Guidelines for Net Energy Metering in Bangladesh

Integrating Distributed Renewable Energy Systems into the Grid

22.10.2017

Submitted to

Power Cell
Power Division, Ministry of Power, Energy & Mineral Resources
Government of the People's Republic of Bangladesh
Biddyut Bhaban (9th Floor), 1 Abdul Ghani Road, Dhaka-1000

Prepared by

Shahriar Ahmed Chowdhury
Director, Centre for Energy Research
United International University
Dhaka, Bangladesh
Email: shahriar.ac@gmail.com
Mobile: +880 1812243581
# Table of Contents

Table of Contents ................................................................. 1  
Abbreviations .............................................................................. 3  
Tables ........................................................................................... 4  
Figures ........................................................................................ 4  
1  Introduction ............................................................................. 5  
  1.1  Background ................................................................. 5  
  1.2  Objectives of the work .................................................. 6  
  1.3  Scope of the work ........................................................ 7  
  1.4  Definitions and interpretations ...................................... 8  
  1.5  How net energy metering works ..................................... 10  
2  Cross country experience ...................................................... 12  
  2.1  United States ............................................................... 12  
  2.1.1  California .............................................................. 12  
  2.1.2  Arkansas ................................................................. 13  
  2.2  Canada ........................................................................... 13  
  2.2.1  Ontario ................................................................. 13  
  2.2.2  Newfoundland and Labrador ....................................... 13  
  2.3  Netherlands .................................................................... 14  
  2.4  Denmark ........................................................................ 14  
  2.5  Slovenia .......................................................................... 14  
  2.6  South Africa .................................................................... 14  
  2.7  Brazil ............................................................................. 15  
  2.8  Thailand ......................................................................... 15  
  2.9  Philippines ..................................................................... 15  
  2.10  Malaysia ........................................................................ 15  
  2.11  India .............................................................................. 16  
  2.11.1  Andhra Pradesh ...................................................... 16  
  2.11.2  Gujarat ..................................................................... 16  
  2.11.3  Maharashtra ........................................................... 17  
  2.11.4  Tamil Nadu ............................................................ 17  
  2.12  Sri Lanka ...................................................................... 17  
3  Net metering guidelines for Bangladesh ................................. 20  
  3.1  Eligibility criteria .......................................................... 20  
  3.2  Consumer Categories ..................................................... 20  
  3.3  Capacity and energy export limits .................................... 20  
  3.3.1  Option I ................................................................. 21  
  3.3.2  Option II ................................................................. 21  
  3.3.3  Option III ............................................................... 21  
  3.4  Energy accounting and settlement .................................. 21  
  3.5  Tariff structure .............................................................. 22
3.6 Metering arrangement .................................................. 22
3.7 Application Procedure .................................................. 23

4 Interconnection requirements ........................................... 25

4.1 Description of Indirect Renewable Energy System .................... 25
  4.1.1 Feeding method .................................................. 25
  4.1.2 Equipment standards .......................................... 25
  4.1.3 Connection types ............................................. 25

4.2 General interconnection requirements ................................ 27
  4.2.1 Normal voltage operating range ................................ 27
  4.2.2 Voltage fluctuation ........................................... 28
  4.2.3 RE generator power factor .................................... 28
  4.2.4 Reactive power compensation .................................. 28
  4.2.5 DC Injection .................................................. 29
  4.2.6 Harmonic ..................................................... 29
  4.2.7 Voltage unbalance ............................................ 29
  4.2.8 Short circuit level ............................................ 29

4.3 Protection guidelines ................................................... 29
  4.3.1 Protection coordination study .................................. 30
  4.3.2 Smart meter .................................................... 30
  4.3.3 Frequency ..................................................... 30
  4.3.4 Synchronization ............................................... 30
  4.3.5 Anti-islanding inverter ......................................... 30
  4.3.6 Inverter fault current contribution: .............................. 31
  4.3.7 Protection schemes: ........................................... 31
  4.3.8 Failure of system protection or control equipment: ............... 31
  4.3.9 Frequency disturbance ......................................... 31
  4.3.10 Voltage Disturbance .......................................... 31
  4.3.11 Utility interface disconnect switch ............................ 31

4.4 Safety requirements ..................................................... 32
  4.4.1 Operation ....................................................... 32
  4.4.2 Interconnection operation manual ............................... 33
  4.4.3 Labeling ....................................................... 33

Annexes ................................................................. 34

Annex I: Application Template ............................................ 35
  i Applicant Information ............................................. 35
  ii Project Information ............................................... 35
  iii Proposed Work Plan .............................................. 36
  iv Supporting Document Checklist .................................. 37
  v Applicant Declaration ............................................. 37

Annex II: Net Meter Specification ........................................ 41

Annex III: Pre-Feasibility Study Checklist Template ....................... 43

Annex IV: Net Metering Agreement Template ................................ 51

Bibliography ............................................................. 56
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACPP</td>
<td>Average Cost of Power Purchase</td>
</tr>
<tr>
<td>ANEEL</td>
<td>Brazilian Federal Energy Regulatory Agency (Brazil)</td>
</tr>
<tr>
<td>APERC</td>
<td>Andhra Pradesh Electricity Regulatory Commission (India)</td>
</tr>
<tr>
<td>BERC</td>
<td>Bangladesh Energy Regulatory Commission (Bangladesh)</td>
</tr>
<tr>
<td>CEB</td>
<td>Ceylon Electricity Board (Sri Lanka)</td>
</tr>
<tr>
<td>ERC</td>
<td>Energy Regulatory Commission (Philippines)</td>
</tr>
<tr>
<td>FiT</td>
<td>Feed in Tariff</td>
</tr>
<tr>
<td>GERC</td>
<td>Gujarat Electricity Regulatory Commission (India)</td>
</tr>
<tr>
<td>JNNSM</td>
<td>Jawaharlal Nehru National Solar Mission (India)</td>
</tr>
<tr>
<td>LEC</td>
<td>Lanka Electricity Company (Sri Lanka)</td>
</tr>
<tr>
<td>MERC</td>
<td>Maharashtra Electricity Regulatory Commission (India)</td>
</tr>
<tr>
<td>MNRE</td>
<td>Ministry of New and Renewable Energy (India)</td>
</tr>
<tr>
<td>NCSL</td>
<td>National Conference of State Legislatures (USA)</td>
</tr>
<tr>
<td>NEM</td>
<td>Net Metering</td>
</tr>
<tr>
<td>NEPC</td>
<td>National Energy Policy Council (Thailand)</td>
</tr>
<tr>
<td>NERSA</td>
<td>National Energy Regulator of South Africa (South Africa)</td>
</tr>
<tr>
<td>PUB</td>
<td>Board of Commissioners of Public Utilities (Canada)</td>
</tr>
<tr>
<td>PUCSL</td>
<td>Public Utility Commission of Sri Lanka (Sri Lanka)</td>
</tr>
<tr>
<td>PV</td>
<td>Photovoltaic</td>
</tr>
<tr>
<td>RE</td>
<td>Renewable Energy</td>
</tr>
<tr>
<td>RET</td>
<td>Renewable Energy Technology</td>
</tr>
<tr>
<td>SSEG</td>
<td>Small Scale Embedded Generator (South Africa)</td>
</tr>
<tr>
<td>STEC</td>
<td>Suruhanjaya Tenaga Energy Commission (Malaysia)</td>
</tr>
<tr>
<td>TEDA</td>
<td>Tamil Nadu Energy Development (India)</td>
</tr>
<tr>
<td>TOU</td>
<td>Time-of-Use</td>
</tr>
</tbody>
</table>
Tables
Table 1: Country-wise analysis of NEM regulations ................................................................. 18
Table 2: Installed capacity limits .......................................................................................... 21
Table 3: Normal operating condition at LV interconnection .................................................. 28
Table 4: Normal operating condition at MV interconnection .................................................. 28
Table 5: Typical equipment rating in distribution network ...................................................... 29
Table 6: Voltage disturbance ................................................................................................. 32

Figures
Figure 1: Typical net metering architecture ......................................................................... 11
Figure 2: State-wise adoption of net metering in United States ........................................... 12
Figure 3: Schematic diagram of indirect connection to the grid ............................................ 25
Figure 4: Type A connection ............................................................................................... 26
Figure 5: Type B connection ............................................................................................... 27
1 Introduction

1.1 Background

Bangladesh aims at achieving universal access to electricity and joining the ranks of middle-income countries by 2021. The country has recently graduated to “lower middle-income” status and expressed her vision of attaining a developed economy status by 2041. The 7th Five-Year Plan (FYP) of the Government sets the country's average GDP growth target of 7.4% during the five-year period (FY2015/16-FY2019/20). To achieve the growth target during the 7th FYP period and beyond, electricity generation capacity needs to be significantly increased to meet the growing demand. Electricity generation now largely relies on fossil fuels, the stock and supply of which is limited in Bangladesh. In view of the challenge of primary fuel sourcing and supply, the Government of Bangladesh has recently developed the power generation strategy based on fuel diversification to enhance energy security. Alongside the conventional energy sources, renewable energy will play a significant role in meeting the future demand of electricity as well as fulfilling environmental obligations. Bangladesh adopted, keeping pace with the global trend, the Renewable Energy Policy in 2008. The Renewable Energy Policy of Bangladesh mandates that 10% of electricity to come from renewable energy sources by 2020. In absolute terms, this means that at least 2000 MW has to be generated from renewable energy sources by 2020.

To date, the installed capacity of renewable energy installations is close to 500 MW including 230 MW hydropower capacity. Most of the recent capacity addition is from standalone solar systems, generally referred to as solar home systems (SHSs). There are 4.5 million cumulative installations of SHSs in predominantly off-grid areas of Bangladesh. Making it the largest off grid renewable energy program in the world. Despite huge potential, grid-connected electricity consumers are yet to reap the benefits of solar energy. Every on-grid household and commercial or industrial consumers can utilize solar energy, which is the most dispersed form of energy, to generate electricity by installing solar photovoltaic (PV) panels on their own roofs and can become electricity producers meeting their electricity demand partly or fully by themselves and can even sell excess electricity produced to the distribution utilities if appropriate policies are in place.

Bangladesh enjoys good amount of sunshine and the use of solar energy continues to grow while the cost of solar technology continues to decline. Incentivizing grid-connected customers is of utmost importance to promote RE-based distributed generation. Net metering is one of the tools to popularize the RE based electricity generation in the country. Net metering is a policy approach designed to encourage distributed renewable energy development by allowing utility customers to generate their own electricity from solar or any other renewable sources and use the electricity produced to offset the amount of energy they draw from the utility grid (sometimes called the distribution grid) and any access generation can feed into the grid. Customers are only billed for their “net” energy use and receive credit usually in the form of kilowatt-hour (kWh) during a given period. A net balance in favor of the customer is carried forward to the next month, while a balance in favor of the utility is settled at the end of the month as usual. Net-metering can potentially drive widespread implementation of distributed generation by incentivizing end-users to adopt localized power generation through renewable energy technologies (RETs) such as solar, wind and biomass. As of 2017, 46 countries have some form of active net metering policy; local governments have adopted net metering policies in another nine countries in the absence of national-level actions.
Realizing its importance, the Government of Bangladesh intends to prepare a net metering guideline to establish a mechanism for distributed RE integration to the grid. In this regard, Power Cell has appointed an individual consultant for preparing the Net Metering guideline suitable for RE integration to the national grid of Bangladesh.

