Indian Rooftop Solar Photovoltaic Landscape - Business Models & Opportunities
Content

- Rationale for Promoting Rooftop Solar Photovoltaic Projects
- Business Models & Opportunities
- Regulatory Aspects
- Status of Policy/Regulations in States
Content

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Installed Capacity – Solar Energy Segment

- Focus on development of large scale capacities
- Lowering down the investment costs
- Preparing the stakeholders with appropriate know-how

Source: Installed Capacity – MNRE; Module Price – Solar Server/pvXchange

Rooftop PV ~41.3MW

Target ~ 10000 MW in 3 years
Benefit of Rooftop Solar Photovoltaic to the DISCOM

1 kWh generated at load centre can save generation of 1.5 kWh by fossil fuel based plants.
Drivers for Rooftop Solar PV Projects

- Well defined regulatory framework,
  - Feed-in tariff
  - Model/Draft Power Purchase Agreement
  - Solar Renewable Purchase Obligation
- Well defined policy framework,
  - Announcement of policy/scheme by Government/Nodal Agency
- Inclining consumer tariff
- Accelerated depreciation benefit under Section 32 of Income Tax Act
- Non-availability of sufficient electricity for meeting Solar RPO
- Optimal utilisation of available roof (as source of revenue)
Benefits Vs Costs of Rooftop Solar PV Installations

**Benefits**
- Saves on expensive and polluting conventional power
- Saves on investment in transmission and distribution infrastructure
- Reduces electricity lost over the wires
- Saves on cost of managing power delivery
- Saves on cost of meeting carbon and renewable requirements

**Costs**
- Costs to manage net metering program
- Lowers revenue to cover utility infrastructure costs

*Source: The Vote Solar Initiative*
Content

- Rationale for Promoting Rooftop Solar Photovoltaic Projects
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Mechanisms to promote Rooftop Solar PV Projects

Rooftop Solar Segment

Grid Connected
- Gross Metering
- Sale to Grid
- Net Metering
- Self-Consumption

Off-Grid
- Standalone Mini-Grid
- Rural
- Bi-lateral Sale
- RESCO

Emerging Segment
Approach for analyzing feasibility of Gross Metering

Solar Purchase Obligation shall compel Obligated Entities to purchase generation from RTPV
Arrangement under Gross Metering Mechanism

- High acceptability - well proven model worldwide and has relatively low risk for developer
- RTPV project can be quickly rolled out due precedence of this mechanism in large scale projects – less regulatory intervention and capacity building
- DISCOMs, Open Access Consumers and Fossil Fuel based Captive Consumers
Transaction framework identified for Gross Metering

