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IMPROVING INVESTMENT PLANNING THROUGH THE IMPLEMENTATION AND ENFORCEMENT OF QUALITY OF SERVICE STANDARDS

TASK 4. REVISED DATA COLLECTION TEMPLATES AND COMMON SET OF METRICS AND METHOD(S) FOR ESTABLISHING PERFORMANCE BENCHMARKS

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REVISED DATA COLLECTION TEMPLATES AND COMMON SET OF METRICS AND METHOD(S) FOR ESTABLISHING PERFORMANCE BENCHMARKS

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Table of Contents

List of Acronyms

CAIDI	customer average interruption duration index
CEER	Council of European Energy Regulators
CoS	continuity of supply
CQ	commercial quality
DSO	distribution system operator
E&E	Europe and Eurasia
EU	European Union
GIS	geographic information system
IT	information technology
LV	low voltage
MV	medium voltage
NARUC	National Association of Regulatory Utility Commissioners
NRA	national regulatory authority
RMS	root mean square
QoS	quality of service
RoW	right of way
SAIDI	system average interruption duration index
SAIFI	system average interruption frequency index
SCADA	supervisory control and data acquisition
USAID	United States Agency for International Development
VQ	voltage quality

List of Figures

List of Tables

1. Introduction

In the framework of this project, with funding support from the United States Agency for International Development (USAID), the National Association of Regulatory Utility Commissioners (NARUC) provides technical advisory support to national regulatory authorities (NRAs) from the Europe and Eurasia (E&E) region, aimed at improving quality of service (QoS) for end users by ensuring targeted investment decisions on the distribution system.

Specifically, this technical assistance project has the following objectives:

- Present to E&E NRAs best practices from the European Union (EU) and the United States, on: (a) QoS monitoring indicators, data collection procedures, and calculation methodologies; (b) setting and enforcing benchmarks/standards; (c) using QoS metrics/indicators for investment planning purposes.
- Develop for E&E NRAs a common/harmonized set of: (a) QoS indicators/metrics, (b) QoS data collection templates, (c) methods(s) for establishing QoS performance benchmarks/standards.
- Develop contextualized and country-specific roadmaps for selected E&E NRAs concerning the above items, taking into account respective barriers/issues, availability of required equipment (e.g., supervisory control and data acquisition [SCADA]/distribution management system) and cost of implementing progressively stricter standards/benchmarks.

QoS monitoring in the electricity sector is a key element of regulatory supervision as it is directly linked to the regulatory authorities' core mandate of ensuring that customers receive safe and reliable electric service at just and reasonable rates/tariffs. QoS monitoring and respective indicators/metrics encompass three broad areas:

- **Continuity of supply (CoS)** concerning interruptions in electricity supply;
- **Voltage quality (VQ)** concerning a wide range of voltage disturbances and deviations in voltage magnitude or waveform from the optimum values; and
- **Commercial quality (CQ)** concerning transactions between electricity companies and customers.

The present document is the main deliverable where data collection templates, a common set of metrics/indicators, and methods for establishing performance benchmarks are presented under a unified common QoS framework. The development of this framework follows publication of an in-country technical assistance series, for which five different countries (NRAs and distribution system operators [DSOs]) collaborated with the project team in mapping the local QoS context and practices, in understanding internationally followed best practices, and then forming country-specific roadmaps migrating to a common improved QoS framework. The common framework aims to:

1. Establish a common set of metrics and indicators for all three QoS pillars: CoS, VQ, and CQ;
2. Establish a common method to record the necessary QoS data through standardized recording templates; and
3. Establish a harmonized method for setting QoS performance benchmarks.

The expected outcome in the medium term is for all regulators to have a common basis for QoS treatment that enhances transparency and ultimately improves service for consumers, the practices of the DSOs, and monitoring by regulators.

The following chapters walk through the common QoS framework pillar by pillar, starting with CoS (Chapter 2), moving on to VQ (Chapter 3), and concluding with CQ (Chapter 4).

2. CoS

2.1. Definitions of Indicators

According to the Council of European Energy Regulators' (CEER's) *4th Benchmarking Report on Quality of Electricity Supply*, system average interruption duration index (SAIDI), system average interruption frequency index (SAIFI), and customer average interruption duration index (CAIDI) are the main CoS indices used for electricity distribution systems in the majority of countries worldwide.[1] These are defined, among others, in IEEE Standard 1366, where weighting based on the number of customers is used. With both SAIFI and SAIDI, a reduction in value indicates an improvement in the CoS. With CAIDI, this is not the case: a reduction in both SAIDI and SAIFI could still result in an increase in CAIDI. Whereas CAIDI remains a useful index, it is therefore not suitable for comparisons or for trend analysis.

