FICCI Solar Energy Task Force Report on

Securing the Supply Chain for Solar in India

by

FICCI Subgroup on Securing Solar Supply Chain



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This paper is a result of work done by the members of the FICCI Solar Subgroup on Securing the Supply Chain under the FICCI Solar Energy Task Force with feedback from other members of the Task Force and industry stakeholders. This paper expresses the views of the industry on creation of an effective supply chain in India for solar energy sector. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording or any information storage and retrieval system, without prior permission in writing from FICCI. FICCI will not accept any liability for loss arising from any use of this document or its content or otherwise arising in connection herewith.

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Foreword



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.

FICCI strongly believes that the creation of a strong and secure supply chain in India for the solar sector will enable creation of jobs, reduce foreign exchange outflow and lead to increase in investments and sustainable growth of the sector in the long run. There is a strong need to incentivize investments in creating the domestic supply chain with help from both domestic and global players, and to facilitate collaborative arrangements towards enhancing research and development efforts. There is also a strong case for international companies with extensive technology and experience globally to participate in building a strong supply chain in India and be part of India's solar growth story.

This Report on Securing the Solar Supply Chain highlights demand opportunities and key issues for the solar manufacturing supply chain and provides policy recommendations to enable creation of a strong supply chain for solar energy in India.

This report reflects the views of players in the solar value chain and is a result of the collaborative work of the FICCI Solar Energy Task Force after intensive discussions and deliberations. I hope this Report will be useful for policymakers to evolve appropriate mechanisms and help shape policy in this direction. I am sure the Report will also be a valuable insight to stakeholders of the solar energy sector in India.

Dr. A Didar Singh
Secretary General
Federation of Indian Chambers of Commerce and Industry



1.Executive Summary

- Energy self-sufficiency is a critical national objective. In case of solar energy, this can be achieved without sacrificing on competitiveness through appropriate global vision and strategic policy to support smart manufacturing and effective supply chain creation.
- India has a robust domestic demand opportunity. At the same time, the global trade dynamics can create opportunities for Indian manufacturers.
- With growing focus on green sources of energy in the country, solar photovoltaic (PV) manufacturing in India is getting an impetus with easier acceptance across potential users and this further leverages certain inherent advantages such as:
    - low cost of HR capital both white and blue collar
    - Widespread penetration of smart manufacturing programs across industry which eases capital investment, maximizes indigenization in a phased, systematic manner with minimal technology obsolescence exposure
- Securing the supply-chain for solar
    - Enables job creation (value addition increases upstream and deploys stable, skilled workforce versus transient, low wage workforce)
    - Reduces foreign exchange dependence - specially for PV based projects substantial portion of total installed cost is directly or indirectly contributed through imports which needs to be addressed in the context of the NSM key objectives while also securing forex exposure to the extent possible with

specific elements of the solar value chain/elements identified being locally assembled/manufactured

- Eliminates risk associated with installations which have a high operating life since the key suppliers being indigenous enforcement of obligations contractually and legally becomes more effective vis-a-vis overseas suppliers and specially from project lenders and investing entities point of view prevents undermining of highly potential sunshine sector in India

- This paper examines the sector providing
  - Demand opportunity over the next 10 years across the supply chain
  - Key issues
  - Value-added analysis across key elements of the supply chain and makes feasible recommendations for securing the supply chain.

2. Background

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. India is taking proactive steps to sustain its rapid economic growth. The increasing per capita income and large population moving into middle class has led to high level of consumerism in India. 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 since it is available across geographies, relatively unlimited vis-à-vis other green sources, freely available and in fact the country is endowed with possibly the highest band of average annual solar energy globally. In addition to grid connected solar energy generation and solar thermal applications 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 and among the eight; 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. The KPMG report "The Rising Sun" released in September 2012, suggests that the cumulative solar capacity will be around 68 GW by 2022. 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. Keeping in view the importance of a strong manufacturing base to cater to domestic requirement, one of the key JNNSM objectives was to create a strong manufacturing base for solar energy in India. This was created for employment generation and long term sustainability of solar energy sector. The National Manufacturing Policy identifies Solar Energy Sector as an industry with strategic significance along with Defence, Aerospace and Telecom and classifies it as a "strategic industry" under the special focus sectors.

Solar Sector is poised for intense growth. In India, however this industry is still at a nascent stage though it has developed multifold over the last two decades primarily with PV and lately with Solar Thermal. While the PV industry was catering mainly to international markets, the local market was restricted to off-grid applications and the solar thermal industry catered primarily to the domestic heat requirements. However, since the last 2 years the demand in the domestic market has grown multifold due to various central and state government initiatives which have the potential to catalyze this industry enormously. However, the Indian photovoltaic and solar thermal equipment industry is competing and facing challenges with global players who have overcapacity, far lower interest costs and higher incentives or subsidies as compared to Indian photovoltaic and thermal equipment manufacturing units. As a result several solar equipment manufacturing industries - in India and abroad- are either operating at sub-optimal capacity and/or have shut down production.

A comparison revealed that the parameters for the low performance of Indian solar manufacturing industry are as follows:

I. Big imbalance between installed capacity (production) and consumption

II. Perpetual disadvantage, as counterparts in other parts of Asia / world enjoy following benefits:

- Low cost of finance (varying from 0-10 % in most of the countries compared to >14% in India)
- Availability of ready finance for technology up-gradations / new installations
- Availability of infrastructure and policy support from the government

While domestic market was non-existent in China, it has managed to capture 60-70% of the world solar market through favorable policy support offered by its government. China has achieved this milestone through extensive financial support with longer loan re-payment schedules, interest rate of 0-5% and creating other favorable conditions.

On comparing with the domestic industry on the above mentioned criteria, the Indian solar industry, in this evolving phase requires handholding to sustain in the market. The Central and State level policies while delivering demand side incentives, has failed to translate into coherent, consistent supply side policies, for most of the Indian solar equipment manufacturers. In order to achieve JNNSM objectives, the industry needs a level playing field where the government ensures a balance between indigenous manufacturing capacity and imports.

A strong indigenous supply chain would lead to increase in investments, job opportunity and sustainable growth of the sector. In some developed markets, government extends additional budgetary support through better Feed in Tariff (FIT) and other incentives for domestically procured systems. Taiwanese and Korean governments took a position that the semi-conductor and solar industry were to be made globally competitive and as a national strategy extended support. The importance of having a well established and growing supply chain cannot be ignored with the National Manufacturing Policy identifying it as an industry of strategic significance reinforcing this fact.

It is appreciated that the short-term effect of improvements in supply chain security may have certain implications for certain industry stakeholders, however, this paper attempts to provide a pragmatic and rational approach with distinct phasing so as to optimise this impact. This immediate term success is but imperative to ensure that the medium-to long-term impact which is likely to be highly beneficial is achieved. For long term sustainability and energy security, it is necessary to secure the solar photovoltaic and solar thermal supply chain across the entire value chain. In this paper, there is an attempt to identify the present status of the supply chain, highlight issues and suggest strategic measures to ensure a sustainable, robust and cost effective manufacturing base for the solar manufacturing industry in the country with focus on employment generation, reducing foreign exchange outgo, reducing climate change impact, and enhancing energy security.

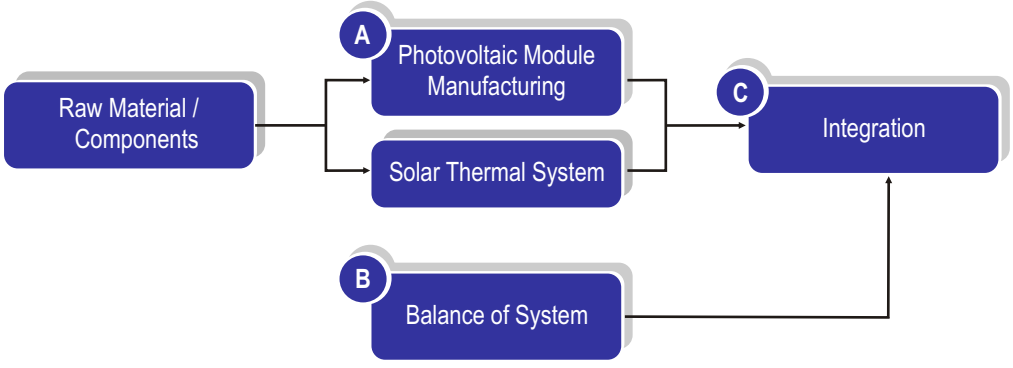
3. Solar Supply Chain

1. Overview

Secure, timely and cost effective supply of raw materials is the backbone of any industry, it not only increases the efficiency of the production process but rationalizes raw material inventory and finally overall product cost. The current solar energy manufacturing base in India comprises primarily PV cell and module manufacturing with 1100 MW of cells and 1800 MW of solar modules with very limited and disparate fabrication and assembly capacities for solar thermal products and accessories. By and large, Indian solar industry has been dependent on imports of critical raw materials such as EVA, back-sheet, reflective glass, balance of system (BOS) for Solar Thermal and PV as also core machinery. With regard to PV industry, till recently, by and large it has exported major part of its finished products to developed western markets. There is clearly tremendous scope for development of domestic production base for some of the key inputs to secure and strengthen the supply chain to reduce the foreign exchange outflow and create direct and indirect long term employment in the solar industry.

