GRID CODE

MEDIUM SCALE DISTRIBUTED GENERATION (MSDG)

Greater than 50kW and not exceeding 500kW

(Version 3.0 – September 2024)

CENTRAL ELECTRICITY BOARD

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Foreword

The purpose of this document is to assist the public to better understand the procedure for application, the requirements of the Grid Code and other related issues regarding Medium Scale Distributed Generation (MSDG).

Any prospective applicant willing to take advantage of the Medium Scale Distributed Generation (MSDG) Scheme is informed that:

I. Compliance to this Grid Code shall be mandatory

II. The provisions of the Electricity Act 2005 and associated relevant Regulations shall be adhered to.

III. The provisions of the Environment Protection Act 2002, Local Government Act 2011 and Finance Act, and any subsequent amendments, shall be adhered to.

IV. This Grid Code will be reviewed and updated when the need arises.

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Disclaimer

The Central Electricity Board's (CEB) "Grid Code for Medium Scale Distributed Generator (MSDG) – Greater than 50kW and not exceeding 500kW", including any periodic revisions, published on the CEB website, constitute the minimum technical requirements for the connection of an MSDG of size greater than 50kW but not exceeding 500kW to CEB's 22 kV distribution network. The owner of the MSDG may be required to meet additional requirements to ensure that the interconnection meets all local regulations and is safe for use. The requirements set in this Grid Code are based on system conditions that may be subject to change. As such, these requirements shall only be used as a guide, subject to in-depth evaluation. The use of this Grid Code and the information it contains is at the user's sole risk. Neither CEB, nor any of its personnel, makes any warranties or representations of any kind in connection with this Grid Code, including its correctness, accuracy, completeness or adequacy for any specific purpose. CEB will not be responsible or liable for any damage or loss that may arise due to the use of the Grid Code, reliance on the information it contains or any decisions made based on the Grid Code. CEB reserves the right to revise this Grid Code at any time. Any person wishing to make use of this Grid Code is invited to contact CEB before proceeding.

The CEB reserves the right to modify such technical specifications and requirements of the MSDG system and the MV switchgear before or during implementation of the MSDG connection process, in order to adhere to the latest operational and safety aspects of the network. The MSDG installation shall abide with the latest MSDG Grid Code and standards at the time of implementation of the project.

Revisions

Revision	Date	Changes
Version 3.0	September 2024	Grid Code reviewed by CEB and updates performed on applicable capacity, DC-to-AC ratio and Certificate of Installation.
Version 2.1	October 2019	Grid Code reviewed by CEB and updates performed on MSDG Interconnection Requirements, Protection Requirements, Typical layout, Harmonics and Metering.
Version 2.0	December 2017	Grid Code reviewed by CEB and updates performed on Protection settings, Standards and Circuit Diagram.
Version 1.0	May 2016	Grid Code reviewed by Consultant and updates performed, for, mainly, sections on protection, maintenance, administrative procedures, MSDG standards and application forms

CHAPTER 1 - Purpose of the Grid Code

This Grid Code describes the technical criteria and requirements for the connection of distributed generation unit(s) of capacity greater than 50 kW but not exceeding 500 kW to the CEB's 22 kV distribution network[1, 2].

The proposed capacity shall be the AC power output from the RE installation. Capacity capping on inverters shall be applicable as appropriate.

This Grid Code caters for the connection to the CEB distribution network and production of electricity by the following list of renewable energy technologies (RETs):

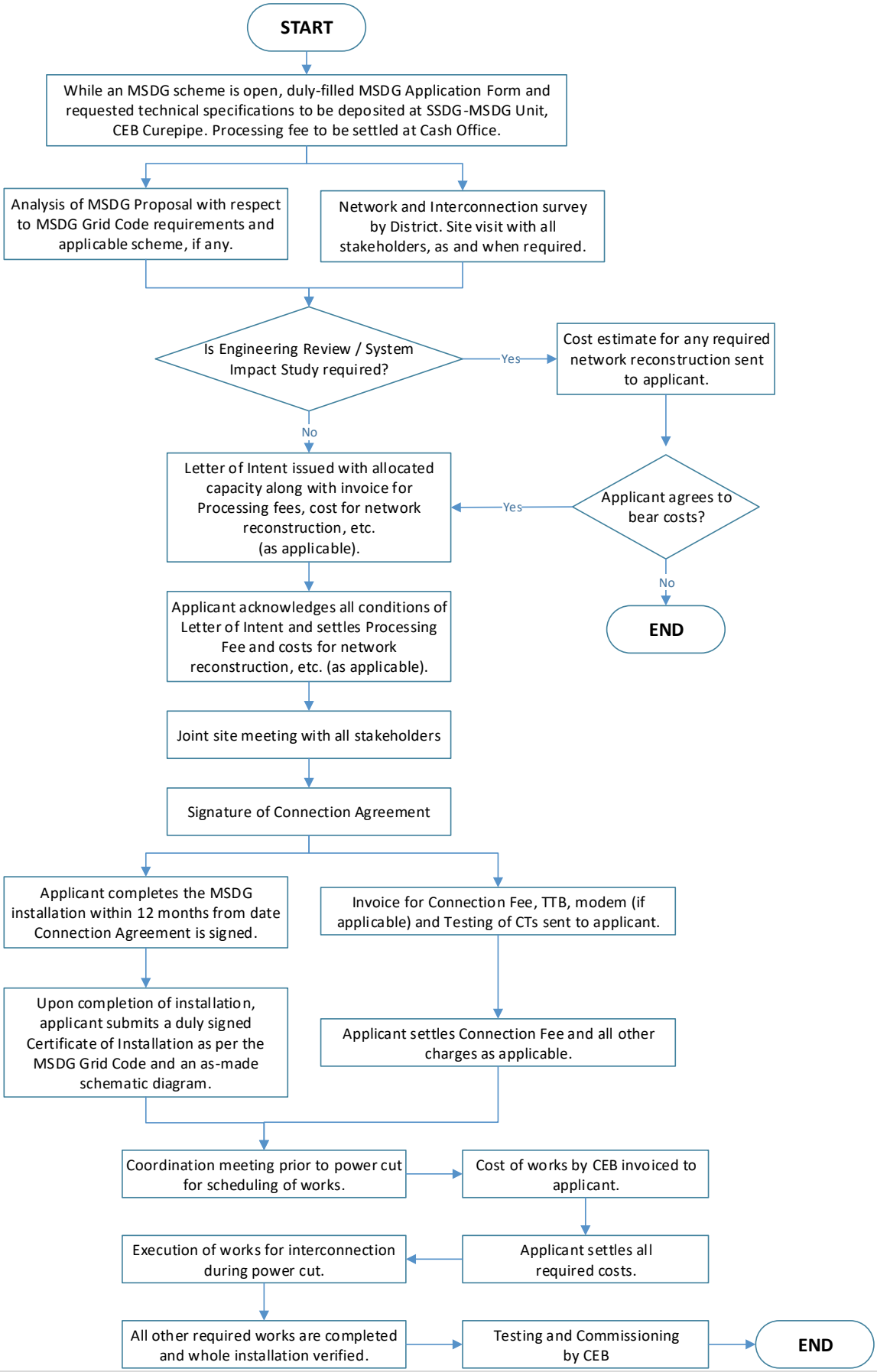
1. Photovoltaic (PV)
2. Wind Turbine Generator (WTG)
3. Hydroelectric Generator
4. Biomass-based generator