1.2 Objectives of the work

The objective of this work is to support the Government of Bangladesh to develop a net metering policy for individual generation. The purpose of this work is to:

a. Prepare a guideline for net metering system;

b. Establish a financial mechanism for RE integration to grid; and

c. Popularize RE based rooftop or grid-tie system in the country.

The net metering policy will bring following benefits:

a. Encourage self-consumption of the electricity produced from renewable energy sources among the consumer to reduce dependency on the grid power;

b. Reduce electricity bill of customers by lowering the use of electricity from the grid and securing payment made for the electricity fed into the grid in the event of surplus generation;

c. Support the utility to allow the consumers interconnect with the distribution network; and

d. Contribute to the reduction of greenhouse gas emission through promoting generation of electricity from renewables while lessening the country’s dependence on costly imported fossil fuels.
1.3 **Scope of the work**

The scope of the work under this assignment is as follows.

- Understanding the basics of policy, regulation and standards of net energy metering;
- Cross-country experiences of net energy metering;
- Prepare a net energy metering guideline for integrating distributed renewable energy systems into the electricity grid of Bangladesh;
- Propose suitable tariff structure for grid-connected RE systems (NEM) considering the affordability of the customers and economic scenario of the country;
- Power purchase agreement (PPA) signing and billing procedures;
- Identification of the appropriate regulations, codes and standards required for the successful implementation of NEM in Bangladesh;
- Eligibility criteria and application procedure for NEM services;
- Preparation of a standard contract document for NEM; and
- Perform any other related work as necessary to prepare the NEM guideline.
### 1.4 Definitions and interpretations

Unless otherwise specified, the terms in this regulation shall adopt the meanings provided as follows.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of supply</td>
<td>The geographic area within which the utility is authorized by its license to supply the electrical energy.</td>
</tr>
<tr>
<td>Average cost of power purchase</td>
<td>The weighted average pooled price at which the utility has purchased the electricity, including the cost of self-generation, if any, plus declared average system loss incurred in the previous year from all the energy suppliers on long-, medium- and short-term basis, but excluding the electricity purchased from renewable energy sources.</td>
</tr>
<tr>
<td>Billing cycle or billing period</td>
<td>The period for which electricity bills shall be prepared for the consumer by the licensee.</td>
</tr>
<tr>
<td>Commencement date</td>
<td>The start of the operation of the renewable energy technology for net energy metering scheme.</td>
</tr>
<tr>
<td>Consumer</td>
<td>An eligible consumer who has an installed renewable energy system or who has applied to the utility to install a renewable energy system under the net energy metering arrangements.</td>
</tr>
<tr>
<td>Commercial consumer</td>
<td>A consumer categorized and connected as a commercial consumer by the distribution utility.</td>
</tr>
<tr>
<td>Connection point</td>
<td>The point where the renewable energy system is connected to the consumer’s internal network.</td>
</tr>
<tr>
<td>Contract</td>
<td>An agreement signed between the utility and the consumer under the net energy metering scheme as in Annex IV.</td>
</tr>
<tr>
<td>Distribution network</td>
<td>An electricity system of electric lines, cables, switchgear and associated equipment at nominal voltage of 33 kV or below for the distribution of electricity.</td>
</tr>
<tr>
<td>Domestic/residential consumer</td>
<td>A consumer categorized and connected as domestic/residential consumer by distribution utility.</td>
</tr>
<tr>
<td>Eligible consumer</td>
<td>A consumer of electricity who is in compliance with the requirements of the utility.</td>
</tr>
<tr>
<td>Indirect connection</td>
<td>The connection of a renewable energy installation to a supply line indirectly through the internal distribution board of the consumer where the renewable energy installation is connected to an electrical point within the premises of the consumer instead of the point of common connection.</td>
</tr>
<tr>
<td><strong>Industrial consumer</strong></td>
<td>A consumer categorized and connected as an industrial consumer by the distribution utility.</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Interconnection point</strong></td>
<td>The point of connection between utility and the consumer.</td>
</tr>
<tr>
<td><strong>Invoice</strong></td>
<td>A monthly or supplementary bill raised/issued by the utility.</td>
</tr>
<tr>
<td><strong>kV</strong></td>
<td>Kilovolt or 1000 volt.</td>
</tr>
<tr>
<td><strong>kW</strong></td>
<td>Kilowatt.</td>
</tr>
<tr>
<td><strong>kWh</strong></td>
<td>Kilowatt hour.</td>
</tr>
<tr>
<td><strong>kWp</strong></td>
<td>Kilowatt peak stands for peak power. Rated kWp in relation to a PV installation means the maximum direct current power such installation can produce under standard test conditions of 1000 watts per square meter of solar irradiation and 25°C ambient temperature.</td>
</tr>
<tr>
<td><strong>Licensee</strong></td>
<td>An individual/entity who has received a license under the BERC Act, 2003.</td>
</tr>
<tr>
<td><strong>Low voltage</strong></td>
<td>Operation of equipment at a voltage less than 1,000 V or 1 kV.</td>
</tr>
<tr>
<td><strong>Maximum demand</strong></td>
<td>The maximum level of the simultaneous power demand of all the electrical equipment and system of a consumer’s installation expressed in kW or kVA units.</td>
</tr>
<tr>
<td><strong>Medium voltage</strong></td>
<td>Voltage exceeding low-voltage but equal to or less than 33,000 V or 33 kV.</td>
</tr>
<tr>
<td><strong>MW</strong></td>
<td>Megawatt or 1000 kilowatts.</td>
</tr>
<tr>
<td><strong>MWp</strong></td>
<td>Megawatt peak. 1 MWp = 1,000 kWp.</td>
</tr>
<tr>
<td><strong>Net energy metering</strong></td>
<td>A mechanism where an eligible consumer installs a renewable energy system primarily for her own use and the excess energy can be exported to the grid, for which credit is to be received that may be used to offset part of the electricity bill issued by the utility for the applicable billing period.</td>
</tr>
<tr>
<td><strong>Net export capacity</strong></td>
<td>The maximum level of electrical power which a renewable energy technology can deliver to the distribution system at the point of interconnection.</td>
</tr>
<tr>
<td><strong>Net meter</strong></td>
<td>An appropriate energy meter capable of recording both import and export of electricity.</td>
</tr>
<tr>
<td><strong>Premises</strong></td>
<td>Rooftops and/or elevated areas on land, building or infrastructure or part or combination thereof owned by or under the control of the consumer.</td>
</tr>
<tr>
<td><strong>Prosumer</strong></td>
<td>The customer who consumes and produces electric energy</td>
</tr>
</tbody>
</table>
Rooftop solar PV system | The solar photovoltaic power system installed on the consumer’s premise that uses sunlight for direct conversion into electricity through photovoltaic technology.

Sanctioned load/demand | Maximum demand in kW, kVA or HP, agreed to be supplied by the utility and indicated in the agreement executed between the utility and the consumer.

Settlement period | The period of time (months or years) by the end of which the consumer is compensated for any accumulated kWh credit.

Tariff structure/order | In respect of a licensee means the most recent order issued by BERC for that licensee indicating the rates to be charged to the various categories of consumers by the utility for the supply of electrical energy and services.

Utility | Authorities who are the holder of a license to distribute electricity issued by the Bangladesh Energy Regulatory Commission.

1.5 How net energy metering works

Net energy metering (NEM) refers to a policy mechanism that allows prosumers to connect their renewable energy systems to the distribution grid. The mechanism allows for the export of energy (e.g. electricity) generated from distributed renewable energy sources in exchange of credits in the form of energy or money. This method of sharing energy is often termed as ‘energy banking’.

From a practical standpoint, NEM allows the consumer to install a bi-directional meter that can measure electricity flow in two directions – from the utility to the customer (import) and from customer to the utility (export). The measured data can be stored in the meter or transferred to a centralized aggregator service. The customer’s bill is calculated according to the net energy recorded on the meter; i.e. the aggregated energy drawn from the network minus the energy delivered to the network over the specified billing period. Any credits earned (in terms of kWh) by the net generating consumers are allowed to roll over to the next billing period. By the end of the specified rolling cycle or settlement period, the consumer is either charged or compensated for the net electricity import or export respectively. Figure 1 illustrates the architecture of a typical net metering arrangement using solar PV as an example of distributed renewable energy system.
The rate at which the customer is billed is determined considering various factors such as the consumer tariff class, type of renewable energy technology, installed capacity and export limitations. While installing such connections, the prosumer must also abide by the interconnection technical requirements and safety regulations set by the concerned authority.

The interconnection process, the mechanism by which net metered distributed energy systems may be legally and safely connected to the electricity grid, is critical to the success of net metering programs. Interconnection standards are typically outlined separately from net metering policy parameters, but are fundamental to the development of the NEM policy. There exist three commonly-used mechanisms for compensating prosumers for local distributed generation; they are: “net energy metering”, "feed-in-tariff” and “power purchase agreement”. To avoid confusion, these three mechanisms are defined as follows.

**Feed-in-tariff (FIT):** FIT is introduced to encourage distributed generation by compensating the consumer using a tariff above the retail level. The tariff can be time-dependent and reduces to the retail level as the number of FIT users increases. It is usual for FIT to be implemented as the first policy measure to kickstart distributed generation.

**Net energy metering (NEM):** Net metering or net energy metering, on the other hand, is set at the retail tariff level. NEM is not technically a compensation, although it may become one if payments for excess generation are allowed.

**Power purchase agreement:** PPA tariff is generally below retail tariff rate and can be above retail depending upon the policy of the government.
2 Cross country experience

In this chapter, net metering implementation experiences and relevant regulations of several countries are discussed briefly. Notable features of these guidelines are summarized in terms of factors such as the year of commencement, limits on installed capacity and electricity export, metering arrangement and cost allocation, nature of credit, settlement period, and the preferred tariff for settlement.

2.1 United States

The history of net metering can be traced back to 1979 when net metering was introduced for the first time in the US state of Massachusetts. Utilities in Idaho adopted net metering in 1980, in Arizona in 1981 and in Massachusetts in 1982. The first statewide net metering law was passed by the state of Minnesota in 1983. According to the National Conference of State Legislatures (NCSL) of the United States, as of October 2016, a total of 44 states, Washington DC and four other US territories have adopted net metering rules (Cleaveland and Durkay 2016). Figure 2 illustrates the state-wise adoption of net metering and their corresponding capacity limitations.