The key elements in the solar energy supply chain framework consists of raw material/component suppliers to solar photovoltaic module and solar thermal system manufacturing, balance of system which includes inverters, connecting wires, trackers etc. and the integration of the different components. It is important to have different equipment and components integrated with proper specification and compatibility, as in some cases even slight variation results in failure or loss of final output.

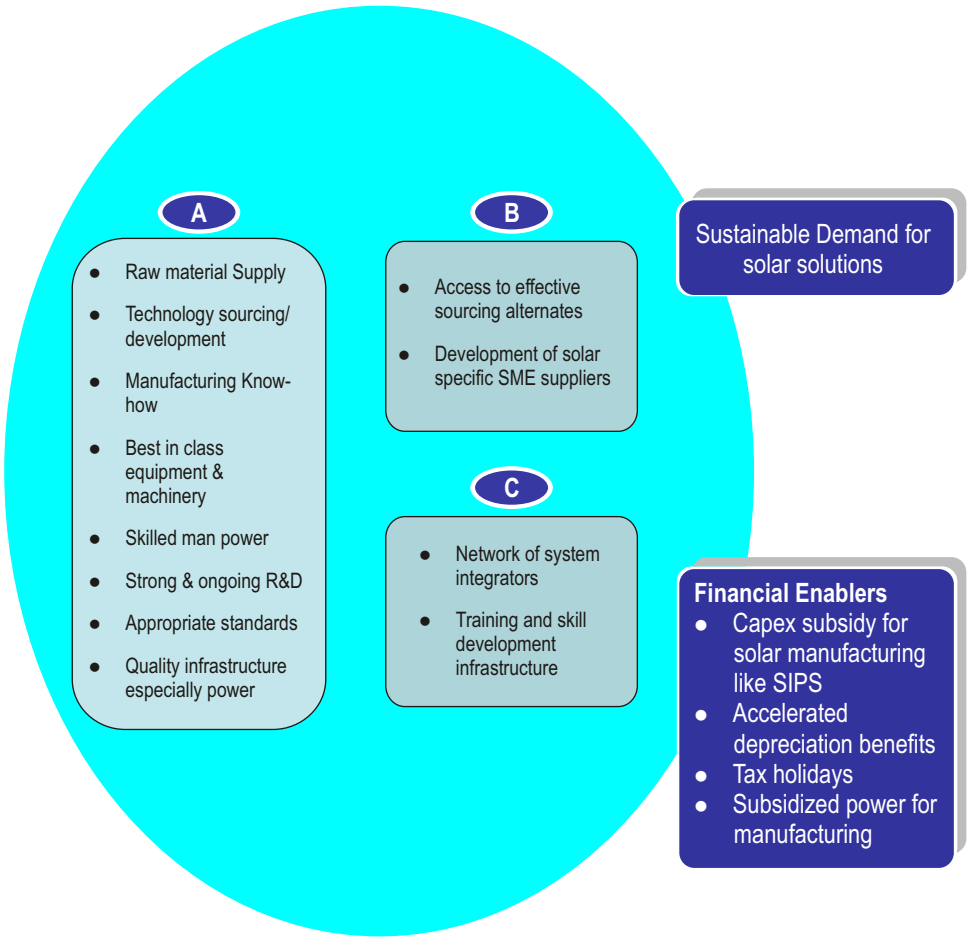
Figure 1: Framework of Solar Energy Supply Chain



2. Key Issues

The impact of changing economic scenarios has created demand-supply imbalance with several Indian manufacturers operating at a sub-optimal capacity or having shut down their production facilities. The Indian market which is evolving currently is seen as one of the huge potential markets globally for solar and to that extent a number of players from developed solar markets are making their presence felt here steadily. This dimension of international entities presence in the country as also impact of global trade dynamics needs to be effectively factored when deciding local supply chain model creation. These global trade practices and developments have resulted in bankruptcies, insolvencies and restructuring of quite a few solar OEMs, manufacturers and supply chain entities. With the announcement of JNNSM, many international companies diverted their resources towards India to take benefit of emerging new solar market. These entities need to be encouraged to support the setting up of facilities in the country with long term plans to invest in India. With the right policy framework, this scenario can change thereby establishing a robust Indian solar manufacturing sector and re-capitalizing the current players. Following issues are analyzed and discussed in detail to define the priority areas in developing an effective and strong supply chain for solar energy in the country.

Figure 2: Key Issues of Solar Energy Supply Chain



3. Key Elements

The solar industry supply chain is primarily divided into two broad categories based on the technology i.e. photovoltaic and solar thermal. The input requirements by stakeholders in the value chain are elaborated against each one of them. The key stakeholders are developers, manufacturers of cells, modules and solar thermal equipment, raw materials suppliers and ecosystem entities for solar manufacturing. The table below mentions the key elements required by the solar manufacturing industry.

Table 1: Solar Industry Supply chain

Supply Chain	Solar Photovoltaic Sector (Without storage)	Solar Thermal- Sector
Primary Components (Developer view)	• PV Modules • Thin Film • Inverters • Trackers	• Reflectors • Receiver Tubes • Vacuum Tubes • Solar Turbines
Manufacturing Value Chain (Manufacturers view)	• PV Cells • Silicon Wafers • Silicon Ingots • Poly-silicon	• Reflector Coatings • Absorber Coatings
Supply chain Eco-system	• Low Iron Glass • Junction Box • Aluminum Frames • EVA • Back-sheet • Silver Paste • Cutting Wires • Graphite parts • Crucibles • Silicon Carbide • MG Silicon • Monosilane gas	• Reflector stands • Solar mirror • Steam drum • Receiver • Level controller • Level switch • Pressure gauge • Pressure switch • Valves • Piping • Pumps • Tracking system • PLC
Infrastructure eco-system for solar Manufacturing	• Quality Power • Low cost power • Solar Mfg Parks	• Solar Mfg Parks • Policy support for importing required capital equipment

The above mentioned list is not exhaustive and mentions only key components of the solar supply value chain based on the discussion with the key industry players.

4. Existing and Projected Requirements

The potential for solar, including grid and off-grid solar applications in India, for the next 10 years is projected to be in the range of 35,000 - 60,000 MW. According to the Rising Sun Report by KPMG, India will add 67,000 megawatts of solar generation capacity by 2022, more than thrice the JNNSM target.

To meet this demand, it is vital to assess the requirements at various levels of supply chain to select and strengthen the strategic links of the value chain based on their advantages as per the Indian conditions. India should carefully prioritize parts of the supply chain that it wishes to take a lead based on the strength of the Indian economy. Even to achieve the objectives of the JNNSM, it is necessary to secure a high quality and cost effective supply chain for the Indian solar industry else it will put tremendous pressure on foreign exchange outflow and loss of employment opportunities in future.

Table 2: Demand in the solar PV value chain 2010-2022

	Units	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
NSM PV Demand		140	350	10	750	650	800	600	1000	1500	1500	2000	2000
State PV Demand		320	366	770	2500	1500	2000	1500	2000	2500	2500	3000	3000
Comment		Gujarat 300 MW; 20 MW Rajasthan /misc	Guj 250 MW; Raj 40 MW; Karnataka 10 MW; 50 MW misc	Guj 300MW; Krntk 70 MW; Misc 400 MW (MP/TN/ Orissa/U P/others)	TN 490 MW; AP 1000 MW; Raj 100 MW; Pun 300 MW; UP 200 M; Bihar 150 MW; MP/Karna taka/Oriss a/Misc 300 MW	NSM demand estimated basis October declaration of PV share of NSM II goals can go up at expense of solar thermal / State solar demand kept at NSM II goals - however, indication are that this may also go up given the strong demand in year up… also basis Rajasthan state solar thermal response being nil- current outlook has been that the market for states will shift totally to PV			Estimated Figures 17-22 are a likely scenario bringing the total solar installed base by 2022 to an installed capacity of 28GW solar PV and upto 7GW Solar thermal; This period will also see the off-grid solar applications take off and move to mainstream markets as the projected solar efficiencies rise, cost/watt drives down to grid parity and early adapter success fuels the early majority of the mainstream market - essentially, this is likely the last major intervention by the government in catalyzing the solar market as the tipping point should be reached in this quarter			
Total PV Installation (On & Offgrid) - 1 yr shift	MW/yr	460	716	780	3250	2150	2800	2100	3000	4000	4000	5000	5000
Total PV Installation (On & Offgrid) - 1 yr shift	MW/yr	25	435	716	780	3250	2150	2800	2100	3000	4000	4000	5000
c-Si Market Share		60%	35%	55%	60%	65%	65%	65%	65%	65%	65%	65%	65%
Module	MW/yr	15.75	159.8625	413.49	491.4	2218.125	1467.375	1911	1433.25	2047.5	2730	2730	3412.5
Cell Demand	MW/yr	17	168	434	516	2329	1541	2007	1505	2150	2867	2867	3583
Wafer	MW/yr	17	176	456	542	2445	1618	2107	1580	2257	3010	3010	3762
Ingots	MT/yr	122	1234	3191	3792	14673	9707	12641	9481	12416	16554	16554	20693
Polysilicon	MT/yr	143	1451	3754	4462	17262	11420	14872	11154	14607	19475	19475	24344
(Assumptions: Aberration in batch 2 guidelines corrected by phase 2 NSM; 7 gm Poly-si/watt till 2015 & 5.5 gm Poly-si/wt post 2018)													
TF mkt share	MW/yr	9	275	303	289	1032	683	889	667	953	1270	1270	1588

