
SECOND SCHEDULE

(Made under Rule 4)

THE DISTRIBUTION CODE

ENERGY AND WATER UTILITIES REGULATORY AUTHORITY (EWURA)

The Tanzania Electricity Distribution Code

Version 1

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Acronyms

Standard SI symbols and abbreviations are used throughout the Distribution Code without re-definition here.

AC: Alternating Current

KVA: Kilo Volt Ampere

CAIDI: Customer Average Interruptions Duration Index

CAIFI: Customer Average Interruptions Frequency Index

CT: Current Transformer

CTI: Confederation of Tanzania Industries

EAPP: Eastern Africa Power Pool

EAPP IC: Eastern Africa Power Pool and East African Community Interconnection Code

E/F: Earth Fault

EMS: Energy Management System

EPP: Emergency Power Producer

EWURA: Energy and Water Utilities Regulatory Authority

DCMC: Distribution Code Management Committee

DNO: Distribution Network Operator

FCT - Fair Competition Tribunal

HV: High Voltage

Hz: Hertz

ICC: Installation completion Certificate

IEC: International Electrotechnical Commission

MAIFI: Momentary Average Interruptions Frequency Index

MV: Medium Voltage

MVA: Megavolt-Ampere

MW: Megawatt

PoC: Point of Connection

PPC: Point of Common Coupling

REA: Rural Energy Agency

SAIDI: System Average Interruptions Duration Index

SAIFI: System Average Interruptions Frequency Index

SCADA: Supervisory Control and Data Acquisition

SPP: Small Power Producer

SPD: Small Power Distributor

EPP: Emergency Power Producer

SO: System Operator

TCCIA: Tanzania Chamber of Commerce Industry and Agriculture

THD: Total Harmonic Distortion

VSPP: Very Small Power Producer

1. Preamble

1.1. Introduction

The preamble provides the context for the Distribution Code and its various sub-sections. It also contains detailed definitions and acronyms of the terms used in the Distribution Code.

1.2. Policy

1.2.1. Electricity Industry Structure

- a) The current structure of the power sector in Tanzania is illustrated in figure 1 below.

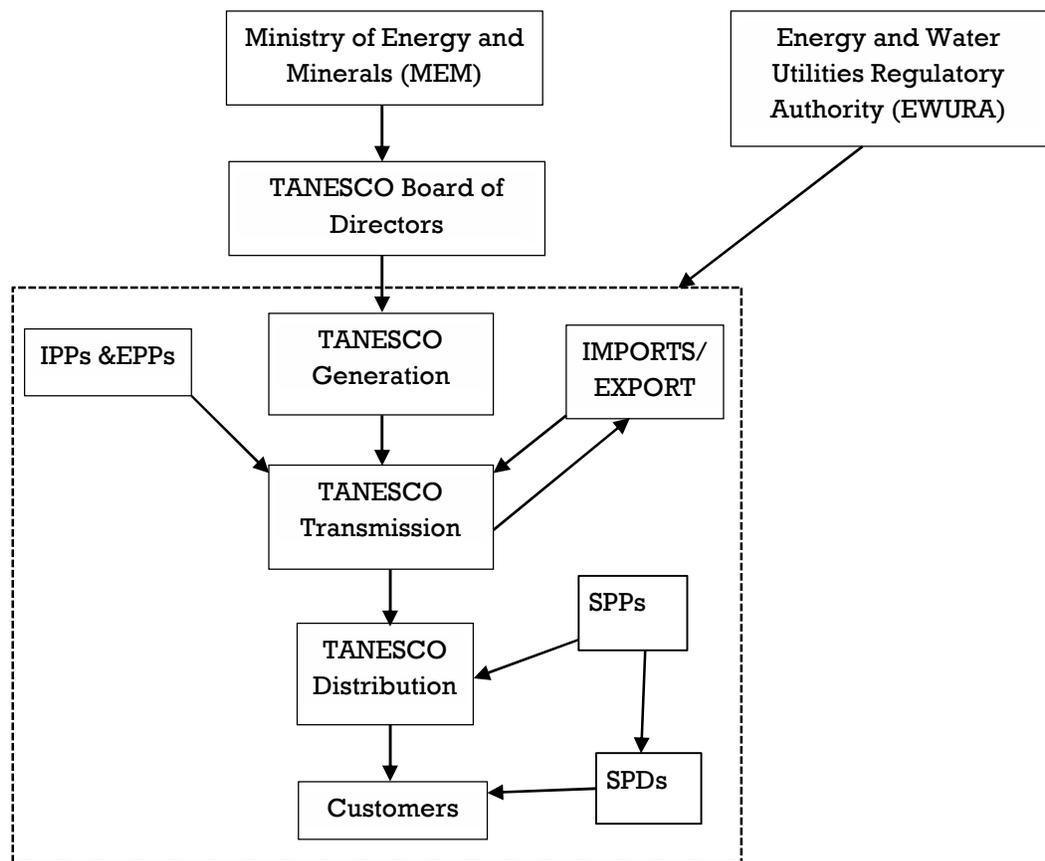


Figure 1: Tanzania Power Sector Structure

- b) The Ministry of Energy and Minerals (MEM) oversees the power sector direction, and appoints TANESCO's Board of Directors. The Energy and Water Utilities Regulatory Authority (EWURA) is an autonomous multi-sectoral regulatory authority. It is responsible for technical and economic regulation of, among others, the electricity sector.
- c) The Tanzania Electric Supply Company Limited (TANESCO) is a state owned, vertically integrated company carrying out generation, transmission and distribution. Under the current market structure, the System Operator is part of TANESCO Transmission.

- d) Independent Power Producers (IPPs) are licensed to operate in the generation segment. In addition, interconnections with Zambia and Uganda enable imports of electricity. TANESCO Transmission acts as the single buyer for the purchases of this power.
- e) Tanzania electricity market is vertically integrated; TANESCO generates imports and buys power in bulk from IPPs under a single buyer model and transports it over the transmission and distribution networks for resale to its customers.
- f) Small Power Producer” (“SPP”) is a licensed entity that generate electricity in the capacity between one hundred (100) kW and ten (10) MW using Renewable Energy, fossil fuels, a cogeneration technology, or some system combining fuel sources mentioned above, and either sells the generated power to TANESCO at wholesale, or directly to a Customer or Customers. An SPP may have an installed capacity greater than ten (10) MW but shall only export power at the Interconnection Point not exceeding ten (10) MW¹;
- g) Small Power Distributor (SPD) is a licensed entity that purchases electricity at wholesale prices from TANESCO or some other bulk supplier and resells at retail prices to Customers. An SPD may also have a generator that qualifies for SPP or VSPP status and may use this generator to sell power to a DNO or some other Buyer, or to provide a backup supply of power to its own Customers;
- h) Emergency Power Producer (EPP) is a licensed entity that generates electricity and sells to TANESCO on short term basis, following an emergency declaration by the Minister responsible for electricity supply.

1.2.2. Electricity Industry Reform

Tanzania will continue to pursue its on-going reform programme in the power sector in phases as follows:

- a) In the immediate term TANESCO is expected to, among other things, ring fence its Strategic Business Units, reduce system losses, assess human capital needs, undertake capacity building and prepare for appropriate regulatory environment.
- b) In the short term, the reform will result in unbundling of the generation segment from transmission and distribution, designation of an Independent System Operator (ISO) and the Independent Market Operator (IMO); creation of semi-autonomous Zones, reduction of system losses, development of management programs to support existing and new roles.
- c) In the medium-term, reform will see the unbundling of distribution from transmission segment into Zonal distribution entities thus allowing generators to sell electricity directly to bulk off-takers while paying wheeling charges for the company responsible for transmission infrastructure; strengthening the IMO; increasing electricity connection levels, reducing system losses and setting up of retail market.
- d) In the long term, the plan ultimately envisages the evolution from a single buyer market structure, with long-term PPAs with TANESCO, to a wholesale power market, in which the producers sell directly (or through a pool or voluntary electricity exchange) to distribution companies. Under this future market

¹ A generator shall not split its capacity that is greater than 10 MW in order to be eligible as an SPP and sign more than one contract for the total capacity available

structure, the roles and relationships associated with Transmission, System Operation and Distribution are likely to change and that the Distribution Code will need to be updated accordingly.

- e) In order to ensure that the goals of the reform process are achieved, it is imperative that various arrangements are put in place that outline how the various parties in the electricity supply industry are expected to interact. The Distribution Code represents one such arrangement with the aims of facilitating and governing open and non-discriminatory access to the distribution system, setting standards for reliable and stable operation of the interconnected system, technically and commercially. The Distribution Code thus addresses the needs of the current market structure while taking cognisance of anticipated market reforms.

1.3. Authority

1.3.1. Legislation

- a) The Distribution Code derives its legal mandate from the Electricity Act, Cap. 131 and from the Energy and Water Utilities Regulatory Authority (EWURA) Act, Cap. 414.
- b) The Authority shall pursuant to Section 5 of the Electricity Act, have powers to:
 - i) award licences to entities undertaking or seeking to undertake a licensed activity;
 - ii) approve and enforce tariffs and fees charged by licensees;
 - iii) approve licensees' terms and conditions of electricity supply; and
 - iv) approve initiations of the procurement of new electricity supply installations.
- c) Sections 8(1) and (2) of the Electricity Act specify the following activities as requiring a licence, unless the person or activity is exempted by the Authority:
 - i) Generation;
 - ii) Transmission;
 - iii) Distribution;
 - iv) Supply;
 - v) System Operation;
 - vi) Cross-border electricity trade;
 - vii) Physical and financial trade in electricity; and
 - viii) Electrical installation.
- d) Furthermore, Section 45 (b) (vi) of the Electricity Act states that the Authority may, make Rules with respect to codes of conduct to be complied with. The Distribution Code is one such code of conduct.

1.3.2. Multiple Licences

- a) Several of the licences identified above may be held by a single entity. The decision to grant multiple licences to a single entity depends on the functions that the company must fulfil.

- b) A DNO may, for example, hold licences for transmission, supply, system operation, cross-border electricity trade, physical and financial trade in electricity and electrical installation.

1.3.3. Applicability

- a) All licensees are required to comply with the provisions of the Act, Regulations and approved codes, specifically Section 21(2) of the Electricity Act requires a distribution licensee to comply with the applicable requirements of the Distribution Code, subject to conditions of licence and rules issued by the Authority. Any breach could result in the suspension or withdrawal of the licence or fine.
- b) In terms of Section 18(1) of the Electricity Act, the Authority may grant exemptions to the licence conditions and code requirements.
- c) The Distribution Code is applicable to all Distribution System Participants registered in accordance with the Distribution Code Governance.

1.4. Distribution Code

1.4.1. Definition

The Electricity Act defines the Distribution Code as technical and procedural rules and standards issued by the Authority governing matters pertaining to the distribution of electricity.

1.4.2. Objectives

- a) The objective of this Code is to regulate the Distribution activities so that they are undertaken in a safe, efficient, reliable and economical manner.
- b) In order to achieve this goal, the Distribution Code must:
 - i) be objective;
 - ii) be transparent;
 - iii) be non-discriminatory;
 - iv) be consistent with Government policies;
 - v) define the obligations and accountabilities of all the parties;
 - vi) specify minimum technical requirements for the Distribution system; and
 - vii) be available.
- c) The Distribution Code provides the following assurances:
 - i) To the Authority, the assurance that the licensees operate according to the respective licence conditions.
 - ii) To customers, the assurance that licensees operate transparently and provide non-discriminatory access to their defined services.
 - iii) To licensees, the assurance that customers will honour their mutual Distribution Code obligations and that there is industry agreement on these.

1.4.3. Distribution Code Overview

a) The Distribution Code covers a range of issues, including governance, technical, commercial and operational. In order to present these issues in a structured way, the Distribution Code is divided into ten (10) sections as follows:

- i) Preamble;
- ii) Governance;
- iii) Connection Requirement;
- iv) Operations;
- v) Metering;
- vi) Performance Standards;
- vii) Planning;
- viii) Information Exchange;
- ix) Asset Management; and
- x) General Conditions.

b) The key aspects of each of these sections are briefly described below.

- i) **Preamble** provides the context for the Distribution Code and its various subsections. It also contains detailed definitions and acronyms of the terms used in the Code.
- ii) **Governance** sets out how the Distribution Code will be managed, which includes the formation of Distribution Code Management Committee and its operating procedures; transparency and non-discrimination procedures, as well as complaints and dispute resolution procedures.
- iii) **Connection Requirement** focuses on equipment which has to be provided by the DNO; customers connection arrangements to the distribution system; customer application procedures; connection conditions; health, safety and emergency handling procedures; disconnections and reconnection procedures and handling of illegal electricity supply issues.
- iv) **Operations** deals with procedures for operating a distribution network, including responsibilities of participants; authority of participants; operational liaison; emergency and contingency planning; abnormal conditions operations; independent action by participants; demand and voltage control; fault and reporting analysis; maintenance programs; testing and monitoring; safety coordination; disconnection and reconnections procedures; commissioning and connection; outage scheduling and coordination as well as tele-control.
- v) **Metering** explains procedures for handling metering system issues which include, installations; maintenance; security; testing and commissioning; meter audit and accuracy testing as well as metering disputes.

- vi) **Performance Standards** focuses on requirements of power quality issues including, quality and reliability of supply; protection; load power-factor; earthing; losses and guaranteed service level.
- vii) **Planning** sets out framework for distribution network planning development and network investment criteria.
- viii) **Information Exchange** sets out requirements for information exchange interface during planning and operations.
- ix) **Asset Management** sets out requirements and procedures for good asset management in the distribution network.
- x) **General Conditions** explain about liability, Force Majeure as well as health, safety and environment.

1.5. Definitions

The glossary of definitions and acronyms is set out taking cognisance of the international and regional context, recognising that some terms are, however, only used in the Tanzanian market.

Act – means the Electricity Act, Cap. 131.

Authority – means the Energy and Water Utilities Regulatory Authority established under EWURA Act, Cap. 414.

Bus bar- means an electrical conductor at a substation where incoming and outgoing electric lines, transformers and other equipment are connected.

Cross-border electricity trade – means trading in electricity between two countries sharing a common border through an interconnector power line, but linked through a power pool, which involves export or import of energy between the countries.

Customer Service Charter – means a document that sets out terms and conditions of provision of service, rights and obligations of a licensee and customers.

Customer – means a person who purchases or receives electricity for own use or sale.

Data – means factual information in numerical form (measurements or statistics) used as a basis for reasoning, discussion, or calculation (See Information).

Day - A period of 24 consecutive hours commencing at 00:00 hours and ending at 24:00 hours.

Distribution - means the transportation of electric energy and power by means of medium to low voltage lines, substation equipment and associated meters, including the construction, installation, operation, management and maintenance of such lines, equipment and meters.

Distribution Code – means the technical and procedural rules and standards issued by the Authority governing matters pertaining to the distribution of electricity.

Distribution Licensee – means a licensee authorised to undertake distribution activities.

Distribution System - mean an electricity network consisting of assets (including: substations, transformers, cables, lines and associated equipment), which are operated at Medium Voltage and Low Voltage.

Distributor Network Operator- means a licensed entity that owns operates and maintains a Distribution system.

Distribution Code Participant - means any legal entity that falls under the mandate of the Distribution Code and registered as set out in the Distribution Code.

Electricity supply industry – includes electricity generation, electric power transmission, electricity distribution and electricity supply.

Eligible Customer – means any person who is authorised by the Authority to enter into contract for the supply of electricity directly with any person licensed to generate electricity.

Embedded generator - means an electricity generator, other than a co-generator, that is supplying electricity in the Distribution Network and not directly connected to the Transmission System.

Emergency - means a situation where Transmission or Distribution licensees have an unplanned loss of facilities, or another situation beyond their control, that impairs or jeopardises their ability to supply their system demand.

Emergency outage - means an outage when plant has to be taken out of service so that repairs can immediately be effected to prevent further damage or loss.

End-use customer - means a user of electricity of different classes such as Domestic, Commercial and Industrial.

Energy Management System - means a system of (usually computer-aided) tools used by operators of electric utility Distributions to monitor, control, and optimize the performance of the generation and/or transmission system. The monitoring and control functions are known as System Control and Data Acquisition (SCADA); the optimization packages are often referred to as "advanced applications".

EWURA Act – means the Energy and Water Utilities Regulatory Authorities Act, Cap. 414.

Fair Competition Tribunal- means a tribunal established under the Fair Competition Act, 2003.

Forced outage - means an outage that is not a Planned Outage.

Frequency - means the number of oscillations per second on the AC waveform.

Generation – means the production of electric energy and power from any primary source of energy.

Generating Unit - means a device used to produce electrical energy.

Generator - means a legal entity operating a licensed Generating Unit or Power Station.

High Voltage – means ac or dc voltage whose nominal r.m.s. value lies in the range $33\text{kV} < U_n \leq 500\text{ kV}$.

Information - means any type of knowledge that can be exchanged, always expressed (i.e. represented) by some type of data.

Information Owner - means the party to whose system or installation the information pertains.

Instruction – means any command, given by the network operator either orally (via telephone), written or via remote control, to a generator in order to perform an action, enable/disable or block functionalities of a power station.

Interruption of Supply - means an interruption of the flow of power to a Point of Supply not requested by the customer.

Licence – means a licence issued by the Authority pursuant to the EWURA Act, relating to the electricity supply industry.

Licensed activity – means the activities specified as requiring a licence as set out in Sections 8(1) of the Electricity Act.

Licensee – means any person licensed to provide services under the licensed activities in the electricity market.

Low Voltage – ac or dc voltage whose upper limit of nominal r.m.s. value is 1 kV plus or minus five percent.

Losses - The technical and non-technical energy losses incurred on the distribution system.

Medium Voltage – ac or dc voltage whose nominal r.m.s. value lies in the range $1\text{kV} < U_n \leq 33\text{kV}$ plus or minus ten percent.

Metering - All the equipment employed in measuring the supply together with the apparatus directly associated with it.

Metering Installation - An installation that contains metering.

Minister – means the Minister responsible for electricity matters.

Month - A calendar month comprising a period commencing at 00:00 hours on the first day of that month and ending at 24:00 hours on the last day of that month.

Non-dispatchable generation - A generator can be non-dispatchable because of two reasons:

1. The generation technology does not allow a dispatch. This is mainly the case for fluctuating primary resources, like wind power or solar power. Such non-dispatchable power stations can be of any size in terms of MW. Depending on its size the point of connection might be at high, medium or low voltage, i.e. in transmission or distribution network.
2. The power generating installation is too small for individual consideration in the scheduling and dispatch process. This is the case for distributed generation in the low-voltage networks.

Participant - means distribution system participant.

Performance Agreement – means an agreement between a licensee and the Authority, which establishes incentives and penalties, related to the measurable performance of the licensee, and which is designed to improve the efficiency and effectiveness of the licensee.

Planned Interruption - means a Planned Outage that will interrupt customer supply.

Planned Outage - means an outage of equipment that is requested, negotiated, scheduled and confirmed a minimum of 14 days prior to the outage taking place.

Point of Common Coupling - means the electrical node, normally a bus bar, in a transmission substation where different feeds to customers are connected together for the first time.

Point of Connection - means the electrical node in a distribution substation where a customer's assets are physically connected to the distribution company assets.

Point of Delivery - See Point of Supply.

Point of Supply - means a distribution substation where energy can be supplied to customers/retailers (also known as Point of Delivery).

Power Station - means one or more Generating Units at the same physical location, including other necessary facilities, including buildings.

Primary Substation Equipment - means a high voltage equipment installed at substations.