[1]For the technical criteria and requirements for the connection of MSDG of capacity greater than 500 kW, please consult the relevant grid code available on https://ceb.mu

[2] For applicants having an existing HT metering supply, refer to Clause 3.1.

CHAPTER 2 - Connecting MSDG to the Grid

2.1 Connection Process



2.2 Connection Capacity

The maximum capacity of MSDG that can be connected to a Medium Voltage (MV) feeder is termed the connection capacity of that feeder. Different feeders have different connection capacities depending on the electrical characteristics of the conductor used, the magnitude and temporal variation of the feeder loading. Furthermore, the connection capacity also depends strongly on the proposed location of the connection of the MSDG to the MV feeder. In general, the connection capacity is larger near the CEB 66 kV-to-22 kV substation compared to the far-end of the feeder.

The feasibility to connect any MSDG to CEB 22 kV distribution network will need to be confirmed by an interconnection impact study which will be conducted by the CEB on a case-to-case basis. In addition, the possibility of interconnecting any MSDG facility with variable power output shall be subject to the maximum amount of variable renewable energy-based power generation that can be accommodated in the CEB's power system while maintaining the system's stability and security.

If any works in the power distribution network are necessary, the CEB will determine what network modifications (reinforcements or extensions) are required, if any, to connect the MSDG by conducting the necessary studies. The description of the required network modifications shall be communicated to the applicant for connection, detailing who will be the party (CEB or the applicant for connection) responsible for execution of each of the works and who will be the party (CEB or applicant for connection) responsible for payment of each of the works.

Capacity allocation in the feeders shall be done according to the following rules:

- Applications shall be processed strictly according to the date/time of the settlement of the application processing fees.
- Authorized applications shall be allocated to the feeder subject to a favorable interconnection impact study.
- Allocated capacity shall remain valid for the period of one (1) year, from the date of signature of connection agreement, where the applicant shall develop the project.
- Failing to finalize the MSDG installation and to submit the Certificate of Installation within the period of one year, from the date of signature of connection agreement, shall result in the automatic cancellation of the authorization and the capacity shall be freed for other applicants.

Note: CEB shall process applications based on the principle of "first in first out". Requests will be processed in this priority order, and in each interconnection study all approved precedents requests will be considered as in service. Requests with positive interconnection study outcomes shall be considered.

The reference point will be when the "processing fees" has been settled.

CHAPTER 3: MSDG Interconnection Requirements and Safety Aspects

3.1 Interconnection Facility Characteristics

The facility shall have the following characteristics:

- The MSDG facility is connected to the CEB's 22 kV network through a dedicated 22/0.415 kV transformer [1, 2].
- Metering is to be performed on the Low Voltage (LV) side.

For applicants having HT Metering supply, an inter-tripping and interlocking mechanism shall be implemented between the 22 kV Circuit Breaker (CEB Side) and the 22 kV outgoing Circuit Breaker(s) (Client side). Refer to Sections 3.7 for Intertripping/Interlocking, Section 3.9 and other relevant sections in MSDG Grid Code 500kW-2MW for additional information.

3.2 Interconnection Facility Design Parameters

The MSDG shall have the following design parameters. The MSDG has to function and protect itself within the following range of the voltages, currents and frequencies existing on the CEB grid. The CEB LV grid is designed as a TT system.

Table 1: Design parameters under normal conditions

Description	Range
Statutory Voltage range	230/400 V ± 6 %
Short circuit Characteristics (excluding contribution of the MSDG installation)	(1 sec) 18 kA, (50 Hz)
Frequency	50.75 Hz and 49.25 Hz (50 Hz ± 1.5%)

CEB is responsible to maintain those values using all normal means available to CEB.

After a single incident or under emergency conditions, frequency and voltage may go out of normal limits but still inside operational acceptable values. Generators must be able to operate within the following limits:

[1] The requirement for dedicated distribution transformer may not be applicable for MSDG applications below 50 kW.

[2] In the absence of a dedicated transformer, CEB will consider the applications on a case-to-case basis.

Table 2: Design parameters under incident and emergency conditions

Description	Range
Voltage	230/400 V + 9 % and – 10 %
Nominal frequency	50 Hz
Operating frequency range	47Hz – 52Hz

3.3 Protection Requirements

3.3.1 General Requirements

The coordination and selectivity of the protection system must be safeguarded even with the entrance of new generation into the system. To satisfy this condition, the protections to be installed are listed in the following chapters and the settings of those protections shall be proposed by the promoter and accepted by CEB.

In case of short circuits in the MSDG side, the MSDG shall adjust its protections in such a way that they will avoid unnecessary trips in the CEB's side of the interconnection facilities (as per Figure 1) and at the same time avoid that the incident propagates to the general system.

In case of incidents originated external to the MSDG system, such as short circuits in the distribution system, voltage or frequency excursions, MSDG shall give priority to the network protections to solve the incidence and act accordingly with the coordination and selectivity principles of the protections system.

