Plant Layout

- WATER RESERVOIR
- SOLAR FIELD-1
- EVAPORATION POND
- SOLAR FIELD-2
- SOLAR FIELD-3
- POWER BLOCK
- SOLAR FIELD-4
- 132 KV SUBSTATION

Total Land: 450 acres
- Solar
- Power
- Others

Location: 72.16°N, 27.60°E
## Project details

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Details</th>
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<tbody>
<tr>
<td>CAPACITY</td>
<td>50 MW excluding Storage</td>
</tr>
<tr>
<td>LOCATION</td>
<td>Village Naukh, District Jaisalmer, Rajasthan</td>
</tr>
<tr>
<td>DATE OF PPA</td>
<td>10 January 2011</td>
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<tr>
<td>TECHNOLOGY</td>
<td>Parabolic Trough</td>
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<tr>
<td>PROJECT COST</td>
<td>141 Million USD</td>
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<td>PRIMARY LENDER</td>
<td>Bank Of Baroda</td>
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<td>IMPORTED ITEMS</td>
<td>Mirrors, Receiver Tubes, HTF, SG, STG</td>
</tr>
<tr>
<td>INDIGENOUS ITEMS</td>
<td>Solar Frames, BOP, Piping</td>
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</table>
### Important Specifications

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Aperture area</td>
<td>3,92,400 M²</td>
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<tr>
<td>No. of Loops</td>
<td>120</td>
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<td>Surface area</td>
<td>2.4 M²</td>
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<tr>
<td>Model</td>
<td>EN572-2:2004</td>
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<tr>
<td>Specular Reflectance</td>
<td>&gt; 94 %</td>
</tr>
<tr>
<td>No. of Mirrors per Module</td>
<td>28</td>
</tr>
<tr>
<td>Total no of Mirrors</td>
<td>1,61,280</td>
</tr>
<tr>
<td>Emissivity</td>
<td>&lt; 0.1</td>
</tr>
<tr>
<td>Solar Transmittance</td>
<td>&gt; 0.96</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>385 Deg C</td>
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<tr>
<td>Rating</td>
<td>75 MVA, 10.5 / 132 KV</td>
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<tr>
<td>Heat rate</td>
<td>2262.3 kcal/kW</td>
</tr>
<tr>
<td>Type</td>
<td>Water Cooled</td>
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<td>Steam flow</td>
<td>Axial</td>
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<tr>
<td>Type</td>
<td>ID Counter Flow</td>
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<td>No. of Passes</td>
<td>03</td>
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<tr>
<td>Approach</td>
<td>07 Deg C</td>
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<tr>
<td>Capacity</td>
<td>11.5 M³/hr</td>
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</tbody>
</table>
Performance at a Glance

Power Generation (Million Units)

- Apr - 14
- May - 14
- Jun - 14
- Jul - 14
- Aug - 14
- Sep - 14
- Oct - 14
- Nov - 14
- Dec - 14
- Jan - 15
- Feb - 15

FY 2014-15: 98
Performance at a Glance

Net Realization Export (Million Units)

<table>
<thead>
<tr>
<th>Month</th>
<th>FY 2014-15</th>
<th>FY 2015-16</th>
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</thead>
<tbody>
<tr>
<td>Apr 14</td>
<td>10.10</td>
<td>9.46</td>
</tr>
<tr>
<td>May 14</td>
<td>7.92</td>
<td>6.37</td>
</tr>
<tr>
<td>Jun 14</td>
<td>5.19</td>
<td>8.44</td>
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<td>Jul 14</td>
<td>9.86</td>
<td>6.32</td>
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<td>Aug 14</td>
<td>9.86</td>
<td>4.24</td>
</tr>
<tr>
<td>Sep 14</td>
<td>5.78</td>
<td>3.98</td>
</tr>
<tr>
<td>Oct 14</td>
<td>3.98</td>
<td>5.78</td>
</tr>
</tbody>
</table>
Performance at a Glance

- CER (tn CO2)

FY 2014-15: 815

<table>
<thead>
<tr>
<th>Month</th>
<th>CER (tn CO2)</th>
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</thead>
<tbody>
<tr>
<td>Sep</td>
<td>8035</td>
</tr>
<tr>
<td>Oct</td>
<td>6113</td>
</tr>
<tr>
<td>Nov</td>
<td>3788</td>
</tr>
<tr>
<td>Dec</td>
<td>4039</td>
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<tr>
<td>Jan</td>
<td>5501</td>
</tr>
<tr>
<td>Feb</td>
<td>8168</td>
</tr>
</tbody>
</table>

Data from [Provisional State of the State Report - FY 2014-15](#)
Performance at a Glance

- Capacity Utilisation Factor (%)

