ruling authorised him to do so on the basis of a specific procedure: (1) there is a first reminder (15 days after the bill due date); (2) then, a formal notice; (3) 7 days after formal notice, if there is no reaction from the customer or if it is impossible to reach agreement about the reimbursement outstanding debt plan. The supplier has the obligation to continue to provide power until the disconnection has been allowed by the judge.

There is a short range of **time limits** for the **time period for reactivation of supply after payment indicator** (IV.7): from 0.5 days to 5 working days (median value is 2 days). In Portugal, the time for reactivation after disconnection following non-payment is 12 hours for domestic customers, 8 hours for non-domestic and 4 hours if customer pays for urgent reactivation. Since 2014 the time is not counted between 20h00 and 8h00, and this rule applies only to simple works.

Portugal and Italy are the only 2 countries that have provided **compensation** amounts for the **time period for activation of supply following request** (IV.3) and the time period for reactivation of supply after payment (IV.7): €35 for Italy and €20 for Portugal. In Italy, the level of the compensation depends on the delay of the network operator: for example, for the time period for activation of supply following the request (IV.3), the compensation is €35 if the 10 working days are not respected, €70 after 20 working days and €105 after 30 working days.

7.4.6 Group V: Metering

Another important commercial quality issue is the meter, and more particularly, the time for meter verification and reading, and the time to replace the meter in case of need. In this section, the analysis focuses on the following indicators: the **time for meter verification (V.3); and the time for the replacement of the meter (when found out of order after verification)** (V.4).

TABLE 7.13 TYPES OF INDICATORS USED IN GROUP V

Subject	Countries grouped by types of indicators in 2014			Time limit (median value and range)	Compensation (median value and range)	Company involved
	GI	OI	OR	2014	2014	
V.3 Time for meter verification	CZ, HU, IT, LV	LV	FR, HU, LT, SI	range 3 work days-20 years	€35 (Only one country)	DSO, SP/USP, MO, TSO
V.4 Time for replacement of the meter (when found out of order after verification)	CZ, HU, IT, LV	LV	FR, HR, LV	5 days (range 0-15 days)	€35 (Only one country)	DSO, SP/USP, MO, TSO

Only Italy provided its performance related to the **time for meter verification** (V.3) and the **time for replacement of the meter (when found out of order after verification)** (V.4). In Italy, 80% of the meter verifications have been performed within 20 working days and in 99.5% of the cases, the replacement of the meter (when found out of order after verification) has been realised within 5 working days.

There is a wide range of **time limits** for the **time for meter verification** (V.3) because it depends on the type of meter: from 3 working days (Croatia) to 20 years (in France, for meters under 15 m^3/h). In France and in Lithuania, the time limit depends on the type of meter: in France, the time limit is 20 years (for a meter under 10 m^3/h), 15 years for diaphragm meters (above 10 m^3/h) and 5 years for turbine and rotary meters (above 10 m^3/h), and in Lithuania it can vary from once in 2 years to once in 12 years.

Italy is the only country that provided compensation amounts (for low pressure customers) for the time for meter verification (V.3) and the time for replacement of the meter (V.4). For the time for replacement of the meter, the compensation is €35 if the 5 working days are not respected, €70 after 10 working days and €105 after 15 working days.

7.4.7 Group VI: Invoices

Some requirements must be respected for **invoices** such as the lead time for the network operator to issue the invoices. In addition, settlement data and corrected invoices must be sent in due time. In this section, the time for **changing provider** based on a customer request is also presented. The analysis focuses on the following indicators: the **percentage of invoices submitted in due time** (VI.1); the **percentage of corrected invoices submitted in due time** (VI.2); and the **time for changing provider at the customer's request** (VI.7).

TABLE 7.14 TYPES OF INDICATORS USED IN GROUP VI

Subject	Countries grouped by types of indicators in 2014			Time limit (median value and range)	Compensation (median value and range)	Company involved
	GI	OI	OR	2014	2014	
VI.1 Percentage of invoices submitted in due time	HU, LV	AT, CZ, HU, LV	BE, HR	from 6 working days to 6 weeks	-	DSO, SP/USP, MO, TSO
VI.2 Percentage of corrected invoices submitted in due time	HR, HU, LV	AT, CZ, HU, LV	-	5 working days (range 2-10 work days)	-	DSO, SP/USP, MO, TSO
VI.7 Time for changing provider on customer request	CZ, HU, PL	HU	FR, HR	13 days (4-21 days)	-	DSO, SP/USP, MO, TSO

The percentage of invoices submitted in due time (VI.1) is mainly monitored as an OI indicator (by Austria, the Czech Republic, Hungary and Latvia). It is also monitored as a GI and an OR by 2 countries. In Austria, 98.02% of the invoices have been submitted in due time (standard is 95%) for 1,509,684 cases for which the limit was respected. In Latvia, 100% of the invoices have been submitted in due time (the time limit varies from 6 to 8 working days and the standard is 100%).

The percentage of corrected invoices submitted in due time (VI.2) is monitored as a GI in Croatia, Hungary and Latvia, and as an OI in Austria, the Czech Republic, Hungary and Latvia. In Austria, 95.7% of the corrected invoices have been submitted in due time (standard is 95%). In Latvia, 100% of the corrected invoices have been submitted in due time (standard is 100%).

The time for changing provider on a customer's request (VI.7) is monitored as a GI in the Czech Republic, Hungary and Poland; as an OI in Hungary; and as an OR in Croatia and France. In the Czech Republic, 100% of the supplier changes have been performed within 10 working days (standard is 100%).

Some time limits vary significantly depending on the process. For example, for the indicator **"percentage of invoices submitted in due time"** (VI.1). In Austria, the time limit is 6 weeks after meter reading if the invoice is sent to a customer and 3 weeks if the invoice is sent to a supplier, who also invoices the network bill (integrated invoice). In Belgium, various limits apply depending on the process (from 6 weeks after meter data, to 60 days as and from the meter readings transmission by the DSO).

7.5. CASE STUDIES

7.5.1 Case study: Activation rates in the agreed lead times in France

In France, activation is carried out at the initiative of the customer that moved in and who has, beforehand, chosen an energy supplier. Activations in gas and electricity are ensured by the same technical teams. Activation is an important issue as it is one of the few occasions of a direct interaction between the DSO and its customer.

Activation consists of linking a connection and estimation point (PCE) to the scope of the transportation contract of a gas supplier when an occupant arrives in his/her premises. If the premises are unoccupied and already served by gas, activation does not require the intervention of an agent. In the case of premises that have been recently connected to the gas network or were previously served but have since then been cut off, activation will require an intervention.

GRDF (the main DSO) monitors the activation (with intervention) rates in the agreed lead times, since 1 July 2011, for all types of customers. In this indicator, GRDF mainly takes into account the activations with intervention and the first activation. Activations without intervention are not taken into account in the calculation of this indicator. The standard lead time (in GRDF's service catalogue) to achieve activation is either 5 or 21 days depending on whether the activation requires a meter installation.

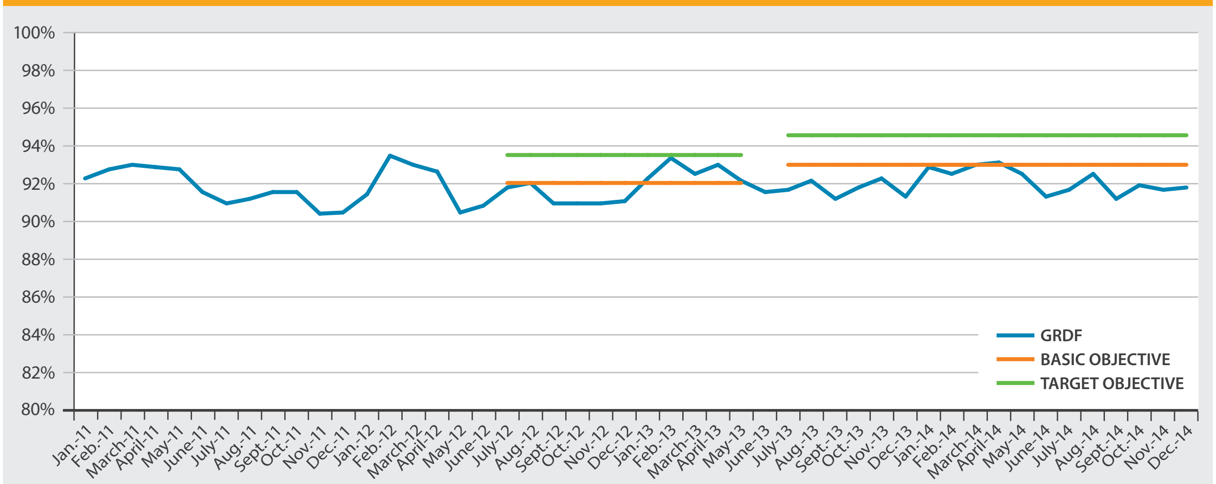
This indicator has financial incentives since 1 July 2012. In practice, the financial incentives had no effect on GRDF's performance. Whilst there had been progress, the activation rates had not reached the basic objective of 92%. Therefore, in July 2013, the French NRA reinforced the objectives and the incentives related to this indicator to:

- A penalty of €100,000 per point of percentage if the biannual rate is strictly lower than the basic objective of 93%; and
- A bonus of €50,000 per point if the monthly rate is equal to or higher than the target objective of 94.5%.

In 2014, the average annual activation rate achieved in the agreed lead times stagnated at a level slightly below the basic objective (93%). It reached 92.2% in 2014, which represents an increase of 0.4 points since 2011. According to GRDF, the failure to comply with the agreed lead times for the first activations can be explained by different factors. For example, when the grid operator intervenes, customer's installation may not be configured properly and consequently the first activation cannot be realised in the agreed lead time. In these cases, the operator is not liable.

For biannual meter reading customers (household and professional customers, including small businesses for which annual consumption is lower than 300 MWh that represent the majority of the customers), GRDF performance reached 92.2% in 2014 and is stable since the implementation of the indicator (+0.30 points compared to 2011). Concerning monthly meter reading customers, the performance of the operator increased from 2011 to 2014 reaching 89% in 2014 (+3.9 points). For daily meter reading customers, the compliance with the time limits regarding activations fell and reached 75.5% in 2014 (-12.1 points). Nevertheless, the number of activations for daily meter reading customers is rather low, which can skew the performance analysis. In 2014, GRDF faced a penalty of €166,000 for the activation rates in the agreed lead times.

FIGURE 7.3 GRDF ACTIVATION RATES IN THE AGREED LEAD TIMES



7.5.2 Case study: Deactivation rates in the agreed lead times in France

A deactivation consists of separating a connection and estimation point (PCE) to the scope of the transportation contract of a natural gas supplier when an occupant leaves his premises, at the time of the cancellation of its supply contract. For all deactivations, the DSO intervenes and reads the consumption data if the DSO has access to the gas meter.

GRDF monitors the deactivation (with intervention) rates in the agreed lead times since 1 July 2011. This indicator measures the proportion of deactivations achieved in the agreed deadlines with the customer. The standard lead time (in GRDF's service catalogue) for a deactivation is 5 days. This indicator has financial incentives since 1 July 2012:

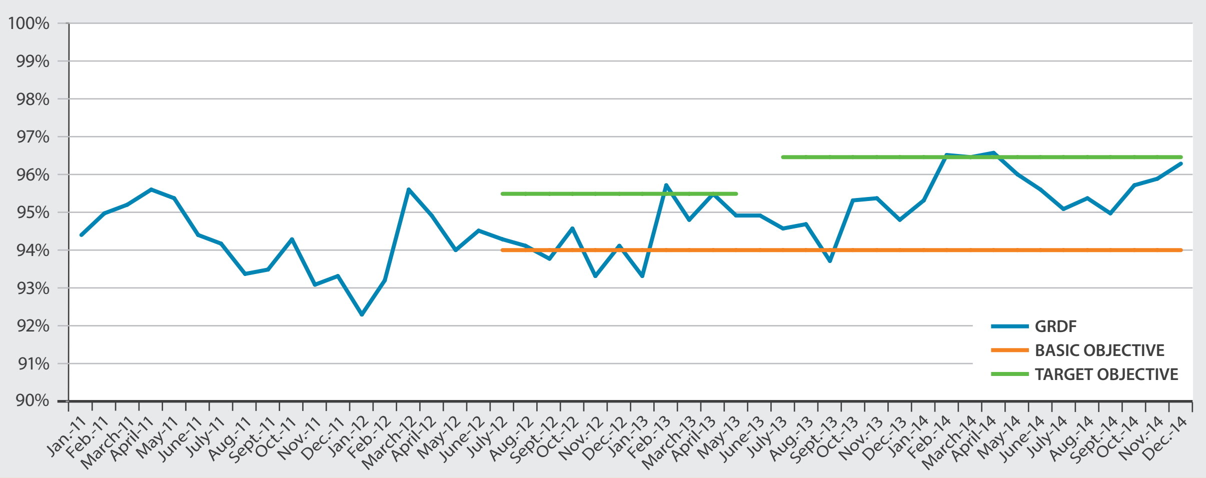
- A penalty of €100,000 per point of percentage if the biannual rate is strictly lower than the basic objective of 94%;
- A bonus of €50,000 per point of percentage if the monthly rate is equal or higher than the target objective of 96.5%.

For all the customers, the deactivation rate in the agreed lead times is increasing since 2011. It reached 95.8% in 2014 (corresponding to an increase of 1.5 points from 2011) and is between the basic objective and the target objective. Since the reinforcement of the financial incentives in July 2013, GRDF's performance has improved.

For biannual meter reading customers (household customers and professional customers, which include small businesses for which annual consumption is lower than 300 MWh, represent the majority of the customers), GRDF performance reached 95.9% in 2014 and is increasing since July 2013 (by +1.5 points compared with 2011). GRDF attributes the improvement to a specific mobilisation of the operational units during the interventions. Regarding monthly meter reading customers, the performance declined slightly from 2011 to 2014 reaching 78.4% in 2014 (-9.7 points). Concerning daily meter reading customers, the compliance of the lead times fell by -18.3 points reaching 69.5% in 2014. Nevertheless, the number of activations for daily meter reading customers is rather low, which can skew the analysis of the performance.

After 1 July 2012, the financial incentives did not have any effect on the performance of GRDF. Whilst there had been progress, the deactivation rate was between the basic objective (94%) and the target objective (95.5%). Therefore, since 1 July 2013, CRE has reinforced the objectives and financial incentives related to this indicator with a basic objective of 94% per semester and a target objective of 96.5% per month.

FIGURE 7.4 GRDF DEACTIVATION RATES IN THE AGREED LEAD TIMES



7.5.3 Case study: Claims processing in France

In France, the processing and registration of claims are mainly carried out via a web portal (called OMEGA), which is used as an interface between the DSO and the natural gas suppliers. However, claims can be submitted in written or oral forms directly by the customer or by the supplier. For gas, the majority of claims come from suppliers. Claims are then classified according to customers' satisfaction about the DSO's response.

The number of suppliers' claims declined by 26% from 2011 to 2012, and by 1.1% from 2013 to 2014. Specifically, the number decreased from 69,834 in 2013 to 69,066 in 2014. The time for processing suppliers' claims is monitored by a financial incentive indicator since 1 January 2010. GRDF has to pay a penalty of €2,000 by percentage point if the monthly rate of response to suppliers' claims within a time limit of 15 calendar days is below 95%. The performance of GRDF is above the objective of 95%. In 2014, GRDF improved its claims processing lead times whereby 98.4% of the claims have been handled in a lead time lower than 15 days while in 2013 its performance was 97.9%. According to GRDF, the improvement can be explained by a mobilisation of its teams on suppliers' claims in 2012. In particular, the financial incentives have had an impact. In 2011, the average annual response rate was equal to 90.9% while since 2013 it is above the objective of 95%, with a rate of 97.9% in 2013 and 98.4% in 2014.

The time for processing customers' claims is monitored via a financial incentive indicator since 1 January 2010. All monthly customers' claims have to be treated within 30 calendar days by the DSO. If the operator does not comply with the time limit, a compensation of €25 per claim not handled within the time limit has to be given to the customer. The rate of responses for customers' claims varied from 93.9% in 2013 to 90.6% in 2014. In 2014, GRDF paid a total amount of €1,225 of compensations in claims related to this indicator. Furthermore, the number of claims made directly by customers diminished by 50% since the introduction of the indicator in 2008.

7.6. SUMMARY OF BENCHMARKING RESULTS

Table 7.15 and 7.16 below synthesise the results in terms of the indicators (see also Section 7.4.1). Indicators for DSOs are the largest part of the total: 165 out of 306 national indicators (see Table 7.3).

TABLE 7.15 TOTAL OF APPLIED INDICATORS PER TYPE

Indicator	GI	OI	OR	Total
I. CUSTOMER INFORMATION				
I.1 Time for response to customer request and/or complaints	5	6		**11**
I.2 Number of customer requests and/or complaints	3	4	2	**9**
I.3 Percentage of responses to customer complaints and/or requests in written form within a given time period	1	3	2	**6**
I.4 Percentage of market participants who display the gas emergency number on invoices, homepage, etc.		1	3	**4**
I.5 Number of market participants who display the quality of supply standards on invoices, homepage, etc.		1	3	**4**
I.6 Times of availability of a market participant's call centre		3	2	**5**
I.7 Time of availability of a network operator's website accessible to providers	2	3		**5**
I.8 Average response time to customer request and/or complaints		1		**1**
TOTAL FOR CUSTOMER INFORMATION INDICATORS	**11**	**22**	**12**	**45**

Indicator	GI	OI	OR	Total
II. CUSTOMER CARE				
II. 1 Punctuality of market participants regarding appointments with customers	6	4		**10**
II. 2 Punctuality of customers regarding appointments with market participants	3	3	3	**9**
II. 3 Time limit for market participants / clients to cancel an appointment	2	3	3	**8**
II. 4 Time limit for waiting in customer centres	2	3	2	**7**
II. 5 Percentage of customers attended within the waiting time limit in customer centres	2	3		**5**
II. 6 Limit time for waiting in call centres	1	2	2	**5**
II. 7 Target call answer time in call centres	1	3	1	**5**
II. 8 Percentage of dropped calls in the call centres	1	3	1	**5**
II. 10 Obligation for DSO regarding response time for emergency situations	1	5		**6**
II. 11 Percentage of customers with a waiting time below the limit in call centres		2		**2**
TOTAL FOR CUSTOMER CARE INDICATORS	**19**	**31**	**12**	**62**
III. GRID ACCESS				
III.2 Average response time of a DSO to customer requests for technical grid access	2	4	1	**7**
III.4 Time for providing a cost estimation of connecting customers to the network	1	2	1	**4**
III.5 Time for execution of connecting customers to the network	3	4	1	**8**
TOTAL FOR GRID ACCESS INDICATORS	**6**	**10**	**3**	**19**
IV. ACTIVATION & DEACTIVATION OF SUPPLY				
IV.2 Time to response to customer request for activation	1	3		**4**
IV.3 Time period for activation of supply following a request	4	1	0	**5**
IV.4 Time period for deactivation of supply following a request	5	2	2	**9**
IV.7 Time period for reactivation of supply after payment	6	2		**8**
IV.8 Time a customer is deactivated following deactivation for non-payment	2	3	1	**6**
TOTAL FOR ACTIVATION & DEACTIVATION INDICATORS	18	11	3	**32**
V. METERING				
V.2 Number of gas meters not installed in due time	2	2	2	**6**
V.3 Time for meter verification	2	1	2	**5**
V.4 Time for replacement of the meter (when found out of order after verification)	3	1	3	**7**
V.5 Number of network customers, who were informed about meter readings in absentia	2	3	1	**6**
V.10 Minimum period for reading the meter	2	2	1	**5**
V.12 Percentage of meter readings made within a certain amount of time after the last one		1		**1**
TOTAL FOR METERS INDICATORS	**11**	**10**	**9**	**30**
VI. INVOICING				
VI.1 Percentage of invoices submitted in due time	2	4	1	**7**
VI.2 Percentage of corrected invoices submitted in due time	2	4		**6**
VI.4 Number of settlement data not transmitted in due time	1	3		**4**
VI.7 Time for changing provider on customer request	3	1	2	**6**
TOTAL FOR INVOICES INDICATORS	**8**	**12**	**3**	**23**

The most monitored indicator is the time for response to customer claim for network connection (I.1). The average number of indicators whose type is specified is 6 ("indicators/activity", that is "(11+21+12)/ 7 activities") in the Customer information group. This figure is one of the highest among the other groups (see below), meaning that customer information and the time to response to complaints in the CEER countries is of primary importance. Customer care indicators (Group II) are the largest group of indicators (with an average value of 7 indicators/activities and a total of 62 indicators). The punctuality of market participants regarding appointments with customers (II.1) and the punctuality of customers regarding appointments with market participants (II.2) are one of the most monitored indicators.

Grid access (Group III) and activation and deactivation of supply (Group IV) have an average value of approximately 6 indicators/activity. A key issue is access to the grid as quickly as possible: the average response time of a DSO to customer requests for technical grid access (III.2) and the time for execution of connecting customers to the network (III.5) are the 2 most monitored indicators of the Grid access group. Regarding the Activation & Deactivation of supply group, the focus is on the time to perform activation, deactivation and reactivation.

Metering and invoicing are regulated to the same extent, with an average value of approximately 6 indicators/activities. In particular, DSO give high priority to submitting invoices in the due time; the percentage of invoices submitted in due time (VI.1) in the Invoicing group is the most monitored indicator.

Looking at the average number of indicators per activity group, there is a considerable difference between them. OIs are the most frequently applied indicators for regulation of customer information, customer care, grid access and invoicing issues. In some important cases GIs, OIs and ORs are used in parallel in CEER countries. GIs are frequently applied for activation and deactivation of supply and metering activities. Many GIs and ORs are applied for customer information and customer care issues. Table 7.16 shows the indicators applied in CEER countries, per group and per type.

TABLE 7.16 COMMERCIAL QUALITY INDICATORS APPLIED BY CEER COUNTRIES PER GROUP AND TYPE OF INDICATORS

Countries	I. Customer information			II. Customer care			III. Grid access			IV. Activations			V. Meters			VI. Invoices		
	GI	OI	OR	GI	OI	OR	GI	OI	OR	GI	OI	OR	GI	OI	OR	GI	OI	OR
Austria		X	X		X			X			X			X			X	
Belgium		X	X		X							X						X
Croatia		X	X	X	X		X			X					X	X		X
Czech Republic	X	X			X			X		X	X		X	X		X	X	
Estonia		X																
Finland																		
France	X		X	X		X			X	X					X			X
Great Britain																		
Greece																		
Hungary		X		X	X	X	X	X		X	X		X		X	X	X	
Italy		X		X			X	X		X			X					
Latvia	X	X	X	X	X	X				X	X	X	X	X	X	X	X	
Lithuania		X						X				X			X			
Luxembourg																		
Malta																		
The Netherlands		X																
Norway																		
Poland	X															X		
Portugal	X	X		X	X					X				X				
Slovenia			X						X						X			
Sweden																		

7.7. FINDINGS AND RECOMMENDATIONS ON COMMERCIAL QUALITY OF GAS

It is important to recall that the results on commercial quality should be interpreted with caution as some elements can be measured in different ways and data are not yet available in every country. This may reflect differences in measurement. For example, some indicators do not differentiate between requests and complaints. Furthermore, the performances of the operators are not comparable across countries since each country has its own regulatory system (with specific time limits, standards, compensation levels, penalty amounts, etc.).

Finding 1

An increased focus by NRAs on the quality of the services provided to customers.

A first finding, in line with the conclusions for electricity from CEER's past Benchmarking Reports, is that NRAs devote significant attention to the commercial quality of the services provided. A total of 17 responding countries reported 211 national commercial quality indicators referring to 36 performances requested by customers.

Finding 2

A broad but increasingly harmonised, range of commercial quality indicators are monitored.

There are significant differences concerning the nature and the number of indicators monitored across countries. The regulation of a given service can be achieved in many different ways such as time limits, standards, compensation levels and penalty levels. NRAs should set the commercial quality regulations taking into account their national, political, cultural and economic specificities. There are significant differences between countries concerning the number and the nature of the indicators. The survey of the 6th Benchmarking Report reveals a considerable number of identical or partially identical regulations concerning commercial quality indicators.

Finding 3

Requirements and compensations vary a lot depending on the customer type

Commercial quality concerns different types of customers: the difference in the amount of consumption is also important from a regulatory point of view. Their classification (location, pressure levels) varies from country to country and from network operator to network operator. In a given country, requirements may vary significantly depending on whether the customer concerned is a low pressure, medium pressure or high pressure customer.

Finding 4

A significant number of OIs and GIs are monitored in the regulation of gas commercial quality.

The data collected shows that commercial quality indicators can be used by NRAs in 3 ways:

- To define OIs, either without any economic consequence for the DSO or supplier upon non-compliance or including economic sanctions. NRAs are entitled to impose sanctions such as penalties;
- To set GIs by which customers receive direct compensation if standards are not met; or
- To apply OR, and in the case of non-compliance, sanctions can be imposed by the NRA.

This benchmarking exercise reports 78 GIs and 112 OIs being applied, out of a total number of 240 indicators.

Finding 5

Commercial quality is mainly focused on the DSO's relationship with customers.

In countries where competition works well, the NRAs are focused more on the DSOs' commercial quality obligations (rather than those of the suppliers) as the distribution activities are closely linked to customers (connection to the grids, activations, etc.).

Finding 6

Customer information, customer care and activations to the network are key considerations.

From a consumer perspective, activations and deactivations are very relevant processes not least because in some cases they represent the customer's first interaction with the energy market. If these processes are well designed and function efficiently, they will help to improve the customer's perception of the energy market. The survey results shown in Table 7.3 demonstrate that priority is given to the standards for customer information, customer care and activation/deactivation.

Finding 7

Automatisation of compensation payment is being developed.

The compensation paid to the customer for non-compliance exists in some countries but it is still not at a sufficient scale: some countries already apply automatic compensation in case of non-compliance for certain indicators. For example, in France, since 2013 the number of missed appointments by the main French DSO (GRDF) is systematically detected and the customers are automatically reimbursed.

Finding 8

The focus needs to be wider than DSO's written responses to consumers.

In addition to the customer's expectation to be connected or reconnected as quickly as possible, there is the noticeable need for a substantive response from the DSO/supplier to any customer request within a reasonable limit of time. The data reveals that the current emphasis is placed on performance with respect to written forms of communication. This results in an incomplete picture of the quality of responses to customer requests for 2 different reasons: (1) non-written forms of communication like telephone (fixed and cell-phone) and internet (website) have been developed significantly and are widespread; (2) in some countries, the more traditional approach of visiting local customer centres continues. In France, in 2014, some improvements have been realised for GRDF (the main natural gas French DSO) with measures to allow better traceability of oral and internet-based complaints, and for recording mails and phone calls. Since 2015, GRDF now takes into account, in addition to the written complaints, oral and internet-based complaints.

RECOMMENDATION 1

PERFORM REGULAR REVIEWS OF NATIONAL REGULATIONS.

It is important for CEER (and NRAs) to regularly review the commercial quality indicators, taking into account the development of national conditions (e.g. the development of smart grids) and the expectations of the customers. Monitoring the actual level of commercial quality (average values of the indicators and percentages of fulfilment) has an important role in such reviews. The most important factor in this process is the availability of wide and realistic data. Therefore, it is necessary to examine in detail (including questioning stakeholders about) the commercial quality regulations in place to know if other indicators or requirements are monitored, or to understand the specificities of each country surveyed. In addition, the number of indicators surveyed by CEER should be limited to make the analysis manageable.