Following the in-country technical assistance series, developed with five countries, and further discussions at the second "Remote Technical Workshop Series: Improving Investment Planning Through the Implementation and Enforcement of Quality of Service Standards" where all of the 10 E&E countries participating in the project contributed, SAIDI, SAIFI, and CAIDI are deemed an appropriate common set of system-level CoS indicators for the E&E countries. These are defined as follows:

$$SAIDI = \frac{\sum r_i N_i}{N_T}$$

$$SAIFI = \frac{\sum N_i}{N_T}$$

$$CAIDI = \frac{\sum r_i N_i}{\sum N_i} = \frac{SAIDI}{SAIFI}$$

where:

i = an interruption event;

r_i = restoration time for each interruption event;

N_i = the number of customers who have experienced a sustained interruption during the reporting period; and

N_T = the total number of customers served for the area being indexed.

SAIDI is the average duration of sustained customer interruptions per customer occurring during the analysis period. It is the average time customers were without power. It is determined by dividing the sum of all sustained customer interruption durations, in minutes, by the total number of customers served. SAIFI is the average frequency of sustained interruptions per customer occurring during the analysis period. It is calculated by dividing the total number of sustained customer interruptions by the total number of customers served.

CAIDI is the average interruption duration of sustained interruptions for those customers who experience interruptions during the analysis period. It represents the average time required to restore service to the average customer per sustained interruption. It is determined by dividing the sum of all sustained customer interruption durations, in minutes, by the total number of interrupted customers.

[1] CEER, *4th Benchmarking Report*, 20.

It is recommended that DSOs be required to monitor and report quarterly to their NRAs on the system-level SAIDI, SAIFI, and CAIDI indicators. These reports should also be aggregated for annual periods. A number of subareas may be differentiated within each DSO, e.g., according to geographical branches of the DSO or population density (urban, rural, etc.) characteristics.

User-level CoS measurements may also be applied to ensure that no customer or category of customers consistently receives suboptimal service, based on surveys asking customers about their satisfaction, expectations, willingness to pay for high quality, or willingness to accept low quality of supply levels. The duration of unplanned interruptions at the individual-customer level may be monitored for important customer categories as well as for the worst-served customers, i.e., those supplied through the worst-performing medium voltage (MV) feeders identified annually by the DSO.

Following international experience, and in general alignment with current practice in the E&E countries, it is further recommended that two categories of CoS interruptions be differentiated in terms of their duration (in any case, all interruptions (irrespective of their duration) should be included in the reported indicators):

- Long interruptions: duration > 3 minutes; and
- Short interruptions: duration <= 3 minutes (including transient momentary interruptions).

In line with international experience and practices, it is also recommended that the reporting of CoS interruptions be disaggregated into planned and unplanned, defined as follows:

- Planned interruptions: at least 48 hours advance warning is given to customers; and
- Unplanned interruptions: all other interruptions (not classified as planned).

It is noted that there is a wide divergence internationally in the warning times set for planned interruptions. Setting a harmonized limit for planned interruptions, i.e., the practical 48-hour limit recommended above for the E&E countries, will facilitate meaningful comparison of DSO performances.

Following international experience, it is further recommended that the reporting of distribution system CoS interruptions also be disaggregated into the following voltage levels of occurrence:

- High voltage: > 36 kV;
- MV: > 1 kV and <= 36 kV; and
- Low voltage (LV): <= 1 kV.

It is very important to also monitor CoS interruptions at the LV level (not only MV and higher), as recommended by CEER to the Energy Community countries,[2] in order not to severely underestimate the number (SAIFI) and duration (SAIDI) of interruptions. A cost-benefit analysis should in particular be performed to evaluate the following LV monitoring methods:

- Automated recording based on smart meters;
- Development of automated methods for estimation of the duration and number of affected customers (i.e., using functions of call centers in combination with geographic information system [GIS] systems for affected customers);
- Protection equipment in LV feeders under supervision of a SCADA system; and
- Organizational and technical measures for appropriate manual logging by system operators.

The voltage levels of CoS interruption origin may be additionally differentiated by the DSO.

[2] ECRB, *Quality of Electricity Supply*, 37.

