Bharat Cleantech Manufacturing Platform: Solar Indigenisation Pathways

Accelerating an Aatmanirbhar, Green and Viksit Bharat

bharat CLIMATE FORUM

Council for International Economic Understanding

Dalberg

As India rapidly moves towards meeting its NDCs, indigenisation of cleantech manufacturing is critical for an *Atmanirbhar* and *Viksit Bharat*

India has national targets and projections across renewable energy and solar for 2030…

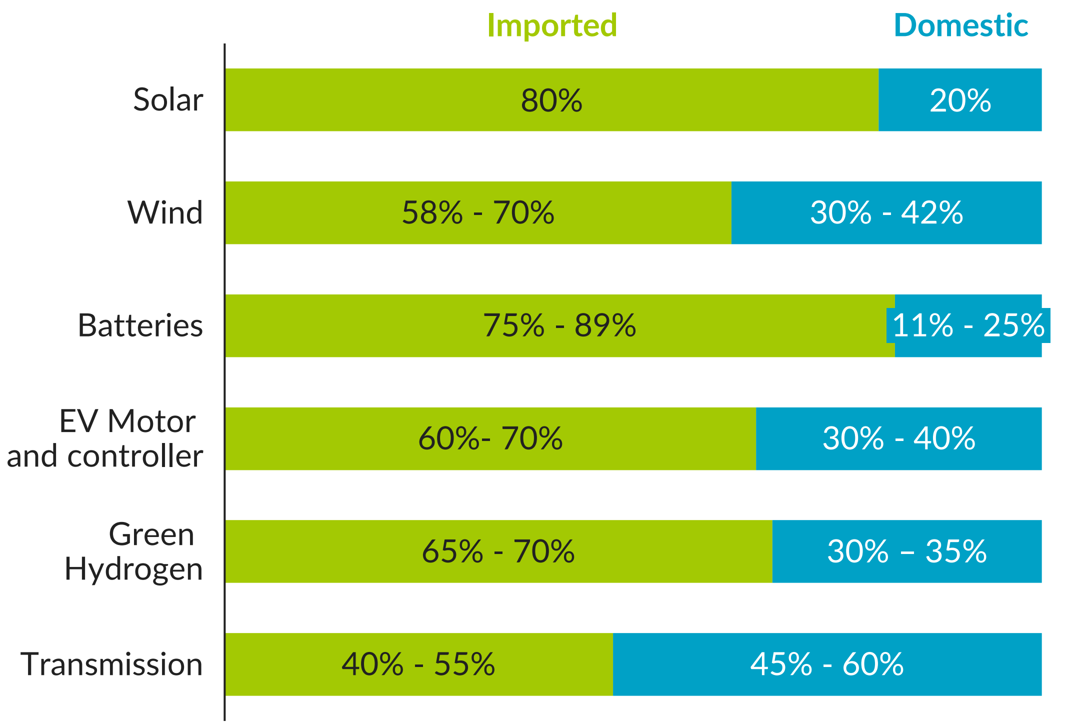
300 GW Solar
installed capacity[1]

30% EV *sales penetration*[2]

100 GW Wind
installed capacity[3]

5 MTPA Green Hydrogen
production[4]

… but cleantech supply chains are heavily import-dependent and need to be indigenised for an Atmanirbhar Bharat



Cleantech manufacturing import dependence across the value chain, 2023

Source: (1) MNRE; Solar capacity projection extrapolated from CEA's 2032 Solar capacity projections, assuming linear growth in capacity; (2) NITI Aayog ; (3) ET ; (4) MNRE - NGHM; MNRE, Ministry of Power; Economics Times; BNEF's installed and announced capacity; IEA, India – World Energy Investment 2024 – Analysis; NITI, India's Power Sector | Capacity & Generation Mix; PIB, India's Ethanol Push: A Path to Energy Security, CEEW, Strengthen India's Clean supply chain, 2024; Bain, India Electric Vehicle Report, 2023; Policy circle; Economist Impact, Scaling clean energy: financing and transition strategies for India's sustainable future

The Platform could support the National Manufacturing Mission to target at least 50% indigenisation of cleantech manufacturing value chains by 2030 enabling net-zero ambition with indigenous production

The Platform's potential to accelerate development of incremental indigenous capacity can be observed across sectors

Sector-wise goals	Solar	Wind	BESS	E-mobility	Green Hydrogen	Transmission
Installed capacity						
2030 targets	300 GW[1]	100 GW[2]	230-240 GWh[3]	30@30[4]	5 MTPA[6]	648,190[7] ckm
*% value chain indigenisation**						
Current levels (est.)	~20%	~35%	~20%	~35%[5]	~35%	~55%
2030 target (Proposed)	~50%	~60%	~45%	~50%	~60%	~70%

May decline due to shifting and unstable demand of domestic components amid intensified global competition

Note: *Indigenisation is domestic value contribution across cleantech value chain from raw materials to end production for all components; : (1) MNRE; (2) ET; (3) Estimated requirements under National Electricity Plan (NEP) 2023 of CEA; (4) NITI Aayog ; (5) For EV Motors and controllers; (6) MNRE - NGHM (7) 2032 target from National Electricity Plan Volume II – Transmission of CEA

Source: MNRE, Ministry of Power; Economics Times; BNEF's installed and announced capacity; IEA, India – World Energy Investment 2024 – Analysis; NITI, India's Power Sector | Capacity & Generation Mix; PIB, India's Ethanol Push: A Path to Energy Security, NEP 2023 of CEA; EV Reporter, India's electric vehicle supply chain landscape | An overview, 2024

A detailed strategy and action plan for the focus sectors would be developed to achieve these goals and objectives and build the cleantech indigenisation pathways for these sectors

Sector-wise gaps would be identified and addressed with all stakeholders across each cross-cutting theme in alignment with the National Manufacturing Mission

Enablers:
Policy recommendations; Trade partnerships; Public and private stakeholder recommendations; Demand and supply drivers; Leveraging AI for Climate and cleantech manufacturing

Sectors

- Solar
- Wind
- BESS
- E-mobility
- Green Hydrogen
- Transmission

Cross-cutting themes

Demand & Market Architecture	*Drive demand and adoption of output, incl.* ***Quality Control Orders (QCOs)***
R&D & Product Innovation	*Drive technology sharing, adoption and indigenous R&D*
Upstream Raw Materials & Critical Inputs	*Streamline raw material sourcing (e.g. critical rare earth elements; bio-energy feedstock etc.)*
Capital Equipment & Infrastructure	*Address machinery sourcing & infrastructure requirements (e.g., grid connectivity)*
Talent & Workforce	*Bridge skilling gaps for specialised and non-specialised workforce*
Financing & Taxation	*Identify financial instruments and mechanisms to reduce the funding gap* *Identify levers to improve* ***Ease of Doing Business*** *to attract investments*

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SECTION ONE

CURRENT SOLAR LANDSCAPE IN INDIA

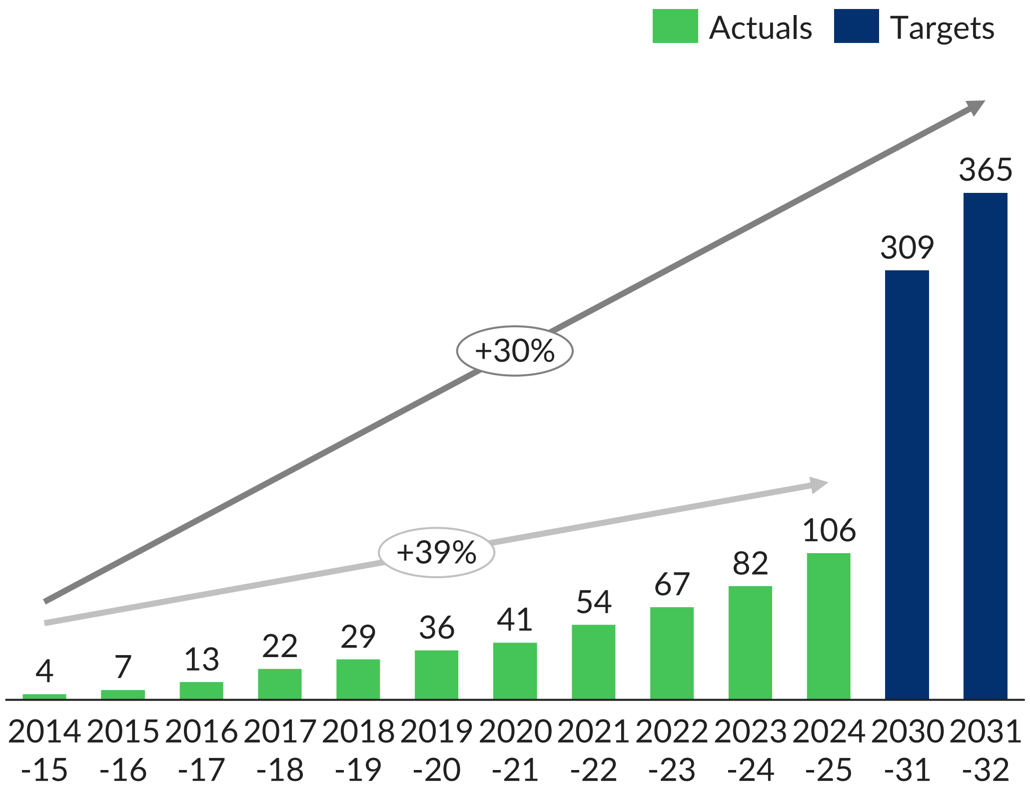
India's installed solar capacity has grown at 39% CAGR over 2014-2025 with targets to triple installed capacity to 300+ GW by 2030-31

Strong policy support and reducing costs drove record capacity additions - challenges related to high DISCOM charges, increased costs from storage mandates, fixed-rate PPAs, and delayed PPAs need to be addressed to accelerate further

Deployment policy landscape

- **Solar deployment growth of 39% CAGR (2014-2025) driven by:**
  - **Supportive government policies** such as RPO, Green Open Access, PM-KUSUM, PM-Suryaghar yojana
  - **Favourable solar LCOE 30-35% lower than thermal power** (INR 2.5 /kWh vs. INR 3.5-4/kWh)
- **Recent policy shifts could impact this demand growth:**
  - **Higher DISCOM charges on renewable energy**[1] at INR 3.4 - 3.7/kWh for RE vs. INR 2.9/kWh for thermal power
  - **Fixed rate PPAs** limit flexibility and risk cover for developers
  - **Delayed PPA signing** leads to project delays (avg 8-10 months) and erodes investors' confidence
  - **15-20 % increase in LCOE for new solar projects with mandated 2-hour BESS system**, however, most of this could be met through viability gap funding for applicable projects

India's cumulative installed solar capacity, GW



Note: 1. Includes charges such as green tariff, cross subsidy surcharge

Source: ET World Energy, Ministry of Power, State Electricity Regulatory Commissions, Ministry of New and Renewable Energy, Wood Mackenzie, Renewable Watch, Dalberg Analysis

Efforts in recent years have also been focused on increasing domestic production of modules and cells through fiscal and non-fiscal policy support of INR 19,500 Cr PLI on solar and ALMM and BCD for imports

However, further capacity expansion would be required to achieve 50% indigenisation by 2030 – this could be enabled through strong fiscal and non-fiscal incentives across the value chain

Manufacturing policy landscape

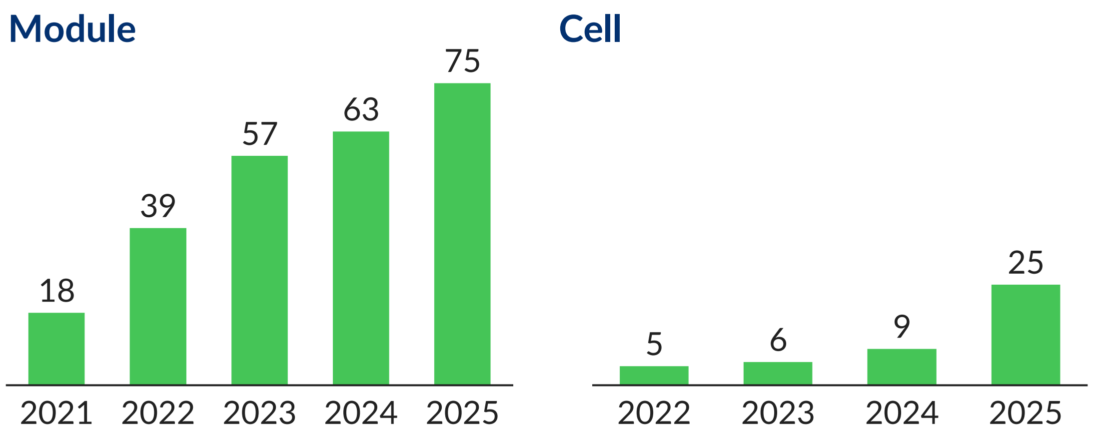
Non-fiscal policies provide long-term demand stable demand signals and protection against import price fluctuations for manufacturers

- **ALMM on modules** (upcoming on cells) secures domestic demand, but also leads to 0.5 INR/kWh LCOE increase
- 40% **BCD** on imported modules and 27.5% on cells supporting price competitiveness for domestic modules (and subsequently cells)
- **ADD on solar glass, aluminium frames** helping competitive pricing for indigenous production and has led to incremental capacity announcements for both solar glass and aluminium frames

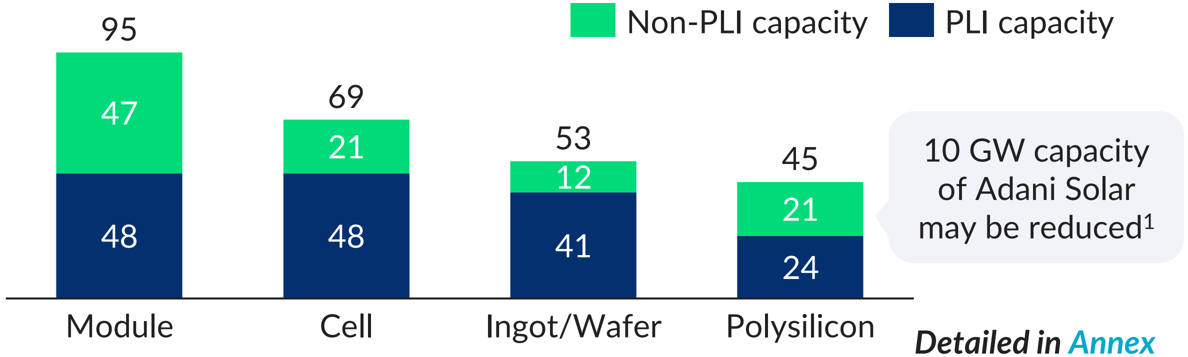
PLI scheme supporting upstream integration, but industry expressed concerns on overall benefits due to stringent timelines eligibility criteria and delayed disbursement

- **>80% of PLI outlay** awarded to Polysilicon-Wafer-Cell-Module (PWCM), Wafer-Cell- Module (WCM) **integrated capacity**
- Incremental capacities announced at **3x the PLI support**
- Industry players less enthused by PLI support due to delayed incentives on **front-loaded capex** investment with **stringent commissioning timelines** (1.5 - 3 years, with incentives reduced for delays) and **delayed PLI disbursement** over 5-years

Current solar manufacturing capacity, GW



Announced solar manufacturing capacity till 2030, GW



10 GW capacity of Adani Solar may be reduced[1]

Detailed in Annex

Note 1. Adani Solar has reportedly paused plans to build 10 GW of polysilicon capacity due to market conditions

Source: Central Electricity Authority National Electricity Plan 2022-32, MNRE, Skill Development Programme; MNRE, PLI details; Energy, Economics Times

There are several opportunities that could be captured through solar value chain indigenisation – the solar indigenisation pathway could help capture these opportunities till 2030

INR 85,000-98,000 Cr

Annual solar module domestic market potential by 2030

USD 14-15 Bn

Cumulative import bill savings from 2025-30

92,000-112,000 jobs[1]

Across solar manufacturing value chain by 2030

INR 14,000-22,000 Cr

Annual solar module export potential by 2030

Up to INR 1.1 Lakh Cr

Capex financing gap closure for solar PV and ancillary manufacturing by 2030

Detailed in Annex: *Domestic Market Potential*; *Import Bill Savings*; *Potential Jobs*; *Export Potential*; *Capex Financing*