RECOMMENDATION 2

PURSUE THE HARMONISATION OF COMMERCIAL QUALITY INDICATOR DEFINITIONS.

Harmonising the definitions facilitates significant results from European countries and a more consistent and understandable database. Comparisons are difficult to make between Member States, as the regulation of a given activity can be achieved in many different ways depending on the country. A clear framework and harmonised parameters can help the analysis of the results and thus the identification of further improvements and recommendations.

RECOMMENDATION 3

ENSURE GREATER PROTECTION THROUGH GUARANTEED INDICATORS WITH AUTOMATIC COMPENSATION FOR CUSTOMERS.

It is recommended that NRAs should apply GIs with automatic compensation or OIs or ORs associated with the option of sanctioning. For the most important indicators (e.g. for connection activities), a combination of OI with economic sanctions (like penalties) and GIs is recommended, in order both to improve the average performances and to protect customers from worst service conditions. This recommendation is targeted mainly at DSOs given their important relationship with customers. In addition, the automatisation of the compensation payment, which is increasingly applied, should be extended to every country.

RECOMMENDATION 4

NRAs SHOULD MONITOR INDICATORS IN ALL FORMS OF COMMUNICATION FOR MORE ACCURATE PERFORMANCE LEVELS.

CEER recommends that, in addition to written form of communication, NRAs should also regulate the performance of the service level of provided to customers through communications such as phone, e-mail and online (e.g. website/apps), and visits to customer centres. In particular, in the performances of DSOs and USPs in the increasingly important field of phone contacts should be monitored. Attention should be paid not only to a rapid response but also to a thorough and useful response. All types of responses should be taken into account in the commercial quality regulation: oral, internet-based and written complaints.

RECOMMENDATION 5

ENSURE THE AVAILABILITY OF THE SERVICES, IN PARTICULAR REGARDING CONNECTION AND CUSTOMER CARE.

CEER recommends countries and their NRAs evaluate customer priorities before creating new regulatory frameworks.

RECOMMENDATION 6

FURTHER DEVELOP THE REGULATION OF CUSTOMER RELATIONS.

Quality perception is not sufficiently evaluated in the Member States. To further develop the commercial quality regulation, satisfaction surveys -although costly- could be implemented to have qualitative elements (in addition to the quantitative elements the CEER questionnaire provides), since it could help in assessing how the customers actually perceive the service achieved by the operator.

ANNEX A
ELECTRICITY – CONTINUITY OF SUPPLY

TABLE A.1 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS (MINUTES LOST PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria		48,105	34,316	38,764	55,765	56,648	42,889	41,646	36,127	28,636	33,807	33,614	33,438
Bulgaria							288,5	231,2	197,24				
Croatia					577,84	250,95	237,24	204,62	188,94	151,95	196,84	176,13	166,34
Cyprus											148		
Czech Republic			102,54	120,5	102,5	124,23	86,7	102,65	106,24	107,08	109,93	98,01	84,31
Denmark							16,45	15,29	15,17	16,09	14,75	11,25	11,55
France	40	51	50,7	52,2	71,5	57,7	62,6	67,2	62,9	52,6	60,1	68,1	50,2
Germany					21,53	19,25	16,89	14,63	14,9	15,31	15,91	15,32	12,28
Great Britain	81,66	81,28	76,59	68,64	65,55	78,03	74,22	73,43	70,02	67,95	55,43	54,71	53,06
Greece							167	138	121	101	101	96	92
Hungary	196,8	155,4	137,4	121,8	127,75	137,42	97,7	99,32	102,38	75,73	76,25	67,21	74
Ireland	183	162	156,5	154,9	123,9	115,4	94,1	81,3	82	69,6	62	86,7	101,1
Italy	108,88	96,83	76,52	65,74	53,84	52,47	53,1	49,45	47,77	43,59	45,45	42,27	41,32
Latvia												192	153
Lithuania				149,85	125,75	135,55	103,37	87,71	83,38	106,1	76,58	72,67	71,56
Luxembourg										13,2	17,7	16,7	14,2
Malta	523,8	566,98	486,83	398,82	304,37	409	186,58	687,85	620,57	191	286,2	360,04	570,6
The Netherlands	28	30	24	27,4	35,6	33,1	22,1	26,5	33,7	23,4	27	23	20
Poland							354,51	316,46	316,26	309,1	254	254,85	191,77
Portugal	334,54	303,75	148,81	142,82	152,08	104,33	133,08	185,62	172,98	97,25	78,48	88,7	74,89
Romania							638	635	639	547	630	427	361
Slovenia							59	54	51	64	75	60	71
Spain	142,557	141,908	123,6	117	112,8	103,92	86,82	90	79,2	58,2	62,4	52,08	54
Sweden									79,3	118,34	84,02	82,18	74,59
Switzerland									13	16	21	15	13

Notes:

Austria: 2002 without flood, 2006 without UCTE-blackout on 4th of November, 2007 without interruptions caused by storm "Kyrill", 2008 storm "Paula" and "Emma", 2013 flood, 2014 snowstorm, storms "Yvonne", "Gonzalo".

Denmark: Interruptions lasting 1 minute or more are monitored.

France: All SAIDI, SAIFI and MAIFI figures only include customers covered by the main DSO (ERDF), which operates about 95% of French distribution networks.

Great Britain: This is based on equal to and greater than 3 minutes.

Greece: Figures refer to MV and LV voltage levels for all years. Figures for all years include non-interconnected islands.

Hungary: Only for HV, MV and LV.

Ireland: These are the storm adjusted values for all of the distribution network.

Italy: Excluding force majeure and interventions of transmission defence systems.

Malta: Interruption data is available only from 11 kV level and above. No exceptional events.

Portugal: Indicator evaluated in LV; Interruptions not attributable to force majeure.

Slovenia: Due to unavailability of LV data, as well as different weighting method for calculation of SAIDI on the EHV/HV level, the MV data only is used. Includes the interruptions attributable to "third party".

TABLE A.2 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS (INTERRUPTIONS PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria		0,777	0,652	0,795	0,986	0,919	0,803	0,775	0,763	0,561	0,679	0,656	0,624
Bulgaria							5,63	5,12	4,65				
Croatia					3,43	3,06	2,58	2,48	2,27	2,06	2,36	1,94	1,83
Cyprus											0,8		
Czech Republic			2,11	1,92	1,87	2,35	1,7	1,63	1,64	1,65	1,82	1,69	1,6
Denmark							0,41	0,36	0,39	0,4	0,4	0,3	0,31
France	1,15	1,4	1,3	1,02	1,3	0,98	1,16	1	0,92	0,81	0,89	0,87	0,73
Germany					0,456	0,326	0,322	0,289	0,263	0,311	0,275	0,47	0,34
Great Britain	0,866	0,7886	0,8073	0,7241	0,7165	0,7802	0,7345	0,7138	0,6894	0,6792	0,5986	0,5889	0,595
Greece							2,1	2,1	2,1	2	1,8	1,6	1,7
Hungary	2,03	2,05	1,9	1,77	1,77	1,88	1,54	1,49	1,45	1,21	1,16	1,04	1,067
Ireland	1,242	1,466	1,679	1,862	1,43	1,485	1,282	1,082	1,178	0,946	0,857	1,142	1,285
Italy	2,74	2,68	2,42	2,333	2,226	2,1	1,923	1,945	1,802	1,669	1,74	1,632	1,646
Latvia												2,9	2,38
Lithuania				1,36	1,36	1,54	1,38	1,28	1,15	1,13	1,06	0,97	0,9
Luxembourg										0,35	0,3	0,27	0,23
Malta	4,4145	5,211	4,688	4,63	2,8867	4,2434	2,3521	5,0435	5,5012	2,6634	4,2833	4,13	2,754
The Netherlands	0,34	0,34	0,32	0,304	0,454	0,33	0,307	0,331	0,384	0,341	0,316	0,296	0,276
Poland							4,08	3,7	3,74	4,14	3,42	3,02	2,95
Portugal	5,93	4,81	2,69	2,71	2,73	2,06	2,36	2,77	3,14	1,94	1,62	1,75	1,56
Romania							6,7	6,4	6,1	5,6	5,5	4,8	4,35
Slovak Republic											2,15	2,03	
Slovenia							1,8	1,49	1,39	1,63	2,16	1,59	1,89
Spain	2,65	2,599	2,52	2,31	2,38	2,229	1,991	2,033	1,816	1,415	3,202	1,31	1,112
Sweden									2,02	1,59	1,33	1,288	1,299
Switzerland									0,28	0,28	0,34	0,28	0,22

Notes:

Austria: 2002 without flood, 2006 without UCTE-blackout on 4th of November, 2007 storm "Kyrill", 2008 storm "Paula" and "Emma", 2014 snowstorm, storms "Yvonne", "Gonzalo".

Denmark: Interruptions lasting 1 minute or more are monitored.

France: All SAIDI, SAIFI and MAIFI figures only include customers covered by the main DSO (ERDF), which operates about 95% of French distribution networks.

Great Britain: This is based on equal to and greater than 3 minutes. GB originally submitted CI values per 100 customers. The values in this table are the CI values divided by 100.

Greece: Figures refer to MV and LV voltage levels for all years. Figures for all years include non-interconnected islands.

Hungary: Only for HV, MV and LV.

Ireland: These are the storm adjusted values for all of the distribution network. The values originally submitted by Ireland (per 100 customers per year) were divided by 100.

Italy: Excluding force majeure and interventions of transmission defence systems.

Malta: Interruption data is available only from 11 kV level and above. No exceptional events. The values originally submitted were divided by 100.

Portugal: Indicator evaluated in LV Interruptions not attributable to force majeure.

Slovenia: Due to unavailability of LV data, as well as different weighting method for calculation of SAIDI on the EHV/HV level, the MV data only is used. Includes the interruptions attributable to "third party".

Sweden: Interruptions over 12 hour are not included. In Sweden, exceptional events are not defined, but interruptions with duration of at least 12 hours are excluded due to economical compensation for those interruptions. All interruptions, however, do include those longer than 12 hours.

TABLE A.3 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS: HV+EHV (MINUTES LOST PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Croatia					13,48	13,41	9,49	10,36	8,16	5,37	22,83	5,99	5,83
Czech Republic									2,9	10,41	2,26	10,34	1,41
Denmark							0,15	0,25	0,16	0,08			
France	1,9	2,2	1,5	6,7	7,5	2,1	6,1	5,6	1,5	1,1	2	2	1,8
Hungary		4,11	1,45	1,29	2,37	0,29	0,56	0,66	0,21	0,33	0,56	0,41	0,323
Ireland	5,3	11,8	16,2	17,4	10,9	19,6	10,4	9	8	6,1	2,8	9,2	8,5
Italy	2,28	2,6	4,469	2,8	2,22	3,384	1,662	1,613	2,846	2,342	1,328	1,927	2,883
Lithuania				0	4,65	15,24	1,18	1,42	2,89	0,92	0,26	0,22	1,9
The Netherlands	6,3	2,8	2,2	7,6	8,2	11,3	1,4	3,2	7,9	3	1	0,8	0,9
Sweden									14,986	21,214	12,632	23,876	54,167
Switzerland									4	2	6	1	2

Notes:
Croatia: In this case, HV is only related to the 110 kV voltage level.
Ireland: These are values for 110 kV and 38 kV distribution network.

TABLE A.4 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS: MV (MINUTES LOST PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Croatia					539,83	197,42	210,2	178,42	162,83	121,92	145,27	144,25	113,63
Czech Republic							88,54	119,92	124,58	114	105,8	97,88	97,74
Denmark							13,56	12,58	12,37	13,2	11,97	10,02	8,89
France	31	40	40,6	36,8	54,8	47,1	47,4	50,5	51	42,6	47,1	54,7	39,4
Hungary	139,24	104,96	99,72	83,77	86,45	98,49	70,31	66,46	74,13	52,94	48,98	48,34	49,54
Ireland	135,4	129,6	126,1	123,8	101,7	85,4	75	65,8	67,8	57,1	54,9	72,2	87,3
Italy	80,59	73,85	56,29	46,7	36,01	33,32	32,4	31,15	28,46	26,12	27,31	25,36	24,49
Lithuania				32	89,79	89,18	75,23	65,23	63,06	64,43	59,14	56,84	54,82
The Netherlands	17,7	22,6	17,7	15,5	21,8	17,1	15,8	18	19	14,6	19	15,9	12,8
Sweden									99,219	110,855	69,301	123,13	102,219
Switzerland									7	12	12	12	10

Notes:
The Netherlands: 1-20 kV.

TABLE A.5 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS: LV (MINUTES LOST PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Croatia					24,53	40,12	17,55	15,83	17,95	24,66	28,73	25,89	18,79
Czech Republic							82,8	102,58	106,17	107,06	109,95	98,02	84,33
Denmark							2,3	2,18	2,03	2,12	2,08	1,77	1,82
France	7	9	8,7	8,8	9,2	8,5	9,1	11,1	10,4	8,9	10,9	11,4	8,9
Hungary	57,56	46,33	40,43	36,75	38,93	38,63	26,82	32,2	28,03	22,47	21,83	18,47	24,473
Ireland	42,4	20,6	14,2	13,8	11,3	10,4	8,6	6,5	6,3	6,4	4,4	5,3	6,2
Italy	26,01	20,38	15,76	16,24	15,61	15,76	19,04	16,69	16,15	14,86	16,26	14,51	13,59
Lithuania				118,03	31,01	30,84	26,97	19,55	17,44	19,32	17,18	15,6	14,84
The Netherlands	4,3	4,9	4,3	4,3	4,6	4,8	4,9	5,3	6,3	5,8	7	6,7	6,3
Sweden									91,88	186,43	88,21	151,99	83,82
Switzerland									2	2	2	2	1

TABLE A.6 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS: HV+EHV (INTERRUPTIONS PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Croatia					0,52	0,4	0,45	0,32	0,25	0,16	0,36	0,15	0,15
Czech Republic									0,18	0,09	0,15	0,21	0,11
Denmark							0,04	0,03	0,02	0,01			
France			0,06	0,11	0,22	0,05	0,11	0,12	0,06	0,05	0,07	0,07	0,05
Hungary		0,1	0,07	0,085	0,077	0,035	0,039	0,058	0,013	0,047	0,019	0,028	0,028
Ireland	0,062	0,334	0,569	0,29	0,264	0,361	0,184	0,148	0,161	0,14	0,094	0,17	0,211
Italy	0,17	0,16	0,2	0,217	0,187	0,218	0,136	0,127	0,12	0,093	0,107	0,119	0,157
Lithuania				0	0,08	0,15	0,05	0,06	0,05	0,02	0,01	0,004	0,03
The Netherlands	0,129	0,101	0,083	0,096	0,159	0,093	0,079	0,092	0,129	0,11	0,059	0,05406	0,04
Sweden									0,295	0,36	0,204	0,36	0,658
Switzerland									0,08	0,07	0,1	0,08	0,06

Notes:
Croatia: In this case, HV is only related to the 110 kV voltage level.
Ireland: These are values for 110 kV and 38 kV distribution network. The values originally submitted by Ireland (per 100 customers per year) were divided by 100.

TABLE A.7 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS: MV (INTERRUPTIONS PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Croatia					2,72	2,44	1,97	2,03	1,88	1,71	1,8	1,63	1,03
Czech Republic							1,45	1,82	1,95	1,93	1,88	1,78	1,78
Denmark							0,34	0,31	0,34	0,36	0,36	0,33	0,27
France			0,94	0,86	1,04	0,88	1,01	0,82	0,81	0,72	0,77	0,75	0,63
Hungary	1,57	1,53	1,46	1,38	1,38	1,54	1,27	1,21	1,24	1,002	0,986	0,86	0,893
Ireland	0,939	1,003	1,033	1,486	1,103	1,061	1,048	0,898	0,983	0,768	0,741	0,946	1,06
Italy	2,41	2,35	2,052	1,951	1,874	1,711	1,58	1,61	1,473	1,365	1,379	1,281	1,268
Lithuania				0,99	1,02	1,11	1,02	0,95	0,88	0,85	0,83	0,79	0,72
The Netherlands	0,184	0,214	0,208	0,18	0,234	0,202	0,193	0,201	0,213	0,191	0,214	0,19948	0,197
Sweden									0,96	1,2	0,94	1,074	1,03
Switzerland									0,17	0,2	0,22	0,19	0,14

Notes:
Ireland: The values originally submitted by Ireland (per 100 customers per year) were divided by 100.

TABLE A.8 UNPLANNED INTERRUPTIONS EXCLUDING EXCEPTIONAL EVENTS: MV (INTERRUPTIONS PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Croatia					0,19	0,21	0,16	0,13	0,14	0,19	0,2	0,16	0,13
Czech Republic							1,6	1,63	1,64	1,65	1,82	1,69	1,6
Denmark							0,02	0,02	0,02	0,02	0,02	0,01	0,02
France			0,05	0,05	0,05	0,05	0,04	0,05	0,05	0,04	0,05	0,05	0,04
Hungary	0,46	0,42	0,37	0,31	0,31	0,31	0,22	0,22	0,2	0,16	0,16	0,15	0,144
Ireland	0,241	0,129	0,078	0,086	0,063	0,062	0,049	0,036	0,035	0,038	0,023	0,026	0,025
Italy	0,16	0,17	0,171	0,164	0,162	0,171	0,207	0,207	0,209	0,193	0,226	0,212	0,195
Lithuania				0,28	0,27	0,28	0,31	0,27	0,23	0,26	0,22	0,18	0,16
The Netherlands	0,023	0,028	0,029	0,028	0,035	0,035	0,035	0,036	0,041	0,04	0,043	0,04252	0,038
Sweden									1,32	1,63	1,33	1,33	1,3
Switzerland									0,02	0,02	0,02	0,02	0,01

Notes:
Ireland: The values originally submitted by Ireland (per 100 customers per year) were divided by 100.

TABLE A.9 UNPLANNED INTERRUPTIONS INCLUDING ALL EVENTS (MINUTES LOST PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria		51,532	34,316	43,454	55,765	83,98	57,601	43,634	36,127	28,682	35,545	39,286	51,953
Belgium										36,18	39,45	34,75	26,15
Croatia					669,49	375,35	330,91	296,26	306,97	250,59	372,49	306,03	411,57
Cyprus											243,16		
Czech Republic							185,54	210,94	135,88	114,08	125,21	195,08	120,89
Denmark							16,48	15,29	15,18	17,04	14,75	15,86	11,59
Estonia					243,49	185,83	405,33	186,69	406	346	170,9	378,5	117,1
Finland	284	212	105	87	64	53	59	41	170	225	68	138	67
France	42	69,3	57,1	55,9	86,3	61,6	74,1	173,8	95,1	53,9	62,9	83,6	51,5
Germany					23,25	35,67	16,96	15,29	20,01	17,25	17,37	32,75	13,5
Great Britain	83,69	110,38	81,11	94,29	69,16	103,48	81,94	75,69	81,42	70,02	68,05	61,02	92,51
Greece									163	166	150	133	122
Hungary	196,8	155,4	137,4	121,8	127,75	141	111	125	132,59	85,12	76,89	138,53	86
Ireland	230,2	171,9	162,8	163,6	148,3	129,7	108,9	100,4	110	76,4	67,7	134,3	420,2
Italy	114,74	546,08	90,53	79,86	60,55	57,89	89,64	78,67	88,84	107,96	132,73	105,4	93,8
Latvia						269	236	424	1073	708	371	341	210
Lithuania				373,57	168,7	301,7	155,65	161,3	260,03	302,59	287,73	153,93	144,04
Luxembourg										13,2	17,7	16,7	14,2
Malta	523,8	566,98	486,83	398,82	304,37	409	186,58	687,85	620,57	191	286,2	360,04	570,6
The Netherlands	28	30	24	27,4	35,6	33,1	22,1	26,5	33,7	23,4	27	23	20
Norway				93	113	96	104	84	66	216	66	144	118
Poland						410	440,64	378,35	386,18	325,76	263,19	281,82	205,41
Portugal	467,98	406,18	217,79	198,73	243,19	136	162,67	280,03	276,04	131,43	94,15	258,8	94,75
Romania							696	682	657	547	668	475	468
Slovak Republic											188,87	187,14	
Slovenia							116	133	81	76	169	109	908
Spain	142,557	141,908	123,6	117	112,8	103,8	86,82	133,86	140,88	58,2	62,4	52,08	52,62
Sweden	101,8	148,1	78,1	912,6	100	321,9	110,8	73,3	92,3	186,46	89,01	151,94	83,85
Switzerland									14	16	22	15	13

Notes:
Cyprus: Figure refers to HV, MV and LV.
Finland: T-SAIDI.
Great Britain: This is based on equal to and greater than 3 minutes.
Greece: Figures refer to MV and LV voltage levels for all years. Figures for all years include non-interconnected islands.
Hungary: Only for HV, MV and LV.
Ireland: These are the values for all of the distribution network.
Italy: The 2003 figure includes two nation-wide events (September blackout and June rolling blackouts).
Latvia: This information is only for MV and LV networks.
Malta: Calculated at 11 kV and include interruptions at this level or upstream.
Norway: LV events are included from 2014.
Portugal: Indicator evaluated in LV interruptions not attributable to force majeure.
Slovenia: Due to unavailability of LV data, as well as different weighting method for calculation of SAIDI on the EHV/HV level, the MV data only is used.

TABLE A.10 UNPLANNED INTERRUPTIONS INCLUDING ALL EVENTS (INTERRUPTIONS PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria		0,798	0,652	0,806	0,986	1,057	0,892	0,788	0,763	0,562	0,698	0,682	0,822
Belgium										0,74	0,81	0,72	1,04
Croatia					4,2	4,06	3,28	3,24	2,96	2,7	3,12	2,7	2,71
Cyprus											0,8		
Czech Republic							2,22	2	1,78	1,82	1,9	2,13	1,86
Denmark							0,42	0,36	0,39	0,4	0,4	0,37	0,31
Estonia					1,544	2,045	4,558	1,835	2,072	1,974	1,793	2,487	0,648
Finland	3,3	4	4,3	1,9	1,8	1,6	1,6	1,2	1,8	2,4	1,8	2,5	1,6
France	1,2	1,43	1,3	1,08	1,33	0,98	1,18	1,1	0,98	0,82	0,9	0,9	0,74
Germany					0,456	0,425	0,334	0,298	0,315	0,337	0,29	0,5	0,37
Great Britain	0,871	0,8625	0,8257	0,7837	0,7444	0,8802	0,7681	0,7286	0,7182	0,6917	0,6494	0,6108	0,7211
Greece									2,8	2,9	2,6	2,4	2,2
Hungary	2,03	2,05	1,9	1,77	1,79	1,92	1,62	1,69	1,63	1,26	1,17	1,15	1,133
Ireland	1,367	1,497	1,703	1,947	1,595	1,57	1,387	1,196	1,317	1,021	0,907	1,39	1,664
Italy	2,76	3,96	2,48	2,419	2,29	2,156	2,38	2,364	2,265	2,082	2,334	2,202	1,994
Latvia						2,18	2,01	0,9	4,15	4,74	3,84	3,52	2,78
Lithuania				1,74	1,65	2,18	1,73	1,74	1,92	2,19	1,82	1,43	1,29
Luxembourg										0,35	0,3	0,27	0,23
Malta	4,4145	5,211	4,688	4,63	2,8867	4,2434	2,3521	5,0435	5,5012	2,6634	4,2833	4,13	2,754
The Netherlands	0,34	0,34	0,32	0,304	0,454	0,33	0,307	0,331	0,384	0,341	0,316	0,296	0,276
Norway				1,54	1,75	1,7	1,79	1,7	1,5	2,4	1,4	2	2,2
Poland						3,1	4,14	3,84	3,77	4,22	3,44	3,32	2,96
Portugal	7,35	5,96	3,66	3,54	3,81	2,62	2,8	3,63	4,32	2,41	1,88	3,09	1,89
Romania							6,9	6,5	6,1	5,6	5,5	5,1	5,1
Slovenia							2,71	2,4	1,81	1,81	2,99	2,2	4,31
Spain	2,65	2,599	2,52	2,31	2,38	2,23	1,991	2,192	1,956	1,417	3,202	1,31	1,127
Sweden	1,838	1,64	1,1	1,49	1,28	1,7	1,38	1,32	2,02	1,63	1,33	1,33	1,3
Switzerland									0,29	0,28	0,34	0,29	0,22

Notes:
Cyprus: Figure refers to HV, MV and LV.
Denmark: Interruptions lasting 1 minute or more are monitored.
Finland: T-SAIFI.
Great Britain: This is based on equal to and greater than 3 minutes. GB originally submitted CI values per 100 customers. The values in this table are the CI values divided by 100.
Greece: Figures refer to MV and LV voltage levels for all years. Figures for all years include non-interconnected islands.
Hungary: Only for HV, MV and LV.
Ireland: These are the values for all of the distribution network. The values originally submitted by Ireland (per 100 customers per year) were divided by 100.
Italy: The 2003 figure includes two nation-wide events (September blackout and June rolling blackouts). SAIFI is not affected by thefts.
Latvia: This information is only for MV and LV networks.
Malta: Calculated at 11 kV and include Calculated at 11 kV and include interruptions at this level or upstream. Calculated per 100 customers. The values originally submitted by Malta were divided by 100.
Norway: LV events are included from 2014.
Portugal: Indicator evaluated in LV interruptions not attributable to force majeure.
Slovenia: Due to unavailability of LV data, as well as different weighting method for calculation of SAIFI on the EHV/HV level, the MV data only is used.

TABLE A.11 PLANNED INTERRUPTIONS (MINUTES LOST PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria		13,904	15,637	19,902	20,044	20,052	16,807	16,223	17,26	16,383	14,865	14,35	16,355
Bulgaria							299,5	289,7	224,21				
Croatia					499,56	421,7	412,72	287,78	293,43	308,5	295,45	253,49	250,15
Czech Republic			148,29	166,19	144,7	150,23	165,82	140,65	159,4	154,73	147,59	159,68	162,33
Denmark							8,76	8,37	5,37	4,94	4,76	4,7	5,05
Estonia					118,59	202,2	195,26	145,04	120,6	104,1	84,93	86,84	66
Finland				23	26	23	23	18	17	19	21	41	13
France	6	5,3	6,6	8	7,9	10,8	19,4	23,2	24	18,9	15,6	15,9	15,8
Germany					15,1	13,85	13,17	11,53	9,66	10,12	11,83	7,23	7,56
Great Britain					4,06	4,96	5,7	6,48	6,72	6,69	6,7	5,68	5,72
Greece								232	195	163	147	151	136
Hungary	137,02	199,24	178,95	138,5	139,86	144,66	156,99	198,17	179,65	156,55	153,41	122,76	132
Ireland	284,1	422,3	390,7	375,4	268,7	79	60,5	59,3	64,1	46,6	44,9	42,1	42,3
Italy	77,97	80,67	62,62	58,77	53,79	46,16	49,35	43,58	55,71	61,85	65,97	55,28	59,6
Latvia						237	261	254	219	236	265	280	256
Lithuania				113,62	98,27	71,23	78,07	93,29	132,72	157,9	179,2	212,76	217,45
Luxembourg										2	2,6	1	1,2
Malta	89,38	72,84	69,28	105,63	94,74	78,88	72,73	75,1	72,6	69,08	80,32	61,04	207
The Netherlands					2,81	3,39	4,13	4,04	4,35	5,1	5,17	6,016	5,888
Norway				44	42	48	44	42	36	42	41	36	43
Poland						121	149,05	140,31	129,7	153,05	147,32	139,12	119,4
Portugal	52,21	62,39	49,16	39,16	18,7	7,31	2,07	2	1,57	2,05	1,68	1,46	2,59
Romania							385	323	324	333	246	270	230
Slovak Republic											188,87	187,14	
Slovenia							138	130	104	126	117	115	119
Spain	30,656	24,791	21,6	13,8	9,6	11,4	10,8	8,34	8,82	9	18,42	19,62	10,6
Sweden	37,1	25,4	24,8	33,5	23,8	23,2	26,4	21,3	20,1	16,7	16,94	18,87	18,2
Switzerland									14	13	12	10	9

Notes:
Denmark: Interruptions lasting 1 minute or more are monitored.
Finland: T-SAIDI.
Great Britain: These are finalised performance values which have weightings applied to them. Under British incentive, a 50% weighting is applied to CI and CML values for planned interruptions to recognise that these are less inconvenient than an unplanned interruption.
Greece: Figures refer to MV and LV voltage levels for all years. Figures for all years include non-interconnected islands.
Hungary: Only for HV, MV and LV.
Ireland: These are the values for all of the distribution network.
Latvia: This information is only for MV and LV networks.
Malta: Calculated at 11 kV and include interruptions at this level or upstream.
Norway: LV events are included from 2014.
Portugal: Indicator evaluated in LV Interruptions not attributable to force majeure or exceptional events.
Slovenia: Due to unavailability of LV data, as well as different weighting method for calculation of SAIDI on the EHV/HV level, the MV data only is used.