![Net Metering](image)

**Figure 2:** State-wise adoption of net metering in United States

However, the authorized policies in the United States vary depending on several key factors such as the eligible technology, capacity limits, NEM credit retention, and RE credit ownership. Salient features of some of the state regulated net metering schemes are briefly discussed in the following sections.

2.1.1 California

In California, solar, wind, biogas and fuel cell generation facilities up to 1 MW are covered by the state’s NEM legislation. The customers are guided to size their generators with respect to their annual load instead of peak demand. At the end of 12-month billing period, the customer
is compensated for any excess supply to the grid at a separate fair market value, otherwise known as net surplus compensation. This rate is based on a 12-month rolling average market rate of energy, which is approximately 4 to 5 cents per kWh (California Public Utility Commission 2017). The eligible consumer is instructed to install one or multiple meters that are capable of ToU (time of use) measurements. Apart from that both aggregate and virtual net metering is permitted in the state of California (State of California 2013).

2.1.2 Arkansas

The Arkansas Public Service Commission has first adopted net metering rules in 2002, which went through stages of amendments up to September 2013. According to this latest version of net metering regulation, residential consumers are allowed to install up to 25 kWp and commercial consumers up to 300 kWp.

For net consumption, the consumer is charged as per the standard rate schedule. On the other hand, kWh credits earned by the consumer for net generation are allowed to roll over for 12 months. The consumer is allowed to assign those credits to any other meters owned by her/him provided that those meters were identified at the time of request. In cases where the excess kWh credit still remains, the consumer is allowed to carry over to the next annual cycle an amount equivalent to the consumer’s 4-month average usage during the cycle that is closing (Arkansas Public Service Commission 2013).

2.2 Canada

In Canada, several provinces such as Ontario, Newfoundland and Labrador, New Brunswick, Saskatchewan and parts of British Columbia offer net metering facilities to their consumers. Important characteristics of NEM regulations of two Canadian provinces are discussed below:

2.2.1 Ontario

Ontario enforces its net metering regulations under the framework of ‘Ontario Energy Board Act, 1998’. The NEM regulations of Ontario label self-generating consumers as ‘eligible generators’, who primarily engage in self-consumption and generate the electricity exclusively from RE sources. The eligible generator is also allowed to distribute its excess to another point without seeking help from the utility. However, in Ontario, the consumer signs an agreement with a third-party retailer, instead of the utility directly. The settlement period is 12 months, by the end of which the bill is calculated using the ‘Retail Settlement Code’ (Ontario Energy Board 2017).

2.2.2 Newfoundland and Labrador

In its ‘Net Metering Policy Framework’ (dated July 2015), the province of Newfoundland and Labrador offers NEM facilities to only household and general service customers. The generation capacity shall not be greater than the consumers load demand. In addition, individual systems shall remain within the maximum limit of 100 kWp. The utilities are also given authority to assess the technical requirements, and if necessary impose limits on the aggregate amount of generation.

The customer’s kWh credits will be settled every 12 months, in terms of either cash equivalent or credits, which will be subjected to approval by the Board of Commissioners of Public Utilities (PUB). The cash compensation is calculated according to the existing retail tariff rates.
However, in Newfoundland and Labrador, customers’ accounts are monitored to prevent any significant accumulation of kWh credits (Ministry of Natural Resources 2015).

2.3 Netherlands

The Dutch government has regulated net metering in Netherlands since 2004. At the beginning, electricity export limit was set at 3,000 kWh per year and there were provisions for penalty for exceeding this limit. This limit was later extended up to 5,000 kWh and the penalty was also waived in February 2011 (BV April 2012).

As of July 2017, the Dutch parliament has ruled to extend the net metering scheme until 2023, which was supposed to terminate by 2020. The current Dutch net metering scheme can be termed as ‘full net metering policy’, which maintains that energy has the same value irrespective of the direction. However, the lawmakers of the Netherlands are considering to abolish it after 2023 and move in favor of policy instruments that will offer more stable incentive to domestic photovoltaic systems (Bellini 2017).

2.4 Denmark

Denmark has adopted a net metering policy in November 2012. According to this policy, for self-generating entities (except geothermal installations) tariffs, duties and value added tax are either fully or partially waived for the exported electricity. This exemption depends on the type and installed capacity. In case of solar photovoltaics, systems less than 50 kW get complete exemption from the Public Service Obligation. In Denmark, the net metering is applied based on hourly basis and the settlement period is set to be 1 year (International Energy Agency 2015).

2.5 Slovenia

A nation-wide regulation regarding net metering came into force in the Republic of Slovenia in January 2016, which at present is applicable to domestic and small-scale electricity producers. The maximum permissible nominal power rating is set at 11 kVA. Since the policy aims to raise the level of self-consumption rather than export to the grid, it puts a limit on annual power as well – 7 MVA for domestic and 3 MVA for small business customers (International Energy Agency 2016). The net electricity exported to the grid is credited in terms of kWh and a single tariff measurement of electricity is applied to calculate the amount (Official Gazette of the Republic of Slovenia 2015).

2.6 South Africa

In September 2011, the National Energy Regulator of South Africa (NERSA) has approved Standard Conditions for Small Scale Embedded Generation (SSEG), which allows net metering. The capacity limit is up to 100 kW.

However, a consultation paper published by NERSA on 25th February 2015 reports that there are still not mandatory standards to regulate grid interconnection of SSEGs’. The paper also addresses a restructuring of the existing tariff for net metering. The proposed scenario is that the consumption tariff shall have a fixed and a variable part. The export credit tariff shall be equivalent to the avoided variable purchase cost of the distributor (Africa 2015).
2.7 Brazil
Brazilian Federal Energy Regulatory Agency (ANEEL) has established a net metering scheme, which includes small scale customer generators up to 1 MW. The Brazilian net metering program classifies customer generators into two categories, namely distributed micro (< 100 kW) and mini (100 kW – 1 MW) generators. The credit cycle is fixed to be 36 months (Clarke 2012).

2.8 Thailand
Thailand established itself as the pioneer among the developing countries by adopting and implementing a net metering policy back in May 2002 (Clarke 2012). The legislation titled ‘Regulations for the Purchase of Power from Very Small Renewable Energy Power Producers’ allowed RE power generators up to 1 MW to be grid-connected. According to this policy, net electricity consumers were billed based on the retail tariff, whereas net producers were compensated at the bulk supply tariff (80% of retail tariff) plus the average tariff adjustment surcharge by the utilities. Other notable features included aggregate net metering and time-of-use metering (Greacen, Plevin and Greacen 2003).

Over the years, Thailand has pursued significant policy shifts starting from 2013, when the first premium price FiT policy was announced. After the announcement of Phase 2 of the same in August 2014, followed by 1 year extension until June 2016, the Thai government showed clear intentions to shift away from the FiT scheme. In September 2015, the National Energy Policy Council (NEPC) of Thailand has acted in favor of rooftop photovoltaic installations in particular. In doing so, a rooftop photovoltaic pilot scheme (‘Solar Quick Win’) based on self-consumption was announced by mid-2016. Even though initially any surplus electricity will not be financially compensated, it is expected that based on the outcome of the pilot project (to be monitored and evaluated in Jan-July 2017), a net metering scheme will be adopted by mid-2017 (Potisat 2017).

2.9 Philippines
‘Rules Enabling the Net-Metering Program for Renewable Energy’ was the first policy instrument of the Philippines’ Renewable Energy Act of 2008, which came into force in July 2013. The net metering policy allows RE generation facilities up to 100 kWp to be connected to the distribution grid. The distribution utilities may choose to install a single bidirectional or two/three unidirectional meter system. On the other hand, the customer is either charged or credited in terms of peso credits (notably not as kWh credits) depending on net usage from or export to the grid. The Energy Regulatory Commission (ERC) has clarified that the accumulated peso credits on part of the consumer can be paid in cash after a certain period of time as agreed upon by both parties.

In Philippines, the distribution utilities charge a net-metering fee, which is intended to cover its’ incremental costs related to system enhancement and other operational costs (Ocampo 2013).

2.10 Malaysia
A net metering scheme guideline came into effect in Malaysia since October 5, 2016. The guideline was approved by the Suruhanjaya Tenaga Energy Commission (STEC), with an aim to cover 500MW by the end of 2020. Consumers are divided into three tariff categories, namely, domestic/residential, commercial and industrial consumers.
The Malaysian net metering guideline differentiates between installed capacity limit and net energy export limit. Domestic solar photovoltaic systems shall not exceed 12 kWp for single phase and 72 kWp for three phase. For commercial consumers, the limit will be either 1 MWp or 75% of the maximum demand of the current installation, whereas for industrial consumers it’s either 60% of the fuse rating or 60% of the current transformer rating. The net export limit should be within the range of 1 kWp to 1 MWp.

STEC has guided to conduct a mandatory pre-study before approving the application, the cost of which should be paid by the consumer and it varies depending on the installed kWp. The net billing is calculated using the following equation:

$$\text{Net billing} = \text{Energy consumed from utility (kWh)} \times \text{Gazetted tariff}$$
$$- \text{Energy exported to utility} \times \text{Displaced cost}$$

The credit is allowed to roll for a period of 24 months. In Malaysia, the consumers who supply net electricity to the grid are allowed to submit an invoice to the utility to claim Goods and Service Tax as well (Tenaga 2016).

2.11 India

As of June 2015, a total of 30 Indian states and union territories have adopted and put in place policies to assist the development of grid connected solar photovoltaic (Ministry of New and Renewable Energy 2015). Among them the majority have also developed net metering related regulations. Notable features of some of the state regulations are briefly discussed below.

2.11.1 Andhra Pradesh

The Government of the state of Andhra Pradesh has released its solar power policy in 2015, which includes a section on net/gross metering regulations for solar power projects in general with capacity up to 1000 kWp at a single location. The consumer(s) are allowed to adopt either net or gross metering systems. In both the cases, the tariff is set to be equal to the average cost of service fixed by the Andhra Pradesh Electricity Regulatory Commission (APERC) on annual basis. Such arrangements will be valid for 25 years for developers who set up their projects within the validity period of the policy. The eligible developers are also allowed by the policy to seek relevant subsidies and other incentive approved by the Ministry of New and Renewable Energy (MNRE) under its Jawaharlal Nehru National Solar Mission (JNNSM) scheme (APERC 2015).