Grid Connected

Net Metering

Gross Metering

Project Implementation Agreement

Support

Project Developer

MNRE

SNA

Rooftop Solar PV Project

Distribution Licensee

Power Purchasing Company

Policy / Scheme

RFP

Electricity Purchase

PPA

Roof Lease Agreement

Roof Owners
## Energy Charges in the Delhi for select consumer

### 1. Domestic

<table>
<thead>
<tr>
<th>Category</th>
<th>Fixed Charges¹</th>
<th>Energy Charges²</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Up to 2 kW connected load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-200 units</td>
<td>40 Rs/month</td>
<td>400 Paise/kWh</td>
</tr>
<tr>
<td>201-400 units</td>
<td>40 Rs/month</td>
<td>595 Paise/kWh</td>
</tr>
<tr>
<td>401 – 800 units</td>
<td>40 Rs/month</td>
<td>730 Paise/kWh</td>
</tr>
<tr>
<td>801-1200 Units</td>
<td>40 Rs/month</td>
<td>810 Paise/kWh</td>
</tr>
<tr>
<td>Above 1200 Units</td>
<td>40 Rs/month</td>
<td>875 Paise/kWh</td>
</tr>
<tr>
<td>b. Between 2kW and 5 kW connected load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-200 units</td>
<td>100 Rs/month</td>
<td>400 Paise/kWh</td>
</tr>
<tr>
<td>201-400 units</td>
<td>100 Rs/month</td>
<td>595 Paise/kWh</td>
</tr>
<tr>
<td>401-800 units</td>
<td>100 Rs/month</td>
<td>730 Paise/kWh</td>
</tr>
<tr>
<td>801-1200 Units</td>
<td>100 Rs/month</td>
<td>810 Paise/kWh</td>
</tr>
<tr>
<td>Above 1200 Units</td>
<td>100 Rs/month</td>
<td>875 Paise/kWh</td>
</tr>
<tr>
<td>c. Above 5 kW connected load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-200 units</td>
<td>25 Rs/kWh/month</td>
<td>400 Paise/kWh</td>
</tr>
<tr>
<td>201-400 units</td>
<td>25 Rs/kWh/month</td>
<td>595 Paise/kWh</td>
</tr>
<tr>
<td>401-800 units</td>
<td>25 Rs/kWh/month</td>
<td>730 Paise/kWh</td>
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<td>25 Rs/kWh/month</td>
<td>810 Paise/kWh</td>
</tr>
<tr>
<td>Above 1200 Units</td>
<td>25 Rs/kWh/month</td>
<td>875 Paise/kWh</td>
</tr>
</tbody>
</table>

### 2. Non-Domestic

<table>
<thead>
<tr>
<th>Category</th>
<th>Fixed Charges³</th>
<th>Energy Charges³</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Non-Domestic Low Tension (NDLT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 10 kW</td>
<td>100 Rs/kW/month</td>
<td>880 Paise/kWh</td>
</tr>
<tr>
<td>Between 10 kW(11kVA) - 100 kW (108 kVA)</td>
<td>115 Rs/kW/month</td>
<td>850 Paise/kVAh</td>
</tr>
<tr>
<td>Greater than 100 kW / 108 kVA (400 volts) (No Supply on LT for load &gt; 215 kVA)</td>
<td>150 Rs/kW/month</td>
<td>995 Paise/kVAh</td>
</tr>
<tr>
<td>b. Non-Domestic High Tension (NDHT)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For supply at 11 kV and above (for load greater than 108 kVA)</td>
<td>125 Rs/kVA/month</td>
<td>840 Paise/kVAh³</td>
</tr>
</tbody>
</table>

### 3. Industrial

<table>
<thead>
<tr>
<th>Category</th>
<th>Fixed Charges³</th>
<th>Energy Charges³</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Small Industrial Power (SIP) [less than 200kW/215 kVA]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 10 kW</td>
<td>80 Rs/kW/month</td>
<td>845 Paise/kWh</td>
</tr>
<tr>
<td>Between 10 kW(11kVA) and 100 kW (108 kVA)</td>
<td>90 Rs/kVA/month</td>
<td>790 Paise/kVAh</td>
</tr>
<tr>
<td>Greater than 100 kW / 108 kVA (400 volts) (No Supply on LT for load &gt; 215 kVA)</td>
<td>150 Rs/kVA/month</td>
<td>950 Paise/kVAh</td>
</tr>
<tr>
<td>b. Industrial Power on 11 kV Single Point Delivery for Group of SIP Consumers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 Rs/kVA/month</td>
<td>710 Paise/kVAh³</td>
<td></td>
</tr>
<tr>
<td>c. Large Industrial Power (LIP) (Supply at 11 kV and above)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>125 Rs/kVA/month</td>
<td>740 Paise/kVAh³</td>
<td></td>
</tr>
</tbody>
</table>

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Source: Tariff Order announced by DERC for TPDDL
## Energy Charges in the UP for select consumers