Finally, it is recommended that the reporting of distribution system CoS interruptions be disaggregated into the following causes:

1. Distribution system: malfunction of network equipment or other events and circumstances that could have been predicted, avoided, or mitigated by the DSO;
2. Other energy sector licensee: neighboring distribution system or other generation or transmission licensee;
3. Third party: another legal or natural person (e.g., excavation contractor), regardless of whether this is identified or unknown;
4. Force majeure: events or circumstances beyond the control of the DSO, the occurrence of which could not have been predicted, avoided, or mitigated by the DSO;
5. Animals and off right of way (RoW) trees: where these could not have been predicted, avoided, or mitigated by the DSO;
6. Unknown: not determined; and
7. Other: determined, but within none of the above predefined causes.

In particular, the definition of force majeure should be as precise as possible to avoid abuse by DSOs and inaccuracies in the reported interruption frequency and duration data. This is because force majeure is not considered in the reported CoS interruption statistics. Interruptions due to force majeure can be very long, even if they are quite rare, and can significantly affect the CoS experienced by customers.

Different countries use different criteria to decide if an interruption should be treated as force majeure. There is no harmonization in place, and perhaps harmonization is neither feasible nor envisaged because of the inherent differences in climate (a dominant cause of force majeure interruptions) between countries. The lack of harmonization as regards force majeure therefore affects the comparison of CoS interruption data between various countries.[3]

The following precise definition is proposed for force majeure in the E&E countries:

Interruption caused by events or circumstances beyond the control of the DSO, the occurrence of which could not have been predicted, avoided, or mitigated by the DSO, such as:

1. Exceptional weather events and natural phenomena (e.g., precipitation, hurricanes, avalanches, fires, floods, earthquakes);
2. Human events (e.g., strikes, riots, uprisings, military/terrorist acts); and
3. Measures/decisions of public authorities.

2.2. Data Reporting Template

In line with the recommended actions above, it is proposed that the following standardized template, presented in Table 1, be used for the submission of DSO data to the NRAs in the E&E countries. This template has been based on the template currently applied in the Czech Republic and is considered appropriate for all E&E countries to use for the quarterly and annual reporting of CoS performance. A separate table should be completed for each of the defined geographical branches or other distribution areas of the DSO with varying characteristics (e.g., urban or rural population density).

[3] CEER, *4th Benchmarking Report*, 42.

Table 1: Standardized data reporting template for CoS indicators

Branch / distribution area: ...	Number of interruptions [number / year]		Duration of interruptions [mins. / year]		SAIDI		SAIFI		CAIDI	
Voltage level of impacted customers →	LV	MV	LV	MV	LV	MV	LV	MV	LV	MV
Unplanned										
Distribution System										
Force Majeure										
Animals and Off ROW Trees										
Other Energy Sector Licensees										
Third Party										
Unknown										
Other										
Planned										
Distribution System										
Other Energy Sector Licensees										
Third Party										
Total - Level indicators										
Total - System indicators										

2.3. Setting the Standard

It is recommended that standards (benchmarks) corresponding to the SAIDI, SAIFI, and CAIDI indicators presented above be set by the NRAs in the E&E countries on the basis of average historical performance. These CoS standards should be set for a sufficiently long period, e.g., equal to the duration of the regulatory period, to allow enough time for the DSOs to prepare (i.e., to invest and/or adjust internal activities and procedures) for adhering to the standards.

It is further recommended that the CoS standards be set only for unplanned (i.e., not planned) and long (i.e., not short or transient) interruptions due to the following categories of causes:

1. Distribution system;
2. Other (i.e., not classified in any of the predefined causes of unplanned interruptions); and
3. Unknown.

The basis for setting the CoS standards for these interruptions should be the respective average historical performance of each DSO over the past three years,[4] further disaggregated by interruption cause. Planned interruptions should also be reported, but without the DSO being evaluated on their respective performance. The same is recommended for short/transient interruptions (in a separate reporting table), to gradually monitor these systematically—it is noted that these are not currently monitored as widely as long interruptions in more than half of the EU countries.[5]

It is additionally recommended that a small, 2% improvement factor be applied to the average historical three-year figures to induce a sustained improvement in the DSO performance. Evaluation of DSO performances against these set CoS standards should be performed annually.

If there are significant variations in CoS performance across different regions of the country, as is currently reported to be the case for most of the E&E countries, different standards may be set for

[4] The period of historic data to be used for setting standards (i.e., three years) may have to be extended depending on the accuracy and reliability of data available to the DSO.