2.11.2 Gujarat

Gujarat Electricity Regulatory Commission (GERC) has introduced ‘Regulations for Net Metering Rooftop Solar Photovoltaic Grid Interactive Systems’ in June 2016. The regulations specify that the capacity of the photovoltaic system should fall within the range of 1kW to 1MW, and it should not exceed 50% of the consumer’s sanctioned load or contract demand. On the other hand, the utility should maintain that the cumulative capacity remains within 65% of the peak capacity of the distribution transformer. They are also instructed to update the allowed capacity annually and the cost of the necessary transformer enhancement or network extension shall be carried by the consumer. In case the utility provides the meters instead of the consumer, the later party should to bear the cost. Apart from this, the eligible customer shall not be charged for transmission charge, wheeling charge, cross subsidy charge, additional surcharge etc.
Considering the billing arrangement, the GERC has classified the consumers or solar photovoltaic owners into two broad categories. Apart from the residential and government consumers, the industrial, commercial and other consumers are distinguished based on whether they utilize any ‘renewable attribute’ or not. They are either consumers, who are not registered with any mechanism (Type 1), or fall under the ‘Renewable Energy Certificate’ system (Type 2a) or comply with the ‘Renewable Purchase Obligation’ (Type 2b).

Irrespective of the consumer category, the consumers pay for net consumption based on the existing tariff structure. However, for net electricity supply to the grid different arrangements are specified. Type 1 consumers are paid at the Average Cost of Power Purchase (ACPP) rate determined by GERC on the commissioning year over its entire lifetime. For the remaining two categories, the electricity is purchased by the utility ‘after adjustment of consumption in specified time blocks (15 minutes) at APPC rate (Type 2a) and at 85% of APPC rate (Type 2b)’ (G. E. COMMISSION 2016).

2.11.3 Maharashtra


In Maharashtra, the allowed capacity limit is < 8 kW for single phase connections, whereas for three phase is limited to < 150 kW for municipal corporation areas and < 80 kW for other areas. The range is either > 80 kW or >150 kW for 11 kV connections depending on the location of the facility. As for the utility, they are permitted to allow the cumulative net metering connection beyond the 40% of the rated capacity of the distribution transformer only when a detailed load study is carried out. The single/three phase net meter shall be afforded by eligible consumer and provided by the utility.

The guideline also includes provision for time-of-day (ToD) tariff, given that the net meter is capable of such measurement. The net metering connection agreement is valid for 20 years and the settlement period is specified to be the fiscal year. The credit is rolled over to next billing period in terms of electricity units. At the time of settlement, in case of net energy export, the utility shall buy that amount at the ACPP rate, which is approved by the Commission for that particular year (MERC 2015).

2.11.4 Tamil Nadu

In March 2013, the Tamil Nadu Electricity Commission released an order addressing some issues related to the Tamil Nadu Solar Energy Policy 2012. In the order, the stakeholders discussed the aspect of adopting net metering for consumers, based on which the Tamil Nadu Energy Development Agency (TEDA) has later released a solar net metering consumer guide.

According to this guide, the installed photovoltaic capacity shall not exceed the sanctioned load and the preferable size should be such that the annual generation remains within the 90% of the annual consumption. It also instructs that the existing unidirectional meters should be replaced by bidirectional ones and the settlement period is set to be one year. By the end of that period, the exported amount that will be subjected to adjustment, and is allowed to be up to 90% of the energy imported (TEDA 2016).

2.12 Sri Lanka

The concept of net metering was approved by the Sri Lankan government in 2008, and it was introduced by the Ministry of Power and Energy in cooperation with two distributor companies:
Lanka Electricity Company (LECO) and the Ceylon Electricity Board (CEB) in July 2010. The Public Utility Commission of Sri Lanka (PUCSL) has reported that as of April 2014, Sri Lanka has brought approximately 6.1 MW (installed capacity) under the net metering scheme.

Customers are offered a 10-year agreement free of charge, except for the initial one-time expense for the bi-directional meter and other necessary safety equipment. They also enjoy flexibility regarding the type of RE source as long as they comply with the utility standards, and the generation capacity remains below 1000 kVA. Until September 2016 (before the FiT was in action), there was no monetary compensation for the kWh credits earned, and this non-transferable credit can only be utilized against the customers’ own usage in the current or future billing period (typically 1 month). At present, the customers can earn Rs. 22 per unit for the first 7 years. (Public Utilities Commission of Sri Lanka 2014).

The key features of net metering regulations of various countries that are discussed above are presented in tabular form in Table 1.

Table 1: Country-wise analysis of NEM regulations

<table>
<thead>
<tr>
<th>Country/ State</th>
<th>Capacity Limit</th>
<th>Consumer classes</th>
<th>Settlement period</th>
<th>Metering arrangement</th>
<th>Credit settlement rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>California</td>
<td>Up to 1 MW</td>
<td>No</td>
<td>12 months</td>
<td>1 or multiple meters</td>
<td>Net Surplus Compensation (4-5ct/kWh)</td>
</tr>
<tr>
<td>Arkansas</td>
<td>&lt;25 kW (res.)</td>
<td>Residential and commercial</td>
<td>12 months</td>
<td>Not specified</td>
<td>Prevailing retail rates</td>
</tr>
<tr>
<td></td>
<td>&lt;300 kW (com.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ontario</td>
<td>No limits</td>
<td>Not specified</td>
<td>12 months</td>
<td>Not specified</td>
<td>Referred to ‘Retail Settlement Code’</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NFL and Labrador</td>
<td>Up to 100 kW</td>
<td>Domestic and general service customers</td>
<td>12 months</td>
<td>Not specified</td>
<td>Prevailing retail rates</td>
</tr>
<tr>
<td>Philippines</td>
<td>Up to 100 kW</td>
<td>Not specified</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>1 phase: &lt;12kW;</td>
<td>Residential, commercial and Industrial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 phase: &lt;72kW</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Commercial: 1MW/ 75% demand load</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Industrial: 60% of fuse rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24 months</td>
<td>1 bi-directional</td>
<td>Net bill = (import unit<em>gazetted tariff) – (export</em>displacement cost)</td>
</tr>
<tr>
<td>Country/ State</td>
<td>Capacity Limit</td>
<td>Consumer classes</td>
<td>Settlement period</td>
<td>Metering arrangement</td>
<td>Credit settlement rate</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Up to 1000 kVA</td>
<td>Not specified</td>
<td>Not specified</td>
<td>1 bi-directional</td>
<td>Fixed amount for first 7 yrs (Rs. 22)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Up to 5000 kWh/year</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Import export has same value</td>
</tr>
<tr>
<td>Slovenia</td>
<td>11 kVA</td>
<td>Domestic and small business</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Single tariff measurement</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>Up to 1000 kWp at a single location</td>
<td>Not specified</td>
<td>12 months</td>
<td>Net or gross metering</td>
<td>ACPP rate set by APERC</td>
</tr>
<tr>
<td>Gujarat</td>
<td>1kW to 1MW; max^m 50% of sanctioned load</td>
<td>Residential, commercial and Industrial</td>
<td>12 months</td>
<td>1 single bi-directional or 2 unidirectional</td>
<td>Different ACPP rate set by GERC for consumer class</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>1 phase: &lt;8kW; 3 phase: &lt;150kW For 11kV: &gt;80 or 150kW</td>
<td>According to voltage</td>
<td>12 months</td>
<td>1 single or 3 phase bi-directional</td>
<td>ACPP rate set by MERC</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>&lt; sanctioned load</td>
<td>Not specified</td>
<td>12 months</td>
<td>1 bi-directional</td>
<td>Prevailing tariff</td>
</tr>
</tbody>
</table>
3 Net metering guidelines for Bangladesh

3.1 Eligibility criteria
A consumer shall be considered ‘eligible’ when the following clauses are complied with.

i. **Current customer of the Utility:** current customer of the Utility that is responsible for the supply electricity in the area;

ii. **No outstanding arrears:** the applicant should not have any outstanding arrears prior to making the application;

iii. **Type of renewable energy source:** electricity produced ONLY from renewable energy sources are eligible;

iv. **Legal rights for installation:** the applicant must either be the legal owner or have the legal permission from the owner(s) or their legal representative(s) for installing the proposed renewable energy system in the premise;

v. **Type of premise:** building rooftops, car parking, garages or similar buildings or at land within own premise of the consumer where utility meters exist or any other suitable area accepted by utility;

vi. **Self-consumption:** shall consume the electricity at the point of RE electricity generation, and only export the excess amount to the grid;

vii. **Interconnection standards:** shall comply with the interconnection rules and standards set by the Utility or other relevant governing authority; and

viii. **System size:** shall comply with Section 3.3 of this regulation.

**Note:** The consumer can be allowed to distribute electricity to another point of use given that s/he is NOT doing so with the help of the existing Distribution Network. In other words, the overhead cost associated with such distribution shall be borne by the consumer.

3.2 Consumer Categories
Eligible consumers (as described in Sec. 3.1) under the framework of this net metering regulation can be broadly classified into three categories.

i. Domestic or residential consumers

ii. Commercial consumers

iii. Industrial consumers

3.3 Capacity and energy export limits
The size of the system and maximum allowable electricity export must correspond with consumer type and usage patterns. There can be several pathways for defining system size and maximum export. Three options are illustrated in the following subsections. However, in all cases the following conditions must be fulfilled:

i. The consumer cannot be net exporter within a settlement period.
ii. In case of a medium-voltage (MV) consumer, the installed generation capacity of the renewable energy system cannot be more than 70% of the rated capacity of the distribution transformer (or, cumulative capacity of the distribution transformers).

iii. Exported amount of electricity for a distribution substation (utility) cannot be more than 50% of the imported energy in a settlement period.

Any or multiple scenarios, which are presented below, can be selected (and combined) to determine the eligibility criteria for system sizes:

3.3.1 Option I

The maximum installed RE capacity can be fixed with respect to the consumer's maximum demand or sanctioned load. 70% on the customer's sanctioned load can be specified as the maximum permissible generator size (installed capacity).

3.3.2 Option II

Irrespective of the customer’s demand, the limit can be set on individual installation sizes. Different sizes can be specified for different consumer classes (as specified in §3.2) as well. A sample scenario is proposed in Table 2.

Table 2: Installed capacity limits

<table>
<thead>
<tr>
<th>Consumer category</th>
<th>Capacity limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential/ domestic</td>
<td>5 kW to 100 kW</td>
</tr>
<tr>
<td>Commercial</td>
<td>10 kW to 500 kW</td>
</tr>
<tr>
<td>Industrial</td>
<td>100 kW to 3 MW</td>
</tr>
</tbody>
</table>

3.3.3 Option III

Irrespective of the installed capacity, limits can be set on the amount of total or net electricity export. 70% of the consumer’s annual electricity consumption can be set as the maximum permissible electricity export that shall be subjected to settlement. In this case, the consumer will always remain a net importer from the grid and the Utility shall bill against his/her net energy usage at the time of the settlement.

