

Electricity (Net Metering) (Amendment Regulations, 2022 (No. 1)

IT is hereby notified that the Minister of Energy and Power Development after consultation with the Authority has, in terms of section 65 of the Electricity Act [*Chapter 13:19*], made the following regulations:—

1. These regulations may be cited as the Electricity (Net Metering) (Amendment) Regulations, 2022 (No. 1).

2. The Electricity (Net Metering) Regulations, 2018, published in Statutory Instrument 86 of 2018 (hereinafter referred as the “principal regulations”) are amended in section 2 by—

(a) the deletion in the definition of “net export”, of “\*0.9” and substitution of “0.8kWh for domestic customers and 0.85kWh for maximum demand time of use customer”;

(b) the deletion of the definition of “licensee” and insertion of the following—

“licensee means any person issued with a Distribution Licence in terms of the Electricity Act”;

(c) the insertion of the following definitions—

““billing period” means the period of the billing of electricity sales as determined by the licensee from time to time;

“maximum demand time of use customer” means a consumer who pays for a demand charge to the utility on top of their consumption charge.”.

3. The principal regulations are amended in section 3(1) (b) by the deletion of “one hundred kilowatts (100kW)” and substitution of “five megawatts (5MW)”.

4. The principal regulations are amended in section 5 by—

(a) the deletion of subsection (1) and substitution with the following—

“(1) Pursuant to section 3(4), an electricity generation facility applied for must comply with the provisions of this section and the Third Schedule on

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net metering technical connection guidelines and requirements.”;

- (b) by the deletion in subsections (2)(a) and (3)(b) of “100kW” and substitution with “five megawatts (5MW)”.

5. The principal regulations are amended in section 6 by the deletion of subparagraph (d) and substitution of the following—

“(d) comply with the Net Metering Guidelines and Connection Requirements, as specified in the Third Schedule.”.

6. The principal regulations are amended in section 11 by—

- (a) the deletion in subsection (1) of “0.9kWh” and substitution with “0.8kWh for domestic customers and 0.85kWh for maximum demand time of use customer;
- (b) the repeal of subsection (3) and the substitution of the following—

“(3) The licensee shall rollover net exports from previous monthly billing periods and offset any future consumption bills of the participant, and the reconciliation procedures and conditions for rollover of excess generation or net exports shall be determined by the Authority from time to time, with the approval of the Minister.”.

7. The principal regulations are amended by the repeal of the First Schedule and the substitution with the following—

“FIRST SCHEDULE (Section 2)

FEES

<i>Section</i>	<i>Description</i>	<i>Form</i>	<i>Fee (\$ZWL)</i>
3	Application for participation in net metering	ENM1	4 000
10	Application for interconnection	ENM2	As per licensee quotation
8	Electronic copy of the register		1 000
8	Hard copy of the register		1 000
11	Appeal fee		1 000

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9	Certificate amendment fee		1 000
9	Certificate replacement fee		1 000”.

8. The principal regulations are amended by the insertion of the Third Schedule after the Second Schedule as follows—

“THIRD SCHEDULE (*Section 5*)

NET METERING GUIDELINES

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Terms, definitions and abbreviations

In this Code, unless the context otherwise requires, the following words shall have the meaning as assigned in these guidelines:

“Bi-directional meter” – means a meter that measures the active energy flow in both directions (import and export) and displays both imported and exported energy in separate registers;

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- “Customer generator” – means any customer of a distribution licensee that generates electricity on the customer’s side of the billing meter with renewable energy generating facility that is primarily intended to offset part or all of the customer’s electricity consumption;
- “Disconnection switching unit” – means a switching unit that disconnects the small scale embedded generator operating in parallel with the utility network from the network in response to an out-of-bounds condition;
- “Distribution Network” – In relation to a Distribution licensee, means a system of electric lines and associated equipment (generally at nominal voltage levels of 36 kV or below), which that Distribution licensee is licensed to use to distribute electricity for supply under its distribution license excluding public lighting assets;
- “Emergency” – means an emergency due to the actual or imminent occurrence of an event which in any way endangers or threatens to endanger the safety or health of any person or which destroys or damages, or threatens to destroy or damage any property;
- “Flicker” – means Voltage fluctuations producing the subjective impression of fluctuations in the luminance via the functional chain electric lamp-eye-brain;
- “Grid-connected renewable energy system” – means a power system energized by a renewable energy source which is connected to the distribution network;
- “Island” – means state in which a portion of the utility or customer’s network containing load and generation, continues to operate in isolation from the rest of the grid;
- “Generating unit” – means a renewable energy generating facility with an inverter that is grid tied through a connection to the low voltage distribution network under the Net Metering scheme;
- “Point of Connection (POC)” – means the circuit breaker and associated ancillary equipment (instrument transformers, protection, isolators) that connects a generator to any electrical network. Where more than one such circuit breaker exists, the Point of Generator Connection (PGC) shall be the circuit breaker electrically closest to the generator, alternatively the PGC;
- “Point of Common Coupling (PCC)” – means Interconnection between the small scale embedded generator and the utility distribution network, referring to the node on the utility network electrically closest to a particular small scale embedded generator’s installation, alternatively Point of Utility Connection (PUC);