Priority customers – means customers of a distribution licensee who, due to the essential nature of their activities, are prioritised by the Authority to receive supply when the licensee suspends electricity supply services.

Protection - means the process of preventing or clearing a fault on the IPS in order to protect plant and people.

Related business – means any business or company, which directly or indirectly, in whole or in part, is owned by the licensee; or is owned by a company, which owns or is owned by the licensee.

Scheduling - means a process to determine which unit or equipment will be in operation and at what loading.

Security - means the probability of not having an unwanted operation.

Service Provider - means any licensed entity that provides services to Distribution Code Participants pursuant to the Distribution Code, including:

- i) Network Operator;
- ii) System Operator; and
- iii) Market Operator (if/when appointed).

Stakeholders - means the persons or entities affected by or having a material interest in the Distribution Code. This includes customers and other industry participants.

Substation - means a site at which switching and transformation equipment is installed.

Supply – means the sale of electricity to end customers.

System Operator – means a person licensed to provide system operation services.

Total Harmonic Distortion – is an indicator for distortion of the sinusoidal waveform of voltage or current and evaluated by the Total Harmonic Distortion factor THD using the following expression:

THD of voltage:

$$THD = \sqrt{\sum_{h=2}^N (U_h)^2}$$

where U_h is the r.m.s. value of the h^{th} harmonic or interharmonic voltage component, as a percentage (relative amplitude (U_h) related to the fundamental frequency voltage U_1), and N is the highest harmonic considered in the calculation. [2]

THD of current:

$$THD = \sqrt{\sum_{h=2}^N (I_h)^2}$$

where I_h is the r.m.s. value of the h^{th} harmonic or interharmonic current component, as a percentage (relative amplitude (I_h) related to the fundamental frequency current I_1), and N is the highest harmonic considered in the calculation.

Note: The value of N is 40 if no other value is defined in the applicable standard referred to at the specific requirement of this code.

Transmission – means the transportation of electrical energy and power by means of high voltage lines, facilities and associated meters, including the construction, operation, management and maintenance of such lines, facilities and meters.

Transmission-Connected Customer – A Customer connected directly to the Transmission system.

Transmission Companies - means the entity responsible for provision of electricity transmission services, including transmission infrastructure owners and operators, System Operator and Ancillary services providers.

Type 1 Generating Unit – A generating units is of Type 1, if it uses a synchronous generators, which is synchronously connected to the grid (directly or via a machine transformer). A Type 1 generating unit is for example the synchronous generator of a steam power plant, a hydro power plant or a conventional combustion engine unit. In this paragraph, the term “generator” refers to the electric device (not to the entity).

Type 2 Generating Unit – A generating unit is of Type 2, if it uses any generator technology which is different from a synchronously grid-connected synchronous generator. A Type 2 generating unit is for example a photovoltaic inverter, a wind turbine with fully rated converter, a wind turbine with doubly-fed induction generator, etc. or a simple induction generator. In this paragraph, the term “generator” refers to the electric device (not to the entity).

1.5.2. Notices and domicile

- a) Communication with the Authority in respect of the normal operations of this Distribution Code shall be sent to the following address:

The Director General,
 Energy and Water Utilities Regulatory Authority,
 P.O. Box 72175,
 7th Floor, LAPF Pension Funds Towers,
 Opposite Makumbusho Village, Kijitonyama,
 Dar es Salaam, Tanzania.
 Email: info@ewura.go.tz
 Fax: (+255 -22) 292 3519

- b) Any notice given in terms of this Distribution Code shall be in writing and shall

- i) if delivered by hand, be deemed to have been duly received by the addressee on the date of delivery and a receipt will have to be produced as proof of delivery;
- ii) if posted by pre-paid registered post, be deemed to have been received by the addressee 14 days after the date of such posting;
- iii) if successfully transmitted by facsimile, be deemed to have been received by the addressee one day after dispatch.
- iv) Notwithstanding anything to the contrary contained in this Distribution Code, a written notice or communication actually received by one of the parties from another, including by way of facsimile transmission shall be adequate written notice or communication to such party.

2. Governance under this Distribution Code

2.1. Introduction

This section describes the Governance provisions necessary for the overall administration and review of the various aspects of the Distribution Code. This code shall be read in conjunction with the relevant legislation, licences issued to generators, transmission companies, Market Operator, Distribution Network Operators and Suppliers, and other operating codes that relate to the electricity supply industry.

Pursuant to Section 1 and Section 45 (b) (vi) of the Act the Authority is mandated to promulgate and enforce the Distribution Code. The Authority shall establish a Distribution Code Management Committee (DCMC) to monitor, evaluate, review, and report and advice the Authority on compliance of the Distribution Code.

2.2. Purpose and Scope Distribution Code Management Committee (DCMC)

2.2.1. Purpose

The purpose of Distribution Code Management Committee is to:

- a) ensure that all users of the distribution system are represented in reviewing and making recommendations pertaining to connection, operation, maintenance, and development of the distribution system;
- b) facilitate the monitoring compliance with the Distribution Code at the operational level; and
- c) Specify the process for the settlement of disputes, enforcement and revision of Distribution Code.

2.2.2. Scope

The function of the Distribution Code Management Committee covers the activities of:

- a) Distribution Network Operators (DNOs);
- b) Other DNOs connected to the distribution system;
- c) System Operator;
- d) Embedded Generators;
- e) Retail Suppliers; and
- f) End Users (including eligible Customers).

2.3. Distribution Code Management Committee

2.3.1. Constitution of Distribution Code Management Committee (DCMC)

The DCMC shall be composed of the following members who shall be appointed by the Authority:

- a) Two members nominated by DNOs;
- b) One member nominated to represent industrial and commercial customers;

- c) One member nominated by EWURA CCC to represent residential customers;
- d) One member nominated by System Operator;
- e) One member nominated to represent embedded generators;
- f) One member nominated by REA;
- g) One Member from Ministry responsible for energy; and
- h) One Members from the Authority.

The representative from the industrial and commercial consumers shall be nominated by the respective associations (CTI, TCCIA).

The members of DCMC shall have sufficient technical background and experience to fully understand and evaluate the technical aspect of distribution system operation, planning and development.

The Chairman of DCMC shall be selected by the Authority from a list of three (3) members nominated by DCMC.

2.3.2. Term of office of DCMC members

All members to DCMC shall have a term of three years, and shall be allowed for one re – appointment. In case a member is not able to continue until the end of the term, the same shall be replaced by a suitable candidate from the relevant group to complete the remaining period of the term.

2.3.3. DCMC operating cost

- a) The DCMC operating costs shall be borne by the Authority;
- b) The Authority shall provide secretariat services to the DCMC;
- c) The DCMC shall prepare and submit annual work plan and budget requirements to the Authority by March every year;
- d) Any direct and incidental expenses to DCMC shall be determined and paid for by the Authority.

2.3.4. DCMC Conduct of Business Procedures

The DCMC shall, within six months of being formed, establish and publish its own procedures relating to the conduct of its business. The procedures shall be approved by the Authority. The procedures shall include, but not limited to:

- a) Administration and operation of the committee;
- b) Establishment and operation of DCMC subcommittees;
- c) Evaluation of distribution system operations reports;
- d) Coordination of dispute resolution process related to the Distribution Code;
- e) Monitoring of Distribution Code enforcement;
- f) Revision of distribution code provisions;

- g) Review of distribution development plans; and
- h) Review of major distribution system reinforcement and expansion projects.
- i) Where necessary, DCMC may establish subcommittees on specific issues as may be deemed necessary.

2.4. Transparency & Non-discrimination

2.4.1. Publication of Procedures

- a) The DNOs shall develop and publish in detail all the requirements, qualifications and administrative procedures to be fulfilled or followed by those seeking to be provided services by the DNOs.
- b) The requirements shall include all technical standards for connection equipment, communication, operating parameters and performance benchmarks for service provision.
- c) The qualifications shall include all legal, financial and technical qualifications to be fulfilled.
- d) The administrative procedures shall include all administrative, financial, technical and any other procedures to be followed prior to the commissioning of the connection as well as the obligations of the main actors for the continued provision of the service.
- e) The Authority shall publish the Distribution Code on its website and where possible copies will be made available to the public.

2.4.2. Equal Application Of Distribution Code

The Distribution Code shall be fairly and uniformly applied to all participants of distribution activities. All conditions and situations that are similar shall also receive consistent and equitable treatment.

2.4.3. Exercise of Discretion by The DNOs & Other Officials

- a) The DNO or any other participant shall not make a decision that is inconsistent with the Distribution Code in respect of the usage or provision of services from the distribution network.
- b) The DNO may use its discretion and good judgment in making decisions on any matter on which this Distribution Code does not contain complete or adequate stipulations.
- c) The exercise of a discretionary power shall however be justified in writing to the Authority and the affected party at the same time that such decision is taken.
- d) The principles and rationale for any discretion exercised or decision taken by the DNO shall be published and made available to any person upon request.
- e) Person aggrieved by a discretionary decision taken by the DNO may request for a review by the Authority as necessary.
- f) The Authority shall consider the complaint and uphold or recommend a reconsideration of the decision.

2.4.4. Charges For Distribution Network Services

Charges for the use of the distribution network or the services of the DNO shall not exceed those approved by the Authority.

2.5. Complaints and Dispute Resolution

- a) A DNO must handle a complaint by a customer in accordance with the provisions of the Act, Regulations and Rules issued by Authority.
- b) The DNO must include information on its complaint handling processes in the DNOs' Customer Service Charter.
- c) When a DNO responds to a customer's complaint, the DNO must inform the customer;
 - i. that the customer has the right to raise the complaint to a higher level within the DNOs' management structure; and
 - ii. if, after referring the complaint to a higher level the customer is still not satisfied with the DNOs' response, the customer has the right to refer the complaint to the Authority, and if not satisfied with the Authority decisions, the customer can further refer the matter to the Fair Competition Tribunal (FCT).

3. Connection requirements

3.1. Introduction

This section describes the connection procedures for connecting to the distribution system.

3.2. Objective

The object of this section is to set the basic procedures of connecting to the distribution system that will ensure that all users are treated in a non-discriminatory manner and specify the technical requirements that will ensure safety and reliability of the Distribution System.

3.3. Equipment

In respect of each location address which is in a DNO's designated area, the DNO must provide, install and maintain standard metering and necessary associated equipment, at a suitable location to be provided by the customer in respect of that location address.

3.4. New Connection

3.4.1. Connection Arrangement

- a) Customers seeking a new connection to the Distribution System shall lodge an application to connect to the Distribution System with the relevant DNO. Each DNO shall develop its own application form in line with this code.
- b) Customers applying for MV and HV supplies should provide additional information on fluctuating loads, capacitor banks and reactors that could affect the performance of the Distribution System.
- c) Upon receiving the application for connection the DNO shall comply with all other requirements relevant to the connection process specified in this code

3.4.2. Application for Connection

- a) Upon receipt of an application for connection to the Distribution System, the DNO shall advise whether the applicant can be connected to the existing system and / or what technical improvements are required to enable the new connection.
- b) The DNO shall provide an offer to connect, and if accepted by the customer, both parties shall enter into a connection agreement.
- c) The connection agreement shall include information such as project planning data, inspection, testing and commissioning programs, electrical diagrams and any other information the DNO may deem necessary to proceed with the processing of the application for connection.
- d) If the application for connection has been declined, the DNO shall advise the customer on the alternative options available for connection to make the connection successful.
- e) If the customer and the DNO cannot reach an agreement on the proposed connection, a dispute resolution process, as outlined in the Governance Section, shall be followed.

- f) Subject to clauses 3.4.2. (b) and 3.4.2 (c), the DNO shall prepare an offer to connect the customer within the period specified in the customer service charter of the DNO.
- g) The offer to connect issued by the DNO, shall be fair and reasonable and may contain alternative options available to the customer.
- h) Any negotiations taking place between the parties shall be conducted in good faith, and both parties shall treat any information provided in a confidential manner.

3.5. Condition for Connection

The DNOs' obligation to connect is subject to:

- a) an adequate supply of electricity being available at the required voltage at the point of connection;
- b) an dully filled Installation Completion Certificate (ICC) being provided to the DNO in respect of the customer's electrical installation;
- c) Payment of respective connection fees;
- d) The customer complying with reasonable technical requirements required by the DNO; and
- e) the customer providing acceptable identification.

3.6. DNOs Equipment on Customer Premises

- a) A customer must:
 - i) not interfere, and must use best endeavours not to allow interference with the DNO's distribution network including any of the DNO's equipment installed in or on the customer's premises; and
 - ii) provide and maintain on the customer's premises any reasonable or agreed facility required by its DNO to protect any equipment of the DNO.
- b) Provided official identification is produced by the DNO's representatives on request, a customer must provide to the DNO's representatives at all times convenient an unhindered access:
 - i) to the Distribution Utility's equipment for any purposes associated with the supply, metering or billing of electricity; and
 - ii) to the customer's electrical installation for the purposes of:
 - A. the inspection or testing of the customer's electrical installation to ascertain whether customer is complying with this Code; or
 - B. connecting, disconnecting or reconnecting supply, and safe access to and within the customer's premises
- c) If necessary, the customer must provide safety equipment and appropriate safety instructions to representatives of the DNO to ensure safe access to the customer's premises.
- d) In cases other than emergencies, a DNO must use best endeavours to access a customer's premises at a time, which is reasonably convenient to both the customer and the DNO.

4. Operations

4.1. Introduction

This section describes operational procedures and responsibilities of the distribution system participants.

4.2. Objective

The objective of this section is to set out the responsibilities and roles of the participants as far as the operation of the Distribution System is concerned and more specifically issues related to:

- a) economic operation, reliability and security of the Distribution System;
- b) operational authority, communication and contingency planning of the Distribution System;
- c) management of power quality;
- d) operation of the Distribution System under normal and abnormal conditions; and
- e) field operation, maintenance and maintenance coordination/ outage planning; and safety of personnel and public.

4.3. Responsibilities

4.3.1. Distribution Network Operator

- a) The DNO shall operate the Distribution System to achieve the highest degree of reliability and shall promptly take appropriate remedial action to relieve any condition that may jeopardise reliability.
- b) The DNO shall co-ordinate voltage control, demand control, operating on the distribution System, and security monitoring in order to ensure safe, reliable, and economic operation of the distribution System.
- c) In the event of an embedded generator having to shut down or island plant because of a disturbance on the distribution network, the DNO shall carry out network restoration to minimise the time required to resynchronise the shed embedded generating units.
- d) Ensuring that the availability and reliability of every power station supply is maximised at all times under normal and abnormal conditions.
- e) The DNO may shed customer load to maintain system integrity. Following such action, the customer load shall be restored as soon as possible after restoring and maintaining system integrity.
- f) The DNO shall operate the Distribution System as far as practical so that instability, uncontrolled separation or cascading outages do not occur.
- g) The DNO is responsible for efficient restoration of the Distribution System after supply interruptions. The restoration plans shall be prioritised in accordance with customer requirements and as prescribed in the governing legislations.
- h) The DNO shall ensure it has sufficient resources to continuously monitor and operate the Distribution System.

- i) The DNO shall establish and implement operating instructions, procedures, standards and guidelines to cover the operation of the Distribution System under normal and abnormal system conditions.
- j) The DNO shall operate the distribution System within defined technical standards and equipment operational ratings.
- k) The DNO shall ensure adequate and reliable communications to all major users of the distribution System.

4.3.2. Embedded Generators and Other Customers

- a) When conditions on the Distribution System, under normal or abnormal conditions, become such that it may jeopardise plant or personnel of customers, customers shall immediately disconnect from the distribution system.
- b) The Embedded Generator shall ensure that its generating units are operated within the capabilities defined in the Connection Agreement entered into with the DNO.
- c) The Embedded Generator shall reasonably cooperate with the DNO in executing all the operational activities during an emergency generation condition.
- d) Customers shall assist the DNO in correcting quality of supply problems caused by the Customer's equipment connected to the Distribution System.
- e) Customers shall at all times operate their appliances or equipment in a manner that ensures their compliance with the conditions specified in Chapter 7 together with firm establishment of settings as agreed with the responsible DNO.
- f) All customers must declare any generating plant that may be paralleled with the Distribution network via switching, and specify the interlocking mechanism to prevent inadvertent parallel operation with the DNO's network. For generating units with a nominal active power of 100 kW or less, a declaration of the manufacturer of the generating unit about the fulfilment of the connection / reconnection conditions according to Section 7.2.3, 7.3.3 or 7.4.3 respectively is sufficient, instead of a specification of the interlocking mechanism.
- g) Embedded generators with Type 1 generating units shall have the required protection to trip in the event of a momentary supply loss causing an island condition to prevent paralleling out of synchronism due to auto-reclose functionality on the DNO's network.

4.4. Operational Authority

- a) The DNO shall have the authority to instruct operating on the Distribution System. Operational authority for other networks operators shall lie with the respective asset owners.
- b) Network control, as it affects the interface between the DNO and a customer, shall be in accordance with the operating agreements between the participants.
- c) Except where otherwise stated in this code, no participant shall be permitted to operate equipment of another participant without the permission of such other participant. In such an event the asset owner shall have the right to test and authorise the relevant operating staff in accordance with its own standards before such permission is granted.
- d) Notwithstanding the provisions of clause 4.3.1 of this code, participants shall retain the right to safeguard their own equipment.

4.5. Procedures

- a) The DNO shall develop and maintain operating procedures for the safe operating of the Distribution System, and for assets connected to the Distribution System. These operating procedures shall be adhered to by participants when operating equipment on the Distribution System or connected to the Distribution System.
- b) Each customer shall be responsible for his own safety rules and procedures at least in compliance with the relevant safety legislation. Customers shall ensure that these rules and procedures are compatible with the DNO developed procedures defined in clause 4.5 (a) above.
- c) Customers and service providers shall enter into operating agreements, where not included in the supply agreement, as defined in the service provider licences.

4.6. Operation Liaison

- a) The DNO shall be responsible for ensuring adequate operational liaison with other connected participants.
- b) The participants shall appoint competent personnel to operate their network, and where needed shall establish direct communication channels amongst themselves to ensure the flow of operational information between the participants.
- c) If any participant experiences an emergency, the DNO may call upon other participants to assist to an extent as may be necessary to ensure that such emergency does not jeopardise the integrity of the Distribution System.
- d) Pursuant to clause 4.5 (c) above, the relevant participant shall ensure that the emergency notification contains sufficient details in describing the event including the cause, timing and recording of the event to assist the DNO in assessing the risk and implications to the distribution system and all the affected Customers' equipment.
- e) For planned events, which have an identified operational effect on the Distribution System, or on Customers' equipment connected to the Distribution System, the relevant participant shall notify the DNO.
- f) Where it is possible for a customer to parallel supply points or transfer load or embedded generation from one point of supply to another by performing switching operations on the customer's network, the operating agreement shall cover at least the operational communication, notice period requirements and switching procedures for such operations.
- g) The DNO and customers shall agree on the bus-bar configuration(s) at each point of supply during normal and emergency conditions. The DNO shall keep updated records of such agreements.

