Detailed Project Report (DPR) of 5 MW Solar Grid-Connected Power Plant
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Main Features of the Project

⇒ **Project promoter:** xxxxxx
⇒ **Project location:** Village, Tehsil
⇒ **State:** Madhya Pradesh
⇒ **Proposed technology:** Si-Poly Technology
⇒ **Technology Supplier (PV Modules):** Waree Si-Poly Module
⇒ **Technology Supplier (Power Condition units):** Power Electronics
⇒ **Design consultant:** enincon LLP
⇒ **Plant capacity:** 5 MW
⇒ **PV Module Type:** Si Poly modules
⇒ **PV Modules Required (area):** 35892 m²
⇒ **Total Area Required:** 101171 m²
⇒ **Annual global solar radiation:** 1976 kWh/m²
⇒ **Annual average temperature:** 25.18 C
⇒ **Annual Gross Output:** 7896505 kWh
⇒ **Miscellaneous PV array losses:** 1 %
⇒ **Miscellaneous power conditioning losses:** 1 %
⇒ **Expected CUF:** 19 %
⇒ **Project implementation period:** 14 months
⇒ **Estimated project cost:** Rs xxxx lakhs
⇒ **Project IRR:** %
⇒ **Design Optimization Software used:** RETScreen, METEONORM, PVSYST V5.72
⇒ **Site selection:** Site identified and suitability confirmed
⇒ **Financial closure:** On approval of the project, promoters will approach banks
Site Assessment

Abc Village (24.xx” North and 79.xx”East) is located in xx tahsil of xx district of Madhya Pradesh. xx located at 24.12 N and 79.59 E with an average elevation of 352 meters. It is surrounded by rocky, sandy and five salt ranges. It has well road and rail connectivity from abc. xxxx is planning to install a solar energy based grid connected power project in xx, Madhya Pradesh under the Madhya Pradesh Solar Policy. The identified technology is solar Si-Poly; while the capacity of proposed power plant is 5 MW. Enincon LLP has been selected by the company as project consultants and for preparation of detailed project report (DPR) of the proposed plant.

Exhibit 01 : Site images for Site Assessment

Source: enincon
Solar radiation over Village x, Madhya Pradesh

The proposed project site is situated in the x Village, x district of the Madhya Pradesh State in India. The distance from the district headquarters xx to the site is 31 km (by road) towards the north. The nearest meteorological station for solar data is in xx. The solar data collected in this station is available in the “Solar Radiation Handbook 2008”, published by the Ministry of New and Renewable Energy (MNRE) and in the “Handbook of Solar Radiation”, compiled by Anna Mani. In this exercise, solar data for “Global solar irradiance” is taken from NASA-SSE, Meteonorm and the “Solar Radiation Handbook 2008. Global solar irradiance for the proposed site, xx from PVsyst5.74 software.

Exhibit 02: Stereographic Sun-path Diagram for xxxx, Madhya Pradesh

Exhibit 03: Orthographic Sun-path Diagram for xxxx, Pradesh

Source: enincon, PV syst 5.74

Source: enincon, PV syst 5.74
### Monthly average daily values (average, maximum, minimum) of climatic parameters for site