TABLE A.12 PLANNED INTERRUPTIONS (INTERRUPTIONS PER YEAR)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Austria		0,14	0,163	0,206	0,195	0,235	0,165	0,161	0,156	0,15	0,133	0,127	0,141
Bulgaria							5,25	5,29	3,61				
Croatia					2,96	2,58	2,25	2,02	2,12	2,14	2	1,63	1,63
Czech Republic			0,57	0,57	0,55	0,56	0,62	0,54	0,59	0,54	0,5	0,52	0,51
Denmark							0,06	0,07	0,05	0,04	0,04	0,04	0,04
Estonia					0,521	0,498	1,314	0,581	0,509	0,525	0,53	0,571	0,478
Finland				0,3	0,4	0,4	0,3	0,3	0,3	0,3	0,3	0,4	0,2
France	0,04	0,04	0,05	0,06	0,06	0,11	0,21	0,24	0,21	0,13	0,11	0,13	0,13
Germany						0,126	0,104	0,101	0,089	0,102	0,116	0,076	0,08
Great Britain					0,0183	0,0204	0,0227	0,0254	0,0262	0,0262	0,0263	0,0229	0,0229
Greece								1,2	1	1	0,8	0,9	0,7
Hungary	0,54	0,75	0,71	0,54	0,57	0,55	0,59	0,66	0,61	0,55	0,54	0,43	0,45
Ireland	0,659	0,764	0,674	0,89	0,684	0,284	0,241	0,237	0,251	0,181	0,185	0,166	0,167
Italy	0,49	0,49	0,4	0,374	0,34	0,303	0,347	0,292	0,384	0,373	0,409	0,368	0,358
Latvia						0,83	0,94	0,9	0,85	0,85	0,94	0,96	0,99
Lithuania				0,4	0,36	0,25	0,26	0,33	0,47	0,48	0,53	0,54	0,56
Luxembourg										0,03	0,03	0,04	0,04
Malta	0,9304	0,9687	0,7214	1,97	0,9888	0,5909	0,54	0,4611	0,82	0,5278	0,7705	0,63	0,858
The Netherlands					0,018	0,022	0,027	0,024	0,027	0,031	0,031	0,0338	0,0324
Norway				0,32	0,3	0,3	0,32	0,3	0,3	0,3	0,27	0,3	0,3
Poland						0,4	0,74	0,76	0,68	0,82	0,7	0,62	0,56
Portugal	0,29	0,3	0,23	0,19	0,09	0,04	0,02	0,01	0,01	0,012	0,0076	0,0067	0,011
Romania							1,6	1,5	1,3	1,3	0,9	1	0,8
Slovenia							1,09	1,05	0,85	0,98	0,88	0,89	0,86
Spain	0,26	0,2015	0,19	0,09	0,08	0,09	0,076	0,06	0,06	0,057	0,323	0,302	0,07
Sweden	0,26	0,22	0,18	0,22	0,2	0,32	0,51	0,23	0,18	0,14	0,14	0,149	0,16
Switzerland									0,12	0,12	0,11	0,09	0,08

Notes:

Denmark: Interruptions lasting 1 minute or more are monitored.

Finland: T-SAIFI.

Great Britain: This is based on equal to and greater than 3 minutes. GB originally submitted CI values per 100 customers. The values in this table are the CI values divided by 100. They are finalised performance values which have weightings applied to them. Under British incentive, a 50% weighting is applied to CI and CML values for planned interruptions to recognise that these are less inconvenient than an unplanned interruption.

Greece: Figures refer to MV and LV voltage levels for all years. Figures for all years include non-interconnected islands.

Hungary: Only for HV, MV and LV.

Ireland: These are the values for all of the distribution network. These values are per 100 customers per year. The values originally submitted by Ireland were divided by 100.

Latvia: This information is only for MV and LV networks.

Malta: Calculated at 11 kV and include interruptions at this level or upstream. Calculated per 100 customers. The values originally submitted by Malta were divided by 100.

Portugal: Indicator evaluated in LV Interruptions not attributable to force majeure or exceptional events.

Slovenia: Due to unavailability of LV data, as well as different weighting method for calculation of SAIFI on the EHV/HV level, the MV data only is used.

TABLE A.13 DEFINITIONS OF EXCEPTIONAL EVENTS AND THEIR INCLUSION IN INTERRUPTION STATISTICS

Country	Regulatory definition of "Exceptional events"	Exceptional events in interruption statistics	Statistical method to define "major event days" or "exceptional condition periods"
Austria	Exceptional regional events mean events that according to previous experience cannot be expected to occur in a given region and during which facilities constructed and maintained with due care cannot be operated without failure.	Statistics with and without	
Belgium	The emergencies that justify the intervention of the network operator, may occur especially in the following unforeseen or exceptional circumstances: (1) natural disasters arising from earthquakes, floods, storms, cyclones or other climatically exceptional situations; (2) a nuclear or chemical explosion and its consequences (3) a computer virus or a computer crash; (4) temporary or permanent technical impossibility for the network to exchange electricity because of failures within the control area caused by electricity flows resulting from energy exchanges within another control area or between two or more other control areas and of which the identity the parties involved in this energy exchange is not known and cannot be reasonably known by the network operator; (5) the inability to use the grid due to a collective dispute that gives rise to unilateral action by employees (or groups of employees) or any other labour dispute; (6) fire, explosion, sabotage, terrorist acts, acts of vandalism, damage caused by criminal acts, criminal coercion and threats of the same nature; (7) state of war declared or not, threat of war, invasion, armed conflict, blockade, revolution or insurrection; (8) a measure from higher up; (9) sudden phenomena; (10) scarcity.	Excluded	
Bulgaria	Force majeure – an extraordinary event which (1) cannot be foreseen, prevented or controlled and (2) leads to disturbances in the normal functioning of the electricity distribution network and (3) has been verified by the competent authorities - ensuring from human activities: military activities, terrorism, embargo, prohibitions imposed by the government, strikes, riots, uprisings - of natural character: storms (which speed above 60 km/h), torrential rains, floods, hailstorms, thunderbolts, snow avalanches, landslides.	Excluded	No
Croatia	Force Majeure	Included	No
Cyprus	Unforeseen circumstances	Included	
Czech Republic	No definition, but there is an individual approach. According to public notice DSOs are allowed to ask for the approval by the regulator and report these events as "1.1.1.2. Under severe weather conditions" NRA evaluates the request and potentially approves it. Besides these events, indicators "without exceptional events" in this BM are lowered by other categories defined in 1.5.(ii)1., namely: 1.2. Enforced, 1.3. Exceptional, 1.4. Caused by event outside network or by producer.	Statistics with and without	No
Denmark	Force majeure due to storm surge, flood, hurricane or other incidents that DERA approves as force majeure.	Statistics with and without	Yes. If the extreme weather event is classified by the Danish Meteorological institute it will be classified as "Exceptional event".
Estonia	Long interruptions caused by events that network operator could not foresee (examples: natural disaster, lightning that exceeds design norms, heavy winds, glazed frost, sabotage actions).	Statistics with and without	Yes. Criteria by extent of interruptions.
Finland	No. There isn't any regulatory definition of "Exceptional events".	Included	No
France	Yes. For climatic events, exceptional events definition is based on both: 1. wideness (simultaneous outage for more than 100,000 final customer); and 2. local occurrence of this type of climatic event (less than 1 / 20 years), according to meteorological data. Other cases of force majeure independent of system operators are also considered as exceptional events.	Statistics with and without	No

Country	Regulatory definition of "Exceptional events"	Exceptional events in interruption statistics	Statistical method to define "major event days" or "exceptional condition periods"
Germany	Force Majeure	Statistics with and without	No
Great Britain	Ofgem does have a regulatory definition of exceptional events and excludes the impact of these from the network operators' performance.	Excluded	Yes. Severe weather events are defined as any event that results in more than eight times the average number of higher voltage (1 kV and above) faults in a licence area over a 24 hour period. These events further fall into three categories, namely medium, large and very large events (1).
Greece	There is no regulatory definition.	Statistics with and without	Yes. Exceptional weather conditions day: the number of interruptions for a distribution area is at least three times the yearly average number of interruptions for this distribution area.
Hungary	There is no definition of exceptional events, but: 1. In Guaranteed standards: there is a definition of "extreme weather": if the number of MV interruptions caused by a weather event reaches or exceeds a value predefined for the different DSOs; and 2. Overall standards: there is a definition of "other event", which includes the following: a) system collapse b) terror attacks c) every event, which is designated as "other event" by HEO. (e.g. strain exceeding the design requirements).	Statistics with and without	Yes. 1. In the Guaranteed standards there is a method to define "exceptional condition periods", which is similar to UK practice. If the number of MV interruptions in any 24 hour interval are above eight (I. category) or thirteen times (II. category) the number of the (8 year) average, then it is considered as an "extreme weather condition period" 2.Overall standards: strain exceeding the design requirements, e.g. wind speed over 100 km/h.
Ireland	There is a definition of 'storm days', but no other exceptional events are defined.	Statistics with and without	Yes. Storm days are days where the reported customer hours lost due to faults is greater than 61,570. 61,570 was the average of two standard deviations from the mean of the daily fault data for the 3 years 1999, 2000, and 2001.
Italy	Force Majeure	Statistics with and without	Yes. In addition to document-proven force majeure (for transmission and for distribution), a statistical method is used for distribution network. It is rather complex, referring to the past number of interruptions in 6-hour periods.
Latvia	No	Statistics with and without	No
Lithuania	No	Included	No
Luxembourg	No		
The Netherlands	Examples of "extreme situations" are earthquakes, floods, extraordinary weather conditions, terrorist attacks and war.	Included	No
Norway	Exceptional events are defined in each individual case. NVE makes separate reports on larger events, Exceptional events are not treated separately in the annual interruption statistics.	Included	No
Poland	According to the definition of "Force majeure" given in the Transmission Grid Code approved by the regulator as exceptional are regarded the sudden events, unpredictable and independent from will of the parties, which makes it impossible to meet contractual obligations, wholly or partly, permanently or temporarily and whose effects cannot be anticipated, even with the due care of the parties. The manifestations of the Force majeure are in particular: natural disasters, including fire, flood, drought, earthquake, hurricane, hoar frost, the acts of state, including martial law, emergency state, embargoes, blockades, etc., acts of war, the acts of sabotage, acts of terrorism, general strikes or other social unrest, including public demonstrations, lockouts.	Statistics with and without	No

Country	Regulatory definition of "Exceptional events"	Exceptional events in interruption statistics	Statistical method to define "major event days" or "exceptional condition periods"
Portugal	An Exceptional Event is an interruption which satisfies the next four criteria (cumulative): (i) the cause of interruption and its consequences are non-predictable, (ii) leads to a considerable decrease in the continuity of supply of the system, (iii) it is non-economically efficient to avoid the interruption and its consequences, (iv) the origin of the interruption and its consequences are attributable to the network.	Included	The Quality of Service Code also establishes the definition of Great Impact Incident. An interruption is classified as a Great Impact Incident when its Not Supplied Energy is greater than 50 MWh. This definition exists only for monitoring purposes. All Great Impact Incidents must be reported to regulator through a detailed report describing the origin of incident and the actions performed by the operator to restore the steady-state of the network.
Romania	There is a general definition but the exceptional events/force majeure have to be confirmed by the Chamber of Commerce, Industry and Agriculture.	Included	No. The Chamber decides.
Slovak Republic	Emergency, natural disaster, damage on TSO and DSO installations caused by third party.	Excluded	No
Slovenia	Force majeure is: a) a natural unforeseeable event which is beyond the control of the system operator (precipitations (snow, sleet)), hurricane, avalanche (snowslide, landslide), fire, flood, earthquake or similar natural disaster which lead to declaration of crisis situation by the authorities), and which effects on continuity of supply cannot be predicted and prevented or avoided b) non-natural event (i.e. war), which lead to declaration of crisis situation by the authorities. An interruption of supply can be qualified under the force majeure only in cases where it was caused by the event beyond the control of system operator and in cases when system operator could not prevent or avoid the event (the cause was unpredictable, irresistible and external to the network). The system operator must have a written evidence that network design criteria have been exceeded for each interruption that is classified under the force majeure due to the more severe conditions than the ones considered at the network design requirements.	Statistics with and without	Yes. According to IEEE 1366:2003, but based on monthly interruption data, not daily.
Spain	Yes, Special event is authorised by the Directorate General for Energy and Mines, and has natural causes and that generally occurs in at least 10% of the municipalities on the peninsula or at least 50% of municipalities each island and peninsular systems and, in accordance with technical regulations applicable to facilities are not provided for in the design of them.	Included	Yes
Sweden	We do not have a definition of exceptional event, but when reporting data to the Benchmarking Report we classify interruptions with an interruption period of at least 12 hours as exceptional event because those interruptions are not considered in the economic regulation due to the law on economical compensation for those interruptions if the customers experience an outage of at least 12 hours.		No
Switzerland	1. low probability of occurrence 2. unavoidable 3. long interruption duration with many affected customers 4. following categories: weather, natural disaster, arrangement by authority, disaster (accident, explosion), influence of others / terrorism.	Excluded	No

(1) Medium events include 1) non lightning events where the number of faults equals or exceeds eight times the average number of daily high voltage faults but is less than 13 times the daily average and where less than 35% of customers have been affected, 2) lightning events where eight times the average daily high voltage faults or above have occurred but less than 35% of customers have been affected. Large events include non lightning events with a number of faults equal to or in excess of 13 times the daily average high voltage fault rate but where less than 35% of customers have been affected. Very large events include all events where more than 35% of customers have been affected. Events that are not related to weather are considered as exceptional if they are outside the companies' control and if more than 25,000 customers have been affected and/or more than 2 million customer minutes have been lost.

(2) An interruption is classified as exceptional event by the regulator after a request from the TSO or the DSO. The request must include a detailed description of the incident and the collected evidences, in order to prove that the four cumulative criteria for the classification as exceptional event are satisfied. The decision of the regulator is based on the analysis of the report and on the technical opinion of the department of the Ministry of Energy responsible for the networks licensing.

ANNEX B
ELECTRICITY – VOLTAGE QUALITY

Part 1 – National Legislation and Regulations that Differ from EN 50160

Cyprus

- Power frequency – local areas (HV, MV, LV): As per CYS EN 50160:
  - 49.5-50.5 Hz Normal Operation
  - 47.0-52.0 Hz Emergency Operation

France

- Supply voltage variations (HV, MV):
  - MV – 100% of time between Uc +/- 5%
  - LV – 100% of time between Un +/- 10%

Great Britain

- Power frequency – local areas (all voltage levels):
  - 50 Hz +/- 1%
- Power frequency – interconnected areas (all voltage levels):
  - 50 Hz +/- 1%
- Supply voltage variations (EHV, HV, MV, LV):
  - EHV – Uc +/- 10%
  - HV and MV – Uc +/- 6%
  - LV – Un +10% / - 6%

Ireland

- Supply voltage variations (HV, MV):
  - HV: For system with nominal voltage of 38 kV, the permitted range is 43 kV and 34.8 kV
  - MV: For system with nominal voltage of 20 kV, the permitted range is 21.8 kV and 19 kV
  - For system the nominal voltage of 10 kV, the permitted range is 10.9 kV and 9.5 kV

Italy

- Power frequency - local areas (HV):
  - 49.9 - 50.1 Hz under normal or alarm operational states
  - 49.5 - 50.5 Hz in Sicily and Sardinia islands
  - 47.5 - 51.5 Hz under emergency or restoration operational state

Malta

- Power frequency – local areas (all voltage levels):
  - 50Hz +/-1% (49.5 - 50.5 Hz) during 99.5% of the year
  - 50Hz +4% / -5% (47.5 - 52 Hz) during 100% of the time
- Supply voltage variations (HV, MV, LV):
  - HV: 132 kV +/- 6%
  - MV: 11 kV +/- 5%; 33 kV +5% / -10%
  - LV: 400/230 V +/- 10%
- Flicker severity (MV, LV):
  - Frequency of occurrence: 0.22 per min - 600 per min
  - $P_{st} < 0.7$ and $P_{lt} < 0.5$
  - Frequency of occurrence: 0.02 per min - 0.22 per min
  - Magnitude of up to 3% is permitted.
  - Frequency of occurrence: < 0.02 per min
  - Magnitude of up to 5% is permitted.
- Voltage dips (MV, LV):
  - A sudden reduction of the voltage to a value between 90% and 1% of the declared voltage followed by a voltage recovery after a short period of time.
- Voltage unbalance (LV):
  - In 3-phase network, a condition in which the rms values of the phase voltages or the phase angles between consecutive phases are not equal.
  - Limit - 1.3%
- Harmonic voltage (MV, LV):
  - 33 kV
  - THD ≤ 1.5%
  - 11 kV
  - THD ≤ 2%
  - 400/230 V
  - THD ≤ 2.5%

Norway

- Power frequency – local areas (EHV, HV, MV, LV): In systems temporarily without physical connections to adjacent transmission grids, the TSO (Statnett) shall ensure that the voltage frequency is normally kept within 50 Hz ± 2%.
- Power frequency – interconnected areas (EHV, HV, MV, LV): The TSO (Statnett) shall ensure that the voltage frequency and time deviations are normally kept within the provisions of the Nordic system operation agreement.
- Supply voltage variations (LV): The DSOs shall ensure that supply voltage variations are within the range of ± 10% of the nominal value measured as 1-minute mean values, in connection points in the low-voltage system.

- Flicker (EHV, HV, MV, LV):
  - Limits for P_{st} (short term flicker severity) 95% of the week:
  - MV and LV: 1.2 [pu]
  - EHV and HV: 1.0 [pu]
  - Limits for P_{lt} (long term flicker severity) 100 % of the time:
    • MV and LV: 1.0 [pu]
    • EHV and HV: 0.8 [pu]

- Transient overvoltages (EHV, HV, MV, LV): High frequency or over frequency overvoltages that normally lasts for less than one half cycle (10 ms). The rise time can vary from less than a microsecond up to a few milliseconds.

- Voltage dips (EHV, HV, MV, LV): See limits given for rapid voltage change

- Voltage swells (EHV, HV, MV, LV): See limits given for rapid voltage change

- Voltage unbalance (EHV, HV, MV, LV): The TSO/DSOs shall ensure that the degree of voltage unbalance does not exceed 2% in connection points, measured as ten-minute mean values.

- Harmonic voltage (EHV, HV, MV, LV):
  - LV and MV: The TSO and the DSOs shall, in connection points with nominal voltages from 230 V to 35 kV, ensure that individual harmonic voltages, measured as ten-minute mean values, do not exceed the following values:

TABLE B.1 LIMIT VALUES FOR HARMONIC VOLTAGES FOR LV AND MV

Odd harmonics				Even harmonics	
Not multiple of 3		Multiple of 3			
Order h	U_h	Order h	U_h	Order h	U_h
5	6.0 %	3	5.0 %	2	2.0 %
7	5.0 %	9	1.5 %	4	1.0 %
11	3.5 %	>9	0.5 %	>4	0.5 %
13	3.0 %				
17	2.0 %				
19, 23, 25	1.5 %				
>25	1.0 %				

- THD: 100% of the time ≤ 8% (10-min mean values) and ≤ 5% (1 week mean value)
  - HV and EHV ≤ 245 kV: The TSO and the DSOs shall, in connection points with nominal voltages from 35 kV to 245 kV, ensure that individual harmonic voltages, measured as ten-minute mean values, do not exceed the following values:

TABLE B.2 LIMIT VALUES FOR HARMONIC VOLTAGES FOR HV AND EHV ≤ 245 KVV

Odd harmonics				Even harmonics	
Not multiple of 3		Multiple of 3			
Order h	U_h	Order h	U_h	Order h	U_h
5	3.0 %	3	3.0 %	2	1.5 %
7, 11	2.5 %	9	1.5 %	4	1.0 %
13, 17	2.0 %	15, 21	0.5 %	6	0.5 %
19, 23	1.5 %	>21	0.3 %	>6	0.3 %
25	1.0 %				
>25	0.5 %				

- THD: 100% of the time ≤ 3% (10-min mean values)
  - EHV above 245 kV: The TSO shall, in connection points with nominal voltages above 245 kV, ensure that individual harmonic voltages, measured as ten-minute mean values, do not exceed the following values:

TABLE B.3 LIMIT VALUES FOR HARMONIC VOLTAGES FOR EHV >245 KV

Odd harmonics				Even harmonics	
Not multiple of 3		Multiple of 3			
Order h	U_h	Order h	U_h	Order h	U_h
5, 7	2.0 %	3	2.0 %	2	1.0 %
11, 13, 17, 19	1.5 %	9	1.0 %	4, 6	0.5 %
23, 25	1.0 %	15, 21	0.5 %	>6	0.3 %
>25	0.5 %	>21	0.3 %		

THD: 100% of the time ≤ 2% (10-min mean values)

- Single rapid voltage change (HV, MV, LV): The TSO/DSOs shall ensure that rapid voltage changes do not exceed the following limits in connection points with respect to the nominal voltage, UN, maximum number per 24-hour period:
  - $\Delta U_{steady\ state} \geq 3\%$:
  - max [#]: 24 for $0.23 \leq U_N \leq 35$ [kV]
  - max [#]: 12 for $35 < U_N$ [kV]
  - ΔU_{max}: ≥ 5%:
  - max [#]: 24 for $0.23 \leq U_N \leq 35$ [kV]
  - max [#]:12 for $35 < U_N$ [kV]

Portugal

- Supply voltage variations (EHV): For EHV the Quality of Service Code establishes that the value of Uc shall be within the range of Un±7% Un. Under normal operating conditions, during each period of 1 week, 95% of the 10 min mean r.m.s. values of the supply voltage shall be within the range of Uc±5% Uc.
- Flicker (EHV): For EHV the Quality of Service Code establishes that under normal operating conditions, in any period of 1 week the long (P_{lt}) and the short (P_{st}) term flicker severity caused by voltage fluctuation should be lower than 1.
- Voltage dips (EHV): Limits are not established
- Voltage unbalance (EHV): Under normal operating conditions, during each period of 1 week, 95% of the 10 min mean r.m.s. values of the negative sequence of the supply voltage shall be less or equal than 2% of the direct sequence voltage.
- Harmonic voltage (EHV): For EHV, under normal conditions, during each period of 1 week, 95% of the 10 min mean r.m.s. values of each individual harmonic voltage, Uh (%), shall be less or equal than:
  - h=5: 3.0
  - h=3: 2.0
  - h=2: 1.5
  - h=7: 2.0
  - h=9: 1.0
  - h=4: 1.0
  - h=11: 1.5
  - h=15: 0.3
  - h=6: 0.5
  - h=13: 1.5
  - h=21: 0.2
  - h=8: 0.4
  - h=17: 1.0
  - h=>21: 0.2
  - h=10: 0.4
  - h=19: 1.0
  - h=12: 0.2
  - h=23: 0.7
  - h=>12: 0.2
  - h=25: 0.7
  - h>25: 0.2+12.5/h
- THD=<4%

Sweden

- Supply voltage variations (HV, MV, LV): U +/- 10%; 100% of time over a week.
- Voltage dips (HV, MV, LV): The dip-table is divided in 3 areas A, B and C. Dips with a duration and severity that puts them in area A is regarded a normal part of the operation of the network. Dips within area B need to be investigated and dips in area C are not allowed. The borders between the areas are slightly different for voltages above and below 45 kV.
- Voltage swells (LV): The swell-table is divided in the 3 areas A, B and C. Swells with a duration and severity that puts them in area A is regarded a normal part of the operation of the network. Swells within area B need to be investigated and swells in area C are not allowed.
- Voltage unbalance (HV, MV, LV): Unbalance must be equal to, or under, 2%; 100% of the time over a week.
- Harmonic voltage (HV, MV, LV): Same as EN 50160; 100% of the time over a week.
  - HV: 100% of time. Limits for harmonics not multiple of 3 of order higher than 13 are already in place.
  - MV and LV: 100% of time.
- Single rapid voltage change (HV, MV, LV): A maximum number of voltage changes are allowed.

The Netherlands

- Power frequency – interconnected areas (HV, MV, LV): 50 Hz +/- 1% during 99.9% of the year, 50 Hz + 2% / - 4% all the year

- Supply voltage variations (EHV, HV, MV, LV):
  - EHV and HV: Uc +/- 10% for 99.9% of 10 minute averaged values during a week
  - MV and LV: Uc +/- 10% for 95% of 10 minute averaged values during a week; Uc +10%/-15% for all 10-minute averaged value

- Flicker (EHV, HV, MV, LV):
  - EHV and HV
    - ≤10%Uc
    - ≤3%Uc in case there is no loss of production, large consumers or connections
    - P_{lt}≤1 during 95% of a week, using 10 minute averages
    - P_{lt}≤5 during 100% of a week, using 10 minute averages
  - MV and LV
    - ≤10%Uc
    - ≤3%Uc in case there is no loss of production, large consumers or connections
    - P_{lt}≤1 during 95% of a week, using 10 minute averages

- Voltage dips (EHV, HV, MV): The limit for voltage dips in EHV and HV depends on the dip duration and the retained voltage. Limits for voltage dips in the MV-network are currently under development.

- Voltage unbalance (EHV, HV, MV, LV):
  - EHV and HV: The inverse component of the voltage should be ≤1% of the normal component, during 99.9% of the 10 minute averaged values during a week.
  - MV and LV: The inverse component of the voltage should be in between 0 and 2% of the normal component, during 95% of the 10 minute measurements per week. The inverse component of the voltage should be in between 0 and 3% of the normal component for all measurements

- Harmonic voltage (EHV, HV, MV, LV):
  - EHV
    - THD ≤ 5% for all harmonics (until 40th) during 95% of the 10 minute averaged values during a week.
    - THD ≤ 6% for all harmonics (until 40th) during 99.9% of the 10 minute averaged values during a week.
  - HV
    - THD ≤ 6% for all harmonics (until 40th) during 95% of the 10 minute averaged values during a week.
    - THD ≤ 7% for all harmonics (until 40th) during 99.9% of the 10 minute averaged values during a week.
  - MV
    - THD ≤ 8% for all harmonics (until 40th) during 95% of the 10 minute averaged values during a week.
    - THD ≤ 12% for all harmonics (until 40th) during 99.9% of the 10 minute averaged values during a week.

