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Making India a Leader in Solar Manufacturing

Ways to Achieve Technology Leadership and Global Competitiveness

Shreyas Garg and Rishabh Jain

Report | May 2022

With only 2.5 GW cell and 11 GW module manufacturing capacity, India lacks sufficient domestic solar manufacturing capabilities.

Image: Waaree Energies Ltd.

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

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CEEW Centre for Energy Finance

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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 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 HE Mr Dharmendra Pradhan and H.E. Dr. Fatih Birol at Energy Horizons.

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Shreyas is a Programme Associate at the CEEW Centre for Energy Finance. He previously worked as a management consultant with a specific focus on infrastructure and renewable energy.

"With the policy movements in 2021, Indian industry now has a strong footing to scale up solar manufacturing. However, incentives and duties can only provide short-term support. To build a sustainable manufacturing sector that can compete in the global market, India must also focus on technology and demand expansion. This report takes learnings from the global solar landscape and identifies measures to make Indian manufacturers technology-led global players."

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Rishabh, a public policy practitioner, leads the market intelligence team at the CEEW Centre for Energy Finance and works closely with key decision-makers in the Indian RE sector. Previously, he worked in India's solar manufacturing sector.

"Better late than never. Solar manufacturing has not been India's strength. Despite the huge market, we continue to rely on imported products for manufacturing and deployment. However, proactive measures by the industry and the government can reduce our reliance on imported products. This report highlights the key strategic steps that need to be undertaken in the short and medium term to ensure the global competitiveness of the solar manufacturers."

Policy interventions, such as incentives, duties, and certification requirements, have created a favourable near-term landscape for domestic solar manufacturing.

Image: Goldi Solar

Contents

Acronyms

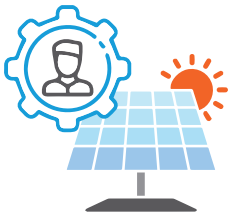
ALMM	Approved List of Models and Manufacturers
ARC	anti-reflective coating
ARPA-E	Advanced Research Projects Agency-Energy
BCD	basic customs duty
BOM	bill of materials
CVD	chemical vapour deposition
DCR	domestic content requirement
DST	Department of Science and Technology
EUR	euro
EVA	ethylene-vinyl acetate
GST	goods and services tax
GW	gigawatt
HJT	heterojunction
INR	Indian Rupee
IREDA	Indian Renewable Energy Development Agency
ISA	International Solar Alliance
MEA	Ministry of External Affairs
MG	metallurgical grade
MNRE	Ministry of New and Renewable Energy
MW	megawatt
PECVD	plasma-enhanced chemical vapour deposition
PERC	passivated emitter and rear contact
PLI	production-linked incentive
PV	photovoltaic
RE	renewable energy
TMA	trimethyl aluminium
TOPCon	tunnel oxide passivated contact
UK	United Kingdom
UNSW	University of New South Wales
US	United States of America
USD	United States Dollar

India's plans to set up new solar manufacturing factories can lead to investments of USD 7.2 billion in capital expenditure and create over 41,000 jobs.

Image: Goldi Solar

Executive summary

The process of manufacturing crystalline silicon solar modules involves four stages – (i) making polysilicon, a highly pure form of elemental silicon, (ii) converting polysilicon into silicon wafers, (iii) processing wafers into solar cells, and (iv) assembling solar cells into modules. Currently, India has no manufacturing capacity for the first two stages, an estimated 2.5 GW of cell manufacturing capacity, and an 11 GW of module manufacturing capacity (MNRE 2021a; Joshi 2021). India is, therefore, heavily reliant on solar imports – domestic modules made up only 35 per cent of utility-scale solar installations in India in financial year 2019-20 (Garg et al. 2021). While new policy measures will increase this share, the volume of imports are also expected to rise further up the supply chain.



10 GW of fully integrated solar manufacturing capacity can create over 10,000 jobs

The current situation of manufacturing presents multiple challenges. First, due to significant import reliance, India is highly exposed to supply chain shocks. These can become a bottleneck for India's solar deployment targets as the global demand for solar products scales up. For instance, the years 2020 and 2021 saw significant disruption across the solar supply chain, delaying deliveries and raising prices. Second, without a robust technology ecosystem, manufacturers must rely on technology developed in other nations. Indian solar manufacturing typically lags global technology shifts by 3–5 years, making Indian products outdated and unable to compete in the global market. Third, India is missing out on significant opportunities for job creation. It is estimated that 10 GW of fully integrated solar manufacturing capacity (polysilicon to modules) can create 10,500 jobs in plant operations alone[1]. Further jobs will be created in ancillary requirements and bill of materials manufacturing.