[5] CEER, *6th CEER Benchmarking Report*, 34.

each DSO to account for differences in network topology and other special conditions, as well as within the defined DSO geographical branches or other distribution areas. The improvement factor (compared to current performance) should be higher for the worst performing DSOs and areas (e.g., 3% to 4%) compared to the better performing ones (e.g., 1%), so that the level of CoS quality across a country converges within a reasonable period of time. Eventually, once performance across various regions converges, the improvement factors should also converge.

The benefit of this approach is that the better-performing DSOs and areas are required to at least maintain their level of quality, while the worst-performing ones are required to gradually meet the benchmark of quality already achieved in other regions. A common standard across all DSOs and areas, when there are significant variations in performance as experienced in the E&E countries, would not provide a clear incentive for convergence and would also permit a deterioration in the performance of better-performing regions (as these would not be monitored separately with respect to their current higher levels). The approach thus provides clear incentives and signals to the DSOs to prioritize performance-improving investments and mitigating actions in the worst-performing segments of their networks.

2.4. Extended CoS Monitoring

At a later stage, and only after the overall CoS standards have been achieved at a level comparable to the one met in very mature markets, user-level CoS measurements may also be applied. This is to ensure that no customer or category of customers consistently receives suboptimal service, based on surveys asking customers about their satisfaction, expectations, willingness to pay for high quality, or willingness to accept low quality of supply levels. The duration of unplanned interruptions at the individual-customer level may be monitored for important customer categories as well as for the worst-served customers, i.e., those supplied through the worst-performing MV feeders identified annually by the DSO.

3. VQ

3.1. Definitions of Indicators

European Standard EN 50160 on VQ defines the limits and measuring methods for several different supply voltage characteristics. In the United States, the ANSI C 84.1 standard is applied, which establishes nominal voltage ratings and subsequent tolerances only in terms of voltage amplitude. As a starting point in terms of VQ monitoring and reporting, two voltage characteristics are the most important in terms of supply quality. They are the most commonly occurring problems with respect to VQ and the ones that can be monitored in the least costly way; these are voltage amplitude and frequency. The recommendation is for the standards to adhere to those of European Standard EN 50160 at a minimum.

Supply Voltage Variations - Amplitude: The amplitude of the supply voltage for each individual customer at any moment is a function of voltage drops on all system components needed to supply the customer. Therefore, sudden changes in the load of the system and/or system faults influence the supply voltage amplitude.

The standard allows for a ±10% variation from the nominal system voltage, taking into consideration that most user appliances are designed to tolerate supply voltages that are within that range. The standard demands that the voltage deviation from the nominal will not exceed ±10% for 95% of the week and never deviate more than -15% or +10% from the nominal.

Frequency: Under normal operating conditions, the mean value of the fundamental frequency measured over 10-second intervals shall be within a range of ±1% 99.5% of the time over a year and

between +4% and -6% 100% of the time over a year, for synchronous connection to interconnected systems.

3.2. Data Reporting Templates

Aligned with the recommended VQ standards to be followed above, it is proposed that the following standardized templates, presented in Table 2 and Table 3, should be used for the submission of DSO data to the NRAs in the E&E countries. Those templates are based on the templates currently used by many EU DSOs when reporting on voltage amplitude and frequency and are considered appropriate for all E&E countries to apply for the quarterly and/or annual reporting of VQ performance.

The voltage amplitude template:

1. Specifies the measuring point where the measurements took place;
2. Has data for each week of the year with data aggregated for each quarter;
3. Shows the amplitude variation percentage that is within bounds per week; and
4. Shows the number of measurements that amplitude variation exceeded the allowed tolerances per week.

Table 2: Standardized data reporting template for amplitude deviations from nominal on a weekly basis with a quarterly aggregate result

Measurement Point	...						
Week	**1**	**2**	**3**	**...**	**...**	**13**	**Q1**
Amplitude Variation (±10% from nominal) *% of measurements within bounds*	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	**99.9%**
Amplitude Variation (>+10% or <-15% from nominal) *# of measurements outside bounds*	-	-	1	-	-	-	**1**

Measuring process:

- All measurements are made over 10-minute intervals.
- The average root mean square (RMS) of measurements within each 10-minute interval is taken.
- $RMS = \sqrt{\frac{1}{n}(x_1^2 + x_2^2 + \cdots + x_n^2)}$, where: x_n = a measurement point within a 10-minute interval and n = the number of measurement points within the 10-minute interval.
- The number of 10-minute intervals where amplitude deviates more than ±10% from the nominal is recorded for each weekly period and the aggregate is then calculated as a percentage of the total 10-minute intervals recorded in the same one-week period. The example template (Table 2) shows that there is one such 10-minute interval outside the allowed tolerance levels during week three.

