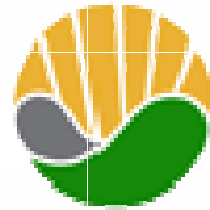




**GODAWARI GREEN ENERGY**

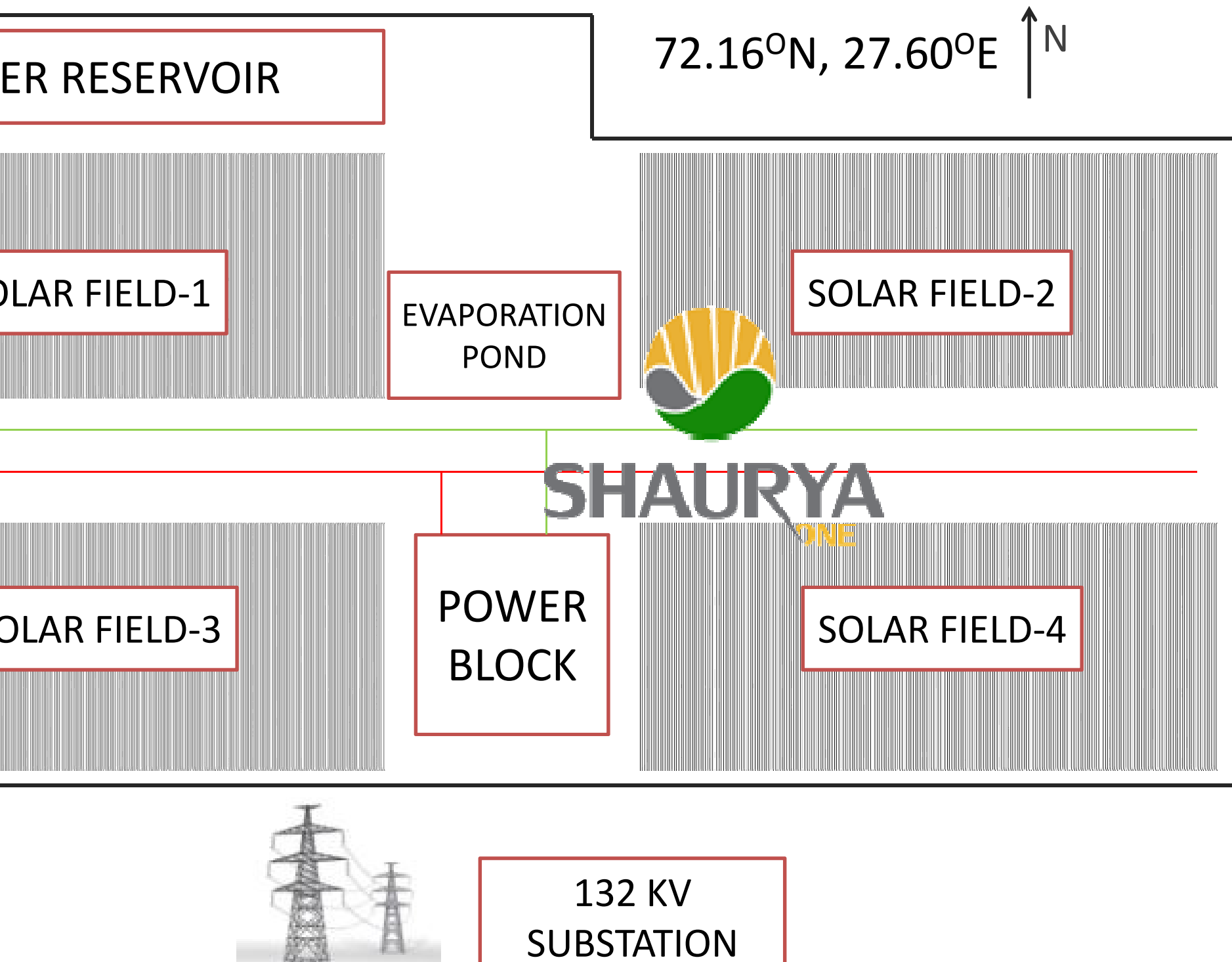


**SHAURYA**  
**ONE**

**Jitendra Solanki**  
**General Manager**



# Plant Layout



- Total
- 450 a
- Solar
  - Power
  - Other

# Object details

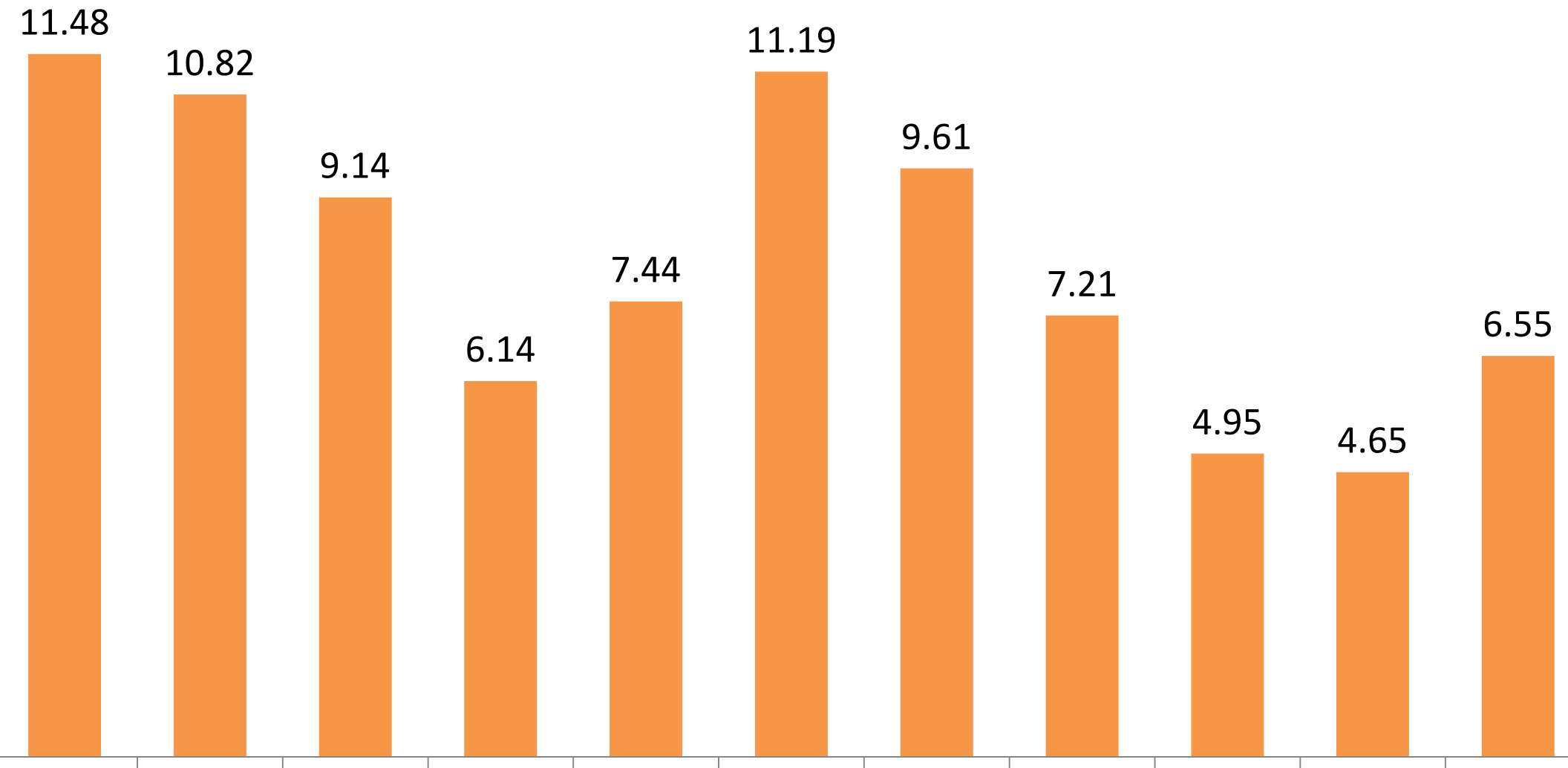
| Particulars | Details |
|-------------|---------|
|             |         |

# Plant Specifications

|                                                                                             | Specification of Equipments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Manufacturer            |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Solar Field<br><br>Generator<br><br>Generator<br><br>Transformer<br><br>Cooler<br><br>Tower | <ul style="list-style-type: none"><li>▪ Aperture area - 3,92,400 M<sup>2</sup></li><li>▪ No. of Loops -120</li><li>▪ Surface area – 2.4 M<sup>2</sup></li><li>▪ Model - EN572-2:2004</li><li>▪ Specular Reflectance &gt; 94 %</li><li>▪ No. of Mirrors per Module – 28</li><li>▪ Total no of Mirrors – 1,61,280</li><li>▪ Emissivity &lt; 0.1</li><li>▪ Solar Transmittance &gt; 0.96</li><li>▪ Operating Temperature – 385 Deg C</li><li>▪ Rating – 75 MVA, 10.5 / 132 KV</li><li>▪ Heat rate – 2262.3 Kcal/kWh</li><li>▪ Type : Water Cooled</li><li>▪ Steam flow : Axial</li><li>▪ Type : ID Counter Flow</li><li>▪ No. of Passes – 03</li><li>▪ Capacity – 11.5 M<sup>3</sup>/hr</li></ul> | <b>EURO</b><br>Germany  |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>FLABE</b><br>Germany |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>SCHOT</b><br>Germany |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>AALBO</b><br>Denmark |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>SIEME</b><br>Sweden  |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>ABB</b><br>India     |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>SIEME</b><br>India   |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>PAHAR</b><br>India   |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>ION EX</b><br>India  |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |
|                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                         |