- Assumes water availability will constrain Solar Thermal plant growth, PV shares factored in total Solar as above
- State demand factored as a best case estimate as long run forecast not available unlike NSM. However, expect solar to expand across all states over a period of time giving rise to a sustained demand at state level, fuelled further by technology/commercial breakthroughs to grid parity

(For supply-chain - we have assumed that the installation inputs are 1 year staggered before the end-user demand-realistic because timelines are for completion in Q1, calendar year)

Additionally, the international trade trends have created an opportunity for Indian manufacturers to tap certain established solar markets as well. As appropriate trade penalties and measures are implemented and global prices stabilize towards a sane price structure with a demand balanced capacity, Indian manufacturers will start getting a part of the global demand. In fact, because of the low cost of human resource capital, the fact that several elements in the solar supply chain are not technology intensive, India can leverage its domestic demand to have a self-sufficient solar manufacturing ecosystem.

Table 3: Existing and Projected requirement of equipment for the development of solar farms and off-grid systems

Supply Chain Items	Existing capacities in India (CY 2012)	Quantities to meet total domestic requirement at the end of 3-4 years timeframe	Quantities to meet total domestic requirement at the end of 5-10 years
PV Modules	1800 MW/year	2,500-3,500 MW/year	3,500-6,000 MW/year
Solar Inverters	<100 MW /year	2,500-3,500 MW /year	3,500-10,000 MW/year
Trackers		2.5-3.5 Million	25 Million
-Single axis (PV)	NIL	50%	50%
-2 Axis for Thermal	NIL	50%	50%
Solar Batteries (For off-grid applications)	Capacity meets the demand; however, cost and maintenance is an issue	300-1000 MW	>3,000-5,000 MW
Reflector Glass	NIL	11million sqm in next 5 years	53 million sqm in next 10 years
Receiver Tubes	NIL	0.9 million meters in next 5 years	4.4 million meters in next 10 years
Solar Turbines	NIL	30 numbers of 50 MW each in next 5 years	150 numbers of 50 MW each in next 10 years
Vacuum Tubes	NIL	To be estimated	To be estimated

The current solar power manufacturing base in India comprises primarily solar photovoltaic cell and module manufacturing with 1100 MW of Cells and 1800 MW of solar modules. By and large, Indian solar industry has been dependent on imports for most of the raw materials such as EVA, back-sheet, reflective glass, balance of systems (BOS) and other equipment. The Indian products are of high quality and reliability and the industry by and large has exported major part of its finished products to US and European markets. Table 4 below shows estimates of existing (2010) and projected requirements for the Indian solar photovoltaic manufacturing industry.

Table 4: Existing and Projected requirements for PV manufacturing

Supply Chain Items	Existing capacities in India (CY 2012)	Quantities to meet total domestic requirement at the end of 3-4 years	Quantities to meet total domestic requirement at the end of 5-10 years
PV Cells	1100 MW installed currently	2,500-3,500 MW/year	3,500-6,000 MW/year
Si Wafers	NIL	1000-1250 million per year	2.4 Billion per yr
Si Ingots	NIL	10-15,000 MT /year	15-20,000 MT/yr
Poly-silicon	NIL	12-17,000 MT /year	About 17-23000 MT/yr
Low Iron Glass	100 TPD	2,500-3,000 TPD	3,500-6,000 TPD
EVA Sheets	NIL	20-30 Million sq.mtr	100 Million sq.mtr
Back-sheet	NIL	10-15 Million sq.mtr	50 Million sq.mtr
Junction Boxes	2.5 Million	8 Million	10-40 Million
Al Frames-anodized	100 MW equivalent	25-35,000 MT/year	60,000 MT/year
Silver Paste	NIL	480 MT/year	600-2500 MT/year
Graphite	NIL	800 MT/Year	2000 MT/Year
Quartz Crucibles	NIL	40,000 /year	60,000 - 2,00,000 /yr
Si Carbide slurry	NIL	660 MT/year	1000-33000 MT/yr
MG Silicon	NIL	17,000 MT/yr	84,000 MT/yr
Reflective Coatings	NIL	11 million sqm in next 5 years	53 million sqm in next 10 years
Absorber Coatings	NIL	0.2 million sqm in next 5 years	1 million sqm in next 10 years
LED circuits/ Lamps	Negligible	To be estimated	To be estimated

Based on the development potential, it is expected that during the next 10 years, the Indian solar energy industry requirement will be growing at a healthy annual rate of 30-40% or more. This growth rate throws up many challenges. Coordinated efforts backed by a strategic policy support can help in the development of the domestic supply chain. The solar manufacturing industry in India has the potential to become a global scale industry in a very short time, similar to automobile industry, if backed by a strategic approach.

5. Benchmarking the Supply Chain

Phase 1 of the National Solar Mission specifically Batch 2 provides pertinent insights with respect to the ecosystem and policy framework which will have to be created for a sustainable and robust solar supply chain in the country. The existing 'on-ground' situation helps define various dimensions across technology, fiscal and policy parameters which have to be addressed for developing strong local supply base across the entire solar value chain.

In India, as is evident the nascent solar industry is beginning to take shape as part of the government's national initiative of creating a robust renewable energy ecosystem. The global solar market is now represented by Gigawatt scale plants with high levels of local content both at machinery level and raw materials. In India, there are only few 100 MW+ plants with high content of imported capital machinery and raw materials. Based on the potential, it is expected that during the next 10 years the Indian solar requirement will be growing at an annual rate of 30-40% or more. This growth rate throws up many challenges for the supply chain. If a well thought out and planned effort is undertaken, the solar manufacturing industry in India can become a globally competitive industry in a very short time. This will not only create jobs, knowledge and wealth but also over time make India a net foreign exchange earner in the sector.

The benchmarking of the present Indian Solar Industry competitiveness as against its global counterparts, in terms of quality /size and thereby cost effectiveness is presented in Table 5 below. The comparisons and benchmarks stated in the table are based on the individual project scenarios in India and not on SEZ, EOU based scenarios.

Table 5: Benchmarking of the present Indian supply chain compared to global peers, in terms of quality/size and resultant cost effectiveness

Parameters		Indian Companies	Chinese, Other Asian & US Companies
Capital Cost	Land & Infrastructure	Availability at a competitive price is a constraint. Development of necessary infrastructure is additional to the cost of the project.	Government allotted or at subsidized rates with integrated infrastructure provided
	Parts & Machinery	Partially available domestically, largely imported, zero import duty	Majority local, tax set-offs are available
	Project Finance	13-15% interest loans, comparatively shorter loan durations, higher interest rate for SMEs	0-5% per annum interest loans with long tenures by government along with grants. Example: Support by US Exim Bank to US exports with low cost financing
	Hence, the total project cost for Indian companies is higher around 15-20% than other countries.		
Operational Cost	Raw Material (RM) Cost	High as majority are imported	Low as majority sourced locally
	Utilities	Higher prices (due to cross-subsidization requirements)	Subsidized
	Manpower	Same	Same
	Interest Cost	Around 12-14%	0-5 %
	Hence, the total operational/variable cost for Indian companies is higher (around 15-20%) than other countries and in some cases 30-50% more where they are high in energy intensity like Poly-silicon, Wafer production, etc.		
Technology	Machinery	Mostly Imported	Mix of local & imported
	Upgradation	High obsolescence; Slow up-gradation due to non-availability of capital	High obsolescence; Fast up-gradation due to availability of capital
	R&D	Lack of industry participation in the R&D initiatives of the government as they are vested with educational institutions which are not aligned with commercial requirements. Not at commercial scale	Matured at commercial scale and is vested in the hands of large industries

Parameters		Indian Companies	Chinese, Other Asian & US Companies
Quality	Standards	Meets international standards – has been exporting to European markets	Meets international standards – but quality of material being sent to India needs to be suitably checked from time to time & Extended Producer Responsibility through a domestic producer organization ensured.
Sourcing – Raw Material	Inventory Cost	High	Low (JIT)
	Lead Times	High	Low (across the fence)
	Supplier Options	Lesser	Higher
	Bargaining Power	Low due to low volumes	High due to high volumes
Marketing Strategy	Exim Benefits	None	Available with buyer's credit finance mechanism
	Logistic System	Poor infrastructure for both domestic & export markets (Roads, ports, clearances). High transportation costs for raw material and finished products.	Well established and low transportation costs
Economies of Scale	Module	Average size top 10 companies < 100 MWp	Average size of top 10 companies +1,000 MWp
	Cells: Capacity	< 200 MWp	>1,000 MWp
	Si Wafers: Capacity	250MWp-1000 MWp (Planned)	> 3,000 MWp
	Si Ingots: Capacity	250MWp-1000 MWp (Planned)	> 3,000 MWp
	Polysilicon: Capacity	1,250 TPA (Planned)	> 10,000 TPA

It is evident that India is competitive in terms of cost of labour and quality standards but is at a disadvantage in terms of high cost of capital, higher power tariff and absence of facilitating ecosystem.

