

# **NET-METERING REFERENCE GUIDE FOR ELECTRICITY CONSUMER AND INSTALLERS**



How to get your solar system connected to  
National Grid in Pakistan for Net Metering



**ALTERNATIVE ENERGY DEVELOPMENT BOARD**

2<sup>nd</sup> Floor, OPF Building G-5/2 Islamabad.

[www.aedb.org](http://www.aedb.org)



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# Glossary

|       |   |
|-------|---|
| AEDB  | Alternative Energy Development Board              |
| CCE   | Connection Charge Estimate                        |
| COC   | Certification of Compliance                       |
| DFI   | Development Finance Institute                     |
| DG    | Distributed Generator                             |
| DISCO | Distribution Company                              |
| EN    | European Standard                                 |
| FESCO | Faisalabad Electric Supply Company                |
| GEPCO | Gujranwala Electric Supply company                |
| HESCO | Hyderabad Electric Supply Company                 |
| IEC   | International Electro-technical Commission        |
| IEEE  | Institute of Electrical and Electronics Engineers |
| IESCO | Islamabad Electric Supply Company                 |
| KW    | Kilowatts   |
| kWh   | Kilowatt hour                                     |
| kWp   | Kilowatt peak                                     |
| LESCO | Lahore Electric Supply Company                    |
| LGU   | Local Government Unit                             |
| MEPCO | Multan Electric Power Company                     |
| MW    | Megawatt  |
| NEPRA | National Electric Power Regulatory Authority      |
| NGO   | Non-governmental organization                     |
| PD    | Power Division, Ministry of Energy                |
| PESCO | Peshawar Electric Supply Company                  |
| PKR   | Pakistani Rupee                                   |
| PV    | Photovoltaic                                      |
| QE    | Qualified End Users                               |
| QESCO | Quetta Electric Supply Company                    |
| QTP   | Qualified Third Party                             |
| RE    | Renewable Energy                                  |
| SBP   | State Bank of Pakistan                            |
| ROI   | Return on Investment                              |
| SEPCO | Sukkur Electric Power Company                     |
| STC   | Standard Test Condition                           |
| TESCO | Tribal Electric Supply Company                    |
| UL    | Underwriters Laboratories                         |

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# 1. Introduction

This guide provides an overview of important points to consider when planning and purchasing a small PV system intended for own consumption. The guide is directed towards the interested parties considering installing a grid-connected photovoltaic system. It attempts to walk the reader through the different stages beginning from the day the idea to buy a PV system is conceived, up to the realization of the PV project. What this user guideline intends is to assure quality and reliable installations. The system can be either a residential PV installation of a household or a larger commercial solar PV system.

## 1.A Background

Pakistan has been facing energy crisis for the past few years as the demand and supply gap has widened. The country's current energy demand far exceeds its generation resources, and facing an energy shortfall of 4000 MW as a result load-shedding and power blackout have become severe issue.

Keeping in mind above issues The Government of Pakistan promotes investment in the generation of small scale distributed renewable energy, through the Alternative Energy Development Board (AEDB), on the basis of net-metering concept.

## 1.B About Net Metering

Net metering is an electricity policy for consumers who own renewable energy facilities which allows them to use electricity whenever needed while getting credit for contributing their production to the grid.

Producing electricity partly for own consumption, and partly for sale to the DISCO, is now available in the Pakistan provided anyone has a roof suitable for solar energy. Solar Energy is a long term power solution. The Solar PV Technology gives access to affordable electricity supply during system life. Residential, industrial, agricultural and commercial customers can switch their electricity load to solar energy and can slash their power bills.

The picture on the next page illustrates the flow of electricity from power generation via high voltage transmission and distribution utilities to the end-user who can now install a renewable energy facility and send the not needed electricity back to the distribution grid and earn credit for his export.



Figure 1.1: Net Metering process

## 1.C Net Metering in Pakistan

The National Electric Regulatory Authority (NEPRA) announced the official Distributed Generation and Net Metering Regulations on September 1<sup>st</sup>, 2015. As per these regulations, any customer of the electric grid (three-phase connections) can avail the possibility of Net Metering for small-scale renewable energies installations.

The net metering mechanism was first introduced in the Policy for Development of Renewable Energy for Power Generation, 2006 (RE Policy). Section 8.4.2 of the RE Policy provides that subject to technical considerations and without discrimination and upon request by distribution end-users, DISCOs shall enter into net-metering agreement with qualified end-users who will be installing the RE system.

NEPRA (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulation 2015 is added in annexes provides for the regulatory regime for net metering in the country.

## 2. How to apply for Net-Metering

This chapter covers the detailed overview of the each step involve in the Net Metering procedure as per NEPRA's Regulation. How to apply for Net Metering services with your DISCOs and how to get Generation license along with the fee involved in the Net Metering Process.

### 2.A Overview and timeline of the Procedure for Net Metering Connections up to 250 kW

The Power Division, Ministry of Energy (MoE) is promoting net metering and intending to provide the services to the customers at their door step. Therefore, MoE has desired that the installers of systems for net metering (DG installers) as shortlisted by AEDB will be required to process the application for net metering on behalf of consumers applying for net metering connections up to 250 kW capacity. MoE seeks that the timelines for various activities to be performed should be shortened and all modalities should be completed within one month of submission of application.

The Flow of steps involve in Net Metering Process along with the timeline for net metering connections up to 250 kW capacity are as follows.

#### 2.A.1 Application for Net Metering

Any applicant who meets the requirement of DG as defined in NEPRA's regulation, submits their application along with the necessary documents to the focal person of the DISCO. Application form is attached at the Annexure and can also be downloaded from NEPRA's website.

Submission of Application



#### 2.A.2 Acknowledgement of application

The DISCO will acknowledge its receipt and inform the applicant whether the application is completed in all respect or not. For the purpose of net metering connections up to 250 kW capacity, NEPRA has relaxed requirement of inspection from Electric Inspector.

Within one (01) working day of receiving application



#### Incomplete application form

In case the application found incomplete, the DISCO will return the application the same day and will ask the applicant to complete the application and re-submit it. The applicant will have to submit the application in complete form to the DISCO office.

Within one (01) working days of being informed

## Initial review

Upon being satisfied that the applicant is complete in all respect, The DISCO office will perform an initial review to determine whether applicant qualifies for interconnection facility and required additional requirements, like comparison between sanctioned load and the size of the system installed.

### 2.A.3 Technical feasibility in initial review

As per DISCOs, for connections up to 250 kW, no technical feasibility study is needed. Power Division, Ministry of Energy has directed the DISCOs to carry out technical studies and approve the connections at the Sub-Division level. In case the initial review reveals that the proposed facility is not technically feasible, the DISCO will return the application and communicate the reason to the applicant.

### 2.A.4 Agreement

If the DISCO office is satisfied that the applicant qualifies as a DG, then the DISCO and the applicant will enter into agreement. Agreement form (Schedule-I) is added in the annexure.

### 2.A.5 Generation license

The DISCO office will send the copy of the agreement between the applicant and the DISCO to the NEPRA along with the application for the issuance of Generation license. NEPRA will issue the Generation Licence within forty hours of submission of application by DISCOs.

### 2.A.6 Connection Charge Estimate

After the agreement DISCO office will issue the Connection Charge Estimate (CCE), if any, to the applicant for the proposed interconnection facility up to the interconnection point including metering installation.

The applicant have the choice either it obtains the bi-directional meter from DISCO or purchased it from

Initial review will be completed in three (03) working days

Within three (03) working days after the completion of initial

Within seven (07) working days of review

Within two (02) working days of signing of agreement

Right after the agreement

private sector manufacturers and get it certified from the concerned DISCO as per technical requirements notified by NTDC.

#### 2.A.7 Payment of CCE

If applicant choose to obtain the meter from concerned DISCO and DISCO has given the notice to the applicant to make the payment of Connection Charge Estimate (CCE), the applicant will pay the same and notify the DISCO office.