The protection system shall provide protection against fault occurring on both the CEB's network and the MSDG facility. The protection system is to provide protection against short circuit, earth faults and overloading conditions and also prevent islanding operation of the CEB distribution feeder.

In addition, the applicant must provide any additional protection functions necessary to adequately protect all equipment and personnel. The settings of the additional protection systems must be appropriately graded to prevent unnecessary trips during disturbances that affect voltage and frequency on the CEB system. Any modifications in the protection settings carried out by the MSDG promoter shall be communicated to CEB.

3.3.2 Availability of protection

The applicant shall ensure that all equipment is protected and that all elements of the protection, including associated inter-tripping, are operational at all times. Unavailability of the protection will require the MSDG plant to be taken out of service.

The MSDG shall be protected against

a) Overload.
b) Short circuit within the MSDG.
c) Earth faults in the close vicinity of the MSDG.
d) Over Current.
e) Abnormal voltages (Table 3 below)
f) Abnormal frequencies (Table 3 below)
g) Lightning.
h) Loss of mains

3.3.3 DC Functions of Protection Apparatus

All protection apparatus functions shall operate down to a level of 50% of the nominal DC supply voltage of the DC system, or the system must be able to safely disconnect and shutdown when operation conditions are outside the nominal operating DC voltage specified in the DC system specifications.

3.3.4 Protection Flagging, Indications and Alarms

All protective devices supplied to satisfy the CEB's requirements shall be equipped with operation indicators. Such indicators shall be sufficient to enable the determination of which devices caused a particular trip.

3.3.5 Trip settings

The trip settings must comply with the values stated in Table 3.

Table 3: Default interface protection settings

Parameter	Symbol	Trip setting	Clearance time
Over voltage ([a])	U>>	230 V + 9 %	0.2 s
Over voltage	U>	230 V + 6 %	1.5 s
Under voltage	U<	230 V – 10 %	3.0 s
Over frequency ([b])	f>	52 Hz	0.5 s
Under frequency	f<	47 Hz	0.5 s
Loss of mains	df/dt	2.5 Hz / s	0.5 s
	Vector shift	10 degrees	

NOTE: Voltage and frequency is referenced to the Supply Terminals.

([a]) If the MSDG can generate higher voltage than the trip setting, the step 2 over voltage is required.

([b]) The trip setting for over frequency is set lower than the maximum operating frequency defined in Table 2 in order to avoid contribution of the MSDG to rising frequency.

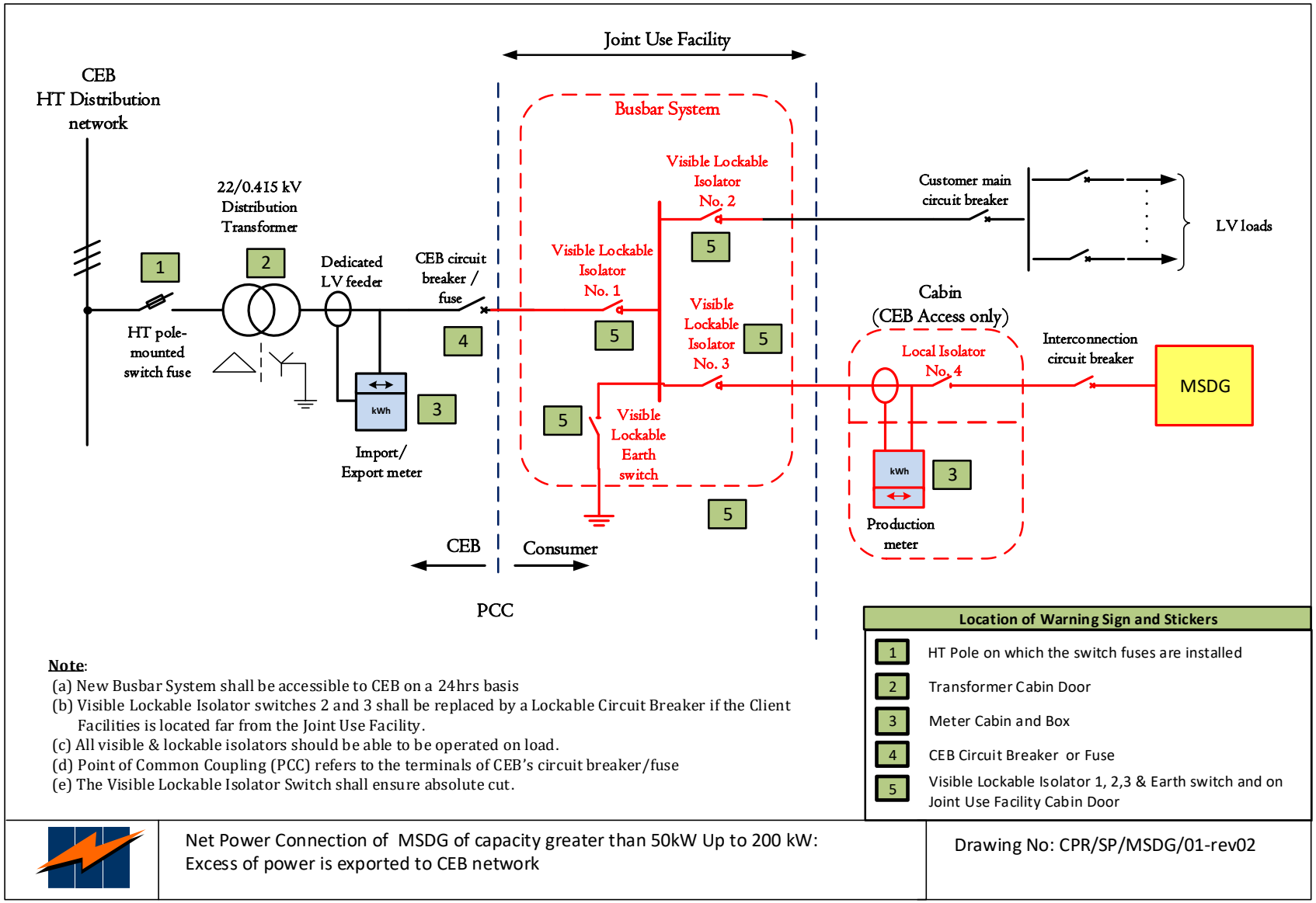


Figure 1: Typical layout for any MSDG of capacity greater than 50 kW and not exceeding 500 kW

3.3.6 Network Islanding

The applicant shall not supply power to the CEB's network during any outages of the system. The MSDG may only be operated during such outages to supply the applicant's own load (isolated generation) with a visibly open tie to the CEB's network. The MSDG shall cease to energise the CEB's network within 0.5 seconds of the formation of an island as shown in Table 3.

