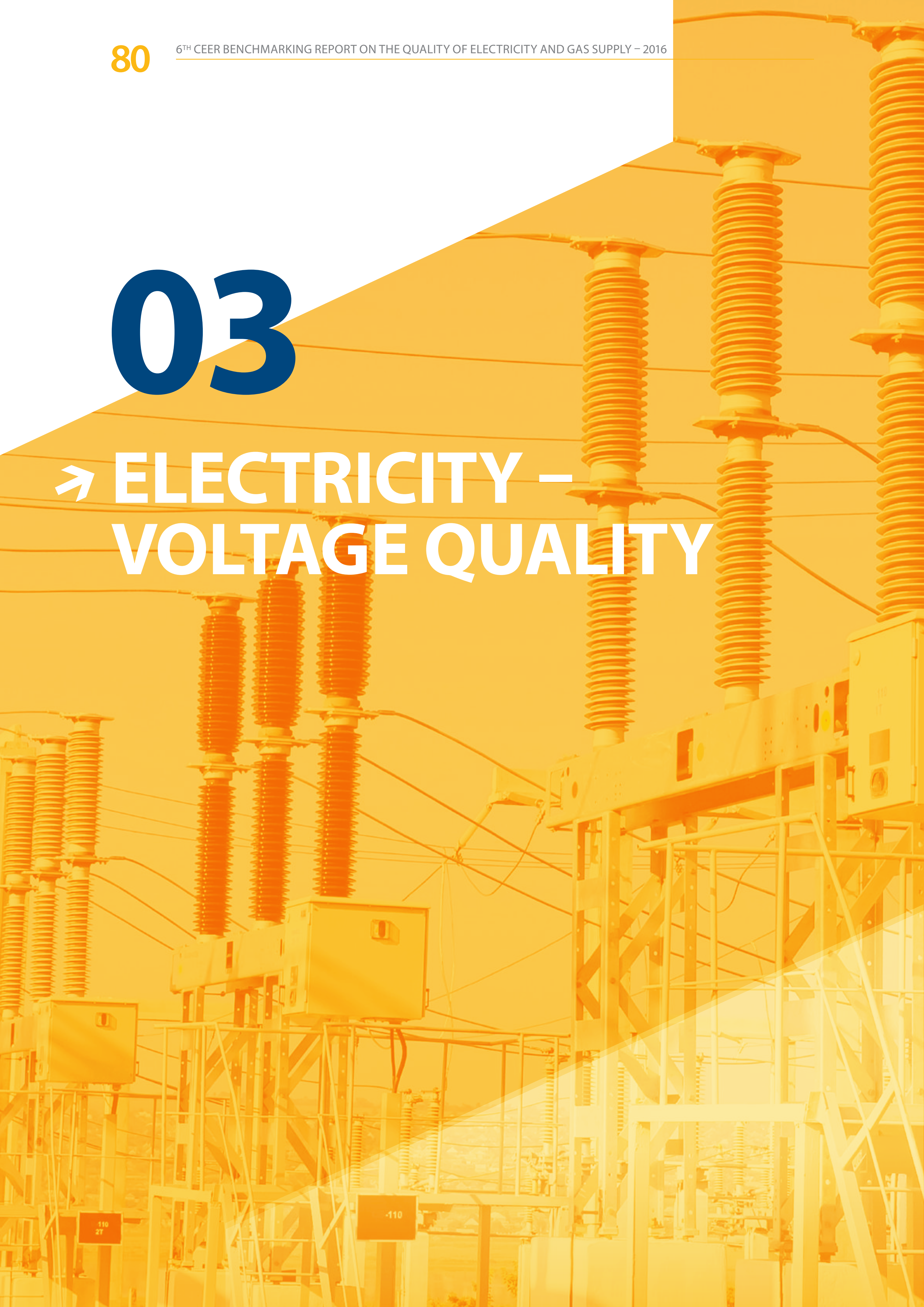
03

➔ ELECTRICITY – VOLTAGE QUALITY



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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.3. STRUCTURE OF THE CHAPTER ON VOLTAGE QUALITY

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

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

3.4. HOW IS VOLTAGE QUALITY REGULATED

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

3.4.1. Responsibilities for regulation of voltage quality

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

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

TABLE 3.1 RESPONSIBILITY FOR VOLTAGE QUALITY REGULATION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.4.2. Voltage quality standardisation (EN 50160)