#### 2.A.8 Installation of interconnection facility

When the charges will be paid the DISCO office will install and commission the proposed interconnection facility after the confirmation of Generation License to the DG by NEPRA.

## 2.B Overview and timeline of the Procedure for Net Metering Connections above 250 kW

Flow of steps involve in Net Metering Process along with the timeline.

### 2.B.1 Application for Net Metering

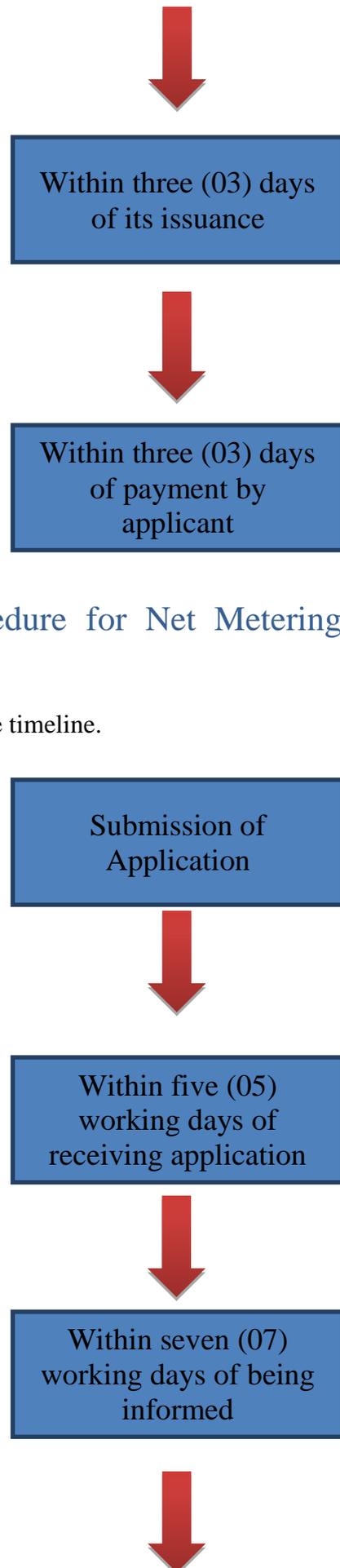
Any applicant, who meets the requirement of DG as defined in NEPRA's regulation, submits their application along with the necessary documents to the focal person of the DISCO. Application form is attached at the Annexure and can also be downloaded from NEPRA's website.

### 2.B.2 Acknowledgement of application

The DISCO will acknowledge its receipt and inform the applicant whether the application is completed in all respect or not.

#### Incomplete application form

In case of any missing information or document, the Applicant has to provide the same to the DISCO office.



### 2.B.3 Initial review

Upon being satisfied that the applicant is complete in all respect, The DISCO office will perform an initial review to determine whether applicant qualifies for interconnection facility and required additional requirements

Initial review will be completed in twenty (20) working days

### 2.B.4 Technical feasibility in initial review

In case the initial review reveals that the proposed facility is not technically feasible, the DISCO will return the application and communicate the reason to the applicant.

Within three (03) working days after the completion of initial

### 2.B.5 Agreement

If the DISCO office is satisfied that the applicant qualifies as a DG, then the DISCO and the applicant will enter into agreement. Agreement form (Schedule-I) is added in the annexure.

Within ten (10) working days of review

### 2.B.6 Generation license

The DISCO office will send the copy of the agreement between the applicant and the DISCO to the NEPRA along with the application for the issuance of Generation license.

Within seven (07) working days of signing of agreement

### 2.B.7 Connection Charge Estimate

After the agreement DISCO office will issue the Connection Charge Estimate (CCE) to the applicant for the proposed interconnection facility up to the interconnection point including metering installation.

Right after the agreement

### 2.B.8 Payment of CCE

The applicant has to make the payment of Connection Charge Estimate (CCE) and notify the DISCO office.

Within twenty (20) days of its issuance

### 2.B.9 Installation of interconnection facility

When the charges will be paid the DISCO office will install and commission the proposed interconnection facility after the confirmation of Generation license to the DG by NEPRA.

Within thirty (30) days  
of payment by  
applicant

### 2.C Fee

Charges to be paid by Distributed Generator for the commissioning of Net Metering at the proposed facility are as follows:

- 1) DG is responsible for all the cost associated with Interconnection Facilities up to the Interconnection Point including metering installation.
- 2) DG is also responsible for any costs reasonably incurred by DISCO in providing, operating or maintaining Interconnection Facilities and Distribution System improvements
- 3) A Distributed Generator have to pay the onetime fee through pay order in the favor of NEPRA for getting Generation license as per following fee Schedule.

| Sr,# | Size of DG facility | Fee to be paid by Applicant |
|------|---------------------|-----------------------------|
| 1.   | 0-20 KW             | Free of Cost                |
| 2.   | 20-50 KW            | Rs. 500/-                   |
| 3.   | 50-100 KW           | Rs. 1000/-                  |
| 4.   | 100-1000 KW         | Rs. 5000/-                  |

Table 2.1: Generation license fee structure



## 3. Interconnection Requirements

This chapter will cover all the requirements and recommendation for getting a Net Metering installed at DG's facility.

### 3.A Initial requirements

When applying for the Net Metering process, DG facility has to fulfill the requirements according to NEPRA's Regulation.

#### 3.A.1 NOC by Electrical Inspector

Before applying for the Net Metering through DISCO, Distributed Generator having facility of size more than 250 kW may follow the suggested process for the getting the NOC by Electrical Inspector

- a. Arrange testing of grounding along with other related requirements by a licensed electrician.
- b. Make a formal written request to concerned Electrical Inspector along with copy of test report.
- c. Electrical Inspector shall detail an individual from his office or visit himself for verification
- d. If satisfied, shall issue the NOC
- e. If not satisfied, shall advise removal of faults /observations
- f. After rectification, repeat the request and get NOC

The NOC by Electrical Inspector is to be attached with the Application for Net Metering for a system above 250 kW capacity.

**NOTE:** The scope of inspection by the Electrical Inspector is not limited to grounding testing only. It includes insulation tests, wiring size suitability and general safety of complete internal wiring. Therefore he may like to check all these elements.

#### 3.A.2 Single line diagram

The protection and control single line diagrams for the interconnection is to be provided by

the DG for the commissioning of Net Metering.

### 3.A.3 Technical standards

As per Regulation by NEPRA, the grid connected inverters shall comply with UL 1741 standard. Other standards for the components are:

- a. IEEE 1547 2003
- b. IEC 61215
- c. EN or other international standards

### 3.A.4 Load flow study

For the Distributed Generators having an installed capacity of more than 500 kW, load flow study (on PSSE software) is compulsory and for the DG facility having capacity less than 500KW load flow study can be carried out using FDRANA

Load flow study for the facility having capacity up to 250kW is not required. Relevant SDO of the concerned DISCO will be approving the studies for such systems.

## 3.B Mandatory safety requirements

According to NEPRA's regulation for Net Metering, mandatory safety requirements for the interconnection facility are to be fulfilled by the applicant. Otherwise the DISCO will declare a technical feasibility in the DG facility in the review.

### 3.B.1 Anti-islanding

Anti-islanding is an in built feature in inverter which trips the flow of energy to the grid on grid failure. Installing an anti-islanding enabled inverter is mandatory by the Regulation for Net Metering.

### 3.B.2 Interconnection disconnect switch

Applicant have to install an interconnection disconnect switch rated for its voltage and fault current requirements which will cut the flow of energy back to the grid if required. That disconnect switch should be locked and can be accessible by both the applicant and the DISCO personnel and shall meet the applicable IEC and IEEE standards.

## 3.C Safety recommendations

Apart from mandatory requirements for the process and installation of net metering, further safety steps has to be consider for the protection of inverters, solar panels, DC wiring and even the mounting frame too.