3.3.7 Re-connection

Following a protection initiated disconnection, the MSDG is to remain disconnected from the network until the voltage and frequency at the supply terminals has been restored within the nominal limits for at least 3 minutes. Reconnection is only allowed when disconnection was due to operating parameters being outside the normal operating range stated in Table 3, not if disconnection was caused by malfunctioning of any devices within the MSDG installation.

3.3.8 Synchronising AC generators

The MSDG shall provide and install automatic synchronizing. Check Synchronizing shall be provided on all generator circuit breakers and any other circuit breakers, unless interlocked, that are capable of connecting the MSDG plant to the CEB's network. Check Synchronising Interlocks shall include a feature such that circuit breaker closure via the Check Synchronising Interlock is not possible if the permissive closing contact is closed prior to the circuit breaker close signal being generated.

CEB will consider MSDG applications using AC generators on a case-to-case basis and additional requirements may be applicable.

3.3.9 Earthing requirements

Earthing shall be according to IEC 60364-5-54.

For systems capable of operating in isolated generation, the neutral point of the a.c. generator must not be earthed when operating in parallel with CEB's network. When the MSDG operates in isolation, the generator neutral-to-earth connection must be closed. The operation of the neutral-to-earth connection shall be carried out by an inter-locking system.

When a MSDG is operating in parallel with the CEB's network, there shall be no direct connection between the co-generator winding (or pole of the primary energy source in the case of a PV array or Fuel Cells) and the CEB's earth terminal.

The winding of an a.c. generator must not be earthed. Note that a DC source or DC generator could be earthed provided the inverter separates the AC and DC sides by at least the equivalent of a safety isolating transformer. However, consideration would then need to be given to the avoidance of corrosion on the DC side.

At the CEB's grid TT earthing system is adopted. The neutral and earth conductors must be kept separate throughout the installation, with the final earth terminal connected to a local earth electrode.

The Busbar System, referred to as the Joint Use Facility in Figure 1, shall be equipped with visible lockable earthing facility, with appropriate labelling, padlock and isolation procedure.

Warning Notice that: "CONDUCTORS MAY REMAIN LIVE WHEN ISOLATOR IS OPEN" shall be conspicuously displayed at the installation.

3.4 Power Quality

The MSDG facilities and equipment shall not cause excessive voltage excursions nor cause the voltage to drop below or rise above the range maintained by CEB. The MSDG facility and equipment shall not introduce excessive distortion to the sinusoidal voltage or current waves.

3.4.1 Limitation of DC injection

The MSDG shall not inject a DC current greater than 0.25 % of the rated AC output current per phase.

3.4.2 Limitation of voltage flicker induced by the MSDG

The MSDG installation shall not cause abnormal flicker beyond the limits defined by the "Maximum Borderline of Irritation Curve" specified in the IEEE 1453

3.4.3 Harmonics

The total harmonic distortion will depend on the injected harmonic current and the system impedance seen from the PCC.

The MSDG system output should have low current-distortion levels to ensure that no adverse effects are caused to other equipment connected to the utility system. The MSDG system electrical output at the PCC should comply with IEEE 519 (Recommended Practice and Requirements for Harmonic Control in Electric Power Systems) which will be used to define the acceptable distortion levels for MSDG installations connected to the utility. The IEEE 519 recommendation is to be applied at the PCC, not to downstream equipment. The key requirements of this clause are summarized as follows:

Recommended Harmonic Voltage Limits: At the PCC, system owners or operators should limit line-to-neutral voltage harmonics as follows. All values should be in percent of the rated power frequency

voltage at the PCC. The table below applies to voltage harmonics whose frequencies are integer multiples of the power frequency.

Bus voltage V at PCC	Individual harmonic (%)	Total harmonic distortion THD (%)
$V \leq 1.0$ kV	5.0	8.0
1 kV < $V \leq 69$ kV	3.0	5.0

Current Distortion Limits

At the PCC, users should limit their harmonic currents as follows:

The table below applies to harmonic currents whose frequencies are integer multiples of the power frequency.

Maximum harmonic current distortion in percent of I_L						
Individual harmonic order (odd harmonics)[a, b]						
I_{SC}/I_L	$3 \leq h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h \leq 50$	TDD
< 20[c]	4.0	2.0	1.5	0.6	0.3	5.0
$20 < 50$	7.0	3.5	2.5	1.0	0.5	8.0
$50 < 100$	10.0	4.5	4.0	1.5	0.7	12.0
$100 < 1000$	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

[a]Even harmonics are limited to 25% of the odd harmonic limits above.

[b]Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

[c]All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L.

where

I_{sc} = maximum short-circuit current at PCC

I_L = maximum demand load current (fundamental frequency component) at the PCC under normal load operating conditions

3.4.4 Surge Withstand Capability

The interconnection system shall have a surge withstand capability, both oscillatory and fast transient, in accordance with IEC 62305-3 and IEC 62305-4, the test levels of 1.5 kV. The design of control systems shall meet or exceed the surge withstand capability requirements of IEEE C37.90.

3.4.5 Voltage Unbalance

The total voltage unbalance in the grid should be smaller than 2%, where the unbalance, $U_{unbalance}$, is defined as the maximum deviation from the average of the three-phase voltages, U_a, U_b and U_c, divided by average of the three-phase voltages.

$$U_{unbalance} = \frac{Max(U_a, U_b, U_c) - U_{avg}(a, b, c)}{U_{avg}(a, b, c)} \times 100\ \%$$

The contribution from the MSDG installation may not cause an increase of the voltage unbalance of more than 1.3%.

