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Scaling Up Solar Manufacturing to Enhance India's Energy Security

Report | August 2020

Rishabh Jain, Arjun Dutt, and Kanika Chawla

Domestic solar module manufacturers import most of the components required for manufacturing, including solar cells.

Image: Vikram Solar ltd

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Organisation: The **Council on Energy, Environment and Water** (ceew.in) is one of Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain and change the use, reuse, and misuse of resources. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions and engages with the wider public. In 2020, CEEW has once again been featured across nine categories in the *2019 Global Go To Think Tank Index Report*. It has also been consistently ranked among the world's top climate change think tanks. Follow us on Twitter @CEEWIndia for the latest updates.

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CEEW Centre for Energy Finance

The CEEW Centre for Energy Finance (CEEW-CEF) is an initiative of the Council on Energy, Environment and Water (CEEW), one of Asia's leading think tanks.

CEEW-CEF acts as a non-partisan market observer and driver that monitors, develops, tests, and deploys financial solutions to advance the energy transition. It aims to help deepen markets, increase transparency, and attract capital in clean energy sectors in emerging economies. It achieves this by comprehensively tracking, interpreting, and responding to developments in the energy markets while also bridging gaps between governments, industry, and financiers.

The need for enabling an efficient and timely energy transition is growing in emerging economies. In response, CEEW-CEF focuses on developing fit-for-purpose market-responsive financial products. A robust energy transition requires deep markets, which need continuous monitoring, support, and course correction. By designing financial solutions and providing near-real-time analysis of current and emerging clean energy markets, CEEW-CEF builds confidence and coherence among key actors, reduces information asymmetry, and bridges the financial gap.

Financing the energy transition in emerging economies

The clean energy transition is gaining momentum across the world with cumulative renewable energy installation crossing 1000 GW in 2018. Several emerging markets see renewable energy markets of significant scale. However, these markets are young and prone to challenges that could inhibit or reverse the recent advances. Emerging economies lack well-functioning markets. That makes investment in clean technologies risky and prevents capital from flowing from where it is in surplus to regions where it is most needed. CEEW-CEF addresses the urgent need for increasing the flow and affordability of private capital into clean energy markets in emerging economies.

CEEW-CEF's focus: analysis and solutions

CEEW-CEF has a twin focus on markets and solutions. CEEW-CEF's market analysis covers energy transition–related sectors on both the supply side (solar, wind, energy storage) and demand-side (electric vehicles, distributed renewable energy applications). It creates open-source data sets, salient and timely analysis, and market trend studies.

CEEW-CEF's solution-focused work will enable the flow of new and more affordable capital into clean energy sectors. These solutions will be designed to address specific market risks that block capital flows. These will include designing, implementation support, and evaluation of policy instruments, insurance products, and incubation funds.

CEEW-CEF was launched in July 2019 in the presence of H.E. Mr Dharmendra Pradhan and H.E. Dr Fatih Birol at Energy Horizons.

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Rishabh, a public policy practitioner, has a keen interest in renewable energy. He leads the Market Intelligence vertical at the CEEW Centre for Energy Finance and works closely with key decision-makers in the Indian RE sector. Before joining The Council, he has worked with Vikram Solar, Energo Labs, and Oxford Policy Management. Rishabh completed his master's in public policy from Lee Kuan Yew School of Public Policy, National University of Singapore, and bachelor's in mechanical engineering from Birla Institute of Technology, Mesra, India.

"Cost should no longer be the centrepiece of new installations and our approach needs to be multi-dimensional, which takes into account the country's growth, creation of new jobs, and energy security. This report recommends both short- and long-term interventions to meet domestic needs and become export competitive."

Arjun Dutt

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Arjun Dutt is an Associate at CEEW-CEF. His work is geared towards enhancing the flow of affordable finance towards clean energy in emerging economies. This includes analysing the risks constraining the flow of capital towards clean energy and developing suitable interventions to de-risk investments. Prior to his association with CEEW, Arjun worked for over three years in equity research. He has a bachelor's in electronics and communication engineering from the Delhi College of Engineering and an MBA from the Management Development Institute, Gurgaon.

"Policymaking to support the scaling up of domestic PV manufacturing must strike a fine balance between predictability and dynamism. Predictability is needed in terms of demand-side drivers and measures of policy support. At the same time, policymaking should be nimble enough to respond to emerging developments in the dynamic clean energy space."

Kanika Chawla

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Kanika is a policy specialist working at the intersection of clean energy and financial markets. She is the Director of the CEEW Centre on Energy Finance and also manages The Council's research and outreach in renewable energy policy, regulation, markets, and socio-economic value. She is actively engaged with private and public enterprises within and outside India in designing and developing financial de-risking instruments.

"To truly develop a thriving solar manufacturing sector, India needs a strategic green industrial policy that allows maximum domestic value capture from the ongoing energy transition. A good policy needs to based on evidence, set clear targets, display long-term vision, and reward innovation."

In addition to solar cells and modules, tariff barriers are currently levied on EVA and solar glass too.

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Image: Vikram Solar ltd

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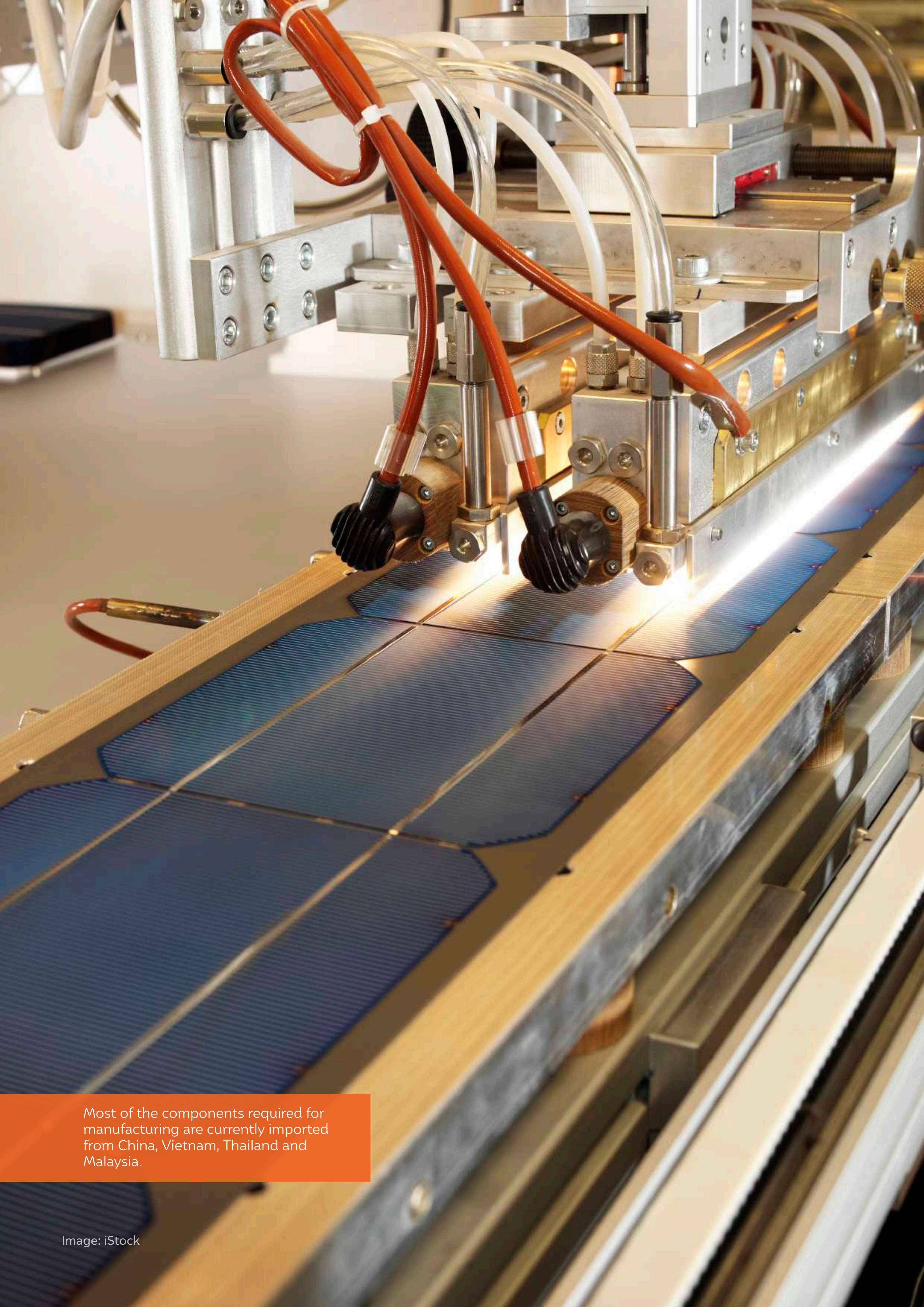
Acronyms

ADD	anti-dumping duty
BCD	basic customs duty
BEL	Bharat Electronics Limited
BHEL	Bharat Heavy Electricals Limited
BOM	bill of materials
CEEW	Council on Energy, Environment and Water
CEEW-CEF	Centre for Energy Finance at the Council on Energy, Environment and Water
CPSU	Central Public Sector Undertaking
CUF	capacity utilisation factor
DCR	domestic content requirement
DGAD	Directorate General for Anti-Dumping and Allied Duties
DGS	Directorate General of Safeguards
DGTR	Directorate General of Trade Remedies
DTA	domestic tariff area
EVA	ethyl vinyl acetate
FiT	feed-in tariff
GBI	Generation Based Incentive
GW	gigawatt
HJT	heterojunction technology
IISc	Indian Institute of Science
IIT	Indian Institute of Technology
INR	Indian Rupees
IREDA	Indian Renewable Energy Development Agency
ISA	International Solar Alliance
M-SIPS	Modified Special Incentive Package Scheme
MeitY	Ministry of Electronics and Information Technology
MNRE	Ministry of New and Renewable Energy
MoC&I	Ministry of Commerce and Industry
MoF	Ministry of Finance
MSME	micro, small, and medium enterprises
MW	megawatt
PERC	passivated emitter and rear cell
PPA	power purchase agreement
PSUs	public sector undertakings
PV	photovoltaic
PVDF	polyvinylidene fluoride
RE	renewable energy
SECI	Solar Energy Corporation of India
SEZ	special economic zone
SGD	safeguard duty
SIPS	Special Incentive Package Scheme
TPT	Tedlar polyester Tedlar
VGF	viability gap funding
Wp	watt peak
WTO	World Trade Organization



Most of the components required for manufacturing are currently imported from China, Vietnam, Thailand and Malaysia.

Image: iStock

Executive summary

India has made rapid advances in the energy transition in recent years, propelled by large-scale additions to solar and wind energy capacity. But the domestic manufacture of solar photovoltaic (PV) cells and modules has not kept pace with this leap in capacity. Still, China accounts for the majority of India's solar PV imports. Certain measures, such as a two-year safeguard duty (SGD) imposed in July 2018 (now extended till July 2021) or the recent award of large manufacturing-linked tenders by the Solar Energy Corporation of India (SECI), to support the domestic manufacturing sector have not yielded much, as the sector is very small to pose any serious competitive challenge.

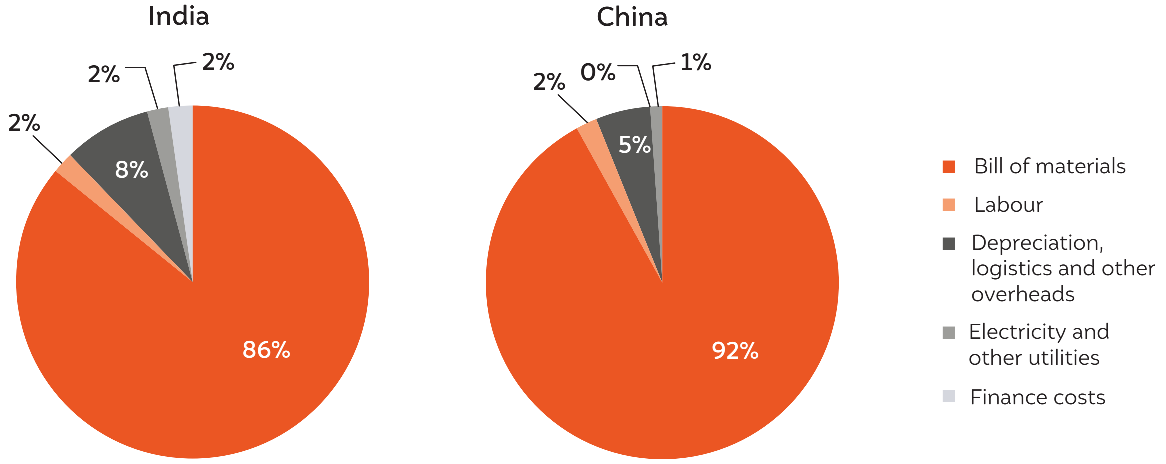
Domestic manufacturing is being pursued with renewed vigour for two reasons. First, Prime Minister Modi gave a clarion call for self-reliance (*Atma Nirbhar Bharat Abhiyaan*) to drive the economic recovery from COVID-19. Second, the tense events at the India–China border have suddenly infused uncertainties into a highly import-dependent sector. The need for enhancing the country's energy security and the ambitious renewable energy targets set for 2022 and 2030 ensure a continuous domestic demand pipeline. Even then, domestic manufacturers are not in a position to gain from this phenomenal opportunity. What ails them and what can be done? To understand the scenario, we empirically assess the competitive advantage that China has over India in solar cell to solar module manufacturing. We then present a suite of interventions that need to be implemented in a comprehensive and balanced manner to yield both short-term relief to the sector, while also making the sector competitive in the long term.

Indian domestic module manufacturing suffers from twin problems of higher pricing and underutilisation of capacity. Indian modules are nearly 33 per cent more expensive than their Chinese counterparts, assuming 50 per cent and 100 per cent capacity utilisation for Indian and Chinese manufacturers, respectively. Capacity utilisation at present in India hovers around 50 per cent as per data gathered from the manufacturers. Indian manufacturers stand to benefit merely by pushing up productivity to full capacity: the resulting cost savings would lower the price differential with China to 22 per cent, thus giving a competitive push.

Figure ES1 provides a snapshot of the components of module selling prices in India and China. The share of bill of materials (BOM) for Indian manufacturers is 86 per cent whereas, other direct costs (labour), overheads (electricity, other utilities, land, logistics, depreciation) and finance costs account for only around 14 per cent of the selling price. The smaller contribution of other costs to unit prices in China is a result of higher scale and superior terms of financing.

An in-depth analysis of selling price of modules using a component-wise contribution paints a different picture. BOM cost accounts for 56 per cent of the difference in selling prices (INR 3.32/watt peak (Wp)) between Indian and Chinese modules assuming same utilisation levels. Direct, overhead, and finance costs contribute another 36 per cent to the difference. The larger scale of manufacturing of Chinese module manufacturers lowers their unit labour and overhead costs. Chinese manufacturers enjoy favourable financing options, which makes an eight per cent contribution to the difference in selling prices.

Figure ES1 **The difference in the contribution of bill of materials to module selling prices is the highest between India and China**



*Source: CEEW-CEF analysis**
** based on a primary survey conducted with key manufacturers in May 2020. Respondent details in Annexure II*

Our proposed recommendations to enhance India's competitiveness in solar manufacturing touch upon policy responses, a long-term vision, infrastructure development, financial subsidy, and non-financial concessions. Policy or fiscal interventions should aim at (i) an immediate price levelling and (ii) providing systemic solutions to build the competitiveness of the domestic manufacturing sector in the medium run. Several interventions necessitate a balanced implementation to lend support to the sector in a progressive, market-making manner. Our recommendations are divided into three components: (i) short-term interventions to support existing manufacturers survive the current crisis; (ii) interventions for enhancing competitiveness and growth of the sector in the medium to long term; and (iii) the short-term interventions to avoid such that the domestic manufacturing sector does not turn into a white elephant.

Short-term response measures

Our recommendations of short-term measures by the government focus on removing ambiguities in policy and structuring of duties and concessions that boost the domestic manufacturing of solar equipment and components.

Policy uncertainty increases risk perception and delays much needed investments in manufacturing. The government has recently extended the SGD duty but it must provide visibility on the implementation timelines and tenure of the proposed basic customs duty (BCD). See Table ES1 for proposed recommendations.

Table ES1 Recommended BCD structure on solar cells and modules

Timelines	BCD on cells	BCD on modules
Till March 2021	Nil	10%
April 2021 to March 2022	Nil	20%
April 2022 to March 2023	10%	20%
April 2023 to March 2027	20%	20%
April 2027 to March 2030	10%	10%
Beyond April 2030	Nil	Nil

Source: CEEW-CEF analysis

Note: The maximum rate of 20 per cent is in line with that announced in the annual budget. Ministry of Finance may revise the numbers in consultation with the Ministry of Renewable Energy (MNRE)

It is expected that a 20 per cent BCD may lead to an increased tariff of INR 0.20 to 0.25 per unit of electricity. Introducing a tariff barrier alone would not guarantee domestic procurement in the short term. Our analysis suggests that non-hardware cost differential between an Indian and a Chinese manufacturer could vary between INR 1.45/watt and INR 3.20/watt.[1] These include the costs of labour, depreciation, finance, utilities, land, and other overhead expenses. Further, domestic module manufacturers are still dependent on imported cells. If fears of foreign cell manufacturers resorting to artificial increase in prices become a reality, Indian module manufacturers would be burdened further. So we recommend a short-term production subsidy for manufacture of modules using domestic cells to reduce the cost differential between domestic and imported modules (Table ES2).

Table ES2 Recommended design of production subsidy for solar modules

Parameter	Recommendations
Timelines September 2020 to March 2021	**Modules based on domestic cells—INR 2.5/watt Modules based on imported cells—INR 1.5/watt**
Maximum support per manufacturer	250 MW (domestic or imported cells)
Minimum threshold efficiency	19%
Project eligibility	Only utility-scale projects with tariffs discovered via reverse bidding with commissioning dates before March 2021.
Who applies for the subsidy	Module manufacturers to apply for subsidy on behalf of the buyer

Source: CEEW-CEF analysis

We recommend an additional subsidy of INR 1/watt for modules manufactured using domestic cells only for a short term—till March 2021. Under this scheme, by restricting the eligibility of the subsidy to 2.5 to 3 GW modules, the central government is likely to incur a financial burden of nearly INR 600 crore.

We also call for the introduction of domestic procurement programmes such as the *Central Public Sector Undertaking Scheme* (*CPSU*) to mandate the usage of domestic components. In the current CPSU scheme, any government producer can bid and seek a maximum viability gap funding (VGF) of INR 70/watt (MNRE

1 Higher capacity utilisation levels can directly improve the competitiveness of Indian module manufacturers. Further, economies of scale can boost the competitiveness of both domestic BOM components as well as modules. We see that at 100 per cent capacity utilisation, the differential between Chinese- and Indian-manufactured modules is INR 1.45/watt whereas at 50 per cent capacity utilisation the differential is INR 3.20/watt.

2020a). Under this scheme, the sale of power from one government entity to another has been capped at INR 2.8/unit. Manufacturers have in the past suggested that a 0.6 per cent increase in efficiency can reduce the final module costs by up to 3 to 4 per cent. Reducing the tariff to INR 2.5 and allocating projects with a capacity of 2.5 GW to high-efficiency modules would ensure that India can become a global leader in solar module technology. Intense research and development (R&D) efforts should be undertaken to reduce the cost of modules and cells, leading to reduced requirement for VGF (Table ES3).

Table ES3 Linking VGF with technological improvements

Deployment year (2.5 GW/year)	Module efficiency
2021–22	20%
2022–23	21%
2023–24	22%
2024–25	23%

Source: CEEW-CEF analysis

Note: The above numbers are indicative, and the eligibility may differ based on module technologies such as multi/mono crystalline and thin film modules

To stimulate investments in solar manufacturing, the government needs to extend the support in form of policies and concessions to ensure that investors (foreign and domestic) develop an interest in the sector. The Ministry of New and Renewable Energy (MNRE) should set a national target of achieving at least 50 GW of manufacturing capacity by 2030.[2] Yearly addition of 5–10 GW of solar module and cell manufacturing will ensure that new capacity is able to offset the impact of dysfunctional factories.

Currently, exemption from customs duty on importing manufacturing equipment is provided to manufacturers (CBIC 2017) and the MNRE is working towards extending the same benefit for wafer, ingot, and polysilicon manufacturing (MNRE 2020b). The government's policy should be directed towards reducing India's over-reliance on imported manufacturing equipment. One way to incentivise domestic wafer manufacturers or independent technological providers to develop, commercialise, and produce manufacturing equipment indigenously is to award them with cash prizes on achieving specific targets—sales, cost, or innovation (patent filing). The prizes need to be reviewed every year to ensure global competitiveness.

In the Union Budget 2020, the government finally split the HS code used to record the import of solar cells and modules in India. Until now, the HS code 8541 4011 was used for both cells and modules. Now an additional code 8541 4012 has been created, which will record data only for modules whereas the former code will be used for cells. In addition to creating this division, the ministry also needs to record data in capacity terms and not just their monetary value. Currently, there is no way to accurately estimate imports based on government records. To ensure targeted policy design, data in INR and kW units need to be gathered. This will increase both transparency and accountability in the sector.

Systemic market-making interventions

Systemic market-driven interventions are required which are aimed at creating a domestic infrastructure for solar equipment manufacture. There needs to be a thrust on micro, small, and medium enterprises (MSME) for sourcing materials, and indigenous R&D efforts for developing novel technologies in the solar sector.

Removing our reliance on imported raw materials would give impetus to energy security of the country. One option is to look for materials that can be sourced within the country. Quartz is abundantly available in India and, needless to say, the government must incentivise companies that come forward to manufacture solar modules using quartz. BCD may be implemented on solar wafers from 2027 to 2030 (in line with BCD on solar cells and modules). These upstream PV manufacturing stages are capital- and energy-intensive and the government should explore avenues to accelerate their scaling up.

Indian manufacturers rely also on imports for sourcing components. Currently, not just cells but other non-cell BOM components like glass, ribbon, ethylene vinyl acetate (EVA) sheet, and others, which constitute 30 to 35 per cent of the total module cost, are imported as well. Micro, small, and medium enterprises (MSMEs) are producing these components in India, but their quality and price are not competitive. Possible ways to procure BOM components from Indian MSMEs by addressing their shortcomings will go a long way in boosting the MSME sector, create additional jobs, and bring down reliance on China.

A solar power plant does not have many moving parts, thus rendering manufacturing of key equipment, such

2 It has been estimated that the annual global PV installations may increase to 270 GW in 2030 from the current levels of 100 GW/year (IRENA 2019). Also, the global production of solar modules was in the range of 130–140 GW in 2019 (Fraunhofer ISE 2020). If India is able to ramp up its capacity, it will not only be able to service the domestic market but export to other countries too.

as solar modules, inverters, and module mounting structure, easy and scalable. Indian solar manufacturers import most of the components and raw materials used in the manufacture of key equipment. We therefore recommend setting up of 10 GW solar manufacturing parks near the ports in the states of Maharashtra, West Bengal, Andhra Pradesh, and Tamil Nadu to boost domestic manufacture of solar plant equipment. The government also, in parallel, should ensure availability of suitable infrastructure in these locations. To provide further boost, tax holiday and duty waiver could be offered to these manufacturers. The states should be entrusted with the responsibility of bringing in the skilled workforce to build self-reliance.

European countries have succeeded in not only identifying new technologies like organic solar modules at the lab scale through consistent R&D effort, but also in deploying them. India's prestigious technology institutions such as the Indian Institute of Technology (IIT) Bombay, IIT Delhi, IIT Madras, and the Indian Institute of Science (IISc) Bangalore could be roped in, through specific financial grants, by the government to develop novel solar technologies and also commercialise them to make India self-reliant.

Interventions to avoid

We also feel it is imperative to have a broad vision and a long-term perspective for the solar manufacturing sector in India. Interventions providing short-term benefits may be either unsustainable in the medium to long run or do little to build competitive advantage for the sector. A long-term commitment to developing local manufacturing should be pledged by the government through support mechanisms. Manufacturers must be encouraged and rewarded for investing in R&D and technology improvements. The vision of domestic solar manufacturing eventually maturing to serve a global market should be pursued rather than just developing a captive protected domestic market. To realise this vision, all support interventions must be accompanied by clearly defined sunset clauses.

Policymakers and financiers cannot be expected to be aware of the rapid scale of global technological advancements. We thus call upon the Indian Renewable Energy Development Agency (IREDA) to take a lead role in providing technical expertise to the government, banks, and lending institutions on solar manufacturing to avoid the government favouring obsolete technologies.

With favourable policies, RE manufacturers, like RE developers, will also be able to raise low-cost capital to scale up their facilities in the medium run. Hence, the government's endeavour should be aimed at developing a vibrant solar manufacturing ecosystem to encourage innovative entrepreneurs to pursue solar manufacturing. Merely offering project finance is not likely to fetch long-term dividends. Providing visibility of a demand pipeline and support mechanisms that use limited pools of public money more effectively may have a better impact on solar manufacturing sector rather than costly project financing with public funds.

Finally, lessons from several sectors suggest that the government must focus on interventions that can be provided in a time-bound manner. Further, overlapping mandates of different ministries like the MNRE, Ministry of Commerce and Industries (MoC&I), Ministry of Finance (MoF), and Ministry of Electronics and Information Technology (MeitY) should be ironed out and a mechanism developed to coalesce their efforts to lend efficiency and create impact.

The government should not view support for the solar manufacturing sector as an isolated policy decision. For creating lasting impact, various concerns need to be addressed, different ministries should work in tandem, and these efforts should be balanced by nimble individual interventions from time to time. We provide evidence for an imbalanced playing field for manufacturers at present and propose a toolbox of policy levers that the government must deploy to create a globally competitive solar manufacturing sector in India by 2030.

1. Introduction

Indian solar manufacturers have not been able to exploit India's ambitious energy transition, as they have not kept pace with the global advancements in technology. The weak link in the grand scale of RE plans is the country's high dependence on imports for solar modules and the raw materials required for its manufacturing. Globally, individual companies have capacities that are greater than the total sum of India's manufacturing capacity (10 GW solar module and 3 GW solar cell) (MNRE 2020c). The COVID-19 pandemic sweeping the world at present and recent geo-political developments have raised concerns about the country's energy security. But unfortunately, there is no silver bullet that can solve this problem. We provide a brief context, investigate the reasons for the higher cost of Indian solar solar modules, and recommend some key interventions that will be required to scale up domestic manufacturing of crystalline solar photovoltaic (PV) modules in the country.

2. Did we learn from the past?

A critical observation of two key features of India's energy transition shows that focus is more on clean energy deployment than on energy security. Indian RE strategy is driven by optimising for tariff decline of renewable power and ad-hoc policy support for solar manufacturing. Many countries rely on a feed-in-tariff (FiT) regime to scale up RE projects (until recently, even China and the United States have opted for FiT regimes). Instead, India resorted to reverse bidding right from the early stages of the *National Solar Mission*. This aggressive tariff decline became the most significant marker of India's renewable energy scale-up, consequently detrimental to domestic industry. Competitive unit economics drove developers to prefer low-cost imports over relatively expensive domestic products. Domestic cell and module manufacturers, already on the backfoot, neither have the scale, time, nor financial resources to catch up to global competition.[3]

Inconsistent policy support for domestic manufacturing of PV cells and modules put domestic manufacturers at a further disadvantage. From designing the domestic content requirement (DCR) in 2011 to promising basic customs duty (BCD) in 2020, the Indian government promised much to domestic manufacturers but ended up delivering little. In the early stages of the National Solar Mission, the government implemented the DCR policy giving preference to domestically produced polycrystalline PV modules and provided financial support to such projects. However, exemption of thin film modules distorted the market. This exemption led to increased deployment of thin film modules in solar projects due to their price advantage, and the ratio of thin film to polycrystalline deployment in India was inverted compared to the global average. The policy was contested by the United States and did not stand the scrutiny of global trade rules in the courts of the World Trade Organization (WTO), and India had to withdraw the scheme (WTO 2016). In anticipation of increased orders under the DCR policy, many manufacturers had set up factories and applied for capex support under the *Special Incentive Package Scheme* (*SIPS*) and *Modified Special Incentive Package Scheme* (*M-SIPS*).[4] The delay in the disbursal of 20 to 25 per cent capex support under these two schemes widened the gap with respect to imported products. Few manufacturers even approached the Directorate General for Anti-Dumping and Allied Duties (DGAD) and the Directorate General of Safeguards (DGS) to impose tariff barriers on imported products. In 2014, while the then DGAD recommended the implementation of anti-dumping duty, the Ministry of Finance rejected the proposal and instead promised greater off-take for domestically produced modules under the *CPSU* scheme. The promise was unkept for years, and manufacturers this time approached the DGS again to impose a safeguard duty.

In 2018, the Ministry of Finance imposed a safeguard duty (SGD) at short notice, creating some avoidable upheaval and confusion (on applicability) in the sector. The duty was imposed for two years, too short a time frame to have any impact on supporting domestic

> **The safeguard duty was imposed for two years, too short a time frame to have any impact on supporting domestic manufacturing.**

3 The Indian wind sector enjoyed support in form of FiT and generation-based incentive (GBI) for a long time (15 years) until the sector moved to reverse bidding in 2017. FiT and GBI, coupled with accelerated depreciation, not only increased project deployment but supported domestic manufacturing industry, which in turn relied on thousands of micro, small and medium enterprises (MSMEs) to supply key components and spare parts. Currently turbines deployed in India have very high degree of indigenisation (70–90 per cent).

4 The Ministry of Electronics and Information Technology (MeitY) through the *Special Incentive Package Scheme (SIPS) and Modified Special Incentive Package Scheme (M-SIPS)* promised both capex support and production subsidy to solar module, cell, and wafer manufacturers in special economic zones (SEZ) and domestic tariff area (DTA). However, even with in-principle approvals, many manufactures have been anticipating disbursal for many years.

manufacturing. Investors too felt two years was too short a window to set up a new manufacturing facility. Meanwhile, the project developers continued with imports, hoping compensation under the *change in law* clause of the contract would cover the changed terms. This eventually proved to be counter-productive for manufacturers since imported products became cheaper when compared to domestically manufactured products. The SGD did not seem to matter any longer. For new bids, manufacturers preferred import modules as the SGD would expire sooner, or its 15 or 20 per cent range still made imported modules more competitive than domestically manufactured modules. Recently on 29th July 2020, the government extended the safeguard duty on solar cells and modules by one year. A 14.9 per cent duty would be applicable on imports from 30th July 2020 to 29th January 2021 and a 14.5 per cent duty would be applicable on imports from 30th January 2021 to 29th July 2021. The order is applicable on imports from all developed countries, China, Vietnam and Thailand (MoF 2020). Unlike the 2018, safeguard duty order, Malaysisa has been exempt which opens the door for increased imports from the country. In February 2020, the government announced its intent to impose BCD on solar cells and modules, which added to the existing activity in the sector.

To ensure reliability of solar PV cells and modules, the MNRE had also issued an order in 2019 to enlist solar PV models and manufacturers to be used in all projects that are bid out as per the central government standard bidding guidelines and are either government-owned or government-assisted. However, this order has also been extended to September 2020 from the earlier implementation date of 1 April 2020 due to the prevailing COVID-19 pandemic (MNRE 2020). This move by MNRE was also indirectly aimed at avoiding the inflow of low-quality imported products into India. It is also important to note here that in December 2017, the MNRE shared a draft policy document to scale up domestic manufacturing, with a target to set up 10 GW of manufacturing over five years. The domestic manufacturers are still hopeful this policy would change their fortunes.

This sets the context for a further discussion because incoherent planning and messaging have put domestic solar module and cell manufacturers at a greater disadvantage and clamped their competitiveness. To ensure the successful implementation of any policy, the government needs to gain the trust of key stakeholders and provide them a commitment of support—regulatory and financial—which will ensure survival of those who are the intended beneficiaries in the short term and increase their competitiveness in the long run.

> To ensure the successful implementation of any policy, the government needs to gain the trust of key stakeholders.

3. Key drivers to enhance the competitiveness of domestic PV module manufacturing (from solar cells)

There are four key steps in the manufacture of solar modules—quartz to polysilicon; polysilicon to wafer; wafer to cell, and finally cell to solar module. As mentioned earlier, India currently has a manufacturing capacity of 10 GW of solar modules (from solar cells) and 3 GW of solar cells (from wafers). In May 2020, we reached out to domestic module manufacturers with annual manufacturing capacity ranging from 100 MW to 2,000 MW. A detailed questionnaire, with the intent to analyse the breakup of manufacturing cost in India, was shared with them. In addition, based on their experience, the manufacturers were asked to share similar details for China. Using the inputs from the manufacturers, a detailed analysis was conducted. **However, we note that the comparative analysis that is provided below is limited to manufacturing of solar modules from solar cells.**

A number of underlying determinants are used to arrive at the selling prices of solar PV modules—including costs and returns to debt and equity investors. The values of these determinants vary across markets, which manifest as differences in selling prices. When comparing the prices of the solar modules produced in India and those imported from China, the country's largest source of solar module imports, the variations in various determinant values is significant. Segmenting the module price into its determinants would aid in ascertaining why Indian modules are at a competitive disadvantage. This, in turn, facilitates an assessment of the impact of targeted measures geared towards improving the competitiveness of domestic module manufacturing.

Methodology

The unit selling price of a module (in INR/Wp) covers all direct and indirect costs involved in the process of production as well as investor returns. Aggregating these determinants applicable to unit module capacity makes up the unit selling price. Direct costs such as raw materials and the variable components of labour and electricity costs can be directly allocated to unit module capacity. In addition, overheads such as other utilities, land lease expenses, and logistics costs were estimated for the entire plant and then allocated to unit module capacity based on an assumed capacity utilisation factor (CUF). Returns for debt and equity investors were also estimated at the plant level and allocated to unit module capacity considering an assumed capacity utilisation level.

Data on these cost drivers for both Indian and Chinese modules was sourced from domestic module manufacturers (names of the manufacturers are provided in Annexure II). The following analysis is based on the mid-points of data inputs provided by these manufacturers for both Indian and Chinese module manufacturing.

Key assumptions

- Production capacity (mono passivated emitted and rear cell (PERC) modules, assumed average size of facilities):
  - Indian module manufacturing plant capacity: 500 MW
  - Chinese module manufacturing plant capacity: 2,000 MW
- Plant's capital expenditure (solar cell to solar module):
  - Indian manufacturing (INR crore/MW): 0.3
  - Chinese manufacturing (INR crore/MW): 0.2
- Plant's useful life:
  - Indian manufacturing: 5 years
  - Chinese manufacturing: 5 years
- Capacity utilisation:
  - Indian manufacturing: 50%[5]
  - Chinese manufacturing: 100%
- Return on equity (pre-tax):
  - Indian manufacturing: 18%
  - Chinese manufacturing: 10%

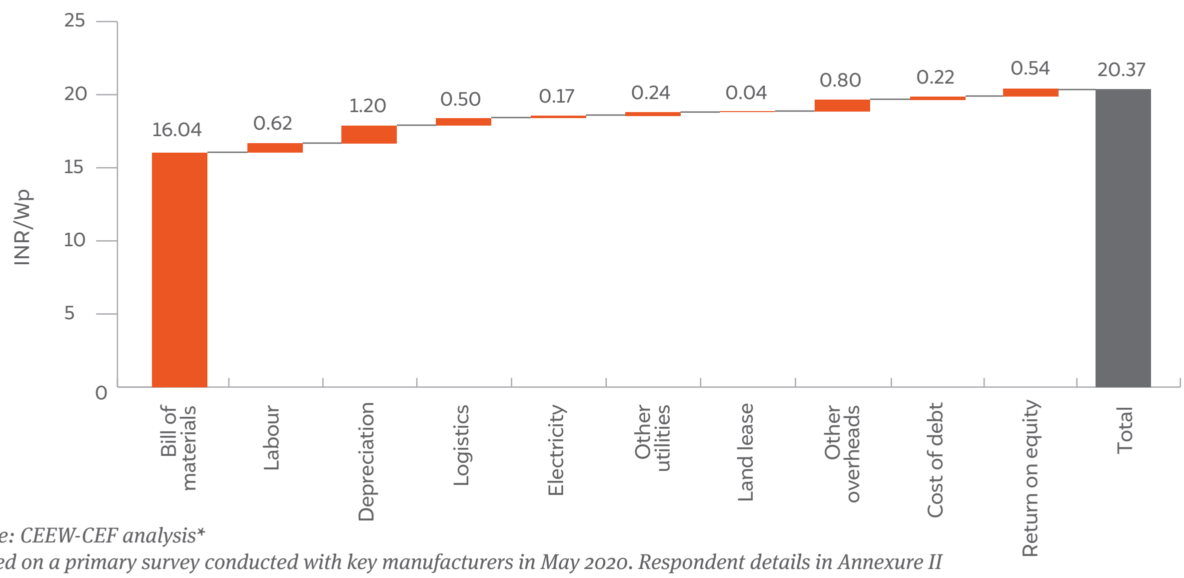
Results

To understand the magnitude of difference in prices, Figures 1 and 2 present a breakdown of Indian and Chinese module prices into their constituents. Based on our analysis, Indian modules are nearly 33 per cent more expensive than their Chinese counterparts.

In our analysis, we have respectively assumed 50 per cent and 100 per cent capacity utilisation for Indian and Chinese manufacturers. We stress that full utilisation of capacity can significantly impact the final cost and increase competitiveness of the domestic players.

In order to understand the fundamental differences in the competitiveness of Indian and Chinese module manufacturers, we need to first control for the distortionary effect of differences in capacity utilisation. If Indian module manufacturers were to operate at 100 per cent utilisation levels, the difference in prices would narrow to INR 3.32/kWh or around 22 per cent. The analysis presented below assumes both Indian and Chinese module manufacturers operating at full capacity utilisation levels.

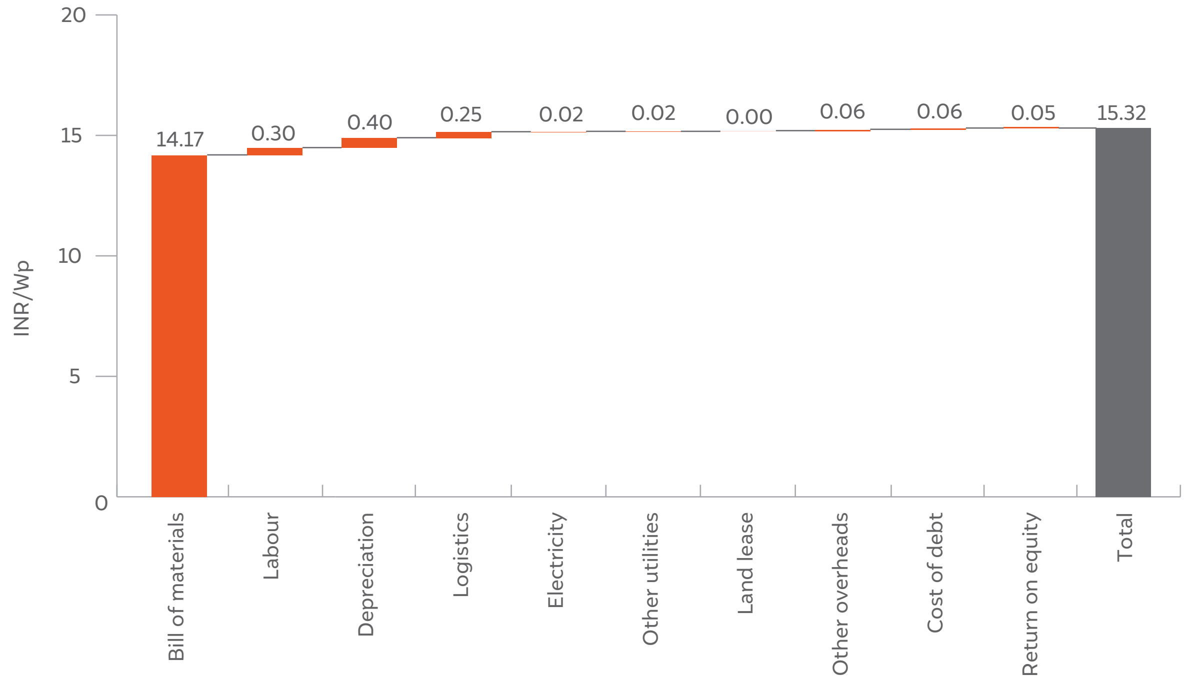
Figure 1 **Bill of materials constitute the lion's share of Indian module selling price (capacity utilisation: 50%)**



*Source: CEEW-CEF analysis**
** based on a primary survey conducted with key manufacturers in May 2020. Respondent details in Annexure II*

5 Assumed average based on our consultations with the industry.

Figure 2 **Electricity, land lease, other overheads, cost of debt, and return on equity contribute insignificantly to Chinese module selling price (capacity utlisation:100%)**



*Source: CEEW-CEF analysis**

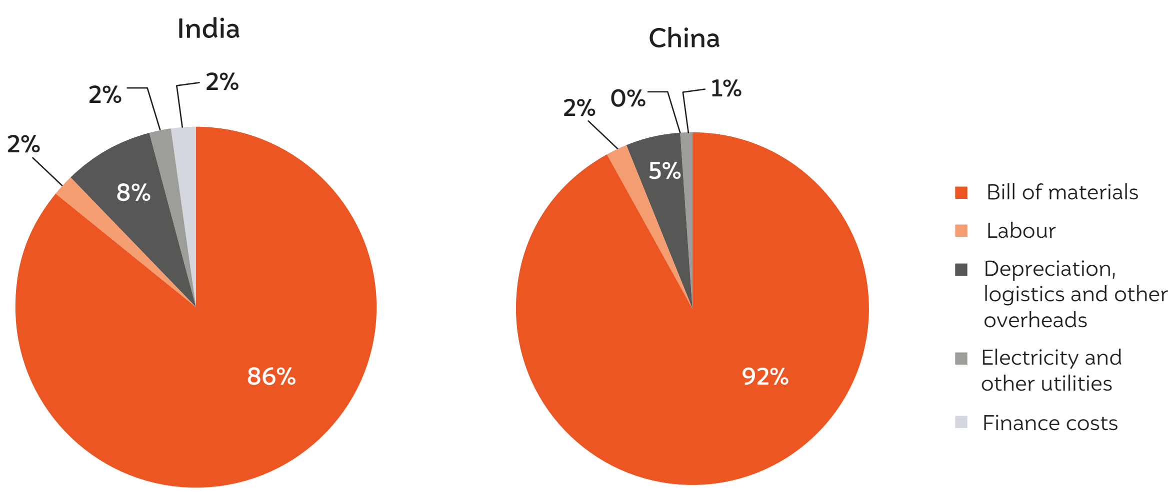
Major determinants of Indian module selling prices

- The bill of materials (BOM) (disaggregated further in Figures 4 and 5) accounts for nearly 86 per cent of the selling price in India (Figure 3). Other direct costs (labour), overheads (electricity, other utilities, land, logistics, depreciation), and finance costs account for around 14 per cent of the selling price. Similarly, BOM cost determines 92 per cent of module selling price in China, while other costs total up to 8 per cent of the unit prices. This is attributed to higher scale and superior terms of financing in China.

Reasons for differences in module prices

- Around 56 per cent of the difference in selling prices (INR 3.32/Wp) between Indian and Chinese modules at the same utilisation levels arises from differences in the BOM costs (Figures 2).

Figure 3 **The difference in the contribution of bill of materials to module selling prices is the highest between India and China**

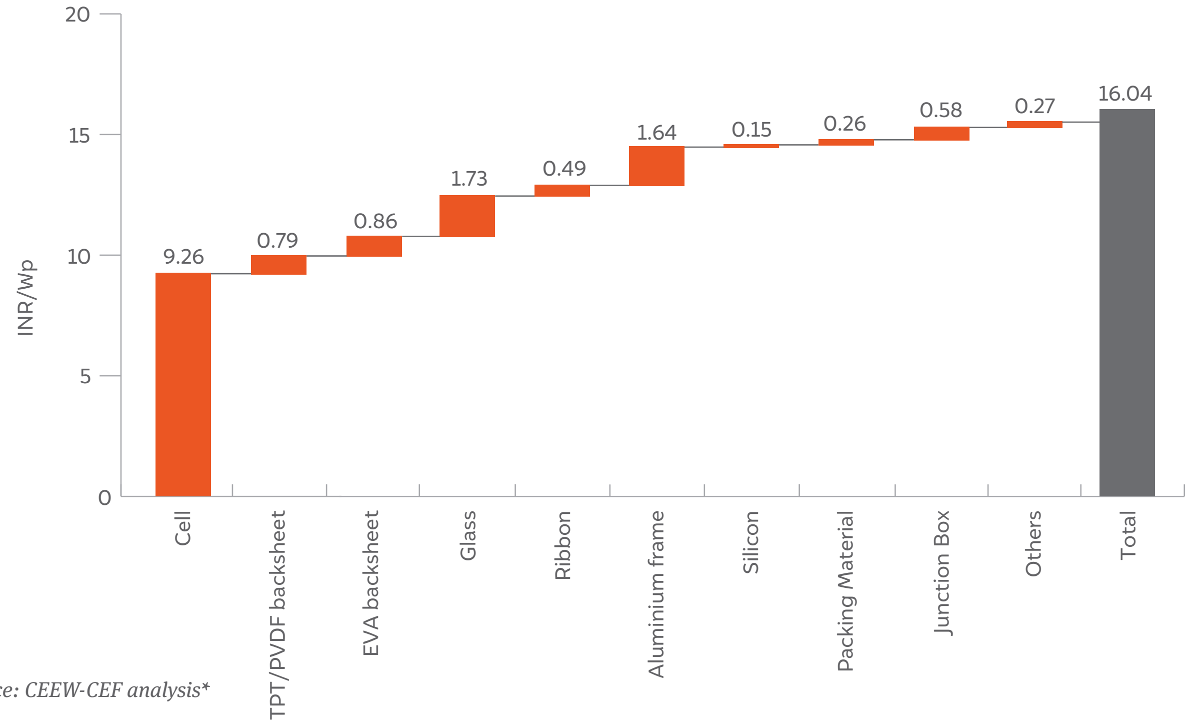


*Source: CEEW-CEF analysis**
** based on a primary survey conducted with key manufacturers in May 2020. Respondent details in Annexure II*

- The remainder of the difference may be explained by differences in other direct, overhead and finance costs. The larger scale of manufacturing of Chinese module manufacturers translates into lower unit labour and overhead costs and accounts for another 36 per cent of the difference in selling prices. Further, lower financing costs for Chinese manufacturers explain another 8 per cent of the difference in selling prices.

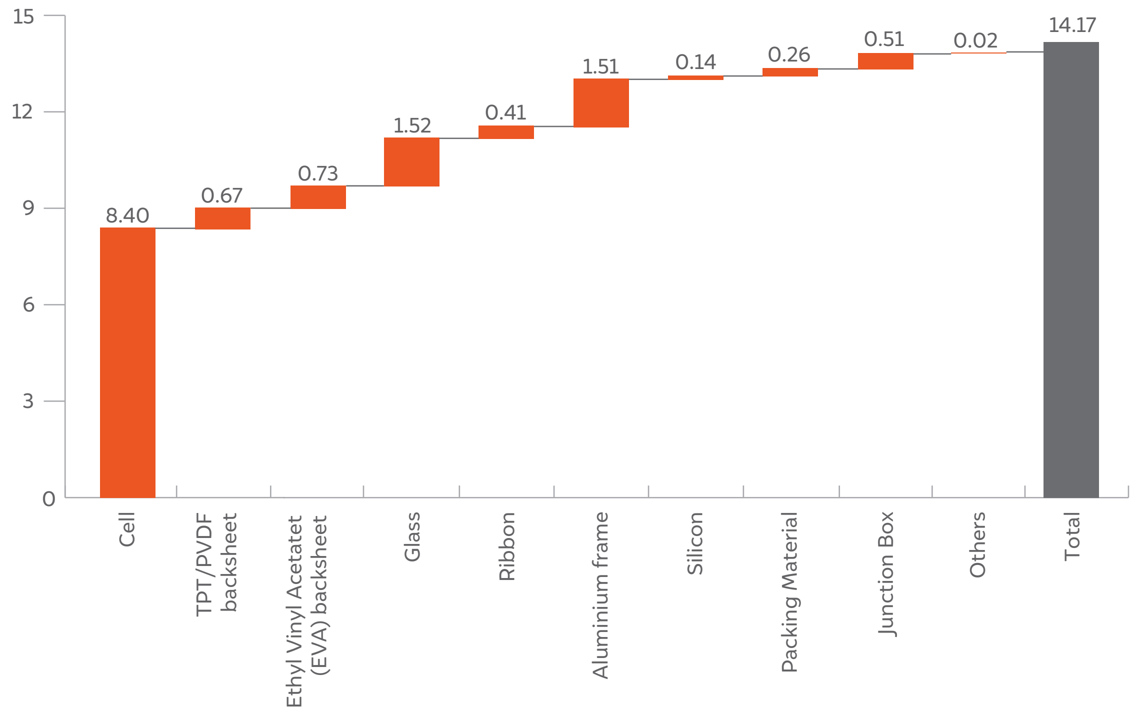
Since the BOM is the key differentiator, Figures 4 and 5 present a comparison between BOM costs for Indian and Chinese manufacturers.

Figure 4 Cell contributes heavily to bill of materials cost of Indian manufacturers



*Source: CEEW-CEF analysis**

Figure 5 Chinese module manufacturers procure non-cell BOM at cheaper rates too

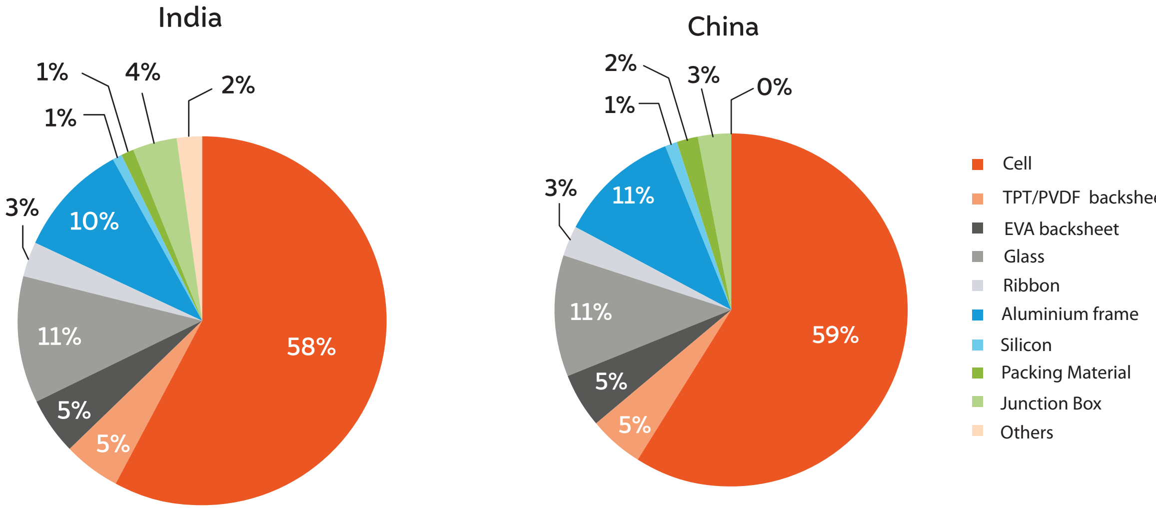


*Source: CEEW-CEF analysis**

** based on a primary survey conducted with key manufacturers in May 2020. Respondent details in Annexure II*

Major determinants of Indian BOM costs

Figure 6 All components contribute almost equally to bill of materials cost in India and China



*Source: CEEW-CEF analysis**
** based on a primary survey conducted with key manufacturers in May 2020. Respondent details in Annexure II*

As is evident from Figure 6, there contribution of components to BOM cost is almost the same in India and China for solar module manufacture. Cells account for around 58 per cent (China, 59 per cent) of Indian BOM costs (Figure 6). The Tedlar polyester Tedlar (TPT)/ polyvinylidene fluoride (PVDF) backsheet, ethyl vinyl acetate (EVA) backsheet, glass, and aluminium frame add up to another 31 per cent of the BOM cost (similar in China).

Differences in BOM costs

- From Figures 5 and 6, nearly 46 per cent of the difference (INR 1.87/Wp) in BOM costs stems from more expensive cells sourced by Indian manufacturers. Differences in TPT/PVDF backsheets, EVA backsheets, glass, and aluminium frame costs account for another 32 per cent of the difference in costs.
- Indian manufacturers rely on imports for most of these raw materials:
  - Solar cells—China, Vietnam, and Thailand
  - TPT/PVDF sheets—Vietnam
  - EVA backsheets—Malaysia (though there is considerable domestic procurement too)
  - Glass—Malaysia
  - Ribbons, aluminium frames, junction boxes—China
- The imposition of duties for some materials (SGD for cells, anti-dumping duty (ADD) on EVA backsheet and glass) further raises the cost. In addition, Indian importers have raised concerns of articifial increase in export prices by foreign suppliers (primarily China).[6]
- The ADD on EVA backsheet and glass is not applicable to module manufacturers in the special economic zone (SEZ). This creates another layer of challenge for manufacturing facilities in domestic tariff area (DTA).

4. Recommendations

India has set a target of solar installed capacity of 100 GW by 2022, which means projects with a capacity of 65 GW have to be installed in the next 30 months. In pursuit of this target, we recommend the key steps that the government needs to undertake to scale up domestic solar manufacturing in India. The recommendations are divided into three components: (i) interventions in the short term, which will avoid the shutdown of factories and help many operational manufacturers to survive the current crisis; (ii) steps to be taken that will have a long-term impact on the sector; and (iii) the pitfall of short-sightedness. A summary matrix of the interventions have also been provided in Annexure I. We classify the recommendations into fiscal and non-fiscal measures. While imposition of duty would bring significant revenue to the government, some measures would require a few ministries to forego revenue. However, the financial implication of the recommended interventions would be limited, and the collection from SGD duty over the past two years (approximately INR 5,000 crore) may be used to cover for these interventions.

6 Based on our consultations with the industry.

Interventions required in the immediate to short term

(a) Clarity on applicability and timelines of tariff barrier

CEEW-CEF recommends the Ministry of Finance (MoF) to implement this intervention

Policy uncertainty increases risk perception and delays much needed investments in manufacturing. The Ministry of Finance has already extended SGD by one year (till July 2021) and now the government needs to provide clear information on the implementation timelines and tenure of the proposed basic customs duty (BCD). This will not only help manufacturers set up factories but also help developers plan their procurement better. The duty must be levied after accounting for construction time and the life of the manufacturing unit (around 10 years). We suggest levying a tapered and a differential BCD on solar cells and modules (Table 1). A higher duty on modules and lower duty on cells would ensure that our module facilities can increase their capacity utilisation factor (CUF) and become competitive with imports. Similarly, a tapered duty on cells has been proposed taking into account the time required for commissioning of new cell manufacturing facilities.

Table 1 Recommended BCD structure on solar cells and modules

Timelines	BCD on cells	BCD on modules
Till March 2021	Nil	10%
April 2021 to March 2022	Nil	20%
April 2022 to March 2023	10%	20%
April 2023 to March 2027	20%	20%
April 2027 to March 2030	10%	10%
Beyond April 2030	Nil	Nil

Source: CEEW-CEF analysis

Note: The maximum rate of 20 per cent is in line with that announced in the annual budget. Ministry of Finance may revise the numbers in consultation with MNRE

At the current levels of tariff and module prices, it is expected that the with 10 and 20 per cent increase in module prices, the tariff may increase by 5 and 10 per cent, respectively. So a 20 per cent BCD may lead to an increased tariff of INR 0.20 to 0.25 per unit of electricity.

However, any decrease (artificial or real) in module prices may compensate for this increase. This trend was witnessed in the last two years when the decline in module prices was steeper than the imposed SGD (meant to deter imports). It should also be noted that project developers will be eligible for reimbursement under the change in law clause for projects that have been bid out before the imposition of the duty. Hence, a clear mechanism needs to be designed so that developers are not burdened with extra cost of procurement. A time-bound reimbursement or exemption for exiting projects should also be planned.

It is, however, important that certain revisions in regulatory provisions are undertaken before the implementation of BCD. Firstly, the Ministry of Finance must devise a mechanism to ensure that manufacturing units in SEZ and DTA are at par for any tariff barriers like basic customs and safeguard duty. Implementing BCD without any changes in customs rules and regulations will be counter productive for domestic solar module manufacturers located in SEZ since BCD will be applicable on the value of the product moved from SEZ to DTA. It needs to be ensured that the duty is not levied on the domestic value add component. Secondly, it should also be noted that solar cells and modules is currently exempted under the Information Technology Agreement-1 (ITA-1). Any move by India to unilaterally impose duties can lead to litigation against India in the WTO. In the past, we have seen Japan and the European Union (EU) initiate dispute proceedings when India imposed customs duty on products exempted under ITA-1 (WTO 2020).

(b) Production subsidy

CEEW-CEF recommends the Ministry of New and Renewable Energy (MNRE) to implement this intervention

A tariff barrier cannot guarantee domestic procurement in a short term because of the change in law clause. Even with significant duty, the current status quo may continue for the next 15–18 months. Our analysis suggests that non-hardware cost differential between an

Indian and a Chinese manufacturer can vary between INR 1.45/watt to INR 3.20/watt.[7] These include the costs of labour, depreciation, finance, utilities, land, and other overhead expenses. In addition, due to limited cell manufacturing capacity, module manufacturers are still dependent on imported cells. In the past, concerns have been raised around an artificial increase in cell prices to reduce the competitiveness of Indian module manufacturers. A sudden surge in demand in the post-COVID-19 scenario can also lead to dumping of low-quality products. A short-term intervention in the form of production subsidy will serve two purposes: (i) reduce cost differential between domestic and imported modules and (ii) ensure deployment of high-efficiency products. We suggest that the domestic module manufacturers be given a production subsidy (Table 2) for modules manufactured till March 2021.

Table 2 **Recommended design of production subsidy for solar modules**

Timelines—September 2020 to March 2021	Modules based on domestic cells—INR 2.5/watt Modules based on imported cells—INR 1.5/watt
Max support per manufacturer	250 MW (domestic or imported cells)
Minimum threshold efficiency	19%
Project eligibility	Only utility-scale projects with tariffs discovered via reverse bidding with commissioning dates before March 2021
Who applies for the subsidy	Module manufacturers to apply for subsidy on behalf of the buyer

Source: CEEW-CEF analysis

Given that capacity utilisation and economies of scale play a very important role in reducing the cost differential, we suggest limiting the subsidy support to 250 MW per manufacturer. This ensures that small players are able to run at full capacity whereas larger companies with benefits of scale can increase their CUF to become competitive with imported products. An additional support of INR 1/watt has been suggested for modules manufactured with domestic cells. Also, production subsidy should only be applicable only on a short term—till March 2021.

Under this scheme, it is expected that only 2.5–3 GW of modules produced may be eligible for subsidy, which would entail a financial outflow of nearly INR 600 crore for the government. The subsidy may be disbursed to the procurer once the project commissioning certificate is obtained by giving details of the DC and AC capacity of the module. The MNRE may decide to increase the duration and extend support for exports based on availability of budget and in accordance with WTO regulations.

(c) WTO-complaint DCR policies

CEEW-CEF recommends the Ministry of New and Renewable Energy (MNRE), Solar Energy Corporation of India (SECI) and Indian Renewable Energy Development Agency (IREDA) to implement this intervention

India had to change its domestic content requirement (DCR) policies due to the WTO ruling in 2016 (WTO 2016). However, domestic procurement programmes like the *Central Public Sector Undertaking Scheme (CPSU)* can still be designed, which mandate usage of domestic components. Any government producer can bid under this scheme and seek a maximum VGF of INR 70/watt (MNRE 2020a). Under this scheme, the sale of power from one government entity to another has been capped at INR 2.8/unit. The scheme currently lapses in 2023, but the government must present a clear pipeline of projects supporting domestic manufacturing till 2030. In addition, the scheme must also mandate usage of locally produced polysilicon, ingots, and wafer at a later stage in a phased manner.

Manufacturers have in the past suggested that a 0.6 per cent increase in efficiency can reduce the final module costs by up to 3 to 4 per cent. The top runner programme in China helped increase the efficiency of passivated emitted and rear cell (PERC) and N-type technologies. The efficiency of solar modules increased from 22 to 23 per cent in 2019 due to the top runner programme. In the absence of any support, the efficiency would have increased by just 0.3 per cent (Xiao 2020). On the above lines, we recommend reducing the tariff to INR 2.5 and allocating projects with a capacity of 2.5 GW to high-efficiency modules annually, which will ensure that India can become a global leader in solar module technology (Table 3).

7 Higher capacity utilisation levels can translate into considerable improvements in the competitiveness of Indian module manufacturers. Further, economies of scale can boost the competitiveness of both domestic BOM components as well as modules. We see that at 100 per cent capacity utilisation, the differential between Chinese and Indian manufactured modules is INR 1.45/watt whereas with 50 per cent capacity utilisation, the differential is INR 3.20/watt.

Table 3 Linking VGF with technological improvements

Deployment year (2.5 GW/year)	Module efficiency
2021–22	20%
2022–23	21%
2023–24	22%
2024–25	23%

Source: CEEW-CEF analysis

Note: The above numbers are indicative, and the eligibility may differ based on module technologies like multi/mono crystalline and thin film modules

Research and development (R&D) efforts should be directed at lowering the cost of modules and cells, which would lead to a reduced VGF requirement. For encouraging companies to invest in R&D, the government needs to provide a clear and visible schedule of support and demand for domestic manufacturing of PV modules, cells, wafers, and polysilicon. It is also expected that manufacturers would be willing to deploy next generation technologies like heterojunction technology (HJT) if a clear demand pipeline exists.

(d) Commitment and clear timelines

CEEW-CEF recommends the Ministry of New and Renewable Energy (MNRE), Ministry of Commerce and Industry (MoC&I) and Ministry of Electronics and Information Technology (MeitY) to implement this intervention

A continued commitment from the government is very essential for scaling up domestic manufacturing in India. To stimulate investments, the government needs to clearly articulate the schedule and timeline of the various forms of support (policies and subsidies) extended to solar manufacturing. This would encourage investors (foreign and domestic) to respond to the market-support signals from the government and develop an interest in the sector. The MNRE should set a national target of installing at least 50 GW of manufacturing capacity by 2030.[8] Yearly addition of 5–10 GW of solar module and cell manufacturing will ensure that new capacity is able to offset the impact of dysfunctional factories. Broadly, at least 25–30 GW of solar cell and module manufacturing should be based on the latest technology.

Therefore, we suggest setting up of nearly 40 GW and 45 GW of additional module and cell capacity based on advanced technology in the next decade to develop India into a leading hub of PV manufacturing for servicing both domestic and international demand. We recommended a graded target for the government (Table 4) and also call upon the government to ensure a conducive and stable regulatory environment with an assured market for solar manufacturers.

Table 4 Recommended deployment targets for solar cell and module manufacturing

Target year (cumulative capacity)	Wafer to cell (GW)	Cell to module (GW)
FY 2021–22	5	15
FY 2022–23	15	20
FY 2023–24	20	25
FY 2024–25	25	30
FY 2025–26	30	35
FY 2026–27	35	40
FY 2027–28	40	45
FY 2028–29	45	50
FY 2029–30	50	50

Source: CEEW-CEF analysis

(e) Producing manufacturing equipment in India

CEEW-CEF recommends the Ministry of Finance (MoF), Ministry of New and Renewable Energy (MNRE) and Department of Science & Technology (DST) to implement this intervention

Currently, manufacturers of solar cells and modules are exempt from paying customs duty on importing manufacturing equipment (CBIC 2017). The MNRE is also working with the Department of Revenue to update the list of equipment required for manufacturing and extend the benefits to wafer, ingot, and polysilicon manufacturing (MNRE 2020b).

Reducing our reliance on imported manufacturing equipment should be the government's priority. There have been instances in the past when many wafer manufacturers increased the size of wafers, which required adjustments in the cell and module manufacturing facilities.

8 It has been estimated that the annual global PV installations may increase to 270 GW in 2030 from the current levels of 100 GW/year (IRENA 2019). Also, the global production of solar modules was in the range of 130–140 GW in 2019 (Fraunhofer ISE 2020). If India is able to ramp up its capacity, it will not only be able to service the domestic market but export to other countries too.

Wafer size has often varied with the whim of the foreign manufacturer. The standard wafer size has increased from 125 mm x 125 mm in 2010 to 158.75 mm x 158.75 mm in 2019. However, many wafer manufacturers have now started producing wafers of a non-standard size, with some even producing wafer of the size of 210 mm x 210 mm. Lack of standardisation can potentially increase the delivered costs to consumers (Hutchins 2019). However, recently seven leading wafer manufacturers have come to a consensus to establish a new standard size of 182 mm x 182 mm (LONGi 2020). It should also be noted that many of these manufacturers also have control over the technological development of manufacturing equipment too. Any change in their offering upstream would require significant changes in the downstream infrastructure for Indian cell and module manufacturers. To avoid any shock in the future, we need to invest significantly in polysilicon and wafer R&D and equipment manufacturing.

We recommend to the government to institute cash prizes to domestic wafer manufacturers or independent technological providers who can develop, commercialise, and produce manufacturing equipment indigenously. Cash prizes should be linked to meeting of specific targets—sales, cost, or innovation (patent filing). The prizes need to be reviewed every year to ensure global competitiveness. Academic and research institutes need to be called to collaborate with the government to ensure support for new technologies. Technological development may also be achieved by a successful joint venture with foreign companies. or through technology transfer. A similar trend was witnessed in the wind sector in the 1980s and 1990s. The government must focus on country's self-reliance in manufacturing equipment in the next 10 years. India should also incorporate solar manufacturing as a focus industry in its foreign policy and leverage the expertise that exists in Europe, Japan, and the United States of America through collaboration with those governments and private parties.

(f) Better recording of data

CEEW-CEF recommends the Ministry of Commerce and Industry (MoC&I) to implement this intervention.

In the Union Budget 2020, the government finally split the HS code used to record import of solar cells and modules in India. Until now, the HS code 8541 4011 was used for both cells and modules. Now an additional code 8541 4012 has been created, which will record data only for modules whereas the former code will be used for cells. In addition to creating this division, the ministry also needs to record data in capacity terms and not just their monetary value. Currently, there is no way to accurately estimate imports based on government records. To ensure targeted policy design, we need to collect data in INR and kW units.

In addition, to remove biases and improve bankability, the MNRE may regularly release generation data of projects based on domestic and imported modules. This will go a long way in increasing both transparency and accountability in the sector.

Interventions required in medium to long term

(a) Backward integration

CEEW-CEF recommends the Ministry of New and Renewable Energy (MNRE), Ministry of Commerce and Industry (MoC&I) and Ministry of Electronics and Information Technology (MeitY) to implement this intervention

India needs to reduce its reliance on imported raw materials. Quartz is abundantly available in India and incentivising companies that are willing to manufacture solar modules from quartz would be a good move by the government to encourage domestic manufacturing and also ensure energy security. We recommend levying BCD on solar wafers from 2027 to 2030 (in line with BCD on solar cells and modules) and the process to manufacture modules from quartz could be planned to begin by the same year. These upstream PV manufacturing stages are capital- and energy-intensive and the government may provide incentives to accelerate their scaling up. Support in the form of concessional power tariffs, capex subsidy and interst subvention may be critical for energy and capital intensive manufacturing stages such as polysilicon and ingot manufacturing. (Table 5)

Table 5 Recommended deployment targets for polysilicon and wafer manufacturing

Target year (cumulative capacity)	Quartz to polysilicon (tons/year)	Polysilicon to wafer (GW)
FY 2021–22	—	—
FY 2022–23	—	2
FY 2023–24	—	4
FY 2024–25	—	6
FY 2025–26	—	8
FY 2026–27	30,000	10
FY 2027–28	60,000	15
FY 2028–29	90,000	20
FY 2029–30	90,000	25

Source: CEEW-CEF analysis

Note: Polysilicon consumption is expected to decrease to 3–3.5 g/watt in the years to follow from the current values of 4 g/watt (Fraunhofer ISE 2020). A 30,000 tons/year facility may be capable of supplying to 8–10 GW of wafer manufacturing facility. The figure of 30,000 tons/year has been suggested keeping in mind the economies of scale to set up such facilities

The government should encourage public sector undertakings (PSUs) such as Bharat Heavy Electricals Limited (BHEL) and Bharat Electronics Limited (BEL) to take a lead in the solar manufacturing indigenisation effort. Any decision on this front should also involve stakeholders from other industries (such as mobile phones), which require polysilicon as a raw material.

(b) Horizontal integration

CEEW-CEF recommends the Ministry of Commerce and Industry (MoC&I) and Ministry of Electronics and Information Technology (MeitY) to implement this intervention

Currently, Indian manufacturers not just import cells but rely heavily on imports for other non-cell BOM components such as glass, ribbon, EVA sheet, and others, which constitute 30 to 35 per cent of the total module cost. Indian micro, small, and medium enterprises (MSMEs) are already producing these components, but they don't measure up on quality and are priced high as well. Currently anti-dumping duty (ADD) is levied on solar glass and EVA sheets in India. Despite the government's protective policy, domestic manufacturers capable of manufacturing these equipment have not ventured into the sector. A detailed analysis of each BOM component is required from the Indian MSMEs point of view and corrective measures should be urgently implemented, which can ensure the growth of the sector, create additional jobs, and increase competitiveness with China.

(c) Setting up manufacturing parks

CEEW-CEF recommends the Ministry of Commerce and Industry (MoC&I) and Ministry of Electronics and Information Technology (MeitY) to implement this intervention

A solar power plant does not have many moving parts. So manufacturing of key equipment like solar modules, inverters, and module mounting structure is easy and scalable. Imports is the source of many of the components and raw materials in equipment manufacture. To indigenise the manufacture of key equipment used in the solar power plant, we recommend that the government set up 10 GW solar manufacturing parks near the ports in the states of Maharashtra, West Bengal, Andhra Pradesh, and Tamil Nadu. Infrastructure in the form of assured and low-cost electricity, availability of water, concessional land, and air connectivity need to be ensured in these locations. Tax holiday and duty benefits may also be extended by the government. State govenrments must be intiate the process to skill the local workforce to work in such facilities. These parks can follow the model of SEZ but they need to be treated on par with DTA to avoid the levy of SGD or BCD on the manufactured products. Wind turbine and component manufacturers may also be given opportunities to set up their factories in these parks.

(d) Indigenisation of novel technologies

CEEW-CEF recommends the Ministry of New and Renewable Energy (MNRE) and Department of Science and Technology (DST) to implement this intervention

European countries have demonstrated success in the adoption of new technologies like organic solar modules from the lab to factory by commercialising innovative technologies that were initially developed by researchers in the lab. Prestigious technology institutions such as the Indian Institute of Technology (IIT) Bombay, IIT Delhi, IIT Madras, and the Indian Institute of Science (IISc) Bangalore should be roped in by the government, by providing financial grants, to develop and commercialise novel technologies, thus making India self-reliant.

Some interventions only yield short-term benefits: tread with caution

Support in the form of upfront capex support, interest subvention, assured off-take, and manufacturing-linked tenders have either been implemented before or may be in process of deployment. They have not been mentioned as probable solutions for the growth of domestic solar manufacturing due to the following reasons.

(a) **Regulations should support technological advancement**—Technological developments are taking place very rapidly across the world, and bankers and policymakers are not expected to be up-to-date on latest technologies. The government may end up supporting obsolete technologies due to lack of information. Besides, significant delays have been seen in the past for capex support and manufacturing-linked tenders, which can have negative impact on the sector. Due to delay, the window of opportunity to set up any facility also gets reduced significantly.

To avoid the trap of lack of expertise, bankers should hire experienced consultants who can provide expert assistance with latest technologies for evaluating solar manufacturing proposals. Many manufacturers have aired the view that banks are not comfortable lending to cell manufacturing facilities. This is purely due to lack of knowledge on the part of bankers. We recommend that the Indian Renewable Energy Development Agency (IREDA) be appointed as the lead agency for banks and policymakers to provide assistance in assessing the technical feasibility of solar manufacturing project proposals.

(b) **Availability and cost of capital is always a challenge**—Availability and cost of capital has remained a recurring problem for India's RE sector. However, RE project developers have managed to secure low-cost capital (from India and abroad) through financial engineering. If favourable policies are in place, RE manufacturers would also be able to raise low-cost capital to scale up their facilities. The government should go a step further in creating a vibrant solar manufacturing ecosystem where entrepreneurs can innovate and make course corrections based on market conditions and requirements. Developing an effective ecosystem to attract entrepreneurs and investment in solar manufacturing hinges on providing visibility of future deployment, policy stability and continuity, quality infrastructure, and a mature banking system.

(c) **Disbursement delays and decisions**—Disbursement of subsidies by the government often encounter delay. Factoring in the risk of such delay, manufacturers are burdened with increased cost, reducing the impact of fiscal support. Additional paperwork and bureaucratic hurdles add to the frustration of the manufacturers, giving rise to suspicions and possibility of foul play. To overcome these issues, the government should stipulate a timeline for each intervention.

In addition, overlapping mandates of different ministries like MNRE, Ministry of Commerce and Industries (MoC&I), Ministry of Finance (MoF), and Ministry of Electronics and Information Technology (MeitY) have often resulted in delays and sub-optimal outcomes. A steering committee may be formed to coalesce the efforts of various ministries for effective implementation of policies.

(d) **Mixing interventions can have the opposite effect**—The manufacturing-linked tender mixes deployment with manufacturing, which have two unrelated business processes. This complexity reduces market participation in the bids, leading to discovery of non-optimal prices and additional burden on the exchequer. Targeting low-cost deployment and low-cost manufacturing simultaneously will always result in a non-optimal outcome. Challenges for each sector are unique and the government should derive outcomes based on informed decision-making. Merely merging several issues in the expectation of an optimal outcome only ends up burdening the end consumers and discoms.

(e) **Expectation from others—**Expecting autonomous government institutions to continuously set up projects based on DCR is a misplaced strategy. While autonomous institutions such the Indian Railways, oil management companies, and NTPC Limited (formerly National Thermal Power Corporation) can set up some projects, the additional cost would be passed on to their consumers. Hence, while they may be encouraged to buy power from DCR projects (implemented following the recommended VGF scheme in this report), they cannot be burdened with the full responsibility to scale up the domestic manufacturing industry.

5. Conclusion

Indian PV module manufacturers lack competitiveness because of higher prices and lower capacity utilisation in comparison to their Chinese counterparts. The increased cost of Indian modules arises from higher raw material and overhead costs. At full capacity utilisation levels, BOM costs alone account for 56 per cent of the price difference between Indian and Chinese modules. India's manufacturing base also remains so low that economies of scale cannot be realised.

An integrated cell and module manufacturing generates around 2.6 full-time equivalent jobs per MW of output. Every 10 GW of additional cell and module manufacturing capacity could generate 26,000 jobs in the PV cell manufacturing sector (Kuldeep 2017). Additional jobs can be created in ingot and wafer manufacturing. Completely relying on local components and raw materials saves forex outflow. Domestic manufacturers also stand to benefit in the long term if they scale up and deploy superior technologies. They can then break into the international market as well by initially supplying modules to member countries of the International Solar Alliance (ISA).

However, to scale up domestic manufacturing in the country, a mix of well thought-out and long-term interventions are needed that can not only support the sector but also make India export competitive and a global leader in solar PV manufacturing technology.

For the domestic industry to gain momentum, the government needs to articulate policies with clear timelines for infusing confidence in the manufacturers and to attract investment. In order to boost the competitiveness of Indian manufacturing, measures that increase capacity utilisation and facilitate scaling up of horizontal and vertical integration can be effective in lowering selling prices. Recognising the solar manufacturing sector as strategic for country's growth and setting up an inter-ministerial body of senior officers may be the first step to achieve self-reliance as well become globally competitive.

The manufacturers would benefit by seeking support for clear mandates with specific timelines and keeping pace with the dynamically evolving nature of the sector. Manufacturing in a globalised world requires strategic planning and informed decision-making. The Indian government has already provided a long-term commitment to scaling up RE, which can be leveraged effectively to develop a thriving manufacturing base in India. Reduced reliance on imported products will make the sector self-sufficient, competitive, and resilient to supply chain disruptions. Apart from increasing India's energy security, the domestic solar manufacturing industry would also help in the creation of jobs and growth of the economy.

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Annexures

Annexure I

Impact matrix of the key interventions in the solar manufacturing sector

S. No.	Intervention	Short-term/ long-term	Fiscal implication (for government)	Ease of implementation	Impact on the sector
1	Tariff barrier	Long-term	Inflow	Easy	Survival
2	Production subsidy	Short-term	Outflow	Difficult	Survival
3	VGF	Long-term	Outflow	Moderate	Growth
4	Manufacturing equipment (duty exemption)	Medium-term	Outflow	Easy	Moderate
5	Commitment from the government	Long-term	Nil	Easy	Growth
6	Better recording of data	Short-term	Nil	Easy	Growth
7	Backward integration	Long-term	Outflow	Difficult	Growth
8	Horizontal integration	Medium-term	Outflow	Difficult	Moderate
9	Indigenisation of novel technologies	Medium-term	Outflow	Easy	Growth
10	Manufacturing parks	Medium-term	Outflow	Easy	Moderate

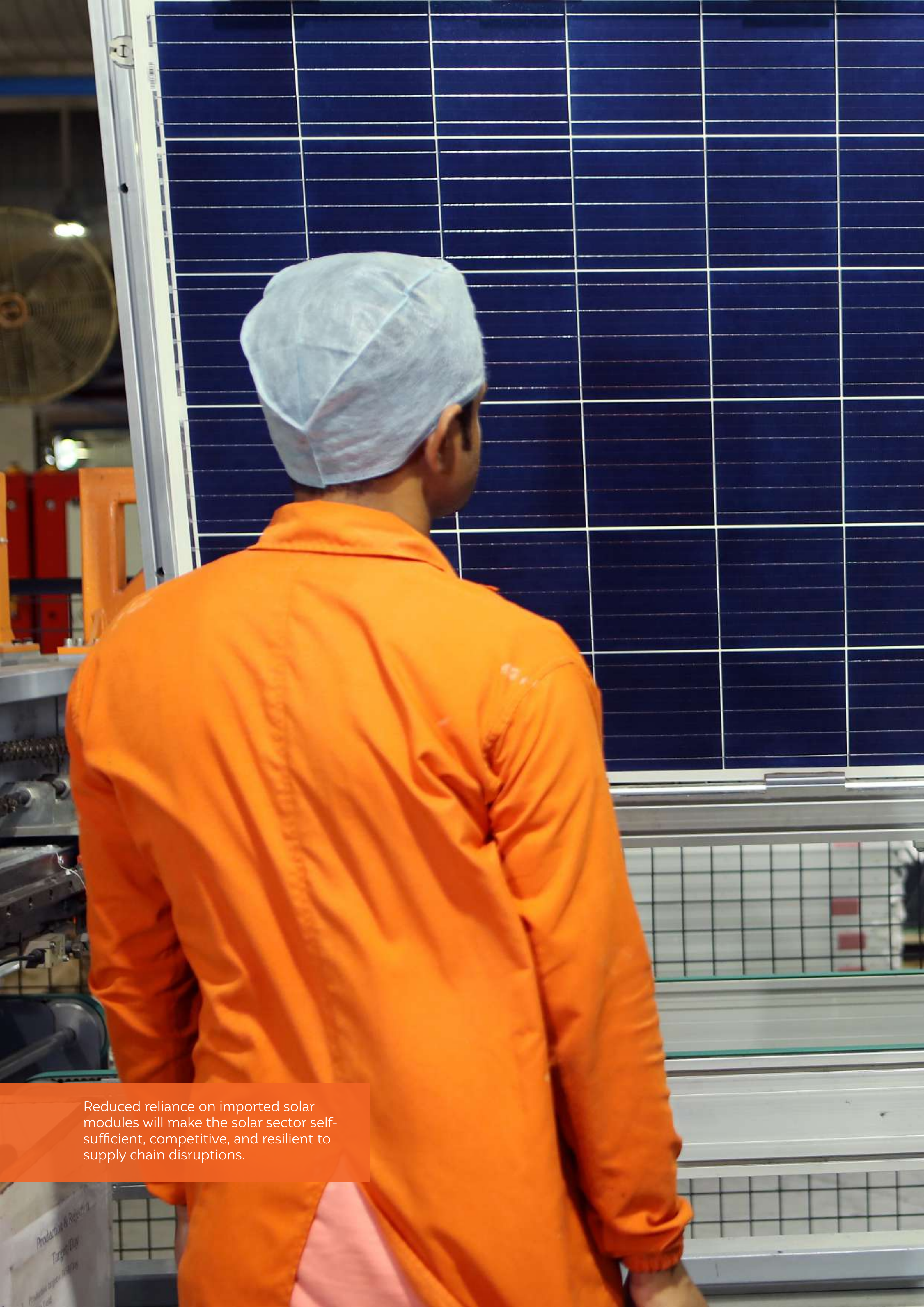
Source: CEEW-CEF analysis

Annexure II

Key respondents to primary survey

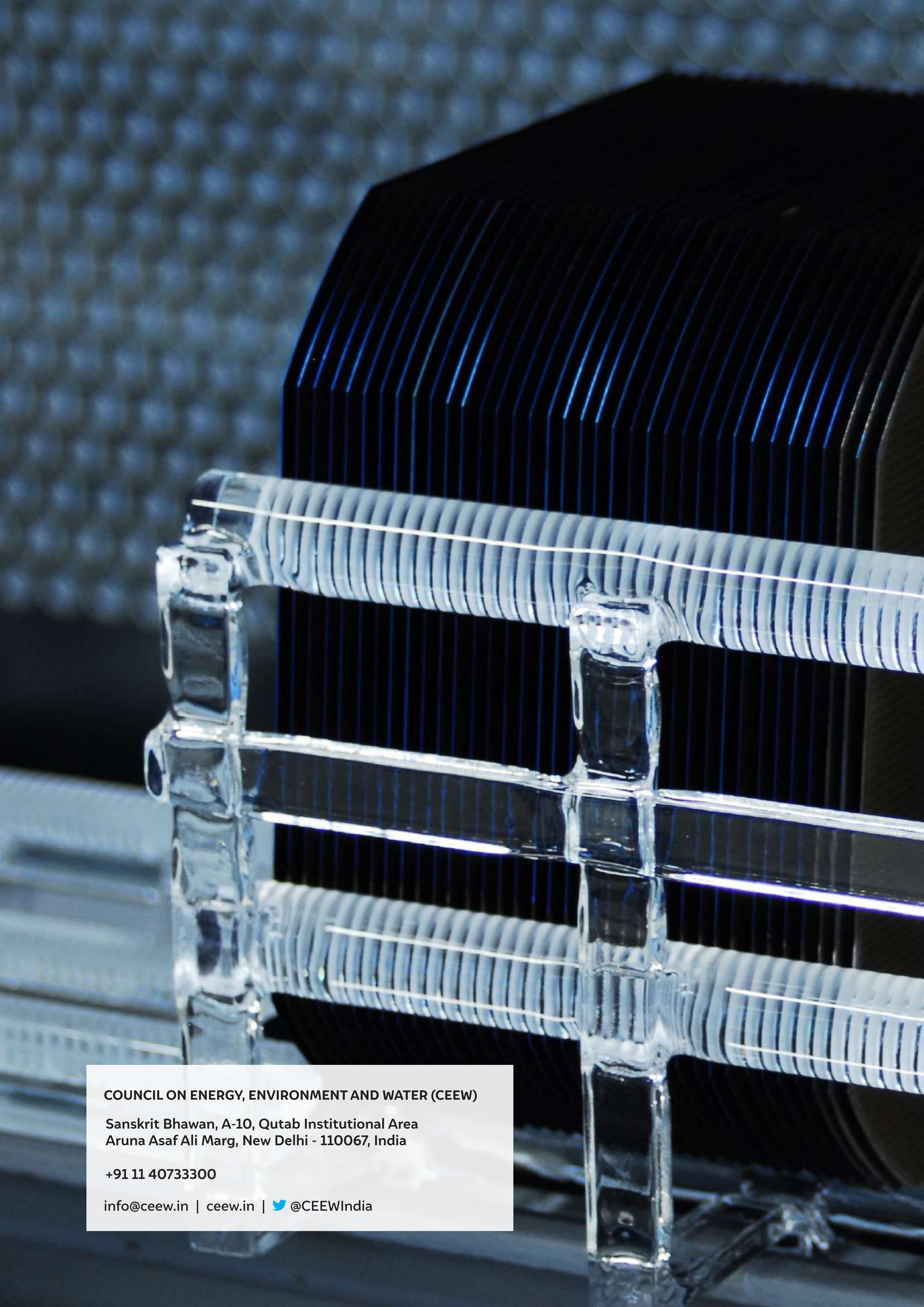
Solar Module manufacturers approached	Name of respondents with capacity
Adani Solar	Adani Solar (1,200 MW)
Emmvee Solar	
Goldi Solar Private Limited	Goldi Solar (500 MW)
IB Solar	
Jakson Limited	Jakson Limited (90 MW)
Navitas Green Solutions Private Limited	Navitas Green Solutions Private Limited (200 MW)
Renewsys India Private Limited	Renewsys India Private Limited (700 MW)
Tata Power Solar	
Vikram Solar Limited	Vikram Solar Limited (1,000 MW)
Waaree Energies Limited	Waaree Energies Limited (2,000 MW)

Source: CEEW-CEF compilation



Reduced reliance on imported solar modules will make the solar sector self-sufficient, competitive, and resilient to supply chain disruptions.


Image: Vikram Solar ltd



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