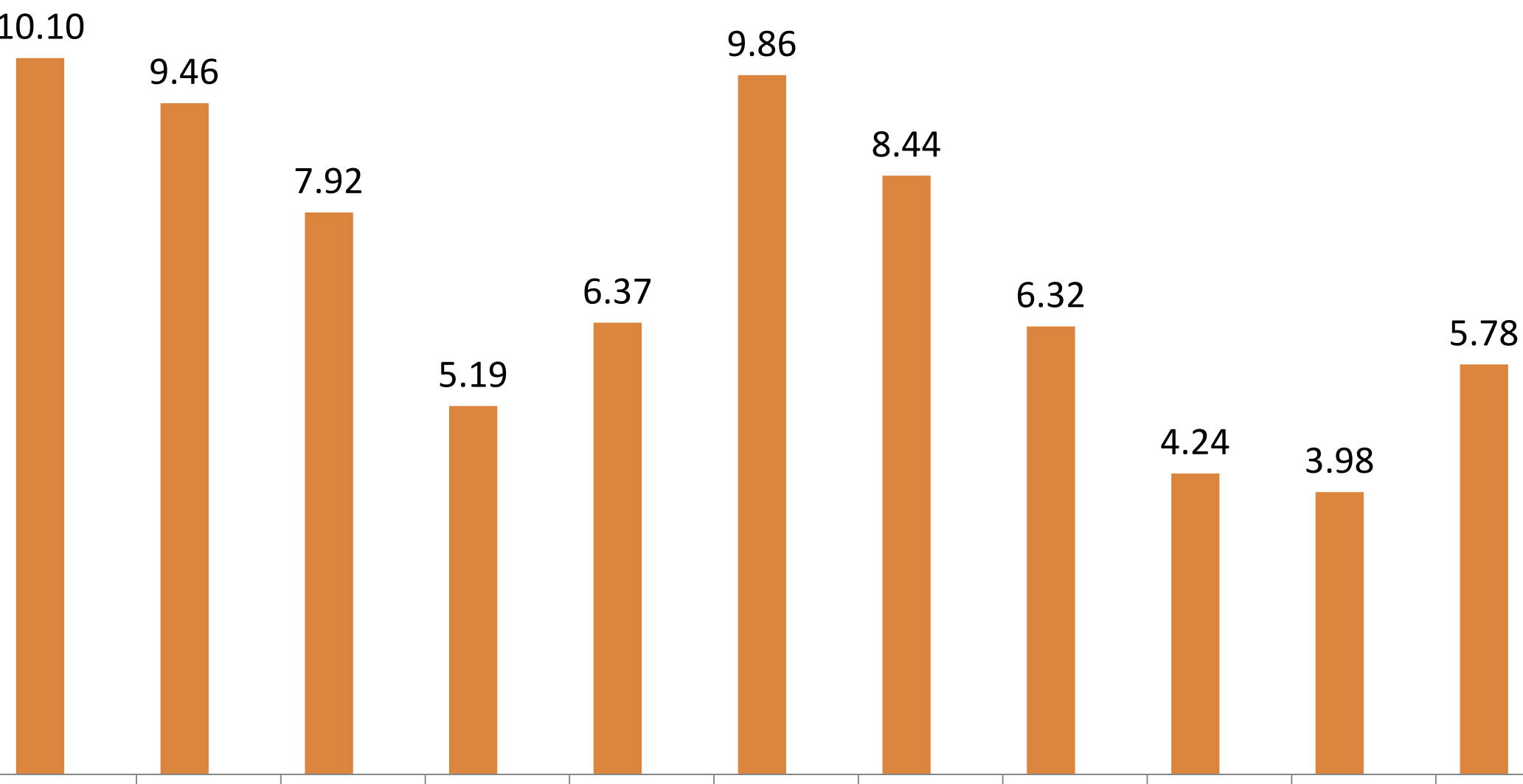
## ■ Power Generation (Million Units)

FY 2014-15 : 98



## ■ Net Realization Export (Million Units)

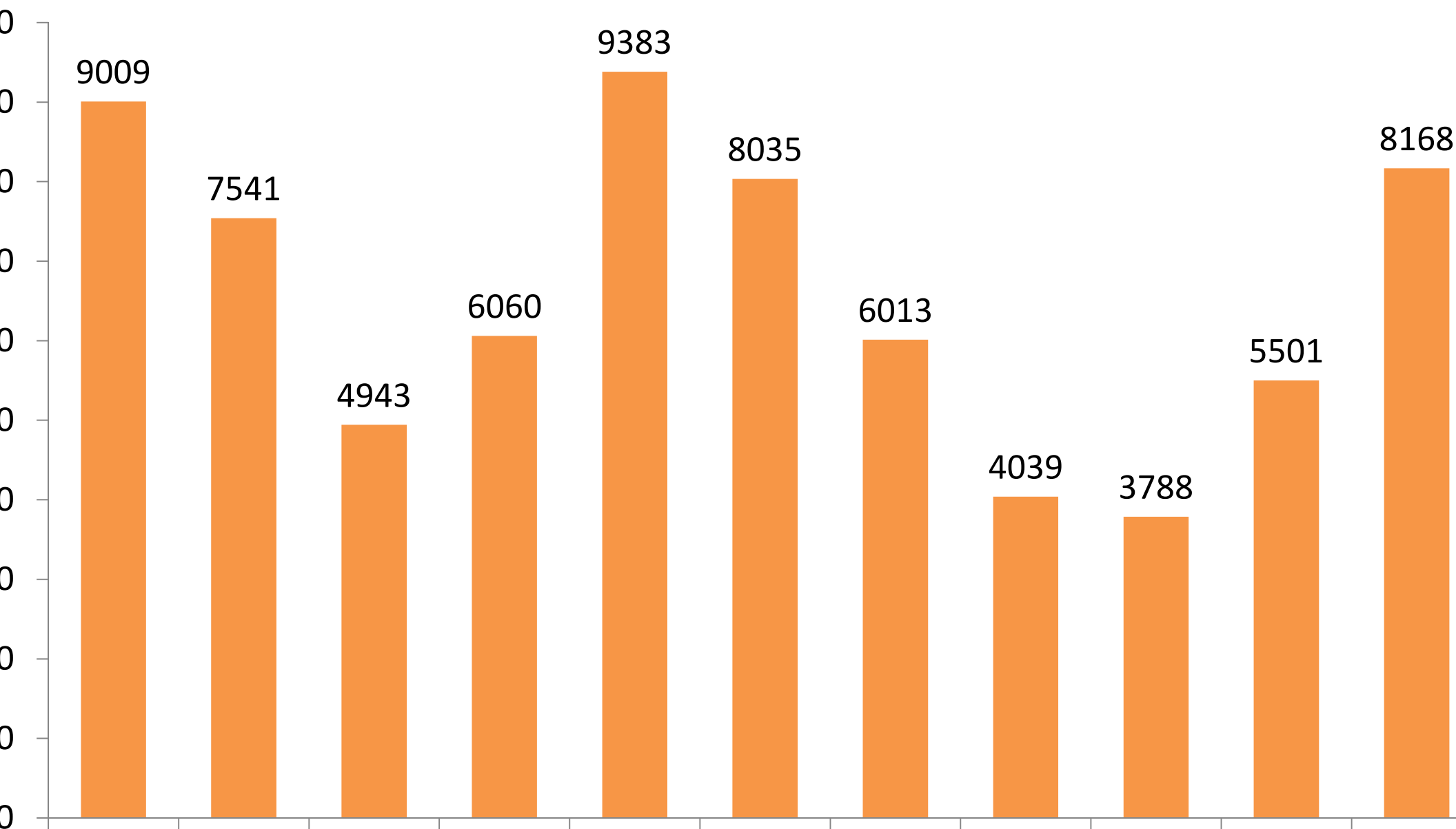
FY 2014-15 : 86



# Performance at a Glance

■ CER (tn CO2)