<table>
<thead>
<tr>
<th>Month</th>
<th>Factor (%)</th>
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<tr>
<td>Apr-14</td>
<td>31.88</td>
</tr>
<tr>
<td>May-14</td>
<td>29.08</td>
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<tr>
<td>Jun-14</td>
<td>25.38</td>
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<tr>
<td>Jul-14</td>
<td>19.99</td>
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<td>Aug-14</td>
<td>31.08</td>
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<td>Sep-14</td>
<td>25.83</td>
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<td>Oct-14</td>
<td>20.02</td>
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<td>Nov-14</td>
<td>13.31</td>
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<td>Dec-14</td>
<td>12.50</td>
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<tr>
<td>Jan-15</td>
<td>19.49</td>
</tr>
<tr>
<td>Feb-15</td>
<td>19.49</td>
</tr>
</tbody>
</table>

FY 2014-15: 22.5

Source: [Company Name]
Performance at a Glance

- CUF (%) no. of days FY 2014-15

<table>
<thead>
<tr>
<th>CUF (%)区间</th>
<th>人数</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 45%</td>
<td>5</td>
</tr>
<tr>
<td>40% - 45%</td>
<td>30</td>
</tr>
<tr>
<td>35% - 40%</td>
<td>42</td>
</tr>
<tr>
<td>30% - 35%</td>
<td>40</td>
</tr>
<tr>
<td>25% - 30%</td>
<td>49</td>
</tr>
<tr>
<td>20% - 25%</td>
<td>46</td>
</tr>
<tr>
<td>10% - 20%</td>
<td>77</td>
</tr>
<tr>
<td>&lt; 10%</td>
<td>58</td>
</tr>
</tbody>
</table>

- Below 120 MW: 240 – 300
- 120 – 240
- 300 – 360
- 240 – 300
- 420 – 480
- 360 – 420
- 480 – 540

Nil generation due to weather conditions in FY 2014-2015.
## Performance at a Glance

### Auxiliary Power Consumption (%)

<table>
<thead>
<tr>
<th>Month</th>
<th>April 14</th>
<th>May 14</th>
<th>June 14</th>
<th>July 14</th>
<th>August 14</th>
<th>September 14</th>
<th>October 14</th>
<th>November 14</th>
<th>December 14</th>
<th>January 15</th>
<th>February 15</th>
</tr>
</thead>
</table>
Solar Energy availability (kWh/M2/Month)

FY 2014-15:

- Apr-14: 169.0
- May-14: 149.4
- Jun-14: 126.7
- Jul-14: 169.0
- Aug-14: 150.5
- Sep-14: 159.3
- Oct-14: 155.5
- Nov-14: 153.7
- Dec-14: 134.7
- Jan-15: 117.0
- Feb-15: 99.0
- Mar-15: 88.9
- Apr-15: 101.7
Performance analysis

Necessity

- It is essential to analyze the hourly output and efficiency parameters with standard tools to enhance the Plant performance.

- System Advisory Model (SAM) for Plant performance analysis.

- SPECULAR REFLECTOMETER to measure mirror reflectance.

- Digital balancer to get the accuracy of SCA tracking.

- Thermal Imager to analyze temperature profile.
### Performance analysis with SAM Mode

#### Input

SAM 2014.1.14: D:\SOLAR\GGEL\sam updated.zsam

#### CSP Trough Physical Case 1

**Location and Resource**
- Location: GGEL, RJ
  - Elevation: 103.0 m

**Typecase Field**
- Multiple: 1.46756
- Number of Loops: 120
- Collector Area: 392400

**Factors (SCAs)**

**Drivers (HCEs)**

**Power Cycle**
- Plate: 50 MWe
- Efficiency: 0.3803

**Thermal Storage**
- Storage Hours: 0
- Volume: 0

**Performance Adjustment**
- Net annual output: 96%
- Net-to-year decline: 0% per year

**High System Costs**
- Installed: $136,769,200
- Capacity ($/kW): $2,763

**Financial**
- Life: 25 years
- Assumption: Specify IRR Target

### Choose Weather Data File

Type a few letters of the location name:

- SAM/WV Elkins.tm2
- SAM/WV Huntington.tm2
- SAM/WV Casper.tm2
- SAM/WV Cheyenne.tm2
- SAM/WV Lander.tm2
- SAM/WV Rock Springs.tm2
- SAM/WV Sheridan.tm2
- SAM/WV Reid_State.tyx
- SAM/WV Reid_State.tyx
- SAM/WV Reid_State.tyx

#### Location Information

- **City**: GGEL
- **State**: RJ
- **Elevation**: 183 m
- **Time Zone**: GMT 5.5
- **Latitude**: 27.573 degrees
- **Longitude**: 72.206 degrees

#### Weather Data Information (Annual)

- **Direct Normal**: 1151.5 kWh/m²
- **Dry-bulb Temp**: 26.6 °C
- **Global Horizontal**: 1981.2 kWh/m²
- **Wind Speed**: 2.4 m/s

