India Solar PV Advisor

A comprehensive guide for developers and investors

(Updated Sep 2010)

Should I Invest in Solar PV?		What are the next steps?
	What is the cost and return on investment?	
What are the opportunities other than power production?		What incentives are available from the government?

India Solar PV Advisor - An Invaluable Guide for Solar PV Entrepreneurs

If you are venturing into the solar PV industry in India, the India Solar PV Advisor is a must-have guide for you.

While the current contribution of solar energy to the total India's energy needs is insignificant, in the medium and long run, it is expected that solar energy, especially solar PV will form a vital component of the country's energy mix.

The most important barrier that had stopped Solar PV from becoming a mainstream renewable energy resource is the high capital cost of the solar PV system. The good news is that the capital costs for solar PV panels are expected to decrease significantly over the next 5-10 years. In addition, solar PV technology is continuously improving in terms of its efficiency. As a result of this combination of capital cost reduction and efficiency increase, by 2015, solar PV is expected to reach grid parity in some parts of the world and by 2020, in most parts of the world.

For India, the recently released National Solar Mission and its generous incentives provide an additional reason for entrepreneurs and investors to explore this industry. The convergence of decrease in capital costs, increase in efficiency and significant financial support by the government is likely to result in a wide range of attractive business opportunities along the entire solar energy value chain in India.

The India Solar PV Advisor provides you critical and actionable intelligence on all the key aspects of the solar PV industry.

Entrepreneurs and investors have a need for a comprehensive resource that provides details on all the critical aspects of the solar PV industry in the Indian context, identifies the key drivers for opportunities, and provides insights on the extensive range of these opportunities. The India Solar PV Advisor was developed to satisfy this clear need.

The objective of the India Solar PV Advisor is to facilitate an entrepreneur keen on starting off in solar PV power production to take the next tangible steps. The emphasis is on providing practical data, updates and insights. The comprehensive guide has been developed with inputs from solar PV industry experts, investors and professionals who have been constantly interacting with the industry. It will be invaluable guide to those keen on venturing into one of the most exciting renewable energy domains in India.

This actionable guide was developed by Energy Alternatives India (EAI – www.eai.in), a leading consulting and research organization for the Indian renewable energy industry.

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Reference

Solar Energy Related Web resources & Other Alternative Energy Web Resources

Solar Energy Web Resources

- Solar Energy News
- Solar Energy Blogs
- Solar Energy Forum
- Solar Energy Portal

Other Alternative & Renewable Energy Related Web Resources

- Renewable Energy News Sites
- Renewable & Renewable Energy Blogs
- Renewable Energy Forums
- Renewable Energy Portals & Guides

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SECTION 1

Should I Invest in Solar PV?

INTRODUCTION

India presents an attractive opportunity for solar PV developers and investors. At the same time, the returns on these projects rely to a significant extent on external support mechanisms, specifically government policies and incentives. In addition, there could be significant competition in the market, with a number of new companies entering the field. It is thus imperative that entrepreneurs keen on investing in solar PV spend efforts in devising optimal business strategies. This chapter provides more details on the business strategies that should be deployed by businesses keen on this sector.

This chapter gives answers to the following key questions

1. Is this the best time to invest in solar PV in India?
2. What are key aspects I should consider before getting into solar PV power production?

SAMPLE CONTENT

Key Aspects to Consider

Value Chain & Key Industry Segments

The solar PV industry value chain comprises a number of sub-segments. It is desirable that developers and investors acquire an understanding of all these sub-segments and the opportunities that they represent before deciding to invest in a solar PV power plant.

It might be useful if they could spend time to analyse the niche areas that are underdeveloped and under serviced where solar PV could be applied. For instance, in India, the following are some of the segments underserved by the current electricity grid and hence could make excellent markets in the context of the solar PV industry:

1. Villages that have no grid connectivity
2. Companies that use diesel generator sets as a power backup
3. Mobile telecom towers in many parts of India that have little access to the utility grid, and other stand alone commercial and industrial ventures.

SWOT Analysis for the Indian Solar PV Industry

Strengths

- A high growth industry with significant future potential.
- Sunlight is available in sufficient quantities in many regions.
- Technology proven, with low operation and maintenance costs, and scalable.
- Availability of soft loans and government incentives for growth and expansion

Weakness

- Solar PV systems have high capital costs.
- Owing to high capital costs, the business needs external incentives to be economically feasible, thus increasing dependence on governmental policies.
- The capital intensive nature of the business might favour larger businesses over smaller ones.
- The distributed and intermittent nature of solar energy makes it difficult for utilities to rely on solar PV for their base load.

Threats

- Technology innovation is high, so there are risks of obsolescence.
- Off-peak seasons reduce cash flow.
- Industry is new, so finding skilled workforce could be a problem.