The global module production capacity stood at 55.7 GW whereas in India it was a mere 1.8 GW cumulative with insufficient demand for domestic products. These capacities deter the Indian companies in terms of economies of scale. In fact India has an opportunity to directly invest in latest technologies which can be sustained by effective tapping of its domestic demand. The Indian solar manufacturers though competent in terms of matching international quality standards face other

limitations such as poor infrastructure, lack of raw materials, an undeveloped supply chain leading to high inventory cost and delivery time and lack of low cost finance. These limitations have discouraged the development of the solar manufacturing ecosystem - correct policies backed by a clear vision can create a successful, vibrant Indian solar energy sector.

The need of a robust domestic manufacturing base lies on various factors such as energy security and access, technology development, product standardization, increase in foreign investment and decrease in foreign exchange outgo and talent creation and employment generation.

Table 6: Benchmarking of the present Indian and global stakeholders for Balance of System (BOS)

Products	Parameters	Indian Companies	Chinese & Other Asian Companies
Solar Inverters	Range	1kw - 250 kw	Above 500 kw
	Efficiency	85- 98%	> 96%
	Microprocessor Controllers	Recently introduced	Well developed
	Manufacturing Strategy	Problems with sourcing of IGBTs	Continuous supply through local sourcing
Trackers	Single Axis (PV)	Lack of proven solutions	Reliable mechanism
	Double Axis (Thermal)	Lack of proven solutions	Highly accurate mechanism
Solar Batteries (For off-grid application)	Battery Life	Around three years	> 3 years
	Recycling		Options available
Low Iron Glass	Transmission Factor	91.6%	91.6%
	Plant Capacities	250 TPD	> 2,000 TPD
Junction Boxes	Certification	International	International

Balance of system plays an important role in a solar power project as it is one of the most important and fragile parts of a solar energy project. Experience shows that project failures due to improper selection of BOS are high in comparison to any other system and to that extent quality, compatibility and robustness of BOS elements is imperative.

6. Securing the Supply Chain

Supply Chain is a key factor for the development of an effective, low cost and a secure manufacturing base. Entire list of components and raw materials cannot be produced locally as perhaps in globally competitive ecosystems but a strategic assessment and selection based on requirements and strength at various levels of supply chain should be developed. These should then be linked through various policies based on their advantages as per Indian conditions. It is the need of the hour that the country should carefully select and prioritize the parts of the supply chain in solar photovoltaic and solar thermal technology that it wishes to take a lead based on the requirement and long term goals of the Indian economy.

For long term sustainability of a secure solar supply chain, the following points need to be addressed immediately:

1) **Strategic positioning of Domestic Ecosystem:** With the bigger objective of meeting energy security for the country a steady and thought out phased plan for indigenization of prioritized elements of the value chain is imperative. A structured approach will enable the Indian manufacturing industry to become competitive domestically as well as globally.

2) **Foreign Exchange outgo:** Presently, most of the solar supply chain materials are imported, causing a great pressure on our foreign exchange. Conservative estimates show that directly and indirectly more than half of project cost incurred on every MW of installation of solar PV power plant in India results in foreign exchange outflow, due to the absence of solar value chain manufacturing in India. This calls for a complete rethinking on the development of indigenous ecosystem for solar manufacturing. We have the ability to turn India into a solar capital of the world. If we look at just 20% value-add across the solar value chain (including depreciation and human resources capital cost, accounting for total cost of capital) - there is a national case for investing in a domestic industry now to reap full benefit within the next plan period- and subsequently.

3) **Loss of employment opportunities:** Indian solar PV manufacturing industry has close to Rs 10,000 crore invested and provides jobs to more than 25,000 employees with total installed capacity of 1100 MW of cells and 1800 MW of modules. It is estimated that if the entire solar value chain is manufactured in India, then the potential to support employment is close to 2 lakh persons.

4) **Global scale plants:** As we can see above, the global market is now represented by gigawatt scale plants, while in India we have only 100 MW+ plants. These huge capacities deter the Indian companies in terms of economies of scale and the bargaining power for sourcing and marketing. However, in a smart manufacturing program, right sizing the capacity can turn to advantage by preventing higher capital costs, better plant utilization and increased technology up-gradation and maneuverability.

5) **Technology Up-gradation:** The solar manufacturing industry is very rapidly adopting new technologies and innovating to achieve higher efficiencies and lower costs. There are important learning and insights from phase 1 of JNNSM which can be properly analyzed and necessary corrective actions initiated. A one-time intervention to build capacity and upgrade the solar sector is recommended. Given the huge capacities of sub-optimal technology across the globe and poor financials of most of the global players, there is a unique opportunity for India to leap frog technology and build a right-to-win position in the sector.

Keeping in mind the above issues, attempt is made in this paper to work out parameters for the development of the domestic manufacturing ecosystem, without affecting solar project development. Following points need to be addressed to ensure that the targets are met effectively and proliferation of solar based solutions achieved as envisaged in the National Solar Mission.

1) Level playing challenges - Solar Manufacturing value chain

2) Supply of Raw Material / Components - Thermal Solar

3) Supply of Raw Material / Components - PV Solar

4) Manufacturing Equipment - PV Solar / Thermal Solar

5) Manufacturing of Balance of Systems (BOS) - PV Solar / Thermal Solar

6) System Integration - PV Solar / Thermal Solar

7) General

7. Level Playing Challenges

1. Power Tariff:

Issue: Availability of low cost reliable and quality power is a major factor for manufacturing of photovoltaic value chain (Poly-silicon, Ingots & Wafers, PV Cells) as 25 - 30% of the total manufacturing cost is power cost and its impact is close to 40-50% of the variable cost (Poly-silicon manufacturing). Majority of the global players in Asia, Europe and US are supported by their respective governments with low cost quality and reliable power, at a tariff equivalent of US Cents 7-11/kWh (equals to Rs. 4.00 - Rs. 6.00 /kWh).

Possible Approach:

1. Central government to recommend to state governments and the State Energy Regulatory Commissions (SERCs) where the solar manufacturing industry including Poly-silicon-Ingots and wafer plants are coming up, for special arrangements for lower tariffs (at about Rs. 4 - 6.00 / kWh) for an initial period of 5 years of start of the manufacturing. However, it is to be noted that predictability and continuity of power is just as important to the final production cost. The costly fossil fuel based DG sets are not an alternative for a viable production unit.
2. Alternately, additional allocation of solar farm capacity; or higher feed-in-tariff for higher domestic content in the solar farms (Domestic content may be made a basis for tariff allocation as is done in Canada and France).
3. To meet the power requirement of solar energy industry, captive power plants (from private sector or on PPP basis) should be promoted with exemption of wheeling and cross subsidy charges, and allocation of coal blocks on priority basis.

2. Low Cost Financing

Issue: Availability of low cost financing to the manufacturing industries of the solar value chain is important, as the finance cost is in the range of 15-25% of the manufacturing cost. The industries in China, Europe and US enjoy interest rates which are much lower than what Indian industries have to bear.

Possible Approach: For encouraging production of raw material for the solar energy industry, schemes for low interest rates and long term loans should be introduced. MNRE has introduced an interest subsidy program for Poly-silicon, Si-Ingots and Wafer industries in the past, but this program was not active due to lack of budgetary support. Now that there are many projects which are taking shape in this domain, it is of paramount importance to re-activate similar schemes for solar photovoltaic and solar thermal sectors.

Investments going to solar manufacturing should also be given accelerated depreciation benefit as given to the solar power plants .This will lower the burden of high depreciation cost burden of this high capital intensive manufacturing sector where the Asset Turnover Ratios are as low as 0.35 - 0.5.

3. SIPS subsidy

Issues: (i) The Special Incentive Package Scheme (SIPS) capital expenditure (capex) subsidy program invited applications in 2008, but the final approvals are yet to be accorded.

(ii) The threshold limit of Rs 1,000 crores is to be calculated with the year of disbursement as the base year, rather than the year of application.

Possible Approach: Ministry of Communication and Information Technology (MoCIT) needs to approve the projects at the earliest with 2011-12 as the base year. The SIPS incentives should be made available for the ecosystem industry with threshold limits reduced to the level of SMEs as most of them fall under that class.

MoCIT should consider (a) prioritized settlement of 2008 SIPS payout to inject

liquidity into the sector and (b) addressing the modified SIPS policy but with the requirement that enough traction from potential manufacturing entities is created so that objective of the policy is fully achieved.

4. Priority Sector lending (Project Finance Loans) for solar companies

Issue: Funding for solar manufacturing and project development should be accorded priority sector status to facilitate access to bank finances.