Part 2 – Voltage Quality Data

This Annex provides an overview of the voltage dip characteristics and actual voltage quality data that countries have provided in response to the questionnaire for this report. The responding countries for this Annex include France, Portugal and Slovenia.

7.7.1 Voltage dips classification

Dip characteristic

The dip characteristics are calculated from the sampled voltage waveform. The resulting characteristics and indicators depend strongly on whether the line-to-neutral or the line-to-line voltages are used as input to the calculation.

The following voltages are to be used according to EN 50160 [31]:

- On LV networks, for 4-wire 3-phase systems, the line-to-neutral voltages shall be considered;
- On LV networks, for 3-wire 3-phase systems the line-to-line voltages shall be considered;
- On LV networks, in the case of a single-phase connection, the supply voltage (line-to-line or line-to-neutral, according to the network user connection) shall be considered; and
- Typically, on MV and HV networks, the line-to-line voltages shall be considered.

The recommendations in CIGRE TB 412 [32] are along the same lines.

Once the appropriate voltages have been sampled, the dip characteristics can be determined. The standard EN 61000-4-30 defines 2 characteristics [33]:

- The residual voltage is the lowest r.m.s. voltage in any of the measurement channels during the event; and
- The duration of the voltage dip is the time during which the r.m.s. voltage is below a dip threshold in at least one of the measurement channels.

7.7.2 Site incidents

From the voltage dips recorded at 1 location over a period of typically 1 year, site indicators can be calculated. These are typically the number of voltage dips with characteristics within a certain range.

TABLE B.4 CLASSIFICATION OF VOLTAGE DIPS ACCORDING TO THE STANDARD EN 50160

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	CELL A1	CELL A2	CELL A3	CELL A4	CELL A5
80 > u ≥ 70	CELL B1	CELL B2	CELL B3	CELL B4	CELL B5
70 > u ≥ 40	CELL C1	CELL C2	CELL C3	CELL C4	CELL C5
40 > u ≥ 5	CELL D1	CELL D2	CELL D3	CELL D4	CELL D5
5 > u	CELL X1	CELL X2	CELL X3	CELL X4	CELL X5

For each of the cells in Table B-4 the number of events per year is presented. To obtain this number of events, 2 levels of aggregation are needed: poly-phase aggregation (any difference in treatment for voltage dips *in 1, 2 and 3 phases); and time aggregation (any difference in treatment for multiple dips based on the time elapsed between these events).*

System indicators

When the site indicators are available at a sufficient number of locations, so called "system indicators" can be determined. The system indicators can be the average of the site indicators over all sites (with or without the use of weighting factors) or a percentile value of the site indicators.

According to the recommendations given in CIGRE TB 412 [32] a number of percentile values should be used, for example the 25%, 50%, 75%, 90% and 95% values.

France

TABLE B.5 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE TRANSMISSION NETWORKS IN FRANCE IN 2010

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	24	1.6	0.73	0.11	
80 > u ≥ 70	5.4	0.38	0.23	0.05	
70 > u ≥ 40	3.3	0.33	0.27	0.15	
40 > u ≥ 5	0.41	0.14	0.06	0	
5 > u					

TABLE B.6 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE TRANSMISSION NETWORKS IN FRANCE IN 2011

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	26	2	0.91	0.25	
80 > u ≥ 70	6.4	0.38	0.31	0.07	
70 > u ≥ 40	3.6	0.37	0.32	0.16	
40 > u ≥ 5	0.48	0.23	0.09	0.04	
5 > u					

TABLE B.7 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE TRANSMISSION NETWORKS IN FRANCE IN 2012

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	25	1.1	0.52	0.35	
80 > u ≥ 70	5.9	0.39	0.17	0.04	
70 > u ≥ 40	3.2	0.35	0.18	0.16	
40 > u ≥ 5	0.55	0.13	0.07	0.04	
5 > u					

TABLE B.8 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE TRANSMISSION NETWORKS IN FRANCE IN 2013

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	30	1.6	0.65	0.15	
80 > u ≥ 70	7.4	0.29	0.27	0.03	
70 > u ≥ 40	4.9	0.48	0.12	0.21	
40 > u ≥ 5	0.75	0.23	0.07	0.06	
5 > u					

TABLE B.9 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE TRANSMISSION NETWORKS IN FRANCE IN 2014

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	30	1.5	0.56	0.06	
80 > u ≥ 70	6.9	0.34	0.21	0.04	
70 > u ≥ 40	3.6	0.33	0.17	0.14	
40 > u ≥ 5	0.45	0.15	0.07	0.05	
5 > u					

Norway

TABLE B.10 NUMBER OF VOLTAGE DIPS (1) PER NUMBER OF MONITORED POINTS IN THE DISTRIBUTION NETWORKS IN NORWAY IN 2014

Residual Voltage *u* [%]	Duration *t* [ms] (2)				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	8.00	5.53	1.29	0.21	1.16
80 > u ≥ 70	4.54	3.58	1.39	0.12	1.12
70 > u ≥ 40	1.80	1.47	1.14	0.08	0.66
40 > u ≥ 5	0.51	0.45	0.76	0.05	0.69
5 > u	0.42	0.30	0.60	0.14	0.11

(1) "Beta-version" after first reporting of voltage quality.
(2) The duration intervals differ from the intervals given in the voltage dip classification table in EN 50160.

Portugal

The data presented in the tables for dips and swells refers to the number of voltage events by the number of monitored points of the network. For the TSO, in 2014, data from 32 delivery points were considered, measured in the HV busbars of the EHV/HV substations. For the DSO, in 2014, data from 70 delivery points were considered, measured in the MV busbars of the HV/MV substations.

TABLE B.11 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE DISTRIBUTION NETWORKS IN PORTUGAL IN 2014

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	46.97	6.26	6.74	1.15	0.11
80 > u ≥ 70	14.64	2.25	3.07	0.24	0.03
70 > u ≥ 40	13.23	3.62	3.29	0.65	
40 > u ≥ 5	4.37	2.58	0.80	0.20	
5 > u	0.06	0.03		0.05	0.02

TABLE B.12 NUMBER OF VOLTAGE DIPS PER NUMBER OF MONITORED POINTS IN THE TRANSMISSION NETWORKS IN PORTUGAL IN 2014

Residual Voltage *u* [%]	Duration *t* [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	40.97	1.5	0.81	0.63	
80 > u ≥ 70	12.06	0.59	0.34	0.16	
70 > u ≥ 40	11.59	0.72	0.13	0.31	
40 > u ≥ 5	1.97	0.31	0.09	0.09	
5 > u	0.03				

Slovenia

The data represent only the DSO level. The data for the TSO level are unavailable.

TABLE B.13 NUMBER OF VOLTAGE DIPS IN THE DISTRIBUTION NETWORKS IN SLOVENIA IN 2014

Residual Voltage *u* [%]	Duration t [ms]				
	10 < t ≤ 200	200 < t ≤ 500	500 < t ≤ 1,000	1,000 < t ≤ 5,000	5,000 < t ≤ 60,000
90 > u ≥ 80	21,211	1,207	712	389	120
80 > u ≥ 70	8,103	471	218	279	35
70 > u ≥ 40	9,142	821	319	149	17
40 > u ≥ 5	3,489	1,808	144	70	15
5 > u	1,053	853	182	67	813

Part 3 – Main Work of the European Energy Regulators on Voltage Quality

TABLE B.14 MAIN WORK OF THE EUROPEAN ENERGY REGULATORS ON VOLTAGE

Title of the report or description of the activity	Year	Reference
3rd Benchmarking Report on Quality of Electricity Supply	2005	C05-QOS-01-03
CEER cooperation with CENELEC on	2006	EN 50160:2010
'Voltage characteristics of electricity supplied by public electricity networks'		
Public Consultation Paper 'Towards Voltage Quality Regulation in Europe'	2006	E06-EQS-09-03
Conclusions Paper 'Towards Voltage Quality Regulation in Europe' (and evaluation of comments paper)	2007	E07-EQS-15-03
E. Fumagalli, L. Lo Schiavo, F. Delestre, "Service quality regulation in electricity distribution and retail"	2007	Book by Springer Verlag
4th Benchmarking Report on Quality of Electricity Supply	2008	C08-EQS-24-04
Round table "CEER/Eurelectric cooperation on continuity of supply and voltage quality requirements and incentives"	2009	RT.2b @ CIRED 2009
CEER-Eurelectric workshop on voltage quality monitoring	2009	-
CEER Guidelines of Good Practice on Estimation of Costs due to Electricity Interruptions and Voltage Disturbances and accompanying "Study on Estimation of Costs due to Electricity Interruptions and Voltage Disturbances"	2010	C10-EQS-41-03 TR F6978
Final Guidelines of Good Practice on Regulatory Aspects of Smart Metering for Electricity and Gas	2011	E10-RMF-29-05
CEER-Eurelectric Round Table "Voltage quality monitoring, dip classification and responsibility sharing"	2011	RT.2a @ CIRED 2011
5th Benchmarking Report on Quality of Electricity Supply 2011	2012	-
CEER-ECRB, "Guidelines of Good Practice on the Implementation and Use of Voltage Quality Monitoring Systems for Regulatory Purposes"	2012	C12-EQS-51-03
CEER Benchmarking Report 5.1 on the continuity of electricity supply	2014	C13-EQS-57-03
CEER Benchmarking Report 5.2 on the continuity of electricity supply	**2015**	C14-EQS-62-03

ANNEX C
GAS – TECHNICAL OPERATIONAL QUALITY

TABLE C.1 LENGTH OF PIPES

Country	Year	Length of transmission network (in km)	Length of distribution network (in km)	Length of high pressure network (in km)	Length of medium pressure network (in km)	Length of low pressure network (in km)
Austria	2010	33,027	6,829	33,027	3,685	3,143
	2011	33,594	6,793	33,594	3,685	3,108
	2012	34,044	6,884	34,044	3,674	3,210
	2013	34,476	7,100	34,476	3,990	3,109
	2014	34,758	7,169	34,758	4,041	3,129
Belgium	2010	4,037	64,438	3,565	472,000	50,422
	2011	4,097	64,868	3,628	469,000	51,596
	2012	4,060	66,232	3,596	464,000	52,688
	2013	4,056	67,197	3,593	463,000	53,472
	2014	4,023	71,220	3,573	450,000	56,465
Croatia	2010	2,289	18,044			
	2011	2,511	18,123			
	2012	2,530	18,368	3,771	13,957	3,170
	2013	2,662	18,576	3,900	13,988	3,351
	2014	2,694	19,313	3,946	14,874	3,187
Czech Republic	2010					
	2011	3,652	61,018	12,951	36,889	11,178
	2012	3,810	61,281	13,022	37,392	10,861
	2013	3,816	61,348	13,006	37,543	10,791
	2014	3,821	61,415	12,986	37,729	10,699
Estonia	2010					
	2011	878,000	2,085			
	2012	878,000	2,097			
	2013	885,000	2,108			
	2014	885,000	2,118			
Finland	2010	1,188	1,878			
	2011	1,314	1,931			
	2012	1,315	1,963			
	2013	1,287	1,984			
	2014	1,287	1,986			
France	2010		192,144		185,177	10,983
	2011	8,260	193,340	4,244	186,617	10,739
	2012	8,340	194,601	4,313	188,211	10,417
	2013	8,380	195,851	4,352	189,721	10,158
	2014	8,390	196,940	4,362	190,991	9,977
Germany	2010	46,829	448,964	117,135	225,835	152,435
	2011	39,495	471,213	157,300	224,880	128,528
	2012	37,695	470,433	130,547	223,076	154,505
	2013	37,880	485,413	132,058	231,624	159,611
	2014	37,580	481,103	129,793	231,603	157,287
Hungary	2010	5,577	82,619	5,577		
	2011	5,785	82,997	5,785		
	2012	5,784	83,092	5,784		
	2013	5,782	83,222	5,782		
	2014	5,782	83,530	5,782		
Ireland	2010	2,143	10,911			
	2011	2,149	11,074			
	2012	2,149	11,076			
	2013	2,149	11,160			
	2014	2,213	11,221			

Country		Length of transmission network (in km)	Length of distribution network (in km)	Length of high pressure network (in km)	Length of medium pressure network (in km)	Length of low pressure network (in km)
Italy	2010	33,768	250,041	35,526	102,353	145,930
	2011	34,135	248,648	36,110	100,780	145,893
	2012	34,415	252,266	36,196	103,915	146,571
	2013	34,510	253,581	362,146	103,690	148,187
	2014	34,628	256,410	36,367	105,331	149,340
Latvia	2010					
	2011					
	2012					
	2013					
	2014	1,242	5,516	851,000	2,518	2,147
Lithuania	2010	1,062	8,053			
	2011	1,062	8,090	2,341	3,939	3,679
	2012	1,098	8,206	2,389	4,021	3,700
	2013	1,201	8,337	2,505	4,111	3,728
	2014	1,201	8,473	2,508	4,208	3,764
Poland	2010	9,753	148,224			
	2011	10,537	150,800			
	2012	10,718	171,786			
	2013	10,761	161,655			
	2014	11,007	178,487			
Portugal	2010	1,267	14,840	1,267		
	2011	1,296	15,433	1,296		
	2012	1,298	15,878	1,298		
	2013	1,375	16,291	1,375		
	2014	1,375	17,374	1,375	1,192	16,182
Slovenia	2010	1,018	4,163	2,427	635,000	2,119
	2011	1,054	4,305	2,541	644,000	2,157
	2012	1,094	4,343	2,593	676,000	2,168
	2013	1,121	4,449	2,676	683,000	2,211
	2014	1,155	4,532	2,748	691,000	2,248
Spain	2010	11,665	62,535			
	2011	11,731	64,672			
	2012	12,815	67,282			
	2013	13,492	67,696			
	2014	13,716	68,090			
Sweden	2010	620,000	2,716			
	2011	620,000	2,708			
	2012	620,000	2,854			
	2013	601,000	2,857			
	2014	601,000	2,882			

TABLE C.2 LNUMBER OF SERVED CUSTOMERS

Country	Year	Number of served customers in total	High pressure customers	Medium pressure customers	Low pressure customers	Other Type 1	Other Type 2	Other Type 3
Austria	2010							
	2011	1,350,842						
	2012	1,350,310						
	2013	1,350,423						
	2014	1,348,958						
Belgium	2010		162,000	96,000				
	2011		165,000	90,000				
	2012		160,000	91,000				
	2013		160,000	86,000				
	2014		157,000	85,000	3,092,271			
Croatia	2010	633,477						
	2011	643,618						
	2012	646,971						
	2013	651,099						
	2014	649,674						
Czech Republic	2010	2,870,634	1,742	7,021	198,449	2,663,422 (a)		
	2011	2,869,023	1,707	7,033	200,496	2,659,787		
	2012	2,868,083	1,652	6,939	202,807	2,656,685		
	2013	2,860,345	1,637	6,946	201,274	2,650,488		
	2014	2,849,162	1,599	6,841	197,824	2,642,898		
Estonia	2010							
	2011	50,221						
	2012	50,261						
	2013	50,485						
	2014	51,166						
Finland	2010	38,150						
	2011	38,009						
	2012	38,111						
	2013	38,101						
	2014	38,049						
France	2010	11,000,000						
	2011	11,000,000	1,000					
	2012	11,000,000	991,000					
	2013	11,000,000	951,000					
	2014	11,000,000	972,000					
Germany	2010	13,503,145						
	2011	13,419,509						
	2012	13,698,780						
	2013	13,979,337						
	2014	13,837,257						
Hungary	2010	3,533,688	35,000		3,533,653			
	2011	3,540,204	35,000		3,540,169			
	2012	3,514,896	35,000		3,514,861			
	2013	354,696	35,000		3,467,661			
	2014	3,644,693	35,000		3,644,658			
Ireland	2010	643,831						
	2011	656,595						
	2012	661,890						
	2013	666,903						
	2014	673,160						

Country	Year	Number of served customers in total	High pressure customers	Medium pressure customers	Low pressure customers	Other Type 1	Other Type 2	Other Type 3
Italy	2010	21,120,814						
	2011	21,237,748						
	2012	21,358,817						
	2013	21,565,608						
	2014	21,689,304						
Latvia	2010							
	2011							
	2012							
	2013							
	2014	443,402						
Lithuania	2010							
	2011							
	2012							
	2013	561,561						
	2014	565,114						
The Netherlands	2010			10,606	7,119,659	7,127,369 (d)	10,606 (f)	7,119,659 (g)
	2011			10,465	7,117,140	7,125,418	10,465	7,117,140
	2012			10,567	7,167,606	7,178,173	10,567	7,167,606
	2013			9,798	7,184,303	7,194,101	9,798	7,184,303
	2014			9,978	721,705	7,227,035	9,978	7,217,057
Poland	2010	6,624,884						
	2011	6,747,364						
	2012	6,806,773						
	2013	6,806,773						
	2014	6,868,294						
Portugal	2010							
	2011							
	2012							
	2013	1,320,052	22,000	393,000	1,319,637	1,299,251 (b)	37,293 (e)	
	2014	1,355,122	22,000	399,000	1,354,701	1,333,437	39,765	
Slovenia	2010	128,769						
	2011	130,293						
	2012	131,652						
	2013	132,939						
	2014	133,230						
Spain	2010	7,180,332	121,000	3,930	7,175,681	600 (c)		
	2011	7,278,501	114,000	3,949	7,273,873	565,000		
	2012	7,366,468	113,000	3,877	7,361,856	622,000		
	2013	7,448,855	118,000	4,133	7,443,893	711,000		
	2014	7,548,654	116,000	3,967	7,543,729	842,000		
Sweden	2010	40,058						
	2011	39,659						
	2012	37,704						
	2013	37,393						
	2014	37,023						

(a) Households.
(b) Domestic.
(c) Single Customers Supplied By A LNG Satellite Plants.
(d) Total (DSO's).
(e) Non-Domestic.
(f) P > 200 mbar (DSO's).
(g) P ≤ 200 mbar (DSO's).

ANNEX D
GAS – NATURAL GAS QUALITY

TABLE D.1 OXYGEN (O_2) MAXIMUM VALUE

Oxygen (O_2)	Max	Unit	Measurement frequency	Publication frequency
Belgium	0.1	Ppm	In real time	Hourly
Croatia	0.001	% mol	Twice per month	Twice per month
Czech Republic	0.020	% mol	In real time	Monthly
Estonia	0.010	% mol	5 minutes	Monthly
France	0.010	% mol	5 minutes	Not published
Great Britain	0.200	% mol		
Hungary	0.200	% mol	Occasionally	Occasionally
Ireland	0.200	% mol	Monthly	Yearly
Italy	0.600	% mol	Quarterly	
Latvia	0.020	% mol	In real time	Monthly
Lithuania	0.5 (1)	% mol	In real time	Not published
	0.02 (2)			
Poland	0.200	% mol		
Portugal		% mol	In real time	Monthly
Spain	0.010	% mol	Daily	
CEN	**0.001 or 1** (3)	**% mol**		

(1) If the pressure P < 1.6 MPa.
(2) If the pressure P ≥ 1.6 MPa.
(3) At network entry points and interconnection points the mole fraction of oxygen shall be no more than 0.001 %, expressed as a moving 24 hour average. However, where the gas can be demonstrated not to flow to installations sensitive to higher levels of oxygen, e.g. underground storage systems, a higher limit of up to 1 % may be applied.

TABLE D.2 CARBON DIOXIDE (CO_2) MAXIMUM VALUE

Carbon Dioxide (CO_2)	Max	Unit	Measurement frequency	Publication frequency
Belgium	2.5	% mol	5 minutes	Not published
Croatia	2.5	% mol	Twice per month	Twice per month
Czech Republic	3.0	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	2.5	% mol	5 minutes	Not published
Hungary	No limit	% mol	4 minutes	Daily
Ireland	2.5	% mol	Monthly	Yearly
Italy	3.0	% mol	Hourly	Monthly
Latvia	2.5	% mol	In real time	Monthly
Lithuania		% mol	In real time	Monthly
The Netherlands	2.5	% mol		
Poland	3.0	% mol	In real time	Monthly
Portugal		% mol	In real time	Monthly
Slovenia	2.5	% mol	Hourly	Daily
Spain	2.5	% mol	Daily	NA
CEN	**2.5 or 4** (1)	**% mol**		

(1) At network entry points and interconnection points the mole fraction of carbon dioxide shall be no more than 2.5%. However, where the gas can be demonstrated not to flow to installations sensitive to higher levels of carbon dioxide, e.g. underground storage systems, a higher limit of up to 4 % may be applied.

TABLE D.3 METHANE (CH_4) MINIMUM VALUE

Methane (CH_4)	Min	Unit	Measurement frequency	Publication frequency
Croatia	85.0	% mol	Twice per month	Twice per month
Czech Republic	85.0	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	91.1	% mol	5 minutes	Daily
Hungary	No limit	% mol	4 minutes	Daily
Ireland		% mol	Monthly	Yearly
Italy		% mol	Hourly	Monthly
Latvia	90.0	% mol	In real time	Monthly
Lithuania	90.0	% mol	In real time	Monthly
Poland	92.0	% mol	In real time	Monthly
Portugal		% mol	In real time	Monthly
Slovenia		% mol	Hourly	Daily
Spain	No limit, except for biogas 95.0	% mol	NA	NA
CEN	**65.0**	**% mol**		

TABLE D.4 ETHANE (C_2H_6) MAXIMUM VALUE

Ethane (C_2H_6)	Min	Unit	Measurement frequency	Publication frequency
Croatia	7.00	% mol	Twice per month	Twice per month
Czech Republic	7.00	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	6.10	% mol	5 minutes	Daily
Hungary	No limit	% mol	4 minutes	Daily
Ireland	12.00	% mol	Monthly	Yearly
Italy		% mol	Hourly	Monthly
Latvia	8.00	% mol	In real time	Monthly
Lithuania		% mol	In real time	Monthly
Poland	4.00	% mol	In real time	Monthly
Slovenia		% mol	Hourly	Daily

TABLE D.5 PROPANE (C_3H_8) MAXIMUM VALUE

Propane (C_3H_8)	Min	Unit	Measurement frequency	Publication frequency
Croatia	6.00	% mol	Twice per month	Twice per month
Czech Republic	3.00	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	1.03	% mol	5 minutes	Daily
Hungary	No limit	% mol	4 minutes	Daily
Ireland		% mol	Monthly	Yearly
Italy		% mol	Hourly	Monthly
Latvia	3.00	% mol	In real time	Monthly
Lithuania	3.00	% mol	In real time	Monthly
Poland		% mol	In real time	Monthly
Slovenia		% mol	Hourly	Daily

TABLE D.6 NITROGEN (N_2) MAXIMUM VALUE

Nitrogen (N_2)	Min	Unit	Measurement frequency	Publication frequency
Croatia	3.00	% mol	Twice per month	Twice per month
Czech Republic	5.00	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	1.59	% mol	5 minutes	Daily
Hungary	No llimit	% mol	4 minutes	Daily
Ireland	5.00	% mol	Monthly	Yearly
Italy			Hourly	Monthly
Latvia	3.00	% mol	In real time	Monthly
Lithuania	5.00	% mol	In real time	Monthly
Poland	2.00	% mol	In real time	Monthly
Slovenia			Hourly	Daily

TABLE D.7 SUM OF BUTANES MAXIMUM VALUE

Sum of Butanes	Max	Unit	Measurement frequency	Publication frequency
Czech Republic	2.00	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	0.26	% mol	5 minutes	Daily
Hungary	No limit	% mol	4 minutes	Daily
Ireland		% mol	Monthly	Yearly
Italy		% mol	Hourly	Monthly
Latvia	1.00	% mol	In real time	Monthly
Lithuania	1.00	% mol	In real time	Monthly
Poland		% mol	In real time	Monthly
Slovenia		% mol	Hourly	Daily

TABLE D.8 SUM OF PENTANES AND HIGHER HYDROCARBONS MAXIMUM VALUE

Sum of Pentanes and Higher Hydrocarbons	Max	Unit	Measurement frequency	Publication frequency
Czech Republic	0.50	% mol	In real time	Monthly
Estonia	No limit	% mol	5 minutes	Monthly
France	0.03	% mol	5 minutes	Daily
Hungary	No limit	% mol	4 minutes	Daily
Ireland			Monthly	Yearly
Italy		% mol	Hourly	Monthly
Latvia			In real time	Monthly, 10 days
Lithuania			In real time	Monthly
Poland	2.00	% mol	In real time	Monthly
Slovenia			Hourly	Daily

TABLE D.9 DELIVERY TEMPERATURE VALUES

Delivery Temperature	Min	Max	Unit	Measurement frequency	Publication frequency
Belgium	2.0	38.0	°C	In real time	Hourly
Estonia	0.0	50.0	°C		
France	-30.0	50.0	°C	5 minutes	Not published
Hungary	0.0		°C	In real time	Daily
Latvia			°C	In real time	Not published
Lithuania			°C	In real time	Not published
The Netherlands	10.0	30.0	°C		
Poland	0.0	50.0	°C	In real time	Not published
Slovenia		42.0	°C	In real time	

TABLE D.10 DUST PARTICLES MAXIMUM VALUES

Dust Particles	Max	Unit	Measurement frequency	Publication frequency
France	5.0	mg/m^3	Not measured	Not measured
Hungary	5.0	mg/m^3	Occasionally	Occasionally
Latvia	0.001	g/m^3	10 days	Monthly, 10 days
Lithuania	0.001		Monthly	Not published
The Netherlands	100.0	mg/m^3		
Poland	1.0	mg/m^3	In real time	Monthly
Spain	Technically pure			

TABLE D.11 HYDROGEN (H_2) MAXIMUM VALUE

Hydrogen (H_2)	Max	Unit	Measurement frequency	Publication frequency
France	6.00	% mol	5 minutes	Not published
Great Britain	0.1	% mol		
Ireland	0.10	% mol	Monthly	Yearly
Lithuania	2.00 (1)	% mol	Twice per year	Not published
The Netherlands	0.02	% mol		
Spain	No limit, except for biogas: 5.00	% mol		

(1) If $P < 1.6$ MPa not allowed if $P \geq 1.6$ MPa.

TABLE D.12 WATER (H_2O) MAXIMUM VALUE

Water (H_2O)	Min	Max	Unit	Measurement frequency	Publication frequency
France	83.0	99.0	mg/m^3	5 minutes	Daily
Hungary		170.0	mg/m^3	10 minutes	Daily
Lithuania	Not allowed			Monthly	Not published

TABLE D.13 CARBON MONOXYDE (CO) MAXIMUM VALUE

Carbon Monoxyde (CO)	Max	Unit	Measurement frequency	Publication frequency
France	2.0	% mol	5 minutes	Not published
Great Britain	0.48	% mol		
The Netherlands	2.9	% mol		

TABLE D.14 INCOMPLETE COMBUSTION FACTOR MAXIMUM VALUE

Incomplete Combustion Factor	Max	Unit	Measurement frequency	Publication frequency
Ireland	0.48	%	Monthly	Yearly
Slovenia			Hourly	

TABLE D.15 SOOT INDEX MAXIMUM VALUE

Soot Index	Max	Unit	Measurement frequency	Publication frequency
Great Britain	0.6	%		
Ireland	0.6	%	Monthly	Yearly
Slovenia			Hourly	

TABLE D.16 THT (C_4H_8S) VALUES

THT (C_4H_8S)	Min	Max	Unit	Measurement frequency	Publication frequency
France	15.0	40.0	mg/m³	5 minutes	5 minutes

ANNEX ON THE 6TH CEER BENCHMARKING REPORT – QUALITY OF ELECTRICITY SUPPLY IN THE ENERGY COMMUNITY[1]

1. Approved by the ECRB Board in May 2016.

1 INTRODUCTION

1.1. ABOUT ECRB

The **Energy Community**[2] comprises Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Kosovo*[3], Moldova, Montenegro, Serbia and Ukraine. Armenia, Georgia, Turkey and Norway are Observer Countries. The key aim of the organization is to extend the EU internal energy market to South East Europe and beyond on the basis of a legally binding framework.