<table>
<thead>
<tr>
<th>Month</th>
<th>Air temperature</th>
<th>Relative humidity</th>
<th>Daily solar radiation - horizontal</th>
<th>Atmospheric pressure</th>
<th>Wind speed</th>
<th>Earth temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°C</td>
<td>%</td>
<td>kWh/m²/d</td>
<td>kPa</td>
<td>m/s</td>
<td>°C</td>
</tr>
<tr>
<td>January</td>
<td>17.3</td>
<td>46.7%</td>
<td>4.23</td>
<td>97.7</td>
<td>2.7</td>
<td>19.1</td>
</tr>
<tr>
<td>February</td>
<td>20.7</td>
<td>41.2%</td>
<td>5.09</td>
<td>97.5</td>
<td>2.8</td>
<td>23.6</td>
</tr>
<tr>
<td>March</td>
<td>26.6</td>
<td>31.1%</td>
<td>5.92</td>
<td>97.2</td>
<td>2.9</td>
<td>30.9</td>
</tr>
<tr>
<td>April</td>
<td>31.9</td>
<td>24.5%</td>
<td>6.60</td>
<td>96.8</td>
<td>3.1</td>
<td>37.6</td>
</tr>
<tr>
<td>May</td>
<td>34.1</td>
<td>32.0%</td>
<td>6.51</td>
<td>96.4</td>
<td>3.3</td>
<td>39.6</td>
</tr>
<tr>
<td>June</td>
<td>31.6</td>
<td>55.2%</td>
<td>5.45</td>
<td>96.1</td>
<td>3.3</td>
<td>34.6</td>
</tr>
<tr>
<td>July</td>
<td>27.9</td>
<td>76.3%</td>
<td>4.32</td>
<td>96.2</td>
<td>2.9</td>
<td>29.2</td>
</tr>
<tr>
<td>August</td>
<td>26.6</td>
<td>81.5%</td>
<td>3.93</td>
<td>96.4</td>
<td>2.5</td>
<td>27.2</td>
</tr>
<tr>
<td>September</td>
<td>26.3</td>
<td>73.6%</td>
<td>4.51</td>
<td>96.7</td>
<td>2.4</td>
<td>27.2</td>
</tr>
<tr>
<td>October</td>
<td>25.4</td>
<td>50.9%</td>
<td>5.04</td>
<td>97.2</td>
<td>2.0</td>
<td>27.0</td>
</tr>
<tr>
<td>November</td>
<td>21.9</td>
<td>40.0%</td>
<td>4.51</td>
<td>97.6</td>
<td>2.1</td>
<td>23.3</td>
</tr>
<tr>
<td>December</td>
<td>17.9</td>
<td>45.4%</td>
<td>4.00</td>
<td>97.8</td>
<td>2.3</td>
<td>19.1</td>
</tr>
<tr>
<td>Annual</td>
<td>25.7</td>
<td>49.9%</td>
<td>5.01</td>
<td>96.9</td>
<td>2.7</td>
<td>28.2</td>
</tr>
<tr>
<td>Measured at (m)</td>
<td>10.0</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Exhibit 04: Estimation of Annual Electrical Output

#### Global System Configuration
- **Number of kinds of sub-fields**: 1
- **Simplified Schema**:

<table>
<thead>
<tr>
<th>Global System configuration</th>
<th>Global System summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of modules: 21735</td>
<td>Nominal PV Power: 4383 kWP</td>
</tr>
<tr>
<td>Module area: 35892 m²</td>
<td>Maximum PV Power: 4785 kWdc</td>
</tr>
<tr>
<td>Nb. of inverters: 5</td>
<td>Nominal AC Power: 5000 kWac</td>
</tr>
</tbody>
</table>

#### Homogeneous System

**Select the PV module**
- **Power**: 230 Wp 24V
- **Technology**: Sirepo, WS-230
- **Manufacturer**: Waaree
- **Sizng voltages**:
  - Vmp (60°C): 23.8 V
  - Voc (-10°C): 40.6 V
- **Approx. needed modules**: 21739

**Select the inverter**
- **Power**: 520-820 V, 50/60 Hz
- **Manufacturer**: FreeSun FS1001 HE/HEC 330V, Power Electronics
- **Operating Voltage**: 520-820 V
- **Input maximum voltage**: 1000 V
- **Nb. of inverters**: 5

**Design the array**
- **Number of modules and strings**:
  - **Modules in series**: 23
  - **Nb. strings**: 945
  - **Overload loss**: 0.0 %
  - **Pm ratio**: 1.00
- **Operating conditions**:
  - Vmp (60°C): 547 V
  - Vmp (20°C): 670 V
  - Voc (-10°C): 934 V
- **Plane irradiance**: 1000 W/m²
- **Imp (STC)**: 7645 A (Max. operating power)
- **Isc (STC)**: 8515 A (at 1000 W/m² and 50°C)
- **Isc (at STC)**: 8411 A

#### Notes
- The inverter power is slightly oversized.

Source: enincon, PV syst 5.74
Exhibit 05: Project report from Pvsyst V5.74

### Grid-Connected System: Simulation parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project</strong>: Grid-Connected Project at kanti, Madhya Pradesh</td>
<td></td>
</tr>
<tr>
<td><strong>Geographical Site</strong>: Kanti, Madhya Pradesh</td>
<td>Country: India</td>
</tr>
<tr>
<td><strong>Situation</strong>: Time defined as</td>
<td>Latitude: 24.1°N</td>
</tr>
<tr>
<td></td>
<td>Longitude: 79.6°E</td>
</tr>
<tr>
<td></td>
<td>Albedo: 0.20</td>
</tr>
<tr>
<td><strong>Meteo data</strong>: kanti madhya pradesh, Synthetic Hourly data</td>
<td></td>
</tr>
<tr>
<td><strong>Simulation variant</strong>: New simulation variant</td>
<td>Simulation date: 07/09/14 23h04</td>
</tr>
</tbody>
</table>