3.4 Energy accounting and settlement

The specifics of the energy accounting and settlement are described below:

i. The utility shall be responsible for preparing and issuing electricity bills for each billing period and adjusting accumulated kWh credit on yearly basis.

ii. For each billing period, the Utility shall prepare an energy statement and send a copy to the consumer, which shall separately mention:

   (a) The amount of electricity exported to the grid by the installed renewable energy systems;

   (b) The amount of electricity injected by the Utility for the consumer’s use; and

   (c) Net amount of electricity billed to be paid by the consumer or net credited kWh to roll over to the next billing period.
iii. If the amount of electricity units imported by the eligible consumer during any billing period exceeds the amount exported, the Utility shall bill for the net electricity consumption after adjusting the credited units.

iv. If the amount of electricity exported exceeds the amount imported during the billing period, the excess amount shall be carried forward to the next billing period as credited units of electricity (kWh).

v. The energy accounting shall be according to the tariff structure as specified in §3.5 of this guideline.

vi. The unadjusted kWh credit shall be allowed to roll over for a maximum period of 12 months, which is otherwise known as the ‘settlement period’. The settlement period will be the end of each calendar year and all the credits should be adjusted with the bill of the last month of the settlement period.

vii. At the beginning of each settlement period, the net units of electricity carried to the next billing period shall be set to zero.

### 3.5 Tariff structure

The tariff structure that shall be used to either charge or credit the consumers under this net metering guideline is specified in this section.

i. Flat rate consumers: Units of imported and exported electricity shall assume the same value.

ii. Consumers of different tariff structure (i.e. peak or off-peak rates), The lowest tariff (for that consumer) will be considered for the exported units.

iii. For each billing period, the Utility conducts the energy accounting based on the tariff order issued by the Bangladesh Energy Regulatory Commission (BERC). The accounting should also accommodate the consumer categories as mentioned in §3.2 of this guideline.

iv. The tariff rates are subjected to change according to the tariff structure determined by the BERC.

v. If the tariff is changed before the settlement period then the tariff of settlement month will be considered for the exported energy to the grid.

### 3.6 Metering arrangement

The metering arrangement shall be done according to the following conditions.

i. A single bidirectional meter shall be installed at the point of interconnection by the Utility.

ii. The net meter shall conform to the specifications as mentioned in Annex II of this guideline.

iii. In case of eligible consumers, who fall under the different tariff metering scheme, smart meter capable of recording electricity consumption and generation during peak and off-peak hours separately shall be installed.
iv. The utility shall be responsible for procuring, testing, installing (and replacing the existing meters), maintaining and reading the net meters.

v. The price of the meters and other relevant costs shall be borne by the consumer.

vi. The reading from the net meters shall be the primary basis of energy accounting and commercial settlement.

### 3.7 Application Procedure

The eligible consumers, who intend to install and/or connect their renewable energy generation system/s with the grid and benefit from net metering shall follow the procedure mentioned in this section.

i. The eligible consumer shall apply for a net metering agreement to the utility.

ii. The eligible consumer shall use the application template as provided in Annex I of this guideline. Only completed applications with the necessary supporting documents shall be considered acceptable by the utility.

iii. Upon receiving the completed application package (and proof of payment, if any), the utility shall officially acknowledge the receipt of the application.

iv. The applicant together with the utility shall agree on the detailed work plan, which shall include a feasibility study, physical installation of the system (for new installations), the establishment of interconnection, checking and verification, approval and signing of the NEM contract.

v. The applicant shall perform with assistance from the utility a feasibility study and technical assessment of the renewable energy System. The specifics of the study are given below.

   a) The purpose of this study is to assess the technical suitability and safety requirements necessary for the installation. The study shall analyze the financial feasibility of the project, and the outcomes shall be communicated with the consumer.

   b) The study shall assist the utility to prepare the technical requirements or any necessary modification to the distribution grid for the establishing the interconnection.

   c) Any cost incurred for such modification shall be paid by the NEM applicant.

   d) Each study shall be valid for a period of 12 months, starting from the date of approval by the utility.

   e) A checklist of issues that shall be addressed during the pre-feasibility study is provided in Annex III.

vi. Within the specified time span, the consumer, with the support of utility shall carry out the necessary steps to install the renewable energy system (required for new installation) and/or establish the necessary interconnections.

vii. The utility shall check and verify the system to ensure that the system components and interconnection parameter comply with the rules and standards that are specified in Chapter 0 of this guideline.
viii. The Utility shall issue a test certificate along with a test report to the NEM applicant, a copy of which shall be submitted with the application package as well. The documents shall be prepared according to the template provided in Annex IV.

ix. Upon successful completion of all the necessary steps mentioned above by the NEM applicant, the utility shall issue the NEM approval, and a contract signing date shall be communicated with the consumer.

x. The NEM consumer shall sign the NEM contract with the utility on the date stated in

xi. The NEM Agreement shall be prepared according to the template provided as specified in Annex IV.

xii. Upon receiving the application from NEM utility should settle all necessary formalities and signed the contact within 60 (sixty) days.
4 Interconnection requirements

4.1 Description of Indirect Renewable Energy System

4.1.1 Feeding method

The consumer may decide to install indirect Renewable Energy systems to reduce their import from the Utility. A schematic diagram of such indirect connection is provided below:

Figure 3: Schematic diagram of indirect connection to the grid

As shown in the figure above, power consumption and export are measured by M1, while energy consumption by the consumer’s load is measured by M2 and energy generation by RE technology is measured by M3. For net metering, meter M1 shall have bi-directional capability and facilitate 'Time-of-Use' reading.

4.1.2 Equipment standards

Major components of the Rooftop Solar PV System to be installed shall comply with the IEC 61727 (PV systems – characteristics of utility interface) and IEEE 1547 (Standard for Interconnecting Distributed Resources with Electric Power Systems) and other relevant national standards in terms of design, operation, maintenance and environmental testing.

4.1.3 Connection types

Two types of connections can be specified according to the output voltage level of the inverter. The connection types are presented below with corresponding schematics:
Type A is applicable for Utility’s consumers with connection to LV network. RE/PV connection point shall be done at the consumer’s DB/MSB.

Use of a single phase inverter shall not cause unbalance conditions to Utility’s system. If such a condition is violated, requirement of a three phase inverter is automatically enforced.
Figure 5: Type B connection

Type B connection is applicable for Utility’s consumer with connection to MV network. RE/PV connection point shall be done at the consumer MSB. Use of single phase inverter shall not cause unbalance conditions to the Utility’s system. If such a condition is violated, requirement of a three phase inverter is automatically enforced.

4.2 General interconnection requirements

The interconnection shall not result in any enhancement of the existing utility supply infrastructure such as cable, fuse, switchgear, and transformer and protection scheme.

The quality of the power at the point of interconnection shall not be worse than the existing quality of supply. Quality of supply is measured as per the standards on voltage, flicker, frequency, harmonics and power factor, as specified by relevant and concerned authorities. To ensure that the interconnection does not adversely impact the quality of supply, the following requirements shall be imposed and adhered to by the NEM consumer.

Deviation from these standards represents out-of-bounds conditions and the rooftop solar PV system shall be able to sense the deviation and disconnect itself from the distribution network accordingly.

4.2.1 Normal voltage operating range

The PV system injects current into the Utility and does not regulate voltage.

i. Indirect renewable energy systems connected with a low-voltage (LV) interconnection shall operate within the voltage specified in Table 3.
### Table 3: Normal operating condition at LV interconnection

<table>
<thead>
<tr>
<th>Nominal voltage [V]</th>
<th>Steady state voltage limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>± 10%</td>
</tr>
<tr>
<td>230</td>
<td>± 10%</td>
</tr>
</tbody>
</table>

ii. Indirect renewable energy systems connected with a medium-voltage (MV) interconnection shall operate within the voltage specified in **Table 4**.

### Table 4: Normal operating condition at MV interconnection

<table>
<thead>
<tr>
<th>Nominal voltage [kV]</th>
<th>Steady state voltage limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>± 10%</td>
</tr>
<tr>
<td>33</td>
<td>± 10%</td>
</tr>
</tbody>
</table>

#### 4.2.2 Voltage fluctuation

Power generation from indirect renewable energy systems varies due to the changing renewable energy sources throughout the day. The varying power generation injected into the distribution network creates voltage fluctuation at the interconnection point and other buses within the grid.

The maximum voltage fluctuation range allowed for LV and MV due to varying renewable energy sources is 6%. Beyond this, there is a danger of utility and consumer equipment heating up. An appropriate voltage control is to be undertaken to mitigate the voltage fluctuation when necessary.

#### 4.2.3 RE generator power factor

The power factor is defined as the ratio between the applied active power and the apparent power.

i. The RE / PV systems shall have a leading or lagging power factor greater than 0.9 when output is greater than 20% of the rated inverter output power. The smart inverters used shall automatically make necessary adjustments to ensure that the power factor does not cause a voltage rise beyond the permissible limit.

ii. The requirement of plant power factor shall be identified during the technical assessment.

#### 4.2.4 Reactive power compensation

If the installed indirect renewable energy system is set to operate at unity power factor, reactive power for the consumer’s load will be totally imported from the Utility and the real power will be a mix of on-site generation and imported electricity from the Utility. This will result in a low power factor reading at the Utility tariff meter as the ratio of reactive power is higher for own generation.

Therefore, the customer is advised to consult the system integrator to provide internal compensation to avoid from being penalized.
4.2.5 DC Injection
The PV system shall not inject DC current greater than 1% of the rated inverter output current into the Utility interface under any operating condition.

4.2.6 Harmonic
The harmonic of a wave is a component frequency of a wave that is an integer multiple of the fundamental frequency. In the presence of non-linear loads such as computer power supplies and other appliances, alternating current (AC) can be distorted by the introduction of various harmonic frequencies. Harmonics can be measured by the percentage of the fundamental frequency or by calculating total harmonic distortion (THD). When present at high levels, harmonics are detrimental to the electrical system and its loads. The following shall be maintained.

i. The PV system output should have low current-distortion levels so that other equipment connected to the Utility system is not adversely affected.

ii. Total harmonic current distortion shall be less than 3% of the rated inverter output at the cable connected to the interconnection point.

4.2.7 Voltage unbalance
Voltage unbalance is defined as the ratio of the negative sequence voltage component to the positive sequence voltage component.

i. Infrequent short duration peaks with a maximum value of 2% over 1-minute duration are permitted for voltage unbalance.

ii. When multiple single-phase PV units are installed the unbalance should be distributed evenly among the three phases of the power system.

iii. The unbalanced voltage shall not exceed 1% on five occasions within any 30-minute period at the terminals of the consumer’s installation.

4.2.8 Short circuit level
By regulation, the Utility is required to ensure that short circuit level of the network is within the equipment ratings. The regulation specifies that network maximum sub-transient 3-phase symmetrical short circuit shall be within 90% of the equipment designed short-time make & break capacity. Table 5 highlights the typical equipment ratings in Utility’s network.