The frequency template:

1. Specifies the measuring point where the measurements took place;
2. Has data for each week of the year with data aggregated for each quarter;
3. Shows the frequency variation percentage that is within bounds per week; and

4. Shows the number of measurements that frequency variation exceeded the allowed tolerances per week.

Table 3: Standardized data reporting template for frequency deviations from nominal on a weekly basis with a quarterly aggregate result

Measurement Point	...						
Week	**1**	**2**	**3**	**...**	**...**	**13**	**Q1**
Frequency Variation (±1% from nominal) *% of measurements within bounds*	100.0%	99.8%	100%	100.0%	100.0%	100.0%	**99.98%**
Frequency Variation (>+4% or <-6% from nominal) *# of measurements outside bounds*	-	1	-	-	-	-	**1**

Measuring process:

- All measurements are made over 10-second intervals.
- The number of 10-second intervals where amplitude deviates more than ±1% from the nominal is recorded for each weekly period and the aggregate is then calculated as a percentage of the total 10-second intervals recorded in the same one-week period. The example template (Table 3) shows that there is one such 10-second interval outside the allowed tolerance levels during week two.

Permanent monitoring of VQ demands significant investment in monitoring equipment for different points on the distribution grid. Given the capital demands, this is not always possible to attain and can mean that a DSO must progressively invest to cover the whole network. Therefore, through a gradual process, the DSO will submit annual monitoring plans to the NRA that include a rotational plan for nonpermanent/portable equipment to be employed at different grid points for the year ahead. The plans should conform to specific targets such as the number and location of points where measuring will be taking place the following year.

The measuring points will be:

- The ones that already have permanent monitoring equipment;
- The ones that will receive permanent equipment as part of an investment that is taking place; and
- The ones that will be monitored as part of the rotational plan with portable monitoring equipment.

3.3. Setting the Standard

There is no setting of standards when it comes to VQ as there in the cases of CoS and CQ. This is because the recommended standard to be adopted comes from European Standard EN 50160, where the minimum tolerances are predefined and only changes that define stricter minima can be considered compatible with the standard itself.

3.4. Extended VQ Indicators

European Standard EN 50160 defines six voltage characteristics that should be monitored and recorded. The two main ones are recommended as the starting points (voltage amplitude and frequency), but there are also voltage harmonics, flicker, unbalance, and dips/swells. The monitoring

and recording of the four latter voltage characteristics will come as the overall system (including monitoring, recording, and reporting) has progressed and improved significantly.

4. CQ

4.1. Definition of Indicators

CQ is an important issue, as it is directly associated with transactions between electricity companies (either DSOs or suppliers, or both) and end-users. In what follows it is assumed that services are offered by the DSO. However, depending on the degree of unbundling in a country, such services could be provided by several different companies (e.g., while the network service—distribution—is usually provided by the DSO, metering could be performed by a different company, depending on the geographical area). Other outsourced services can include call centers, fuse replacement, and others.

Commercial services may be classified according to when they are provided:

- **Before** the supply of electricity begins; or
- **After** supply begins and during the validity of a connection contract with a customer.

In addition, commercial **types of services** may be **grouped** as follows:

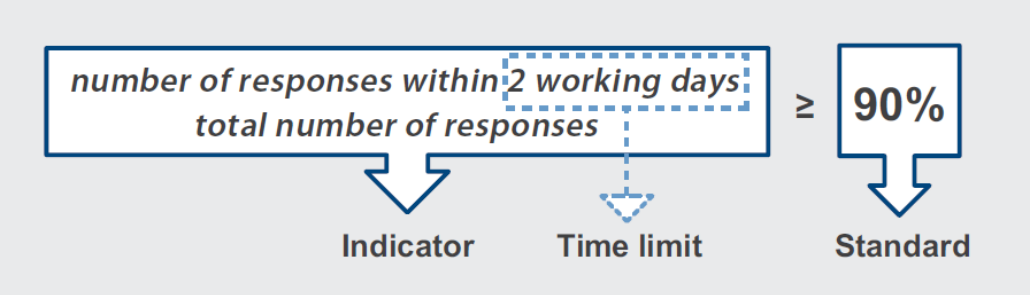
1. Connection;
2. Customer care;
3. Technical services; and
4. Metering and billing.