Opportunities

- Opportunities exist all along the solar PV business value chain, not just for power plants.
- Entirely new opportunities could open up as the there is high innovation in technology and the technology could prove to be a disruptive business, especially with reductions in costs in future.

SECTION 2

What is the cost and return on investment?

INTRODUCTION

It still is quite expensive to obtain power from solar PV, and this is primarily owing to the high capital costs, as the operational costs are quite low for solar PV. At the same time, the costs of solar PV cells have been falling significantly, and it is expected that solar PV based power will achieve grid parity by 2015. Such an event – grid parity –makes solar PV an attractive option for those keen on investing in this sector. This chapter provides extensive details and analyses of the capital and operating expenses of solar PV systems and solar PV based power generation. It also provides costs and cost break-ups for the various stages of the solar energy value chain and details for cost reduction possibilities by scale and by time. Investment data (VC, PE, asset finance) for solar energy are also provided.

SAMPLE CONTENT

Capital Cost

Solar PV has one of the highest capital costs of all renewable energy sources, but it has relatively low operational costs, owing to the low maintenance and repair needs.

For a solar PV power plant, the approximate capital cost per MW is approximately Rs. 16 crores – the precise cost depends on scale. This includes the cost of panels, the balance of systems, the cost of land and other support infrastructures.

Break-Up for the Capital Expenses per MW

Component	Amount (in Rs crores)	% of Total
Solar panel arrays	8	50
Inverter	2	12.5
Balance of System	2	12.5
Installation	1.6	10
Others (Infrastructure, Margins)	2.4	15

Example of investments into solar PV

KPCL

Karnataka Power Corporation (KLPCL) is a key catalyst behind key power sector reforms in the state of Karnataka. KPCL today has an installed capacity of 5509.82 MW of hydel, thermal and wind energy, with 4000 MW in the pipeline.

Karnataka Power Corporation Limited (KPCL) has so far invested Rs 120 crore on setting up two solar PV power plants, 3 MW each in Kolar, Belgaum and Raichur districts. In Jun 2010, the solar PV plant located at the Yalesandra village in Kolar district was formally launched. The will provide energy to 500 pumpsets of 10 HP each and benefit about 1,000 farmers. While the Belgaum power plant is also operational, the Raichur PV power plant is expected to become operational before end of 2010.

Capital Costs for Solar Photovoltaic Systems by Scale

The following table provides the approximate capital costs for solar PV power (2010)

Capital Cost for Solar PV in 2010

Capacity (MW)	Capex (Rs Crores/MW)
1-5	17
5-10	16
10-50	15.5
50-100	15

Source: EAI

Investment in Solar PV in India

Until the end of 2009, Wind energy had held the attention of investors in India because it was considered a proven investment. This segment is now considered comparatively mature and many have started looking at other areas. Many investors see India's potential in tapping solar energy as even greater than wind, given that its sunny days are around 93% of the year and can be more easily distributed.

According to a UNEP report, total investment in clean energy excluding large hydro power in India grew 12% to $4.1 billion in 2008.

- The largest portion of new investment in India went to the wind sector, growing 17% -- from $2.2 billion to $2.6.

- Thanks to a supportive policy environment, solar investment grew from $18 million in 2007 to $347 million in 2008, most of which went to setting up module and cell manufacturing facilities.

Both equity-based and debt-based investments into solar PV power plants in India are expected to accelerate dramatically in 2010 owing to the National Solar Mission and similar thrusts provided by the state governments for solar PV investments.

Some prominent examples of investments into solar PV that have taken place until Mar 2010 are provided below

1. Azure Power
2. Moser Baer Photovoltaic (for solar PV cell production)
3. Titan Solar
4. KPCL
5. Clover Solar

Financial Institutions That Fund Renewable Energy Projects in India

Some of the financial institutions that fund renewable energy projects in India are given below:

- ADB
- DBS
- DEG
- ICICI Bank
- IDFC
- IFC
- IL&FS
- IREDA
- PFC
- Proparco
- Rabobank
- SBI
- SBI Caps
- Yes Bank

VC/PE Investment in India in Solar PV

Equity-based finance infusions are increasingly becoming common in renewable energy, though in terms of overall amounts invested, project financing investments are significantly higher than equity-based investments.

There are two primary equity-based investment possibilities:

- Venture Capital
- Private Equity

For medium and large capital requirements (upwards of $100 million), private equity is the most optimal route, as venture capital companies try to invest relatively smaller amounts.

On the other hand, private equity companies consider investments *only* where the capital requirements are medium or large; as a result, for smaller capital requirements (especially for those that are less than Rs. 25 crores), venture capital is the most optimal option.

Private equity companies look for growth opportunities in relatively established companies with steady revenue streams, and usually are more hesitant to invest in completely new technologies and potentially high-risk ventures. Investing in solar PV power plants could fit in their portfolio owing to the fact a long power purchase agreement with a government-backed entity assures them of a stable revenue flow.