<table>
<thead>
<tr>
<th>Nominal voltage [kV]</th>
<th>Rated voltage [kV]</th>
<th>Fault current [kA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>36</td>
<td>25</td>
</tr>
<tr>
<td>11</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>0.4</td>
<td>1.0</td>
<td>31.5</td>
</tr>
</tbody>
</table>

4.3 Protection guidelines
Protection systems for indirect renewable energy generators shall be designed to isolate the faulty part of the system from the remaining properly functioning portion. NEM consumer shall design a protection system, which shall suit her/his target degree of system security.
Nevertheless, the NEM consumer shall comply with the Utility’s protection requirements to ensure that the fault will not spread beyond the RE generator system.

4.3.1 Protection coordination study
The NEM consumer shall perform protection coordination study to determine suitable settings for protecting the system during a fault. Outcomes of such studies shall be communicated with the Utility. After which, the Utility shall advise the consumer on appropriate settings at the point of common coupling. Interconnection feeder protection scheme shall prohibit unsafe synchronization.

4.3.2 Smart meter
Connection of power generation to distribution network could cause voltage rise during low load conditions. Also, sudden loss or generation from distributed generation could cause instability of the network, especially for system with high distributed generation penetration.

Advanced inverters or known as smart inverters are capable of providing additional features in addition to the power conversion. Smart inverters are capable of assisting the grid during its time of need. Such features include:

- Reactive power control
- Active power control
- Grid management

Inverters used by the consumer’s system shall comply with the requirement of the smart inverter as described in §4.3.3 to §4.3.11.

4.3.3 Frequency
Utility shall maintain the system frequency and the PV system shall operate in synchronization with the Utility’s frequency. Utility shall operate with nominal 50 Hz system with ±1% range band. The inverter should be capable of producing power at the frequency band of at least ±6%.

4.3.4 Synchronization
Synchronization is an act of matching, within allowable limits. The RE generator should be equipped with automatic Synchronization system. For solar PV system the Synchronization is to be done at the inverter.

4.3.5 Anti-islanding inverter
i. Non-islanding inverters are unable to supply the load without the presence of the Utility’s system. For personnel safety, the PV plant is not allowed to be energized during the outage of utility grid (loss of mains). The NEM consumer shall disconnect from the Utility’s system for loss of main within one second.

ii. Inverters used by the NEM consumer shall provide the following anti-islanding detection techniques:
   a. Under voltage
   b. Over voltage
c. Under frequency

d. Over frequency

iii. NEM consumer is to prove the anti-islanding capability of the plant during commissioning tests.

4.3.6 Inverter fault current contribution:

The fault current contribution by the inverter will be limited usually by the inverter control. Based on IEEE 1547, the typical range of short circuit current is between 100% and 200% of the rated inverter current. NEM consumer shall ensure that inverters used comply with the IEEE 1547 requirements.

4.3.7 Protection schemes:

The basic requirements for the design of the protection schemes shall be as follows:

i. For any internal fault in the indirect RE System must not cause problems to the Utility’s system and its customers.

ii. For any distribution network fault outside the indirect RE System, the PV system must be protected from any damaging effect.

iii. NEM consumer shall be required to provide other protection devices to complement existing special features.

4.3.8 Failure of system protection or control equipment:

The indirect RE System must be disconnected from the distribution system during any of the system failure. Failure condition of the indirect RE System shall include:

i. Failure of protection equipment

ii. Failure of control equipment

iii. Loss of control power

4.3.9 Frequency disturbance

The under frequency and over frequency levels and the corresponding inverter trip time shall be as follows:

i. When the Utility frequency is outside the nominal 50 Hz value by ±2%.

ii. Trip time shall be within 0.20s.

iii. Applicable for both LV and MV interconnection.

4.3.10 Voltage Disturbance

i. The inverter should sense abnormal voltage and respond according to the conditions in Table 6. Consideration shall be given to monitoring voltage in this clause in order to avoid problems due to voltage drop in various transformer, wiring or feeder circuit. When the inverter senses that the voltage lies outside its operating limits, the actions recommended in Table 8 shall be taken.
Table 6: Voltage disturbance

<table>
<thead>
<tr>
<th>Voltage at interconnection</th>
<th>Maximum trip time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V &lt; 50%</td>
<td>0.10</td>
</tr>
<tr>
<td>50% ≤ V &lt; 90%</td>
<td>2.00</td>
</tr>
<tr>
<td>90% ≤ V ≤ 110%</td>
<td>Continuous operation</td>
</tr>
<tr>
<td>110% &lt; V &lt; 135%</td>
<td>2.00</td>
</tr>
</tbody>
</table>

ii. Inverters are expected to continuously operate which during distribution network voltage fluctuation ±10% of its nominal.

iii. During the time of voltage disturbance, which could be the result of transmission network switching and distribution switching on nearby feeder, the voltage would be affected. Therefore, inverters must be able to ride thru the voltage disturbance bands of 50% to 90% and 110% to 135%. This is to help stabilize the Utility’s system.

iv. Loss-of-mains is indicated by voltage drop less than 50%.

v. Over voltage and under voltage detection shall be provided for all 3 phases.

4.3.11 Utility interface disconnect switch

Indirect RE System interconnection must incorporate utility interface disconnect switch to allow disconnection of the system output from interconnecting with the Utility for safe utility line works. The requirement of such switch could be referred to Standard Switch. The switch shall be manual and lockable. Load break disconnect switch that:

- Provide clear indication of switch position;
- Visible and accessible to maintenance and operational personnel; and
- Provide visual verification of the switch contact position when the switch is in open position.

4.4 Safety requirements

The installation of grid-connected RE system shall comply with the relevant national and international safety standards. The provisions of this section are aimed at ensuring that system topologies and earthing arrangements are taken into account for the safe operation of the connected system.

4.4.1 Operation

i. It is important that for the safety of operating staff and public, both the Utility and the NEM consumer must coordinate, establish and maintain the necessary isolation and earthing when work and/or tests are to be carried out at the interface/ connection point.

ii. The safety coordination applies to when work and/or test that are to be carried out involving the interface between the distribution network and the indirect Rooftop Solar PV System and it is the responsibility of the Utility and NEM consumer to comply with
the requirements of the statutory acts, regulations, sub-regulations, individual license conditions, Standardized utility’s Safety Rules and the National Grid and Distribution Code.

4.4.2 Interconnection operation manual
Interconnection operation manual (IOM) shall be prepared by the NEM consumer for RE systems over 500 kW.

4.4.3 Labeling
Labels shall be clearly and visibly placed to remind the operator that the device should be accessed with caution as there could be an energized part that comes from the indirect RE generation system.
Annex I: Application Template

i Applicant Information

Please select your consumer category:

- [ ] Domestics/ Residential
- [ ] Commercial
- [ ] Industrial

For Individual Applicants (If Applicable):

<table>
<thead>
<tr>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
</tr>
</tbody>
</table>

| Nationality: |
| National ID: |

| Passport no. (If non Bangladeshi): |
| Telephone:                  | Mobile: |
| Email:                      |

Alternate Contact Person:

<table>
<thead>
<tr>
<th>Name:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
</tr>
</tbody>
</table>

| Relationship: |
| Nationality: |
| National ID: |

| Passport no. (If non Bangladeshi): |
| Telephone:                  | Mobile: |
| Email:                      |

For Non-Individual Applicants (If Applicable):

| Name of the Organization/Company: |

| Registration no.: |
| Trade License no. |
| Address:          |

| Mailing Address (if different): |
Contact Person:
Name: 
Position: 
Address: 

Nationality: 
National ID: 
Passport no.(If non Bangladeshi): 
Telephone: 
Mobile: 
Email: 

### ii Project Information

#### 2.1 Installation Site Address

<table>
<thead>
<tr>
<th>Site Address:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Post code:</th>
<th>District:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Site Ownership:</th>
<th>☐ Fully Owned</th>
<th>☐ Owned (Charged to Bank)</th>
<th>☐ Leased</th>
</tr>
</thead>
</table>

GPS Location of Site Installation:
Latitude: ° ' " Longitude: ° ' "

#### 2.2 Information of Installation

<table>
<thead>
<tr>
<th>Utility:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Billing Account no.</th>
</tr>
</thead>
</table>

Tariff Category: 
Contract no.: 
Installed Capacity: 

#### 2.3 Information of Installation Premise

<table>
<thead>
<tr>
<th>Voltage Level at the Connection Point:</th>
<th>☐ Low Voltage (Single Phase)</th>
<th>☐ Low Voltage (Three Phase)</th>
<th>☐ Medium Voltage (Three Phase-11 kV)</th>
<th>☐ Medium Voltage (Three Phase-33 kV)</th>
</tr>
</thead>
</table>

Voltage at Point of Common Coupling (RE):

For Commercial and Industrial Category ONLY:

Low Voltage: Whole Current <= 100A, Fuse Rating: 
or, LV CT Rating: 

Medium Voltage: MV CT Rating: 

Project Status: ☐ New Project ☐ Existing Project 

Types of Building: ☐ (House/ Shop/ Office/ Others etc.)
Types of Installation:

- □ Rooftop of Building
- □ Car park or Garage
- □ Others:

Use of Battery Storage:  □ Yes  □ No

If yes, please provide detail design:

Battery Capacity:  

Brand and Model:  

Country of Origin

2.4 Technical Information

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Brand</th>
<th>Model</th>
<th>Manufacturer</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>RETs / Module / technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(monocrystalline / polycrystalline/ thin film/ others)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inverter / Power conditioner</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data logger (if installed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.5 Technical Self-Assessment [For Commercial and Industrial Category ONLY]

|                        |       |       |              |        |
| Daytime Peak Demand (09 am to 05 pm): | kWac  |       |              |        |
| Daytime Lowest Demand (09 am to 05 pm): | kWac  |       |              |        |
| Declared Maximum Demand: | kW/ kVA |       |              |        |
| % of Maximum Demand (Proposed RE capacity) | (kW or kWp)/ kVA |       |              |        |

iii Proposed Work Plan

<table>
<thead>
<tr>
<th>No.</th>
<th>Steps</th>
<th>Estimated Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NEM application submission date</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Proposed date for signing of NEM contract</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NEM Commencement Date</td>
<td></td>
</tr>
</tbody>
</table>

iv Supporting Document Checklist

Certified copies of the following documents should be provided in support of this application, where applicable:

<table>
<thead>
<tr>
<th>#</th>
<th>Required Document</th>
<th>Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Applicant Information:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.1 Individual (For Domestic Category)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Applicant's National ID (front and back) / Passport (if foreign person).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Company / Organization / Society / Government Body, where applicable, the documents on (if any):</td>
<td></td>
</tr>
<tr>
<td>i) Company:</td>
<td>Certificate of Incorporation / Trade License</td>
<td></td>
</tr>
<tr>
<td>ii) Organization (Body Corporate):</td>
<td>The certificate from the appropriate authority certifying that the body has been duly constituted under the said written law;</td>
<td></td>
</tr>
<tr>
<td>iii) Organization (Society):</td>
<td>The certificate of registration issued by the ......................;</td>
<td></td>
</tr>
<tr>
<td>iv) Organization (Firm):</td>
<td>The certificate of registration of the firm issued by the ....................; or the letter or certificate relating to the constitution of the firm from bodies regulating the profession in which the firm is practising in;</td>
<td></td>
</tr>
<tr>
<td>v) Organization (Registered Society):</td>
<td>The certificate of registration issued by the ......................;</td>
<td></td>
</tr>
<tr>
<td>vi) Organization (Care Centre):</td>
<td>The certificate of registration of the care centre issued by the ......................;</td>
<td></td>
</tr>
<tr>
<td>vii) Organization (Place of Worship):</td>
<td>The certificate of registration of the place of worship issued by the relevant religious authority; or the certificate of registration of the society in charge of the place of worship issued by the Registrar of Societies and a letter from the relevant local authority confirming that the place of worship has duly obtained a certificate of completion and compliance or certificate of fitness or other applicable approval; or</td>
<td></td>
</tr>
<tr>
<td>viii) Organization (Educational Institution):</td>
<td>The certificate of registration of the educational institution issued by the Ministry of Education or relevant authority; or in the case of religious schools, the certificate of registration of the religious school issued by the relevant religious authority.</td>
<td></td>
</tr>
</tbody>
</table>

ix) Others:

2.0 Site Information:

2.1 Documents proving the Applicant's ownership of the site, or other conditional or unconditional rights (e.g. letter or agreement) that the Applicant has to utilize/lease the site for a minimum period equivalent to the effective period

3.0 Technical Information:

3.1 The detailed engineering design of the renewable energy installation, including all relevant calculations to justify the installed capacity and claimed efficiencies, proposed plant layout and AC/DC single line diagram certified by relevant Competent Person under ......................... and the regulations thereunder

3.2 Report on the Net Energy Metering Assessment Study; Conducted in accordance with the .................................................. (Technical and Operational Requirements)
### 3.3 Product data sheet / technical parameter for all electrical components.
Please provide rating of each electrical components (SPD, fuses, switches, PV modules/ RETs, Inverters)

### 3.4 Form Load Profile (Form LP) - NEM Customer Load Profile

### 3.5 If use battery storage, please provide detail design

### 4.0 Billing Information:
- i) Copy of three (3) months electricity bill (latest);

### 5.0 Competent Person and Electrical Contractor Certificates:

#### 5.1 Mandatory certificates:
- i) A certificate of registration as an Electrical Contractor issued by ............... ;
- ii) A certificate of registration as a Professional Engineer (Electrical) with ................. for each Competent Person;
- iii) A certificate(s) of Competency as a Wireman issued by the ................. for each Competent Person

#### 5.2 Non-mandatory certificates:
- iv) A certificate of Competency in .......... System Design issued by SREDA / ........ for each Competent Person

### 6.0 Others (Please specify):
- i)
- ii)
- iii)
- iv)

### v Applicant Declaration

*To be filled by the Applicant (Individual)*

I, .........................................................................................................................., National ID No./ Passport No.: .............................................................and address:
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................
..........................................................................................................................

... sincerely declare the following:

i. I hereby authorize (name of the Competent Person)  ............................................................. with National ID No./Passport No.: ............................................................. as the Competent Person to act on my behalf to manage my NEM application; OR
I hereby declare myself with National ID No./ Passport No.: ..................................................... as a Competent Person to manage my own NEM application;

ii. I hereby attest that the Competent Person appointed here is a Competent Person within the definition of a Competent Person under ........................................... and the regulations thereunder;

iii. I hereby confirm that I have not committed any offences under the .................................................. and/or any other relevant laws and regulations pertaining to the supply and licensing of electricity;

iv. I hereby certify that all information given is true and correct to my knowledge and belief;

v. I understand and agree that .................................................. will have the right to take any action including to forfeit all initial fees paid, if any of the information given is false; .................................................. shall not be held liable for any loss, damage and inconvenience suffered by me after my application has been approved by ..................................................;

vi. I hereby agree, understand and will comply with all the relevant laws and guidelines applicable to this application; and

vii. For whatever reason if my application is rejected by .................................................. after my application being approved by .................................................., all application fees paid by me or by the authorized Competent Person to .................................................. shall not be refunded.

........................................................................................................................................
Name:
National ID/ Passport no.:
Address:
Date:
Annex II: Net Meter Specification

- Existing single and three whole current meters needs to be replaced by a bi-directional supply meter.
- The existing meter board and its wiring (if required) shall be re-located or replaced by the registered technician appointed by the consumer. The location of the meter shall be accessible to Utility personnel.
- The consumer shall bear all costs associated with the interconnection including the costs of meter replacement, supply upgrading, and system connection/ modification (if applicable).
- The Utility shall use wireless communication mode between the Net Meter and the Headquarter. Location of the meter room shall have adequate reception of wireless signal to enable data transmission. NEM consumer shall provide a signal booster device whenever the communication signal is weak.

Or,

The installed NEM system should have remote monitoring system. The NEM consumer should provide the online monitoring access to the Utility.

(a) Meter for Net Renewable Energy Generation Measurement:

<table>
<thead>
<tr>
<th>#</th>
<th>Technical Parameters</th>
<th>Connectivity at 415V &amp; below voltage level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Whole current meters</td>
</tr>
<tr>
<td>1</td>
<td>Applicability</td>
<td>Plant capacity up to 7 kW</td>
</tr>
<tr>
<td>2</td>
<td>Number of phases and wires</td>
<td>Single phase, 2 wire</td>
</tr>
<tr>
<td>3</td>
<td>Measurand(s)</td>
<td>kWh</td>
</tr>
<tr>
<td>4</td>
<td>Standard voltage and frequency</td>
<td>240 V, 50Hz ± 5%</td>
</tr>
<tr>
<td>5</td>
<td>Current rating</td>
<td>10 - 40</td>
</tr>
<tr>
<td>6</td>
<td>Accuracy Class</td>
<td>1.0</td>
</tr>
<tr>
<td>#</td>
<td>Technical Parameters</td>
<td>Connectivity at 415V &amp; below voltage level</td>
</tr>
<tr>
<td>----</td>
<td>----------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Whole current meters</td>
</tr>
<tr>
<td>1</td>
<td>Applicability</td>
<td>Up to 7 kW sanctioned load</td>
</tr>
<tr>
<td>2</td>
<td>Number of phases and wires</td>
<td>Single phase, 2 wire</td>
</tr>
<tr>
<td>3</td>
<td>Measurand (s)</td>
<td>kWh</td>
</tr>
<tr>
<td>4</td>
<td>Standard voltage and frequency</td>
<td>240 V</td>
</tr>
<tr>
<td>5</td>
<td>Current rating</td>
<td>10 - 40</td>
</tr>
<tr>
<td>6</td>
<td>Accuracy Class</td>
<td>1.0</td>
</tr>
<tr>
<td>7</td>
<td>Export-import feature</td>
<td>Import &amp; export</td>
</tr>
<tr>
<td>8</td>
<td>Communication port/ protocol</td>
<td>Optical/ DLMS</td>
</tr>
</tbody>
</table>

(b) Meter for Net Metering Measurement:

For 100 kW/kWp system the net meter should be connected in 11 kV or in 33 kV system. In that case the NEM consumer should follow the Utility standard.
Annex III: Pre-Feasibility Study Checklist Template

1. **Components used:**
   a. **Solar PV Panels**

<table>
<thead>
<tr>
<th>General Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer (company name, headquarters)</td>
</tr>
<tr>
<td>Brand and Model No.</td>
</tr>
<tr>
<td>Rated Capacity</td>
</tr>
<tr>
<td>Numbers of Panels</td>
</tr>
</tbody>
</table>

   b. **Inverters**

<table>
<thead>
<tr>
<th>General Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer (company name, headquarters)</td>
</tr>
<tr>
<td>Brand and Model No.</td>
</tr>
<tr>
<td>Rated Capacity</td>
</tr>
<tr>
<td>Numbers of Inverters</td>
</tr>
</tbody>
</table>
c. Mounting system:

<table>
<thead>
<tr>
<th>General Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer (company name, headquarters)</td>
</tr>
<tr>
<td>Type, description if applicable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of fastening system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounting location: ☐ flat roof ☐ sloped roof (&gt;5° slope) ☐ facade ☐ open space</td>
</tr>
<tr>
<td>Design: ☐ integrated ☐ parallel ☐ elevated (non-parallel) ☐ tracking</td>
</tr>
<tr>
<td>Fastening system: ☐ weight-loading: ☐ fastening provided ☐ other</td>
</tr>
<tr>
<td>☐ estimated static friction coefficient: ______</td>
</tr>
<tr>
<td>☐ calculated static friction coefficient: ______</td>
</tr>
<tr>
<td>☐ All relevant requirements pertaining to building authority regulations, such as BNBC, building rules lists and technical building specifications have been met.</td>
</tr>
</tbody>
</table>

The dimensioning of the photovoltaic mounting system, including all fasteners and the applied load, has been carried out in accordance with relevant norms and standards as demonstrated by:

☐ separate verification, issued by:

☐ object-specific system calculation / type structural calculation, issued by:

☐ general building authority approval:

| Roof hooks (if applicable) |
d. Cables/ power lines:

<table>
<thead>
<tr>
<th>General information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PV string cable / power line</strong></td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
<tr>
<td><strong>PV main cable / power line (DC)</strong></td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
<tr>
<td><strong>Inverter supply cable / power line (AC)</strong></td>
</tr>
<tr>
<td>Manufacturer</td>
</tr>
</tbody>
</table>

e. Feed-in Management/ communication:

<table>
<thead>
<tr>
<th>General information</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ effective power reduction.</td>
</tr>
<tr>
<td>□ 70% provision □ other provision : ____________%</td>
</tr>
</tbody>
</table>
| Implementation takes place with:
| ☐ permanent inverter settings ☐ feed-in management system |
| ☐ other measures: |
| Type, manufacturer (company name, headquarters) |
| ☐ communication of effective feed-in levels to network operator: |

**Yield protection, system security**

The system has integrated function monitoring capability: ☐ Yes ☐ No

If yes: ☐ with a clearly perceptible alarm system
☐ with remote monitoring capability

The following theft-control measures have been implemented:
☐ theft protection of mounting system/modules through:
☐ theft protection of inverter through:
☐ other measures:

2. **Information regarding planning and installation:**

**General**

☐ The installation of the PV system was carried out in accordance with recognized technical rules and standards.

☐ The PV system was built with minimal shadowing effect.
☐ A shading analysis was incorporated into the yield forecast (required given a notable degree of shading).
**Structural information**

- For roof-mounted systems, the load bearing capacity of the substructure has been assessed by (name of person or firm with contact details):

- For roof-mounted system, the aging condition of the rooftop surface has been assessed by (name of person or firm with contact details):

- The anchoring and load application was carried out in accordance with the manufacturer’s calculatory proofs or the type structural calculations for the mounting structure as well as relevant mounting instructions.

- The fastening of the modules was carried out in accordance with the manufacturer’s guidelines.

- Using alternative means (description, reason):

- Roof perforations were carried out in accordance with technical rules and standards.

<table>
<thead>
<tr>
<th>Height of building:</th>
<th>Wind load zone:</th>
<th>Cable:</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________ m</td>
<td>_______</td>
<td>______</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Edge distances:</th>
<th>Roof ridge:</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________ m</td>
<td>_______ m</td>
</tr>
</tbody>
</table>

**Fire safety measures**

- Smoke and heat exhaustion systems are fully functional.

- Firewalls and fire compartments have been taken into consideration in accordance with fire protection regulations.
Other measures:

**Electrical safety, choice and installation of electrical equipment**

The system and the choice and installation of equipment was installed according to the general provisions of DIN VDE0100 and the specific provisions of VDE 0100-712 and VDE-AR-N 4105, and inspected according to the provisions of E DIN IEC 62446 (VDE 0126-23). Among others, the following specifications were met:

- The RE system's cables and power lines were selected and installed in a way that makes them “earth fault and short circuit safe” in accordance with VDE 0100-520.

- The installation of the inverter(s) with regard to max. input voltage and voltage at the maximum power point (MPP) was carried out in accordance with the manufacturer’s guidelines.

- The location of the installed inverter was chosen in accordance with the manufacturer’s guidelines on heat dissipation and IP protection ratings.

- The cables and power lines used in outside areas have sufficient UV and temperature resistance in accordance with manufacturer’s guidelines for PV systems in outside areas.

- The cables are attached to the frame, have no contact to the surface of the roof and are not routed over sharp edges. If possible, cables have been laid in shaded areas. The necessary strain relief has been ensured at all connection points.

- The circuit breakers used in the direct-current circuit are sufficient according to the manufacturer’s guidelines with regard to the direct-current suitability and load switching capacity.
**Lightning and voltage surge protection**

Note: A PV system does not necessarily require the installation of a lightning protection system, which can be required in compliance with national building regulations or according to the respective contractual situation (e.g. insurance policy).

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Is a lightning protection system required for the building? (building law, risk assessment, VdS)</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td><strong>If no, continue with point 11. Retrofitting is recommended.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Does a test report exist for the lightning protection system?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>3. Was the outside lightning protection system adjusted accordingly?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>4. Have separation distances been calculated?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>5. Have separation distances been observed?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>6. Is the PV generator directly connected to the lightning protection system?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>7. Has lightning protection equipotential bonding been carried out?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>8. Are type 1 DC lightning arresters installed in proximity to the entry point to the building’s string cable?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>9. Is a type 1 lightning arrester installed on the AC-side of the inverter?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>10. Is a type 1 lightning arrester installed at the feed conduit’s building entry point?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>11. Is there a type 2 DC surge arrester installed in front of the inverter on the DC side?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>12. Is there a type 2 surge arrester installed in front of the inverter on the AC side?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>13. Has a type 1-2-3 combination arrester been installed at the feed conduit’s building entry point?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Has equipotential bonding been carried out for the mounting structure?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Note: Separate lightning protection = min. 4 mm² (unprotected cable channels)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined lightning protection = min. 16 mm²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Annex IV: Net Metering Agreement Template

This Agreement is made and entered into at (location) ___________ on this (date) ________ day of (month)______ year _____ between the Consumer, by the name of __________________________ having premises at (address) ______________________________________________ as first party

AND

_____________________________________, (Name of the Utility), Company registered under the Companies Act 1994 (Act XVIII of 1994) and functioning as the "Utility" under the BERC Act 2003 having its Head Office at, __________________________ (hereinafter referred to as ________________ or utility which expression shall include its permitted assigns and successors) as second party.

AND, WHEREAS ___________________________ (name of the consumer) desires to set-up such renewable energy System of _______ kW (or kWp) at ____________________________ connected with (Name of the Utility)’s grid at ______________ Voltage level for his/her/its own use within the same premises.

WHEREAS, the ___________________________ (name of authority) through letter dated _______________ has registered for developing and setting up ________ kW (or kWp) own renewable energy system for his/her/its own use under ____________________________ (name of the policy) at his/her/its premises in legal possession including rooftop or terrace.

And whereas, the Utility agrees to provide grid connectivity to the Eligible Consumer for injection of the electricity generated from his Rooftop Solar PV System of capacity ________ kilowatts Peak (kWp) into the power system of utility and as per conditions of this agreement and in compliance with the applicable Policy/ rules/ Regulations/ Codes (as amended from time to time) by the Consumer which includes-

[List of relevant documents: Utility should determine]

Both the parties hereby agree as follows:

1. Eligibility
   i. The consumer should be eligible as per conditions that are specified in the Section 3.1 of ‘Net Metering Guideline for Renewable Energy Systems’.
   ii. The Eligible Consumer must abide by the generation and electricity export limits regulated in the Section 3.3 of the same document as above.
iii. The Eligible Consumer should agree to abide by the Government regulated rules and eligibility conditions as amended from time to time.

2. Technical and Interconnection Requirement

i. Consumer agrees that his Renewable Energy System and Net Metering System will conform to the standards and requirements specified in the National Policy, Regulations and Grid and Distribution Code as amended from time to time.

ii. Consumer agrees that he has installed or will install, prior to connection of Rooftop Solar Photovoltaic System to Utility’s distribution system, an isolation device (both automatic and inbuilt within inverter and external manual relays) and agrees for the Utility to have access to and operation of this, if required and for repair & maintenance of the distribution system.

iii. Consumer agrees that in case of non-availability of grid, Renewable Energy System will disconnect/isolate automatically and his plant will not inject power into the Utility’s distribution system.

iv. All the equipment connected to the distribution system shall be compliant with relevant International and National Codes and Regulations.

v. Consumer agrees that utility will specify the interface/inter connection point and metering point.

vi. Consumer and utility agree to comply with the relevant regulations in respect of operation and maintenance of the plant, drawing and diagrams, site responsibility schedule, harmonics, synchronization, voltage, frequency, flicker etc.

vii. In order to fulfill utility’s obligation to maintain a safe and reliable distribution system, consumer agrees that if it is determined by the Utility that Consumer’s Renewable Energy System either causes damage to and/or produces adverse effects affecting other consumers or Utility’s assets, Consumer will have to disconnect RE System immediately from the distribution system upon direction from the Utility and correct the problem to the satisfaction of Utility at his own expense prior to reconnection.

viii. The consumer shall be solely responsible for any accident to human being/animals whatsoever (fatal/non-fatal/departmental/non-departmental) that may occur due to back feeding from the Rooftop Solar plant when the grid supply is off. The Utility reserves the right to disconnect the consumer’s installation at any time in the event of such exigencies to prevent accident or damage to man and material.

3. Clearance and Approvals

The consumer shall obtain all the necessary statutory approvals and clearances (environmental and grid connection related) before connecting the photovoltaic system to the distribution system.
4. **Access and Disconnection**
   
i. Utility shall have access to metering equipment and disconnecting means of the RE generation System, both automatic and manual, at all times.

   ii. In emergency or outage situation, where there is no access to the disconnecting means, both automatic and manual, such as a switch or breaker, Utility may disconnect service to the premises of the Consumer.

5. **Liabilities**
   
i. Consumer shall indemnify Utility for damages or adverse effects from his negligence or intentional misconduct in the connection and operation of RE System.

   ii. Utility shall not be liable for delivery or realization by the Consumer of any fiscal or other incentive provided by the Government.

6. **Metering**
   
Metering arrangement and specification should comply with Section 3.6 and ANNEX II of ‘Net Metering Guideline for Renewable Energy Systems’ as amended from time to time.

7. **Commercial Settlement**
   
Commercial Settlement shall follow the regulations as specified in Section 3.4 of ‘Net Metering Guideline for Rooftop Solar PV Systems’ as amended from time to time.

8. **Connection Cost**
   
The Eligible Consumer shall bear all the cost related to setting up of Rooftop Solar Photovoltaic System including metering and inter-connection. The Consumer agrees to pay the actual cost of modifications and upgrades to the service line, cost of upgradation of transformer to connect photovoltaic system to the grid in case it is required.

9. **Inspection, Test, Calibration and Maintenance Prior to Connection**
   
Before connecting, Consumer shall complete all inspections and tests finalized in consultation with the (Name of the Distribution Utility). Consumer shall make available to the Utility all drawings, specifications and test records of the project or generating station as the case may be.

10. **Records**
Each Party shall keep complete and accurate records and all other data required by each of them for the purposes of proper administration of this Agreement and the operation of the Rooftop Solar PV System.

11. Dispute Resolution
   i. All disputes or differences between the Parties arising out of or in connection with this Agreement shall be first tried to be settled through mutual negotiation, promptly, equitably and in good faith.
   ii. In the event that such differences or disputes between the Parties are not settled through mutual negotiations within sixty (60) days or mutually extended period, after such dispute arises, then for:
       a) any dispute in billing pertaining to energy injection and billing amount, it would be settled by the Utility.
       b) any other issues pertaining to the Regulations and its interpretation; it shall be decided by the Ministry of Power, Energy and Mineral Resources following appropriate prescribed procedure or any other entity authorized by Power Division.

12. Termination
   i. The Consumer can terminate agreement at any time by giving Utility 30 (thirty) days prior notice.
   ii. Utility has the right to terminate Agreement with 30 days prior written notice, if Consumer commits breach of any of the terms and conditions of this Agreement and does not remedy the breach within 30 days of receiving written notice from Utility of the breach.
   iii. Consumer shall upon termination of this Agreement, disconnect the Renewable Energy Generation System from Utility’s distribution system within one week to the satisfaction of Utility.
Communication:
The names of the officials and their addresses, for the purpose of any communication in relation to the matters covered under this Agreement shall be as under:

<table>
<thead>
<tr>
<th>In respect of the (Name of Utility):</th>
<th>In respect of the Consumer:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

IN WITNESS WHEREOF, the Parties hereto have caused this Agreement to be executed by their authorized officers, and copies delivered to each Party, as of the day and year herein above stated.

<table>
<thead>
<tr>
<th>FOR AND ON BEHALF OF The Utility</th>
<th>FOR AND ON BEHALF OF The Project Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authorized Signatory</td>
<td>Authorized Signatory</td>
</tr>
<tr>
<td>Witness</td>
<td>Witness</td>
</tr>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
</tbody>
</table>

1.
2.


COMMISSION, ARKANSAS PUBLIC SERVICE. "NET METERING RULES." COMMISSION, ARKANSAS PUBLIC SERVICE, September 11, 2013.