### 3.C.1 Earthing Protection

A minimum of two separate dedicated and interconnected earth electrodes must be used for

the earthing of the solar PV system support structure with a total earth resistance not exceeding 5 ohms as below:

- a. Equipment earth (DC)
- b. System earth (AC)

### 3.C.2 Lightning and surge protection

Lightning (surge) arrestors are designed to absorb voltage spikes caused by electrical storms and effectively allow the surge to bypass power wiring and your equipment. Applicant have to make sure that DG facility is separately grounded and the lightning arrestors are provided.

Applicant have to install lightning arrestors to get a NOC by electrical inspector

### 3.C.3 Circuit breakers

Fuses and circuit breakers are primarily used to protect the PV system wiring from getting too hot and catching fire. They are also used to protect your devices from becoming more seriously damaged if there is a short circuit. Keep in mind it is also very important to properly size your cables and wires to prevent excessive heat and possible fire.

Wire gauge scale is given in the DC wiring section of chapter 3, that should be considered while installing inverter and circuit breakers should also be installed according to the rating of you panel and wire.

## 3.D Extra precautions

Installation of DG facility requires some additional checks/precautions which are listed below for guidance.

- 1) PV mountings and other metallic structure must be grounded using adequate sized good quality cable. The earth connection must also be tested for its continuity and resistance value to see that grounding is adequate. The preferred ohm value is less than 5 ohms (for small scale home hold system).
- 2) PV modules mountings arrangement should be sturdy, long lasting, galvanized steel or aluminum channels
- 3) The mountings itself should be properly secured with base/floor to ensure it can withstand wind storms and other climatic vagaries.
- 4) The PV modules should be attached to the mountings by stainless steel nut bolts using SS spring washers.
- 5) PV module's electrical cables should not be cut and twisted together for any kind of inter-connection.
- 6) For paralleling PV strings, adequate sized combiner box or other similar accessories

be used.

- 7) The PV module cables should be properly secured using proper sized ties, not tied with metal wire or ordinary string.
- 8) Current carrying cable from PV modules to inverter should be DC cable of proper rating, separate colors to identify plus/minus and in UPVC conduit NOT normal PVC conduit.
- 9) AC circuit breakers should not be used for DC circuits.
- 10) All terminations should be done using proper sized terminal. These terminal should have insulation sleeves and be attached to cables by proper crimping tools.
- 11) The in/out AC to inverters should be properly protected by proper amperage circuit breakers.
- 12) If batteries are used, it is necessary that battery leads and termination should be done using proper size terminals.

## 4. Technical considerations for a solar PV system for Net Metering

The most important decision that one should make when setting up a solar energy plant is selecting what materials to use or in which company we will place the trust throughout the project execution phase. Cost is a critical factor, but we must be fully assured that the system we are installing can be completely adapted to meet project needs and that its long-term durability is guaranteed and the roof is eligible for installation of solar system.

The basic Components of a Solar PV System are:

- Solar Panels
- Inverters
- Batteries
- Mounting structure

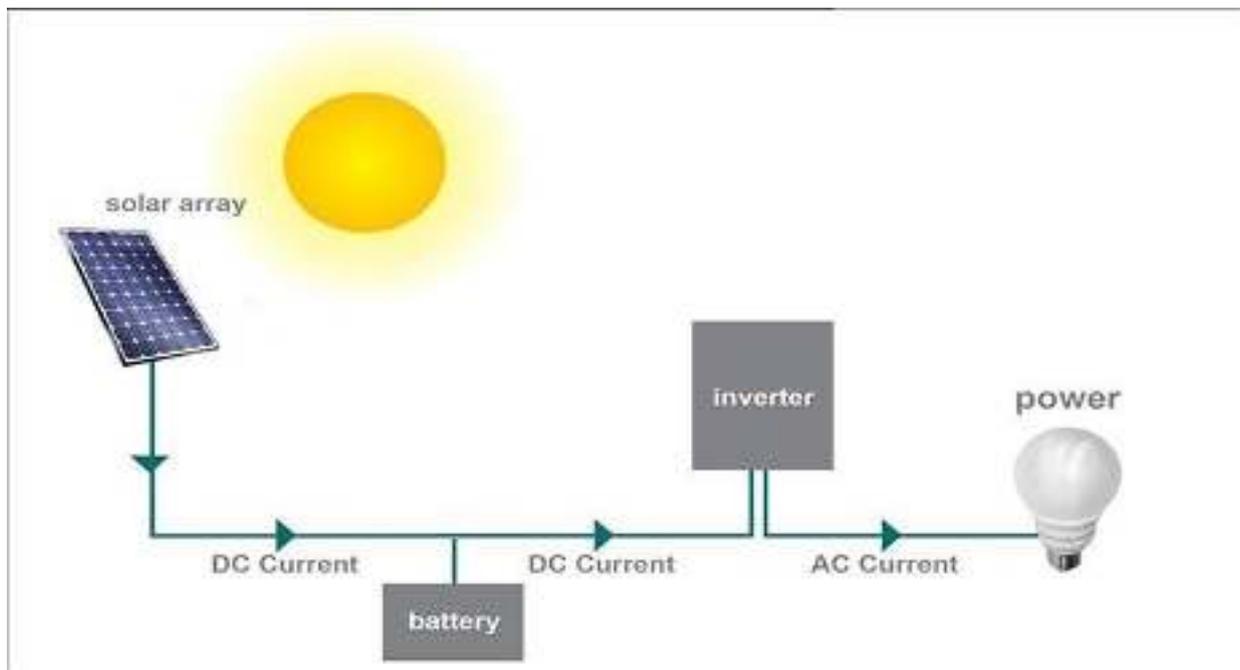


Figure 4.1: Solar PV system

### 4.A Selecting components for Solar system

#### 4.A.1 Type of Solar PV Modules

The solar panels (photovoltaic or PV modules) convert daylight into electricity. A number of modules are connected together to increase the electrical power that can be generated. The entire bank of modules may be referred to as the solar array. There are basic two types of modules in the market.

1. Crystalline silicon modules (c-Si)

2. Thin Film

Crystalline silicon (c-Si) cells have high efficiency rate, high stability, ease of fabrication, and high reliability. Other benefits include high resistance to heat and lower installation costs.

On the other side of the fence, thin-film solar cells are less expensive than older c-Si wafer cells. Available in thin wafer sheets, they are more flexible and easier to handle. They're also less susceptible to damage than crystalline silicon modules (c-Si) but are less efficient



Figure 4.2: Thin Film Module

Figure 4.3: Crystalline Silicon module (c-Si)

When buying a module, it is important to check if the module passes the design qualification (see below the section “test specifications”).

|   |   |
|---|---|
| <ul style="list-style-type: none"> <li>• Manufactured for maximum energy yield per m<sup>2</sup>.</li> <li>• Manufactured mostly with aluminum profile frame which protects glass edges, facilitates mounting, improves statics of modules and can be used for fixation on mounting structures.</li> <li>• Most frames are produced with mounting holes and holes for water discharge.</li> </ul> | <p><b>Crystalline Silicon Modules</b></p> |
|---|---|

Table 4.1: c-Si specifications

|   |                               |
|---|-------------------------------|
| <ul style="list-style-type: none"> <li>• Choose the module with at least 8 years of warranty.</li> <li>• Most manufacturers guarantee a 25-year limited warranty on the power output, usually 90 % of the minimum output power rating of the modules during the first 10 years of operation, and 80 % during the following 15 years. Sometimes, manufacturer provides a warranty stating guaranteed power output of 97 % of the minimum output power rating during the first year of operation and a guaranteed maximum linear degradation of 0.5% p.a. until the 25th year.</li> </ul> | <p><b>MODULE WARRANTY</b></p> |
|---|-------------------------------|

Table 4.2: Module warranty

**Useful Tips:**

- Check the module type with IEC standards and type of warranty.
- Buy modules with measurement record and serial numbers as reference.
- Do not use different rated modules for the system in order to minimize power losses.

**4.A.2 Choosing inverters**

The inverter represents the connection between the photovoltaic system and the public distribution grid. It converts the direct current generated by the PV system into alternate current. Therefore, the inverters have to adapt to the grid frequency (50 Hz) and the voltage (3 phase 400V and single phase 220V for up to 5kW system).