Possible Approach: Keeping in view the energy securitization and its high socio-economic and environmental benefits, Solar Energy sector should be accorded Priority Sector status and funds may be allocated to manufacturing industries in this sector. Possibility and approach for public sector funds like those with IREDA wherein dollar lines of credits are available, need to be evaluated so that the manufacturing sector can access these easily.

5. Technology Up-gradation Schemes for Solar Manufacturers & Suppliers

Issue: The Solar manufacturing processes are undergoing rapid changes to achieve higher efficiencies and lower costs. At present, falling prices, higher efficiencies, outdated machineries, imports, new materials and economic slowdown have created a challenge for the industry. To meet these challenges and take advantage of the new technologies or raw materials, the manufacturing industry needs to upgrade its facilities.

Possible Approach: A solar industry technology roadmap needs to be defined and agreed upon between the industry, technical innovation bodies, and the government. This will focus energies and enable the industry to synchronize up-gradation plans with demand.

Up-gradation support to the Indian Solar Energy Manufacturing industry would result in sustained growth and enormous benefits to the country. Upgradation of both the process of manufacture and corresponding plant and machinery is

necessary for the industry to improve the efficiency, reduce the cost of production and remain price competitive at a time when cheaper products are easily available in the global market.

A technology up-gradation scheme for solar energy sector should be introduced where induction of the state-of-the-art or near-state-of-the art technology should be promoted. But in the widely varying mosaic of technology adopted by the industry, atleast a significant step up from the present technology level to a substantially higher one would be essential. Accordingly, technology levels should be benchmarked in terms of specified machinery for each sector of the solar industry. Machinery with technology levels lower than that specified should not be permitted for funding.

Various ministries at the central and state level have introduced schemes to support their industries. Some of the schemes are mentioned below in brief:

1. The Ministry of Small Scale Industry introduced a scheme in 2006 for the Small Scale Industry where in it provided a 15% upfront capital subsidy to a maximum of Rs 1 Crore.[1]

2. Ministry of Textile has Technology Up-gradation Fund (TUF) Scheme. This Scheme was restructured and was valid till March 2012. The scheme has been widely successful and has released 11,196 Crores in last 11 years and has attracted an investment of 2.03 lakh crores.[2]

3. States like Gujarat[3], Rajasthan and Maharashtra provide technology up-gradation support to various sectors to improve their efficiency, quality and production.

Incentive package or viability gap funding to upgrade the facilities or for substitution of costly raw materials with cost effective raw materials needs to be introduced. Technology up-gradation for improving efficiency, productivity

[1] http://dcmsme.gov.in/schemes/sccredit.htm

[2] http://www.texprocil.org/doc/GR_on_restructured_TUFS.pdf

[3] http://www.imd-gujarat.gov.in/plan05-06/large-index.html

enhancement for gaining global competitiveness and thus attracting new investments alongwith employment should be the broad objective of this scheme. There are similar policies which are already operational for other sectors at the central as well as state levels.

Some of the possible options for facilitating technology up-gradation are mentioned below:

1. A **one-time technology up-gradation scheme** through the National Clean Energy Fund (NCEF) should be created to support the solar energy industry for technological up-gradation for improving efficiency, productivity enhancement and attracting new investments. The funding should be provided once in five years with a maximum cap of 30% subject to a maximum of Rs 5 Crore.

2. The survival and growth of the Indian solar manufacturing sector is critically dependent on its modernisation and technological up-gradation. A **credit linked capital subsidy scheme** similar to Ministry of Small Scale Industry scheme or Ministry of Textile Scheme, as mentioned above should be introduced at a larger scale for this green energy sector. The scheme should aim at facilitating technology up-gradation by providing upfront capital subsidy to the tune of 40% to the Indian solar manufacturing sector.

8. Supply of Raw Material / Components – Solar Thermal

a) Reflector

Issue: Presently most of the thermal systems use primarily mirror and coated aluminum based reflector in certain cases. While availability is not a major issue as of now, costs are very high since requirement is presently being met through imports. Further, Indian projects do not have economies of scale which are seen in other mature solar markets.

Possible Approach: Waiver of duties and taxes on such imports is one of the near term requirements to rationalize input costs for users, however, immediate steps need to be taken by the government to encourage a couple of already established mirror manufacturers in the country (Indian & MNCs) to set up solar mirror line to service the growing local demand in the country. Such investments will need to be backed by a strong incentive package since project viability is not expected to be achieved in the two to three years time frame expected out of such capex investments by most companies. Small and medium enterprises could also be promoted with suitable financial packages to take put up mirroring and cutting processes as concurrent initiatives.

b) Reflector Coating

Issue: Availability of effective reflector coating.

Possible Approach: There is a need to develop appropriate reflector coating by which there would be a possibility of using the substrate itself as a reflector. This needs to be done indigenously to ensure capability building as well as ensure lower costs. Research institutions and industry collaboration initiative for such developments is an imperative and this needs to be aggressively encouraged.

c) Receiver Tubes

Issue: Mirror finish receiver tubes used in line focusing concentrators are required to be imported presently in the absence of suitable alternatives available in the country.

Possible Approach: There are two approaches which can be promoted. The first is to have indigenous manufacturing based on technology collaboration. Second approach could be to have focused research between Indian academia and interested companies leading to creation of commercially viable products and their manufacturing value chain.

d) Absorber Coating

Issue: Presently appropriate facilities for developing absorber coating are not available in the country.

Possible Approach: The same has to be promoted and developed to meet the growing demand expected in the coming years, while doing so specific focus should be given on handling increased lengths of absorber tubes. Absence of critical mass in the initial period requires government facilitation or encouragement to an existing PSU to take up this manufacturing. Simultaneous approach of bringing in the best technology and developing indigenous facilities requires to be pursued.

e) Vacuum tube availability

Issue: Availability of vacuum tubes which is a key component of solar thermal installations is a major issue presently.

Possible Approach: There are a limited number of international suppliers for these products presently. R&D funding from government for development of a comparable product is crucial and this will necessarily entail engagement with international experts and institutions with domain expertise in relevant areas. Cost reduction and availability would be the key targets for such development. Indigenous manufacturing option will be necessary post the above.

f) Glass to Mirror

Issue: Lack of domestic mirroring and mirror cutting facilities for solar grade mirrors.

Possible Approach: Mirroring and mirror cutting facilities should be developed within the country to reduce dependence on external suppliers. This needs to be addressed on a priority basis as availability of solar grade mirrors could become a major hindrance in proliferation of solar installations in the country. It would be pertinent to develop 3 to 4 facilities for mirroring and mirror cutting of solar grade mirrors in the country.

g) Heat Transfer Fluid / Heat Storage System

Issue: Lack of domestic heat transfer fluid suppliers.

Possible Approach: The heat transfer fluid forms a major cost in the capex and is an important component for the performance of the plant. The present market is controlled by few players. It would be of importance to develop domestic manufacturers who have petrochemical facilities in India to produce such fluids at affordable prices through R&D and technology transfer routes.

The heat storage system is vital for the improvement in CUF of the solar thermal plant that can ultimately replace certain base load conventional power plants. The molten salts are currently not available in India and the heat storage design is also held by few people. It is imperative to develop this indigenously for the solar thermal industry to thrive.

Table 7: Capital requirement for manufacturing (in Rs. Cr.) if the market requirement has to be met completely locally

Mfg Capex (Rs. Cr.)	Up to 2013	Up to 2017	Up to 2022
Collector	982.36	2,947.08	14,628.96
Receiver tube	3.11	9.32	45.48
Receiver Surface	2.67	8.01	39.71
Total	**988**	**2,964**	**14,714**

Note: Critical manufacturing capacity for collectors is 1,50,000 - 2,00,000 m^2 per annum

Table 8: Total Market size (in Rs. Cr.)

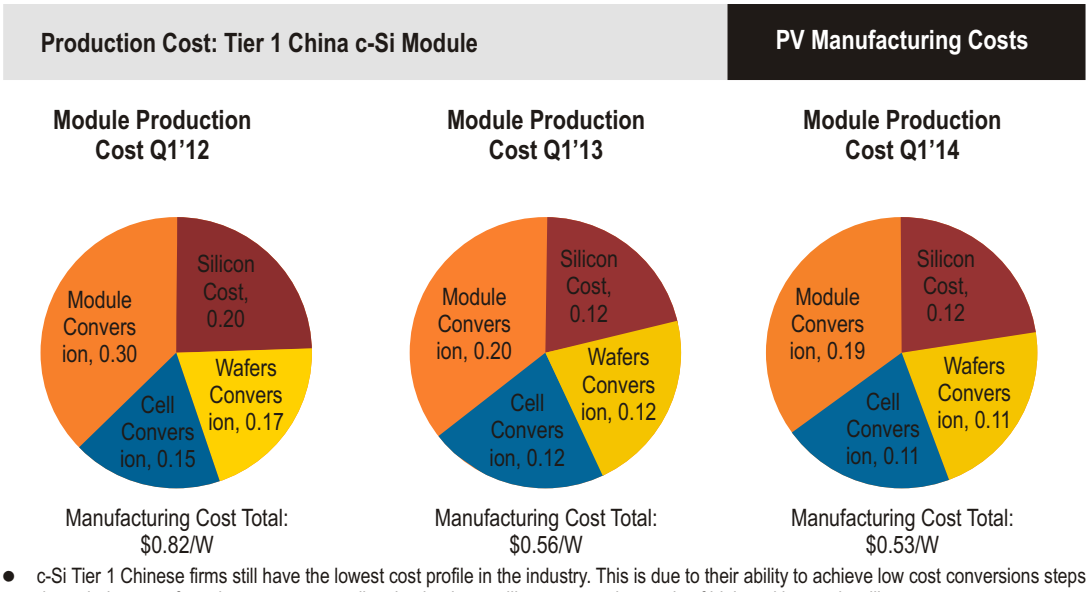
Mfg Capex (Rs. Cr.)	Up to 2013	Up to 2017	Up to 2022
Power	1650	4500	20250
Cooling & Heating	67.5	180.7	232.8
Total	**1718**	**4681**	**20,483**