4.7. Emergency and Contingency Planning

- a) The DNO shall develop and maintain emergency and contingency plans to manage the system contingencies and emergencies that affect the delivery of the Distribution System and the Interconnected Power System. Such plans shall be developed in consultation with all affected participants, and shall be consistent with internationally acceptable best practices, and shall include but not be limited to:

- i) under-frequency load shedding,
 - ii) Prevention of voltage slide and collapse,
 - iii) meeting any national disaster management requirements including the necessary minimum load requirements,
 - iv) forced outages at any point of connection,
 - v) restoration and continuation of supply to every power station during normal and abnormal conditions is to be classified as a high priority, and
 - vi) supply restoration.
- b) Emergency plans shall enable the safe and orderly recovery from a partial or complete system collapse, with minimum impact on customers.
- c) All contingency and emergency plans shall be reviewed biennially or in accordance with changes in network conditions.
- d) All contingency and emergency plans shall be verified by audits, if possible by using on-site inspections and actual tests. In the event of such tests causing undue risk or undue cost to a participant, the DNO shall take such risks or costs into consideration when deciding whether to conduct the tests. Any tests shall be carried out at a time that is least disruptive to the participants. The costs of these tests shall be borne by the respective asset owners. The DNO shall ensure the co-ordination of the tests in consultation with all affected participants.
- e) The DNO shall, in consultation with the transmission company and system operator, set the requirements and implement:
 - i) Automatic and manual under frequency load shedding in accordance with the System Operator's requirements.
 - ii) Automatic and manual under voltage load shedding to prevent voltage collapse.
 - iii) Manual load shedding to maintain network integrity.
- f) Participants shall make available loads and schemes to comply with these requirements.
- g) The DNO shall be responsible for determining emergency operational limits on the Distribution System, updating these periodically and making these available to the participants.
- h) The DNO shall conduct network studies, which may include but not be limited to load flow, fault level, stability and resonance studies to determine the effect that various component failures would have on the reliability of the Distribution System.

4.8. Operations during abnormal condition

- a) During abnormal operating conditions the DNO shall be obliged to take necessary precautionary measures to prevent network disturbances from spreading and to restore supply to consumers as quickly as possible.
- b) The DNO shall cooperate with the system operator and transmission network service provider in taking corrective measures in the event of abnormal conditions on the Distribution System. The corrective

measures shall include both supply-side and demand-side options. Where possible, warnings shall be issued by the DNO to affected participants on expected utilisation of any contingency resources.

- c) The DNO shall be entitled to disrupt some sections of the network in the event of a prolonged disturbance resulting from unsuccessful corrective measures undertaken.
- d) Termination of the use of emergency resources shall occur as the order of return being determined by the most critical loads, first in terms of safety and then plant.
- e) During emergencies that require load shedding, the request to shed load shall be initiated in accordance with procedures prepared by the DNO.

4.9. Independent Action by Participant

Each participant shall have the right to reduce supply or demand, or disconnect a point of connection under emergency conditions, if such action is necessary for the protection of life or equipment and shall give advance notice of such action where possible.

4.10. Demand and Voltage Control

- a) The DNO shall implement demand control measures when:
 - i) Instructed to by the System Operator;
 - ii) Abnormal conditions exist on the Distribution System;
 - iii) Multiple outage contingency exists resulting in island grid operation; and
 - iv) Any other operational event the DNO deems to warrant the implementation of demand control measures for the safe operation of the Distribution System.
- b) Demand control shall include but not limited to:
 - i) Customer demand management;
 - ii) Automatic under-frequency load shedding;
 - iii) Automatic under-voltage load shedding;
 - iv) Emergency manual load shedding; and
 - v) Voluntary load curtailment.
- c) The DNO shall develop load reduction procedures, which shall be regularly updated, to reduce load in a controlled manner taking cognisance of the type of load.
- d) The DNO shall endeavour to maintain system voltage to be within statutory limits at the points of supply or otherwise as agreed in the operating/ supply agreement.

4.11. Fault Reporting and Analysis

- a) The end-user customers and embedded Generators shall report the loss of major loads or generation (as agreed by the participants) to the DNO within 15 minutes of the event occurring. Notice of the

intention to reconnect such load shall be given with at least 15 minutes advance notice to enable the DNO to take any necessary action required.

- b) The DNO shall investigate all incidents that materially affected the quality of supply to another participant. The DNO shall initiate and coordinate such an investigation and make available the findings of such investigation to affected participants on request.
- c) The findings of such an investigation shall include where relevant:
 - i) Date and time of the incident.
 - ii) Location of the incident.
 - iii) Duration of the incident.
 - iv) Equipment involved.
 - v) Cause of the incident in compliance with applicable national standards.
 - vi) Demand control measures undertaken specifically recording the customer MWs shed and energy lost as a result of the measures taken.
 - vii) Supply restoration details.
 - viii) Embedded Generation interrupted.
 - ix) Under-frequency Load Shedding response.
 - x) Estimated date and time of return to normal service.
 - xi) Customer load tripped MW and energy lost when incident occurred or as a direct result of incident not including any Demand Control Measures taken.
 - xii) Estimate number of customers having lost supply.
 - xiii) Recommendations.
- d) Any participant shall have a right to request an independent audit of the findings, at its own cost. If these audit findings disagree with the original findings, the participant may follow the dispute resolution mechanism as specified in the Governance section.

4.12. Maintenance Program

- a) Each DNO shall have a maintenance philosophy against which their maintenance practices and programs are compiled and documented in accordance with applicable national standards. These documented maintenance programs must be auditable.
- b) The DNO shall compile at least an annual maintenance plan in line with the budget period.
- c) Accurate records of maintenance done shall be kept for a period of at least 5 years.
- d) Scheduling of planned outages should coincide with the maintenance requirements of other participants connected to the affected network.

- e) All participants that may be affected by the planned outages will be informed at least 2 days or 48 hours in advance.

4.13. Testing and Monitoring

- a) A participant has the right to request to test and / or monitor any equipment at the point of connection to the Distribution System to ensure that the participants are not operating outside the technical parameters specified in any part of the Distribution Code and other applicable standards which the participants are required to comply with. Such testing and / or monitoring shall be carried out as mutually agreed by the parties.
- b) A participant found to be operating outside the technical parameters shall, within such time agreed upon by the parties involved, remedy the situation or disconnect from its network the equipment causing problems.
- c) Any dispute arising out of the test and monitoring process shall be resolved through the dispute resolution mechanism in the Governance section.

4.14. Safety Coordination

- a) The DNO shall comply with relevant legislation and develop Operating Regulations to ensure safety of personnel, whilst operating on the Distribution System or any equipment connected to the Distribution System.
- b) Where operational boundaries exist, there shall be a joint agreement on operating procedures to be complied with by all affected participants.
- c) There shall be written authorisation of personnel who operate on or work on live equipment forming part of or connected to the Distribution System.
- d) The “Operating Regulations” referred to in clause 4.14(a) of this code shall include rules and regulations for the safe operating of plant, continuity of supply and authorisation of personnel related to the operating of HV, MV and LV equipment.

4.15. Disconnection and Reconnection

4.15.1. Non-compliance

A DNO may disconnect supply to a customer’s supply address if:

- a) the customer has not fulfilled an obligation to comply with this Code;
- b) the DNO has given the customer a written notice of disconnection in accordance with the existing legislation; and
- c) the customer fails to comply with a written notice of non-compliance issued by the DNO or any arrangement entered into by the DNO and the customer which the customer has failed to comply with including non-compliance with the DNO applicable standards.

4.15.2. Health, Safety or Emergency

- a) A DNO may disconnect supply to a customer’s supply address if supply otherwise would potentially endanger or threaten to endanger the health or safety of any person or the environment, or an element of the environment or if there is otherwise an emergency.

- b) except in the case of an emergency, or where there is a need to reduce the risk of fire or where relevant regulations require otherwise, a DNO must not disconnect a customer's supply under clause 4.15.2(a) unless the DNO has:
 - i) given the customer written notice of the reason; and
 - ii) allowed the customer reasonable time in accordance with relevant legislations from the date of receipt of the notice to eliminate the cause of the potential danger.
- c) The DNO shall have the right to interrupt or disconnect supply if a threat of injury or material damage is anticipated as a result of the malfunctioning of the electrical installation equipment on the Customer's premises or on the Distribution System.

4.15.3. Retailer's request

- a) A DNO must disconnect supply to a customer's supply address if the customer's retailer has requested disconnection.
- b) Upon the receipt of a valid request by the customer's retailer, where the DNO is able to disconnect supply to the customer's supply address by de-energising the customer's supply address remotely and reasonably believes that it can do so safely, subject to clause 4.15.6, the DNO must use its best endeavours to disconnect supply to the customer's supply address within two hours.
- c) Part (b) does not apply to a request for disconnection at a scheduled time.

4.15.4. Customer's request

- a) A DNO must disconnect supply to a customer if the customer has requested disconnection and must use best endeavours to disconnect supply in accordance with the customer's request.
- b) Upon such a request, where the DNO is able to disconnect supply to the customer by de-energising the customer's supply remotely and reasonably believes that it can do so safely, subject to clause 4.15.6 the DNO must use its best endeavours to disconnect supply to the customer within two hours of a request being validated by the DNO.
- c) Paragraph (b) does not apply to a request for disconnection at a scheduled time.
- d) Customer (connected at MV and HV levels) shall give written notice to the DNO of any intended voluntary disconnection.

4.15.5. Illegal supply

A DNO may disconnect supply to a customer immediately if:

- a) the supply of electricity to a customer's electrical installation is used other than at the customer's premises, except in accordance with the Act;
- b) a customer takes the supplied electricity at a customer's premises to another supply premise;
- c) a customer tampers with, or permits tampering with, the meter or associated equipment; or
- d) a customer allows electricity supplied to the customer's supply address to bypass the meter.

4.15.6. No disconnection

- a) A DNO must not disconnect supply to a customer's supply address except in the case of an emergency or under clause 4.15.5 or otherwise as agreed with a customer:
 - i) after 2 pm on a weekday; or
 - ii) on a Friday, a weekend, public holiday or on the day before a public holiday.
- b) Despite any other provision of this Code, a DNO must not disconnect supply to a customer:
 - i) if the customer's supply address is registered as a life support machine supply address except in the case of an emergency; or
 - ii) for non-compliance under clause 4.15.1 if:
 - A. the customer is a tenant and is unable to remedy the non-compliance as it is not the owner of the supply address;
 - B. there is a dispute between the customer and the DNO which has been notified by the customer under clause 2.5 and is still being dealt with by the DNO under that clause, or is the subject of proceedings before the Authority or other relevant external disputes resolution body; or
 - iii) if the DNO reasonably considers that disconnecting supply would in any way immediately endanger the health or safety of any person.

4.15.7. Reconnection of Supply

- a) If a DNO has disconnected a customer as a result of:
 - i) non-compliance with this Code under clause 4.15.1 and the customer has remedied the non-compliance; or
 - ii) danger under clause 4.15.2 has been eliminated by the customer; or
 - iii) a request from a retailer, on request by the customer or by a retailer on behalf of the customer, but subject to other applicable laws and codes and the customer paying any reconnection charge (determined by reference to its approved statement of charges), the DNO must reconnect the customer.
- b) If a customer, or a retailer on behalf of a customer, makes a request for reconnection under clause 4.15.7 (a) (iii) to a DNO:
 - i) before 3 pm on a working day, the DNO must reconnect the customer on the day of the request; or
 - ii) after 3 pm on a working day, the DNO must reconnect the customer on the next working day.
 - iii) where the DNO is able to reconnect the customer by re-energising the customer's supply address remotely, subject to paragraphs (i) and (ii), the DNO must use its best endeavours to reconnect the customer within two hours of a request being validated by the DNO.

- c) Notwithstanding 4.15.7 (b) above, DNO and a customer may agree later times and a customer has to apply to the DNO for reconnection.

A DNO is not obliged to reconnect a customer under clause 4.15.7 (b) unless the DNO reasonably believes that it can do so safely.

4.16. Commissioning and Connection

- a) MV and HV customers shall supply commissioning programmes to the DNO control and operating facility at least 1 month in advance. Subsequently, a notice of first connection shall be given to the DNO control and operating facility at least 2 weeks before actual connection. Details of the information required shall include but not be limited to the following:
 - i) Commissioning procedures and programmes
 - ii) Documents and drawings required
 - iii) Proof of compliance with standards
 - iv) Documentary proof of the completion of all required tests
 - v) SCADA information, to be available and tested before commissioning
 - vi) Site responsibilities and authorities.
- b) When commissioning equipment at the point of connection, the DNO shall liaise with the affected participants on all aspects that could potentially affect their operation.
- c) The DNO and customers shall perform all commissioning tests required in order to confirm that the DNO's and the customers' plant and equipment meet all the requirements of the Distribution Code before being connected to and energised from the Distribution system.

4.17. Outage Scheduling and Coordination

4.17.1. Responsibilities of the Distribution Network Operator

- a) DNO shall, with reference to the relevant network Service Providers outage plans and relevant Generators outage programs, compile the daily outage schedule which shall:
 - i) endeavour to cater for the planned maintenance and commissioning of new equipment.
 - ii) describe the planned outage.
 - iii) Identifies the risks and impact on network performance.
 - iv) describe the practical contingency plans devised to counter risks, and
 - v) define the roles and responsibilities of the personnel designated to manage and minimise the impact of these outages on the Distribution System and its users.
- b) Notwithstanding clause 4.17.1 (a) above, the DNO shall co-ordinate relevant outages with the system operator.

- c) In addition to clause 4.17.1 (a) above, the DNO may require information from the Customers regarding major plant and associated equipment, which may affect the performance of the Distribution System and may require additional resources to be committed during the outage planning process.
- d) Customers with co-generation and Embedded Generators with the maximum capacity greater than 1MW shall furnish to the DNO information on planned outages in order for the DNO to properly plan, and coordinate its control, maintenance and operation activities.
- e) The Distribution outage schedule shall be submitted to the Authority upon request.

4.17.2. Risk-related Outages

- a) All risk-related outages shall be scheduled with an executable contingency plan in place. The compilation of the contingency plan is the responsibility of the relevant DNO.
- b) Contingency plans shall address:
 - i) Safety of personnel.
 - ii) Security and rating of equipment
 - iii) Continuity of supply
- c) The relevant control centres shall confirm that it is possible to execute the contingency plan successfully.

4.17.3. Communication of System Conditions, Operational Information and Distribution System Performance

- a) The DNO shall be responsible for providing participants with operational information as may be agreed from time to time. This shall include information regarding planned and forced outages on the DNO.
- b) The DNO shall inform participants of any network condition that is likely to impact the short and long-term operation of that participant.
- c) The DNO shall record operational information as specified in the Information Exchange section. This information shall be made available to all participants on request.

4.18. Unplanned Interruptions or Outages

- a) In case of unplanned interruptions or outages the DNO may require a customer to comply with reasonable and appropriate instructions from the DNO and may further:
 - i) Require the customer to provide the DNO emergency access to customer owned distribution equipment normally operated by the DNO or DNO owned equipment on customer's property.
 - ii) Interrupt supply to the customer to effect repairs to the Distribution System.
- b) Subsequent to clause 4.18 (a), the DNO shall make arrangements to keep customers informed about the expected duration and other details following unplanned interruptions.

4.19. Refusal/Cancellation of Outages

- a) No participant may unreasonably refuse an outage request.
- b) No participant may unreasonably postpone or cancel a previously accepted outage.
- c) The direct costs related to the cancellation / postponement of an outage shall be borne by the respective asset owners.

4.20. Planned Interruptions or Outages

For planned interruptions or outages the DNO shall act in accordance with its Customer Service Charter and provide the affected Customers with information relating to the expected date of the outage, time and duration of the outage, and shall established reasonable means of communication to the Customers for outage related enquiries.

4.21. Tele-control

Where Tele-control facilities are shared between the DNO and other participants, the DNO shall ensure that operating procedures are established in consultation with the participants.

5. Metering

5.1. Introduction

The purpose of this Distribution Metering section is to specify the technical and operational criteria, including the procedures to be complied with by the DNO, in carrying out its obligation to provide metering services to Distribution Network Users at each Metering Point. It also applies to Distribution Network Users in so far as their equipment may affect the Distribution System.

5.2. Application

The Distribution Metering section applies to the following:

- i) DNOs; and
- ii) Distribution Network Users connected to, or seeking connection to the Distribution System.

The DNO shall:

- a) own, install, verify, operate, maintain, inspect and replace all Metering Systems at Metering Points on the Distribution System, except Metering Systems situated at Connection Points to the Transmission System;
- b) ensure that each Metering System installed on its Distribution System meets the performance, functional and technical requirements set out in this code;
- c) ensure that each Metering System installed on its Distribution System is certified where so required by the Authority, is in working condition and has been tested for accuracy;
- d) retrieve data from each Metering System installed on its Distribution System for the purposes of billing and settlement;
- e) process data retrieved from each Metering System installed on its Distribution System for the purposes of billing and settlement;
- f) notify the Authority of all Metering Systems where the DNO cannot comply with the Distribution Metering requirements.
- g) fully implement Net Metering systems, as appropriate.

5.3. Obligations

5.3.1. Installation and Replacement of Metering Equipment

- a) The installation of Metering Equipment shall be in accordance with the technical requirements of the DNO.

The DNO may replace Metering Equipment for which it is responsible at any time after it has been installed, subject to the provisions of this code. The DNO shall notify the Distribution Network User in advance of any replacement, unless that replacement is an urgent condition.

The DNO shall:

- i) assign a unique identifier to the metering system, cross referenced to the location of the metering system;
 - ii) record the date of installation of the metering system;
 - iii) record the functionality of the meter and the unit of measurement used to measure energy flowing through the metering system or maximum load, as it corresponds;
 - iv) record the identification of the ancillary equipment;
 - v) record any site-specific loss adjustment factors to be applied;
 - vi) record redundancy details and sources of check metering data and identification of the meters designated as the main meter and as the check meter;
 - vii) record the initial meter register reading;
 - viii) ensure that the metering data stored in the metering system is retrieved and, where a meter is removed, shall ensure that a final meter reading is obtained.
- b) The DNO shall maintain the following information for each Metering System:
- i) location of the Metering System;
 - ii) a record of any malfunction of the Metering System including any test results and of repairs made to the metering System; and
 - iii) documentation of meter testing prior to installation.
- c) The DNO shall, on request, make the information available for each metering system to:
- i) the Distribution Network User;
 - ii) the Authority.

5.4. Standard Metering Systems

- a) Each metering Point shall be situated as close as is reasonably practicable to the relevant Connection Point.
- b) Prior to the installation of any meter or current and voltage transformers that form part of a metering system, such metering equipment shall be:
 - i) Submitted by the DNO to a laboratory for testing and certification; or
 - ii) Received by the DNO directly from a manufacturer with a test certificate endorsed by an independent laboratory.
- c) Copies of all test certificates shall be retained by the DNO for the metering equipment that is in service and for metering equipment that is no longer in use for a minimum period of five years. The DNO shall produce these certificates upon notice from the Authority.

- d) No metering equipment shall be certified unless the DNO has received the relevant test certificates from the relevant accredited laboratory or manufacturer.
- e) The DNO shall install and maintain at the power delivery point an appropriate metering system which shall be equipped with the following:
 - i) a multifunction meter type with accuracy of class 1 or better and which is able to store historical information with integrated interval of 20 minutes for kVA registration;
 - ii) Current and voltage transformers with an accuracy of 0.5 or better.

5.5. Additional Requirement for Metering System

Upon the request of a distribution network user, the DNO may arrange for a metering System to install a check meter, or to contain features or equipment in addition to those specified in this code, provided that:

- a) The distribution network user agrees to pay the full costs of the additional features or equipment, including the costs of installation, operation, maintenance, repairs and replacement; and
- b) The additional features or equipment are compatible with the rest of the metering system and do not lead to any degradation of the capability of the metering system that would cause the metering system to fail to meet any standards contained in this code.