There are grid-connected, stand alone and hybrid inverters. As the name suggests, grid-connected inverters are directly linked to the public electricity grid through the in-house electrical network.

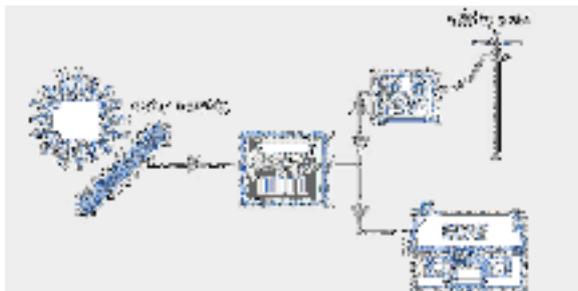


Figure 4.4: Grid connected inverter

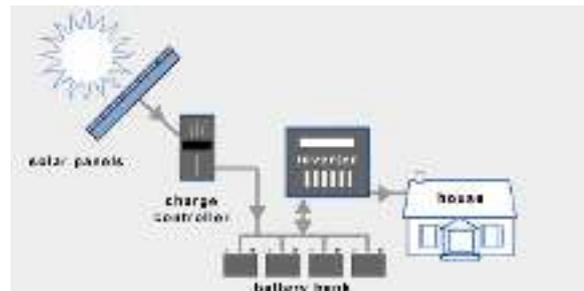


Figure 4.5: Stand-alone inverter

A hybrid solar system combines the best from grid-tied and off-grid solar systems. These systems can either be described as off-grid solar with utility backup power, or grid-tied solar with extra battery storage.

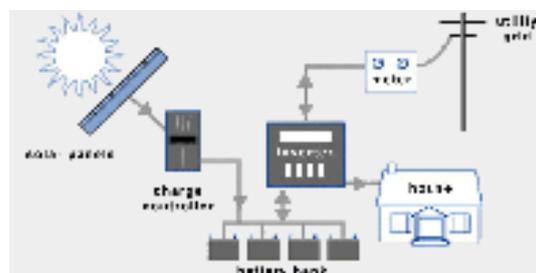


Figure 4.6: Hybrid inverter

- As much as possible, the inverter should be installed near the utility meter. Shorter the DC cabling less will be the power loss of solar system.
- Inverters get slightly warm during their operations. To achieve higher performance, there should be adequate ventilation.

**PLACE  
OF  
INSTALL-ATION**

|   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Always comply with the external conditions demanded by the manufacturer, particularly permissible humidity and ambient Temperature.</li> </ul> |  |
|---|--|

Table 4.3: Placement of inverter

**Useful Tips:**

- Ensure adequate ventilation
- Consider range of permissible ambient temperature for inverter (avoid power limitation due to high temperatures)
- If an inverter is mounted outdoors it has to be protected against rain and insolation.

Renowned inverter’s manufacturers

Below is the list of manufacturers that provides inverters which support Net Energy Metering.

|                 |             |                  |
|-----------------|-------------|------------------|
| ABB             | Fronius.USA | Solectria        |
| Advanced Energy | Growwatt    | Sungrow          |
| APS system      | Satcon      | Sun Power        |
| BAYKEE          | Schneider   | Voltronics Power |
| Delta           | Sharp       | Outback Power    |
| Direct Grid     | SMA-America | Sunfree          |
| Enphase Energy  | Solar Edge  | INVT-Solar       |
| Goodwe          |             |                  |

4.A.3 Choosing batteries

A brief overview of the different types of batteries that may be used in solar electric and backup power systems.

Lead Acid batteries are used in 99 % of the solar system for the backup purpose. New deep-cycled/OpzS and OpzV lead batteries should be preferred.

Deep-cycled batteries are designed to regularly deep discharge using most of its capacity. OpzS and OpzV batteries have tabular plates especially designed for all industrial level applications which demands low-maintenance as well as average and long discharges. The tabular design with lead selenium alloy guarantees best operating life, minimum maintenance and optimal performances in cyclic and standby applications.

By comparing the cost and the performance of the batteries, it is recommended that Lead Acid batteries with deep-cycle should be installed for small PV systems and for the large PV systems OpzS/OpzV batteries should be preferred.

**Useful Tips:**

- On average deep cycled batteries lasts 4-5 years and with good care Lead Acid batteries can even last longer
- A new battery should be checked every few weeks to estimate the acid level.

#### 4.A.4 Selecting mounting systems and warranty

Unlike in the past, manufacturers now offer easy to install mounting systems for flat roofs. For large roofs on industrial and commercial buildings, frames are now generally lightweight, aerodynamic, self-supporting, and without roof penetration challenges.

When installing the modules, no holes should be drilled into the frame. Call your module manufacturer before you drill further holes, as warranty commitment may be invalidated.

#### Penetrating mounting Structure – GI

Low cost compact structure suitable for flat roofs and small to mid-sized installations

- Compact structure for flat roofs made of roll formed GI profiles
- Between 50-70 kg per kW, based on latitude
- Stainless steel fasteners, SS stud bolts for foundations
- Designed to withstand wind gusts of 150 km/h
- Tilt adjustable to latitude
- Area required 8 to 12 square meter without shading.



Figure 4.7: GI mounting structure

#### Fixing of modules

When fixing or clamping the solar panels on the rails of the chosen mounting system the appropriate points have to be considered.

- The weight of the modules is approx. 20 kg per module. Always check the kind of roof surface.
- In case no information is provided by the manufacturer, the module attachment should be along the longer side of the module, at around  $\frac{1}{4}$  of the module length. The pre-drilled module holes are mostly in this part of the frame.

**Useful Tips:**

- Choose a corrosion-resistant and statically tested mounting system.
- Check if chosen mounting system complies with the requirements of module manufacturer.
- Consider maximum local wind loads.
- Structure should be protected by 2 layers of paint i.e. red oxide and galvanized paint for protecting it from corrosion throughout the life of the Solar Panels

#### 4.A.5 DC Wiring

Dc wires should be selected carefully for connecting panel to the inverters. Wires are rated according to the current rating (Amps) that can safely pass along it, higher the current thicker will be the wire. Allow at least 35% margin in the rating of wire and the load. If you are in doubt of your own ability then consult a qualified electrician with knowledge of DC wiring and Solar System.

The distance between inverter and the panel should also be minimum, longer the wire, more likely their will be a chance for voltage drop.

**Useful Tips:**

- One thing to remember though is that the individual runs to all appliances must be connected to a fuse box.
- A breaker should be installed on DC wiring before inverter for safety purpose.

The wire gauge guide on the next page is a quick reference for choosing the correct wire thickness

| AWG     | 12<br>3mm <sup>2</sup> | 10<br>5mm <sup>2</sup> | 8<br>8mm <sup>2</sup> | 6<br>13mm <sup>2</sup> | 4<br>21mm <sup>2</sup> | 2<br>32mm <sup>2</sup> |
|---------|------------------------|------------------------|-----------------------|------------------------|------------------------|------------------------|
| 4 Amps  | 7m                     | 11.1m                  | 17.7m                 | 28.2m                  | 44.9m                  | 71.4m                  |
| 6 Amps  | 4.6m                   | 7.4m                   | 11.8m                 | 18.8m                  | 30m                    | 47.7m                  |
| 8 Amps  | 3.5m                   | 5.6m                   | 8.8m                  | 14.1m                  | 22.5m                  | 35.7m                  |
| 10 Amps | 2.8m                   | 4.4m                   | 7.1m                  | 11.3m                  | 18m                    | 28.5m                  |
| 12 Amps | 2.3m                   | 3.7m                   | 5.9m                  | 9.4m                   | 14.9m                  | 23.7m                  |
| 14 Amps | 2m                     | 3.2m                   | 5.1m                  | 8.1m                   | 12.8m                  | 20.4m                  |
| 16 Amps | 1.7m                   | 2.8m                   | 4.5m                  | 7m                     | 11.2m                  | 17.8m                  |
| 18 Amps | 1.6m                   | 2.5m                   | 4.0m                  | 6.3m                   | 10m                    | 15.9m                  |
| 20 Amps | 1.4m                   | 2.2m                   | 3.6m                  | 5.6m                   | 9m                     | 14.3m                  |
| 25 Amps | 1.1m                   | 1.8m                   | 2.9m                  | 4.5m                   | 7.2m                   | 11.4m                  |
| 30 Amps | 0.9m                   | 1.4m                   | 2.4m                  | 3.7m                   | 6m                     | 9.5m                   |
| 35 Amps | 0.8m                   | 1.29m                  | 2m                    | 3.2m                   | 5.1m                   | 8.1m                   |
| 40 Amps | 0.7m                   | 1.1m                   | 1.8m                  | 2.8m                   | 4.5m                   | 7.1m                   |

Table 4.4: Reference wire gauge

## 4.B Sizing of PV system

### 4.B.1 House hold solar system

The electrical power of a PV system is measured in kilowatt peak (kWp) and refers to the maximum power under standard test conditions (STC). For the installation of a 1 kWp power plant, you will need an area of about 10 m<sup>2</sup>. If you have a small roof area, you may want to choose solar modules with higher efficiency.