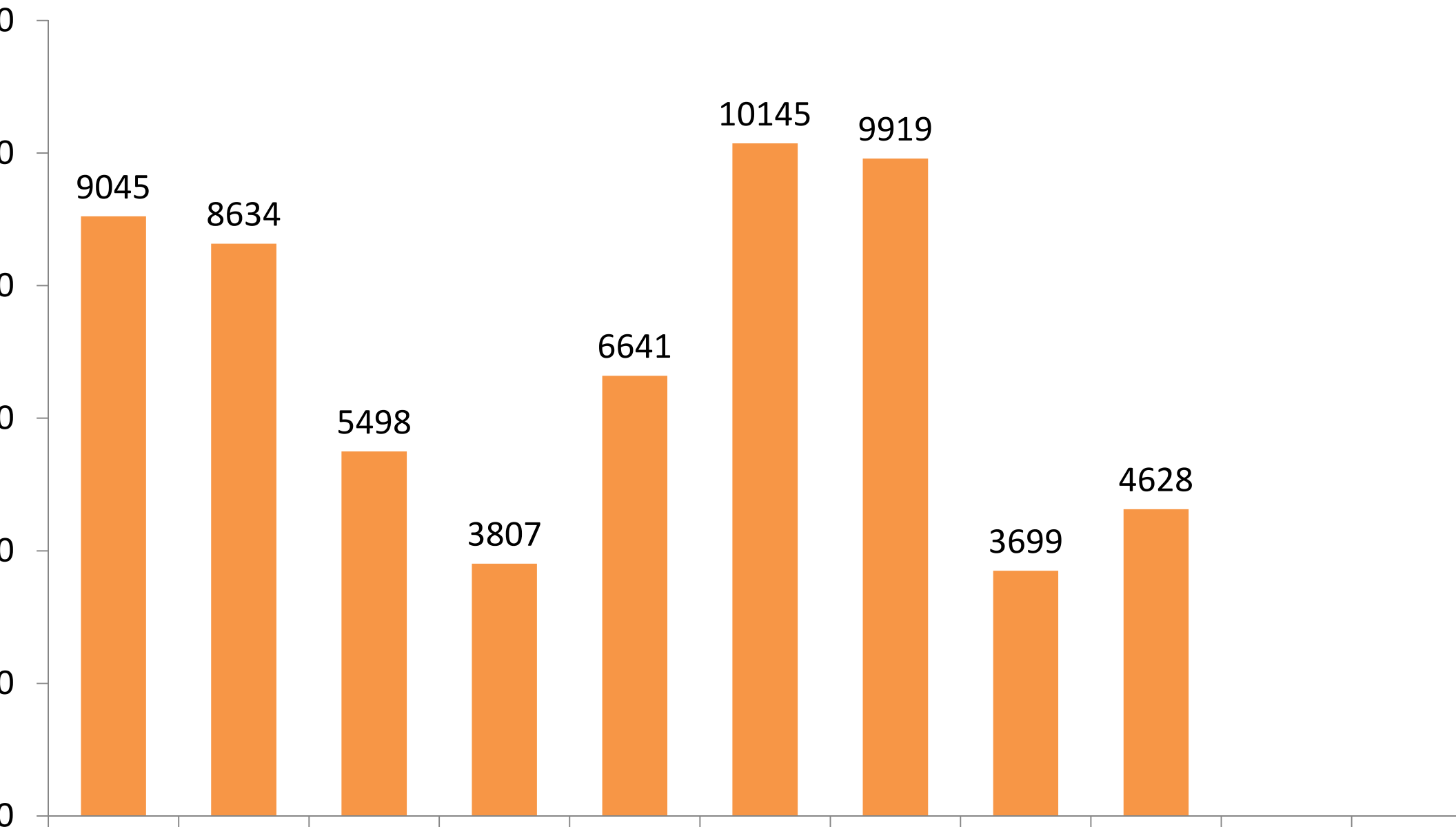
FY 2014-15: 8168



# Performance at a Glance

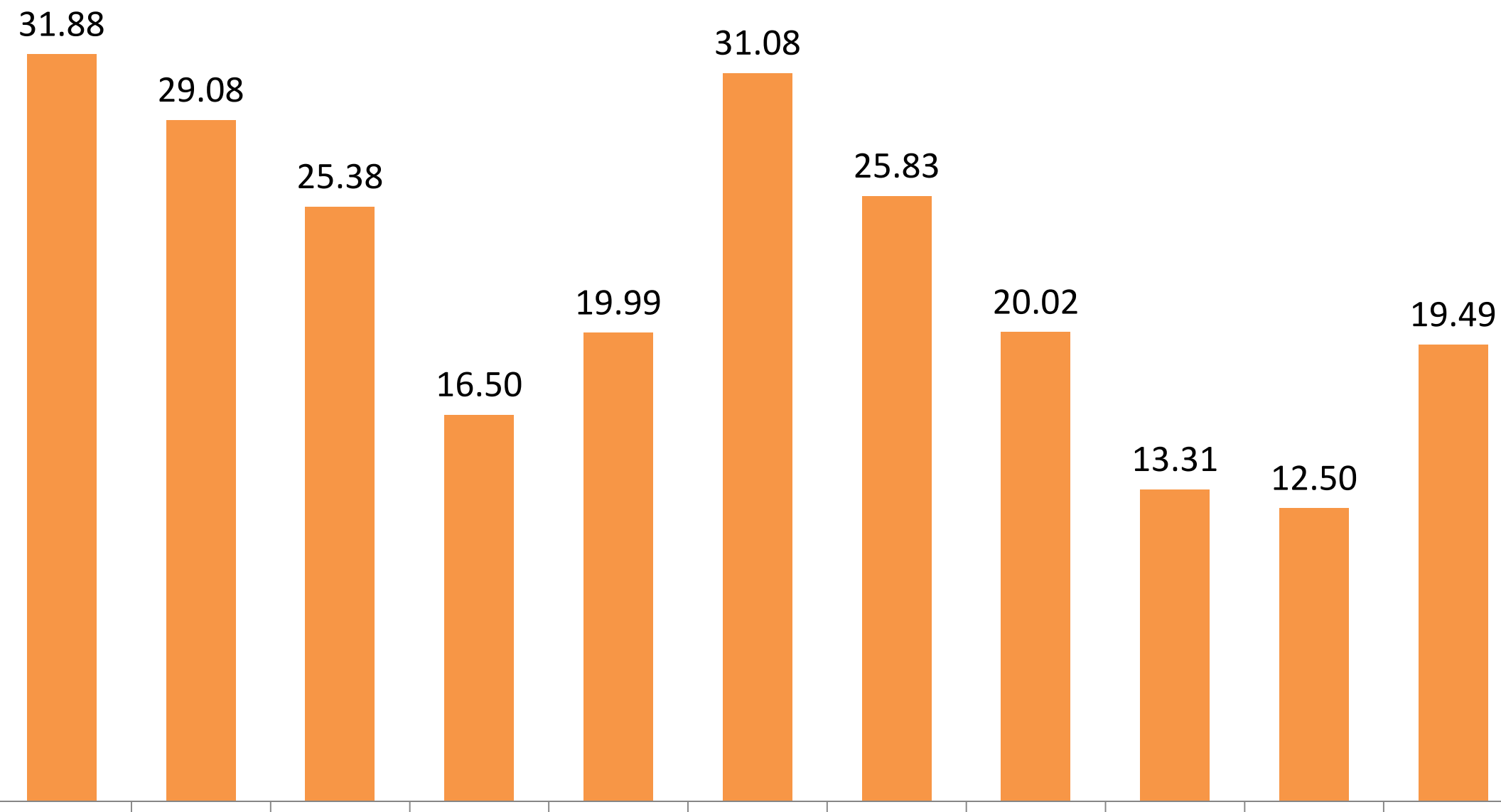
■ CER (tn CO2)

FY 2015-16: 62

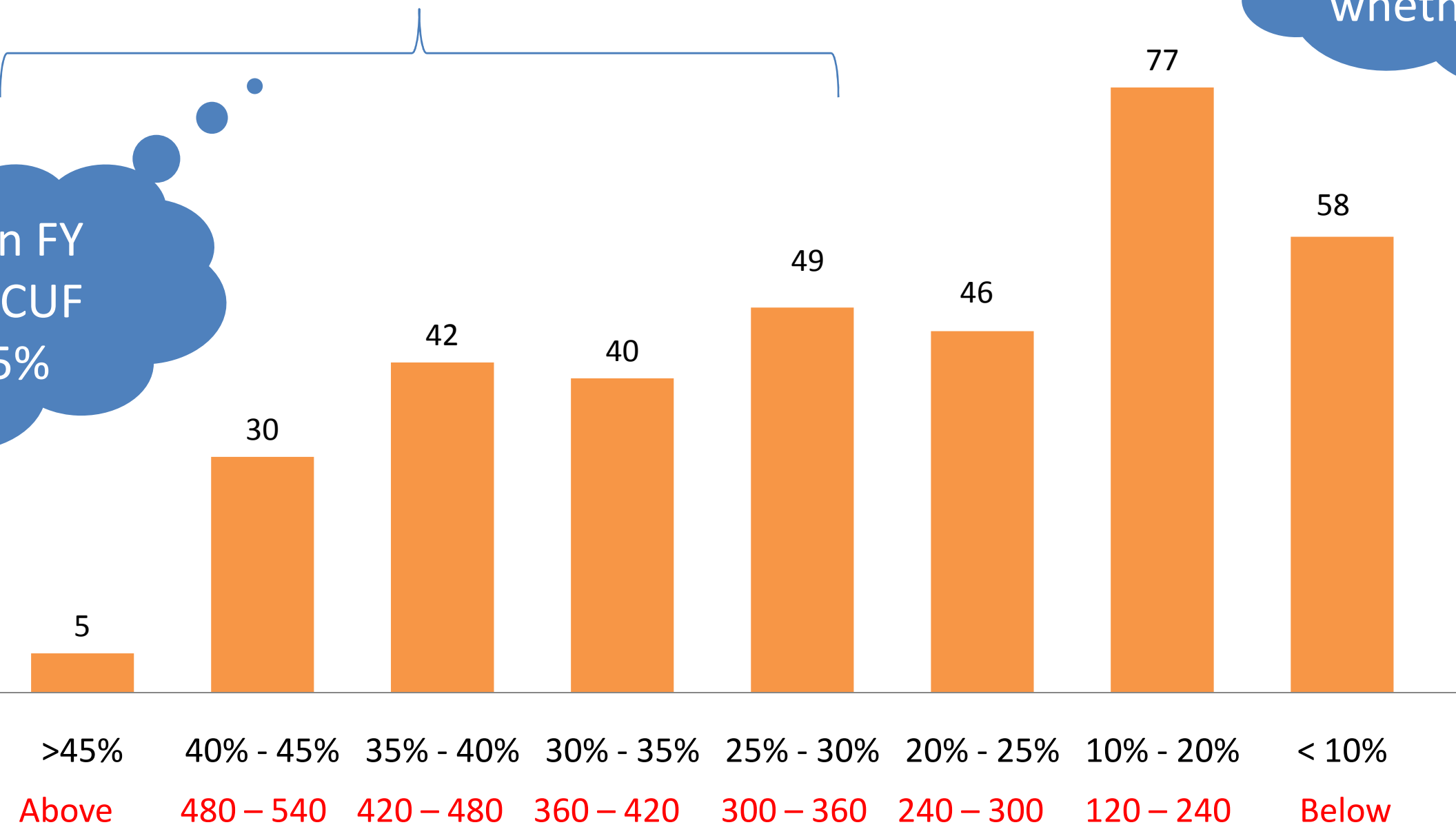


## ■ Capacity Utilisation Factor (%)

FY 2014-15: 22

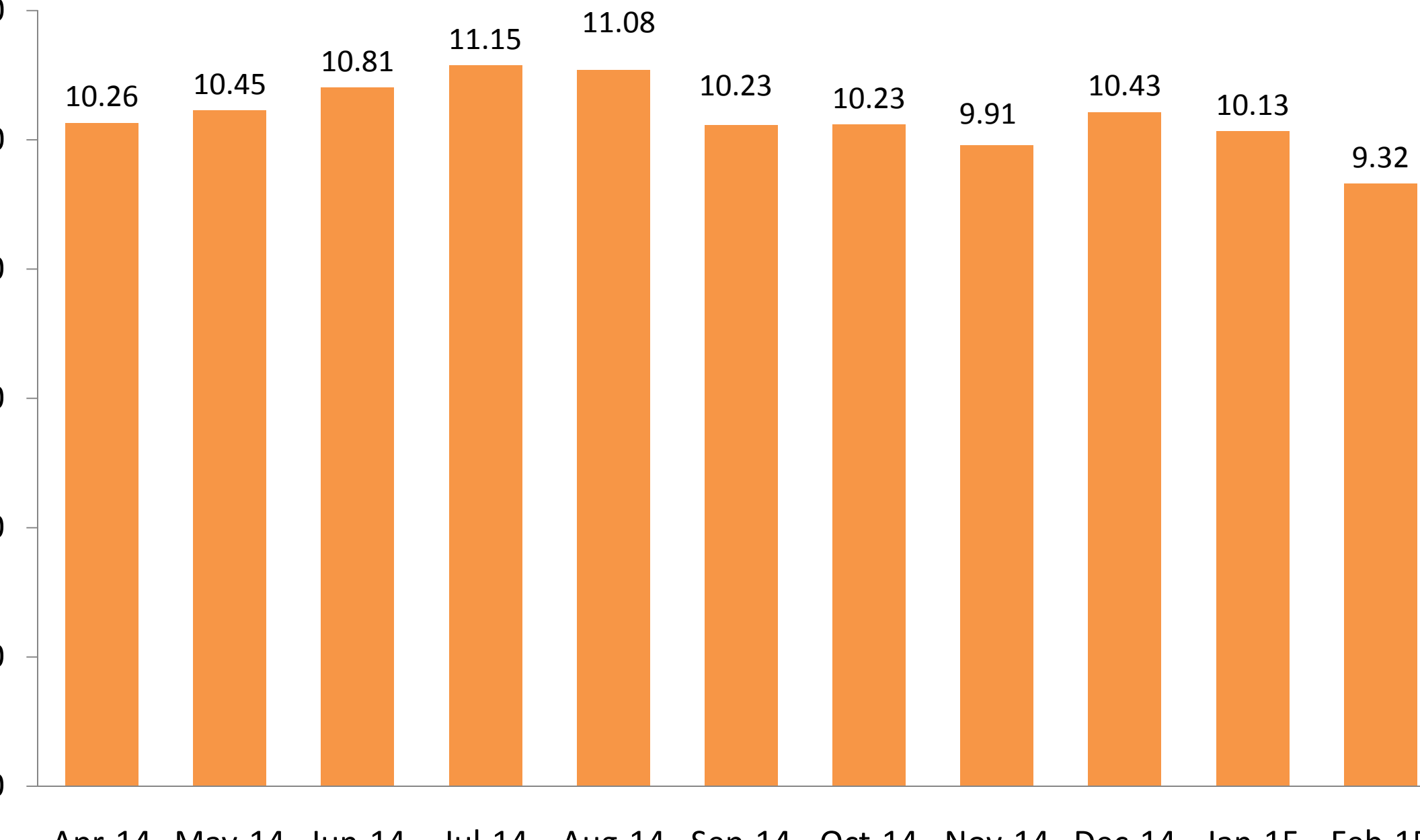


## ■ CUF (%) no.of days FY 2014-15



## Auxiliary Power Consumption (%)

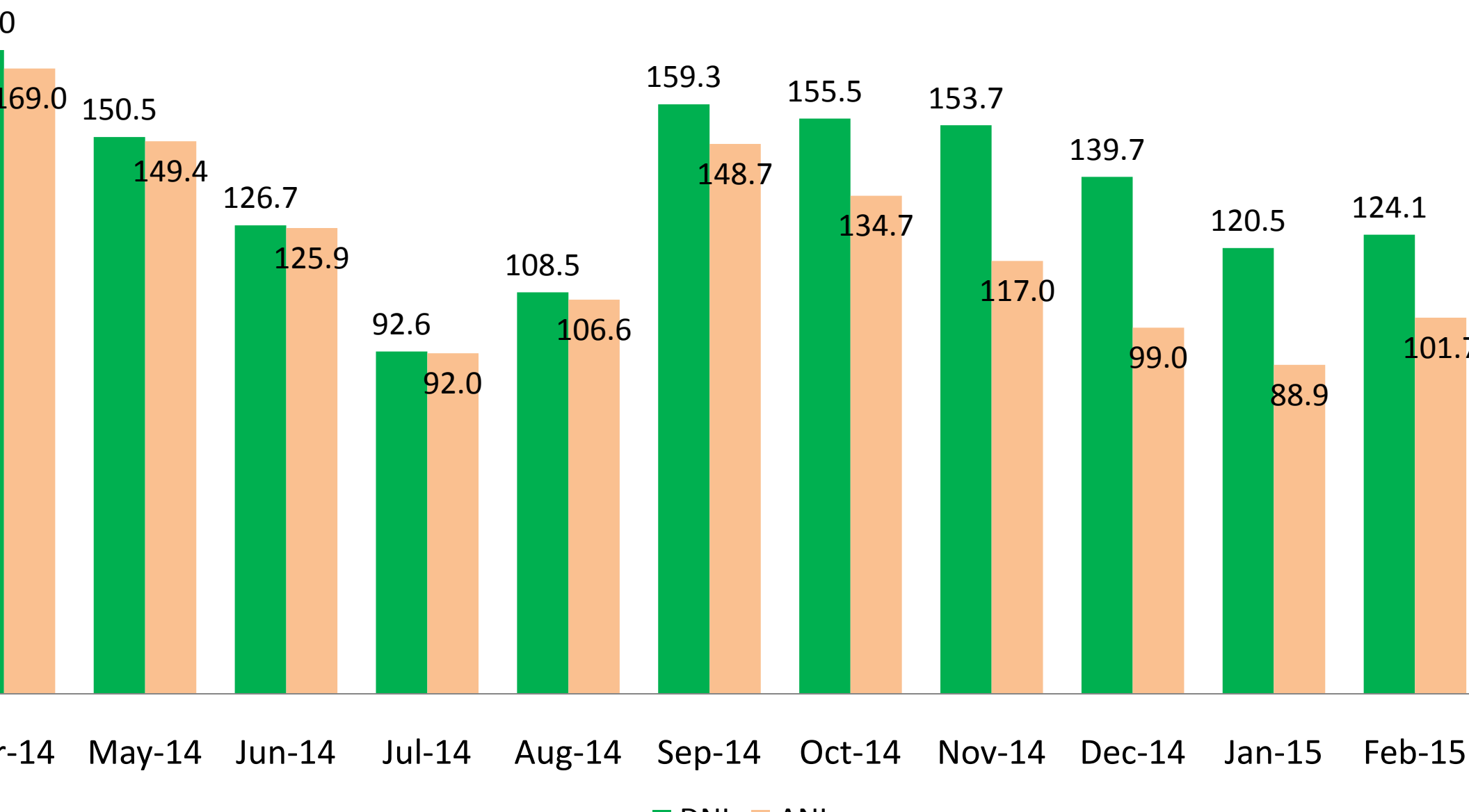
FY 2014-15: 10.13



## ■ Solar Energy availability (kwh/M2/Month)

FY 2014-15 : 1

FY 2014-15 : 1



## ■ 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.

## put

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

Case Analysis Tools Script Help

New CSP Trough Physical Case 1 X

Select Technology and Market...

CSP Trough Physical, Single Owner

### Location and Resource

Location: GGEL, RJ  
Latitude: 27.6 Long: 72.2 Elev: 183.0 m

### Collector Field

Number of Collectors: 1,46756  
Number of Loops: 120  
Collector Area: 392400

### Collectors (SCAs)

### Receivers (HCEs)

### Power Cycle

Plate: 50 MWe  
Efficiency: 0.3803

### Thermal Storage

Storage Hours: 0  
Storage Volume: 0

### Financials

### Performance Adjustment

Percent of annual output: 96 %  
Year-to-year decline: 0 % per year

### High System Costs

Installed: \$ 136,769,200  
Levelized Cost of Energy (\$/kWh): \$ 2,763

### Financing

Analysis: 25 years  
Financing mode: Specify IRR Target

### Utilities

### Choose Weather Data File

Type a few letters of the location name:

SAM/WV Elkins.tm2  
SAM/WV Huntington.tm2  
SAM/WY Casper.tm2  
SAM/WY Cheyenne.tm2  
SAM/WY Lander.tm2  
SAM/WY Rock Springs.tm2  
SAM/WY Sheridan.tm2  
D:\SOLAR\GGEL\New Project\IND\_Chirtadurg.432330\_ISHRAE.epw  
D:\SOLAR\GGEL\New Project\NEW\_PROJ\_AVGTY.csv  
D:\SOLAR\GGEL\GGEL\_NAUKH\_AVGTY.csv

Download weather

Folder settings

Refresh list

Copy to project

Remove from project

Create TMY3 file

Click a file in the list to choose a file from the NREL NSRDB TMY2 dataset, or click Download Weather File to enter an address and download a weather file from the NREL Solar Prospector database. A blue highlight indicates the weather file SAM uses for simulations. SAM lists files in the default weather folder and in any folders you specify in Folder Settings. The prefix "SAM/" indicates a file from the default folder. To embed weather data in your .zsam file for sharing with other people, click Copy to Project: SAM indicates the embedded weather file in the list with the prefix "USER/". See Help for details.

### Location Information

City GGEL

Time Zone GMT 5.5

Latitude 27.573 degrees

State RJ

Elevation 183 m

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

View hourly data

### 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

# Hourly output

R\GGEL\sam updated.zsam

ols Script Help

Case 1

CSP Trough Physical, Single Owner

View and export data:



Graphs



Tables



Cash Flows



Time Series



Loss Diagram

Choose Simulation:

Base Case

Copy to clipboard

Save as CSV...

Send to Excel

- ☐ Field pumping power (MWh)
- ☐ Fixed parasitic load (MWh)
- ☐ Fossil backup mass flow (kg/s)
- ☐ Fraction of operating cost
- ☐ Freeze protection energy (MWh)
- ☒ Gross electric power output (MWh)
- ☐ Hot tank HTF volume (m³)
- ☐ Hot tank mass level (kg)
- ☒ Hour of the day (hours)
- ☐ Hourly Dispatch Factors
- ☐ Hourly Energy (kWh)
- ☐ Incidence angle modifier
- ☐ Incident energy-cosine effect
- ☐ Net electric power output (MWh)
- ☐ Power block HTF mass flow (kg/s)
- ☒ Power cycle HTF inlet temperature (°C)
- ☒ Power cycle HTF return temperature (°C)
- ☒ Power cycle efficiency - %
- ☐ Power cycle/TES pumping power (MWh)
- ☐ Receiver thermal losses (MWh)
- ☐ Row shadowing effect, %
- ☐ Single loop mass flow rate (kg/s)
- ☒ Solar azimuth angle (deg)
- ☒ Solar elevation angle (deg)
- ☒ Solar field mass flow rate (kg/s)
- ☒ Solar field pressure drop (bar)
- ☐ Solar field startup energy (MWh)
- ☐ Solar field thermal output (MWh)

Gross electric power output (MWh), hourly

the day (hours)

HTF inlet temperature

return temperature

cycle efficiency

|     |          |    |         |         |       |
|-----|----------|----|---------|---------|-------|
| 730 | 0.510011 | 10 | 387.448 | 293     | 0.391 |
| 731 | 44.2935  | 11 | 390.483 | 289.872 | 0.396 |
| 732 | 42.0654  | 12 | 390.535 | 289.51  | 0.392 |
| 733 | 57.433   | 13 | 390.828 | 293.042 | 0.416 |
| 734 | 44.5869  | 14 | 390.405 | 290.004 | 0.391 |
| 735 | 56.6245  | 15 | 389.989 | 292.089 | 0.414 |
| 736 | 42.8817  | 16 | 390.701 | 289.887 | 0.38  |
| 737 | 43.6616  | 17 | 391.034 | 290.373 | 0.390 |
| 738 | 0        | 18 | 325.855 | 293     |       |
| 739 | 0        | 19 | 293     | 293     |       |
| 740 | 0        | 20 | 293     | 293     |       |
| 741 | 0        | 21 | 293     | 293     |       |
| 742 | 0        | 22 | 293     | 293     |       |
| 743 | 0        | 23 | 293     | 293     |       |
| 744 | 0        | 0  | 293     | 293     |       |
| 745 | 0        | 1  | 293     | 293     |       |
| 746 | 0        | 2  | 293     | 293     |       |
| 747 | 0        | 3  | 293     | 293     |       |
| 748 | 0        | 4  | 293     | 293     |       |
| 749 | 0        | 5  | 293     | 293     |       |
| 750 | 0        | 6  | 293     | 293     |       |
| 751 | 0        | 7  | 293     | 293     |       |
| 752 | 0        | 8  | 293     | 293     |       |
| 753 | 0        | 9  | 293     | 293     |       |
| 754 | 10.5458  | 10 | 388.922 | 293     | 0.3   |
| 755 | 51.8292  | 11 | 391.686 | 292.76  | 0.403 |
| 756 | 31.1983  | 12 | 390.191 | 286.825 | 0.37  |
| 757 | 0        | 13 | 334.364 | 293     |       |
| 758 | 27.5896  | 14 | 389.196 | 285.143 | 0.366 |
| 759 | 0        | 15 | 369.853 | 293     |       |

# Monthly output

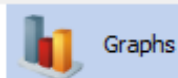
R\GGEL\sam updated.zsam

Tools Script Help

Case 1 X

CSP Trough Physical, Single Owner

View and export data:



Graphs



Tables



Cash Flows



Time Series



Loss Diagram

Add a new graph...

Edit...

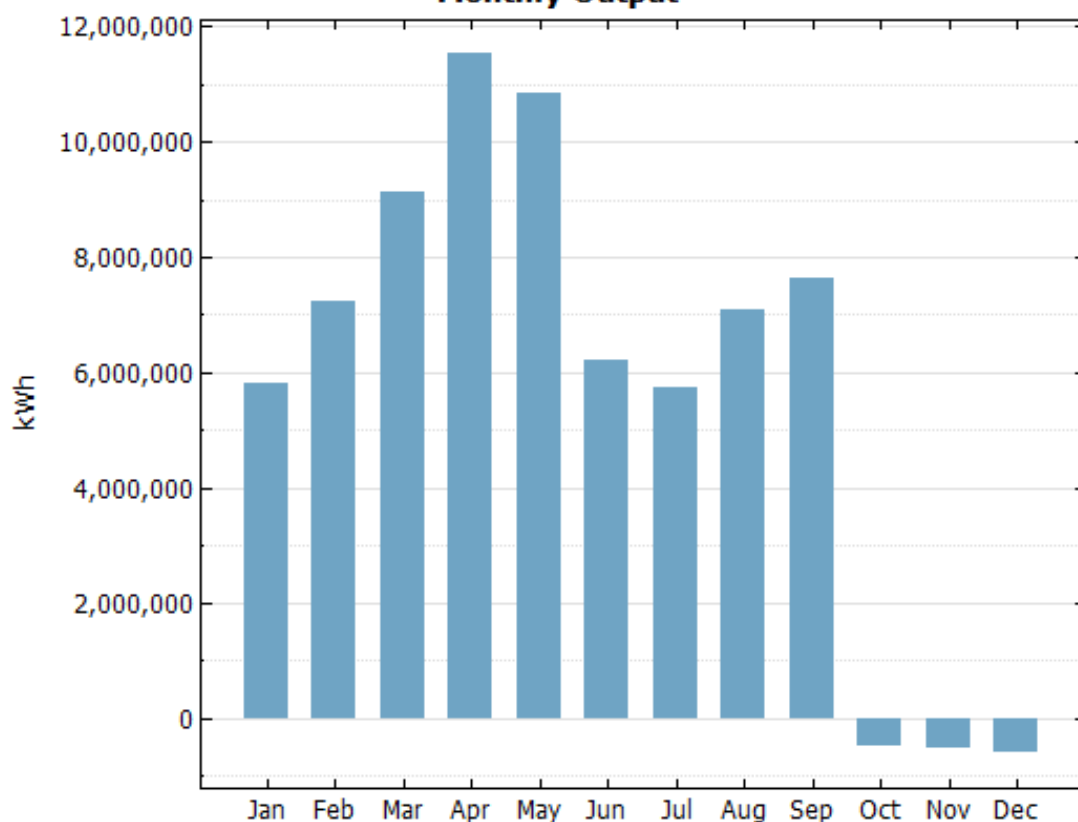
Remove

Remove All

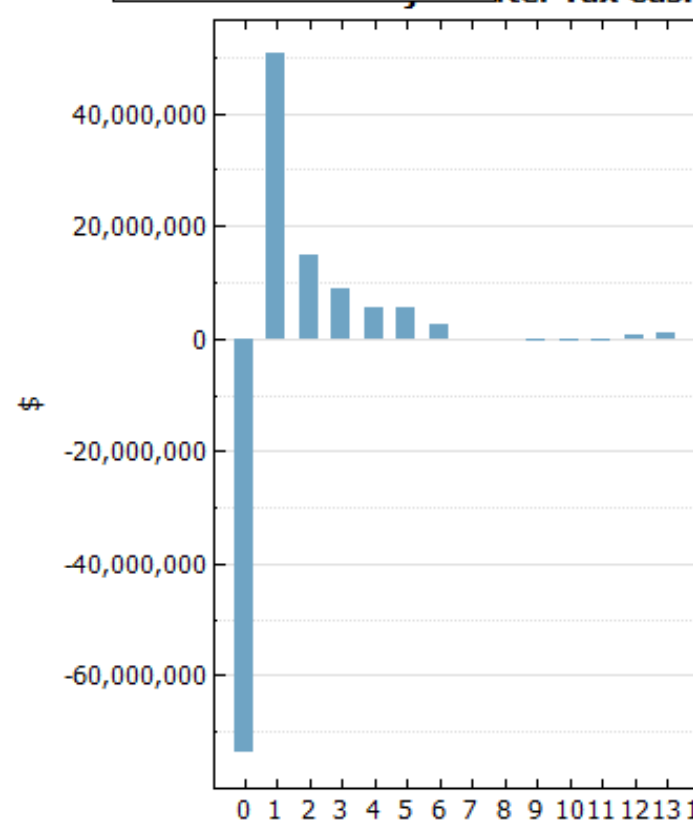
Copy Graph Data

Show Graph Data

## Monthly Output



## After-tax project returns (\$)



Value

9,658,320 kWh

9.98 ¢/kWh

5.31 ¢/kWh

0.63 ¢/kWh

0

1.00 %

0

1.00 %

2.81 %

11,684,937.00

0.00 %

1.82 %

136,769,200.00

0.00

16,062,576.00

152,831,776.00

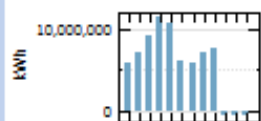
79,192,272.00

73,639,504.00

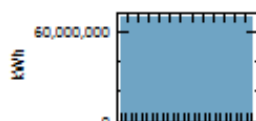
5.1 %

89

## Monthly Output



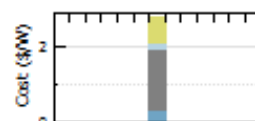
## Annual Output



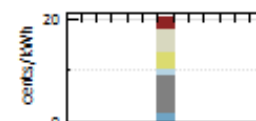
## Annual Energy Flow



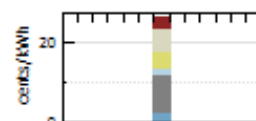
## Cost per Watt



## Stacked Real LCOE



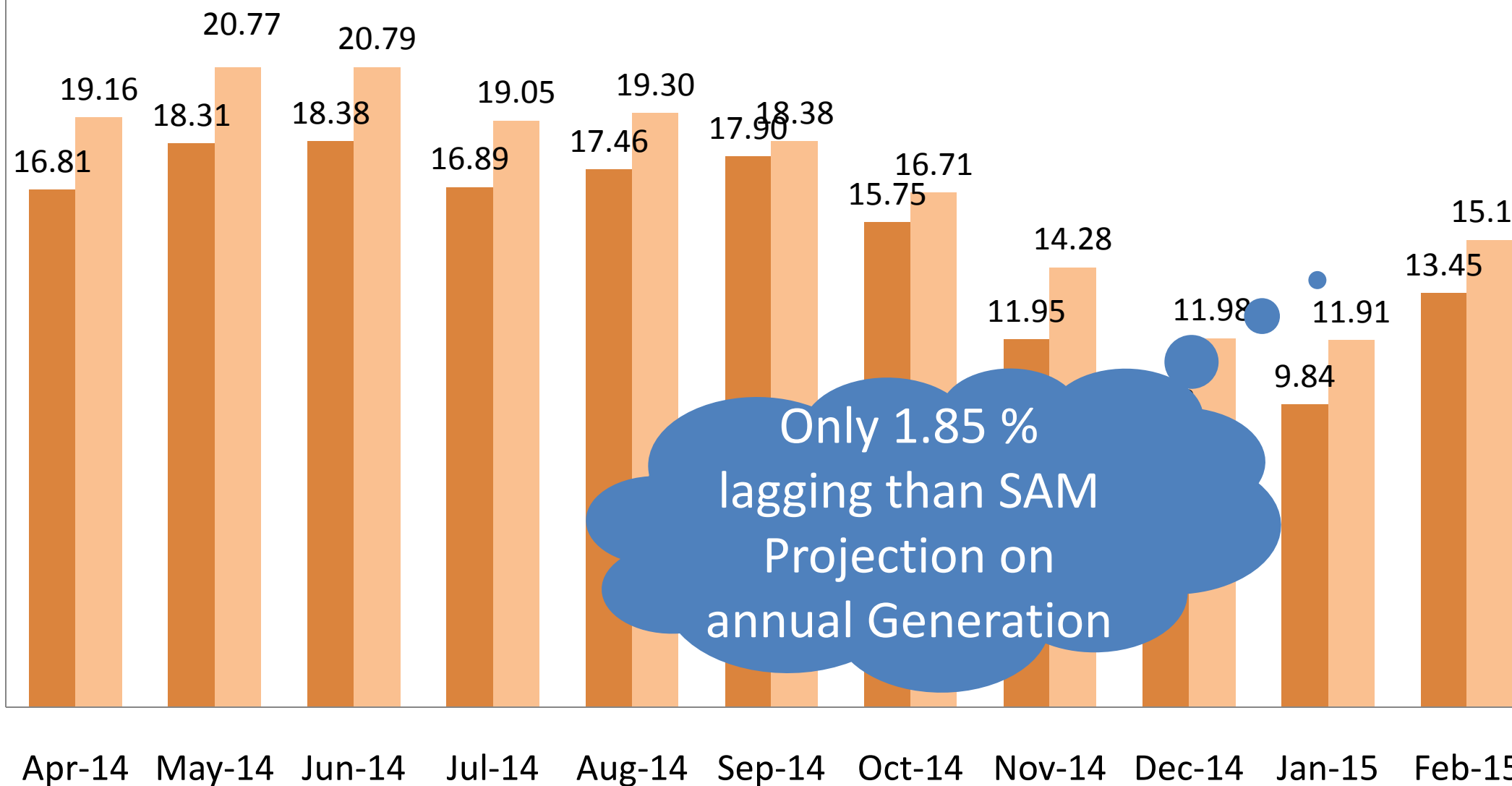
## Stacked Nominal LCOE



## ■ Energy Conversion Factor – Solar to Power(%) SAM Proj Vs Actual

FY 2014-15: 15

FY 2014-15: 17



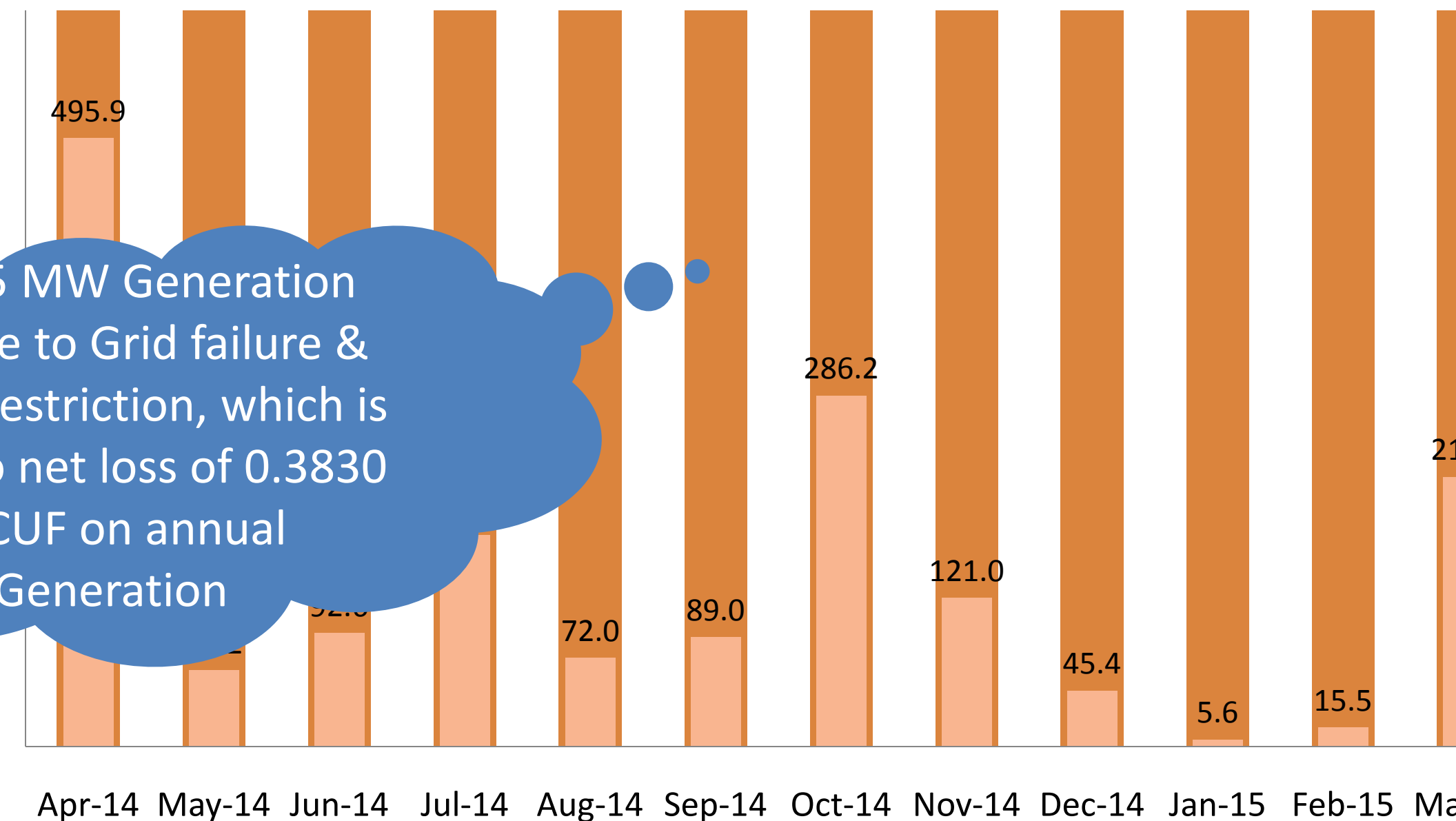
Only 1.85 %  
lagging than SAM  
Projection on  
annual Generation

# Performance at a Glance

■ Grid Stability (%)

FY 2014-15 : 98

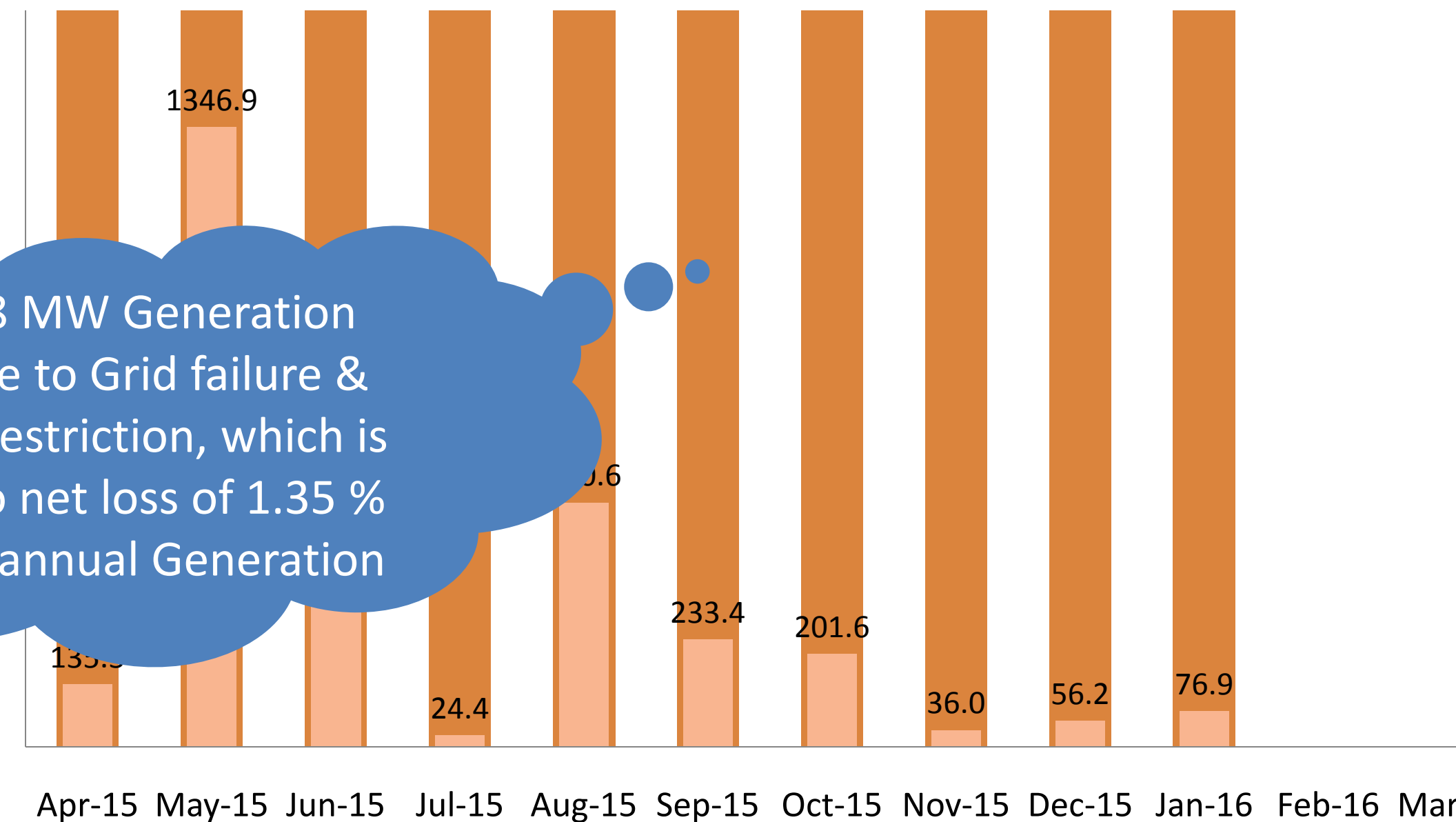
■ & Generation Loss (MWh)



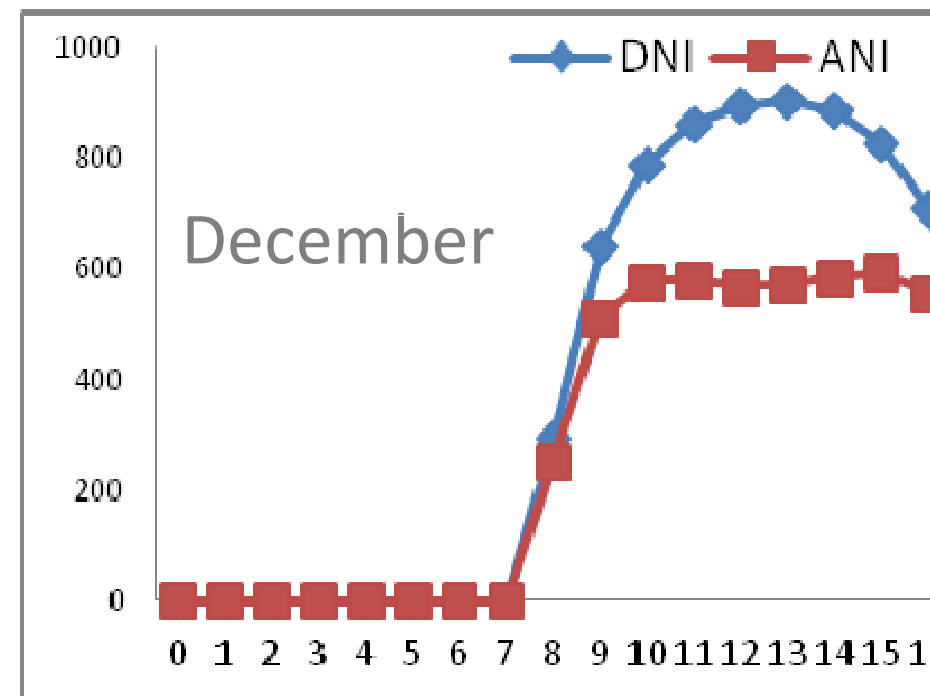
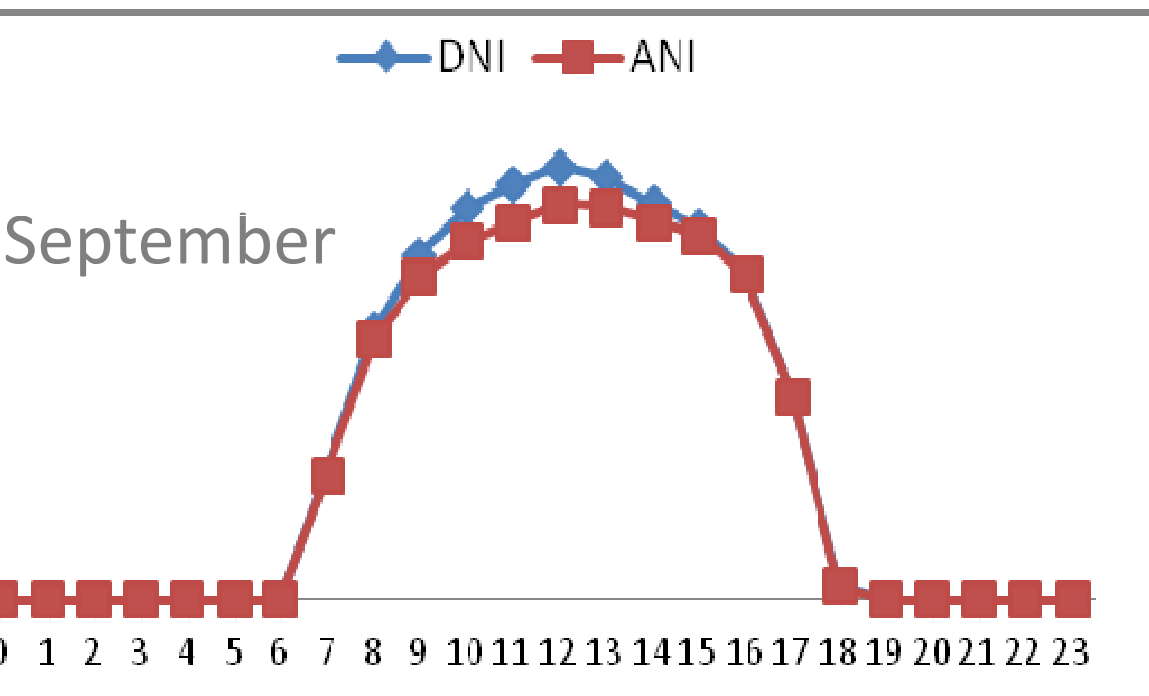
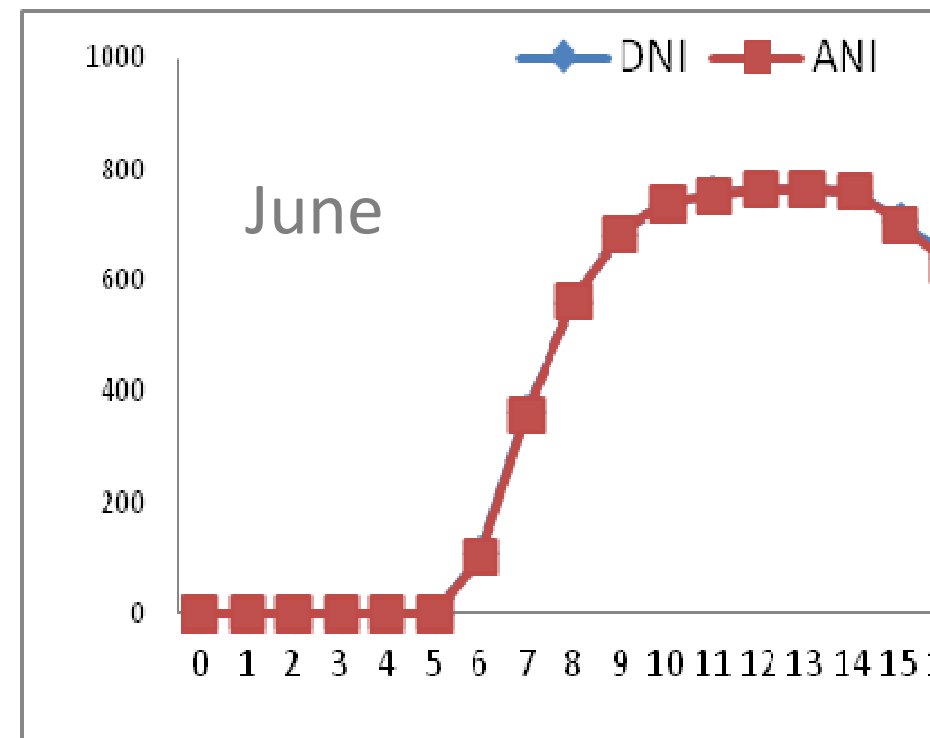
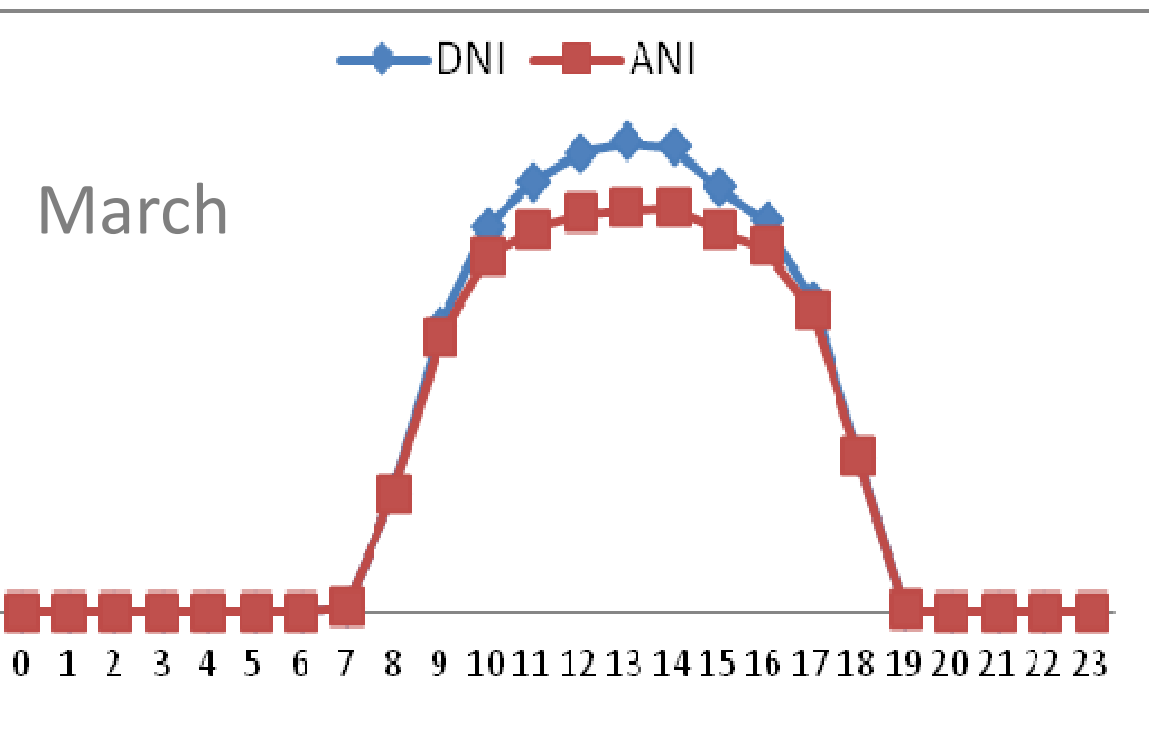
■ Grid Stability (%)

■ & Generation Loss (MWh)

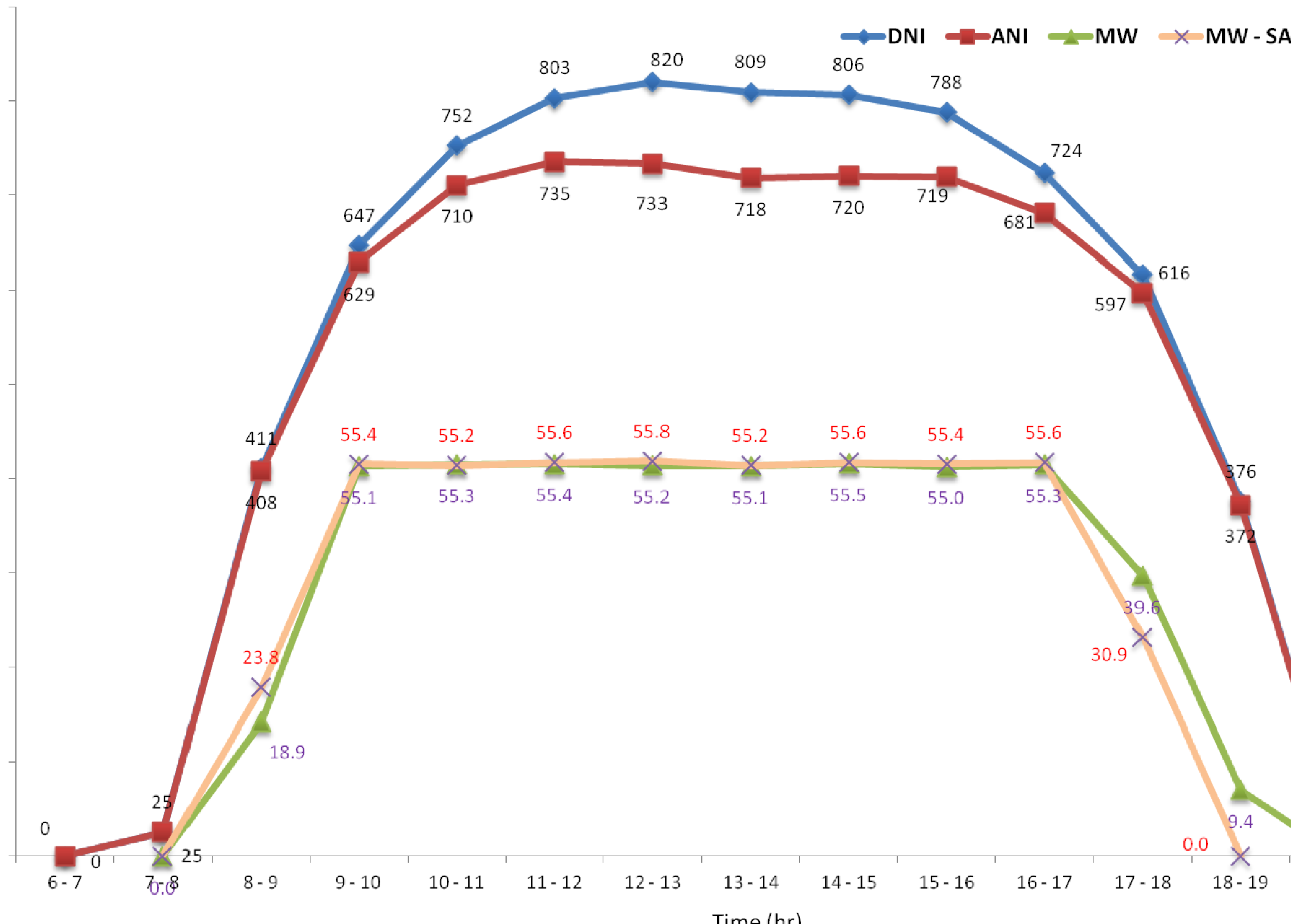
FY 2015-16 : 96



# DNI / ANI at different quarter



# Loadance & Generation in a day



## 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  
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

## **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 CSP**

---

**Higher CUF with storage**

**Better grid stability**

**24 hour operation possible with storage or hybridization**

# day Forward

**OPERATION**  
**MAINTENANCE**

JS :

[a.solanki@ggel.in](mailto:a.solanki@ggel.in)

# THANK YOU



**GODAWARI**