5.6. Faulty Metering Equipment

- a) A Metering System shall be considered faulty and not in compliance with this Code if it is determined that any part of that metering system does not comply with this code.
- b) If a Metering System fault occurs, the DNO shall repair or replace the metering system as soon as is reasonably practicable and in any event within two working days of the DNO discovering that the fault exists.
- c) The distribution network user shall use metering equipment in a safe and prudent manner and shall take due care to avoid damage. The Distribution Network User shall notify the DNO of any damage to the metering equipment, however caused.
- d) The DNO shall ensure that suitable data is obtained or estimated for the period of time commencing when a meter or metering Equipment becomes faulty until the completion of the repair or replacement. Where the check meter exists then it should be used.
- e) The DNO shall record all relevant Meter parameters for a replacement Meter in that Metering System.

5.7. Technical Requirement and Accuracy of Meters

- a) The DNO shall ensure that the accuracy of each Meter in each Metering System is certified by an accredited Meter test laboratory and meets the applicable accuracy limits.
- b) In the event of non-compliance with the required standards, the DNO shall ensure that the accuracy of any Meter in that Metering System is restored to comply with the accuracy standards as soon as is reasonably practicable.
- c) The DNO shall maintain certification records and test results relating to the accuracy class and compliance with the relevant standards for the particular type and model of Meter in that Metering System.

- d) The DNO shall maintain records of the information referred to in this section for each Metering System, either in use or no longer in use, as per clause 5.4 (c), and shall produce these records when required by the Authority.

5.8. Audit and Installation Tests

- a) The DNO shall ensure that each metering system is inspected according to the minimum frequencies specified:
 - i) Medium and high Voltage: Once every year.
 - ii) Low Voltage, including prepayment: Once every 5 years.
- b) The DNO may carry out periodic, random and unannounced inspection and or testing of any metering system and associated data for the purpose of ascertaining whether the metering system complies with the requirements of this code.
- c) The distribution network user may request the DNO to carry out such inspection and or testing, provided that the distribution network user pays the cost, unless an error or malfunction not caused by the distribution network user is discovered. In addition, the Authority may carry out its own unannounced inspection and or test, in which case the distribution network user shall grant access to the Authority.
- d) The DNO shall, as soon as practicable, make the results of any inspection and or tests conducted pursuant to this section available to the requesting party and to the distribution network user associated with the metering system.

5.9. Access to Metering System

- a) The distribution network user shall grant access to the DNO to enable the DNO to fulfill its obligations. This right of access is conditional upon;
 - i) where practicable, prior notice by the DNO; and
 - ii) the production of identification by the DNO's staff or contractor.
- b) Prior arrangement by the DNO shall not be required in respect of routine meter reading or periodic, random and unannounced audits or when the DNO is performing urgent metering repairs.

5.10. Security of Metering System

- a) Appropriate seals shall be applied to each metering system.
- b) Seals shall be replaced following work requiring the removal of any seals.
- c) The DNO shall have procedures for the control of seals and sealing pliers.
- d) The DNO shall, so far as is reasonably practicable, ensure that physical access to each meter contained in each metering system is protected by:
 - i) Sealing all associated links, circuits, data storage and data processing systems;
 - ii) ensuring that the metering system meets the requirements for the security of metering systems;

- e) The DNO shall use reasonable endeavours to ensure that all metering data within each metering system is secure.

5.11. Metering Disputes.

- a) If the DNO receives a complaint about the accuracy of metering data or the calculation of any substitute or estimated metering data from the Distribution Network User, the DNO shall investigate the complaint.
- b) The investigation shall include a review of all available information, including any information supplied by the Distribution Network User.
- c) If the DNO determines that there is an inaccuracy due to Meter error, malfunction or error in the metering data, the DNO shall take appropriate steps to remedy the defect, including repair or replacement of equipment and adjustment of metering data.
- d) Appropriate adjustments shall also be made to the Distribution Network User's bill.
- e) In the event of a dispute, the dispute shall be settled using the procedure specified in this code.

6. Performance Standards

6.1. Introduction

This section describes the quality and reliability of power supply, protection requirements, losses and performance levels.

6.2. Quality of Supply

- a) The DNO and other participants shall comply with the applicable National standards and the Authority's directives regarding the parameters listed below:
 - i) Voltage harmonics and inter-harmonics
 - ii) Voltage flicker
 - iii) Voltage unbalance
 - iv) Voltage dips
 - v) Interruptions
 - vi) Voltage regulation
 - vii) Frequency
 - viii) Voltage surges and switching disturbances
- b) Special quality of supply criteria apply to Embedded Generator, as specified in Chapter 7.

6.3. Reliability of Supply

- a) Before end of year, a DNO must publish on its website, and in a newspaper circulating in the area in which its distribution system is located, its targets for reliability of supply for the following year.
- b) As a minimum, these targets must include for customers supplied from Industrial feeders, urban feeders and rural feeders:
 - i) average duration in minutes of interruptions per customer (SAIDI) due to planned interruptions;
 - ii) average duration in minutes of interruptions supply per customer (SAIDI) due to unplanned interruptions;
 - iii) average number of unplanned interruptions per customer (SAIFI), excluding momentary interruptions;
 - iv) average number of momentary interruptions per customer (MAIFI); and
 - v) average cumulative duration of unplanned interruptions (CAIDI).
- c) A DNO may interrupt supply at any time for the following reasons:
 - i) planned maintenance, repair, or augmentation of the distribution system;

- ii) unplanned maintenance or repair of the distribution system in circumstances where, in the opinion of the DNO, the customer's electrical installation or the Distribution System poses an immediate threat of injury or material damage to any person, property or the distribution system;
 - iii) to shed energy because the total demand for electricity at the relevant time exceeds the total supply available;
 - iv) as required by Transmission Utility's System Operator;
 - v) the installation of a new supply to another customer;
 - vi) in the case of an emergency; or
 - vii) to restore supply to a customer.
- d) In the case of an unplanned interruption or an emergency, a DNO must:
- i) within 30 minutes of being advised of the interruption or emergency, or otherwise as soon as practicable, make available, by way of a 24 hour telephone service, radio announcement and by way of frequently updated entries on a prominent part of its website, information on the nature of the interruption and an estimate of the time when supply will be restored or when reliable information on restoration of supply will be available;
 - ii) provide options for customers who call the service to be directly connected to a telephone operator if required; and
 - iii) use best endeavours to restore the customer's supply as soon as possible making allowance for reasonable priorities.
- e) Wherever reasonable and practicable, a DNO must provide prior information to customers who may be interrupted by load shedding.
- f) In the case of a planned interruption, the DNO must provide each affected customer with at least 2 days written notice of the interruption. The notice must:
- i) specify the expected date, time and duration of the interruption; and
 - ii) include a 24 hour telephone number for enquiries.
- g) The DNO must use best endeavours to restore the customer's supply as quickly as possible.
- h) Interruption Performance Indices
- i) The Authority shall be responsible for setting the format in which the Distribution Reliability Indices are reported.
 - ii) The Authority shall annually evaluate the Distribution System Reliability Indices to compare each DNO's actual performance with the DNO unique targets set by the Authority and the Authority shall publish these comparative results

6.4. Protection Requirement

- a) The DNO's protection system shall be appropriately designed and maintained to ensure optimal discrimination, safety and minimum interruptions to customers.
- b) The customer shall install and maintain protection, which is compatible with the existing Distribution System protection. The customer's protection settings shall ensure coordination with the DNO's protection.
- c) The customer shall, on request, provide the DNO with test certificates, prior to commissioning, of the protection system/s that are installed at the point of interface with the DNO.
- d) Participant's protection system shall, where applicable, make provisions to safeguard their own equipment from faults or conditions that may occur at the point of connection including loss of one or two phases of the three phase supply and low voltages on the phases and any auto-reclosing or sequential switching features that may exist on the Distribution System.
- e) Where equipment or protection schemes are shared, the participants shall provide the necessary equipment and interconnections to the equipment of the other party.
- f) Embedded generators have to fulfil the requirements specified in Chapter 7, in addition to the requirements described in this section.

6.5. Load Power Factor

- a) Customers, except for embedded generators, (with demand exceeding 100kVA) shall ensure that the power factor shall not be less than 0.9 lagging nor shall it go leading unless otherwise agreed to with the relevant DNO.
- b) Should the power factor go beyond these limits, participants shall take corrective action within a reasonable timeframe or as agreed between the parties, to remedy the situation.
- c) The participant intending to install power factor correction equipment for the purpose of complying with the power factor requirements shall inform the relevant DNO.
- d) Requirements for embedded generators are specified in Chapter 7.

6.6. Earthing Requirement

- a) The DNO shall advise customers upon request about the neutral earthing methods used in the Distribution System.
- b) The method of neutral earthing used on those portions of Customer's installations that are physically connected to the Distribution System shall comply with the DNO's applicable earthing standards for loads and for embedded generators.
- c) Protective earthing of equipment must be done in accordance with the applicable national standard.
- d) In cases where the calculated Ground Potential Rise exceeds 5kV the responsible party shall inform the affected participants.
- e) Approved designed lightning protection requirements shall be applied to the Distribution System and switching yards.
- f) Substation earthing requirement shall be in accordance with the National standards.

6.7. Losses

- a) Losses shall be classified into two categories:
 - i) Technical Losses; and
 - ii) Non-Technical Losses
- b) The DNOs shall endeavour to keep the distribution losses at economically acceptable levels in compliance with the Authority's directives on distribution losses given from time to time.

6.8. Equipment Requirement

- a) Equipment at the connection point shall comply with the technical requirements specified in Chapter 7, the DNO's prescribed standards or any equivalent national standards prevailing at the time.
- b) The DNO shall, upon request, provide the customer with the necessary information to enable the customer to install equipment with the required rating and capacity.
- c) The participants shall ensure that all equipment at the connection point is maintained at least in accordance with the manufacturers' specifications or an alternate industry recognised methodology.
- d) The participants connected at MV and HV levels shall retain the test results and maintenance records relating to the equipment at the connection point and make this information available if requested.

6.9. Guaranteed Service Levels.

DNOs shall comply with Guaranteed Service Level Standards as prescribed in the approved Customer Service charter and Performance agreement between DNO and the Authority.

7. Technical Requirements

7.1. Technical Requirements for Generation with Type 1 Generating Units and a PoC at MV

- a) The Subsection “Generator Connection Conditions” of The Network Code [1] of the Grid Code applies to generation with Type 1 generating units and a point of connection (PoC) at medium voltage (MV) in the same way as with a PoC at high voltage (HV).

7.2. Technical Requirements for Generation with Type 2 Generating Units and a PoC at MV

- a) This section describes technical requirements for generation with Type 2 generating units and a PoC in an MV network, including Isolated Mini Grids.
- b) These requirements do not apply to micro off-grids. However, if it is intended to let off-grid generating units run in parallel to the grid once an off-grid is interconnected to the main network, it is recommended to consider these requirements as far as possible during off-grid operation as well.

7.2.1. Operating Voltage Band

- a) The generation facility must be able to fully operate in steady-state in a voltage band of +/- 5%, i.e. 0.95 p.u. through 1.05 p.u. around the nominal voltage at the point of connection (PoC).

7.2.2. Operating Frequency Band

- a) The generation facility must be able to operate in steady-state in a frequency band of +/- 2.5% around the nominal frequency of 50 Hz, i.e. 48.75 Hz through 51.25 Hz.
- b) In island systems and Isolated Mini Grids the maximum deviation from standard frequency can be larger (up to +/- 5% [2]). Therefore a capability to operate in steady-state in a frequency band of +/- 5.0% around the nominal frequency is recommended in these systems, but not mandatory.

7.2.3. Connection and Reconnection Requirements

- a) A connection of a power generating unit shall be admissible only if the network voltage at the PoC is inside its normal operating voltage band (0.95 p.u. – 1.05 p.u.) and the frequency is between 47.5 Hz and 50.5 Hz (which are the lower frequency band limit under extreme system operation or fault conditions and the upper frequency band limit under normal operation in the EAPP Interconnected Transmission System). In Isolated Mini Grids the threshold values may differ from the values given above and have to be specified by the responsible network operator with respect to the voltage and frequency bands in the Isolated Mini Grid.
- b) If the voltage at the PoC is outside of the above mentioned voltage band (0.95 p.u. – 1.05 p.u.), connection shall be blocked.
- c) If the frequency is below 47.5 Hz or above 50.5 Hz, connection shall be blocked. A different value for the setting may be applied in agreement with the responsible DNO (especially in island systems or Isolated Mini Grids).
- d) The reconnection of a power generating unit after being disconnected for protection with respect to Section 7.2.9 or Section 7.2.10, is only allowed:
 - i. if the voltage at the PoC is within the normal operating voltage band of 0.95 p.u. – 1.05 p.u.,

- ii. if the frequency is above 47.5 Hz and below 50.5 Hz (a different value for the setting may be applied in agreement with the responsible DNO, especially in island systems or Isolated Mini Grids),
 - iii. if there is no Instruction from the network operator for disconnection or for power limit of 0%, compare Section 7.2.11, and
- e) If the power station consists of several generating units, the responsible DNO can specify a minimum delay time interval between the connection/reconnection of the individual units in order to limit impact on voltage and ensure desired power quality (e.g. flicker).

7.2.4. Harmonics and Flicker

- a) The power station shall withstand and function correctly in the presence of harmonic voltages up to the compatibility levels for MV networks specified in [2] (long-term and short-term).
- b) The power station is not allowed to inject harmonic currents into the network which lead to harmonic voltages or a THD at the PCC which are higher than the compatibility levels for MV networks specified in [2]. The responsible DNO may provide lower planning limits in order to ensure that the compatibility levels at the PCC are met.
- c) If the compatibility levels for harmonic voltages or THD at the PCC are exceeded in operation, the responsible DNO has to carry out measurements in accordance to [2] in combination with [3] or if applicable in combination with [4] in order to find the most disturbing device. If this device belongs to the power station, the generator has to do countermeasures to lower the harmonic disturbance.
- d) The power station shall withstand and function correctly in the presence of voltage flicker up to the compatibility level for MV networks specified in [2].
- e) The power station is not allowed to perform power changes which lead to voltage flicker at the PCC which are higher than the compatibility levels for MV networks specified in [2]. The responsible DNO may provide lower planning limits in order to ensure that the compatibility levels at the PCC are met.

7.2.5. Reactive Power Capability

- a) If the generating units run with nominal active power, the reactive power flow at the point of connection (PoC) of the installation shall be sufficient to provide a power factor at the PoC of at least 0.95 overexcited to 0.95 underexcited, i.e. 0.95 or lower for voltage increasing operation and 0.95 or lower for voltage decreasing operation, if the voltage at the PoC is within 0.95 through 1.05 p.u.
- b) In partial load operation, the power station shall have the capability to inject/absorb the same amount of reactive power as at nominal active power of the generating units, down to 20% of the nominal active power of the power station, as depicted in Figure 7.1.

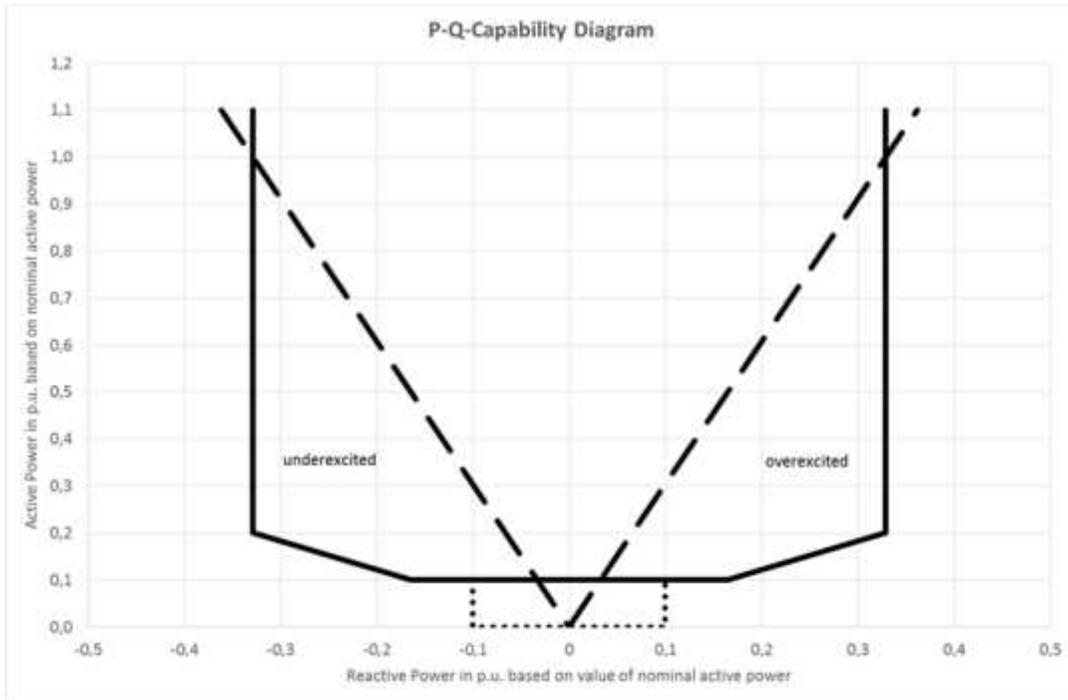


Figure 7.1: P-Q-Capability Diagram (generation oriented),
 solid curve: requirement,
 dashed curve: power factor = 0.95
 dotted curve: area of 10% reactive power below 10% active power

- c) Between 10% and 20% of the nominal active power of the power station, the reactive power requirement is as depicted Figure 7.1.
- d) Below 10% of the nominal active power of the power station, the reactive power injection/absorption shall not be larger than 10% based on the value of the nominal active power of the installation (i.e. inside the dotted line of Figure 7.1). This requirement does not apply, if an operation in synchronous condenser or STATCOM mode has been agreed with the network operator.
- e) With respect to voltage-dependency of the reactive power capability.
 - i. above 1.02 p.u. voltage at the PoC, the same underexcited reactive power (absorption of reactive power) is require as at 1.00 p.u. voltage, but less overexcited reactive power (injection of reactive power), as depicted in Figure 7.2,
 - ii. below 0.98 p.u. voltage at the PoC, the same overerexcited reactive power (injection of reactive power) is require as at 1.00 p.u. voltage, but less underexcited reactive power (absorption of reactive power), as depicted in Figure 7.2.

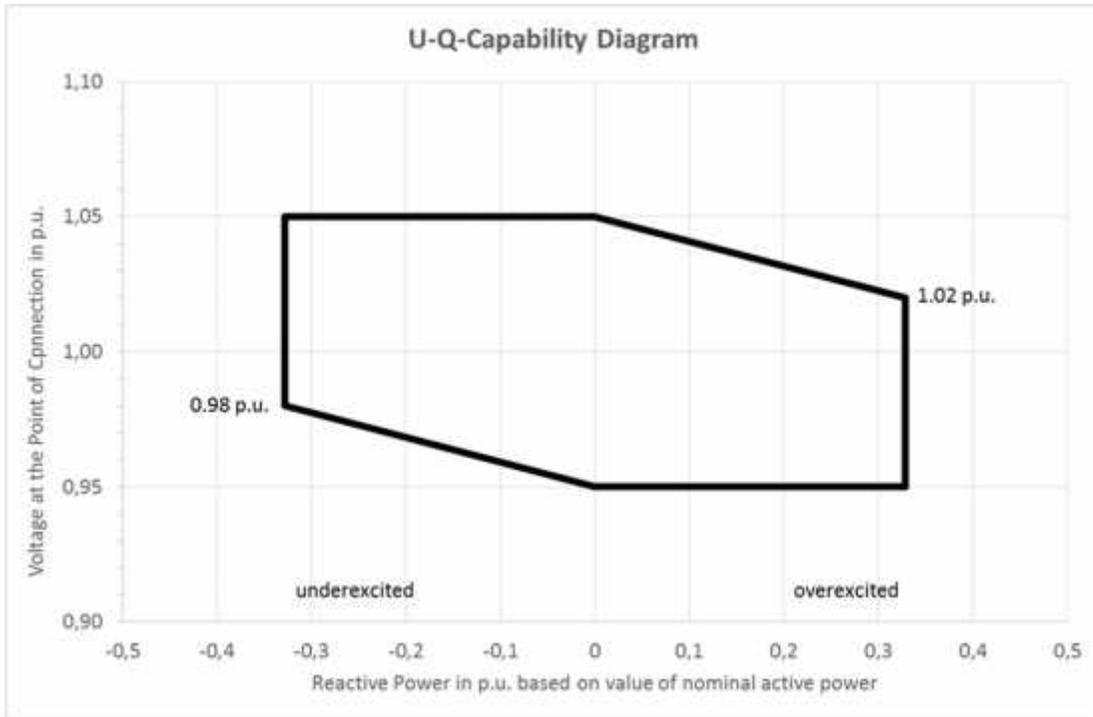


Figure 7.2: U-Q-Capability Diagram solid line = requirement for 20% to 100% nominal active power

- f) The generator shall document the maximum possible reactive power capability in terms of five P-Q-Capability Diagrams of the power station as follows, and a U-Q/Pmax-Profile of the power station and provide the information to the network operator. Voltage drop and voltage rise within the power station and loading of the equipment within the power station (e.g. cables, transformers) has to be considered.
- i. P-Q-Capability Diagram of the installation for 0.95 p.u. voltage at the PoC
 - ii. P-Q-Capability Diagram of the installation for 1.00 p.u. voltage at the PoC
 - iii. P-Q-Capability Diagram of the installation for 1.05 p.u. voltage at the PoC
 - iv. U-Q/Pmax-Profile of the installation
- g) In order to achieve the requirement at the PoC, usually the generating units have to provide a larger reactive power capability at their terminals. If the generating units cannot provide sufficient reactive power to fulfil the requirement of the installation at the PoC, additional devices such as capacitor banks, shunt reactors, STATCOMs or synchronous condensers can be installed within the power station.

7.2.6. Power Factor Control Capability

- a) A power station with Type 2 generating units shall provide the capability of the following two control modes effective at the point of connection (PoC) of the power station:
- i. reactive power (constant Q)
 - ii. power factor (constant cos phi)

- b) For power stations with Type 2 generating units, the network operator selects the control mode which has to be activated for operation and specifies the parameter settings, depending on the location of the PoC in the network.
- c) A power station with Type 2 generating units shall be able to operate in any operating point of the reactive power capability diagram specified in Section 7.2.5, for the active power range which is possible to operate with respect to the primary power source of the power station.
- d) For an adjusted control mode and parameter set, the power station with Type 2 generating units shall be able to settle each accessible operating point with respect to the control mode within 30 seconds.

7.2.7. Voltage Control Capability

- a) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV becomes larger than 30%² of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must have voltage control capability, in addition to the power factor control capabilities described in Section 7.2.6.
- b) In order to run stable with neighbouring power stations, the voltage control has to be equipped with a voltage/reactive power droop functionality.

7.2.8. Behaviour During Network Faults

- a) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV is smaller than or equal to 15% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), these generating unit shall disconnect from the grid as fast as possible by means of protective disconnection devices, if the voltage at the PoC becomes lower than 0.9 p.u.
- b) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV becomes larger than 15% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must have Under-Voltage-Ride-Through (UVRT) and Over-Voltage-Ride-Through (OVRT) capability. Any new generating unit and any equipment of a new power station shall be designed with anticipation of the following voltage conditions at the Point of Connection:
 - i. A voltage deviation in the range of 95% to 105% for protracted periods.
 - ii. A voltage dip to zero for up to 0.2 s, to 75% for 2 s, or to 85% for 60 s provided that during the 3 minute period immediately following the end of that 0.2 s, 2 s, or 60 s periods the actual voltage remains in the range 95-105% of the nominal voltage (compare Section “External supply disturbance withstand capability“ of The Network Code [1]).

² The limitation of the requirement with respect to share of the sum of nominal power of Type 2 generating units shall allow easier network access as long as there are not as many installations with Type 2 generating units with PoC at MV, but guarantee a strict enough requirement if Type 2 generating units reach a share with considerable impact on the system.

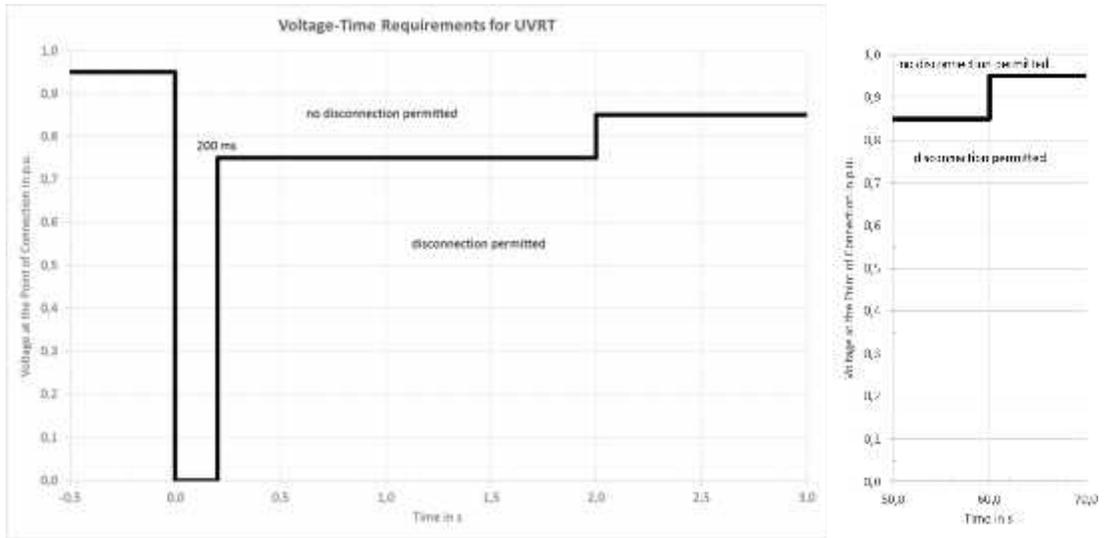


Figure 7.3: Voltage-Time Requirements for Under-Voltage-Ride-Through (UVRT)

- iii. A voltage rise to 120% for 2 s, or to 110% for 60 s provided that during the 3 minute period immediately following the end of that 2 s, or 60 s periods the actual voltage remains in the range 95-105% of the nominal voltage.

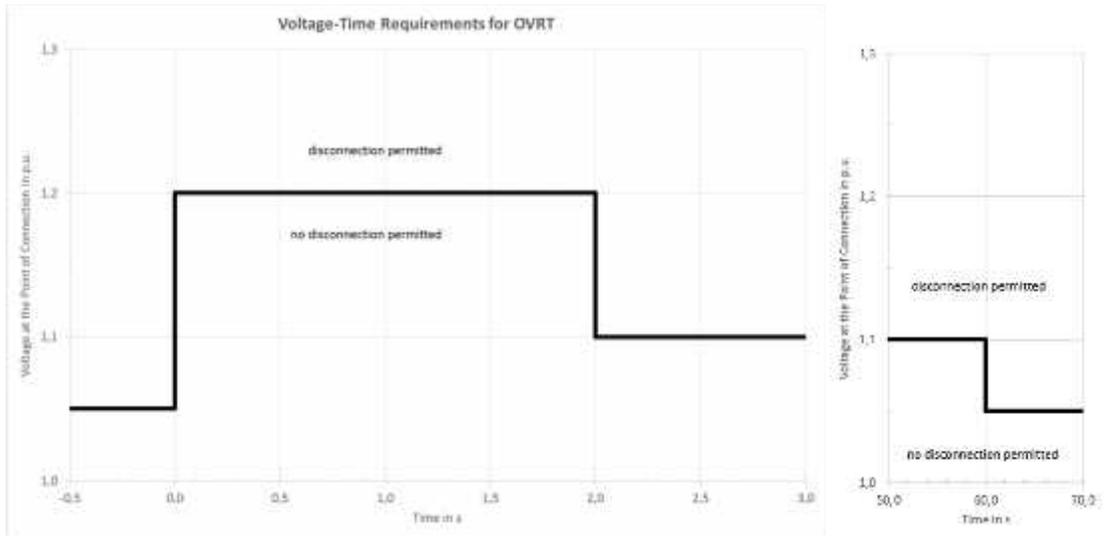


Figure 7.4: Voltage-Time Requirements for Over-Voltage-Ride-Through (OVRT)

- iv. The voltage to be considered is:
 - the lowest of the three line-to-line voltages in cases of voltages below 100% of the nominal voltage, and

the highest of the three line-to-line voltages in cases of voltages above 100% of the nominal voltage.

- v. During UVRT or OVRT the injected active and reactive current has to be reduced to the minimum possible current (reduction to zero is recommended).
- c) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must inject additional reactive during to support the voltage during the aboe specified Under-Voltage-Ride-Through (UVRT) and Over-Voltage-Ride-Though (OVRT):

- i. Generating units of Type 2 shall start to inject an additional reactive current I_Q at their terminals in proportion to the deviation of the voltage U from the pre-fault voltage U_0 , following the equation given below, if the voltage at the unit's terminal is 10% (percentage based on nominal voltage) below the pre-fault voltage U_0 , as depicted in Figure 7.5.

$$\Delta I_Q / I_n = K \cdot (-\Delta U) / U_n = -K \cdot (U - U_0) / U_n$$

The equation is written generation oriented, i.e. the additional current is an overexcited reactive current (supporting voltage) in case of a voltage dip.

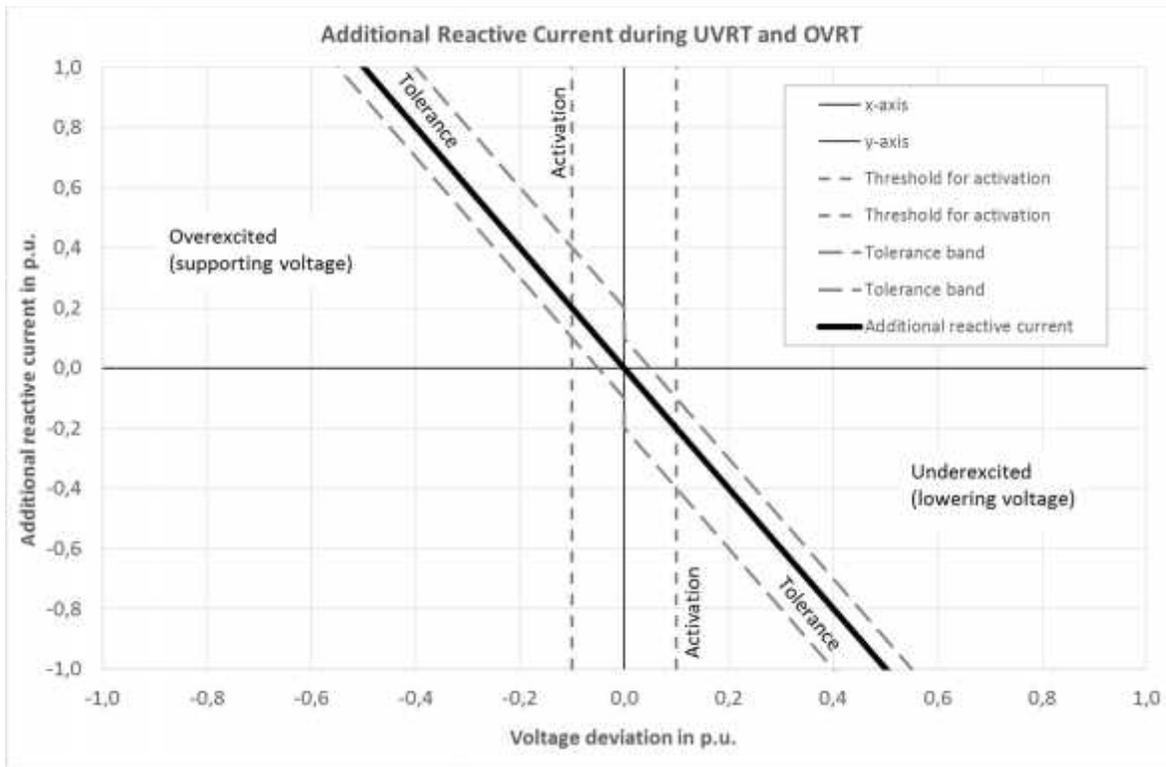


Figure 7.5: Requirement for additional reactive current

Note: The diagram is drawn in a generation-oriented way, i.e. positive additional reactive current is overexcited operation, increasing the voltage.

- ii. The factor K is an integer number and has to be adjustable in the range from 0 to 8. The default setting is 2. The network operator may require a different value within the range from 0 to 8, if needed.

- iii. The voltage U in the equation given in Paragraph i is the positive sequence value of the fundamental frequency at the generating unit terminals. The pre-fault voltage is the 1-minute mean value of the RMS value of the voltage at the generating unit terminals.
- iv. It is allowed to adjust the threshold for activating the additional reactive current injection (10% below the pre-fault voltage U_0) to a value closer to the pre-fault voltage U_0 , i.e. 0%-10% below U_0 (0% means a permanent voltage control).
- v. With the pre-fault reactive current I_{Q0} , the total injected reactive current I_Q is:

$$I_Q = I_{Q0} + \Delta I_Q$$
- vi. The tolerance band for accuracy of the magnitude $|I_Q|$ of the additional reactive current is -10% and +20% of the nominal current of the generating unit, as depicted in Figure 7.5.
- vii. In case of a three-phase fault, the generating unit must be able to inject a reactive current I_Q of at least 100% of the generating unit's nominal current. In case of a single-phase fault or a two-phase fault, the generating unit must be able to inject a reactive current I_Q of at least 40% of the generating unit's nominal current.
- viii. The additional reactive current has to be settled within 60 ms after beginning of the fault, i.e. 60 ms after beginning of the fault the additional reactive current has to be and stay within the tolerance band.
- ix. The additional reactive current has to reach the tolerance band for the first time within 30 ms after beginning of the fault.
- x. Note: There is no deadband for the additional reactive current. Once the voltage is below the activation band of 10% below the pre-fault voltage, the additional current has to be injected according to equation given in Paragraph i
- xi. During UVRT or OVRT generating units of Type 2 shall give priority to reactive current injection, it is allowed to reduce active current. It is recommended to reduce active current I_P in proportion to the deviation of the voltage, as indicated by the following equation or similar:

$$I_P/I_n = (I_{P0} - \Delta I_P)/I_n = (I_{P0}/I_n) - |(-\Delta U/U_n)| = (I_{P0}/I_n) - |(U - U_0)/U_n|$$
- xii. The responsible DNO has to announce if this functionality of dynamic voltage support (additional reactive current during UVRT and OVRT) shall be activated and which value shall be used for the K factor (default value is 2). The DNO has the right at any time in the future to require the activation of this functionality.

7.2.9. Over-Current and Earth-Fault Protection

- a) Over-current protection shall be provided as short-circuit protection.
- b) The connection of a power station to the MV network is implemented either by means of circuit breakers or through an on-load-switch-fuse combination.
- c) A power station connected through a circuit breaker shall be equipped at least with over-current time protection as short-circuit protection.

- d) Short-circuit protection of a power station connected by means of a combined on-load-switch-fuse is ensured by the fuse.
- e) The short-circuit protection devices and earth-fault protection devices of the power station must be integrated into the overall protection concept of the network operator. For this reason, the protection scheme shall be agreed with the network operator at the stage of planning. The protection equipment settings are specified by the network operator as far as they have an impact on his network.
- f) The generator is responsible himself for the reliable protection of his power station (e.g. short-circuit, earth-fault and overload protection, protection from electric shock, etc.).

7.2.10. Protective disconnection devices

- a) The function of protective disconnection devices described here is to disconnect the power station or the individual generating units from the network in the event of disturbed operating conditions. Examples are network faults, islanding, or a slow build-up of the network voltage after a fault in the transmission system. The reason for disconnection can be either to avoid unstable or unsecure operation of the power system, or to protect the installations and other customer facilities connected to the network. The generator is responsible for a reliable protection of his power station.
- b) The following functions of the protective disconnection equipment shall be realized:
 - i. Over-frequency protection $f >$
 - ii. Under-frequency protection $f <$
 - iii. Over-voltage protection $U >$ and $U >>$
 - iv. Under-voltage protection $U <$ and $U <<$
- c) The settings of the protective disconnection devices are not allowed to counteract other requirements.
- d) The parameter settings have to be agreed with the responsible DNO.
- e) The settings for the under-frequency protection shall allow to ride through typical under-frequency fault cases which might happen in the system and which shall be withstand by the system, for example the temporary frequency drop subsequent to the loss of a power station in the system (compare Section “System Frequency Variations” of the Network Code [1]).
- f) If a power station consist of more than one generating unit, the settings must be chosen in a way to disconnect the individual generating units at slightly different thresholds or time settings in order to minimize the power change to the system at one instant in time. The DNO may provide accordingly different settings to different power stations in the network to minimize the power change to the system at one instant in time.
- g) Protective disconnection can be realized within a self-sufficient device or within the control system of the generating unit. The loss of the auxiliary voltage of the protection equipment or of the power station’s control system must lead to an instantaneous tripping of the switch. Tripping through integrated protection relays must not be inadmissibly delayed by other functions of the control system.
- h) Protective disconnection devices are installed at the Point of Connection and/or at the terminals of the power generating units.

7.2.11. Power Reduction on Demand

- a) Power reduction to zero (i.e. stop of power injection) must be possible upon Instruction (e.g. telephone call). To run the customer’s facility in an isolated mode, disconnected from the network of public supply, is allowed.
- b) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV becomes larger than 15% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must have a remote-control connection to reduce the power by the distribution network operator (DNO). The technical requirements for the remote control connection have to be specified by the responsible DNO.

7.2.12. Frequency Sensitive Mode

- a) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV becomes larger than 15% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must be able to run in a limited frequency sensitive mode in cases of over-frequencies:

- i. In cases of frequency above 50.5 Hz (which is the upper frequency band limit under normal operation in the EAPP Interconnected Transmission System), power stations shall reduce active power output with a droop of 4%, starting from 50.5 Hz. This refers to as Limited Frequency Sensitive Mode – Over-Frequency (LFSM-OF). The droop s of the LFSM-OF is defined as given in the equation below with the momentary value of the active power output of the installation at the instant of time when exceeding the 50.5 Hz threshold as P_{ref} .

$$s[\%] = 100 \cdot \frac{f - 50.5 \text{ Hz}}{50.0 \text{ Hz}} \cdot \frac{P_{ref}}{|\Delta P|}$$

The responsible network operator can specify other values for the droop and the activation threshold for LFSM-OF, if technically justified. At 52.0 Hz and above it is allowed to reduce active power output to zero, if agreed with the responsible network operator.

Hint: In other African Grid Codes the LFSM-OF may refer to as “power curtailment during over-frequency”.

- ii. The following equation defines the required power change for cases in which the frequency f is higher than 50.5 Hz.

$$\Delta P = \frac{100}{s[\%]} \cdot \frac{-(f - 50.5 \text{ Hz})}{50.0 \text{ Hz}} \cdot P_{ref}$$

A droop of 4% results in a power change ΔP of 50% of P_{ref} per Hz.

- iii. The power station shall be capable of activating active power frequency response as fast as technically feasible with an initial delay that shall be as short as possible (usually within 2 seconds).
- iv. The power station shall be capable of continuing operation at its minimum regulating level when reaching it.

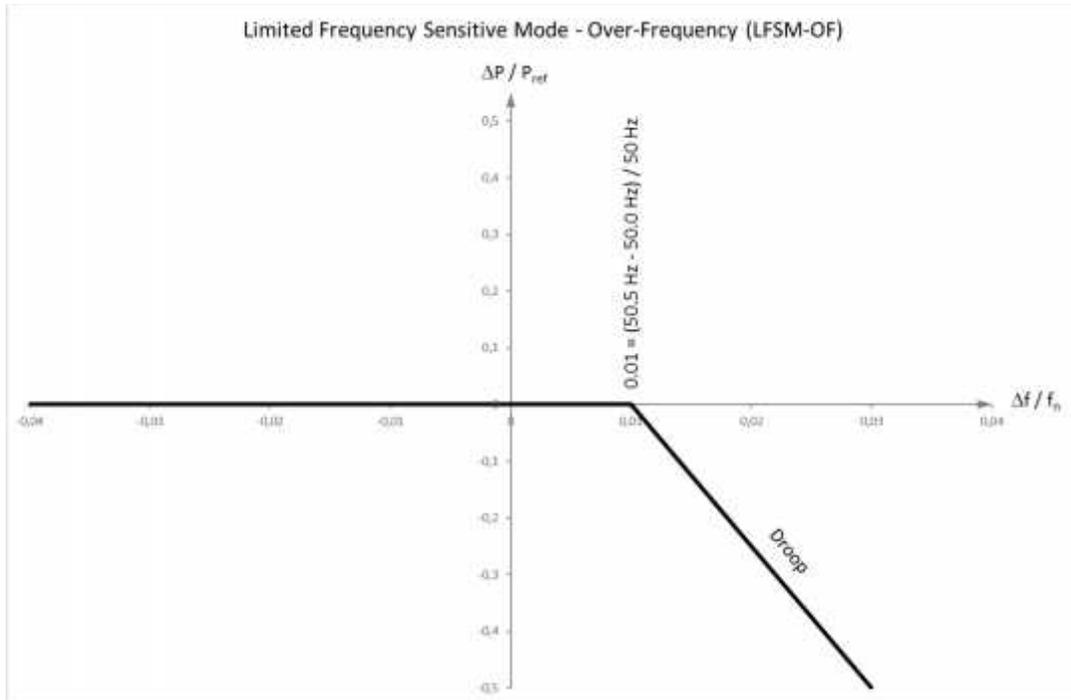


Figure 7.6 Limited Frequency Sensitive Mode – Over-Frequency (LFSM-OF)

- b) If the share of the sum of the nominal power of all Type 2 generating units with PoC at MV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must be able to run in full frequency sensitive mode, i.e. they must be able to participate in frequency control of the system.
- i. In case of over-frequency, the active power frequency response is limited by the minimum regulating level.
 - ii. In case of under-frequency, the active power frequency response is limited by maximum capacity, which depend on environment conditions in cases of wind and solar for example.
 - iii. The initial activation of active power frequency response required shall be provided within 2 seconds.
 - iv. Activation of a minimum response of 3% of maximum continues rating shall be provided within 10 seconds.
 - v. The power station shall be capable of providing full active power frequency response for a period of 10 minutes.
 - vi. Deviant settings may be provided by the network operator.
 - vii. Deviant settings must be agreed with the network operator.
 - viii. During operation of the power station, the responsible network operator can ask to activate or deactivate the frequency sensitive mode via instruction. The generator has to follow the

instruction. The network operator and the generator have to mutually agree on the way how the instruction is transferred and received.

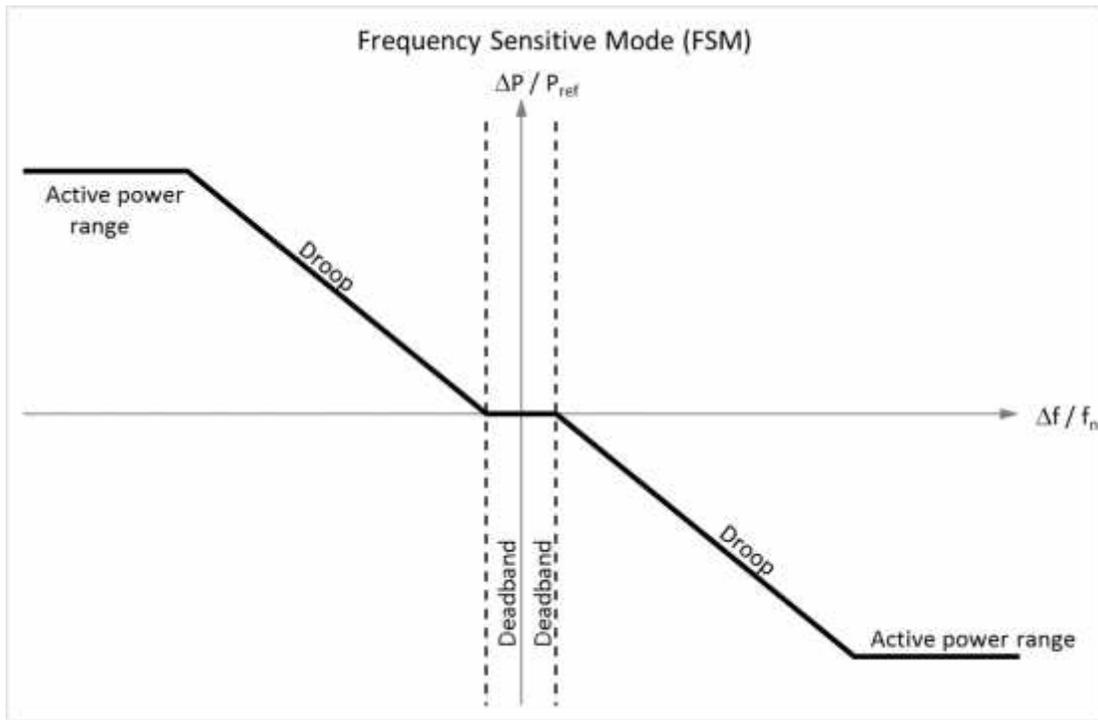


Figure 7.7: Frequency Sensitive Mode (FSM)

$$s[\%] = 100 \cdot \frac{|\Delta f|}{50.0 \text{ Hz}} \cdot \frac{P_{ref}}{|\Delta P|}$$

$$\Delta P = \frac{100}{s[\%]} \cdot \frac{-(\Delta f \mp \text{deadband})}{50.0 \text{ Hz}} \cdot P_{ref}$$

7.3. Technical Requirements for Generation with Type 1 Generating Units and a PoC at LV

- a) This section describes technical requirements for generation with Type 1 generating units and a PoC in an LV network, including Isolated Mini Grids.
- b) These requirements do not apply to micro off-grids. However, if it is intended to let off-grid generating units run in parallel to the grid, once an off-grid is interconnected to the main network, it is recommended to consider these requirements as far as possible during off-grid operation already.
- c) It is assumed that generation with a PoC at LV is non-dispatchable generation.

7.3.1. Operating Voltage Band

- a) The generation facility must be able to fully operate in steady-state in a voltage band of +/- 5%, i.e. 0.95 p.u. through 1.05 p.u. around the nominal voltage at the point of connection (PoC).

7.3.2. Operating Frequency Band

- a) The generation facility must be able to operate in steady-state in a frequency band of +/- 2.5% around the nominal frequency of 50 Hz, i.e. 48.75 Hz through 51.25 Hz.
- b) In island systems and Isolated Mini Grids the maximum deviation from standard frequency can be larger (up to +/- 5% [2]). Therefore a capability to operate in steady-state in a frequency band of +/- 5.0% around the nominal frequency is recommended in these systems, but not mandatory.

7.3.3. Connection and Reconnection Requirements

- a) A connection of a power generating unit shall be admissible only if the network voltage at the PoC is inside its normal operating voltage band (0.95 p.u. – 1.05 p.u.) and the frequency is between 47.5 Hz and 50.5 Hz (which are the lower frequency band limit under extreme system operation of fault conditions and the upper frequency band limit under normal operation in the EAPP Interconnected Transmission System). In Isolated Mini Grids the threshold values may differ from the values given above and have to be specified by the responsible network operator with respect to the voltage and frequency bands in the Isolated Mini Grid.
- b) If the voltage at the PoC is outside of the above mentioned voltage band (0.95 p.u. – 1.05 p.u.), connection shall be blocked.
- c) If the frequency is below 47.5 Hz or above 50.5 Hz, connection shall be blocked. A different value for the setting may be applied in agreement with the responsible DNO (especially in island systems or Isolated Mini Grids).
- d) The reconnection of a power generating unit after being disconnected for protection with respect to Section 7.3.8 or Section 7.3.9, is only allowed:
 - i. if the voltage at the PoC is within the normal operating voltage band of 0.95 p.u. – 1.05 p.u.,
 - ii. if the frequency is above 47.5 Hz and below 50.5 Hz (a different value for the setting may be applied in agreement with the responsible DNO, especially in island systems or Isolated Mini Grids),

- iii. if there is no Instruction from the network operator for disconnection or for power limit of 0%, compare Section 7.3.10, and
- e) If the power station consists of several generating units, the responsible DNO can specify a minimum delay time interval between the connection/reconnection of the individual units in order to limit impact on voltage and ensure desired power quality (e.g. flicker).

7.3.4. Voltage Unbalances, Harmonics and Flicker

- a) If the power station consists of several single-phase units, the single-phase units shall be connected to the Point of Connection in a way, that the power output is distributed as symmetric as possible to the three phases, in order to keep the voltage unbalance as small as possible.
- b) Single-phase installations shall be distributed among the three phases of the network (for example within a network feeder) as balanced as possible. Therefore single-phase installations should be connected to phase A, B, or C, but not always at the same phase. The selection of the particular phase to which an installation is connected shall be agreed with the network operator.
- c) The compatibility level for voltage unbalance in LV three-phase networks shall be 2% [2]. In networks with a predominance of single-phase or two-phase devices connected, a compatibility level of 3% may be applied [2].
- d) The power station shall withstand and function correctly in the presence of harmonic voltages up to the compatibility levels for LV networks specified in [2] (long-term and short-term).
- e) The power station is not allowed to inject harmonic currents into the network which lead to harmonic voltages or a THD at the PCC which are higher than the compatibility levels for LV networks specified in [2]. The responsible DNO may provide lower planning limits in order to ensure that the compatibility levels at the PCC are met.
- f) Usually it can be assumed that generating units of Type 1 do not inject relevant harmonic currents and thus fulfil the requirement related to harmonic voltages of this code without any further verification.
- g) Nevertheless, if the compatibility levels for harmonic voltages or THD at the PCC are exceeded in operation, the responsible DNO has to carry out measurements in accordance to [2] in combination with [3] in order to find the most disturbing device. If this device belongs to the power station, the generator has to do countermeasures to lower the harmonic disturbance.
- h) The power station shall withstand and function correctly in the presence of voltage flicker up to the compatibility level for LV networks specified in [2].
- i) The power station is not allowed to perform power changes which lead to voltage flicker at the PCC which are higher than the compatibility levels for LV networks specified in [2]. The responsible DNO may provide lower planning limits in order to ensure that the compatibility levels at the PCC are met.
- j) If a generating unit or a device of the power station with a rated current less or equal to 16 A fulfils the requirement of IEC 61000-3-3 [6], it is assumed to fulfil the requirement related to voltage changes, voltage fluctuations and flicker of this code without any further verification.

7.3.5. Reactive Power Capability

- a) Generating units of Type 1 shall have a reactive power capability of at least a power factor of +/- 0.9.

7.3.6. Power Factor Control Capability

- a) A power station with Type 1 generating units shall provide the capability of the following two control modes effective at the point of connection (PoC) of the power station:
 - i. reactive power (constant Q)
 - ii. power factor (constant cos phi)
- b) For power stations with Type 1 generating units, the network operator selects the control mode which has to be activated for operation and specifies the parameter settings, depending on the location of the PoC in the network. As long as not specified individually by the responsible network operator, a power factor of 1.00 (reactive power equal to 0 Mvar) shall be used as operating setpoint.
- c) A power station with Type 1 generating units shall be able to operate in any operating point of the reactive power capability specified in Section 7.3.5.
- d) For an adjusted control mode and parameter set, the power station with Type 1 generating units shall be able to settle each accessible operating point with respect to the control mode within 30 seconds.

7.3.7. Behaviour During Network Faults

- a) Type 1 generating units with PoC at LV shall disconnect from the grid as fast as possible by means of protective disconnection devices, if the voltage at the PoC becomes lower than 0.9 p.u. The voltage to be considered is the lowest of the three line-to-line voltages.
- b) Type 1 generating units with PoC at LV must have Over-Voltage-Ride-Through (OVRT) capability which shall be designed with anticipation of the following voltage conditions at the Point of Connection:
 - i. A voltage rise to 120% for 2 s, or to 110% for 60 s provided that during the 3 minute period immediately following the end of that 0.1 s, 2 s, or 60 s periods the actual voltage remains in the range 95-105% of the nominal voltage.

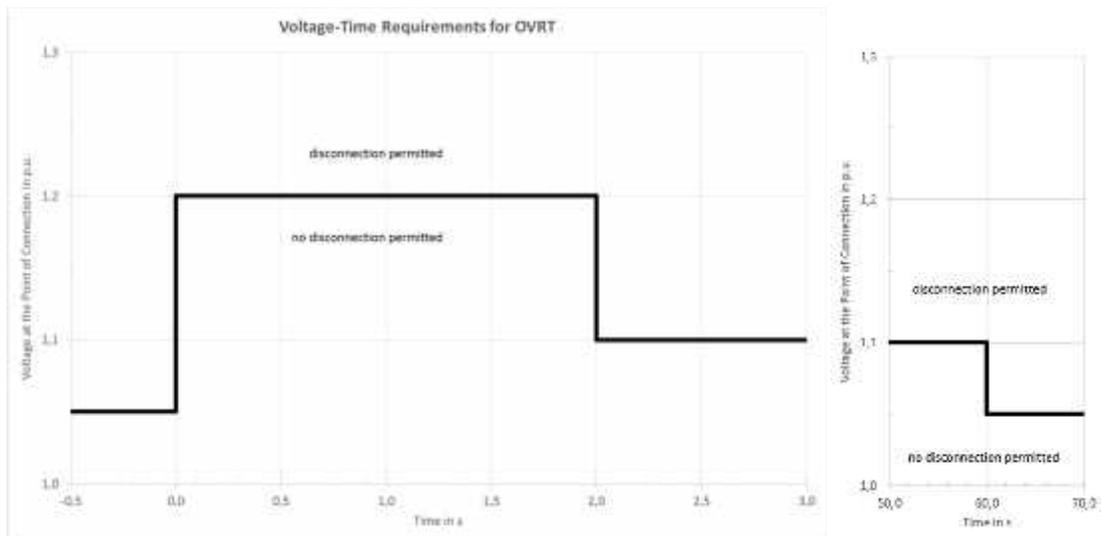


Figure 7.8: Voltage-Time Requirements for Over-Voltage-Ride-Through (OVRT)

- ii. The voltage to be considered is the highest of the three line-to-line voltages in cases of voltages above 100% of the nominal voltage.

7.3.8. Over-Current and Earth-Fault Protection

- a) Over-current protection shall be provided as short-circuit protection.
- b) The connection of a power station to the LV network is implemented either by means of circuit breakers or through an on-load-switch-fuse combination or a simple fuse.
- c) A power station connected through a circuit breaker shall be equipped at least with over-current time protection as short-circuit protection.
- d) Short-circuit protection of a power station connected by means of a combined on-load-switch-fuse is ensured by the fuse.
- e) A fuse is sufficient for over-current protection, if no circuit breaker or on-load-switch-fuse combination is used.
- f) The short-circuit protection devices and earth-fault protection devices of the power station must be integrated into the overall protection concept of the network operator. For this reason, the protection scheme shall be agreed with the network operator at the stage of planning. The protection equipment settings are specified by the network operator as far as they have an impact on his network.
- g) The generator is responsible himself for the reliable protection of his power station (e.g. short-circuit, earth-fault and overload protection, protection from electric shock, etc.).

7.3.9. Protective disconnection devices

- a) The function of protective disconnection devices described here is to disconnect the power station or the individual generating units from the network in the event of disturbed operating conditions. Examples are network faults, islanding, or a slow build-up of the network voltage after a fault in the transmission system. The reason for disconnection can be either to avoid unstable or unsecure operation of the power system, or to protect the installations and other customer facilities connected to the network. The generator is responsible for a reliable protection of his power station.
- b) The following functions of the protective disconnection equipment shall be realized:
 - i. Over-frequency protection $f >$
 - ii. Under-frequency protection $f <$
 - iii. Over-voltage protection $U >$ and $U >>$
 - iv. Under-voltage protection $U <$ and $U <<$
- c) The settings of the protective disconnection devices are not allowed to counteract other requirements.
- d) The parameter settings have to be agreed with the responsible DNO.
- e) If a power station consists of more than one generating unit, the settings must be chosen in a way to disconnect the individual generating units at slightly different thresholds or time settings in order to minimize the power change to the system at one instant in time. The DNO may provide accordingly

different settings to different power stations in the network to minimize the power change to the system at one instant in time.

- f) Protective disconnection can be realized within a self-sufficient device or within the control system of the generating unit. The loss of the auxiliary voltage of the protection equipment or of the power station's control system must lead to an instantaneous tripping of the switch. Tripping through integrated protection relays must not be inadmissibly delayed by other functions of the control system.
- g) Protective disconnection devices are installed at the Point of Connection and/or at the terminals of the power generating units.
- h) If the share of the sum of the nominal power of all Type 1 generating units with PoC at LV compared to the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid) becomes as large as so that a potential loss of these generating units may have a considerable impact on the frequency of the system, the settings for the under-frequency protection newly commissioned generators shall allow to ride through typical under-frequency fault cases which might happen in the system and which shall be withstand by the system, for example the temporary frequency drop subsequent to the loss of a power station in the system (compare Section "System Frequency Variations" of the Network Code [1]). This capability to ride through such under-frequency fault cases is also recommended (but not mandatory) if the share of the sum of the nominal power of all Type 1 generating units with PoC at LV is smaller than described at the beginning of this paragraph

7.3.10. Power Reduction on Demand

- a) Power reduction to zero (i.e. stop of power injection) must be possible upon Instruction (e.g. telephone call). To run the customer's facility in an isolated mode, disconnected from the network of public supply, is allowed.
- b) If the share of the sum of the nominal power of all Type 1 generating units with PoC at LV becomes larger than 30%³ of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must have a remote control connection to reduce power injection to zero by the distribution network operator (DNO). The technical requirements for the remote control connection have to be specified by the responsible DNO.

7.3.11. Frequency Sensitive Mode

- a) If the share of the sum of the nominal power of all Type 1 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must be able to run in a limited frequency sensitive mode in cases of over-frequency.
 - i. In cases of frequency above 50.5 Hz (which is the upper frequency band limit under normal operation in the EAPP Interconnected Transmission System), power stations shall reduce active power output with a droop of 4%, starting from 50.5 Hz. This refers to as Limited Frequency

³ The limitation of the requirement with respect to share of the sum of nominal power of Type 1 generating units shall allow easier network access as long as there are not as many installations with Type 1 generating units with PoC at LV, but guarantee a strict enough requirement if Type 1 generating units reach a share with considerable impact on the system.

