Indian Chamber of Commerce

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

ICF

REPORT ON

SURYA* TO BOOST SOLAR MANUFACTURING IN INDIA

Supporting

"Make In India" campaign for solar power

*Solar Utpaadan & Rozgaar Yojana

Prepared by:

Indian Chamber of Commerce
in association with
ICF Consulting India Pvt. Ltd.

Supported by:

Shakti Sustainable Energy Foundation

Indian Chamber of Commerce

SHAKTI SUSTAINABLE ENERGY FOUNDATION

ICF

Coverage

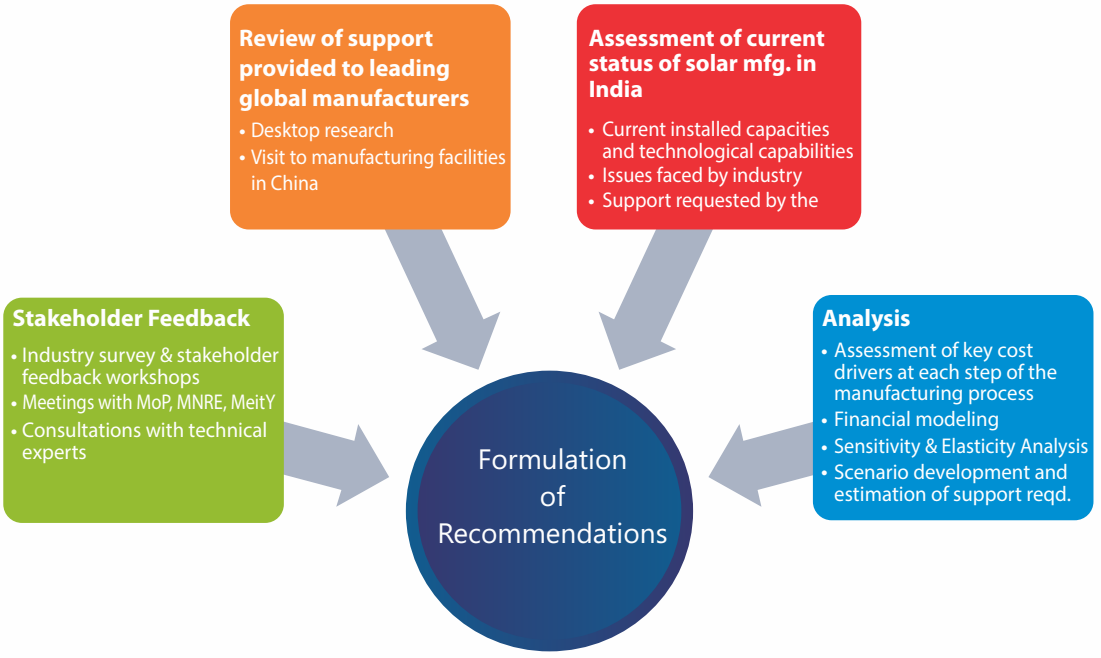
- Demand drivers for solar panels in India
- Current status of Indian solar PV manufacturing industry
- PV manufacturing value chain and raw materials
- Government support to PV manufacturing in China and Malaysia
- Anti–dumping and Countervailing duties on Chinese modules in US and EU
- Current policy support to solar PV manufacturing in India
- Estimated cost of integrated solar PV mfg. in India in current scenario
- Industry response to Survey
- Recommendations to promote solar PV manufacturing in India

Background to the Project

- India's solar market is one of the fastest growing markets in the world, offering an average potential of at least INR 35,000 crores (~ USD 5.4 billion*) per annum for solar modules over the next 5 years.
- India's domestic solar PV manufacturing industry, however, has not been able to tap into this market on account of its inability to compete with imported products. As a result, India is largely reliant on imports to meet its growing domestic demand and this trend is likely to continue unless domestic capacity is ramped up with suitable policy support.
- This Report therefore aims to:
  - Identify the main issues and challenges faced by India's solar PV manufacturing industry;
  - Understand the incentives being provided to leading manufacturers in countries such as China and Malaysia;
  - Identify and quantify the key cost drivers of solar PV manufacturing in India; and
  - Provide the Hon'ble Minister for New and Renewable Energy with a specific set of policy recommendations for boosting solar PV manufacturing in the country.
- The target of 100 GW of installed solar capacity by 2022 offers a tremendous opportunity to create skilled jobs, bring about technology transfer, and contribute to the Make in India campaign, in addition to reducing the country's trade deficit and reliance on imports. ICC and ICF welcome this opportunity and are pleased to submit this Report to the Hon'ble Minister.

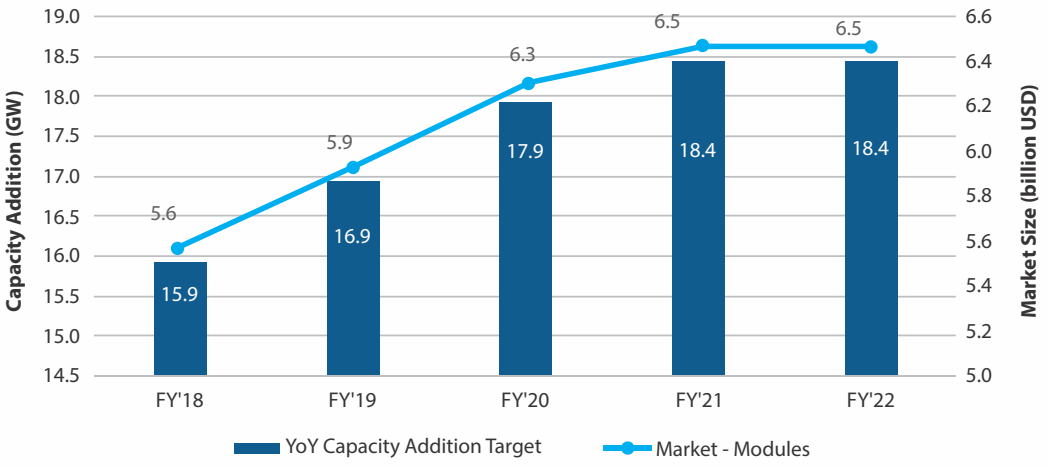
*1 USD = INR 65

Approach & Methodology



Demand drivers for solar panels in India

India has a HUGE domestic market potential of INR > 35,000 crore per annum in the immediate term for solar modules!

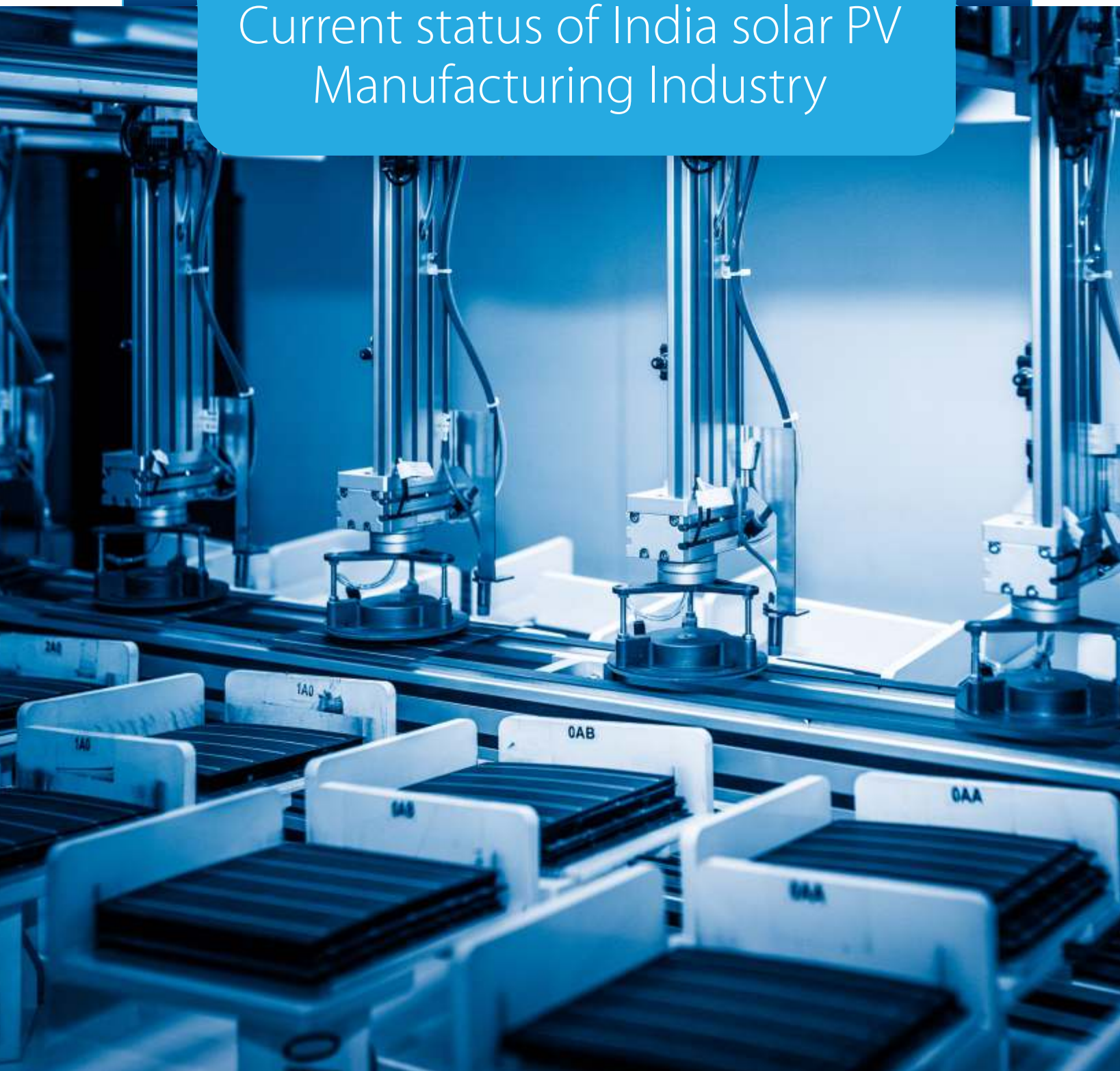


Source: ICF Analysis

- To meet YoY Government target for solar capacity additions, significant import of modules will be needed as domestically produced modules not cost-competitive with imported products
- Even with increased domestic capacity for cells & modules, significant wafer imports will be needed
- Therefore, huge opportunity to set up complete solar PV value chain in the country!
- In addition to the local demand, an enhanced domestic manufacturing base can cater to the international market and become a global player

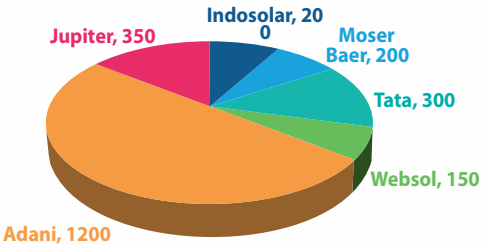
Note: Price assumed for module = USD 35 ¢/Wp. Source: Current price as per feedback received from industry.

Current status of India solar PV Manufacturing Industry

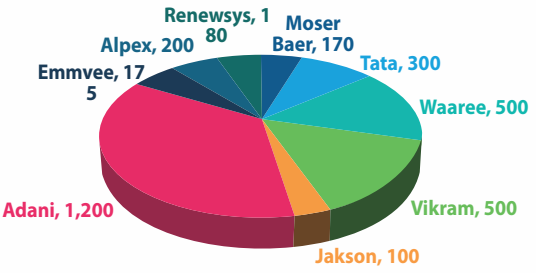


Solar PV manufacturing in India – only cell and module, old capacities with high cost, fragmented small units

Installed Capacity of Major Cell Manufacturers: 2,400 MW



Installed Capacity of Major Module Manufacturers: ~3,300 MW

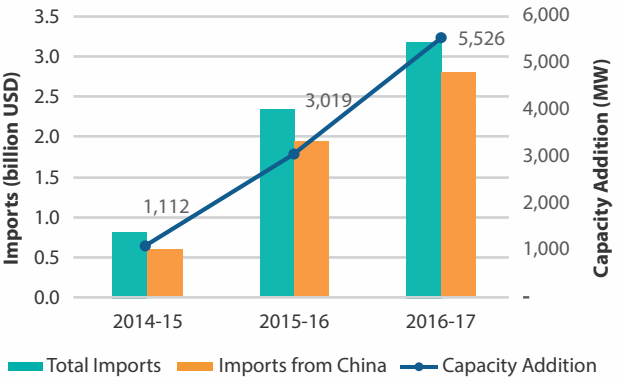


Source: Industry Feedback

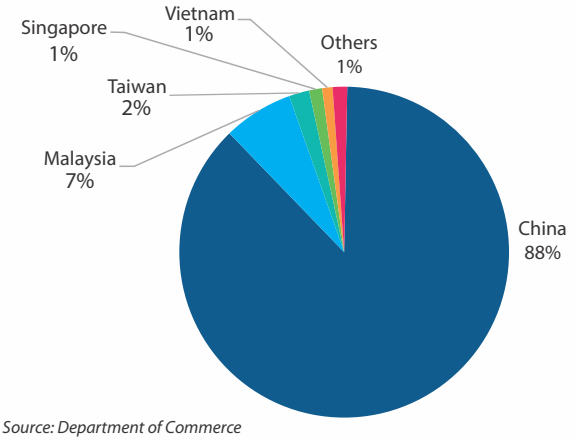
- Latest market reports indicate that the installed capacity of major cell and module manufactures is roughly 2,400 MW and ~3,300 MW respectively.
- Of the existing manufacturers, only Adani is manufacturing cells of Passivated Emitter Rear Cell (PERC) technology (300 MW out of the total), which offers superior performance. Global players are adopting this technology as conventional multi-crystalline Al-BSF (Aluminium-Back Surface Field) solar cells have reached efficiency limitations.
- Therefore, there is a need to retrofit existing cell and module capacities so as to enable them to manufacture PERC technology cells and modules.

Ex-Im scenario for cells and modules – steadily rising imports over the last three years

- Imports have been increasing proportionately with capacity additions over the last three years
- 88% and 7% of imports from China and Malaysia respectively in FY 2016-17
- Imports from Malaysia are primarily produced by Chinese manufacturers who have shifted operations to avoid anti-dumping/countervailing duties in US and EU

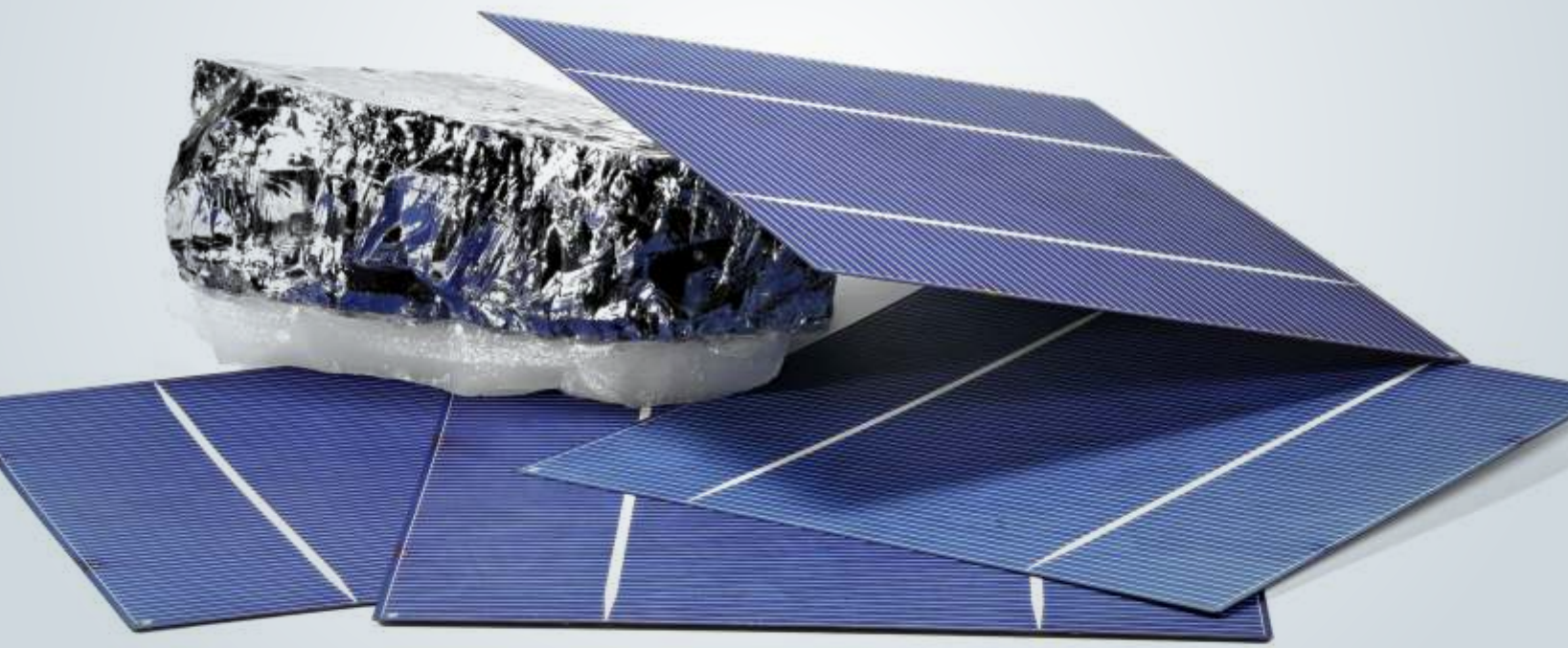


Country-wise breakdown of imports in FY 2016-17



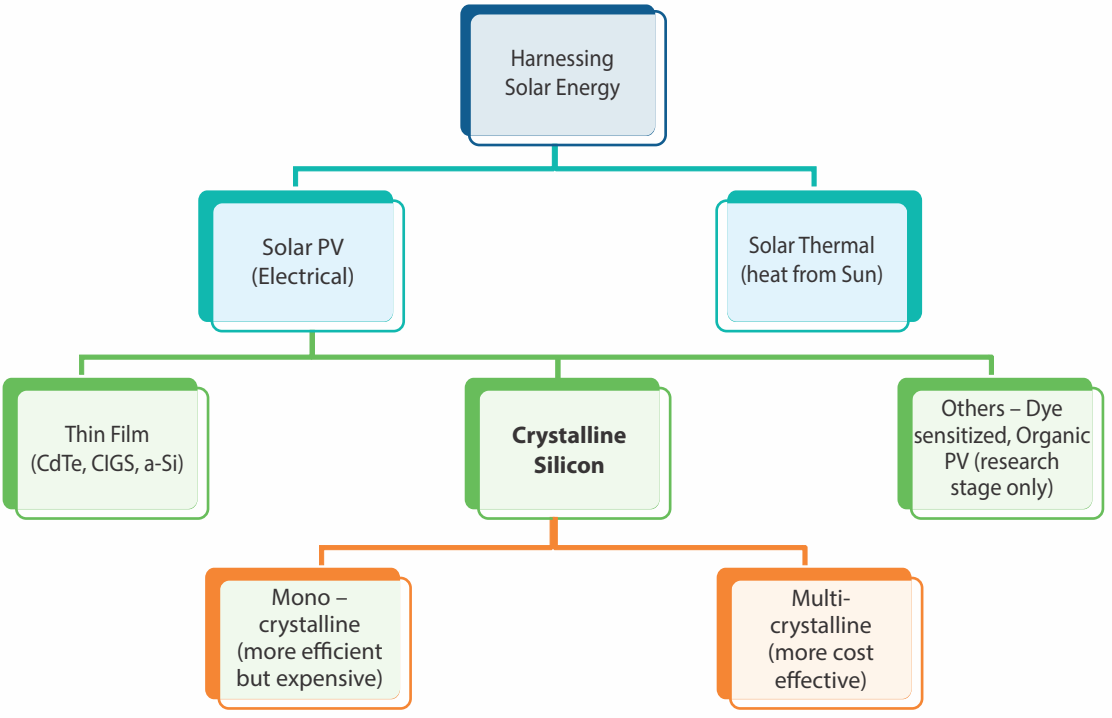
Source: Department of Commerce

PV manufacturing value chain and raw materials



Harnessing solar energy

- Solar energy can be used to heat a medium to increase its internal energy to either produce electricity or heat for a process (solar thermal), or to produce electricity through the photovoltaic effect (solar PV).
- The two most prevalent solar PV technologies today are thin film and crystalline silicon.
- The present assessment focuses on the use of solar irradiation to produce electricity using crystalline silicon technology.
- Industry is moving towards PERC technology, which has been commercialized for mono crystalline cells.



Crystalline silicon PV manufacturing value chain – highly specialized and technology-driven process

- **Quartz to MG-Si:** In the first step to make solar cells, the raw materials—silicon dioxide of either quartzite gravel (the purest silica) or crushed quartz—are first placed in an electric arc furnace, to which a carbon arc is applied to release the oxygen. This simple process yields Metallurgical Grade silicon (MG-Si).
- **MG-Si to poly-Si:** MG-Si is purified by converting it to a silicon compound that can be more easily purified by distillation than in its original state, and then converting that silicon compound back into pure solar-grade polysilicon. The two commonly used methods are the Siemens process and fluidized bed technology.
- **Poly-Si to ingot:** Polysilicon is then melted and crystallized into mono or poly crystalline silicon ingots. For monocrystalline Si cells, the atomic structure of the silicon is modified using the Czochralski method.
- **Ingot to wafer:** Wafers are sliced with a multi-wire diamond saw. The wafers are then polished to remove saw marks and to optimize light absorption by surface micromachining of the polished wafer. One of the key processes in silicon surface micromachining is the selective etching of a sacrificial layer to release silicon microstructures.
- **Wafer to cell:** A surface diffusion of n-type dopants is performed on the front side of the wafers to create a p-n junction. Subsequently, an anti-reflective coating of silicon nitride or silicon oxide is applied to the wafers to reduce reflection of sunlight. The wafer then has a full area metal contact made on the back surface. After the metal contacts are made, the solar cells are given connections such as flat wires or metal ribbons and encapsulated, that is, sealed into silicone rubber or ethylene vinyl acetate (EVA).
- **Cell to module:** The encapsulated solar cells are interconnected and placed into an aluminium frame that has a BoPET (Biaxially oriented Poly-Ethylene Terephthalate) or PVF (Poly-Vinyl Fluoride) back sheet and a glass or plastic cover. Front and rear connections are channelled through the junction box.

Source: Local Manufacturing Potential for Solar Technology Components in Egypt, World Bank

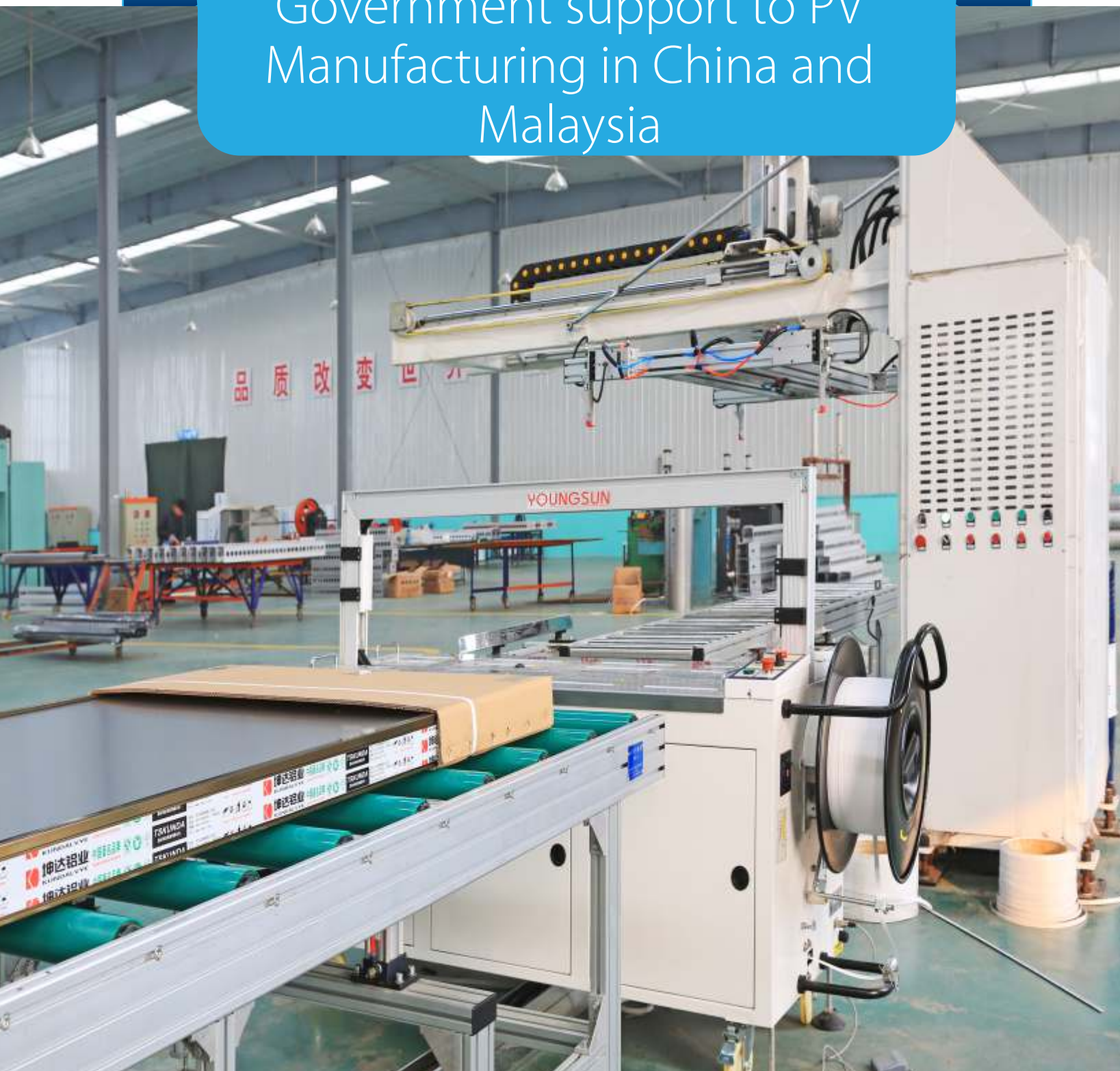
Current technology trends

- The crystalline silicon (c-Si) technology continues to dominate the global market, comprising more than 90% of the total photovoltaic module shipments in 2016 with the rest being accounted for by thin film technology. Within c-Si modules, poly-crystalline modules accounted for a dominant share of around 70% in 2016. However, the annual market share in wafer production of monocrystalline modules, which are around 2 percentage points more efficient than poly-crystalline modules, has gradually increased from 20% in 2012 to 29% in 2016, and is expected to further increase to 37% by 2020. The increasing uptake of mono c-Si is mainly because of the narrowing price differential between the mono and poly technologies from 20% in 2014 to 8% in June 2017.*

- Demand for high efficiency mono c-Si and mono PERC cells has also been bolstered by China's Top Runner programme. Mainly due to this push, many leading manufacturers have announced expansion plans. Therefore, global share of mono c-Si and mono PERC technologies is expected to continue to increase in the near future.

*Source: India Solar Compass, Q2 2017, Bridge to India

Government support to PV Manufacturing in China and Malaysia



Context

- China is the global leader in solar PV manufacturing, accounting for **nearly 70% of the global production capacity.** Despite not having an attractive domestic market initially, Chinese firms ventured to fulfil global demand with support from local and provincial governments. The local governments provided the firms with incentives such as low interest loans to purchase equipment, land transfer price refunds, electricity price refunds and multiple-year corporate tax reductions. With easy access to low-cost capital and a soaring national and international demand, solar mfg. **capacity in China has grown from about 10 GW in 2010 to roughly 50 GW at the end of 2016.**

- However, with import taxes in a number of countries and regions limiting free trade of solar goods, the largest cell and module manufacturers from China have started to build their factories outside their home country. As further decreasing cost is key for solar's success, the locations of the big PV cell and module makers' new production facilities are in other Asian countries, such as Malaysia, Vietnam, and Thailand. Malaysia, which already is a major electronics manufacturing hub, has leveraged its existing infrastructure and emerged as the third largest producer of photovoltaics in the world.

- The following slides provide an overview of the subsidies and incentives available to solar PV manufacturers in China and Malaysia.

Indian Chamber of Commerce

SHAKTI SUSTAINABLE ENERGY FOUNDATION

ICF

China case study: summary of incentives available to solar PV industry

Soft loans – state-owned commercial/policy banks providing the solar industry with loans at preferential, lower than commercial rates and terms

Export credits - Export-Import Bank of China provides export-contingent loans at preferential rates and assistance in the form of export seller's credit

Income tax reduction – export oriented (>70%) FIEs eligible to pay only half the income tax rate; preferential tax benefits to enterprises recognized as "high" or "new" technology enterprises

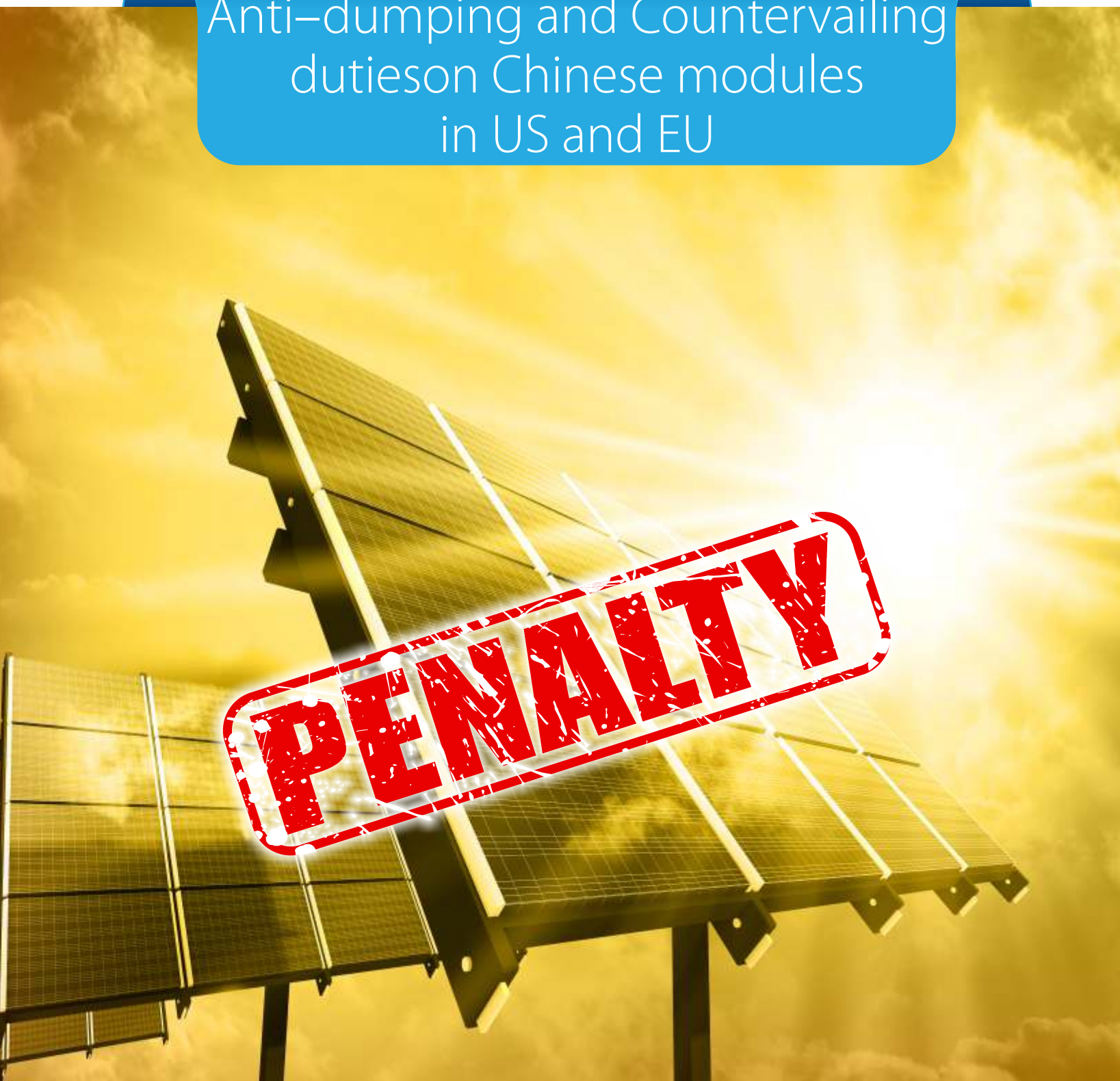
VAT exemptions – VAT and import tariff rebates on imported equipment for solar manufacturing

Subsidies - grants, loans, and other incentives to enterprises in China, in part to implement an industrial policy of promoting the development of global Chinese brand names, and to increase sales of Chinese- branded and other Chinese merchandise around the world

Malaysia case study: Summary of incentives given to solar PV industry

Incentives for strategic projects	pioneer status with 100% income tax exemption of statutory income for 10 years given to product/ activity of national importance
Incentives for SMEs	reduced corporate tax of 20% on incomes up to RM 500,000; remaining income taxed on 25% basis
Reinvestment allowance	RA allotted on qualifying capital expenditure incurred to be offset against company's statutory income
Accelerated capital allowance	write off of capital expenditure within 3 years`
Incentives for industrial building systems	expense in purchase of moulds used in production are eligible for ACA for 3 years
Group relief	70% of current year's losses to be offset against income of another company in the same group
Other provisions	Import duty and sales tax exemption on raw materials and components; production machinery and equipment
Promotion of exports	VAT exemptions
Proprietary rights acquisition	Deduction in cost incurred for acquiring patents, trademarks

Anti–dumping and Countervailing dutieson Chinese modules in US and EU



Background

- Countervailing Duty (CVD) and Anti-Dumping Duty (ADD) investigations were launched in the US on October 19, 2011 when the Coalition for American Solar Manufacturing (CASM) filed official complaints, both with the US Department of Commerce (DOC) and the US International Trade Commission (ITC), charging unfair and injurious trade practices by China in the crystalline silicon solar industry. In December 2011, the ITC found that "there is a reasonable indication that a US industry is materially injured by reason of imports of crystalline silicon photovoltaic cells and modules from China that are allegedly subsidized and sold in the United States at less than fair value."

- The European Commission launched a nine month investigation in September 2012, during which the Commission found that Chinese companies were selling solar panels to Europe at far below their normal market value, which was causing significant harm to EU solar panel producers. The fair value of a Chinese solar panel sold to Europe should have been 88% higher than the price at which it was actually sold. The dumped Chinese exports exerted undue price pressure on the EU market, which had a significant negative effect on the financial and operational performance of European producers.

- The following slides summarize the actions taken by the US Commerce Department and the European Commission with regards to imposition of anti-dumping and anti-subsidy duties on solar imports from China.

US Anti-dumping Duties (ADD) and Countervailing Duties (CVD) on Chinese modules – on average 25% ADD and 15% CVD imposed

- The US International Trade Commission (US ITC), vide its order dated 7th December, 2012, imposed anti-dumping and countervailing duties on Chinese cells and modules. The ADD and CVD rates for the major manufacturers have been listed in the table below.

Company	ADD rate	CVD rate
Trina Solar	18.32%	15.97%
Wuxi Suntech	29.14%	14.78%
Yingli Energy	24.48%	15.24%
Jinko Solar	24.48%	15.24%

Source: https://www.gpo.gov/fdsys/pkg/FR-2012-12-07/pdf/2012-29668.pdf
https://www.gpo.gov/fdsys/pkg/FR-2012-12-07/pdf/2012-29669.pdf

- It may also be noted that on 23rd May, 2017, the US ITC formally initiated a Section 201 "global safeguard" investigation on crystalline silicon photovoltaic (CSPV) solar cells and modules. This investigation was launched in response to a petition submitted by Suniva, a US solar cell manufacturer that is currently in bankruptcy. In its petition, Suniva has proposed an additional tariff of up to $0.40 per watt on imports of solar modules and panels and a floor price of $0.78/watt—measures that would significantly impact the export market potential of Indian manufacturers.

EU Anti-dumping, Countervailing duties and Minimum Import Price (MIP) – MIP set at €0.56/ Wp

Duties on Chinese solar cells & panels originally imposed by the EC on 4 June 2013 for 2 years, as a combination of (a) anti-dumping (b) anti-subsidy duties and (c) an MIP.

MIP of 0.56 Euros/watt, anti-dumping duties of up to 64.9 percent for those outside the agreement and anti-subsidy duties capped at 11.5 percent

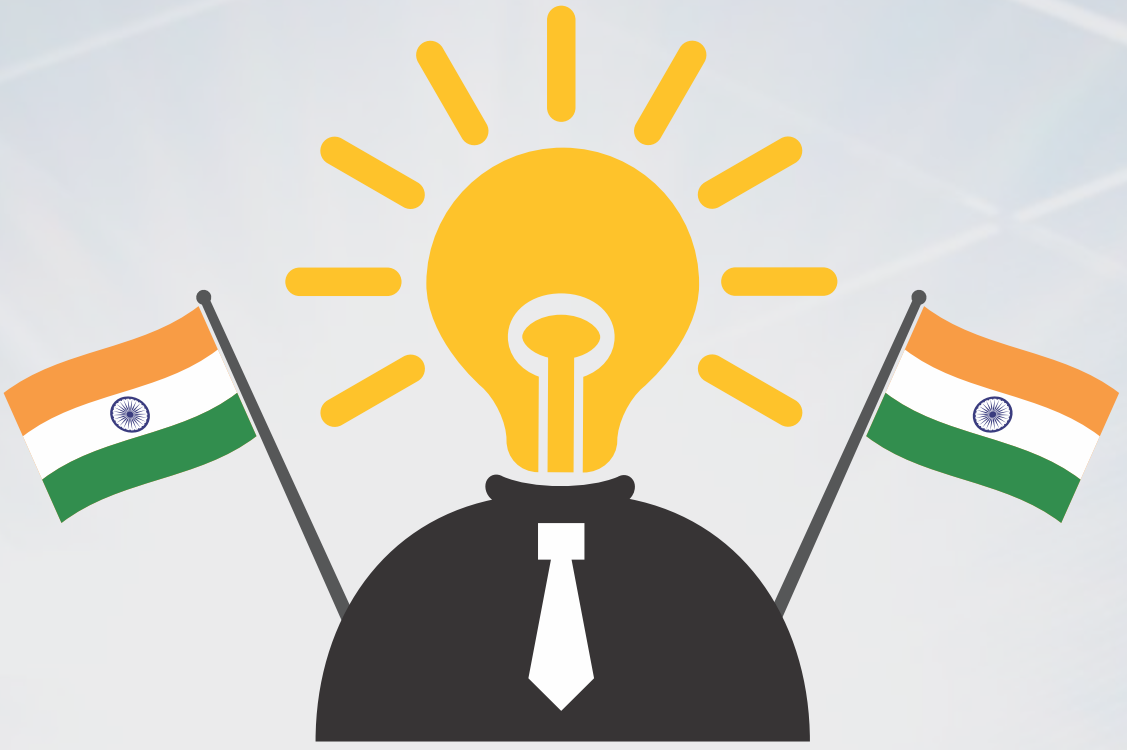
Chinese companies are subject to AD and CVD unless they sign and adhere to a MIP Agreement.

The measures were supposed to end by Dec 2015, however based on EU ProSun appeal, postponed the end day to March 2017.

In Feb 2017, EU granted a final extension on Anti-dumping and Anti-subsidy Duties of 18 months

Commission has proposed cutting the MIP for panels to 0.46 Euros/watt

Current policy support to solar PV manufacturing in India



Modified Special Incentive Package Scheme (M-SIPS)

- To attract investments in electronics manufacturing, the Modified Special Incentive Package Scheme (M-SIPS) was notified on 27th July, 2012.
- The scheme is available for both new projects and expansion projects. The scheme provides capital subsidy of 20% in SEZ (25% in non-SEZ) for units engaged in electronics manufacturing. It also provides for reimbursements of CVD/ excise for capital equipment for the non-SEZ units.
- M-SIPS gives preference to state-of-the art technology.
- The investment threshold varies from INR 1 Crore to INR 5,000 Crores depending upon the type of project. Units all across the manufacturing value chain are covered under the scheme.
- The M-SIPS requires applicants to submit applications with Financial Closure (tied up funds) for the project they propose to execute. The Financial Closure for a project, however, can be given in phases.
- A separate vertical has been created for solar PV.

Benefits available under M-SIPS

	Type	Investment Threshold (in INR Crore)			Financial Incentives	
		Fab	Assembly, Testing, Marking and Packaging (ATMP)	Manufacturing	SEZ	Non-SEZ
1	Polysilicon	500	N.A.	N.A.	20% of capex + 10% of Production Subsidy on production turnover (ex factory)	25% of capex+ reimbursement of Excise/CVD on capital equipment + 10% of Production Subsidy on production turnover (ex factory)
2	Ingotsand/ or wafers	150	N.A.	N.A.	-do-	-do-
3	Cells	75	N.A.	N.A.	-do-	-do-
4	Modules/ panels (technology agnostic)	N.A.	N.A.	10	20% of capex	25% of capex+ reimbursement of Excise/CVD on capital equipment

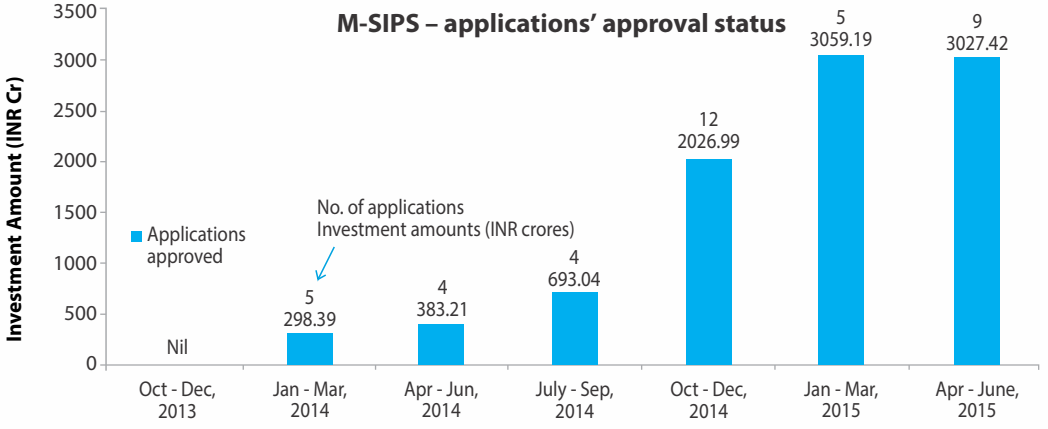
M-SIPS – key amendments & project approvals to date

Time period – earlier of Dec 2018 or reaching incentive of INR 10,000 crore

Incentive available for a period of 5 years from approval date

Unit to remain in commercial production for 3 years (undertaking)

For mega projects > INR 6,850 crores, approval by a separate committee



Note: Last available data.
Source: http://www.msips.in/MSIPS/

M-SIPS – current status

- **190 proposals received in the first round and 40 in the second**
  - Total value of the proposals = INR 1.2 lakh crore, Subsidy = 25% of this
  - Of this, 17 proposals in solar PV manufacturing = INR 20,000 Crore value
- **These proposals have already exhausted INR 10,000 crore subsidy limit**
- **Production subsidy difficult to implement under current provisions**
  - 10% of production turnover?
  - How to calculate arms length price?
- **M-SIPS was conceptualized to promote manufacturing of all electronics, hence it is not a sector-specific scheme**
- **Ministry of Electronics and Information Technology (MeitY) does not have a separate allocation for Solar PV**
- **Points to a need for a dedicated scheme targeted towards Solar PV**

Estimated cost of integrated solar PV manufacturing in India in current scenario

Analysis Assumptions (1)

- The analysis has been done with the assumption that 7.5% basic import duty + 18% CVD is applicable on plant and machinery. All raw materials are assumed to be exempt from basic import duty except glass which draws a duty of 5% (BCD). CVD of 5% is applicable on top. We assume no input tax credit is available on CVD.
- The analysis has been carried out for a fully integrated (polysilicon to module) multi-GW scale plant scaled down to 1 GW.
- Financing Assumptions :

Equity %	30%
Debt %	70%
Equity MIRR	16%
Interest on long term loan	12%
Long term loan period (years)	15
Interest capitalization (quarters)	3
Interest on WC loan	12%

Category	Life (years)	Salvage Value	Rate (WDV)	Rate (SLM)	Accelerated Depreciation
Building	62	0%	10%	1.63%	-
Plant and Machinery	7	5%	15%	14%	40%

Analysis Assumptions (2)

- **Taxation Assumptions**
  - Corporate Tax Assumptions

Tax Rate	**30%**
Surcharge	**12%**
Education Surcharge	**3%**
Effective Corporate Rate	**34.6%**
Tax Holiday	**0 years**

  - MAT Rate Assumptions

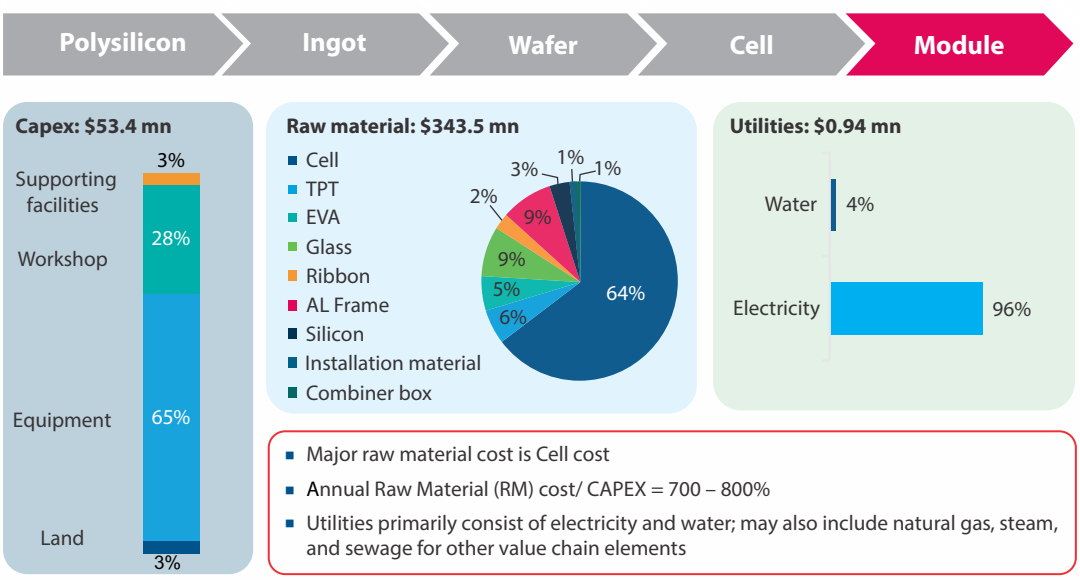
Tax Rate	**18.5%**
Surcharge	**12%**
Education Cess	**3%**
Effective MAT Rate	**21.3%**

- The analysis of CAPEX, OPEX, and raw materials required for each of the five (5) key elements of the solar PV value chain (starting from modules and going back up to polysilicon) is presented in the following slides.

Polysilicon to Module manufacturing: Major costs/ GW

Stage 5: Cell to modules

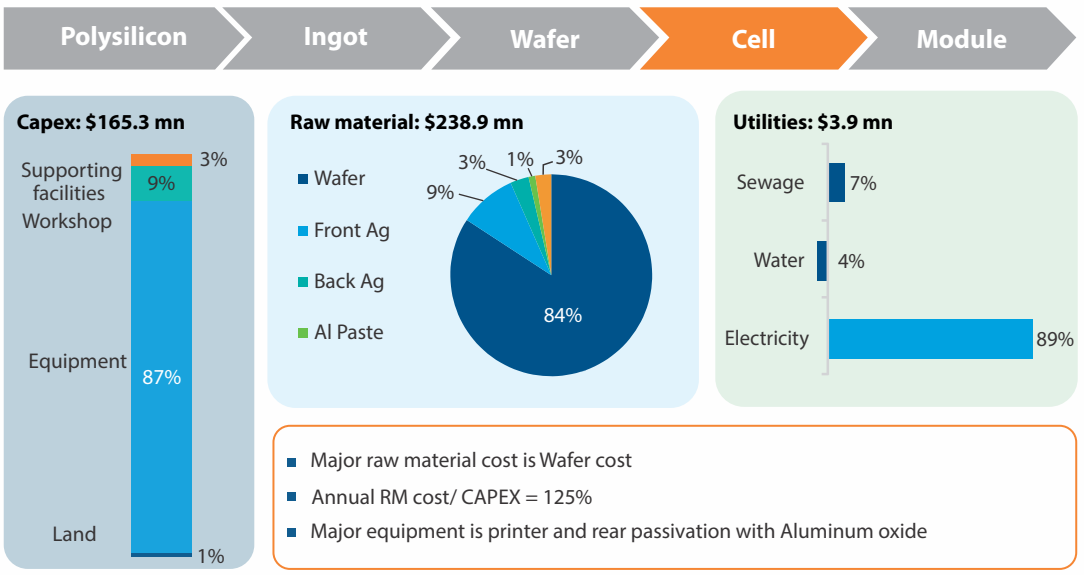
Usually manufacturers start from setting up module manufacturing and then vertically go backwards in the chain



Note: Costs are for a multi-GW scale plant (min. 3 GW) scaled down to 1 GW; TPT: Tedlar Polyester Tedlar, EVA: Ethylene Vinyl Acetate

Polysilicon to Module manufacturing: Major costs/GW

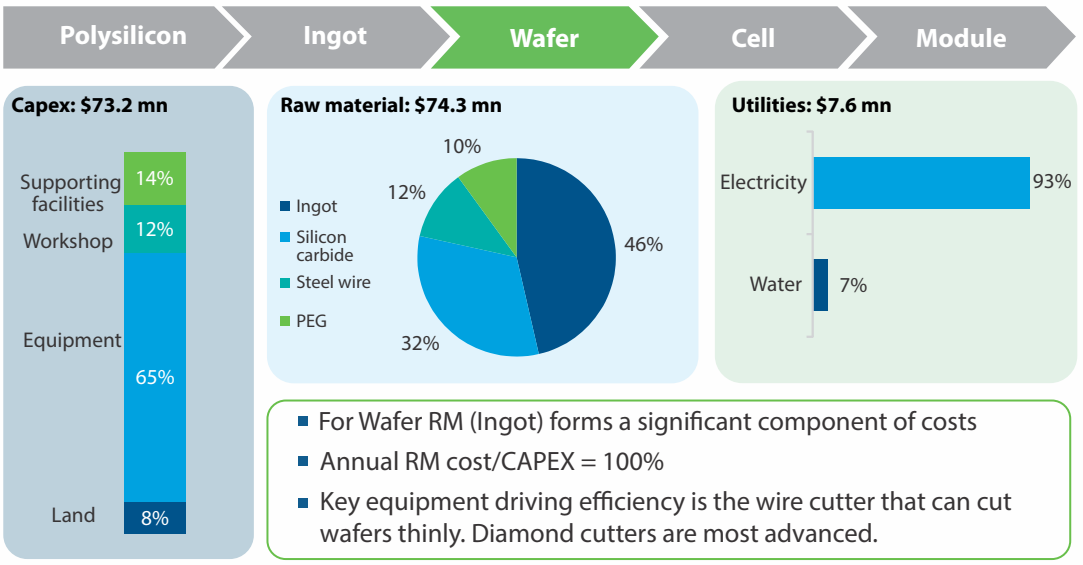
Stage 4: Wafer to cells



Note: Costs are for a multi-GW scale plant scaled to 1 GW

Polysilicon to Module manufacturing: Major costs/ GW

Stage 3: Ingot cutting into wafers

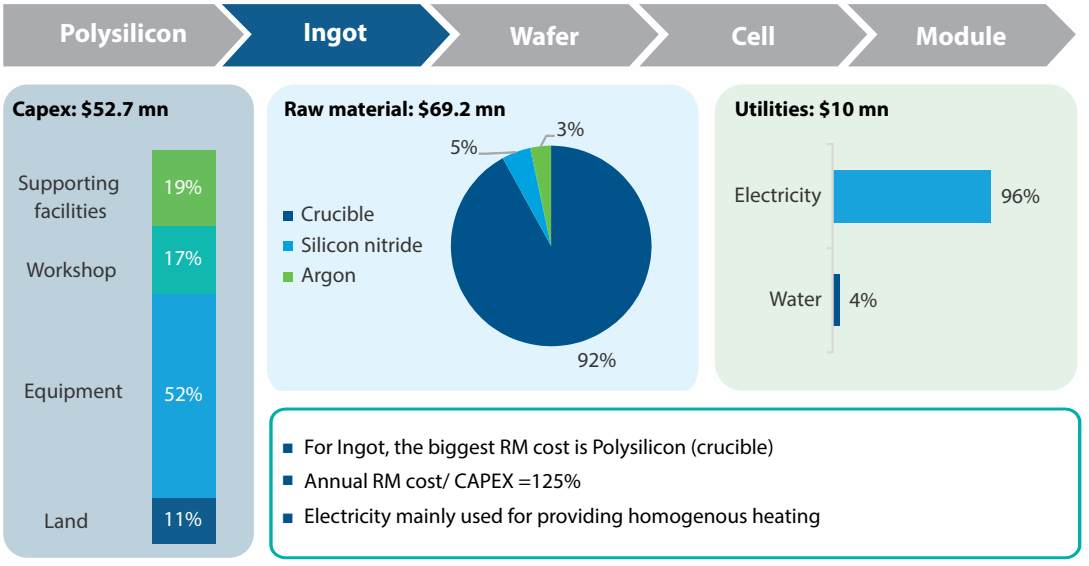


- For Wafer RM (Ingot) forms a significant component of costs
- Annual RM cost/CAPEX = 100%
- Key equipment driving efficiency is the wire cutter that can cut wafers thinly. Diamond cutters are most advanced.

Note: Costs are for a multi-GW scale plant scaled to 1 GW; PEG: PolyEthylene Glycol

Polysilicon to Module manufacturing: Major costs/GW

Stage 2: Polysilicon to crystalline silicon ingots

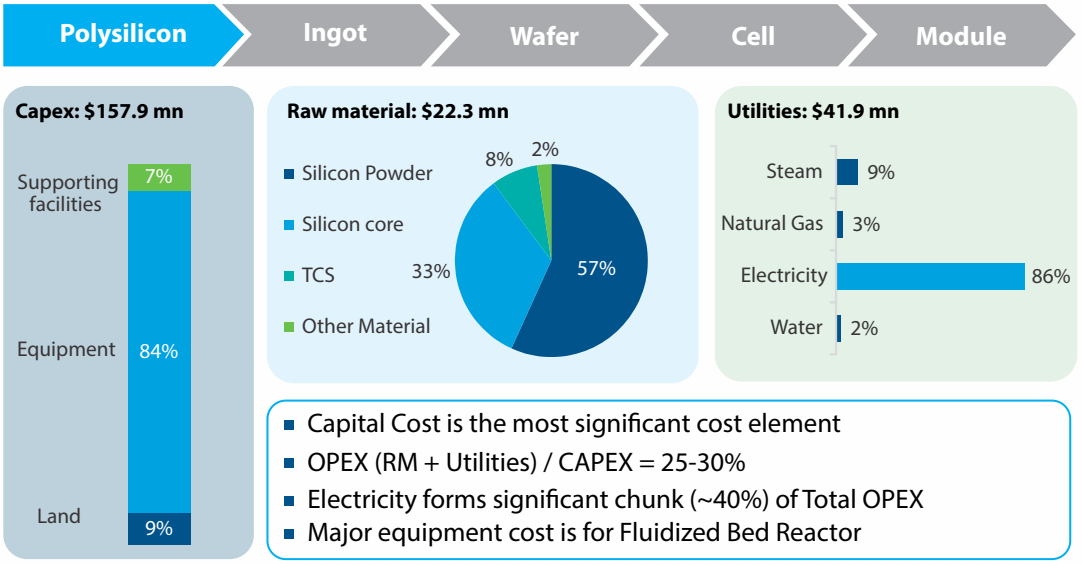


- For Ingot, the biggest RM cost is Polysilicon (crucible)
- Annual RM cost/ CAPEX =125%
- Electricity mainly used for providing homogenous heating

Note: Costs are for a multi-GW scale plant scaled to 1 GW

Polysilicon to Module manufacturing: Major costs/GW

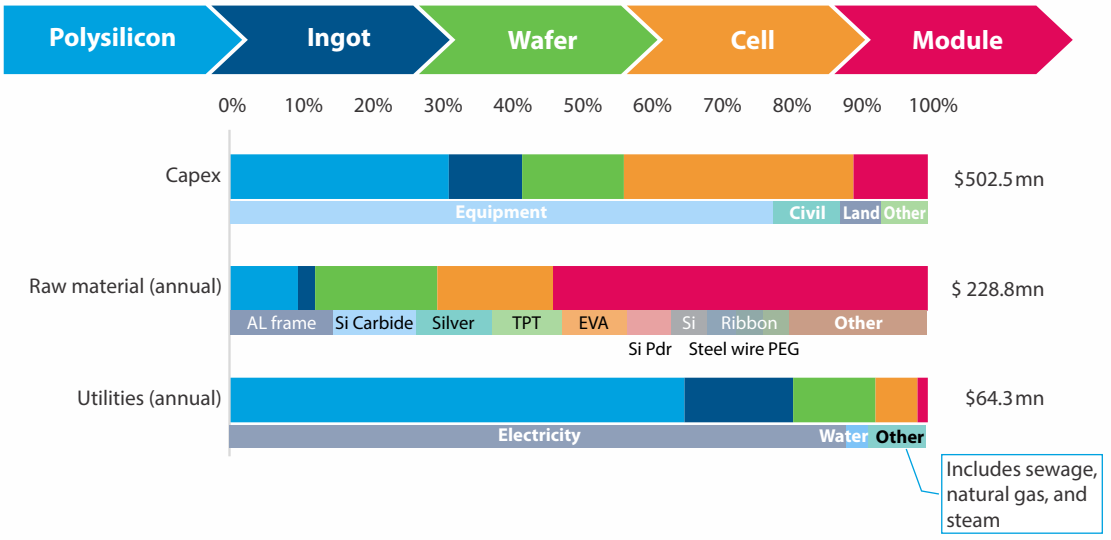
Stage 1: Quartz to Semiconductor grade Polysilicon



- Capital Cost is the most significant cost element
- OPEX (RM + Utilities) / CAPEX = 25-30%
- Electricity forms significant chunk (~40%) of Total OPEX
- Major equipment cost is for Fluidized Bed Reactor

Note: Costs are for a multi-GW scale plant scaled to 1 GW; TCS: TriChloroSelane

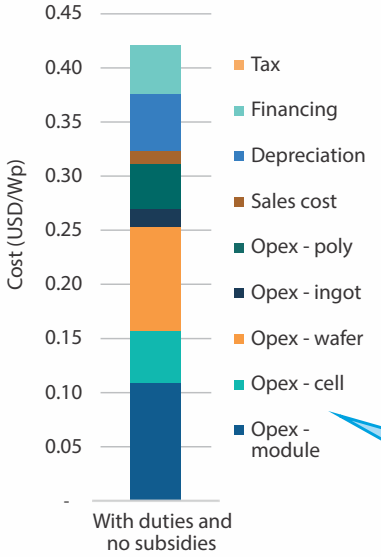
Polysilicon to Module : Major costs are raw material costs, electricity constitute 90% of utility cost (per GW of mfg.)



- For a multi-GW scale fully integrated unit (min. 3 GW) scaled down to 1 GW
- Raw material costs are significant costs compared to capex investment
- Of the utilities cost, electricity is the largest element
- Significant CAPEX required in polysilicon and cell manufacturing

Raw material costs account for a major chunk of the cost of the finished product in a fully integrated 1 GW facility

Estimated module cost from an integrated facility in current scenario – USD 0.423 ¢/Wp



BOM costs constituting a large share of raw materials

Stage	Cost of Raw Materials (annual)	Share of BOM
Polysilicon	$22.3 mn	43%
Ingot	$69.2 mn	8%
Wafer	$74.3 mn	54%
Cell	$238.9 mn	16%
Module	$343.5 mn	36%

- **Major BOM:**
  - Aluminum frame
  - TPT
  - EVA
  - Silver paste
  - Silicon Carbide
  - Steel/ diamond cutting wire
  - PEG
  - Silicon Powder
  - Silicon Core

Taken as Base Case for Sensitivity Analysis

Sensitivity Analysis – description of scenarios

- **A sensitivity analysis was performed to assess the impact of different incentives/subsidies on the cost of integrated solar PV manufacturing. The five (5) scenarios assumed in this analysis have been described below:**

  - **Base Case:** The base case assumes no CAPEX or OPEX subsidies but import duties on capital equipment and applicable raw materials. The cost of electricity has been assumed at a standard industrial rate of INR 7/kWh.

  - **Scenario 1:** Scenario 1 assumes that cheap electricity at INR 3.5 per unit is provided to the manufacturing facility. Electricity is one of the major inputs across the solar value chain and accounts for almost 90% of the cost of utilities.

  - **Scenario 2:** In this scenario, a subvention of 4% on the interest rate is assumed, thereby lowering the interest rate from 12% to 8%.

  - **Scenario 3:** In this scenario, an additional CAPEX support of 25% is assumed to match the maximum incentive offered by M-SIPS.

  - **Scenario 4:** In this scenario, an additional OPEX support of 10% is assumed to match the incentive offered by M-SIPS.

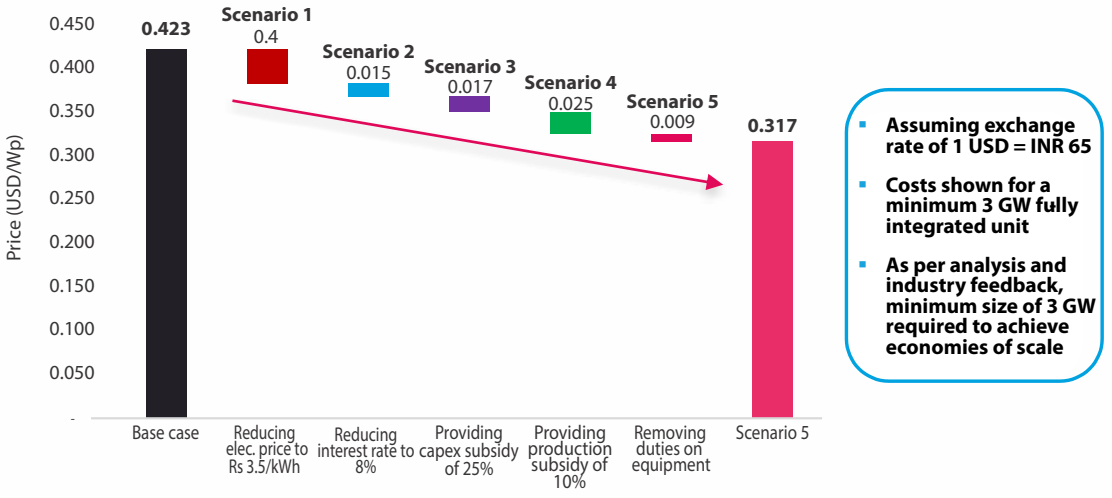
  - **Scenario 5:** In this scenario, all duties on capital equipment are assumed to be waived off, in addition to the benefits of Scenarios 1, 2, 3, and 4.

Summary of scenarios

Scenario	Electricity Cost	OPEX Support	CAPEX Support	Duties on capital equipment	Rate of Interest
Base Case	INR 7/kWh	No	No	25.5%	12%
Scenario 1	**INR 3.5/kWh**	No	No	25.5%	12%
Scenario 2	INR 3.5/kWh	No	No	25.5%	**8%**
Scenario 3	INR 3.5/kWh	No	**@ 25%**	25.5%	8%
Scenario 4	INR 3.5/kWh	**@ 10%**	@ 25%	25.5%	8%
Scenario 5	INR 3.5/kWh	@ 10%	@ 25%	**0%**	8%

- **The results of the sensitivity analysis have been presented in the following slides.**

Sensitivity Analysis: Impact on module costs



- Overall, electricity cost and production subsidy have the greatest impact on the overall cost of manufacturing.
- Removal of duties on capital equipment lowers the cost only by a cent.

Elasticity Analysis – module cost most sensitive to electricity cost and OPEX support

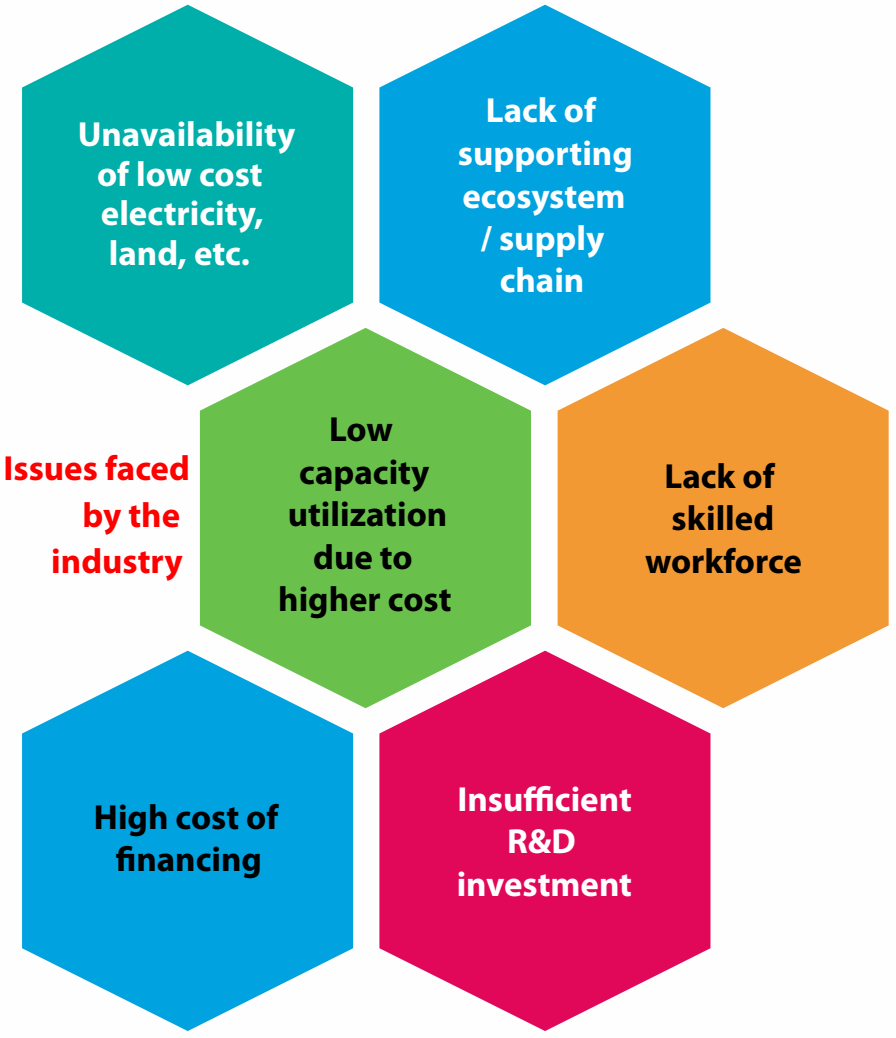
- An elasticity analysis was carried out to study the relative impacts of the three major subsidies/incentives – **electricity cost, CAPEX support**, and **OPEX support** – on the cost of modules. The impact was measured one parameter at a time.
- For example, starting from the base cost of USD 42.3¢/Wp, the CAPEX support was increased from 5% to 30% in steps of 5% while all the other parameters were held constant. For each step, the module cost and the corresponding percent change from the previous value was evaluated.
- **RESULTS**
  - For every 0.5 rupee reduction in electricity cost, the cost drops on average by 1.5%
  - For every 5% reduction in CAPEX (through support), the cost drops on average by 1%
  - For every 5% reduction in OPEX (through support), the cost drops on average by 3%
- **Therefore, cost of integrated manufacturing is most affected by OPEX support and electricity cost.**

Industry response to Survey

Industry response to Survey

- Questionnaire responses received from 12 companies
- Video messages sent by 5 companies
- Two Stakeholder Consultation Workshops organized on 15th March and 24th July at Shangri La Hotel, New Delhi attended by participants from more than 8 companies

Issues – industry response to questionnaire



Summary of Government support requested by industry

Fiscal	• Waiver of import duties on raw materials throughout the chain • Continuation of excise exemptions under GST regime
Financial	• Interest subvention for existing units • Low cost financing for new investments
Infrastructure	• Development of solar mfg. parks with ancillary industries • Low cost electricity and support in quick access to land • Facilitation of approvals through single window clearance
Policy	• Issuance of dedicated solar manufacturing policy • Guaranteed offtake of locally produced cells/ modules • Incentives for procuring better performing modules
Others	• Anti-dumping duty on imported cells & modules • Stricter QA/QC checks of imported products

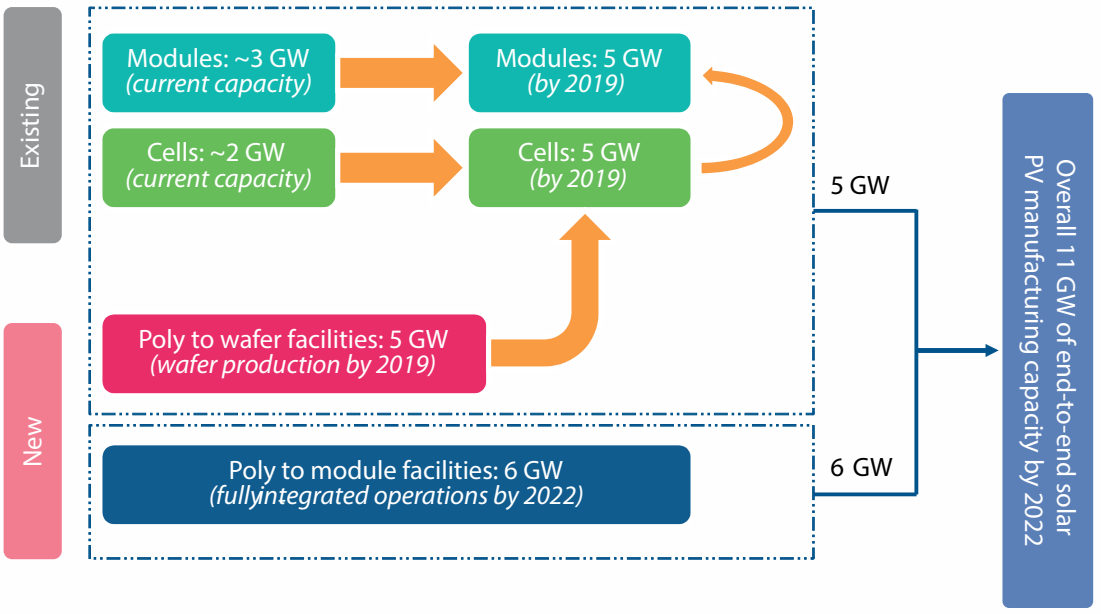
Recommendations to promote solar PV manufacturing in India

Recommendations on support required for PV manufacturing

- **Why is support needed?**
  - With 15-17 GW annual installation, INR 35,000 crore annual market exists for modules, cells & wafers
  - Under business as usual, this entire market will go to Chinese modules (impacting trade balance)
  - Domestic manufacturing can boost Indian economy significantly
    - Every 3 GW integrated polysilicon to module manufacturing facility creates > 5,500 jobs
- **Current M-SIPS scheme was conceptualized to promote manufacturing of all electronics**
  - **Recommended – A Central Solar Mfg. Policy and incentive package beyond M-SIPS**
  - Policy name - **SURYA : Solar Utpaadan & Rozgaar YojanA**
  - Policy duration – **5 years**; total outlay – **from INR 9,042 to INR 22,380 crores for 5 years (depending on the level of support provided)**
  - **SURYA** to support:
    - Ramping up of existing **cell and module capacities to 5 GW each** with upgrade to PERC technology
    - Setting up of **two fully-integrated** (poly to module) facilities of **3 GW each**
    - Setting up of **two poly to wafer** facilities of **2.5 GW each**

Overall 11 GW of end-to-end solar PV domestic mfg. capacity by 2022

SURYA to support phased development of solar PV manufacturing value chain (1)



SURYA to support phased development of solar PV manufacturing value chain (2)

- **Existing cell capacity to 5 GW with technology enhancement:** Promote capacity addition of select existing manufacturers selected on the basis of qualifying criteria and support technology enhancement to PERC technology
  - Currently, only 300 MW out of the existing 2.4 GW cell mfg. capacity in India is capable of manufacturing cells of PERC technology
  - Technology upgrade cost estimated to be about INR 187.5 crores per GW
- **Existing module capacity to 5 GW:** Promote capacity addition of select existing manufacturers selected on the basis of qualifying criteria
- **Fully-integrated poly to module facilities (total – 6 GW):** Support development of two (2) polysilicon to module integrated mfg. facilities of capacity at least 3 GW each (target segment: large-scale industries)
  - Facilities to initially manufacture cells and modules with further upstream development to polysilicon
- **Integrated poly to wafer facilities (total – 5 GW):** Support development of two (2) polysilicon to wafer facilities of capacity at least 2.5 GW each (target segment: large-scale industries)
  - Facilities to support existing cell capacities

Proposed implementation plan for SURYA

	Calender Year									
	2018		2019		2020		2021		202	
Activities	**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
Filing of applications (3 months)										
Review of applications (3 months)										
Financial closure of awarded projects (6 months)										
Selected module facilities - Capacity addition of 2 GW										
Selectetd cell facilities - Capacity addition of 3 GW - Technology enhancement to PERC bifacial technology										
2 poly to module facilities (3 GW each)										
Module operations										
Cell operations										
Wafer operations										
Ingot operations										
Polysilicon operations										
2 poly to wafer facilities (2.5 GW each)										
Wafer operations										
Ingot operations										
Polysilicon operations										

Annual aggregate capacity under SURYA – complete end-to-end solar manufacturing capacity by 2022

All figures in GW

Component	2017 (current)	2018	2019	2020	2021	2022
Module	3	3	11	11	11	11
Cell	2	2	5	11	11	11
Wafer	-	-	-	11	11	11
Ingot	-	-	-	-	11	11
Polysilicon	-	-	-	-	-	11

- In 2019, existing cell and module capacities are enhanced to 5 GW each and module operations of two fully-integrated facilities (poly to module) are commissioned resulting in a total module capacity of 11 GW.
- In 2020, wafer operations of the two fully-integrated facilities and the two poly to wafer facilities are commissioned resulting in wafer and cell capacities of 11 GW each.
- In 2021, ingot operations of the two integrated facilities come online. By 2022, the polysilicon operations of the two fully-integrated facilities as well as the two poly to wafer units are commissioned.

Interim import requirements - select value chain elements will need to be imported during certain periods

- **Cells, wafer, ingots, poly, and other raw materials**
  - Current import duty post notification 50/2017 of MoF – 0%
  - Only tempered glass attracting a basic import duty of 5%*
  - 5% CVD assumed to be applicable on top of BCD
- **Capital equipment**
  - Almost entire equipment is being imported
  - 7.5% import duty plus 18% IGST
  - Outlay on account of exemption of all duties on equipment and impact of exemption on module cost has been calculated in Option 4 (Page 54)

Interim import requirements (in GW)

	2018	2019	2020	2021	2022
Cell	1	6	-	-	-
Wafer	2	5	-	-	-
Ingot	-	-	11	-	-
Poly	-	-	-	11	-

- In 2018, wafer imports are required to support existing cell capacity of 2 GW. Since module capacity is 3 GW, an additional 1 GW of cells would be required to be imported.
- In 2019, domestic module capacity reaches 11 GW whereas cell capacity is only 5 GW. Therefore, 6 GW of cells would need to be imported. Similarly, 5 GW of wafer imports would be required to support cell manufacturing.
- In 2020, 11 GW of cell capacities come online which would need ingots.
- In 2021, polysilicon imports would be required to support the aggregate 11 GW of ingot capacities.

*Anti-dumping duty has been imposed on tempered glass as per notification 38/2017 of Ministry of Finance. However, the same has not been considered in our analysis.

Outlay under SURYA (1)

- **Option 1 – provision of cheap electricity (INR 7/kWh INR 3.5/kWh) and interest rate subvention of 4% (12% 8%)**

All figures in INR Crores

Cheap electricity support	2018	2019	2020	2021	2022	TOTAL
Existing facilities	30	68	68	68	68	**302**
Fully-integrated facilities	-	17	214	392	1,060	**1,683**
Poly→wafer facilities	-	-	110	258	815	**1,184**
Sub-total						***3,169***

- **Further, lump sum outlay on account of interest rate subvention to:**
  - 6 GW of fully-integrated facilities = INR 3,456 Crores
  - 5 GW of poly to wafer facilities = INR 1,950 Crores
  - 2 GW of standalone module facilities = INR 158 Crores
  - 3 GW of standalone cell facilities = INR 309 Crores
  - Sub-total = INR 5,873 Crores
- **Total outlay under Option 1 = INR 9,042 Crores**
  - Lion's share goes to integrated facilities

Type of facility	Total outlay (INR Crores)
Existing cell + module	769
Fully - integrated facilities	5,139
Poly to wafer facilities	3,134
TOTAL	**9,042**

Outlay under SURYA (2)

- **Option 2 – only CAPEX (@25%) and OPEX (@10%) subsidies**

All figures in INR Crores

Support	2018	2019	2020	2021	2022	TOTAL
CAPEX Support						
Existing facilities	-	979	-	-	-	979
Fully - integrated facilities	-	521	2,325	514	1,540	4,899
Poly →wafer facilities	-	-	595	428	1,283	2,306
Sub-total						***8,185***
OPEX Support						
Existing facilities	316	789	-	-	-	1,105
Fully-integrated facilities	-	-	967	1,141	1,143	3,251
Poly→wafer facilities	-	-	266	411	413	1,091
Sub-total						***5,447***
TOTAL						**13,631**

- OPEX support is discontinued to downstream units once upstream capacities come online to avoid dual disbursement of benefits. For example, year 2020 onwards, OPEX subsidies to existing cell and module manufacturers are discontinued as 5 GW of wafer mfg. facilities are commissioned.

Outlay under SURYA (3)

- **Option 3 – combination of Option 1 and Option 2**
  - In this option, annual OPEX is reduced as cheap electricity is available to the facilities. Therefore, while the outlay on account of electricity, interest subvention, and CAPEX support remains the same, OPEX support is reduced as shown in the table below.

All figures in INR Crores

OPEX Support	2018	2019	2020	2021	2022	TOTAL
Existing facilities	313	784	-	-	-	1,097
Fully-integrated facilities	-	-	945	1,102	1,037	3,085
Poly to wafer facilities	-	-	255	386	332	972
Sub-total						***5,154***

- **Total outlay under Option 3 = INR 3,169 crores (cheap electricity) + INR 5,873 crores (interest subvention) + INR 8,185 crores (CAPEX) + INR 5,154 crores (OPEX) = INR 22,380 crores.**

Outlay under SURYA (4)

- **Option 4 – removal of all duties on capital equipment + benefits under Option 3**
  - Removal of duties on capital equipment reduces the CAPEX and thus, the outlay on CAPEX support. The revised CAPEX support numbers are presented in the table below.

All figures in INR Crores

CAPEX Support	2018	2019	2020	2021	2022	TOTAL
Existing facilities	-	814	-	-	-	814
Fully integrated facilities	-	452	1,925	440	1,254	4,070
Poly to wafer facilities	-	-	499	366	1,045	1,910
Sub-total						***6,794***

  - Total outlay under Option 4 = INR 3,169 crores + INR 5,873 crores + INR 6,794 crores + INR 5,154 crores = INR 20,990 Crores
  - The amount of duty forgone is presented below:

All figures in INR Crores

Duty forgone	2018	2019	2020	2021	2022	TOTAL
Existing facilities	-	685	-	-	-	685
Fully integrated facilities	-	288	1,637	297	1,139	3,360
Poly to wafer facilities	-	-	382	247	949	1,578
Sub-total						***5,623***

Rationale for subsidies and incentives

A. **Cheaper utilities:** Utility consumption (primarily electricity) is highest and a significant portion of the OPEX for upstream elements of the solar PV value chain (polysilicon, ingot, and wafer). It is our understanding that leading Chinese manufacturers are being provided cheap electricity by the government.

B. **CAPEX support:** polysilicon and cell manufacturing requires significant capital investment ($170-190 million); support of 25% taken to match incentive offered by M-SIPS.

C. **OPEX support:** OPEX as % of CAPEX is very high for wafer, module, and cell manufacturing; support can be provided as a percentage or at a fixed rate/ MW; support taken as 10% of annual OPEX (raw materials +utilities) to match incentive offered by M-SIPS.

D. **Duty relief:** Duties account for 25% of the CAPEX. Therefore, duty relief may be granted on **key high value capital equipment.**

Key features proposed for SURYA

A. Promote development of large integrated manufacturing facilities

1. Allow full flexibility to large-scale players in setting up fully-integrated facilities; location should not be a constraint; to be determined based on whichever state offers best incentives including in SEZs
2. Facilitate provision of cheap electricity to these facilities by granting open access + allowing stranded super-criticial coal plants to supply electricity via bidding route
3. SURYA to encourage upward mobility along the value chain

B. Options for incentives under Central Package

1. Interest rate subvention of up to 4% to reduce financing costs
2. Capital support – proposed at 25%
3. OPEX support – proposed at 10% of annual OPEX (raw materials + utilities + labor)
4. Waiver of duties may be allowed on high value capital goods

C. Options for incentives under State Incentive Package

1. Cheap electricity (~INR 3.5/kWh)
2. Government owned land at concessional rates to manufacturing facilities

Suggested criteria for selection of existing units for enhancement and for selection of new projects

Existing module facilities	Existing cell facilities	Proposed integrated facilities
1. **Current capacity** a. If < 1 GW, go to 1 GW 2. **Performance**– whether facility produces modules with all standard certifications 3. **Net worth** of the company or its parent 4. **Adaptable equipment**– whether current equipment can be adapted to PERC technology 5. **Availability of land and electricity** 6. **Expansion plans**-whether already planning to invest	1. **Current capacity** a. If < 500 MW, go to 1 GW 2. **Performance**– cell efficiency to be at least 18%; based on feedback from vendors 3. **Net worth** of the company or its parent 4. **Adaptable equipment**– whether current equipment can be adapted to PERC technology 5. **Availability of land and electricity** 6. **Expansion plans**- whether already planning to invest	1. **Selection of technology**– technology proposed should be state-of-the-art 2. **Technical strength**– proposal should include setting up of R&D facility; availability of manpower 3. **Financial capacity** 4. **Capability to obtain financial closure**– creditworthiness with FIs 5. **Related background**

Conclusion (1)

- **The key drivers of cost of solar PV manufacturing have been identified as:**
  - Electricity cost – electricity consumption is very high for upstream elements of the solar value chain, especially polysilicon (350 MUs per GW)
  - OPEX – OPEX as % of CAPEX is very high for wafer, module, and cell manufacturing
  - CAPEX – polysilicon and cell manufacturing each requires capital investment to the tune of $170-190 million (INR ~1,200 crores) per GW
- **Therefore, it is essential to drive down these costs to lower the overall cost of solar PV manufacturing in India. Different scenarios were considered to analyze the relative impact of these drivers on the cost of manufacturing. Starting from base cost of USD 42.3cents /Wp for a module produced by a multi-GW integrated facility (scaled down to 1 GW) in current policy scenario, the impacts are summarized in the table below.**

Incentive	Reduction in cost of manufacturing
Electricity price reduction (from 7 to 3.5 per kWh)	4 US cents
Interest rate subvention of 4%	1.5 US cents
CAPEX support of 25%	1.7 US cents
OPEX support of 10%	2.5 US cents
Waiver of duties on capital goods	0.9 US cents

- Final cost if all incentives are provided =31.7 cents/Wp

Conclusion (2)

- **The responsivity of the cost to these drivers was also evaluated through an elasticity analysis. It was found that:**
  - For every 0.5 rupee reduction in electricity price, the cost drops on an average by 1.5%
  - For every 5% reduction in CAPEX (through support), the cost drops on an average by 1%
  - For every 5% reduction in OPEX (through support), the cost drops on an average by 3%
- Therefore, the cost of solar PV manufacturing is primarily driven by and sensitive to cost of electricity and OPEX.
- We understand that MNRE has proposed to introduce a scheme designed to support the installation of 7.5 GW solar capacity using locally produced components. The creation of a captive market is expected to significantly boost existing domestic capacity.
- Further, we understand that the anti-dumping duty investigation initiated against Chinese, Taiwanese and Malaysian solar cells is likely to provide an anchor point for the extent up to which GoI wants to support and promote domestic manufacturing.

Conclusion (3)

- Therefore, in light of the analysis carried out and the mentioned developments, we suggest that **support to only the integrated facilities** (two (2) poly to module and two (2) poly to wafer) may be considered.
- The outlays under the different options specified earlier but limited only to integrated facilities are summarized in the table below.

*base cost of USD 42.3¢/Wp

Option	Nature of support	Outlay (INR Crores)	Reduction from base cost* (US cents/Wp)	Expected cost of integrated manufacturing (US cents/Wp)
Option 1	Electricity price reduction (from 7 to 3.5 per kWh) + interest rate subvention of 4%	8,273	5.5	36.8
Option 2	CAPEX support of 25% + OPEX support of 10%	11,547	4.3	38.0
Option 3	Option 1+ Option 2	19,535	9.7	32.5
Option 4	Option 3 + waiver of duties on capital equipment	18,310	10.6	31.7

- **It may be noted that:**
  - The outlay on account of cheap electricity support can be significantly reduced by allowing stranded coal plants to supply electricity to the integrated facilities via bidding route.
  - **The amount of duty forgone under Option 4 (INR 5,623 crores) will be a source of revenue for the government in the other three options, thereby further reducing the net outlay.**

Indian Chamber of Commerce

About Indian Chamber of Commerce

Founded in 1925, **Indian Chamber of Commerce (ICC)** is the leading and only National Chamber of Commerce operating from Kolkata, and one of the most pro-active and forward-looking Chambers in the country today. Its membership spans some of the most prominent and major industrial groups in India. ICC is also the founder member of FICCI, the apex body of business and industry in India. ICC's forte is its ability to anticipate the needs of the future, respond to challenges, and prepare the stakeholders in the economy to benefit from these changes and opportunities. Set up by a group of pioneering industrialists led by Mr G D Birla, the Indian Chamber of Commerce was closely associated with the Indian Freedom Movement, as the first organized voice of indigenous Indian Industry. Several of the distinguished industry leaders in India, such as Mr B M Birla, Sir Ardeshir Dalal, Sir Badridas Goenka, Mr S P Jain, Lala Karam Chand Thapar, Mr Russi Mody, Mr Ashok Jain, Mr. Sanjiv Goenka, Mr Roopen Roy, Mr Shiv Siddhant Kaul, Mr Aditya V Agarwal have led the ICC as its President. **Currently, Mr. Shashwat Goenka, Sector Head, Spencer's Retails Limited is leading the Chamber as its President.**

ICC is the only Chamber from India to win the **first prize** in **World Chambers Competition** in **Quebec, Canada.**

ICC's North-East Initiative has gained a new momentum and dynamism over the last few years, and the Chamber has been hugely successful in spreading awareness about the great economic potential of the North-East at national and international levels. Trade & Investment shows on North-East in countries like Singapore, Thailand and Vietnam have created new vistas of economic co-operation between the North-East of India and South-East Asia. ICC has a special focus upon India's trade & commerce relations with South & South-East Asian nations, in sync with India's 'Look East' Policy, and has played a key role in building synergies between India and her Asian neighbors' like Singapore, Indonesia, Bangladesh, and Bhutan through Trade & Business Delegation Exchanges, and large Investment Summits.

ICC also has a very strong focus upon Economic Research & Policy issues - it regularly undertakes Macro-economic Surveys/Studies, prepares State Investment Climate Reports and Sector Reports, provides necessary Policy Inputs & Budget Recommendations to Governments at State & Central levels.

The **Indian Chamber of Commerce headquartered in Kolkata**, over the last few years has truly emerged as a national Chamber of repute, with full-fledged offices in **New Delhi, Mumbai, Guwahati, Bhubaneshwar, Patna and Ranchi** functioning efficiently, and building meaningful synergies among Industry and Government by addressing strategic issues of regional and national significance.

About ICF

ICF (NASDAQ:ICFI) is a global consulting and technology services provider with more than 5,000 professionals focused on making big things possible for our clients. We are business analysts, policy specialists, technologists, researchers, digital strategists, social scientists and creatives. Since 1969, government and commercial clients have worked with ICF to overcome their toughest challenges on issues that matter profoundly to their success. Come engage with us at icf.com.

ICF is one of the world's leading consulting firms in areas of climate change, carbon finance, carbon markets, and international development. Year-after-year, ICF has been recognized as a leading carbon market advisory firm. For the sixth straight year, ICF has been honored by companies participating in the Environmental Finance and Carbon Finance survey for its outstanding work in carbon strategy and greenhouse gas mitigation. ICF is one of the world's leading climate adaptation consultancies, having received the top awards from the Climate Change Business Journal for climate risk management in the past few years. CCBJ has also noted that ICF is the largest climate adaptation consultancy.

Indian Chamber of Commerce

SHAKTI
SUSTAINABLE ENERGY
FOUNDATION

ICF

Contact us

ICF Consulting India Private Limited

3rd Floor, Ashoka Estate,
24, Barakhamba Road,
New Delhi – 110001

Tel.: +91-11-4354 3000
Website: www.icf.com

Nitin Zamre, Managing Director
Nitin.Zamre@icf.com

Gurpreet Chugh, Consulting Director
Gurpreet.Chugh@icf.com

Indian Chamber of Commerce

4, India Exchange Place,
Kolkata – 700001

Tel.: +91-33-22303242/44
Website: www.indianchamber.org

Dr. Rajeev Singh, Director General
sg@indianchamber.net

Suparna Chatterjee, Deputy Director
suparna.chatterjee@indianchamber.net

Indian Chamber of Commerce

Indian Chamber of Commerce

4, India Exchange Place, Kolkata-700001

91.33.22303242-44 | www.indianchamber.org