The Energy Community Regulatory Board (ECRB) operates based on the Energy Community Treaty. As an institution of the Energy Community ECRB advises the Energy Community Ministerial Council and Permanent High Level Group on details of statutory, technical and regulatory rules and makes recommendations in the case of cross-border disputes between regulators.

ECRB is the independent regional voice of energy regulators in the Energy Community. ECRB's mission builds on three pillars: providing coordinated regulatory positions to energy policy debates, harmonizing regulatory rules across borders and sharing regulatory knowledge and experience.

1.2. BACKGROUND AND SCOPE

Quality of electricity supply as a topic was introduced into the ECRB Work Program already in 2008; the first ECRB "Report on Quality of Electricity Service Standards and Incentives in Quality Regulation" was published in 2009. Also, during 2009 and 2010, the ECRB organized two workshops which were followed by the report "Assistance to regulators in introducing and improving service quality regulation in the Energy Community", published in 2010.

In 2011 ECRB members participated in the 5th CEER Quality of Supply Benchmarking Report to which the analysis for the ECRB member countries – performed based on the CEER benchmarking indicators – was added as an annex.

Following the well established ECRB-CEER cooperation tradition on the very topic, the present benchmarking report represents an annex to the "6th CEER Benchmarking Report[4] on Quality of Electricity Supply", covering the Energy Community Contracting Parties (CPs) **Albania, Bosnia and Herzegovina, FYR Macedonia, Kosovo*,**[5] **Montenegro, Serbia and Ukraine**.

This report covers all **three aspects of quality of electricity supply**, namely:

- Continuity of Supply (CoS),
- Voltage Quality (VQ) and
- Commercial Quality (CQ).

In general, the present report aims to present an overview and analysis of current practices in the CPs. It also provides an assessment of areas where a move towards harmonisation could further improve quality of supply. The findings and recommendations of the report will hopefully lead to further development of national regulation and harmonization among the CPs.

Chapter 2 of the report deals with continuity of supply related to the availability of electricity. It provides an overview of the existing quality of service regulation frameworks of continuity of supply applied in the CPs. Analyses in this chapter are made on the basis of data from CoS measurements and statistics as well as on the basis of information on: audits on continuity data; regulation and standards on continuity of supply; incentive mechanisms for continuity of supply and effects of continuity of supply incentive regimes.

2. www.energy-community.org.
3. Throughout this document the symbol * refers to the following statement: This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Advisory Opinion on the Kosovo declaration of independence.
4. The Council of European Energy Regulators (CEER) prepares a Benchmarking Report on the Quality of Electricity Supply every few years. The first report was issued in 2001, followed by the second, third and fourth editions in 2003, 2005, 2008 and 2011. These five benchmarking reports, published up to now, present an overview and analysis of practices in the CEER countries related to quality of electricity supply.
5. This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

Chapter 3 is dedicated to voltage quality. In simple terms, voltage quality deals with deviations from nominal values of voltage frequency and voltage magnitude and by distortions. This chapter provides an overview of existing practice in voltage quality monitoring and regulation in transmission and distribution of electricity in the CPs and covers VQ regulation and legislation, voltage quality monitoring system (VQMS), data collection, aggregation and publication from VQMS, VQ indicators, actual data for voltage dips, other VQ parameters, mitigation measures and studies on estimation of costs due to poor voltage quality.

Chapter 4 focuses on commercial quality, which relates to the nature and quality of customer services provided to end-consumers of electricity. Commercial quality is directly associated with transactions between electricity companies (either DSOs or suppliers, or both) and customers. Commercial quality covers not only the supply and sale of electricity, but also various forms of contacts between electricity companies and customers. The questionnaires on commercial quality were divided in the following groups: connection related activities, customer care, technical service, metering and billing. Therefore, this chapter also follows that grouping.

1.3. METHODOLOGY

The analysis for the Energy Community is based on indicators used by CEER for its benchmarking analysis. To this extent the assessment for the CPs bases on the same definitions and theoretical background as defined for the EU Member States, in particular with a view to ensure comparability.

1.4. ACKNOWLEDGEMENTS

ECRB expresses its gratitude for the colleagues from the regulatory authorities (RAs), transmission system operators (TSOs) and distribution system operators (DSOs) from the Energy Community Contracting Parties for participating in the present analysis. In this context special thanks are also addressed to Mr Srdjan Žutobradić, Mrs Milodarka Dautović and Mr Nikola Dubajić for their effort in preparing this survey. At the same time ECRB also expresses its appreciation for the support received from the EU regulators on CEER level.

2 CONTINUITY OF SUPPLY

2.1. INTRODUCTION

This chapter provides an overview of the existing quality service regulation frameworks of continuity of supply (CoS) applied in the Energy Community CPs.

This section will place a special focus on general experiences, experiences with the implementation processes and possible future improvements of the systems in place. Although there is some minor evidence on better developed regulation frameworks (by means of minimal standards on continuity of supply as well as the implementation of incentive schemes in particular CPs), **most of the observed CPs are in a very early stages of the development of service quality regulation**. The main focus within this chapter is therefore put on the characteristics of CoS monitoring schemes in distribution and transmission. The proper application of such schemes is the precondition for the future framework extensions.

For some rare cases with applied minimal standards on continuity of supply, as well as reward/penalty schemes, examples of existing regulatory practice in the area will be presented.

Review and analysis of collected data on continuity of supply show also the differences in timing and scope of CoS monitoring development among CPs. Consequently, countries were not able to provide the complete data set on different aspects of CoS monitoring and regulation expected from the questionnaire.

Continuity of supply is examined from different aspects and categorized into the following chapters:

- Continuity monitoring
- Audits on continuity data
- Regulation and standards on continuity of supply
- Incentive mechanisms for continuity of supply
- Effects of continuity of supply incentive regimes

Information on the provided data on continuity of supply is presented in Table 1.

TABLE 1 INDICATION OF WHAT KIND OF INFORMATION ON CONTINUITY OF SUPPLY HAS BEEN PROVIDED BY DIFFERENT COUNTRIES

Country	Continuity measurement	Audits on continuity data	Regulation and standards on continuity of supply	Incentive mechanisms for continuity of supply	Effects of continuity of supply incentive regimes	Data on Network and Continuity indicators
Albania	X (Partially)					
Bosnia and Herzegovina	X	X				X (Partially)
FYR of Macedonia	X		X			X (Partially)
Kosovo*	X		X			X (Partially)
Montenegro	X		X			X (Partially)
Serbia	X	X	X			X (Partially)
Ukraine	X	X				X (Partially)

It can be concluded from Table 1 that **most of the analyzed elements are not applicable due to an early stage of continuity of supply regulation implementation in all CPs**. The lack of data limits the scope of benchmarking of the actual levels and trends of continuity of supply among different CPs.

According to the current status of implementation, the following chapters mainly focus on an overview of the monitoring concepts, on the aspects and on the characteristics of regulation frameworks applied (including standards on continuity of supply). The aim is to benchmark the implementation process of continuity of supply monitoring and regulation, and to look deeper into related prerequisites, namely:

- the establishment of legal framework,
- usage of standards and guidelines of good practice,
- the implementation of the continuity of supply monitoring system,
- continuity standards and incentive schemes.

Such structured information should be useful for NRAs that have plans to introduce quality regulation regime in depth in the future.

In the subsequent sections different terms for the network user are used:

- customer
- consumer
- (network) user

While the "network user" (or simply "user"), comprising both generator and consumer, is certainly the most appropriate term, different terms with the same meaning are used having in mind that there is no harmonized use of terms in place in the analyzed markets.

Also, different terminology is used when referring to the responsible party for continuity of supply. Although the Electricity Directive EC/72/2009 defines the terms transmission system operator and distribution system operator, or simply system operator, the concept of system operation refers to dispatching of generators and it is different from network ownership and operation.

2.2 CONTINUITY OF SUPPLY MONITORING

Monitoring of quality levels by using indicators and standards represents the basis for regulating quality. In general, the actual monitoring of continuity of supply can be performed on two different levels, namely on the system level and on the consumer-specific level. The implementation of adequate monitoring systems is essential for setting standards as well as penalties and rewards related to both monitoring levels.

In the CPs monitoring of continuity of supply is performed in different ways – including different types of interruptions, different sets of indicators as well as different reporting detail. The following sections pinpoint the differences as well as concepts that are harmonized among the CPs. The harmonization, where existing, is not a result of legal enforcement but it has been implemented following examples of good practice in the EU[6].

An overview on monitoring techniques and results is presented in this section.

2.2.1. Types of interruptions monitored

All CPs use some sort of monitoring of interruptions as shown in Table 2. The focus of the CPs is mainly on long interruptions (duration > 3 minutes). The qualitative information on long interruptions is essential for calculation of continuity indicators that are widely used in regulation.

Three regulators declare to have access to the information regarding the number of short-term interruptions: short interruptions are monitored in the Ukraine, FYR Macedonia, and in a part of Bosnia and Herzegovina. In this context it is important to explain the way how short interruptions are currently monitored, especially due to the fact that SCADA is not yet fully implemented in the networks of CPs. The CPs that reported monitoring of short interruptions were additionally asked to provide brief information on the type of measurement method that is used, i.e. manual recording, usage of SCADA DMS, local substation logging, counter readings on reclosing devices or other methods.

In Bosnia and Herzegovina most of the distribution facilities do not have equipment for remote supervision and control installed (except facilities of one out of the five distribution companies which have SCADA system installed). All (short and long) interruptions are recorded manually and stored locally in registers (registry books). Contingency statistics are recorded manually by the staff on duty.

Registered data are consolidated in the main dispatching centers for the distribution network control. These data are subject to checks by the regulatory commission staff during monitoring activities.

Considering the general lack of SCADA, it can be concluded that **local substation logging and counter readings on reclosing relays are most commonly used practice for recording the interruptions**.

Unplanned long interruptions are monitored in all countries. However, not all countries monitor this type of interruptions at all voltage levels.

6. E.g. by adopting standards as EN 50160 and others.

Moreover, usually there is also a distinct and separate data collection for planned and unplanned interruptions. An "on time" announcement of the planned action reduces the effect of the interruption on the consumer.

Bosnia and Herzegovina and FYR Macedonia have also accomplished to set some rules with limited scope (SCADA installed at certain voltage level or proprietary solutions by DSOs), the other CPs either have not set any rules yet or are planning to establish the rules and implement SCADA in the future.

Nearly half of the CPs has established some sort of standardized way for recording and reporting applied by means of dedicated application software or by the use of harmonized forms for data collection. This is usually a result of national regulations imposing obligations for companies to implement reporting without taking into consideration technical preconditions for interruption monitoring and time for such implementation. EU experiences showed that this is not the best approach and such practice should be gradually replaced by the automated logging of interruptions by SCADA and associate software solutions (DMS, GIS etc.).

TABLE 2 TYPES OF INTERRUPTIONS MONITORED

Country	Transient	Short	Long	Unplanned	Planned	Rules for automatic logging of interruptions (i.e. SCADA)	Standardized system for recording and reporting of interruptions
Albania			X	X	X	No	No
Bosnia and Herzegovina		X, partly (E RS only)	X	X	X	Partly. Some DSO use proprietary software for processing of interruptions, some use SCADA system at MV.	Yes, there is a uniform form for keeping records on interruptions in electricity supply and reporting forms prescribed by Regulatory Commission.
FYR of Macedonia		X	X	X	X	SCADA comprising 110 kV substations that have possibility for remote records of interruptions.	DSO should keep records and report to ERC
Kosovo*			X	X	X	No (TSO has installed SCADA in 2011 and are able to record interruptions on HV also in some MV feeders	DSO should keep records for long interruptions(planed/unplanned) and report to ERO
Montenegro			X	X	X	SCADA for transmission	Yes, for long interruptions only
Serbia			X	X	X	No	Standardized form for recording and reporting of long interruptions is prescribed by the Information Rules issued by the NRA
Ukraine		X	X	X	X	No	Yes (approved by the NERC)

Definitions related the duration of long, short, and transient interruptions in different countries are shown in Table 3.

TABLE 3 DEFINITIONS OF LONG, SHORT AND TRANSIENT INTERRUPTIONS

Country	Transient	Short	Long
Albania	< 3 min	< 15 min	> 15 min
Bosnia and Herzegovina	Not defined	1 s < T ≤ 3min	> 3 min
FYR of Macedonia	Not defined	1.5 s < T ≤ 3 min	> 3 min
Kosovo*	Not defined	< 3 min	> 3 min
Montenegro	Not defined	≤ 3 min	> 3 min
Serbia	Not defined	Not defined	> 3 min
Ukraine	Not used	< 3 min	≥ 3 min

Albanian definitions significantly differ from the rest of the countries as well as from definitions that can be found in standards (EN 50160) where the *unplanned interruption* ("accidental supply interruption") is classified as:

- *a long interruption* (>3 min),
- *a short interruption* (≤ 3 min).

The deviation in Ukraine, where an interruption lasting exactly three minutes is classified as *long interruption*, is minor and therefore not significant; the same can be concluded for Kosovo*, where the same type of interruptions (duration of exactly three minutes) are excluded from monitoring.

Furthermore, some minor differences in definitionscan be found also for the duration of *short interruptions*, especially at setting the lower limits: some definitions do not set lower bounds; some set the limit at 1.0 second or 1.5 seconds.

Albania is also the only CP that defines the type of *transient interruptions*; the transient interruptions in Albania would classify as *short interruptions* in other countries.

2.2.2. Planned and unplanned interruptions

An overview of the definitions used for *unplanned and planned interruptions*, as well as rule on advance notice regarding the planned interruptions is given in Table 4. **The majority of CPs has set definitions for both *planned* and *unplanned interruptions* referring to the availability of advance notices to customers. Both types of interruptions are monitored accordingly.**

A *planned interruption* is defined in EN 50160 ("prearranged supply interruption") as an interruption for which customers are informed in advance, to allow the execution of scheduled works on the distribution system.

An *unplanned interruption* is defined in EN 50160 ("accidental supply interruption") as an interruption caused by permanent or transient faults, mostly related to the external events, equipment failures or interference.

Most CPs use similar definitions for *planned interruptions*. However, they do not refer to EN 50160 or any other references, such as international guidelines or norms. Advanced notification is necessary for an interruption to be classified as a planned interruption. More detailed descriptions of definitions, comprising also some information on exemptions, were provided by Ukraine and Bosnia and Herzegovina.

All CPs have issued the rules on notice to customers affected, whereas the requirements for advance notice vary between 24 hours up to 10 days.

TABLE 4 DEFINITIONS OF PLANNED AND UNPLANNED INTERRUPTIONS

Country	Transient	Short	Long
Albania	customers are noticed in advance	All breakdowns not noticed in advance	Rules and procedures for giving notice defined by DSO are applied (72 hours in advance)
Bosnia and Herzegovina	Planned interruptions are those announced ones for the purposes of doing planned activities of regular and extraordinary maintenance, inspection and overhaul, connections of new customers, testing and control of measuring and protection devices and enlargement of the network.	Non-planned interruptions are those non-announced ones. If the planned interruption lasts longer than it has been announced, the time above the planned is included in the non-planned interruptions which the operator is responsible for	Distributor is obliged to inform the end-users on the term and expected time of duration of the planned interruption, no later than 24h (RS)/48h (FBiH) before the planned interruption as follows: • for end-users at medium voltage – directly by phone along with the written notice on information details by fax or email and • for end-users at low voltage – in the mass media, in a clear and appropriate way
FYR of Macedonia	An interruption notified in advance to all affected customers with adequate notice	An interruption non notified in advance to all affected customers or notified with inadequate notice	Timely in written form in case of singe customer affected, 24 hour in advance in case of group of customers affected
Kosovo*	An interruption notified in advance to all affected customers with adequate notice.	An interruption non notified in advance to all affected customers.	Where the TSO and DSO carries out planned service interruptions on the distribution system it shall use its best endeavors to ensure that it provides a minimum of 24 hours notice to at least 90% of the affected customers. For the purposes of this standard, the notice given to affected customers shall be in the form of announcements through local TV and radio for interruptions that occurs in local areas (limited) and where the proposed interruption is widespread, through a national TV and suitable high-circulation daily national newspaper
Montenegro	An interruption notified in advance to all affected customers with adequate notice	An interruption non notified in advance to all affected customers (an interruption not notified on time to all affected customers)	Yes. Minimum time-lag requested is at least 24h, notice by public media or in other adequate way
Serbia	An interruption notified in advance to all affected customers with adequate notice	An interruption non notified in advance to all affected customers	Yes, minimum time-lag requested is at least 24h, noticed by public media or in other adequate way
Ukraine	De-energization of a part of the network and equipment, made by the DSO to undertake routine repair or maintenance of electrical networks. Exemptions are also defined	Temporary suspension of power supply to consumers as a result of de-energization of a part of the network due to the fault of other licensees (UTILITIES), consumers, force majeure event, fault of others, technical failures in the electrical network of the DSO	Yes 10 days for legal entities with repeated notice 1 day and 10 days for households

2.2.3. Voltage levels monitored

The incidents at different voltage levels are monitored in different CPs as shown in Table 5.

Incidents on MV and HV level are monitored in all CPs. Surprisingly, most of the CPs reported that they monitor interruptions on LV level (except Albania). The reliable recording of interruptions on LV level (interruption register) requires big investments in equipment for protection and remote supervision and control or call center functions, and it is not yet widely implemented in the EU Member States.

Efficient monitoring of interruptions for particular voltage levels covers the recording interruptions caused by incidents on own voltage level and by incidents on all higher voltage levels that affect the observed interruptions[7]. However, interruptions that are caused on LV remain unrecorded in case there is no manual, semi-automated (i.e. using call centre services) or automated process of monitoring implemented on LV network (i.e. SCADA). The interruptions caused on LV that do not affect the protection system under supervision of SCADA installed on MV (or LV) or that are not reported by affected customers through the call centers, don't attribute to the MV statistics and consequently to the CoS indicators.

Only Ukraine, with monitoring on LV level established already in 2008, is on a good way to achieve comprehensive monitoring on all voltage levels.

TABLE 5 VOLTAGE LEVELS FOR WHICH MONITORING OF CONTINUITY TAKES PLACE

Country	LV	X	HV	EHV
Albania		X	X	
Bosnia and Herzegovina	See note	X	X	X
FYR of Macedonia	See note	X	X	
Kosovo*	See note	X	X	X
Montenegro	See note	X	X	
Serbia		X	X	X
Ukraine	X (1)	X	X	X

(1) Established since 2008; use of data from Call Centre IS + manual processing.

Notes:
The table represents the voltage level at which incidents are recorded. The incident is typically recorded by an opening of a circuit breaker or another interrupting device. The customers at that voltage level and at any lower voltage levels have their interruptions counted in that way. Although monitoring at LV level was reported by CPs, in practice LV recording is partially implemented only in Ukraine. In many CPs, the network operators usually provide the number of affected customers at lower voltage levels (i.e. LV) due to the interruption at certain (higher) voltage level (i.e. MV) and this number is considered when calculating continuity indicators. However, this is not sufficient to be considered as monitoring of interruptions at certain voltage level.

2.2.4. Classification of the interruption's cause

An overview of the classification of interruption causes is given in Table 6. **Most CPs collect the information on the cause of interruptions.** Such information is very important for both the system operator and the regulator.

From the CPs' answers it can be concluded that **there is no harmonization related to classification of interruption causes.** It is also obvious that almost all CPs divide causes into separate categories. 5 CPs (all except Montenegro and Kosovo*) use the categories "third party" or "force majeure" (in a few cases with different designations).

It is interesting that Ukraine also uses the category "planned interruption without notice" – such classification indicates quite sophisticated integration of different databases, and implementation of interacting e-business processes supporting such classification.

7. For example, a fault at MV will result in interruption for an LV customer: such interruptions may be recorded (registered) also for LV level.

TABLE 6 CAUSE CATEGORIES USED WHEN RECORDING INTERRUPTIONS

Country	Categories used when recording interruptions	Recording scope (All/Only of specified cause)	Separately recording according to interruption's cause	Classification of causes adopted
Albania	1) Planned interruptions 2) Force majeure 3) Third Party 4) DSO Responsibility	All	Yes	The classification, which relates to: transformers, bus bars, isolators, cable, wires, etc.
Bosnia and Herzegovina	Interruptions caused by force majeure, third party responsibility and responsibility of distributor	All	Yes	Force majeure, third party responsibility and responsibility of distributor
FYR of Macedonia	HV and MV: unplanned, planned, interruptions due to force majeure, interruptions due to weather conditions, damages caused by third persons, due to interruptions on the transmission grid (MEPSO)	All (HV, MV)	Yes	Planned, unplanned, interruptions due to force majeure, interruptions due to force weather conditions, damages caused by third persons, due to interruptions on the transmission grid
Kosovo*	Planned and unplanned interruptions.	All	Yes	Interruptions that result from system faults
Montenegro	Planned works, damages in the system, damages with customers, meteorological conditions, unknown causes	All	Yes	Planned works, damages in the system, damages with customers, meteorological conditions, unknown causes
Serbia	Own network/other energy entity/third party/ animals/force majeure/unknown/other	All	Yes	Own network/other energy entity/third party/animals/ force majeure/unknown/other
Ukraine	Planned interruption with notice; Planned interruption without notice; unplanned (emergency) interruption through the fault of other licensees or consumers; force majeure; Unplanned (emergency) interruption through the fault of others; Unplanned (emergency) interruption due to the technical failures in the electrical network of the licensee	All	Yes	

2.2.5. Exceptional events

Exceptional weather conditions and other exceptional circumstances can significantly affect the continuity of supply. Interruptions caused by exceptional events, even if quite rare, are usually very long and/or affect a substantial number of customers. The concept of exceptional events may reflect the unique characteristics of each CP's electricity sector and the impact of severe weather conditions in each CP.

This section contains information on existing concepts on exceptional events among the CPs. According to the terminology used by the CEER, the term "exceptional events" will be used as a collective term in this section.

In Table 7, exceptional events, their definitions and their influence on interruption statistics are presented.

Albania, Montenegro and Serbia do not consider the concept of exceptional events or other similar concepts related to situations which are subject of the specific treatment in their national quality of supply regulations. In Serbia the information code regarding the classification of interruptions comprises the definition of force majeure.

The concepts of different kinds of exceptional events of other four countries are defined as described in Table 7 and can be grouped, despite of similar designation, as follows:

- extraordinary situations with significant impact on the continuity of supply (Bosnia and Herzegovina, Serbia and Ukraine);
- force majeure (FYR Macedonia, Serbia and Kosovo*[8]).

These situations can be classified based on their causes or on their impact on network performance.

8. An assumption since information on concept hasn't been provided!

TABLE 7 DEFINITIONS OF EXCEPTIONAL EVENTS

Country	Designation	Concept	Exceptional events excluded from the interruption statistics
Albania	Not defined	Not applicable	No
Bosnia and Herzegovina	Force majeure	"Force majeure" – all events which cause interruption of supply, and are out of control of a distributor: natural disasters (earthquake, fire, flooding), extreme weather conditions (lightning, storm wind, excessive ice etc), interruptions at the transmission voltage level, load shedding due to shortage of supply, under-frequency relief of load and orders of the respective authorities.	Normally not (but available also excluded)
FYR of Macedonia	Force majeure	Force majeure is defined as all unpredictable natural events, disasters and circumstances determined by the law (defined in Rulebook on conditions for electricity supply).	No (data is available upon request)
Kosovo*	Force majeure	Yes. Events, circumstances or occurrences beyond the control of the system operator. The force majeure will be defined by the government for special cases.	Yes
Montenegro	Force majeure	Force Majeure are natural events that have the character of natural disasters (floods, earthquakes, fires, atmospheric discharges; winds, ice and snow that exceed projected technical standards established for a particular building/ facility or equipment of an relevant operators, etc.) that could not be predicted, prevented, avoided or eliminated by taking measures that are applied in order to maintain safe and reliable operation of the power system, and which are determined on the basis of the report of the competent state authorities, as well as emergency and military actions and measures that have been introduced based on the decisions of the competent state authorities.	No
Serbia	Force majeure (1)	Events, circumstances or occurrences beyond the control of the system operator, the appearance of which he could not foresee, avoid or eliminate, and in particular natural phenomena such as – floods, earthquakes, landslides and rockfalls, as well as social phenomena – wars, terrorist acts and strikes, as well as measures and decisions of governmental bodies.	No
Ukraine	Force majeure	Yes. Interruption due to force majeure – interruption as a result of an irresistible emergency force which cannot be prevented by the use of highly skilled personnel and practices and can be caused by exceptional weather conditions and natural disasters (hurricanes, storm, flood, snow accumulation, ice, earthquake, fire, subsidence and landslide) and other contingencies. The event of force majeure must be documented.	No, but interruption due to exceptional events are not used for calculation of target indices.

(1) Informational definition only.

No statistical methods defining "major event days" or "exceptional condition periods" (i.e. IEEE Std 1366-2003, Annex B) **exist. Also, there is no evidence of explicit regulations defining "exceptional events".**

The information collected from the CPs shows **a lack of harmonization which is probably caused by different concepts of national legislation on obligations and by inherent climate differences.** Therefore stringent harmonization might most probably not be feasible at all. The lack of harmonization as regards exceptional events affects the comparison of interruption data between the observed CPs significantly.

It is important to mention that Kosovo* excludes exceptional events from their statistics. In Bosnia and Herzegovina and FYR Macedonia such separate statistics (with/without exceptional events) are only provided upon request.

8. An assumption since information on concept hasn't been provided!

2.3. CONTINUITY OF SUPPLY INDICATORS

An overview on the definitions of different indices used for quantifying the number of interruptions is given in CEER's 5th Benchmarking Report on Quality of Electricity Supply (2011). The same definitions are used for the purpose of this report.

Continuity of supply indicators measure grid performance at delivery points. The meaning of these indicators depends on the set of interruptions considered in calculation and related interruption durations.

If all interruptions are considered in the indicators calculation, they will provide information on the continuity of supply as seen by the customers – such a calculation is also important for evaluating the impact of the exceptional/force majeure events in terms of continuity of supply. For such analysis, all interruptions caused by exceptional events must be identified.

Usually, the indicators for long interruptions are split into two categories, namely unplanned and planned interruptions. Short interruptions are mostly caused by unexpected events, therefore a separation in planned and unplanned cases is not used.

There are no significant CP-specific differences between typically used continuity indicators. It is obvious that a range of indicators is in use, depending on their purpose and, of course, availability and comprehensiveness of the interruption statistics.

Regarding the measurement of long interruptions (> 3 minutes), the most common indicators for measuring continuity of supply are System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) for distribution networks and Energy Not Supplied (ENS) and Average Interruption Time (AIT) for transmission networks. Momentary Average Interruption Frequency Index (MAIFI) values are used for short interruptions.