Indicators commonly used by NRAs to monitor the **level** of CQ are as follows:

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

The CQ indicators described above are summarized in the following Figure 1[6]:

Figure 1: Example of a CQ indicator with respective limit and standard



[6] CEER, *6th CEER Benchmarking Report.*

It is important to note that the first method of measuring the actual quality level does not depend upon a standard and is therefore comparable between countries (assuming that requirements of the same type are considered). The second method of measuring (compliance percentages) is only meaningful for comparison if the limits (time limits or other) to which they refer are the same (even if the standards are not), otherwise performance cannot be compared between countries by that method.

The table below (Table 4) presents a set of CQ indicators to be used that cover all types of services (connection, customer care, technical services, and metering and billing) and represents a minimum of indicators to be followed. Having high-quality historical data that go back at least three years is a prerequisite to setting a baseline that can be used as a starting point for NRAs to set CQ standards for DSOs to attain.

There are significant variations in CQ data availability, as well as recording methods, between the different countries examined. Therefore, in Section 4.2, following the recommended set of indicators and reporting templates, Table 5 provides an extensive set of indicators per type of service, and in Section 4.4, Table 6 provides an extended set of CQ indicators that can be used for guaranteed service, recommended for those NRAs that already have both good historical data and the necessary recording systems in place.

The recommended (and commonly addressed) set of commercial services for each type of service are presented in Table 4:

Table 4: Recommended minimum CQ indicators to be monitored per type of service

Type of Service: Connection	**Dimensions and Indicator(s)**
1. Response to connection request	Time period between the receipt of the customer's request for connection and the response of the DSO (date of dispatch), including cost estimate for connection, if no intervention is necessary on the public network • Percentage of requests answered within limit • Average time to respond
2. Connecting a new connection	Time for connecting a new connection following a request (assuming all prerequisites are in place), if no intervention is necessary on the public network • Percentage of requests answered within limit • Average time to respond
Differentiations (i.e., sub-indicators and respective **limits** and **standards**) may be introduced, depending on specificities, as follows: • **Voltage level** (LV, MV) • **Geographic area and location** (e.g., with preexisting network, connections, etc.) • **Type of customer** (residential consumer, commercial/industrial consumer, generator).	
Type of Service: Customer Care	**Dimensions and Indicator(s)**
1. Response to consumer complaints related to VQ	Time for responding • Percentage of requests answered within limit • Average time to respond
2. Call center waiting time	Waiting time • Percentage of cases within limit • Average waiting time

<table>
<tr><td colspan="2">Different indicators and limits may be defined depending on:
• Voltage level (LV, MV)
• Geographic area
• Type of customer (residential consumer, commercial/industrial consumer, generator)</td></tr>
<tr><th>Type of Service: Technical Services</th><th>Dimensions and Indicator(s)</th></tr>
<tr><td>1. Restoration of supply in case of unplanned interruption</td><td>Time until the restoration of supply in case of unplanned interruption
• Percentage of cases served within limit
• Average time to restore supply
(These two indicators may be considered as single user-level indicators for CoS.)</td></tr>
<tr><td>2. Elimination of problems following a VQ complaint</td><td>Time between the date of the answer to the VQ complaint and the elimination of the problem
• Percentage of cases served within limit
• Average time to eliminate problem</td></tr>
<tr><td colspan="2">Different indicators & limits may be defined depending on:
• Voltage level (LV, MV)
• Geographic area
• Type of customer (residential consumer, commercial/industrial consumer, generator)</td></tr>
<tr><th>Type of Service: Metering and billing</th><th>Dimensions and Indicator(s)</th></tr>
<tr><td>Meter inspection in case of meter failure</td><td>Time for meter inspection in case of meter failure
• Percentage of cases served within limit
• Average time to provide the service</td></tr>
<tr><td>Billing accuracy</td><td>Percentage of bills within a certain period (e.g., a quarter) for which complaints were made</td></tr>
<tr><td>Settle billing complaints</td><td>Time between the registration of a customer billing complaint and the date of the response to it</td></tr>
<tr><td colspan="2">Different indicators & limits may be defined depending on:
• Voltage level (LV, MV)
• Geographic area
• Type of customer (residential consumer, commercial consumer, generator)</td></tr>
</table>

4.2. Data Reporting Templates

This section presents examples of templates (in Table 5) that may be adopted for reporting of CQ indicators by the DSO to the NRA.