9. Supply of Raw Material / Components - Solar PV

a) Module BOM

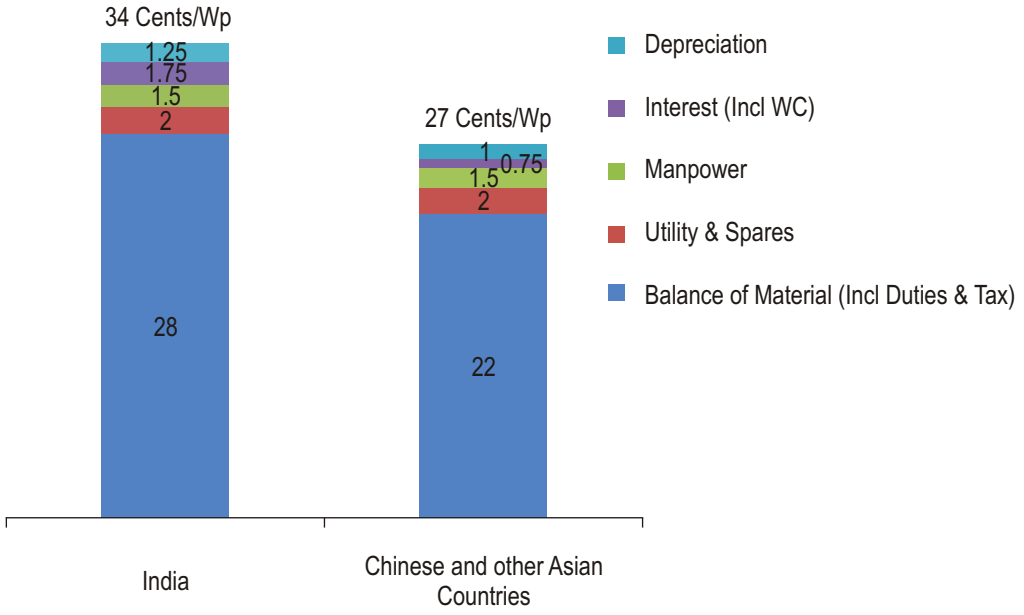
Issue: Presently, in module manufacturing, 90% value of materials is imported. The goal of the National Solar Mission for local component will be truly achieved only when the materials like EVA, Back-sheet, Junction Box, Low Iron tempered Glass, Aluminum Frame are available indigenously with competitive quality and cost advantage. Import of these materials is an impediment for the growth of the module manufacturing industry in India as this makes local module costing highly unattractive compared to that from other Chinese and other Asian countries. To ensure material offered from Asian countries meets pre-defined standards and specifications which will ensure that user/developer does not land up with non-performing or low-performing assets, it is crucial that plan for standards to enable control on quality is established.

Figure 3: Module Production Cost of Tier 1 China C-Si Module: Existing and Projection



- c-Si Tier 1 Chinese firms still have the lowest cost profile in the industry. This is due to their ability to achieve low cost conversions steps through the manufacturing process as well as having lower silicon costs using a mix of high and low purity silicon
- Any upturn in polysilicon prices could have an impact on module production cost (and profitability) because non-silicon cost improvements are becoming harder to achieve.

Figure 4: Estimated Module Manufacturing Cost Comparison



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.

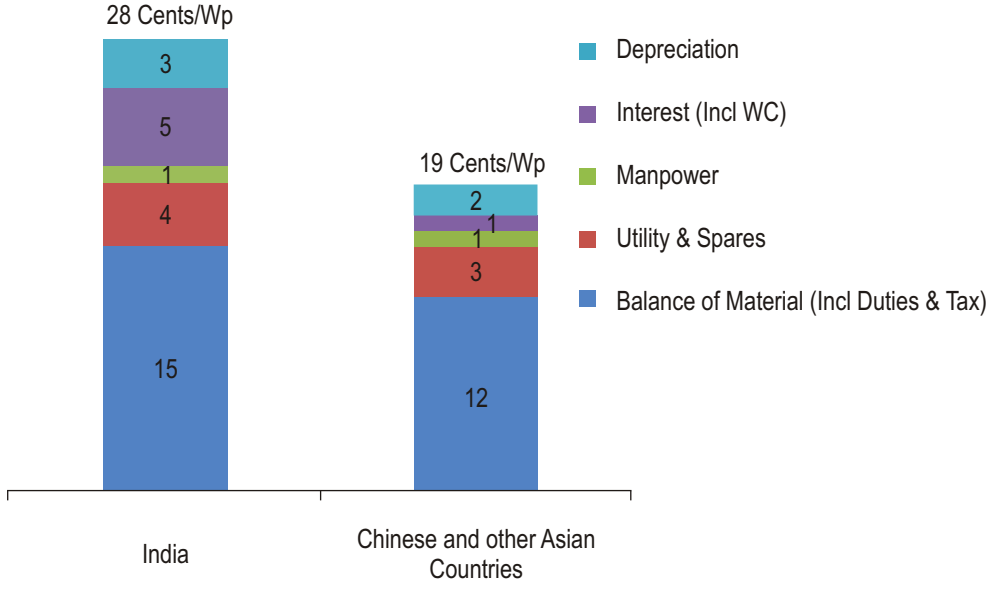
Technology transfer and tie-ups with EU or USA based industries should be supported through dialogues with their governments.

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.

b) Cell Manufacturing

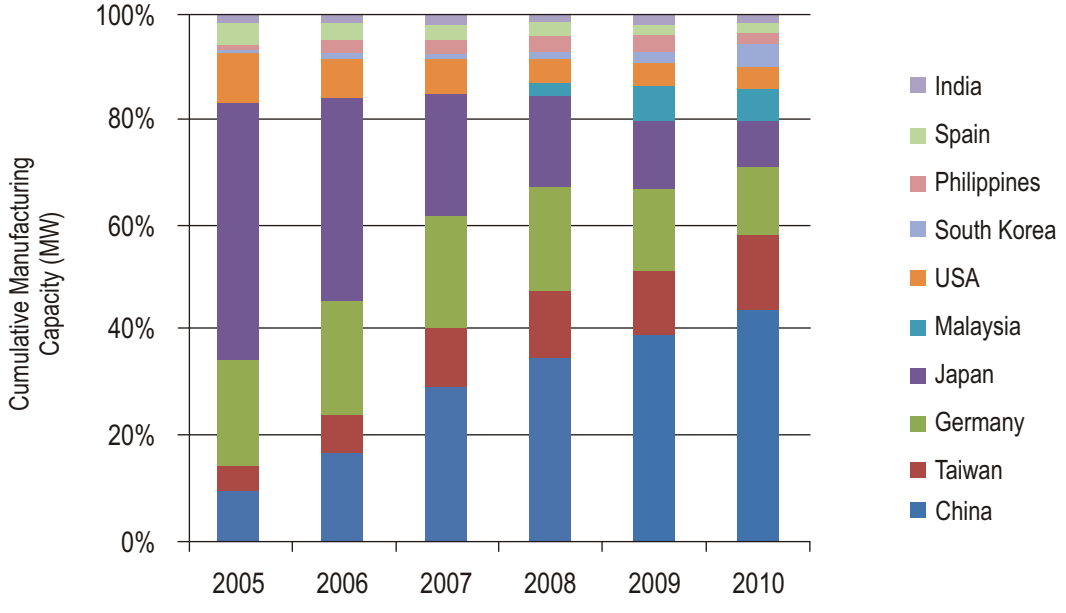
Issue: (i) Similar to module manufacturing, PV cell manufacturing is also dependent on nearly 100% imports of all the raw materials and gases.
(ii) Substituting costly raw materials with alternate raw materials. Dependence on imports has resulted in a significantly high cost at cell level for Indian manufacturers as compared to the competition from Chinese and other Asian countries.