2.3.1. Level of detail of the calculated indicator

Continuity of supply indicators can be calculated for a country or region as a whole, for each system operator, for a certain city, for each feeder, or even for each individual customer. Calculation of indicators for a different observation scope is an essential tool in the process of benchmarking for regulators and systems operators. Regulators use such data for benchmarking DSOs, for setting the appropriate continuity standards according to regional or network characteristics, etc. DSO can use such data to make investment or maintenance decisions. The practice on calculation of system indicators varies strongly between different CPs, as shown in Table 8.

All CPs publish indicators calculated for the entire jurisdiction. In only few of the investigated markets, the indicators are calculated per system operator and/ or per region/city. Further distinctions can be made based on the voltage level on which the incident takes place or on the cause of the incident. **A distinction based on voltage level is made by all CPs. Information on the cause of the incident is also provided by all CPs. However, the classifications used for the voltage levels and causes significantly differ between the investigated markets:** the reason is different level of data availability and non-harmonized types of causes among CPs. Four CPs provided separate indicators for rural and urban areas; one CP distinguishes between underground and overhead ("aerial") networks. Also here, different CPs use different classifications. Bosnia and Herzegovina reported that indicators are calculated also according to the grounding of MV networks.

For three countries that provided disaggregated data according to the network type, the classification concepts are as follows:

- Bosnia and Herzegovina: in Republika Srpska the classification of distribution areas is done without formal definition by DSO as follows: city areas, outskirts, village areas (the indices are calculated aggregated only in Federation BiH);
- Ukraine: the Supreme Council Presidium Decree № 1654 X "Settlement of administrative-territorial structure" defines separation of urban settlements from rural settlements.

TABLE 8 LEVEL OF DETAIL IN INTERRUPTION RECORDING

Country	National	System Operators	Region	City/ District	Sub-station	Feeder	Customer	Voltage level	Causes	Urban/ Rural	Cable/ Overhead	Other
Albania	X							X	X	X	X	
Bosnia and Herzegovina	X	X	X (Partly)					X	X	X		X (grounding of MV network)
FYR of Macedonia	X	X			X	X		X	X			
Kosovo*	X							X	X (planned/ unplanned only)			
Montenegro	X							X	X			
Serbia	X							X	X			
Ukraine	X	X		X				X	X	X		

2.3.2. Indices for long and short interruptions

An overview of the different indices used for quantifying long interruptions as well as weighting method used when calculating indices is provided in Table 9.

SAIDI and SAIFI are the most commonly-used indices for distribution networks. Serbia calculates also the index Customer Average Interruption Duration Index (CAIDI) which is a derivate of SAIDI in SAIFI. The method of weighting impacts the results by introducing different bias. All CPs that calculate these indices use the same weighting method based on the number of customers: each customer is therefore treated equally, independent of its size and load profile. This is an important finding that has positive impact on benchmarking.

ENS and AIT are the most commonly-used indices for continuity of supply in transmission networks.

TABLE 9 LONG INTERRUPTION – INDICES FOR QUANTIFYING

Country	Index	Weighting (N/A for ENS)
Albania	Raw data on interruption properties and location of interruption only	The number of customers (identified manually)
Bosnia and Herzegovina	SAIDI & SAIFI ENS (Transmission)	The number of customers (manually, using the connectivity models or estimated)
FYR of Macedonia	Distribution -SAIDI, SAIFI, CAIDI (Requested by Grid Code, but no data yet)	Not applicable (no rules, SCADA is used on HV level)
Kosovo*	Distribution-SAIDI, SAIFI, ENS (Transmission)	The number of customers (manually by DSO)
Montenegro	SAIDI and SAIFI for DSO, ENS and AIT for TSO	Not applicable
Serbia	Distribution – SAIDI, SAIFI, CAIDI; AITS, ENS (Transmission)	Distribution indicators (SAIDI, SAIFI) – number of customers; transmission indicators (AIT) – average power supplied (weighting is done manually according to the NRA rules)
Ukraine	SAIDI, SAIFI, ENS (only for distribution; for Transmission – data not yet available)	The number of customers

The number of short interruptions per year (MAIFI) is used as indicator in Bosnia and Herzegovina (but only for the distribution network of the power utility "Elektroprivreda Republike Srpske") and in Ukraine, based on SCADA, where available. None of the CPs gathers data on transient interruptions.

2.4. ANALYSIS OF DATA ON CONTINUITY OF SUPPLY

This section provides an overview of the CPs' networks and compares the values of the most important indicators over a number of years. Even though the calculation methods slightly differ between the CPs, the results are shown in the same diagrams. When interpreting the results, the differences in calculation and scope of monitoring (voltage levels) should be considered.

For the purpose of this benchmarking, it is crucial to exclude the influence of CP specific factors from indices, caused by non-harmonized proprietary rules applied for interruption monitoring. The typical example is the influence of exceptional events. As it was not possible to neutralize the consequences of these differences between CPs by excluding the impact of the exceptional events from the reported CoS index values (exceptional events are mostly not excluded from the interruption statistics), it is also **very difficult to assess how exceptional events influence the interruption statistics of each CP. Accordingly, any conclusion concerning the level of continuity of supply that exclusively relates to the responsibility of the performance of system operators is not feasible**.

Due to the lack of availability of the required data and the problems of comparability, the benchmarking analysis is focused on the indices that have been provided by at least four CPs:

- representing the value aggregated on the national level;
- comprising interruptions at all voltage levels monitored;
- including the interruptions caused by exceptional events.

Furthermore, some additional analysis on the impact of planned interruptions is shown in the total statistics.

The reported set of indices per CP and the indices that are used in comparison (bold "X") are shown in Table 10.

TABLE 10 THE INDICES PROVIDED

Continuity indicator	Interruptions considered	Scope	BA	RS	UA	Kosovo*
UNPLANNED, SAIDI	**w/o exc. events (All networks)**	**Whole country**	**X**		**X**	**X**
UNPLANNED, SAIFI	**w/o exc. events (All networks)**	**Whole country**	**X**		**X**	**X**
UNPLANNED, SAIDI	**All interruptions (All networks)**	**Whole country**	**X**	**X**	**X**	**X**
UNPLANNED, SAIFI	**All interruptions (All networks)**	**Whole country**	**X**	**X**	**X**	**X**
PLANNED, SAIDI	**All interruptions (All networks)**	**Whole country**	**X**	**X**	**X**	**X**
PLANNED, SAIFI	**All interruptions (All networks)**	**Whole country**	**X**	**X**	**X**	**X**
UNPLANNED, MAIFI	All interruptions (All networks)	Whole country	X		X	
AIT (Transmission)	w/o exc. events (Only interruptions on T network)	Whole country, transmission system		X		X
ENS (Transmission)	**w/o exc. events (Only interruptions on T network)**	**Whole country, transmission system**	**X**	**X**		**X**
UNPLANNED, MAIFI	w/o exc. events (All networks),	Whole country			X	
Unplanned AIT (Transmission)	w/o exc. events (Only interruptions on T network)	Whole country, transmission system		X		
Planned AIT (Transmission)	w/o exc. events (Only interruptions on T network)	Whole country, transmission system		X		
Unplanned ENS (Transmission)	w/o exc. events (Only interruptions on T network)	Whole country, transmission system	X	X		
Planned ENS (Transmission)	w/o exc. events (Only interruptions on T network)	Whole country, transmission system	X	X		
UNPLANNED, SAIDI	w/o exc. events (Only interruptions on EHV networks)	Whole country, EHV	X			
UNPLANNED, SAIDI	w/o exc. events (Only interruptions on HV networks)	Whole country, HV			X	X
UNPLANNED, SAIDI	**w/o exc. events (Only interruptions on MV networks)**	**Whole country, MV**	**X**		**X**	
UNPLANNED, SAIDI	w/o exc. events (Only interruptions on LV networks)	Whole country, LV	X		X	X
UNPLANNED, SAIFI	w/o exc. events (Only interruptions on HV networks)	Whole country, HV			X	X
UNPLANNED, SAIFI	**w/o exc. events (Only interruptions on MV networks)**	**Whole country, MV**	**X**		**X**	
UNPLANNED, SAIFI	w/o exc. events (Only interruptions on LV networks)	Whole country, LV	X		X	X
UNPLANNED, MAIFI	w/o exc. events (Only interruptions on HV networks)	Whole country, HV			X	
UNPLANNED, MAIFI	w/o exc. events (Only interruptions on MV networks)	Whole country, MV			X	

Legend: All networks: EHV, HV, MV and LV; w/o exc. **Events:** Interruptions not attributable to exceptional events

Only two CPs, namely Bosnia and Herzegovina and Ukraine provided indices classified by territorial density. The reported set of indices per CP is shown in the table below.

TABLE 11 THE INDICES BY TERRITORIAL DENSITY

Continuity indicator	Interruptions considered	Scope	BA	UA
UNPLANNED, SAIDI	w/o exc. events (All networks)	Only urban areas	X	X
UNPLANNED, SAIFI	w/o exc. events (All networks)	Only urban areas	X	X
UNPLANNED, MAIFI	w/o exc. events (All networks)	Only urban areas		X
UNPLANNED, SAIDI	w/o exc. events (All networks)	Only suburban areas	X	
UNPLANNED, SAIFI	w/o exc. events (All networks)	Only suburban areas	X	
UNPLANNED, SAIDI	w/o exc. events (All networks)	Only rural areas	X	X
UNPLANNED, SAIFI	w/o exc. events (All networks)	Only rural areas	X	X
UNPLANNED, MAIFI	w/o exc. events (All networks)	Only rural areas		X

2.4.1. Interruptions originated on different voltage levels

Considering all facts and issues discussed above, strengthened by the fact that incidents on MV contribute to the continuity indices the most (at least 70%), the available aggregated data of all those comparable indices that comprises the interruptions that occurred on MV was benchmarked among the CPs.

Due to the identified problems concerning the calculation of indices SAIDI and SAIFI on transmission level, the following analysis covers only the incidents that occurred on HV, MV and LV voltage levels. The contribution of Extra High Voltage (EHV) is therefore not considered in the analysis.

TABLE 12 UNPLANNED SAIDI (ALL EVENTS; HV, MV, LV) – THE DISTRIBUTION OF INCIDENTS ACCORDING TO THEIR VOLTAGE LEVEL [%]

Country	2011	2012	2013	2014	Avg
Albania – LV	n/a	n/a	n/a	n/a	n/a
Albania – MV	n/a	96.33	84.60	77.57	86.17
Albania – HV	n/a	15.88	33.10	34.25	27.74
Bosnia and Herzegovina (E RS only) - LV					
Bosnia and Herzegovina (E RS only) - MV					
Bosnia and Herzegovina (E RS only) - HV					
FYR of Macedonia - LV					
FYR of Macedonia - MV					
Kosovo* - LV		92.5	89	93	91
Kosovo* - MV					
Montenegro - LV					
Montenegro - MV					
Serbia - LV					
Serbia - MV					
Ukraine - LV	86.3	75.6	86.2	91.9	85.0
Ukraine - MV	428.1	429.3	435.7	435.9	432.3
Ukraine - HV (1)	4.4	6.9	5.2	6.5	5.8

(1) Not attributable to exceptional events.

TABLE 13 UNPLANNED SAIFI (ALL EVENTS; HV, MV, LV) – THE DISTRIBUTION OF INCIDENTS ACCORDING TO THEIR VOLTAGE LEVEL [%]

Country	2011	2012	2013	2014	Avg
Albania – LV	n/a	n/a	n/a	n/a	n/a
Albania – MV	n/a	29.22	42.60	39.71	37.18
Albania – HV	n/a	7.19	10.50	12.15	9.94
Bosnia and Herzegovina (E RS only) - LV					
Bosnia and Herzegovina (E RS only) - MV					
Bosnia and Herzegovina (E RS only) - HV					
FYR of Macedonia - LV					
FYR of Macedonia - MV					
Kosovo*- LV		96	96	93	95
Kosovo*- MV					
Montenegro - LV					
Montenegro - MV					
Serbia - LV					
Serbia - MV					
Ukraine - LV	0.52	0.52	0.64	0.66	0.58
Ukraine - MV	3.41	3.68	3.83	3.94	3.72
Ukraine - HV (1)	0.12	0.14	0.11	0.12	0.12

(1) Not attributable to exceptional events.

In average, about 85% of SAIDI and SAIFI are reasoned by incidents on MV. It is important to point out that incidents at EHV were not considered in this analysis – from the experience in the EU Member States, this portion is very small, especially if observed in the networks with relative small ratio of undergrounding on MV and LV.

2.4.2. The evaluation of the impact of exceptional events

A difference between the same type of indices comprising the exceptional events and those excluding exceptional events was identified in several CPs. This may be an indication of the presence of the exceptional events in the continuity indices – according to the CPs' rules on classification of interruption causes.

The following analysis provides a comparison of the indices including interruptions that were recorded in all networks with exceptional events included and those reported with exceptional events excluded (SAIDI and SAIFI due to incidents at MV only). The disaggregated data on continuity indices without exceptional events that include the interruptions recorded at HV, MV and sometimes also LV (Ukraine) voltage levels was aggregated and compared with the aggregated indices comprising the exceptional events: according to the definition, latter should comprise also the interruptions recorded at EHV.

The contribution of interruptions recorded on MV (supposedly without exceptional events) in the aggregated indices (covering interruptions in all networks and supposedly comprising exceptional events) is shown in the tables below (Table 14, Table 15): by analyzing the extent of the contribution on MV we can assume the contribution of interruptions recorded at EHV (also LV and/or HV, depending on each CP) and those caused by the exceptional events in the indices.

TABLE 14 UNPLANNED SAIFI (ALL EVENTS; HV, MV, LV) – THE DISTRIBUTION OF INCIDENTS ACCORDING TO THEIR VOLTAGE LEVEL [%]

Country	2011	2012	2013	2014
Albania - MV				
Albania - Other (HV, EHV, exceptional events)				
Bosnia and Herzegovina - MV				
Bosnia and Herzegovina - Other (HV, EHV, exceptional events)				
FYR of Macedonia - MV				
FYR of Macedonia - Other (HV, EHV, exceptional events)				
Kosovo* - MV				
Kosovo* - Other (HV, EHV, exceptional events)		7.47	10.78	6.69
Montenegro - MV				
Montenegro - Other (HV, EHV, exceptional events)				
Serbia - MV			52.58	
Serbia - Other (HV, EHV, exceptional events)				
Ukraine - MV (1)	428.1	429.3	435.7	435.9
Ukraine - Other (LV, HV, EHV, exceptional events) (2)	221.4	305.6	267.2	1972.2

(1) Not attributable to exceptional events.
(2) Including exceptional events.

TABLE 15 UNPLANNED SAIFI (ALL EVENTS) – CONTRIBUTION OF MV TO THE AGGREGATED VALUE [%]

Country	2011	2012	2013	2014
Albania - MV				
Albania - Other (HV, EHV, exceptional events)				
Bosnia and Herzegovina - MV				
Bosnia and Herzegovina - Other (HV, EHV, exceptional events)				
FYR of Macedonia - MV				
FYR of Macedonia - Other (HV, EHV, exceptional events)				
Kosovo* - MV				
Kosovo*- Other (HV, EHV, exceptional events)		3.21	3.97	6.86
Montenegro - MV				
Montenegro - Other (HV, EHV, exceptional events)				
Serbia - MV			73.1	
Serbia - Other (HV, EHV, exceptional events)				
Ukraine - MV (1)	3.41	3.68	3.83	3.94
Ukraine - Other (LV, HV, EHV, exceptional events) (2)	1.45	1.64	1.73	9.62

(1) Not attributable to exceptional events.
(2) Including exceptional events.

Due to the identified problems related to the robustness of the provided data, the impact of different sets of voltage levels considered in the calculation of indices[9] is difficult to evaluate. If the presence of exceptional events is neglected, the difference between the aggregated value of indices and the values containing the interruptions on MV only represents the contribution of other voltage levels to the aggregated value of indices, including the EHV (the contribution of interruptions that could be attributed to the transmission exceeds the EU average). Possible reasons for this are:

- the "leakage" in recording of interruptions on MV (mostly manual processing): the portion of interruptions recorded on MV is lower than expected;
- differences between CPs as regards rules and practice for the recording of interruptions and, even more, the calculation of indices SAIDI and SAIFI on EHV level (transmission) due to different weighting methods used for calculation and the usage of estimation methods;
- differences between CPs as regards rules and interpretation of exceptional events.

9. i.e. inclusion/exclusion of interruptions recorded at EHV/LV level in different sets of indexes.

2.4.3. Network characteristics

An overview on available system data of particular CPs is given in Table 16. The networks vary a lot across CPs in their size and structure.

TABLE 16 INFORMATION ON NETWORK, EQUIPMENT, ENERGY SUPPLIED, NUMBER OF CUSTOMERS

SYSTEM DATA	measure unit	Albania	Bosnia and Herzegovina	FYR of Macedonia	Kosovo*	Montenegro	Serbia	Ukraine
Item # 1 - Length of networks		2014	2014	2014	2014	2014	2014	2014
Total length of circuits - EHV network	km				188		3498	22332
Total length of circuits - HV network	km			212	1043	1.300,40	5910	41200
Length of cable circuits - MV network	km			2.777	1166	1.420	13118	47108
Total length of circuits - MV network	km			8.662	6543	5.890	48557	349268
Length of cable circuits - LV network	km			3.697	423	1.686,42	15456	38313
Total length of circuits - LV network	km			15.452	11243	13.216	110018	415606
Item # 2 - Energy								
Transmitted/distributed energy (all customers)	TWh				5.2	3.267	28	133.9
Distributed energy (only MV and LV customers)	TWh			4.973	4.6	2.426	25	85.8
Item # 3 - Customers								
Number of MV connection points of final customers								92201
Number of LV connection points of final customers	number			699.948	491586	384.186	3579080	20776431
Item # 4 - Equipment								
Number of MV feeders starting from HV/MV or EHV/MV transf. stations	number			1.480	352			22825
Number of MV feeders equipped with remote control (SCADA)	number			642	149			13975 (1)
Item # 5 - General info								
Number of Distribution System Operators	number			2	1	1	5	44
Customers served by the largest Distribution System Operators	number			700.897	491823	384.732	935158	1836659
Customers served by the three largest Distribution System Operators	number			700.897	There is only one DSO	384.732-	2715105	4563995

(1) 2013 data.

Remark:
Total length as sum of length of underground cable circuits, bare overhead lines and insulated overhead lines (overhead cables). Distributed energy excluding self-consumption.

2.5. CONTINUITY STANDARDS AND INCENTIVE SCHEMES

The following section provides an overview of the existing frameworks of continuity of supply regulation in the CPs. It will also illustrate which indicators and standards are used in this regard.

In the subsequent sections different terminology is used for the required performance defined by the NRAs by means of setting the targets on continuity at the system level:

- continuity standards set on system level;
- overall (continuity) standards;
- (average) required performance;
- (average) performance targets.

While some of the terms are not often used, some have a sound base in the CEER documents[10]. However, harmonization has not been achieved yet.

The regulation frameworks are assessed on two different levels:

1. Continuity standards at system level with the quality reward/penalty regimes;
2. Continuity standards at single-customer level with the customer compensation schemes

The development of the regulation frameworks in the CPs is on an initial stage in the prevailing number of cases. The main emphasis is put on continuity monitoring, however, from the responses on questionnaires provided by many CPs, it can be concluded that activities for assuring the maintenance and improvement of continuity levels, as well as activities to protect the worst served customers are ongoing or will be started soon.

TABLE 17 AN OVERVIEW ON EXISTING CONTINUITY STANDARDS AND INCENTIVE SCHEMES

Standards and regulation	Overall standards	Individual standards	Overall reward/ penalty scheme	Individual compensations
Distribution	Kosovo*	MD, ME (1), RS (2)		
Transmission	Kosovo*	RS	-	-
Definition of worst served customer	-			
Responsibility	Al, BA, ME, UA (NRA); MK, RS, Kosovo* (Shared)			
Publication of indices	AL (monthly), BA, Kosovo* (annually)			
Intention/plans for implementation	MK (2016-2018), ME (2012), RS (2013-2015), UA (ongoing)			

(1) Individual standards: for individual large industrial customers (e.g. KAP-Aluminium Plant) connection to 110 kV in which technical processes require special conditions regarding continuity and quality of supply.
(2) Defined by the Decree on Conditions for Electricity Delivery and the Grid Code.

No explicit regulatory or other definitions of the worse served customer are applied. Not all CPs publish data on indicators but, if, they are published mostly on annual basis. Only Albania reported monthly publication.

Montenegro protects special large industrial customers only by individual standards on continuity of supply. Serbia also applies individual standards applied and set minimal requirements on duration of interruptions but no compensation scheme. Also in Kosovo*, the overall standards on continuity of supply were applied for 2011.

The economic effects and outcomes of the regulatory actions cannot be addressed, due to lack of data availability.

10. i.e. papers on smart grids, such as: Status Review on Regulatory Aspects of Smart Metering (Electricity and Gas) as of May 2009 (http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Customers/Tab/E09-RMF-17-03_SmartMetering-SR_19-Oct-09.pdf), Final Guidelines of Good Practice on Regulatory Aspects of Smart Metering for Electricity and Gas (http://www.ceer.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Customers/Tab2/E10-RMF-29-05_GGP_SM_8-Feb-2011.pdf) etc.

2.6. EXPECTED DEVELOPMENTS ON CONTINUITY OF SUPPLY REGULATION

The regulation of continuity of supply will be for sure subject to further changes and developments in the future. Many CPs that have not implemented related rules yet will do so, while others will focus on improving their regulation. Making use of the experience and good regulatory practice within the EU will be of great help to CPs.

CPs are working towards a more comprehensive approach in regulation of continuity of supply, some of them analyzing the possibility to introduce the reward-penalty mechanism (a link between the continuity and tariffs).

All observed CPs have initially put emphasis to improvement and assurance of the preconditions for the regulation of continuity of supply. Monitoring of continuity of supply on all levels with the highest level of detail, backed up with harmonized and standardized rules shall be wrapped up with the continuous publication of data. The transparency of the achieved level of continuity of supply is the very first step in a long journey towards better regulation.

2.7. FINDINGS AND RECOMMENDATIONS ON CONTINUITY OF SUPPLY

Monitoring is applied in all CPs that participated in the survey. As a first objective pursued by the regulators and as the core component of the service quality regulation framework, **monitoring has widely reached the phase that can start to back-up regulatory decisions** successfully. Different approaches to the regulation – driven by CPs' legal frameworks and, in particular, different monitoring methodologies used, combined with different geographical, meteorological characteristics, different networks structures and age – make benchmarking of actual levels of continuity of supply difficult.

The comparative analysis of the monitoring schemes and the continuity of supply regulation across CPs shows that **regulators have generally approached continuity issues with emphasis on long interruptions first, treating the planned and unplanned interruptions separately. Distinction is made between different voltage levels and the classification of the interruptions by its cause is as well applied. In several CPs both number and duration of interruptions are available and almost harmonized combinations of indicators (SAIDI, SAIFI) are used. Short interruptions are barely recorded**. Few examples of regulatory practices with advanced regulation instruments applied, by means of continuity standards and incentive schemes, are identified in the region as well.

Monitoring schemes are developing and are currently in different development stages:

- monitoring is focused mostly on long interruptions;
- monitoring on transmission level is not applied in all CPs;
- monitoring is performed in different level of detail;
- different sets of indicators are used, although basic indicators (i.e. SAIDI, SAIFI, ENS) are widely used;
- not all incidents are considered in the statistics (i.e. LV).

A lack of harmonization in the basic monitoring rules is also identified, but it is not predominant. The lack of emphasis on monitoring of continuity at the transmission level in some CPs may be result of an underestimation of its importance due to the robust network design enabling high reliability ("n-1" operational criteria), apparent low number of customers connected to the transmission network, the problem of weighting (atypical customers, specifics in calculation of certain continuity indexes) and the estimation (i.e. "ENS" based indices).

All CPs are encouraged to strengthen their efforts on further developing and optimizing their monitoring process and make further steps towards comprehensive and robust monitoring schemes. The transparency of data and its quality is essential. Findings and recommendations are provided as follows:

Finding 1
Rules, business processes and tools for automatic logging of interruptions are not applied in all countries

Many CPs reported only limited use of SCADA and prevailing manual recording of interruptions. Lack of rules for automatic recording of interruptions has a direct impact on completeness, robustness and the quality of data on interruptions collected. Decisions taken (by the regulator or the system operator) on the basis of such data may be misleading. Also auditing such data is time consuming and not efficient.

RECOMMENDATION 1

EFFICIENT RULES FOR AUTOMATIC LOGGING OF INTERRUPTIONS HAVE TO BE INTRODUCED

Implementations of SCADA and its Distribution Management System (DMS) functions in a wider scope that to a larger extent enable automatic logging (at least for EHV, HV and MV voltage levels) is crucial for efficient monitoring of continuity of supply.

It is recommended that all CPs define rules for automatic logging of interruptions. These rules on recording should be harmonized. Deviations or CP specific rules should be adequately upheld.

Finding 2
Harmonization of interruption definitions is not achieved and the monitoring schemes are lacking comprehensiveness and efficiency

Some minor differences in definitions of interruptions exist. Available norms (EN 50160) and guidelines of good practice (5th CEER Benchmarking Report on Quality of Electricity Supply, 2011 are used. Not all types of interruptions are monitored. Transient interruptions are not monitored by any of the CPs and monitoring schemes are lacking efficiency: the main problem is in the way how the interruptions are recorded – in the absence of SCADA or Advance Metering Infrastructure (AMI) (i.e. for recording the interruptions on LV), manual logging of interruptions and data processing does not assure required efficiency and reliability of data.

RECOMMENDATION 2

MONITORING OF ALL BASIC INTERRUPTIONS TYPES SHOULD BE INTRODUCED, BASED ON HARMONIZED DEFINITIONS

It is recommended that all CPs harmonize their definitions for basic interruption types (firstly long, secondly short and, if justifiable, transient). Available norms and examples of good practice could be used as a basis for harmonization process.

Harmonization should aimed at meeting the following criteria:
- long interruptions > 3 min
- short interruptions > 1 s and ≤ 3 min
- transient interruptions ≤ 1 s

This way, the definitions of interruptions would be aligned with the definitions of interruptions provided by EN 50160 as well as with European practices (5th CEER Benchmarking Report on Quality of Electricity Supply, 2011).

Short interruptions do also have a negative impact on business and industrial customers, aside of household customers, and should therefore also get appropriate attention by the regulators.
It is recommended that some type of monitoring scheme for short interruptions is in place.

The fact that SCADA will be implemented in many CPs from scratch provides a good opportunity for the CPs to plan appropriate SCADA functions and the appropriate level of network coverage by SCADA, to ensure automatic recording of short interruptions. SCADA is usually implemented starting at the highest voltage levels and moving to the high-load-density parts of the lower-voltage levels. Short interruptions occur mainly in the low-load-density parts of the lower-voltage levels. This important technical issue needs to be considered when planning the introduction of SCADA. The costs needed for such comprehensive monitoring scheme will be lower in comparison to the situations where existing SCADA lacking functionality is upgraded. It is important for CPs to consider all related aspects; among those are rules for aggregation of interruptions that occur in a short time span.

NRAs should also decide on the extension of monitoring schemes with the transient interruptions.