3.4.6 Voltage Step Change

The process of starting a medium scale distributed generation (MSDG) can sometimes cause step changes in voltage levels in the distribution network. These step changes are caused by inrush currents, which may occur when transformers or induction generators are energised from the network. Step voltage changes will also occur whenever a loaded generator is suddenly disconnected from the network due to faults or other occurrences.

Step voltage changes caused by the connection and disconnection of generating plants at the distribution level should not exceed ± 3% for infrequent planned switching events or outages and ± 6% for unplanned outages such as faults.

Where induction generators are used, as in fixed speed wind turbines, they shall be fitted with" soft starters". These devices limit inrush currents to roughly the same level as the normal rated current. This reduces the magnitude of the step voltage changes which occur on starting.

3.5 Power Factor

The power factor of the MSDG at normal operating conditions across the statutory range of nominal voltage shall be between 0.95 leading and 0.95 lagging.

3.6 Maintenance

3.6.1 Generation Forecast

Generators under 500 kW do not need to do Generation Forecast in order to communicate it to CEB.

3.6.2 Generation Maintenance

Generators under 500 kW do not need to communicate the maintenance plans to CEB, for its approval.

3.6.3 Network Maintenance

The MSDG owner shall disconnect its MSDG system during the maintenance of the network by CEB.

For preventive maintenance and corrective action, no compensation will be applied for the loss of generation.

CEB will communicate their maintenance plans alike the general clients.

3.7 Safety, Isolation and Switching

3.7.1 Rules for working on low voltage grid (LV)

The safety of the personnel working on the network should comply with the "CEB T&D Safety Rules".

The "CEB T&D Safety Rules" are in compliance with the Occupational Safety and Health Act 2005 or any subsequent amendment(s) in connection with this present Act.

According to the CEB safety rules based on Occupational Safety and Health Act 2005, the following rules must be respected before working on a LV grid:

(a) The system must be made DEAD, Isolated from all possible sources of supply, all switches must be locked in **visibly** open positions, the system must be tested on the site of work, and the system must be short-circuited and Earthed

(b) The MSDG shall have a local means of isolation that disconnects all live conductors including the neutral. The producer shall not energize a de-energized CEB's Power circuit.

(c) Switches shall be installed to disable the automatic or manual closing of the interconnecting switches or breakers. These switches shall be accessible to the CEB's personnel to obtain the necessary safety requirements when the CEB's personnel is working on associated equipment or lines. While the CEB's personnel is working on the grid, the operation of switches shall not be possible for persons other than the CEB authorized personnel, which can be assured by keeping the keys to lockable switches. Alternatively the CEB's authorized personnel will remove and keep fuses while its personnel are working on lines.

(d) In all circumstances the switches, which must be manually operated, must be capable of being secured in the 'OFF' isolating position. The switches must be located at an easily accessible position in the producer's installation.

(e) The Busbar system, referred to as the Joint Use Facility, shall be accessible to the CEB on a 24 Hours basis for switching and isolation operations by CEB personnel.

(f) All MSDG installations should be labelled with proper signage at appropriate locations as per Figure 1.

(g) The number and sequence of procedures shall be affixed in the Joint Use Facility and shall be followed at all times to ensure that correct switching operation during both the earthing of the busbar system and isolated generation setup.

(h) The CEB will maintain an updated register of all MSDG installations with precise addresses, connecting points and relevant transformers.

3.7.2 Safety Concerns

For any work or activity in the connection point between distributed generation and the CEB network, all agents involved will follow the "CEB T&D Safety Rules".

The "CEB Safety Rules" are based on the Occupational Safety and Health Act 2005. In addition to the requirements stipulated in the "CEB Safety Rules", the MSDG owner shall observe the following safety concerns which include:

(a) Persons must be warned that the installation includes any MSDG so that precautions can be taken to avoid the risk of electric shock. Both the mains supply and the electric generator must be securely isolated before electrical work is performed on any part of the installation. Adequate labelling must be available to warn that the installation includes another source of energy.

(b) Photovoltaic (PV) cells will produce an output whenever they are exposed to light, and wind turbines are likely to produce an output whenever they are turning. Additional precautions shall be taken to prevent the generator from generating electric energy or even generating voltage, such as covering the PV cells or restraining the turbine from turning will be necessary when working on those parts of the circuit close to the source of energy and upstream of the means of isolation.
To guarantee this isolation, the generation operator shall follow the supplier instructions.

(c) The manufacturer or supplier of the MSDG is required to certify compliance with the Electrical Equipment Safety Regulations and the Electromagnetic Compatibility Regulations. The MSDG will be CE marked or tested by equivalent accredited testing agencies to confirm this. This should ensure that the MSDG is satisfactory in a domestic installation in terms of the power factor, generation of harmonics and voltage disturbances arising from starting current and synchronisation.

(d) The maintenance works at the MSDG installation shall be carried out in such a way that all safety procedures recommended by the manufacturer or supplier are followed.

(e) CEB personnel must be warned of the safety procedures pertaining to switching operation applicable to the MSDG. These procedures must clearly be displayed and visible at the MSDG site.

3.7.3 Electromagnetic emission/Immunity

The MSDG shall comply with the requirements of the EMC Directive and in particular the product family emission standards.

3.7.4 Labels

To indicate the presence of the MSDG within the premises, a label as per Figure 2 will be fixed by the CEB at:

i. the 22 kV pole on which the switch fuses are installed (or the Ring Main Unit in case of underground networks)
ii. the transformer cabin door and/or fence
iii. the metering cabin and box
iv. the low voltage CEB circuit breaker or fuse
v. the visible lockable isolators 1 and 2, 3 & lockable earth switch and the Joint Use Facility cabin door
vi. Any other locations that are found necessary by the CEB.

Figure 2: MSDG label

The installation operating instructions must contain the manufacturer's contact details e.g. name, telephone number and web address.

3.7.5 Documentation

Up-to-date information must be displayed at the MSDG as follows:

(a) A circuit diagram showing the relationship between the MSDG and the CEB's circuit breaker/ fused cut-out. This diagram is also required to show by whom the generator is owned and maintained.