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

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

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

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

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

TABLE 3.2 STANDARD EN 50160 – SUMMARY FOR CONTINUOUS PHENOMENA

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

3.4.3. National legislation and regulations that differ from EN 50160

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

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

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

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

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

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

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

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

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

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

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

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

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

TABLE 3.5 VOLTAGE QUALITY REGULATION DIFFERING FROM EN 50160 – EVENTS

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

3.5. VOLTAGE QUALITY AT CUSTOMER LEVEL

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

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

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

3.5.1. Individual information on voltage quality

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

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

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

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

3.5.2. Individual voltage quality verification

3.5.2.1 By costumer complaint

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

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

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

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

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

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

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

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

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

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

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

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

3.5.2.2 On request by costumer

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

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

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

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

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

3.5.2.3 Requirements regarding VQ monitoring instruments

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

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

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

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

3.5.3. Emission limits

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

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

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

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

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

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

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

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

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

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

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

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

3.5.3.1 Case study: Responsibility sharing among stakeholders in Latvia

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

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

Responsibilities for the grid system operators

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

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

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

Responsibilities for the grid users

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

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

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

3.6. VOLTAGE QUALITY MONITORING SYSTEMS AND DATA

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

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

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

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

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

3.6.1. Development of voltage quality monitoring systems

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

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

TABLE 3.7 MONITORING SYSTEMS IN OPERATION

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

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

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

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

3.6.1.1 Network points monitored

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

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

TABLE 3.8 MONITORING OF HV/MV SUBSTATIONS

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

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

TABLE 3.9 NETWORK POINTS MONITORED

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

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

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

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

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

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

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

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

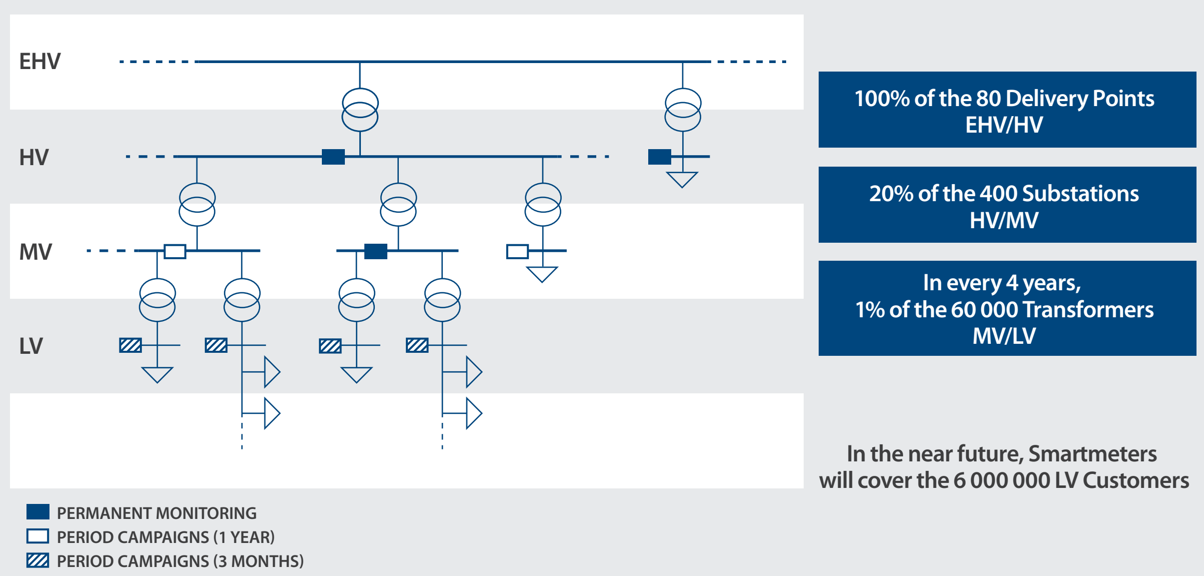
The production unit is another criteria used for determining the placement of voltage monitoring. In Ireland, all generator sites with maximum export capacity greater than 300 kW are monitored. In Cyprus, the connection points of independent producers at the transmission level are measured with a permanent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

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

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

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

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



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

3.6.1.2 Voltage disturbances monitored

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

TABLE 3.10 VOLTAGE QUALITY PARAMETERS MONITORED

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

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

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

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

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

3.6.1.3 Responsibility and purpose of the monitoring programmes

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

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

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

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

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

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

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

TABLE 3.12 RESPONSIBILITY FOR VOLTAGE QUALITY MONITORING COSTS

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

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

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

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

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

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

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

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

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

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

Measuring points

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

Technical standards for the measurements

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

Reporting

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

3.6.2. Smart meters and voltage quality monitoring

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

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

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

TABLE 3.13 SMART METERS AND VOLTAGE QUALITY MONITORING

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

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

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

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

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

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

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

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

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

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

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

Examples for usage of data from smart meters

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

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

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

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

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

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

3.6.3. Actual data on voltage dips

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

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

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

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

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

3.6.4. Publication of voltage quality data

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

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

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

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

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

TABLE 3.14 PUBLICATION OF VOLTAGE QUALITY DATA

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Transmission System Operator

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

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

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

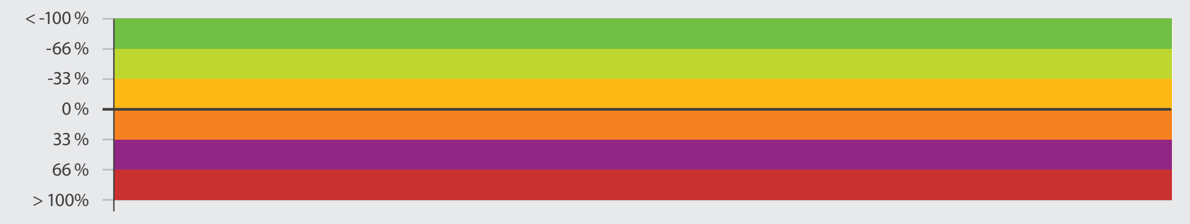
Year 2014								
Features/ Week	1	2	3	4	5	6	7	8
Amplitude								
Unbalance								
Harmonics								
Frequency								
Flicker								

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

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

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

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



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

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

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

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

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

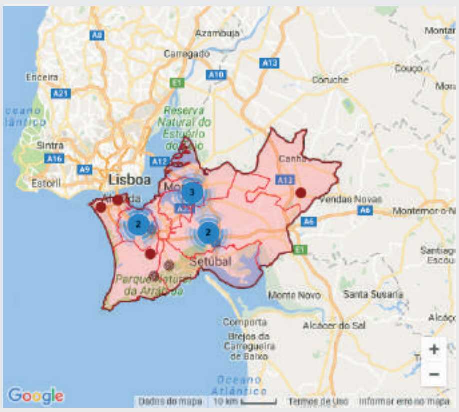
Regarding voltage events, since no regulatory limits are established, this labelling system is not applied. The results of the voltage events monitoring are published based on the tables defined by the Portuguese code (adopted from standard EN 50160: 2010), which aggregate the events according to the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