- “Power factor” – means the Ratio of the r.m.s. value of the active power to the apparent power, measured over the same integrating period;
- “Prevention of islanding” – means the Small scale embedded generator’s ability to detect loss-of-grid and prevent the condition of unintended islanding;
- “Safety disconnect” – means the Independent control system that monitors the Distribution licensee network conditions and disconnects the a.c. output of the small scale embedded generator from the network for out-of-bounds conditions;
- “Simple separation” – means the Galvanic separation between circuits or between a circuit and earth by means of basic insulation;
- “Static power converter” – means the Power electronic device that converts variable d.c. or a.c. to grid compatible a.c. either synchronously (able to operate in stand-alone mode) or asynchronously (requires utility interconnection);
- “Small scale embedded generator” – means One or more energy generation sources rated up to 5MW, that includes the energy conversion device (devices), the static power converter (converters), if applicable, and the control and protection gear within a customer’s network that operate in synchronism with the utility’s supply;
- Synchronisation – the process of connecting two previously separated alternating current apparatuses after matching frequency ,voltage, phase angles like paralleling a generator to the electric system;
- “Uni-directional meter” – means a meter that measures the active energy flow in one direction only and ignores the active energy flow in the reverse direction;
- “Utility interface” – means interconnection between the small-scale renewable generating facility/system and the utility distribution network, the PUC or point of common coupling.

#### Abbreviations

a.c.:	alternating current
CB:	circuit-breaker
DB:	distribution board
d.c.:	direct current
E/L:	earth leakage
EG:	Embedded Generator
PGC:	Point of Generator Connection
POC:	Point of Connection
PV:	Photovoltaic
r.m.s.:	root mean square
TDD:	Total Demand Distortion

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### 1. Scope of Code

The Net Metering Code provides guidelines and technical connection conditions for the inter-connection of domestic, commercial and industrial renewable energy generating facilities to the low voltage distribution network under the net metering scheme.

### 2. Utility Compatibility Requirements

#### 2.1. General

A customer generator shall meet the requirements of this guideline relating to power quality parameters, at the Point of Connection (POC) or the utility interface unless otherwise specified by the Distribution Licensee.

The Customer-generator is responsible for protecting its equipment in such a manner that faults or other disturbances in the Distribution Licensee's network does not cause damage to Customer-generator's equipment.

The design, installation, maintenance, and operation of the renewable energy generating facility shall be conducted in a manner that ensures the safety and security of both the generating facility and the Distribution Licensee's network.

The Customer-generator shall ensure the automatic disconnection of the renewable energy generating facility from the Distribution Licensee's network, in the event of a power outage in the Distribution Licensee's network or any abnormal operation of the Distribution Licensee's network as specified in this document.

The Customer-generator accepts that the renewable energy generating facility shall be disconnected immediately from the distribution network upon direction from the Distribution Licensee that in the event the Licensee determines (a) causes damage to or (b) is producing adverse effects affecting other distribution network customers or the Distribution Licensee's assets.

The customer generator facility's a.c. voltage, current and frequency shall be compatible with the Licensee's distribution network.

Inverters of renewable energy generating units larger than 13.8 kVA shall be of balanced three-phase type and inverters up to 13.8 kVA can be of single phase type.

A customer with a multiphase connection shall split the generating unit in a balanced manner over all phases if the unit is larger than 4.6 kVA.

2.2. Frequency Range of Operation

The allowable system frequency allowed under continuous operation is in the range between 47.5Hz and 52.5 Hz.

2.3. Voltage Range of Operation

The allowable continuous voltage range of operation shall be between 90% and 110% of the rated voltage otherwise the Distribution Licensee’s protection system will disconnect the generator.

Voltage excursions beyond this operating range is deemed abnormal voltage operating range. The renewable energy generating facility’s response to such voltage excursions is listed in Table 1.

2.4. Power Factor

The generating unit should operate at unity power factor or at least at a power factor greater than 0.98.

2.5. Response to Network Disturbance

2.5.1 Maximum fault current

A renewable energy-inverter based generating unit shall not contribute to fault currents in the network, nor inject any additional reactive current during voltage dips.

2.5.2 Voltage sags/Voltage spikes/Abnormal voltage range of operation

For voltages outside the normal operating range a generating unit is recommended to remain connected at least during time periods shown in Table 1.

Table 1: Recommended connection time during Abnormal Voltage Conditions

Voltage range (at point of utility connection)	Minimum connection time
$50\% < V < 85\%$	10 s
$85\% \leq V < 90\%$	1 min
$90\% \leq V \leq 110\%$	Continuous operation
$110\% < V \leq 115\%$	1 min

**Note:** A graphical representation of the voltage ranges can be found in Figure 1 under clause 3.1.7.

2.6 Power Quality

2.6.1 DC current injection

The renewable energy generating facility shall not inject a

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d.c. current greater than 1% of the unit rated output current, into the utility AC interface under any operating condition as recommended by IEC 61727.

### 2.6.2 Rapid voltage changes

Voltage changes at POC attributable to the simultaneous connection and disconnection of the renewable energy generating facility should not exceed a value of 3 % of rated r.m.s voltage at POC.

### 2.6.3 Voltage unbalance

The compatibility level of voltage unbalance applies to both single phase generating unit up to 13.8 kVA and three phase generating unit larger than 13.8 kVA (as stated in section 3.1). The compatibility level for voltage unbalance on LV three-phase networks shall be 2 %. On networks where there is a predominance of single-phase or two-phase customers, a compatibility level of 3 % may be applied.

### 2.6.4 Flicker

The total voltage flicker Pst and Plt resulting from all loads, other generation and background flicker injected from higher voltage levels must not exceed the following values, as recommended by IEC 61000-3-7:

- Pst = 1.0
- Plt = 0.8

For each generating unit, the applicable flicker emission limits are based on flicker planning levels according to IEC61000-3-7, existing background flicker levels, possible future installations and the total size of unit to be connected. The methodology for apportioning unit-specific flicker limits shall be in-line with IEC61000-3-7.

The following are limits to the contribution of individual generating units to voltage flicker:

- Pst = 0.35
- Plt = 0.3

Short term flicker (Pst) and long term flicker (Plt) emissions as measured at the PUC and the limits are based on 95% probability levels.

### 2.6.5 Harmonics

For each unit, the individual harmonic voltage distortion limits are based on planning level for individual harmonic distortions



(HD) and total harmonic distortion (THD) as guided by the Distribution Code, existing background harmonics, possible future installations and the total size of unit to be connected, according to methodology described in IEEE standard 519:1992.

In the absence of any apportioned limits, individual harmonic voltage distortion limits for odd harmonics shall not exceed 2% and in the case of even harmonics shall not exceed 1%; Total Harmonic Voltage Distortion shall not exceed 3% at the POC.

In addition, generators shall not exceed harmonic current distortion limits specified in Table 2 at the POC.

Table 2: Current distortion limits for generating units

Isc/IL	Current Harmonic Distortion limits					
	Maximum Harmonic Current Distortion in Percent (%) of $I_L$					
	Individual Harmonic Order “h” (Odd Harmonics)					
	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	TDD
<20*	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

\* All power generation equipment is limited to these values of current distortion, regardless of actual Isc/IL.

- (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) Isc = maximum short-circuit current at POC.
- (d) IL = maximum demand load current (fundamental frequency component of generation current) at POC.
- (e) TDD (Total Demand Distortion) = harmonic current distortion in % of maximum demand load (or generation) current (15 or 30 min demand).

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### 3. Safety and Protection

#### 3.1 System Safety and Protection

##### 3.1.1 General

The customer generator shall be responsible for providing adequate protection for its facility under all operating conditions regardless of whether or not the generating facility is in operation.

Conditions include but are not limited to single phasing of supply, system faults, equipment failures, abnormal voltage or frequency, lightning and switching surges, excessive harmonic voltages, excessive negative sequence voltages and islanding.

##### 3.1.2 Synchronisation

The utility voltage and frequency shall be within the steady state range for at least 5 minutes before synchronizing the generating facility to the distribution network, i.e., voltage between 90% and 110% of rated voltage and frequency between 47.5Hz and 52.5 Hz. During synchronisation the controller of the renewable energy inverter must ensure that no transient currents or voltages occur that would adversely impact the distribution network.

##### 3.1.3 Protection and control devices

The customer generator's protection system shall co-ordinate with the Distribution Licensee's protection system.

###### (a) Disconnect Device

The disconnect device should be located at the PGC, where the generating facility and the buildings electrical system interconnects, or at the distribution board. The disconnection device also referred to as main switch, inverter supply shall be visible, easily accessible to service personnel and should allow manual operation.

###### (b) Protective Relays

Protective relays shall be installed to trip the corresponding circuit breaker, or relays internal to the inverter shall trip the inverter, during inadmissible network conditions.

Refer sections 3.1.7 and 3.1.8 for relay response times.

The admissible tolerance value between setting value and trip value of the voltage shall be maximum  $\pm 1\%$  and the admissible tolerance for the frequency at the maximum  $\pm 0.1\%$ .

##### 3.1.4 Reclosing

For a distribution network with automatic reclosing, the generating unit shall wait for at least 5 minutes until the re-closer has

normalized the portion of the system to which the facility is connected before synchronising back to the system according to section 3.1.2.

3.1.5. Loss of utility voltage (Islanding)

To prevent islanding, a generating unit shall cease to energise irrespective of connected loads or other generators within two seconds of loss of utility voltage according to IEC 61727.

3.1.6. Earthing

Renewable energy generating facilities and the associated interconnection systems must be grounded as per recommendations according to the Distribution Code.

The grounding scheme of the renewable energy generating facility shall not cause voltage disturbances or disrupt the coordination of the ground fault protection on the local distribution network.

3.1.7. Over/under voltage

The customer generator must provide an automatic method of disconnecting its facility from the Distribution Licensee’s network if utility voltage excursions are beyond the limits stated in Table 3. The limits according to Table 3 apply to the lowest phase voltage in case of voltage dips and to the highest of the three phase voltages in the case of voltage spikes.

Voltage protection device shall use the half wave r.m.s. value from the 50 Hz fundamental voltage component.

Table 3: Over/under voltage protection relay response time

Voltage Range (at Point of utility connection)	Maximum clearing time (s)
$V < 50 \%$	0.16
$50\% \leq V < 85 \%$	11
$85\% < V < 90\%$	61
$110 \% < V < 115\%$	61
$115 \% < V$	0.16

Figure 1 shows the region of continuous operation, recommended remain-connected region according to Table 1 (grey shaded area) and the must-trip region for generator protection (coloured area) according to Table 3.

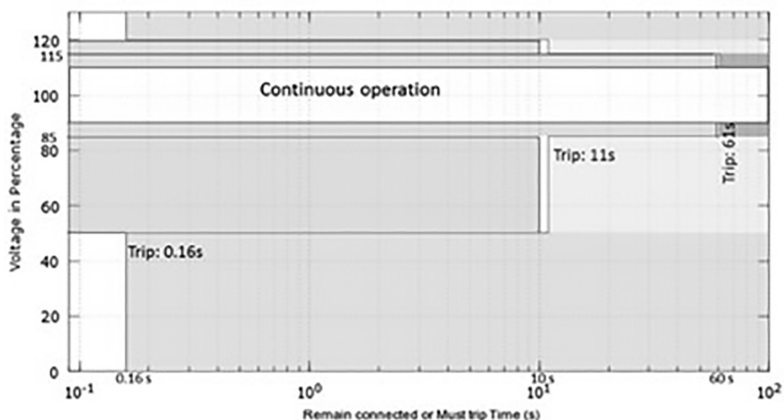


Figure 1: Generator Remain-connected and Must-trip regions during normal and abnormal voltage operation

### 3.1.8. Over/under frequency

The customer generator must provide an automatic method of disconnecting its facility from the Distribution Licensee’s network if utility frequency excursions are beyond the limits stated in Table 4.

Table 4: Over/under frequency relay response times

Frequency	Protection relay setting values
F<48,75Hz	0.2 s
F>51,25Hz	0.2 s

### 3.1.9. Short circuit protection

The generating facility shall have short-circuit protection in accordance to IEC 603647-712.

## 3.2 Safety and Protection

### 3.2.1. General

The customer generator and the Distribution Licensee operator shall ensure safe operation of the generating facility and the utility network. Safe operation also includes the safety of the following persons:

- (a) owner (including personnel and inhabitants of the property) of the generator facility;

- (b) general public safety;
- (c) distribution Licensee personnel;
- (d) general emergency response personnel, e.g. fire brigade should fire arise at the small generating facility.

Any other applicable safety standards for electric installations, as they may be defined by the applicable codes and regulations under the Electricity Act.

#### 3.2.2. Labelling

An appropriate signage shall be displayed on the distribution board where the generating unit is connected, warning any personnel to completely disconnect the generating facility and isolate it from the distribution lines before working with equipment therein. The Distribution Licensee shall ensure that the following is written legibly on a background of a sharply contrasting colour for each identifying marker as guided by IEC 60417 (Graphic symbols).

- (a) “Warning”, “Caution”, or “Danger” followed by “MV Cable” or “LV Cable” as applicable; and
- (b) The name of the Distribution Licensee and contact telephone number, on which contact is possible at all times.

#### 3.2.3. Emergency shutdown

All generating facilities shall have emergency shutdown capability. During an emergency, all fuel inputs (e.g. d.c. input to inverter, etc.) and a.c. voltages shall be shut off regardless of the operating mode of the equipment.

D.C connection of solar PV panels and other storage medium should be open circuited.

### 4. Metering

#### 4.1. Metering Arrangement

All meters utilised in the local distribution network shall be the property of the Distribution Licensee operator even when the meters are located on the premises of the Customer-generator.

Figure 2 shows the metering arranged applicable to Net Metering scheme.

The Net Metering arrangement shown in Figure 2 can be realised using a bi-directional meter recording import and export energy separately.

The generating unit feeds into the customer network or into utility network through the distribution board.

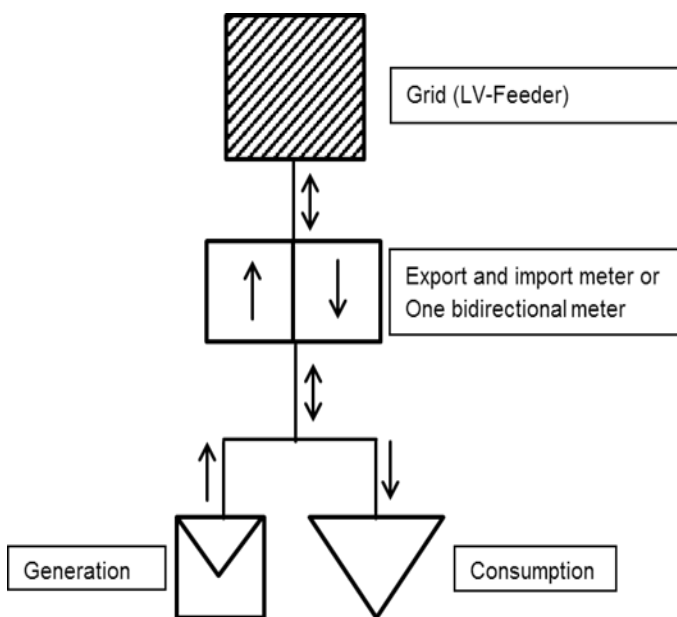


Figure 2: Metering Configuration for Bi-directional Net Metering

The Distribution Licensee shall own and shall be responsible for the design, provision, installation, operation, maintenance, testing and sealing of the meter and associated meter equipment.

The Distribution Licensee shall be responsible for keeping and updating a register and related drawings of all Customers connected to the Distribution Licensee's distribution network. The information contained in the abovementioned register shall include, the location of the Customer, the name plate rating and type of the Customer renewable energy generator and the estimated excess generation of the Customer renewable energy generator.

#### 4.2. Type of Meter

The meter used shall be four quadrant electronic, bi-directional type meters and a meter with the capability of metering quality of supply parameters shall activate the monitoring facility on the meter.

### 5. Testing and Commissioning

#### 5.1. General

The Distribution Licensee shall have the right to witness testing and

commissioning of generating units upon completion of construction and shall have a copy of the test data.