Separate reports should be provided to the NRA depending on:

- **Voltage level** (LV, MV)
- **Geographic area**
- **Type of customer** (residential consumer, commercial consumer, generator)

Reporting should be performed on a quarterly or half-yearly basis.

Table 5: Data reporting template for recording CQ indicators per type of service

Type of Service	Service	Indicator	Unit	Value
Connection	Response to connection request	If no intervention is necessary on the public network • Total number of requests • Percentage of requests answered within time limit • Average time to respond	• number • % • days	
		When intervention is necessary on the public network • Total number of requests • Percentage of requests answered within time limit • Average time to respond	• number • % • days	
	Connecting a new connection	Assuming all prerequisites are in place • Total number of requests • Percentage of requests answered within time limit • Average time to respond	• number • % • days	
Customer Care	Response time to consumer complaints related to VQ	• Total number of complaints • Percentage of complaints answered within time limit • Average time to respond	• number • % • days	
	Call center waiting time	• Total number of calls • Percentage of cases within limit • Average waiting time	• number • % • seconds	
Technical Services	Restoration of supply in case of unplanned interruption	• Total number of cases • Percentage of cases served within limit • Average time to restore supply	• number • % • hours	
	Elimination of problems following a VQ complaint	• Total number of cases • Percentage of cases served within limit • Average time to eliminate problem	• number • % • days	
Metering and billing	Meter inspection in case of meter failure	• Total number of cases • Percentage of cases served within limit • Average time to provide the service	• number • % • days	
	Billing accuracy	• Total number of bills within reporting period • Percentage of bills within period (e.g., a quarter) for which complaints were made	• number • %	
	Settle billing complaints	• Total number of complaints • Percentage of complaints served within limit • Average time to settle billing complaints	• number • % • days	

4.3. Setting the Standard

Benchmarks (or performance standards) on commercial services date from the era of national/monopoly utilities and were originally usually presented in the form of a customer charter, with *customer satisfaction surveys* sometimes being used for this purpose.

In general, performance standards should be chosen by the NRA based on the following factors:

- The DSO's performance over time (if available);
- Consultation with the DSO and customers; and
- International experience.

Furthermore, specific limits and standards should be introduced depending on parameters such as:

- Voltage level (LV, MV);
- Geographical area & location (e.g., with preexisting network, connections, etc.);
- Type of customer (residential consumer, commercial consumer, generator); and
- Time allowed to the DSO to reach the target limit and standard.

It is of vital importance for the NRA, when setting limits and standards, to always try to obtain estimates of the benefits (to end users) and the costs (to be borne by the DSO) that are as accurate as possible in order to develop specific requirements, given that such costs are usually recovered through distribution network tariffs. For cases where significant investments are deemed necessary to reach performance standards, the DSO and the NRA should use cost-benefit analysis methodologies.

4.4. Extended CQ Services and Indicators

As mentioned above, a comprehensive set of commercial indicators grouped under the different service types is provided in Table 6 for those NRAs that are already advanced in terms of having set overall CQ indicators and that are in a position to establish guaranteed services.

Table 6: Extended set of CQ indicators for all different types of service

Type of Service Connection	Dimensions and Indicator(s)
1. Response to connection request	Time period between the receipt of the customer's request for connection and the response of the DSO (date of dispatch), including cost estimate for connection a) If no intervention is necessary on the public network • Percentage of requests answered within limit • Average time to respond b) When intervention is necessary on the public network • Percentage of requests answered within limit • Average time to respond
2. Connecting a new connection	Time for connecting a new connection following a request (assuming all prerequisites are in place), if no intervention is necessary on the public network • Percentage of requests answered within limit • Average time to respond