Distribution System Operator

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

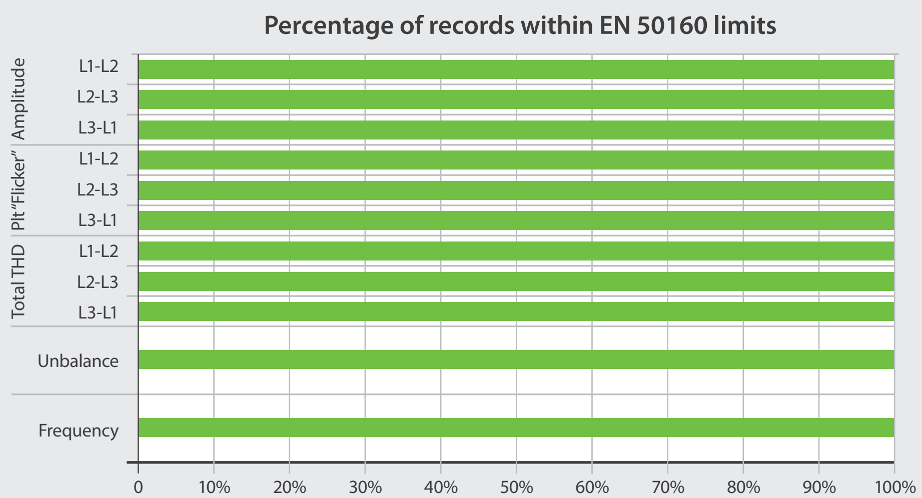
The report available for each network point includes the identification of the delivery point, the voltage level of the monitored bus or buses, the measuring period and the results for the different voltage characteristics.

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



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

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



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

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

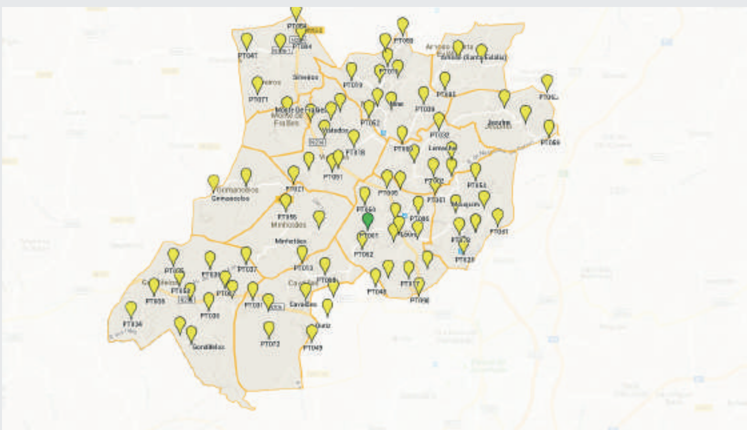
For the publication of the voltage events, the approach is the same as the one used by the TSO, based on the EN 50160: 2010 tables for voltage dips and swells.

Distribution System Operators exclusively in LV

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

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

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



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

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

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

2014	4th Quarter												
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Amplitude													S/M
Imbalance													S/M
Harmonics													S/M
Frequency													S/M
Flicker													S/M

VERY GOOD QUALITY · GOOD QUALITY · SUFFICIENT QUALITY · POOR QUALITY · VERY POOR QUALITY · BAD QUALITY

Some Guidelines for Publication of the Monitoring Results

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

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

3.7. AWARENESS ON VOLTAGE QUALITY

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

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

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

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

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

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

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

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

3.8. CASE STUDY: VOLTAGE QUALITY REGULATIONS IN ISRAEL

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

Voltage Quality Monitoring Programme

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

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

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

1-52 kV		2010	2011	2012	2013	2014
voltage dip (pu)	high value	967	561	308	386	295
	average	133.1	65.6	82.5	90.7	66
voltage swell (pu)	high value	-	1734	748	493	225
	average	-	31.2	14,9	6,8	3,8
supply interruption (pu)	high value	61	34	78	61	40
	average	6,6	5,6	6,5	7,3	5,7
thd v (%)	high value	6,3	5,2	6	8,8	6,6
	average	3,3	3,1	3,2	3	3
voltage unbalance (%)	high value	1,5	2	2,8	2	2,3
	average	0.6	0.6	0.7	0.6	0.6
P_{lt} (pu)	high value	1,9	2	3,3	2,8	2
	average	0.7	0.7	0.7	0.8	0.7
frequency (Hz)	max	50.1	50.1	50.1	50.1	50.1
	min	49.9	50	49.9	49.9	49.9
supply voltage variation 95% (%)	max	-8.1\9.2	-8.2\8.9	-10.4\9	-6.1\9.1	-6.8\9.6
	min	0.4\5.3	0.3\5.2	0.3\5.4	0.4\5.3	0.3\5.4
supply voltage variation 99% (%)	max	-	-	-11.1\9.9	-7.2\9.4	-7.3\10
	min	-	-	-0.8\6.1	-0.9\6.1	-1\6.2
52-161 kV		**2010**	**2011**	**2012**	**2013**	**2014**
voltage dip (pu)	high value	305	176	196	215	176
	average	137.8	47.4	79.5	79.3	57
voltage swell (pu)	high value		39	36	14	25
	average		1,3	1,4	0,5	1
supply interruption (pu)		3	2	-	2	1
thd v (%)	high value	2,8	3,4	2,4	3	3
	average	2,1	2,1	1,7	1,7	1,7
voltage unbalance (%)	high value	1,4	1,1	0,9	0,9	1,2
	average	0.5	0.5	0.5	0.4	0.5
P_{lt} (pu)	high value	1,5	1,2	1,2	1,4	3,2
	average	0.7	0.7	0.6	0.7	0.7
frequency (Hz)	high value	50.1	50.1	50.1	50.1	50.1
	average	49.9	50	49.9	49.9	49.9
supply voltage variation 95% (%)	high value	-6.2\4.5	-4.7\5.7	-5.8\4.7	-3.7\4.5	-4.5\4.6
	average	-2.1\3.3	-1.8\3.4	1.8\3.4	-1.5\3.3	-1.5\3.3

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

Customer compensation regulation for voltage quality

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

3.9. FINDINGS AND RECOMMENDATIONS ON VOLTAGE QUALITY

Finding 1
Voltage quality regulation:
From the responding NRAs, 15 have powers and duties to define voltage quality regulation and have issued regulatory orders regarding voltage quality. The term "regulation" includes setting standards, rules, and minimum requirements, implementing rewards, monetary penalties and other sanctions, publishing and setting obligations for voltage quality monitoring.

Finding 2
Voltage quality at customer level:
A number of countries have introduced legislation regarding emissions by individual customers. The concept of responsibility sharing for adequate voltage quality between the network operator, the customer and the manufacturer is identified. Of the responding NRAs, 16 foresee penalties for customers in the case of violation of disturbance limits.