(b) A summary of the protection's separate settings incorporated within the equipment. The Figure 3 below is an example of the type of circuit diagram that needs to be displayed. Figure 3 is for illustrative purposes and not intended to be fully descriptive.

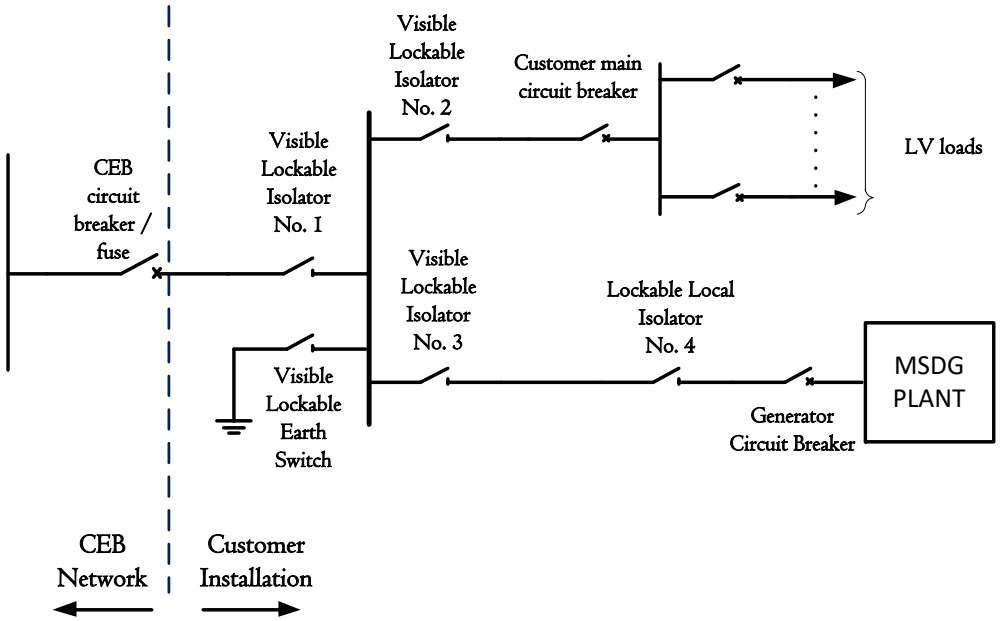


Figure 3: Example of a circuit diagram for any MSDG installation

(c) Isolation procedures of both CEB and the applicant

(d) In addition the maintenance requirements and maintenance services available shall be documented if required.

(e) The MSDG Owner shall keep a certificate signed by the maintenance contractor containing at least the following:

- A statement confirming that the solar PV system/wind turbine/hydro meets the requirements of this grid code.
- Client's name and address.
- Site address (if different).
- Contractor's name, address, contacts etc.
- List of key components installed.
- Estimation of system performance
- Maintenance schedule

3.7.6 Information plate

The following information shall appear on the information plate:

(a) manufacturer's name or trade mark;
(b) type designation or identification number, or any other means of identification making it possible to obtain relevant information from the manufacturer;
(c) rated power;
(d) nominal voltage;

(e) nominal frequency,
(f) phases;
(g) power factor

3.7.7 Electrical contractor / Installer

The MSDG shall be installed in accordance with the instructions issued by the manufacturer.
In designing a connection for any MSDG, the electrical contractor /installer must consider all the issues that would need to be covered for a conventional final circuit, including:

- the maximum demand (and the generator output);
- the type of earthing arrangement;
- the nature of the supply;
- external influences;
- compatibility, maintainability and accessibility;
- protection against electric shock;
- protection against thermal effects;
- protection against overcurrent;
- isolation and switching;
- Selection and installation issues.

The installer must affix a label clearly indicating the next scheduled maintenance of the installations and inform the CEB, who will add the information to the MSDG-register.

The installer must be skilled in the field of MSDG installations and possesses an MQA-approved qualification or equivalent in electrical installation and renewable energy installations (as applicable to the MSDG installation) and which is acceptable to the CEB.

3.8 Metering

In order to enable correct billing of the applicant, a bidirectional meter measuring both the import and export energy shall be installed. Billing will **depend on the applicable MSDG scheme**., A second meter measuring the gross production of the MSDG shall also be installed as shown in Figure 1. The power cable should fit in the inner diameter of the CT for the production meter and the CT shall be according to IEC 61869-2. The CTs must have sealing facilities.

As regard to the CTs and VTs, the MSDG promoter shall first seek CEB's approval prior to ordering and send same to CEB's Meter Lab Section for tests prior to installation.

Toroidal CTs WILL NOT BE ACCEPTED for HT metering purposes.

In cases where it is not possible to locate the production meter next to the import/export meter, the production meter shall be equipped with a separate modem and SIM card and shall be installed at a convenient location and be easily accessible to CEB officers. The cost of this additional modem and the monthly communication charge shall be charged to the applicant, as well as any faulty metering equipment in the future.

In cases where additional production meters are required due to site specificities, all production meters, including the associated modems, SIM cards and communication charge, shall be charged to the applicant, as well as any faulty metering equipment in the future.

The MSDG promoter shall send the specifications and burden calculations of the proposed CTs and Test Terminal Block (TTB) to the CEB for approval before procurement. Alternatively, the TTB can also be purchased from CEB. Before installation, the CTs shall be sent to the CEB for testing, which will be chargeable to the applicant.

Both Import/Export and production meters shall primarily be CT-connected meters. The CTs used for the Production meter shall have an independent core for metering with accuracy class of 1.

All meters and related equipment (such as CT, TTB, etc.) shall be housed in a secured cabin, as per CEB's requirements.

A metering cabin shall be erected to house the production meter, TTB, CTs and an isolator, as per CEB's requirements.

All metering cabins shall be fitted with a 13A power socket, protected by a 2A circuit breaker and fed from a secured source of supply.

3.9 Testing, Commissioning and Maintenance

Testing of MSDG installations will be done in the presence of the CEB. The MSDG Owner shall notify the CEB in advance with a testing and commissioning plan. The MSDG Owner shall keep written records of test results and protection settings. The MSDG Owner shall regularly maintain their protection systems in accordance with good electrical industry practice and any revision brought to this Grid Code.