Finding 3
Continuity statistics do not include incidents at all voltage levels

None of the CPs has established efficient monitoring schemes for recording interruptions on all voltage levels. While interruptions are recorded separately according to the particular voltage level in most CPs, the monitoring is not always performed on all voltage levels. Usually, data is collected on the HV and MV level only. LV has not been sufficiently covered yet – in the early stage, a similar status was observed in the EU. Consequently, whenever interruptions on the LV level are not monitored, the consumers connected to these levels (which are all domestic customers and the majority of non-domestic customers) will be affected more than suggested by the provided data.

The lack of monitoring or inefficient monitoring at LV level could result in a significant underestimation of the number and duration of interruptions experienced by low voltage customers (unplanned and planned), especially in urban areas, but also on CP level. Indeed, even if each incident in LV will affect much fewer customers than each incident on MV and higher voltage levels, incidents on LV cannot be neglected: the resulting interruptions often last longer[11] than interruptions due to incidents at higher voltage levels and are also important in number[12]. The SAIDI contribution from LV therefore might be even underestimated.

RECOMMENDATION 3

INTERRUPTIONS SHOULD BE ALSO MONITORED AT LV LEVEL

All CPs are encouraged to include monitoring of interruptions at all voltage levels including LV in the continuity of supply statistics. The cost-benefit analysis should be performed to evaluate different possibilities:

- automated recording based on AMI;
- development of methods for estimation of duration and number of affected customers (i.e. using functions of call centers);
- other (i.e. protection equipment in LV feeders under supervision of SCADA).

Wherever manual logging is applied, system operators should be more vigilant regarding manual entries of outages in LV networks. This can be supported by appropriate organizational and technical measures.

Finding 4
Categories of interruption causes vary between CPs

Information on causes is essential for DSOs to improve continuity of supply. This is also true for the NRA to identify and approve appropriate investments in time. Such information should be collected by system operators as detailed as possible. There is no need for harmonization of the certain types of causes, but it may be useful to achieve harmonization of main categories.

Especially, the treatment of so called "third party" causes is sometimes mixed with the cause category of "exceptional events".

RECOMMENDATION 4

THE BASIC CAUSE CATEGORIZATION SHOULD BE HARMONIZED

The harmonization of basic cause categories between the CPs is recommended. Also, a clean split between third party and exceptional events categories is highly recommended.

We recommend the use of the following three main cause categories:

- the responsibility of system operator;
- third party; and
- exceptional events

Each interruption cause (not necessarily harmonized) shall be linked to the appropriate category.
The usage of causes like "other", "not available", "unexplained" as main categories should be avoided as much as possible. Such causes may be used only as sub-types, being therefore linked to the particular cause category.

Among the interruption causes in the category "third party", the responsibility of another system operator (DSO or TSO) for an interruption shall be distinguished from the others by its own dedicated type of cause: the interruptions caused by another system operator need to be easily identifiable in the processes of determining the responsible party for the damages caused by interruptions.

The distinction between the main cause categories (to avoid mixing the "third party" and "exceptional events") shall be achieved by clear definitions.

11. LV networks are usually radial networks without redundancy.
12. According to the experience in some EU countries, the contribution of interruptions from LV to the continuity indicators (SAIFI and SAIDI) varies from 7% up to 30% on national level – this analysis is based on the evaluation of impacts of incidents on LV network that are mostly estimated based on notification through the phone calls (AMI is not installed).

Finding 5
Level of detail in calculating continuity indicators differs among CPs

Due to the fact that continuity is benchmarked using indices that include exceptional events and that explicit information on such events was not provided, any conclusion on trends would be misleading. More historical, year-to-year data would be needed for "in-depth" analyses.

The calculation on the level of individual system operators, region and area is not a common practice in CPs. Only two CPs calculate the indices in such detail. Also, only few CPs reported that they calculate indices per network type (according to the population density) – among them only3 CPs provided data on such indices. In each of these three CP the continuity of supply is much better in urban areas than in rural areas.

The lack of disaggregated CoS data hinders NRAs and system operators in their decisions (regulatory, R&D) on measures to be taken.

RECOMMENDATION 5

LOGGING OF INTERRUPTIONS SHALL COMPRISE ALL NECESSARY DETAILS TO ENABLE DISAGGREGATED CALCULATION OF CONTINUITY INDICES

Network operators should use the extended set of interruption properties[13] when recording and post-processing interruption data. Such comprehensive approach enables the calculation of disaggregated indices. For that purpose, system operators should meet the technical preconditions for obtaining such data and implement the appropriate business processes for backing up the necessary post-processing of data.

System operators should be required to provide aggregated and disaggregated continuity data (on voltage levels, network types, etc.) to the NRA.

For NRAs, it is important to calculate the indices per system operator with a view to benchmark their performance and identify possible larger differences in the level of continuity of supply. The calculation of indices according to the network type (rural/suburban/urban networks) provides the essential information for decisions on measures for improvement of continuity of supply.

It is therefore recommended that indicators are calculated for each system operator separately, as well as according to the population density (urban/suburban/rural). The latter requires rules for classification that may not be harmonized, due to differences in the network structure and geography, as well as demographic characteristics of CPs. Non aggregated calculation of indices will ensure better flexibility for NRA when designing regulatory incentive schemes[14].

NRAs are encouraged to continue monitoring of CoS based on an extended set of indicators. Historic data, aggregated and disaggregated data (on voltage levels, network types, etc.) is essential for identifying trends and performing correlation analyses. Monitoring scheme should evolve in such a way to assure CoS data for wider time-spans, as well as in greater detail: disaggregated data should be calculated in order to identify problems and direct priorities.

13. Control area, i.e. population density (urban/suburban/rural), voltage level, network type (cable/overhead), cause, sub-cause etc.
14. For example the differences in the level of continuity of supply according to the population density should be considered when applying the minimal continuity standards.

Finding 6

Lack of explicit information on the use of concepts of "exceptional events" hinder the impact analysis of "exceptional events" on the level of continuity

Some interruptions are considered to be due to exceptional events and they are either not considered in the continuity statistics or are treated separately. From the available information, it is hard to evaluate the real use of the concept of "exceptional events", even if its application is widely reported by CPs. Different CPs use different criteria for defining an interruption as exceptional event.

Where exceptional events are displayed in the statistics, knowledge on the contribution of exceptional event is of utmost importance when analyzing continuity of supply data. Although concepts of "exceptional events" are reported to be applied, the impact of exceptional events is not clearly clear – the estimated contribution of exceptional events is more or less constant. This indicates that the concepts of "exceptional events" are not properly defined or used – the classification of incidents as an exceptional events may comprise also the interruptions due to the weather circumstances that occur once a year or more often (as lightning etc.).

RECOMMENDATION 6

PROPER USE AND TRANSPARENCY OF CONCEPTS OF "EXCEPTIONAL EVENTS" SHOULD BE ASSURED

The possibilities for harmonization of definitions on exceptional events should be explored. It is recommended that CPs harmonize the definition by means of the common characteristics of the natural and non-natural exceptional event. An exceptional event that is beyond the control of the system operator is characterized as:

1. unforeseeable;
2. unpredictable;
3. unpreventable;
4. unavoidable.

All four event characteristics must be confirmed for the event to classify as "exceptional". Furthermore, the weather circumstances that occur once a year or more often should not be considered as exceptional events. Lightning should not be treated as an exceptional event anywhere in the Energy Community since it is a foreseeable and predictable event in all CPs. The CP specifics aggravate the harmonization in further detail[15]. Harmonization of such detail is not feasible.

Until adequate harmonization has been achieved, it is recommended for each CP to transparently use the definitions and designations of their own regulation. The use of expressions, like "exceptional events", with an apparent intuitive meaning, but without a clear definition of the manner in which it is used can result in misinterpretation.

Network operators should appropriately and reasonably minimize effects of events that are outside of their control, in line with appropriate regulatory schemes.

15. For example, if snowstorms are not an exceptional event in the northern countries, it could be seen as an exceptional event in southern parts of the Energy Community.

Finding 7
The set of indicators in use does not provide a complete picture of continuity of supply

Most of the CPs calculate SAIDI and SAIFI for distribution networks and ENS (also AIT) for transmission networks. The main interruption properties (duration and frequency) are therefore covered on distribution level only.

Some CPs do not calculate indices for transmission, some reported the use of (rough) estimation when calculating indices. Besides, indicators that express the level of continuity in terms of interruption frequency in transmission networks are not calculated.

RECOMMENDATION 7

THE NUMBER OF CONTINUITY INDICES USED SHOULD BE EXTENDED

The use of multiple indicators to quantify CoS provides more information and, therefore, more possibilities to observe trends. Frequency and duration should be observed from different aspects, using different indicators.

CPs are encouraged to gradually extend the set of continuity indicators used. For a balanced view on the achieved level of CoS, indices should always cover both duration and frequency of interruptions. The recommended set could be SAIDI, SAIFI, MAIFI for distribution and ENS, AIT, SAIFI and MAIFI for transmission. The following transmission user types can be used for the calculation of SAIFI and MAIFI (transmission):

1. using three types of transmission users: HV transformation stations (counted each as 1 user, independently from number and size of transformers installed), HV/EHV final customer (large industry) and producers connected to transmission grid) or
2. using of the whole number of the affected network users (at the transmission and all lower voltage levels (distribution)).

Whenever the first option is chosen, the results should be accompanied by information on the weighting method. Also, the aggregation of the indicators calculated using different user types (i.e. in the transmission and distribution levels) should be avoided. The minimal set of indices used for measuring the level of continuity of supply in distribution and transmission should be harmonized.

Finding 8
Publication of continuity data is not performed in all CPs and differs

The publication of continuity data is not performed by all countries. Also, the frequency of reporting varies across countries. Publication of continuity data usually does not consider exceptional events.

RECOMMENDATION 8

PUBLICATION OF CONTINUITY DATA ON A REGULAR BASIS WITH EXPLANATORY NOTES

Publication of data is one of the primary regulatory instruments and should be applied as soon as data is available. Published comparison of company performance is very effective: it simulates a competitive environment and encourages companies to make improvements. Comparisons on supranational level are useful for NRAs in the process of developing and improving their quality regulation schemes and CP related performance.

It is recommended that system operators publish CoS data regularly and at least once a year. System operators should provide explanatory notes on the data published. NRAs should likewise regularly publish CoS data aggregated on CP level, including remarks regarding system operators' performance.

It is recommended for any publication of continuity of supply data to include information on included and excluded interruptions, together with information about those situations that are treated specifically. This especially applies to exceptional events.

In case of exclusions disaggregated CoS data should be provided for regulatory purposes.

The cooperation and the exchange of experience between the CPs via the ECRB provide helpful support. The examples of good practice and lessons learned on EU level should also be considered.

Finding 9
Minimal continuity standards and incentive schemes are rare and have different formulations

The regulation framework in CPs is mostly in an initial stage. Therefore, incentive schemes on system level (reward/penalty schemes based on overall continuity standards (references) influencing the tariff) or individual level (guaranteed standards with the compensation payments to customers) are rare. According to the maturity of the continuity regulation, such status is not uncommon and expected. The few schemes that are applied are not similar and are rather simple.

RECOMMENDATION 9

GRADUAL IMPLEMENTATION OF INCENTIVE MECHANISMS IS ENCOURAGED

The examples of reward/penalty regimes already applied for several years in many countries of the EU show their positive impact in improving or preserving the level of continuity of supply. It is therefore recommended that each CP develop its own reward/penalty regime taking into account its specific conditions[16]. The development of regulation should be gradual and the prerequisites for incentive schemes at any level should include robust monitoring scheme and audits.

It is recommended that a step-by-step approach is used in setting minimal standards on continuity of supply. Robust historical data is a prerequisite for such decisions. Gradual implementation of minimal standards (in the form of overall and guaranteed standards) will encourage the development of different incentive mechanisms (reward/penalty schemes and/or compensation payments) to maintain and further improve the level of continuity supply.

16. Network development, investment levels, regional differences and automation projects.

3 VOLTAGE QUALITY

3.1. INTRODUCTION

This chapter provides an overview of the existing practice in voltage quality monitoring and regulation on transmission and distribution level in CPs. Review and analysis of collected voltage quality data shows that activities towards the introduction of voltage quality monitoring and regulation have started in all CPs. However the activities are only in an initial stage and consequently CPs were not able to provide a complete set of data on all voltage quality aspects. The following aspects were analyzed:

1. Voltage quality regulation and legislation;
2a. Voltage quality monitoring system (VQMS);
2b. Data collection, aggregation and publication from VQMS;
3. Voltage quality indicators;
4. Actual data for voltage dips, other VQ parameters and mitigation measures; and
5. Studies on estimation of costs due to poor voltage quality.

Information provided by the CPs on these categories is provided in Table 18.

TABLE 18 INDICATION OF PROVIDED VOLTAGE QUALITY INFORMATION BY DIFFERENT CPS

EnC Contracting Party	Voltage quality regulation and legislation	Voltage quality monitoring system	Data collection, aggregation and publication	VQ indicators	Actual VQ data and mitigation measures	Studies on estimation of costs due to poor VQ
Albania	Yes					
Bosnia and Herzegovina	Yes	Yes	Yes	Yes	Yes	
FYR of Macedonia	Yes	Yes	Yes	Yes		
Kosovo*	Yes			Yes		
Montenegro	Yes			Yes		
Serbia	Yes			Yes		
Ukraine	Yes			Yes		

The table shows that **most of the data is not available yet**. The analysis of this chapter therefore focuses on an overview of the development status of voltage quality monitoring and regulation in the individual CPs.

3.2. VOLTAGE QUALITY LEGISLATION, REGULATION AND STANDARDIZATION

Data regarding voltage quality implementation via legislation, regulation and standardization are provided by all the CPs. This implies that CPs have recognized the need for introducing voltage quality requirements into their legal and regulatory framework. Most of the CPs have adopted standard EN 50160 and other VQ and EMC related standards and have created VQ provisions in line with those standards. However, **direct obligations and procedures regarding voltage quality monitoring and regulation are still not clearly defined in the legislation and therefore need to be more directly addressed in the future by adjustments and improvements of legislation and regulation in the CPs.**

3.2.1. Introducing EN 50160

The majority of CPs implemented EN 50160, mainly as a voluntary standard or, also, in legislation and regulation. It is usually defined in the general conditions of supply or network codes, either by a reference to EN 50160 or by directly using the limits required by EN 50160 in legislation or regulation. Consequently, **EN 50160 can be considered the basic instrument for voltage quality assessment in the CPs.**

EN 50160 is mainly applied on low and medium voltage levels up to 35 kV. In the majority of CPs where it is implemented, EN 50160 is predominantly used as a standard for supply voltage variations. The implementation status of EN 50160 in each of the reporting CPs is presented in Table 19

TABLE 19 EN 50160 IMPLEMENTATION STATUS

EnC Contracting Party	Implementation status	Different standards from EN 510160 and the way they are enforced
Albania	Voluntary standard	Yes, national law
Bosnia and Herzegovina	partially, General conditions of supply and Grid Code; BA: fully from 2016 Republika Srpska: fully from 2015	Yes, national law, grid/distribution code
FYR of Macedonia	Yes partially MKC EN 50160:2009, Grid Code;	Yes, national law, grid/distribution codes
Kosovo*	Yes	Yes, distribution code
Montenegro	No	Yes, grid/distribution codes
Serbia	Voluntary standard.	Yes, national law, grid/distribution code
Ukraine	implemented as a voluntary standard	Yes, standards committee

3.2.2. Legislation and regulations that differ from EN 50160

All CPs have introduced voltage quality requirements **going beyond EN 50160** in their legislation and regulation. Voltage quality standards that are different from those indicated in EN 50160 are implemented for some voltage characteristics, mainly via laws and network codes, as presented in Table 19. In Ukraine, voltage quality limits for different voltage characteristics are defined by an interstate standard on voltage quality, GOST 13109-97, approved by the *Interstate Council of standardization, metrology and certification*.

The limits that are defined in legislation and network codes on supply voltage variations mainly correspond to EN 50160 for MV and LV level. In some CPs more strict requirements for supply voltage variations are in place. Voltage limits on other voltage levels are mainly ±5% for 400 kV, ±10% or ±5% for 220 kV and ±10% for 110 kV. Currently applied voltage quality standards in observed CPs are shown in Table 20.

TABLE 20 VQ STANDARDS ENFORCED/USED AT NATIONAL LEVEL

EnC Contracting Party	Supply voltage variation standards	VQ standards for other voltage characteristics
Albania	400 kV: +5%, -10%; 220, 150, 110 kV: ±10%; 35 kV: 31-39 kV; 20 kV: 24 kV (highest voltage); 10 kV: 10,75 kV (highest voltage); 380 V, 220 V: +10%, -15%	No
Bosnia and Herzegovina	Partially EN 50160, IEC 60038 400kV: ±5%; 220kV: ±10% HV, MV: ±10% LV: ±10%(RS), +5%, -10% (BA)	Yes, IEC 61000-3-6, IEC 61000-3-7 IEC 61000-3-12, national standards
FYR of Macedonia	EHV: ±5%; HV, MV: ±10% LV: +5%, -10%	No, MKC EN 50160:2009
Kosovo*	400 kV: ±5%, (exceptional event ±10%); 220 kV: ±5%, (exceptional event ±10%); 110 kV: ±10%, (exceptional event 88 to 130kV); MV, LV: (35kV, 20kV, 10kV, 6.3kV, 400 V, 230V): +10%; -15%	Yes, distribution code
Montenegro	400 kV: +5%; 220 kV: ±10%; 110 kV: ±10%; 35 and 10 kV: ±5% LV: ±10%;	No
Serbia	400kV: ±5%; 220kV: 200-240kV HV, MV, LV: ±10%	
Ukraine	All voltage levels: ±5% (95% of the time) ±10% (marginal voltage variation) or EN 50160:2010 (with some amends: LV voltage 220 kV) (must be determined in contract)	Yes, GOST 13109-97 and EN 50160:2010

3.2.3. Obligations for monitoring voltage quality

Monitoring voltage quality requires monitoring of voltage quality parameters with voltage quality monitoring instruments in such a way that provides a system-wide evaluation. In some CPs, a direct obligation for the TSO/DSOs to measure voltage quality parameters on a continuous basis or at predefined intervals has been introduced by legislation and regulation.

However, **in the majority of the CPs detailed procedures and obligations for the establishment of a voltage quality monitoring system have not been defined in the legal and regulatory framework yet**. Only in FYR Macedonia legislation defines detailed procedure and obligations for the implementation of a voltage quality monitoring system: in line with the provisions for implementation of a voltage quality monitoring system, the legal framework in FYR of Macedonia also prescribes provisions for collection, aggregation and publication of voltage quality data from the voltage quality monitoring system.

In the other CPs, no specific requirements regarding voltage quality measuring have been implemented in legislation and regulation, except for Bosnia and Herzegovina where the General Conditions[17] require that measurements of voltage quality have to be in accordance with IEC 61000-4 or with the respective standard in Bosnia and Herzegovina (BAS). In some CPs certain requirements for voltage quality monitoring instruments still exist from the time before the NRA was operational.

In the majority of the CPs, TSO/DSOs are legally obliged to install a voltage quality recorder only upon request of an end-user who experiences problems due to insufficient voltage quality at its own connection point. For the rest of the reporting CPs, the common practice is that voltage quality monitoring is performed even if the TSO/DSOs are not legally obliged to do so. In most of the cases, the costs are covered by the TSO/DSO, while in some CPs the costs are charged to the customer in case that the voltage quality proofs to comply with the requirements. A possibility for an end-user to install its own voltage quality recorder and use measurement in a dispute with the TSO/DSOs is not recognized in the majority of the CPs, except in Ukraine where such a procedure is defined. Monetary penalties in cases where quality limits are not met are foreseen only in Ukraine.

3.2.4. Individual information on voltage quality

The obligation of providing individual information on voltage quality is still not legally defined in the majority of the CPs. Only in Bosnia and Herzegovina TSO/DSOs are legally obliged to inform the end-user about the past or expected future voltage quality levels. However, it seems that even without legal obligation, TSO/DSOs inform customers about voltage-quality levels upon their request. An overview of the legal obligations covered in Sections 3.2.3, 3.2.4 and 3.2.5 is provided in Table 21.

17. Of FERC.

TABLE 21 VQ MEASUREMENT OBLIGATIONS

EnC Contracting Party	VQ measurement by the system operator		VQ measurement at end-user's request		TSO/DSO's obligation to inform user on voltage quality
	TSO	DSO	TSO/DSO's recorder	user's recorder	
Albania	Yes, hourly	Yes, hourly	Yes	No	No
Bosnia and Herzegovina	Yes	Yes	Yes	No	Yes
FYR of Macedonia	Yes	Yes	Yes, operator pays if request justified	No	No
Kosovo*	No	No	Yes	No	Upon user's request
Montenegro	Yes	Yes	Yes, no pre-defined payment by user	No	No
Serbia	No	No	No	No	No
Ukraine	Yes	No	Yes	Yes	No

In most of the CPs, the responsibility for improving the overall voltage quality and/or rectifying voltage disturbances is shared between the State Inspectorate, the TSO/DSOs, customers and the NRA. However the responsibilities are not clearly legally defined. The role of the NRA is mainly limited to approving codes, while the direct authority for voltage quality regulation is not defined.

3.2.5. Emission limits

In order to regulate the impact that customer installations have on the voltage quality of the transmission and distribution network, **the majority of the CPs has imposed legislation defining emission limits for individual customer**. Maximal levels of disturbances concerning voltage quality for the end-user installations that are connected to the network are usually defined by the grid and distribution codes[18]. However, **different approaches are identified in defining emission limits**. In the majority of the CPs, such as Bosnia and Herzegovina, Montenegro and Kosovo*, emission limits are defined in terms of voltages according to international standards, such as IEC standards and EN 50160. A different approach is used in Serbia, where maximum levels of electricity current emissions are set for the installations connected to the network.

Penalties for customers in case of violation of the maximum levels of disturbances – other than disconnection – are not envisaged in any of the observed CPs.

3.3. VOLTAGE QUALITY MONITORING SYSTEMS AND DATA

A voltage quality monitoring system has been implemented only in Bosnia and Herzegovina and consequently actual voltage quality data has been provided by Bosnia and Herzegovina only. Other CPs still have not installed any voltage quality monitoring system.

3.3.1. Development of voltage quality monitoring systems

Bosnia and Herzegovina has voluntarily implemented a voltage quality monitoring system for the purpose of statistics and research. Voltage quality monitoring is mainly done on the HV/MV delivery points between the TSO and the DSO with portable instruments, namely with 1 instrument per location and type of network points monitored, on a rolling basis. Pre-defined tariffs exist for the cost of monitoring.

3.3.2. Smart meters and voltage quality monitoring

In most of the CPs, smart meters have not been introduced for the time being. In some CPs a small number of smart meters has been already installed but those meters do not allow voltage quality monitoring and there are no such functionality requirements for smart meters imposed.

18. Namely in the chapters dealing with connection to the transmission and distribution network.

3.3.3. Data collection, aggregation and publication from VQMS

Taking into account that most of the surveyed CPs still do not have a voltage quality monitoring system implemented, they also do not have any practice and procedures established for data collection, aggregation and publication.

Consequently, only Bosnia and Herzegovina provided information on current practice in collection, aggregation and publication of voltage quality data from the voltage quality monitoring system: collected data is stored in the central computer and available upon request of the NRA and network users. These data have been published only in the studies, since responsibility for publication has not been defined yet.

3.3.4. Actual data for voltage dips, other VQ parameters and mitigation measures

Almost no CP was able to provide any actual data on voltage dips and other VQ parameters. Additionally, there are no reported data on mitigation measures from any of the CPs concerned.

Only Bosnia and Herzegovina has provided some monitoring data of VQ parameters. Bosnia and Herzegovina has reported a value of 132 voltage dips per HV substation delivery points per year estimated based on 33 voltage dips registered in the measurement campaign at a limited number of locations (6) during parts of 2008 (91 day). Data for the following years were not available. In the period 27March to 2 May 2010 high voltages were recorded in 400 kV and 220 kV network in Bosnia and Herzegovina, where practically in all nodes at 400 kV and in some nodes at 220 kV, voltages exceeded the upper limits up to 32% of the total measuring time. In order to resolve VQ problems in the network, a study has been made and non-allowed voltages were identified.

3.4. FINDINGS AND RECOMMENDATIONS ON VOLTAGE QUALITY

Finding 1
EN 50160 is implemented in most CPs

EN 50160 is implemented in the majority of the CPs, mainly as voluntary standard, but also by legislation and regulation. It is usually defined in the general conditions of supply or network codes, either as a reference to the EN 50160 or by taking over the limits given in the legislation and regulation. EN 50160 is mainly applied on low and medium voltage levels up to 35 kV. Additionally, it is predominantly used as a standard for supply voltage variations. In most of the CPs EN 50160 has not been translated into local language.

Voltage quality standards that differ from EN 50160, such as IEC 61000-x-x have been introduced for some voltage characteristics, mainly via legislation and network codes. Different standards are introduced for different reasons: historical, different network characteristics, introducing new stricter limits, etc.

RECOMMENDATION 1

INTRODUCTION OF EN 50160 AND IEC 61000-X-X IN CP STANDARDIZATION, LEGISLATION AND REGULATION

CPs that have not adopted EN 50160 are encouraged to do so. Those CPs that have adopted, but have not translated EN 50160 should make the effort to translate EN 50160 in order to have precise definitions in national language and to allow further development of terminology. This also applies to other widespread standards like IEC 61000-x-x.

Implementing provisions in legislation (i.e. grid codes or voltage quality rules) that are consistent or stricter than EN 50160 and IEC 61000-x-x is recommended. Those CPs that have done this already should further improve the precision of definitions, limitations and exceptions. Since most CPs have been focused on supply voltage variations, efforts should be extended to encompass all voltage characteristics mentioned in EN 50160. Deviations from EN 50160, IEC 61000-x-x and other should be avoided as much as possible keeping in mind national specifics.

The previous recommendations are preconditions for NRAs to make efficient decisions on voltage quality regulation.

Finding 2
Legislation and regulation do not address voltage quality monitoring

Detailed procedures and obligations for the establishment of a voltage quality monitoring system have not been defined in legal and regulatory frameworks of the majority of the CPs. FYR Macedonia is the only CP where legislation defines detailed procedure and obligations for implementation of a voltage quality monitoring system.

RECOMMENDATION 2

INTRODUCTION OF VOLTAGE QUALITY MONITORING OBLIGATIONS

Direct obligations, as well as detailed procedures for establishment of a voltage quality monitoring system, should be defined in the legislation and regulation in all CPs. Provisions regarding requirements for voltage quality instruments, collection, aggregation and publication of voltage quality data from the voltage quality monitoring system should be established as well.

Finding 3
Voltage quality monitoring systems have not been implemented

Voltage quality monitoring systems for continuous voltage quality monitoring have not been installed in any of the CPs and therefore they were not able to provide relevant data on actual voltage quality levels. Only in Bosnia and Herzegovina, a voltage quality monitoring system for the purpose of research has been voluntarily installed, and consequently some data has been provided.

RECOMMENDATION 3

VOLTAGE QUALITY MONITORING SYSTEMS SHOULD BE IMPLEMENTED

CPs should encourage T/DSOs to develop voltage quality monitoring systems for continuous voltage quality monitoring in their networks. Monitoring should take place at locations at which a good estimation of the voltage quality as experienced by customers can be made. It is further acknowledged that data from continuous voltage quality monitoring can provide useful information for T/DSOs, resulting in significant cost savings and information to support investment decisions.

Having in mind that implementation of voltage quality monitoring systems has not started yet in CPs, it is recommended for the CPs – prior to the implementation – to undertake joint activities towards harmonization of voltage quality parameters and measurement methods.

The principle aims of compulsory or regulator-controlled monitoring should be to verify compliance with voltage-quality requirements (both overall and for individual customers); to provide information to customers on their actual or expected voltage quality; and to obtain information for the setting of appropriate future requirements. This should be considered when deciding about the need for compulsory or regulator-controlled monitoring.

Finding 4
Individual voltage quality verification is available in the majority of the CPs

In majority of the CPs T/DSOs are legally obliged to provide individual voltage quality verification upon request of end-users who experience voltage quality problems. In several CPs, even without a legal obligation, in practice T/DSOs perform individual voltage quality verification. In most of the cases, costs are paid by the T/DSO, while in some CPs costs are paid by the customer in the case that voltage quality proofs to comply with the requirements. An obligation of providing individual information on voltage quality is still not legally defined in the majority of the CPs.

RECOMMENDATION 4

INTRODUCTION AND DEVELOPMENT OF INDIVIDUAL VOLTAGE QUALITY VERIFICATION PROVISIONS

The legal obligation for T/DSOs to provide individual voltage quality verification upon user's request should be adopted in all CPs. This obligation should be accompanied by a detailed description of the procedure by the T/DSOs ensuring that all relevant information about the procedure is available to customers, including definition and allocation of costs related to the verification.

Statistics on complaints and verification results should be used by system operators for identifying areas that need improvements or at least for identifying areas that should be investigated further. NRAs should use such statistics for regulatory decisions regarding voltage quality.

It is further recommended that statistics on complaints and verification results are correlated with results from continuous voltage quality monitoring (if in place).

In the verification process, the system operator should make reasonable efforts to identify the cause of the disturbance.

Finding 5
Emission levels of network users

In most CPs legislation defining emission limits by individual network users has been imposed. Emission limits are usually defined by grid and distribution codes[19]. Different approaches are identified in defining emission limits. In most CPs emission limits are defined in terms of voltages according to international standards, such as IEC standards and EN 50160, except in Serbia where maximum levels of electricity current emissions are set.

Penalties for customers in the case of violation of emission limits – other than disconnection – are not envisaged in any of the CPs.

RECOMMENDATION 5

PROVISIONS REGARDING EMISSION LEVELS SHOULD BE DEVELOPED

Emission limits from individual customers are necessary to maintain the voltage disturbance levels within the voltage-quality requirements without excessive costs for other customers. The limits on emission should be reasonable for both T/DSOs and the customers causing the emission.

Introduction of emission limits for individual network users by legislation or regulation should go hand in hand with the legal establishment of voltage quality standards that TSO and DSOs have to comply with.

In case of violations of emission limits by a network user, mitigation measures should be coordinated by the TSO and DSOs.

A network user should pay penalties or be obliged to carry out corrective measure if user's installation is the source for a voltage complaint.

19. Namely in the chapters dealing with connection to the transmission and distribution network.

4 COMMERCIAL QUALITY

4.1. INTRODUCTION

The answers received indicate that regulation of Commercial Quality (CQ) is still in an early stage in all assessed CPs.

The questionnaire used for the present survey stressed the complexity of CQ with multiple suppliers and regulated entities like DSO and Universal Service Providers (USP). A brief examination of a supposedly simple business process, like solving a Voltage Quality complaint, reveals that CQ standards are strongly correlated with the market design and legal framework. **For most CPs this implies the need to further develop legislation and practice to accommodate even basic service quality regulation.** For example, concerning the process of solving a Voltage Complaint, precise definitions of triggers and time intervals are crucial, as well as defining the entity on which a certain trigger/event/process applies to, since it is really different if the customer calls his supplier in comparison to the scenario where the customer calls to DSO directly.

4.2. OVERVIEW OF COMMERCIAL QUALITY STANDARDS IN CPS

As suggested by the previous CEER Benchmarking Reports, CQ requirements have been categorized in two main and two supplementary types:

- **Guaranteed Standards** (GSs) refer to quality levels which must be met in each individual case. If the company fails to provide the level of service required by the GS, it must compensate the customer affected, subject to certain exemptions. The definition of guaranteed standards includes the following features:
  - performance covered by the standards (e.g. estimation of the costs for the connection);
  - maximum time before execution of the performance – commonly determined in terms of response (fulfilment) time (e.g. 5 working days);
  - economic compensation to be paid to the customer in case of failure to comply with the requirements.

- **Overall Standards** (OSs) refer to a given set of cases (e.g. all customer requests in a given region for a given transaction) and must be met with respect to the whole population in that set. Overall standards are defined as follows:
  - performance covered (e.g. connection of a new customer to the network)
  - minimum level of performance (commonly in % of cases), which has to be met in a given period (e.g. in a 90% of new customers have to be connected to the distribution network within 20 working days).

- **Other Available Requirements** (OAR). In addition to GSs and OSs regulators (and/or other competent parties) can issue requirements in order to achieve a certain quality level of service. These quality levels can be defined by the regulator, e.g. a minimum level which must be met all customers at all times. If the requirements set by the regulators are not met, the regulator can impose sanctions (e.g. financial penalties) in most cases.

- **Only Monitoring** (OMs). Before issuing GSs and OSs, regulators (and/or other competent parties) can monitor the performance of DSOs, suppliers, universal suppliers and/or metering operators, in order to understand the actual quality level and to publish – when deemed appropriate – the actual data on services provided to the customers.

Commercial quality has been reviewed by using the following four groups of indicators:
- Connection (Group I);
- Customer Care (Group II);
- Technical Service (Group III);
- Metering and Billing (Group IV).

The assessment shows an overwhelming use of explicit provisions regarding quality where standard is applied to all (100%) cases (Table 22). Although such provisions are in essence GSs, in line with the benchmarking guidelines, such standards are labeled as OARs because there is no compensation for individual customers and often there is no penalty defined for the company. For most of these standards, penalties are based either on vague and imprecise general penal provisions or simply do not exist (even if required by primary legislation). Additionally, it should be mentioned that the OARs present in the CPs are usually not influenced by the NRA, but are rather defined by primary or secondary legislation.

Table 22 shows that commercial quality in CPs is enforced largely by OAR (91 within the total of 116).

TABLE 22 COMMERCIAL QUALITY

Country	Guaranteed standards (GS)	Overall standards (OS)	Other available requirements (OAR)	Only Measuring (O/M)	Total
Albania	0	3	0	0	3
Bosnia and Herzegovina	0	0	13	3	16
FYR of Macedonia	0	0	13	0	13
Kosovo*	0	8	11	0	19
Montenegro	0	0	10	0	10
Serbia	0	0	15	6	21
Ukraine	0	0	13	0	13
Total	2	14	91	9	116

TABLE 23 NUMBER OF COMMERCIAL QUALITY STANDARDS FOR EACH INDICATOR

Standards	GS	OS	OAR	O/M	Total
I. CONNECTION					
I.1 Time for response to customer claim for network connection		2	8		10
I.2 Time for cost estimation for simple works		1	3		4
I.3 Time for connecting new customers to the network		4	7		11
I.4 Time for disconnection upon customer's request			7	1	8
TOTAL FOR CONNECTION INDICATORS	0	7	25	1	33
II. CUSTOMER CARE					
II.5 Punctuality of appointments with customers			1		1
II.6 Response time to customer complaints and enquiries (including 6a and 6b)			7	2	9
II.6a Time for answering the voltage complaint		1	6	2	9
II.6b Time for answering the interruption complaint			3	2	5
II.7 Response time to questions in relation with costs and payments (excluding connection)			5		5
II.8 Call Centres average holding time					0
II.9 Call Centres service level					0
II.10 Waiting time in case of personal visit at client centres					0
TOTAL FOR CUSTOMER CARE INDICATORS	0	1	22	6	29
III. TECHNICAL SERVICE					
III.11 Time between the date of the answer to the VQ complaint and the elimination of the problem	1	1	4		6
III.12 Time until the start of restoration of supply following failure of fuse of DSO		4	1	1	6
III.13 Time for giving information in advance of a planned interruption		2	5		7
III.14 Time until the restoration of supply in case of unplanned interruption	1		3	1	5
TOTAL FOR TECHNICAL SERVICE INDICATORS	2	7	13	2	24
IV. METERING AND BILLING					
IV.15 Time for meter inspection in case of meter failure			6		6
IV.16 Time from the notice to pay until disconnection			9		9
IV.17 Time for restoration of power supply following disconnection due to non-payment			7		7
IV.18 Yearly number of meter readings by the designated company			8		8
TOTAL FOR METERING AND BILLING INDICATORS	0	0	30	0	30
TOTAL	2	15	90	9	116

Table 23 shows that there is no particular group with a prevalent number of standards. This means that **CQ is equally developed** (or rather equally undeveloped) in all indicator groups, with the exception of group II – Customer Care which has twice as many indicators in comparison to other groups.

If the total number of standards per indicator is considered (Table 23), it is visible that indicator "I.3 Time for connecting new customers to the network" has the highest number of standards. Closely behind are indicators dealing with connections claims and disconnections (I.3, I.4 and IV.16). Also, handling complaints is important with a high total of standards (II.6, II.6a).

For the present benchmarking the distinction between standards applied to DSOs, Suppliers and Universal Suppliers is presently not informative since national electricity markets are developing. Therefore, an overview of standards and data availability with respect to relevant company is skipped. However, some remarks will be given in chapters analyzing particular groups of indicators.

It should be noted that the current benchmarking is more focused on commercial performances of the DSOs and less on performances in the competitive sector of supply.

The analysis also proofed that no adequate statistical data exists for most CQ indicators.

4.3. MAIN RESULTS OF BENCHMARKING COMMERCIAL QUALITY STANDARDS

4.3.1. Group I – Connection

Most electricity legal frameworks encompass commercial standards regarding connections. CPs have similar standards and approaches to monitoring connection issues. This of course accounts for predominant use of OAR standards as explained earlier.

Connection-related activities have a complex structure. Nevertheless, the four quality indicators (as presented in Table 24) defined in the questionnaire used for the present survey represent the whole process for connection. The questionnaire put emphasis on the division between LV and MV customers (requesting information on voltage levels that a standard applies to). However, CPs instead rather differentiate connection procedures based on the type of customer. In addition to the obvious household type, categorizations in different CPs distinguish between legal entities, commercial customers on different voltage levels, etc. Connection procedures revolve around those types and "simple works" do not rely on common criteria.

Due to the current levels of market opening, standards for connection related activities in CPs apply to the DSO.

TABLE 24 COMMERCIAL QUALITY STANDARDS FOR CONNECTION-RELATED ACTIVITIES

Quality Indicator	Countries (grouped by type of standard)	Standards (median value and range)	Compensation (median value, GS only)	Company involved
Time for response to customer claim for network connection	**OS:** AL **OAR:** BA, MK, ME, RS, UA, Kosovo*	25 days (15 - 30 days)	-	DSO
Time for cost estimation for simple works	**OS:** AL **OAR:** BA, MK, Kosovo* **None:** ME,RS, UA	21 days (8 - 30 days)	-	DSO
Time for connecting new customers to the network	**OS:** AL, Kosovo* **OAR:** BA, MK, ME, RS, UA **None:**	20 days (4- 45 days)	-	DSO
Time for disconnection upon customer's request	**OAR:** MK, ME, RS, UA, Kosovo* **O/M:** BA **None:** AL	12 days (3- 30 days)	-	DSO

4.3.2. Group II – Customer Care

Customer Care relates to the group of indicators with the least number of standards. For certain indicators none of the CPs has adopted standards. Of course it can be argued that this is a direct reflection of the low level of competition. Another reason that can be valid is that liberalization of energy sectors is lagging behind comparing to EU countries.

Direct interaction with customers is not monitored – starting with the lack of call centers (used by DSOs and incumbent suppliers), appointments and visits are not planned/recorded, etc.

Another aspect is that DSOs and incumbent companies have not been focusing on customers and many customer care indicators encountered in this benchmarking were purely statistical information on certain commercial activities. For example, customer complaints are recorded and average times can be calculated (or more often estimated). However, as a rule, **DSOs and incumbent companies do not have customer relationship management or any similar system**, so there is no possibility to track a specific customer with a specific issue. That is the reason why CPs cannot obtain data regarding indicators related to customer care as defined in the questionnaire used for the present survey.

TABLE 25 COMMERCIAL QUALITY STANDARDS FOR CUSTOMER CARE ACTIVITIES

Quality Indicator	Countries (grouped by type of standard)	Standards (median value and range)	Compensation (median value, GS only)	Company involved
Punctuality of appointments with customers	OAR: BA None: AL, MK, ME, RS, UA, Kosovo*	-	-	DSO
Response time to customer complaints and enquiries (total, including 6a and 6b)	OAR: BA, MK, ME, UA, Kosovo* O/M: RS None: AL	26 days (15 - 30 days)	-	DSO
Time for answering the voltage complaint (as part of q6)	OAR: BA, MK, ME, UA, Kosovo* O/M: RS None: AL,	16 days (2- 30 days)	-	DSO
Time for answering the interruption complaint (as part of q6)	O/M: RS OAR: MK, ME, Kosovo* None: AL, BA, UA	20 days (15- 30 days)	-	DSO
Response time to questions in relation with costs and payments (excluding connection)	OAR: BA, ME, UA, Kosovo* None: AL, MK, RS	8 days (1h- 8 days)	-	DSO
Call Centres average holding time	-	-	-	-
Waiting time in case of personal visit at client centres	-	-	-	-

Table 25 clearly shows that all CPs lack standards related to Call Centers and do not record visits/appointments. This information has been intentionally left in the table to emphasize the need to develop technical systems designed for customer care.

4.3.3. Group III – Technical Service

This particular group of quality indicators is the most diverse group within Commercial Quality. The reason is that different CPs use different approaches for CQ regulation and are at different development stages. This is not evident from the benchmarking data presented in this report, but was observed in the answers and remarks given by the CPs.

Standards related to technical services in principle correspond to standards during the contract period and are tied to technical services of the DSO. All CPs identified the DSO as company in charge. Nevertheless, it was observed that standards for technical services (and the legal framework governing the supplier business) must be developed to accommodate scenarios where customers contact the DSO directly or their supplier for technical services.

TABLE 26 COMMERCIAL QUALITY STANDARDS FOR TECHNICAL SERVICES

Quality Indicator	Countries (grouped by type of standard)	Standards (median value and range)	Compensation (median value, GS only)	Company involved
Time between the date of the answer to the VQ complaint and the elimination of the problem	OS: Kosovo* OAR: BA, RS, UA None: AL, MK, ME	25 days (1 - 60 days)	-	DSO
Time until the start of restoration of supply following failure of fuse of DSO	OS: Kosovo* OAR: MK O/M: BA None: AL, ME, RS, UA	12 hours (1 - 24 hours)	-	DSO
Time for giving information in advance of a planned interruption	OS: Kosovo*, MD OAR: BA, MK, RS, UA None: AL, ME	3 days (1 - 10 days)	-	DSO
Time until the restoration of supply in case of unplanned interruption	O/M: BA OAR: MK, RS, UA None: AL, ME, Kosovo*	18 hours (2- 24 hours)	-	DSO

4.3.4. Group IV – Billing and metering

Billing and metering is the only group of quality indicators where CPs reported standards that apply to companies other than the DSO. This is not surprising, since the development of markets starts with payments and measurements (in this case electricity metering).

Although the indicators in this group (as shown in the first column of Table 27) are instantly recognizable, the actual standards and ranges used by different CPs show that **billing and metering should be developed in terms of definitions needed for precisely defining standards.** For example, the indicator "Time from the notice to pay until disconnection" may be viewed as "time from sending the notice…" or "Time from the notice is received…"

Similar to the group "Technical Services", standards within "Billing and Metering" depend whether or not customers must rely on a supplier for billing and metering or can directly communicate or carry out business with the DSO or the metering company.

TABLE 27 COMMERCIAL QUALITY STANDARDS FOR BILLING AND METERING

Quality Indicator	Countries (grouped by type of standard)	Standards (median value and range)	Compensation (median value, GS only)	Company involved
Time for meter inspection in case of meter failure	OAR: BA, MK, RS, UA, Kosovo* None: AL, MK	14 days (2 - 30 days)	-	DSO, MO
Time from the notice to pay until disconnection	OAR: BA, MK, ME, RS, UA, Kosovo* None: AL	13 days (3 - 30 days)	-	DSO
Time for restoration of power supply following disconnection due to non-payment	OAR: BA, MK, ME, RS, UA, Kosovo* None: AL,	2 days (1 - 7 days)	-	DSO, SP
Time until the restoration of supply in case of unplanned interruption	OAR: BA, MK, ME, RS, UA, Kosovo* None: AL	8 Meter Readings per Year (2-12)	-	DSO, SP, USP, MO

4.4. FINDINGS AND RECOMMENDATIONS ON COMMERCIAL QUALITY

In general, commercial quality is in an early development stage in all surveyed CPs. Therefore, all general recommendations for developing quality of service standards can apply. However, there four issues specific for the CPs that should be recognized. It should be also mentioned that Commercial Quality in the CPs should be considered in a broader perspective. Customer rights are definitely lagging behind in comparison to customer rights in the EU.

Finding 1
There is an overwhelming use of standards that apply to all customers

There is an overwhelming use of explicit provisions that apply to all (100%) customers (cases). These provisions are in essence GS but they do not entail compensation for individual customers or a penalty for the company.

RECOMMENDATION 1

EXISTING STANDARDS THAT APPLY TO ALL CUSTOMERS SHOULD BE MORE SPECIFIC

At first sight, it would not be difficult to develop such OARs into GS. It would be a simple matter of defining compensation for individual customers. However, that approach would be risky since quality standards should be introduced gradually – initially starting with measuring performance. Applying a GS without a proper quantitative analysis can affect companies financially much more than expected or initiate an tremendous number of complaints that must be handled (by the utility or the NRA).

Therefore, starting from the existing standards, new ones should be created based on the following approach:

- Exemptions should be possible, allowing same flexibility until a proper percentage of cases can be defined within a GS;
- Definitions should be developed in order to allow monitoring and acquisition of data (proper regulatory decisions or standards can be adopted only based on statistical data);
- For those standards or regulatory provisions that lack compensation for customers or penalties for companies, the most appropriate penance should be found. In other words, an investigation should be made regarding compensation vs. penalty or GS vs. OS (or even a combination) to accommodate practice and regulatory schemes.

Of course, OAR standards are not predetermined to be supplemented by a GS. With a gradual approach for creating standards, an OAR can be transformed into one or more different standards of different type. The process can also maintain the original OAR standard if necessary.

The 5th CEER Benchmarking Report on Quality of Electricity Supply showed that countries in the Central East of Europe (CEE) use predominantly guaranteed standards. Due to similarities between CEE countries and the CPs, it may be worthwhile to investigate their experiences in CQ.

Finding 2
CQ standards are not specifically applied to suppliers or operators

Commercial Quality Standards may be applied to different market participants and operators. As the benchmarking questionnaire suggests, standards can apply to DSOs, suppliers, universal service provides and others. Currently, the distinction between standards applied to DSOs, suppliers, universal service provides is not informative for the CPs since electricity markets are at early development stage.

RECOMMENDATION 2

CQ STANDARDS SHOULD BE CREATED HAVING IN MIND DIFFERENT ENTITIES (DSOs, SPs, USPs, ETC.) AND DIFFERENT MARKET MODELS

The existence of different entities (DSOs, SPs, USPs, etc.) requires that standards should be defined with very specific definitions and with specific business processes in mind. For example, CQ standards related to interruptions can be different depending of the (retail) market model. In one market, customers could be compelled to call their supplier for power restoration with no direct contact with the DSO. In another market, customers could have the choice to call either their supplier or the DSO. Consequently, "Time until the restoration of supply in case of unplanned interruption" is not universally applicable and may distort benchmarking results.

This also implies that NRAs should have deep insight in the procedures of suppliers.

It may be argued that CQ standards should be tied to regulated activities (DSO/USP/ regulated SP).

However, using CQ standards for all market players may be beneficial in a couple of ways:

- required publication of CQ performance can be used as a tool for making the market more active by forcing the suppliers to differentiate by CQ performance;
- with new market entrants, some customer groups could be troubled (i.e. residential customers switching to new suppliers) by dominant incumbent electricity companies, so CQ standards are necessary to resolve certain problems;
- poor performance of a supplier may indicate to the NRA a more serious issue afflicting the supplier.

It should be emphasized that the Directive 2009/72/EC calls for regulation of CQ, particularly with Article 3 dealing with "Public service obligations and customer protection".

Finding 3
CQ standards are usually loosely defined

During the benchmarking, it was observed that many CQ indicators were rather obvious (according to the wording), but only superficially defined. Minor differences in legal provisions or practice between CPs showed that standards need to be defined on precise terms and supported with explanations and exceptions.

The indicator "Time from the notice to pay until disconnection" can be used here to clarify. The standard should precisely define the initial trigger and define the closing event. Otherwise, there could be questions like – does this standard imply time counted from the post of notice or from the reception of the notice?

RECOMMENDATION 3

CQ STANDARDS SHOULD BE BASED ON SPECIFIC AND PRECISE DEFINITIONS

This issue does not need a specific solution since the recommendation is rather obvious. However, NRAs and DSOs should cooperate by sharing experiences or participating in benchmarks. By doing so, the development of definitions and standards will be more efficient and rapid.

Of course, practice of EU MS should also be considered.

Since most CPs did not provide historic data, it would be beneficial to commence with measuring performance in any way possible. The framework for measuring performance will gradually evolve, producing basis for introducing adequate definitions and standards.

Finding 4
DSOs and incumbent companies do not place emphasis on interaction with customers

DSOs and incumbent companies have not been focused on customers but predominantly on their own activities. Most of their statistical data which can be correlated with commercial standards is related to the "system". Historically, they had no need to track a specific customer with a specific issue. Consequently, data regarding commercial quality, especially to customer care, is not available.

RECOMMENDATION 4

DSOs AND SUPPLIERS SHOULD IMPLEMENT CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

DSOs and suppliers should implement IT solutions for Customer Relationship Management (CRM). Apart from inherently adopting customer care, the use of such tools is essential for CQ standards. The most important paradigm for companies is to implement the ability to track a specific customer with a specific issue. Apart from having better and more efficient relations with specific customers, statistics on an issue (time, cases, etc.) are statistics relevant for CQ standards related to Customer Care.

APPENDIX A – TABLE OF TABLES

LIST OF ABBREVIATIONS

Term	Definition
ACER	Agency for the Cooperation of Energy Regulators
ACM	The Netherlands Authority for Consumers and Markets (Dutch National Regulatory Authority)
AIT	Average Interruption Time
AMI	Advanced Metering Infrastructure
ASIDI	Average System Interruption Duration Index
ASIFI	Average System Interruption Frequency Index
BR	(CEER) Benchmarking Report (on Quality of Electricity Supply)
CAIDI	Customer Average Interruption Duration Index
CAIFI	Customer Average Interruption Frequency Index
CEER	Council of European Energy Regulators
CEMI	Customer Experiencing Multiple Interruptions
CENELEC	European Committee for Electrotechnical Standardization
CI	Customer Interruptions
CIGRE	International Council on Large Electric Systems
CIRED	International Conference on Electricity Distribution
CML	Customer Minutes Lost
CoRDiS	The Standing Committee for Disputes and Sanctions (France)
CoS	Continuity of Supply
CQ	Commercial Quality
CRE	Commission de Régulation de l'Energie (French National Regulatory Authority)
CTAIDI	Customer Total Average Interruption Duration Index
DNO	Distribution Network Operator
DSO	Distribution System Operator
DVGW	German Technical and Scientific Association for Gas and Water
ECRB	Energy Community Regulatory Board
EHV	Extra High Voltage
EI	Swedish Energy Markets Inspectorate (Swedish National Regulatory Authority)
EMC	Electromagnetic Compatibility
END	Energy Not Distributed
ENS	Energy Not Supplied
ERDF	Electricity Distribution Network France
ERSE	Entidade Reguladora dos Serviços Energéticos / Energy Services Regulatory Authority (Portuguese National Regulatory Authority)
EU	European Union
GGP	Guidelines of Good Practice
GI	Guaranteed Indicators
GIS	Geographic Information System

Term	Definition
GRDF	Gaz Réseau Distribution France
HEO	Hungarian Energy Office (Hungarian National Regulatory Authority)
HP	High Pressure
HV	High Voltage
IEC	International Electrotechnical Commission
IEEE	(formerly) Institute of Electrical and Electronics Engineers
LNG	Liquefied Natural Gas
LP	Low Pressure
LV	Low Voltage
MAIFI	Momentary Average Interruption Frequency Index
MAIFIE	Momentary Average Interruption Event Frequency Index
MO	Meter Operator
MP	Medium Pressure
MV	Medium Voltage
NA	Not Applicable
NIEPI	Equivalent number of interruptions related to the installed capacity
NRA	National Regulatory Authority
NVE	Norges Vassdrags – og Energidirektorat (Norway)
Ofgem	Office of Gas and Electricity Markets (British National Regulatory Authority)
OI	Overall Indicators
OR	Other Requirements
r.m.s.	Root Mean Square
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SEWRC	State Energy and Water Regulatory Commission (Bulgaria)
SP	Supplier
THD	Total Harmonic Distortion
TIEPI	Equivalent interruption time related to the installed capacity
TNC	Transmission Network Code
T-SAIFI	Transformer System Average Interruption Frequency Index
TSO	Transmission System Operator
UCTE	Union for the Coordination of the Transmission of Electricity
Un	Nominal Voltage
USP	Universal Supplier
VQ	Voltage Quality
VQM	Voltage Quality Monitoring
WI	Wobbe Index

LIST OF COUNTRY ABBREVIATIONS

Abbreviation	Full country name
AL	Albania
AT	Austria
BE	Belgium
BA	Bosnia and Herzegovina
BG	Bulgaria
HR	Croatia
CY	Cyprus
CZ	Czech Republic
DK	Denmark
EE	Estonia
FI	Finland
FR	France
DE	Germany
GB	Great Britain (GB is used for Great Britain: England, Scotland and Wales)
EL	Greece
HU	Hungary
IS	Iceland
IE	Ireland
IT	Italy
KS	Kosovo
LV	Latvia
LT	Lithuania
LU	Luxembourg
MK	The Former Yugoslav Republic of Macedonia (FYR of Macedonia)
MT	Malta
MD	Moldova
ME	Montenegro
NL	The Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
SK	Slovak Republic
SI	Slovenia
ES	Spain
SE	Sweden
CH	Switzerland
UA	Ukraine

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ABOUT CEER

The Council of European Energy Regulators (CEER) is the voice of Europe's national regulators of electricity and gas at EU and international level. CEER's members and observers (from 33 European countries) are the statutory bodies responsible for energy regulation at national level.

One of CEER's key objectives is to facilitate the creation of a single, competitive, efficient and sustainable EU internal energy market that works in the public interest. CEER actively promotes an investment-friendly and harmonised regulatory environment, and consistent application of existing EU legislation. Moreover, CEER champions consumer issues in our belief that a competitive and secure EU single energy market is not a goal in itself, but should deliver benefits for energy consumers.

CEER, based in Brussels, deals with a broad range of energy issues including retail markets and consumers; distribution networks; smart grids; flexibility; sustainability; and international cooperation. European energy regulators are committed to a holistic approach to energy regulation in Europe. Through CEER, NRAs cooperate and develop common position papers, advice and forward-thinking recommendations to improve the electricity and gas markets for the benefit of consumers and businesses.

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