Remember that only a portion of your household electricity demand will be covered by the PV system. It is therefore important to get a rough estimate of the overall power of the PV system obtained - based on the space allowed on your roof – and match the PV energy output with your consumption.

Solar allows you to reduce your consumption during the daytime. It is essential to improve the demand profile of your home by utilizing the loads whenever the PV system delivers a lot of electricity and reaches peak capacity. Managing your load this way will reduce the peak demand for electricity.

## 4.B.2 Commercial and industrial scale PV system

The installation of a PV system is a good investment, which can provide higher returns than a savings deposit

Larger PV systems for commercial use will make sense if you can arrange loads to coincide with high solar generated electricity.

In the case that the owner of the building is the operator of the PV system, it can be considered to include the solar roof top in the property insurance.

## 4.C How to recognize a good offer from Installer

The first question to ask is: Where will I find a good PV installation company? System installation can be found by advertisements in printed media and internet search. Websites of the companies providing solar installation service can be easily searched and there are some solar associations in Pakistan as per the list provided in chapter 7.

Sometimes, component providers and its local distributors frequently offer lists of authorized installers of their Components.

It is recommended that when choosing a vendor/supplier select the one which offers the installation of the PV system along with the application process for Net Metering on consumer's behalf.

### 4.C.1 Commercial, Agricultural and Industrial scale PV system

In order to compare different offers, it is necessary that all basic items are listed. Some components can be a useful add-ons, but not critical to the operations of the PV system - like a data logger, an operation and maintenance contract, warranty extensions and insurance policy for the PV system.

In case of comparable offers, a local company is preferable. Another useful aspect to consider is the possible date of installation of the PV system.

The quote for the PV installation should also include an estimate of cost-effectiveness. This calculation has to be based on the expected yield, the electricity demand and the achievable degree of self-consumption. Besides, the energy produced which is not consumed onsite and is fed into the grid will be credited to the next billing cycle.

## 4.D Important aspects considering the installation

### 4.D.1 Quality aspects of installation and mounting

On flat roofs, protection mats should be provided as an installation foundation, as these protect the roof membrane. Enough space should be provided in between PV arrays for accessibility in times of servicing and repair purposes. The commissioning of the PV system has to be carried out by a registered electrician. During the commissioning a protocol has to

be written by the PV plant installer. This document points out important data about the PV plant and records measured electrical values.

#### 4.D.2 Quality assurance during operation time

The installer should offer a warranty on construction works for a certain period of time (at least one year). This has to be reviewed with the installer and should form part of the documentation of the PV plant. The inverter should be checked on a regular basis (on vision panel or data logger).

#### 4.D.3 Maintenance of the PV system

For maintenance measures by the PV plant owner, regularly monitor the performance to avoid disruptions. Maintenance work consists mainly on control of operational readiness of the system in order to rapidly resolve any failures. Operational manual for the inverter and a documentation of the installation provided by the installer are necessary for maintenance.



## 5. Financing solar system

Solar Technology is characterized by high capital cost requirements but have a low operating cost and a long service life. The ability to finance a solar system eases up the burden on the initial cost of procuring the system and spreads this cost over the long term while the system is already generating savings on electricity costs. This makes solar affordable to more users who cannot afford to pay upfront for the system in a single payment.

### 5.A State bank of Pakistan Financing Scheme for Renewable Energy

According to SBP Financing scheme, consumer (domestic, commercial or industrial) willing to install RE facility ranging from 4kW to 1 MW considering that the consumer is eligible as per NEPRA's regulation will be provided with the financing facilities through all commercial banks and DFIs on first come first served basis.

Consumers have to pay back the loan in tenor of ten (10) years in monthly/quarterly installment with 6% or higher (rate applicable on the date of starting the process) mark-up following any specific condition imposed by the banks or DFI.

Any commercial bank or DFI affiliated with the SBP can be contacted for any further queries regarding RE financing scheme.



## 6. FAQs

Basic questions about Net Metering Process, Policy, Regulation and standards will be addressed in this Frequently Asked Question section.

### 6.A About Net Metering

Q1. What is net-metering?

A1. Net-metering allows customers of Distribution Companies (DISCOs) to install an on-site Renewable Energy (RE) facility not below 1 kilowatts (kW) and not exceeding 1 megawatts (MW) in capacity so they can generate electricity for their own use. At the end of each Billing Cycle the DISCO will net off the off-peak kWh supplied by DG against the kWh supplied by DG.

Q2. Is net-metering already available in the Pakistan?

A2. On 1 Sep 2015, the National Electric Power Regulatory Authority adopted Regulation of Generation, Transmission and Distribution of Electric Power Act 1997 section 7(1), approving the Rules & Regulations enabling the Net-Metering Program for Renewable Energy. Thus, the Net-Metering Rules took effect in the Pakistan on Sep 01, 2015.

Q3. What types of power generating facilities are eligible for net-metering?

A3. RE facilities such as Solar, and Wind energy systems not exceeding 1 MW in power generating capacity, capable of being installed within the customer's premises, are eligible to participate in the net-metering program.

### 6.B Eligibility criteria for Net Metering

Q4. Who are qualified to participate in the net-metering program?

A4. Any person who meets the requirements of a Distributed Generator as defined under the regulations 2(k) in NEPRA net metering rules qualifies to participate in the net-metering Program.

2(k): "Distributed Generator" means a distribution Company's 3 phase 400v or 11kV consumer i.e. domestic, commercial or industrial and who owns and/or operates the Distribution Generation Facility, and is responsible for the rights and obligations related to Agreement and licensed by Authority under these regulations.

Q5. If I am a customer getting my power supply from a Bulk supplier like Bahria Town, am I qualified to participate in the net-metering program?

A5. NEPRA's Rules and Regulations clearly stated that the consumers of Distribution

Company are qualified for the net metering process. In case of Bahria town it buys electricity from IESCO and distributes it to the consumers, which makes it a Distribution Company.

So any consumer who is getting electricity from a bulk supplier is qualified for the net metering process.

Q6. If I am a customer directly-connected to the transmission grid, am I qualified to participate in the net-metering program?

A6. No. Customers directly-connected to the transmission grid are not DISCO's customers but are transmission load customers of the National Transmission & Despatch Company (NTDC).

## 6.C How Net Metering works

Q7. How will my DISCO meter import and export energy?

A7. The DISCO will install a single bi-directional meter that can both import and export energy. The DISCO may also opt to install two uni-directional meters – one to meter the energy you buy from your local DISCO, and the other to meter the energy you export to the DISCO.

Q8. Who will get the energy I am exporting through my meter?

A8. On average, only 20-40% of a solar energy system output goes into the grid. Exported solar electricity mostly serves nearby customer's loads.

## 6.D Benefits of Net Metering

Q9. What benefit will I get if go into net-metering?

A9. By generating electricity for own use, you reduce the amount of electricity you buy from your local DISCO. The rate of savings on electricity generated for own use is equivalent to the DISCO's retail rate consisting of charges for generation, transmission, system loss, distribution, subsidies, taxes and other charges.