Venture capital companies look for innovative (and hence more risky) but high return investment opportunities. As a result, few, if any venture capital companies invest in solar PV power plants, where the potential upside is limited. Venture capital companies could be more interested in financing innovative products and/or technologies in the solar PV value chain that have a high “upside” potential.

SECTION 3

What incentives are available from the government?

INTRODUCTION

Owing to the high cost of producing power from Solar PV, power plant developers world over need to be supported by incentives – either through subsidies or tax breaks – for them to have a sustainable business. The Indian government had recently announced the National Solar Mission which proposes to provide significant incentives to the solar PV industry. This chapter provides comprehensive details on the governmental support and incentives available to the solar PV industry in India.

SAMPLE CONTENT

The following guidelines were issued in mid-June, 2010. The guidelines are for both solar PV and solar thermal based energy.

Summary of JNNSM Guidelines for off-grid (captive, Rooftop etc.) solar systems:

- The National Solar Mission aims to provide an enabling environment for solar technology penetration in India.
- For financial assistance, the government has declared that in projects availing this scheme, in the debt and equity mixture, the promoters' equity contribution must be at least 20%.
- Incentives announced:

Solar Payment Security Fund
(Jun 2010)

In a move to initiate private investment in grid-connected solar power projects, the Centre is setting up a Solar Payment Security Fund that would guarantee compensation to power producers in case of default by state-run distribution utilities.

"This (Fund) will ensure an uninterrupted payment stream for sale of power by solar power developers contracted with NTPC Vidyut Vyapar Nigam Ltd (NVVN)," says the proposal from the Ministry of New & Renewable Energy.

The Rs 330-crore scheme — available only for photovoltaic projects that are set up in the first phase of the National Solar Mission — would provide "adequate security" to project developers and financiers to make power-purchase agreements more bankable and hence, secure project financing.

The security would provide lifetime payment assurance to private firms to invest in solar power projects. "Once the mechanism is approved, NVVN would come out with request for proposal for inviting applications for developing 700 MW of grid-connected solar power," says the proposal.

Solar PV			
Condition	**Subsidy**	**Capital Subsidy**	**Special Regions**
Grid connected projects at least 100 kW and up to 2 MW, connected to HT level [below 33 kV] of distribution network	A GBI is payable to the project developer. Its value is the difference between the tariff determined by the CERC (17.9 for solar PV and Rs 15.4 for solar thermal) and the base rate, which is equal to Rs 5.5 per kWh for the financial year of 2010 to 2011, and escalates @ 3% every year.		
For off-grid / rooftop solar PV installations of a maximum capacity of 100 Wp per site, and for mini-grids for remote electrification with a maximum capacity of up to 250 kW:	Subsidy, which is calculated on the basis of a cost benchmarked by MNRE, is notionally equal to 30% of benchmarked cost of solar power systems. For 2010 it is fixed at Rs. 90 per Wp with battery storage, and at around Rs. 70 per Wp without battery storage.	Solar PV plants in micro-grid mode/local distribution network, to meet unmet community need for power in unelectrified rural areas, will be provided a capital subsidy of Rs 150/ Wp	In special category states, viz. NE, Sikkim, Himachal Pradesh, and Uttarakhand, a capital subsidy of up to 90% of installation cost can potentially be availed. Moreover, in difficult-to-reach areas such as Lakshadweep, Andaman and Nicobar Islands, and districts on India's borders, the subsidy availed will also be 90%
In addition to the above, the debt portion of investment can be financed by a soft loan at 5% interest rate, to be availed from the IREDA.			