<table>
<thead>
<tr>
<th>Year</th>
<th>FY09</th>
<th>FY10</th>
<th>FY11-FY13</th>
<th>FY14</th>
<th>FY15</th>
<th>FY15</th>
<th>New Slab</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic (Urban)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 200</td>
<td>₹3.00/kWh</td>
<td>₹3.45/kWh</td>
<td>₹3.45/kWh</td>
<td>₹4.00/kWh</td>
<td>₹4.00/kWh</td>
<td>0-150</td>
<td></td>
</tr>
<tr>
<td>201 - 500</td>
<td>₹3.30/kWh</td>
<td>₹3.80/kWh</td>
<td>₹3.80/kWh</td>
<td>₹4.50/kWh</td>
<td>₹4.50/kWh</td>
<td>151-300</td>
<td></td>
</tr>
<tr>
<td>&gt;500</td>
<td>₹3.30/kWh</td>
<td>₹3.80/kWh</td>
<td>₹3.80/kWh</td>
<td>₹5.00/kWh</td>
<td>₹5.00/kWh</td>
<td>301-500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>₹5.50/kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;501</td>
<td></td>
</tr>
<tr>
<td>Non-Domestic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 300</td>
<td>₹4.30/kWh</td>
<td>₹4.95/kWh</td>
<td>₹5.75/kWh</td>
<td>₹6.00/kWh</td>
<td>₹6.00/kWh</td>
<td>0-150</td>
<td></td>
</tr>
<tr>
<td>&gt;300</td>
<td>₹4.30/kWh</td>
<td>₹4.95/kWh</td>
<td>₹6.00/kWh</td>
<td>₹6.50/kWh</td>
<td>₹6.50/kWh</td>
<td>151-300</td>
<td></td>
</tr>
<tr>
<td></td>
<td>₹6.80/kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>301-1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>₹7.10/kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;1000</td>
<td></td>
</tr>
<tr>
<td>Public Institutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Units</td>
<td>₹4.00/kWh</td>
<td>₹4.60/kWh</td>
<td>₹6.20/kWh</td>
<td>₹6.50/kWh</td>
<td>₹6.50/kWh</td>
<td>0-1000</td>
<td></td>
</tr>
<tr>
<td>Private Institutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Units</td>
<td>₹4.30/kWh</td>
<td>₹4.95/kWh</td>
<td>₹6.75/kWh</td>
<td>₹6.75/kWh</td>
<td>₹6.80/kWh</td>
<td>0-1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>₹7.10/kWh</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt;1000</td>
<td></td>
</tr>
</tbody>
</table>
Approach for analyzing feasibility of Net Metering

**Description Without Subsidy**

<table>
<thead>
<tr>
<th>Description (FY 2014-15)</th>
<th>Domestic</th>
<th>Non-Domestic</th>
<th>Public Institution</th>
<th>Private Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed Charge</td>
<td>0.75</td>
<td>1.00</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>Energy Charge</td>
<td>4.55</td>
<td>6.64</td>
<td>6.72</td>
<td>7.02</td>
</tr>
<tr>
<td>Regulatory Surcharge</td>
<td>0.13</td>
<td>0.18</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Electricity Duty</td>
<td>0.05</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Effective Billing Rate</td>
<td>5.48</td>
<td>7.90</td>
<td>8.09</td>
<td>8.40</td>
</tr>
</tbody>
</table>

**Description With 15% Subsidy**

<table>
<thead>
<tr>
<th>Description (FY 2014-15)</th>
<th>Without Subsidy</th>
<th>With 15% Subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levellised Cost of Generation (25 Years)</td>
<td>8.66</td>
<td>7.49</td>
</tr>
<tr>
<td>Accelerated Depreciation, if availed</td>
<td>0.94</td>
<td>0.80</td>
</tr>
<tr>
<td>Net Cost of Generation</td>
<td>7.72</td>
<td>6.69</td>
</tr>
</tbody>
</table>

**Commercially – Yes (in some consumer segment)**

**Technically – Yes (when grid is available)**

*Parity of consumer bill with cost of generation for RTPV has formed the basis*
Net Metering Mechanism – Interconnection at or below 415V

Solar Rooftop PV – Energy Generation

Injection before Utility Meter

Bi-Directional Meter

Distribution Transformer

DSO

TSO

Net Metering Agreement between Consumer and DISCOM
Net Metering Mechanism – Interconnection above 415 V

Solar Rooftop PV – Energy Generation

Step-Down Transformer

Injection after Utility Meter

Utility Meter

DSO

TSO

Consumer Grid

Net Metering Agreement between Consumer and DISCOM
Transaction framework identified for Net Metering