3.10 Standards and Regulations

All electrical apparatus, materials and wiring supplied shall comply with the Electricity Act, the Central Electricity Board Act, Electricity Regulations, this code and the following standards:

Table 4: List of Standards

PV Modules	
IEC TS 62804-1	Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Crystalline Silicon
IEC TS 62804-2	Photovoltaic (PV) modules – Test methods for the detection of potential-induced degradation – Part 1: Thin-film
EN 50380	Datasheet and nameplate information of photovoltaic module.
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61646	Thin-film terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61701	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 61730	Photovoltaic (PV) module safety qualification
IEC 61853-1	Photovoltaic (PV) module performance testing and energy rating – Part 1: Irradiance and temperature performance measurements and power rating
PV INVERTERS	
EN 50524	Data sheet and name plate for photovoltaic inverters
IEC 61683	Photovoltaic Systems – Power conditioners – Procedure for measuring efficiency
IEC 62109	Safety of power converters for use in photovoltaic power systems
IEC 62116	Test Procedure for islanding prevention measures for Utility connected photovoltaic inverters
GRID-CONNECTED PV SYSTEM	
EN 50438	Requirements for the connection of micro-generating plants in parallel with public low voltage distribution networks
ER G59/3	Recommendations for the Connection of Generating Plant to the Distribution Systems of Licensed Distribution Network Operators
ER G83/2	Recommendations for the connection of type tested small-scale embedded generators (up to 16 A per phase) in parallel with low-voltage distribution systems
EN 50521	Connectors for photovoltaic systems – Safety requirements and tests
IEC 61727	Photovoltaic (PV) systems - Characteristics of the utility interface
IEC 61836	Solar photovoltaic energy systems - Terms, definitions and symbols
IEC 62093	Balance-of-system components for photovoltaic systems – Design qualification natural environments

IEC 62446-1	Photovoltaic (PV) systems - Requirements for testing, documentation, and maintenance – Part 1: Grid-connected systems – Documentation, commissioning tests and inspection
IEC: 60904-1	Photovoltaic devices - Part 1: Measurement of photovoltaic current-voltage characteristics
IEEE P1547	Series of Standards for Interconnection, May, 2003, NREL/CP-560-34003
WIND TURBINE GENERATORS	
IEC 61400 -21	Wind Turbines – Part 21: Measurement and assessment of power quality characteristics of grid connected wind turbines.
GENERAL ENGINEERING STANDARDS	
BS 7354	Code of Practice for Design of high voltage open terminal stations
BS 7430	Code of Practice for Protective Earthing of electrical installations
IEC 60068-2	Environmental testing of specimen to withstand specific severities of repetitive and non- repetitive nature
IEC 60076	Power transformers - ALL PARTS
IEC 60228	Conductors of Insulated Cables
IEC 60364-1	Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions
IEC 60364-5-54	Low-voltage electrical installations - Part 5: Selection and erection of electrical equipment. Chapter 54: Earthing arrangements and protective conductors
IEC 60364-5-55	Electrical installations of buildings – Part 5: Selection and erection of electrical equipment. Chapter 55: Other equipment
IEC 60502-1	Power Cables with extruded insulation and their accessories for rated voltages from 1 kV (Um – 1.2 kV) up to 30 kV (Um = 36 kV) Part 1 - Cables for rated voltages for 1 kV (Um=1.2 kV) and 3 kV (Um = 3,6 kV)
IEC 60664-1	Insulation coordination for equipment within low-voltage systems –Part 1: Principles, requirements and tests
IEC TR 60909-1	Short circuit currents in three-phase ac systems – Part 1: Factors for the calculation of short-circuit currents according to IEC 60909-0
IEC 62208	General requirements for empty enclosures for low voltage switchgear and control gear assemblies
IEC 62305-3	Protection against lightning - Part 3: Physical damage and life hazard in structures
IEC 62305-4	Protection against lighting Part 4: Electrical and Electronic systems with structures
IEEE C37.90	IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
POWER QUALITY	
IEC 61000-3-2	Electromagnetic compatibility (EMC) - Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)

IEC 61000-3-3	Electromagnetic compatibility (EMC) - 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
IEC 61000-3-11	Electromagnetic compatibility (EMC) - Part 3-11: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems - Equipment with rated current ≤ 75 A and subject to conditional connection
IEC TR 61000-3-7	Electromagnetic compatibility (EMC) - Assessment of emission limits for the connection of the connection of fluctuating installations to MV, HV and EHV power systems.
IEC 61000-6-1	Electromagnetic compatibility (EMC) - Generic standards – Immunity for Residential, Commercial and Light-industrial environments
IEC 61000-6-3	Electromagnetic compatibility (EMC) - Generic standards – Emission standard for Residential, Commercial and Light-industrial environments
IEEE 519	IEEE Recommended practice and requirements for harmonic control of electric power systems
IEEE 1453	Recommended Practice for the Analysis of Fluctuating Installations on Power Systems

The applicant may be required to produce certificates conforming to the above standards for their MSDG installation upon CEB's request.

Note:

1. **All specifications shall be according to the latest edition of the standards mentioned above.**
2. **In addition the MSDG owner shall ensure that his proposed installations comply with all prevailing regulations pertaining to environment, health and safety, etc.**

CHAPTER 4- Compliance with the Code

In case of non-compliance with any of the technical provisions in this Grid Code, CEB shall inform the owner in writing of the discrepancies. The MSDG owner shall have 90 days to rectify the discrepancies.

Failing to do that, CEB shall be entitled to disconnect the MSDG installation.

CEB shall be entitled to disconnect the MSDG facility without prior notification if the installation conditions are harmful or creates unavoidable risks for the safety.

CEB shall not be responsible for any damage if such disconnection requires the disconnection of other loads associated or connected to the same connection as the MSDG.

Reconnection of the MSDG shall require that CEB certifies that the installation complies with this Grid Code. Fees applicable shall be the same as for reconnection fees.