Sensitive Mode – Over-Frequency (LFSM-OF). The droop s of the LFSM-OF is defined as given in the equation below with the momentary value of the active power output of the installation at the instant of time when exceeding the 50.5 Hz threshold as P_{ref} .

$$s[\%] = 100 \cdot \frac{f - 50.5 \text{ Hz}}{50.0 \text{ Hz}} \cdot \frac{P_{ref}}{|\Delta P|}$$

The responsible network operator can specify other values for the droop and the activation threshold for LFSM-OF, if technically justified. At 52.0 Hz and above it is allowed to reduce active power output to zero, if agreed with the responsible network operator.

Hint: In other African Grid Codes the LFSM-OF may refer to as “power curtailment during over-frequency”.

- ii. The following equation defines the required power change for cases in which the frequency f is higher than 50.5 Hz.

$$\Delta P = \frac{100}{s[\%]} \cdot \frac{-(f - 50.5 \text{ Hz})}{50.0 \text{ Hz}} \cdot P_{ref}$$

A droop of 4% results in a power change ΔP of 50% of P_{ref} per Hz.

- iii. The power station shall be capable of activating active power frequency response as fast as technically feasible with an initial delay that shall be as short as possible (usually within 2 seconds).
- iv. The power station shall be capable of continuing operation at its minimum regulating level when reaching it.

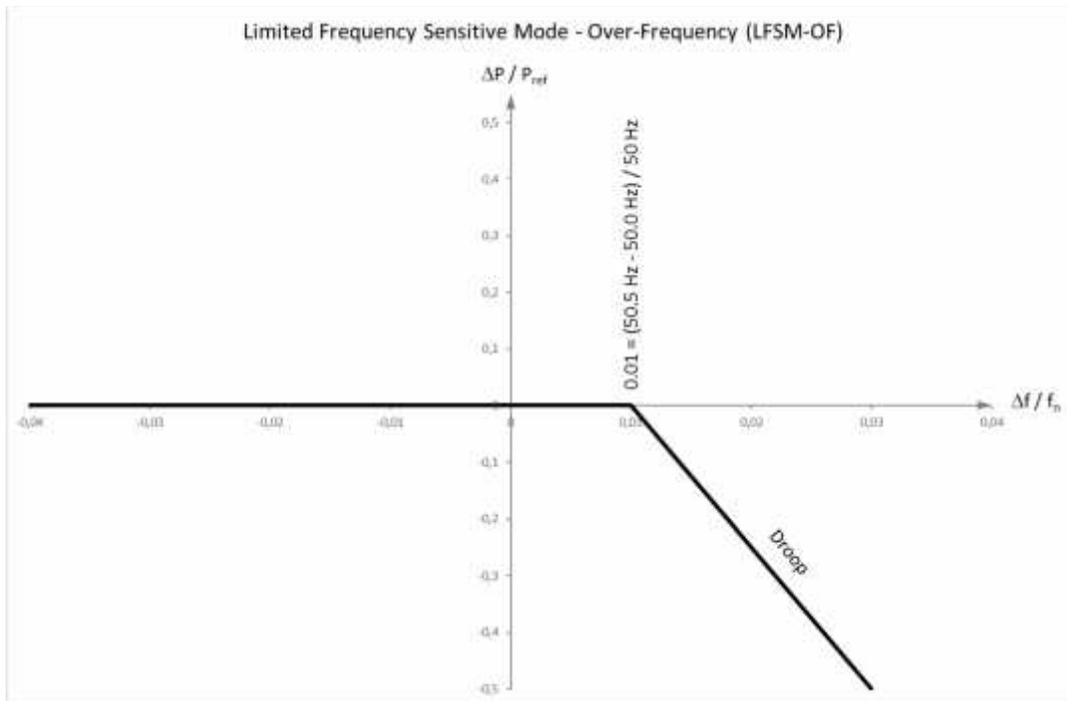


Figure 7.9: Limited Frequency Sensitive Mode – Over-Frequency (LFSM-OF)

7.4. Technical Requirements for Generation with Type 2 Generating Units and a PoC at LV

- a) This section describes technical requirements for generation with Type 2 generating units and a PoC in a Tanzanian LV network, including Isolated Mini Grids.
- b) These requirements do not apply to micro off-grids. However, if it is intended to let off-grid generating units run in parallel to the grid, once an off-grid is interconnected to the main network, it is recommended to consider these requirements as far as possible during off-grid operation already.
- c) It is assumed that generation with a PoC at LV is non-dispatchable generation.

7.4.1. Operating Voltage Band

- a) The generation facility must be able to fully operate in steady-state in a voltage band of +/- 5%, i.e. 0.95 p.u. through 1.05 p.u. around the nominal voltage at the point of connection (PoC).

7.4.2. Operating Frequency Band

- a) The generation facility must be able to operate in steady-state in a frequency band of +/- 2.5% around the nominal frequency of 50 Hz, i.e. 48.75 Hz through 51.25 Hz.
- b) In island systems and Isolated Mini Grids the maximum deviation from standard frequency can be larger (up to +/- 5% [2]). Therefore a capability to operate in steady-state in a frequency band of +/- 5.0% around the nominal frequency is recommended in these systems, but not mandatory.

7.4.3. Connection and Reconnection Requirements

- a) A connection of a power generating unit shall be admissible only if the network voltage at the PoC is inside its normal operating voltage band (0.95 p.u. – 1.05 p.u.) and the frequency is between 47.5 Hz and 50.5 Hz (which are the lower frequency band limit under extreme system operation of fault conditions and the upper frequency band limit under normal operation in the EAPP Interconnected Transmission System). In Isolated Mini Grids the threshold values may differ from the values given above and have to be specified by the responsible network operator with respect to the voltage and frequency bands in the Isolated Mini Grid.
- b) If the voltage at the PoC is outside of the above mentioned voltage band (0.95 p.u. – 1.05 p.u.), connection shall be blocked.
- c) If the frequency is below 47.5 Hz or above 50.5 Hz, connection shall be blocked. A different value for the setting may be applied in agreement with the responsible DNO (especially in island systems or Isolated Mini Grids).
- d) The reconnection of a power generating unit after being disconnected for protection with respect to Section 7.4.8 or Section 7.4.9, is only allowed:
 - i. if the voltage at the PoC is within the normal operating voltage band of 0.95 p.u. – 1.05 p.u.,
 - ii. if the frequency is above 47.5 Hz and below 50.5 Hz (a different value for the setting may be applied in agreement with the responsible DNO, especially in island systems or Isolated Mini Grids),

- iii. if there is no Instruction from the network operator for disconnection or for power limit of 0%, compare Section 7.4.10, and
- e) If the power station consists of several generating units, the responsible DNO can specify a minimum delay time interval between the connection/reconnection of the individual units in order to limit impact on voltage and ensure desired power quality (e.g. flicker).

7.4.4. Voltage Unbalances, Harmonics, Flicker and DC Current Injection

- a) If the power station consists of several single-phase units, the single-phase units shall be connected to the Point of Connection in a way, that the power output is distributed as symmetric as possible to the three phases, in order to keep the voltage unbalance as small as possible.
- b) Single-phase installations shall be distributed among the three phases of the network (for example within a network feeder) as balanced as possible. Therefore single-phase installations should be connected to phase A, B, or C, but not always at the same phase. The selection of the particular phase to which an installation is connected shall be agreed with the network operator.
- c) The compatibility level for voltage unbalance in LV three-phase networks shall be 2% [2]. In networks with a predominance of single-phase or two-phase devices connected, a compatibility level of 3% may be applied [2].
- d) The power station shall withstand and function correctly in the presence of harmonic voltages up to the compatibility levels for LV networks specified in [2] (long-term and short-term).
- e) The power station is not allowed to inject harmonic currents into the network which lead to harmonic voltages or a THD at the PCC which are higher than the compatibility levels for LV networks specified in [2]. The responsible DNO may provide lower planning limits in order to ensure that the compatibility levels at the PCC are met.
- f) If a generating unit or a device of the power station with a rated current less or equal to 16 A fulfils the requirement of IEC 61000-3-2 [5], it is assumed to fulfil the requirement related to harmonic voltages of the Tanzanian Distribution Code without any further verification.
- g) If the compatibility levels for harmonic voltages or THD at the PCC are exceeded in operation, the responsible DNO has to carry out measurements in accordance to [2] in combination with [3] or if applicable in combination with [4] in order to find the most disturbing device. If this device belongs to the power station, the generator has to do countermeasures to lower the harmonic disturbance.
- h) The power station shall withstand and function correctly in the presence of voltage flicker up to the compatibility level for LV networks specified in [2].
- i) The power station is not allowed to perform power changes which lead to voltage flicker at the PCC which are higher than the compatibility levels for LV networks specified in [2]. The responsible DNO may provide lower planning limits in order to ensure that the compatibility levels at the PCC are met.
- j) If a generating unit or a device of the power station with a rated current less or equal to 16 A fulfils the requirement of IEC 61000-3-3 [6], it is assumed to fulfil the requirement related to voltage changes, voltage fluctuations and flicker of this code without any further verification.
- k) The installation shall not inject a DC current greater than 1% of its rated output current into the Point of Connection under any operating condition.

7.4.5. Reactive Power Capability

- a) As long as the share of the sum of the nominal power of all Type 2 generating units with PoC at LV is lower than or equal to 30%⁴ of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), the reactive power output or demand of a generating unit of Type 2 shall be as small as possible, no reactive power capability is required.
- b) If the share of the sum of the nominal power of all Type 2 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), all newly commissioned generating units shall have a reactive power capability of at least a power factor of +/- 0.9.

7.4.6. Power Factor Control Capability

- a) As long as the share of the sum of the nominal power of all Type 2 generating units with PoC at LV is lower than or equal to 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), the power factor shall be above 0.98 (“close to 1.00”), while operation with a power factor at or close to 1.00 is recommended. When operating with partial active power, the reactive power output or demand shall not be larger than the reactive power that corresponds to a power factor of 0.98 (“close to 1.00”) at nominal active power.
- b) Only if the share of the sum of the nominal power of all Type 2 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), all newly commissioned generating units shall have the following power factor control capabilities.
- c) A power station with Type 2 generating units shall provide the capability of the following two control modes effective at the point of connection (PoC) of the power station:
 - i. reactive power (constant Q)
 - ii. power factor (constant cos phi)
- d) For power stations with Type 2 generating units, the network operator selects the control mode which has to be activated for operation and specifies the parameter settings, depending on the location of the PoC in the network.
- e) A power station with Type 2 generating units shall be able to operate in any operating point of the reactive power capability specified in Section 7.4.5, for the active power range which is possible to operate with respect to the primary power source of the power station.
- f) For an adjusted control mode and parameter set, the power station with Type 2 generating units shall be able to settle each accessible operating point with respect to the control mode within 30 seconds.

7.4.7. Behaviour During Network Faults

- a) If the share of the sum of the nominal power of all Type 2 generating units with PoC at LV is smaller than or equal to 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), these

⁴ The limitation of the requirement with respect to share of the sum of nominal power of Type 2 generating units shall allow easier network access as long as there are not as many installations with Type 2 generating units with PoC at LV, but guarantee a strict enough requirement if Type 2 generating units reach a share with considerable impact on the system.

generating units shall disconnect from the grid as fast as possible by means of protective disconnection devices, if the voltage at the PoC becomes lower than 0.9 p.u.

- b) If the share of the sum of the nominal power of all Type 2 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must have Under-Voltage-Ride-Through (UVRT) and Over-Voltage-Ride-Through (OVRT) capability. Any new generating unit and any equipment of a new power station shall be designed with anticipation of the following voltage conditions at the Point of Connection:
- i. A voltage deviation in the range of 95% to 105% for protracted periods.
 - ii. A voltage dip to zero for up to 0.2 s, to 75% for 2 s, or to 85% for 60 s provided that during the 3 minute period immediately following the end of that 0.2 s, 2 s, or 60 s periods the actual voltage remains in the range 95-105% of the nominal voltage (compare Section “External supply disturbance withstand capability“ of The Network Code [1]).

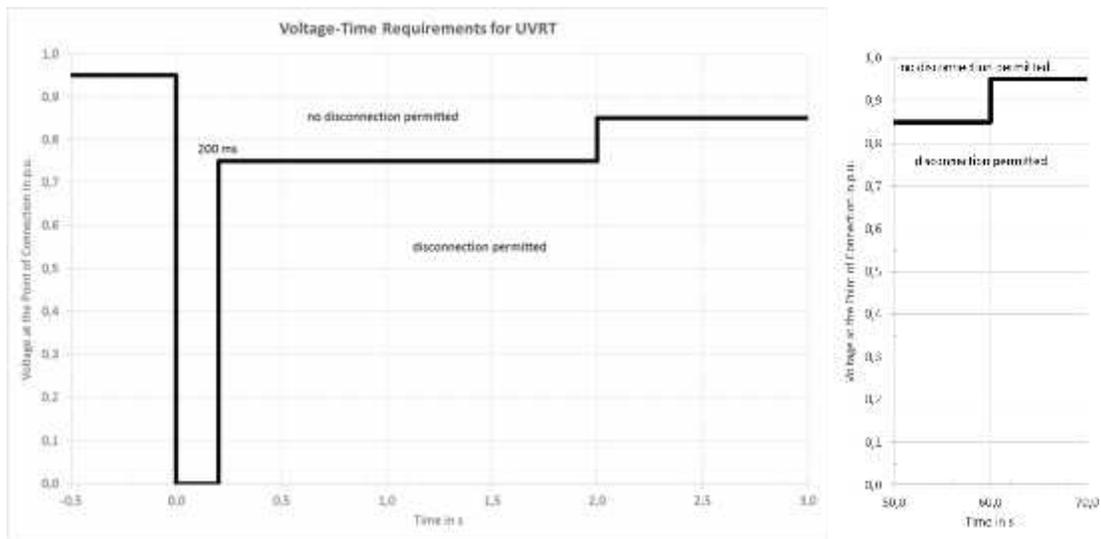


Figure 7.10: Voltage-Time Requirements for Under-Voltage-Ride-Through (UVRT)

- iii. A voltage rise to 120% for 2 s, or to 110% for 60 s provided that during the 3 minute period immediately following the end of that 0.1 s, 2 s, or 60 s periods the actual voltage remains in the range 95-105% of the nominal voltage.

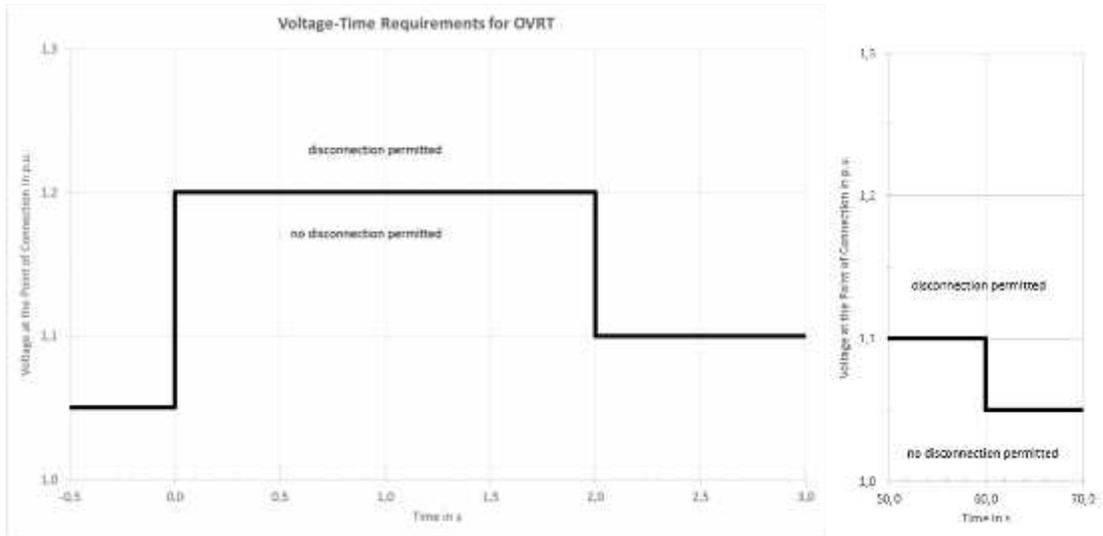


Figure 7.11: Voltage-Time Requirements for Over-Voltage-Ride-Through (OVRT)

iv. The voltage to be considered is:

the lowest of the three line-to-line voltages in cases of voltages below 100% of the nominal voltage, and

the highest of the three line-to-line voltages in cases of voltages above 100% of the nominal voltage.

v. During UVRT or OVRT the injected active and reactive current has to be reduced to the minimum possible current (reduction to zero is recommended).

7.4.8. Over-current and Earth-Fault Protection

a) For Generation with Type 2 Generating Units and a PoC at LV, with respect to over-current and earth-fault protection, the same requirements apply as for Generation with Type 1 Generating Units and a PoC at LV. Refer to Section 7.3.8.

7.4.9. Protective disconnection devices

a) For Generation with Type 2 Generating Units and a PoC at LV, with respect to protective disconnection devices, the same requirements apply as for Generation with Type 1 Generating Units and a PoC at LV. Refer to Section 7.3.9.

b) Paragraph h) of Section 7.3.9 applies to Generation with Type 2 Generating Units and a PoC at LV, if the share of the sum of the nominal power of all Type 2 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid).

7.4.10. Power Reduction on Demand

a) Power reduction to zero (i.e. stop of power injection) must be possible upon Instruction (e.g. telephone call). To run the customer's facility in an isolated mode, disconnected from the network of public supply, is allowed.

- b) If the share of the sum of the nominal power of all Type 2 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must have a remote control connection to reduce power injection to zero by the distribution network operator (DNO). The technical requirements for the remote control connection have to be specified by the responsible DNO.

7.4.11. Frequency Sensitive Mode

- a) If the share of the sum of the nominal power of all Type 2 generating units with PoC at LV becomes larger than 30% of the installed capacity in the system (i.e. in main grid or in Isolated Mini Grid), newly commissioned generators must be able to run in a limited frequency sensitive mode in cases of over-frequency (Limited Frequency Sensitive Mode – Over-Frequency, LFSM-OF).
- b) The LFSM-OF is defined for Type 2 generating units with PoC at LV in the same way as for Type 1 generating units with PoC at LV. Refer to Section 7.3.11.

8. Planning

8.1. Introduction

This section describe framework of the distribution network, network investment overview and criteria, dedicated and premium customers connection procedures, and strategic investments issues.

8.2. Framework for Distribution Network Planning and Development

- a) The DNO shall source relevant data from various sources to establish the need for network strengthening including the following where relevant:
 - i) National resource planning authorities,
 - ii) Local government resource planning,
 - iii) National Development Plan,
 - iv) customer information,
 - v) system performance statistics,
 - vi) Distribution network load forecast, and
 - vii) Government and customer development plans
- a) The DNO shall annually compile a 5-year load forecast at the DNO's incoming points of supply including DNO's cross-boundary connections.
- b) The DNO shall be responsible for compiling network development plans with a minimum window period of five years. These network development plans shall be reviewed at least every 3 years. The aim of network development plans is to ensure a capable network and should therefore include all relevant activities such as electrification and refurbishment. Such plans should be drawn up taking into account only available information. Unexpected loads or customer requests can be retrospectively added to the plan.
- c) The network development plans and post release changes shall be submitted to the Authority upon request.
- d) The network development plans shall be made available to customers on request.

8.3. Network Investment Criteria

8.3.1. Overview

- a) Distribution tariffs should be sufficient to allow the necessary investments in the networks to be carried out in a manner allowing these investments to ensure the viability of the networks.
- b) The DNO shall invest in the Distribution System when the required development meets the technical and investment criteria specified in this section.