**Simulation parameters**

- **Collector Plane Orientation**: Tilt: 24°, Azimuth: 0°
- **Horizon**: Free Horizon
- **Near Shadings**: No Shadings

**PV Array Characteristics**

- **PV module**: Si-poly, Model: WS-230
- **Number of PV modules**: 23 modules
- **Total number of PV modules**: 21735
- **Array global power**: Nominal (STC): 4999 kWp
- **Array operating characteristics (50°C)**: U mpp: 578 V, I mpp: 7645 A
- **Module area**: 35892 m²

**Inverter**

- **Model**: FreeSun FS1001 HE/HEC 330V
- **Power Electronics**: 520-820 V, Unit Nom. Power: 1000 kW AC
- **Total Power**: 5000 kW AC

**PV Array loss factors**

- **Thermal Loss factor**: Uc (const) = 20.0 W/m²K, Uv (wind) = 0.0 W/m²K / m/s
- **Wiring Ohmic Loss**: Global array res. = 1.3 mOhm
- **Module Mismatch Losses**: Loss Fraction = 3.0 %
- **Incidence effect, ASHRAE parameterization**: IAM = 1 - bo (1/cos i - 1)
- **bo Parameter**: 0.05

**User's needs**: Unlimited load (grid)

Source: enincon, PV syst 5.74
Detailed project report (DPR) of 5 MW Solar Grid-connected Power Plant

Project: Grid-Connected Project at Kanti, Madhya Pradesh
Simulation variant: New simulation variant

Main system parameters:
- System type: Grid-Connected
- Tilt: 24°
- Azimuth: 0°
- PV modules: WS-230
- Nb. of modules: 21735
- Inverter: FreeSun FS1001 HE/HEC
- Nb. of units: 5
- Unlimited load (grid): 1000 kW ac, 6000 kW ac

Main simulation results:
- System Production: 7896505 kWh/year
- Specific prod.: 1580 kWh/kWp/year
- Performance Ratio PR: 74.7%

New simulation variant:
Balances and main results:

<table>
<thead>
<tr>
<th>Month</th>
<th>GlobHor kWh/m²</th>
<th>T Amb °C</th>
<th>GlobInc kWh/m²</th>
<th>GlobEff kWh/m²</th>
<th>EArray kWh</th>
<th>E_Grid kWh</th>
<th>EffArrR %</th>
<th>EffSysR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>118.0</td>
<td>14.70</td>
<td>165.0</td>
<td>150.7</td>
<td>636031</td>
<td>625418</td>
<td>11.43</td>
<td>10.12</td>
</tr>
<tr>
<td>February</td>
<td>137.0</td>
<td>17.30</td>
<td>166.8</td>
<td>162.4</td>
<td>654155</td>
<td>653022</td>
<td>11.10</td>
<td>10.24</td>
</tr>
<tr>
<td>March</td>
<td>188.0</td>
<td>22.70</td>
<td>206.6</td>
<td>201.0</td>
<td>795143</td>
<td>762291</td>
<td>10.72</td>
<td>10.55</td>
</tr>
<tr>
<td>April</td>
<td>207.0</td>
<td>28.80</td>
<td>204.6</td>
<td>196.6</td>
<td>780843</td>
<td>737680</td>
<td>10.22</td>
<td>10.04</td>
</tr>
<tr>
<td>May</td>
<td>222.0</td>
<td>32.50</td>
<td>203.0</td>
<td>196.7</td>
<td>791628</td>
<td>718413</td>
<td>10.04</td>
<td>9.86</td>
</tr>
<tr>
<td>June</td>
<td>197.0</td>
<td>32.90</td>
<td>175.1</td>
<td>169.0</td>
<td>633246</td>
<td>622059</td>
<td>10.08</td>
<td>9.90</td>
</tr>
<tr>
<td>July</td>
<td>157.0</td>
<td>30.30</td>
<td>152.5</td>
<td>147.5</td>
<td>557936</td>
<td>555170</td>
<td>10.36</td>
<td>10.18</td>
</tr>
<tr>
<td>August</td>
<td>180.0</td>
<td>29.90</td>
<td>163.1</td>
<td>148.0</td>
<td>647948</td>
<td>647089</td>
<td>10.32</td>
<td>10.13</td>
</tr>
<tr>
<td>September</td>
<td>171.0</td>
<td>29.50</td>
<td>178.6</td>
<td>173.7</td>
<td>655596</td>
<td>644063</td>
<td>10.22</td>
<td>10.04</td>
</tr>
<tr>
<td>October</td>
<td>165.0</td>
<td>26.20</td>
<td>193.8</td>
<td>188.8</td>
<td>730732</td>
<td>718504</td>
<td>10.50</td>
<td>10.33</td>
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<tr>
<td>November</td>
<td>129.0</td>
<td>20.90</td>
<td>187.5</td>
<td>163.0</td>
<td>651100</td>
<td>650855</td>
<td>10.99</td>
<td>10.82</td>
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<tr>
<td>December</td>
<td>115.0</td>
<td>16.00</td>
<td>158.9</td>
<td>152.6</td>
<td>639821</td>
<td>629064</td>
<td>11.36</td>
<td>11.17</td>
</tr>
<tr>
<td>Year</td>
<td>1978.0</td>
<td>25.18</td>
<td>2114.0</td>
<td>2052.0</td>
<td>8033309</td>
<td>7896505</td>
<td>10.59</td>
<td>10.41</td>
</tr>
</tbody>
</table>