Finding 3
Voltage quality monitoring:
A total of 18 countries are monitoring voltage quality. There are, however, some differences in the number of measurement instruments installed, the duration of monitoring and the monitored voltage levels. The data and aggregated data are available for most of the countries' NRAs. In some countries, data is also available for end-users. Only a few countries publish statistics based on the data: 4 countries provided tables with classification of voltage dips. Portugal provides a web-service with information about voltage quality at the substation level.

Finding 4
Awareness about voltage quality:
Of the responding NRAs, 5 informed that courses, seminars and information material is provided among stakeholders through branch organisations, research companies or other stakeholder groups. Only a few countries have replied that information on voltage quality is shared on the internet, in dedicated meetings/workshops and such.

RECOMMENDATION 1

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

RECOMMENDATION 2

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

RECOMMENDATION 3

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

RECOMMENDATION 4

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

04

ELECTRICITY – COMMERCIAL QUALITY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.3. STRUCTURE OF THE CHAPTER ON ELECTRICITY COMMERCIAL QUALITY

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

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

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

4.4. MAIN ASPECTS OF ELECTRICITY COMMERCIAL QUALITY

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

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

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

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

4.4.1. Main groups of commercial quality aspects

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

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

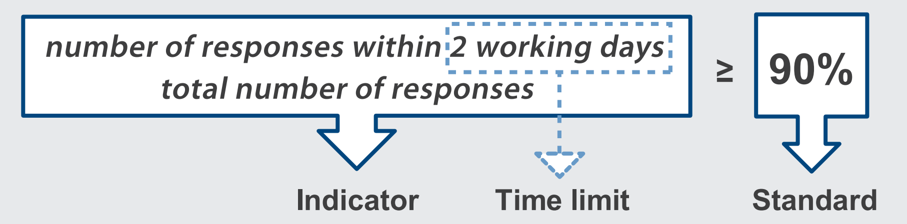
4.4.2. Commercial quality indicators and their definitions

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

TABLE 4.1 EXAMPLES OF USE OF NEW TERMS

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

FIGURE 4.1 EXAMPLE OF A COMMERCIAL QUALITY INDICATOR



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

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

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

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

TABLE 4.2 COMMERCIAL QUALITY INDICATORS SURVEYED

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

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

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

4.4.3. How to regulate commercial quality

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

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

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

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

4.5. MAIN RESULTS OF BENCHMARKING COMMERCIAL QUALITY INDICATORS

4.5.1. Commercial quality indicators applied

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

TABLE 4.3 SUMMARY OF COUNTRIES WHICH ADOPT COMMERCIAL QUALITY INDICATORS

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

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

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

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

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

TABLE 4.5 NUMBER OF COMMERCIAL QUALITY INDICATORS SURVEYED

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

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

4.5.2. Group I: Connection

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

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

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

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

* including LV non-domestic customer (Italy).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.5.3. Group II: Customer care

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

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

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

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

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

TABLE 4.9 COMMERCIAL AND QUALITY INDICATORS FOR CUSTOMER CARE RELATED ACTIVITIES

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

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

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

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

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

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

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

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

*including LV non-domestic customer (Italy).

4.5.4. Group III: Technical Service

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

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

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

TABLE 4.11 COMMERCIAL AND QUALITY INDICATORS FOR TECHNICAL CUSTOMER SERVICE

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.5.5 Group IV: Metering and billing

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

TABLE 4.14 COMMERCIAL AND QUALITY INDICATORS FOR METERING AND BILLING SERVICE

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

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

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

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

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

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

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

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

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

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

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

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

4.5.6 Compensations to customers

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

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

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

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

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

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

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

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

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

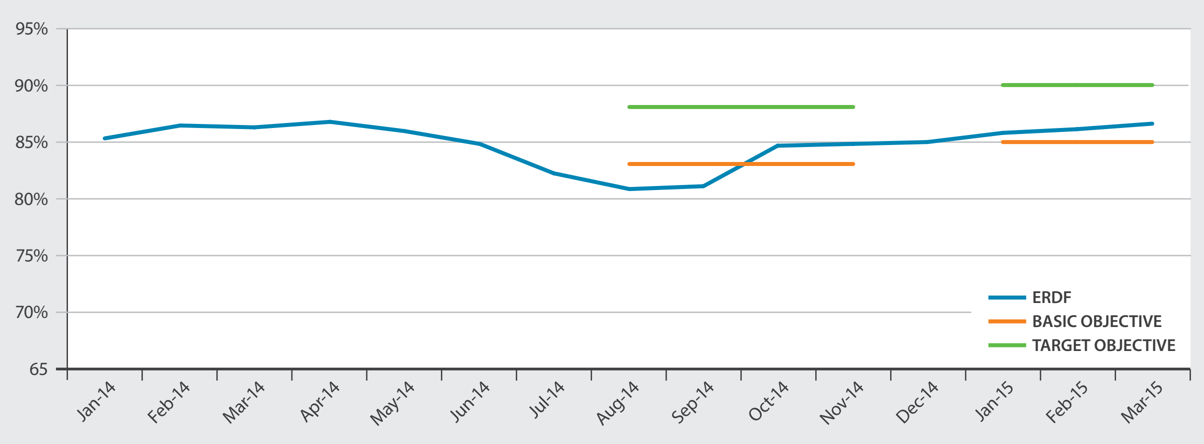
This indicator has financial incentives since 1 January 2014:

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

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

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

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



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

4.7. ACTUAL LEVELS OF COMMERCIAL QUALITY

There are 2 ways to monitor the actual level of commercial quality:

- Monitoring the **average value of the indicator** (e.g. the average time for making a new connection);
- Monitoring the **percentage of cases for which the company complies with the time limit** set by the NRA, i.e. the percentage of cases for which the limit was met (over the total number of cases) is below or above the standard (90% for example).