Figure 5: Estimated Cell Manufacturing Cost Comparison



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

Figure 6: PV Cells Manufacturing Capacity Growth across the Globe



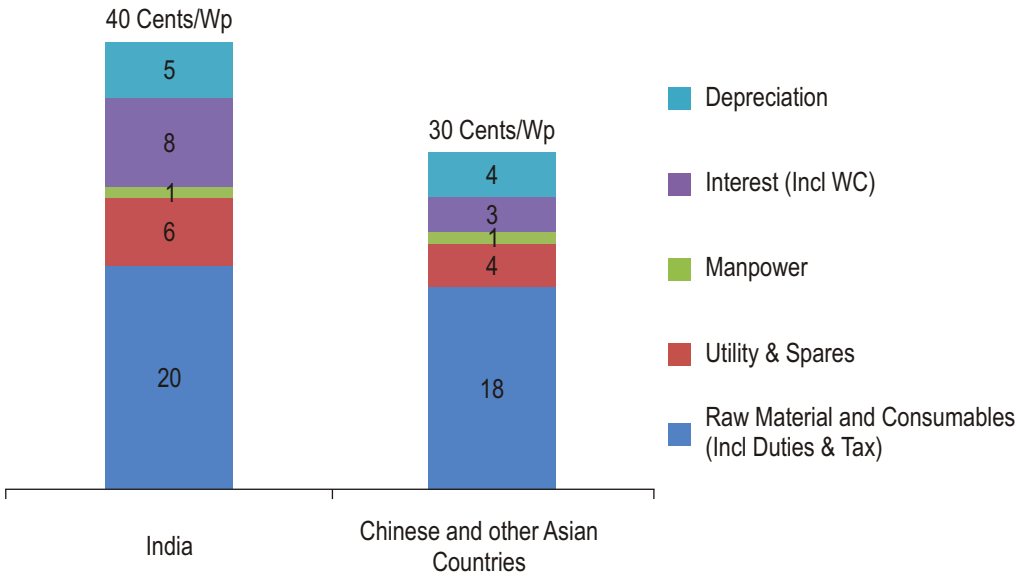
As is evident from the above mentioned statistics, capacity addition in India has been stagnant over past few years, with China and Taiwan accounting for 59% of the cell manufacturing capacity in 2010.

c) Wafer Manufacturing

Issue: Processing of waste slurries.

Possible Approach: Encouragement to licensors / technology providers to install common facilities is needed.

Figure 7: PV Poly Ingots & Wafers Manufacturing Cost Comparison



10. Solar Equipment Fabrication / Assembly

(Manufacturing requirements, Technology Sourcing / Development)

a) Tracking System

Issue: Presently the tracking systems being developed are done using universally available components.

Possible Approach: To ensure efficient solar based systems are developed at competitive costs, development of efficient tracking systems is the need of the hour. There should be a focus on developing dedicated tracking systems and related components for solar applications which will help in driving the costs down.

b) Solar Manufacturing Hubs

Issue: Need for creating solar manufacturing hubs in India.

Possible Approach: Promotion of Solar manufacturing hubs for solar thermal and PV is an effective mechanism to ensure high grade ecosystem with all necessary infrastructure and utilities essential for such solar manufacturing being made available. Such investments could be encouraged with attractive fiscal benefits to investors. There is sufficient number of case studies in other industries such as auto-ancillary, pharmaceuticals and leather which can be suitably adopted. Locally existing fabrication capacity should be leveraged to ensure quick capacity buildup. Special zones for solar would help India to service global requirements. In case of solar thermal, with proper regulatory and fiscal support, entire equipment value chain can be indigenously owned thus promoting and ensuring capability and capacity build-up.

c) Equipment & Machinery

Issue: Absence of manufacturers for high capital intensive equipment and machinery in India.

Possible Approach: While solar manufacturing is highly capital intensive, major portion of the investment is towards equipment and machinery. There has been a huge capacity built in European countries in the past for solar. The idle capacity of this installed base could be assessed to analyze if there could be a possibility of using capital equipment presently unused in these countries. Appropriate fiscal and trade incentives and exemptions should be considered to encourage and support such equipment import with clear caveats on productivity and performance of such machineries.

11 Balance of System - Solar Thermal and Solar Photovoltaic System

a Solar Turbines

Issue: Presently there are only few international vendors for solar turbines.

Possible Approach: If the CSP proliferation plans of the government have to be made effective, there have to be other alternatives including possibility of supporting indigenous developments and manufacturing over a period of time without compromising quality and performance standards.

b Inverters

Issue: The Inverter manufacturers in India have huge manufacturing capacities. One estimate is that there is an average of 4 million inverters sold per year. With an average capacity of 800 W, this amounts to 3200 MW of non-solar inverters being manufactured every year in India. Though traditional inverters cannot be directly compared with more sophisticated solar PV inverters, with right technology backing, the Indian manufacturers will be able to easily augment their capacity to meet the PV inverter requirement under the JNNSM.

There is also a need to customize the PV inverter for Indian conditions. India's utility grid (especially Low Voltage grid) is known to be unstable. If we go with the international PV standards, then the PV inverter cuts off the power when the grid voltage goes below 207V or above 264V. This will result in a sub-optimal usage of solar PV system. Hence, the solar PV inverters and standards will have to be "adapted" for Indian conditions for optimal use.[1]

Component shortage was a key issue in PV Inverter manufacturing with the new manufacturing capacities being set up by global majors and Indian companies in

this domain. The same is being mitigated to a large extent. Key components such as Insulated Gate Bipolar Transistor (IGBT) modules, Digital Signal Processor (DSP) based controllers are still imported.

c Batteries

Issue: Sustainable and consistent availability of quality inverters and deep discharge needs to be ensured. There is high dependence on imports.

Possible Approach: Rationalization of existing duty structure for near term on both these components when used for solar applications could be considered. Feasibility of local manufacturing and sourcing for these items should be evaluated and necessary incentive package to promote expansion of capacity by existing players and setting up of new projects by international as well local players should be ensured.

d Capability Development

Small and Medium Enterprises will require capacity and capability enhancements in the areas like fabrication, section bending, glass bending, surface coating, selective coating and mirror bending tending toward higher degree of automation. There is a reasonable cost arbitrage benefit estimated for manufacturing in India which can be leveraged effectively. The country has a potential base for meeting global requirements in addition to meeting domestic demand, however, to ensure the same, appropriate incentives should be provided to these enterprises to encourage them towards building capabilities pertaining to solar.

[1] Indian Semiconductor Association report, 2010

12. System Integration

Network of System Integrators

As industry matures, different parts of the value chain and the system integration will also evolve. There should be a focus on developing a network of system integrators to meet the local demand.

Possible Approach: We must ensure that appropriate quality checks are in place to qualify such integrators. There can be regular audits of such entities from time to time to ensure that they maintain the required quality standards. To strengthen system integration, schemes similar to Channel Partner scheme should also be initiated for system integrators.

Successful development of the off-grid opportunity will require a large scale, low cost workforce for the site integration of the solar PV systems. It is recommended that an off-grid PV integration program be launched through NSDC to target 10,000 electricians/integrators in 50 targeted solar cities of the 12th plan.

13. General Requisites

a. Availability of Skilled Manpower

Issue: With solar landscape evolving at a fast pace in the country, one of the key challenges would be to ensure that the required talent pool is made available for the industry to grow. There are more than 10,000 technicians/ITI personnel and 1000 engineers required in order to realize the targets mentioned. While there are few colleges/institutes in India offering courses in energy engineering and specialized renewable energy courses related to solar, there are even lesser number of options available for creating the operating level technical talent pool. Further, appropriate faculties are not available, leading to ineffective and non-pragmatic courses.

Possible Approach: The existing government initiative of including and promoting solar related programs at various levels needs to be accelerated so as to have a suitable engineering base for the growing solar industry. This concerted action plan needs to have an optimal mix of participation between industry, academic institutions and research institutes for meeting training and manpower requirements which needs to be addressed immediately. Industry engagement is pertinent to have an effective roadmap developed which is currently missing. Technicians and operator training and certification programs need to be conceptualized centrally and rolled out in a structured manner ensuring minimum quality standards w.r.t training infrastructure, faculty and qualifying criteria.

IBR adherence is a major qualifying criterion for solar thermal installations delivering steam, thereby creating a need for certified Solar Thermal Operators. Necessary augmentation of available resources in the country with this domain

expertise is a pre-requisite and a suitable program to ensure this in tandem with Central Boiler Board needs to be pursued by MNRE.

b. Strong and Ongoing R&D

Focused effort on research and development should be initiated at various institutes like the IITs along with involvement from the industry while ensuring minimum overlaps so as to utilize limited resources effectively. The developments so made should be supported by the industry with live cases to test the viability and performance of any such research. Working with international entities and experts in specific domains through government-to-government engagement programs should be leveraged.

Cluster R&D for cells in solar PV value chain and local alternatives development for solar thermal value chain (reflectors, coatings, vacuum tubes, turbines) should be facilitated for near-term commercial applications.

c. Appropriate Standards

Manufacturing and performance standards for the solar industry are a necessity and the relevant government bodies including BIS and MNRE have to take the lead in developing the same. Mandatory compliance to such standards for solar equipment in the country also needs to be put in place in a phased manner.

Apart from the above mentioned issues, the government should take the lead in making available accurate radiation data for the OEMs. This will go a long way in predicting performance of new solar installations with reasonable level of accuracy and building confidence with the user segments due to lesser deviation between actual and projected output.