You also get credit on your electricity bill of next billing cycle on any excess electricity exported to the DISCO equivalent to the DISCO's blended generation cost, excluding other generation adjustments

Q10. Would the energy I export to the grid will be subtracted from the energy I will be importing from the grid?

A10. Customer will receive monthly net export/import bill indicating either net export to the grid or net import from the grid in case of net import bill, the DG will be billed for net kWh in accordance with the applicable tariff.

- Q11. What if the energy exported exceeds the energy I import?
- A11. In this case the net kWh will be credited against DG's next billing cycle for consumption.
- Q12. Will I ever get paid in PKR by the DISCO for exporting excess energy to the grid?
- A12. If the DG is receiving a net export bill each month, then the DISCO will pay for the net export energy as per off peak rate in PKR quarterly (every 3 months).
- Q13. If I install a PV plant on my own without using net metering, what difference does it make?
- A13. If a customer has a rooftop PV system, it may at certain times of the day generate more electricity than it uses during the daylight hours. If the home is net-metered, the electricity meter will run backwards to provide a credit against what electricity is consumed at night or other periods where the home's electricity use exceeds the system's output.

## 6.E RE system for Net Metering

- Q14. What is the optimum size of an RE facility should I install in my premises?
- A14. If you consume all of your RE production, you avoid 100% of the retail rate of your electric bill.

For a RE facility like a solar system, the optimum capacity that you should install in your premises should not exceed your daytime peak demand for electricity so that you can maximize your savings/avoided cost on electricity, and shorten to the extent possible the payback period of your investment in the solar roof top facility.

## 6.F Economics of Net Metering

- Q15. At what rate will the DISCO buy energy generated by my system?
- A15. Off-peak rate, as determined by NEPRA from time to time, is applicable as your tariff rate for sale of electricity to the DISCO. You could check your off-peak rate from the utility bill issued by your DISCO.
- Q16. How long will it take to return my investment?
- A16. Payback period in case of residential system is 6 to 7 years, depends upon the rating and type of the system (with or without battery backup) and hours of load-shedding. And in case of commercial and industrial scale system, Payback period can even drop to 5 years

## 6.G Post installation

Q17 What if I want to modify my DG facility?

A17 If you are planning for any modification of material at your DG facility, you have to notify the DISCO providing at least forty working days of advance notice.

Q18 What if I want to terminate the Net Metering Process?

A18 If the Distributed Generator wants to discontinue the selling of electricity to the DISCO, Distributed Generator should send a thirty days advanced notice to the DISCO in order to terminate the agreement between Distributed Generator and DISCO.

## 7. List of useful links and organizations

This chapter provides a listing of government and private organizations directly or indirectly connected to Energy/RE sector in Pakistan

### 7.A National Electric Power Regulatory Authority (NEPRA)

Director Customer Affair

Address: NEPRA Tower Attaturk Avenue (East), Sector G-5/1,  
Islamabad, Pakistan

Website: [www.nepra.org.pk](http://www.nepra.org.pk)

Tel: +92 51 2013200 Fax: +92 51 2600021

Email: [cad@nepra.org.pk](mailto:cad@nepra.org.pk)

### 7.B DISCOs in Pakistan

#### Faisalabad Electric Supply Company (FESCO)

Address: West Canal Road, Abdullah Pur, Faisalabad

Website: [www.fesco.com.pk](http://www.fesco.com.pk)

Tel: +92- 41- 9220184-9220229

Fax: 041-9220233

#### Gujranwala Electric Power Company (GEPCO)

Address: 565/A, Model Town, Gujranwala

Website: [www.gepco.com.pk/](http://www.gepco.com.pk/)

Tel: (055) 9200995

Fax: 055-9200122

Email: [ceogepeco@yahoo.com](mailto:ceogepeco@yahoo.com)

#### Hyderabad Electric Supply Company (HESCO)

Address: WAPDA Complex, Hussainabad,  
Hyderabad, Pakistan

Website: [www.hesco.gov.pk/](http://www.hesco.gov.pk/)

Tel: 022-9260025, 361

Email: [psoc\\_ceilhesco@yahoo.com](mailto:psoc_ceilhesco@yahoo.com), [akhtaralirandhawa@gmail.com](mailto:akhtaralirandhawa@gmail.com)

#### Islamabad Electric Supply Company (IESCO)

Address: St, 40, Sector G-7/4

Islamabad, Pakistan

Website: [www.iesco.com.pk](http://www.iesco.com.pk)

Tel: 051-9252937, 9252938, 9252939

Email: [ceo@iesco.com.pk](mailto:ceo@iesco.com.pk)

### K-Electric

Address: KE House, 39-B, Sunset Boulevard, Phase-II, DHA, Karachi, Pakistan

Website: [www.ke.com.pk](http://www.ke.com.pk)

Tel: 92-21-3263 7133, 92-21-3870 9132

Fax: 021-213-9205192

Email: [customer.care@ke.com.pk](mailto:customer.care@ke.com.pk)

### Lahore Electric Supply Company (LESCO)

Address: 22/A Queens Road

Lahore, Pakistan

Website: [www.lesco.gov.pk](http://www.lesco.gov.pk)

Tel: 99204820-30, Ext: 100

Fax: 042-39203148

Email: [ceo@lesco.gov.pk](mailto:ceo@lesco.gov.pk)

### Multan Electric Power Company (MEPCO)

Address: MEPCO HQ, Khanewal Road

Multan, Pakistan

Website: [new.mepco.com.pk](http://new.mepco.com.pk)

Tel: 061-9220222

Fax: 061-9220204

Email: [rashid.tariq@mepco.com.pk](mailto:rashid.tariq@mepco.com.pk), [ceo\\_mepco@yahoo.com](mailto:ceo_mepco@yahoo.com),

### Peshawar Electric Supply Company (PESCO)

Address: 166 Wapda House, Shami Rd

Peshawar, Pakistan

Website: [pesco.gov.pk](http://pesco.gov.pk)

Tel; 9211990, 9212041-47 Ext 214

Email: [info@pitc.com.pk](mailto:info@pitc.com.pk)

### Quetta Electric Supply Company (QESCO)

Address: Main Zarghoon Road, Beside CCPO Office

Quetta Cantt, Pakistan

Website: [www.qesco.com.pk](http://www.qesco.com.pk)

Tel: 081-9202211

Fax: 0812836554

Email: [ceo\\_qesco@yahoo.com](mailto:ceo_qesco@yahoo.com)

### Sukkur Electric Power Company (SEPCO)

Address: Head Office St, 40

Sukkur, Pakistan

Website: [www.sepeco.com.pk](http://www.sepeco.com.pk)  
Tel: 071-9310795  
Fax: 071-9310801  
Email: [ceo\\_speco@yahoo.com](mailto:ceo_speco@yahoo.com)

### Tribal Electric Supply Company (TESCO)

Address: 213-Mini WAPDA House, Shami Road,  
Peshawar, Pakistan  
Website: [www.tesco.gov.pk](http://www.tesco.gov.pk)  
Tel: 091-9212964  
Fax: 091-9212950  
Email: [contact@tesco.gov.pk](mailto:contact@tesco.gov.pk)

## 7.C Private Solar Associations in Pakistan

### Renewable & Alternative Energy Association of Pakistan (REAP®)

Mir Ahmad Shah  
Executive Secretary  
Address: Plot No. 140, Street No. 9, Sector I-10/3  
Islamabad, Pakistan.  
Website: [www.reap.org.pk](http://www.reap.org.pk)  
Cell: +92-300-5221718  
Tel: +92-51-4100084  
Email: [write@reap.org.pk](mailto:write@reap.org.pk)

### Pakistan Solar Association (PSA)

Address: 09-Egerton Road, Lahore, Pakistan  
Website: [www.pakistansolarassociation.org/](http://www.pakistansolarassociation.org/)  
Tel: +92 320 8180180  
E-mail: [info@pakistansolarassociation.org](mailto:info@pakistansolarassociation.org)



TO BE PUBLISHED IN THE GAZETTE OF PAKISTAN  
EXTRAORDINARY, PART-II

**National Electric Power Regulatory Authority (NEPRA)**



**NOTIFICATION**

Islamabad, the 1<sup>st</sup> day of September, 2015

S.R.O 892 (1)/2015.— In exercise of the powers conferred by section 47 read with section 7 (1) of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 (XL of 1997), the National Electric Power Regulatory Authority, is pleased to make the following Regulations to establish a framework for the regulation of Distributed Generation by using alternative and renewable energy and net metering, namely: -

**1. Short title, commencement and application.** — (1) These Regulations may be called the National Electric Power Regulatory Authority (Alternative & Renewable Energy) Distributed Generation and Net Metering Regulations, 2015.