It is important to note that the first way of measuring the actual quality level does not depend upon the standards and is therefore comparable between countries (assuming that requirements of the same type are considered). The second way of measuring, also called **compliance percentages**, is only meaningful for comparison if the time limits to which it refers are the same, even if the standards are not, otherwise, it cannot be compared between countries. For example, the percentage of customers complaints responded within 15 days (time limit) is 99% in country A (country A has a standard of 80%) and 90% in country B (which has as standard of 95%), then these values can be compared if country B also has a time limit of 15 days.

In the 4th Benchmarking Report, insufficient data was provided on the actual performance levels of the quality indicators, therefore cross-country comparisons were not feasible. For the 5th Benchmarking Report, respondents were asked to report data for the period 2008- 2010, and for the 6th Benchmarking Report, data from 2010 to 2014 was requested. In this report, the analysis focuses on the 2010-2014 results.

A larger amount of information became available for the current 6th Benchmarking Report, possibly due to NRAs' growing attention to commercial quality standards. In Table 4.17 below, a small selection of indicators from each of the 4 main groups is shown (e.g. for the group I "Connection", data for the first 4 indicators has been included). The figures were calculated by averaging the non-compliance figures within the main group: Connection, Customer care, Technical service, and Metering and billing. Although the values are not weighted by the importance of the questions included in the groups, it still provides a reliable impression of the direction of the improvements. However, this analysis, based on data from a period of 4 years, has to be considered with caution, as the database was partially scarce (not all the countries responded to all the indicator values).

Furthermore, the average performances should not be compared across countries, the only purpose of it is to provide a view into the actual levels of commercial quality, at a glance.

TABLE 4.17 AVERAGE NON-COMPLIANCE PERCENTAGE BY COUNTRIES

Average non-compliance percentage	I. Connection					II. Customer care				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Austria					4.00%					2,3%
Belgium										
Croatia					30.00%					
Czech Republic	0.29%	0.19%	0.14%	0.10%	0.03%	1.94%	0.46%	0.22%	0.50%	0.26%
France					1.05%					6.15%
Greece	2.04%	3.02%	3.65%	2.39%	1.12%		0.49%	0.30%	0.25%	0.10%
Hungary	6.04%	5.16%	4.06%	5.61%	5.95%	10.66%	14.00%	10.90%	18.88%	16.87%
Ireland										
Latvia				0.11%	0.0%				7.90%	3.23%
Lithuania		0.35%	0.85%	3.55%	4.75%					
The Netherlands										
Portugal					29.45%	2.95%	3.54%	3.52%	3.39%	10.90%
Slovenia		7.99%	7.64%	6.74%	7.22%		31.92%	24.57%	21.06%	55.24%
Average	**2.79%**	**3.34%**	**3.27%**	**3.08%**	**8.36%**	**5.19%**	**10.08%**	**7.91%**	**8.66%**	**13.25%**

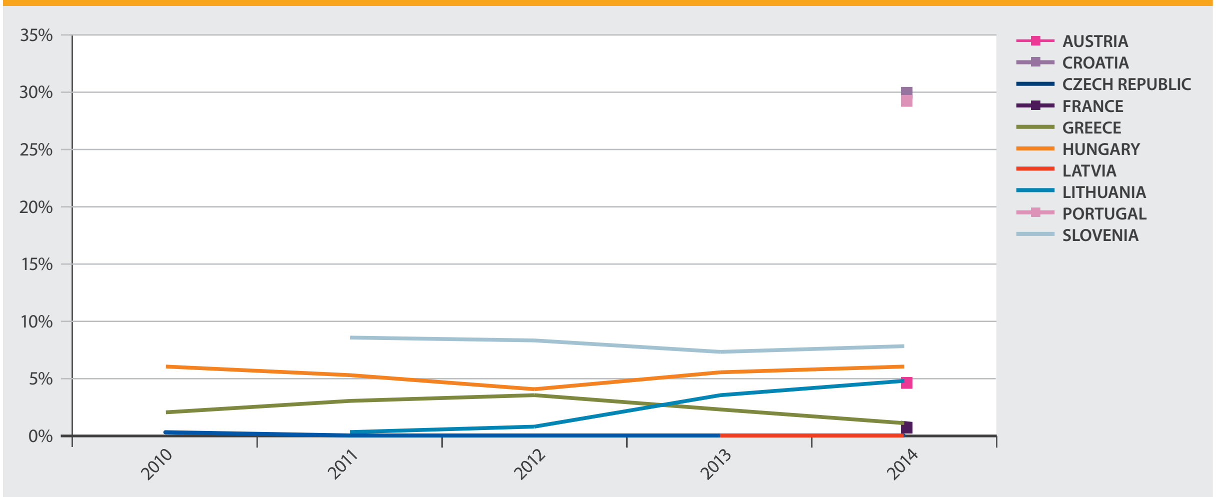
Average non-compliance percentage	III. Technical service					IV. Metering and billing				
	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014
Austria										
Belgium										
Croatia										5.00%
Czech Republic	4.09%	7.23%	6.03%	5.87%	5.24%	0.14%	0.39%	0.61%	0.04%	2.35%
France										
Greece	1.50%	1.48%	1.56%	1.77%	0.46%	1.58%	1.58%	1.58%	1.80%	4.41%
Hungary	17.22%	19.01%	6.28%	15.92%	12.52%	2.54%	4.025%	4.025%	3.71%	5.645%
Ireland										
Latvia				0.0%	0.0%					
Lithuania										
The Netherlands										
Portugal	1.57%	0.14%	0.16%	0.36%	0.58%	0.61%	0.26%	0.20%	0.35%	7.17%
Slovenia		31.02%	36.50%	32.82%	36.52%		1.25%	3.75%	14.43%	3.76%
Average	**6.10%**	**11.78%**	**10.10%**	**9.45%**	**9.22%**	**1.22%**	**1.50%**	**2.03%**	**4.07%**	

The growing number of countries collecting data is encouraging. However, not all the countries responded to the questionnaire because they do not monitor the indicator required or because the indicator they monitor does not correspond exactly to the indicator's definition in the CEER questionnaire.

4.7.1 Connection

Connection performance indicators (Group I) are the most monitored commercial quality indicators. Most countries made noticeable progress in the past few years. The average non-compliance percentage for the Czech Republic decreased from 0.29% (in 2010) to 0.03% (in 2014). Greece achieved a good and relatively stable performance since 2010: from 2.05% (in 2010) to 1.12% (in 2014). In Hungary, since 2010, the country registered an average non-compliance percentage of 5.36% over 5 years. In 2014, 8 countries (Austria, the Czech Republic, France, Greece, Hungary and Latvia) are below the overall average of non-compliance of 8.36%.

FIGURE 4.3 AVERAGE NON-COMPLIANCE PERCENTAGE BY COUNTRIES FOR CONNECTION ACTIVITIES



The overall average time for connecting new customer to the network (I.3) is 7.89 days in 2014 (including the Czech Republic, France, Greece, Hungary, Lithuania, Portugal and Slovenia results). For most of the countries, the overall trend is positive (average percentages of compliance higher than 90%). In 2014, Croatia and Portugal registered average non-compliance percentages of 30.0% for Croatia and 29.45% for Portugal. In fact, in Croatia the time limit (15 days) to response to customer claim for network connection (I.1) is respected in 70% of the cases. And in Portugal, the time limit (15 working days) to response to customer claim for network connection (I.1) is respected in 72.61% of the cases, for a total number of 9,355 requests.

4.7.2 Customer care

Similarly to connection (Group I), the reported non-compliance indicators related to **customer care** (Group II) for most countries are also relatively low and homogeneous on the 2010-2014 period: the percentages are lower than 10% for Austria, the Czech Republic, France, Greece, Portugal (except in 2014) and Latvia.

In Portugal, from 2010 to 2013, non-performance percentages were lower than 4%: a particularly good performance has been observed concerning the response time to customer complaints (II.2). In 2014, it reached 10.90%: this higher non-compliance percentage can be explained by a lower performance achieved for the "punctuality of appointments with customers" (88.77%).

Slovenia and Hungary are the 2 countries whose non-compliance results are above the overall average since 2011. Since 2010, Hungary shows non-performance from 10.66% to 16.87%: the percentages of compliance for the indicator "response time to customer voltage and/or current complaints" (II.3) are pulling down the average percentage of compliance related to customer care: the operators achieved a performance lower than 50% in 2013 and 2014 for this indicator. The highest non-performance percentages related to customer care are observed in Slovenia: in particular, improvements should be provided to the time to response to customer enquiries (II.3) and customer voltage and/or current complaints (II.4).

4.7.3 Technical service

The indicators of **technical service** (Group III) remained either about the same or improved slightly during the period of 2010-2014 for the Czech Republic, Greece, Hungary, and Portugal. Most results are below the overall average percentage of non-compliance (9.22%) in 2014. Slovenia registered high levels of non-compliance (between 31% and 36.52%) on the 2011-2014 period. Particularly, the percentages of compliance for the time between the date of the answer to the VQ complaint and the elimination of the problem (III.1) from 2011 to 2014 are low (34.11%).

Concerning the time between the date of the answer to the VQ complaint and the elimination of the problem (III.1), Hungary registered very heterogeneous percentages of compliance on the period 2010-2014 (e.g. 24.41% in 2011, 75.75% in 2012 and 51.22% in 2014). Regarding the time until the start of restoration of supply following failure of fuse of DSO (III.2), the percentages of compliance from 2010 to 2014 are good (> 96%) for the Czech Republic, Greece, Hungary, Portugal and Slovenia.

4.7.4 Metering and billing

Performance indicators for **metering and billing** (Group IV) were the least monitored commercial quality indicators in the previous 5th Benchmarking Report. For the 6th Benchmarking Report, 6 countries provided their metering and billing indicators performance. All the countries registered non-compliance percentages lower than 8% on the 2010-2014 period. In 2014, the overall average of non-performance reaches 4.72% and 3 countries are slightly above the average: Croatia (5.00%), Hungary (5.65%) and Portugal (7.17%). The non-compliance percentages are slightly increasing on the 2010-2014 period but the overall picture is relatively homogeneous. Quite large differences are observed for Portugal (i.e. 0.61% in 2010 and 7.17% in 2014).

Performance results are particularly good for the time for restoration of power supply following disconnection due to non-payment (IV.3), for which the percentages of compliance of the Czech Republic, Greece, Hungary, Portugal and Slovenia are above 98% on the 2010- 2014 period. The average performance time for restoration of power supply following disconnection due to non-payment (IV.3) has decreased from 2011 to 2014 for the Czech Republic (from 0.9 days to 0.8 days, with a time limit of 2 days), Lithuania (from 1.87 days to 1.5 days, with a time limit of 2 working days) and Slovenia (from 3 to 1.1 days, with a time limit of 3 days).

4.8. SUMMARY OF BENCHMARKING RESULTS

Tables 4.18 and 4.19 on the next page synthesise the results according to the indicators (see also Section 4.5.1). Indicators for DSOs account for 147 out of 193 national indicators (as per Table 4.4).

TABLE 4.18 TOTALS OF APPLIED INDICATORS BY TYPE

Totals of applied indicators by type	OI	GI	OR	Total
I. CONNECTION				
I.1 Time for response to customer claim for network connection	8	4	5	**17**
I.2 Time for cost estimation for simple works	1	4	4	**9**
I.3 Time for connecting new customers to the network	5	4	6	**15**
I.4 Time for disconnection upon customer's request	1	1	3	**5**
I.5 Time for a switching of supplier	3	0	9	**12**
TOTAL FOR CONNECTION INDICATORS	**18**	**13**	**27**	**58**
II. CUSTOMER CARE				
II.1 Punctuality of appointments with customers	0	4	1	**5**
II.2 Response time to customer complaints	3	4	5	**12**
II.3 Response time to customer enquiries	2	4	5	**11**
II.4 Response time to customer voltage and/or current complaints	1	4	2	**7**
II.5 Response time to customer interruption complaints	0	1	4	**5**
II.6 Response time to questions in relation with costs and payments (excluding connection)	1	1	1	**3**
II.7 Call Centres average holding time	0	1	0	**1**
II.8 Call Centres service level	0	0	0	**0**
II.9 Waiting time in case of personal visit at client centres	0	0	0	**0**
TOTAL FOR CUSTOMER CARE INDICATORS	**7**	**19**	**18**	**44**
III. TECHNICAL SERVICE				
III.1 Time between the date of the answer to the VQ complaint and the elimination of the problem	1	3	3	**7**
III.2 Time until the start of restoration of supply following failure of fuse of DSO	0	6	2	**8**
III.3 Time for giving information in advance of a planned interruption	2	3	6	**11**
III.4 Time until the restoration of supply in case of unplanned interruption	2	4	5	**11**
TOTAL FOR TECHNICAL SERVICE INDICATORS	**5**	**16**	**16**	**37**
IV. METERING AND BILLING				
IV.1 Time for meter inspection in case of meter failure	3	5	3	**11**
IV.2 Time from the notice to pay until disconnection	2	1	5	**8**
IV.3 Time for restoration of power supply following disconnection due to non-payment	3	4	3	**10**
IV.4 Yearly number of meter readings by the designated company	1	2	6	**9**
TOTAL FOR METERING AND BILLING INDICATORS	**9**	**12**	**17**	**38**

According to Table 4.18, there are 58 indicators for connection activities (Group I). The most monitored indicators are the time for response to customer claim for network connection (I.1), the time for connecting new customers to the network (I.3), and the time for a switching of supplier (I.5), which was introduced as a new commercial quality performance in the 5th benchmarking report. The average number of indicators whose type is specified is 12 ("standards/activity", that is "(18+13+27)/5") in the connection (Group I). This figure is the highest among the other groups, meaning that connection to the network in the countries surveyed is of primary importance. Customer care (Group II) is the lowest group of indicators, with an average value of 6 indicators/activity.

Technical service (Group III) (with an average value of 9 indicators/activity) and metering and billing (Group IV) (with an average value of 10 indicators/activity) are more or less regulated to the same extent. Of note is that much attention is paid to the quickest possible restoration of supply, irrespective of whether the loss of supply was caused by faults, missing payments and information on notice for planned interruptions. This confirms the priority in energy regulation to ensuring the availability of supply.

There are considerable differences in the average number of indicators per activity group. ORs are the most frequently applied for regulation of connection, customer care, technical service and billing and metering issues.

In some important cases GIs, OIs and ORs are used in parallel by the countries. OI are frequently applied for connection group activities. A lot of GIs are applied for customer care, technical service, and metering and billing issues. Table 4.19 shows the indicators applied in the countries, per group and per type.

TABLE 4.19 COMMERCIAL QUALITY INDICATORS APPLIED BY THE CEER COUNTRIES PER TYPE OF INDICATOR AND GROUPS

Countries	I. Connection			II. Customer care			III. Technical service			IV. Metering and billing		
	OI	GI	OR	OI	GI	OR	OI	GI	OR	OI	GI	OR
Austria	X			X			X			X		
Belgium			X			X			X			X
Croatia	X		X			X			X	X	X	
Czech Republic		X	X		X			X			X	X
Estonia	X					X	X			X		
Finland			X									
France			X	X	X	X			X	X		
Great Britain								X			X	X
Greece		X	X		X			X			X	
Hungary	X	X	X	X	X			X			X	X
Italy	X	X										
Latvia			X			X			X			X
Lithuania	X						X			X		
Luxembourg	X		X							X		
Malta	X	X										
The Netherlands		X						X			X	
Norway			X			X						X
Portugal	X		X	X	X			X		X	X	
Slovenia	X	X		X	X		X	X	X		X	
Sweden			X						X			X

4.9. FINDINGS AND RECOMMENDATIONS ON COMMERCIAL QUALITY OF ELECTRICITY

It is important to recall that the results on commercial quality should be interpreted with caution as some elements can be measured in different ways and data is not yet available in every country. This may reflect differences in measurement. For example, some indicators do not differentiate between simple and complex work. Furthermore, the performances of the operators are not comparable across countries since each country has its own regulatory system (with specific time limits, standards, compensation levels, penalty amounts, etc.).

Finding 1
An increased focus by NRAs on the quality of the services provided to customers.

The first finding, in line with the conclusions from CEER's past Benchmarking Reports, is that NRAs devote significant attention to the commercial quality of the services provided. A total of 22 responding countries reported 177 national commercial quality indicators referring to 22 performances requested by customers.

Finding 2
A broad, but increasingly harmonised, range of commercial quality indicators are monitored.

There are significant differences concerning the nature and the number of indicators monitored across countries. Although the set of activities and the expected goals of the regulation are similar, in some countries the regulations are not clearly defined or are less enforced than specific quality indicators (e.g. "within reasonable time", "in reasonable terms"). The regulation of a given service can be achieved in many different ways such as time limits, standards, compensation levels, penalty levels. NRAs should set the commercial quality regulations taking into account their national, political, cultural and economic specificities. At the same time, progresses in harmonisation have been achieved compared with the previous CEER Benchmarking Reports. At the time of the 3rd Benchmarking Report (in 2005), the commercial quality parameters were rarely regulated in the same way across CEER Members, whilst the 6th Benchmarking Report reveals that the number of identical or partially identical regulations concerning these indicators has grown considerably.

Finding 3
Requirements and compensations vary a lot depending on the customer type.

Commercial quality concerns different types of customers: the difference in the amount of consumption is also important from a regulation point of view. Their classification (location, voltage levels) varies from country to country and from network operator to network operator. In a given country, requirements may vary a lot depending on whether the customer concerned is a LV customer or a HV customer. In general, commercial quality is mainly focused on residential customers with a connection to the LV network because they represent the largest group and because small domestic customers often need more protection.

Finding 4
The move towards more Guaranteed Indicators (with compensation) is again confirmed.

Some definitions and names related to commercial quality requirements have changed from past editions, e.g. "standards" are now referred to as "indicators". The data collected shows that commercial quality indicators can be used by NRAs in 3 ways:

- To define OIs, either without any economic consequence for the DSO or supplier upon non-compliance or including economic sanctions. NRAs are entitled to impose sanctions such as penalties;
- To set GIs by which customers receive direct compensation if standards are not met; or
- To apply OR, and in the case of non-compliance, sanctions can be imposed by the NRA.