- Grid Connected
- Net Metering
- Gross Metering

Diagram:
- MNRE
  - Support
  - Policy / Scheme
- SNA
- ERC
- Distribution Licensee
- Project EPC
- Subsidy Disbursement
- EPC Agreement
- Roof Owners
- Rooftop Solar PV Project
- Order
- Net Energy Metering Connecting Agreement
- Electricity Banking
Content

- Rationale for Promoting Rooftop Solar Photovoltaic Projects
- Business Models & Opportunities
- Regulatory Aspects
- Status of Policy/Regulations in States
Regulatory Aspects

- Distinction between Supply and Distribution of Electricity
- Understanding Connectivity of the Power Plant with the Grid – Distribution System
- Interpretation of Section 7 of Electricity Act, 2003
- Structuring as Captive Power Plants as per Electricity Rules, 2005
Content

- Rationale for Promoting Rooftop Solar Photovoltaic Projects
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Status of Policy/Regulations in States

- **Delhi** - Surplus Generation to be accounted as if it has occurred during off-peak time block

- **Orissa** - Regulatory Commission has announced Order for implementation of projects under Net Metering on Government and PSU Buildings only

- **Karnataka** - *Solar Rooftop PV systems connected to LT grid of a distribution company, the concept of net metering shall be adopted and the net energy pumped into the grid shall be billed*

- **Tamil Nadu** - Net Metering Mechanism has been extended to LT (as recommended in policy) and HT Consumers

- **Punjab** - Government has announced Policy on Net Metering – project size up to 1 MW;

- **Kerala** - The quantum of electricity banked shall be settled first in the corresponding normal period and the balance in the peak period and in the off peak period in succession in subsequent billing period.
  - Excess electricity generated by the solar energy system installed in one premises and to use such excess electricity in other premises owned by the consumer is permitted within the area of supply of the licensee

- **Madhya Pradesh** – Net Metering Regulations & Policy at public consultation stage

- **Maharashtra** – Draft Net Metering Regulations

- **Uttar Pradesh** – Draft Net Metering Regulations
Our profile

• Owned by the Federal Republic of Germany
• Operations in Germany and in over 130 countries around the world
• Around 17,000 employees
• Operates in India since 60 years, currently 250 staff members in India
• GIZ is working in areas in which demand in India’s emerging economy is high and in which Germany is particularly strong.
Commercialisation of solar energy in urban and industrial areas (www.ComSolar.in)

<table>
<thead>
<tr>
<th>Project Duration</th>
<th>October 2009 till 2014 (extended till 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning Ministry</td>
<td>Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) - International Climate Initiative</td>
</tr>
<tr>
<td>Partner Ministry</td>
<td>Ministry of New and Renewable Energy (MNRE), Government of India</td>
</tr>
<tr>
<td>Focus sectors</td>
<td>Rooftop PV &amp; solar thermal in industrial process heat</td>
</tr>
</tbody>
</table>
| Approach | • Demonstration lighthouse projects  
            • Supporting regulative/policy framework  
            • Capacity & awareness building |
| Project team | Seven National & International experts |
Realising potential of rooftop PV with Metro Rail systems in India

- Huge potential of rooftop PV with Metro Rail systems in India
- GIZ is providing economical and technical advisory and active support to Delhi Metro
- The first project 500 kW is under construction, to be operational in August 2014 with replication of 10 MW on other DMRC buildings in Delhi (in feasibility stage).
- First large scale rooftop PV plant on RESCO business model
- GIZ is receiving similar support requests from other rail corporations
Realizing potential of rooftop PV with Cricket/Sports stadiums

- Cricket is a passion for millions in India having the power to influence how people think
- GIZ is providing economical & technical advisory for a 400 kW solar plant on the roof of Bangalore cricket stadium
- Replication potential - 1.3 MW at the same site, hundreds of MW on other stadiums
- Along with GIZ Environment Programme, the stadium becomes a green stadium (Green wicket campaign) with waste management, rain water harvesting etc.
Further information on activities

› Factsheets
› Brochure
› Website
All the best & Thank you!!

Hemant Bhatnagar
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