(2) They shall come into force at once.

**2. Definitions.** - (1) In these Regulations unless there is anything repugnant in the subject or context,—

- (a) "Act" means the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 (XL of 1997)
- (b) "Agreement" means the agreement between the Distribution Company and the Distributed Generator on the Authority's approved format as per **Schedule I**;
- (c) "Applicable Documents" means the rules and regulation issued in pursuance of the Act by the Authority, from time to time, the generation, distribution and transmission licences, the Grid and Distribution Codes and any documents, instruments, approvals, directions or authorizations issued or granted by the Authority in exercise of its powers under the Act and any document in each case of a binding nature applicable to the licensee;
- (d) "Applicable Tariff" means tariff approved by the Authority for the relevant period and category of consumers of the Distribution Company;
- (e) "Applicant" means a consumer of a Distribution Company which submits an Application to interconnect its Distributed Generation Facility to the Distribution

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System of the Distribution Company and who applies for grant of the license to operate a Distributed Generation Facility as a Distributed Generator;

- (f) "Application" means the application submitted by an Applicant to Distribution Company, for interconnection of a Distributed Generation Facility to the Distribution System of a Distribution Company and includes application for grant of license to the Authority;
- (g) "Authority" means the National Electric Power Regulatory Authority established under the Act;
- (h) "Billing Cycle" means energy recorded by the meters in a period of thirty days;
- (i) "Distributed Generation Facility" means a facility set up by a Distributed Generator using Solar or Wind energy resource for generation of electricity up to 1 MW;
- (j) "Distributed Generation" means electrical power generation by solar or wind that is interconnected to the Distribution System of the Distribution Company at Interconnection Point;
- (k) "Distributed Generator" means a Distribution Company's 3 phase 400V or 11kV consumer i.e. domestic, commercial or industrial and who owns and/or operates the Distributed Generation Facility, and is responsible for the rights and obligations related to the Agreement and licensed by the Authority under these Regulations;
- (l) "Distribution System" means the distribution facilities situated within the Service Territory owned or operated by the licensee for distribution of electric power including, without limitation, electric lines or circuits, electric plant, meters, interconnection facilities or other facilities operating at the distribution voltage, and shall also include any other electric lines, circuits, transformers, sub-stations, electric plant, interconnection facilities or other facilities determined by the Authority as forming part of the distribution system, whether or not operating at the distribution voltage;
- (m) "Fault" means an equipment failure, conductor failure, short circuit, or other condition resulting from abnormally high or low amounts of current from the power system;
- (n) "Grid Code" means the guidelines, standards and procedures of technical and commercial aspects for the access, use and operation of transmission system and transmission facilities of NTDC as modified and approved by Authority from time to time;
- (o) "Interconnection Facilities" means the equipment, including, without limitation, electrical lines or circuits, transformers, switch gear, safety and protective devices, meters or electrical plant, used for interconnection services;

- (p) "Interconnection Point" means the point where the metering, installation and protection apparatus of the Distributed Generator is connected to the Distribution System of the Distribution Company;
- (q) "kWh" means kilowatt hour;
- (r) "MW" means megawatt;
- (s) "Net Energy Billing" means a billing and metering practice under which a Distributed Generator is billed on the basis of net energy over the billing cycle;
- (t) "Net Energy" means a balance (positive or negative) of the kWh generated by Distributed Generator against the kWh supplied by Distribution Company at the end of Billing Cycle;
- (u) "Net Metering Facility" means a facility comprising of one or two meters for measuring the kWh generated by Distributed Generator and supplied by Distribution Company for determining the net energy;
- (v) "Registrar" means a person designated by the Authority to register and record the receipt of communications, applications and petitions filed with the Authority and to perform such other duties under these Regulations as may from time to time be assigned by the Authority; and
- (w) "Tariff" means the rates, charges, terms and conditions for sale of electric power to consumers as approved by the Authority and duly notified by the Federal Government from time to time.

2) The words and expressions used but not defined in these Regulations shall have the same meaning as are assigned to them in the Act.

## **APPLICATION AND INTERCONNECTION PROCESS**

### **3. Application Process for Interconnecting Distributed Generation Facility.—**

(1) Any person who meets the requirements of a Distributed Generator as defined under the regulations 2(k) is eligible for submitting application as specified in **Schedule-II** to a Distribution Company.

Provided that the Distribution Company shall be bound to provide information and Authority's approved documents in response to the request from Applicant free of cost within two working days.

(2) Application to Distribution Company along with necessary documents shall be submitted by intending Distributed Generator to Distribution Company.

(3) Within five working days of receiving an Application, the Distribution Company shall acknowledge its receipt and inform the Applicant whether the Application is completed in all

respect.

Provided that in case of any missing information or documents the Applicant shall provide the same to Distribution Company within seven working days of being informed by Distribution Company.

(4) Upon being satisfied that the Application is complete in all respect, the Distribution Company shall perform an initial review to determine whether the Applicant qualifies for Interconnection Facility, or may qualify subject to additional requirements.

Provided that the initial review shall be completed within twenty working days.

(5) In case the initial review reveals that the proposed facility is not technically feasible, the Distribution Company shall return the Application and communicate the reasons to the Applicant within three working days after the completion of initial review.

(6) If the Distribution Company is satisfied that the Applicant qualifies as Distributed Generator, then the Distribution Company and the Applicant shall enter into an Agreement within ten working days and Distribution Company shall send a copy of the Agreement to the Authority within seven working days of the signing of the Agreement.

(7) Within seven working days of execution of the Agreement, the Distribution Company shall issue the Connection Charge Estimate to the Applicant for the proposed interconnection facility up to the Interconnection Point including the metering installation.

(8) The Applicant shall make the payment of Connection Charge Estimate within twenty days of its issuance.

(9) The Distribution Company shall install and commission the proposed interconnection facility within thirty days of the payment of demand notice by the Applicant.

Provided that the net metering arrangement shall commence upon grant of license to the Distributed Generator in accordance with Regulation 4 of these Regulations.

**4. Licensing.**– (1) Notwithstanding anything contained in NEPRA Licensing (Application and Modification Procedure) Regulations, 1999 any consumer who enters into an Agreement with the Distribution Company under net metering arrangement qualifies for grant of a Distributed Generator License.

(2) Distribution Company shall forward the Application for grant of License as specified in **Schedule -III** to the Authority along with following;

- (a) Agreement
- (b) Application for exemption from the requirement of section 24 of the Act as specified in **Schedule-IV**,
- (c) Evidence of deposit of fee as may be specified by the Authority as specified in **Schedule-V**
- (d) Affidavit by Distributed Generator as specified in **Schedule-VI**

(3) The Authority may, on receipt of the Application and the documents specified in sub-regulation (2), grant a license as specified in **Schedule VII** to the Applicant.

**5. General Powers, Rights and Obligations of the Distribution Company.—** (1) A Distribution Company shall.—

- (a) allow any of its consumers to establish Distributed Generating facilities to be interconnected with its Distribution System using either (a) a standard meter capable of registering the flow of electricity in two directions, or (b) two separate meters one for selling electricity to the Distribution Company and other for purchasing electricity from the Distribution Company.
- (b) enter into an Agreement with the Distributed Generator, and shall grant interconnection approval under Regulation 3 (6) after following due process

Provided that the approval of interconnection facility shall not be unreasonably withheld.