- c) The need to invest must first be decided on technical grounds. All investments must be the least lifecycle cost technically acceptable solution, that is, shall provide for standard supply:
 - i) Minimum quality requirements in terms of National Standards.
 - ii) Minimum reliability and operational requirements as determined by this code and the Authority.
- d) The investment choice must be justified by considering technical alternatives on a least- life cycle cost approach. Least life cycle cost is the discounted least cost option over the lifetime of the equipment, taking into account the technical alternatives for investment, operating expenses and maintenance.
- e) Calculations to justify investment shall assume a typical project life expectancy of 20 years, except where otherwise dictated by plant life or project life expectancy.
- f) The following key economic and financial parameters shall be determined by the Authority approved process:
 - i) Discount rate.
 - ii) Customer interruption cost (cost of un-served energy).
 - iii) Other parameters, such as tariffs and additional economic parameters.

8.3.2. General Investment Criteria

- a) Investments should be prudent (that is justified) as a least life-cycle cost solution after taking into account, where applicable, alternatives that consider the following:
 - i) The investment that will minimize the cost of the energy supplied and the customer interruption cost (cost of un-served energy).
 - ii) Current and projected demand on the network.
 - iii) Reduction of life-cycle costs (e.g. reduction of technical losses, operating and maintenance costs and telecommunication projects).
 - iv) Current condition of assets and refurbishment and maintenance requirements
 - v) Demand and supply options.
 - vi) Any associated risks.
- b) General (shared) network investments shall be evaluated on the least-life-cycle economic cost. Economic cost will consider the least life cycle total cost of the electricity related investment to both the DNO and the customer.
- c) Investments made by the DNO dedicated to a particular customer shall be evaluated on a least life-cycle DNO cost. DNO cost will consider only the least-life cycle investment cost to the DNO.
- d) The DNO shall evaluate investments in terms of the following categories:
 - i) Shared network investments.

- ii) Dedicated customer connections.
- iii) Statutory investments.
- iv) International connections (cross-border connections).

8.3.3. Least economic cost criteria for shared network investments

- a) Shared network investments are:
 - i) Investments on shared infrastructure (not-dedicated) assets.
 - ii) Investments required providing adequate upstream network capacity.
 - iii) Investments required to maintain or enhance supply reliability and/or quality to attain the limits or targets, determined in section 6.1 of this code, on existing network assets.
 - iv) Refurbishment of existing standard dedicated connection assets.
- b) All shared network investments are to be justified on least economic cost. In determining the least economic cost for shared network investments the investment must be justified to minimize the cost to the electricity industry and not just to the DNO.

8.3.4. Least life cycle cost criteria for standard dedicated customer connections

- a) A standard connection is defined as the lowest life-cycle costs for a technically acceptable solution and will be charged for as described in the Electricity (Tariff Setting) Rules issued by the Authority.
- b) Dedicated customer connections are:
 - i) New connection assets created for the sole use of a customer to meet the customer's technical specifications.
 - ii) Dedicated assets are assets that are unlikely to be shared in the DNO's planning horizon by any other end-use customer.
- c) All dedicated connection investments are to be justified on the technically acceptable least life-cycle costs.
- d) Where the investment meets the least life-cycle cost, the customer shall be required to pay a standard connection charge as shall have been approved by the Authority
- e) For certain customer groupings, as approved by the Authority, the investments shall be justified collectively as per customer grouping and not per customer.
- f) The DNO will refurbish / replace / reconfigure all equipment in terms of its new standards to meet standard supply criteria at no cost to the customer and this will allowed to be recovered in the use-of system (network charges). This will be a non-discriminatory approach where no consideration will be given to the special or unique requirements of the customer.

8.3.5. Investment criteria for premium customer connections

- a) The DNO shall investigate these additional requirements and will provide a least life-cycle cost solution.

- b) If the customer agrees to the solution, all costs to meet the customer requirement in excess of what is considered the least life-cycle cost investment is payable as a premium connection charge by the customer as described in Electricity (Tariff Setting) Rules. Such costs shall be appropriately pro-rated, if a portion of the investment can be justified based on improved reliability or reduction of costs.
- c) The refurbishment of identified premium connection assets will occur when the equipment is no longer reliable or safe for operation. The DNO must justify the need for refurbishment of the premium assets to the customer, and the customer must agree to the continuance of the premium supply.
- d) At the time of refurbishment, should the customer have any requirements that cannot be met in as per clause 7.3.4 (e), any additional investment will be seen as a premium connection.
- e) Where the refurbishment of a supply in accordance with current technical standards will result in additional cost to the customer, an engineering solution that minimizes the sum of the DNO's and the customer's costs will be found. This least economic cost option will be implemented but any expenditure in excess of the DNO least life-cycle cost solution (as per clauses 7.3.2 and 7.3.4 (e) above, will be borne by the customer through a new premium connection charge and shall not be recovered through use-of-system (network) charges

8.3.6. Statutory or strategic investments

- a) DNO will be obligated to make statutory investments in terms of clause 7.3.6 (c) below.
- b) Statutory and strategic investments will be motivated on a least economic cost basis, as defined in clause 7.3.3.
- c) Strategic and statutory projects include the following:
 - i) Investments formally requested in terms of published government policy but not considered dedicated customer as under clause 7.3.4.
 - ii) Projects necessary to meet environmental legislation, e.g. the construction of oil containment dams.
 - iii) Expenditure to satisfy the requirements on the DNO to comply with the Occupational Health and Safety Act; this classification is intended to ensure the safety of operating and maintenance personnel who are exposed to possible danger when busy with activities related to electricity transmission.
 - iv) Possible compulsory contractual commitments.
 - v) Generators.

9. Information Exchange

9.1. Introduction

The section defines obligations of participants with regard to the provision and exchange of planning, operational and maintenance information for the implementation of the Distribution Code.

9.2. Information Exchange Interface

- a) The parties shall identify the following for each type of information exchange:
 - i) The name and contact details of the person(s) designated by the information owner to be responsible for provision of the information.
 - ii) The names, contact details of, and the parties represented by persons requesting the information.
 - iii) The purpose for which the information is required.
 - iv) The parties shall agree on appropriate procedures for the transfer of information.
- b) Participants (with installed capacity of more than 100kVA) shall exchange information, prior to commissioning, of new or altered equipment connected at the point of connection or changes to the operational regimes that could have an adverse effect on the distribution system to enable proper modifications to any affected participants networks and related systems.

9.3. Provision and exchange of Information during the planning and connection process

- a) Each DNO shall have a supply application form, which shall request, at minimum, the information stipulated in this section
- b) Customers requesting supply at low voltage shall provide the DNO with the information relating to:
 - i) New or change in connected loads.
 - ii) Type of load to be connected to the Distribution System.
 - iii) Requested connection date.
 - iv) Proposed network connection point address.
- c) Customers requesting supply at HV or MV shall, in addition to 8.3b above, provide the DNO with the following information:
 - i) Requested supply voltage
 - ii) Expected and / or projected maximum demand (in kVA)
 - iii) Expected load power factor
 - iv) Switched customer capacitor banks and reactors, which could affect the Distribution System

- v) Whether the load is capable of producing Harmonics as specified by equipment manufacturers
 - vi) The nature and type of process the supply is requested for
 - vii) Minimum required fault levels
 - viii) Start-up requirements
 - ix) Whether the customer has any standby generator.
- d) The DNO may request Customers to provide information on the Customer's proposed installation and equipment at the Point of Connection.
- e) Participants shall exchange information relating to the protection of Distribution System and customer equipment protection coordination at the point of connection.
- f) Upon any reasonable request, the DNO shall provide customers or potential customers with any relevant information that they require to properly plan and design their own networks/installations. This may include but not limited to:
- i) Nominal voltage at which connection will be made.
 - ii) Method of connection, extension and/or reinforcement details.
 - iii) The maximum and minimum fault levels.
 - iv) Method of earthing.
 - v) Maximum installed Capacity at the point of connection.
 - vi) Specification of any accommodation of equipment requirement.
 - vii) Individual customer limits relating to:
 - A. Harmonic Distortion
 - B. Voltage Flicker
 - C. Voltage Unbalance
 - viii) Expected lead time of providing connection (following formal acceptance of terms for supply).
 - ix) An indication of network single contingency capability.
 - x) An indication of current network performance and power quality.
 - xi) Cost of connection.
 - xii) Range of current approved tariff structures.

9.4. Operational Information

- a) Commissioning and notification

- i) Customers shall confirm that all information given in the application for supply and additional information subsequently requested by the DNO is correct before the commissioning.
- ii) The commissioning dates shall be negotiated between the parties. Participants will agree on the type of operational data to be submitted prior to commissioning, which shall include test and commissioning report.
- iii) The asset owner (DNO or Customer) shall ensure that all equipment records, that affect the integrity of the Distribution System or relevant to the interconnection, are maintained for reference for the duration of the operational life of the plant. On request from the DNO, information shall be made available within a reasonable time.
- iv) The DNO shall indicate to the customer what information is relevant in terms of this section.

b) Sharing of Assets and Resources

DNO sharing assets and resources shall enter into agreements for the provision and sharing of their assets, resources, services and information.

c) Additional Information Requirements

Should one participant, acting reasonably, determine that additional measurements and/or indications are needed in relation to another participant's plant and equipment; the requesting participant shall consult with the affected participant(s) to agree on the manner in which the need may be met. The costs related to the modifications for the additional measurements and/or indications shall be for the account of the causal participant.

d) Communication and Liaison

- i) Participants shall establish a communication channel for exchange of information required for distribution operations, which may include the installation of DNO's SCADA equipment at the customer's or DNO's installation to facilitate the flow of information and data to and from the DNO and / or Transmission control facilities.
- ii) Each participant shall designate a person with delegated authority to perform the duties of information owner in respect of the granting of access to information covered in this code to third parties. A party may, at its sole discretion, designate more than one person to perform these duties.
- iii) The DNO shall take reasonable steps to exchange information with the DNO's affected customers for distribution system and transmission system outages.
- iv) Customers shall exchange information with the DNO within an agreed lead time on all operations on their installations, which may have an adverse effect on the Distribution System including any planned activities such as plant shutdown, or scheduled maintenance.
- v) The communication facilities standards shall be set and documented by the DNO. Any changes to communication facilities standards impacting on participant equipment shall be brought to the attention of the participant well in advance of the proposed upgrade.
- vi) Any back up or emergency communication channels established by the DNO and deemed necessary for the safe operation of the Distribution System shall be agreed upon by the DNO and the participant affected.

e) Data Storage and Archiving

- i) The obligation for data storage and archiving shall lie with the information owner.
- ii) The systems that store the data and/or information to be used by the participants shall be of their own choice and for their own cost.
- iii) All data storage systems must be able to be audited by the Authority. The systems must provide for clear and accessible audit trails on all relevant operational transactions. All requests that require an audit on a system shall be undertaken with reasonable notice to the parties.
- iv) The information owner shall keep all information, except voice recorded information, in its original format for a period of at least five (5) years (unless otherwise specified differently in other parts of this code) commencing from the date the information was created.
- v) Participants shall ensure reasonable security against unauthorized access, use and loss of information for the systems that contain the information.
- vi) DNO shall use a voice recorder for historical recording of all operational voice communication with participants. These records shall be available for at least three (3) months except where there is an incident involved, in which case the requirements of any applicable legislation shall apply. The DNO shall make the voice records of an identified incident in dispute available within a reasonable time period after such a request from a participant and/or the Authority.
- vii) An audit trail of all changes made to archive data should be maintained. This audit trail shall identify every change made, and the time and date of the change. The audit trail shall include both before and after values of all content and structure changes.

9.5. Confidentiality of information

- a) Information exchanged between participants governed by this code shall not be confidential, unless otherwise stated.
- b) Participants receiving information shall use the information only for the purpose for which it was supplied.
- c) The information owner may request the receiver of information to enter into a confidentiality agreement before information, established to be confidential, is provided.
- d) Confidential information shall not be transferred to a third party without the written consent of the information owner. Parties shall observe the proprietary rights of third parties for the purposes of this code. Access to confidential information within the organisations of parties shall be provided as reasonably required.
- e) The participants shall take all reasonable measures to control unauthorised access to confidential information and to ensure secure information exchange. Parties shall report any leak of information that is governed by a confidentiality agreement as soon as practicable after they become aware of the leak, and shall provide the information owner with all reasonable assistance to ensure its recovery or destruction (as deemed appropriate by the information owner).

10. Assets Management

10.1. Introduction

This section covers assets management issues including customers' electrical installations and equipment, and DNO's equipment on customer's premises.

10.2. Good Asset Management

- a) A DNO must use best endeavours to:
 - i) assess and record the nature, location, condition and performance of its distribution network assets;
 - ii) develop and implement plans for the acquisition, creation, maintenance, operation, refurbishment, repair and disposal of its distribution network assets:
 - A. to comply with the laws and other performance obligations which apply to the provision of distribution services including those contained in this Code;
 - B. to minimize the risks associated with the failure or reduced performance of assets; and
 - C. in a way which minimises costs to customers taking into account distribution losses; and
 - iii) develop, test or simulate and implement contingency plans (including where relevant plans to strengthen the security of supply) to deal with events which have a low probability of occurring, but are realistic and would have a substantial impact on customers.

10.3. Customer's Electrical Installation and Equipment

- a) A customer must use best endeavours to ensure that:
 - i) the customer's electrical installation and any equipment within it complies with this Code and is maintained in a safe condition; and
 - ii) Protection equipment in the customer's electrical installation is at all times effectively coordinated with the electrical characteristics of the distribution network.
- b) A customer must use best endeavours to:
 - i) ensure that the distribution network and the reliability and quality of supply to other customers are not adversely affected by the customer's actions or equipment;
 - ii) not allow a supply of electricity to its electrical installation to be used other than at the customer's premises nor supply electricity to any other person;
 - iii) not take electricity supplied to another supply address at the customer's supply address;
 - iv) not allow electricity supplied to the supply address to bypass the meter;
 - v) not allow electricity supplied under a domestic tariff to be used for non-domestic purposes; and

- vi) not allow electricity supplied under a specific purpose tariff to be used for another purpose.

10.4. Distribution Network Operator's Equipment on Customer Premises

- a) A customer must:
 - i) not interfere, and must use best endeavours not to allow interference with the DNO distribution network including any of the DNO's equipment installed in or on the customer's premises; and
 - ii) provide and maintain on the customer's premises any reasonable or agreed facility required by its DNO to protect any equipment of the DNO.
- b) Provided official identification is produced by the DNO's representatives on request, a customer must provide to the DNO representatives at all times convenient and unhindered access:
 - i) to the DNO's equipment for any purposes associated with the supply, metering or billing of electricity; and
 - ii) to the customer's electrical installation for the purposes of the inspection or testing of the customer's electrical installation in order to assess whether the customer is complying with this Code or connecting, disconnecting or reconnecting supply, and safe access to and within the customer's premises for the purposes described in this code.

11. General Conditions

11.1. Liability

- a) A DNO shall only be liable to a customer and a customer shall only be liable to a DNO for any damages which arise directly out of the wilful misconduct or negligence:
 - i) of the DNO in providing distribution services to the customer;
 - ii) of the customer in being connected to the DNO's network; or
 - iii) of the DNO or Customer in meeting their respective obligations under this Code, their licences and any other applicable law.
- b) Notwithstanding Clause 10.1 (a), neither the DNO nor the customer shall be liable under any circumstances whatsoever for any loss of profits or revenues, business interruption losses, loss of contact or loss of goodwill, or for any indirect, consequential, incidental or special damages, including but not limited to punitive or exemplary damages, whether any of the said liability, loss or damages arise in contract, tort or otherwise. The DNO shall educate its customers on the use of appropriate equipment to control loss or damage, which may result from poor quality or reliability of electricity supply within its distribution network.
- c) A customer shall be liable to the DNO for any loss or damage resulting from the use of electricity in a manner that will make the DNO's system unsafe.

11.2. Force majeure

- a) Neither party shall be held to have committed an event of default in respect of any obligation under this Code if prevented from performing that obligation, in whole or in part, because of a force majeure event.
- b) If a force majeure event prevents a party from performing any of its obligations under this Code and the applicable Connection agreement, that party shall:
 - i) Promptly notify the other party of the force majeure event and its assessment in good faith of the effect that the event will have on its ability to perform any of its obligations. If the immediate notice is not in writing, it shall be confirmed in writing as soon as reasonably practicable.
 - ii) Not be entitled to suspend performance of any of its obligations under this Code to any greater extent or for any longer time than the force majeure event requires it to do;
 - iii) Use its best efforts to mitigate the effects of the force majeure event, remedy its inability to perform and resume full performance of its obligations;
 - iv) Keep the other party continually informed of the efforts to mitigate the effects of the force majeure event; and
 - v) Provide written notice to the party when it resumes performance of any of its obligations affected by the force majeure event.
- c) Notwithstanding any of the foregoing, settlement of any strike, lockout, or labour dispute constituting a force majeure event shall be within the sole discretion of the party to the agreement involved in the

strike, lockout, or labour dispute. The requirement that a party must use its best efforts to remedy the cause of the force majeure event, mitigate its effects, and resume full performance under this Code shall not apply to strikes, lockouts, or labour disputes.

11.3. Health, Safety & Environments

- a) DNO shall show good utility practice in operating and maintaining its distribution network and shall abide by the safety rules and regulations that apply to routine work.
- b) DNO shall implement an industry recognized health and safety programme that includes training and regularly conducted audits. This programme also will include Public Education and Public Safety Initiatives.
- c) Any problems that a DNO identifies as part of the audit shall be remedied as soon as possible or in accordance with the DNO's health and safety programme.
- d) DNO shall have a corporate policy that addresses environmental stewardship that applies to all the DNO's operations. A documented programme supporting procedures and appropriate training should be in place to ensure compliance with environmental regulations and indicate a proactive approach to environmental damage avoidance.
- e) Before any civil works are undertaken, due notice in writing shall be given to all utilities whose services may be in conflict with the proposed cable route, e.g. telephone, water, sewage, road and railway, etc. Where cables are to be installed in roads, footpaths or streets, it is advisable to liaise closely with the roads authority and police to ensure that all necessary measures are taken to minimize the hazards and disruptive effects of installation works.
- f) Working signs, bollards, danger tapes, light and watchmen shall be provided where necessary to ensure ample advance warning of, and restrict public access to, the works area. Warning lights and signs shall be displayed along pits and trenches, on both sides. Steel plate or wooden planks shall be provided across the trench at entrances to residences.
- g) DNO shall ensure that a line marker is placed and maintained as close as practical over each buried underground cable:
 - i) at each crossing of a public road and railway; and
 - ii) whenever necessary to identify the location of the buried underground cable to reduce the possibility of damage or interference.
- h) DNO shall ensure that the following is written legibly on a background of a sharply contrasting colour on each line marker:
 - i) the word "Warning", "Caution", or "Danger" followed by the words "MV Cable" or "LV Cable"; and
 - ii) the name of the Distribution Utility and telephone number, on which the Distribution Utility can be reached at all times.

12. References

- [1] Energy and Water Utilities Regulatory Authority (EWURA): The Tanzanian Grid Code – The Network Code
- [2] Tanzania Bureau of Standards (TBS): Tanzania Standard – Power quality – Quality of supply
- [3] IEC 61000-4-7, International Standard: Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto
- [4] IEC 61400-21, International Standard: Wind turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines
- [5] IEC 61000-3-2, International Standard: Electromagnetic compatibility (EMC) – Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
- [6] IEC 61000-3-3, International Standard: Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection