Financial Sustainability / Viability with Optimum Design

IN

SOLAR INDUSTRIES in INDIA

Submitted

By

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2K 14 / MBA / 509

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This is to certified that the Thesis entitled Study of

“**Financial Sustainability / Viability with Optimum Design In Solar Industries in INDIA**”

Is being submitted by the candidate, K S S Senthamil Selvan – 2K14/EMBA/509 in partial fulfillment for the award of Exe Master of Business Administration by Delhi School of Management, Delhi Technological University, Delhi and is original work carried out by he under my guidance and supervision. The matter contained in this thesis has not been submitted elsewhere for award of any other degree.

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DECLARATION

I K S Senthamil Selvan student of EMBA 2014-2016 batch of Delhi School of Management, Delhi Technological University, Bawana road, Delhi-42 declare that term project "**Financial Sustainability / Viability with Optimum Design In Solar Industries in INDIA**" Submitted in partial fulfilment of Executive MBA programme is the original work conducted by me.

The information and data given in the report is authentic to the best of my knowledge.

This Report is not being submitted to any other University for award of any other Degree, Award and Fellowship.

K S S Senthamil Selvan.

2K14 / MBA / 509

Place: New Delhi

Date: 25th May' 2016

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ABBREVATION

General:

ACB	Air Circuit Breaker
AC	Alternate current
ACSR	Aluminum Conductors Steel Reinforced
BOS	Balance Of the System
BSPHCL	Bihar State Power (Holding) Company limited
CO_2	Carbon Dioxide
CT	Current Transformer
DC	Direct Current
DP	Double Pole
GoI	Government of India
HT	High Tension
LT	Low Tension
LV	Low Voltage
MNRE	Ministry of New and Renewable Energy
NBPDCL	North Bihar Power Distribution Company Limited
kWh	kilo Watt Hour
MCB	Main Combiner Box / Miniature Circuit Breaker
PLF/ CUF	Plant Load Factor/ Capacity Utilization factor
PPA	Power Purchase Agreement
PV	Photo Voltaic
PT	Power Transformer
SBPDCL	South Bihar Power Distribution Company Limited
SECI	Solar Energy Corporation of India
SPV	Special Purpose Vehicle
TEV	Techno Economic Viability
VCB	Vacuum Circuit Breaker

XLPE	Cross Linked Polyethylene

Units

%	Percentage
˚C	Degree Centigrade
kg	Kilogram
kV	kilo Volt
kW	kilo Watt
kWh	Kilo Watt hour
kWp	kilo Watt peak
Lt	Litre
M	Meter
MW	Mega Watt
m^2	Square meter
m^3	Cubic meter
Tons	Tons

1. Executive Summary

This study of this project is done for the Management Studies in Delhi School of

Management (DSM). This studies shows the involvement of "**Financial Sustainability / Viability with Optimum Design In Solar Industries in INDIA**". The project done in the field of Solar Energy in INDIAN. The overview includes general information about the Solar Energy the Current installed capacity and expected growth,

1.1 Need of the Study :

The Solar Energy will have an important role to play in meeting India's energy security needs in the coming years. The growing energy needs of India and the focus on clean energy has created unique opportunities for the solar energy sector in India. India presents a huge market for the growth and penetration of solar energy. The study is a starting point to assist in determining where and how to focus resources to maximize profit, cost effective design employment growth in the solar industry.

The main objective of this project is to enable oneself to prepare a Financial Model and inspect the financial feasibility of the project from both Owner's and Lender's perspective. Projects related to power sector requires huge amount of investment at the beginning stage itself, it is necessary to prepare the project based financial model. Thorough this Financial model the systematic analysis will be carried out to find the financial viability of the proposed project prior taking any decision regarding the initiation and further proceedings related to the proposed project.

1.2 Objective of Study:

The solar power capacity installation target under the NSM is divided into three phases with specific target ranges for each phase (MNRE, 2009):

- Phase 1: 1,000-2,000 MW by March 2013; 500 MW awarded to CSP1
- Phase 2: 4,000-10,000 MW by March 2017
- Phase 3: 20,000 MW by March 2022 (information from NSM site)

1.3 Tools and Techniques:

In this project the necessary inputs are taken from various sources like web site, some expert advice, and self experience, and also some are taken as per CERC Guidelines and some of them are assumed rationally in order to proceed the Financial Modelling process. After compiling the input data various dependent variables such as Depreciation, Working Capital , Interest on Working Capital, ROE, O & M cost, Interest on Loan etc. are calculated which are further used to calculate the Tariff. In order to keep in mind the time value of money the levelised tariff is calculated to denote the nominal tariffs of different years by a single value. Then the next step is to prepare sheets of Profit & Loss account, Cash flow statement, Balance Sheet and Debt service coverage ratio which are main determinants for the analysis of financial viability of any upcoming power generation project. Once the relationships between various indicators of the financial aspects of the project are developed (in excel sheet) with the help of financial tools, we interpolate the different values of the changeable inputs such as Interest on loan, PLF, O&M expenses etc to find out the different outcomes and the way the changes in these inputs impacts the Levelised Tariff. This is done to know the degree and direction of impact of inputs on the outputs in order to select the best suited set of inputs.

The financial plan and tariff calculation for the Project has been done in light of regulatory, technical and financial clauses under the CERC RE Tariff Regulations 2012. In Profit & Loss account, the taxation has been done in accordance with IT Act.

Financial modelling tool has been designed to calculate Levelised tariff for 25 years at 15.97% discount rate. The financial model also offers the flexibility to change and adapt different inputs and assumptions for different projects.

The Model aims at answering few key questions

- How much would be the actual return on equity (after tax) to the owner?
- At what Tariff rate under CERC‟s guidelines can the project engage in a long term PPA with a distribution licensee assuming Grid connectivity?
- What would be the return if the owner chooses to opt for APPC rate rather than preferential Tariff structure?

- What would be the total income and savings if the owner‟s opts for Captive generation?

- What would be the Debt Service Coverage Ratio over the tariff period?
- Impact of various financial factors on tariff

1.4 Definitions :

1.4.1 Levelised Tariff :

Levelised tariff in the power sector is basically the Sum of the Present value of all the tariff calculated over the tariff period w.r.t. inception of the project upon the sum of the discount factors.

Levelised Tariff:

$$\frac{\text{Sum of P.V. of Tariff over the life of the plant/PPA}}{\text{Sum of Discount Factors}}$$

1.4.2 CUF / PLF:

It is the ratio of actual energy generated, to the energy the plant would have generated if it was operating at its maximum capacity. It is given as percentage and is usually calculated for a period of one year.

CUF/PLF:

$$\frac{\text{100* Energy Generated in a year}}{\text{Maximum energy generated in a Year}}$$

1.4.3 DISCOUNT FACTOR:

The discount factor is the factor by which a future cash flow must be multiplied in order to obtain the present value.

1.4.4 DEBT-EQUITY SERVICE COVERAGE RATIO:

In corporate finance, it is the amount of cash flow available to meet annual interest and principal payments on debt, including sinking fund payments.

In general, it is calculated by:

DSCR:

$$\frac{\text{Net Operating Income}}{\text{Total Debt Service}}$$

1.4.5 DEBT-EQUITY RATIO:

It is the ratio of debt and equity employed in any business. It is a measure of a company's financial leverage calculated by dividing its total liabilities by stockholders' equity. It indicates what proportion of equity and debt the company is using to finance its assets.

D/E Ratio:

$$\frac{\text{Total Long Term Loan}}{\text{Owner"s equity}}$$

1.4.6 NET PRESENT VALUE (NPV):

The difference between the present value of cash inflows and the present value of cash outflows. NPV is used in capital budgeting to analyze the profitability of an investment or project.

NPV analysis is sensitive to the reliability of future cash inflows that an investment or project will yield.

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0$$

1.4.7 INTERNAL RATE OF RETURN (IRR):

The discount rate often used in capital budgeting that makes the net present value of all cash flows from a particular project equal to zero. Generally speaking, the higher a project's internal rate of return, the more desirable it is to undertake the project.

1.4.8 RETURN ON EQUITY:

The amount of net income returned as a percentage of shareholders equity. Return on equity measures a corporation's profitability by revealing how much profit a company generates with the money shareholders have invested.

ROE is expressed as a percentage of the total equity invested in the project.

RoE: $\dfrac{\text{Net Income}}{\text{Share-holder‟s Equity}}$

2. INTRODUCTION

Energy use is an important factor for the growth of a nation which in turn ensures the socio-economic development of a country. Power plays an important role in industrial, regional and overall societal development as it supports in employment, knowledge and skills generation thereby creating long term sustainable growth. In India, energy demand and supply gap has widened over time as the demand has increased faster than the supply over time. India is in need of sustainable energy solutions and amongst the various energy sources solar energy can be considered as preferred option. In addition to grid connected solar energy generation across industrial and commercial verticals, solar power is also well suited for decentralized and distributed power requirements which can assist in electrifying 400 million people with no access to electricity. Solar can play a huge role in bridging the increasing peak load power gap and also base load electricity demand which is expected to double by 2020.

Government of India announced the National Action Plan for Climate Change. one of the most important missions is the Jawaharlal Nehru National Solar Mission (JNNSM). The JNNSM envisages a capacity addition of 20 GW of solar energy generation by 2022. After phase 1, it is estimated that the remaining capacity under JNNSM will require an investment of more than USD 35 billion. This will significantly multiply the requirement of foreign exchange. The role of solar energy in energy security, decentralized energy demand and subsequently the benefits of a strong manufacturing base in the long term cannot be ignored.

2.1 WHY SOLAR REQUIRED ?

Solar Energy can be utilized for varied applications. So the answer to “Why Solar” question can be sought from two different perspectives: utilizing solar energy for grid-interactive and off-grid (including captive) power generation.

2.1.1 SOLAR FOR GRID CONNECTED ELECTRICTY:

Grid interactive solar energy is derived from solar photovoltaic cells and CSP Plants on a large scale. The grid connection is chosen due to following reasons:

- Solar Energy is available throughout the day which is the peak load demand time.

- ➢ Solar energy conversion equipments have longer life and need lesser maintenance and hence provide higher energy infrastructure security.
- ➢ Low running costs & grid tie-up capital returns (Net Metering).
- ➢ Unlike conventional thermal power generation from coal, they do not cause pollution and generate clean power.

Abundance of free solar energy throughout all parts of world (although gradually decreasing from equatorial, tropical, sub-tropical and polar regions). Can be utilized almost everywhere.

2.1.2 SOLAR FOR OFF-GRID SOLUTION:

While, the areas with easier grid access are utilizing grid connectivity, the places where utility power is scant or too expensive to bring, have no choice but to opt for their own generation. They generate power from a diverse range of small local generators using both fossil fuels (diesel, gas) and locally available renewable energy technologies (solar PV, wind, small hydro, biomass, etc.) with or without its own storage (batteries). This is known as off- grid electricity. Remote power systems are installed for the following reasons:

- Desire to use renewable - environmentally safe, pollution free
- Combining various generating options available- hybrid power generation
- Desire for independence from the unreliable, fault prone and interrupted grid connection
- Available storage and back-up options
- No overhead wires- no transmission loss
- Varied applications and products: Lighting, Communication Systems, Cooking, Heating, Pumping, Small scale industry utilization etc.
- Captive power generation is done mainly considering the replacement of diesel

with solar. Comparison of diesel vs captive power generation is available here.

Our tailor- made report on Captive Solar Power Generation can be downloaded here.

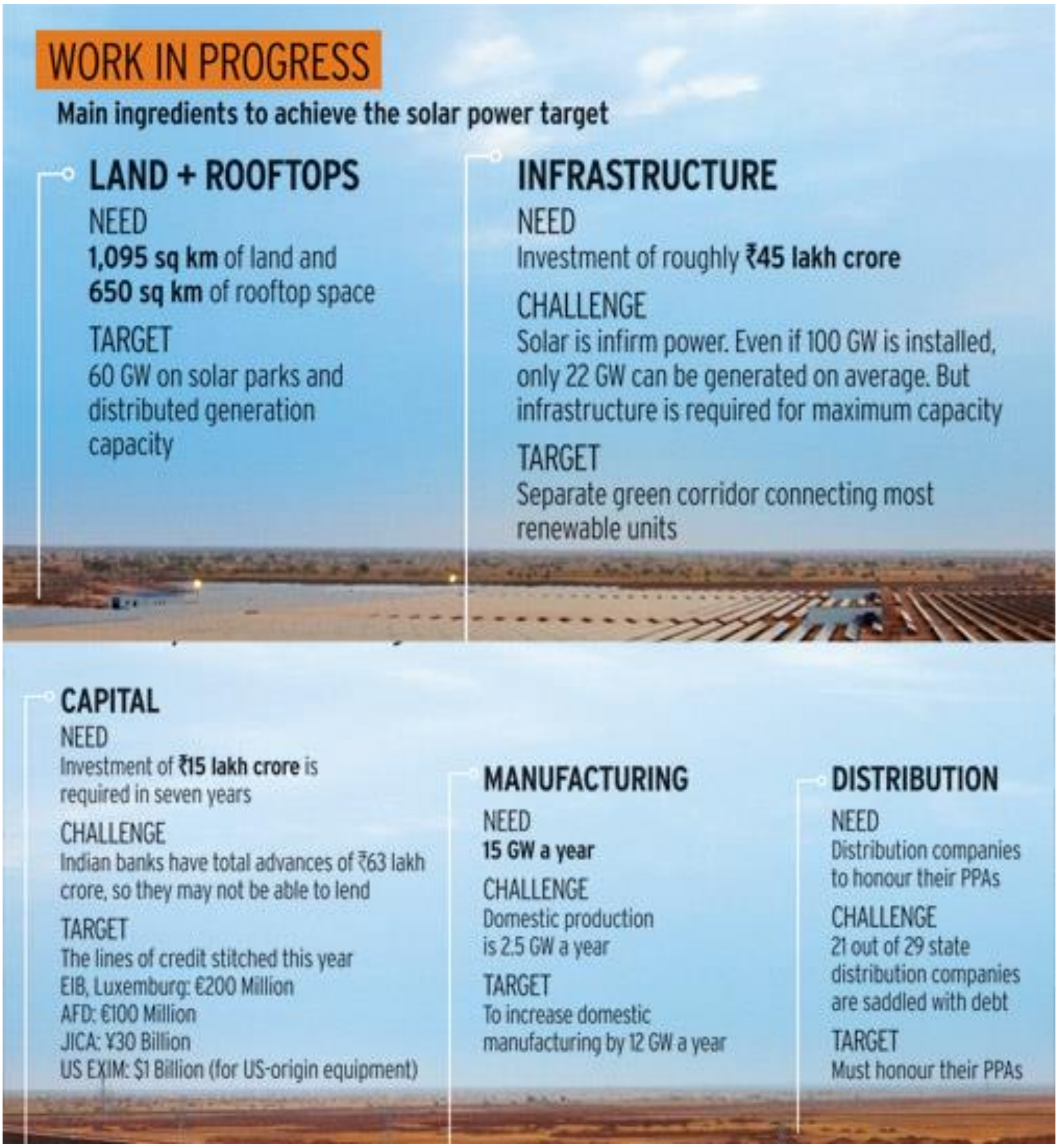


Fig – 1 (Sources from MNRE site)

Figure -2, (Sources from MNRE site)

2.1.3 MNRE TARGET:

Targeted setting up an ambitious 100,000 MW (or 100 GW) of solar power capacity by 2022. That's equivalent to 300 Charanka-like parks or 30 times of India's existing solar power capacity (interestingly, despite the hype around the target, the website of the Ministry of New and Renewable Energy (MNRE) still claims India plans 22,000 MW of grid-connected solar power by 2022!) But critics say they would be surprised if even 30 per cent of the 100 GW target is achieved. Here's why they think it is such a herculean task.

One, no country in the world has set up 100 GW of solar capacity. Not even Germany - the biggest proponent of solar energy - whose capacity is 38 GW. Nowhere in the world has a country added 15 GW of solar capacity every year. "It is not an easy task by any means, but we are determined to make it happen," says Goyal.

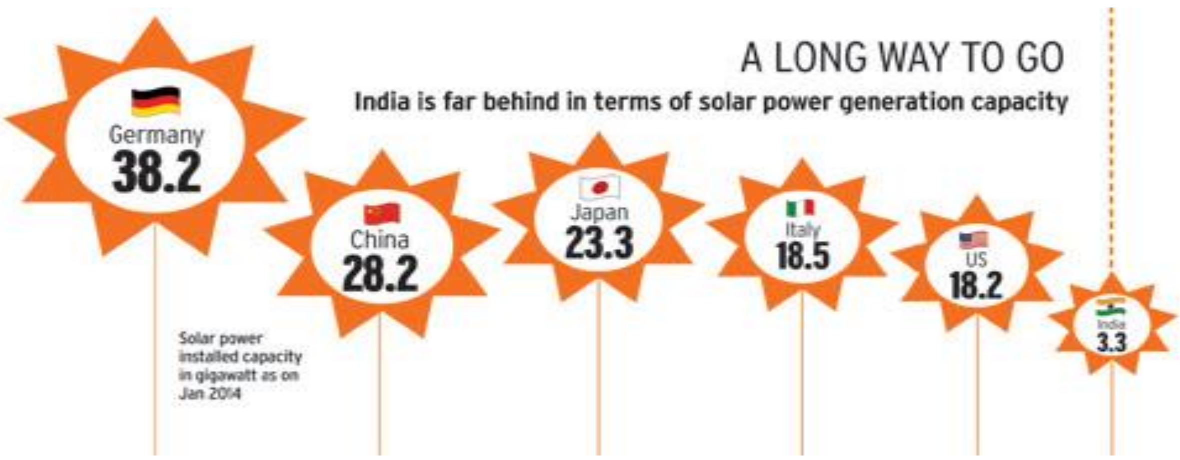


Figure -4, (Sources from MNRE site)

Figure -4, (Photo: Bloomberg Sources from MNRE site)

Figure 5 – Thin Flim Modules

3. PRESENT SITUATION

OF

SOLAR POWER IN INDIA

3.1 MNRE PLANNING HISTORY :

India’s plans to install 100,000MW of solar power capacity by 2022 and needs as much as $200 billion to meet this target. The government aims to provide green power at less than Rs4.50 a unit.

New Delhi: As part of the government’s green energy push, India will award contracts for the supply of 15,000 MW this year. According to the plan, Solar Energy Corp. of India (SECI) will shortly call for bids from developers for buying 2,000 MW, a government official said, requesting anonymity. The procurement will be done through a reverse bidding process, and it will provide a purchase guarantee, making such projects bankable and help solar power eventually cost the same as that purchased from the grid.

India’s plans to install 100,000MW of solar power capacity by 2022 and needs as much as $200 billion to meet this target. The government aims to provide green power at less than Rs.4.50 a unit. The states have already tendered for around 3000 MW. Also, NTPC has already tendered 2600 MW. We are confident that by 31 March 2016, a capacity of 15,000 MW will be awarded,” said the official quoted above.

Analysts see a lot of potential for solar power in India.

The strong demand outlook for solar energy sector in the long run, aided by favourable regulatory and policy support in place by Central and State Governments,” There has been growing interest from overseas investors in the Indian renewable energy space as well. SoftBank Corp., along with Bharti Enterprises Ltd and Taiwan’s Foxconn Technology, in June proposed to invest at least $20 billion in solar energy projects in India through a joint venture, SBG Cleantech Ltd. US-based First Solar Inc. and China’s Trina Solar are among companies that are planning to set up factories in India. While the present installation cost of a solar project is around Rs.6 crore per MW, economies of scale are expected to drive down the cost to Rs.4.5 crore per MW. The plan to reduce solar power tariffs comes in the backdrop of state electricity boards (SEBs) increasingly showing reluctance to buy power on account of their poor financial health. State-owned NTPC Ltd has been calling for bids from solar project developers for buying 15,000 megawatts on behalf of the ministry of new and renewable energy. This is in addition to NTPC’s plans to set up 10,000 MW of solar power capacity on its own.

Commissioning Status of Grid Connected Solar Power Projects as on 30-04-16

Sr. No.	State/UT	Total commissioned capacity till 30-04-16 (MW)
1	Andhra Pradesh	792.966
2	Arunachal Pradesh	0.265
3	Bihar	5.1
4	Chhattisgarh	93.58
5	Gujarat	1119.173
6	Haryana	15.387
7	Jharkhand	16.186
8	Karnataka	145.462
9	Kerala	13.045
10	Madhya Pradesh	776.37
11	Maharashtra	385.756
12	Odisha	66.92
13	Punjab	405.063
14	Rajasthan	1285.932
15	Tamil Nadu	1061.82
16	Telangana	527.843
17	Tripura	5
18	Uttar Pradesh	143.495
19	Uttarakhand	41.145
20	West Bengal	7.772
21	Andaman & Nicobar	5.1
22	Delhi	14.28
23	Lakshadweep	0.75
24	Puducherry	0.025
25	Chandigarh	6.806
26	Daman & Diu	4
27	J&K	1
28	Himachal Pradesh	0.201
29	Mizoram	0.1
27	Others (PSU/channel partner) under Rooftop	58.311
TOTAL		**6998.853**

Table - 1 (Source from MNRE Site)

Against a target of 1,400 MW for 2015-16, the achievement in the first four months of the financial year was 358 MW, or 25 per cent. On the basis of projects awarded in the recent months, both under the federal and States' schemes, solar industry experts are confident that installations in the current year will exceed 2,500 MW. This contrasts favourably with the 1,112 MW installed in 2014-15 and 948 MW in the previous year.

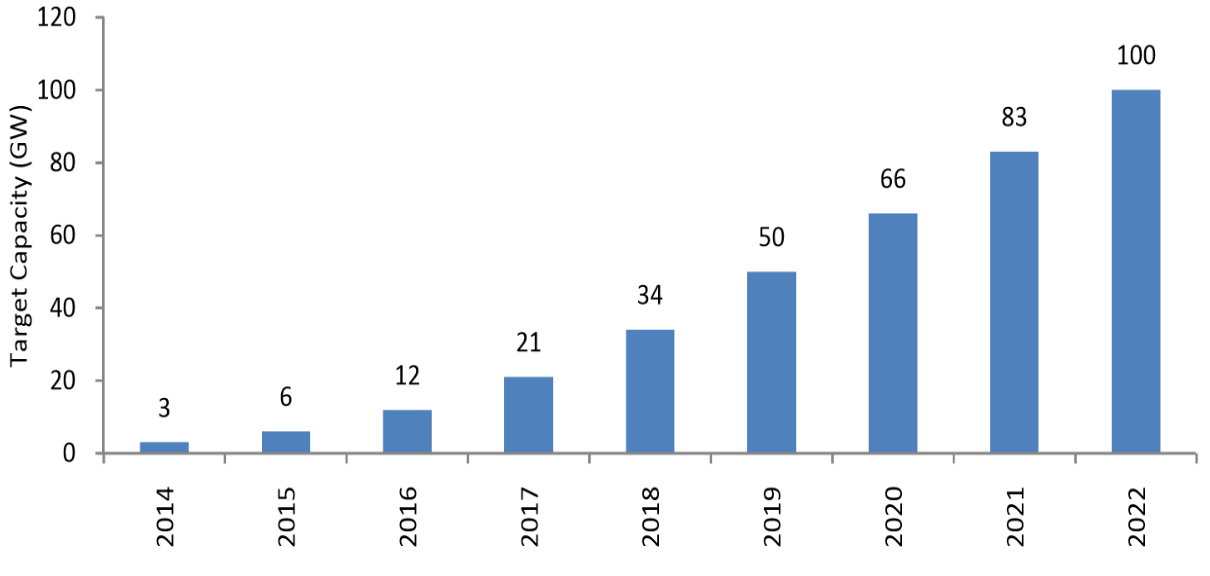
Solar capacity reaching the 4-GW milestone is said to be creditable considering that as recently as in 2010, India had only 12 MW of solar capacity.

The MNRE has set a target of 100 GW of solar capacity to be achieved by 2022. An ambitious target, and the big question is whether it would be met.

A Citi group report, titled Energy Darwinism II, has projected that India's solar installations in 2020 would be 26,523 MW— a respectable number, but way below the target. Such installed capacity would make India the fourth largest solar market, after China (148,141 MW), Japan (64,863 MW) and the US (64,133 MW).

3.2 Current status

Government-funded solar electricity in India was approximately 6.4 MW per year as of 2005. India is ranked number one in terms of solar electricity production per watt installed, with an insolation of 1,700 to 1,900 kilowatt hours per kilowatt peak (kWh/KWp) 25.1 MW was added in 2010 and 468.3 MW in 2011. As of 31 August 2015, the installed grid connected solar power capacity is 4,229.36 MW and India expects to install an additional 10,000 MW by 2017, and a total of 100,000 MW by 2022.



Graph 1 – (Source from MNRE Site)

State wise installed solar power

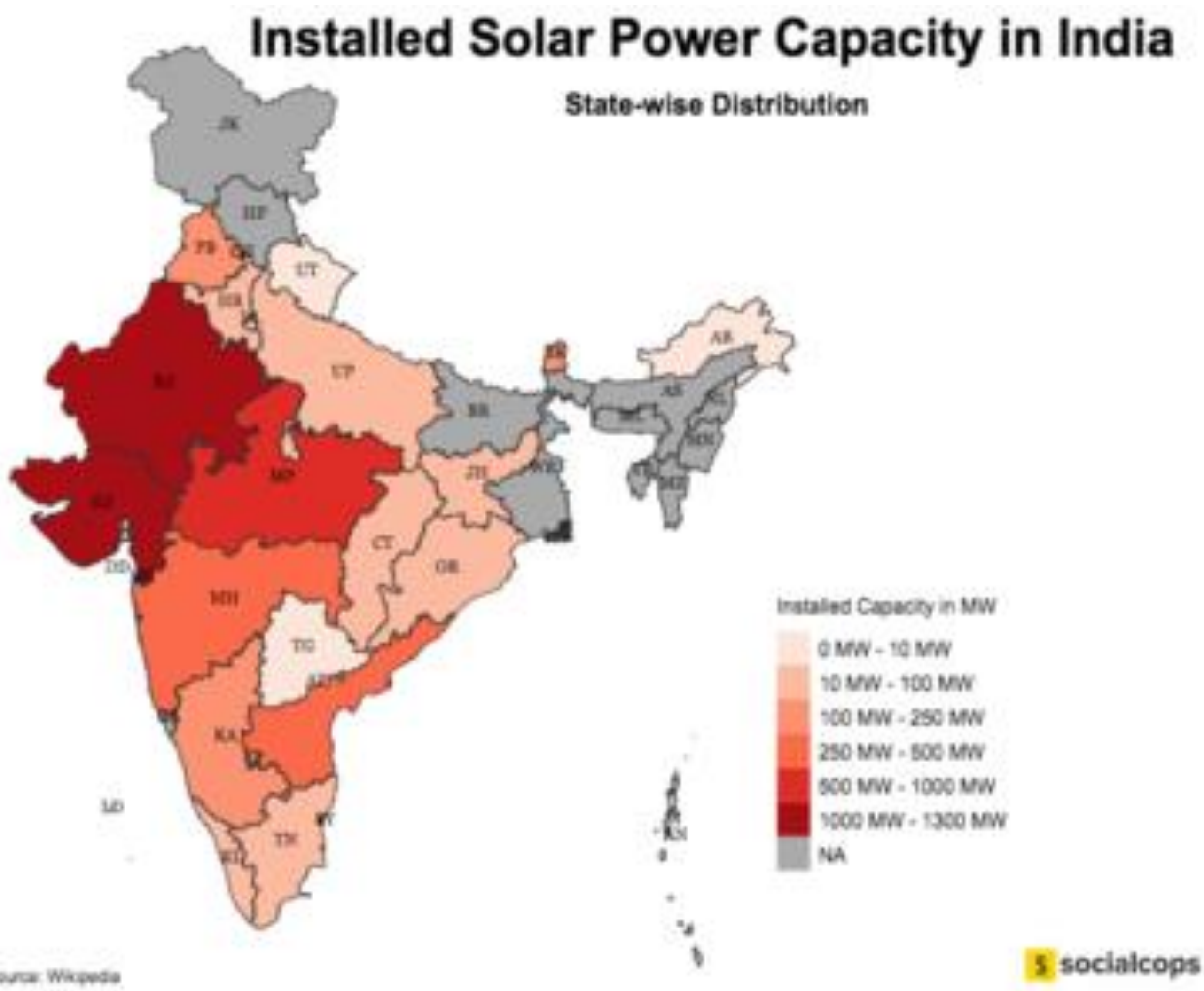


Fig –6. Installed Solar Power Capacity as of 30 September 2015 (Sources from From Wikipedia)

ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS (As on 30.04.2016) (UTILITIES)										
Region	Ownership/ Sector	Modewise breakup								Grand Total
		Thermal				Nuclear	Hydro	RES * (MNRE)		
		Coal	Gas	Diesel	Total					
Northern Region	State	16598.00	2879.20	0.00	19477.20	0.00	7502.55	661.56		27641.31
	Private	17266.00	108.00	0.00	17374.00	0.00	2478.00	7968.57		27820.57
	Central	12000.50	2344.06	0.00	14344.56	1620.00	8266.22	0.00		24230.78
	Sub Total	**45864.50**	**5331.26**	**0.00**	**51195.76**	**1620.00**	**18246.77**	**8630.13**		**79692.66**
Western Region	State	22800.00	2993.82	0.00	25793.82	0.00	5480.50	311.19		31585.51
	Private	36455.00	4288.00	0.00	40743.00	0.00	447.00	15003.73		56193.73
	Central	12898.01	3533.59	0.00	16431.60	1840.00	1520.00	0.00		19791.60
	Sub Total	**72153.01**	**10815.41**	**0.00**	**82968.42**	**1840.00**	**7447.50**	**15314.92**		**107570.84**
Southern Region	State	16882.50	556.58	287.88	17726.96	0.00	11558.03	506.45		29791.44
	Private	8270.00	5557.50	554.96	14382.46	0.00	0.00	17647.67		32030.13
	Central	11890.00	359.58	0.00	12249.58	2320.00	0.00	0.00		14569.58
	Sub Total	**37042.50**	**6473.66**	**842.84**	**44359.00**	**2320.00**	**11558.03**	**18154.12**		**76391.15**
Eastern Region	State	7540.00	100.00	0.00	7640.00	0.00	3168.92	225.11		11034.03
	Private	8731.38	0.00	0.00	8731.38	0.00	195.00	250.28		9176.66
	Central	14351.49	90.00	0.00	14441.49	0.00	925.20	0.00		15366.69
	Sub Total	**30622.87**	**190.00**	**0.00**	**30812.87**	**0.00**	**4289.12**	**475.39**		**35577.38**
North Eastern Region	State	60.00	445.70	36.00	541.70	0.00	382.00	254.25		1177.95
	Private	0.00	24.50	0.00	24.50	0.00	0.00	9.47		33.97
	Central	250.00	1228.10	0.00	1478.10	0.00	860.00	0.00		2338.10
	Sub Total	**310.00**	**1698.30**	**36.00**	**2044.30**	**0.00**	**1242.00**	**263.72**		**3550.02**
Islands	State	0.00	0.00	40.05	40.05	0.00	0.00	5.25		45.30
	Private	0.00	0.00	0.00	0.00	0.00	0.00	5.85		5.85
	Central	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
	Sub Total	**0.00**	**0.00**	**40.05**	**40.05**	**0.00**	**0.00**	**11.10**		**51.15**
ALL INDIA	State	63880.50	6975.30	363.93	71219.73	0.00	28092.00	1963.81		101275.54
	Private	70722.38	9978.00	554.96	81255.34	0.00	3120.00	40885.57		125260.91
	Central	51390.00	7555.33	0.00	58945.33	5780.00	11571.42	0.00		76296.75
	Total	**185992.88**	**24508.63**	**918.89**	**211420.40**	**5780.00**	**42783.42**	**42849.38**		**302833.20**

Table - 2 (Source from Ministry of Power Site) **Figures at decimal may not tally due to rounding off**

Abbreviation:-SHP=Small Hydro Project (≤ 25 MW), BP=Biomass Power, U&I=Urban & Industrial Waste Power, RES=Renewable Energy Sources

Note : - 1.RES include SHP, BP, U&I, Solar and Wind Energy. Installed capacity in respect of RES (MNRE) as on 31.03.2016

(As per latest information available with MNRE)

***Break up of RES all India as on 30.03.2016 is given below (in MW) :**

Small Hydro Power	Wind Power	Bio-Power		Solar Power	Total Capacity
		BM Power/Cogen.	Waste to Energy		
4273.47	**26866.66**	**4831.33**	**115.08**	**6762.85**	**42849.38**

Table - 3

2 Installed capacity of Andhra Pradesh has been bifurcated in the ratio of 53.89 and 46.11 among Telangana and New Andhra Pradeh respectively. Except the installed capacity of Thamminapatnam (300 MW), Simhapuri (450 MW) and Tanir Bhavi (220 MW) are shown in the state of New Andhra Pradesh.

3 * Koldam (1000 MW, four units) shares are provisional

4 Two units of Kondapalli Stg-II of 371 MW each taken in private sector in A.P.

5 IPP Panipuram (2x660=1320 MW) , Tied capacity of 270 MW with Telangana and balance capacity of 1050 MW has been shown in Andhara Pradesh

6 Four unis of 110 MW each of Panipat TPS, HPGCL has been retired and 440 MW capacity(Steam) has been deucted from state sector of Haryana.

7 Brahmapuram Diesel Power Plant (2X21.32 MW) and Kozhikode Diesel Power Plant (2X16 MW Units) has been retired and 74.64 MW capacity(Diesel) has been deucted from state sector of Kerala

4. FUTURE POTENTIAL

OF

SOLAR POWER IN INDIA

Solar Resource Map of India. **Fig – 7** (Sources From Wikipedia)

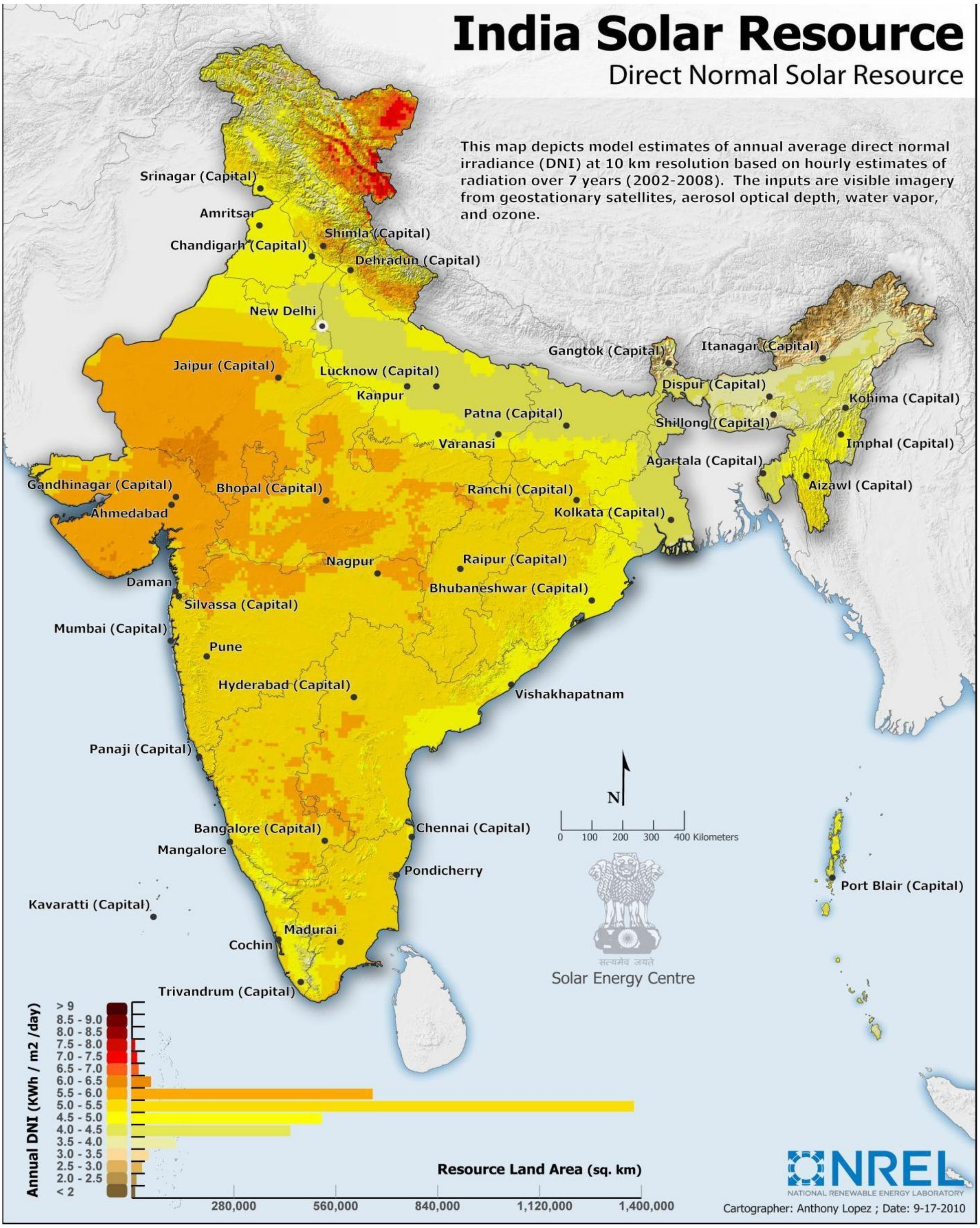
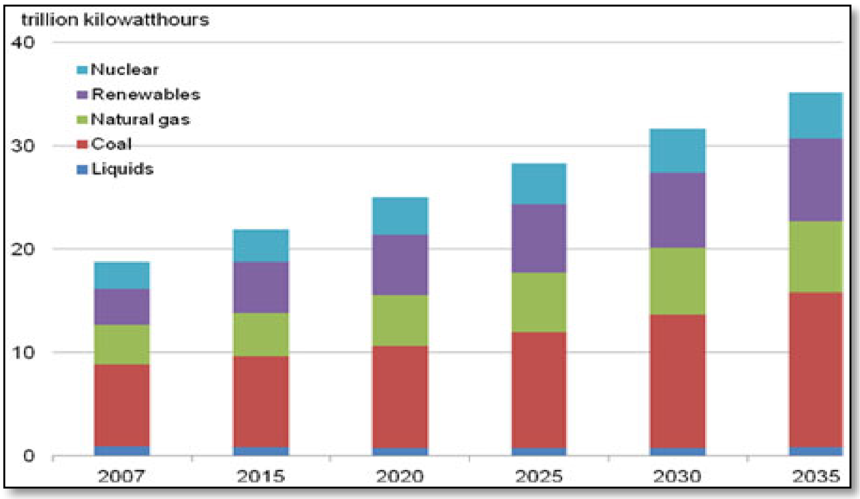


Fig – 7 (Sources From Wikipedia)

4. INDUSTRY OUT LOOK:

4.1 GLOBAL AND INDIAN ENEGRY SCENARIO.

Electricity is one of the world's fastest-growing form of end-use energy consumption. It is estimated that, world energy consumption will increase by 56% by 20402. Renewable energy and nuclear power are the world's fastest-growing energy sources, each increasing 2.5% per year. Net electricity generation worldwide will rise by 2.3 percent per year on average from 2007 to 2035 as compared to 1.4 percent per year growth for total world energy demand. The growth in electricity generation for non-OECD countries increases by an average annual rate of 3.3 percent, as rising standards of living increases the demand. In OECD nations, where infrastructures are more mature and population growth is relatively slow, growth in generation is much slower, averaging 1.1 percent per year from 2007 to 2035.



Graph 2: World Electricity Consumption Projections. (Source from CEA report)

The Indian government has set ambitious goals in the 12th plan for power sector owing to which the power sector is poised for significant expansion. Under 12th Plan of Central Electricity Authority, the capacity addition target was 88,537 MW in December 2014 while only 61,979 MW was achieved up to May 2015. So, nearly 70% was achieved.

Table – 4 State wise Estimated Solar Power Potential

Total Solar Power in GWp:	748.98 GWp
STATE	SOLAR POTENTIAL(GWp)
Andhra Pradesh	38.44
Arunachal pradesh	8.65
Assam	13.76
Bihar	11.2
Chhattisgarh	18.27
Delhi	2.05
Goa	0.88
Gujarat	35.77
Haryana	4.56
Himachal Pradesh	33.84
Jammu & Kashmir	111.05
Jharkhand	18.18
Karnataka	24.7
Kerala	6.11
Madhya Pradesh	61.66
Maharashtra	64.32
Manipur	10.63
Meghalaya	5.86
Mizoram	9.09
Nagaland	7.29
Orissa	25.78
Punjab	2.81
Rajasthan	142.31
Sikkim	4.94
Tamil nadu	17.67
Telangana	20.41
Tripura	2.08
Uttar pradesh	22.83
Uttarakhand	16.8
West Bengal	6.26
UT	0.79
TOTAL	748.98

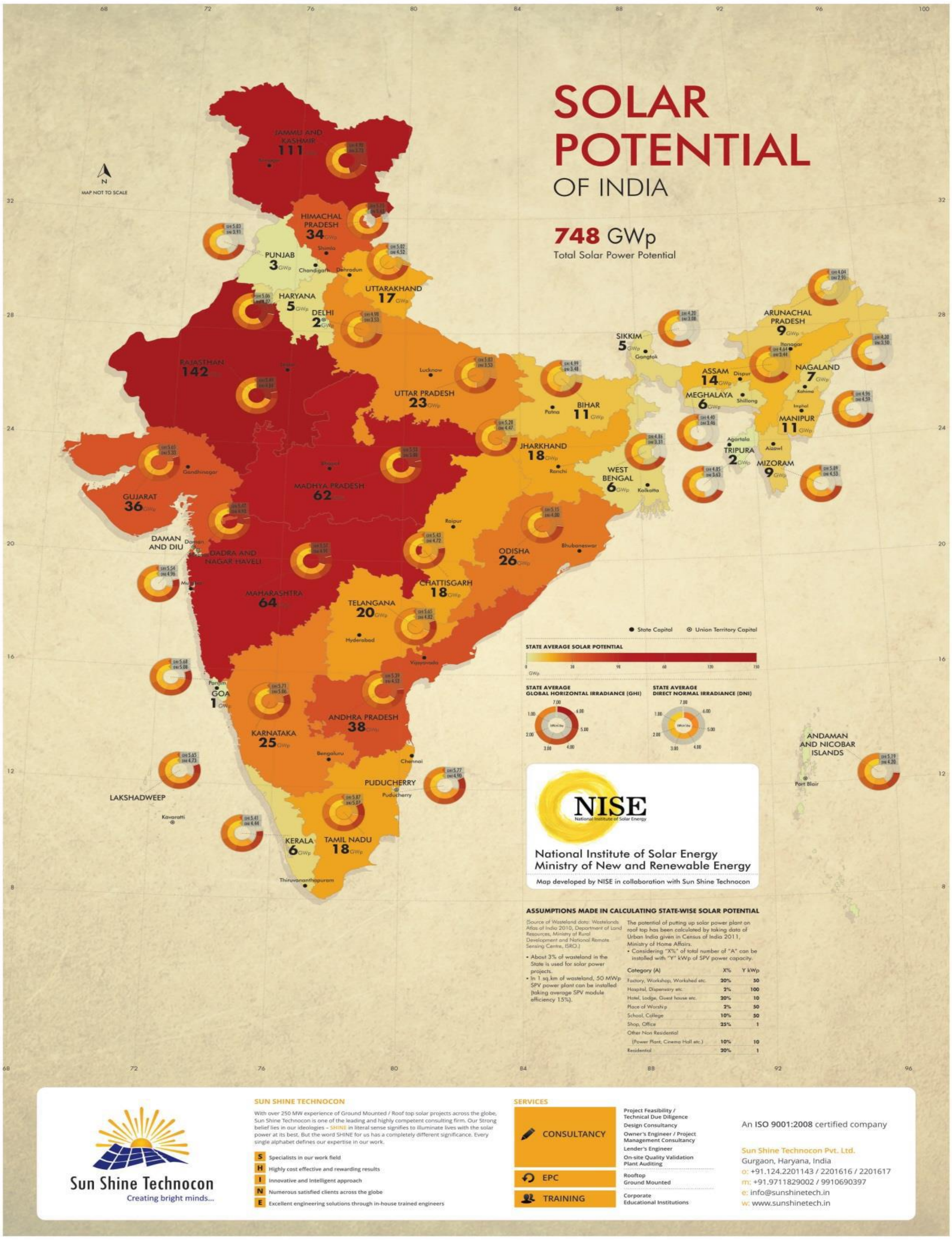


Fig – 8 Solar Potential Map

4.2 NATIONAL SOLAR MISSION AMBITION.

The Ministry of New & Renewable Energy in India has shared year-wise capacity addition targets for the ambitious National Solar Mission. As per the updated targets under the National Solar Mission, India aims to have an installed solar power capacity of 100 GW by 2022.

The original target under the mission was 22 GW by 2022. 100 GW capacity will include 40 GW rooftop solar power capacity and 57 GW utility-scale solar power

projects; India had an operational solar power capacity of around 3 GW when the upgraded mission targets were announced earlier this year.

For the current financial year, the ministry has set a target of adding 200 MW rooftop solar power capacity. This is supposed to increase to 4.8 GW in the next financial year (2016–17). In 2017-18, capacity of 5 GW rooftop solar power projects has been envisaged, with a 1 GW additional target up to 9 GW in financial year 2021–22.

The rooftop solar power projects are expected to be commissioned mostly by the state governments through their own solar power policies.

The ministry expects 1.8 GW of utility-scale solar power capacity additions in the current financial year, followed by 7.2 GW in financial year 2016–17. Capacity addition targets for financial years 2017–18 to 2019–20 are 10 GW each, while a total of 18 GW capacity would be added in financial years 2020–21 and 2021–22.

To set up utility-scale solar power projects, the central government as well as the state governments shall organise competitive auctions. These will include auctions for ultra mega solar power projects as well. The government has announced plans to set up 25 such projects, which will have a capacity of up to 4 GW each. They are expected to have a cumulative installed capacity of 20 GW.

Tentative State-wise break-up of Renewable Power target to be achieved by the year 2022 So that cumulative achievement is 1,75,000 MW

State/UTs	Solar Power (MW)	Wind (MW)	SHP (MW)	Biomass Power (MW)
Delhi	2762			
Haryana	4142		25	209
Himachal Pradesh	776		1500	
Jammu & Kashmir	1155		150	
Punjab	4772		50	244
Rajasthan	5762	8600		
Uttar Pradesh	10697		25	3499
Uttrakhand	900		700	197
Chandigarh	153			
Northern Region	31120	8600	2450	4149
Goa	358			
Gujarat	8020	8800	25	288

Chhattisgarh	1783		25	
Madhya Pradesh	5675	6200	25	118
Maharashtra	11926	7600	50	2469
D. & N. Haveli	449			
Daman & Diu	199			
Western Region	28410	22600	125	2875
Andhra Pradesh	9834	8100		543
Telangana		2000		
Karnataka	5697	6200	1500	1420
Kerala	1870		100	
Tamil Nadu	8884	11900	75	649
Puducherry	246			
Southern Region	26531	28200	1675	2612
Bihar	2493		25	244
Jharkhand	1995		10	
Orissa	2377			
West Bengal	5336		50	
Sikkim	36		50	
Eastern Region	12237		135	244
Assam	663		25	
Manipur	105			
Meghalaya	161		50	
Nagaland	61		15	
Tripura	105			
Arunachal Pradesh	39		500	
Mizoram	72		25	
North Eastern Region	1205		615	
Andaman & Nicobar Islands	27			
Lakshadweep	4			
Other (New States)		600		120
All India	99533	60000	5000	10000

Table – 5 (Source from MNRE Site)

4.3 GOVERNING INSTITUTIONS

The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country.

4.4 FUNCTIONS OF MNRE

Facilitate research, design, development, manufacture and deployment of new and renewable energy systems/devices for transportation, portable and stationary applications in rural, urban, industrial and commercial sectors through:

Technology Mapping and Benchmarking.

1. Identify Research, Design, Development and Manufacture thrust areas and facilitates the same.
2. Lay down standards, specifications and performance parameters at par with international levels and facilitate industry in attaining the same.
3. Align costs of new and renewable energy products and services with international levels and facilitate industry in attaining the same.
4. Appropriate international level quality assurance accreditation and facilitate industry in obtaining the same.
5. Provide sustained feed-back to manufacturers on performance parameters of new and renewable energy products and services with the aim of effecting continuous up gradation so as to attain international levels in the shortest possible time span.
6. Facilitate industry in becoming internationally competitive and a net foreign exchange earner especially through (ii) to (v) above and related measures.
7. Resource Survey, Assessment, Mapping and Dissemination.
8. Identify areas in which new and renewable energy products and services need to be deployed in keeping with the goal of national energy security and energy independence.
9. Deployment strategy for various indigenously developed and manufactured new and renewable energy products and services.
10. Provision of cost-competitive new and renewable energy supply options

4.5 FUNCTION OF GOVERNMENT.

Central Government shall, from time to time, prepare the National Electricity Policy, policy for stand-alone systems in rural areas and tariff policy, in consultation with the State Governments and the Authority for development of the power system. The information flows according to the organizational structure as stated below.

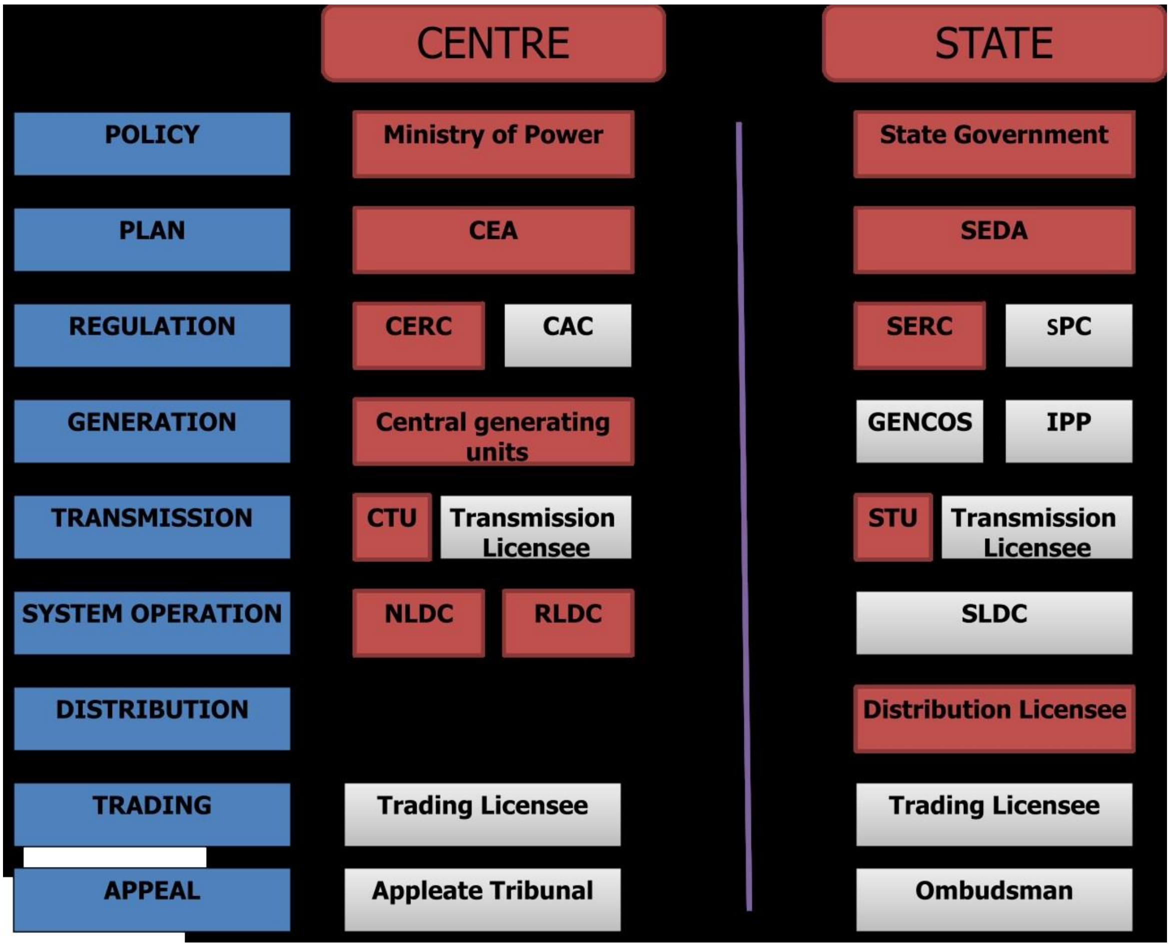


Fig. 9 Organizational Structure of Indian Electricity Sector

4.6 STATE SOLAR POLICY ANALYSIS

States have issued polices for promoting solar energy, some have issued a separate policy for solar while others have integrated the same in policy for new/renewable/non-conventional or energy policy, some states have also issued orders for the section following parameters.

1. Eligible Producer
2. Land Allotment
3. Operative period

4. Sale of power and tariff
5. Wheeling
6. Banking
7. Power evacuation & grid interfacing
8. Incentives and general

The states have issued guidelines/policy or orders keeping in view the requirement (present and future) of state and to fulfil mandatory obligation. All policies have pros and cons.

5. SELECTION OF TECHNOLOGY

FOR

SOLAR POWER IN INDIA

5.1 SELECTION OF TECHNOLOGY.

Photovoltaic comprises the technology to convert sunlight directly into electricity. The term “photo” means light and “voltaic,” electricity. A photovoltaic (PV) cell, also known as “solar cell,” is a semiconductor device that generates electricity when light falls on it. Since its first commercial use in powering orbital satellites of the US space programs in the 1950’s, PV has made significant progress with total photovoltaic module industry growing at more than 40% in the past decade. The PV modules combined with a set of additional application-dependent system components (e.g. inverters, batteries, electrical components, and mounting systems), form a PV system. These PV systems are highly modular, i.e. modules can be linked together to provide power ranging from a few watts to tens of megawatts (MW).

The solar PV panels typically produce DC electricity that is fed to a grid interactive inverter, which in turn converts the DC electricity into AC electricity at a required voltage level. In order to achieve a higher system voltage, the output of inverters is fed to step up transformers to increase the voltage levels at the desired level. From the transformer, the power is routed through the high voltage panel and eventually to other required measuring & protection devices before connecting to the grid. The major equipment and components of a typical solar plant are shown in the following figure.

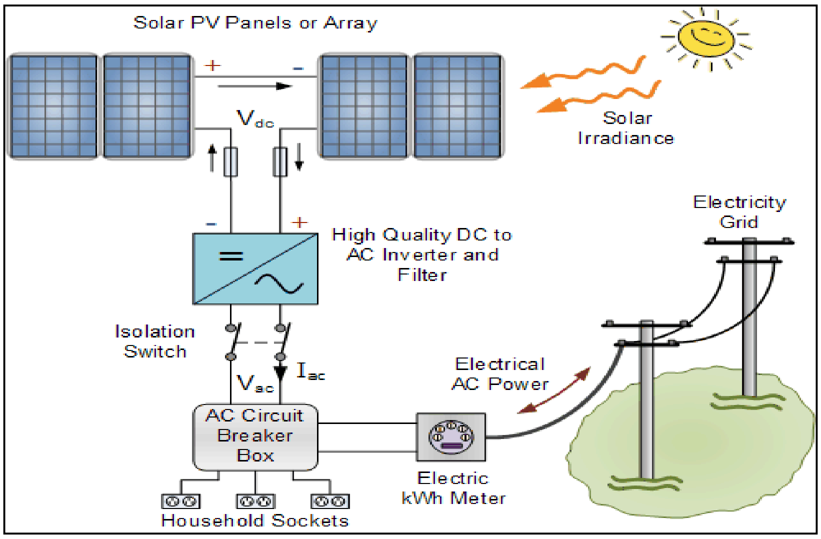


Figure 10: Typical Solar PV System Component. (Source from TEV report)

5.1.1 PHOTOVOLTAIC TECHNOLOGIES.

Traditional solar cells are made from silicon, are usually flat-plate, and generally are the most efficient. Second-generation solar cells are called thin-film solar cells because they are made from amorphous silicon or non-silicon materials such as Cadmium Telluride. Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Because of their flexibility, thin film solar cells can double as rooftop shingles and tiles, building facades, or the glazing for skylights.

Third-generation solar cells are being made from variety of new materials besides silicon, including solar inks using conventional printing press technologies, solar dyes, and conductive plastics. Some new solar cells use plastic lenses or mirrors to concentrate sunlight onto a very small piece of high efficiency PV material. In addition to this, the technologies are described concisely as follows:

5.1.2 CRYSTALLINE TECHNOLOGIES.

Typically, there are two types of crystalline technology mono-crystalline and multi-crystalline. Both the technologies are made up of silicon material and have some pros and cons. Basic features of individual technology are as follows:

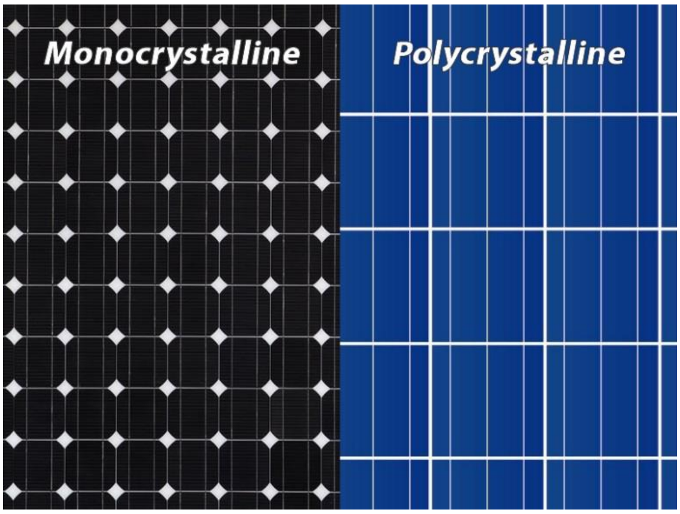


Figure 111: Crystalline PV Module

5.1.3 Mono-Crystalline Silicon

Mono-crystalline Silicon has a continuous crystal lattice structure with practically zero defects or impurities. Mono-crystalline Silicon is superior to other types of silicon cells in terms of higher efficiencies – which are typically around 18-23%. However, the mono crystalline Si-cell production is an expensive process when compared to other types of PV cells. Mono-Crystalline panels are mostly considered where the space is limited as in the case of rooftops. The lifespan of mono-crystalline cells is a minimum of 25 years and can go more, making them a worthwhile investment for long-term use.

5.1.4 THIN FLIM TECHNOLOGY.

Thin film modules cells have a wider customer appeal as design elements due to their homogeneous appearance present. Disadvantages include low-conversion efficiencies and requiring larger areas of PV arrays and more material (cables, support structures) to produce the same amount of electricity.

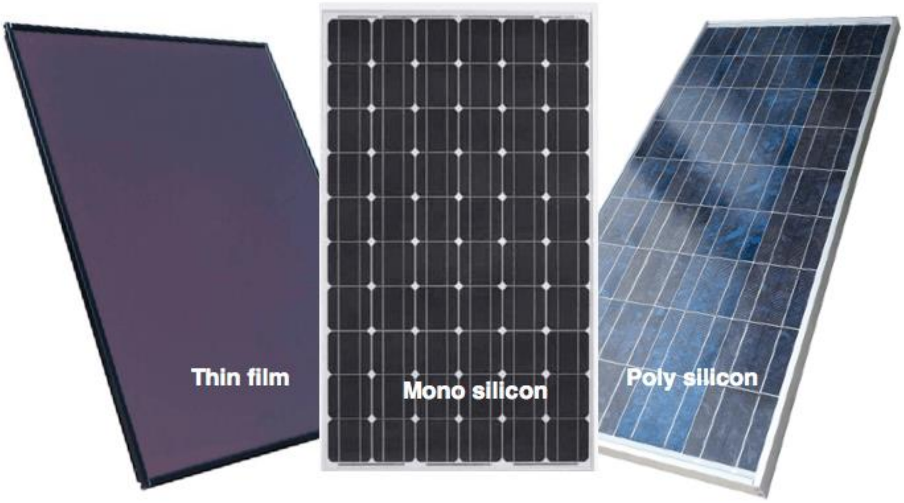


Figure 122: Thin Film PV Module

Thin Film technology is highly efficient at higher temperature levels. Thin Film Modules have the advantages of high shade tolerance & lower temperature coefficient. It is estimated that large percentage of modules used in India are based on thin film technology.

5.2 PV TECHNOLOGY RECOMMENDATION.

Each of the above technologies has their own particular strengths and limitations. Thin film photovoltaic technology is recommended for the project on the grounds of easy availability, cost effectiveness and technological stability. First Solar 110Wp (approx.) PV modules selected for the Project have all the required certificates, such as:

IEC 61646; it is a thin film specific certificate which covers all the performance and quality requirements.

IEC 61730; it is a supplementary to IEC 61646 and certifies safety of the product for those handling it.

IEC 61701; this certificate implies the ability of the PV module to resist corrosion due salt mist.

UL 1703 and ILC listed class B Fire Rating (Class A Spread Flame);

Micro generation Certification Scheme (MCS) certifies micro generation technologies used to produce electricity and heat from renewable sources.

FSEC Certification. The modules are typically guaranteed for ten years (material and workmanship) and are provided with a 25 year linear performance warranty. First Solar modules offer good performance across a wide range of climatic conditions with good low light response and temperature response coefficients. First Solar 110 Wp approx. modules have been specified for the Project with a power tolerance of ±5% at standard test

Module manufacturer is well established and have high accreditations. Technical specifications of the selected modules can be considered suitable for the conditions encountered at the site. The selected PV modules of First solar (CdTe) are considered to have a good track record and the product specifications appear to be suitable for the project

5.3 BALANCE OF PLANT SYSTEM (Bos)

On an average, BoS constitutes 40-45 % of the total project cost of a solar PV Project. For a solar PV Plant, the BoS comprises of inverters, cables, mounting structures, foundations and power electronics. Often assigned secondary importance irrespective of their being a significant cost component, BoS are critical determinants of the actual plant life. High technical standards of BoS components should therefore be ensured as a matter of standard practice.

5.3.1 INVERTER TECHNOLOGIES.

Solar inverter is a critical component in the solar energy system. It performs the conversion of the variable DC power output of array (string of the Photovoltaic (PV) modules) into a utility frequency AC power, which can be fed into the commercial electrical grid. There are mainly two category of solar inverters are available central, and string. A central inverter is generally for adopted for MW scale plant and string inverter can handle comparatively less power.

Figure 13: SMA Inverter

Inverter is the heart of a solar power project. It is also known as Power Conditioning Unit (PCU). A PCU consists of an electronic Inverter along with associated control, protection and data logging devices. Typically the utility scale inverters are unidirectional and supply the power to the grid in the form of AC power conforming to IEC 61727 or equivalent standard. The inverter has a feature that it automatically adjusts with the grid conditions such as the voltage & frequency levels to suit the Grid. It is advised that following key points can be considered while specifying your inverter requirements to various vendors.

a) **Proven Technology:** The inverter should be selected based on the proven technology and it is advisable that the inverter has completed at least one year successful operation in the high temperature weather conditions and fluctuating grid conditions.

b) **Grid Compliance**: At times you may require changing some of the key parameters of the inverters to match with your local grid conditions, hence the inverter should have features of changing some of the threshold parameters, and it can be programmed accordingly. It should also have features of grid islanding through Air Circuit Breakers. Some of the new generation inverters have provision of self-protective and self-diagnostic features so that it can protect itself from the PV array faults and adjust with the changing parameters of the solar PV array. The Inverter should have provisions of automatically 'wake up' in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.

   The inverter should have MPPT control algorithm in such a way that it adjust itself with the voltage of the SPV array to optimize solar energy fed into the grid. The MPPT must have provision for constant voltage operation. The inverter MPPT feature should comply with EN50530 or Equivalent standard.

   The inverter output always follows the grid in terms of voltage and frequency. This should be achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter. Thus control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid.

c) **Inverter Efficiency:** The efficiency of the inverter is another key factor, and most of the inverters are available in the efficiency range of about 97-98% efficiency levels. However it is important to make a note of the inverter efficiency at the part load conditions. Typically the part load efficiency levels are more than 97 % at 75% load as per IEC 61683 or equivalent standard. It is important to assess the inverter efficiency levels at different load say 25%, 50%, 75% and 100% and it should meet the IEC 61683 standard.

d) Control and Protection: The inverter should have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line. It should also have the required protection arrangements against earth leakage faults. The inverter should also have suitable rated DC disconnecting arrangement to allow safe start up and shut down of the system. Inverter should also have required protection arrangements against reverse polarity of DC Connection. There should be suitable surge protection arrangement to pass the fault current to Earthing system. During the earth fault condition, the inverter should be having provision of disconnection.

e) Operational Flexibility: The inverter should have provision of parallel operation. Generally two inverters are connected to a single 3 winding transformer, the inverter should have flexibility to work in such combinations. The inverter should have feature of "ON" and "OFF" automatically based on solar radiation variations during the day.

The inverter should have suitable display panels so that all important parameters such as DC input voltage, DC input current, all phase to phase AC voltages, all phase AC current, AC output power, frequency, apparent power, reactive power etc. are visible to the plant operators. Some of the inverters come with a suitable PCU with display, and can be connected to the SCADA system.

During the sleep mode the inverter should be having the automatic control provisions so that the threshold dc voltage of the inverter can decide the inverter to enter in sleep mode and back to standby mode. The inverter must also automatically re-enter standby mode when threshold of standby mode.

The standard warranty of these inverters is 5 to 10 years. However many inverter manufacturer offer extended warranty also considering string inverter is a costlier proposition as compared to a central inverter, however an apple to apple comparison can only be made consideration of not only cost per watt of string versus central, but also cost reduction of DC cables and other associated benefits such as reduced down time in case of string inverter.

The central inverter takes input from number of arrays and operates at single MPP. Hence the inverter MPP (maximum power point) is governed by the arrays which are having partial shading ,mismatch losses , modules with tolerances which may lead to reduce output in case of central inverter. However this can be reduced by selection of string inverter as different strings have different MPP so that the output is maximized.

5.3.2 CABLING.

DC Cables and Connectors: Working with solar PV arrays can be hazardous since Solar panels connected together in an array are often configured to produce high DC voltage. Furthermore, DC voltages are constant in nature so, effect of electric shock due to DC voltage will surely be severe. Hence, DC Cables should be double insulated and polarized and DC connectors should always be used. The minimum technical requirements for Cables laid down by MNRE states that they should conform to ''General Test and Measuring Method PVC insulated cables for working voltage up to and including 1100 V and UV resistant for outdoor installation'' (Standard: IEC 60227 / IS 694 IEC 60502 / IS 1554 (Pt. I & II)). However, operating temperatures at the proposed Solar PV plant are expected to be high. Additionally, the corrosive conditions at the site would put the cable strength to test. Therefore, Electron–beam cross-linked DC cables, though marginally costlier, may be used. Adequate size of cable is selected for minimal voltage drop i.e. maximum voltage drops in the string designed to be around 1%.

AC Cables: In order to make the system more reliable and facilitate maintenance and management, output of three phase AC cables from the inverter are connected to AC disconnected unit. The voltage output of the inverter is connected to the transformer using required rating LT cables to step up the voltage. From the transformer, the lines are connected to grid. AC cables sizing are designed to achieve less than 1% of AC voltage drop from inverter to transformer. However, size of cable varies by relative position of inverter, transformer and grid supply lines.

5.3.3 MODULE MOUNTING SYSTEM.

Solar PV modules are mounted on the structure, generally casted of galvanized steel. Designing of mounting structure is majorly depended on two factors namely orientation scheme and wind load. In case orientation scheme is sun tracking scheme (Single tracking or duel tracking) then scope of movement in the tiled part of the structure is provided. Generally, this movement is achieved through a motor.

Second important consideration in the design of mounting structures is the nature of wind loads in the proposed location, taking into cognizance any seasonal /local winds that may exert additional load. Accordingly, the concrete blocks are to be designed to counter balance the load. This is done through STAAD Pro analysis or Field flow analysis. In addition, the material of the structure is to be selected in such a way that it serves at least for 25 years. In general "galvanized steel" is used to make the structures. The mounting structures shall be designed as per the soil and wind conditions at the site. However the typical practice is to design mounting structure to withstand a wind load of 160-170 km/hr. The support structure design & foundation shall also be designed to withstand wind speed applicable for the site conditions.

Nut & bolts, supporting structures including Module Mounting Structures shall have to be adequately protected from atmosphere and weather prevailing in the area.

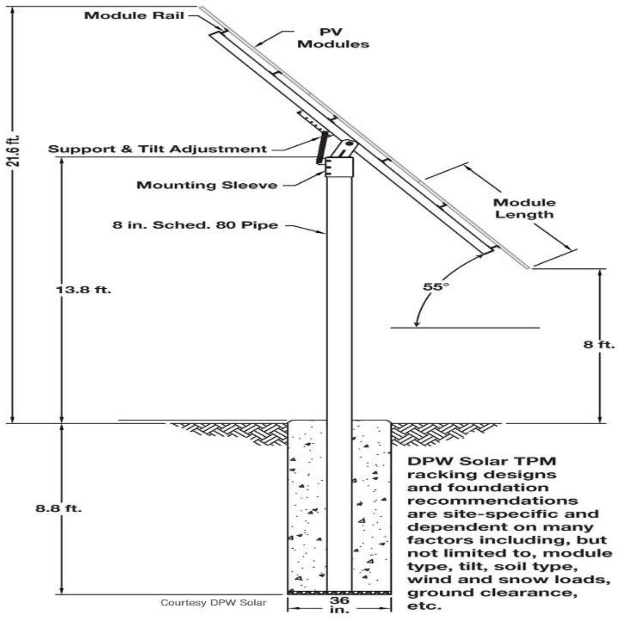


Figure 14 Mounting Sreucture

Figure 35 Mounting Sreucture.

5.4 POWER PLANT DESIGN CRITERIA

The Power Plant is sized on the following major criteria:

- Solar Power (average insolation available)
- Power evacuation facility in the vicinity of the proposed site along with grid availability on 24 Hours a day basis.

5.4.1 DESIGN AND SIMULATION PROJECTION BY PVSYST 6.37.

PVSYST 6.37 tool is one of the most accepted design tool for the study, sizing, simulation and data analysis of complete PV systems. We have used this tool to generate the most realistic energy yield simulation results, which are detailed in this report. Main features of PVSYST 6.37:

1. Detailed computation of the used components (modules, inverters, etc.)
2. Simulation on hourly basis and detailed evaluation and consideration of different loss factors.
3. Calculation of arbitrary orientated module planes (fixed and tracking systems)
4. Most accepted and used tool to generate simulation results for PV power plants, as the results are based on systematic and refined approach.
5. Program with the most accurate results and functions available in the market.

5.4.2 PV POWER PLANT ENEGRY PRODUCTION.

The system lifetime energy production is calculated by determining the first-year energy generation as expressed in Energy injected into grid [kWh (AC)] / Installed Capacity[kWp (DC)], and then degrading output over the system life based on an annual performance degradation rate. System degradation (largely a function of PV panel type and manufacturing quality) and its predictability are important factors in lifecycle costs since they determine the probable level of future cash flows. This stream of energy produced is then discounted to derive a present value of the energy generated to make a levelized cost calculation. The first year production is a function of the:

I. The amount of sunshine the project site receives in a year.
II. The mounting and orientation of the system (i.e., flat, fixed-tilt, tracking, etc.)
III. The spacing between PV panels
IV. The energy harvest of the PV panel (i.e., performance sensitivity to high temperatures, sensitivity to low or diffuse light, etc.).
V. System losses from soiling, transformers, inverters, and wiring inefficiencies.
VI. System availability largely driven by inverter downtime.

5.4.3 SPV Plant Capacity Utilization Factor (CUF).

The capacity utilization factor, a standard methodology used in the utility industry to measure the productivity of energy generating assets, is a key driver of a solar power plant's economics. A PV power plant's capacity utilization factor is a function of the insolation at the project location, the performance of the PV panel (primarily as it relates to high-temperature performance), and the orientation of the PV panel to the sun, the system electrical efficiencies, and the availability of the power plant to produce power.

5.4.4. SELECTION OF INVERTER & COMPONENT.

For a complete reliable system and to ensure high energy yield from the plant, innovative components with latest technology are selected. The inverter operates in range of 96.0% - 98.6% efficiency.

5.4.5 SELECTION OF MONITORING SYSTEM.

Basic features of the monitoring system are presented as follows:

- Monitors the performance of the entire power plant (string wise monitoring, junction boxes, inverters, etc.)
- Evaluates (strings, inverter, nominal/actual value), quantity of DC Power & AC Power produced.
- Measures instantaneous irradiation level and temperature at site. It also measures the module back surface temperature.
- Alerts in case of error (discrepancy in normal operation of components, like module string/ diodes/ inverter/ junction box / loose contacts/ etc.) to facilitate recognition and correction of the fault with minimum downtime.
- Visualizes nominal status of the connected components via control center PC Software (diagnosis on site or remote).
- Logs system data and error messages for further processing or storing.
- Stores and visualizes energy yield data (for life of the plant) in the portal from where the data can be accessed remotely.

5.4.6 DESIGN CRITERIA FOR CABLE & JUNCTION BOXES.

The power plant will adopt the best engineering practice for complete cable routing in the power plant by using minimal cable length while connecting in series string, using optimal size cables to ensure the entire plant cable losses are minimum. The junction boxes proposed are completely pre-wired to ensure ease of installation, maintenance and eliminates any installation hassles. These junction boxes not only combine the DC power from strings but also monitor each string performance and feed the same data to the central monitoring system.

5.6 MAJOR COMPONENT OF THE POWER PLANT.

(10 MW solar plat was consider to arrive the design)

5.6.1 INTRODUCTION.

The solar electricity is produced when the photons from the sun rays hit the electrons in the solar PV panels, this will generate Direct Current (DC). The DC electricity from the panels passes through inverter, which converts the DC electricity into 380V three phase AC which is stepped up through transformers at about 33 kV voltage levels to feed this electricity into the grid.

In order to achieve a higher system voltage, modules are connected in series, called a string. A higher system voltage has the advantage of less installation work (smaller conductor cross sections). Lower currents flow at the same efficiency so that cable losses are reduced. The strings are connected with the photovoltaic branch or the PV-distributor (Smart connect box). This distributor is connected with the Main Combiner Box (MCB) which acts as the main DC collecting unit which passes the power to be converted to the central inverters.

Central inverters combine the various advantages of the other installation technologies. Thus the module fields are less sensitive towards partial darkening, as is the case with string inverters. This results in a very good MPP-matching of the inverters. Furthermore, installations can be expanded with additions of more modules without problems. Thus photovoltaic installations of greater efficiency can be constructed economically.

The AC power from the inverter are passed to low voltage panel and then to the main transformer. From the transformer, the power is routed through the high voltage panel and eventually to other required measuring & protection devices before connecting to the grid.

Grid connected solar power plant comprises of the main equipment and components listed below.

- Solar PV Modules
- Central inverters
- Module mounting system
- Grid connect equipment
- Monitoring system
- SCADA

- Cables & connectors

- Buildings for housing the electronics (Power-house)

A simple block diagram, related to the interconnection of various systems for grid connectivity, is shown below for reference. The power from modules is directed to the central inverters through the DC combiner boxes and from the inverters it is routed though the Low voltage panel to the transformer. From the transformer, the high voltage power is routed to the metering panel and eventually to grid through the High Voltage Panel.

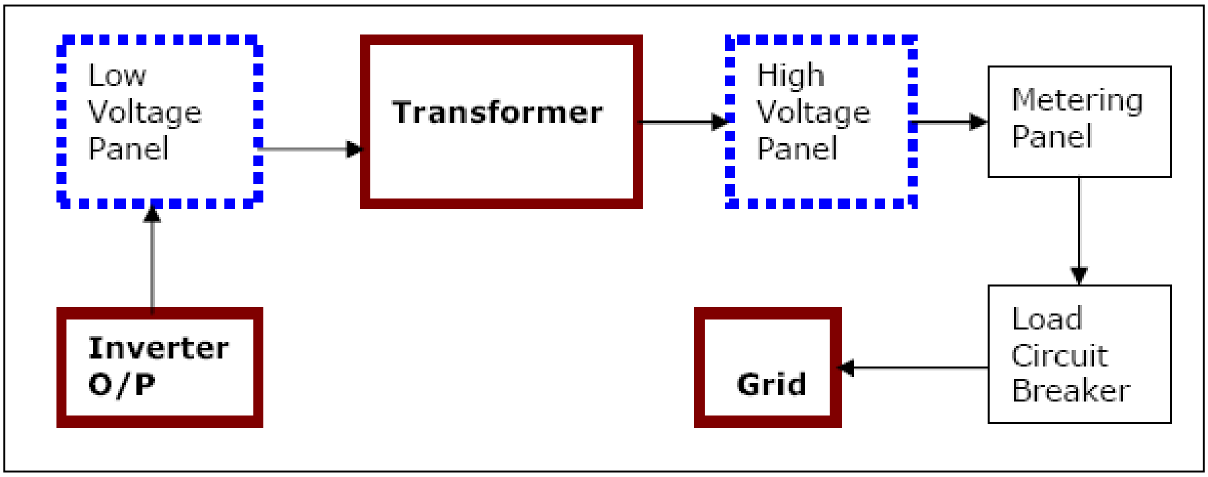


Figure 4: Block Diagram Showing Interconnection of Various Systems

5.6.2 SOLAR PV MODELS.

A photovoltaic module is a packaged interconnected assembly of photovoltaic cells, which converts sunlight into energy. For this project, thin film PV technology solar module of 107.50 Wp is. Modules of higher capacity may also be used. The modules shall conform to IEC 61646, IEC 61730, IEC 61701 and 60068-2-68 standards. The proposed tilt angle for the modules is 25° (all the modules will be facing south)

5.6.3 INVERTER.

Inverters are used for DC voltage to AC voltage conversion. According to output voltage form they could be rectangle, trapezoid or sine shaped. The most expensive, yet at the same time the best quality inverters have output voltage in sine wave. Inverters connecting a PV system and the public grid are purposefully designed, allowing energy transfers to and from the public grid. Central inverters are used in large applications. Many times they can be connected according to the "master-slave" criteria, when the succeeding inverter switches on only when enough solar radiation is available or in case of main inverter malfunction.

Inverters connected to module strings are used in wide power range applications allowing for more reliable operation.

In the proposed project the inverters will connect string of modules (each module of 110 Wp) approx. The output of the strings will be connected to SMA 1100 kW Solar and SMA 20 kW solar inverter. For 10 MW solar PV plant 9 number of 1100 kW Sunny Central and 5 number of 20 kW Sunny Tri Power Shall be used. The inverter converts the DC Power into AC power and feeds it to the grid. The inverters are designed with a high efficiency >98% with IGBT technology. It has a provision to deliver the maximum power generated through solar modules in to grid due to its in-built feature of MPPT operations. The inverter is having internal self-protection in case of any fault in the grid in addition to the inbuilt contactors/breakers with fuses for self-protections.

The inverters are self-synchronizing with the utility (grid) power with respect to the Voltage and frequency of grid and it gets corrected itself according to the grid parameters within its settable limits. The inverter is designed in such a way that it will sense the array power and grid power; if both are available it starts and stops automatically in the morning and evening respectively. Each inverter is having a remote and local data monitoring system with which we can monitor all the parameters and current energy generation & past generation for the given period. The output voltage of the inverter shall be connected to a step-up transformer of 0.405/33 KV.

5.6.4 MODEL MOUNTING SYSTEM.

The module mounting structure is designed for holding suitable number of modules in series. The system will be fixed-tilt type hence requiring negligible maintenance requirements .The frames and leg assembles of the array structures is made of mild steel hot dip galvanized of suitable sections of Angle, Channel, Tubes or any other sections conforming to IS:2062 for steel structure to meet the design criteria. All nuts & bolts considered for fastening modules with this structure are of very good quality of stainless steel. The array structure is designed in such a way that it will occupy minimum space without sacrificing the output from SPV panels at the same time.

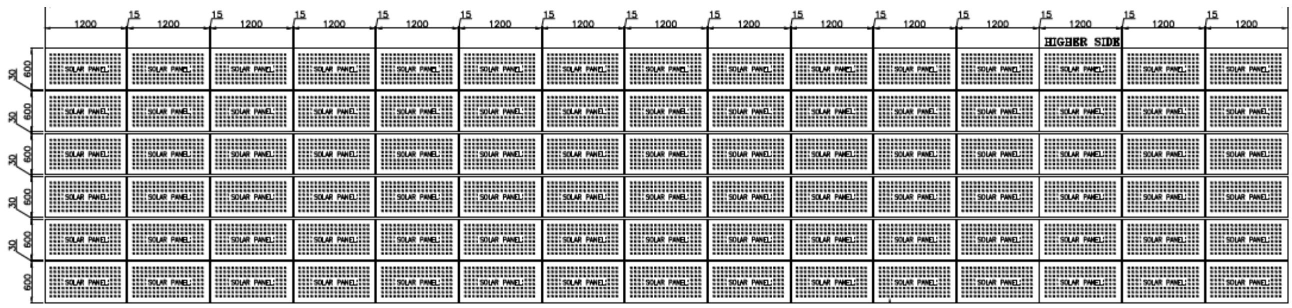


Figure 17: Typical Fixed Tilt Module Mounting Structure (front side)

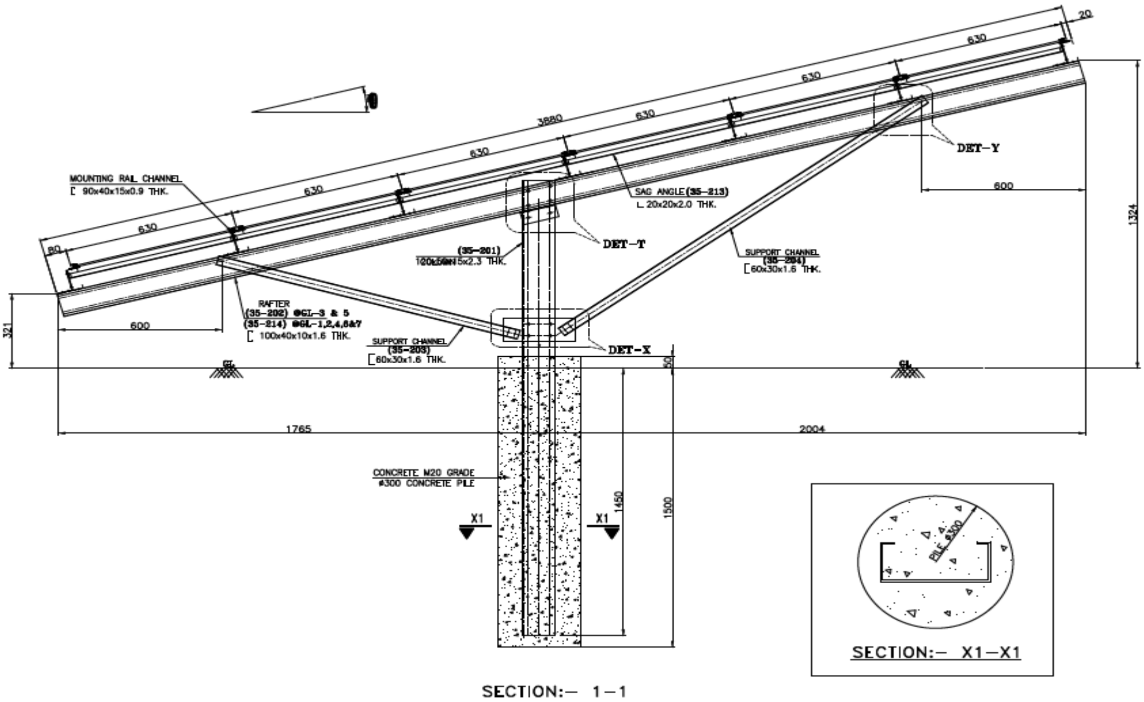


Figure 18 Typical side view of MMS

Foundations and structures shall be designed in view of the following standards with a minimal safety factor of 1.5:

Table 6: Standards for Foundation and Structure

IS-875-1987 (Part-2)	IS Code of practice for design load (imposed loads)
IS-1893-2002 (Part-1)	IS Code of practice for Earthquake Resistant Design
IS-875-1987 (Part-3)	IS Code of practice for Design Load (wind loads)
SP-16	Design Aid for RCC
SP-34	Handbook of reinforced concrete & detailing
IS 800-2009	General construction in steel – code of practice
IS 8147-1976	Code of practice for use of Aluminum alloy in structure
IS 801-1975	Code of practice for use of cold formed light gauge steel structural membrane in general building
IS 456-2000	Plain & reinforced concretes
IS 2911-2010	Design & construction of pile foundation

5.6.5 STRING COMBINER BOX.

Dust, water and vermin proof string combiner boxes of adequate rating and adequate terminal facility made of Fire Resistant Plastic (FRP) shall be provided for wiring. Each box shall be provided with fuses and surge arrestors of adequate rating to protect the solar arrays from accidental short circuit.

5.6.6 MONITORING SYSTEM.

System proposed will maintain and provide all technical information on daily solar radiation availability, hours of sunshine, duration of plant operation and the quantum of power fed to the grid. This will help in estimation of generation and number of other generation parameter of array capacity installed at the site. The system also enables diagnostic and monitoring functions for these components. Communication: Data modem (analogue/Ethernet), few features are presented as follows.

- Monitors the performance of the entire power plant (string wise monitoring, junction boxes, inverters, etc.)
- Evaluates (strings, inverter, nominal/actual value), quantity of DC Power & AC Power produced.
- Measures instantaneous irradiation level and temperature at site. It also measures the module back surface temperature.
- Alerts in case of error (discrepancy in normal operation of components, like module string/ diodes/ inverter/ junction box / loose contacts/ etc.) to facilitate recognition and correction of the fault with minimum downtime.
- Visualizes nominal status of the connected components via Control Center PC Software (diagnosis on site or remote)
- Logs system data and error messages for further processing or storing
- Stores and visualizes energy yield data (for life of the plant) in the Portal from where the data can be accessed remotely.

5.6.7 SCADA.

The instrumentation & control system for the solar power plant will be based on the prevailing standard engineering practices

Design will ensure full compliances of codes and standards as applicable the field of instrumentation & control for power plant

The whole plant will be operated through SCADA system

The SCADA system shall have the following features:

I. **Monitoring:** Ability to control, using specially designed devices, the state & evolution of one or various physiologic (or others) parameters to detect possible malfunctions
II. **Remote control:** Group of devices which allow modifying the state of the equipment and devices of the plant, from a remote location

The SCADA system shall be used for the following minimum tasks:

- To invoice the produced energy
- To detect the incidences and malfunctions (up to logical string level)

- To give the information at a given time interval: a) Availability, b) Performance Ratio and Energy Production

The SCADA System will be reliable and robust and some components need redundancy for trouble free operation

5.6.8 CABLE AND CONNECTORS.

The size of the cables between array interconnections, array to junction boxes, junction boxes to PCU etc. shall be so selected to keep the voltage drop and losses to the minimum. The bright annealed 99.97% pure bare copper conductors that offer low conductor resistance, they result in lower heating thereby increase in life and savings in power consumption. These wires are insulated with a special grade PVC compound formulated. The skin coloration offers high insulation resistance and long life. Cables are flexible & of annealed electrolytic grade copper conductor and shall confirm to IS 1554/694-1990 and are extremely robust and resist high mechanical load and abrasion.

Cable is of high temperature resistance and excellent weather proofing characteristics which provides a long service life to the cables used in large scale projects. The connectors/lugs of copper material with high current capacity and easy mode of assembly are proposed.

5.6.9 BUILDING FOR PLANT EQUIPMENT (Inverter Rooms and Control Room).

Concrete or pre-fabricated buildings will be utilized for housing the inverters, Low Voltage panels, High Tension panels, Plant Monitoring system, Safety equipment, Office room etc.

The buildings will be equipped with all necessary safety equipment as per the safety rules and shall be appropriately ventilated. The equipment will be erected as per the Indian Electrical Standards. The cables will be routed through cables trenches or cable trays as required. Alarm system will be provided to alert the operator in case of emergency or plant break-down.

The proposed power transformer will be installed outside next to the main control room.

The civil engineering and building works shall include the design, detailing and construction of all foundations, structures, buildings, installation and service of facilities required for the installation, commissioning, operation and maintenance of all equipment associated with the power plant.

The civil works includes preliminaries, additional survey, soil exploration, piling if needed, ground improvement, foundations and all necessary site investigation associated with the operations: Site roads, site leveling and grading with boundary fences, and gates. In order to avoid flooding, rain water drainage system is provided all around the plant layout.

5.6.10 POWER EVACUTION PLAN.

The Direct Current (DC) from modules is converted into Alternating Current (AC) by Inverters. The inverter outputs are given to a 0.405kV/33 kV and 0.280 kV/33 KV external transformers located outside the inverter rooms. Then power shall be evacuated to the nearest substation.

The Power evacuation system comprises of following major components:

33kV Transformer – Oil immersed type with Off circuit tap changer with all accessories

Low Voltage (LV) Panel

High Tension (HT) Panels

LT & HT cables.   Control & Power evacuation cables.

5.6.11 TRANSFORMERS.

The proposed transformer shall be installed outdoor suitable for hot, humid and tropical climate. The transformer will be free from annoying hum and vibration when it is in operation, even at 10% higher voltage over the rated voltage. The noise level will be in accordance with respective standards.

The transformer will be designed and constructed so as not to cause any undesirable interference in radio or communication circuits. The oil filled transformer will be capable of operating continuously at its rated output without exceeding the temperature rise limits as given below over design ambient temperature of 50 deg C.

In oil by thermometer 50 deg C

In winding by resistance 55 deg C

The transformer will be designed to withstand without injury, the thermal and mechanical effect of short circuit at its terminal with full voltage maintained behind it for a period of 1 second. The transformer will be capable of continuous operation at the rated output under voltage and frequency variation without injurious heating at that particular tap for all tap positions.

Phase connections will be delta on LV side and star on HV side. HV side shall be resistance earthed. HV side shall be suitable for connection to HT panels for the respective transformers. LV side shall be suitable for connection to LV panel. Transformer will be designed for over fluxing withstand capability of 110% continuous and 125% for at least 1 minute. Further it shall be capable of withstanding 140% of rated voltage at the transformer LV terminal for a period of 5 seconds to take into account sudden load throw off conditions.

Overloads will be allowed within conditions defined in the loading guide of applicable standard. Under these conditions, no limitations by terminal bushings, off circuit tap changers or other auxiliary equipment shall apply.

5.6.12 33 kV SWITCHYARD.

33kV Switchyard has been envisaged for evacuation of power through Step up Transformers for the proposed plant. The switchyard shall be located in adjacent to Central Control Building. The switchyard shall be interconnected with the 33 kV grid Substation by means of overhead conductor.

6. Central Electricity Regulatory Commission

(Terms and Conditions for Tariff determination from Renewable Energy Sources)

OF

SOLAR POWER IN INDIA

6.1 Overview.

The Commission has notified the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012, on 06.02.2012 (hereinafter referred to as “the RE Tariff Regulations”), which provide for terms and conditions and the procedure for determination of tariff of the following categories of Renewable Energy (RE) generating stations:

- Wind Power Project;
- Small Hydro Projects;
- Biomass Power Projects with Rankine Cycle technology;
- Non-fossil fuel-based co-generation Plants;
- Solar Photo Voltaic (PV)Projects;
- Solar Thermal Power Projects;
- Biomass Gasifier based Power Projects; and
- Biogas based Power Project.

The Commission, in the meanwhile, has notified the Central Electricity

Regulatory Commission (Terms and Conditions for Tariff determination from

Renewable Energy Sources) (First Amendment) Regulations, 2014 (hereinafter referred to as “the RE Tariff (First Amendment) Regulations”), on 18.03.2014, wherein, various technical norms of Biomass Power Projects with Rankine Cycle technology have been amended. These norms are effective from the notification of the First Amendment Regulations.

The Commission, in the meanwhile, has notified the Central Electricity

Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) (Second Amendment) Regulations, 2014 (hereinafter referred to as “the RE Tariff (Second Amendment) Regulations”), on 5.01.2015, wherein, the use of fossil fuels in biomass power plants has been limited to the extent of 15% in terms of calorific value on annual basis, till 31.03.2017.

The Commission, has notified the Central Electricity Regulatory Commission

(Terms and Conditions for Tariff determination from Renewable Energy Sources) (Fifth

Amendment) Regulations, 2016, on 30.03.2016 wherein, Operation and Maintenance expenses for Solar PV projects for FY 2016-17 have been specified.

The Regulations enjoin upon the Commission to determine the generic tariff on the basis of the suo-motu petition, for the RE technologies for which norms have been provided in the RE Tariff Regulations. Generic Tariff is different from the project specific tariff for which a project developer has to file petition before the Commission as per the format provided in the RE Tariff Regulations. Pertinently, project specific tariff has been envisaged for the new RE technologies and the technologies which are still at the nascent stage of development, and the Commission shall determine the project specific tariff for such technologies on a case to case basis.

Clause (1) of Regulation 8 of the RE Tariff Regulations provides that “the Commission shall determine the generic tariff on the basis of suo-motu petition at the beginning of each year of the Control period for renewable energy technologies for which norms have been specified under the Regulations”.

The Commission has notified the RE Tariff Regulations on 06.02.2012 and subsequently issued generic suo-motu tariff orders, which were applicable for the renewable energy projects to be commissioned during first, second, third and fourth year of the control period (i.e. FY2012-13, FY 2013-14 ,FY 2014-15 and FY-2015-16)."

The Commission, in due discharge of the mandate under Regulation 8(1) of the RE Tariff Regulations proposes to determine the generic tariff of the RE projects for the fifth year of control period (i.e. FY 2016-17) as per the proposal enclosed as Annexure-I.

ANNEXURE-I

The Proposed Levellised Generic Tariff for Various Renewable Energy Technologies fro FY – 2016-17

6.2 The proposed levellised generic tariffs for various renewable energy technologies, for FY 2016-17 are discussed below:

6.2.1 USEFUL LIFE.

Clause (aa) of sub-Regulation (1) of Regulation 2 of the RE Tariff Regulations defines 'useful life' in relation to a unit of a generating station (including evacuation system) to mean the following duration from the date of commercial operation (COD) of such generation facility:

Renewable Energy Projects	Years
Wind energy	25
Small Hydro	35
Biomass power project with Rankine Cycle technology	20
Non-fossil fuel based co-generation	20
Solar PV	25
Solar Thermal	25
Biomass Gasifier	20
Biogas	20
Municipal Solid Waste	20

6.2.2 CONTROL PERIOD.

Regulation 5 of the RE Tariff Regulations provides that the control period for determination of tariff for renewable energy projects (RE projects) shall be of five years of which the first year of the control period was FY 2012-13. The Provision to the said regulation stipulates that the tariff determined for the RE projects commissioned during the control period shall continue to be applicable for the entire duration of the tariff period as specified in Regulation 6 of the RE Tariff Regulations. Accordingly, the tariff determined for FY 2016-17 is for the last year of the control period.

6.2.3 TARIFF PERIOD.

In terms of Regulation 6 of the RE Tariff Regulations, the tariff period in respect of the RE projects is as under:

Renewable Energy Projects	Years
Wind energy	13*
Small Hydro below 5 MW	35
Small Hydro (5 MW -25 MW)	13*
Biomass	13*
Non-fossil fuel co-generation	13*
Solar PV and Solar Thermal	25
Biomass Gasifier and Biogas	20

* The RE Tariff Regulations provides for a minimum period of thirteen (13)years.

In terms of clauses (e) and (f) of the said regulation, the tariff period specified above shall be reckoned from the date of commercial operation of the RE projects and the tariff determined under the regulations shall be applicable for the duration of the tariff period.

6.2.4 TARIFF STRUCTURE.

Clause (1) of Regulation 9 of the RE Regulations stipulates that the tariff for RE projects shall be single part tariff consisting of the following fixed cost components:

a) Return on equity;
b) Interest on loan capital;
c) Depreciation;
d) Interest on working capital;
e) Operation and maintenance expenses;

For renewable energy technologies having fuel cost component, such as biomass power projects and non-fossil fuel based cogeneration, single part tariff with two components i.e. fixed cost component and fuel cost component, is to be determined.

6.2.5 TARIFF DESIGN.

In terms of Regulation 10 of the RE Tariff Regulations, the tariff design for renewable energy generating stations is as under:

The generic tariff shall be determined on levellised basis for the Tariff Period. Provided that for renewable energy technologies having single part tariff with two components, tariff shall be determined on levellised basis considering the year of commissioning of the project for fixed cost component while the fuel cost component shall be specified on year of operation basis.

For the purpose of levellised tariff computation, the discount factor equivalent to Post Tax weighted average cost of capital shall be considered.

Levellisation shall be carried out for the 'useful life' of the Renewable Energy project while Tariff shall be specified for the period equivalent to Tariff Period."

6.2.6 LEVELLISED TARIFF.

Levellised Tariff is calculated by carrying out levellisation for 'useful life' of each technology considering the discount factor for time value of money.

6.2.7 DISCOUNT FACTOR.

In accordance with Regulation 10(2) of RE tariff regulation, the discount factor considered for this exercise is equal to the post tax weighted average cost of the capital on the basis of normative debt: equity ratio (70:30) specified in the Regulations. Considering the normative debt equity ratio and weighted average of the post tax rates for interest and equity component, the discount factor is calculated. Interest Rate considered for the loan component (i.e.70 %) of capital

cost is 12.76 %. For equity component (i.e. 30 %), rate of Return on Equity (ROE) is considered at post tax ROE of 16 %. The discount factor derived by this method for all technologies is

10.70 % ((12.76 % × 0.70 × (1 – 33.99 %)) + (16.0% × 0.30)).

6.2.8 CAPITAL COST.

Regulation 12 of the RE Tariff Regulations stipulates that the norms for the capital cost as specified in the technology specific chapter shall be inclusive of all capital works like plant and machinery, civil works, erection and commissioning, financing and interest during construction, and evacuation infrastructure up to inter-connection point. The Commission has specified the normative capital cost, applicable for the first year of control period i.e. FY 2012-13, for various RE technologies viz. Wind Energy, Small Hydro Power, Biomass Power based on Rankine cycle, Non-Fossil Fuel based Cogeneration, Solar PV, Solar Thermal, Biomass Gasifier and Biogas based power projects.

In order to determine the normative capital cost for the remaining years of the control period, the regulations stipulate the indexation mechanism for Wind Energy, Small Hydro Power, Biomass Power, Non-Fossil Fuel based Cogeneration, Biomass Gasifier and Biogas based power projects. However, the Capital Cost norms for Solar PV, Solar Thermal Power Projects and MSW projects shall be reviewed on annual basis by the Commission. The indexation mechanism shall take into account adjustments in capital cost with the changes in Wholesale Price Index of Steel and Wholesale Price Index of Electrical Machinery as per formulation stipulated under the RE Tariff Regulations, which is reproduced overleaf:

CC(n) = P&M(n)* (1+F1+F2+F3) P&M(n) = P&M(0) * (1+d(n))

d(n) = [a*{(SI(n-1)/SI(0))– 1} + b*{(EI(n-1)/EI(0)) – 1}]/(a+b)

Where,

CC (n) = Capital Cost for nth year

P&M (n) = Plant and Machinery Cost for nth year

P&M (0) = Plant and Machinery Cost for the base year

Note: P&M (0) is to be computed by dividing the base capital cost (for the first year of the control period) by (1+F1+F2+F3). Factors F1, F2, F3 for each RE technology has been specified separately, as summarized in following table.

d (n) = Capital Cost escalation factor for year (n) of Control Period

SI (n-1) = Average WPI Steel Index prevalent for calendar year (n-1) of the Control Period

SI (0) = Average WPI Steel Index prevalent for calendar year (0) at the beginning of the Control Period

EI (n-1) = Average WPI Electrical Machinery Index prevalent for calendar year (n- 1) of the Control Period

EI(0) = Average WPI Electrical Machinery Index prevalent for calendar year (0) at the beginning of the Control Period

= Constant to be determined by Commission from time to time, (for weightage to Steel Index)

= Constant to be determined by Commission from time to time, (for weightage to Electrical Machinery Index)

F1 = Factor for Land and Civil Works

F2 = Factor for Erection and Commissioning

F3 = Factor for IDC and Financing Cost

The default values of the factors for various RE technologies as stipulated under the said RE Regulations, is summarized in the table overleaf:

6.3 Technology specific capital cost of RE projects is discussed herein as under:

6.3.1 Capital Cost of Solar PV based Power Projects for FY 2016-17.

Solar Photo Voltaic (PV) power projects which directly convert solar energy into electricity using crystalline silicon or thin film technology or any other technology as approved by the Ministry of New and Renewable Energy and are connected to the grid, qualify for the purpose of tariff determination under the RE Tariff Regulations.

- The Commission by way of its suo-motu orders, determined the capital cost as follows:

Year	Capital Cost for Solar PV (Rs. Lakhs/MW)
2010-11	1700
2011-12	1442
2012-13	1000
2013-14	800
2014-15	691
2015-16	605.85

- The Commission under Regulation 57 specified the normative capital cost for the Solar PV power projects as Rs. 1000 lakhs/MW for FY 2012-13.

- The Commission vide its suo-motu Order (Petition No. SM/005/2015) dated 31st

- March 2015 determined the normative capital cost for the Solar PV power projects as Rs. 605.85 lakhs/MW for FY 2015-16.

- It may be seen that over the years, the capital cost has shown a declining trend due toreasons such as advancement of technologies, reduction in module prices and economies of scale.

- The Commission vide its suo-motu Order dated 23rd March 2016 determined the normative capital cost for the Solar PV power projects as Rs. 530.02 lakhs/MW for FY 2016-17.

6.3.2 DEBT-EQUITY RATIO.

Sub-Regulation (1) of Regulation 13 of the RE Tariff Regulations provides that the debt-equity ratio of 70:30 is to be considered for determination of generic tariff based on suo-motu petition.

- Based on the debt equity ratio of 70:30, the debt and equity components of the normative capital cost for determination of tariff for the RE projects have been worked out as under:

Renewable Energy Projects	Debt (Rs. Lakh)	Equity (Rs. Lakh)
(1) Wind Energy (for all zones)	433.86	185.94
(2) Small Hydro		
(a) Himachal Pradesh, Uttarakhand and North Eastern States (below 5 MW)	581.00	249.00
(b) Himachal Pradesh, Uttarakhand and North Eastern States (5 MW to 25 MW)	528.18	226.36
(c) Other States (below 5 MW)	452.73	194.03
(d) Other States (5MW to 25 MW)	415.00	177.86
(3) Biomass		
(a) project [other than rice straw and Juliflora (plantation) based project] with water cooled condenser	391.32	167.71
(b) Project [other than rice straw and Juliflora (plantation) based project] with air cooled condenser	420.31	180.13
(c) Rice straw and Juliflora (plantation) based project with water cooled condenser	427.56	183.24
(d) Rice straw and Juliflora (plantation) based project with air cooled condenser	456.54	195.66
(4) Non-fossil fuel co-generation	316.92	135.82
(5) Solar PV	371.01	159.01
(6) Solar Thermal	840.00	360.00
(7) Biomass Gasifier based Power Projects	310.02	132.86
(8) Biogas based Power Projects	620.03	265.73

6.3.3 RETURN ON EQUITY.

Sub-Regulation (1) of Regulation 16 of the RE Tariff Regulations provides that the value base for the equity shall be 30% of the capital cost for generic tariff determination. Sub-Regulation (2) of the said Regulation stipulates the normative Return on Equity (ROE) as under:

a) 20% per annum for the first 10 years, and
b) 24% per annum from the 11th year onwards.

6.3.4. INTEREST ON LOAN.

Sub-Regulation (1) of Regulation 14 of the RE Regulations provides that the loan tenure of 12 years is to be considered for the purpose of determination of tariff for RE projects. Sub-Regulation (2) of the said Regulations provides for computation of the rate of interest on loan as under:

> “(a) The loans arrived at in the manner indicated in the Regulation 13 shall be considered as gross normative loan for calculation for interest on loan. The normative loan outstanding as on April 1st of every year shall be worked out by deducting the cumulative repayment up to March 31st of previous year from the gross normative loan.
>
> *(b)* For the purpose of computation of tariff, the normative interest rate shall be considered as average State Bank of India (SBI) Base rate prevalent during the first six months of the previous year plus 300 basis points.
>
> *(c)* Notwithstanding any moratorium period availed by the generating company, the repayment of loan shall be considered from the first year of commercial operation of the project and shall be equal to the annual depreciation allowed".

The weighted average State Bank of India (SBI) Base rate prevalent during the first six months has been considered for the determination of tariff, as shown in the table below:

From	To	Interest rate
Wednesday, April 1, 2015	Thursday, April 9, 2015	10.00%
Friday, April 10, 2015	Sunday, June 7, 2015	9.85%
Monday, June 8, 2015	Wednesday, September 30, 2015	9.70%

Source: State Bank of India (www.statebankofindia.com)

- In terms of the above, the computations of interest on loan carried out for determination of tariff in respect of the RE projects treating the value base of loan as 70% of the capital cost and the weighted average of Base rate prevalent during the first six months of FY 2015-16 (i.e. 9.76%) plus 300 basis points is equivalent to interest rate of 12.76%.

6.3.5 DEPRECIATION.

- Regulation 15 of the RE Tariff Regulations provides for computation of depreciation in the following manner:

- "(1) The value base for the purpose of depreciation shall be the Capital Cost of the asset admitted by the Commission. The Salvage value of the asset shall be considered as 10% and depreciation shall be allowed up to maximum of 90% of the Capital Cost of the asset.

- Depreciation per annum shall be based on 'Differential Depreciation Approach' over loan period beyond loan tenure over useful life computed on 'Straight Line Method'. The depreciation rate for the first 12 years of the Tariff Period shall be 5.83% per annum and the remaining depreciation shall be spread over the remaining useful life of the project from 13th year onwards.

- Depreciation shall be chargeable from the first year of commercial operation. Provided that in case of commercial operation of the asset for part of the year, depreciation shall be charged on pro rata basis".

- In accordance with the above, the rate of depreciation for the first 12 years has been considered as 5.83% and the rate of depreciation from the 13th year

onwards has been spread over the balance useful life of the RE project as under:

Details	Wind Energy	Small Hydro	Biomass	Non-fossil fuel cogeneration	Solar PV	Solar Thermal	Biomass Gasifier	Biogas
Useful Life (in years)	25	35	20	20	25	25	20	20
Rate of depreciation for 12 years (%)	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83
Rate of depreciation after first 12 years (%)	1.54	0.87	2.51	2.51	1.54	1.54	2.51	2.51

6.3.6 INTEREST ON WORKING CATIAL.

Regulation 17 of the RE Tariff Regulations provides for the working capital requirements of the RE projects as under:

- "(1) The Working Capital requirement in respect of wind energy projects, Small Hydro Power, Solar PV and Solar thermal power projects shall be computed in accordance with the following:
- Wind Energy / Small Hydro Power /Solar PV / Solar thermal
- Operation & Maintenance expenses for one month;
- Receivables equivalent to 2 (Two) months of energy charges for sale of
- electricity calculated on the normative CUF;
- Maintenance spare @ 15% of operation and maintenance expenses

The Working Capital requirement in respect of biomass power projects and non-fossil fuel based co-generation projects shall be computed in accordance with the following clause:

- Biomass(Rankine Cycle Technology), Biomass Gasifier, Biogas Power andNon-fossil fuel Co-generation
- Fuel costs for four months equivalent to normative PLF;
- Operation & Maintenance expense for one month;
- Receivables equivalent to 2 (Two) months of fixed and variable charges
- for sale of electricity calculated on the target PLF;
- Maintenance spare @ 15% of operation and maintenance expenses
- Interest on Working Capital shall be at interest rate equivalent to the average State Bank of India Base Rate prevalent during the first six months of the previous year plus 350 basis points".

Receivables equivalent to two months of actual fixed cost and variable cost, (as applicable for biomass power and non-fossil fuel based co-generation) have been considered. Interest rate has been considered as weighted average of State Bank of India Base Rate prevalent during the first six months of the previous year plus 350 basis points (equivalent to interest rate of 13.26%). The interest on working capital has been worked out as specified below for determination of tariff of the RE projects:

Details	Wind Energy	Small Hydro	Biomass, Biomass Gasifier and Biogas	Non-fossil fuel cogeneration	Solar PV	Solar Thermal
(A)For Fixed charges						

(i) O&M expenses (month)	1	1	1	1	1	1
Details	Wind Energy	Small Hydro	Biomass, Biomass Gasifier and Biogas	Non-fossil fuel cogeneration	Solar PV	Solar Thermal
(ii) Maintenance spares (%) of O&M expenses	15	15	15	15	15	15
(iii) Receivables (months)	2	2	2	2	2	2
(B) For Variable Charges						
Biomass/Bagasse stock (months)	-	-	4	4	-	-
(C) Interest On Working Capital (%)	13.26%	13.26%	13.26%	13.26%	13.26%	13.26%

Source for SBI Base Rate: State Bank of India (www.statebankofindia.com)

6.3.7 OPERATION AND MAINTENANCE EXPENSES.

Regulation 18 of the RE Tariff Regulations provides for Operation and Maintenance Expenses (O&M expenses) in respect of RE projects as under**: ‘’Operation and Maintenance Expenses ‘’**

Operation and Maintenance or O&M expenses’ shall comprise repair and maintenance (R&M), establishment including employee expenses and administrative & general expenses.

Operation and maintenance expenses shall be determined for the Tariff Period based on normative O&M expenses specified by the Commission subsequently in these Regulations for the first Year of Control Period.

Normative O&M expenses allowed during first year of the Control Period (i.e. FY 2012-13) under these Regulations shall be escalated at the rate of 5.72% per annum over the Tariff Period”

Solar PV: As per CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) (Fifth amendment) Regulations, 2016 the "Normative O&M expenses for the last year of the Control Period (i.e. FY2016-17) shall be Rs 7 Lakh per MW". Accordingly, O&M expense norm for solar PV power projects for FY 2016-17 has been considered as Rs. 7.00 lakhs/MW.

6.3.8 CAPACITY UTILISATION FACTOR.

Regulations 26, 30, 58 and 62 of the RE Tariff Regulations specify the norms for Capacity Utilization Factor (CUF)/Plant Load Factor (PLF) in respect of the Wind Energy, Small Hydro, Solar PV and Solar Thermal based power generating stations as per the details given in the table below which has been considered for determination of tariff.

Renewable Energy Projects	**CUF**
(A) Wind Energy: Annual Mean Wind Power Density (W/m2)	
Wind zone - 1 (Upto 200)	20 %
Wind zone - 2 (201 - 250)	22 %
Wind zone - 3 (251 - 300)	25 %
Wind zone - 4 (301 - 400)	30 %
Wind zone - 5 (Above 400)	32 %
(B) Small Hydro	
(i) Himachal, Uttarakhand and North Eastern States	45 %
(ii) Other States	30 %
(C) Solar PV	19 %
(D) Solar Thermal	23 %

6.3.9 PLANT LOAD FACTOR (PLF)

Regulations 36, 68 and 78 of the RE Tariff Regulations specify the plant load factor for Biomass, Biomass Gasifier and Biogas based renewable energy generating stations as given in the table below which has been considered for determination of fixed charges component of tariff.

Renewable Energy Projects	PLF
(A) Biomass (a) During stabilization (6 months) (b) During remaining period of the first year (after stabilization) (c) Second year onwards	 60 % 70 % 80 %
(B) Biomass Gasifier	85 %
(C) Biogas	90 %

Regulation 49 of the RE Tariff Regulations stipulates the plant load factor for Nonfossil Fuel based Co-generation projects as under, computed on the basis of plant availability for number of operating days considering the operations during crushing season and off-season and load factor of 92%. The number of Operating days for different States as specified in the Regulation 49(2) is as under:

States	Operating days	PLF
Uttar Pradesh and Andhra Pradesh	120 days (crushing)+ 60 days (off-season) = 180 days	45 %
Tamil Nadu and Maharashtra	180 days (crushing)+ 60 days (off-season) = 240 days	60 %
Other States	150 days (crushing) + 60 days (off-season) = 210 days	53 %

6.3.10 AUXILIARY POWER CONSUMPTION.

Regulations 31, 37, 50, 64, 69 and 79 of the RE Tariff Regulations as amended from time to time, stipulate the auxiliary power consumption factor as under which has been considered for determination of tariff of the RE projects :

Renewable Energy Projects	Auxiliary Consumption Factor
Small Hydro	1 %
Biomass a) the project using water cooled condenser	i. During first year of operation: 11%; ii. From 2nd year onwards: 10%.
b) project using air cooled condenser	i. During first year of operation: 13%; ii. From 2nd year onwards: 12%.
Non-fossil fuel co-generation	8.5 %
Solar Thermal	10 %
Biomass Gasifier	10 %
Biogas	12 %

6.3.11 SUBSIDY or INCENTIVE by THE CENTRAL / STATE GOVERNMENT.

Regulation 22 of the RE Tariff Regulations provides as under:

- "The Commission shall take into consideration any incentive or subsidy offered by the Central or State Government, including accelerated depreciation benefit if availed by the generating company, for the renewable energy power plants while determining the tariff under these Regulations.

Provided that the following principles shall be considered for ascertaining income tax benefit on account of accelerated depreciation, if availed, for the purpose of tariff determination:

1) Assessment of benefit shall be based on normative capital cost, accelerated depreciation rate as per relevant provisions under Income Tax Act and corporate income tax rate.

ii) Capitalization of RE projects during second half of the fiscal year. Per unit benefit shall be derived on levellised basis at discount factor equivalent to Post Tax weighted average cost of capital".

- In terms of the above regulation, for the projects availing the benefit of accelerated depreciation as per applicable Income tax rate @ 33.99% (30% IT rate+ 10% surcharge +3% Education cess) has been considered. For the purpose of determining net depreciation benefits, depreciation @ 5.28% as per straight line method (Book depreciation as per Companies Act, 1956) has been compared with depreciation as per Income Tax rate i.e. 80% of the written down value method. Moreover, additional 20% depreciation in the initial year is proposed to be extended to new assets acquired by power generation companies vide amendment in the section 32, sub-section (1) clause (iia) of the Income Tax Act.

- Depreciation for the first year has been calculated at the rate of 50% of accelerated depreciation 80% and 50% of additional depreciation 20% (as project is capitalized during the second half of the financial year as per proviso to Regulation 22). Income tax benefits of accelerated depreciation and additional depreciation, has been worked out as per normal tax rate on the net depreciation benefit. Per unit levellised accelerated depreciation benefit has been computed considering the post tax weighted average cost of capital as discount factor. Accelerated depreciation benefit has been computed as per existing provisions of Income Tax Act. The provisions related to Accelerated Depreciation announced in Union Budget of India presented on February 29, 2016 would be applied once the same are notified.

In the light of the discussion made in the preceding paragraphs, the generic tariffs of the following RE projects for the financial year 2016-17 have been arrived at and are proposed as under:

Solar PV Projects

Annexure 5A

Assumpion for Solar PV Power Projects Parameters

S. No.	Assumption Head	Sub-Head	Sub-Head (2)	Unit	Asumptions
1	Power Generati	On Capacity	Installed Power Generation Capacity	MW	1
			Auxiliary Consumption	%	0.00%
			Capacity Utilization Factor	%	19.0%
			Useful Life	Years	25
2	Project Cost	Capital Cost/MW	Power Plant Cost	Rs Lacs/MW	530.02
3	Financial Assumptions		Tariff Period	Years	25
		Debt: Equity	Debt	%	70%
			Equity	%	30%
			Total Debt Amount	Rs Lacs	371.02
			Total Equity Amout	Rs Lacs	159.01
		Debt Component	Loan Amount	Rs Lacs	371.02
			Moratorium Period	years	0
			Repayment Period(incld Moratorium)	years	12
			Interest Rate	%	12.76%
		Equity Component	Equity amount	Rs Lacs	159.01
			Return on Equity for first 10 years	% p.a	20.00%
			RoE Period	Year	10
			Return on Equity 11th year onwards	% p.a	24.00%

			Weighted average of ROE		22.40%
			Discount Rate		10.70%
4	Financial Assum	ptions			
		Fiscal Assumptions	Income Tax	%	33.990%
			MAT Rate (for first 10 years)	%	20.000%
			80 IA benefits	Yes/No	Yes
		Depreciation	Depreciation Rate for first 12 years	%	5.83%
			Depreciation Rate 13th year onwards	%	1.54%
			Years for 5.83% rate		12
5	Working Capital	For Fixed Charges			
		O&M Charges		Months	1
		Maintenance Spare	(% of O&M exepenses)	%	15%
		Receivables for Debtors		Months	2
		For Variable Charges			
		Interest On Working Capital		%	13.26%
6	Operation & Maintenance				
	O&M Expenses (2016-17)			Rs. Lacs	7.00

TABLE - 7

Levellised Tariff 5.68 Rs/Unit (A3 CHART TO ATTACHED)

7. Financial Analysis and Considerations

For

SOLAR POWER IN INDIA

7.1 PROJECT FINANCE.

Project Finance is long term financing of infrastructure and industrial projects based on projected cash flows of the project rather than balance sheet of the project sponser.

- Usually, a project financing structure involves a number of equity investors, known as sponsors or promoters, as well as a syndicate of banks or other lending institutions that provide loans to the operation.
- The loans are most commonly non-recourse loans, which are secured by the project assets and paid entirely from project cash flow, rather than from the general assets or creditworthiness of the project sponsors, a decision in part supported by financial modeling.
- The financing is typically secured by all of the project assets, including the revenue- producing contracts.
- Project lenders are given a lien on all of these assets, and are able to assume control of a project if the project company has difficulties complying with the loan terms.
- Generally, a special purpose entity is created for each project, thereby shielding other assets owned by a project sponsor from the detrimental effects of a project failure.
- As a special purpose entity, the project company has no assets other than the project.
- Capital contribution commitments by the owners of the project company are sometimes necessary to ensure that the project is financially sound, or to assure the lenders of the sponsors‟ commitment.
- Project finance is often more complicated than alternative financing methods.
- Traditionally, project financing has been most commonly used in the extractive (mining), transportation, telecommunications and energy industries.
- More recently project financing principles have been applied to other types of public infrastructure under public–private partnerships (PPP)

Project finance models are usually built as Excel spreadsheets and typically consist of the following interlinked sheets:

- Data input and assumptions
- Capital Expenditure
- Debt Schedule
- Revenue Sheet
- Cost Sheet
- Accounting Statements
- Analysis for Debt repayment and return on Equity

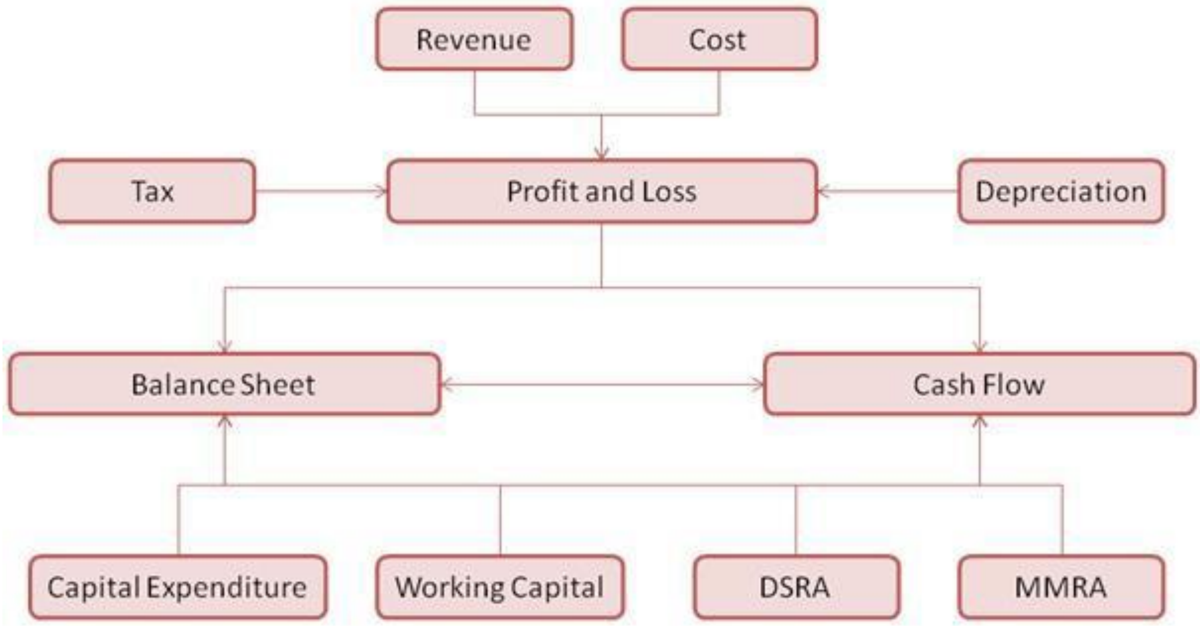


Figure 19 Typical side view of MMS

7.2 TERMINOLOGIES:

7.2.1 CAPITAL COST.

Capital expenditure or CAPEX is the amount of money spent on a project before it gets operational. All expenses incurred for the project like design, engineering, procurement, construction, installation, commissioning, duties and taxes etc. contributes to capital expenditure.It composes a Debt and an equity component.

7.2.2 DEBT.

It is the total amount of Long term fixed liabilities. Generally a bank or a Financial institute Issues debentures to the developing party for fixed period of time (maturity period) at a fixed rate of interest.

7.2.3 EQUITY.

Equity is the amount of owner‟s share capital put up in the total capital cost.

7.2.4 DISCOUNT RATE.

The interest rate used in discounted cash flow analysis to determine the present value of future cash flows. The discount rate takes into account the time value of money.

7.2.5 BALANCE SHEET.

An accounting statement, classifying all the financial entities into assets or liabilities. The basic checking point is the value of all the assets should be equal to all the liabilities

7.2.6 INCOME STATEMENT.

An accounting sheet that displays the flow from total earnings to earnings after tax or the actual earnings of the company

7.2.7 WORKING CAPITAL.

A measure of both a company's efficiency and its short-term financial health. The working capital ratio is calculated as:

Current Assets- Current Liabilities

Also known as "net working capital", or the "working capital ratio".

7.2.8 O&M EXPENCES.

Annual fixed cost incurred for maintenance, repairs and operation of plant. A Normative O&M Expense is taken with a certain escalation price. Escalation price is an assumed per annum percentage increase in the O&M costs.

7.3 FINANCIAL MODELING (Def).

The process by which a firm constructs a financial representation of some, or all, aspects of the firm or given security. The model is usually characterized by performing calculations, and makes recommendations based on that information. The model may also summarize particular events for the end user and provide direction regarding possible actions or alternatives.

7.3.1 FINANCIAL INDICATORS USED IN THE MODEL.

I. Debt Service Coverage ratio
II. Internal Rate of Return

7.3.2 THE PURPOSE OF FINANCIAL MODELS.

Financial models serve five purposes:

1. to demonstrate the size of the market opportunity
2. to explain the business model
3. to show the path to profitability
4. to quantify the investment requirement
5. to facilitate valuation of the business

The Basic Idea behind Building a financial Model is to answer these questions that may pop in the mind of the developer or the lender. From a Power Sector Perspective we can add determination of tariff for Power Purchase agreements to that list. Also we would like to know the volatility of the project viz.what changes would occur in the tariff, in earnings, in Cash flow if we certain variables factors change. In case of solar this is all the more plausible as Solar power is dependent on the intensity of Sun‟s radiation in the project area, which is a factor we have no control over, atleast not yet.

7.4 The Components for calculation of tariff in a solar project has been taken as per the CERC guidelines.

These are based on Single part Tariff and compose only of the fixed components due to lack of fuel costs. These are

O & M expenses

Depreciation

Interest on Loan

Interest on Working Capital

Return on Equity

All the above except Return on equity are costs incurred by the developer and thus are included in the tariff. RoE gives a picture of the profit margin of the developer.

As per the IT act, a tax holiday of 10 years is taken into the model.

7.5 ASSUMPTION & INPUT DATA.

Below is the assumptions taken into consideration while building the model. Most of the assumptions have been taken as per the CERC Guidelines

7.6 TARIFF STRUCTURE.

The tariff for Solar PV Technologies shall be single part tariff consisting of the following fixed cost components:

- Return on equity;
- Interest on loan capital;
- Depreciation;
- Interest on working capital;
- Operation and maintenance expenses;
-

7.7 DESPATCH PRINCIPLES.

Solar generating plants with capacity of 5 MW and above and connected at the connection point of 33 KV level and above shall be subjected to scheduling and despatch code as specified under Indian Electricity Grid Code (IEGC) -2010, as amended from time to time.

7.8 Financial Principles

7.8.1 CAPITAL COST.

The norms for the Capital cost as specified in the subsequent technology specific chapters shall be inclusive of all capital work including plant and machinery, civil work, erection and commissioning, financing and interest during construction, and evacuation infrastructure up to inter-connection point.

7.8.2 DEBT-EQUITY RATIO.

- For generic tariff to be determined based on suo-motu petition, the debt equity ratio shall be 70:30.
- For Project specific tariff, the following provisions shall apply:- If the equity actually deployed is more than 30% of the capital cost, equity in excess of 30% shall be treated as normative loan. Provided that where equity actually deployed is less than 30% of the capital cost, the actual equity shall be considered for determination of tariff, provided further that the equity invested in foreign currency shall be designated in Indian rupees on the date of each investment.

7.8.3 INTEREST RATE.

- The normative loan outstanding as on April 1st of every year shall be worked out by deducting the cumulative repayment up to March 31st of previous year from the gross normative loan.
- For the purpose of computation of tariff, the normative interest rate shall be considered as average State Bank of India (SBI) Base rate prevalent during the first six months of the previous year plus 300 basis points.
- Notwithstanding any moratorium period availed by the generating company, the repayment of loan shall be considered from the first year of commercial operation of the project and shall be equal to the annual depreciation allowed.

7.8.4 DEPRECIATION.

The value base for the purpose of depreciation shall be the Capital Cost of the asset admitted by the Commission. The Salvage value of the asset shall be considered as 10% and depreciation shall be allowed up to maximum of 90% of the Capital Cost of the asset.

- Depreciation per annum shall be based on „Differential Depreciation Approach' over loan period beyond loan tenure over useful life computed on CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012
- Depreciation shall be chargeable from the first year of commercial operation, provided that in case of commercial operation of the asset for part of the year, depreciation shall be charged on pro rata basis.

7.8.5 RETURN ON EQUITY.

- The value base for the equity shall be 30% of the capital cost or actual equity (in case of project specific tariff determination)

7.8.6 INTEREST ON WORKING CAPITAL.

- Operation & Maintenance expenses for one month.
- Receivables equivalent to 2 (Two) months of energy charges for sale of electricity calculated on the normative CUF.
- Maintenance spare @ 15% of operation and maintenance expenses

7.8.7 OPERATION AND MAINTENANCE EXPENSES.

- Operation and Maintenance or O&M expenses" shall comprise repair and maintenance (R&M), establishment including employee expenses and administrative
- & general expenses.
- Operation and maintenance expenses shall be determined for the Tariff Period based on normative O&M expenses specified by the Commission subsequently in these Regulations for the first Year of Control Period.
- Normative O&M expenses allowed during first year of the Control Period (i.e. FY 2012-13) under these Regulations shall be escalated at the rate of 5.72% per annum over the Tariff Period.

7.9 Model Layout.

Below is a Layout of the Financial model prepared. Modeling was done on Excel worksheet utilizing various tools and formulas of excel. Most of the data is soft coded and hard coding is limited to bare minimum. The first sheet is the Input sheet, where the green coded cells denote the variable input cells, changing which would change the model‟s result provided the change is within the boundary limits of the coding.

The Sheets included in the Model are

1. Assumptions and Inputs
2. Balance sheet
3. Captive generation
4. Cash flow analysis
5. Debt Repayment
6. Depreciation
7. Internal rate of Return
8. Profit and loss account
9. Renewable Energy Certificate
10. Sensitivity Analysis
11. Tariff
12. Tariff breakdown
13. Working Capital

8 Findings :

Figure 20 – Modules Structure.

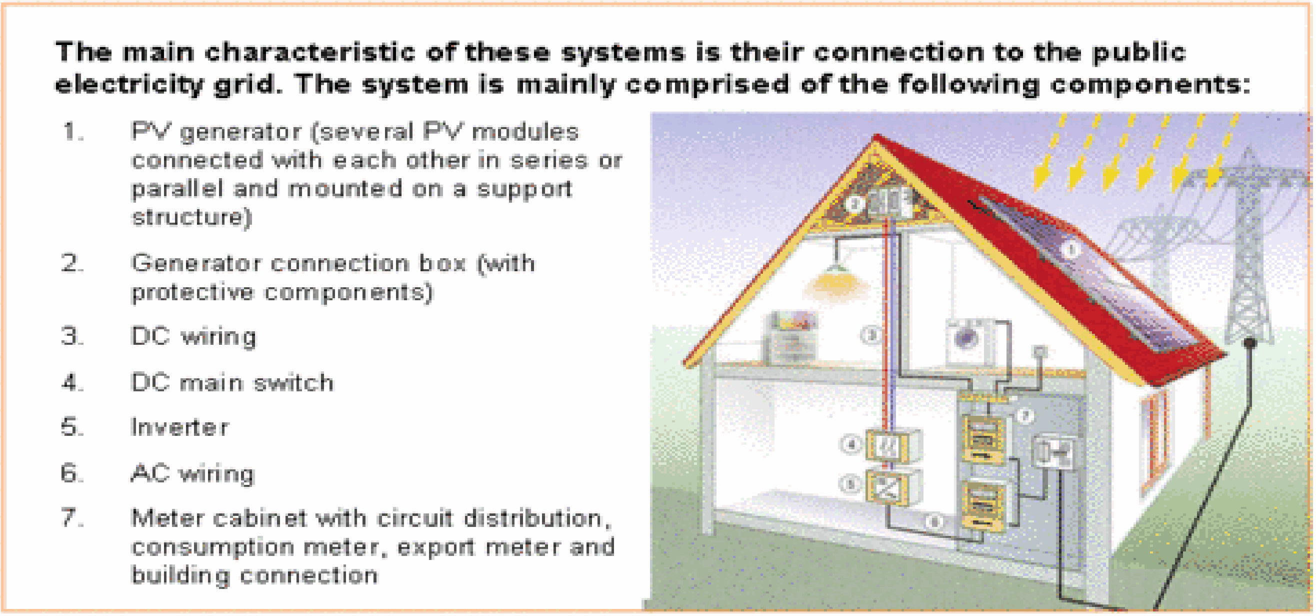


Figure 21 Solar Export Scheme. (Sources from First Solar site)

Possible Approach:

Government can identify strategic partner industries within India for each of the above materials and encourage them through R&D incentives, process up-gradation schemes, etc.

Technology transfer and tie-ups with EU or USA based industries should be supported through dialogues with their governments.

This industry is ideal for a small and medium enterprise (SME) set up. The investment benefits like SIPS should be developed for this segment also.

ASSUMPSIONS.

Power Generation			
Capacity			
Installed Power Generation Capacity	MW	1	
Capacity utilization factor	%	19.00%	
Commercial Operations Date			
Useful life	Years	25	
Deration factor	%	0.50%	
Project Cost			
Capital cost (as per 2016 rate)	Rs lacs	478.00	
Normative Capital Cost	Rs lacs/MW	478.00	
Capital Subsidy (if any)	Rs lacs	0.00	
Net Capital cost	Rs lacs	478.00	
Financial Assumptions			
Debt:Equity			
Tariff period	Years	25	
Debt	%	70.00%	
Equity	%	30.00%	
Total Debt Amt	Rs Lacs	334.60	
Total Equity Amt	Rs Lacs	143.40	
Debt Component			
Loan Amount	Rs Lacs	334.60	
Moratorium period		4	
Repayment period (excluding moratorium)	Years	12	
No of payments in a year		4	
Total no. of payments (excluding moratorium)		48	
Total no. of payments (including moratorium)		52	
Interest rate	%	13.25%	
Date of Start of loan			
Equity Component			
Equity Amount	Rs Lacs	143.40	
Return on equty first 10 years	%	19.38%	
Return on equty 11th year onwards	%	24.00%	
Discount Rate	%	15.97%	
Depreciation & Incentives			
Depreciation Rate for Loan Tenure	%	5.83%	
Depreciation rate Post Loan Tenure	%	1.54%	
Generation Based Incentives (if any)	Rs lacs p.a.		
Period for GBI	Years		
Operation and Maintainence			
Normative O&M Expenses	Rs Lakhs/MW	3.63	
O&M Expenses per annum	Rs Lakhs	3.63	
Escalation factor for O&M Expenses	%	5.72%	
Working Capital			
O&M Expenses	Months	1	
Maintainence Spares (% of O&M Expenses)	%	10.00%	
Recievables	Months	2	
Interest on working capital	%	13.00%	
Tax assumption			
Income tax	%	32.45%	
MAT Rate (first 10 years)	%	20.01%	

8.1 Challenges Faced by Solar Sector.

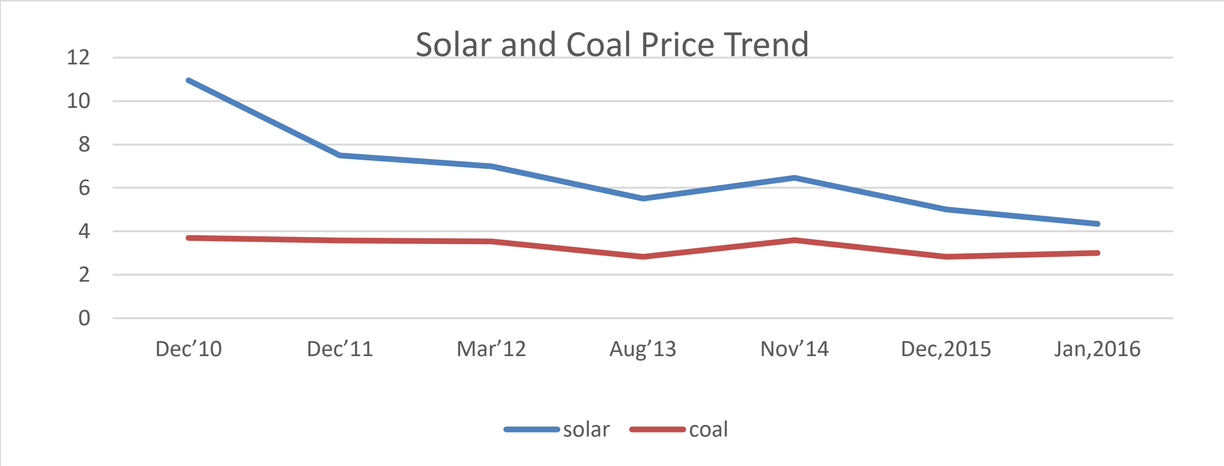
Key challenges facing the growth and development of PV in India include:

- **Cost and T&D Losses:** Solar PV is some years away from true cost competitiveness and from being able to compete on the same scale as other energy generation technologies. Adding to the cost are T&D losses that at approximately 40 percent make generation through solar energy sources highly unfeasible. However, the government is supporting R&D activities by establishing research centres and funding such initiatives. The government has tied up with world-renowned universities to bring down the installation cost of solar power sources and is focusing on upgradation of substations and T&D lines to reduce T&D losses.
- **Land Scarcity**: Per capita land availability is very low in India, and land is a scarce resource. Dedication of land area near substations for exclusive installation of solar cells might have to compete with other necessities that require land.
- Funding of initiatives like National Solar Mission is a constraint given India's inadequate financing capabilities. The finance ministry has explicitly raised concerns about funding an ambitious scheme like NSM.
- Manufacturers are mostly focused on export markets that buy Solar PV cells and modules at higher prices thereby increasing their profits. Many new suppliers have tie-ups with foreign players in Europe and United States thereby prioritizing export demand. This could result in reduced supplies for the fast-growing local market.
- The lack of closer industry-government cooperation for the technology to achieve scale.
- The need for focused, collaborative and goals driven R&D to help India attain technology leadership in PV.
- The need for a better financing infrastructure, models and arrangements to spur the PV industry and consumption of PV products.
- Training and development of human resources to drive industry growth and PV adoption
- The need for intra-industry cooperation in expanding the PV supply chain, in technical information sharing through conferences and workshops, in collaborating with BOS (balance of systems) manufacturers and in gathering and publishing accurate market data, trends and projections
- The need to build consumer awareness about the technology, its economics and right usage

- Complexity of subsidy structure & involvement of too many agencies like MNRE, IREDA, SNA, electricity board and electricity regulatory commission makes the development of solar PV projects difficult.
- Land allotment & PPA signing is a long procedure under the Generation Based Incentive scheme

9. CONCLUSIONS.

Year	Solar Lowest (Rs./KWh)	Coal Lowest (Rs./KWh)
Dec'10	10.95	3.7
Dec'11	7.49	3.57
Mar'12	7	3.54
Aug'13	5.5	2.83
Nov'14	6.46	3.59
Dec,2015	5	2.82
Jan,2016	4.35	3



The project involves study of Electricity Act 2003, National electricity policy, National tariff policy and Indian electricity rules 2005, Tariff regulations of CERC.

Financial viability of the project has been checked by calculating the Levelised tariff, profit & loss, cash flow statement, NPV and IRR.

Levelised tariff (under the given assumptions) comes out to be Rs 5.25/kwh

Project IRR (pre-tax) comes out to be 15.93%

Equity IRR (pre-tax) comes out to be 22.15%

The project has an average **DSCR** ratio of 1.67.

It can be concluded that since the price of the Solar Enegry was drastically come down still there is lot opportunity to the development of project is beneficial for both the developer, considering the DSCR and Project IRR is comparable with other projects. Thus investing in the project would be beneficial for the lender.

10 Calculation's as fallows,

Debt Repayment

Repayment Schedule(For Finanancial Institute's Loan Repayment Purpose)

Year		1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7
Pmt no		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Pmt date																											
Opening Balance	Rs Lacs	334.60	334.60	334.60	334.60	334.60	327.63	320.66	313.69	306.72	299.75	292.78	285.80	278.83	271.86	264.89	257.92	250.95	243.98	237.01	230.04	223.07	216.10	209.13	202.15	195.18	188.21
Principal Payment	Rs Lacs	0.00	0.00	0.00	0.00	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97
Closing Balance	Rs Lacs	334.60	334.60	334.60	334.60	327.63	320.66	313.69	306.72	299.75	292.78	285.80	278.83	271.86	264.89	257.92	250.95	243.98	237.01	230.04	223.07	216.10	209.13	202.15	195.18	188.21	181.24
Average Balance	Rs Lacs	334.60	334.60	334.60	334.60	331.11	324.14	317.17	310.20	303.23	296.26	289.29	282.32	275.35	268.38	261.41	254.44	247.46	240.49	233.52	226.55	219.58	212.61	205.64	198.67	191.70	184.73
Interest on Loan	Rs Lacs	11.08	11.08	11.08	11.08	10.97	10.74	10.51	10.28	10.04	9.81	9.58	9.35	9.12	8.89	8.66	8.43	8.20	7.97	7.74	7.50	7.27	7.04	6.81	6.58	6.35	6.12
Total Payment	Rs Lacs	11.08	11.08	11.08	11.08	17.94	17.71	17.48	17.25	17.02	16.78	16.55	16.32	16.09	15.86	15.63	15.40	15.17	14.94	14.71	14.48	14.24	14.01	13.78	13.55	13.32	13.09
Cummalative Interest	Rs Lacs	11.08	22.17	33.25	44.33	55.30	66.04	76.55	86.82	96.87	106.68	116.26	125.61	134.74	143.63	152.28	160.71	168.91	176.88	184.61	192.12	199.39	206.43	213.24	219.83	226.18	232.29
Yearly cummalative Interest	Rs Lacs				44.33				86.82				125.61				160.71				192.12				219.83		
Cummalative Principal	Rs Lacs	0.00	0.00	0.00	0.00	6.97	13.94	20.91	27.88	34.85	41.83	48.80	55.77	62.74	69.71	76.68	83.65	90.62	97.59	104.56	111.53	118.50	125.48	132.45	139.42	146.39	153.36
Yearly cummalative Principal	Rs Lacs				0.00				27.88				55.77				83.65				111.53				139.42		

Year		7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12	13	13	13	13
Pmt no		27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Pmt date																											
Opening Balance	Rs Lacs	181.24	174.27	167.30	160.33	153.36	146.39	139.42	132.45	125.48	118.50	111.53	104.56	97.59	90.62	83.65	76.68	69.71	62.74	55.77	48.80	41.82	34.85	27.88	20.91	13.94	6.97
Principal Payment	Rs Lacs	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97
Closing Balance	Rs Lacs	174.27	167.30	160.33	153.36	146.39	139.42	132.45	125.48	118.50	111.53	104.56	97.59	90.62	83.65	76.68	69.71	62.74	55.77	48.80	41.82	34.85	27.88	20.91	13.94	6.97	0.00
Average Balance	Rs Lacs	177.76	170.79	163.81	156.84	149.87	142.90	135.93	128.96	121.99	115.02	108.05	101.08	94.11	87.14	80.16	73.19	66.22	59.25	52.28	45.31	38.34	31.37	24.40	17.43	10.46	3.49
Interest on Loan	Rs Lacs	5.89	5.66	5.43	5.20	4.96	4.73	4.50	4.27	4.04	3.81	3.58	3.35	3.12	2.89	2.66	2.42	2.19	1.96	1.73	1.50	1.27	1.04	0.81	0.58	0.35	0.12
Total Payment	Rs Lacs	12.86	12.63	12.40	12.17	11.94	11.70	11.47	11.24	11.01	10.78	10.55	10.32	10.09	9.86	9.63	9.40	9.16	8.93	8.70	8.47	8.24	8.01	7.78	7.55	7.32	7.09
Cummalative Interest	Rs Lacs	238.18	243.84	249.27	254.46	259.43	264.16	268.66	272.93	276.98	280.79	284.36	287.71	290.83	293.72	296.37	298.80	300.99	302.95	304.68	306.19	307.46	308.49	309.30	309.88	310.23	310.34
Yearly cummalative Interest	Rs Lacs		243.84				264.16				280.79				293.72				302.95				308.49				310.34
Cummalative Principal	Rs Lacs	160.33	167.30	174.27	181.24	188.21	195.18	202.15	209.13	216.10	223.07	230.04	237.01	243.98	250.95	257.92	264.89	271.86	278.83	285.80	292.78	299.75	306.72	313.69	320.66	327.63	334.60
Yearly cummalative Principal	Rs Lacs		167.30				195.18				223.07				250.95				278.83				306.72				334.60

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Yearly interest	Rs lacs	44.33	42.49	38.79	35.10	31.40	27.71	24.01	20.32	16.63	12.93	9.24	5.54	1.85												
Yearly Cummalative Interest	Rs lacs	44.33	86.82	125.61	160.71	192.12	219.83	243.84	264.16	280.79	293.72	302.95	308.49	310.34												
Yearly Principal Payment	Rs lacs	0.00	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88												
Yearly Cummalative Principal	Rs lacs	0.00	27.88	55.77	83.65	111.53	139.42	167.30	195.18	223.07	250.95	278.83	306.72	334.60												
Yearly Total Payment	Rs lacs	44.33	70.37	66.68	62.98	59.29	55.59	51.90	48.20	44.51	40.81	37.12	33.43	29.73												
Yearly Cummalative Payment	Rs lacs	44.33	114.71	181.38	244.36	303.65	359.24	411.14	459.34	503.85	544.67	581.79	615.21	644.94												

For Tariff Calculation Purposes (Excluding Moratorium)

Year		1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6
Pmt no		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Opening Balance	Rs Lacs	334.60	327.63	320.66	313.69	306.72	299.75	292.78	285.80	278.83	271.86	264.89	257.92	250.95	243.98	237.01	230.04	223.07	216.10	209.13	202.15	195.18	188.21	181.24	174.27
Principal Payment	Rs Lacs	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97
Closing Balance	Rs Lacs	327.63	320.66	313.69	306.72	299.75	292.78	285.80	278.83	271.86	264.89	257.92	250.95	243.98	237.01	230.04	223.07	216.10	209.13	202.15	195.18	188.21	181.24	174.27	167.30
Average Balance	Rs Lacs	331.11	324.14	317.17	310.20	303.23	296.26	289.29	282.32	275.35	268.38	261.41	254.44	247.46	240.49	233.52	226.55	219.58	212.61	205.64	198.67	191.70	184.73	177.76	170.79
Interest on Loan	Rs Lacs	10.97	10.74	10.51	10.28	10.04	9.81	9.58	9.35	9.12	8.89	8.66	8.43	8.20	7.97	7.74	7.50	7.27	7.04	6.81	6.58	6.35	6.12	5.89	5.66
Total Payment	Rs Lacs	17.94	17.71	17.48	17.25	17.02	16.78	16.55	16.32	16.09	15.86	15.63	15.40	15.17	14.94	14.71	14.48	14.24	14.01	13.78	13.55	13.32	13.09	12.86	12.63
Cumulative Interest	Rs Lacs	10.97	21.71	32.21	42.49	52.53	62.35	71.93	81.28	90.40	99.29	107.95	116.38	124.58	132.54	140.28	147.78	155.06	162.10	168.91	175.49	181.84	187.96	193.85	199.51
Yearly cumulative Interest	Rs Lacs				42.49				81.28				116.38				147.78				175.49				199.51
Cummalative Principal	Rs Lacs	6.97	13.94	20.91	27.88	34.85	41.83	48.80	55.77	62.74	69.71	76.68	83.65	90.62	97.59	104.56	111.53	118.50	125.48	132.45	139.42	146.39	153.36	160.33	167.30
Yearly cumulative Principal	Rs Lacs				27.88				55.77				83.65				111.53				139.42				167.30

Year		7	7	7	7	8	8	8	8	9	9	9	9	10	10	10	10	11	11	11	11	12	12	12	12
Pmt no		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Opening Balance	Rs Lacs	167.30	160.33	153.36	146.39	139.42	132.45	125.48	118.50	111.53	104.56	97.59	90.62	83.65	76.68	69.71	62.74	55.77	48.80	41.82	34.85	27.88	20.91	13.94	6.97
Principal Payment	Rs Lacs	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97	6.97
Closing Balance	Rs Lacs	160.33	153.36	146.39	139.42	132.45	125.48	118.50	111.53	104.56	97.59	90.62	83.65	76.68	69.71	62.74	55.77	48.80	41.82	34.85	27.88	20.91	13.94	6.97	0.00
Average Balance	Rs Lacs	163.81	156.84	149.87	142.90	135.93	128.96	121.99	115.02	108.05	101.08	94.11	87.14	80.16	73.19	66.22	59.25	52.28	45.31	38.34	31.37	24.40	17.43	10.46	3.49
Interest on Loan	Rs Lacs	5.43	5.20	4.96	4.73	4.50	4.27	4.04	3.81	3.58	3.35	3.12	2.89	2.66	2.42	2.19	1.96	1.73	1.50	1.27	1.04	0.81	0.58	0.35	0.12
Total Payment	Rs Lacs	12.40	12.17	11.94	11.70	11.47	11.24	11.01	10.78	10.55	10.32	10.09	9.86	9.63	9.40	9.16	8.93	8.70	8.47	8.24	8.01	7.78	7.55	7.32	7.09
Cumulative Interest	Rs Lacs	204.93	210.13	215.09	219.83	224.33	228.60	232.64	236.45	240.03	243.38	246.50	249.38	252.04	254.46	256.66	258.62	260.35	261.85	263.12	264.16	264.97	265.55	265.89	266.01
Yearly cumulative Interest	Rs Lacs				219.83				236.45				249.38				258.62				264.16				266.01
Cummalative Principal	Rs Lacs	174.27	181.24	188.21	195.18	202.15	209.13	216.10	223.07	230.04	237.01	243.98	250.95	257.92	264.89	271.86	278.83	285.80	292.78	299.75	306.72	313.69	320.66	327.63	334.60
Yearly cumulative Principal	Rs Lacs				195.18				223.07				250.95				278.83				306.72				334.60

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Date																										
Yearly Principal Payment	Rs lacs	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88													
Yearly Cumulative Principal	Rs lacs	27.88	55.77	83.65	111.53	139.42	167.30	195.18	223.07	250.95	278.83	306.72	334.60													
Yearly Interest	Rs lacs	42.49	38.79	35.10	31.40	27.71	24.01	20.32	16.63	12.93	9.24	5.54	1.85													
Yearly Cumulative Interest	Rs lacs	42.49	81.28	116.38	147.78	175.49	199.51	219.83	236.45	249.38	258.62	264.16	266.01													
Yearly Total Payment	Rs lacs	70.37	66.68	62.98	59.29	55.59	51.90	48.20	44.51	40.81	37.12	33.43	29.73													
Yearly Cumulative Payment	Rs lacs	70.37	137.05	200.03	259.32	314.91	366.81	415.01	459.52	500.33	537.45	570.88	600.61													

Extra Payment During Moratorium	Rs lacs	44.33

Depreciation

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Base value	478.00	450.12	422.23	394.35	366.47	338.58	310.70	282.82	254.93	227.05	199.17	171.28	143.40	136.05	128.69	121.34	113.98	106.63	99.28	91.92	84.57	77.22	69.86	62.51	55.15
Depreciation	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35
Depreciated value	450.12	422.23	394.35	366.47	338.58	310.70	282.82	254.93	227.05	199.17	171.28	143.40	136.05	128.69	121.34	113.98	106.63	99.28	91.92	84.57	77.22	69.86	62.51	55.15	47.80
Cumulative Depreciation	27.88	55.77	83.65	111.53	139.42	167.30	195.18	223.07	250.95	278.83	306.72	334.60	341.95	349.31	356.66	364.02	371.37	378.72	386.08	393.43	400.78	408.14	415.49	422.85	430.20

Working Capital

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
O & M Expenses (monthly)	Rs Lakhs	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.45	0.47	0.50	0.53	0.56	0.59	0.62	0.66	0.70	0.74	0.78	0.82	0.87	0.92	0.97	1.03	1.09	1.15
Recievables	Rs Lakhs	17.36	16.76	16.17	15.58	15.00	14.41	13.83	13.25	12.68	12.10	12.66	12.10	8.35	8.42	8.50	8.57	8.66	8.75	8.84	8.94	9.04	9.15	9.27	9.39	9.52
Maintainence Spares	Rs Lakhs	0.36	0.38	0.41	0.43	0.45	0.48	0.51	0.54	0.57	0.60	0.63	0.67	0.71	0.75	0.79	0.84	0.88	0.93	0.99	1.04	1.10	1.17	1.23	1.30	1.38
Total Working Capital	Rs Lakhs	18.02	17.47	16.92	16.37	15.83	15.29	14.76	14.23	13.71	13.20	13.82	13.32	9.65	9.79	9.95	10.11	10.28	10.46	10.65	10.85	11.07	11.29	11.53	11.78	12.05
Interest on Working capital	Rs Lakhs	2.34	2.27	2.20	2.13	2.06	1.99	1.92	1.85	1.78	1.72	1.80	1.73	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.41	1.44	1.47	1.50	1.53	1.57

Tariff

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Units Generation																										
Installed capacity	MW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Net Generation	MU	1.66	1.66	1.65	1.64	1.63	1.62	1.62	1.61	1.60	1.59	1.58	1.58	1.57	1.56	1.55	1.54	1.54	1.53	1.52	1.51	1.51	1.50	1.49	1.48	1.48
Tariff component (Fixed Charge)																										
O&M expenses	Rs lakhs	3.63	3.84	4.06	4.29	4.53	4.79	5.07	5.36	5.66	5.99	6.33	6.69	7.08	7.48	7.91	8.36	8.84	9.34	9.88	10.44	11.04	11.67	12.34	13.05	13.79
Depreciation	Rs lakhs	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35
Interest On Loan	Rs lakhs	42.49	38.79	35.10	31.40	27.71	24.01	20.32	16.63	12.93	9.24	5.54	1.85													
Interest On Working capital	Rs lakhs	2.34	2.27	2.20	2.13	2.06	1.99	1.92	1.85	1.78	1.72	1.80	1.73	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.41	1.44	1.47	1.50	1.53	1.57
Return on Equity	Rs lakhs	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42
Total Fixed Cost	Rs lakhs	104.13	100.58	97.03	93.50	89.98	86.47	82.98	79.51	76.05	72.62	75.97	72.57	50.10	50.52	50.97	51.44	51.95	52.47	53.03	53.63	54.25	54.91	55.61	56.35	57.13
Per unit Tariff component (Fixed Charge)																										
Per unit O&M expenses	Rs/kwh	0.22	0.23	0.25	0.26	0.28	0.30	0.31	0.33	0.35	0.38	0.40	0.42	0.45	0.48	0.51	0.54	0.58	0.61	0.65	0.69	0.73	0.78	0.83	0.88	0.93
Per unit Depreciation	Rs/kwh	1.68	1.68	1.69	1.70	1.71	1.72	1.73	1.74	1.74	1.75	1.76	1.77	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.50	0.50
Per unit Interest On Loan	Rs/kwh	2.55	2.34	2.13	1.92	1.70	1.48	1.26	1.03	0.81	0.58	0.35	0.12													
Per unit Interest On Working capital	Rs/kwh	0.14	0.14	0.13	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.11
Per unit Return on Equity	Rs/kwh	1.67	1.68	1.69	1.70	1.70	1.71	1.72	1.73	1.74	1.75	2.17	2.18	2.20	2.21	2.22	2.23	2.24	2.25	2.26	2.27	2.29	2.30	2.31	2.32	2.33
Per unit Tariff component	Rs/kwh	6.26	6.07	5.89	5.70	5.52	5.33	5.14	4.95	4.76	4.56	4.80	4.61	3.20	3.24	3.29	3.33	3.38	3.43	3.49	3.54	3.60	3.67	3.73	3.80	3.87
Levellised Tariff																										
Discount Factors	15.97%	0.86	0.74	0.64	0.55	0.48	0.41	0.35	0.31	0.26	0.23	0.20	0.17	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.03	0.02
Discount Tariff Components	Rs/kwh	5.39	4.52	3.78	3.15	2.63	2.19	1.82	1.51	1.25	1.04	0.94	0.78	0.47	0.41	0.36	0.31	0.27	0.24	0.21	0.18	0.16	0.14	0.12	0.11	0.10
Levelised Tariff	Rs/kwh	5.25																								

Profit & Loss account

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Generation	In Lakh Kwh	16.64	16.56	16.48	16.40	16.31	16.23	16.15	16.07	15.99	15.91	15.83	15.75	15.67	15.59	15.52	15.44	15.36	15.28	15.21	15.13	15.06	14.98	14.91	14.83	14.76
Tariff	Rs/Kwh	6.26	6.07	5.89	5.70	5.52	5.33	5.14	4.95	4.76	4.56	4.80	4.61	3.20	3.24	3.29	3.33	3.38	3.43	3.49	3.54	3.60	3.67	3.73	3.80	3.87
Income From Sale of Electricity	Rs Lakhs	104.13	100.58	97.03	93.50	89.98	86.47	82.98	79.51	76.05	72.62	75.97	72.57	50.10	50.52	50.97	51.44	51.95	52.47	53.03	53.63	54.25	54.91	55.61	56.35	57.13
Income From REC Sale	Rs Lakhs																									
Captive Generation	Rs Lakhs																									
Operation and Maintainence	Rs Lakhs	3.63	3.84	4.06	4.29	4.53	4.79	5.07	5.36	5.66	5.99	6.33	6.69	7.08	7.48	7.91	8.36	8.84	9.34	9.88	10.44	11.04	11.67	12.34	13.05	13.79
EBDIT	Rs Lakhs	100.50	96.74	92.97	89.21	85.44	81.68	77.91	74.15	70.39	66.63	69.64	65.88	43.02	43.04	43.06	43.08	43.11	43.13	43.15	43.18	43.21	43.24	43.27	43.30	43.34
Depreciation	Rs Lakhs	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35	7.35
EBIT	Rs Lakhs	72.62	68.85	65.09	61.32	57.56	53.79	50.03	46.27	42.50	38.74	41.75	38.00	35.67	35.69	35.71	35.73	35.75	35.78	35.80	35.83	35.85	35.88	35.92	35.95	35.98
Interest on working capital	Rs Lakhs	2.34	2.27	2.20	2.13	2.06	1.99	1.92	1.85	1.78	1.72	1.80	1.73	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.41	1.44	1.47	1.50	1.53	1.57
Interest	Rs Lakhs	42.49	38.79	35.10	31.40	27.71	24.01	20.32	16.63	12.93	9.24	5.54	1.85													
EBT	Rs Lakhs	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	27.79	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42	34.42
Tax	Rs Lakhs	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17
EAT	Rs Lakhs	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25	23.25
Return on equity (pre-tax)	%	19.38%	19.38%	19.38%	19.38%	19.38%	19.38%	19.38%	19.38%	19.38%	19.38%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%
Return on equity (post-tax)	%	15.50%	15.50%	15.50%	15.50%	15.50%	15.50%	15.50%	15.50%	15.50%	15.50%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%	16.21%
Reserves and surplus	Rs Lakhs	22.23	44.46	66.69	88.92	111.15	133.38	155.61	177.84	200.07	222.30	245.55	268.80	292.04	315.29	338.54	361.79	385.04	408.28	431.53	454.78	478.03	501.28	524.52	547.77	571.02

Cash Flow

Total cash inflow

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Income From Sale of Electricity	Rs Lakhs	104.13	100.58	97.03	93.50	89.98	86.47	82.98	79.51	76.05	72.62	75.97	72.57	50.10	50.52	50.97	51.44	51.95	52.47	53.03	53.63	54.25	54.91	55.61	56.35	57.13
Income From REC Sale	Rs Lakhs																									
	Rs Lakhs																									
Total cash inflow	Rs Lakhs	104.13	100.58	97.03	93.50	89.98	86.47	82.98	79.51	76.05	72.62	75.97	72.57	50.10	50.52	50.97	51.44	51.95	52.47	53.03	53.63	54.25	54.91	55.61	56.35	57.13

Total cash Outflow

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Principal payment	Rs lakhs	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88	27.88													
Interest Payment	Rs lakhs	42.49	38.79	35.10	31.40	27.71	24.01	20.32	16.63	12.93	9.24	5.54	1.85													
Interest on working capital	Rs lakhs	2.34	2.27	2.20	2.13	2.06	1.99	1.92	1.85	1.78	1.72	1.80	1.73	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.41	1.44	1.47	1.50	1.53	1.57
O&M expense	Rs lakhs	3.63	3.84	4.06	4.29	4.53	4.79	5.07	5.36	5.66	5.99	6.33	6.69	7.08	7.48	7.91	8.36	8.84	9.34	9.88	10.44	11.04	11.67	12.34	13.05	13.79
Tax	Rs lakhs	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	5.56	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17	11.17
Total Cash outflow	Rs lakhs	81.90	78.35	74.80	71.27	67.75	64.24	60.75	57.28	53.82	50.39	52.72	49.32	19.50	19.92	20.37	20.84	21.34	21.87	22.43	23.02	23.65	24.31	25.01	25.75	26.53

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Total Cash Flow	Rs Lakhs	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23	22.23	23.25	23.25	30.60	30.60	30.60	30.60	30.60	30.60	30.60	30.60	30.60	30.60	30.60	30.60	30.60
Cash Reserves	Rs Lakhs	22.23	44.46	66.69	88.92	111.15	133.38	155.61	177.84	200.07	222.30	245.55	268.80	299.40	330.00	360.60	391.20	421.80	452.41	483.01	513.61	544.21	574.81	605.42	636.02	666.62

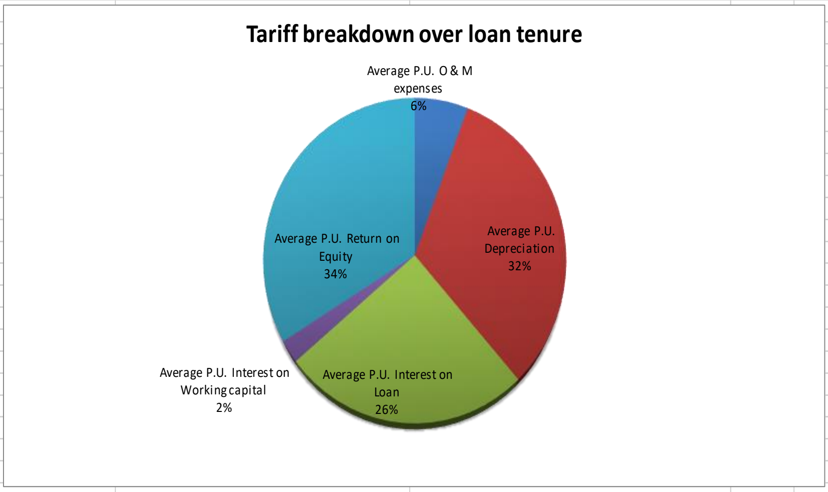
Debt Service coverage ratio

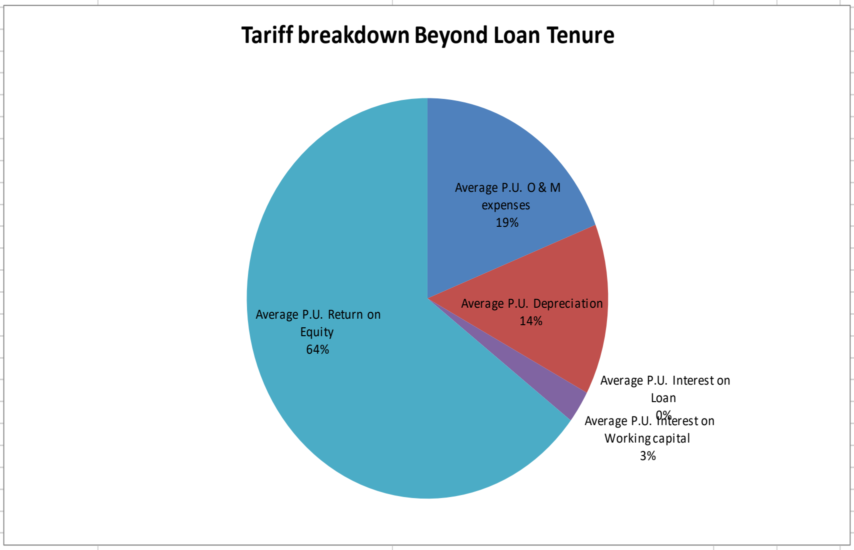
Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Net operating Income	Rs lakhs	70.37	66.68	62.98	59.29	55.59	51.90	48.20	44.51	40.81	37.12	33.43	29.73													
EBDIT	Rs Lakhs	100.50	96.74	92.97	89.21	85.44	81.68	77.91	74.15	70.39	66.63	69.64	65.88	43.02	43.04	43.06	43.08	43.11	43.13	43.15	43.18	43.21	43.24	43.27	43.30	43.34
DSCR Ratio		1.43	1.45	1.48	1.50	1.54	1.57	1.62	1.67	1.72	1.79	2.08	2.22													

Balance Sheet

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Assets																										
Fixed assets																										
Capital cost	Rs lacs	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00	478.00
Cumulative Depreciation	Rs lacs	27.88	55.77	83.65	111.53	139.42	167.30	195.18	223.07	250.95	278.83	306.72	334.60	341.95	349.31	356.66	364.02	371.37	378.72	386.08	393.43	400.78	408.14	415.49	422.85	430.20
Net Capital cost	Rs lacs	450.12	422.23	394.35	366.47	338.58	310.70	282.82	254.93	227.05	199.17	171.28	143.40	136.05	128.69	121.34	113.98	106.63	99.28	91.92	84.57	77.22	69.86	62.51	55.15	47.80
Current assets																										
Cash Reserves	Rs lacs	22.23	44.46	66.69	88.92	111.15	133.38	155.61	177.84	200.07	222.30	245.55	268.80	299.40	330.00	360.60	391.20	421.80	452.41	483.01	513.61	544.21	574.81	605.42	636.02	666.62
Net Current Assets	Rs lacs	22.23	44.46	66.69	88.92	111.15	133.38	155.61	177.84	200.07	222.30	245.55	268.80	299.40	330.00	360.60	391.20	421.80	452.41	483.01	513.61	544.21	574.81	605.42	636.02	666.62
Net assets																										
Total Assets	Rs lacs	472.35	466.69	461.04	455.39	449.73	444.08	438.43	432.77	427.12	421.47	416.83	412.20	435.44	458.69	481.94	505.19	528.44	551.68	574.93	598.18	621.43	644.68	667.92	691.17	714.42
Liabilities + Equity																										
Liabilities																										
Equity	Rs lacs	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40	143.40
Outstanding Loan Repayment	Rs lacs	306.72	278.83	250.95	223.07	195.18	167.30	139.42	111.53	83.65	55.77	27.88	0.00													
Reserves and Surplus	Rs lacs	22.23	44.46	66.69	88.92	111.15	133.38	155.61	177.84	200.07	222.30	245.55	268.80	292.04	315.29	338.54	361.79	385.04	408.28	431.53	454.78	478.03	501.28	524.52	547.77	571.02
Net Liabilities	Rs lacs	472.35	466.69	461.04	455.39	449.73	444.08	438.43	432.77	427.12	421.47	416.83	412.20	435.44	458.69	481.94	505.19	528.44	551.68	574.93	598.18	621.43	644.68	667.92	691.17	714.42

	Average Tariff Over Tariff period	
	Tariff breakdown over loan tenure	Tariff breakdown beyond loan tenure
1 Average P.U. O & M expenses	0.31	0.67
2 Average P.U. Depreciation	1.72	0.48
3 Average P.U. Interest on Loan	1.36	0.00
4 Average P.U. Interest on Working capital	0.12	0.09
5 Average P.U. Return on Equity	1.79	2.26
Average Tariff	**5.30**	**3.51**





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