### Web Links

SAM reads weather files in the TMY3, TMY2, EPW, and SMW file formats. The default weather folder contains copies of the complete NREL TMY2 dataset. You can use the links below to visit websites with other weather files. If you download files from the web, click Folder Settings, then Copy to Project: SAM indicates the embedded weather file in the list with prefix "USER/". See Help for details.
### CSP Trough Physical, Single Owner

**View and export data:**

- Graphs
- Tables
- Cash Flows
- Time Series
- Loss Diagram

**Choose Simulation:** Base Case

<table>
<thead>
<tr>
<th>Gross electric power output (MWh), hourly</th>
<th>the day (hours)</th>
<th>HTF inlet temperature</th>
<th>return temp</th>
<th>efficiency (%)</th>
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</thead>
<tbody>
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<td>730</td>
<td>0.510011</td>
<td>10</td>
<td>387.48</td>
<td>293</td>
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<tr>
<td>731</td>
<td>44.2935</td>
<td>11</td>
<td>390.483</td>
<td>289.872</td>
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<td>732</td>
<td>42.0654</td>
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<td>15</td>
<td>369.853</td>
<td>293</td>
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</tbody>
</table>
Performance analysis with SAM Model

Monthly output

Graph showing monthly output with a bar chart for each month from January to December.
### Energy Conversion Factor – Solar to Power (%)

<table>
<thead>
<tr>
<th>Month</th>
<th>SAM Proj</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr-14</td>
<td>16.81</td>
<td>19.16</td>
</tr>
<tr>
<td>May-14</td>
<td>18.31</td>
<td>18.38</td>
</tr>
<tr>
<td>Jun-14</td>
<td>18.38</td>
<td>20.77</td>
</tr>
<tr>
<td>Jul-14</td>
<td>16.89</td>
<td>20.79</td>
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<td>Aug-14</td>
<td>19.05</td>
<td>19.05</td>
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<tr>
<td>Sep-14</td>
<td>17.46</td>
<td>19.30</td>
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<tr>
<td>Oct-14</td>
<td>17.90</td>
<td>18.38</td>
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<td>Nov-14</td>
<td>15.75</td>
<td>17.90</td>
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<td>Dec-14</td>
<td>16.71</td>
<td>18.38</td>
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<td>Jan-15</td>
<td>14.28</td>
<td>16.71</td>
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<td>Feb-15</td>
<td>11.98</td>
<td>11.98</td>
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<tr>
<td>Mar-15</td>
<td>11.91</td>
<td>11.95</td>
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<tr>
<td>Apr-15</td>
<td>9.84</td>
<td>11.91</td>
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<td>13.45</td>
<td>15.11</td>
</tr>
<tr>
<td>Jun-15</td>
<td>15.11</td>
<td>15.11</td>
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</table>

FY 2014-15: **15.2**

FY 2014-15: **17.0**

Only 1.85 % lagging than SAM Projection on annual Generation.
Performance at a Glance

- Grid Stability (%)
- Generation Loss (MWh)

FY 2014-15: 98.3%

3 MW Generation loss due to Grid failure & Export restriction, which is 0.3830 % CUF on annual Generation.
Performance at a Glance

- Grid Stability (%)
- Generation Loss (MWh)

Grid Stability (%)

<table>
<thead>
<tr>
<th>Month</th>
<th>MW Loss</th>
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</thead>
<tbody>
<tr>
<td>Apr-15</td>
<td>1346.9</td>
</tr>
<tr>
<td>May-15</td>
<td>24.4</td>
</tr>
<tr>
<td>Jun-15</td>
<td>9.6</td>
</tr>
<tr>
<td>Jul-15</td>
<td>233.4</td>
</tr>
<tr>
<td>Aug-15</td>
<td>201.6</td>
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<tr>
<td>Sep-15</td>
<td>36.0</td>
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<td>Oct-15</td>
<td>56.2</td>
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<td>Nov-15</td>
<td>76.9</td>
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<td>Dec-15</td>
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<td>Jan-16</td>
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<tr>
<td>Feb-16</td>
<td></td>
</tr>
<tr>
<td>Mar-16</td>
<td></td>
</tr>
</tbody>
</table>

3 MW Generation loss due to Grid failure & Export restriction, which is 1.35% CUFC on annual Generation.
DNI / ANI at different quarter
Focus Area

Technical Challenges:-

Auxiliary Power reduction
Fine tuning Solar Field efficiency
Reducing non generating hours power consumption
Achieving much closer results to SAM output
Reducing non generating hours temperature drop in loops
Sustaining Turbine & Steam generators efficiency
Others Challenges :-

- Developers failures
- Lack of knowledge on the part of developers in execution and associated problems
- Financial closures difficulties at initial stage
- High rate of interest
- Time allotted is not as per capacity
- Non availability of site base realistic DNI data
Focus Area:

Others Challenges :-

- Hybridization of CSP not allowed
- Local issues
- Demonstration model in the form of Pilot Project
- Lack of focus on development of CSP
- Power evacuation or grid availability
Advantages of CSI

Higher CUF with storage

Better grid stability

24 hour operation possible with storage or hybridization