3. Disconnecting a connection upon customer's request	Time period between the receipt of customer's request for disconnection and the response of the DSO • Percentage of disconnections performed within limit • Average time to respond
4. Reconnecting a connection following disconnection	Time for reconnecting a connection following disconnection (assuming all prerequisites are in place) • Percentage of reconnections performed within limit • Average time to respond
5. Switching supplier	Time period between the receipt of the customer's request for switching supplier and the actual registration of the customer under the new supplier (assuming all prerequisites are in place) • Percentage of switches performed within limit • Average time to respond
Type of Service Customer Care	**Dimensions and Indicator(s)**
1. Appointments with customers	Ability to keep a scheduled appointment • Percentage of appointments not kept within one hour of agreed time (and for which the customer was contacted by the day before the appointment if a problem arose)
2. Response to consumer inquiries	Time for responding • Percentage of requests answered within limit • Average time to respond
3. Response to consumer complaints related to interruption of supply	Time for responding • Percentage of requests answered within limit • Average time to respond
4. Response to consumer complaints related to VQ	Time for responding • Percentage of requests answered within limit • Average time to respond
5. Response to consumer complaints (other than interruption of supply and VQ)	Time for responding • Percentage of requests answered within limit • Average time to respond
6. Call center waiting time	Waiting time • Percentage of cases within limit • Average waiting time
7. Waiting in case of personal visit in customer centers	Waiting time • Percentage of cases within limit • Average waiting time
Type of Service Technical Services	**Dimensions and Indicator(s)**
1. Provision of information in advance of a planned interruption	Time for giving information in advance of a planned interruption • Percentage of cases served within limit • Average time of advance warning
2. Restoration of supply in case of unplanned interruption	Time until the restoration of supply in case of unplanned interruption • Percentage of cases served within limit • Average time to restore supply (These two indicators may be considered as single user-level indicators for CoS.)

3. Elimination of problems following a VQ complaint	Time between the date of the answer to the VQ complaint and the elimination of the problem • Percentage of cases served within limit • Average time to eliminate problem
4. Fuse replacement	Time until the start of restoration of supply following failure of a fuse of a DSO • Percentage of cases served within limit • Average time to restore supply
Type of Service Metering and billing	**Dimensions and Indicator(s)**
1. Meter inspection in case of meter failure	Time for meter inspection in case of meter failure • Percentage of cases served within limit • Average time to provide the service
2. Notice to pay until disconnection	Time from the notice to pay until disconnection (i.e., time period between the notice to pay/notice of disconnection after missing payments and the disconnection of the customer) • Percentage of cases of not observing limit (i.e., disconnecting earlier than set deadline)
3. Restoration of power supply following disconnection due to nonpayment	Time for restoration of power supply following disconnection due to nonpayment • Percentage of cases served within limit • Average time to restore supply
4. Billing accuracy	• Percentage of bills within a certain period (e.g., a quarter) for which complaints were made
5. Settle billing complaints	• Time period between the registration of a customer billing complaint and the date of the response to it

Guaranteed services

To decide which services should be characterized as guaranteed, the following criteria should be considered:

- The percentage of the total number of the DSO's customers using the service;
- The overall number of transactions performed by the DSO for a specific service; and
- Whether transactions for the service have a standard form.

The following services (and corresponding CQ indicators in distribution), shown in Table 7, are (almost universally) considered important for end users and thus should be priorities for the NRA to introduce relevant requirements for the DSO (and, potentially, monetary compensation) that pertain to them:

Table 7: Services that, when enough historical data is available and specific criteria have been met, can be monitored and characterized as guaranteed

TYPE OF COMMERCIAL SERVICE	COMMERCIAL SERVICE
Connection	Response to connection request including cost estimate for connection
	Connecting a new connection (assuming all prerequisites are in place)
	Reconnecting a connection following disconnection (assuming all prerequisites are in place)
	Switching supplier
Customer care	Punctuality of appointments with customers
	Response time to consumer complaints related to VQ
	Timely compensation (in case compensation is foreseen for guaranteed services)
Technical services	Provision of information in advance of a planned interruption
	Restoration of supply in case of unplanned interruption
	Elimination of problems following a VQ complaint
	Fuse replacement
Metering and billing	Meter inspection in case of meter failure
	Restoration of power supply following disconnection due to nonpayment

Different limits and compensation levels may be defined by the NRA depending on:

- **Voltage level** (LV, MV)
- **Geographic area**
- **Type of customer** (residential consumer, commercial consumer, generator)

5. Final Remarks

QoS is an integral part of the service that utilities are responsible for providing to their customers. This document combines the best international practices with the realities on the ground in E&E countries to provide some practical direction to the beneficiary NRAs. With the goal in mind of gradually establishing a unified basis for all NRAs to follow with respect to the three main pillars of QoS (CoS, VQ, and CQ), a common framework of indicators and templates for reporting measurements and setting standards is provided. The vision is for all beneficiary NRAs to finally adopt, monitor, and record the same data on the same indicators, thus enhancing transparency and comparability and incentivizing continuous improvement.

This document also points to extended/further work (*to what the project recommends as a first step for all*) that can be considered by the NRAs after they attain the basic framework. Given the different starting points of NRAs, we should expect some to reach the point of being able to extend the depth of their monitoring by including more indicators in the reporting they require.

6. Bibliography

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