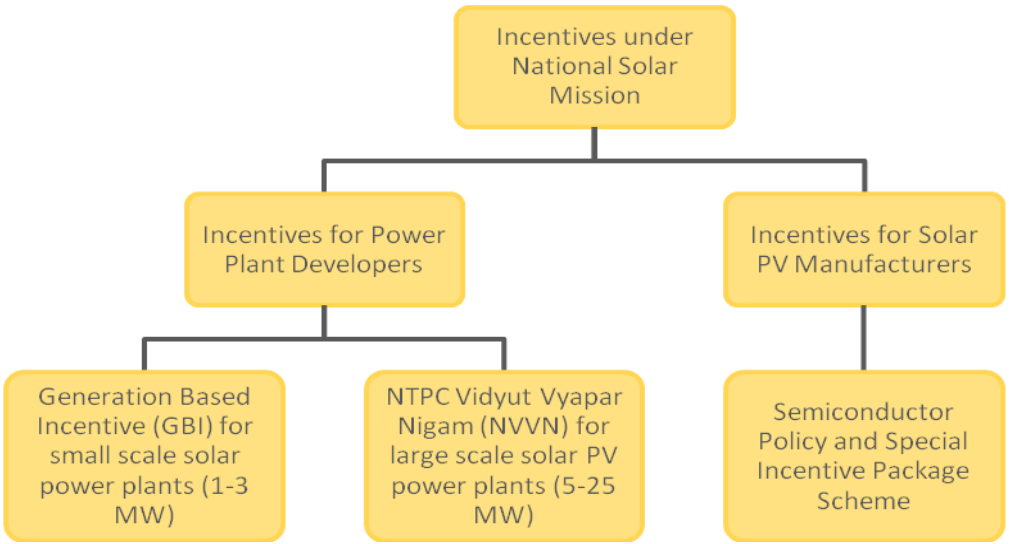
Solar CSP			
Off-grid solar CSP installations of a maximum capacity of 100 Wp per site, and for mini-grids for remote electrification with a maximum capacity of up to 250 kW	Subsidy, which is calculated on the basis of a cost benchmarked by MNRE, is notionally equal to 30% of benchmarked cost of solar power systems. For 2010 it is fixed at Rs. 90 per Wp with battery storage, and at around Rs. 70 per Wp without battery storage.	In difficult-to-reach areas such as Lakshadweep, Andaman and Nicobar Islands, and districts on India's borders, the capital subsidy availed will be 60% of benchmarked costs for solar thermal installations.	
Subsidies on costs of CSP equipment: Rs. 3000 per sq. meter for Evacuated Tube collectors, 3300 for Flat plate collectors with liquid as the working fluid, 2400 for Flat plate collectors with air as the working fluid, 3600 for Solar collector system for direct heating application, 2100 for Concentrator with manual tracking, 3600 for non-imaging concentrators, 5400 for Concentrator with single axis tracking, and Rs 6000 per sq. meter for Concentrator with double axis tracking.			
• In addition to the above, the debt portion of investment can be financed by a soft loan at 5% interest rate, to be availed from the IREDA.			

Notes

- The benchmarked costs (of standard solar systems) will be changed every year.
- GBI = Generation based Incentives

National Solar Mission

The structure of the National Solar Mission (NSM) is seen below



SECTION 4

Next steps to be taken by a Solar PV power plant developer

INTRODUCTION

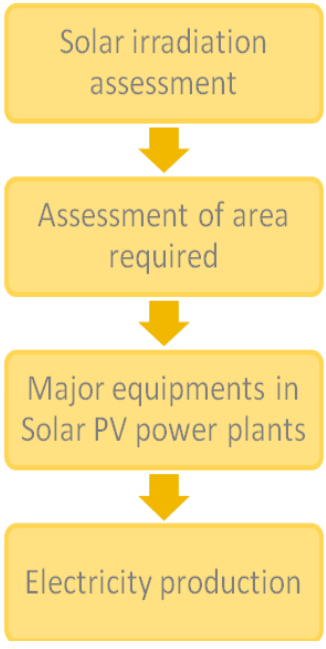
Solar power developers need to undertake a series of steps before they can start the implementation of the solar PV power plant. These steps include efforts for both analyses (technical and economic feasibility) as well as interactions with government departments and prospective suppliers. This chapter provides detailed inputs on how entrepreneurs can undertake each of these activities.

SAMPLE CONTENT

Developing a Prefeasibility Report

Template for Preparing the Report

The template for preparing a technical feasibility report of a solar power project is given below.