The commissioning test shall be conducted after the interconnection system is installed and is ready for operation.

Commissioning test shall include the following:

- (a) Verification and inspections
- (b) Response to abnormal voltage
- (c) Response to abnormal frequency
- (d) Synchronization
- (e) Unintentional islanding functionality test
- (f) Cease-to-energize functionality test

The Distribution Licensee shall not be responsible for verifying any control or signal wiring not directly related to the interconnection protection.

Prior to final approval by the Distribution Licensee or anytime thereafter, the Distribution Licensee reserves the right to test the relaying and control related to the protection of the distribution network.

If the Distribution Licensee personnel is not present to witness the commissioning tests, the Distribution Licensee shall still consider approving the commissioning of the generating facility if the inverter of the generating facility is certified according to section 5.2 and upon receiving a copy of the test data.

## 5.2. Inverter certification

The inverter of the generating unit shall be product certified to comply with relevant IEEE and IEC standards, as referred to by these interconnection rules.

IEEE standard certification must certify inverter harmonic emission levels according to IEEE 519:1992 or an updated version of a similar standard with limits as shown in section 2.6.5.

IEC standard certification must certify inverter's performance according to IEC 61727, in relevance to disconnection during loss of grid (3.1.5), islanding (3.1.5) and excessive d.c current injection (2.6.1). The inverter's islanding prevention measures must be tested and certified according to IEC 62116 standard.

The person responsible for the installation of a generating unit must declare that the installation of the system complies with all requirements according to IEC 60364-7-712 and this document.

### 5.3 Typical Renewable Energy Facility Connection

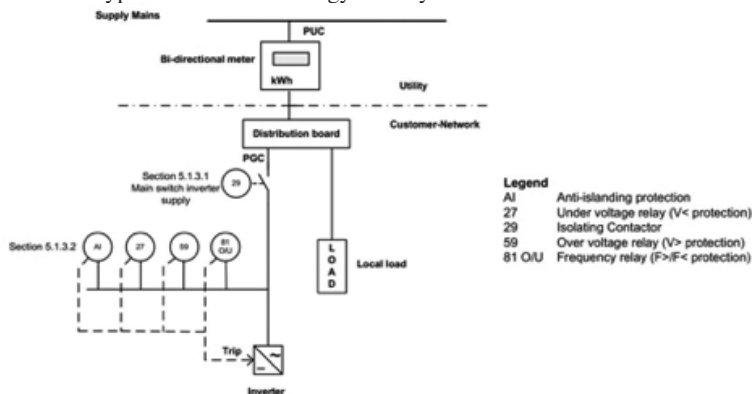


Figure 3: Renewable Energy Generating Facility connection to the Low Voltage Distribution Network.

Figure 3 depicts a single line diagram of a simple connection between the customer generator’s local load, generating facility and the Distribution Licensee’s network.

The manually operated disconnection switch or main switch inverter supply must be visible and must have a locking system or device that allows the Distribution Licensee personnel to work on the system safely. The disconnect-switch’s locking device shall include a warning sign that informs of the personnel working.

Bi-directional meter records energy use. When limits for protection functions specified in this document is exceeded, which includes over/under frequency, over/under voltage, loss of mains and islanding, the main protection relay shall trip. Relays internal to the inverter shall trip the inverter in cases including but not limited to, short circuit protection, synchronisation, and internal faults.

#### 5.4 Power Supply Isolator in Switchboard

It is recommended that the interconnection of the generating facility and the building’s electrical system is undertaken at a switchboard or distribution board. This connection shall be at an a.c. power supply isolator located on the switchboard (or distribution board) where the renewable energy generating facility is connected. This switch is referred to as main switch inverter supply. This isolator shall be lockable.

A switch or isolator being lockable means it needs a padlock or a similar device to lock it. In addition, a switch or isolator shall have a tag or small plastic with inscription “DO NOT SWITCH ON-PERSON WORKING ON SYSTEM” or similar.



The cable between the switchboard and inverter requires protection. Thus, a suitable rated circuit breaker shall be used as the isolator. For example, a low voltage air circuit breaker can be used as an isolator switch that can be used to connect or disconnect the circuit by manually moving an operating handle to the ON or OFF position. Such a circuit breaker is also reset manually and can trip automatically when the current in the circuit exceeds a predetermined value (in case of short circuit or over).”

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