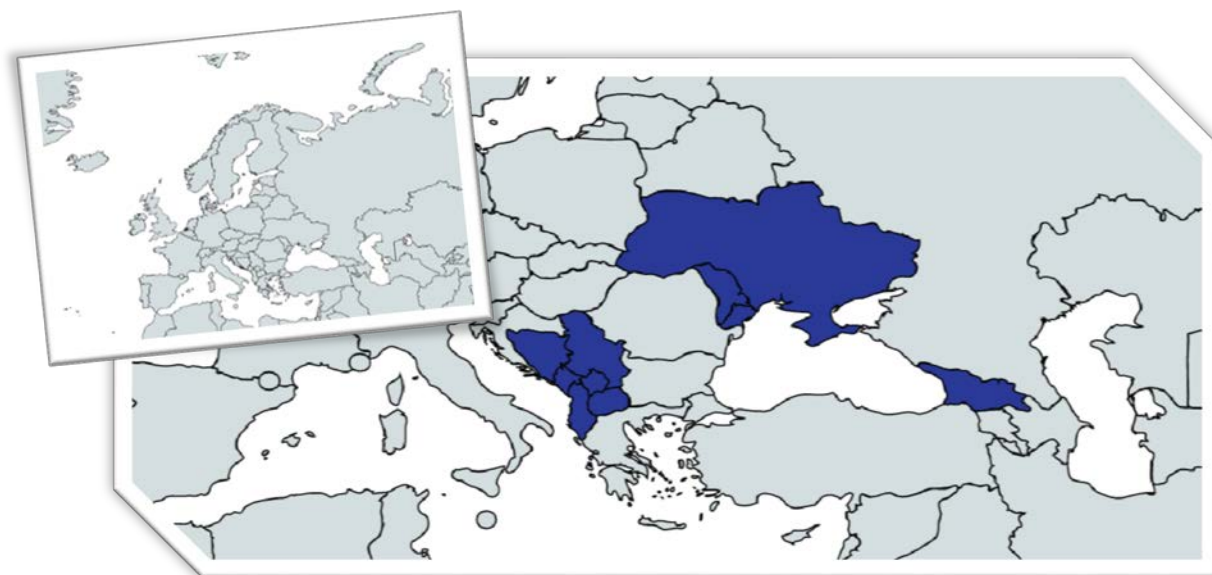




ECDSO-E

Energy Community Distribution System Operators



Quality of Supply POSITION PAPER 2019

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PREFACE

The Energy Community is an international organization which brings together the European Union and its neighbors to create an integrated pan-European energy market.

The Energy Community (EnC) institutional setting did not provide a distinct platform for Distribution system operators (DSO) from the outset. In light of the implementation of the Third Energy Package, the Secretariat found it necessary to enhance the DSOs' involvement and to provide a platform for expressing their opinions and changing information.

Coordination Platform for Energy Community Distribution System Operators for Electricity (ECDSO-E) is established as a group of experts from the electricity Distribution system operator undertakings in the EnC CPs, acting as a sub-group within the Energy Community Security of Supply Coordination Group (SoS CG).

The operational structure of the ECDSO-E consists of:

- a) The ECDSO-E Coordination Group
- b) ECDSO-E Task Forces, including the joint working teams within the SoS CG
- c) Technical Networking.

ECDSO-E Coordination Group established special task force groups, with an appointed convener, to study a precisely defined problem and to report back on it.

On the 11th meeting, ECDSO-E established Task Force (TF) to deal with the Quality of Supply (QoS).

The purpose of QoS Task Force is to conduct, with the assistance of the Secretariat, a mapping of existing information, mandates, activities and initiatives to enhance policy coordination, facilitate dialogue, share knowledge as well as to identify future needs and action based on findings. Detailed Terms of Reference is attached to this Report.

EXECUTIVE SUMMARY

This Position paper addresses three major aspects of Quality of Supply: Continuity of Supply, Voltage Quality and Commercial Quality.

In preparation of this document, the work of the QoS TF was assigned to the three aspects of quality of supply, and work was coordinated by responsible expert members:

- Continuity of Supply, by Viktor Dimitrievski,
- Voltage Quality, by Ms. Sanja Rikalo, and
- Commercial Quality, by Yuliana Onischuk and Teimuraz Shengelia.

This Position Paper sets out ECDSO-E's views on the different aspects of the Quality of supply of electricity.

The overall objective of this document is to ensure harmonized definition of the service quality indices, monitoring and reporting as well as measurement techniques, thus providing a useful tool for benchmarking of consistent and comparable information.

Also, the document aims to present an overview and analysis of current practices in the Contracting Parties (CPs). It also provides an assessment of areas where a move towards harmonization could further improve quality of supply. At the end the findings and recommendations of the document will hopefully lead to further development of national regulation and harmonization among the CPs.

The research is designed in reliance to the respective The Council of European Energy Regulators (CEER) Benchmarking Report with the aim to develop main recommendations for electricity quality regulation on a national level of the CPs as well as on the EnC level.

The Task force conducted the survey based on the questionnaires for participating DSOs. Distribution System Operators from all EnC CPs participated in the survey. The list of the participating DSOs replied to the questionnaires:

Albania:

- Electricity Power Distribution System Operator (OSHEE);

Bosnia and Herzegovina:

- JP Elektroprivreda BiH d.d (EPBIH),
- JP Elektroprivreda Hrvatske zajednice Herceg Bosne d.d. (EPHZHB) and
- MH Power Utility of Republic of Srpska (ERS);

Kosovo*:

- Kosovo Energy Distribution Services JSC (KEDS);

Moldova:

- JSC Premier Energy (PE);

Montenegro:

- Crnogorski elektrodistributivni system d.o.o (CEDIS);

North Macedonia

- Elektrodistribucija DOOEL (ED);

Serbia:

- EPS Distribution (EPSD);

Georgia

* 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.

- JSC Energo-Pro (EP);

Ukraine

- DTEK Grids LLC (DTEKG) .

(Note: ERS and DTEK Grids represent all the respective distribution companies integrated within the holding.)

The responses are summarized and analysed with the objective to draw conclusions and to make recommendations for DSOs.

Each chapter of this Position Paper contains:

- An explanation of the QoS indicators and the importance of their regulations;
- Regulation and standards on the QoS;
- Analysis of the results of the survey – comparative overview;
- Specific details on indicators and regulation;
- General findings and conclusions;
- Recommendations.

The survey and analysis show that all CPs address the responsibility of DSO to ensure required level of quality of its service, in accordance with national legislative framework based on Third Energy Package and in particular Directive 2009/72/EU concerning common rules on internal market in electricity.

In all CPs, DSOs are responsible that their network are capable to ensure security of supply of electricity in the short and long run.

However, monitoring of this capability and measuring how DSO complies with these requirements are not consistently defined in the implementing legislation, resulting in significant differences in the level of observed quality indicators among DSOs and CPs, as well as in defined quality standards, where such exist

Whereas DSOs are committed to continuously improve the quality of service and increase the level of guaranteed quality standards, it is equally important that regulatory authorities and network users understand and acknowledge associated costs and make as fair as possible trade off between quality of service and costs of service.

Precondition for this is setting right indicators for monitoring and reporting of different aspects of the quality level, recognizing that benchmarking of different DSOs is useful tool to set quality standards and targets and implement incentive schemes.

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INTRODUCTION

In the Energy Community, the electricity market has been governed by the “3rd Package”¹ Directive 2009/72/EC of 13 July 2009 concerning common rules for internal market in electricity, which had to be transposed by the CPs by 1 January 2015.

Although this Directive emphasizes the quality of service that should be provided by electricity undertakings, it does not give precise definition of quality of supply. However, it states that the regulatory authority shall have the duty of setting or approving standards and requirements for quality of supply or contributing thereto together with other competent authorities². Also national regulatory authority shall ensure the monitoring of security of supply issues.

Tasks and responsibilities relevant for setting and observing quality of service provided by network operators are contained in the following provisions of the Directive:

“Article 4 (Monitoring of security of supply)

Member States shall ensure the monitoring of security of supply issues. Where Member States consider it appropriate, they may delegate that task to the regulatory authorities referred to in Article 35. Such monitoring shall, in particular, cover the balance of supply and demand on the national market, the level of expected future demand and envisaged additional capacity being planned or under construction, and the quality and level of maintenance of the networks, as well as measures to cover peak demand and to deal with shortfalls of one or more suppliers. The competent authorities shall publish every two years, by 31 July, a report outlining the findings resulting from the monitoring of those issues, as well as any measures taken or envisaged to address them and shall forward that report to the Commission forthwith.”

“Article 25 (Tasks of distribution system operators)

The distribution system operator shall be responsible for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity, for operating, maintaining and developing under economic conditions a secure, reliable and efficient electricity distribution system in its area with due regard for the environment and energy efficiency.”

The most important provision as regards standards and requirements in continuity of supply and quality of supply is given in Article 37:

“Article 37

The regulatory authority shall have the following duties:

(h) Monitoring compliance with and reviewing the past performance of network security and reliability rules and setting or approving standards and requirements for quality of service and supply or contributing thereto together with other competent authorities.”

The requirements related to commercial quality of the service provided by DSO are mainly defined in accordance with Article 3 and Annex I of the Directive 2009/72, guaranteeing customers, among others, transparent, simple and inexpensive procedures for dealing with their complaints, right to good standard of service. It also allows for provision of a system of reimbursement and/or compensation.

¹ In the EU it is replaced with the legislative framework of “Clean Energy Package”, including relevant legislation for electricity market

² Article 37(1h) of Directive 2009/72/EC

The requirements of the Directive 2009/72/EC referring to Quality of supply are mainly transposed into the national legislation of the CPs, i.e. their laws and bylaws.

Requirements to maintain certain level of Quality of supply (especially voltage quality and continuity of supply) exist in all European countries, via the standard EN 50160 or national regulations.

Since it is responsibility of a network operator to maintain an acceptable level of continuity of supply and voltage quality and to ensure that the quality at connection points complies with the requirements, direct obligation for the actual monitoring, needed for compliance verification, should be thus given to the network operators. A national regulatory authority (NRA) should have the authority to instruct a network operator to take measures in the case when trends in continuity of supply levels warrant such action.

The responsibility for maintaining required level of quality shall remain, however, fully with the network operator and the NRA shall in no way take over any of this responsibility.

Whereas interruptions affect all network users, voltage disturbances do not affect all users in the same way. Also, the impact of different types of disturbances can be completely different for different individual users. There is need for harmonization as regards limits on voltage disturbances, considering the fact that end-user equipment is the same throughout Europe, but regulatory frameworks are different.

Besides the voltage quality and continuity of supply, which are traditionally the core characteristics of the electricity, no less important is the commercial quality that represents the quality of relationship between electricity company and customer even before the start of using the service.

The Council of European Energy Regulators has been routinely analysing and summarizing different aspects of the electricity quality. Analysis in this Position paper relies on the methodology, findings and assessments presented in the CEER Benchmarking Reports³, with the focus on the status of the DSOs operating in the EnC, based on their replies to the questionnaires.

³ mainly 6th CEER Benchmarking Report on the Quality of Electricity and Gas Supply -2016, and BR 6.1 -2018

1. CONTINUITY OF SUPPLY



1.1. GENERAL REMARKS

Continuity of supply is one of the three main segments of QoS that DSO are obliged to provide to final customers connected to the distribution grid. Continuity of supply, together with Voltage quality and Commercial quality as components of QoS, is crucial task of DSO prescribed and regulated in appropriate EU Directive and national law and bylaws in EnC.

One of the main tasks of the electricity utilities, especially electricity system operators (DSO and TSO), is to provide reliable electricity to customers at a reasonable and competitive price. Since worldwide, and mostly in developed areas and countries, the share of electricity in total energy consumption grows, higher continuity levels of electricity supply become an unavoidable request to the utilities.

Indeed, electricity supply interruptions are less and less acceptable to customers, mainly because their social-economical effects become heavier and heavier. The expectation of customers to be served by electricity utilities with higher levels of continuity of supply becomes more stringent, especially in developed areas and countries.

Severe outages and blackouts that occurred in the past years in the United States and in Europe clearly showed that, besides the price of electricity, continuity of service (in terms of **reliability/continuity** of supply) is also a very important issue for customers and society as a whole. Therefore, regulators and institutions are strongly promoting the improvement of continuity of service in the electricity sector.

Then reliability of supply and its value are key factors for decision making process underlying expansion plans not only of electricity generation systems but also of transmission and distribution networks. It is evident that low levels of investment can result in unreliable supply, i.e. unacceptable low level of

continuity, while on the other hand, excessive investments can result in unnecessary expenditures resulting in increase of the cost of electricity to customers.

The key motivation for continuity regulation in the electricity sector lies in the strong incentives to cost reduction for regulated undertakings. In this context, indeed, if continuity is not enforced or not incentivized, operators could reduce maintenance activities or investments in network, thus causing a lower continuity of service for the final customers.

Incentive regulation for continuity can ensure that cost cuts as a result of regulatory regimes are not achieved at the expense of continuity itself.

In some European countries national regulatory authorities have started implementing continuity regulation schemes. As far as the distribution service is concerned, at the end of 2005 incentive/penalty schemes were in place in 8 countries out of the 19 surveyed by the Council of European Energy Regulators: Italy (from 2000), Norway and Ireland (from 2001), Great Britain (from 2002), Hungary and Portugal (from 2003), Sweden (from 2004), and Estonia (from 2005)⁴. In 2016, according to 6th CEER Benchmarking Report, 16 European Union Members States were applying incentive schemes to optimize continuity of supply levels⁵.

1.2. DEFINITION OF INTERRUPTIONS AND INDICATORS FOR CONTINUITY OF SUPPLY

Continuity of supply is measured by means of interruptions in electricity supply identifying the events during which the voltage at the supply terminals of a network user drops to zero or nearly zero (EN 50160). 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.

1.2.1. SAIDI

The System Average Interruption Duration Index (SAIDI) is the average outage duration for each customer served, and is calculated as:

$$SAIDI = \frac{\sum U_i * N_i}{N_t}$$

where N_i is the number of customers and U_i is the annual outage time for location i and N_t is the total number of customers served.

SAIDI is measured in units of time, often minutes or hours. It is usually measured over the course of a year.

1.2.2. SAIFI

The System Average Interruption Frequency Index (SAIFI) is the average number of interruptions that a customer would experience, and is calculated as:

⁴ 3rd CEER Benchmarking Report (https://www.arera.it/allegati/pubblicazioni/volume_ceer3.pdf)

⁵ 6th CEER Benchmarking Report, page 51 (<https://www.ceer.eu/documents/104400/-/-/d064733a-9614-e320-a068-2086ed27be7f>)

$$SAIFI = \frac{\sum \lambda_i * N_i}{N_t}$$

where λ_i is the failure rate, N_i is the number of customers for location i and N_t is the total number of customers served.

1.2.3. CAIDI

The Customer Average Interruption Duration Index (CAIDI) is related to SAIDI and SAIFI, and is calculated as:

$$CAIDI = \frac{SAIDI}{SAIFI}$$

CAIDI gives the average outage duration that any given customer would experience. CAIDI can also be viewed as the average restoration time. CAIDI is measured in units of time, often minutes or hours. It is usually measured over the course of a year.

1.2.4 ENS

Energy Not Supplied is the total volume of energy that is not delivered to customers as a result of faults or failures on the network. The fact that there is no energy consumption during the interruption makes it difficult to measure this indicator and it is estimated. The estimation methods are different, depending on the aggregation level and in general can be calculated as:

$$ENS = SAIDI * \frac{W}{t}$$

Where W is energy supplied over the observed period and t is duration of period in hours. This indicator can be used to calculate the costs of outage (CENS – cost of energy not supplied), used as a basis for setting reward and penalty in incentive based regulation.

1.3. MONITORING OF INTERRUPTIONS AND INDICATORS FOR CONTINUITY OF SUPPLY

Continuity of supply refers to the availability of electricity to all network users. All countries that participated in 6th CEER Benchmarking Report stated that they monitor continuity of supply in their electricity networks. CEER published Benchmarking Report 6.1 in 2018, with updated key data in Continuity of Supply. Compared to the 6th CEER Benchmarking Report, the BR 6.1 includes several additional figures, such as aggregated box-plot summary graphs. These additional figures illustrate the range of values over the last seven years (provided that the data for at least four of those years are available) in addition to the mean and the latest available value (in this case from 2016). However, there are significant differences in manner of monitoring across the EU Member States (EU MS).

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.

In the following table, 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.

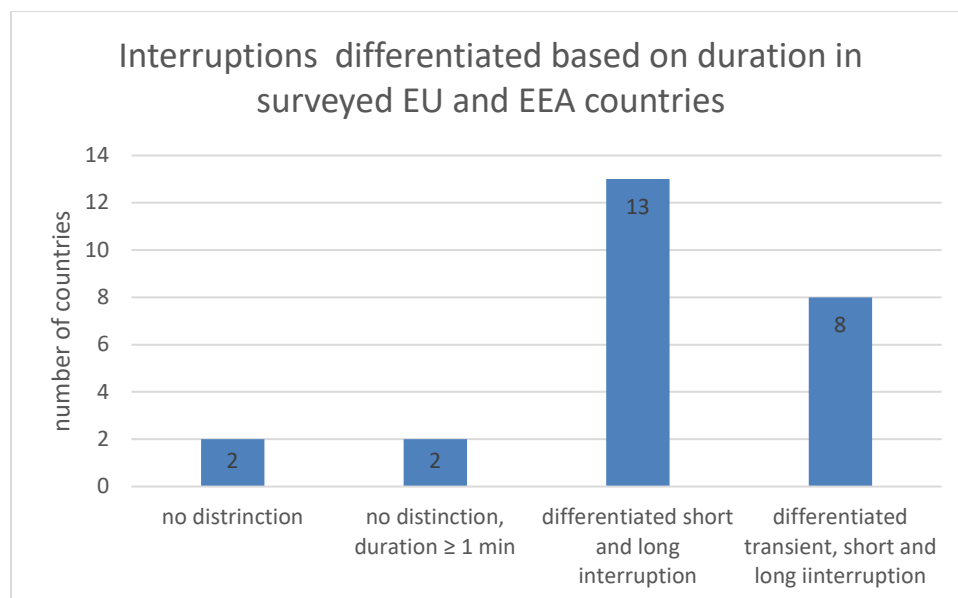


Figure 1 Definitions of long, short and transient interruptions⁶

As illustrated above, about half of the surveyed EU MSs and the European Economic Area (EEA) countries make no distinction between long and short interruptions.

The 6th Benchmarking report further concludes that 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, that there are still cases when boundaries between interruptions of different duration are blurred, as there is no clear distinction between long and short interruptions.

In the following table are presented definitions of interruptions per duration, as applied and reported by DSOs in the EnC:

Table 1 Definitions of long, short and transient interruptions

Contracting Party	DSO	Transient interruption	Short interruption	Long interruption
Albania	OSHEE	No definition	t < 10 min	t ≥ 10 min
	EPBIH	t ≤ 1sec	1 sec < t ≤ 3 min	t > 3 min
Bosnia and Herzegovina	EPHZHB	No definition	No definition	t > 3 min
	ERS	No definition	1sec < t < 3 min	t > 3 min
Georgia	EP	No definition	< 5 min	≥ 5 min
Kosovo*	KEDS	No definition	t ≤ 3 min	t > 3 min
North Macedonia	ED	No definition	< 3 min	≥ 3 min
Moldova	PE	t ≤ 1 second	1 sec < t < 3 min	t > 3 min
Montenegro	CEDIS	No definition	No definition	≥ 3 min
Serbia	EPSD	No definition	No definition	t > 3 min
Ukraine	DTEKG	No definition	t < 3 min	t ≥ 3 min

⁶ compiled from 6th CEER Benchmarking report on the quality of electricity and gas supply – 2016

* 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.

Interruptions shorter than 1 second are defined only in Bosnia and Herzegovina (EPBIH) and in Moldova, operator Premier Energy.

Differentiation only between long term interruptions (longer than 3 minutes) and short interruptions (shorter than 3 minutes) is established in Republic of Srpska (Bosnia and Herzegovina), North Macedonia, Kosovo*, Ukraine.

Albania and Georgia also differentiate only short and long interruptions, but with the time limit for short interruption set at 10 and 5 minutes respectively.

For operator EPHZHB from Federation Bosnia and Herzegovina, operators from Montenegro and Serbia only interruptions longer than 3 minutes are recorded.

It is still not clear, when the definition is established, how it is enforced for an operator to monitor, register and report these interruptions.

1.3.1. INTERRUPTION BY CAUSE: PLANNED AND UNPLANNED INTERRUPTIONS

Most countries use separate classifications for planned (notified) and unplanned interruptions. The concept “planned interruption” is cited in EN 50160 (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.

There are different classifications of unplanned interruptions. Most common definition is: all interruption that is not planned. The majority of surveyed EU MSs and EEA countries have the same or very similar definition for planned interruptions⁷.

All other interruptions are “unplanned”. 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. Most of the EU MSs and EEA countries require the DSO to inform the customer about the planned interruption through the mass-media. In case of Slovenia, 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. In Ukraine DSO is obliged to inform customers about planned interruption through the mass media, specifically to publish the notification on its official web site and in printed periodical publications, TV or radio broadcaster, whereas messaging or e-mail services could not be applied for this purpose.

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. Definitions of planned and unplanned interruptions are similar relating to the obligation to inform customer in advance of a planned interruption.

In the following table are presented definitions of planned and unplanned interruptions observed by DSOs in the EnC.

⁷ 6th CEER Benchmarking report on the quality of electricity and gas supply – 2016

Table 2 Definitions of planned and unplanned interruptions

Country	Planned interruption	Unplanned interruption
ALB / OSHEE	Planned maintenance works: planned reconstructions and investments works; planned third parties requests	Faults in the distribution network; force majeure; interventions by third parties
BIH/ EPBIH	Interruptions that are predicted in the plan and for which customers are informed	Interruptions for which customers weren't informed (result of unplanned releases)
BIH / EPHZHB	Not defined	Not defined
BIH / ERS	Announced interruptions (no later than 24h before the planned interruption) for the purposes of doing planned activities of regular and extraordinary maintenance, inspection and overhaul, connections of new customer, testing and control of measuring and protection devices and network upgrades	Interruptions caused by switching devices trips and unannounced planned interruptions
GEO / EP	Scheduled outages-planned interruption of supply, of which the customers have been informed in advance	Unscheduled outages – unplanned interruption of supply, of which the Customers have not been informed in advance
XKX/ KEDS	Publicly published interruptions for which are the customers also notified	Blackouts and other manual disconnections related to fixing the blackouts, as well as emergency cases that cannot be published publicly or notify the customers in advance
MKD / ED	The disruptions in the distribution system for which the DSO informs the distribution network users, in a timely manner through the public media and on its website 24 hours in advance	Interruptions in the distribution network that occur due to the occurrence of faults and defects in the distribution system
MDA / PE	An interruption, notified in advance by TSO and/or DSO, and performed for repair, maintenance, prophylaxis of power lines and/or electrical equipment, that cannot be carried out under voltage, including interruptions at the request of third parties	An interruption that customers have not previously been notified of TSOs and/or DSOs, caused by failure of the distribution system or transmission system equipment and other external causes
MNE / CEDIS	1) If interruption started and ended within the announced termination term, and 2) If interruption resulted from the occurrence of a market disturbance, as defined by the Law, and if interruption was performed according to the plan that was announced in the prescribed manner	All other interruptions are unplanned interruptions
SRB / EPSD	Previously agreed and when DS users are notified in due time	Occurs due to events that could not have been foreseen by the DSO
UKR / DTEKG	De-energization of a part of the network and equipment made by the DSO to undertake routine repair or maintenance of electrical networks. Interruption is classified as planned only in case of advance notice.	Temporary suspension of electricity supply to customers because of de-energization of a part of the network due to the fault of other licensee (undertakings), customers , force majeure events, fault of others, technical failures in the electrical network of the DSO

1.3.2. MONITORING CONTINUITY PER VOLTAGE LEVELS

It would be very difficult to discuss the monitoring of interruptions on different voltage levels without first addressing how those voltage levels are defined. The terms medium voltage (MV), high voltage (HV) and extra high voltage (EHV) may have quite different meanings. In addition, in some jurisdictions exists strict delineation between transmission and distribution based on voltage levels assigned to them, and in other the delineation is based on the functional criteria.

Sometimes, the actual voltage level is not strictly defined or is different from its definition. According to the 6th CEER Benchmarking Report and BR 6.1, certain voltages may be only defined nominally but their real value varies according to operating conditions. It is possible that certain voltage levels correspond to both transmission and distribution, when DSOs are allowed to build grids with voltage normally assigned to transmission, if they have a distribution function. These grids are mainly developed to directly connect local generation units that are too big to the existing distribution grid.

Not all countries monitor interruptions that originate at all voltage levels, but all generate statistics of incidents at more than one voltage level.

In the following table are presented classifications of causes, voltage level and areas of interruptions for DSOs in the EnC.

Table 3 Classification of interruptions per voltage levels and area

CP/ DSO	Classification of causes	Classification of voltage level	Classification of area
ALB / OSHEE	Planned interruptions; Unplanned interruptions-interruptions due to OSHEE fault, force majeure, interventions by third parties	110/35/20/6/0, 4 kV (excluded the 110kV side monitored by TSO)	Rural and Urban
BIH / EPBIH	Planned interruptions: regular maintenance, emergency maintenance, investment, TSO requests, third party requests. Unplanned interruptions: distribution network failures, transmission network failures, generator failures, failures on third party facilities, TSO requests, requests by supplier.	MV (10, 20 and 35 kV; summary) and LV	For the whole territory
BIH / EPHZHB	Not defined	Medium voltage	In the entire area of operation
BIH / ERS	Force majeure Responsibility of third party Responsibility of distribution company	HV, MV, LV	Separately for urban/suburban /rural area, separately for each DSO's area
GEO / EP	Force-Major, internal and external causes, (internal cause is divided into planned/unplanned)	110/35/10/6/0, 4 kV	Currently: City/ village/ borough. From 1 st July 2019 city and other types of settlements classified on the basis of the regional (network) arrangements
XKX* / KEDS	Blackout and manual disconnection. Each	0.4kV, 6kV,	Reported for the whole

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	category has a variety of options enabling us to select the cause	10(20)kV and 35kV	territory, can be reported for different areas upon request
MKD / ED	<ol style="list-style-type: none"> 1. Unfavorable atmospheric influences 2. Unplanned interruptions caused by animals or subjects 3. Unplanned interruptions caused by third parties 4. Unplanned interruptions caused by defect in the grid 5. Unplanned interruptions caused by TSO/National energy producer 6. Planned interruptions 7. Interruption due to state bodies requests 	0.4kV, 6kV, 10(20)kV, 35kV and 110 kV	For the whole territory
MDA / PE	<ol style="list-style-type: none"> a) Force majeure or special weather conditions b) Events caused by third parties c) Interruptions caused by system users' installations d) Other reasons 	HV, MV, LV	Rural and Urban
MNE / CEDIS	System operators, third parties, force majeure	35kV, 10kV and 0,4kV	For the whole territory. The definition of urban and rural areas is in the process of determination.
SRB / EPSD	<ol style="list-style-type: none"> (a) Force majeure or special weather conditions; (b) events caused by third parties; (c) interruptions caused by system users' installations; (d) other reasons (e) events caused by another energy entity (f) animals/unknown 	On HV and MV level	Interruption statistics are reported separately for distribution areas
UKR / DTEKG	<ol style="list-style-type: none"> 1. Planned interruption with notice 2. Planned interruption without notice 3. Unplanned (emergency) interruption through the fault of other licensees or customers 4. Unplanned (emergency) interruption due to the force majeure 5. Unplanned (emergency) interruption through the fault of others 6. Unplanned (emergency) interruption due to the technical failures in the electrical networks of the licensee 	LV, MV, HV	<p>Urban area – the cities and small towns.</p> <p>Rural area – all other communities, localities and villages.</p>

1.3.3. METHODS USED FOR IDENTIFICATION OF NETWORK USER AFFECTED BY OUTAGES

Roughly half of the observed EU and EEA countries use automatic logging or automatic identifications when measuring long and short interruptions. About a third of them use both, and nearly half do identify affected users in an automated process.

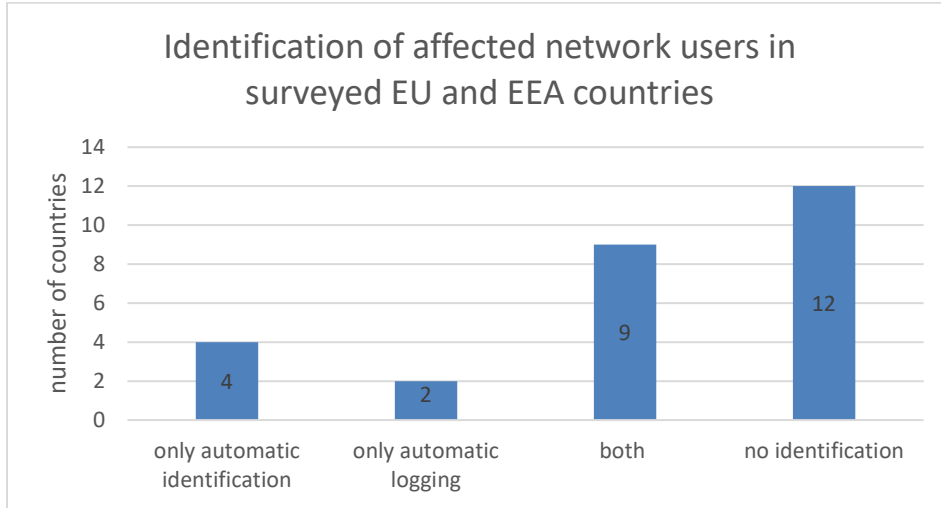


Figure 2 *Applied method for identification of network user affected by outage⁸*

Only few DSOs in the EnC are able to identify network users affected by the interruption by means of an automatic system.

Where automatic system exists, it mainly covers middle and high voltage networks.

In the following table are given methods used by DSOs for identification of network user affected by outage in the EnC.

⁸ Compiled from 6th CEER Benchmarking report on the quality of electricity and gas supply – 2016

Table 4 Method used for impact monitoring

CP / DSO	Identification of affected network users	Standardized system for recording and reporting of long and short interruptions	Automated system (OMS,SCADA etc.) to record outages
ALB / OSHEE	Based on Billing System database	No	No. Currently OSHEE is working with WB team on preparing of Bid Documents for installation of smart meters within all transformation points and MDM system. MDM system is foreseen to have OMS.
BIH / EPBIH	Affected customers (number of customers) are identified from existing relevant databases.	At this moment there is an internally developed system for recording of long and short interruptions and reporting of long interruptions.	Not at this moment
BIH / EPHZHB	Assessment.	SCADA, AMR center, AMM center	Yes
BIH / ERS	Customers affected are identified by the customer's ID, which follows the network tree.	Yes, there is uniform form for keeping records on interruptions in electricity supply and reporting forms prescribed by Regulator.	Some DSO use proprietary software for processing of interruptions; some DSOs use SCADA system at MV level to record outages
GEO / EP	The software provides information from the database where the so-called network and consumption tree is identified Substation -> Feeder -> Transformer Point etc.	The company is using software based on the requirements of service rules	Only for 23 Substations

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XKX* / KEDS	Each customer has unique ID that corresponds with the code of their 10(20)/0.4kV substation or 10(20)kV feeder. Our interruptions registration system and customer management system are interconnected.	No	DSO is using KosovaNet software, which helps DSO to monitor and record online the outages. The software is linked also with the call-center so whenever there's a call it automatically shows/alerts the operators in field. Moreover, SCADA project is an ongoing project.
MKD / ED	If the interruption happens due to faults in the HV or MV level the customers are identified through the SCADA system. If the interruption occurs in the LV they are identified according to the transformer and the feeder where the fault happened.	There is no standardized system developed, although DSO uses SCADA and OMS system for recording and reporting the interruptions.	Yes. The OMS system is used for LV outages recording and the SCADA is used for MV and HV outages recording.
MDA / PE	Customers affected by interruptions are identified based on electrical addresses. Each point of consumption is associated with electrical installations where the energy is distributed.	The data required to be recorded are reflected in Table 1 and 2 of Annex 1 to the Regulation on service quality of electricity transmission and distribution. This information is recorded continuously, then reported to ANRE monthly and annually.	Interruptions are recorded on the basis of TSO and DSO automated means and on the basis of calls by end users or network users registered at the call center 24/24 hours.
MNE / CEDIS	Affected customers are associated with each interruption.	No. SCADA systems and interrupt monitoring software are currently in the project preparation phase	No
SRB / EPSD	Each point of consumption (address of customer) is associated with electrical supply where the energy is distributed.	Only SCADA system for HV and MV.	Interruptions are recorded on the basis of TSO and DSO automated means and on the basis of calls by end users or network users registered at the call center 24/24 hours.

<p>UKR / DTEKG</p>	<p>Affected of supply interruption customers are identified by:</p> <ul style="list-style-type: none"> - calls-requests on special phone numbers (call-center or control operators); - SCADA-system signals; - by a conclusion of control operator <p>In the future there is prospective to use smart-meters for such identification</p>	<p>Either by using the SCADA system or manually. Not all DSOs have the equipment with SCADA system for all voltage levels. There are no common rules or standardized way to identify affected customers. In most cases, SCADA is used for HV and only few DSOs installed SCADA for MV. The interruptions of LV and MV are, therefore, recorded manually and the data is stored locally in registers (registry books). NEURC monitors long interruptions For both unplanned and planned interruptions, the standardized system for recording and reporting is adopted.</p>	<p>SCADA is used for HV and only some of the DSOs installed SCADA for MV. For other MV and LV automated system to record outage is absent.</p>
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1.3.4. CONTINUITY OF SUPPLY INDICATORS

Different types of indicators or same indicators with different weighting methods present an obstacle for comparison of national continuity data. Moreover, while all operators are obliged to keep track of their long interruptions, short interruptions are monitored in less than half of the surveyed countries. This section will examine the types of indicators used for long and short interruptions.

The definitions of Indicators used across Europe to quantify the number and duration of long interruptions are compared from the CEER 4th Benchmarking Report on quality of electricity supply (2008) for distribution and transmission systems.

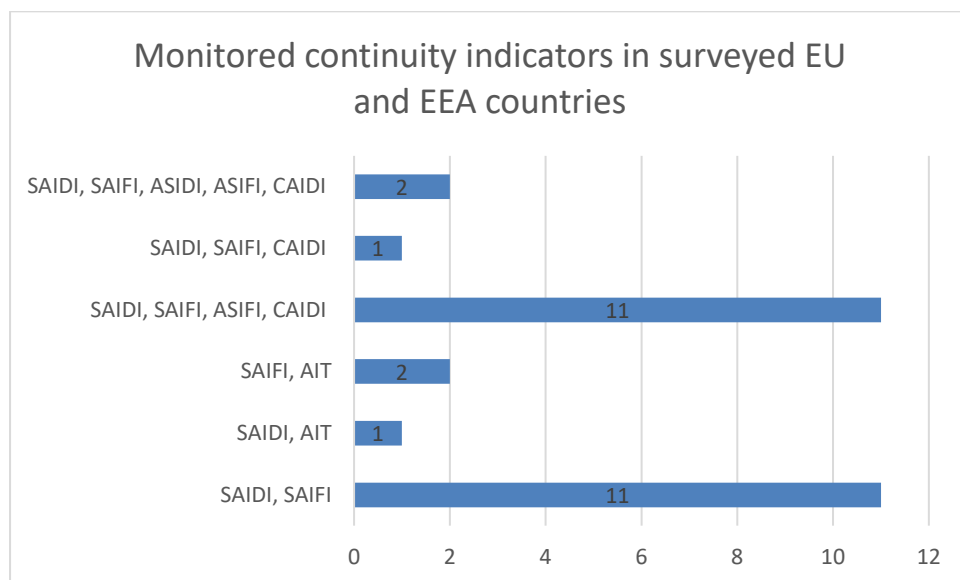


Figure 3 Indicators used to monitor continuity in the EU MSs and EEA countries⁹

As stated in the CEER 6th Benchmarking Report, 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 surveyed countries in the CEER Report, albeit under different names and with different methods for weighting the interruptions.

According to the 6th CEER Benchmarking Report, it is important to remember that both SAIDI and SAIFI can be presented with or without exceptional events. The Report states that more than two thirds of the surveyed 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 harmonized. Non-natural causes include, among others, wars, sabotage, acts of terrorism and embargos.

The Report further states that 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 and cannot be measured, but only estimated¹⁰. In the surveyed EU MSs and EEA countries, ENS indicator for DSO is monitored in two of them, in combination with different other continuity indicators.

The method of weighting the impacts of the observed indicators leads to different biases towards different types of network users.

⁹ Compiled from 6th Benchmarking Report on the quality of electricity and gas supply, table 2.9

¹⁰ Ibid, p 35

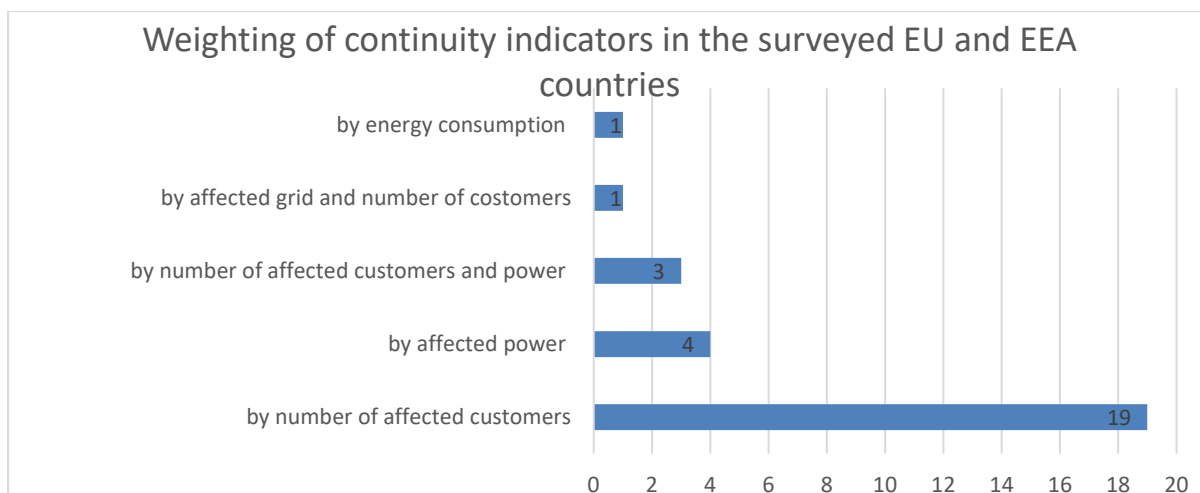


Figure 4 Factors used for weighting continuity indicators in the EU MSs and EEA countries¹¹

The mentioned CEER Benchmarking Report elaborates impact of the weighting method.

“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.”¹²

Reporting and monitoring obligations by DSOs in the EnC is more harmonized in terms of Continuity of Supply Indicators, in particular for long interruptions.

Table 5 Monitoring obligations Continuity of Supply Indicators

CP / DSO	Indicators for short interruptions	Indicators for long interruptions
ALB / OSHEE	The short interruptions are recorded, not monitored	SAIDI, SAIFI, CAIDI, ENS
BIH/ EPBiH	Short interruptions are not monitored.	SAIDI, SAIFI and CAIDI ¹³
BIH / EPHZHB	N/A	SAIDI, SAIFI
BIH / ERS	SAIFI	SAIDI, SAIFI
GEO / EP	SAIDI/SAIFI/MAIFI/ENS	SAIDI/SAIFI/MAIFI ¹⁴ /ENS
XKX / KEDS	SAIDI, SAIFI	SAIDI, SAIFI
MKD / ED	SAIDI, SAIFI and CAIDI	SAIDI, SAIFI and CAIDI
MDA / PE	N/A	SAIDI, SAIFI, CAIDI
MNE/ CEDIS	SAIDI, SAIFI	SAIDI, SAIFI
SRB / EPSD	N/A	SAIDI, SAIFI
UKR / DTEKG	The short interruptions are monitored only for the purpose of finding the reason of such interruption	SAIDI, SAIFI, CAIDI, ENS

SAIDI and SAIFI for long interruptions are monitored in all observed DSOs, CAIDI in five of eleven DSOs and ENS in three DSOs. Some DSOs in the EnC also record short term interruptions for monitoring SAIDI and SAIFI indicators.

¹¹ Compiled from 6th Benchmarking Report on the quality of electricity and gas supply -2016, table 2.9

¹² Ibid, p. 35

¹³ Customer Average Interruption Duration Index

¹⁴ Momentary Average Interruption Frequency Index

1.4. INCENTIVES AND PERFORMANCE BASED REGULATION

General reward or penalty schemes or incentives to optimize the continuity of supply on a system level were applied in more than half of the EU MSs surveyed in 2016 and 2018. Most countries use a combination of rewards and penalties in both distribution and transmission, some focus exclusively on penalties (Denmark, Hungary) or on rewards (Belgium, Spain). The incentive schemes are often based on benchmarking or on network operator's historical level of actual continuity of supply.

In the EnC, incentive schemes are not applied yet in any form of reward for compliance, however, in some CPs penalties can be imposed on DSO for damage caused by interruption in supplying electricity of required quality.

As stipulated in the mentioned CEER 6th Benchmarking Report, a performance-based regulation may incentivize improvement of continuity indicators taking due care of the following main aspects:

“Continuity measurement – a prerequisite for setting standards and reward/penalty regimes. Here, robust and reliable data recording of the actual continuity levels is needed, along with solid record keeping system in place;

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 allow sufficient costs to ensure 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 incentives to reach these goals include publishing continuity data and implementing reward/ penalty schemes; and

Continuity ensured for each network user – the focus is placed on individual users. Minimum standards for quality levels accompanied with associated payments will guarantee that single users will be compensated if the standard is not met by the network operator.”¹⁵

Customer satisfaction survey – an additional tool to evaluate the customers' perception of the quality of provided service. Well-designed survey can provide information to estimate the price customers are willing to pay for incremental quality.

1.5. SUMMARY OF FINDINGS

1.5.1. RECORDING AND MONITORING

Continuity of supply is monitored by all electricity networks operators.

The monitoring usually covers long interruptions and differentiates between planned and unplanned outages. Short interruptions are monitored by a minority of CPs.

Voltage level definitions are not standardized, neither classification of interruptions in short and long interruptions.

All DSOs in the EnC have classification of planned and unplanned interruptions.

Minor differentiation exists in definition of planned interruptions and significant difference in classification of causes of unplanned interruptions.

¹⁵ CEER 6th Benchmarking Report on the quality of electricity and gas supply - 2016, p. 50

Interruptions are not classified by cause in a harmonized manner in the EnC.

1.5.2. PROCEDURES FOR DATA COLLECTION AND ANALYSIS

Diverse indicators and weighting methods are employed when evaluating interruptions. The use of multiple indicators enables collection of more information and offers more possibilities to observe trends. The most commonly used indicators are SAIDI and SAIFI, often weighted by the number of users.

The actual measurement of continuity can be performed on two different levels, namely system level and user-specific level.

The level of detail being monitored is not harmonized either. In most EU MSs as well as in EnC CPs DSOs collect some, but limited information on the cause of interruptions. Systematic approach to data collection in detail would provide an essential tool for benchmarking, experience sharing and improvement of continuity of supply.

1.5.3. CALCULATION METHODOLOGY FOR CONTINUITY OF SUPPLY INDICATORS

As already mentioned, various indicators of continuity of supply are used. Even in case of using the same indicators (e.g. SAIFI, SAIDI), different approaches exist to calculate these parameters. One of the differences, for example, is including or excluding each specific cause of interruption (force majeure, exceptional events etc.).

Concurrently, each jurisdiction can have different approach to calculate indicators where lots of sequences of interruptions with different causes, duration (long or short) and different numbers of affected customers occur.

Harmonized approach is a precondition for a correct evaluation and comparison of DSO performance.

1.5.4. EXCEPTIONAL EVENTS

Treatment of exceptional events has serious impact on the values of continuity of supply indicators. There are different definitions and approaches to exceptional events. One of the reasons for the difference could be that some CPs define exceptional events with respect to their historical experiences or geographic reasons. Some CPs have no definition in place.

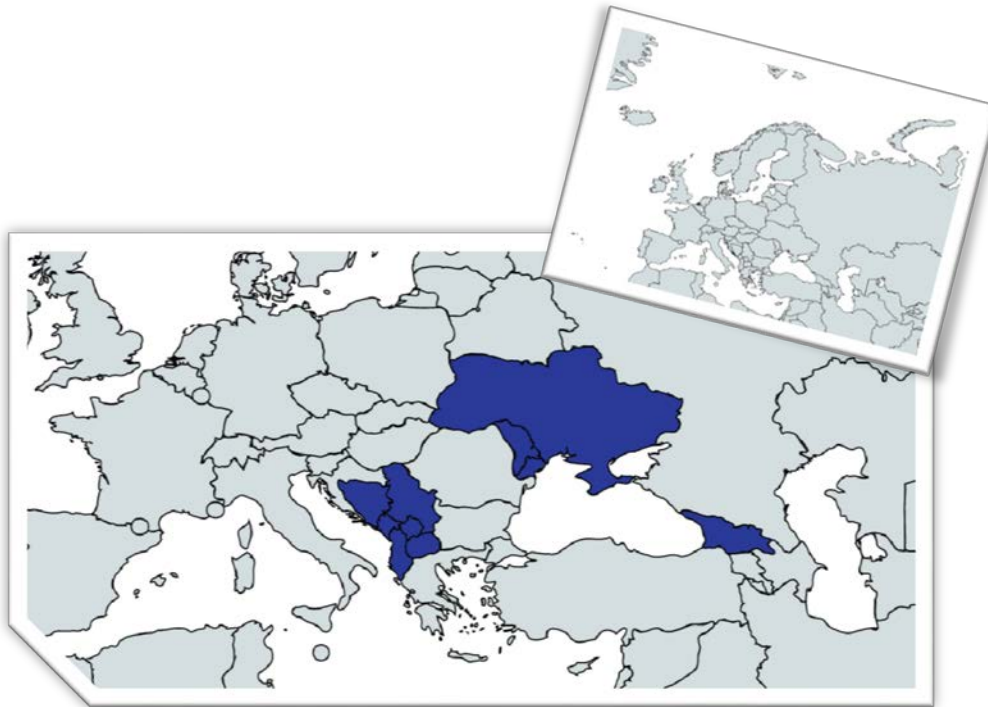
As a result, it is not clear what types of interruptions are considered to be a consequence of exceptional events. Therefore, the comparison of continuity of supply indicators must take into account this diversity in definitions of exceptional events and strive toward harmonized definition.

1.6. RECOMMENDATIONS

<p>MEASUREMENT OF QUALITY LEVELS</p>	<p>The continuous measurement of actual continuity levels over several years constitutes the basis to set standards for regulating continuity and quality of supply.</p> <p>For those CPs where measurement is carried out manually, it is important to foresee investments and implement measures for the automatic logging and identification of interruptions in order to minimize impact of human factor on the monitoring results.</p>
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	<p>The absence of rules and procedures for automatic recordings of interruptions has a direct impact on completeness, robustness and the quality of collected data on interruptions.</p> <p>DSOs should establish data base for recording interruptions by cause, duration and voltage level.</p>
<p>DEFINITIONS OF CAUSE</p>	<p>DSOs should work toward consistent classification of unplanned interruptions</p> <p>Event of force majeure should be defined as clearly as possible, as well as any other event triggering applicability of contractual conditions for extraordinary circumstances.</p> <p>DSOs together with the NRA should define exceptional weather condition, natural disaster and force majeure to be applied in the methodology for calculation of continuity of supply indicators.</p>
<p>RECOGNITION OF COSTS OF QUALITY STANDARD</p>	<p>Network tariff should include investments for automatization of the processes for monitoring continuity of supply (SCADA, software).</p> <p>Most DSOs in the EnC do not implement automatic logging, even at HV and MV level, due to the lack of human, technical or financial resources. In order for the DSOs to efficiently monitor the continuity of electricity supply, the associated costs to implement automatization of the monitoring process have to be planned and recognized.</p> <p>When preparing the network development plan and investment plan, DSOs should emphasize the investments dedicated to achieve guaranteed level of continuity of supply standard. Plans should be approved by the NRAs.</p> <p>Guaranteed level of quality for each customer category should be set at the level that the customers are willing to pay for.</p>
<p>INCENTIVE BASED REGULATION</p>	<p>NRAs should introduce the incentive based regulation of service quality, with both penalties and reward system, only after reliable recording, monitoring and reporting system is in place.</p> <p>The compensation mechanism should be revised to one that requires DSO to pay the compensation only upon the complaint of customer, when actual harm was inflicted to the customer.</p> <p>DSOs should keep record of customer's interruptions complaints, number of justified customer's complaints and publish information on the number of complaints.</p>
<p>TRANSITIONAL PERIOD AND TIME NEEDED FOR IMPLEMENTATION</p>	<p>DSOs need transitional period to implement standards for continuity of supply. The duration of the transitional period should be reasonably set in order to give proper time for DSOs to undertake necessary adaptations to improve continuity.</p> <p>Since most of the necessary adaptations are related to the reinforcement, reconstruction and upgrading of the distribution systems, requiring substantial investments, a step wise approach should be implemented to set guaranteed level of quality for different categories of network users.</p> <p>NRAs should revise their regulation regarding means to inform the customers of planned interruptions in order for DSO to use the most effective technologies (messengers, SMS, mobile client applications etc.) allowing DSO to build better communication with the clients.</p>

2. VOLTAGE QUALITY



2.1. GENERAL REMARKS

Voltage quality (VQ) covers a wide range of voltage disturbances and deviation in voltage magnitude or waveform from the optimum values. Voltage quality is used to refer to all disturbances in the supply of electricity, excluding interruptions.

Power frequency is however not considered in this document, as the power frequency is monitored and managed by the interconnected European transmission system operators and international system operation agreements.

Every year the network operators of different countries around the world receive many complaints about voltage quality problems from different groups of network users. A customer complains when the operation of devices in his/her installation is interrupted leading to inconveniences. An overview of different voltage quality problems as noticed by different customers is summarized as follows:

- Residential customers suffer inconveniences because of under-voltage and light flicker. These problems generally do not have major financial impacts.
- Voltage dips can create inconveniences to commercial customers because of equipment damage and data loss followed by business down time. Also, they complain about large neutral currents because of harmonics that cause additional heating of their devices. This group of customer is also vulnerable to sudden transient current surges that can cause unwanted tripping of protective devices.
- Large industries (for example the semiconductor industry, paper plants, glass and steel industries, etc.) suffer significant financial losses when voltage dips occur at their sites. The industrial customers also complain about harmonics that cause fast ageing and early failure of various devices.

- Network operator suffers inconveniences because of inaccurate operation of protective devices and failure or shortening of the lifetime of network components such as transformers, cables, etc. These problems are often caused by harmonic currents generated from the customer's installations.

Everyone connected to the power grid could affect 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.

Voltage quality is becoming an increasingly important issue for DSOs and customers 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.

Voltage quality is the most technically complex part of QoS. Measurement issues, the choice of appropriate indicators and setting the 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 assign the responsibility to 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.

In preparation of this document, the Task force conducted a survey based on five questionnaires with 45 questions related to voltage quality for DSO participating in ECDSO-E from nine EnC CPs. The responses are summarized and analysed with the objective to draw conclusions and to make recommendations for DSOs.

2.2. LEGISLATION AND REGULATION

At present a number of standards are available for defining limits to various voltage quality disturbances. The international communities such as IEEE and IEC have created a group of standards for defining different voltage quality disturbances. The standard EN 50160¹⁶ describes the voltage characteristics of the electricity supplied by a network operator (in Europe) at a customer's installation.

Since it is responsibility of the network operator to maintain an acceptable level of voltage quality and to ensure that the quality at connection points complies with requirements, direct obligation for the actual monitoring needed for compliance verification should be thus delegated to the network operators. A National regulatory authority should have the authority to instruct a network operator to take appropriate measures in the case the trends in voltage quality levels require such action. The responsibility for maintaining sufficient VQ shall remain, however, fully with the network operator and the NRA shall in no way take over any of this responsibility.

Whereas interruptions affect all network users, voltage disturbances do not affect all users in the same way, as the impact of different types of disturbances can be completely different for different individual users. There is a need therefore for harmonization regarding the limits on voltage

¹⁶ European Standard EN 50160 - Voltage characteristics of electricity supplied by public electricity networks

disturbances, considering the fact that end-user equipment is standardized throughout Europe, but regulation is different.

According to the 6th CEER Benchmarking Report on the Quality of Electricity and Gas Supply – 2016 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 influence the role that different NRAs would 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 standardization with approval procedures from the NRA.

The European standard EN 50160 gives an overview of all voltage quality disturbances and sets limits or indicative values for many of them. Standard EN 50160 has become an important basis for voltage quality regulation throughout Europe. A further important contribution comes in the form of the standard on power quality measurements, EN 61000-4-30¹⁷ which has resulted in standardized common methods for voltage quality monitoring.

The survey performed as a part of the 6th CEER Benchmarking Report on Quality of Electricity and Gas Supply, reveals that in 24 countries 2010 version of the standard EN 50160 has been translated and applied. In 4 countries (Cyprus, Hungary, Romania and the Slovak Republic) the 2007 version of the standard is still in force. In case of Estonia and Spain, the standard is implemented on a voluntary basis. In 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 Transmission System Operator to guarantee sufficient voltage quality to allow DSOs to fulfill 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, flickers, power frequency and voltage unbalance.

As far as EnC is concerned, the European standard EN 50160 is implemented either on voluntary basis or alternatively it is enforced as mandatory, as given by respective legislation and regulation. In Bosnia and Herzegovina (Republic of Srpska), Serbia, North Macedonia and Kosovo* the standard is part of the national legislation, mostly by means of the rule adopted or approved by the NRA. Also, in Ukraine after adoption of the new Distribution code (came into force 19.04.2018) nationally adopted standard DSTU EN 50160:2014 became a mandatory one. In Montenegro and Albania the Standard EN 50160 is implemented on the voluntary basis. In Georgia and Moldova fulfillment of the Standard EN 50160 is not obligatory.

The limits set by EN 50160 for voltage disturbances are presented in Table 6¹⁸. In the case of supply voltage variations, limits are set only for LV and MV networks.

¹⁷ European Standard EN 61000-4-30 - Testing and measurement techniques - Power quality measurement methods

¹⁸ 6th CEER benchmarking report on the quality of electricity and gas supply – 2016, pg. 85

Table 6 Standard EN 50160

Voltage disturbance	Voltage level	Voltage quality index (limit)
Supply voltage variations	LV	<ul style="list-style-type: none"> 95% of the 10 minute mean r.m.s. values for 1 week ($\pm 10\%$ of nominal voltage) 100 % of the 10 minute mean r.m.s. values for 1 week (+ 10%/-15% of nominal voltage)
	MV	<ul style="list-style-type: none"> 99% of the 10 minute mean r.m.s. values for 1 week below +10% reference voltage 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 ($\pm 15\%$ of reference voltage)
Flicker	LV, MV, HV	<ul style="list-style-type: none"> 95% of the P values for 1 week, should be less than or equal to 1
Unbalance	LV, MV, HV	<ul style="list-style-type: none"> 95% of the 10 minute mean r.m.s values of the negative phase sequence component divided by values of the positive sequence component for 1 week, should be within the range 0% to 2%
Harmonic voltage	LV, MV	<ul style="list-style-type: none"> 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
	HV	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 99% of a day, the 3 second mean value of signal voltages less than limits presented in graphical format

The next table shows the overview of the responsibility for voltage regulation in the EnC CPs. The same set of information for EU MSs is presented in the 6th CEER benchmarking report on the quality of electricity and gas supply¹⁹.

NRAs need to consider imposing obligations requiring TSO to guarantee sufficient voltage quality, to allow DSOs to fulfill the EN 50160 standard.

¹⁹ 6th CEER benchmarking report on the quality of electricity and gas supply – 2016, pg. 83

Table 7 The responsibility for voltage quality regulation

CP	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 consultation regarding voltage quality?
ALB	N/A	Yes	Distribution Code; Regulation on standards criteria of supply quality and security performance of electric energy distribution network	N/A
BIH	Yes	Yes	No	No
GEO	Yes, Network Rules	Yes	Yes	Yes
XKX	Yes, through article 47 of the Law on Electricity	No. NRA have exclusive powers, while Network Operators have to follow the criteria set by the NRA.	Yes it has. It is into the Distribution Code.	Yes, on 26 April 2019
MDA	Yes	Yes	Yes. Regulation on the quality of electricity transmission and distribution services no. 282/2016 of 11.11.2016 issued by ANRE, comespls the DSO to comply with the quality parameters according to the national standard in force.	No

MNE	Yes; Based on requirements of the Energy Law (article 43), the Energy Regulatory Agency defined RULES ON MINIMUM QUALITY OF DELIVERY AND SUPPLY OF ELECTRICITY. The Rules was issued in July 2017 (Official gazette Montenegro 50/2017). Financial compensations set by these Rules are applied after the period of two years following the promulgation of these Rules.	Yes	The Energy Regulatory Agency promulgated the Rules on minimum quality of delivery and supply of electricity. Voltage Quality is a part of this rules.	Yes
MKD	In accordance to the Energy law, the regulatory is empowered to approve Electricity Distribution Grid Code previously prepared by DSO. In the Electricity Distribution Grid Code in accordance to the Energy law should be prescribed the quality of electricity delivered through the distribution system. If during the adoption of the Distribution Grid Code DSO does not follow recommendation of the regulatory authority, regulatory authority has to make changes and supplements of the documents and to request DSO to publish them in the Official Gazette. Having in mind the above stated, regulatory authority has power to define voltage quality regulation.	NRA has sole power to define voltage quality regulation.	Until now NRA has not issued regulatory orders.	Regarding voltage quality NRA issues public discussions in the procedure for approving Distribution Grid Code
SRB	Yes	Yes	No	No
UKR	Yes, the Regulator is responsible to monitor the DSOs compliance with the standards of quality of electricity supply.	Yes. Together with NRA (NEURC) the State Inspectorate of Energy supervision define the voltage quality regulation.	Yes	Yes

2.2.1. NATIONAL LEGISLATION AND REGULATIONS THAT DIFFER FROM EN 50160

Standard EN 50160 is generally 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.

Information on the different application of the standard EN 50160 in the European countries is presented in 6th CEER Benchmarking Report on the Quality of Electricity and Gas Supply – 2016. For example, 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. In Netherlands, it is assumed that the voltage quality is better than in the standard EN 50160. 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. In Sweden, the same definitions as in EN 50160 are used but the limits should not be exceeded for 100% of time.

In the next table are shown voltage quality indicators different from the indicators used in the standard EN 50160 for CPs. The analysis was made on the basis of the data provided through the questionnaires.

Table 8 Voltage quality regulation different from the EN 50160 for the EnC CPs

Voltage disturbances	Indicator	Integrated period	Time	Limit			CP	
				HV	MV	LV		
Supply voltage variation	r.m.s. voltage	10 min	99% for MV, 95% for LV	-	±10% Un	±10% Un	MNE (only LV), BIH (RS i EP BiH), UKR (Un = 220V)	
	r.m.s. voltage	10 min	100%	±10% Un	±10% Un	±10% Un	MKD	
	admissible deviation	7 days	95%	±10%	±10%	±10%	SRB	
	Analyzes-Planing's Partialy with SCAD, Relay, meter, measurement of moment and customer complaints	Momentary and 15 minutes	15	Continuity	-	35,10(20) kV±10%	0.4kV±10% (-15%)	XKX
	Admissible deviation			95%	5%	-	-5%	
	Admissible limit deviation	24h		5%	10%	-	-10%	MDA
	kV			1 week	1%	1%	1%	GEO
Flicker	Pst/Plt	10 min	95%	-	<0,8; <0,5	<0,8; <0,5	MKD	
	Monitoring with SCAD, Relay meter	moment	Continuity		Shaking, frequency of appearance per minute. Amplitude up to 3%; Frequency of phenomena Amolitude up to 5%	Shaking, frequency of appearance per minute. Amplitude up to 3%; Frequency of phenomena Amolitude up to 5%	XKX	
	Dose flicker: Pst, Plt	10min, 120 min		1,38:1,0, 1,0:0,74	-	-	MDA	
	%	-	1 week	0,8	0,8	0,8	GEO	
Supply voltage unbalance	Vt,m	10min	0,95		≤2%Un	≤3%Un	MKD	
	K2u inverse sequence non-symmetry coefficient	24h	95%	2%			MDA	
	k0u homopolar sequence	24h	95%	2%				

QUALITY OF SUPPLY
VOLTAGE QUALITY

	non-symmetry coefficient		5%	4%			
	Following of loads and voltages for each phase	Momentary and 15 minutes	Continuity	8.5÷11 kV and 29.75÷38.5 kV		195.5 ÷253 V	XKX
	r.m.s. voltage	10 min	95%; 7 days	<2%	<2%	<2%	MNE (only LV), UKR, BIH/RS, SRB
Harmonic voltage	THD (%Un)	10 min	95%; 7 days		THD < 8 %	THD < 8 %	MNE (only LV), UKR, BIH/RS, MKD, SRB
	Distortion coefficient Ku(n)	24h	95%	see Tab. 1			MDA
			5%	1,5*Ku(n)			
	Measurement and successive monitoring and according to case (relay, meter)	moment measurement	Continuity		V(5, 7) - 1% etj	V(5, 7) - 2% etj	XKX
%		1 Week	1.50%	1.50%	1.50%	GEO	
Interharmonic voltages	Distortion coefficient Ku(n)	24h	95%	See Tab 1			MDA
			5%	1,5*Ku(n)			
	Measurement and successive monitoring and according to case (relay, meter)	Moment measurement	Continuity		V(5,7)-1% etj	V(5,7)-2% etj	XKX
Mains signal voltages	Monitoring in SCADA	continuation	Continuity		kV, V	V	XKX
	%Un	3s	99%; 1 day				MNE, SRB, UKR
Transient overvoltages	r.m.s voltage	1 min	100%		±2%Un	±3%Un	MKD
	Number of atmospheric discharges, registration in relay	Monitoring	Time by time		28kV min god 70kV min 170 kv god	3 kV one minute and 6kV god	XKX
	33	30 minutes		- 10%/+ 15%	-10%/+15%	-10%/+15%	GEO
Supply voltage dips	Number	1 year			10-1000		MNE
	Customers in threshold-beginning of overhead lines and lines overvoltages of moment		Night-Continuity		Un+5%	Un+5%	XKX
	Length of the voltage dip	30s					MDA
%	24hours		5%	5%	5%	GEO	
Supply voltage swells	Overvoltages of moment	Action of protection - disconnection	ms		Un+10%	Un+10%	XKX
	%	24 hours		10%	10%	10%	GEO

The table shows that the most CPs have introduced voltage quality requirements beyond EN 50160 in their legislation and regulation. For North Macedonia voltage quality standards that are different from those indicated in EN 50160 are implemented for some voltage characteristics. In Kosovo*, Moldova and Georgia, voltage quality limits for different voltage characteristics are defined by their legislation.

2.3. VOLTAGE QUALITY CHARACTERISTICS AND MEASUREMENT METHODS

European Standard EN 50160 defines, describes and specifies the main characteristics of the voltage at a network user's supply terminals in public low voltage (LV does not exceed 1000V) and medium voltage (MV is between 1kV to 36kV) of electricity distribution networks under normal operating conditions. This standard describes the limits or values within which the voltage characteristics can be expected to remain over the whole of the public distribution network and does not describe the average situation usually experienced by an individual network user.

Standard EN 50160 does not apply under abnormal operating conditions including the following:

- a temporary supply arrangement to keep the network users supplied during condition arising as a result of a fault, maintenance and construction work or to minimize the extent and duration of a loss of supply;
- in case of non-compliance of a network user's installation or equipment with the relevant standards or with the technical requirements for connection, established either by the public authorities or the DSO including the limits for the emission of conducted disturbances;
- in exceptional situations, in particular,
 - exceptional weather conditions and other natural disasters,
 - third party interference,
 - acts by public authorities,
 - industrial actions (subject to legal requirements),
 - force majeure,
 - power shortages resulting from external events.

Exceptional weather conditions and other exceptional circumstances can significantly affect the quality of supply, especially continuity of supply, as elaborated above. Interruptions caused by exceptional events, even if quite rare, are usually very long and/or affect a substantial number of customers. The concept and definition of exceptional events may reflect the unique characteristics of each CP's electricity sector and the impact of severe weather conditions in each CP.

The analysis of the DSOs responses to the questionnaires reveals that all CPs have different definition of the force majeure and exceptional situation. Table 15 shows definitions of force majeure per CP.

Table 9 Definition of force majeure

CP	Definition of force majeure
ALB	"Force majeure" is an act or a natural or social event, such as earthquake, lightning cyclones, floods, volcanic eruptions, fires or wars, armed conflicts, insurgencies, terrorist or military actions, which prevents the licensed from fulfilling his obligations under the license, as well as acts or other events that are beyond the reasonable control and that did not come to the licensed fault and the licensed did not have the opportunity to avoid such an act or event through the exercise of will, effort, his skills and reasonable care, Albania Law " On electric energy sector"
BIH	Exceptional situations – force majeure which includes all events that lead to the termination of delivery, which are beyond the control of the distributor: Natural disaster (earthquake, fire, flood, avalanches, landslide, etc); Extreme weather condition; Atmospheric lightning discharge; Tornado/Storm wind; Excessive; Great frosts; Other; Reduction of load due to shortage of electricity; Under-frequency load curtailment; Orders of the competent authorities; Social events (war, rebellion, strike, etc.)
GEO	"Service Quality Rules - Article 3 – hh) Force majeure (insurmountable force) – such circumstances (earthquakes, floods, state coup etc.) that do not depend on the Utility or are beyond its control, are of unpredictable character and due to which the Utility is unable to fulfill the service conditions envisaged under these Rules. Such circumstances shall be confirmed by the relevant competent body, the mass media and/or the document signed by the Head of the Utility (or the person authorized by him/her);"
XKX	Law on Electricity defines Force majeure as an act or natural or social event, such as earthquakes, lighting, cyclones, floods, volcanic eruptions, fire or wars, armed conflicts, rebellion, terrorist or military acts, which prevent the licensee to comply with its obligations under the license, as well as other acts or events that are beyond the reasonable control and that did not happen as a fault of the licensee and the licensee has been unable to avoid such act or event through the exercise of will, effort, skill and his reasonable care;
MDA	Regulation on the issue of the certificate of force majeure event, dated 21.12.2004, Chamber of Commerce and Industry of the Republic of Moldova 4. "Force Majeure" means unpredictable events that are caused by natural phenomena: earthquake,

	<p>landslide, fire, drought, heavy wind, etc. The list of such phenomena and circumstances is not exhaustive.</p> <p>5. Events are recognized as force majeure by three criteria: a) their exceptional character, b) their unpredictability: the impossibility of their provision when signing the contract; c) their objective character, they can not be prevented, they are invincible.</p>
MKD	<p>The force majeure is broadly defined in the Rules for determination of reimbursement of damage caused to the producers and customers such as: Force majeure within the meaning of these Rules is an event or condition that at the time of the occurrence was out of operator's control, could not be foreseen by the operator, and the consequences from such events or conditions the operator could not prevent, avoid or remove them nor by applying a reasonably acceptable effort, in particular:</p> <ol style="list-style-type: none"> 1) natural disasters of greater scale and intensity, such as earthquakes, floods, landslides, droughts, volcanic eruptions, orthopedic winds, snow drifts, torrential rains, thunderbolt, fires, epidemics and similar natural events, whereupon the impact of natural disasters on causing the event of force majeure are evaluated in accordance with the technical specifications of the equipment, plants, devices and the installations used by the operator, as well as the design standards and carrying out the operator's facilities; 2) damage, destruction or blocking of another energy, telecommunication or traffic infrastructure that is not owned by the Operator, 3) war or state of war, a state of emergency pronounced in accordance with law, comprehensive military mobilization, invasion, armed conflict, blockade or serious threat from such conditions, 4) civil war, insurrection, uprising, revolution, military or coup, terrorist acts, sabotage, civil unrest, mass violence, 5) actions of state bodies undertaken in accordance with law or actions taken for the utmost need, and which are not caused by the actions that they have downloaded or not downloaded by the Operator, 6) breaks at work, strikes, boycotts or occupation of plants by employees, and 7) declaring an energy crisis situation in accordance with the Law on Energy
MNE	In accordance with the Law of obligations
SRB	Law of obligations and contractors
UKR	According to the NEURC Decision No. 374 "exceptional events" are determined as interruption due to force majeure because 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 and other contingencies. The event of force majeure must be documented.
* BiH – only for the Republic of Srpska, in Federation of BiH force majeure is not defined	

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.

Standard EN 50160 put all disturbances into two "categories"; they are continuous phenomena and voltage events. Continuous phenomena are deviations from the nominal value that occur continuously over time and require continuous measurements. Voltage events are sudden and significant deviations from nominal wave shape, and require a triggering mechanism as well as characteristics to be calculated upon triggering. Voltage events typically occur due to unpredictable events (e.g. faults) or to external causes (e.g. weather conditions, third party actions).

Disturbances classified as the "continuous phenomena" are:

- Power frequency variations,
- supply voltage variation,
- rapid voltage changes
 - single rapid voltage change

- flicker severity,
- supply voltage unbalance,
- harmonic voltage,
- interharmonic voltage,
- main signalling voltage.

Disturbances classified in “voltage event” group are:

- interruptions of the supply voltage,
- supply voltage dips/ swells,
- transient overvoltages.

2.3.1. CLASSES OF MEASUREMENT METHODS

Standard EN 61000-4-30 defines the methods for measurements and interpretation of results for power quality parameters in power supply system. EN 61000-4-30 is used as the reference for the requirements of VQ monitoring 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.

The Standard defines three classes of measurement methods for each parameter (class A, B, S).

Class A is used where precise measurements are necessary, for example, for contractual applications that may require resolving disputes, verifying compliance with standard, etc.

Class S is used for statistical applications such as surveys or power assessment, possibly with a limited subset or parameters.

Class B is defined in order to avoid making many existing instrument designs obsolete.

A recommendation for class of measurement methods is class A and avoiding counting single event more than once in different parameters (Flagged value).

2.3.2. VOLTAGES TO BE USED FOR EVALUATION

Measurement of voltage can be performed on single-phase or poly-phase supply systems. Depending on the context, it may be necessary to measure voltages between phase conductors and neutral (line-to-neutral) or between phase conductors (line-to-line) or between phase conductors or neutral and ground (phase-to-earth, neutral-to-earth).

A recommendation for voltage which should be used for measurement is line-to-neutral voltage for LV network, and line-to-line for voltage in other voltage levels.

2.3.3. MEASUREMENT AGGREGATION

The basic measurement time interval for parameter magnitudes (supply voltage, harmonics, interharmonics and unbalance) shall be a 10-cycle time interval (200ms) for a 50Hz power system. The 10-cycle values are further aggregated over 3 additional intervals:

- 150-cycle interval (3s) shall be aggregated without gap from fifteen 10-cycle time intervals;
- 10 min interval shall be aggregated without gap from two hundred 3s intervals;
- 2h interval shall be aggregated from twelve 10 min intervals.

For supply voltage variations, flickers, voltage unbalance, harmonic voltages and interharmonic voltages, the characteristic is calculated over a 10 minute interval. For flickers, an additional characteristic is obtained over each 2 hour interval.

Standard EN 61000-4-30 suggest that in some applications, other time intervals (e.g. 1 min) may be useful, and should be implemented with an aggregation method that is analogous to the 10 minute aggregation method.

In future, discuss about possibilities to calculate characteristics over shorter intervals, especially for supply voltage variations, such information is important for understanding the causes of limits being exceeded, for explaining certain equipment problems and for the setting of future limits.

2.3.4. FLAGGING

During a voltage dip, swell or interruption, the measurement algorithm for other parameters might produce unreliable values. The flagging concept therefore avoids counting a single event more than once in different parameters (for example, counting a single dip as both a dip and an unbalance), and indicates that an aggregated value might be unreliable.

Standard EN 61000-4-30 defines a flagging concept for 10-minute period during which a voltage dip, a voltage swell or an interruption occurs. The detection of dips and swells is dependent on the threshold selected by user, and this selection will impact which data are flagged.

If during a given time interval, any value is flagged, the aggregated value which includes that value shall also be flagged. The flagged value shall be stored and also included in the aggregation process. For example, if during a given time interval, any value is flagged, then the aggregated value that includes this value shall also be flagged and stored.

The following is considered as a good practice:

- *Flagged 10-minute values should be removed from the statistics for flickers, voltage unbalance, harmonic voltage and interharmonic voltage.*
- *For supply voltage variation, only flagged value due to interruptions should be removed. All other values, including flagged values due to supply voltage dips or swells, should be included in the calculation of the indices.*

2.3.5. EMISSION LIMITS

Distribution System Operators are responsible for the operation of distribution systems; therefore most of the requirements on voltage quality are directed towards DSOs.²⁰ However, voltage quality is different from other quality aspects in the sense that it is not fully determined by the DSOs. Rather, the electrical installations of connected network users may have an impact on the voltage quality in a local electricity network. This implies that different methods exist for maintaining a sufficient voltage quality, including DSOs strengthening the network or connected customers installing preventative measures.

To prevent excessive network tariffs for customers, DSOs commonly define requirements for the emissions from (mainly industrial) customers (also known as emission limits). Typically, these requirements are set either in the Network Codes or in the connection agreement. The NRA is responsible for approving the methodologies used to calculate or establish the terms and conditions for connection and access to networks²¹, i.e. the emission limits are subject to regulatory scrutiny. It must be highlighted that these methodologies should include provisions for cases where the requirements cannot be met by the customers without further investments.

Both the NRAs and the DSOs should ensure that the above mentioned methodologies are known to customers²².

²⁰ Article 25(1) of Directive 2009/72/EC

²¹ Article 37(6a) of Directive 2009/72/EC

²² Article 25(3) of Directive 2009/72/EC

Furthermore, it is important to note that the existence of emission limits for customers does not imply that DSOs may neglect voltage quality issues (foreseen conditions, problems identified by measurements) in network development planning and design. All stakeholders must accept responsibility for maintaining, or achieving, good voltage quality in the distribution networks.

It is important to ensure that the functioning of equipment is not impacted by voltage disturbances coming from the network. The probability of malfunctioning due to voltage disturbances from the network 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 harmonized standards. The Electromagnetic Compatibility (EMC) Directive 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.

A different approach is considered by the EU MSs in case of non-compliance of the prosumers with the voltage quality standards. For example, in Latvia 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.

In order to regulate the impact that network users have on the voltage quality, it is necessary to introduce legislation on emission by individual users. In case that such legislation is in place, the responsibility for the non-compliance with the voltage quality shall be imposed on the prosumers (active customers).

2.4. MONITORING AND DATA COLLECTION

Monitoring and regulation of voltage quality from the international experience²³ has shown that the introduction of systems for monitoring and regulation of service quality is the long-term process that require depending of the level of knowledge of NRAs and electricity undertakings, development of the metering system and information systems, databases and relevant legal and regulatory framework.

2.4.1. APPROACH FOR SELECTION OF MONITORING LOCATIONS TO CONTROL VOLTAGE QUALITY

This chapter engages in different approach for selection of monitoring locations to control voltage quality, the number of monitors at which locations in the network should be placed and the length of the measurements period. In most countries the potential impact of “lack of quality” is growing. It is therefore likely that more measuring equipment will be placed in the network and at customer connection points.

Voltage quality monitoring is carried out for one of three reasons:

- Troubleshooting – to diagnose incompatibility between the electric power source and existing equipment connected within an installation;
- Power quality evaluating – to evaluate the electrical environment at a particular location to refine modeling techniques or to develop a power quality baseline;
- Planning the connection of new equipment – to predict future performance of equipment or power quality mitigating devices that are planned to be connected within an installation.

²³ Service Quality Monitoring and Regulation

Measurement of voltage characteristics can be divided into next categories according to the purpose of the measurement:

- Permanent monitoring, e.g. system performance monitoring, connection points of HV customers, producers, and industrial customers
- Temporary/periodical monitoring, e.g. customer complaint, monitoring on request by network users, controlling voltage quality.

In the next table are shown information about number of portable and fixed instrument for measurement voltage quality in CPs.

Table 10 Devices for VQ measurement

Contracting Party		Number of fixed device	Number of portable device
ALB /OSHEE		109	-
BIH	EPBIH	1	47
	EPHZHB	-	10
	ERS	1	7
GEO /EP		-	4
XKX /KEDS		Meters (44972 pcs) and 366 MV Protection Relays.	-
MDA /PE		-	5
MNE /CEDIS		-	9 (fluke)
MKD /ED		137	9
SRB /EPSD		-	30
UKR /DTEKG		313	78 ²⁴

The Table above shows that Montenegro, Ukraine, Georgia, Serbia and Moldova don't have device for permanent monitoring of voltage quality, but in Albania exist 109 fixed devices for measurement of the voltage quality. It is important to mention that Kosovo* does not have fixed and portable devices for t voltage quality measurement in accordance with standard EN 61000-4-30, but the voltage quality is measured with 44.972 smart meters, and 366 MV protection relays.

The information collected from the CPs shows very small number of portable device for voltage quality measurement. Therefore, it can be concluded that substantial investments in measurement equipment are needed in all CPs.

2.4.1.1. SYSTEM PERFORMANCE MONITORING

System performance monitoring consists of monitoring of the performance of the system as a whole, with predefined objectives. It can also involve acquiring knowledge of average performances of the network and an understanding of significant trends in the overall network, specific region, voltage levels, type of network. Monitoring can be carried out choosing one of the next criteria²⁵:

- Type of network (cable / overhead / mixed)
- Length of network cables;
- Type of system earthing (isolated neutral/ compensated);
- Voltage level (HV / MV / LV);

²⁴ Data of the 7 DSOs of DTEK

²⁵ GGP on the Implementation and USE of VQM Systems for Regulatory Purpose, pg. 38

- Type of customer (household / small business / industrial);
- Distributed generation (present / high / low / absent);
- Degree of customers with self-generation (yes / no);
- Type of region (urban / suburban / rural);

For supply voltage dips, it is of interest to compare the behavior of cable and overhead lines, the difference between high voltage (HV) and MV networks and performances of different region. For voltage supply variations, it is of interest to report the effects of the presence of distributed generation in the network, as well as difference between short and long lines. Solar panels connected to the low-voltage networks will result in overvoltages, the switching frequency of the converters in wind turbines causes high-frequency signals flowing into the grid, harmonics are generated by EV chargers, the repeated starting of heat pumps can result in visible light flicker, etc.

Based on the data obtained from such monitoring procedures, decisions are normally made by the network operator with respect to network development planning. This is considered as a „regular“ part of the network operator’s duties for guaranteeing the existing and future performance of the network.

Each DSO individually defines the number of points of monitoring on the HV/MV/LV level based on the characteristics of each electrical network. That would enable every DSO to analyze current condition of voltage quality. Also this would help DSO to define how long the transition period for the fully implementation of EN 50160 standard would last.

2.4.1.2. SPECIFIC SITE MONITORING

Specific site monitoring implies a measurement aimed at providing information on voltage quality at a specific site in the network. This kind of monitoring is an issue of major importance in the case of complaints by network users, new customers wanting to know the voltage quality before being connected to the grid, or in the case of voltage quality contracts.

The normal reaction following complaints by network users on voltage quality is to perform measurements at these locations. The handling of such complaints is normally addressed by network operator, but in the case of disagreement, the NRA can try to resolve the matter or order independent investigation. The data should be stored in such a way that access is possible without significant additional effort. To enable the NRA to perform an independent verification of complaints, the NRA should have access to the measured data in sufficient detail, especially for events like voltage dips and swells, for which long monitoring periods are needed.

Table 20 below provide a summary of the voltage quality compliance in 2018 year for CPs, response time to customer’s voltage compliance, number of justified complaints and number of resolved voltage problems.

Table 11 Customer's voltage compliance (data for 2018)

CP/DSO		Number of customer's voltage complaints	Response time to customer's voltage compliance	Number of justified customer's voltage complaints	Number of resolved voltage problems
ALB /OSHEE		-	-	-	-
BIH	EPBIH	1.344	cca 25 days (30 days max.)	1.112	1.118
	ERS	51	10,41	24	13
GEO /EP		6706	immediately	n/a	Up to 5 day
XKX /KEDS		792	30 working days	595	545
MDA /PE		12.000	25,68h	10.858	10.858
MNE/CEDIS		193	30	61	9
MKD /ED		420	3	341	-
SRB EPSD		79	3 days	79	79
UKR /DTEKG		2.577	15,69	-	-

Previous table gives information about voltage quality complaints by customers in 2018 year for CPs. It should be noticed that Montenegro, Georgia, Kosovo*, for response time to customer's voltage compliance is regulated time, not average.

Network operator need to keep statistics on complaints and verification results and correlate these with the result from continuous voltage quality monitoring.

Network operators should set up, maintain and produce the records of the transformer area with a poor voltage conditions, accompanied with the review of the planed works and the timetable of their execution, in the function of improving voltage quality.

This report and work plan should be made available on the operator's web site, so that network user who might potentially appeal should have timely and completely information.

All employees in the Service centre should be familiar with the records of the transformer area with a poor voltage conditions so as to allow network users all necessary information if they want to lodge an appeal or complaint.

In case of pre-connection, new customers are entitled to information on voltage quality levels in the respective transformer area of the planned site to connect their facilities to the grid, in order to quantify in advance potential damages, plan counteractions to prevent them, use correct equipment and design processes with adequate levels of immunity.

Network operator should make available enough information about voltage quality to the customer.

Additional quality In case of contracts, network users and network operators can sign additionally quality contract or agreement concerning voltage quality, and can include emissions limits. VQ contracts are not regulatory issue, but they can become on in the case of disputes.

Network operators should control voltage quality choosing one or a combination of the next approaches:

- voltage quality monitoring in points with overload, in points 80% of nominal load but with a tendency of load increase, part of network with long feeders;
- voltage quality monitoring in parts of network where there is increased frequency of complaints;
- voltage quality monitoring in parts of network with increased frequency of failures;
- voltage quality monitoring in parts of network with the presence of big number of distributed generation.

2.4.2. MONITORING ON DIFFERENT VOLTAGE LEVEL

2.4.2.1. MONITORING IN HIGH VOLTAGE NETWORK

For high voltage networks measurement need to be performed at all HV substations and at the connection points of all HV customers, producers (power stations) and industrial customers.

Monitoring in HV networks should be permanent at all measuring locations, monitoring instrument remains at the same location for the entire year to provide a representative image of all voltage quality aspects. The number of substations and a number of customers in HV networks is relatively small, thus the costs of voltage quality monitoring at these locations will be limited.

Monitoring instrument need to be placed on the MV side of the transformers, because measured voltage quality resembles the voltage quality as experienced by the network users from this transformer as closely as possible.

2.4.2.2. MONITORING IN MEDIUM VOLTAGE NETWORK

Monitoring of voltage quality in HV networks should be permanent at all measuring locations, but in MV networks permanently monitoring at all locations is not recommended because of costs and high number of locations. In MV networks, location for voltage measurement can be chosen randomly.

For MV/LV substations, the measurement location should be on LV side of a transformer in order to obtain the best estimation of the voltage quality as experienced by the LV customers. The exact number of monitoring locations in MV networks is expected to vary between different countries due to the specific network structure and other local circumstances.

Voltage quality monitoring may not be necessary for MV customers if the voltage quality at a nearby MV busbar in HV/MV substations is being monitored already. This is especially true for the monitoring of the voltage dips in MV networks. If VQ monitoring at the connection points of MV customers is deemed necessary or preferred, then the selection of MV customers should primarily be based on their susceptibility to VQ disturbances. In practice, this will mainly be the customer's susceptibility to voltage dips and transients. If the current is also monitored at the MV customer's connection point, then MV customers who emit or are expected to emit high levels of VQ disturbances should be selected for monitoring as well. Voltage quality monitoring at MV customers with high emissions levels is mostly of interest to the network operator for planning purposes.

Similarly to monitoring VQ in the HV networks, VQ monitoring should be performed continuously over an entire year (52 weeks at each location) in the MV networks at selected locations with the aim to capture the number of voltage disturbance events and seasonal influences on the VQ in MV networks.

In the future, voltage quality monitoring on feeder in MV station should be based on Advanced Metering Infrastructure (AMI) including smart meters, with voltage quality features.

However, the obligation to the DSO to permanently monitor VQ at the points of connection to HV networks shall be subject to the recognition of associated monitoring cost, be it through network tariffs or connection charges, or any other incentive mechanism for the DSO.

2.4.2.3. MONITORING IN LOW VOLTAGE NETWORK

In LV networks, voltage quality monitoring should be performed at the connection point of a selection of LV customers. The VQ at these connection points may be monitored permanently or for the period at least one entire week.

For VQ monitoring in LV network can be used a limited number of portable monitors for monitoring at each location (one week before being moved to another location), or a higher number of monitors permanently installed to monitor over a period of years.

Voltage quality monitoring based on portable monitors are cheaper in capital costs but likely to be more expensive in operational costs. They will also allow more locations with high levels of VQ disturbances to be found. In at least 14 full days (midnight to midnight) of monitoring, per location and one working day without monitoring between two locations, about 20 locations can be monitored in one year for each monitor. Over a five-year period the number of locations monitored is 100 times the number than if fixed monitoring locations are used.

Voltage quality monitoring based on permanent monitor has the following advantages:

- gives a better overall view of the voltage quality at each location;
- possibility to provide information on seasonal variations; and
- gives information on voltage dips, swells and other relatively rare voltage events.

Due to the huge number of possible measuring points in the LV grid, a compromise of costs and completeness of information is necessary. Therefore, for monitoring harmonics, supply voltage variations, unbalance, flicker and individual rapid voltage changes, using portable monitors are considered acceptable as long as they are combined with a number of locations with fixed monitors to provide information on seasonal variations. To obtain information on voltage dips and swells, fixed monitors are considered necessary.

In the future, voltage quality monitoring should base on AMI including smart meters with voltage quality features. Currently available smart meters, even if equipped with VQ functionalities, are able to detect only a limited set of voltage disturbances. This varies between manufacturers and will certainly be subject to future changes. However, most currently available smart meters at LV are not able to monitor the following disturbances: flicker, voltage unbalance (for single-phased meters), harmonic and interharmonic voltage, mains signaling voltage, transient overvoltages and voltage transients, dips and swells, but they are able to monitor the main disturbances (supply voltage variation) that the most domestic customers are sensitive to.

Supply voltage variations are considered to be the most important voltage quality parameter to be monitored in LV networks because problems with the supply voltage tend to be very local and especially impact on LV customers. It is possible for voltage dips and swells to be measured using smart meters as well but, in the foreseeable future, smart meters are not expected to be adopted for use in the monitoring of harmonics and flicker in the LV networks.

DSOs should request from NRAs to recognize costs for monitoring of voltage quality through capital expenses and operational expenses (maintenance) and financing should be provided by the grid tariffs.

NRAs are encouraged to include VQ measurements in the functionality of at least a fraction of all conventional meters or smart meters if it is economically and technically possible for the DSO. With regard to smart meters, it is important to know whether the measurements are performed in accordance with international standards and/or good engineering practice.

It is important to exploit the possibilities of available and installed smart meters to the extent and benefits possible. However, it should be ensured that VQ monitoring through smart meters does not result in an excessive increase in the price of the meters or of the tariffs for network users. CEER and

the Energy Community Regulatory Board (ECRB) do not deem it necessary to monitor all VQ characteristics through smart meters for all LV users.

2.4.3. REPORTING

Different stakeholders are interested in performances of networks concerning voltage quality:

- NRAs should have information about VQ monitoring results therefore network operators should enable access of data to them whenever needed (aggregated and analyzed data);
- Individual network users have an interest in data concerning voltage quality at their connection points, current or future connection points;
- Research and education institutions.

Level of detail of VQ data to be reported depends on their use and should be taking into account the following scopes:

- Publication of VQ data on a national or regional level by the NRA – VQ data should be aggregated and analyzed, and contain analytics of all of the VQ parameters that are monitored.
- Publication of VQ data for research purpose should be aggregated to such a level as to not reveal too much information of individual customers as well.
- Reporting to single customers regarding the VQ on their connection point contains the analytics of measurement data.

Several European countries report specifically when a site does not comply with the requirement. These requirements can be either the EN 50160 requirements or stricter requirements that are set in national regulation. For a specific location it is recommended to consider publication of the following information:

- Number of weeks per year during which the requirements are not complied with;
- For each week of the year, the number of percentage of sites for which the requirements are not complied with.

Network operators, for each voltage level, can calculate voltage quality indices based on the number of sites and weeks not complying with the requirements. The index gives the percentage of sites and weeks for which the requirements are complied with. The index can be calculated as follows:

$$index = \frac{\sum_{i=1}^N (N_i - W_i)}{\sum_{i=1}^N N_i}, \text{ where are:}$$

- W_i – the number of weeks of non-compliance at location i ;
- N_i – the number of weeks of monitoring at location i ;
- N – the number of monitor locations.

The index can be calculated separately for supply voltage variations or other VQ disturbances like flicker, harmonics and voltage unbalance with same equation, only difference is number of weeks of non-compliance for each disturbance, respectively.

For voltage dips or other events it is interesting to report about number of dips/events per year on locations on which there are permanent VQ measurement.

Network operators should collect information about the following number of:

- substations with poor voltage quality;
- feeders with poor voltage quality;
- customers with poor voltage quality;
- permanent and portable device for voltage quality measurement;
- customer's voltage complaints;

- response time to customers' voltage complaints;
- justified customer's voltage complaints;
- resolved voltage problems;

Also, network operators should make records of the transformer area with a poor voltage conditions followed by review of the planned works and the timetable of their execution.

Voltage quality data can be published by NRAs, DSOs/TSOs or other organizations on the internet on their website.

A centralized approach should be used in designing data collection and reporting systems for VQ.

Data should be made available to all interested parties, taking due care of security mechanisms aiming at protecting the interests of network operators and of individual customers.

Adequate initiatives should be designed in order to inform users about their responsibilities.

NRAs should publish result of VQ monitoring, including report on the compliance with VQ regulation at least once a year.

The use of the internet is strongly encouraged for the publication of VQ data.

2.4.4. VOLTAGE QUALITY REGULATION

In the deregulated electricity business, it is possible that different customers demand for different levels of voltage quality for their individual needs and the network operator should be able to meet individual customer's wish. For this, voltage quality incentive schemes and specific regulations are needed. Figure 5 shows the directions of voltage quality regulation in the network²⁶.

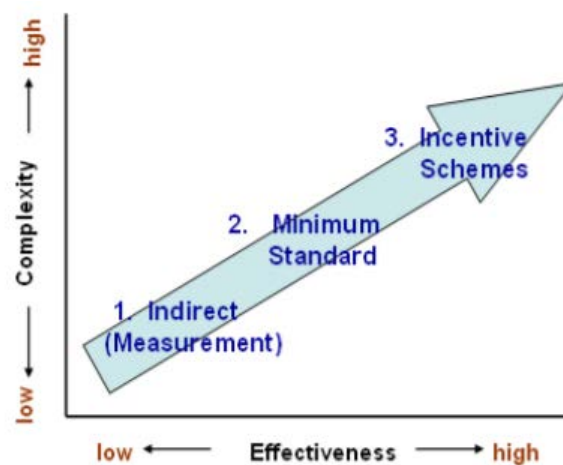


Figure 5 Steps towards VQ regulation

First step towards voltage quality regulation is an indirect method of quality control by continuous monitoring the voltage quality characteristics in the network. This will give an insight to the network's existing performance level in comparison to limits of the applicable voltage quality standards. Further, the customers can be informed about the performance and quality that they are receiving from the network operators.

The second step is to develop a minimum standard for the network's voltage supply. It can be achieved by comparing various national and international standards and define clearly the limiting values for each voltage quality parameter.

²⁶ Eindhoven University of technology, Power quality requirements and responsibilities at the point of connection, pg. 10

Finally, the third step is to introduce incentive schemes (as penalty or a reward) for the customers as well as the network operators. Network operators should request national regulatory authorities to introduced incentive based service quality methods, in line with the implementation of incentive-based price regulation methods.

With the deregulation in the electricity business, the network operators are under pressure to provide a good quality electricity supply at a low price. Price and quality are complementary terms but together they define the value of the electricity service that the customers obtain from the network. Voltage quality regulation is a complex issue because of its multi-dimensional nature and inherent difficulties of its measurements. It can be effectively applied in the electricity business by introducing regular monitoring, defining optimum voltage quality limits at a customer's connection point and implementing incentive schemes for the network operators.

When a customer demands to receive a better quality of supply than the normal supplied quality, a special agreement called '*power quality contract*' (VQ contract) can be introduced between the customer and the network operator. Thus, the customer can obtain his desired quality of electric supply by paying an extra tariff for it. In this case, the network operator gets higher revenues for providing a higher quality of supply. On the contrary, if the supplied voltage quality of the electricity is below than the agreed value, the customer gets compensation from the network operator.

Thus, a premium voltage quality market can be introduced in the present electricity business to provide an electricity supply to the customers according to their individual's desire. This also requires regulatory involvement.

In France, such type of VQ contract between a network operator and a customer is already in use for restricting the number of voltage dips at a customer's connection point²⁷.

The Italian regulatory authority is working toward the introducing incentives for the network operators to reduce voltage dip numbers in the networks, whenever possible. From the regulatory point of view, the network operator should be given an incentive for providing the customers with an optimal VQ of the supply²⁸.

It is difficult to introduce an incentive scheme on a global for flicker and harmonics. It is because these disturbances are time-varying and can originate in a certain location but can propagate and cause inconveniences to other parts of the network. If the network operator performs regular (decentralized) monitoring at several locations of a network, then he can identify the problem sources.

Competitive markets produce different price-quality levels and companies that offer inappropriate quality of supply lose customers. Natural monopoly companies do not face such a threat of customer losses and might therefore offer low quality, but without additional quality regulation, lower network tariffs might come at the expense of lower quality levels.

An individual VQ contract can be signed between the network operator and a customer about specific quality requirements of the electricity to optimize the societal benefit.

Alternatively, DSOs should request national regulatory authorities to introduced incentive based service quality methods, in line with the implementation of incentive-based price regulation methods. On the beginning to ensure incentive, for example, for voltage dips or number of short faults, and with time to other disturbances.

²⁷ Eindhoven University of technology, Power quality requirements and responsibilities at the point of connection, pg. 229

²⁸ M. Delfanti. E. Fumagalli. P. Garrone. L. Grill and L. Lo Schiavo. "Toward voltage-quality regulation in Italy". IEEE transactions on power delivery. vol. 25. no. 2. April 2010

2.5. SUMMARY OF FINDINGS

2.5.1 FINANCIAL FRAMEWORK

Network operators are usually required to maintain a certain quality of service to network users by local legislation or regulation. Quality of service may be defined by a number of parameters, such as availability and voltage stability. In an existing network, performance can be improved by rearranging and reinforcing the network. Regular maintenance strategy can reduce failure rate and enhance lifetime of network components. Implementing a mitigation measure is another method to increase VQ performance level in the network. Voltage quality cost analysis in the networks would involve the following aspects:

- Network's mitigation cost (such as changes in network infrastructure, implementing an extra feeder, placing a VQ mitigation device, etc.);
- Extra energy losses in the network components (such as cables, transformers etc.) due to inadequate VQ of the network;
- Evaluation of cost of higher quality by introducing individual 'VQ contract' schemes;
- Extra costs to handle customer's complaints (effort in finding the problem, network operator's intervention for modification and improvement);
- Customer's willingness to pay extra money (and tariff) to minimize VQ disturbances at their installations;
- Costs aspects that concern manufacturers to design equipment to improving PQ (emission and immunity of a device);

The economic analysis of a network's VQ cost can be also divided at two levels:

- **Individual level** – investment required to provide a desired voltage quality level at a customer's or a group of customers' connection point.
- **Global level** – investment requirements to maintain a specified voltage quality level in the network.

2.5.2. COSTS OF VOLTAGE QUALITY MONITORING

The implementation of voltage quality monitoring scheme, due to a large number of network sites intended to be measured, implies some investment in procurement of devices, as well as some maintenance costs.

Costs of voltage quality monitoring are divided into:

- Capital expenses – voltage quality device and installation costs
- Operational expenses – calibration, data collection, transport of device to the site, analysis and data storage.

Network development is one of the core tasks of the network operator and the NRA should be involved to a limited extent in this process. However, investments associated with network development have a direct impact on the tariffs to be paid by the network users.

This fact may lead to a sense of unfairness for some of the connected customers, namely residential customers, as they do not expect to receive direct benefits from implementation of voltage quality monitoring. However, well designed grid tariffs can avoid this issue and evenly distribute the expenses of voltage quality monitoring. On the other hand, large industrial customers representing less than 5% of all the customers and consuming close to or more than 50% of the annual consumed energy, are the main direct beneficiaries of implementation voltage quality monitoring.

Allocating the costs of VQ monitoring on the consumed energy is an example of a fair allocation of the costs into the tariffs. This approach enables an almost negligible cost increase per consumed kWh and, simultaneously, enables customers to contribute to expenses of VQ monitoring in proportion to their energy consumption [10].

Similarly, allocation of costs on the basis of subscribed power or peak hourly demand per month provides a fair allocation of the costs for tariff setting.

In this case, the network operator will need approval from the NRAs, either on a case-by-case basis, as an annual investment plan, or over a pre-defined regulatory period.

The costs for monitoring of voltage quality should be recognised by regulatory authorities through capital and operational expenses and cost recovery should be provided from the grid tariffs per unit of consumed energy, or per unit of subscribed power, or per unit of maximum hourly demand.

2.5.3. TRANSITIONAL PERIOD AND TIME NEEDED FOR IMPLEMENTATION OF STANDARDS

From the above explained it is obvious that DSOs are not ready to immediately implement standard EN 50160. It can be concluded that DSOs need transitional period to implement this standard. The duration of the transitional period should be reasonably set in order to give proper time for DSOs to undertake necessary actions.

Distribution system operators in the EnC work on equipping a number of points of measurement in order to make estimation. For example in Albania, even though the standard EN 50160 is not obligatory, the pilot project has started (installation of smart meters for customers in Tirana area and installation of SCADA system. Based on this ongoing projects, Albania shall be able to have an appropriate estimation of the necessary investments.

Georgia has very strong voltage quality regulation through their Network Rules which is mandatory for DSOs and this country doesn't need transitional period for implementation of standard EN 50160 because is more soft than existing rules.

It is understood that most of the actions are related to the reinforcement and upgrading of the distribution systems (grid, TK, IT) and dedicating substantial funds for investments. Distribution system operator in North Macedonia made estimation of necessary investments into the distribution grid in order to fully implement Standard EN 50160. According to this estimate, necessary investments in the MV and HV grids are around EUR 750 million and in LV network between EUR 200-250 million.

It is considered to apply step wise approach that should be agreed between NRAs and DSOs.

2.6. RECOMMENDATIONS

<p>LEGISLATION AND REGULATION</p>	<p>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 an 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.</p> <p>Transposition of the voltage related provisions that are consistent EN 50160 and IEC 61000-x-x in the legislation (i.e. grid codes or voltage quality rules) is recommended. Those CPs that have done this already should further improve the definitions, limitations and exceptions.</p> <p>National regulatory authorities should consider imposing an obligations on TSO to guarantee sufficient voltage quality in order to allow DSOs to fulfill the EN 50160 standard.</p> <p>Precise definitions of exceptional weather condition, natural disaster, as well as force majeure in which EN 50160 does not apply have to be regulated.</p> <p>Additionally, it is necessary to establish the requirements for prosumers to comply with the voltage quality and impose their responsibility for compliance.</p>
<p>CHARACTERISTICS OF VQ AND MEASUREMENT METHOD</p>	<p>For measurement of voltage quality exclusively should be used measurement device with class A (in accordance to standard EN 61000-4-30) and avoid counting a single event more than once in different parameters, using flagged value.</p> <p>Depending on the obligation for installation of the smart meters, DSO or customers should be obligated to install smart meters with possibility to measurement some of voltage characteristics (variation, interruption, etc).</p>
<p>MONITORING AND DATA COLLECTION</p>	<p>Having in mind that implementation of voltage quality monitoring systems has not started yet in all 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 need for harmonization applies to, among others, the choice of monitor locations, types of disturbances monitored, characteristics recorded and indices calculated.</p> <p>DSOs may individually define the number of points of monitoring on the HV/MV/LV level in accordance to the configuration of the system and its size based on an available data.</p> <p>Also, statistics on customer's 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.</p> <p>Number of fixed and portable device (class A) for measurement voltage quality should increase per year in each DSO.</p>
<p>REPORTING</p>	<p>DSOs should establish database with characteristic of the voltage with as much as possible data.</p> <p>DSOs should collect information on number of customer's voltage complaints, number of justified customer's voltage complaints, number of resolved voltage problems and publish it on regular basis.</p>
<p>VOLTAGE QUALITY REGULATION</p>	<p>DSOs should request national regulatory authorities to introduce incentive based service quality methods, along with the implementation of incentive-based price regulation methods. Implementation of the incentive based tariff regulation will allow the DSOs to invest in the technologies improving their performance in the voltage quality control.</p>

INVESTMENT	<p>The costs for monitoring of voltage quality should be recognized by regulatory authorities through capital and operational costs and financing should be provided by the grid tariffs.</p> <p>When preparing the network development plan and investment plan, DSOs should specify the investments dedicated to implementation of monitoring and achieving voltage quality standard. Plans should be approved by the national regulatory authorities.</p> <p>Customer may request better voltage quality level than guaranteed standard. This should be arranged in the connection contract. The costs of providing additional guarantees for voltage quality should be borne by the customer.</p>
TRANSITIONAL PERIOD	<p>DSO and national regulatory authorities should define the transition period for the implementation of EN 50160 standard. Recommendation is step wise approach.</p>

3. COMMERCIAL QUALITY



3.1. GENERAL REMARKS

The European regulations define the basic principles and requirements for commercial quality. According to the Article 36 of Directive 2009/72/EC, the National Regulation Agency (hereinafter NRA or Regulator) aims to create, promote and secure environmentally sustainable internal electricity market and effective market opening for all customers and suppliers, ensuring appropriate conditions for the efficient and reliable operation of electricity networks, taking the long-term objectives into account.

According to the paragraph (f) and (g) of mentioned Article 36 the Regulator should create incentives in order to increase efficiency of network and should ensure continuous high quality functioning of electricity market and customer protection:

“(f) ensuring that system operators and system users are granted appropriate incentives, in both the short and the long term, to increase efficiencies in system performance and foster market integration;

“(g) ensuring that customers benefit through the efficient functioning of their national market, promoting effective competition and helping to ensure consumer protection“

Article 37 of the EU regulations defines the power and right of the NRA to monitor performance of DSO in terms of security, connection to the network, time taken for repairs (planned and unplanned ones), controlling customer safety systems and creating flexible accessibility to the data of DSO (electronic journals):

“(h) monitoring compliance with and reviewing the past performance of network security and reliability rules and setting or approving standards and requirements for quality of service and supply or contributing thereto together with other competent authorities;

(m) monitoring the time taken by transmission and distribution system operators to make connections and repairs;

(n) helping to ensure, together with other relevant authorities, that the consumer protection measures... are effective and enforced;

(e) have the powers to carry out inspections, including unannounced inspections, at the premises of transmission system owner and independent system operator;”

Following the paragraph (h), the NRA have the duty to monitor the compliance and review the past performance of security measures of network. The Regulator also has an obligation to establish the relevant legislation to safeguard user's interests.

In addition, in order to protect the user's rights in terms of commercial quality regulation and to increase efficiency of electricity network, NRA's have power to conduct the inspections (including unannounced ones) at the premises of DSO:

(e) have the powers to carry out inspections, including unannounced inspections, at the premises of transmission system owner and independent system operator;

In order to have consistent data for all participants, EU Directive defines record keeping obligations. DSO's are obliged to provide recording of different types indicators of commercial quality according to the defined by NRA's regulations. All data should be consistent for NRA to provide the possibility for evaluation of past performance of DSO.

DSO shall provide network users with the information they need for efficient access to, including use of the network system (Article 25, Paragraph 3).

Customer has the right to receive compensation for delayed or incorrect bills, to receive information about the quality of service with no extra costs for contacting with the DSO.

In order to stimulate DSO, the NRA usually sets the standards of indicators along with incentives/penalties mechanisms.

Despite the general meaning of commercial quality as a proper service to the customers, different countries define different list of indicators. Due to the previous national experience of regulation, the discrepancies in the interpretation and evaluation criteria of indicators, many countries use their own indexes of commercial quality.

3.2. DEFINITION AND ASPECTS OF ELECTRICITY COMMERCIAL QUALITY

Commercial quality is directly associated with transactions between electricity companies (either DSOs or suppliers, or both) and customers²⁹. 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. Usually, commercial quality aspects understood as the timeliness of services requested by customers.

In the entirely deregulated market, the competition is expected to result in sufficient quality. Most of the CPs indicated that the electricity market in their countries is partially or in process of deregulation. At the same time in Georgia and Kosovo* there is no competition between the retailers while in Macedonia and

²⁹ From this point onward: quotes of 6th CEER Benchmarking Report on the Quality of Electricity and Gas Supply (2016)

Serbia competition in terms of commercial quality between the retailers exists. For those countries where there is no competition, the NRA as usual intervene the market with the aim of protection the customers by means of regulation the quality standards. Commercial quality indicators help ensure sufficient levels of quality for services provided by the network operators.

Numerous commercial quality aspects (e.g. times for connections) are related to distribution networks and therefore, given their monopolistic nature, should still be regulated.

Important to note that regulatory frameworks in some countries still do not apply the financial incentives: legislation of Montenegro with compensation definitions will take the effect in August 2019, whereas in Kosovo* the draft Law is yet at public consultation only.

Commercial interactions between electricity companies and customers could be 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;
- 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.

3.3. ASPECTS OF COMMERCIAL QUALITY

According to the 6th CEER Benchmarking report³⁰, to simplify the approach to such a complex matter as commercial quality the indicators relating to commercial quality have been classified into 4 main groups:

- **Connection (Group I)**

It includes commercial quality indicators that are applicable only to DSOs

- **Customer Care (Group II)**

Indicators that apply mostly to DSOs but also to suppliers and TSOs. Most of the indicators related to customer care are guaranteed indicators with payment of compensation to the customer in case of non-compliance.

- **Technical Service (Group III)**

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.

- **Metering and Billing (Group IV)**

Includes a set of commercial quality indicators related to metering and billing.

³⁰ The same 6th CEER Benchmarking Report on the Quality of Electricity and Gas Supply (2016)

3.4. COMMERCIAL QUALITY INDICATORS AND THEIR DEFINITIONS

According to the 6th CEER Benchmarking Report, the "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. A standard is a limit, a value (e.g. a percentage).

Thus, there are 3 types of indicators (i.e. the requirements for commercial quality): guaranteed indicators, overall indicators, and other requirements.

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.

The NRA has performed regular monitoring of service quality for over two years on quarterly basis. The legislation of most countries (both European and non-EU) regulates that non-compliance with the Guaranteed Indicators results in charging penalty from DSO and/or in payment the compensation to affected customers.

In Table 21 there listed all the indicators as per 6th CEER Benchmarking Report along with its definitions used in this survey.

Table 12 The referent list of indicators (according to CEER questionnaire)

	Identif. number	Indicator	Definitions
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.
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 were 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.

3.5. RESULTS AND ANALYSIS OF THE SURVEY

This section represents the general summary data of the survey on Commercial quality involving the CPs – members of ECDSO-E.

3.5.1. NATIONAL PECULIARITIES

3.5.1.1. NATIONAL PECULIARITIES: UKRAINE

In the legislation of Ukraine there defined GI and OI in the following definition:

Guaranteed quality standard for electricity – the minimum level of quality of services provided by the DSO or an electricity Supplier, which should be provided to the customer in the amount and in the terms established by the current legislation, and for non-compliance of which the customer is compensated;

Overall quality standard for electricity – the level of the quality of the provision of services by the DSO or the electricity supplier, which must be provided by the DSO or an electricity supplier to its customers in general.

The compliance of DSO with the Guaranteed standards is monitored by the NRA. The DSO shall keep the register of provision the compensation to the customers in the blank required according to the Rule of NRA. The registers of provision the compensation to the customers to be sent to NRA in electronic form every month.

The time defined for non-standard connection including confirmation with TSO is 20 working days that often is hard to achieve due to growing amount of such connections for DSO. Such legislative requirement to be reviewed to 30 working days.

3.5.1.2. NATIONAL PECULIARITIES: BOSNIA AND HERZEGOVINA

The legislation of BIH defines no Guaranteed indicators. There are requirements in the status of other regulatory requirements (OR), that are defined outside the regulatory framework related to commercial quality regulation.

The requirements are defined by the General conditions for power supply and by Consumer protection law in BIH. The compensation is not defined in power supply regulations, though the customers are

protected by Consumer protection law. For example, by this law the customer could claim for not responding to customer complaints (indicator II.2) the compensation between 2.500÷5.500 BAM (1275-1805 €).

3.5.1.3. NATIONAL PECULIARITIES: GEORGIA

Compliance to the targeted Overall standards could be incentivized by tariff increase for DSO's, as it appears in Georgia.

In addition, in Georgia the amount and usage of indicators depend on such aspects as:

- numbers of customers
- topography of the area (country)
- technical condition of the network
- mentality of customers

3.5.1.4. NATIONAL PECULIARITIES: MONTENEGRO

Legal basis for the adoption of Rules on the minimum quality of delivery and supply of electricity is contained in Energy Law (Official gazette Montenegro 5/2016), prescribing that the Regulator makes these Rules.

The Rules determine minimum level of indicators and performances of quality which the energy subject – service provider must fulfil. The Rules were issued in July 2017 (Official gazette Montenegro 50/2017).

For non-achieving a certain level of quality of service there are financial compensation, which came into effect in August 2019. Initial values of financial compensations have already been defined and they can be subjected to change prior to their application (in 2019).

3.5.2 SUMMARY OF FINDINGS

The tables given below (13-17) show the profiles of indicators by the type, referent company, time limits (standards) and corresponding amount of compensation, if applicable. There are found indicators of GI type without compensation (Albania, Macedonia), as well as Overall Indicators with prescribed compensation for non-compliance (Moldova, Georgia).

As for compensation, the most expensive penalty for non-compliance of commercial quality is in Montenegro, though it has been put into effect just in August 2019. In four CPs the compensation is up to date absent fully (Albania, Bosnia and Herzegovina, Serbia) or almost (North Macedonia). However respondents from few CPs indicated that regulation for compensation are yet to come into force (Kosovo*, North Macedonia, Montenegro). In other CPs there is a variety of payment methods in case of compensations to customers when GIs are not fulfilled.

Table 13 Summary of Commercial quality indicators adopted by CPs, distinguishing between GIs, OIs and ORs

No.	Indicator	ALB	BIH	GEO	XKX	MKD	MDA	MNE	SRB	UKR
I.1	Time for response to the customer's claim for network connection	GI	OR	GI*	-	GI*	OI	GI	GI	GI*
I.2	Time for the cost estimation for simple works	-	OR	-	-	-	OI*	GI	-	-
I.3	Time for connecting new customers to the network	-	OR	GI*	OR	GI*	OI	GI	-	GI
I.4	Time for disconnection upon customer's request	GI	OR	-	-	-	OI	-	-	-
I.5	Time for a switching of supplier	GI	OR	-	-	GI*	OI	-	GI	-
II.1	Punctuality of appointments with customers	GI	-	-	-	-	-	GI	OR	-
II.2	Response time to customer complaints	GI	OR	-	OR*	GI	OI	GI	GI	GI*
II.3	Response time to customer enquiries	GI	-	-	OR	GI	-	-	GI	-
II.4	Response time to customer voltage and/or current complaints	GI	OR	GI*	OR *	GI	OI	GI	GI	GI
II.5	Response time to customer interruption complaints	GI	OR	-	-	GI	OI	-	GI	-
II.6	Response time to questions in relation to costs and payments (excluding connection)	GI	-	-	OR	GI	-	GI*	-	-

II.7	Call Centers average holding time	GI	-	OI *	-	OI	-	-	OR	-
II.8	Call Centers service level	GI	-	GI*	OR	OI	-	-	OR	OI *
II.9	Waiting time in case of personal visit at client centers	GI	-	-	-	OI	-	-	OR	-
II.10	Percentage of customers with a waiting time below the limit in call centres	GI	-	-	-	-	-	-	-	OI
II.11	Percentage of customers with a waiting time below the limit in customer centres	GI	-	-	-	-	-	-	-	-
II.12	Percentage of customers' requests answered within the time limit	GI	-	-	-	-	-	-	-	-
II.13	Average response time to customer complaints and/or requests	GI	-	-	-	OI	-	-	-	-
III.1	Time between the date of the answer to the VQ complaint and the elimination of the problem	GI	OR	GI*	OR *	-	OI	GI	GI	GI*
III.2	Time until the start of restoration of supply following failure of a fuse of a DSO	GI	-	-	-	-	-	-	-	-
III.3	Time for giving information in advance of a planned interruption	N/A	OR	OI	-	OI	OI	GI	GI	-
III.4	Time until the restoration of supply in case of unplanned interruption	GI	-	OI *	OR	-	GI	GI	GI	GI*
IV.1	Time for meter inspection in case	GI	OR	GI*	-	OI	OI	GI	GI	GI

	of meter failure									
IV.2	Time from the notice to pay until disconnection	GI	OR	-	OR *	-	OI	-	-	-
IV.3	Time for restoration of power supply following disconnection due to non-payment	GI	OR	GI	OR	OI	OI	GI*	-	GI*
IV.4	Yearly number of meter readings by the designated company	GI	OR	-	OR	OI	-	-	GI	-
IV.5	Percentage of meter readings made within less than a certain amount of time after the last one	GI	-	-	OR	OI	-	-	-	-
	Technical supervision of construction, installation of the metering node and network setting-in			GI						
	Reduction of average duration of supply outage			GI						
III	Supply the voltage for testing of customer's electrical equipment									GI
I	Issue of a paper copy of the concluded agreement on the provision of distribution services									GI
I	Issuance of a signed passport distribution point									GI
I	Restoration of power supply of electrical installation of the customer, which was disconnected according to the									GI

	customer 's request									
III	Time to restore the electricity supply to the customer's electrical installation that was disconnected under the request of the supplier									GI
II	Response time to the customer complaint on the compensation for the non-compliance by the DSO with the VQ indicators.									GI
IV	Time period between the customer enquiry on the inspection of the correctness of the billing for electricity distribution or supply services									GI
	Compliance by the DSO the established voltage limits of deviations									GI
	Time period between the customer enquiry on the electricity consumption data									GI

* - with some differences in terminology.

Table 14 Summary of the indicators, distinguishing between DSO, Supplier (SP) or Universal Supplier (USP), they are referred to

No.	Indicator	ALB	BIH	GEO	XKX	MKD	MDA	MNE	SRB	UKR
I.1	Time for response to the customer's claim for network connection	-	DSO	DSO	-	DSO	DSO	DSO	DSO	DSO
I.2	Time for the cost estimation for simple works	-	DSO	-	-	-	DSO	-	-	-
I.3	Time for connecting new customers to the network	DSO	DSO	DSO	DSO	DSO	DSO	DSO	-	DSO
I.4	Time for disconnection upon customer's request	SP & USP	DSO & SP	-	DSO	-	DSO & SP	-	-	-
I.5	Time for a switching of supplier	SP & USP	DSO & SP	-	SP	DSO	SP	-	DSO	-
II.1	Punctuality of appointments with customers	SP & USP	-	-	DSO & SP	-	-	DSO	DSO & SP	-
II.2	Response time to customer complaints	SP & USP	DSO & SP	-	SP	DSO & SP	DSO & SP	Supplier	DSO & SP	DSO & SP
II.3	Response time to customer enquiries	SP & USP	-	-	Supplier	DSO	-	-	DSO & SP	-
II.4	Response time to customer voltage and/or current complaints	SP & USP	DSO	DSO	DSO	DSO	DSO	DSO	DSO & SP	DSO
II.5	Response time to customer interruption complaints	SP & USP	DSO	-	DSO	DSO	DSO	-	DSO & SP	-
II.6	Response time to questions in relation to costs and payments (excluding connection)	SP & USP	-	-	SP	DSO	-	Supplier	-	-

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II.7	Call Centers average holding time	SP USP	&	-	DSO	SP	DSO SP	&	-	-	DSO SP	&	-
II.8	Call Centers service level	SP USP	&	-	DSO	SP	DSO SP	&	-	-	DSO SP	&	DSO SP
II.9	Waiting time in case of personal visit at client centers	SP USP	&	-	-	SP	DSO SP	&	-	-	DSO SP	&	-
II.10	Percentage of customers with a waiting time below the limit in call centres	SP USP	&	-	-	SP	-	&	-	-	-	&	DSO SP
II.11	Percentage of customers with a waiting time below the limit in customer centres	SP USP	&	-	-	SP	-	&	-	-	-	&	-
II.12	Percentage of customers' requests answered within the time limit	SP USP	&	-	-	SP	-	&	-	-	-	&	-
II.13	Average response time to customer complaints and/or requests	SP USP	&	-	-	SP	DSO SP	&	-	-	-	&	-
III.1	Time between the date of the answer to the VQ complaint and the elimination of the problem	DSO USP	&	DSO	DSO	DSO	-	&	DSO	DSO	DSO SP	&	DSO
III.2	Time until the start of restoration of supply following failure of a fuse of a DSO	DSO		-	-	DSO	-		-	-	-		-
III.3	Time for giving information in advance of a planned interruption	DSO		DSO	DSO	DSO	DSO		DSO	DSO	DSO		-
III.4	Time until the restoration of supply in case of unplanned	DSO		-	DSO	DSO	-		DSO	DSO	DSO		DSO

	interruption									
IV.1	Time for meter inspection in case of meter failure	USP	DSO	DSO	DSO	DSO	DSO	DSO	DSO	DSO
IV.2	Time from the notice to pay until disconnection	USP	SP	-	SP	-	SP	-	-	-
IV.3	Time for restoration of power supply following disconnection due to non-payment	USP	DSO & SP	DSO	DSO	DSO	DSO	SP	-	DSO
IV.4	Yearly number of meter readings by the designated company	USP	DSO	-	DSO	DSO	-	-	DSO	-
IV.5	Percentage of meter readings made within less than a certain amount of time after the last one	USP	-	-	DSO	DSO	-	-	-	-
	Technical supervision of construction, installation of the metering node and network setting-in			DSO					-	
	Reduction of average duration of supply outage			DSO						
III	Supply the voltage for testing of customer's electrical equipment									DSO
I	Issue of a paper copy of the concluded agreement on the provision of distribution services									DSO
I	Issuance of a signed passport distribution point									DSO
I	Restoration of power supply of electrical installation of the									DSO

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	customer, which was disconnected according to the customer's request									
III	Time to restore the electricity supply to the customer's electrical installation that was disconnected under the request of the supplier									DSO
II	Response time to the customer complaint on the compensation for the non-compliance by the DSO with the VQ indicators.									DSO
IV	Time period between the customer enquiry on the inspection of the correctness of the billing for electricity distribution services									DSO & SP
	Compliance by the DSO the established voltage limits of deviations									DSO
	Time period between the customer enquiry on the electricity consumption data									Supplier

Table 15 Summary of regulatory standards (time limits) of each country

No.	Indicator	ALB	BIH	GEO	Kosovo*	MKD	MDA	MNE	SRB	UKR
I.1	Time for response to the customer's claim for network connection	-	90/60 days*	5 w. days	-	15/40 days*	10/30 days*	15/120 days*	15 days	10/20 days* w.
I.2	Time for the cost estimation for simple works	-	60/30 days*	-	-	-	-	-	-	-
I.3	Time for connecting new customers to the network	10/20 days w.	100/70 days*	5 w. days	30 days (+30 days)	15 days (+30 days)	2 days	15 days*	-	5/10 days* w.
I.4	Time for disconnection upon customer's request	3 days	24 hours	-	-	-	7 days	-	-	-
I.5	Time for a switching of supplier	15 days	21 days	-	-	3 weeks	20 days	-	21 days	-
II.1	Punctuality of appointments with customers		-	-	-	-		8 days	15 min	-
II.2	Response time to customer complaints	5-30 days	15/8days*	-	30 days*	15 days	20 days	8 days	7 days	30/45 days*
II.3	Response time to customer enquiries	1-60 days	-	-	30 days*	15 days		-	7 days	-
II.4	Response time to customer voltage and/or current complaints	15 days	30 days		30 days	15 days	30 days	30 days	15 days	15/30 days*

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II.5	Response time to customer interruption complaints	5 days	15 days	-	-	15 days	30 days	-	7 days	-
II.6	Response time to questions in relation to costs and payments (excluding connection)	1 day	-	-	30 days*	15 days		8 days	-	-
II.7	Call Centers average holding time	60 sec	-	80 sec	60 sec	N/A		-	5 sec	-
II.8	Call Centers service level		-	80 sec	60 sec	N/A		-	1 min	10%*
II.9	Waiting time in case of personal visit at client centers		-	-	-	N/A		-	5 min	-
II.10	Percentage of customers with a waiting time below the limit in call centres	5%	-	-	-	-		-	-	NLT 75 %*
II.11	Percentage of customers with a waiting time below the limit in customer centres	20 %	-	-	-	-		-	-	-
II.12	Percentage of customers' requests answered within the time limit	80%	-	-	-	-		-	-	-
II.13	Average response time to customer complaints and/or requests	-	-	-	-	N/A		-	-	-
III.1	Time between the date of the answer to the VQ complaint and the elimination of the problem	30 w. days	3 years		12 months/36 months	-	30 days	3 days 3 months	15 days	30/180 days*
III.2	Time until the start of restoration of supply following failure of a fuse of a DSO	-	-	-	-	-		-	-	-

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III.3	Time for giving information in advance of a planned interruption	24 hours	48 hours	24 hours	48 hours (24 hours)*	24 hours	3/7/1 days*	24 hours	3/15 days	-
III.4	Time until the restoration of supply in case of unplanned interruption	-	-		10/14/15/17 hours*	-	6/12/48 hours	24 hours	12 hours	24 hours
IV.1	Time for meter inspection in case of meter failure	7 days	72/24 hours*		-	N/A	5 w. days	8 days*	7 days	20 days
IV.2	Time from the notice to pay until disconnection	30 days	8 days	-	15+15+3 days*	-	10 days	-	-	
IV.3	Time for restoration of power supply following disconnection due to non-payment	24 hours	24 hours	10/6 hours*	24 hours	4 - 24 hours	2 w. days	4 hours*	-	3/5 days* w.
IV.4	Yearly number of meter readings by the designated company	1 week time	12	-	30 days*	1 time per year/meter		-	12 (times per year)/meter	
IV.5	Percentage of meter readings made within less than a certain amount of time after the last one	1 week time	-	-	30 days*	N/A		-	-	
	Technical supervision of construction, installation of the metering node and network setting-in								-	
	Reduction of average duration of supply outage									
III	Supply the voltage for testing of customer's electrical equipment									5/10 days* w.

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I	Issue of a paper copy of the concluded agreement on the provision of distribution services									3 w. days
I	Issuance of a signed passport distribution point									10 w. days
I	Restoration of power supply of electrical installation of the customer, which was disconnected according to the customer's request									5 w. days
III	Time to restore the electricity supply to the customer's electrical installation that was disconnected under the request of the supplier									3/5 days* w.
II	Response time to the customer complaint on the compensation for the non-compliance by the DSO with the VQ indicators.									30 days
IV	Time period between the customer enquiry on the inspection of the correctness of the billing for electricity distribution services									5 w. days*
	Compliance by the DSO the established voltage limits of deviations									permanent
	Time period between the customer enquiry on the electricity consumption data									5 w. days*

Table 16 Summary of compensation levels to customer for non-compliance per CP

No.	Indicator	ALB	BIH	GEO	XKX	MKD	MDA	MNE	SRB	UKR
I.1	Time for response to the customer's claim for network connection	-	N/A	50 % of the cost	-	N/A	1 % tariff reduct.	20 €/200 €	N/A	6.8/13.5/20.3 €
I.2	Time for the cost estimation for simple works	-	N/A	-	-	-		20 €	-	-
I.3	Time for connecting new customers to the network	N/A	N/A		N/A	Penalty interest rate for delay		20 €	-	6.8/13.5/20.3 €
I.4	Time for disconnection upon customer's request	-	N/A	-	-	-	25 % of connect. charge	-	-	-
I.5	Time for a switching of supplier	-	N/A	-	N/A	N/A	25 % of connect. charge	-	N/A	-
II.1	Punctuality of appointments with customers	-	-	-	-	-		20 €	N/A	-
II.2	Response time to customer complaints	N/A	N/A(1275-1805 €)	-	N/A	N/A		20 €	N/A	6.8/13.5/20.3 €
II.3	Response time to customer enquiries	N/A	-	-	N/A	N/A		-	N/A	-
II.4	Response time to customer voltage and/or current complaints	N/A	N/A	1.6 €/3.2 €	N/A	N/A		20 €	N/A	3.4/6.8/13.5 €
II.5	Response time to customer interruption complaints	N/A	N/A	-	N/A	N/A		-	N/A	-
II.6	Response time to questions in relation to costs	N/A	-	-	N/A	N/A		20 €	-	-

	and payments (excluding connection)									
II.7	Call Centers average holding time	N/A	-	0.01 % of the regulated cost	N/A	N/A		-	N/A	-
II.8	Call Centers service level	N/A	-	1.6 €/ 3.2 €	N/A	N/A		-	N/A	N/A
II.9	Waiting time in case of personal visit at client centers	N/A	-	-	-	N/A		-	N/A	-
II.10	Percentage of customers with a waiting time below the limit in call centres	N/A	-	-	-	-		-	-	N/A
II.11	Percentage of customers with a waiting time below the limit in customer centres	N/A	-	-	-	-		-	-	-
II.12	Percentage of customers' requests answered within the time limit	N/A	-	-	N/A	-		-	-	-
II.13	Average response time to customer complaints and/or requests	N/A	-	-	N/A	N/A		-	-	-
III.1	Time between the date of the answer to the VQ complaint and the elimination of the problem		N/A	1.6 €/ 3.2 €	N/A	-	25% of electric. consum.	20 €	N/A	3.4/6.8/13.5 €
III.2	Time until the start of restoration of supply following failure of a fuse of a DSO		-	-	-	-		-	-	-
III.3	Time for giving information in advance of a planned interruption	N/A	N/A		N/A	N/A	1 % tariff reduct.	20 €	N/A	-
III.4	Time until the restoration of supply in case of unplanned interruption		-	0.01 % of the regulated	N/A	-	Formula	20 €	N/A	6.8/13.5/ 20.3 €

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				cost						
IV.1	Time for meter inspection in case of meter failure	N/A	N/A	1.6 €/3.2 €	-	N/A		20 €	N/A	6.8/13.5/20.3 €
IV.2	Time from the notice to pay until disconnection	N/A	N/A	-	N/A	-		-	-	-
IV.3	Time for restoration of power supply following disconnection due to non-payment	N/A	N/A	1.6 €/3.2 €	N/A	N/A	25 % of connect. charge	20 €	-	3.4/6.8/13.5 €
IV.4	Yearly number of meter readings by the designated company	N/A	N/A	-	N/A	N/A		-	N/A	
IV.5	Percentage of meter readings made within less than a certain amount of time after the last one	N/A	-	-	N/A	N/A		-	-	-
	Technical supervision of construction, installation of the metering node and network setting-in			Reduced cost					-	
	Reduction of average duration of supply outage			Regulated cost base						
III	Supply the voltage for testing of customer's electrical equipment									3.4/6.8/13.5 €
I	Issue of a paper copy of the concluded agreement on the provision of distribution services									3.4/6.8/13.5 €
I	Issuance of a signed passport distribution point									3.4/6.8/13.5 €
I	Restoration of power supply of electrical installation of the customer, which was disconnected according to the customer's request									3.4/6.8/13.5 €

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III	Time to restore the electricity supply to the customer's electrical installation that was disconnected under the request of the supplier									3.4/6.8/13.5 €
II	Response time to the customer complaint on the compensation for the non-compliance by the DSO with the VQ indicators.									6.8/13.5/ 20.3 €
IV	Time period between the customer enquiry on the inspection of the correctness of the billing for electricity distribution services									3.4/6.8/13.5 €
	Compliance by the DSO the established voltage limits of deviations									25% of tariff
	Time period between the customer enquiry on the electricity consumption data									3.4/6.8/13.5 €

Table 17 The summary of commercial quality indicators by distinguishing per type of indicators and assignment of indicators between the companies

No.	Indicator	Total			Indicators per referred company					
		GI	OI	OR	DSO	Supplier	DSO+ Supplier	Supplier+ USP	USP	DSO+ USP
1	Albania	24	0	0	4	-	-	15	5	1
2	Bosnia and Herzegovina	0	0	14	9	1	4	-	-	-
3	Georgia	9	3	0	12	-	-	-	-	-
4	Kosovo*	0	0	12	12	12	1	-	-	-
5	Macedonia	8	9	0	12	-	5	-	-	-
6	Moldova	1	13	0	10	2	2	-	-	-
7	Montenegro	12	0	0	8	3	-	-	-	-
8	Serbia	11	0	4	6	-	9	-	-	-
9	Ukraine	17	2	0	14	1	4	-	-	-

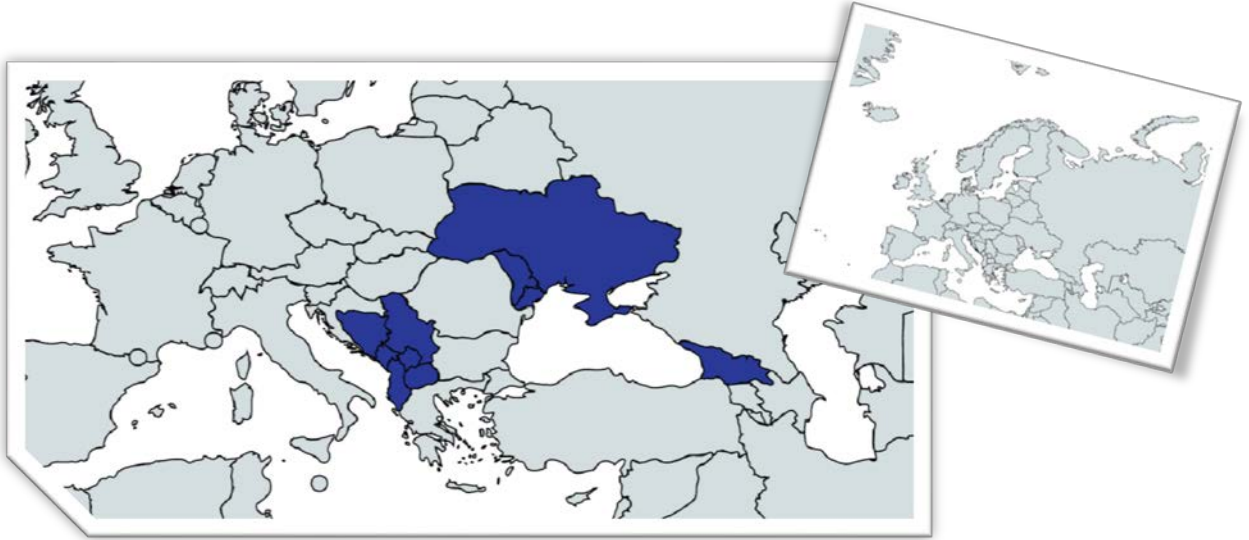
Based on the results obtained in this research the following recommendations are concluded

- 1) **Strengthening regulatory framework** by adoption of new secondary legislation (DSOs' position to be defined and presented to NRAs);
- 2) **Harmonizing** QoS indicators and standards, recording, monitoring, reporting and publishing practices (e.g. time for connecting new customers);
- 3) Dynamics of **improving the quality indicators**;
- 4) **Strengthening cooperation** between CPs NRAs, TSOs and DSOs on QoS issues;
- 5) **Continuous monitoring and benchmarking**;
- 6) **DSO-TSO harmonization of plans.** In order for DSO to speed up the process of non-standard connection, the better synchronization with the TSO is required. Such synchronization may take place at time of development the "grid development plans" between TSO and DSO, that would allow better estimation and planning the future construction and connection of electrical installations;
- 7) **Assignment of lands.** The whole process of non-standard connection to the distribution grid in most cases is impeded by complicated agreement process with land owners in terms of land allotments for electrical installations.. It is necessary to apply simplified system of land allotments to accelerate the process of connection to electricity distribution grids

3.6. RECOMMENDATIONS

REGULATORY FRAMEWORK	<p>DSO's tasks and responsibilities related to commercial requirements should be explicitly stipulated in the legislation.</p> <p>General terms and conditions of contracts with DSO have to approved by NRA and clearly communicated to network users.</p> <p>The role of DSO and its relation to other market players have to be explicitly stipulated in the contract, in particular relations with suppliers and TSO.</p>
DEFINITION OF GUARANTEED STANDARDS	<p>Indicators and standards to measure commercial quality have to be defined, along with procedure for recording, monitoring, reporting and publishing.</p>
HARMONIZATION AND COOPERATION	<p>In order for DSO to speed up the process of connection, in particular non-standard connection, the better synchronization with the TSO is required, at time of development the "grid development plans" to would allow better network development.</p>
IMPROVEMENT	<p>Monitoring and benchmarking should serve as a basis for evaluation of DSO's performance and for setting targets for improvement.</p>

4. ABBREVIATION AND ACRONYMS



Abbreviations used in this report for countries and territories are two and three letters code according to the international codes (ISO 3166-1).

Abbreviations used in this report for DSOs are their respective official abbreviations or terms usually used in communication.

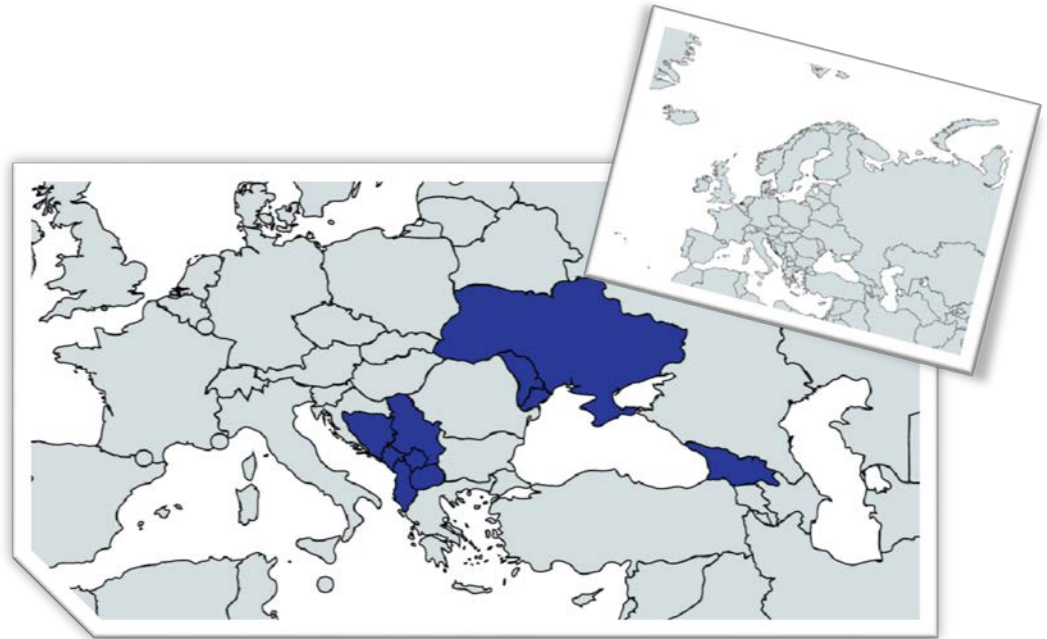
Table 18 List of abbreviations

CP	Albania	Bosnia and Herzegovina	Georgia	Kosovo*	North Macedonia	Moldova	Montenegro	Serbia	Ukraine
Code	ALB	BIH	GEO	XKX	MKD	MDA	MNE	SRB	UKR
	AL	BA	GE	XK	MKD	MD	ME	RS	UA
DSO	OSHEE	EPBIH EPHZHB ERS	EP	KEDS	ED	PE	CEDIS	EPS	DTEKG

Acronym	Meaning
CEER	Council of European Energy Regulators
DSO	Distribution System Operator
ECDSO-E	Coordination Platform for Energy Community Distribution System Operators for Electricity
EN	European Norm
EnC	Energy Community
EU MS	European Union Member State
SoS CG	Energy Community Security of Supply Coordination Group
EEA	European Economic Area
CPs	Contracting Parties
TF	Task force
EHV	Extra high voltage
HV	High voltage
LV	Low voltage
MV	Medium voltage
NRA	National Regulatory Authority
THD	Total harmonic distortion
TSO	Transmission System Operator
QoS	Quality of supply
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
ENS	Customer Average Interruption Duration Index
CAIDI	Energy Not Supplied
VQ	Voltage quality

ITIC	Information Technology Industry Council
CBEMA	Computer and Business Equipment Manufacturers Association
IEC	International Electrotechnical Commission
CENELEC	European Committee for Electrotechnical Standardization
EMC	Electromagnetic Compatibility
GI	General Indicator
OI	Overall Indicator
USP	Universal Supplier
SP	Supplier
MO	Meter operator
AMI	Advanced Metering Infrastructure
ECRB	Energy Community Regulatory Board

5. REFERENCES



This chapter summarizes the list of references used by Task force members for preparations the document.

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