A. Solar manufacturing received strong policy support in 2021

In 2021, the government announced import duties, constituted a pre-approved list of modules for usage in projects, and announced a manufacturing-linked subsidy scheme. In March 2021, the Ministry of New and Renewable Energy (MNRE) announced a basic customs duty (BCD) of 25 per cent on imported solar cells and 40 per cent on imported solar modules from April 2022 (MNRE 2021b). MNRE released the first Approved List of Models and Manufacturers (ALMM) for solar modules in 2021. As per government orders, nearly all projects to be set up in India must use only the modules included in the ALMM list.[2] The December 2021 version of the list only includes domestic manufacturers, essentially restricting foreign manufacturers from selling in India (MNRE 2021a).

1. Based on data from industry experts and Woodhouse et al. (2019).
2. Only models and manufacturers included in the ALMM list are eligible for use in government projects, government-assisted projects, projects under government schemes and programmes, open access, net-metering projects installed in the country, including projects set up for sale of electricity to the government (MNRE 2022).

The government also announced USD 600 million (INR 4,500 crore) support through the *Production Linked Incentive* (PLI) scheme to scale integrated solar manufacturing.[3] The scheme received bids totalling 16 GW of polysilicon, 29 GW wafer, 52 GW cell, 52 GW module, and 3 GW integrated thin film manufacturing capacity. Three manufacturers planning to set up a total of 12 GW of fully integrated solar manufacturing capacity were shortlisted (IREDA 2021a). The government has allocated an additional USD 2.6 billion (INR 19,500 crore) to expand the list of PLI awardees (Ministry of Finance 2022a).

B. Focusing on technology and ecosystem-building is now essential

Submissions to the PLI scheme and other announcements by solar manufacturers suggest that India will rapidly scale up manufacturing capacity across the four solar manufacturing stages by 2025. While the BCD, ALMM, and PLI provide strong near-term protections in the domestic market, manufacturers must gradually become competitive in the global market to create a self-sustaining sector that can thrive in the absence of policy support. This will require:

- **A holistic approach to research and development (R&D)** – The solar technology landscape is dynamic and major shifts in production processes are typically seen in every five years. To stay competitive, India must both develop new manufacturing technologies and successfully take them to market. This will require a drastic increase in industry involvement in R&D programs.
- **Localising production of bill of materials (BOM) and manufacturing machinery** – Localising production of BOM is critical to ensure supply chain security and reducing import dependence. Further, making manufacturing equipment in India can help cut capital expenditure and improve manufacturers' access to servicing. Industry-led R&D is critical for both BOM and machinery, as Indian players must first develop high-quality, cost-competitive options before scaling up.
- **Unlocking new sources of demand** – Establishing multi-gigawatt scale manufacturing facilities and running them at high utilisation rates is essential to drive down production costs. As multiple players have announced plans to set up manufacturing facilities, they may face high competition in the domestic market. Therefore, manufacturers should simultaneously try to unlock demand from export markets.

Further, in the near term, India's push to indigenise solar manufacturing will require USD 7.2 billion (INR 53,773 crore) in capital expenditure and can create over 41,000 jobs.[4] These investments can unlock significant revenues for manufacturers. For example, suppose India achieves a 70 per cent share of domestic modules in Indian solar installations from 2022–2030 and meets its 2030 target of 280 GW installed solar capacity. In this scenario, manufacturers would clock revenues of USD 32 billion (INR 2.4 lakh crore) during 2022–2030, while the government would be able to earn USD 3.9 billion (INR 29,000 crore) in GST revenue in this period.[5]

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3. USD-INR conversion at USD 1 = INR 75, based on average USD-INR exchange rate in 2021 (data from Financial Benchmarks India Limited).
4. Detailed in Section 4.1.
5. Considering a fixed module price of INR 15/Wdc and GST rate of 12 per cent. 24 GW of annual solar installations are required from 2022 to 2030 to meet the 2030 target (Ranjan 2022a).