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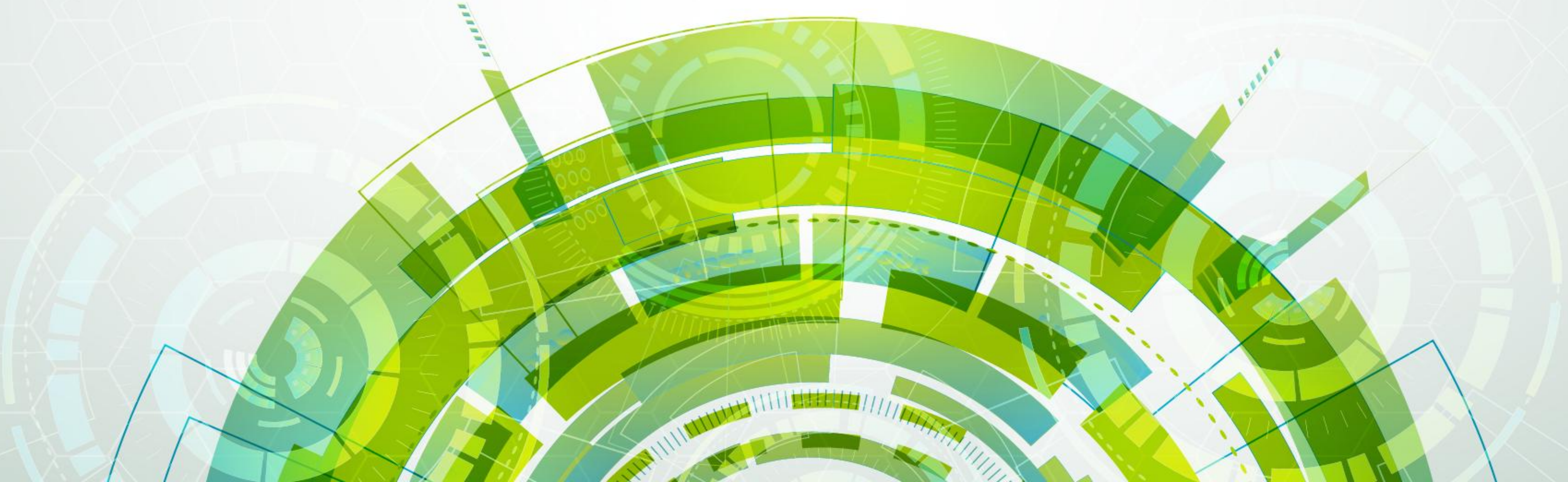
(1) Workforce estimation does not include solar ancillaries

Source: Dalberg analysis; Bloomberg NEF, Energy Transition Investment trend, 2024

SECTION TWO

SOLAR INDIGENISATION PATHWAYS FOR INDIA



The solar indigenisation pathways have been built on two demand scenarios – conservative and optimistic – to identify potential pathways and key enablers to achieve 50% indigenisation for solar value chain by 2030

		CONSERVATIVE SCENARIO	OPTIMISTIC SCENARIO
Scenario criteria			
1	Government policy landscape	Continue existing policies and 50% of off-grid and C&I consumers adopt domestic modules	70% of off-grid and C&I consumers adopt domestic modules
2	Solar use for green hydrogen generation	Solar / solar-wind hybrid meets 70% of green hydrogen energy demand	Solar / solar-wind hybrid meets 100% of green hydrogen energy demand
3	Export growth	Africa: Extend Credit to 4 priority Africa countries conditional on use of Indian modules US: Module deployment grows at 8% CAGR	Africa: Extend Credit to all Africa countries conditional on use of Indian modules US: Module deployment grows at 10% CAGR
2030 annual demand for modules , GW		**80 GW**	**97 GW**
Incremental capex investment required for 50% indigenisation by 2030, INR Cr		**INR 52,500– 64,500 Cr[1]**	**INR 89,000 – 109,000 Cr[1]**
Total government support needed till 2030, INR Cr		**INR 26,000 Cr[2]**	**INR 43,000 Cr[2]**
Potential import bill savings (2025-2030), INR Cr		**INR 119,000 Cr**	**INR 131,000 Cr**

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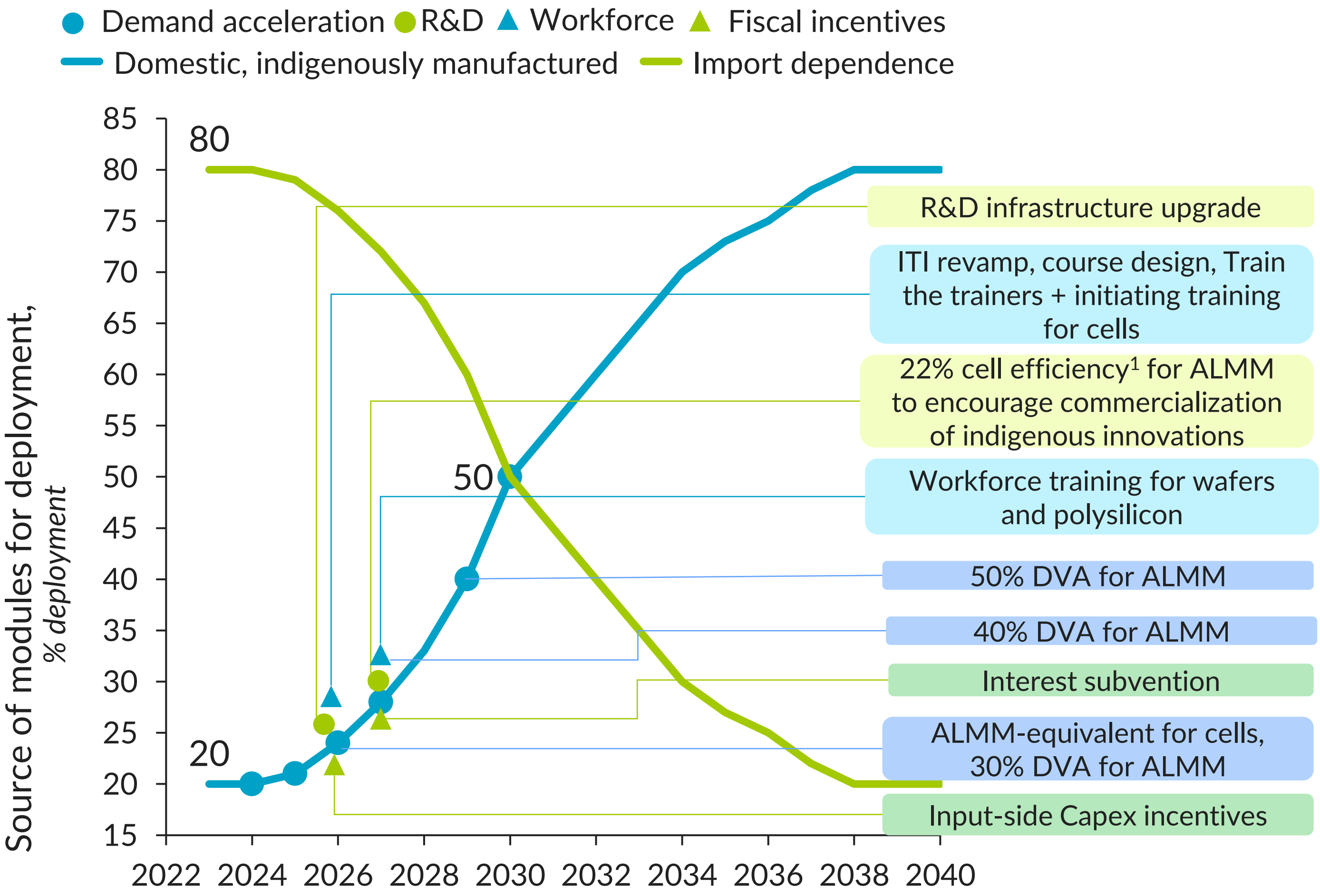
(1) Does not include input side capex subsidies

(2) Does not include potential tax revenue impact of proposed import duty waiver on key raw materials (INR 3500-4500 Cr) and proposed GST rate reduction from 12% to 5% (INR 22,000-25,000 Cr)

Detailed in Annex

India could achieve 50% indigenisation on solar manufacturing by 2030 across the value chain from polysilicon to module and ancillaries through focused interventions, fiscal and non-fiscal incentives

Solar Indigenisation Pathway



R&D infrastructure upgrade

ITI revamp, course design, Train the trainers + initiating training for cells

22% cell efficiency[1] for ALMM to encourage commercialization of indigenous innovations

Workforce training for wafers and polysilicon

50% DVA for ALMM

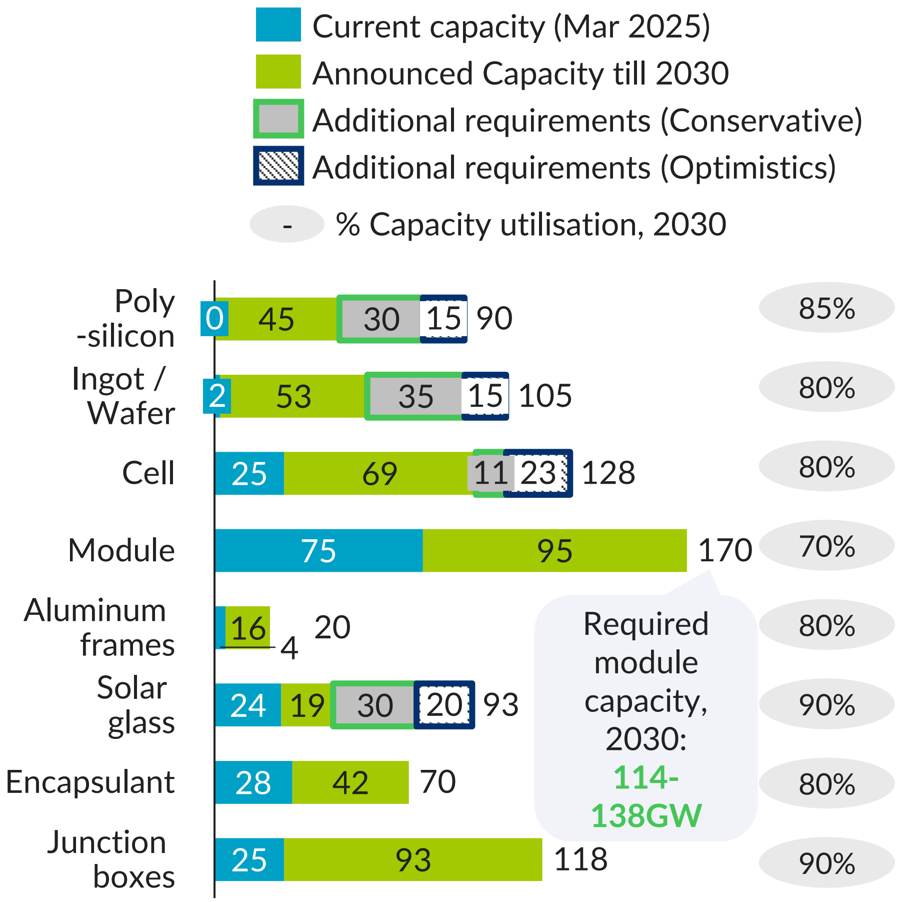
40% DVA for ALMM

Interest subvention

ALMM-equivalent for cells, 30% DVA for ALMM

Input-side Capex incentives

Manufacturing capacity required to achieve 50% indigenisation, 2030, GW[2]



Required module capacity, 2030: **114-138GW**

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(1) Cell efficiency for Utility scale solar for c-Si modules compared to 20% today (target efficiency for other applications such as rooftop and off-grid could be adjusted in-line)

(2) Chart excludes ancillaries such as Silicon sealant, Interconnects, Backsheets due to limited information available and lower contribution to Value Addition;

Source: Company announcements, PV Tech, Solar PLI, MNRE, Industry experts (industry associations, key manufacturing players); Dalberg analysis

Detailed in Annex

Demand acceleration interventions such as DVA for ALMM could fuel indigenous manufacturing across the value chain, while investment in R&D and upstream raw materials could drive innovation and self-reliance

Demand & Market Architecture

- **Integrate DVA[1] requirements into existing ALMM policies** (30% by 2027, 40% by 2028, and 50% by 2029)
- **Increase BCD on ancillary components** to enhance domestic cost-competitiveness
- Leverage **EXIM Line of Credit** to **boost solar module exports to key African markets**, while **prioritising EU and Middle East** countries with high solar demand, strong trade ties, supportive RE policies

Overall **Government** fiscal incentives required:

INR 700-800 Cr

R&D & Product Innovation

- **50-50 co-financing** from government and private sector to scale solar R&D ecosystem[2]
- **Develop shared R&D labs[3]** for R&D on **10-20 indigenous solar technologies**
- **Efforts led by a Core Working Group[4]** with industry-academia-government representation
- **Increase ALMM cell efficiency to 22%[5]** from 2027 to boost commercialization of indigenous solar innovations

Overall **Government** investment (50% of total investment required):

INR 675-1,050 Cr

Upstream Raw Materials & Critical Inputs

- Target capacity of **75-90 GW polysilicon refining by 2030**, including 45 GW of announced capacity
- Provide **INR 7,500-12,500 Cr worth capex subsidies and interest subvention** to drive cost competitiveness for domestic polysilicon
- Explore **Metallurgical Grade Silicon** capacity expansion post achieving cost competitiveness on domestic refining

Incremental capex investment required:

INR 18,500 – 34,000 Cr

***Detailed in Annex:** Demand Acceleration; R&D Ecosystem; Upstream Raw Materials*

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(1) DVA: Domestic Value Addition; (2) Infrastructure and project grants; (3) Upgrading current/ building new labs; (4) Potentially set up by MNRE/ANRF; (5) Cell efficiency for Utility scale solar for c-Si modules compared to 20% today (target efficiency for other applications, e.g. rooftop/ off-grid could be adjusted in-line)

Fiscal incentives combined with public-private partnerships for R&D and workforce skilling could accelerate indigenisation at cost-competitive prices for integrated solar module manufacturing in India

Capital Equipment & Infrastructure

- **Support MSMEs to indigenise building select equipment** for solar manufacturing (less-specialised equipment having synergies with existing industries)
- **Leverage bi-lateral G2G partnerships** to enable accelerated capital equipment import for solar (for highly specialised, advanced equipment)

Incremental capex investment required:

INR 52,500-109,000 Cr

(Includes capex for Polysilicon, no subsidies)

Talent & Workforce

- Launch **"Train the Trainers" program** and industry-linked fellowships and international PhD for R&D researchers
- **Introduce cleantech manufacturing courses** in engineering colleges, with industry co-delivered modules and internships
- Develop **standardized courses**, and allocate **up to 12% ITI upgradation budget** for low-skilled workforce

Overall **Government** investment (83% of total investment required):

INR 4,200-6,000 Cr

Financing & Taxation

- Driving **additional investment for capacity expansion** of Polysilicon, Ingot and Wafer, Cell, and Solar Glass
- **Targeted input subsidies** on capex, interest subvention to improve cost competitiveness for Indian solar cells (including polysilicon) of **INR 20,000-35,000 Cr** till 2030
- Proposed import duty waivers on key raw materials, and GST rate reduction with **potential tax revenue impact of INR 26,000-29,000 Cr**

Overall **Government** fiscal incentives required:

INR 20,000-35,000 Cr

*Achieving **50% indigenisation** across the solar value chain requires **INR 26,000-43,000 Cr** total government investment by 2030 and could result in **USD 14-15 Bn (INR 119,000 – 131,000 Cr) of** total import bill savings.*

***Detailed in Annex:** Capex and Infra; Workforce; Financing*

Increasing solar value chain indigenisation to 50% could support cumulative import savings of USD 14-15 Bn (INR 119,000-131,000 Cr) by 2030, including capital equipment imports for domestic manufacturing

Annual Solar deployment imports could increase from ~USD 6 Bn in 2025 to USD 19-23 Bn by 2030 without increased indigenisation beyond current and announced capacities across the solar value chain