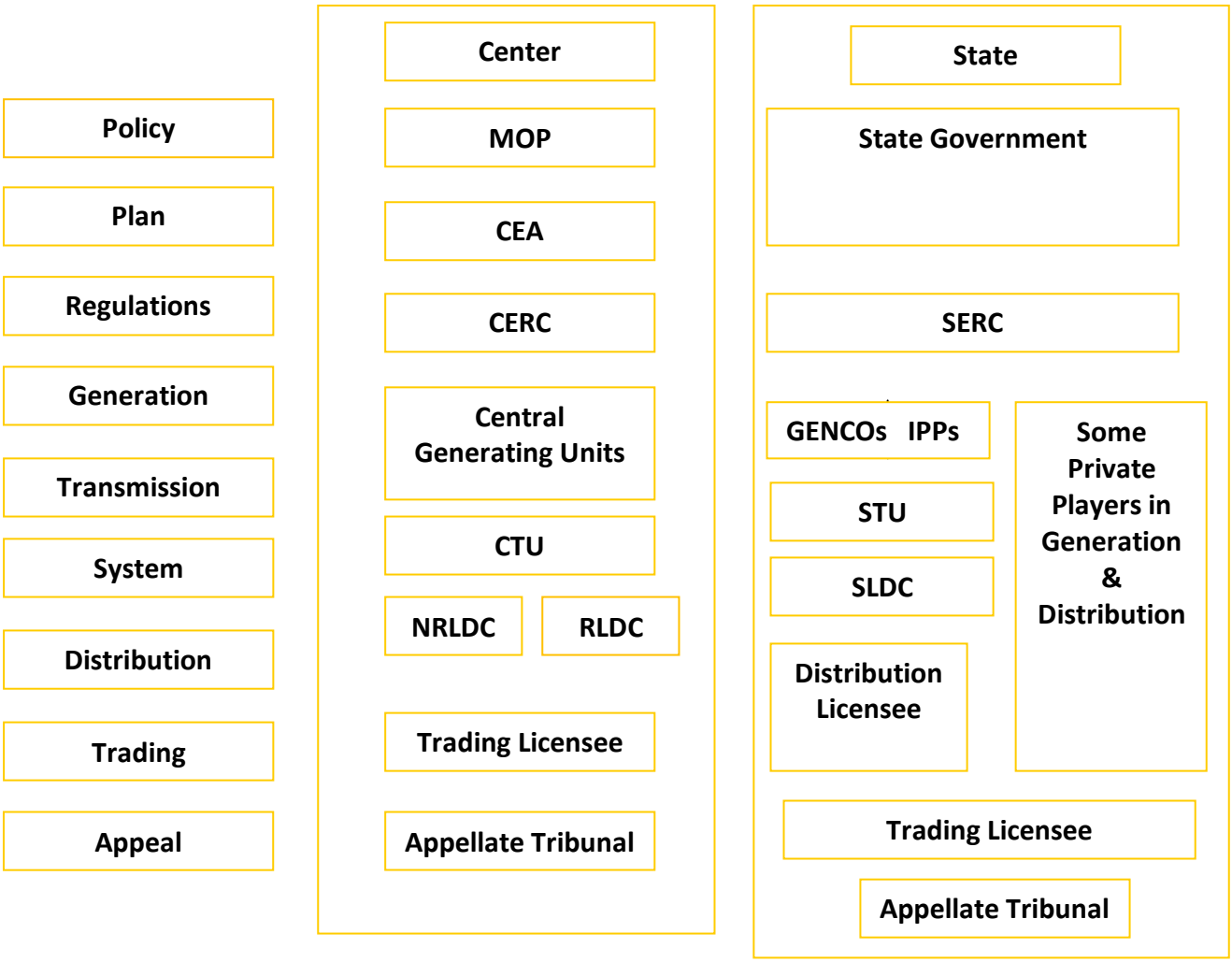
Real-life Data of Electricity Produced per MW from Solar PV Plants

Name/ Location	Capacity MW	Yearly output (Units , kWh)	per MW capacity in million units
Masdar city, UAE	10	17.5 million	1.75
Phoenix solar Germany	5.8	5.8millin	1
Spain	3	5 million	1.67
Planta Solar Fuente, Spain	26	44 million	1.7
Beneixama PV Plant, Spain	20	30 million	1.5
Monte Alto, Spain	9.55	14 million	1.47
Zebrasolar Inc, Gujarat, India	10	16.37 million	1.64
Shree Ram Energy, Gujarat	25	44 million	1.76

Meeting Government Departments

Organizational Setup of Indian Power Sector

According to the Constitution of India, the electricity sector falls under the "Concurrent List". This means that both the central and the state government are involved in the legislation of the sector. The Government's Ministry of Power provides overall guidance to the power sector with the help of the Central Electricity Authority (CEA). The CEA is a statutory body formed under the previous Electricity Regulatory Commissions (ERC) Act of 1998 which was replaced by the Electricity Act of 2003. The CEA is responsible for the technical coordination and supervision of programmes and the office of the CEA is as "Attached Office" of the Ministry of Power.



Organizational set up of the Indian Power Sector, Available at http://www.ic2.utexas.edu/images/faces/mishra-2008-indianpowersector.pdf)

SECTION - 5

What are the opportunities available in solar PV, other than power production?

INTRODUCTION

While developing solar PV plants is the most highlighted business opportunity for those interested in participating in the solar energy revolution, there are other concentric and related opportunities in this industry. These opportunities span all the three major industry sectors - manufacturing, trading and services. This chapter throws light on the spectrum of opportunities available in the solar PV industry in India.

A number of attractive business opportunities are present in niche domains and less explored areas within solar energy. A complete understanding of the industry value chain will hence be useful in identifying these attractive opportunities. This chapter provides detailed inputs on the business value chain in solar energy. It also provides critical inputs on suppliers, component and equipment manufacturers for each stage of this value chain.

SAMPLE CONTENT

Polysilicon Manufacturing

The metallurgical-grade silicon (quartz) is processed to produce electronics-grade or slightly less pure solar-grade silicon. The polysilicon is used to manufacture crystalline wafers for solar modules.

The significance of this stage can be seen from the fact that around a quarter of the cost of a crystalline module is just for polysilicon.