Legends: GlobHor = Horizontal global irradiation
T Amb = Ambient Temperature
GlobInc = Global incident in coll. plane
GlobEff = Effective Global, corr. for IAM and shadings
EArray = Effective energy at the output of the array
E_Grid = Energy injected into grid
EffArrR = Effic. Eout array / rough area
EffSysR = Effic. Eout system / rough area
## Grid-Connected System: Loss diagram

### Project:
Grid-Connected Project at Kanti, Madhya Pradesh

### Simulation variant:
New simulation variant

<table>
<thead>
<tr>
<th>Main system parameters</th>
<th>System type</th>
<th>Grid-Connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV Field Orientation</td>
<td>tilt</td>
<td>24°</td>
</tr>
<tr>
<td>PV modules</td>
<td>Model</td>
<td>WS-230</td>
</tr>
<tr>
<td>PV Array</td>
<td>Nb. of modules</td>
<td>21735</td>
</tr>
<tr>
<td>Inverter</td>
<td>Model</td>
<td>FreeSun FS1001 HE/HEC 350W</td>
</tr>
<tr>
<td>Inverter pack</td>
<td>Nb. of units</td>
<td>5.0</td>
</tr>
<tr>
<td>User's needs</td>
<td></td>
<td>Unlimited load (grid)</td>
</tr>
</tbody>
</table>

### Grid-Connected
- azimuth: 0°
- Pnom: 230 Wp
- Pnom total: 4,999 kWp
- 1000 kW ac
- 5000 kW ac

### Loss diagram over the whole year

- Horizontal global irradiation
- Global incident in coll. plane
- IAM factor on global
- Effective irradiance on collectors
- PV conversion
- Array nominal energy (at STC effic.)
- PV loss due to irradiance level
- PV loss due to temperature
- Module quality loss
- Module array mismatch loss
- Ohmic wiring loss
- Array virtual energy at MPP
- Inverter Loss during operation (efficiency)
- Inverter Loss over nominal inv. power
- Inverter Loss due to power threshold
- Inverter Loss over nominal inv. voltage
- Inverter Loss due to voltage threshold
- Available Energy at Inverter Output
- Energy injected into grid
Exhibit 06 : Financial aspect of Project

<table>
<thead>
<tr>
<th>SR.No.</th>
<th>PARAMETER</th>
<th>UNIT</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IRR</td>
<td>%</td>
<td>Xxxxxx</td>
</tr>
<tr>
<td>2</td>
<td>IRR EQUITY</td>
<td>%</td>
<td>Xxxxxxx</td>
</tr>
<tr>
<td>3</td>
<td>DSCR</td>
<td>%</td>
<td>Xxxxxxx</td>
</tr>
<tr>
<td>4</td>
<td>PAYBACK PERIOD</td>
<td>YEAR</td>
<td>Xxxxxxx</td>
</tr>
<tr>
<td>5</td>
<td>LEVELISED TARIFF</td>
<td>Kwh/Rs.</td>
<td>xxxxxxx</td>
</tr>
</tbody>
</table>

Source: enincon, PV syst 5.74
Do you have any queries: Please Contact Us

enincon.com/in

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