Key insights

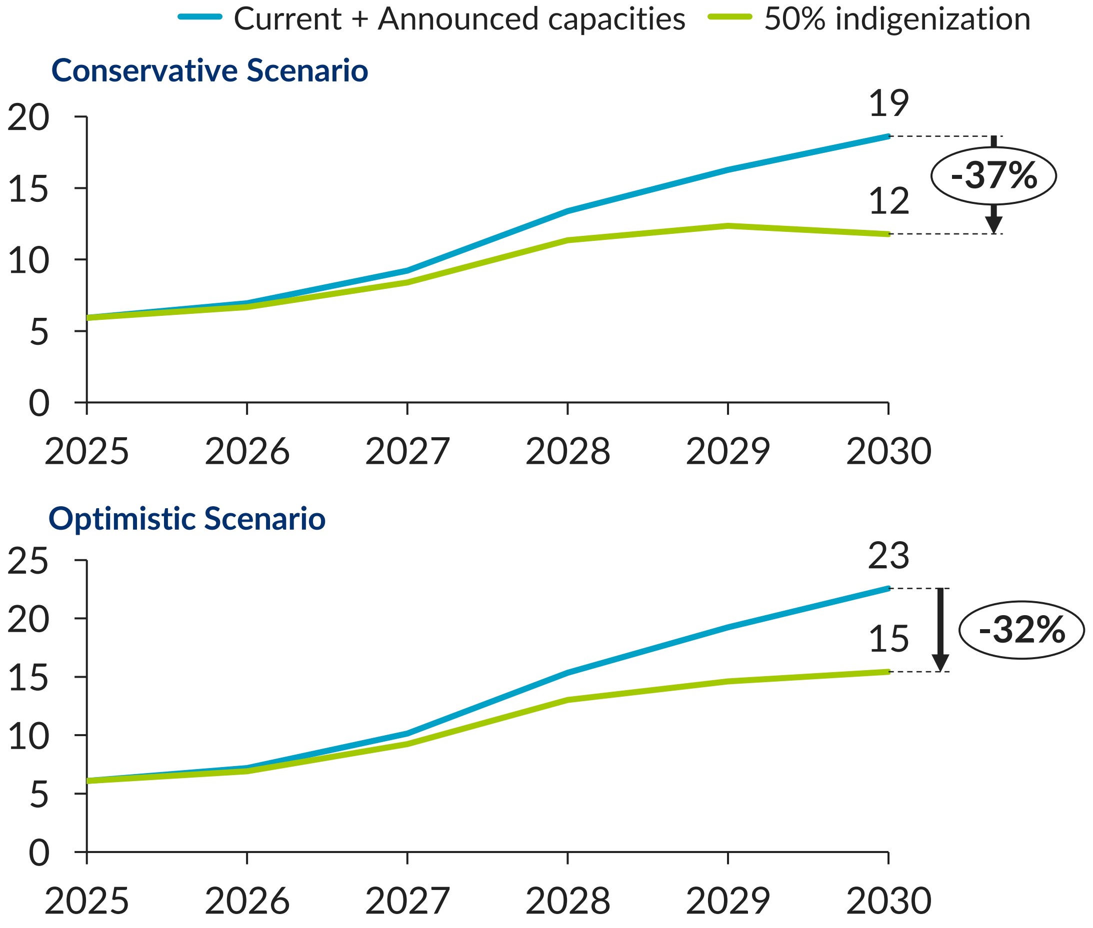
Comparison of cumulative import bill savings of USD 14-15 Bn till 2030:

Legend: 🟢 Potential Savings/Income ● Cost/Investment

Import savings comparison	**Cumulative impact 2025-2030, USD Bn**	
Cumulative import bill savings	USD 14-15 Bn	🟢
Cumulative capex investment required for 50% indigenisation*	USD 9-18 Bn	●
Government investment / fiscal incentive support	USD 3-5 Bn	●

Import bill savings resulting from 50% Indigenisation of the solar value chain outmatch the investment required

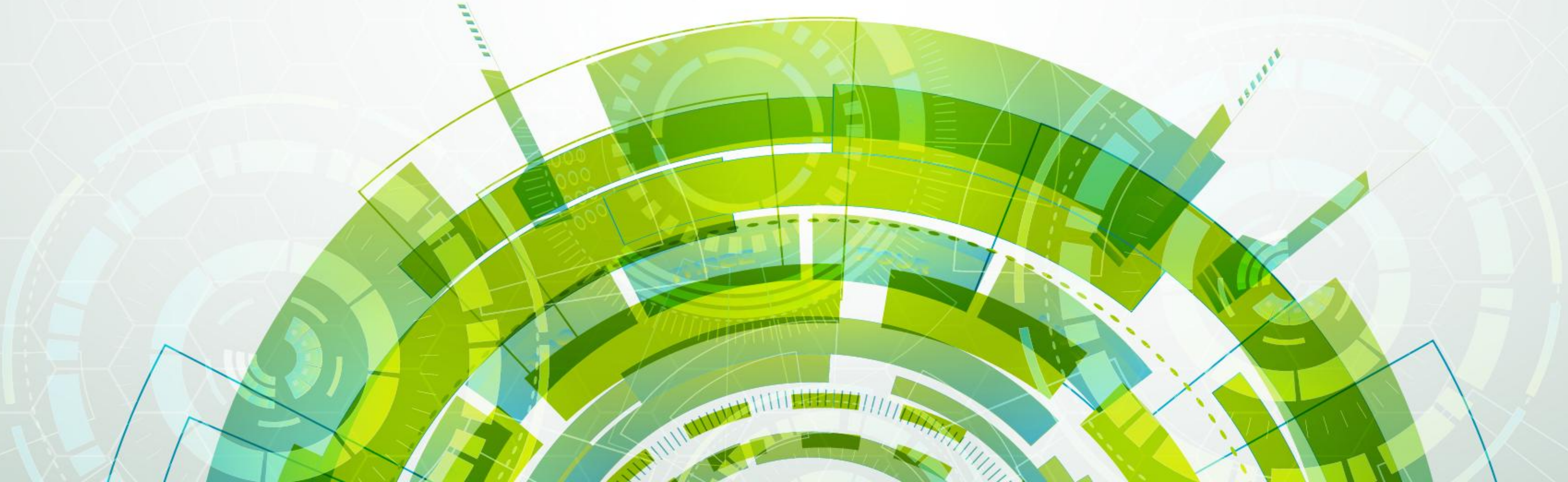
Expected annual import for solar deployment, USD Bn



Sources: EXIM bank database, Fortune India, Economic Times

SECTION THREE

SOLAR INDIGENISATION PATHWAYS FOR INDIA: DETAILED BY CROSS-CUTTING THEMES



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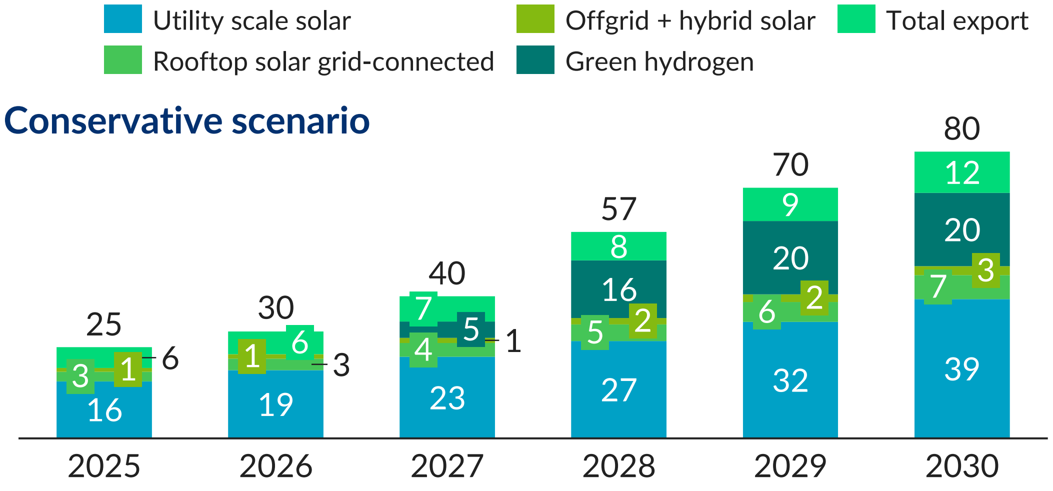
Demand | Non-fiscal demand drivers across the value chain and targeted export focus could fuel domestic module demand to 80-97 GW by 2030

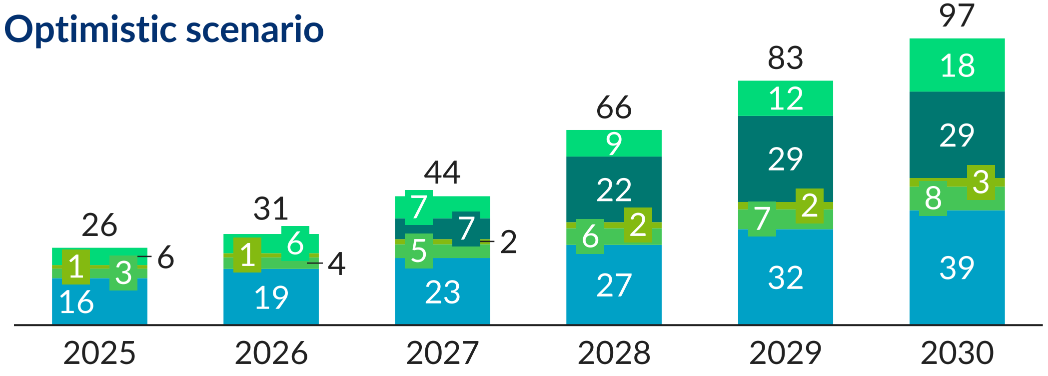
Non-fiscal policies such as DVA requirements for existing ALMM, higher BCD on ancillaries could boost domestic module adoption, while up to INR 800 Cr in interest subvention could support solar module exports to five priority African countries

Annualized solar module demand 2025 -2030, GW



Conservative scenario

Optimistic scenario



Key policy interventions

- **Value chain drivers:** Protect domestic manufacturers from global price fluctuations and accelerate demand by:
  - **Integrate phased Domestic Value Addition (DVA) requirements into existing** ALMM policies (30% by 2027, 40% by 2028, and 50% by 2029)
  - **Increase Basic Customs Duty (BCD) on ancillary components to ensure cost-competitiveness of domestic manufacturers**, and consider complementary measures such as Anti-Dumping Duties (ADD) in response to global price fluctuations on a need basis
- **Downstream demand drivers for indigenous modules:** Increase domestic adoption and fuel export demand by
  - **Integrate DVA requirements for solar modules** used in solar or solar-wind hybrid powered green hydrogen projects
  - **Leveraging INR 15,050 Cr (USD 1.75 Bn) EXIM Line of Credit**[1] at the interest subvention of **INR 700– 800 Cr to** boost solar modules exports to key African countries
  - **Promoting exports to EU and Middle East** by prioritising countries with strong solar demand, strong trade relation, supportive RE policy, enabling infrastructure

(1) India announced USD 2 Bn support to solar projects in ISA member countries in 2018 of which only USD 250 Mn has been allocated, USD 1.75 Bn remains unused

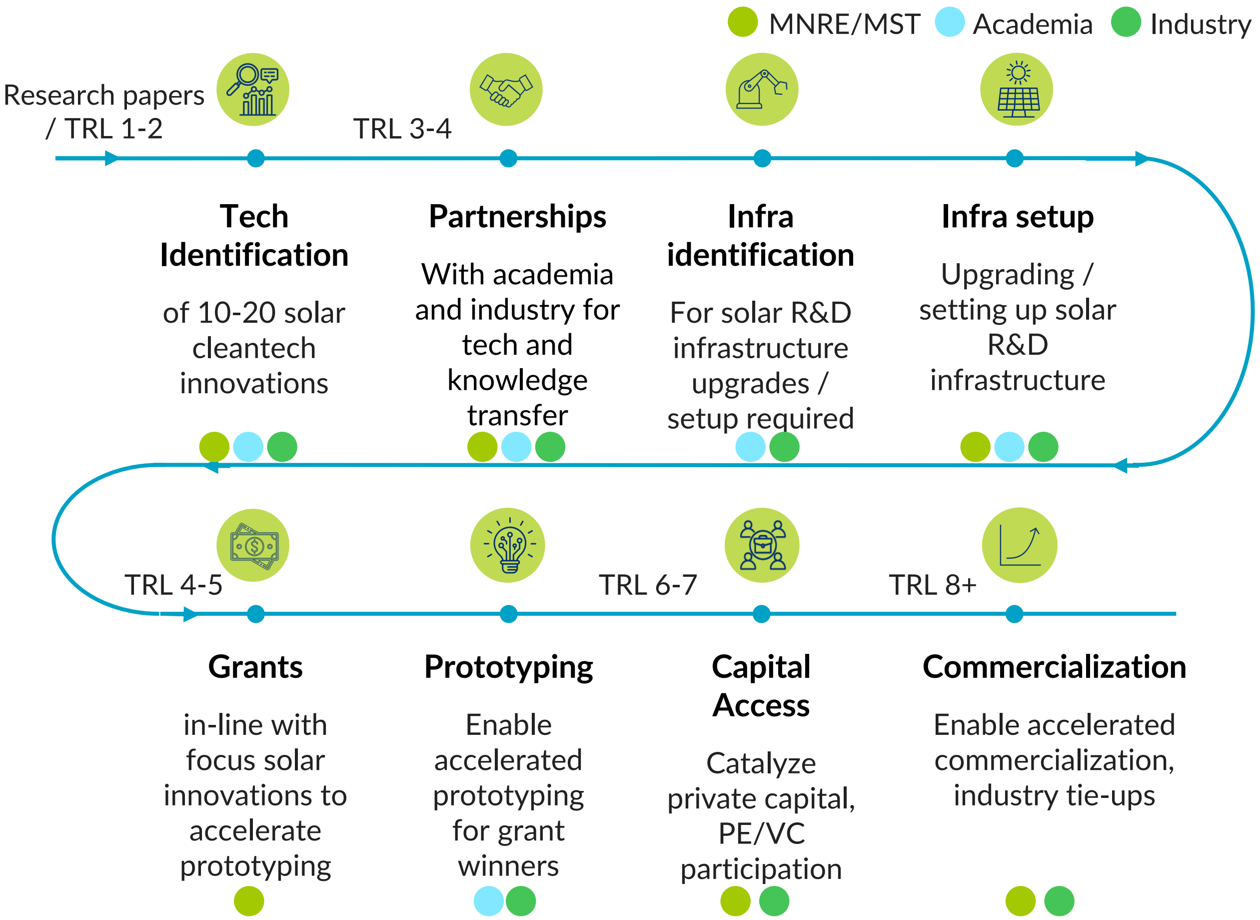
Source: MNRE, Physical progress; MNRE, Press release; : ISA, India EXIM bank ; PV Magazine, Industry experts (industry associations; Dalberg analysis

Detailed in Annex

2 **R&D** | Build a collaborative R&D ecosystem with industry-academia-government collaboration to support prototyping to commercialization for 10-20 indigenous solar innovations

The R&D ecosystem would require industry and academia participation and shared investment of INR 1,350-2,100 Cr on infrastructure investment, grants and capital access to fuel R&D and innovation for indigenous solar technologies

Steps for solar cleantech R&D acceleration



Tech Identification
of 10-20 solar cleantech innovations

Partnerships
With academia and industry for tech and knowledge transfer

Infra identification
For solar R&D infrastructure upgrades / setup required

Infra setup
Upgrading / setting up solar R&D infrastructure

Grants
in-line with focus solar innovations to accelerate prototyping

Prototyping
Enable accelerated prototyping for grant winners

Capital Access
Catalyze private capital, PE/VC participation

Commercialization
Enable accelerated commercialization, industry tie-ups

Key insights on R&D ecosystem development

- **MNRE and ANRF could set up a Core Working Group** with industry-academia-government representation **to lead efforts on** infrastructure set up, grants, private participation[1]
- **Industry participation crucial** from beginning to identify the right, focus 10-20 innovations where industry could support commercialisation
- **INR 1,350-2,100 Cr[2]** total solar R&D investment required
  - **R&D infrastructure:** INR 750-910 Cr;
  - **Project grants:** INR 600-1,200 Cr
  - **50:50 co-financing** from **private sector and government (INR 675-1,050 Cr fund share each)**
- **Open-access, shared R&D labs** to be set up across HEIs, public and private sector[3] focusing on **select, high-quality labs** maximising resource efficiency and public-private collaboration
- **Increase solar cell efficiency threshold in ALMM to 22%[4]** from 2027 onwards to encourage to encourage accelerated commercialization of indigenous solar R&D prototyping