ANNEX 1 - Abbreviations and Definition

"AC" or "a.c." means Alternating Current;

"Applicant" means a producer of electricity through any MSDG installation;

"CEB" means the Central Electricity Board;

"Circuit breaker" means a switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal conditions such as those of short circuit;

"DC" means Direct Current;

"DG" means Distributed Generation;

"Distributed generation" means electric generation facilities connected to the Utility network at the PCC;

"Flicker" means a variation of input voltage sufficient in duration to allow visual observation of a change in electric light source intensity;

"Fault" means a physical condition that causes a device, a component, or an element to fail to perform in a required manner, for example a short-circuit, a broken wire, an intermittent connection;

"Frequency" means the number of complete cycles of sinusoidal variations per unit time;

"Greenfield" means an installation of MSDG at a location without existing connection point;

"Grid" means CEB's network that brings electricity from power stations to consumers"

"Harmonic distortion" means continuous distortion of the normal sine wave; typically caused by nonlinear loads or by inverters, measured in Total Harmonic Distortion (THD);

"HT" means High Tension (refers to systems normally operating at a voltage exceeding 1000 volts A.C. or 1500 volt D.C.)

"HV" means High Voltage (see "HT")

"Installer" means a person who is skilled in the field of MSDG installations and possesses an MQA-approved qualification or equivalent in electrical installation and

renewable energy installations (as applicable to the MSDG installation) and which is acceptable to the CEB.

"Islanding" means a condition in which a portion of the CEB's network is energised by one or more MSDGs through their PCC(s) while electrically separated from the rest of the system;

"Isolated Generation" means a condition where the electrical path at the PCC is open and the MSDG continues to energise local loads;

"kV" means kilovolt;

"kVA" means Kilovolt Ampere

"kW" means Kilo Watt (1,000 W = 1,000 J/s);

"kWh" means Kilowatt hour (1,000 watt hours);

"LV" means Low Voltage (refers to systems normally operating at a voltage not exceeding 1000 volts A.C. or 1500 volt D.C.);

"MSDG" means Medium Scale Distributed Generation

"MW" means megawatt (1,000,000 W = 1,000,000 J/s);

"Parallel operation" means a condition where the MSDG is operating while connected to CEB's network;

"PCC" means point of common coupling;

"Point of Common Coupling (PCC)" means the point at which a MSDG is connected to the CEB's network

"Power factor" means ratio of real to total apparent power (kW/kVA) expressed as a decimal or percentage;

"Producer" means a producer of electricity through a MSDG installation or the owner thereof;

"PV" means photovoltaic;

"RE" means renewable energy;

"Registered Professional Engineer" means a person registered as a Professional Engineer (Electrical or an alternative equivalent acceptable to the CEB) under the Registered Professional Engineers Council Act (Mauritius);

"SWC" means Surge Withstand Capability, the immunity of this equipment to fast and repetitive electrical transients;

"TT system" means in a TT earthing system, the protective earth connection of the consumer is provided by a local connection to earth;

"THD" means Total Harmonic Distortion

ANNEX 2- CEB Fees

Interconnection facility and cost

The MSDG will be connected to CEB 22kV network through a dedicated 22/0.415 kV distribution transformer and metered on the low-voltage side as per schematics shown in Figure 1 of this Code.

In addition, the applicant shall bear fees for processing applications and preparation of cost estimate for network construction or modification. The list of fees is available on CEB website.
In the absence of a dedicated transformer, CEB will consider the applications on a case-to-case basis.

ANNEX 3: Certificate of Installation

Applicant/installer to submit duly signed certificate (as shown below), with the Company's header and seal, to the CEB. For HT Metering clients, the MSDG installation shall be certified by a Registered Professional Engineer (Electrical or an alternative equivalent acceptable to the CEB) (CRPE Mauritius).

CERTIFICATE OF INSTALLATION

I hereby certify that the installation of the MSDG of Capacity [……..] kW, situated at address [……..…] for [……] has been done as per the requirements of the MSDG Grid Codes and as per attached detailed schematic diagram.

Serial No.: _____

1. The details of the equipment installed are as follows:

Equipment		Make/Model	Rating (W)	Quantity
Photovoltaic Modules				
Inverter	Rated Output Power (AC)			
	Serial No			

2. The inverter has been set as per the following settings:

Protection Parameters Settings	Trip Setting	Clearance Time	Trip Indication Provided
Over Voltage ([a]) (230 V + 9 %)			
Over Voltage (230 V + 6 %)			
Under Voltage (230 V – 10 %)			
Over Frequency (52 Hz)			
Under Frequency (47 Hz)			
Loss of Mains(df/dt - Vector shift)			
Reconnection Time			
Active Power Limit Set (W) - (if applicable)			
Line impedance (ohm)			

Name of Installer company: ……

Name of Registered Professional Engineer / Installer:……

RPEM No. (if applicable): …… Signature:……..

Seal of Installer Company: Date:……

Name of Applicant:……

Signature of Applicant:…….. Date:……

ANNEX 4: Certificate of Compliance

Certificate of Compliance

This is to certify that on **[date]** the MSDG installation with an installed capacity of …….kWp, situated at **[address]** in the name of **[Applicant/Company name]**bearing Serial No. **[MSDG/XX/XXX],** has been found compliant with the requirements of the MSDG Grid Code (50 kW to 500 kW) by the Representatives of the CEB Sections found hereunder and it has been found to be fit for the connection to the Grid. The installation shall be commissioned after the signature of the Connection Agreement.

Representative of Distribution Network

Name (Block Letters): …… Signature: ……..….

Representative of Meter Installation

Name (Block Letters): …… Signature: ……

Representative of MSDG Unit

Name (Block Letters): …….. Signature: ……..…….

Representative of Safety and Health Section

Name (Block Letters): …….. Signature: ……..….

Date: ……..……..

ANNEX 5: Capping Certificate

CAPPING OF INVERTER

I hereby certify that the inverter make _____ , model _____, S/N _____ for an installation of Capacity kWp, installed at _____ for _____ has been set to _____ W . Please see screenshot below.

Name of Installer Company:
Name of Registered Professional Engineer / Certified Installer:
RPEM No. (if applicable): Signature:
Date: Seal of Installer Company:

Name of applicant:
Signature of applicant:
Date: