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GAP ANALYSIS WITH RECOMMENDATIONS FOR AMENDMENTS OF DISTRIBUTION NETWORK CODES AND RELEVANT RULEBOOKS - SUMMARY OVERVIEW

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BOSNIA AND HERZEGOVINA

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ABBREVIATIONS

ARC	Automatic Reclosure
AC	Alternating Current
BAS	BiH Standard
BESS	Battery Energy Storage Systems
BiH	Bosnia and Herzegovina
CBA	Cost Benefit Analysis
CDSO	Closed Distribution System Operator
CENELEC	Comité Européen de Normalisation Électrotechnique
CHP	Combined Heat Production
CIGRE	Conseil international des grands réseaux électrique
DC	Direct Current
DG	Distributed Generation
DSO	Distribution System Operator
DSP	Defense Service Provider
EMC	Electromagnetic Compatibility
EN	European Norms
ENTSO-E	European Network of Transmission System Operators for Electricity
EP BiH	Elektroprivreda BiH
EP HZHB	Elektroprivreda HZHB
EPA	Energy Policy Activity
EU	European Union
EV	Electric Vehicle
FERC	Regulatory Commission for Energy in FBiH
FON	Final Operational Notification
FRR	Frequency Restoration Reserve
FRT	Fault Ride Through
FSM	Frequency Sensitive Mode
GLEB	EU Guideline on Electricity Balancing
IEC	International Electrotechnical Commission
IEV	International Electrotechnical Vocabulary
ISO BiH	Independent System Operator BiH
IT	Information Technology
LFSM-O	Limited Frequency Sensitive Mode – Over frequency
LFSM-U	Limited Frequency Sensitive Mode – Underfrequency
LV	Low Voltage
MH ERS	Mixed Holding Elektroprivreda Republike Srpske
MV	Medium Voltage
NC DC	EU Network Code on Demand Connection
NC EER	EU Network Code on Electricity Emergency and Restoration
NC RfG	EU Network Code on Requirements for Generators
OVRT	Over Voltage Ride Through
PGM	Power Generating Module
Pmax	Maximum Output Power
P-Q	Operating diagram of active and reactive power of the generator
PS HPP	Pump Storage Hydro Power Plants
ROCOF	Rate of Change of Frequency
RSERC	Regulatory Commission for Energy in the Republic of Srpska
RSP	Restoration Service Provider

RTU	Remote Terminal Unit
SERC	State Electricity Regulatory Commission
SGU	Significant Grid User
SOGL	EU System Operation Guideline
TSO	Transmission System Operator
U-Q/Pmax	Operating diagram of the reactive power capability of a power-generating module

1. INTRODUCTION

Distribution network codes provide basic technical requirements for the operation of the distribution system in normal and emergency operating regimes, as well as for the connection of network users' facilities, types and accuracy classes of metering devices, technical characteristics of switching devices, network development planning criteria and other issues of relevance for the operation of the distribution system.

The focus of these *Recommendations for Amendments of Distribution Network Codes and Relevant Rulebooks*, is to harmonize regulations in Bosnia and Herzegovina (BiH) with the relevant European Union (EU) Network Codes and technical standards. It also aims to enable integration of new categories of network users, establish a power quality monitoring system in the distribution network, improve the distribution network development planning process, and to improve the Distribution System Operator (DSO) – Transmission System Operator (TSO) cooperation and data exchange in the electricity system with an increased share of distributed generation (DG).

The USAID Energy Policy Activity's (EPA) development of recommendations for amendments to the distribution network codes were performed through the assessment of the regulatory framework and technical regulations under eight thematic units for each of the distribution system operators in BiH individually, as follows:

1. Requirements for connection of generators to the distribution network,
2. Requirements for demand connection,
3. Requirements of the remaining EU network codes,
4. Connection to the network and integration of new categories of distribution network users,
5. Requirements for planning the development of the distribution network,
6. Requirements for energy efficient power transformers,
7. Requirements for demand side management service providers, and
8. Requirements for monitoring the power quality in the distribution network.

For each of the thematic units, a gap analysis with recommendations for the harmonization of distribution network codes, and relevant regulations of the competent distribution system operator was prepared.

The gap analyses were prepared by the USAID EPA team in cooperation with a working group consisting of representatives of relevant entities and institutions within the BiH electricity sector. The overall basis for the analysis includes EU and European Network of Transmission System Operators for Electricity (ENTSO-E) network codes and guidelines, relevant technical standards (European Norms adopted as BiH Standard [BAS EN] and International Electrotechnical Commission norms adopted as BiH Standard [BAS IEC]), CIGRE technical brochures, and European best practices in the areas analyzed. The gap analyses with the recommendations were adopted by the working group, following an internal review process of the draft documents.

The list of individual documents containing the gap analysis with recommendations for changes and amendments of the distribution network codes, is provided in Table 1 below.

The gap analyses with the recommendations for amendments of distribution network codes have been prepared separately for each individual DSO, given the fact that the legislation in this area is different for each of these entities.

An individual gap analysis with the recommendations for amendments of distribution network codes is denoted with the Roman numerals that represent the ordinal number of the document and a letter that represents a reference to the particular DSO:

- a - Elektroprivreda BiH (EP BiH),
- b - Mixed Holding Elektroprivreda Republike Srpske (MH ERS),
- c - Elektroprivreda HZHB (EP HZHB),
- d - Komunalno Brcko.

Table 1. List of documents

No.	Document	Name of document
1.	VOL. I-a	Gap analysis with the recommendations for amendments of EP BiH Distribution Network Codes Requirements of network codes for connection of generators and technical standards BAS EN 50549
2.	VOL. I-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes Requirements of network codes for connection of generators and technical standards BAS EN 50549
3.	VOL. I-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes Requirements of network codes for connection of generators and technical standards BAS EN 50549
4.	VOL. I-d	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes Requirements of network codes for connection of generators and technical standards BAS EN 50549
5.	VOL. II-a	Gap analysis with the recommendations for amendments of EP BIH Distribution Network Codes Requirements of network code for demand connection
6.	VOL. II-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes Requirements of network code for demand connection
7.	VOL. II-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes Requirements of network code for demand connection
8.	VOL. II-d	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes Requirements of network code for demand connection
9.	VOL III	Gap analysis with the recommendations for amendments of EP BIH Distribution Network Codes Requirements of Network Code on Electricity Emergency and Restoration, Guideline on Electricity Balancing and Guideline on Electricity Transmission Systems Operation
10.	VOL. IV-a	Gap analysis with the recommendations for amendments of EP BIH Distribution Network Codes

No.	Document	Name of document
		Requirements for connection of new categories of distribution network users
11.	VOL. IV-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes Requirements for connection of new categories of distribution network users
12.	VOL. IV-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes Requirements for connection of new categories of distribution network users
13.	VOL. IV-d	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes Requirements for connection of new categories of distribution network users
14.	VOL. V-a	Gap analysis with the recommendations for amendments of EP BiH Distribution Network Codes The processes and criteria for planning the development of the distribution network
15.	VOL. V-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes The processes and criteria for planning the development of the distribution network
16.	VOL. V-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes The processes and criteria for planning the development of the distribution network
17.	VOL. V-d	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes T The processes and criteria for planning the development of the distribution network
18.	VOL. VI-a	Gap analysis with the recommendations for amendments of EP BiH Distribution Network Codes Requirements for energy efficient power transformers
19.	VOL. VI-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes Requirements for energy efficient power transformers
20.	VOL. VI-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes Requirements for energy efficient power transformers
21.	VOL. VI-d	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes Requirements for energy efficient power transformers
22.	VOL. VII-a	Gap analysis with the recommendations for amendments of EP BiH Distribution Network Codes Requirements for demand side management
23.	VOL. VII-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes Requirements for demand side management
24.	VOL. VII-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes Requirements for demand side management
25.	VOL. VII-d	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes Requirements for demand side management
26.	VOL. VIII-a	Gap analysis with the recommendations for amendments of EP BiH Distribution Network Codes

No.	Document	Name of document
		Requirements for monitoring the power quality in the distribution network
27.	VOL. VIII-b	Gap analysis with the recommendations for amendments of MH ERS Distribution Network Codes Requirements for monitoring the power quality in the distribution network
28.	VOL. VIII-c	Gap analysis with the recommendations for amendments of EP HZHB Distribution Network Codes Requirements for monitoring the power quality in the distribution network
29.	VOL. VIII-b	Gap analysis with the recommendations for amendments of Komunalno Brcko Distribution Network Codes Requirements for monitoring the power quality in the distribution network

This document provides a summary overview of guidelines and recommendations for harmonization of the distribution network codes and relevant regulations, which is based on the detailed analyses outlined in the documents listed in Table 1.

The activities on changes and amendments to the distribution network codes and relevant regulations shall be carried out by the DSOs, in cooperation with the competent regulatory commissions. These activities need to be performed as a part of the general obligation to harmonize bylaws with the adopted Laws on Electricity, in the area of MH ERS and Brcko District competence and following the adoption of the new law on electricity in the Federation of BiH. The content of the distribution network code as it is defined by the existing electricity law in the Federation of BiH, does not explicitly reflect all the issues assessed in the gap analyses. Therefore, the electricity law in Federation of BiH needs to be amended to address and prescribe the missing aspects of the distribution network code.

This summary overview is based on the detailed individual analyses as stated in Table 1 and it can serve as a guideline for the necessary network code amendments, as well as for the monitoring of the transposition process.

A summary of the recommendations for the amendments of distribution network codes and relevant regulations is given in Chapters 2-9, as follows:

Table 2. Summary of recommendations

Chapter	Recommendation
Chapter 2	Requirements of network code for connection of generators and technical standards BAS EN 50549 (four volumes)
Chapter 3	Requirements of network code for demand connection (four volumes)
Chapter 4	Requirements of network code on electricity emergency and restoration, guideline on electricity balancing and guideline on electricity transmission systems operation (single volume)
Chapter 5	Requirements for connection of new categories of distribution network users (four volumes)
Chapter 6	Processes and criteria for planning the development of the distribution network (four volumes)
Chapter 7	Requirements for energy efficient power transformers (four volumes)
Chapter 8	Requirements for demand side management (four volumes)
Chapter 9	Requirements for monitoring the power quality in the distribution network (four volumes)

The specific issues listed in the recommendations tables (column 2 in the Tables 3-16) are discussed in detail through individual gap analyses with recommendations. The recommendations tables also provide a reference to the legislation needed to regulate relevant issues (titles of columns 3 and 4 in the Tables 3-16), thus defining the structure and content of the necessary amendments to distribution network codes and relevant rulebooks.
Letter marks, that are added to the ordinal numbers in columns 3 and 4 of Tables 3-16, denote multiple recommendations which are related to the relevant issues indicated by the same ordinal number given in column 2 of each Table.

2. REQUIREMENTS FOR CONNECTION OF GENERATORS TO THE DISTRIBUTION NETWORK

The harmonization of the distribution network codes with the requirements of the "Network Code on Requirements for Grid Connection of Generators"[1] (Network Code on Requirements for Generators [NC RfG]) is an obligation of the Energy Community Treaty Contracting Parties[2], which stems from the harmonization of the legal and regulatory framework in the electricity sector with the requirements of the Third EU energy package. In this regard, the NC RfG is the one of the key documents from the package of EU network codes and guidelines, which need to be transposed into the regulatory framework of BiH. The latest editions of the European technical standards EN 50549-1[3] and EN 50549-2[4] from 2019, were completely adopted by Bosnia and Herzegovina. These standards elaborate in more detail the requirements for connection of generators given by the NC RfG and they are complementary with this document.

The NC RfG are incorporated into the legal framework of the Energy Community by the decision of the Permanent High-Level Group of the Energy Community (No 2018/03 / PHLG-EnC from January 12, 2018). According to the stated Decision, the deadline for transposition of regulations into the national legislation was six months, while the deadline for full implementation was three years from the deadline for transposition. Under this, the Energy Community Treaty Contracting Parties are obliged to fully apply the NC RfG by July 12, 2021, at the latest. NC RfG were incorporated into the regulatory framework in Bosnia and Herzegovina by the Decision of the State Electricity Regulatory Commission (SERC) on transposition of the rules for the operation of networks regarding connection, from June 12, 2018[5]. With this Decision, SERC also invited Regulatory Commission for Energy in FBiH (FERC), Regulatory Commission for Energy of RS (RSERC) and other competent bodies to ensure compliance of their relevant acts with the requirements contained in the regulations referred to in point II of the Decision regarding rules for the operation of networks regarding connection.

This chapter provides a summary of recommendations for the harmonization of distribution network codes and rulebooks on connection of generators to the distribution network with the requirements of the NC RfG and the requirements of technical standards BAS EN 50549-1, "Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a low voltage distribution network - Generating plants up to and including Type B" and BAS EN 50549-2, "Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a medium voltage distribution network - Generating plants up to and including Type B."

The basis for the preparation of the summary overview are the detailed analyses with recommendations for harmonization of relevant regulations for each individual DSO in BiH[6]. In addition to recommendations for harmonization of distribution network codes and relevant regulations, it is

[1] Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&from=EN.
[2] The members of the Energy Community are Albania, Bosnia and Herzegovina, Kosovo*, North Macedonia, Georgia, Moldova, Montenegro, Serbia and Ukraine.
[3] EN 50549-1:2019, Requirements for generating plants to be connected in parallel with distribution networks, Connection to a LV distribution network. Generating plants up to and including Type B.
[4] EN 50549-2:2019, Requirements for generating plants to be connected in parallel with distribution networks, Connection to a MV distribution network. Generating plants up to and including Type B.
[5] SERC, Decision on transposition of rules for operation of networks regarding connection, Number 05-14-1-97-3 / 18, June 12, 2018. http://www.derk.ba/DocumentsPDFs/Odluka-o-transpon-pravila-za-rad-mreza-u-vezi-prikljucivanja-b.pdf.
[6] An overview of the individual documents is contained in the introductory chapter of the document.

important to emphasize the need for amendments to all laws on electricity regarding the powers of regulatory commissions to grant derogations from the specific requirements for connection of generating plants to the distribution network.

The competent authorities in Federation of BiH should additionally amend the Law on Electricity, to explicitly provide for the adoption of a rulebook which would regulate connection to distribution network and operation of distributed generators, and which would be approved by FERC.

The recommendations for amendments and harmonization of distribution network codes and rulebooks on connection of power plants with requirements of NC RfG and technical standards BAS EN 50549-1 and BAS EN 50549-2 are given in Table 3.

Table 3. Requirements of NC RfG and technical standards BAS EN 50549-1 and BAS EN 50549-2

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
1.	General issues: 1. Definitions, 2. Scope, 3. Application to existing generation modules 4. Determination of the significance of generation modules, 5. Application to offshore power generating modules (PGMs), pump storage hydro power plants (PS HPP), combined heat production (CHP) and generation modules in industrial plants, 6. Regulatory aspects, 7. Cost recovery, 8. Public consultations, and 9. Obligation of confidentiality	1. Define basic terms and harmonize definitions with NC RfG, technical standard EN 60050 IEV (International Electrotechnical Vocabulary) and CENELEC terminology. 2. Define the application of the NC RfG and the standards BAS EN 50549-1 and BAS EN 50549-2 for electricity storage devices. 4. Prescribe the categorization of power generating modules and application of the set installed capacity thresholds to the synchronous generators and power park modules (non-synchronously connected power plants). Adjust the installed capacity thresholds with the categorization set by the TSO, including the definition of type C generation modules. 9. Prescribe the obligation of the DSO regarding the treatment of confidential information.	1. Define all relevant terms and harmonize the definitions with the NC RfG, technical standard EN 60050 IEV and CENELEC terminology. 2. and 5. Define specifics and exemptions from the application of the requirements of the NC RfG (pump storage hydropower plants – PS HPP, power plants in island operation, backup generators, generators with limited duration of parallel operation with the network, power plants connected to medium voltage (MV) network with installed capacity not exceeding 150 kVA, CHP generators, generators with linear Sterling machines, gas generators with rotational machines with installed capacity lower than 50 kW). 3. Define the conditions for the application of functional requirements to the existing generation modules, in accordance with the principles defined by the TSO. 8. Define the DSO's obligation to conduct the public consultation procedure when preparing the: – proposals for extending the application of NC RfG to existing PGMs, – proposals of the installed capacity thresholds, – CBA reports on the application of NC RfG on the existing PGMs, and – CBA developed in the process of granting a derogation at the request of the system operator.
2.	Requirements for type A generation modules: 1. Stability at frequency changes, 2. Active power response to over frequencies (LFSM-O),	1. a) define mandatory frequency bands and appropriate time periods for PGM operation; b) define PGM stability requirements at rapid frequency changes and the rate of change of frequency (ROCOF) value. 2. Define the basic requirements for the PGM active power response to the power system frequency increase (LFSM-O).	1. a) define the type of the loss-of-mains protection that is applied; b) prescribe that the loss-of-mains protection has hierarchical priority in the power plant control scheme in relation to the stability of the PGM during rapid frequency changes; c) define the possibility of contracting wider frequency ranges

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
	3. Requirements for the active power generation when the frequency is reduced, 4. Logical interface to cease active power generation, 5. Network connection conditions, 6. Requirements for the switching device at the power plant connection point, 7. Operating voltage range, 8. Over-Voltage Ride Through stability (OVRT,) 9. Power regulation at voltage deviations and reactive power generation, 10. Requirements for operation and generation of reactive power at short circuits, 11. Electromagnetic compatibility (EMC) and power quality, 12. Requirements for protection devices at the connection point - Interface protection, and 13. Requirements for single failure tolerances for protection and switching devices at the connection point.	3. Define the requirements for the stability and allowed reduction of the PGM active power output at decreased frequencies in the power system. 8. Define the basic requirements for operating stability at the voltage deviations at the connection point.	or longer time periods with individual PGM operators. 2. a) define the reference power, frequency threshold, droop value, requirements for PGM active power response to the increased power system frequency (LFSM-O) and conditions for active power increase after the power system frequency returns to the normal operating range; b) define the conditions for disconnection and reconnection of type A PGMs when the power system frequency increases; c) define the requirements for the battery energy storage system (BESS) response to the power system frequency increase. 3. a) define the permissible reduction of active power from the maximum output when the power system frequency is decreased. The permissible reduction needs to be within the frequency and power gradient ranges given by the NC RfG and technical standards; b) define the ambient conditions to which the requirements for reduction of the active power at decreased power system frequency apply. 4. Define the requirements for equipping the PGM with a logical interface, through which the electricity generation can be interrupted within a period not longer than five seconds following the external signal reception. 5. a) define the conditions for PGM connection to the network, which refer to the permissible voltage and frequency deviations and the minimum observation time (separately for a normal network connection and a reconnection following an outage). Define the allowed rate of change of the active power following the connection; b) define requirements for automatic PGM synchronization; c) define the conditions and the possibility of automatic connection when the conditions for connection are fulfilled.

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			6. Define the requirements for breaking and switching capacity of the switch at the connection point of the power plant. Prescribe the obligation of an automatic trip when the auxiliary voltage in the power plant is lost. 7. a) define the requirements for the power plant operation in case of voltage deviations at the connection point within the permitted range; b) prescribe the possibility of reducing the active power output when voltage at the connection point drops outside the prescribed limits. 8. Define PGM obligations regarding the overvoltage ride through capabilities (OVRT), based on the voltage-time characteristic given by the standard. 9. a) define the requirements for the generation of reactive power at the nominal voltage and at the voltage deviations at the connection point, the range of power factor and the requirements for the accuracy of the reactive power generation; b) set the installed capacity threshold of power plants (Smax), above which the requirements for the generation of reactive power are assessed at the network connection point. For the power plants having the installed capacity below the threshold, the reactive power generation capabilities should be assessed at the generator terminals; c) prescribe the required modes of the regulation of reactive power generation and the voltage regulation. Define requirements for settings and the reactive power generation response for relevant regulation regimes; d) define the possibility of reducing the active power output when the voltage increases at the connection point, to avoid the disconnection due to the excessive voltages; e) define the possibility for the DSO and the power producer to contract additional services (continuous Var compensation or continuous generation of reactive power regardless

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			of the availability of the primary energy source) for PGM connected to MV. 10. Define the type B PGM requirements for voltage support and reactive power generation during the short circuits. Define whether these requirements are mandatory for type A PGM. 11. Define the application of generic EMC standards, series IEC 61000 for the assessment of the PGM impact on the distribution network. Define that injection of a direct current component into the distribution network is not permitted. 12. a) define requirements for the elements of interface protection, including protection against network voltage loss (loss of mains), protection settings, conditions on acting on the switching device, requirements for measurement and accuracy of measured values; b) define requirements for the application of protection functions of undervoltage protection of positive voltage component, overvoltage protection of negative voltage component and overvoltage protection of zero voltage component, for power plants connected to MV, as required by BAS EN 50549-2; c) define requirements for automatic disconnection of the power plant in case of loss of interface protection power supply; d) define the way the voltage transformers shall be connected and requirements for protection windings of voltage transformers; e) define the installed capacity threshold above which the PGM is required to install a protection device as a dedicated unit in relation to the generating unit; f) prescribe the obligation to equip the interface protection with two digital inputs, which are used to enable the transfer trip or for switching to operation mode with a narrower frequency range for power plants connected to MV.

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			13. Define requirements regarding single fault tolerances of interface protection and interface switch of the PGMs connected to the low voltage (LV) network.
3.	Requirements for type B generation modules: 1. Requirements for type A generation modules, 2. Frequency stability requirements, 3. Fault-ride-through capability (fault ride through [FRT] stability), 4. System restoration requirements, and 5. System control requirements.	1. Requirements from point 2 for type A PGM. 2. Prescribe the installed capacity threshold of the power plants above which the remote real-time data exchange is mandatory. 3. a) define the obligation of type B PGMs regarding the fault-ride-through capabilities for symmetrical and asymmetrical faults, in accordance with the FRT characteristics which will be specified by the rulebook on connection of power plants. Prescribe whether the requirements for FRT stability are binding for type A PGM; b) prescribe the DSO's obligation to harmonize the FRT characteristics for symmetrical and asymmetrical faults with the FRT characteristics prescribed by the TSO. 5. Prescribe the basic requirements for the PGM active power response when the power system frequency is reduced (limited frequency sensitive mode – underfrequency [LFSM-U]).	1. Requirements from point 2 for type A PGM. 2. a) define the requirements for the input interface through which the remote reception of the active power setpoint is performed; define the requirements for the active power response; b) prescribe the application of standard communication protocols between the DSO's control center and the power plant control system, allow the application of alternative protocols only upon the special agreement of DSO and the power producer; c) define a standard list of signals, measurements and commands that are exchanged in real time and periodically between the DSO control center and the power plant. 3. a) define the voltage-time FRT characteristic which represents the lower limit of line voltages at the connection point during the symmetrical short circuit for which the PGM must remain in operation, except in the case the protection against internal faults is activated. Define separate FRT characteristics for synchronous generators and power park modules; b) adjust the FRT characteristics to the characteristics prescribed by the TSO, including the pre-fault and post-fault conditions; c) prescribe the FRT characteristics for asymmetric faults and adjust them to the characteristics prescribed by the TSO; d) prescribe requirements for active power recovery after the network voltage returns to normal operating range. 4. Prescribe the conditions for reconnection following the PGM disconnection due to the network disturbances.

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			5. a) define whether the requirements for LFSM-U functionality are mandatory for type A or type B generators. Prescribe that requirement for LFSM-U functionality are mandatory for BESS devices; b) define parameters (frequency threshold, droop, active power reference value), activation conditions and LFSM-U functionality response requirements, and align them with the requirements prescribed by the TSO; c) define requirements for control schemes and settings of protection devices, including protection against internal faults; prescribe priorities in the operation of control and protection devices.
4.	Requirements for type B synchronous generators: 1. Requirements for type A and B PGMs, 2. Voltage stability requirements, and 3. Robustness and the FRT capability.	1. Requirements from points 2 and 3 for type A and B PGMs. 2. Define the basic requirements for voltage stability and regulation of voltage and reactive power generation. 3. Define general requirements for the stability of synchronous generators during short circuits in the transmission network (FRT stability) and the capability of active power recovery after fault clearing.	1. The requirements of points 2 and 3 for type A and B PGMs, except for the provision defining the possibility of automatic switch-off at randomly selected frequencies in case of a frequency increase. 2. Define detailed requirements for voltage stability and regulation of voltage and reactive power generation. 3. a) define the FRT characteristic for synchronous generators and adjust it to the characteristic prescribed by the TSO, including the pre-fault and post-fault conditions; b) define detailed requirements for active power recovery after fault clearing.
5.	Requirements for type B power park modules: 1. Requirements for type A and B PGMs, 2. Voltage stability requirements, 3. Optional operating modes, and 4. FRT capability.	1. Requirements from points 2 and 3 for type A and B PGMs. 2. a) define the basic requirements for provision of the additional reactive power; b) define the basic requirements regarding the provision of fast fault current at the connection point in the case of symmetrical short circuits. 4. Define the general requirements for the stability of power park modules during short circuits in the transmission network (FRT stability) and the capability of active power recovery after fault clearing.	1. The requirements of points 2 and 3 for type A and B PGMs, except for the provision defining the possibility of automatic switch-off at randomly selected frequencies in case of a frequency increase. 2. a) define detailed requirements for the PGM operating mode during a short circuit in the power system (current limiting mode or voltage support). Exempt induction PGMs connected to the LV network from the obligation to provide voltage support during a short circuit in the power system or surge voltage changes; b) define detailed requirements regarding the provision of fast fault current (reactive component) at the connection

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			point in case of symmetrical faults and optionally in case of asymmetrical faults. Define activation conditions and characteristics of the fast fault current of the positive and negative components (magnitude, rate of change in relation to the voltage deviation, response and stabilization times, response accuracy). 3. Define whether the power park modules connected to MV network are required to have the capability of optional operating modes depending on local conditions (active power priority, reactive current limitation or zero component current limitation). Prescribe specific requirements for the current-limited mode for power park modules connected to the grid via converters. 4. a) define the FRT characteristic for power park modules and adjust it to the characteristic prescribed by the TSO, including the pre-fault and post-faults conditions; b) define detailed requirements for the post-fault active power recovery.
6.	Requirements for type C generation modules: 1. Requirements for type A and B PGMs, 2. Frequency stability requirements, 3. Voltage stability requirements, 4. Robustness requirements, 5. System restoration requirements, 6. System control requirements, and 7. Simulation models' requirements.	1. Requirements from point 2 for type A PGM and point 3 for type B PGM. 2. a) define the requirements for the capability to set the active power setpoint according to the instructions of the DSO or TSO; b) prescribe the basic requirements for the active power response of type C PGM in case the power system frequency is reduced (LFSM-U); c) prescribe the basic requirements for FSM frequency response of active power of type C PGM. 5. a) define whether the requirements for the capability to start PGM without an external power supply source ("black start") are obligatory; b) define whether the requirements for the island operating mode are obligatory; c) define basic requirements for fast resynchronization.	1. Requirements from point 2 for type A PGM and point 3 for type B PGM. 2. a) define the parameters of LFSM-U functionality - reference power, frequency threshold, droop and active power response requirements; b) define detailed requirements for FSM active power frequency response, including active power range, frequency response dead band, droop, permitted activation delay, activation time, and active power frequency response period; c) define requirements for real-time monitoring of FSM active power frequency response. 3. Define the possibility of automatic disconnection when the voltage reaches the prescribed value. 4. Define the obligations of type C PGM in terms of maintaining static stability in case of power system oscillations, maintaining active power within the

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
		7. Define basic requirements for type C PGM simulation models for stationary and dynamic state simulations or simulations of electromagnetic transients.	defined voltage and frequency ranges, and remaining in operation during the operation of automatic reclosure (ARC) in the ring-shaped networks. 5. a) if the requirements for "black start" functionality are mandatory, define detailed requirements (start-up time, automatic voltage regulation, block load connection control, operation in LFSM-O and LFSM-U modes, frequency control, island regime in parallel operation with multiple PGMs); b) if the requirements for island mode are mandatory, define detailed requirements (frequency and voltage ranges, FSM mode, reduction of active power generation, island mode detection method, LFSM-O and LFSM-U mode); c) define specific requirements for PGMs whose minimum resynchronization time is longer than 15 minutes. 6. a) define criteria for detection of PGM loss of angular stability or PGM loss of control and disconnection of PGM under given conditions; b) define requirements for PGM equipment for detection of faults, monitoring of dynamic system behavior and monitoring of power quality. Define requirements regarding the installation of additional devices required for the operation or security of the power system; c) define requirements for minimum and maximum rates of change of active power of type C PGM. 7. Define requirements for type C PGM simulation models, their sub models, model submission format and requirements for recording the PGM's performance for model quality assessment purposes.
7.	Requirements for type C synchronous generators: 1. Requirements for type A, B and C PGMs and type B synchronous generators, and	1. Requirements from point 2 for type A PGM, point 3 for type B PGM, point 4 for type B synchronous generators and point 6 for type C PGM. 2. Define the basic requirements for the capability to generate reactive power at the point of connection.	1. Requirements from point 2 for type A PGM, point 3 for type B PGM, point 4 for type B synchronous generators and point 6 for type C PGM. 2. a) define the right of the DSO to prescribe additional requirements for the delivery of reactive power to compensate for the consumption of reactive power

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
	2. Voltage stability requirements.		on a high-voltage line or cable; b) define the U-Q / Pmax) characteristic within which the PGM must generate reactive power at Pmax; c) define the PGM capability to operate with an output power less than Pmax at any operating point within the P-Q generator operating diagram, at least up to the generator stability level.
8.	Requirements for type C power park modules: 1. Requirements for type A, B and C PGMs and type B power park modules, 2. Frequency stability requirements, and 3. Voltage stability requirements.	1. Requirements from point 2 for type A PGM, point 3 for type B PGM, point 5 for type B power park modules and point 6 for type C PGM. 2. Define the obligation of type C power park modules regarding the capability to provide synthetic inertia. 3. Define the basic requirements for the capability to generate reactive power at the point of connection.	1. Requirements from point 2 for type A PGM, point 3 for type B PGM, point 5 for type B power park modules and point 6 for type C PGM. 2. If the requirements for providing synthetic inertia are binding for type C power park modules, define the principles of operation and parameters of the control system for providing synthetic inertia. 3. a) define the right of the DSO to prescribe additional requirements for the delivery of reactive power to compensate for the consumption of reactive power on a high-voltage line or cable; b) define the U-Q/Pmax characteristic within which the power park module must generate reactive power at Pmax; c) define a P-Q/Pmax characteristic that represents the capability to generate reactive power at an output power that is lower than the maximum capacity Pmax; d) define the required operating modes of reactive power generation for type C power park modules, requirements for setting the thresholds, speed and accuracy of reactive power response in different operating modes, and requirements for installation of equipment for remote setting of parameters; e) define the priority of active or reactive power generation during faults for which FRT capability is required; f) prescribe that the power park module must be capable to contribute to the damping of power oscillations if required by the TSO.

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
9.	Connection of new generation modules: 1. Connection procedure, 2. Procedure for type A PGM, and 3. Procedure for types B and C PGMs.	1. Define the basic elements of the connection procedure of new PGMs to the distribution network. 3. Prescribe the possibility of using equipment certificates issued by the authorized certifiers.	1. Define in detail the connection procedure of new PGMs to the distribution network, including application forms, standard connection approval forms and connection contracts templates. 2. If applicable, define a simplified connection procedure for micro-generating plants which is based on the installation document (application for connection approval). 3. Prescribe standard application forms to be applied during the network connection and commissioning procedure.
10.	Cost-benefit analysis of applying NC RfG requirements to existing PGMs.	Not applicable for DSOs, except in the part related to the DSO's obligation to provide data to the TSO for analysis.	Not applicable for DSO.
11.	Compliance monitoring: 1. Responsibilities of the power producer, 2. DSO duties, 3. PGM compliance testing, and 4. PGM compliance simulations.	1. Define the general tasks of the power producer in terms of ensuring the conformity of PGM. 2. Define the general responsibilities of the DSO regarding the monitoring and control of the PGM compliance. 3. Define the power producer's obligations to carry out conformity tests; define the DSO's right to require additional or repeated testing. 4. Define the power producer's obligations to perform conformity simulations and submit the generator simulation models; define the DSO's right to require implementation of additional or alternative simulations.	1. a) define the power producer's obligations to ensure the PGM compliance with the requirements of NC RfG, Rulebook on connection and technical standards during the generator lifetime; b) define the power producer's obligations to inform the DSO about the planned changes of the PGM technical parameters that may affect compliance with the requirements of NC RfG, the Rulebook on connection and technical standards. Prescribe obligations regarding the announcement of planned tests for the verification of PGM compliance, as well as information exchange in case of failures that affect compliance. 2. a) define the DSO's responsibilities regarding the monitoring and verification of PGM compliance over its lifetime; b) define the DSO's right to request testing of PGM according to the established time schedule, after failure, modification or replacement of any equipment when the DSO assesses that these events may affect the compliance of PGM with the requirements of the NC RfG; c) define a list of information and documents to be provided by the

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			power producers during the compliance verification process with the requirements of NC RfG; d) prescribe that the DSO may not unreasonably delay the issuance of a final operational notification (FON) in conditions when compliance testing cannot be carried out due to reasons attributable to the DSO. 3. Define in detail the power producer's obligations to conduct conformity tests; define the DSO's right to require additional or repeated testing. 4. Define in detail the power producer's obligations to conduct conformity simulations; define the DSO's right to request implementation of additional or alternative simulations. Define the cooperation between the DSO and power producers regarding the exchange of data that are necessary for conducting simulations.
12.	PGM compliance testing: 1. Conformity tests for type B synchronous generators, 2. Conformity tests for type C synchronous generators, 3. Conformity tests for type B power park module, and 4. Conformity tests for type C power park module.	Define the general obligation to test the PGM compliance with the requirements of NC RfG, the Rulebook on connection and technical standards. Define the possibility to apply the equipment certificates instead of performing the specific tests.	1. Define the power producer's obligations to test the response of type B synchronous generators to increased frequency and the manner of conducting the test. 2. Define the power producer's obligations to perform tests of type C synchronous generators, which in addition to tests of type B synchronous generators, include testing of response to reduced frequency, testing of operation in frequency sensitive mode (FSM), testing of response in frequency restoration reserve (FRR) mode, "black start" capability test (if applicable), tripping to house load test and reactive power control capability test. 3. Define the power producer's obligations to perform tests of type B power park modules, which include testing the response to increased frequency. 4. Define the power producer's obligations to perform tests of type C power park modules, which in addition to tests of type B power park modules, include tests of active power regulation, testing of response to reduced frequency, testing of operation

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			in FSM, testing of response in FRR mode, testing the capability to generate reactive power, voltage control mode tests, the reactive power control mode tests and the power factor control mode tests.
13.	PGM compliance simulations: 1. Conformity simulations of type B synchronous generators, 2. Conformity simulations of type C synchronous generators, 3. Conformity simulations of type B power park modules, and 4. Conformity simulations of type C power park modules.	Define the general obligation to simulate the PGM compliance with the requirements of NC RfG, the Rulebook on connection and technical standards. Define the possibility to apply the equipment certificates instead of performing the specific simulations.	1. Define the power producer's obligations to implement the simulations of type B synchronous generators response to increased frequency, simulation of FRT capabilities and simulation of active power recovery after fault. Define the manner of conducting simulations and assessing the performance. 2. Define the power producer's obligations to perform compliance simulations of type C synchronous generators, which in addition to simulations of type B synchronous generators, include simulation of response to reduced frequency, simulation of operation in FSM, simulation of response in FRR mode, simulation of "black start" (if applicable), simulation of house load operation and simulation of reactive power regulation capability. 3. Define the power producer's obligations to perform compliance simulations of type B power park module which include simulation of response to the increased frequency, simulation of fault current injection, simulation of FRT capability and simulation of active power recovery after fault. Define the manner of conducting simulations and assessing the performance. 4. Define the power producer's obligations to perform compliance simulations of type C power park module, which in addition to simulations of type B power park module, includes simulation of active power response to reduced frequency, simulation of operation in FSM, simulation of island operation mode, simulation of capabilities to provide synthetic inertia, simulation of the response in FRR mode, simulation of the capability to regulate reactive

No.	Issue	Distribution Network Codes	Rulebook on connection of power plants
			power and simulation of the power oscillations damping.
14.	Derogations: 1. The right to grant a derogation, 2. Criteria for granting derogations, 3. Derogation procedure at the request of the PGM owner, 4. Derogation procedure at the request of the DSO, and 5. Register of derogations.	1. Prescribe that regulatory commission has the right to grant derogations from the application of NC RfG provisions, in the domain of its competence. 2. State the criteria for granting a derogation from the application of NC RfG provisions. 5. Define that the regulatory commission is responsible to maintain the register of granted or refused derogations from the application of NC RfG provisions.	3. Define the procedure for granting derogations from the application of the NC RfG provisions at the request of the PGM owner. 4. Define the procedure for granting derogations from the application of the NC RfG provisions at the request of the DSO.

3. REQUIREMENTS FOR DEMAND CONNECTION

The harmonization of the distribution network codes with the requirements of the Network Code on Demand Connection[7] (NC DC) is an obligation of the Energy Community Contracting Parties, which stems from harmonization of the legal and regulatory framework in the field of electricity with the Third EU energy package.

NC DC is incorporated into the legal framework of the Energy Community by the decision of the Permanent High-Level Group of the Energy Community (No 2018/03 / PHLG-EnC from January 12, 2018). The deadline for transposition of regulations into the national legislation was six months, while the deadline for full implementation was three years from the deadline for transposition. The Energy Community Contracting Parties are therefore obliged to fully apply the NC DC by July 12, 2021, at the latest. ND DC's were incorporated into the regulatory framework in Bosnia and Herzegovina by the Decision of SERC on the transposition of the rules for the operation of networks regarding connection, from June 12, 2018[8]. With this Decision, SERC also invited the FERC, the RSERC and other competent bodies to ensure compliance of their relevant acts with the requirements contained in the regulations referred to in point II of the Decision regarding rules for the operation of networks regarding connection.

This chapter provides a summary overview of recommendations for harmonization of the distribution network codes and rulebooks on customer connection to the distribution network with the requirements of the NC DC. The basis for the preparation of the summary overview is detailed analyzes with recommendations for harmonization of relevant regulations for each individual DSO in BiH[9].

In addition to recommendations for harmonization of distribution network codes and relevant regulations, it is important to emphasize the need for amendments to all laws on electricity regarding the powers of regulatory commissions to grant derogations from the specific requirements for connection of demand facilities to the distribution network.

The recommendations for amendments and harmonization of distribution network codes and customer connection rules with requirements of NC DC are given in Table 4.

[7] COMMISSION REGULATION (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0631&from=EN.

[8] SERC, Decision on transposition of rules for operation of networks regarding connection, Number 05-14-1-97-3 / 18, June 12, 2018. http://www.derk.ba/DocumentsPDFs/Odluka-o-transpon-pravila-za-rad-mreza-u-vezi-prikljucivanja-b.pdf.

[9] An overview of the individual documents contained in the introductory chapter of the document.

Table 4. Requirements of NC DC

No.	Issue	Distribution Network Code	Customer connection rules
1.	General issues: 1. Definitions, 2. Scope, 3. Application to existing demand facilities and existing elements of the customer's facilities, 4. Application to PS HPP and industrial power plants, 5. Regulatory aspects, 6. Cost recovery, 7. Public consultations, and 8. Obligation of confidentiality.	1. Define basic terms and harmonize definitions with the NC DC, technical standard EN 60050 IEV and CENELEC terminology. 2. a) prescribe the application of connection requirements set by NC DC to new distribution systems, new closed distribution systems and new elements of the customer's facilities used for the provision of demand response services to the relevant system operators; b) prescribe an exemption from the application of the NC DC requirements to storage devices other than PS HPPs. 3. Define the criteria and conditions for the application of NC DC to existing demand facilities and existing elements of the customer's facilities that are used to provide demand response services. 4. Define conditions of application to PS HPP and industrial sites. 5. Regulatory aspects are not subject of distribution network codes. 6. Prescribe the DSO's obligations to submit the data to the regulatory commission regarding costs that are result of the NC DC implementation. Recovery of DSO costs that are result of the NC DC implementation should be defined by law or tariff setting methodology. 8. Prescribe the DSO's obligations regarding the treatment of the confidential information.	1. Define all relevant terms and harmonize the definitions with the NC DC, technical standard EN 60050 IEV and CENELEC terminology. 7. Define the DSO's obligation to conduct public consultation in the process of drafting: – proposals for extending the application of NC DC to existing facilities, – CBA Reports on the application of NC DC to existing facilities, and – the requests for derogations to system operator and specific requirements for demand units.
2.	Connection of distribution systems: 1. General frequency requirements, 2. General voltage requirements, 3. Short circuit requirements,	1. Define mandatory frequency ranges and relevant time periods for the operation of distribution system. 2. Prescribe that distribution systems must remain in operation within the voltage ranges and time periods defined by the TSO in accordance with the requirements of the NC DC.	

No.	Issue	Distribution Network Code	Customer connection rules
	4. Reactive power requirements, 5. Protection requirements, 6. Network control requirements, 7. Information exchange, 8. Disconnection and reconnection, 9. Power quality, and 10. Simulation models.	3. a) prescribe the DSO's obligations to determine the maximum short-circuit current threshold that shall be applied by TSO when submitting data on changes in short-circuit current at the connection point; b) prescribe the DSO's obligations to submit the data to the TSO on the short-circuit current contribution and equivalent network models. Prescribe the obligation to submit data when the short-circuit current contribution changes as a result of unplanned and planned events. 4. a) prescribe the DSO's obligation to maintain the reactive power exchange within the range determined by the TSO and an obligation to jointly determine the optimal solution for the reactive power exchange between power systems; b) prescribe the DSO's obligations to actively control the reactive power exchange at the point of connection if required by the TSO. 5. Prescribe the DSO's obligations regarding the harmonization of protection schemes and settings with the TSO. 6. a) prescribe the DSO's obligations regarding the harmonization of schemes and settings of control devices which are relevant for the power system security; b) define the operation priorities of the protection and control devices. 7. Prescribe the DSO's obligations to install equipment for information exchange with the TSO, according to the requirements of the TSO. 8. a) prescribe the DSO's obligations regarding the low frequency demand disconnection capabilities, in accordance with the frequency thresholds and degrees of disconnection prescribed by the; TSO b) prescribe the DSO's obligations regarding the application of low voltage demand disconnection functionalities.	

No.	Issue	Distribution Network Code	Customer connection rules
		9. Prescribe the DSO's obligations to prevent the negative impact of its facilities on the transmission network regarding the voltage distortion and fluctuation at the connection point. 10. a) prescribe the DSO's obligations to submit the simulation models or equivalent information at the request of the TSO, which simulates the behavior of the distribution system in the steady and dynamic states; b) prescribe the DSO's right to require data recording to compare the response of the simulation model with these recordings.	
3.	Connection of demand units used to provide demand response services: 1. General provisions, 2. Specific requirements for demand units providing services on the transmission network, 3. Specific requirements for demand units providing frequency regulation services, and 4. Specific requirements for demand units with demand response very fast active power control.	1. a) define those requirements relate to the demand units within the customer's demand facilities or closed distribution system; b) define the right of customers to offer demand response services to DSOs and TSOs. 3. Define that customer facilities and closed distribution systems can offer demand response services of the power system frequency regulation to the relevant TSO. 4. Define the right of distribution system users to conclude a contract with the TSO for the provision of demand response services with the aim of very fast active power control.	2. a) define requirements for demand units with remotely controllable demand (to change active power, to change reactive power and to manage congestion in the transmission network), individually or jointly (as part of an aggregated unit via a third party), regarding: – frequency and voltage operating ranges, – equipment for receiving instructions to modify their demand (power), – ability to adjust power consumption upon the instruction receipt, – stability of operation during power system frequency changes, – exchange of information, and – disconnection and reconnection of the voltage regulation devices. b) define technical requirements for the transmission of instructions for low frequency and low voltage demand disconnection and for the control of the active and reactive power consumption. 3. Define requirements for demand units with controllable demand for the frequency regulation services, individually or jointly (as part of an aggregated unit, through a third party), regarding: – frequency and voltage operating ranges, and

No.	Issue	Distribution Network Code	Customer connection rules
			– control system equipment, frequency measurement equipment and capability to detect the power system frequency changes.
4.	Connection procedure: 1. Connection procedure, and 2. Procedures for demand units used to provide demand response services.	1. Define the basic elements of the connection procedure of new demand units to the distribution network.	1. Define in detail the connection procedure of new demand units to the distribution network, including application forms and standard forms of the connection approval and connection contract. 2. Create specific standard forms of documents tailored to the network users that provide demand response services, to be applied in the connection process.
5.	Compliance: 1. Responsibilities of the demand facility owner and DSO, and 2. Tasks of the relevant system operator.	1. Prescribe the general obligations of the demand facility owner that provides demand response services and the DSO, regarding the compliance of their facilities with the requirements of NC DC. 2. Define the general tasks of the DSO regarding the monitoring and control of the compliance of demand units with the requirements of the NC DC, and the obligation to cooperate with the TSO when monitoring the facilities that provide demand response services.	1. a) define the procedure for assessing the conformity of demand facility and CDSO that are used to provide demand response services and the manner of information exchange. Prescribe the obligation of demand facility and CDSO to submit information on changes due to planned or unplanned events, which affect the capability to provide demand response services; b) define the DSO's powers to approve the conformity assessment test procedure. Prescribe the DSO's right to participate in tests and register the customer's facilities performance. 2. a) define the DSO's tasks regarding the monitoring and verification of compliance of the demand units with the requirements of the NC DC during their lifetime; b) define the DSO's right to request testing of the customer's facilities according to the established time schedule, after any failure or replacement of equipment, reconstruction of facilities when the DSO assesses that these events may affect the compliance of the customer's facilities with the NC DC requirements; c) define a list of information and documents provided by the demand facility owner or CDSO as part of the NC DC compliance verification process; d) prescribe that the DSO may not unreasonably delay the issuance of a FON in conditions when compliance testing cannot

No.	Issue	Distribution Network Code	Customer connection rules
			be carried out due to reasons attributable to the DSO.
6.	Compliance testing: 1. General provisions, 2. Compliance testing of disconnection and reconnection of distribution facilities, 3. Compliance testing of information exchange of distribution facilities, and 4. Compliance testing of the demand units with demand response active power control, reactive power control and transmission constraints management.	1. Define the general obligation of the compliance testing of demand units with demand response with requirements of NC DC, the Rulebook on connection and technical standards. Define the possibility of submission of equipment certificates instead of carrying out specific tests. 2. a) define the basic requirements for testing the disconnection and reconnection functionalities of transmission connected distribution facilities; b) define the basic requirements for testing the low frequency demand disconnection functionality of distribution facilities; c) define the basic requirements for testing the low voltage demand disconnection functionality of distribution facilities; d) prescribe that the DSO may provide equipment certificates instead of carrying out the tests, if approved by the TSO. 3. a) define basic requirements for testing the capability of distribution facilities to exchange information with the TSO; b) prescribe that the DSO may provide equipment certificates instead of carrying out the tests, if permitted by the TSO.	1. a) define the obligations of the demand facility owner or the CDSO to carry out compliance tests; define the DSO's right to allow alternative tests or to require additional or repeated tests; b) prescribe the obligation of the demand facility owner or CDSO regarding the provision of equipment for monitoring and registration of test signals and measurements. 2. a) define requirements for testing the functionalities of the demand units with demand response active power control, reactive power control and transmission constraints management. Prescribe the possibility of providing equipment certificates instead of carrying out individual tests; b) define requirements for testing the disconnection and reconnection functionalities of a static compensation facilities.
7.	Compliance simulations: 1. General provisions, and 2. Compliance simulations of demand units with demand response very fast active power control.	1. a) define that compliance simulation is performed when a new connection to the transmission network is required, when a new demand unit of the demand facility is used to provide a demand response very fast active power control services, when a development, replacement or modernization of equipment takes places and when there is alleged incompliance by the relevant system operator with the requirements of NC DC; b) prescribe the DSO's obligation to provide the TSO with a validated simulation model of its facilities and a report on the results of the performed simulations; c) prescribe	1. a) prescribe the DSO's right to allow the demand facility owner or the CDSO to carry out alternative simulations if they can demonstrate compliance with the requirements of the NC DC; b) prescribe the DSO's right to require the demand facility owner or the CDSO to perform additional or alternative simulations if the submitted data are not sufficient to prove the compliance with the provisions of the NC DC. 2. Define the requirements for compliance simulations of the demand units with the demand response very fast active power control at reduced frequency.

No.	Issue	Distribution Network Code	Customer connection rules
		the DSO's obligation to provide the demand facility owner and the CDSO with the data and network simulation model which are required to carry out the simulations.	
8.	Applications and derogations: 1. Principles of cost-benefit analysis, 2. The right to grant a derogation, 3. Derogation procedure at the request of the demand facility owner, DSO or closed distribution system operator (CDSO), and 4. Register of derogations.	1. Define the principles of cost-benefit analysis, which include the calculation of cost-effectiveness, benefits of the security of supply improvements, benefits to the internal electricity market, cross-border trade and integration of renewable energy sources, and the costs of applying the rules to the existing facilities. 2. a) prescribe that regulatory commission has the right to grant derogations from the application of NC DC provisions, in the domain of its competence; b) state the criteria for granting a derogation from the application of the NC DC provisions. 3. a) define the procedure for granting derogations from the application of the NC DC provisions at the request of the DSO; b) define the procedure for granting derogations from the application of the NC DC provisions at the request of the demand facility owner or the CDSO. 4. Define that the regulatory commission is responsible to maintain the register of granted or refused derogations from the application of NC DC provisions.	1. Define the requirements for the exchange of data and information for the purposes of preparing a cost-benefit analysis of the application of the NC DC requirements to the existing demand units and cost-benefit analysis for the preparation of derogation requests.

4. REQUIREMENTS OF NON-TRANSPOSED EU NETWORK CODES

The Energy Community has not yet formally transposed the remaining ENTSO Network Codes and Guidelines, which contain, inter alia, significant provisions related to the operation of distribution systems and DSOs. This group of ENTSOs Network Code and Guidelines includes the Guidelines on Electricity Transmission System Operation[10], the Emergency and Restoration Network Code[11] and the Electricity Balancing Guidelines[12]. The transposition of these regulations into the legal framework of the Energy Community is expected during 2022.

These EU Regulations focus primarily on the operation of ENTSO interconnections, and then on the operation of individual power systems.

Although these Grid Code and Guidelines have not yet been transposed into the legal and regulatory framework of the Energy Community Contracting Parties, their application may be binding on system operators on matters that are relevant to the ENTSO-E interconnection.

This chapter provides a summary overview of the recommendations for harmonization of distribution network codes with the stated EU regulations, on issues that may have an impact on the operation of distribution systems and thus on the obligations of DSOs.

RECOMMENDATIONS FOR HARMONIZATION OF DISTRIBUTION NETWORK CODES WITH THE ENTSO-E GUIDELINES FOR ELECTRICITY TRANSMISSION SYSTEM OPERATION

The Guidelines for the Electricity Transmission System Operation, address three very important areas from the regular activities of TSOs: Operational Security, Operational Planning and Frequency Regulation (including the provision of regulation reserves).

All three areas have a significant impact on the operation of the power system, and thus on all system/network operators and system users. Currently, DSOs are partners of TSOs in these processes in terms of providing network parameters at the points of connection to the transmission network, providing appropriate input data, execution of operational orders, and coordination with significant grid users which are connected to the DSO network. Taking into account the increasing capacities of distributed generation, including generation capacities which are connected to the distribution network, the roles and responsibilities of DSOs in these processes are significantly increasing as well.

In that sense, most of the activities in transposition of this document into the electricity sector legislation in BiH will continue to be related to the Independent System Operator (ISO) BiH and the BiH Grid Code. The identified recommendations and proposals relevant to the DSO for inclusion into the existing distribution network codes and relevant documents are summarized in Table 5 below.

[10] COMMISSION REGULATION (EU) 2017/1485 of August 2, 2017 establishing guideline on electricity transmission system operation: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R1485&from=EN.
[11] COMMISSION REGULATION (EU) 2017/2196 of November 24, 2017 establishing a grid code on electricity emergency and restoration: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2196&from=EN.
[12] COMMISSION REGULATION (EU) 2017/2195 of November 23, 2017 establishing guideline on electricity balancing: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32017R2195&from=EN.

Table 5. Requirements of System Operation Guideline (SOGL)

No.	Issue	Distribution Network Codes
	Operational Security	
1.	Operational security requirements: 1. Obligations regarding voltage limits, and 2. Obligations related to voltage regulation and reactive power control.	1. Prescribe the obligation to harmonize voltage range limit values at the points of connection of DSO networks with TSO. 2. a) prescribe the DSO's obligation to harmonize with the TSO the requirements for the reactive power exchange, voltage settings and the power factor range at the connection points between the transmission and distribution network; b) prescribe the DSO's obligation regarding cooperation with the TSO in conditions when the TSO directly or indirectly manages the generation of reactive power of the distribution network users.
2.	Data exchange: 1. General requirements, 2. Exchange of structural data between DSO and TSO, 3. Real-time data exchange between DSO and TSO, 4. Data exchange between TSO, DSO and power producers connected to the distribution network, and 5. Data exchange between TSOs and customers connected to the distribution network.	1. Define the categories of data that the DSO exchanges with the TSO in accordance with the Article 40 of the system operation guideline (SOGL). 2. a) prescribe the DSO's obligations regarding the provision and updating of structural information to the TSO, according to the requirements of Article 43 of the SOGL; b) prescribe the DSO's obligations to provide the TSO the data on type A generation modules connected to the distribution network. 3. Prescribe the DSO's obligations regarding the delivery of real time measurements and data to the TSO, according to the requirements of Article 44 of the SOGL. 4. a) prescribe the obligations of generators which are significant grid users (SGUs) connected to the distribution network, regarding the provision of structural data to TSOs and DSOs, in accordance with the Article 48 of the SOGL; b) prescribe the obligations of generators which are SGUs connected to the distribution network, regarding the provision of scheduled data to TSOs and DSOs, in accordance with the Article 49 of the SOGL; c) prescribe the obligations of generators which are SGUs connected to the distribution network, regarding the provision of real-time data to TSOs and DSOs, in accordance with the Article 50 of the SOGL; d) prescribe the DSO's obligation to exchange the data with the TSO on generators which are SGUs connected to the distribution network, in accordance with the Article 51 of the SOGL. 5. Prescribe the obligations of customers which are SGUs connected to the distribution network, and which participate in the provision of demand response services, regarding the provision of scheduled and real-time data to the DSOs and TSOs in accordance with the Article 53 of the SOGL.
3.	Compliance: 1. Roles and responsibilities, and 2. Operational tests.	1. a) prescribe the obligations of the SGUs connected to the distribution network regarding the delivery of information to the DSO and TSO on planned changes and operational disturbances that may affect compliance with the requirements of the SOGL; b) prescribe the obligations of the SGUs connected to the distribution network regarding the delivery of information to the DSOs and the TSOs on the planned tests and procedures to verify compliance with the requirements of the SOGL; c) prescribe the obligations of the SGUs connected to the

No.	Issue	Distribution Network Codes
		distribution network to carry out the compliance tests and simulations with Regulation (EU) 2016/631 and Regulation (EU) 2016/1388 at the request of the TSO or DSO. 2. a) prescribe the right of DSOs and SGUs connected to the distribution system regarding carrying out the operational tests of their facilities, in accordance with the Article 56 of the SOGL; b) prescribe the DSO's right to require the SGU to carry out operational tests for the compliance assessment purposes; c) define a list of information and documents to be provided by the SGU before performing operational tests.
Operational planning		
4.	Outage coordination: 1. List of significant generators and significant customers, 2. List of significant network elements, and 3. Treatment of significant facilities in the distribution system.	1. Define that the list of significant generators and significant customers for the outage coordination purposes will be prepared and submitted to the DSO by the TSO. 2. Define that a list of significant distribution network elements for the outage coordination purposes will be prepared and submitted to the DSO by the TSO. 3. Prescribe that the DSO coordinates with the TSO planning of outages of significant assets connected to the distribution system.
5.	Development and updates of availability plans for significant assets: 1. Annual outage plan, 2. Provision of preliminary availability plans for the year in advance, 3. Validation of annual outage plans, and 4. Final annual outage plan.	1. Prescribe the manner of coordination of the availability status of significant network elements in accordance with the Article 96 of the SOGL. 2. Define that the preliminary availability plan for the next year is submitted by the TSO to the DSO by the beginning of November of the current year. 3. Define the manner of resolving incompatibilities and validation of outage plans between DSOs and TSOs, for assets connected to the distribution system, in accordance with the Article 98 of the SOGL. 4. Define that the final availability plan for the relevant assets in the distribution system for the next calendar year, TSO submits to the DSO by the beginning of December of the current year.
Load-frequency control and reserves		
6.	Cooperation with the DSO: 1. Groups or units providing frequency regulation services connected to the distribution network.	1. a) prescribe the DSO's obligations to cooperate with the TSO to facilitate provision of active power reserve by groups or units connected to the distribution network, in accordance with the Article 182 of the SOGL; b) prescribe the DSO's right to temporarily or permanently limit or prevent provision of active power reserve services by providers connected to the distribution system, based on technically provable reasons, in accordance with Article 182 paragraphs (4) and (5) of the SOGL.
Final provisions		
7.	Amendments to the contract and general terms and conditions.	1. Prescribe the obligation to harmonize contracts and technical regulations related to the operation of the distribution system with the requirements of SOGL.

RECOMMENDATIONS FOR HARMONIZATION OF DISTRIBUTION NETWORK CODES WITH THE ENTSO-E NETWORK CODE ON ELECTRICITY EMERGENCY AND RESTORATION

The Network Code on Electricity Emergency and Restoration (NC EER) primarily contains provisions relevant to the TSO for activities within a single power system, then at the level of regional operational security centers, and finally at the level of the entire interconnection. NC EER sets the requirements for the power systems protection from disturbances and for the power system restoration following partial or complete blackouts.

The key role in planning, coordinating and executing these procedures is performed by the TSO, while the role of the DSO is to participate in the preparation and implementation of the power system defense and restoration plans. The plans prescribe requirements for the DSOs and the network users that are identified or contracted as defense service providers and/or restoration service providers or as a significant grid users. The referred network users are mainly large customers and/or significant generation modules.

In that sense, most of the activities in transposition of this document into electricity sector legislation in BiH will be related to the ISO BiH and the BiH Grid Code and the relevant power system defense and restoration plans. The identified activities of the DSO in the form of a summary overview of recommendations and proposals for inclusion into the existing distribution network codes and relevant documents are given in Table 6 below.

Table 6. Requirements of the Network Code on Electricity Emergency and Restoration (NC EER)

No.	Issue	Distribution Network Code
1.	System defense plan: 1. Development, implementation, and activation of a System Defense Plan.	1. a) Prescribe the DSO's obligations to cooperate with the TSO in the process of drafting the power system defense plan; b)Prescribe the DSO's obligations to implement the measures from the power system defense plan and inform the defense service providers (DSPs) or SGUs about the obligations from the power system defense plan that apply to them; c) Prescribe the DSO's obligations regarding the activation of measures from the power system defense plan in coordination with the TSO.
2.	Measures of the System Defense Plan: 1. Automatic under and over frequency control schemes, 2. Automatic scheme against voltage collapse, 3. Frequency deviations management procedure, 4. Voltage deviations management procedure, and 5. Manual demand disconnection procedure.	1. a) prescribe the application of automatic low frequency demand disconnection schemes and LFSM-U at the conditions of reduced system frequency; b) prescribe the DSO's obligation to install the automatic low frequency demand disconnection relays in coordination with the TSO; c) prescribe the principles of application of automatic low frequency demand disconnection scheme (type of customers, presence of distributed generators, etc.). 2. Prescribe the elements of an automatic scheme against voltage collapse in accordance with Article 17 of the NC EER. 3. Prescribe the DSO's obligations regarding cooperation with the TSO in the frequency deviation management procedure which includes the DSPs or SGUs connected to the distribution system.

No.	Issue	Distribution Network Code
		4. Prescribe the DSO's obligations to execute the TSO instructions for the reactive power generation/consumption control and voltage regulation. 5. Prescribe the DSO's obligations to execute the TSO instructions for manual demand disconnection.
3.	System Restoration Plan: 1. Design, implementation and activation of the System Restoration Plan, and 2. Activation of the re-energization procedure.	1. a) Prescribe the DSO's obligations to cooperate with the TSO in the design of the power system restoration plan; b) Prescribe the DSO's obligations to implement the measures from the system restoration plan and inform the RSPs or SGUs about the obligations from the system restoration plan that apply to them; c) Prescribe the DSO's obligations to activate the measures of the system restoration plan according to the TSO instructions. 2. Prescribe the DSO's obligations regarding the reconnection of the notified amount of the netted demand, taking into account the automatic reconnection of load and generation.
4.	Information exchange and communication: 1. Exchange of information, 2. Communication systems, and 3. Tools and facilities.	1. Prescribe the DSO's obligations to exchange the information with the TSO when the power system is in state of emergency, blackout, or restoration, in accordance with the Article 40 of the NC EER. 2. Prescribe the obligations of the DSO, SGU and RSP regarding the installation of voice communication equipment that is used in the system restoration process, in accordance with the Article 41 of the NC EER. 3. Prescribe the obligations of the DSO, SGU and RSP regarding the availability of critical tools and facilities that are used in the system restoration process.
5.	Compliance and review: 1. General principles, 2. Compliance testing of the low frequency demand disconnection relays, 3. Testing of communication systems and backup power supply, 4. Testing of tools and facilities, 5. Periodic review of the System Defense Plan, and 6. Periodic review of the System Restoration Plan,	1. Prescribe the obligations of the DSO, SGU, DSP and RSP regarding the implementation of compliance tests prescribed by the TSO. 2. Prescribe the DSO's obligations to test the low frequency demand disconnection relays in time intervals and according to the methodology defined in NC DC. 3. Prescribe the obligations of DSO, SGU and restoration service provider (RSP) regarding the testing of communication systems and backup power supply systems. 4. Prescribe the DSO's obligations regarding the testing of backup power sources in substations which are used for power system restoration. 5. Prescribe the DSO's obligations regarding the revision of measures of the System Defense Plan. 6. Prescribe the DSO's obligations regarding cooperation with the TSO in performing simulation tests of the System Restoration Plan and executing the operational tests of parts of the System Restoration Plan.

RECOMMENDATIONS FOR HARMONIZATION OF DISTRIBUTION NETWORK CODES WITH THE ENTSO-E GUIDELINE ON ELECTRICITY BALANCING

The Guideline on Electricity Balancing (GLEB) primarily contains provisions relevant to the TSOs, for control areas, control blocks and generally the complete infrastructure that provides the electricity balancing in the ENTSO interconnections. The document addresses the functioning of the electricity balancing market, imbalance netting at the regional and interconnection levels, harmonization of prequalification rules and procedures, procurement and activation of balancing capacity and energy, tasks and roles of balancing service providers, but above all the activities that TSO should implement in order to efficiently use the balancing capacity and energy in the electricity interconnections in Europe.

In that sense, most of the activities in transposition of this document into the electricity sector legislation in BiH will be related to the ISO BiH, the BiH Network Code and the BiH Market Rules. As far as DSOs are concerned, their role is primarily in coordination with the balancing service providers connected to the distribution network.

The identified activities of the DSO in the form of a summary overview of recommendations and proposals for amendments of the existing distribution network codes and relevant rulebooks are given in Table 7 below.

Table 7. Requirements of the Guideline on Electricity Balancing (GLEB)

No.	Issue	Distribution Network Codes
1.	Balancing electricity market: 1. Coordination with DSO, and 2. Conditions for balancing service providers.	1. Prescribe the DSO's obligations to cooperate with the TSO in order to establish the efficient and effective balancing that involves the service providers connected to the distribution network, in accordance with the Article 15 of the GLEB. 2. Prescribe obligations of balancing service providers connected to the distribution network, to inform DSOs about the results of pre-qualification and provide the operational data.

5. CONNECTION TO THE NETWORK AND INTEGRATION OF NEW CATEGORIES OF DISTRIBUTION NETWORK USERS

The new category of distribution network users and market participants includes prosumers who individually or collectively generate electricity for their own needs, electricity storage devices and electric vehicles (EV) charging stations.

This chapter provides a summary overview of recommendations for the amendments of distribution network codes with the requirements of the relevant EU directives, international technical standards, and good regulatory best practices in this area. Relevant directives are the EU Directive 2019/944 on common rules for the internal market in electricity[13] and the EU Directive 2018/2001 on the promotion of the use of energy from renewable sources[14]. The recommendations are defined on specific issues that are relevant from the DSO perspective in the grid connection, electricity metering and energy settlement procedures.

The basis for the preparation of the summary overview include the detailed analysis with recommendations for harmonization of relevant regulations for each individual DSO in BiH.

The chapter contains five subchapters, which provide recommendations for individual categories of new network users:

1. Individual prosumers,
2. Collective prosumers,
3. Energy communities,
4. EV Charging stations, and
5. Electricity storage devices.

The identified activities of the DSO in the form of a summary overview of recommendations and proposals for amendments of the existing distribution network codes and relevant rulebooks are given in Tables 8-12 below.

[13] Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0944.

[14] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L2001

Table 8. Connection and integration of power plants for self-consumption needs - individual prosumers

No.	Issue	Distribution Network Code	Connection Rules
1.	Individual prosumers: 1. Definition of prosumers, 2. Categorization of power plants for self-consumption, 3. Connection procedure, 4. Certification, 5. Interface protection requirements, 6. Functional requirements for power generating modules, 7. Metering requirements, 8. Metering of gross electricity generated, 9. DSO tasks in the energy billing process, and 10. Standardization of prosumer's load profiles.	1. Define the term prosumer, who generates electricity for its own needs and who has the right to store and sell the surplus generated electricity that is delivered to the distribution network. 2. a) define the categories of power plants for self-consumption purposes, depending on the customers category, the installed capacity of the power plant and the applied commercial scheme for the electricity billing; b) define the category of microgenerators used for the customer's self-consumption needs. 3. a) define that standard connection procedures are applied for connection of power plants for prosumer's self-consumption, except in case the microgenerators are installed on existing objects when a simplified connection procedure is applied; b) define the basic conditions for the application of the simplified connection procedure of microgenerators. 4. Prescribe the possibility of providing the equipment certificate of compliance with the requirements of technical standards BAS EN 50549, instead of performing functional tests of generation modules during the commissioning. 5. Define the basic requirements for the elements of the interface protection. 6. Define the basic functional requirements for power generation modules for self-consumption purposes, in accordance with the relevant categorization defined by the rulebook on power plants connection to the distribution network. 7. Define the basic requirements for the metering point at the point of connection of prosumer's facilities. 8. Define the basic requirements for the metering point of the gross electricity generation.	2. Prescribe the limitation of the installed capacity of microgenerators that are single phase connected to the low-voltage distribution network. 3. a) define in detail the simplified connection procedure for microgenerators that are installed in/on existing customer's facilities; b) define in detail the conditions for the application of the simplified connection procedure of microgenerators (requirements for interface protection, mandatory functionalities and settings of parameters, qualification of micro-installations). 4. Prescribe the obligatory tests that should be carried out during the certification process; prescribe the content of the certificate's accompanying documentation. 5. Define in detail the functionalities and parameters of interface protection relays at the point of connection of the power plant for own needs. 6. Define in detail the functional requirements for power generation modules for self-consumption purposes, in accordance with the relevant categorization defined by the rulebook on power plants connection to the distribution network. 7. Define in detail the technical requirements for the metering point at the point of connection of prosumer's facilities. 8. Define in detail the technical requirements for the metering point of the gross electricity generation and analyze the possibility of using alternative methods to register the electricity generated (registration on the inverter).

No.	Issue	Distribution Network Code	Connection Rules
		9. Define the DSO's obligations regarding the reading of electricity meters and determination of relevant billing parameters of prosumers. 10. Prescribe the DSO's obligations to develop the standard load profiles of customers who generate electricity for their own needs (when applicable, such as generation in solar photovoltaic power plants).	

Table 9. Connection and integration of power plants for self-consumption needs - collective prosumers

No.	Issue	Distribution Network Code	Connection Rules
1.	Collective prosumers: 1. Definition of joint generation for self-consumption purposes, 2. Limitation of the power plant installed capacity, 3. Connection scheme, 4. Connection procedure 5. Interface protection requirements, 6. Functional requirements, 7. Certification of the power generating modules, 8. Metering requirements, 9. Metering of gross electricity generated, 10. DSO tasks in the energy billing process, application of the virtual billing scheme, and 11. Standardization of prosumer's load profiles.	1. a) define the category of prosumers who jointly generate electricity for self-consumption needs and who have the right to store and sell the surplus generated electricity that they deliver to the network; b) prescribe whether the usage of the public distribution network is permitted for the implementation of joint generation scheme with the application of virtual billing schemes; c) prescribe the obligation of final customers who jointly generate electricity for self-consumption needs to conclude a contract defining the participants in the joint generation scheme and the rules of the electricity sharing. 2. Define the application and method of setting the limits of the installed capacity of power plants in the collective generation schemes for self-consumption needs. 4. Define that standard connection procedures are applied for connection of power plants for self-consumption needs of jointly acting customers, except in case the microgenerators are installed on existing objects when a simplified connection procedure is applied.	1. Define spatial constraints for the application of collective generation schemes for self-consumption purposes. 2. Define the rules on the limitation of the power plants installed capacity in collective generation schemes, in relation to the installed capacity and consumption of customers participating in the collective generation scheme. 3. a) define standard connection schemes for customers who collectively generate electricity for their self-consumption needs; b) define standard points of connection of power plants for self-consumption needs. 4. a) define in detail the simplified connection procedure for microgenerators that are installed in/on existing customer's facilities; b) define in detail the conditions for the application of the simplified connection procedure of microgenerators (requirements for interface protection, mandatory functionalities and settings of parameters, qualification of micro-installations). 5. Define in detail the functionalities and parameters of interface protection relays at the point of

No.	Issue	Distribution Network Code	Connection Rules
		5. Define the basic requirements for the elements of interface protection relays. 6. Define the basic functional requirements for power generation modules for self-consumption purposes, in accordance with the relevant categorization defined by the rulebook on power plants connection to the distribution network. 7. Prescribe the possibility of providing a certificate of compliance with the requirements of technical standards BAS EN 50549, instead of performing functional tests of generation modules during the commissioning. 8. Define the basic requirements for the metering point at the point of connection, depending on the applied connection scheme for the connection of power plants for self-consumption purposes. 9. Define the basic requirements for the metering point of gross electricity generation, depending on the applied connection scheme. 10. a) prescribe the obligation of the DSO and the person representing jointly acting customers, to conclude a contract defining the participants in the joint generation scheme and the rules for sharing the generated electricity between the individual participants; b) define the DSO's obligations with regard to the reading of electricity meters and the determination of the relevant billing parameters, including the implementation of virtual billing schemes. 11. Prescribe the DSO's obligations regarding the development of standard load profiles of customers who generate electricity for their own needs (when applicable, such as generation in solar photovoltaic power plants).	connection of the power plant for self-consumption needs. 6. Define in detail the functional requirements for power generation modules for self-consumption purposes, in accordance with the relevant categorization defined by the rulebook on power plants connection to the distribution network. 7. Prescribe the obligatory tests that should be carried out during the certification process; prescribe the content of the certificate's accompanying documentation. 8. a) define in detail the technical requirements for the metering point at the point of connection, depending on the applied connection scheme to connect the power plant for self-consumption purposes; b) prescribe the obligation to install smart electricity meters to register generated and consumed electricity, thus providing preconditions for the precise allocation of generated and consumed electricity in shorter time intervals (including the level of the imbalance settlement period at the balancing market). 9. Define in detail the technical requirements for the metering point of the gross electricity generation, depending on the applied connection scheme, and analyze the possibility of using alternative methods to register the generated electricity (registration on the inverter).

Table 10. Connection and integration of power plants for self-consumption needs - Energy communities

No.	Issue	Distribution Network Code	Connection Rules
1.	Energy communities: 1. Definition of the energy community, 2. The right to participate in the energy community, 3. Limitation of the installed capacity of power plants owned by the energy community, 4. Responsibility for maintenance and metering, 5. Connection scheme, 6. Connection procedure, 7. Interface protection requirements, 8. Functional requirements, 9. Certification of power plants, 10. Metering requirements, 11. Metering of gross electricity generated, 12. DSO tasks in the energy billing process, and 13. DSO tasks in the imbalance settlement process.	1. Define the term citizen energy community in accordance with the principles and definition given by EU Directive 2019/944 on common rules for the internal market in electricity. 2. a) define the right of final customers to participate in the energy community; b) define spatial constraints for the participation of final customers in the energy community; c) prescribe the obligation of persons who are members of the energy community to conclude a contract defining members of the energy community, rules for the sharing of generated electricity and other issues of importance for the operation of energy community. 3. Define the rules of limitation of the installed capacity of power plants owned by the energy community. 4. a) define the tasks and responsibilities of entities that perform metering and technical maintenance activities within the internal network of the energy community; b) define the borders of the DSO's responsibilities for system security, metering, network maintenance, and quality of supply. 6. Define that standard connection procedures are applied for connection of power plants owned by the energy community, except in case the microgenerators are installed on existing objects when a simplified connection procedure is applied. 7. Define the basic requirements for the elements of the interface protection relays at the connection point. 8. Define the basic functional requirements for power generating modules owned by the energy community, in accordance with the relevant categorization defined by the rulebook on power plants connection to the distribution network	3. Define the rules on limitation of the installed capacity of power plants owned by the energy community (if applied), in relation to the installed capacity and consumption of customers who are members of the energy community. 5. Define standard connection schemes of energy communities, depending on the right to use the public distribution network when establishing the energy community and the manner the spatial and regulatory boundaries of the energy community are determined. 6. a) define in detail the simplified connection procedure for microgenerators that are installed in/on existing customer's facilities; b) define in detail the conditions for the application of the simplified connection procedure of microgenerators (requirements for interface protection, mandatory functionalities and settings of parameters, qualification of micro-installations). 7. Define in detail the functionalities and parameters of interface protection relays at the point of connection of the power plant for self-consumption needs. 8. Define in detail the functional requirements for power generation modules owned by the energy community, in accordance with the relevant categorization defined by the rulebook on power plants connection to the distribution network. 9. Prescribe the obligatory tests that should be carried out during the certification process; prescribe the content of the certificate's accompanying documentation. 10. a) define in detail the technical requirements for the metering point at the point of connection depending on the applied connection scheme to connect facilities owned by energy community; b) prescribe

No.	Issue	Distribution Network Code	Connection Rules
		9. Prescribe the possibility of submitting an equipment certificate of compliance with the requirements of technical standards BAS EN 50549, instead of performing functional tests of generation modules during the commissioning. 10. Define the basic requirements for the metering point at the point of connection, depending on the applied connection scheme of the energy community. 11. Define the basic requirements for the metering point of gross electricity generation, depending on the applied connection scheme. 12. a) prescribe the obligation of the DSO and the energy community to conclude a contract defining the responsibilities for the administration of collective generation scheme, participants in the collective generation scheme and the rules for sharing the generated electricity between individual participants; b) define the DSO's tasks in the energy billing process depending on the applied connection scheme, and depending on the responsibilities for the administration of the collective generation scheme as determined by the contract between the DSO and the energy community. 13. a) define the DSO's obligations to provide measurement data that are needed for the imbalance settlement of energy communities; b) prescribe the DSO's obligations regarding the development of standard load profiles of energy communities that generate electricity for their own needs (where applicable, such as generation in solar photovoltaic power plants).	the obligation to install smart electricity meters to register generated and consumed electricity, thus setting preconditions for the precise allocation of generated and consumed electricity in shorter time intervals (including the level of the imbalance settlement period at the balancing market). 11. Define in detail the technical requirements for the metering point of the gross electricity generation, depending on the applied connection scheme, and analyze the possibility of using alternative methods to register the generated electricity (registration on the inverter).

Table 11. EV charging stations

No.	Issue	Distribution Network Code	Connection Rules
1.	EV charging stations: 1. Definitions of terms, 2. Categorization of chargers depending on the connection method, 3. Categorization of chargers depending on the charging speed (installed capacity), 4. Technical requirements for chargers, 5. Switching device at the point of connection to the distribution network, 6. Electromagnetic compatibility, 7. Electricity metering, and 8. DSO tasks in the imbalance settlement process.	1. Define basic terms and concepts related to electric vehicles and charging infrastructure. 3. Define the categories of EV chargers depending on the charging speed (charging power), and the type of voltage used for charging. 6. Define the general EMC requirements for EV chargers. 8. Prescribe the DSO's obligations regarding the development of standard load profiles of the EV charging stations.	1. Define the terms and concepts related to the electric vehicles and charging infrastructure. 2. Define the standard connection schemes of EV chargers, depending on whether they are directly connected to the network or sharing the connection with other objects. 3. Define: – categories of very fast direct current (DC) and alternating current (AC) chargers, – categories of fast DC and AC chargers, with and without connecting cable, and – categories of slow DC and AC chargers, with and without connection cable. 4. a) prescribe that electric vehicle chargers must meet requirements of the relevant technical standards of the BAS EN 61851 series: – BAS EN 61851-1 - General requirements, – EN BAS EN 61851- 22 - AC electric vehicle charging station, and – BAS EN 61851-23 – DC electric vehicle charging station; b) prescribe that connector for electric vehicles charging must comply with the requirements of the BAS EN 62196 series of standards; c) prescribe that communication and information exchange between the electric vehicles and electric vehicle chargers must comply with the standards of the BAS ISO 15118 series. 5. Prescribe the obligation to install a switching device at the connection point, which is used for automatic disconnection of the charging station in case of the internal fault or deviation of operating parameters. 6. Define that AC electric vehicles chargers must meet the requirements of the relevant

No.	Issue	Distribution Network Code	Connection Rules
			electromagnetic compatibility standards of the BAS IEC 61000-x-xx series, while DC chargers must meet the requirements of technical standard BAS IEC 61851-21. 7. a) define the metering requirements for electricity that is delivered via electric vehicle chargers, depending on the applied connection scheme of the charging station; b) prescribe the application of the smart electricity meters with the interval metering (including the imbalance settlement period on the balancing market), thus providing preconditions for the tariff design improvements, application of advanced tariff models, imbalance allocation, etc.

Table 12. Electricity storage devices

No.	Issue	Distribution Network Code	Connection Rules
1.	Electricity storage devices: 1. Definitions of terms, 2. Categorization according to the installed capacity, 3. Connection procedure, 4. Standard connection schemes, 5. Application of simplified connection procedure, 6. Certification of storage devices, 7. Technical data provided with the connection application, 8. Functional requirements, 9. Interface protection requirements,	1. Define electricity storage devices as a new category of network users. 2. Define the categories of storage devices depending on the applied connection scheme and installed capacity. 4. Prescribe that electricity storage devices are connected in accordance with the procedure defined for generators of the respective installed capacity. 6. a) define that certification of electricity storage devices is performed in accordance with the conditions and requirements prescribed for generation modules of the respective installed capacity; b) prescribe the possibility of providing an equipment certificate of compliance with the requirements of technical standards BAS EN 50549, instead of carrying out the functional tests of storage devices during the commissioning.	3. Prescribe the application of different connection procedures, depending on whether the storage device is a part of the new final customer installations, or it is subsequently connected within the installations of an existing final customer (with or without a power plant for self-consumption needs). 4. Define standard connection schemes, depending on whether the storage device is connected independently via a separate inverter or via a common inverter in combination with a photovoltaic power plant. 5. Prescribe the application of a simplified connection procedure for the electricity storage devices that belong to the category of microgenerators and that are installed in the existing facilities of final customers.

No.	Issue	Distribution Network Code	Connection Rules
	10. Switching device at the point of connection to the distribution network, 11. Metering requirements, and 12. DSO's representatives' presence during commissioning.	8. Define that electricity storage devices in discharge mode are treated as generation modules and that functional requirements for power generating modules of respective installed capacity apply to storage devices as well. 9. Define basic requirements for the elements of the interface protection relays. 11. Prescribe that the requirements for metering point at the point of connection of the storage devices correspond to the requirements for the power generating modules of the respective installed capacity.	6. Prescribe mandatory tests to be conducted in the certification process. 7. Define standard technical data to be submitted with the connection application. 8. Define that electricity storage devices in discharge mode are treated as generation modules and that functional requirements for power generating modules of respective installed capacity apply to storage devices as well, except for functional requirements for active power response at reduced frequencies (LFSM-U mode) which are mandatory for storage devices. 9. Define in detail the functionalities and parameters of the interface protection relays at the point of connection of the electricity storage devices. 10. Prescribe the obligation to install a switching device at the connection point which is used for automatic disconnection of the storage devices in case of the internal faults or deviation of operating parameters. 11. Define detailed technical requirements for metering devices, depending on whether the storage devices are connected directly to the network or within the installations of the final customer (with or without a power plant for self-consumption needs). 12. Define the installed capacity threshold of storage devices for which the presence of DSO representatives during the commissioning is obligatory.

6. DISTRIBUTION NETWORK DEVELOPMENT PLANNING

This chapter defines recommendations for amendments to distribution network codes to improve the distribution network development planning process. Specific requirements address the issues of importance for distribution network development planning in changed circumstances which are primarily related to the integration of distributed resources, definition of planning scenarios and optimization of investment costs.

Changes to the structure of the power system with increased penetration of distributed generators, the emergence of electricity storage devices, new categories of electricity consumers and demand response services, with a constant growing trend of electrification in the transport and space heating sectors, inevitably leads to lower reliability of planning data used in the network development planning process.

The advantages of conventional, deterministic network development planning methods are reflected in the application of a relatively simple network model, a systematic approach in the selection of planning scenarios (extreme scenario and unforeseen events), an application of standardized methods for forecasting network user needs, and a focus on capital investment costs.

However, the shortcomings of the conventional planning methods are reflected in their dependence on reliable planning data on consumption and production portfolios, insufficient assessment of the impact of distributed resources on the security of supply, and insufficient consideration of operating costs over the lifetime of distribution network elements.

The key aspects of improvement of the distribution network development planning process, that are addressed in this document relate to:

- Normative regulation of the planning process,
- Scope and manner of providing input data used in the planning process,
- Definition and optimization of the various criteria and constraints in the planning process,
- The impact of distributed resources on the determination of the required capacity of network elements from the security of supply perspective, and
- Optimization of capital and operating costs of investments.

The basis for the preparation of the summary overview includes a detailed analysis with recommendations for the harmonization of relevant regulations for each individual DSO in BiH.

The identified recommendations for improvement of distribution network development planning process are given in Table 13 below.

Table 13. Recommendations for improvement of distribution network development planning process

No.	Issue	Distribution Network Code	Methodology for designing a distribution network development plan
1.	Distribution network development and planning: 1. Obligation to design distribution network development plans, and 2. The process of designing distribution network development plans.	1. a) prescribe the obligation to design distribution network development plans, the planning period and the periodicity of preparation and innovation; b) prescribe deadlines for submission of distribution network development plans for approval to the regulatory commission. 2. a) define the principles of designing the distribution network development plans; b) define the consumption forecasting scenarios applied in designing distribution network development plans; c) prescribe the obligations of network users to provide the data which are needed to design distribution network development plans; d) prescribe the DSO's obligations to cooperate with the competent authorities and institutions for the purposes of drafting and adjusting the distribution network development plans; e) prescribe the DSO's obligations regarding the implementation of the public consultation procedure upon the proposal of the distribution network development plans; f) prescribe the DSO's obligation to set a methodology for the preparation of the distribution network development plans (separate document or annex to the Grid Code). Define the procedure for approving the methodology or informing the regulatory commission.	
2.	Criteria for preparation of the distribution network development plan: 1. Criteria for drafting a 10-year network development plan, 2. Planning scenarios, and	1. Define general criteria for the preparation of distribution network development plans. 2. Prescribe the obligation to determine planning scenarios for the preparation of the network development plans. 3. a) prescribe the application of stochastic planning methods of distributed generation and distribution	1. a) define detailed criteria for the preparation of distribution network development plans; b) rank the planning criteria according to priorities and constraints, considering the business policy of the DSO. 2. a) define the rules for determination of the planning scenarios (extreme network conditions), that are

No.	Issue	Distribution Network Code	Methodology for designing a distribution network development plan
	3. Distributed generation planning. 4. Consumption planning, 5. Impact of distributed resources on the required capacity of the distribution network from the security of supply perspective, 6. Distributed resources contribution to the security of supply, and 7. Power curtailment of distributed generators.	network development; b) prescribe the DSO's obligation regarding the calculation of the DG hosting capacity at network nodes where the presence of DGs is already increased or in a situation where the connection capacity is limited due to the low level of three-phase short circuit capacity. 5. a) prescribe that impact of distributed resources on the assessment of security of supply of network elements according to the criterion "n-1", is taken into account; b) prescribe the DSO's obligation to coordinate with the TSO the application of the criterion "n-1" at the interface point between the transmission and distribution network. 6. Define the categories of distributed resources for the security of supply assessment purposes. 7. a) define the congestion management in the distribution network as an ancillary service, as a basis for contracting flexibility services with distributed generators; b) define the manner of regulating the contractual and commercial relations between DSOs and providers of the congestion management services in the distribution network.	applied as a basis for the preparation of the distribution network development plans, under conditions of increased penetration of distributed resources; b) prescribe the application of statistical methods to determine the extreme network states, which consider the probability of occurrence of existing and assumed critical conditions, events and loads in the distribution system. 3. a) define the methods for planning distributed generation and collection of input data, as well as criteria for inclusion of the planned power plants in network planning scenarios; b) prescribe the conditions in which stochastic network development planning criteria can be applied; c) prescribe the method and rules for calculation of the DG hosting capacity for the DG connection purposes. 4. Define consumption planning methods, which in addition to statistical methods which are based on the consumption realized in the historical periods and defined development scenarios, may include the "bottom-up" analysis that could be performed for the distribution network segments in which the impact of one or more external factors (economic, demographic, energy, etc.) is particularly evident. 5. Define methods to assess the security of supply of distribution network elements in accordance with the "n-1" criterion, considering the internal reserve capacity, transfer capacity and the contribution of distributed resources in reducing the load from the transmission network. 6. Define rules for the determination of the distributed resources contribution to the security of supply, depending on the type of distributed resources and the manner of regulating relations with the DSO (with and without a concluded service provision contract).

No.	Issue	Distribution Network Code	Methodology for designing a distribution network development plan
3.	Investment planning: 1. Investment cost benefit analysis (CBA), 2. Analysis of costs in the planning process, and 3. Selection of an optimal conductor cross section.	1. Prescribe the DSO's obligation to prepare a cost-benefit analysis for individual projects (above a certain threshold of investment value, installed capacity or voltage level), as a precondition for its inclusion in the network investment plan. 2. Prescribe that techno-economic optimization of a variant solutions of the distribution network development, includes both the capital and operating costs during the lifetime of the network assets. 3. Prescribe that selection of the distribution lines conductors' cross-section is performed on the basis of minimum capital and operating costs during its lifetime.	1. Define minimum thresholds for the investment value, installed capacity or voltage level for which the preparation of the CBA is mandatory for individual projects to be included in the network investment plan. 2. a) define the categories of capital and operating costs/benefits that are taken into account when preparing a CBA of the planned projects; b) define the methodology for the preparation of the CBA which is used to optimize the variant solutions of the distribution network development. 3. a) define the methodology for determination of the optimal cross-section of distribution line conductors, which is based on an analysis of the capital and operating costs over the lifetime of the power line; b) define the categories of operating costs that are taken into account in determination of the optimal cross-section of distribution line conductors.

7. REQUIREMENTS FOR ENERGY EFFICIENT POWER TRANSFORMERS

This chapter defines recommendations for the harmonization of distribution network codes with the requirements for energy efficient power transformers given by EU Regulation 548/2014 on the implementation of Directive 2009/125 / EC of the European Parliament and of the Council on small, medium and large power transformers (with changes and amendments given by Regulation 2282/2016 and Regulation 1783/2019).

EU Regulation 548/2014, together with the corresponding amendments, is an implementing Act that implements EU Directive 125/2009 establishing a framework for the setting of eco-design requirements for energy-related products. The Regulation defines the requirements for energy efficient power transformers in terms of allowed load and no-load losses and minimum peak efficiency index. The regulation envisages a gradual increase in the requirements for the efficiency of power transformers, starting from July 1, 2015, when the binding requirements were defined as "Tier 1" requirements, and from July 1, 2021, when the binding requirements in the EU were defined as "Tier 2".

Regulation 548/2014, as amended, is still not part of the binding "Acquis Communautaire" of the Energy Community, which Bosnia and Herzegovina is obliged to apply under the Energy Community Treaty. Notwithstanding this fact, the application of technical requirements given by the Regulation is recommended in order to harmonize the requirements in this area with European best practices. It also aims to increase energy efficiency in electricity distribution, in order to install power transformers that have a proper level of quality that is already available on the European market.

The basis for the preparation of the summary overview includes a detailed analysis with recommendations for harmonization of relevant regulations for each individual DSO in BiH.

The recommendations for harmonization of the requirements for energy efficient power transformers are given in Table 14 below.

Table 14. Requirements for energy efficient power transformers

No.	Issue	Distribution Network Code	Technical specifications of power transformers with reduced losses
1.	Subject and scope of application.	• Define the application scope of technical requirements and specifications for energy efficient power transformers (liquid immersed and dry type). • Define the obligation to reassess the conformity of medium and large power transformers in the event of significant interventions on the transformer.	• Depending on the asset management strategy and strategical decisions of the DSO regarding the type of transformers that are installed in the distribution network, define the requirements for dry-type power transformers if relevant.
2.	Categorization and Definitions.	• Prescribe the basic categorization of power transformers and definitions in accordance with the definitions given by Regulation 548/2014 (as amended).	
3.	Eco-design requirements (Annex I of the Regulation).	• Prescribe general requirements for energy efficiency of power transformers that are installed in the distribution network. • Define the timeframe for the application of requirements for load losses and no-load losses of energy transformers classified as Tier 1 and Tier 2 (Annex I of Regulation 548/2014).	• Prescribe detailed requirements for load losses and no-load losses or for minimum peak efficiency index of the medium-sized power transformers, in accordance with Annex I of Regulation 548/2014 (as amended). • Prescribe detailed requirements for the minimum peak efficiency indexes of the large power transformers, in accordance with Annex I of Regulation 548/2014 (as amended). • Prescribe detailed requirements for load losses and no-load losses of the power transformers intended for installation on a pole, having a rated voltage 10 (20) /0.4 kV, in accordance with Annex I of Regulation 548/2014 (as amended). • Define requirements for load losses and no-load losses of the medium-sized dry-type power transformers, in accordance with Annex I of Regulation 548/2014 (as amended).
4.	Exemptions from application.	• Define the conditions in which special conditions or exemptions from the application of requirements for load losses and no-load losses of power	

No.	Issue	Distribution Network Code	Technical specifications of power transformers with reduced losses
		transformers apply in the circumstances defined by Regulation 548/2014 (as amended).	
5.	Calculation of the peak efficiency index.		• Prescribe the methodology for calculation of the peak efficiency index of medium and large power transformers in accordance with Annex 2 of Regulation 548/2014 (as amended).

8. REQUIREMENTS FOR DEMAND SIDE MANAGEMENT SERVICE PROVIDERS

This chapter provides recommendations for the harmonization of distribution network codes in relation to the requirements for demand response service providers.

Demand response services are defined by the Network Code on Demand Connections (NC DC). This document addresses the explicit demand response schemes[15] ("incentive-based" schemes), where individual or aggregated demand resources are used to trade flexibility in the wholesale and balancing markets or to manage congestion in the distribution network.

In this way, consumers (owners of facilities that provide demand response services) receive direct payments to change their own consumption at the request of service users, through the activation of balancing energy, resolving network congestion or participation in the wholesale market based on differences in electricity prices.

The basis for the preparation of the summary overview includes a detailed analysis with recommendations for harmonization of relevant regulations for each individual DSO in BiH.

The recommendations for harmonization of the distribution network codes in relation to the requirements for demand response service providers are given in Table 15 below.

[15] In addition to explicit, there is an implicit demand response ("price-based schemes") for consumers who choose to be exposed to the time-varying electricity prices or network tariffs. In this case, they react to changes in prices from the wholesale market or dynamic network tariffs.

Table 15. Requirements for demand response service providers

No.	Issue	Distribution Network Code	Connection Rules
1.	Definitions of terms.	• Define basic terms which are related to the provision of demand response services at the distribution level. • Define basic terms which are related to the aggregation of distributed resources.	
2.	Types of demand response services.	• Define types of demand response services in accordance with Article 27 of the NC DC. • Define in detail and separate the responsibilities of the consumer (aggregator) who provides flexibility services and the supplier which is in charge of electricity supply.	
3.	Classification of demand units that provide demand response services.	• Define the categories of demand units that provide flexibility services (according to the type of services, voltage level, or method of providing services).	
4.	Connection method and procedures.	• Prescribe the application of standard connection procedures for demand units that provide demand response services, that also includes the pre-qualification to prove the capability of the demand units to meet the prescribed requirements for the specific type of services.	
5.	Requirements for pre-qualification of demand response service providers.	• Prescribe the obligation to carry out a pre-qualification procedure which proves that the demand units that provide demand response services for the DSO needs, meet the necessary technical and other requirements for the provision of services, directly or through a third party (aggregator). • Prescribe the DSO's obligation to define the pre-qualification procedure for the providers of demand response services for the DSO's needs. • Prescribe the application of the pre-qualification procedure defined by the TSO for the providers of frequency regulation services.	

No.	Issue	Distribution Network Code	Connection Rules
6.	Communication requirements between the network user facilities (aggregator) and the control center of the system operator.	• Prescribe the general obligation of the network user regarding the fulfillment of IT and telecom requirements prescribed by the relevant system operator.	• Define IT and telecom requirements for communication between the network user facilities (aggregator) and the control center of the system operator.
7.	Requirements for the exchange of information technology (IT) and telecom data.		• Prescribe detailed requirements for the exchange of data and information between system operators and aggregators, relating to the concept, characteristics and relevant operational data on IT and telecom systems.
8.	Requirements for metering devices in customer facilities that provide demand response services.	• Prescribe the obligation to install a separate electricity meter that registers only the sub consumption of the demand units that provide the service, applicable in case when only one part of the customer's facilities provides a demand response services.	• Define the requirements for the main metering point and the sub-consumption metering point of the customers who provide the demand response service. • Prescribe the obligation to install smart electricity meters.
9.	Requirements for provision of real-time measurement and statuses.	• Prescribe the general obligation of the customers who provides demand response services to provide real-time measurements and data.	• Prescribe technical requirements for a real-time measurement and monitoring system between the customer's facilities providing the demand response services and the network operator which is a service user.
10.	Billing data exchange requirements.	• Prescribe the rules for the exchange of data that are needed for quantification and settlement of demand response services.	

9. REQUIREMENTS FOR POWER QUALITY MONITORING IN THE DISTRIBUTION NETWORK

This chapter provides recommendations for harmonization of distribution network codes with the requirements related to power quality monitoring[16] at the distribution level. The power quality, together with the continuity of supply and the quality of commercial services[17] make up the quality of electricity supply. Only the power quality requirements will be discussed in this chapter.

EU Directive 2009/72 on common rules for the internal market in electricity does not define the quality of service but emphasizes the obligation of Regulatory Authorities to set or approve the standards and requirements regarding service quality (Article 37 (1) (h)). Requirements to maintain a specific level of power quality exist in all European countries, either through the international standard EN 50160 or national regulations. The responsibility for maintaining the required level of power quality lies entirely with the network operator, while the Regulatory Body is responsible for adoption of the appropriate regulatory and legal framework and monitoring the quality of supply.

The basis for the preparation of the summary overview includes a detailed analysis with recommendations for harmonization of relevant regulations for each individual DSO in BiH.

The recommendations for establishment of a power quality monitoring system in the distribution systems are given in Table 16 below.

[16] The term refers to all disturbances in the electricity supply except for interruptions.
[17] It represents the quality of the commercial relationship between the power company and the customer.

Table 16. Requirements for the power quality monitoring system

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
1.	Definition and categorization of voltage disturbances.	• Define and categorize voltage disturbances.	
2.	Application of the standards BAS EN 50160 and BAS IEC 61000-x-xx in the legal and regulatory framework.	• Prescribe the applicability of power quality standards BAS EN 50160 and electromagnetic compatibility standards BAS IEC 61000-x-xx.	
3.	Power quality requirements at the interface point with TSO.	• Prescribe the manner of regulation and maintaining of power quality at the interface points with TSO.	
4.	Conditions when the standard BAS EN 50160 does not apply.	• Prescribe conditions in which the standard BAS EN 50160 is not applied, such as temporary conditions during faults or network maintenance works, non-compliance of network users' equipment with relevant standards, and in exceptional situations affecting the operation of the distribution system.	
5.	Contracting a higher level of power quality.	• Prescribe the possibility and conditions for concluding contracts with a higher level of power quality with individual network users.	
6.	Limitation of emissions from network users' facilities.	• Prescribe permitted emissions of individual network users, including active customers, in accordance with technical standards BAS IEC 61000-3-xx series.	
7.	Standards for power quality measurement.	• Prescribe the application of the technical standard BAS EN 61000-4-30 for the power quality measurements in the distribution network.	• Prescribe the application of the technical standard BAS EN 61000-4-30 for the power quality measurements in the distribution network.
8.	Classes of power quality instruments.		• Define classes of metering instruments in accordance with the standard BAS EN 61000-4-30, define the method and conditions of application.

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
			• Prescribe that voltage quality metering instruments must comply with the technical standards BAS EN 62586-1[18] and BAS EN 62586-2[19].
9.	Application of alternative devices for power quality monitoring.	• Prescribe that alternative device such as smart electricity meters, protection relays, control devices, remote thermal units (RTUs), may be used for the power quality monitoring.	• Describe the technical capabilities of alternative devices for the power quality measurements and define the manner and conditions of their application.
10.	Communication with power quality instruments.		• Prescribe requirements for the communication protocols that are applied for communication between the power quality instruments and data processing and storage center.
11.	Measured voltages.		• Define the way the voltage is measured, depending on the voltage level at which the voltage characteristics are assessed. • Prescribe that connection of the power quality instruments at the three-phase network users is done in all three phases.
12.	Instrument transformers.		• Define the conditions of using the measuring and protective windings of instrument transformers, depending on the measurement objectives. • Define the conditions for the application of inductive voltage measuring transformers for measurements of the higher voltage harmonics.
13.	Time aggregation of measurements.		• Define the basic time interval of measurements depending on the parameter being observed. Define the rules of aggregation of measurements and measurement intervals.

[18] IEC 62586-1:2017 Power quality measurement in power supply systems - Part 1: Power quality instruments (PQI).
[19] IEC 62586-2:2017 Power quality measurement in power supply systems - Part 2: Functional tests and uncertainty requirements.

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
			• Define the period of aggregation of measured quantities. • Provide for the possibility of applying shorter aggregation periods in case the more detailed assessments of system performance are needed and where the contracts on a higher level of power quality are applied.
14.	Resolution of measurements.		• Prescribe the requirements for a sampling rate that should be at least twice as high as the highest observed harmonic of the measured quantity.
15.	Time accuracy.		• Define the requirements for the time accuracy of the power quality instruments, depending on the purpose of the measurement. • Prescribe specific requirements for the measurements that include recording of waveforms and transient phenomena, and in the case when the measurement results are compared with recordings from other instruments.
16.	Concept of flagging.		• Define the application of the flagging concept in accordance with the technical standard BAS EN 50160, which refers to the ten-minute periods during which a voltage sag increases or interruption occurs. • Prescribe the obligation to remove "marked" ten-minute values from the statistics of measured quantities.
17.	Special measurements of power quality.		• Prescribe the obligation to perform special measurements with the instruments that have higher resolution in relation to the requirements of the technical standard BAS EN 50160. Special measurements should be carried out in case of detection of disturbances or damage to equipment and processes due to transient phenomena.

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
18.	Measurement period.	Prescribe the types of power quality measurements depending on the period of measurement (continuous and periodic).	• Define the conditions and manner of application of continuous and periodic power quality measurement. • Define the rules of continuous monitoring of power quality in the MV network. • Define the rules of monitoring of power quality in the LV network from the aspect of measurement duration. • Define the minimum duration of the measurement period when the portable power quality instruments are applied. • Define the possibility of a longer duration of the measurement period depending on the characteristics of the operating cycle of the network user.
19.	Objectives of power quality measurement.	• Define the basic objectives of power quality measurement, which include: • Assessment of compliance and performance of the distribution network, • Assessment of power quality at a specific location, and • Resolving the power quality problems.	• Prescribe in detail the reasons for the power quality measurements and categorize them according to the purpose of measurement. • Prescribe the rules for the selection of measuring locations depending on the objectives of power quality measurement.
20.	Assessment of system performance depending on network characteristics.		• Define that assessment of system performance is made depending on the specific characteristics of the observed part of the distribution network, such as voltage level, network type, neutral point grounding arrangements, presence of distributed generators, or customer type.
21.	Monitoring of locations for which a contract on a higher level of power quality has been concluded.		• Define the rules for power quality monitoring at locations where a contract on a higher level of power quality has been concluded.

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
22.	Monitoring of sites with potential power quality problems.	• Prescribe the obligation of the DSO to establish and maintain registers of MV/LV substations areas with unsatisfactory power quality.	• Establish a list of predefined criteria based on which the specific site can be categorized as a site with a potential power quality problem. • Define the rules of establishing and maintaining the register of MV/LV substations with unsatisfactory power quality.
23.	Monitoring the connection points of distributed generators.		• Define the rules for power quality monitoring at the connection points of distributed generators.
24.	Selection of measurement parameters.		• Define that selection of measurement parameters is performed depending on the objectives of measurements and measurement data usage.
25.	Data format.		• Prescribe the application of standardized data formats to the extent possible, depending on the degree of standardization achieved at the international level.
26.	Reporting and publishing the power quality data.	• Define the DSO's obligations to report the Regulatory Commission and network users regarding the power quality data at the distribution network and individual level, respectively. • Define the DSO's obligations to prepare and publish the reports on the power quality in the distribution network.	
27.	Power quality reporting methods for an individual measurement location.		• Define the requirements for the preparation of reports on power quality, which relate to the calculation of indicators and indices of measured quantities, graphical and tabular presentation of measured quantities. • Define that graphical display of continuous phenomena (disturbances) can consist of diagrams of measured quantities in time, histograms of disturbance levels, contour displays of voltage disturbances, displays of voltage dips on the equipment tolerance curve or on the FRT curve.

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
			• Define that the tabular data display can be applied to display voltage dips and swells according to the magnitude of deviation and duration, display the voltages and currents of higher harmonics, display the indices of measured quantities in the reporting period, which includes several periods of data analysis. • Define the rules for the presentation of indices for disturbances that occur in all three phases.
28.	Power quality reporting methods for the multiple measurement locations.		• Define the requirements for the preparation of power quality reports for the multiple locations, which relate to the calculation of indicators and indices of measured quantities for multiple locations, graphical and tabular presentation of measured quantities, and presentation of trends.
29.	Voltage dip reporting method.		• Define the rules for registration of voltage dips in all three phases, and presentation of the measurement results in accordance with the technical brochure CIGRE TB 412[20] or the international standard IEEE 1564[21].
30.	Content of the power quality report.	• Define the framework content of the power quality report.	• Prescribe the detailed content of the annual power quality report.
31.	Costs of power quality monitoring system.	• Define the rules for costs recovery of the power quality monitoring, depending on the measurement purposes (network usage tariffs, fees charged through individual contracts with increased power quality or fees charged to network users at whose request the measurement was performed).	

[20] CIGRE TB 412 Voltage Dip Immunity of Equipment and Installations, 2010.
[21] IEEE 1564 - Guide for Voltage Sag Indices, 2014.

No.	Issue	Distribution Network Code	Guidelines for establishing a power quality monitoring system
		• Define the DSO's obligation to separately record the capital and operating costs of the power quality monitoring system.	

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