- (c) have the right to review the design of a Distributed Generation Facility and Interconnection Facilities and to inspect the same prior to the commencement of parallel operation with its Distribution System and may require the Distributed Generator to make modifications as necessary to comply with the requirements of these Regulations.

- (2) A Distribution Company may limit the operation and/or disconnect or require the disconnection of a Distributed Generation Facility from its Distribution System at any time, with or without notice, in the event of Fault.

- (3) A Distribution Company may also limit the operation and/or disconnect or require the disconnection of Distributed Generation Facility from its Distribution System upon the provision of thirty days written notice for the conditions which include as follows:

- a) To allow for routine maintenance, repairs or modifications to the Distribution System of the Distribution Company;
- b) Upon Distribution Company's determination that Distributed Generation Facility is not in compliance with these Regulations;
- c) Upon termination of the Agreement.

**6. Rights and Obligations of the Distributed Generator.—** (1) A Distributed Generator shall operate and maintain its Distributed Generation Facility and Interconnection Facilities in accordance with prudent electrical practices.

- (2) The Distributed Generator shall not have any right to utilize Distribution Company's Interconnection Facilities for the sale of electricity to any other person.

**Terms of Agreement, Termination of Agreement and Dispute Resolution**

**7. Term of Agreement.—** (1) The term of the Agreement between Distributed Generator and Distribution Company shall be three years with effect from commissioning of Distributed Generator Facility.

- (2) At the expiry of initial term, the Agreement may be automatically renewed by the mutual understanding between the Distributed Generator and the Distribution Company for another

term of three years and so on.

**8. Termination of Agreement.**— (1) The Distributed Generator may terminate the Agreement upon thirty days written notice if the Distributed Generator decides to discontinue the sale of electricity to the Distribution Company.

(2) The Distribution Company shall not terminate the Agreement in any event without prior approval of the Authority.

(3) All rights and obligations accrued up to termination shall continue in force upon termination.

### **DISTRIBUTED GENERATION FACILITY DESIGN AND OPERATING REQUIREMENTS**

**9. Protection Requirements.**— (1) The protection and control diagrams for the interconnection of the Distributed Generator shall be in accordance with the provisions of the Grid and Distribution Codes and approved by the Distribution Company prior to commissioning of the proposed Interconnection Facilities and a typical single line diagram as specified in **Schedule-VIII**.

(2) The Distributed Generator shall be responsible for the installation of equipment, including, without limitation, electrical lines or circuits, transformers, switch gear, safety and protective devices, meters or electrical plant, to be used for interconnection.

Provided that, if the Distributed Generator is unable to install equipment, including, without limitation, electrical lines or circuits, transformers, switch gear, safety and protective devices, meters or electrical plant, used for interconnection, the Distribution Company may execute the requisite work in case the Distributed Generator offers to deposit the cost to be incurred on the requisite work at mutually agreed terms.

(3) The protective functions shall be equipped with automatic means to prevent reconnection of the Distributed Generation Facility with the Distribution facilities of the Distribution Company;

Provided that the service voltage and frequency is of specified setting and is stable and mutually agreed between the Distribution Company and the Distributed Generator.

(4) The Distributed Generator will furnish and install a manual disconnect device that has a visual break to isolate the Distributed Generation Facility from the Distribution facilities.

(5) The grid connected inverters and generators shall comply with Underwriter Laboratories UL 1741 standard (Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources) which addresses the electrical interconnection design of various forms of generating equipment, IEEE 1547 2003, IEC 61215, EN or other international standards.

**10. Prevention of Interference.-** (1) The Distributed Generator shall not operate such equipment that superimposes upon the Distribution System a voltage or current that interferes with Distribution Company's operations, service to its consumers, or communication facilities.

(2) In the event of such interference, the Distributed Generator must diligently pursue and take corrective action at its own expense after being given notice and reasonable time to do so by the Distribution Company.

(3) On account of any failure on part of the Distributed Generator to take timely corrective action, the Distribution Company may, without liability, disconnect the Distributed Generation facility from the Distribution System, in accordance with these Regulations.

**11. Voltage and Frequency Range.-** A variation of  $\pm 5\%$  and  $\pm 1\%$  is permissible to the nominal voltage and frequency respectively.

## **INTERCONNECTION FACILITY FINANCING**

**12. Responsibility for Costs of Interconnecting a Distributed Generation Facility.—**

(1) A Distributed Generator shall be responsible for all costs associated with Interconnection Facilities up to the Interconnection Point including metering installation.

(2) The Distributed Generator shall also be responsible for any costs reasonably incurred by Distribution Company in providing, operating, or maintaining Interconnection Facilities and Distribution System improvements required solely for the interconnection of the Distributed Generation Facility with Distribution Company's Distribution System.

(3) In case of non-availability of meter(s) with Distribution Company, the Distributed Generator may procure such meter(s) directly subject to testing by Distribution Company, before installation.

## **NET ENERGY METERING SERVICES**

**13. Metering Requirements.—** (1) The equipment installed for net metering shall be capable of accurately measuring the flow of electricity in two directions.

Provided that in case two separate meters are installed, the net energy metering calculation shall yield the same result as when a single meter is used.

(2) The Net Energy Metering Facility, shall meet all safety and protection requirements that are necessary to assure safe and reliable operation of the Distributed Generation Facility when connected to the Distribution System of the Distribution Company and that have been approved by the Authority.

**14. Billing for Net Metering.—** (1) At the end of each Billing Cycle following the date of

final interconnection of Distributed Generation Facility to the Distribution System of the Distribution Company, the Distribution Company shall net off the kWh supplied by Distributed Generator against the kWh supplied by it.

Provided that the meter readings shall be carried out preferably through Hand Held Units (HHU) and through automated means as directed by the Authority from time to time.

(2) In case the kWh supplied by Distribution Company exceed the kWh supplied by Distributed Generator, the Distributed Generator shall be billed for the net kWh in accordance with the Applicable Tariff.

(3) In case the kWh supplied by Distributed Generator exceed the kWh supplied by Distribution Company, the net kWh shall be credited against Distributed Generator's next billing cycle for future consumption, or shall be paid by the Distribution Company to the Distributed Generator quarterly.

Provided that where the Distributed Generator is to be paid, the kWh in a month will be charged at the tariff of that respective month.

(4) The tariff payable by the Distribution Company shall only be the off-peak rate of the respective consumer category of the respective month and other rates such as variable charges for peak time, fixed charges, fuel price adjustment, duties/levies will not be payable by Distribution Company.

**15. Power of the Authority to give directions, instructions and guidelines.**— (1) For carrying out the purposes of these Regulations, the Authority may issue directions, instructions and guidelines to the Distributed Generator and the Distribution Company in the form and manner determined by the Authority, which shall be complied with by the Distributed Generator and the Distribution Company.

(2) The Authority may, on representation made to it or on its own motion modify or cancel any direction, instruction or guidelines issued under sub-rule (1), and in so modifying or cancelling any direction, instruction or guidelines may impose such conditions as it thinks fit.

**16. Power to require information.**—The Authority may, at any time, by notice in writing require any director, officer and member of the Distribution Company and/or the Distributed Generator, generally or in particular to furnish it within the time specified therein or such further time as the Authority may allow, with any statement or information and without prejudice to the generality of the foregoing power, may call for information, at such intervals as the Authority may deem necessary.

**17. Resolution of disputes.**— Any dispute or disagreement between Distributed Generator and Distribution Company relating to any matter arising out of, or in connection with, the activities covered under the Regulations shall be submitted for decision to the Authority.

**18. Penalty for failure, refusal to comply with, or contravention with any provision of the Regulations.**— If any person fails or refuses to comply with, or contravenes any of the provisions of these Regulations or any direction or order passed by the Authority under these Regulations or knowingly or willfully authorizes or permit such failure, refusal or contravention, he shall, be punishable with a fine which may extend to 100 million rupees.