The analysis of the results confirms that there is a general trend over time to move away from Overall Indicators (OIs) to Guaranteed Indicators (GIs). This trend was already identified by the 4th and the 5th Benchmarking Reports. This 6th Benchmarking Report reports 60 GIs compared to 39 OIs currently being applied. Automatisation of compensation payment is being developed: some countries already apply automatic compensation in the case of non-compliance for certain indicators (France, Greece, Hungary, Italy and Portugal).

Finding 5
Commercial quality is mainly focused on the DSO's relationship with customers.

In countries where competition works well, the NRAs are focused more on monitoring the DSOs' commercial quality obligations (rather than those of the suppliers) as the distribution activities are closely linked to customers (connection to the grids, activations, etc.). In fact, 147 (out of a total of 193 indicators) relate to DSOs and 25 indicators relate to suppliers / USP.

Finding 6
Network connection and customer care remain as key considerations.

From a consumer perspective, connections, activations, and maintenance are very relevant processes, as, in some cases, they represent the consumer's first interaction with the energy market. If these processes are well designed and function efficiently, they will help to improve consumer's perception of the energy market. The survey stresses that priority is given to the standards for connection of customers to the network and customer care like the response time to complaints. In fact, out of a total of 177 indicators, 58 indicators are monitored for connection to the network activities and 44 for customer care services.

Finding 7
Smart meters impact on commercial quality regulation.

Having accurate billing based on the actual, measured consumption is becoming more and more important both for customers and licensees. All parties expect a more detailed picture of consumption habits (profiles) on the basis of which they would be able to plan network maintenances, energy purchases or eventual changes in the daily consumption practices. Recognising this need, many countries aim to collect monthly (or even more frequent) meter data with meter readings through the roll-out of smart meter programmes. Smart meters facilitate a more accurate picture of electricity consumption, of grid status and can ease and shorten both the procedure of supplier switching and the process of deactivation and reactivation due to unpaid bills.

Finding 8
The focus needs to be wider than DSO's written responses to consumers.

In addition to the customer's expectation to be connected or reconnected as quickly as possible, there is a noticeable need for a substantive response from the DSO/supplier to any customer request within a reasonable limit of time. The data reveals that the current emphasis is placed on DSO's performance with regard to written forms of communication. This results in an incomplete picture of the quality of responses to customer requests for 2 different reasons: (1) non-written forms of communication like telephone (fixed and cell-phone) and internet (website) have developed significantly and are widespread; (2) in some countries, the more traditional approach of visiting local customer centres continues. In some countries, oral claims are still not taken into account and only written complaints are counted.

RECOMMENDATION 1

PERFORM REGULAR REVIEWS OF NATIONAL REGULATIONS.

It is important for CEER (and NRAs) to regularly review the commercial quality indicators, taking into account the development of national conditions (e.g. the development of smart grids) and the expectations of the customers. Monitoring the actual level of commercial quality (average values of the indicators and percentages of fulfilment) has an important role in such reviews. The most important factor in this process is the availability of wide and realistic data. Therefore, it is necessary to examine in detail (including questioning stakeholders about) the commercial quality regulations in place to know if other indicators or requirements are monitored, or to understand the specificities of each country surveyed. In addition, the number of indicators surveyed by CEER should be limited to make the data analysis manageable. It is recommended to treat the actual performances for MV and HV customers separately, in order to avoid distorting the median value.

RECOMMENDATION 2

PURSUE THE HARMONISATION OF COMMERCIAL QUALITY INDICATORS DEFINITIONS.

Harmonising the definitions[11] facilitates significant results from European countries and a more consistent and understandable database. Comparisons are difficult to make between Member States, as the regulation of a given activity can be achieved in many different ways depending on the country. A clear framework and harmonised parameters can help the analysis of the results and thus the identification of further improvements and recommendations.

RECOMMENDATION 3

ENSURE GREATER PROTECTION THROUGH GUARANTEED INDICATORS WITH AUTOMATIC COMPENSATION FOR CUSTOMERS.

It is recommended that NRAs should apply GIs with automatic compensation, or OIs or ORs associated with the option of sanctioning. For the most important indicators (e.g. for connection activities), a combination of OI with economic sanctions (like penalties) and GIs is recommended, in order both to improve the average performances and to protect customers from worst service conditions. This recommendation is targeted mainly at DSOs given their important relationship with customers. In addition, the automatisation of the compensation payment, which is increasingly applied, should be extended to every country.

RECOMMENDATION 4

NRAs SHOULD MONITOR INDICATORS IN ALL FORMS OF COMMUNICATION FOR MORE ACCURATE PERFORMANCE LEVELS.

Most of the indicators take into account only written forms of communication, which is an incomplete picture of the commercial quality. Non-written forms of communication like telephone (fixed and cell-phone) and internet (website) should also be considered. For example, not all the countries monitor oral and written complaints. CEER recommends that NRAs should also regulate the performance of the service level provided to customer through communications such as phone, e-mail and online (e.g. website/apps), and visits to customer centres. In particular, the performances of DSOs and USPs in the increasingly important field of phone contacts should be monitored. Attention should be paid not only to a rapid response but also to a thorough and useful response. All types of responses should be taken into account in the commercial quality regulation: oral, internet-based and written complaints.

11. 2014 CEER-ACER report on the results of monitoring the internal electricity and natural gas markets.

RECOMMENDATION 5

ENSURE THE AVAILABILITY OF THE SERVICES, IN PARTICULAR REGARDING CONNECTION AND CUSTOMER CARE.

CEER recommends that countries and their NRAs evaluate customer priorities before creating new regulatory frameworks.

RECOMMENDATION 6

FURTHER DEVELOP THE REGULATION OF CUSTOMER RELATIONS.

To further develop the commercial quality regulation, satisfaction surveys -although costly- could be implemented to have qualitative elements (in addition to the quantitative elements the CEER questionnaire provides), since it could help in assessing how the customers actually perceive the service achieved by the operator.