14. Recommendations

To ensure a sustainable, robust and cost effective manufacturing base for the solar manufacturing industry in the country, a 5-point agenda is recommended which would be crucial for creating domestic manufacturing base for the solar supply chain and priortising those elements of the value chain that are relevant in the present Indian context to meet the domestic demand in the next few years.

1. Capex support for solar manufacturing

The estimated requirement of funds in the near term for solar thermal and PV by 2013 is Rs 395 Crore and Rs 2000 Crore, respectively. The midterm (upto 2017) and long term (upto 2022) requirement for solar thermal is Rs 1186 Crore and Rs 5886 Crore, respectively, and Rs 12000 Crore and Rs 16000 Crore for solar photovoltaic. National Manufacturing Policy has identified solar as one of the sectors of strategic importance. Sectors of strategic significance should be given special thrust in terms of capex support.

a. Capex support policy:

1. For encouraging production of raw material for the solar PV and thermal industry, schemes for low interest rates and long term loans should be introduced.

2. Encouragement for integrated plants in solar hubs, as they are self-sufficient.

3. A one-time technology up-gradation scheme through the National Clean Energy Fund (NCEF) should be created to support the solar energy industry for technological up-gradation for improving cell efficiency and production enhancement.

b. Low cost funding to be extended to PV and solar thermal towards for meeting capex requirement for entire value chain (including components and machinery)

   1. Viability gap funding for new technologies up to 40%.

   2. Low interest finance to be made available to ensure a level playing field (0-5%).

2. Integrated Solar Manufacturing Hubs

Integrated Solar Manufacturing Hubs will create a cohesive ecosystem for solar related manufacturing encompassing all elements of the solar value chain, supported by complete infrastructure availability such as availability of reliable and quality power, transport connectivity, waste treatment facilities etc. This will support in creating a secure supply chain and also optimize the costs by ensuring common utilities and economies of scale.

a. Central and State governments should provide capital subsidy / tax exemptions for development of common Infrastructure in such Integrated Solar Manufacturing Hubs.

b. Multi - Unit concept with one or two anchor industries at a location.

c. Location preferences based on the end market.

d. MNRE should ensure that projects that come for clearance from Department of Industrial Planning & Promotion (DIPP) under the National Manufacturing Policy (NMP) must be aligned with the objectives and deliverables of the National Solar Mission.

e. Waiver on environmental clearance at the central level applicable to solar manufacturing facilities under Environmental Impact Assessment (EIA) notification should also be applicable for solar hubs.

3. Power to Energy Intensive Segments of Solar Manufacturing

Cost of power constitutes major input cost for MG Silicon, Poly-silicon, Wafer manufacturing, etc. The government should consider lower power tariffs for this green energy sector at par with the global competition (Rs. 0.9 to 1.1 / kWh) for this strategically significant emerging sector which will help in making it cost competitive.

a. There is a need to extend concessional power for energy intensive segments of the PV value chain as the percentage share of power in the cost of manufacturing of these raw materials is significant. The estimated percentage share of power for the manufacturing of raw materials are 50%, 30%, 25% and 10% for MG silicon, poly-silicon, Crystal Growing Ingots and Wafers, respectively.

b. The State Governments and State Electricity Regulatory Commissions should provide special category tariffs (approximately Rs. 4-6 per unit) at par with global competition[1].

4. Tax & duty rationalization / exemption

There is an urgent need to rationalize taxes and duties on the solar thermal and solar photovoltaic value chain to make Indian solar manufacturing industry competitive and to bring down cost of solar power. The inverted duty structure for the solar photovoltaic sector is a matter of grave concern for the sustainability of the Indian solar energy sector.

While certain capacities should be developed through promotion of local manufacturing, there will be specific components which will have to be imported in near future, as developing capacities would take some time. Tax and duty rationalization of these components should be given priority. The break-up of these components under Thermal and PV for domestic capacity creation and duty rationalization is shown in tables 9 and 10 below.

[1] * LDK, Daqo, Waker, Tokuyama – Recent Annual Reports / Analyst Reports

The tax and duty concerns and concessions required for the manufacturing industry are as follows:

a. Current tax and duty structure regime translates up to 23% taxes and duties on imported machinery (except for SEZs and EOUs). Same needs to be exempted to facilitate quick capacity build-up in the country to cater to domestic market.

b. Duty structure applicable to select components as mentioned in table 10 below, where domestic manufacturing could have a strategic advantage needs to be rationalized with a sunset clause. The inverted duty structure on components adds up to between 10% and 20% currently.

c. States have imposed Central Sales Tax, VAT to the tune of 5% against sales of Solar PV cells/Solar PV modules, Solar SPV systems, Solar Collectors, Solar Water Heating Systems and various other systems running and operating on Solar Energy. While this is not applicable for imports, it makes the domestically manufactured products further uncompetitive. The VAT and Central Sales Tax on these items should be permanently removed to promote manufacturing and sale of solar energy products as these are Green and Clean Energy products.

Table 9: Prioritizing Solar manufacturing support for Solar Thermal

Details	Domestic Capacity Creation	Duty Rationalization
Tracking System		☝
Reflector Glass	☝	☝
Recervier Tubes	☝	
Solar Turbines		☝
Vacuum Tubes		☝

Table 10: Prioritizing Solar manufacturing support for Solar Photovoltaic

Details	Domestic Capacity Creation	Duty Rationalization
PV Cells	☝	
Si Wafers	☝	
Ploysilicon	☝	
Low Iron Glass	☝	
EVA Sheets	☝	
Backsheet		☝
Junction Boxes	☝	
Al Frames- anodized	☝	
Silver Paste		☝
Graphite		☝
Quartz Crucibles		☝
SiCarbide slurry		☝
MG Silicon		☝
Reflective Coatings		☝
Absorber Coatings		☝
LED circuits/ Lamps		☝

5. Promoting cluster R&D

Promotion of cluster R&D for improvements in cell efficiencies in solar PV value chain and local alternatives development for solar thermal value chain should be facilitated for near-term commercial applications. Short to medium term research and development projects with industry partners should be promoted. This will provide flawless transfer of technology from lab to commercial scale.

a. PV Cell Efficiencies - Incremental improvements from 16.4% and above to ensure that the locally available options are at par with the global benchmarks

b. PV Cell Consumables - substituting Silver paste with Copper or abundantly available low cost materials; optimizing Silver paste quantities

c. Solar Thermal Value Chain - Low cost indigenous options for anti-reflective coatings, absorber coatings, receiver tube coating, turbines, etc. to be developed to reduce dependence on imports

d. Cost and efficiency improvement programs for storage devices such as batteries, Inverters, etc.

15. About the FICCI Solar Energy Task Force

FICCI Solar Energy Task Force was launched in March 2010, with the launch of Jawaharlal Nehru National Solar Mission (JNNSM) to provide a platform for the solar energy sector to deliberate on policy and regulatory issues and advance interests of the sector at domestic and global platforms. The Task Force is represented by 32 members from the entire value chain of the solar industry including manufacturers, project developers, system integrators, EPC companies, raw material suppliers as well as the certification agencies. Mr V Saibaba, CEO, Lanco Solar is the current Chairman, and Mr Vivek Chaturvedi, CMO, Moser Baer Solar is the Co-Chairman of the FICCI Solar Energy Task Force.

The Task Force has six Subgroups: Subgroups on on Solar Financing, Securing Supply Chain, Creating Sustainable Demand, Off-grid and Decentralized Solar Applications, Solar Thermal, and Performance Standards, comprising solar industry stakeholders and chaired by industry leaders.

The members of the FICCI Solar Energy Task Force include the following:

- Abengoa Solar India
- ACME Telepower Limited
- Allied Glasses Pvt. Ltd
- Alstom Power
- Applied Materials India Pvt. Ltd.
- AREVA India
- Astonfield Renewable Resources Limited
- Bharat Heavy Electricals Ltd.
- DSM India Private Limited
- Emmvee Photovoltaic Power Pvt Ltd.
- Grundfos Pumps India Pvt Ltd.
- IL&FS Energy Development Company Ltd.

- Indian Oil Corporation Limited (IOCL)
- Kiran Energy
- Lanco Solar
- Larsen & Toubro Limited
- Maharishi Solar Technology (P) Ltd.
- Mahindra Partners
- Moser Baer Solar
- NTPC Limited
- OMC Power
- Photon Energy Systems Ltd.
- Solar Semiconductor Pvt. Ltd.
- Solid Solar
- Sunborne Energy
- Suryachakra Power Corporation Limited
- Tata Power Solar
- Thermax Limited
- Titan Energy Systems Ltd
- TUV Rheinland
- Underwriters Laboratories
- Welspun Energy Limited

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- Mr Salil Dutt

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- Dr Gangadhar Rao, Co-Chair, FICCI Solar Subgroup on Securing Supply Chain

Applied Materials

- Mr Puneet Gupta
- Mr Ashwini Aggarwal

FICCI

- Ms Rita Roy Choudhury, Senior Director & Head - Environment, Climate Change, & Renewable Energy
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