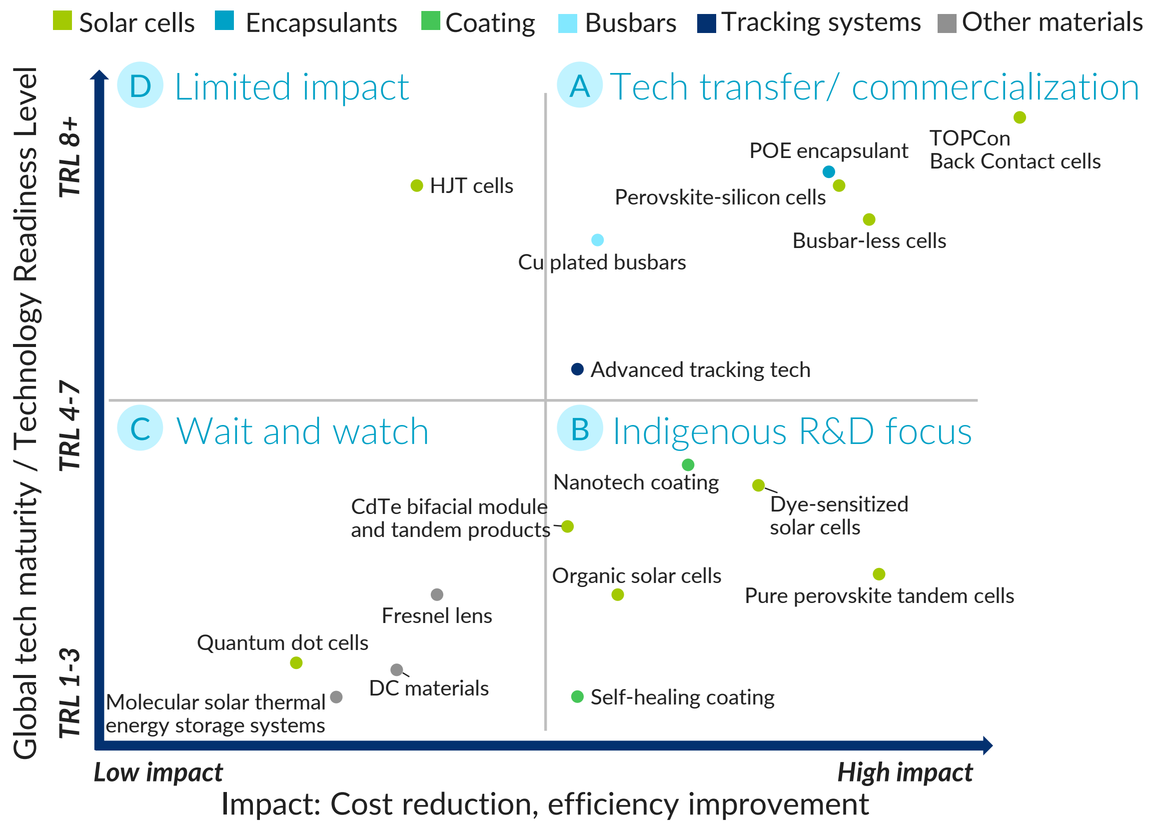
Detailed in Annex: Steps; Infrastructure; Funding

(1) Tech identification and funding; (2) Grant estimates based on USA's Small Business Innovation Research (SBIR) program; (3) Upgrading existing/ building new; (4) Cell efficiency for Utility scale solar for c-Si modules compared to 20% today (target efficiency for other applications, e.g. rooftop/ off-grid could be adjusted in-line)
Source: Academia and industry experts; US Small Business Administration, Annual Report, 2022

2 R&D | Focus R&D and innovations across the value chain and required infrastructure could be aligned with industry and academia to ensure commercialization potential and pathways prior to investment mobilization

Potential focus technologies for tech-transfer / indigenous R&D could be identified basis impact potential and global TRL levels

Focus R&D and innovation technologies: Solar



***Prioritised solar technologies could be integrated** into **solar R&D infrastructure planning**, aligning with TRL requirements*

India could invest in 14-17 R&D labs to upgrade existing labs, set up new ones, and ensure efficient operations

	DEVELOPMENT LABS	TESTING LABS
Number of labs	**10-12 development labs** *5-6 each for existing and new labs*	**4-5 testing labs** *~4 regional testing labs under 1 central facility*
Cost per lab, INR Cr	**INR 750-900 Cr** *INR 50 Cr/ lab for upgrades; INR 100 Cr/ lab for new setup*	**INR 4-10 Cr** *INR 1-2 Cr for upgrades/ new setup*
Existing labs for upgrade	*IIT Bombay* *IIT Delhi* *IIEST* International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) AN AUTONOMOUS R&D CENTRE OF DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVERNMENT OF INDIA *DST*	Central testing facility NISE
Machinery needs	- Material synthesis and deposition machines - Coating machines - Device fabrication machine	- Material testing equipment - Efficacy testing machines (lab, field, and commercial testing)
Manpower and support needs	**Advanced training** for new materials, equipment	- **PPP-led lab management** for maximizing utilisation and industry connect - **Market needs assessment** to inform relevant research

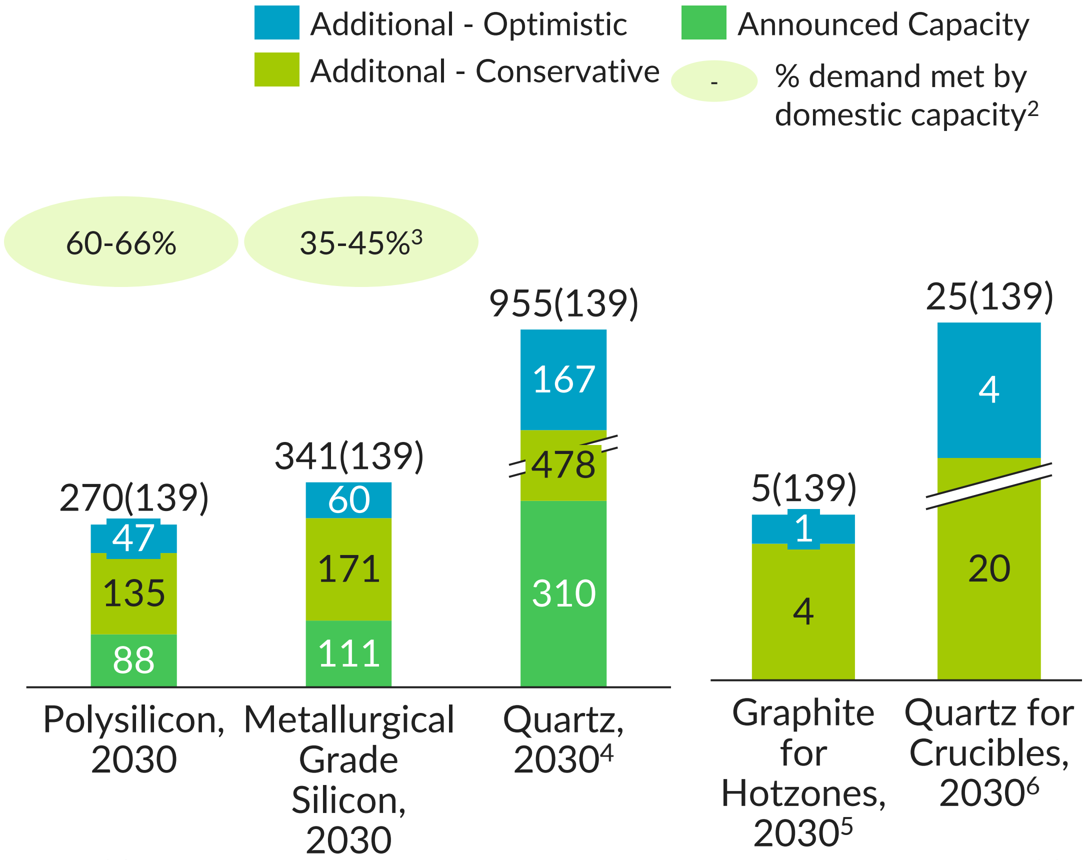
***Detailed in Annex:** Technologies; Infrastructure*

Source: Sansad and PIB reports; US Department of Energy; NREL; IEA; World Economic Forum; PV Magazine, PV Tech, Mercom India; Energetica India Magazine; Fraunhofer Institute for Solar Energy Systems ISE; Company websites and news reports; Academia and Industry experts

3 **Upstream: Raw Materials** | India could secure two-thirds of solar and semi-conductor polysilicon (10N–12N) supply domestically by 2030 with INR 18,500-34,000 Cr incremental[1] capex investment in polysilicon refining

75-90 GW of domestic polysilicon refining infrastructure could support two-thirds of polysilicon annual demand by 2030 however this would still depend on imported metallurgical grade silicon

Raw materials annual demand, including solar and semiconductor sectors, kTPA (GW)



Landscape and potential for domestic Polysilicon and Metallurgical grade silicon refining till 2030:

- **Polysilicon:** Domestic polysilicon production would require:
  - Incremental[1] Capex investment of **INR 18,500 – 34,000 Cr** for **30-45 GW** capacity by 2030
  - **INR 7,500 – 12,500 Cr** subsidies on capex and interest subvention required to be cost-competitive by 2030
- **Metallurgical grade silicon:** Imports more feasible in short term as domestic production is **2-3X import cost**
  - **Announced capacity of 50 GW[2]** could meet **35-45% of demand domestically** once commissioned
- Raw material **imports** for ingots, wafer such as **quartz crucibles** and **graphite likely to continue**

Key Benefits:

- **Co-evolution** of **solar and semiconductor industries** by domestic availability of polysilicon
- **Raw material security** for domestic solar module manufacturers
- **Potential** to become a **polysilicon export hub** in the long term and leverage for **India plus many strategy**

Detailed in Annex

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(1) Incremental investment for 30-45 GW additional capacity, above 45 GW announced; (2) Refers to 50 GW of upstream (raw material) capacity and 40 GW integrated module capacity; (3) Assuming announced capacities are implemented; (4) No clarity available on sourcing of Quartz; Sources: WITS, India Quartz exports by country, 2022; Electronics for you Business, Indosol aims for world's first whole solar module manufacturing, launches plant in Andhra Pradesh, 2024

Capital equipment & infrastructure | India could reduce capital equipment import dependence by up to 30% across polysilicon, ingot/wafer, cell, module (50%) manufacturing by building select equipment domestically (1/2)

Domestic capacity for capital equipment manufacturing could be built for equipment with cross-sector synergies and economies of scale potential, low tech expertise needs, and low efficiency and cost gaps vs. imported machines

Potential pathways for catalyzing India's capital equipment manufacturing:

🟢 High 🟡 Medium 🔴 Low

Pathway criteria	**1** Domestic manufacturing for *select, non-specialized solar equipment*	**2** Import *highly specialized, advanced solar capital equipment*
Synergies with other sectors	🟢 Existing synergies with adjacent industries (similar machine/ components/ processes like solar)	🔴 No existing synergies
Tech expertise	🟢 Need marginal improvements/ tweaks to existing machines	🔴 China leads in technical expertise; India to face very long lead time to build comparable domestic know-how
Efficiency and costs	🟡 Potential to attain global competitiveness in tech and cost efficiencies	🔴 Highly tech and cost-efficient Chinese capital equipment; domestic production unlikely to catch up
% Capex contribution	**20-30%** Potential domestic manufacturing for machinery across Polysilicon to cells (modules could be higher: up to 50%) ***Examples:*** Distillation columns, Wire sawing machines, Diffusion and IR belt furnaces, Lamination machines, etc.	**70-80%** Continued import dependence for machinery across Polysilicon to cells (could be lower for modules: up to 50%) ***Examples:*** CVD Reactors, Ingot pullers, PECVD systems, cell testing/ sorting machines, layup stations, etc.

Detailed in *Annex*

Source: Money Control; BHEL, Renewables Solar, 2025; Business Standard, "L&T's first electrolyser factory to start commercial operations soon", 2024; Bharat Forge, Power Business; SolarPower Europe, Solar Production Equipment – Key players in the EU's industrial ecosystem for solar PV, 2025 ; SaurEnergy; Industry experts

Capital equipment & infrastructure | India could reduce capital equipment import dependence by up to 30% across polysilicon, ingot/wafer, cell, module (50%) manufacturing by building select equipment domestically (1/2)

Domestic capacity for capital equipment manufacturing could be built for equipment with cross-sector synergies and economies of scale potential, low tech expertise needs, and low efficiency and cost gaps vs. imported machines

Potential pathways for catalyzing India's capital equipment manufacturing:

1 **Domestic manufacturing** for *select, non-specialized solar equipment*

2 **Import** *highly specialized, advanced solar capital equipment*

Key benefits

1:
- Potential to repurpose and build on **existing capacity**
- Reap benefits of **economies of scale and long term market opportunity**
- Initiate building resilience against foreign supply shocks

2:
- **Leverage existing foreign capabilities** to procure at effective costs and diversify supplier base
- **Quick access** to capital equipment supports rapid production ramp up
- SEA partnerships to enable trans-shipment of highly efficient Chinese capital equipment, helping overcome supply constraints

Pathway unlocks

1: ***Identify equipment synergies for solar equipment with other sectors***

- **Synergies with other industries**, e.g., Wire sawing machines with stone crushing industry; Distillation columns across multiple industries
- **Synergies in same industry for other applications**, e.g., Glass industry equipment for low-iron solar glass, aluminium frame from metal casting and shaping industry etc.

2: ***Potential to explore partners beyond China for capital equipment sourcing***

Solar component	Polysilicon	Ingots, wafers	Cells	Modules	Glass	Aluminium frames
Existing capacity	🇺🇸 🇪🇺 🇰🇷	🇰🇷	🇩🇪 🇰🇷	🇪🇺 🇯🇵	🇪🇺	No major China alternates

Detailed in Annex

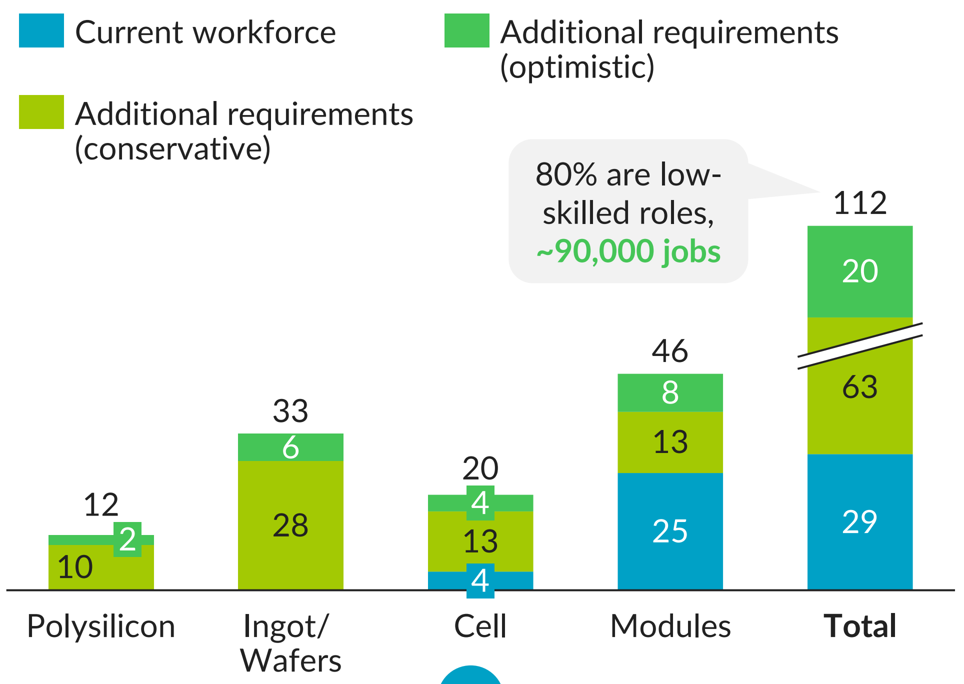
Sources: Money Control; BHEL, Renewables Solar, 2025; Business Standard, "L&T's first electrolyser factory to start commercial operations soon", 2024; Bharat Forge, Power Business; SolarPower Europe, Solar Production Equipment – Key players in the EU's industrial ecosystem for solar PV, 2025 ; SaurEnergy; Industry experts

5

Workforce | 8-12% of ITI budget could support training infrastructure and training for ~90,000 low-skilled workforce for solar sector across polysilicon to modules till 2030

To build a ready workforce, targeted interventions would be required across four critical levers including trainers, training modules, employability, finance; with skilling efforts focusing on strengthening industry linkages and global partnerships

Current and projected (2030) workforce requirement for solar manufacturing value chain, '000



80% are low-skilled roles, **~90,000 jobs**

Total budget[1]

INR 5,000 -7,200 Cr

Share of ITI upgradation budget

~8-12%

Levers: ● Trainer ● Training modules ● Employability ● Finance

Focus

Ultra-Skilled

- Develop "Train the Trainer" program for 200 – 300 trainers / academicians / professors from Top 100 engineering colleges[1]
- Attract global solar and cleantech experts to train faculty at Tier 1 engineering institutes
- Launch industry-linked fellowships and international PhD programs for 500-600 researchers annually in solar R&D

High-Skilled

- Introduce cleantech manufacturing courses for Top 100 engineering colleges
- Co-deliver cleantech manufacturing modules, and internships at manufacturing plants for engineering students

Low skilled

- Create standardized courses and qualification packs aligned with industry-defined competencies
- Allocate 8-12% of the ITI upgradation scheme to promote public-private skilling partnerships (apprenticeship – using NAPS, joint trainings by ITIs and manufacturers)
- Launching a Digital Cleantech Training Platform – an online learning hub with courses, certification programs, and job-matching services

Detailed in Annex

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(1) The total budget covers training costs and demo facility investment, focused on training for additional low-skilled workers required

6

Financing | INR 0.80 to 1.54 Lakh Cr would be required during 2025-30 to achieve 50% cost-competitive indigenisation across the solar value chain, build a cohesive R&D ecosystem and train the required workforce

Government funding of INR 26,000-43,000 Cr would be required across demand acceleration, R&D, workforce skilling and subsidies on capex and interest by 2030 to achieve these goals

Theme	Total Funding Required (INR Cr)	Government Funding Required (INR Cr)	Key Activities	Potential outcomes
Demand & Market Architecture	700- 800	700- 800	EXIM Line of Credit[2] interest subvention for solar module export (Africa)	Boost solar modules export and reduce risks of dependency on the US as the main export market
R&D & Product Innovation	1,350-2,100	675-1,050	R&D infrastructure: INR 750-910 Cr for upgrades/ set up across 14-17 R&D labs; and R&D grant funding: INR 600-1,200 Cr	Prototyping to commercialization of high-potential 10-20 solar tech indigenously with industry-academia-government collaboration
Upstream Raw Materials & Critical Inputs	18,500-34,000	Detailed in cost competitiveness below	Capex for additional capacity to develop domestic polysilicon refining	Meet two-third of polysilicon demand for solar and semi-conductor sectors through domestic refining capacities
Capital Equipment & Infrastructure	34,000-75,000[1]	Detailed in cost competitiveness below	Invest in capex expansion across the value chain; Support MSMEs to build select solar equipment domestically	Reduce import dependence for capital equipment where feasible; Ensure accelerated capacity expansion to meet 50% indigenisation
Talent & Workforce	5,000 -7,200	4,200-6,000	Training additional 60,300 low-skilled workers across solar value chain (polysilicon – module) and set up demo training facility at ITIs	Ensuring a stable supply of workers, reducing attrition and lowering training costs for manufacturers
Cost Competitive-ness Ⓐ	20,000-35,000[3]	20,000 - 35,000[3]	Input subsidies on capex and interest subvention till 2030 and import duty exemption [4], GST rate reduction to 5% from 12% leading to potential tax revenue impact of INR 26,000-29,000 Cr	Increased cost competitiveness of domestic cells – potentially bringing within 5% of Chinese landed costs
TOTAL	80,000-154,000	26,000-43,000		

Detailed in Annex

(1) Does not include capex for polysilicon (2) India announced USD 2 Bn support to solar projects in ISA member countries in 2018 - USD ~250 Mn has been allocated, USD 1.75 Bn remains unused, (3) Includes Input side capex subsidy and interest subvention till 2030 (4) On select raw materials – quartz crucible and graphite

6A

Cost Competitiveness | INR 20,000-35,000 Cr of targeted capex subsidies and low-cost financing, could improve cost competitiveness for indigenous Indian solar cells to within 5% of Chinese cells landed costs today

Indigenisation of upstream components, subsidized capex and interest subvention could reduce domestic cell costs by 26% vs. current costs, ensuring no impact on LCOE and cost competitiveness with current landed costs for Chinese cells

Current landscape indicate strong need for cost competitiveness

- **Global prices** for solar modules **reduced** significantly due to geo-political shifts and over-capacity in China leading to a wider cost-gap of up to 75% for Indian modules (Latest Chinese modules cost: 8-8.5 Cents/Watt)
- Limited impact of existing **State-level incentives** on capex, interest subsidies for large manufacturers due to **low ceilings**

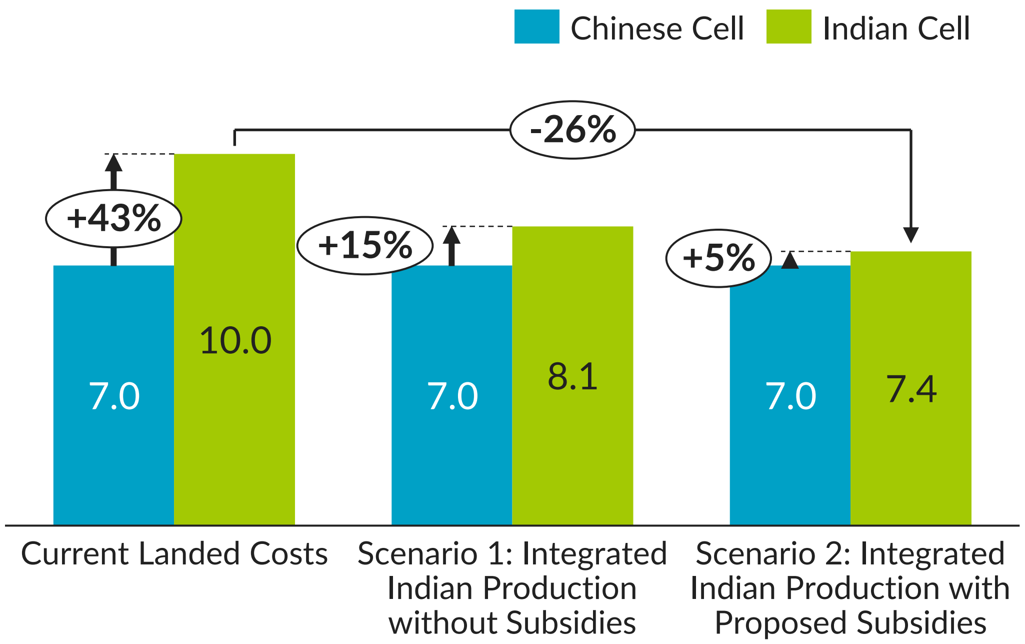
50% indigenisation could increase LCOE by 1-2% (3-5p/kWh), proposed subsidies could keep LCOE flat at current level:

- **Upfront capex subsidy** of **25%** up to **INR 10,000-22,000 Cr**
- **Interest subvention** of **25%** up to **INR 9,500-13,000 Cr**

Proposed interventions:

- **Import duty exemption** on **quartz crucibles (23%)** and **graphite for graphite hotzones (7.5%)** up to **INR 3,500-4,500 Cr till 2030**
- Reduce GST rate on modules from **12% to 5%** - potential tax revenue impact of up to **INR 22,000-25,000 Cr till 2030**
- Improved EODB policies could also lower risk perception and improve attractiveness for financiers, potentially at better cost

Comparison of Chinese and Indian Cell Landed Cost[1], US cents/ Watt, ex-GST



Targeted subsidies on capex and interest subvention

INR 20,000-35,000 Cr till 2030

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(1) Chinese solar cell landed cost is assumed to remain consistent through interventions like BCD, ALMM for cells etc. to ensure demand for domestic manufacturing

Source: MEC+, RE Supply Chain Report 2024, CSTEP, Feasibility Analysis for c-Si PV Manufacturing in India, Economic Times, Press Report, December 2024, Industry experts (industry associations, key manufacturing players), Dalberg Analysis

Detailed in Annex

SECTION FOUR

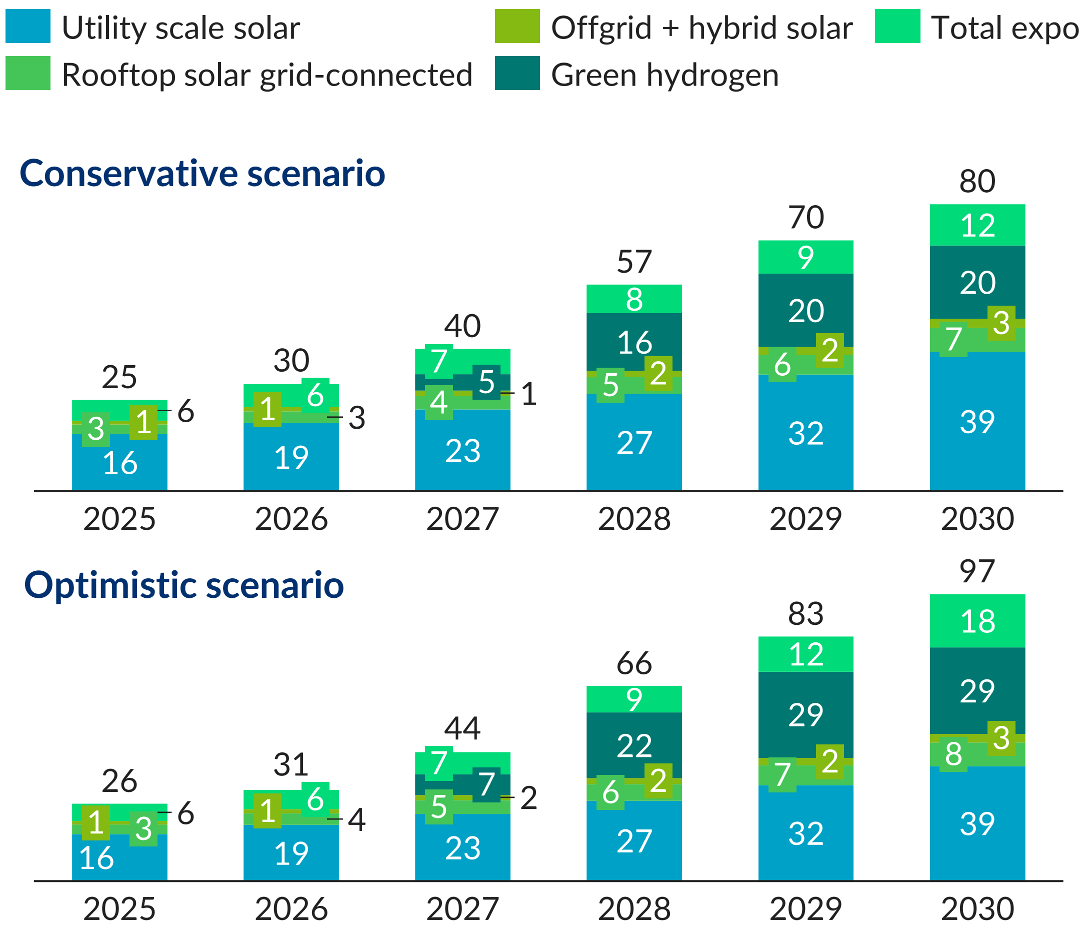
ANNEX

SUB-SECTION ONE

DEMAND & MARKET ARCHITECTURE

Demand for indigenous solar modules (and upstream value chain) could increase to 80-97 GW by 2030 driven by domestic deployment, green hydrogen and augmented through exports

Annualized solar module demand 2026 -2030, GW



Scenario description

Conservative scenario assumes:

- Existing policies continue and **50% of C&I consumers could adopt domestic modules** due to enhanced cost competitiveness
- **70% of green hydrogen generation** is through solar / solar-wind hybrid and integration of DVA requirements for solar modules in green hydrogen projects
- Exports growth is fueled by **EXIM line of credit for Africa** and in-line with **deployment growth in US (8% CAGR)**

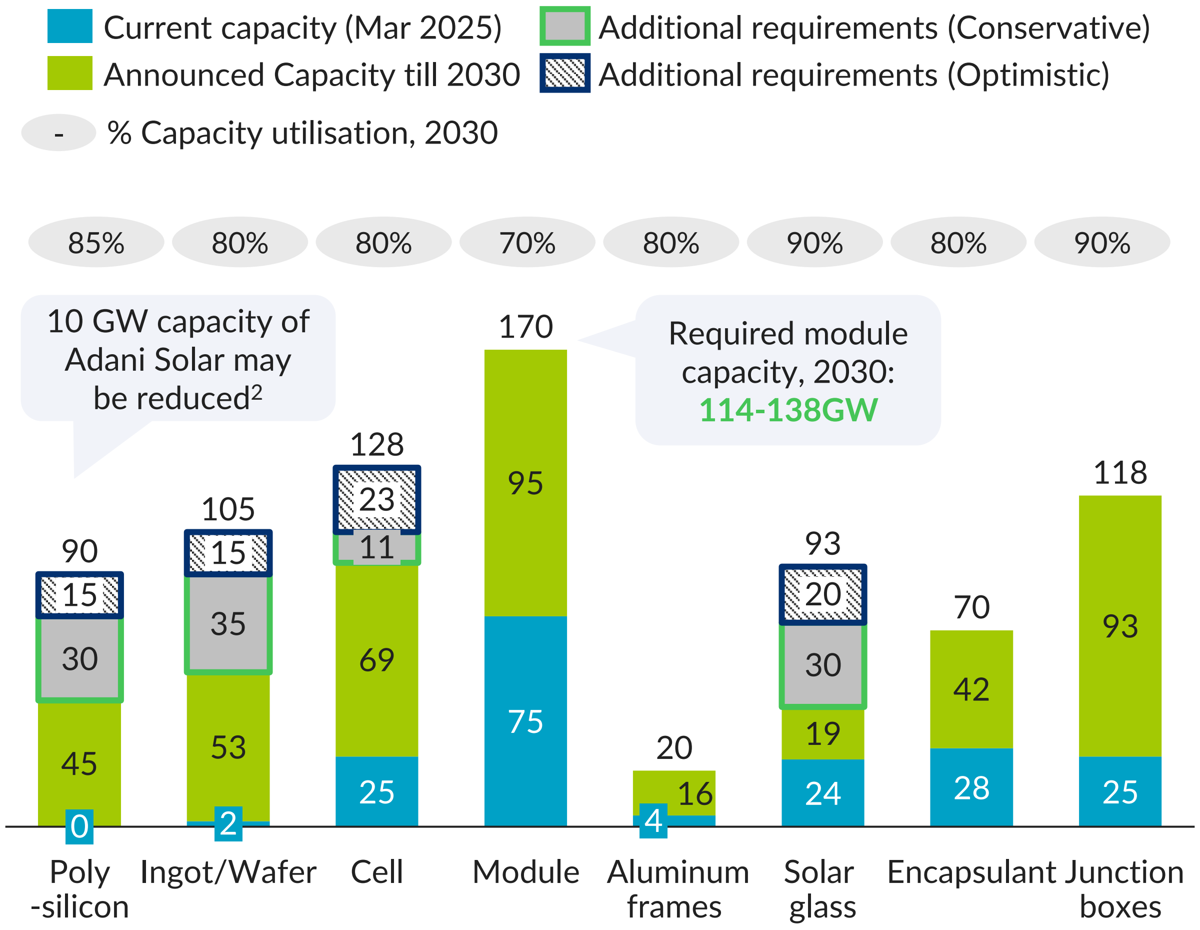
Optimistic scenario assumes:

- **70% of C&I consumers could adopt domestic modules**
- **100% of green hydrogen generation is through solar** / solar-wind hybrid and integration of DVA requirements for solar modules in green hydrogen projects
- Exports growth is fueled by **EXIM line of credit for Africa** and in-line with accelerated **deployment growth in US (10% CAGR)**

Source: MNRE, Physical progress; MNRE, Press release; Industry experts (industry associations; Dalberg analysis

90-138 GW capacity is required to meet this demand indigenously by 2030 across polysilicon to modules and ancillaries to achieve 50% indigenisation across the value chain

Manufacturing capacity required to achieve 50% indigenisation, 2030, GW[1]



10 GW capacity of Adani Solar may be reduced[2]

Required module capacity, 2030: **114-138GW**

Key insights:

- **Modules:** Current and announced capacity of 160-170 GW capacity for **modules is likely to be under-utilised**
  - Minimal future demand for ~47 GW of PERC capacity as all new deployment contracts are/expected on TOPCon/HJT
- **Cells: ALMM-equivalent** expected on domestic **cells by 2026** could support **additional expansion to 128 GW** by 2030
- **Ingot/wafer: DVA requirements in existing ALMM policies would drive deeper indigenisation across value chain** and encourage domestic production of upstream components like ingots and wafers
- **Polysilicon: Co-evolution of solar and semiconductor** could be supported through 90 GW of polysilicon refining capacity
- **Ancillaries:**
  - **Solar Glass:** Leading players are **co-locating solar glass capacities** to minimize logistics costs and have stronger quality control
  - **Aluminium frames: Module manufacturers** like Premier Energies and large players like Hindalco among those **announcing capacities for solar frames manufacturing**

(1) Chart excludes ancillaries such as Silicon sealant, Interconnects, Backsheets due to limited information available and lower contribution to Value Addition; (2) Adani Solar has reportedly paused plans to build 10 GW of polysilicon capacity due to market conditions

Source: Company announcements, PV Tech, Solar PLI, MNRE, Industry experts (industry associations, key manufacturing players); Dalberg analysis

Policy interventions such as integration of DVA requirements in existing ALMM policies, increased BCD for ancillaries and leveraging EXIM line of credit for Africa could fuel domestic solar components demand

	Recommendations	Rationale
Manufacturing		
Value chain demand driver	• **Integrate phased Domestic Value Addition (DVA) requirements** into existing ALMM policies (30% by 2027, 40% by 2028, and 50% by 2029) • **Increase BCD on ancillary components to ensure cost-competitiveness** of domestic manufacturers, and consider Anti-Dumping Duties (ADD) in response to global price fluctuations as needed	• DVA requirements would drive deeper indigenisation across the value chain • Raising BCD on ancillary components would enhance the cost-competitiveness of domestic manufacturers • ADD on a need basis protects domestic manufacturers from unfairly priced imports
Deployment		
Distributed solar	• No interventions needed. **50% of C&I consumers would adopt domestic solar modules** due to enhanced cost competitiveness	
Green hydrogen projects	• **Integrate DVA requirements for solar modules** in green hydrogen projects that used solar/solar-wind as a source of energy	• Encourage the adoption of domestic solar modules. No financial subsidy recommended due to existing financial support provided for green hydrogen under National Green Hydrogen Mission
Export	• **Leverage USD 1.75 Bn EXIM Line of Credit**[1] at the interest subvention of **INR 700 – 800 Cr** to expand solar modules exports to Kenya, Morrocco, Nigeria, South Africa • **Expand exports to EU and Middle East** with prioritisation of countries to be done based on strong solar demand, strong trade relation, supportive RE policy, enabling infrastructure	• Export diversification by leveraging India plus Many strategy could reduce over-dependence on US exports and provide an alternative supplier to global trade partners to reduce their dependence on China

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(1) India announced USD 2 Bn support to solar projects in ISA member countries in 2018 of which only USD 250 Mn has been allocated, USD 1.75 Bn remains unused
Source: ISA, India EXIM bank; Sustainable Energy for all, Africa Renewable Energy Manufacturing – Opportunity and Advancement, 2023; Dalberg analysis

SUB-SECTION TWO

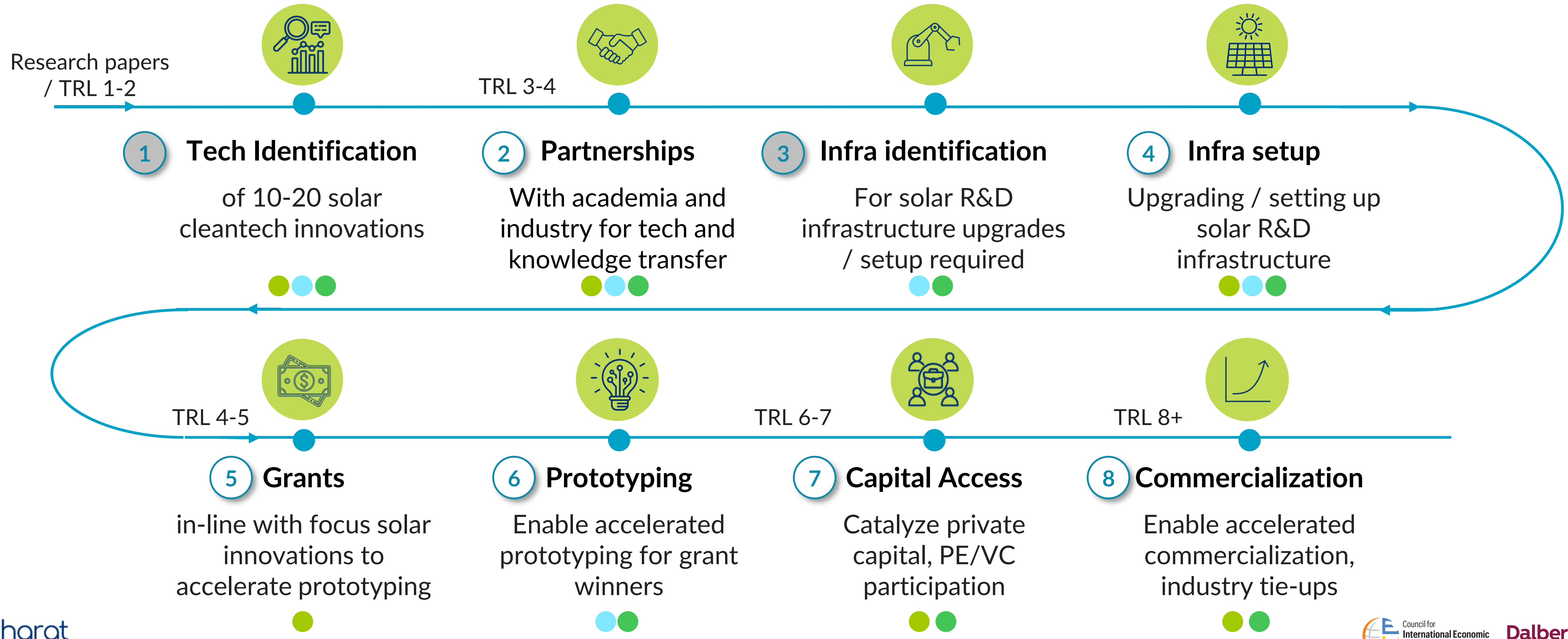
SOLAR R&D & PRODUCT INNOVATION

India could accelerate indigenous innovation on solar from identification to prototyping and commercialization through an industry-academia-government collaborative approach

MNRE and ANRF could establish a Core Working Group (with representation from industry, academia, government) to spearhead this effort and engage relevant stakeholders across various steps

Steps for solar cleantech R&D acceleration

🟡 MNRE/MST and other line ministries 🔵 Academia 🟢 Industry ⓧ Detailed ahead



Research papers / TRL 1-2

1 Tech Identification

of 10-20 solar cleantech innovations

🟡🔵🟢

TRL 3-4

2 Partnerships

With academia and industry for tech and knowledge transfer

🟡🔵🟢

3 Infra identification

For solar R&D infrastructure upgrades / setup required

🔵🟢

4 Infra setup

Upgrading / setting up solar R&D infrastructure

🟡🔵🟢

TRL 4-5

5 Grants

in-line with focus solar innovations to accelerate prototyping

🟡

6 Prototyping

Enable accelerated prototyping for grant winners

🔵🟢

TRL 6-7

7 Capital Access

Catalyze private capital, PE/VC participation

🟡🟢

TRL 8+

8 Commercialization

Enable accelerated commercialization, industry tie-ups

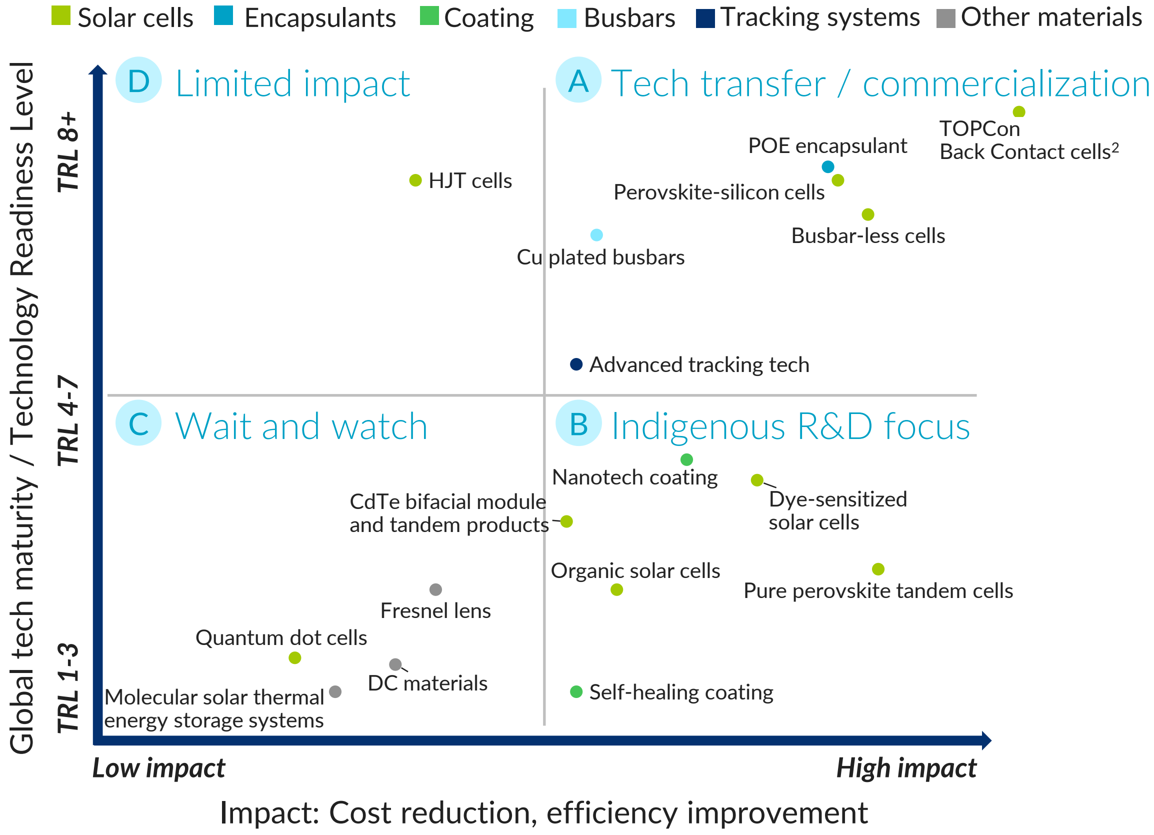
🟡🟢

Identification and discoverability | It is critical to identify key solar technologies with inputs from relevant stakeholders for targeted R&D efforts and pathways to commercialisation

NON-EXHAUSTIVE

Solar technologies can be prioritised based on their impact potential and TRL levels globally to identify focus technologies for tech-transfer or indigenous R&D and innovation

Focus R&D and innovation technologies[1]: Solar



Key Insights

Steps to identify focus solar R&D technologies:

- **Conduct global landscape assessments** and engage sector-specific stakeholders to build a validated pipeline of potential solar technologies
- **Undertake impact-based prioritisation** to focus on solar technologies with the highest relevance and potential for India
- **Use Technology Readiness Level (TRL) frameworks** to map appropriate pathways for solar technology indigenisation or transfer

Next steps:

- **Integrate** these prioritised solar technologies **into solar R&D infrastructure planning**, ensuring alignment with TRL- stage requirements
- **Increase solar cell efficiency threshold in ALMM to 22%[3]** from 2027 onwards to encourage accelerated commercialization of indigenous solar R&D prototyping

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(1) Already mature and commercial technology in India (e.g. TOPCon) not featured here; displayed tech in early R&D/ lab pilot stages; (2) Combination of TOPCon and IBC, i.e. (Interdigited Back Contact) cell architecture type; (3) Cell efficiency for Utility scale solar for c-Si modules compared to 20% today (target efficiency for other applications, e.g. rooftop/ off-grid could be adjusted in-line)

Source: Sansad and PIB reports; US Department of Energy; NREL; IEA; World Economic Forum; PV Magazine, PV Tech, Mercom India; Energetica India Magazine; Fraunhofer Institute for Solar Energy Systems ISE; Company websites and news reports

R&D infrastructure | There is need to assess R&D infrastructure requirements (upgrades/ new setups) to drive prototyping to commercialization for solar technologies (1/2)

NON-EXHAUSTIVE

Establishing select, open-access R&D development and testing labs across HEIs, public and private sector research labs can help maximize resource efficiency and encourage public-private collaboration

	KEY LEVERS	RATIONALE
1	**Create new, open-access infrastructure**	• **Improve access to R&D infrastructure** overcoming current issues like lab use restrictions and complex processes of academic R&D labs • Promote **public-private collaborations and resource sharing** across stakeholders from academia and industry
2	**Focus on developing select, state-of-the art facilities**	• Advance **multiple solar tech ideas** under one facility to maximize **infrastructure** and talent use (e.g. global solar labs like Fraunhofer, Germany) • **Reduce fragmentation, duplicity** of solar tech research across many labs
3	**Upgrade existing R&D infrastructure**	• **Enable financial efficiency** by optimizing India's existing labs progressing on solar tech, e.g. IIT-Bombay; vs. setting up new, costly infrastructure • **Build on trained human resource** and existing solar tech know-how
4	**Ensure operational efficiency and alignment with industry**	• Robust **operational management** can help **maximize capital utilisation** and sustained use of infrastructure (currently not optimum in R&D labs) • **Mapping to industry trends and needs** could ensure **solar tech innovations are relevant** and can move beyond TRL 4 to commercialization

Source: Academia and industry experts

R&D infrastructure | India could invest INR 750-910 Cr across 14-17 R&D labs to upgrade current solar R&D labs, establish new facilities, and ensure needed human resource for efficient lab operations (2/2)

	DEVELOPMENT LABS	TESTING LABS
Number of labs	**10-12 development labs** *5-6 each for existing and new labs*	**4-5 testing labs** *About 4 regional testing labs under 1 central facility*
Cost per lab	**INR 750-900 Cr** *INR 50 Cr/ lab for upgrades; INR 100 Cr/ lab for new setup*	**INR 4-10 Cr** *INR 1-2 Cr for upgrades/ new setup*
Prospective existing labs for upgrade	*IIT Bombay lab* *IIT Delhi lab* *IIEST lab* International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) AN AUTONOMOUS R&D CENTRE OF DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVERNMENT OF INDIA *DST lab*	**Central testing facility** *NISE lab*
Machinery needs	• Material synthesis and deposition machines • Device fabrication equipment • Coating machines	• Material testing equipment • Efficacy testing machines (including lab, field, and commercial testing)
Manpower and support needs	**Advanced training** for new equipment/ materials; leveraging researchers' pre-existing tech know-how	• **PPP-driven lab management team** for max. capacity utilisation, avoid delays, and develop industry connect • **Market needs assessment** of upcoming tech trends to inform relevant research

Source: Academia and industry experts

The private sector, alongside government support could help orient solar R&D priorities to industry needs, provide needed financial investments, and unlock shared R&D infrastructure

NON-EXHAUSTIVE

Private sector role

Government support

1 Provide strategic input for industry-aligned R&D

- **Support identification** of scalable, high-impact solar technologies and **commercialization pathways**
- **Designate nodal representatives** in industry associations to drive solar R&D beyond firm-level efforts

- Ensure **private sector inputs are incorporated** in decision-making; MNRE could potentially coordinate and help **align government-industry priorities**

2 Increase private R&D investment

- **Invest in prototype development and commercialization,** and support **tech transfer** by investments in academia, R&D
- **Invest in infrastructure building** (e.g., equipment in HEIs, IITs, incubators)

- **Co-finance with private sector** basis alignment with focus solar technologies and clear TRL-based commercialization pathways

__INR 675-1,050 Cr government funding__ for solar R&D (from INR 1 lakh crore R&D fund), as a __1:1 match__ for equal __private sector contribution__[1]

3 Enable greater R&D infrastructure sharing

- **Enable shared access to existing R&D infrastructure** to maximise resource utility and collaboration

- Create **public-private partnerships, joint R&D mechanisms**, etc. to **setup shared R&D labs**, accessible to start-ups
- Design **incentives/ mechanisms for shared use of private labs** while ensuring protection of intellectual property

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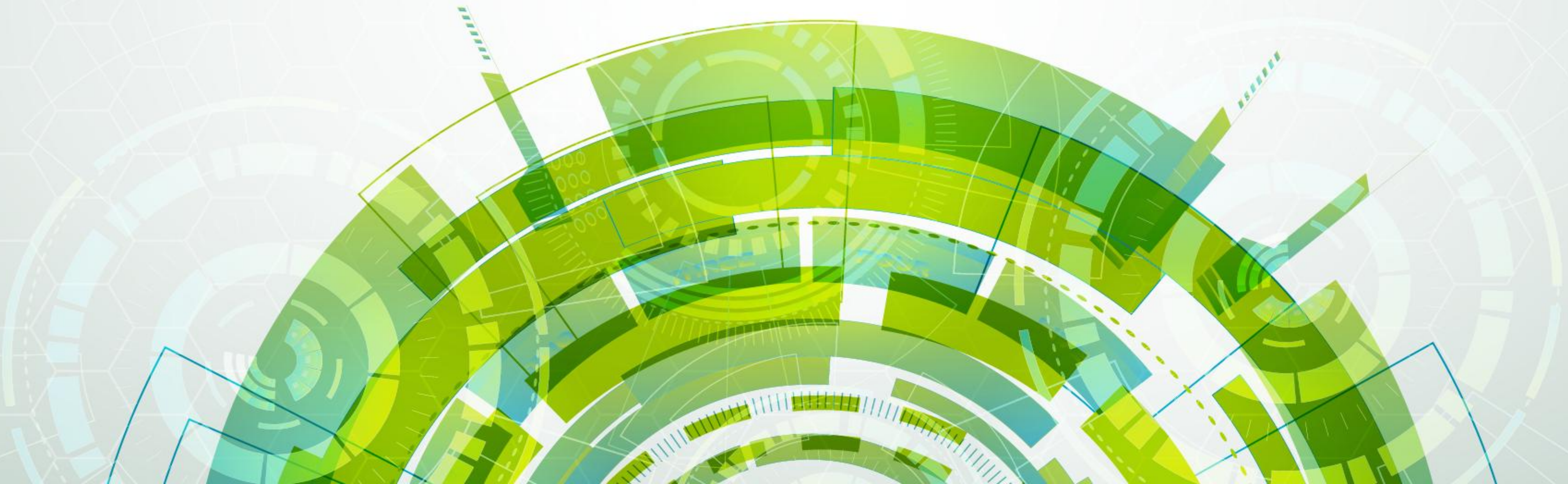
(1) Total investment required for solar R&D INR 1,350-2,100 Cr (R&D infrastructure: INR 750-910 Cr; Solar R&D grants: INR 600-1,200 Cr); Grant estimates based on USA's Small Business Innovation Research (SBIR) program

Source: Academia and industry experts; US Small Business Administration, Annual Report, 2022

SUB-SECTION THREE

UPSTREAM RAW MATERIALS & CRITICAL INPUTS



Increased indigenisation for wafers, cells and modules could lead to cumulative demand of up to **967 kT** of polysilicon between 2025- 2030, 86% of which might need to be imported from China

Polysilicon is currently imported in wafer or cell form, however, with upward integration, this could change. Current imports for raw materials are primarily critical minerals for thin film solar and for module frames and interconnects etc.

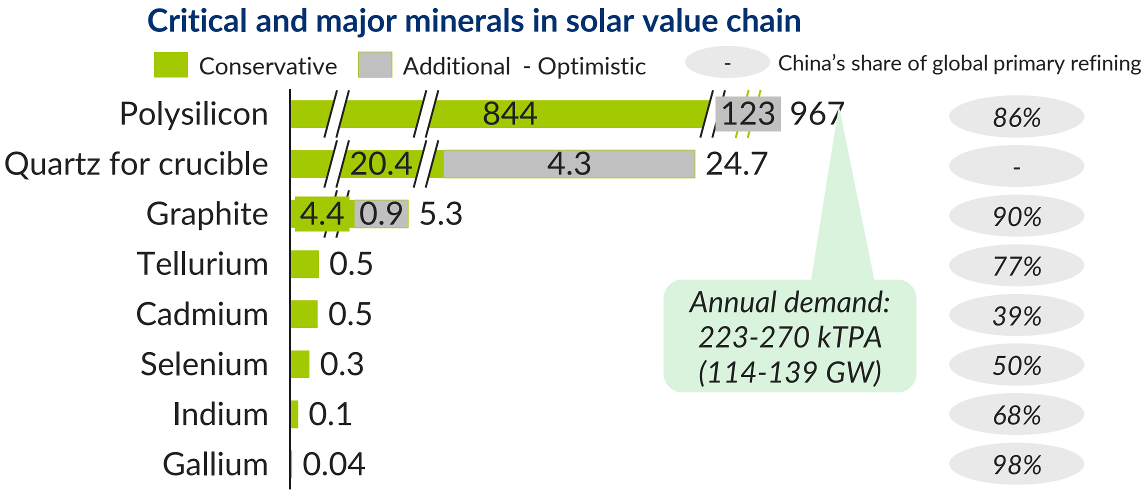
Critical minerals nearly entirely imported but not major demand component:

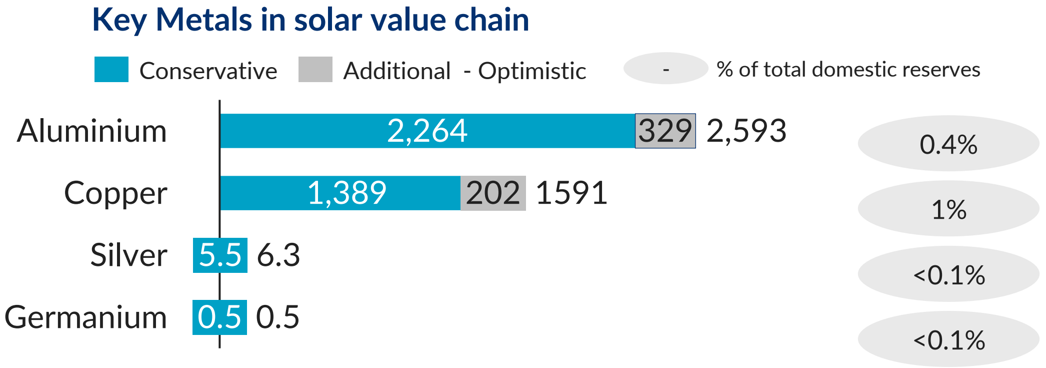
- Primarily used for **thin film modules**, 6-8% of PV demand till 2030
  - Mainly obtained through **co-refining of byproducts** during refining common ores like Bauxite, Copper, Zinc
  - India currently **lacks co-refining capacities** for domestic Bauxite, Copper, Zinc
- Estimated cumulative critical mineral import demand: **INR 507 Cr (USD 59 Mn) till 2030**
- **Import dependance** for **Quartz crucibles** (on China and North Carolina, USA) and **Graphite hotzones** (China, Madagascar, Germany, etc.) expected to continue for ingots, wafers production

Demand for other metals in solar value chain such as Aluminium largely imported despite domestic reserves:

- India has 646 Mn Tons of Bauxite reserves, but **limited capacity for refining required grade of Aluminium** for solar frames leading to high import dependence
- **Silver** is primarily imported as silver paste for **interconnects and busbars** due to no domestic capacity for producing silver paste
- Germanium is primarily used in thin film solar

Cumulative demand 2025-2030, kT





Sources: Polysilicon is obtained from quartz which was recently classified as a Major Mineral by the Ministry of Mines; Press Information Bureau, Ministry of Mines classifies Barytes, Felspar, Mica and Quartz as Major Minerals, 2025; BloombergNEF China extends cleantech dominance over US, 2024; US Department of the Interior, USGS – Mineral Commodity Summaries, 2025; Ministry of Commerce and Industry, Export Import Database; Estimated cumulative import demand based on current costs of imports

Total domestic polysilicon refining capacity of 75-90 GW is needed to achieve 50% indigenisation across solar value chain, requiring incremental investment of INR 18,500-34,000 Cr

Of the three potential pathways to reduce import dependence for polysilicon, two-thirds of the domestic demand could be met by increased domestic refining capacities by 2030

Pathways for reducing India's Polysilicon import dependance in the solar value chain

Sources of minerals and metals

	2030 Potential	**Investment / Enabler**
Domestic mineral refining capacities	Total capacity required by 2030: 75-90 GW for 50% indigenisation	Incremental investment for **30-45 GW additional capacity**[1] - INR 18,500 – 34,000 Cr
Scaling circularity	R&D in early stages, currently low potential for reuse in solar in India[2]	*To be estimated*
Diversifying import partners	Additional imports required to meet polysilicon demand worth 39-49 GW (76-95 kTPA) unmet capacity	Leverage bi-lateral, multilateral G2G partnerships with other polysilicon producers - **Germany**, **USA**, **Japan**, **South Korea**

Key insights

- Domestic capacity could meet **two-thirds of 2030 annual** demand for polysilicon (worth 114-139 GW capacity)
- R&D in early stages on **module delamination** and **material purification** technologies to drive closed loop circularity for polysilicon
- The domestic polysilicon refining capacity would still require **imports of 185-222 kTPA metallurgical grade silicon** to meet **75-90 GW** domestic polysilicon capacity from producers such as Brazil, Norway, France, etc

(1) Additional capacity beyond currently announced 45GW capacity; (2) Solar panel recycling machines by Ecoprogetti are being commercialized in EU (Italy, Spain, Greece) and indicate potential for recovering 95% silicon (98.4% purity metallurgical grade), 100% aluminium, 99% of both copper and glass, and 98.5% plastic from solar panels
Sources: BloombergNEF China extends cleantech dominance over US, 2024; US Department of the Interior, USGS – Mineral Commodity Summaries, 2025; Expert consultations and Dalberg Analysis;

Domestic refining | Strong potential to drive co-evolution of solar and semiconductor industry by setting up 75-90 GW domestic polysilicon refining capacity to achieve 50% indigenisation by 2030

Successful implementation of announced 50 GW of metallurgical grade silicon refining capacity could result in raw-material self sufficiency for 35-45% of polysilicon demand

Potential for domestic polysilicon and metallurgical grade silicon refining

- **Polysilicon:** MNRE promotes upstream indigenisation of solar PV manufacturing: **>80% of PLI outlay** targeted at Polysilicon, Wafer, Cell, Module (PWCM) and Wafer, Cell, Module (WCM) **integrated capacities**
- **Metallurgical grade silicon: 50 GW** (30 GW for raw materials and 20 GW integrated quartz to module) capacity has been announced by Indosol and Reliance Industries

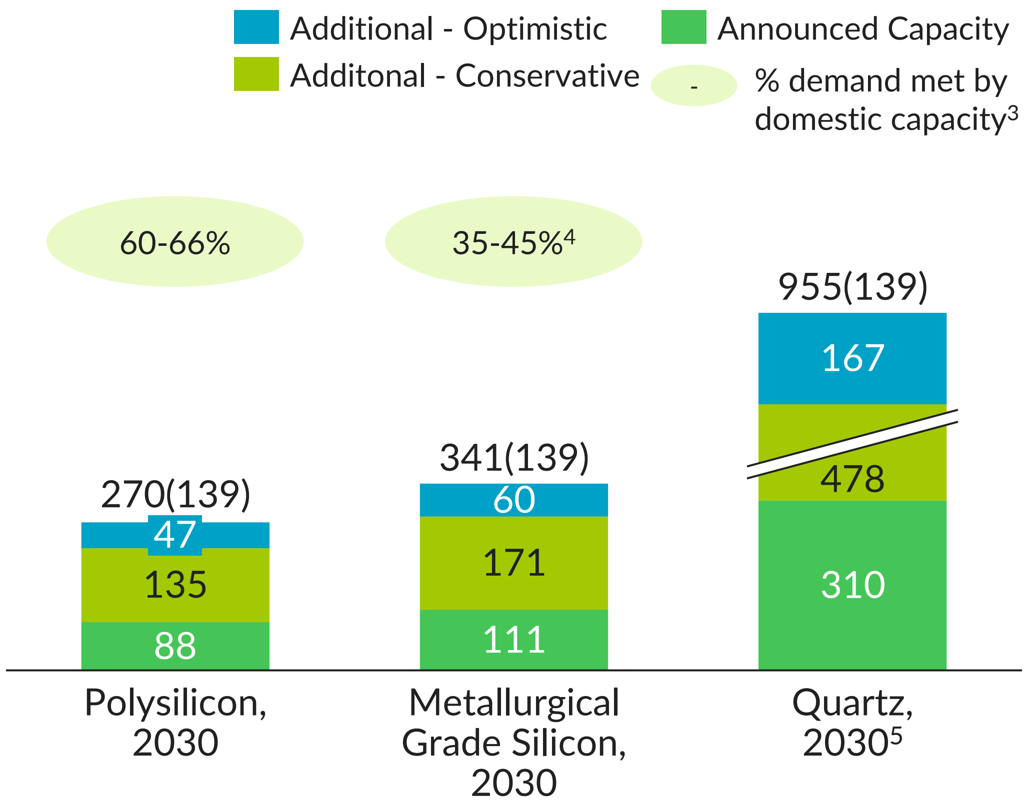
Co-evolution opportunity for polysilicon refining:

- **Rising semiconductor demand** has the potential to add an estimated additional polysilicon demand of **6-7 GW, of 10-12N polysilicon**
- Investing in polysilicon refining of 10N-12N[1] could support raw material sufficiency for both solar and semiconductor industries

Investment required:

- **INR 18,500 - 34,000 Cr** incremental[2] capex investment for 30-45 GW additional polysilicon refining capacity, over announced 45 GW

Annual demand for polysilicon, metallurgical grade silicon and quartz, including solar and semiconductor sectors, kTPA (GW)



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(1) New solar cell technologies (e.g., TOPCon) require polysilicon purity levels similar to semiconductors (10-12N); (2) Incremental investment over 45 GW announced capacity; (3) Refers to 50 GW of upstream (raw material) capacity and 40 GW integrated module capacity; (4) Assuming announced capacities are implemented; (5) No clarity available on sourcing of Quartz; Source: Ministry of Mines and Indian Bureau of Mines, Indian Minerals Yearbook 2022 Mineral Reviews – Quartz and other Silica Metals; Expert consultations and Dalberg Analysis; IEA, Solar PV Global Supply Chains, 2022; Electronics for you Business, Indosol aims for world's first whole solar module manufacturing, launches plant in Andhra Pradesh, 2024

Domestic refining | Raw-material self-reliance for polysilicon could be achieved post 2030 but is contingent on success of private players in establishing cost competitive domestic metallurgical grade refining

Roadmap for self-reliance on polysilicon and metallurgical grade silicon refining

Domestic polysilicon refining (2025-2030)

- Target **75-90 GW** total capacity (including 45 GW announced capacity) to achieve 50% indigenisation
- **Import Metallurgical Grade Silicon** as current estimated domestic cost is 2-3X import cost
- **INR 7,500-12,500 Cr Government support** required for cost competitive polysilicon production across input-side capex subsidies and interest subvention

Metallurgical grade silicon refining readiness (2027-2030)

- **50 GW upstream (raw materials)** capacity has already been announced
- Identify pathways to **reduce projected domestic Metallurgical grade silicon cost**; e.g., explore **G2G partnerships** with Australia and Africa to source **Bituminous coking coal** at favorable costs
- Identify **domestic suppliers for Electric Arc Furnaces** as per required temperature ratings

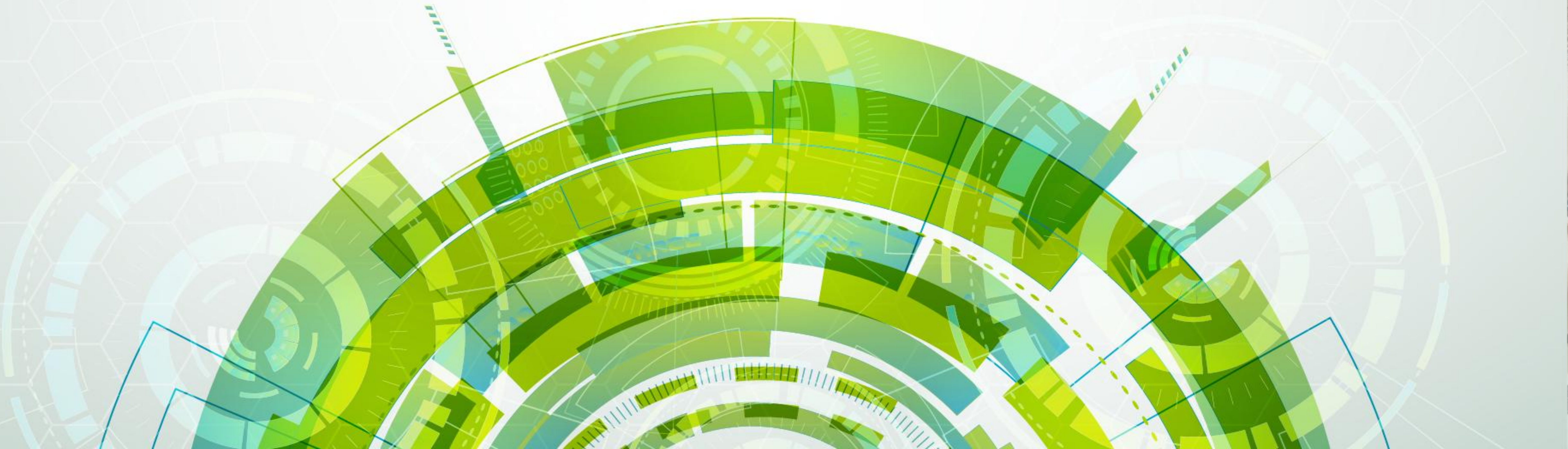
Domestic Metallurgical grade silicon refining (Beyond 2030)