Type of entrepreneurs / investors who can benefit	Entrepreneurs keen on building up capital intensive manufacturing facilities for an emerging market.
Scale of investment	Typical investments of $500 million - $1 billion for building a polysilicon manufacturing plant
High R&D or commodity manufacturing?	Commodity manufacturing
Bottlenecks/threats	• High capital requirements • High energy input requirements

	• Long-term supply contracts could be a deterrent to new entrants
Competition	The industry is dominated by a few companies that supply around 90% of the total polysilicon market.
Market size	The world market of polysilicon has been growing 30-40% annually since 2004, primarily from the growth in solar PV industry. The market size of the solar cell polycrystalline silicon market in 2009 was $ 5.13 billion.
Supply and Demand	Fluctuating. After years of supply shortage, the industry in 2009 was plagued by lower demand and overcapacity, resulting in increased competition.
Indian scenario	*No companies in India are into polysilicon manufacturing*
Other Notes	Synergy benefits - fully integrated chemical plant has cost advantage over pure-play silicon producers

Non-core Solar PV Business Opportunities

In addition to the core business opportunities in manufacturing available along the solar PV value chain, there are also other non-core opportunities for entrepreneurs and investors in this industry. We list the prominent non-core manufacturing opportunities below.

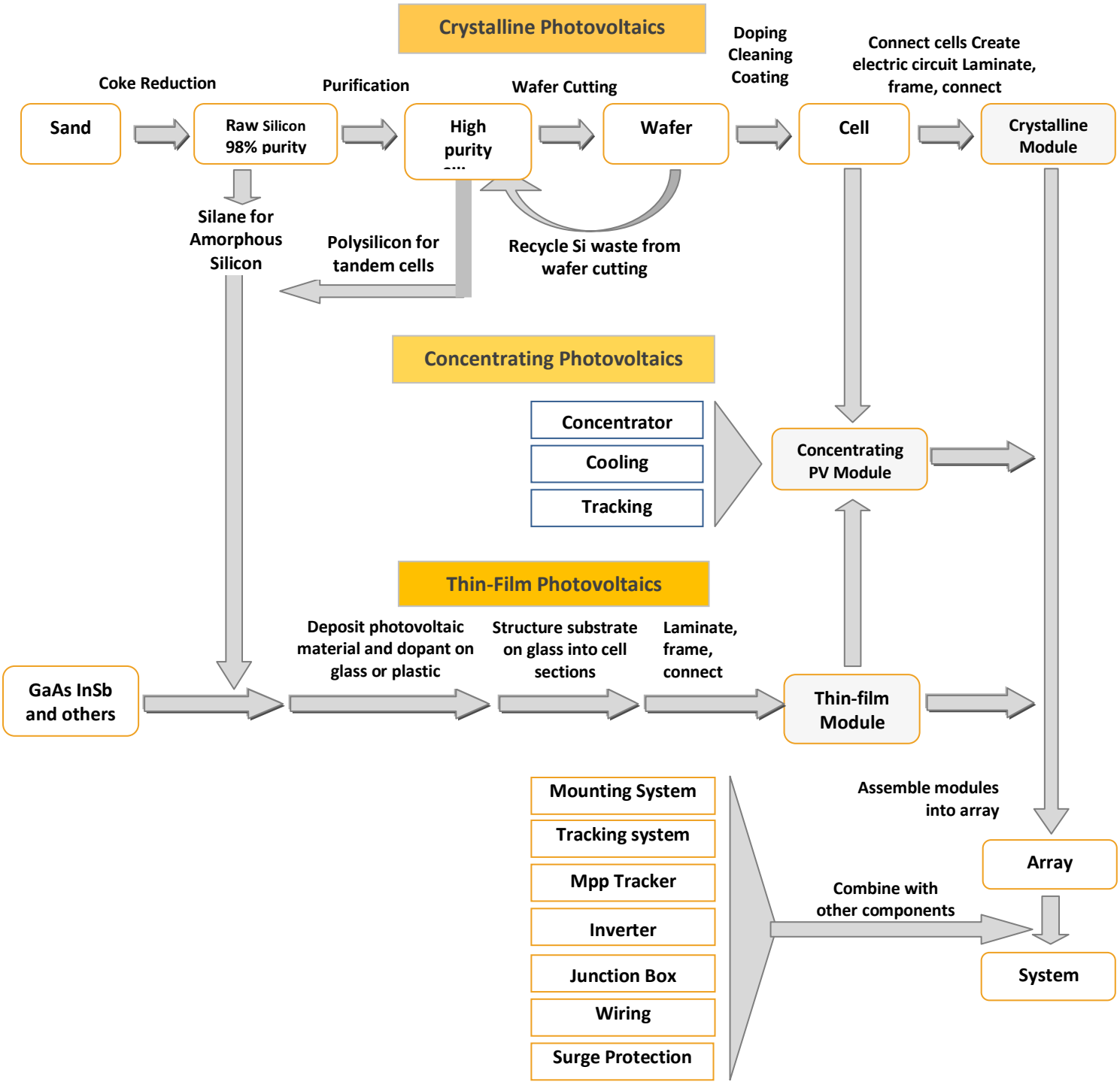
- Electrical Components: Inverters, Wires and Transformers
- Machinery & Equipment for Manufacturing Solar PV Cells – Crystalline and Thin-film
- Manufacturing Chemicals for Solar Industry

Manufacturing Chemicals for Solar PV Industry

The manufacturing of photovoltaic modules, thermal receivers and reflectors requires a number of chemicals and materials such as coatings, laminates, photovoltaic materials and solar glass.

There are no Indian companies that manufacture such chemicals.

Solar PV Value Chain Detailed Schematic



SECTION - 6

What are the current trends in the solar PV industry in India?

INTRODUCTION

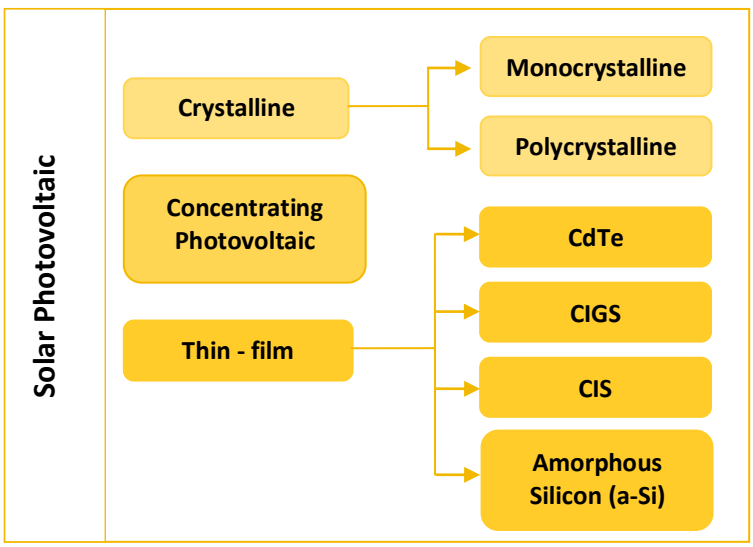
India presents an attractive opportunity for solar PV developers and investors. At the same time, the returns on these projects rely to a significant extent on external support mechanisms, specifically government policies and incentives. In addition, there could be significant competition in the market, with a number of new companies entering the field. It is thus imperative that entrepreneurs keen on investing in solar PV spend efforts in devising optimal business strategies. This chapter provides more details on the business strategies that should be deployed by businesses keen on this sector.

SAMPLE CONTENT

Solar PV Technology

The solar PV energy technology can be broadly classified as follows:

Figure 2.1: Solar Energy Technology



Specifics of the Solar PV Plant at Kolar, Karnataka

Description	Quantity
Total Capacity	3 MW
Module size	240 Wp
Module Inclination	17 deg
No. of modules per array	24
Total array	521
Total no. of PCU (250 KVA)	12
Distance between two rows	3 metres

Regional Potential for Solar Power

This section of the chapter provides irradiation in various districts of the top 3 states for solar energy in India, namely Gujarat, Rajasthan and Madhya Pradesh.

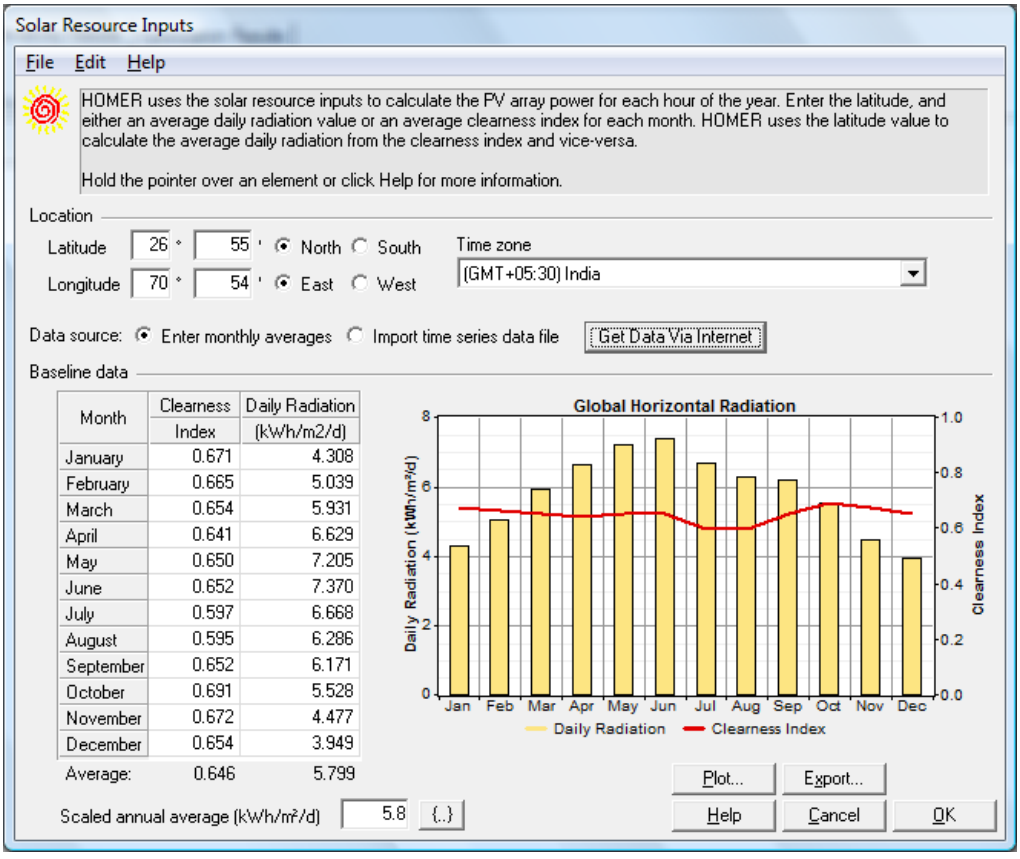
Gujarat

The top 5 districts with the best solar irradiation in Gujarat are given below.

Sl. No	District	Average annual radiation ($kWh/m^2/day$)
1	Patan	5.44
2	Mehsana	5.41
3	Banaskantha	5.38
4	Porbandar	5.32
5	Amreli	5.31

Given below is a sample of solar irradiation data in Jaisalmer**,** Rajasthan

Solar irradiation in Jaisalmer



Current PV Solar Energy Scenario

PV constitutes a miniscule part in India's installed power generation capacity with grid connected solar PV generation at a mere 6 MW.

PV installations in India today almost entirely comprise small capacity applications. They are most visibly seen in lighting applications (street lighting, and home lightning systems) in the cities and towns, and in small electrification systems and solar lanterns in rural areas. PV is also being deployed to a small degree in powering water pump sets.

No.	Sources / Systems	Achievements during 2009-10 (up to 31.12.2009)	Cumulative Achievements (up to 31.12.2009)
I. Power From Renewables			
A. Grid-interactive renewable power			
1.	Biomass Power (Agro residues)	131.50 MW	834.50 MW
2.	Wind Power	683.00 MW	10925.00 MW
3.	Small Hydro Power (up to 25 MW)	129.15 MW	2558.92 MW
4.	Cogeneration-bagasse	253.00 MW	1302.00 MW
5.	Waste to Energy	4.72 MW	65.01 MW
6.	Solar Power	3.10 MW	6.00 MW
	Sub Total (in MW) (A)	**1204.47 MW**	**15691.43 MW**
B. Off-Grid/Distributed Renewable Power (including Captive/CHP Plants)			
7	Biomass Power / Cogen.(non-bagasse)	39.80 MW	210.57 MW
8.	Biomass Gasifier	4.10 MWeq.	109.62 MWeq
9.	Waste-to- Energy	3.91 MWeq.	37.97 MWeq
10.	Solar PV Power Plants and Street Lights	0.086 MWp	2.39 MWp
11.	Aero-Generators/Hybrid Systems	MW	0.89 MW
	Sub Total (B)	**47.876 MWeq**	**361.44 MWeq**
	Total (A + B)	**1252.346 MW**	**16052.87 MW**
II.	**Remote Village Electrification**	700 Villages & Hamlets	4997 villages / 1257 hamlets

III. Decentralized Energy Systems			
12.	Family Type Biogas Plants	0.41 lakh	41.68lakh
13.	SPV Home Lighting System	48 nos.	5,10,877 nos.
14.	Solar Lantern	58,064 nos.	7,67,350 nos.
15.	SPV Street Lighting System	2767 nos.	82,384 nos.
16.	SPV Pumps		7,247 nos.
17.	Solar Water Heating - Collector Area	0.35 Mln. sq.m.	3.25 Mln. sq.m.
18.	Solar Cookers	0.15 lakh	6.72 lakh
19.	Wind Pumps	nos.	1347 nos.
IV. Other Programmes			
20.	**Energy Parks**	**nos.**	**511 nos.**
21.	**Akshay Urja Shops**	**nos.**	**284 nos.**
MWeq. = Megawatt equivalent; MW = Megawatt; kW = kilowatt; kWp = kilowatt peak; sq. m. = square meter			

Source: MNRE (as on Dec 31, 2009)

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