- Target Metallurgical grade silicon refining capacity expansion to **75-90 GW** if announced capacity is **successfully installed**, and **achieves cost competitiveness** with global Metallurgical grade silicon prices

Source: Electronics for you Business, Indosol aims for world's first whole solar module manufacturing, launches plant in Andhra Pradesh, 2024; Industry announcements, Expert consultations and Dalberg Analysis

SUB-SECTION FOUR

CAPITAL EQUIPMENT & INFRASTRUCTURE



India's solar capital equipment ecosystem is heavily import-dependent, particularly on China — posing potential risks to long-term indigenisation goals and energy security

Despite rising solar manufacturing capacity, India has negligible domestic capital equipment production — 65-100% of capital equipment imports come from China

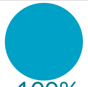
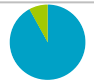
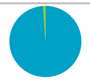
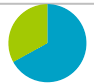
Current landscape I China leads global solar capital equipment supply while India heavily relies on imports

- **China,** home to top 10 solar capital equipment manufacturers is globally leading on efficient, cost-effective solar equipment
- **India's solar capital equipment** is heavily import dependent and enabled by **supportive government initiatives** (customs duty exemption on cells and module manufacturing equipment)
- **Other countries such as Germany, Korea and Japan** have some capital equipment production capacity, but unable to match cost and efficiency of Chinese machines

Risks I Complete import reliance, especially on single source, could increase supply chain and capital equipment cost risks

- **India's import dependence for capital equipment could increase** as manufacturing capacity grows (e.g. Module capacity expected to increase from 75 to 170 GW by 2030)
- **Trade barriers, geopolitical shifts** could disrupt capital equipment supply
- **After-sales support** like maintenance, spare parts etc. could lead to increased and **continued foreign dependence**

Solar capital equipment imports across key value chain components

Components *with ~80% value add*[1]	**Import dependence on China** *% share*	**Key machines**	**Capacity required for 50% indigenisation**[2] *GW Till 2030*
Polysilicon	No imports *as no polysilicon refining in India today*	CVD reactors	75-90
Ingots, wafers	 100%	Solar Cz pullers, diamond wire saws	88-103
Cells	 80-100%	PECVD system, metallization	80-103
Modules	 95-100%	Tabbing & stringing lines, laminator	95
Glass	 60-80%	Glass furnace, etching machine	49- 69
Aluminium frames	 100%	Furnace, anodizing equipment	16

*Current incentives do not focus much on capital equipment sourcing - addressing current risks **requires a fresh strategy** (detailed ahead)*

(1) Components adding ~80% value based on respective share in total Bill of Materials (BOM); (2) Refers to total manufacturing capacity for solar

Sources: IEA, Solar PV Global Supply Chains, 2022; Union Budget 2024-25, MEC+, RE Supply Chain Report, 2024; Dalberg analysis

Indigenous solar capital equipment manufacturing in India would need to overcome challenges such as limited economies of scale, technical expertise, large efficiency and cost gaps vs. global players and long lead times

Key challenges in developing domestic capital equipment manufacturing:

Limited economies of scale	**Nascent, small-scale domestic solar manufacturing** in India (e.g. modules: total 160-170 GW till 2030 vs. ~180 GW added by China in 2024 alone) **may not justify future, large investments** needed to set up capital equipment base
Limited tech expertise	**High technical expertise needed**, to keep pace with fast-moving and rapidly evolving PV technologies; **India currently lacks** this and could require a **long time to ramp-up**
Large gap vs. global efficiency and costs	**Chinese machines** are **highly efficient and cost effective** which **Indian capital equipment** manufacturing may not be able to **match** ***Global example:*** *Germany, once a leader in machine supply, is now trying to catch up with China's efficiency improvements on their own machines*
Long lead time for development	**Long timelines** to develop indigenous capital equipment capacity could result in **machines lagging technological advancements by the time of commercialization** ***India example:*** *In oil refining sector, government incentives target local machine sourcing increase from 20% to 50% over 10 years (2017-26)*

*Considering the priorities for solar manufacturing in India, **indigenous CAPEX manufacturing, particularly for highly specialised equipment could be deprioritised***

CASE STUDY: Lessons from China

- ***Context:*** In the 2000s, leading capital equipment manufacturers, e.g. US and Europe shifted base to China due to lower costs
- **China's rise in capital equipment manufacturing**
- **Imported machines; started domestic production**
  - **Imported machinery from Germany,** especially more advanced ones (e.g. PECVD)
  - Began **domestic production with simpler machines** (e.g. thermal machines)
  - **Significant government support** (up to 80% subsidy on domestic machinery) enabled low-cost production of capital equipment too
- **Gained technical knowledge**
  - **Reverse engineered imported machines** to absorb technical know-how
- **Built efficiencies and became market leader**
  - Made **marginal improvements** to machines; **within 10-15 years** became **self reliant** and **export leader** in low-cost, high-efficiency machinery

Sources: MEC+, RE Supply Chain Report, 2024; IEA: Renewable Energy Market Update - June 2023; Ministry of Petroleum and Natural Gas, Circular for Minimum Local Content (MLC) for purchase preference, 2017 and 2023; Industry experts

India could reduce its capital equipment import dependence by up to 30% across polysilicon, ingot/wafer, cell and module (50%) manufacturing by building select equipment domestically (1/2)

Domestic capacity for capital equipment manufacturing could be built for equipment with cross-sector synergies and economies of scale potential, low tech expertise needs, and low efficiency and cost gaps vs. imported machines

Potential pathways for catalyzing India's capital equipment manufacturing:

🟢 High 🟡 Medium 🔴 Low

Pathway criteria	**1** **Domestic manufacturing** for *select, non-specialized solar equipment*	**2** **Import** *highly specialized, advanced solar capital equipment*
Synergies with other sectors	🟢 **Existing synergies** with adjacent industries (similar machine/ components/ processes like solar)	🔴 No existing synergies
Tech expertise	🟢 Need **marginal improvements**/ tweaks to existing machines	🔴 China leads in technical expertise; India to face very long lead time to build comparable domestic know-how
Efficiency and costs	🟡 Potential to attain global competitiveness in tech and cost efficiencies	🔴 Highly tech and cost-efficient Chinese capital equipment; domestic production unlikely to catch up
% Capex contribution	**20-30%** Potential domestic manufacturing for machinery **across Polysilicon to cells** (**modules** could be higher: up to 50%) ***Examples:*** Distillation columns, Wire sawing machines, Diffusion and IR belt furnaces, Lamination machines, etc.	**70-80%** Continued import dependence for machinery **across Polysilicon to cells** (could be lower for **modules**: up to 50%) ***Examples:*** CVD Reactors, Ingot pullers, PECVD systems, cell testing/ sorting machines, layup stations, etc.

Sources: Money Control; BHEL, Renewables Solar, 2025; Business Standard, "L&T's first electrolyser factory to start commercial operations soon", 2024; Bharat Forge, Power Business; SolarPower Europe, Solar Production Equipment – Key players in the EU's industrial ecosystem for solar PV, 2025 ; SaurEnergy; Industry experts

India could reduce its capital equipment import dependence by up to 30% across polysilicon, ingot/wafer, cell and module (50%) manufacturing by building select equipment domestically (2/2)

Domestic capacity for capital equipment manufacturing could be built for equipment with cross-sector synergies and economies of scale potential, low tech expertise needs, and low efficiency and cost gaps vs. imported machines

Potential pathways for catalyzing India's capital equipment manufacturing:

1 Domestic manufacturing for *select, non-specialized solar equipment*

2 Import *highly specialized, advanced solar capital equipment*

Key Benefits

1:

- Potential to repurpose and build on **existing capacity**
- Reap benefits of **economies of scale and long term market opportunity**
- Initiate building resilience against foreign supply shocks

2:

- **Leverage existing foreign capabilities** to procure at effective costs and diversify supplier base
- **Quick access** to capital equipment supports rapid production ramp up
- SEA partnerships to enable trans-shipment of highly efficient Chinese capital equipment, helping overcome supply constraints

Pathway unlocks

1:

Identify equipment synergies for solar equipment with other sectors

- **Synergies with other industries**, e.g., Diamond wire cutters with stone crushing industry; Submersible Electric Arc Furnace (EAF) with Steel EAF etc.
- **Synergies in same industry for other applications**, e.g., Glass industry equipment for low-iron solar glass, aluminium frame from metal casting and shaping industry etc.

2:

Potential to explore partners beyond China for capital equipment sourcing

Solar component	Polysilicon	Ingots, wafers	Cells	Modules	Glass	Aluminium frames
Existing capacity	🇺🇸 🇪🇺 🇰🇷	🇰🇷	🇩🇪 🇰🇷	🇪🇺 🇯🇵	🇪🇺	No major China alternates

Sources: Money Control; BHEL, Renewables Solar, 2025; Business Standard, "L&T's first electrolyser factory to start commercial operations soon", 2024; Bharat Forge, Power Business; SolarPower Europe, Solar Production Equipment – Key players in the EU's industrial ecosystem for solar PV, 2025 ; SaurEnergy; Industry experts

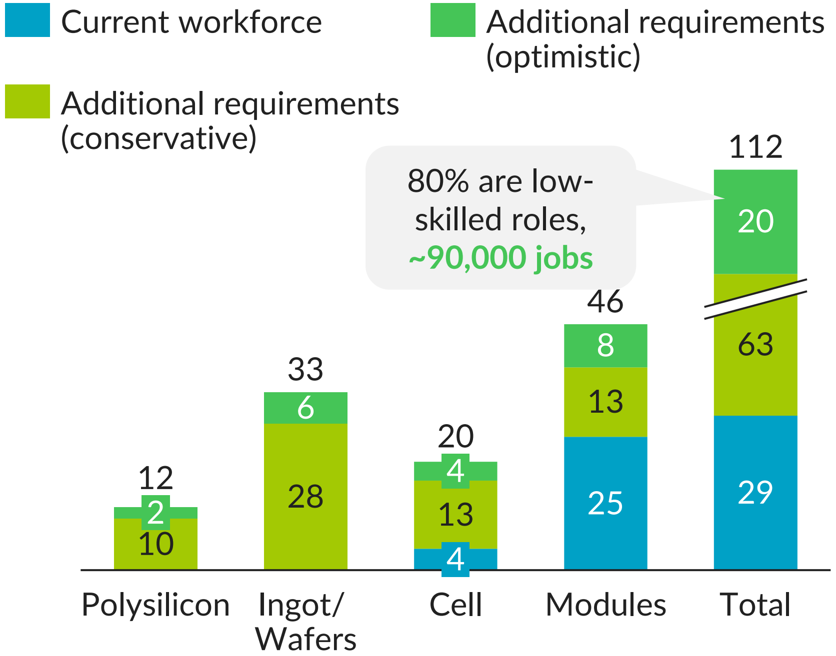
SUB-SECTION FIVE

TALENT & WORKFORCE

India would require up to 90,000 low-skilled workers across solar manufacturing by 2030, who could be trained with 8-12% of ITI upgradation budget

Workforce for cell manufacturing will be priority to prepare for upcoming production. Further, a higher focus would be required for training ultra-skilled R&D talent as majority of lower-skill workforce could also be hired from adjacent industries[1]

Current and projected (2030) workforce requirement for solar manufacturing value chain, in '000



80% are low-skilled roles, **~90,000 jobs**

Skill levels and sources of talent for solar manufacturing

Focus

Ultra-skilled	**R&D and Innovation Experts** *Research labs, PhD/Postgrad programs, Tier-1 engineering institutes*
High-skilled	**Engineers & Technical Specialists** *Tier-1 and Tier-2 engineering colleges*
Low-Skilled	**Production line workers** *ITIs, vocational training programs*

Industry insight[3]

Cells:

- **Shortage of high-skilled workers** who can meet cleanroom and process discipline and **ultra-skilled workforce** for R&D in cell technology

Ingots/Wafers:

- Potential to hire from adjacent industries like **automotive and mechanical** industries

Polysilicon:

- Potential to hire from adjacent industries like **petrochemical** industry

Total training cost[2]

INR 2,000-2,700 Cr

+

Total demo facility investment[3]

INR 3,000-4,500 Cr

Total budget (estimated share of ITI upgradation budget[4])

INR 5,000-7,200 Cr (~8-12%)

(1) Assumption: Current workforce for polysilicon, ingot, and wafer assumed to be zero as no domestic capacity yet; (2). Training cost for additional low-skill workers required; (3) Assumption: 2–3 ITIs tagged to each manufacturing plant (total 25 plants today; assuming 20% new plants will come up by 2030 to total of 30 plants); (4) Solar glass industry could benefit from ITI skilling programs but could also cross-hire from broader glass workforce, thus, excluded from current investment estimation

Source: Industry experts (industry associations, key manufacturing players), Dalberg analysis

To successfully build this workforce, action would be required across four critical levers: reducing foreign trainer dependency, standardizing training, improving employability and securing financing

LEVERS	CURRENT STATUS	RECOMMENDATIONS
Trainers	Dependent on foreign trainers for capital machinery set up, especially for upstream manufacturing	• **Launch a 'Train the Trainer' program** for professors and academicians at Tier-1 engineering colleges, with overseas immersion in advanced solar manufacturing hubs like EU, Korea, Japan, China
Training modules	Varied training approaches and modules across different industry players	• **Standardise qualification packs and courses** through collaboration with industry, academia • **Expand initiatives like Suryamitra** to include manufacturing training • **Utilise R&D infrastructure**[1] to train ultra-skilled workforce
Employability	Employability impacted due to limited manufacturing job-ready skills for graduates from ITIs, engineering colleges	• **Co-delivery of cleantech manufacturing modules by academia and industry** • **Internships and apprenticeships** at manufacturing facilities for engineering students, can help reduce retraining costs for manufacturers
Finance	Disaggregated investment in manufacturing skills – either directly at ITI level or manufacturer-led on-the-job training	• Invest INR 5,000-7,200 Cr for training and demonstration facility set up through **innovative financing instruments** (e.g., skill bonds) • Catalyze private sector investments in skilling, **CSR and private foundation** funding for ultra-skilled talent development and ITI investments

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(1) As per recommendations for R&D infrastructure upgrade in R&D section, leveraging the upgraded infrastructure for training is imperative

Source: Industry experts (industry associations, key manufacturing players)

Skilling efforts for solar manufacturing across skill levels could focus on strengthening industry linkages and global partnerships, along with offering specialized courses in engineering colleges and ITIs

Skill level	Recommendations	Responsible Ministry/Agency
Ultra-Skilled	• **Develop 'Train the Trainer'[1] program** to train 200–300 trainers/academicians/professors from Top 100 engineering colleges with the help of 25 leading global trainers through government-to-government (G2G) partnerships with academia and industry in countries such as EU, Korea, Japan, China	Ministry of Education, Ministry of Skill Development and Entrepreneurship (MSDE), Directorate General of Training (DGT)
	• **Attract solar/cleantech experts** from the EU, Korea, Japan, China to **train academicians and professors** at Tier 1 Engineering colleges (top 25-30)	MSDE, Ministry of Education
	• **Establish research fellowships and industry-linked PhD programs with institutions abroad** (Germany, China, Korea, Japan etc.) on solar R&D for 500-600 researchers per year	Ministry of Education
High-Skilled	• **Introduce specialized courses specifically for clean tech manufacturing** for Top 100 engineering colleges	Ministry of Education
	• **Strengthen industry-academia** by co-delivery of cleantech manufacturing modules, and internships at manufacturing plants for engineering students	Ministry of Education
Low-skilled	• **Develop standardized qualification packs and courses** that reflect a superset of competency requirements defined by private sector manufacturers	National Council for Vocational Education and Training, DGT, Skill Council for Green Jobs
	• **Repurpose 8-12% of the ITI upgradation scheme** to promote public-private skilling partnerships (apprenticeship programs using NAPS, joint trainings by ITIs and manufacturers) between 15 solar manufacturers and ITIs in proximity (total of 60-90 ITIs)	MSDE, DGT, ITIs
	• **Launch a Digital Cleantech Training Platform** – an online learning hub with courses, certification programs, and job-matching services	MSDE, ITIs

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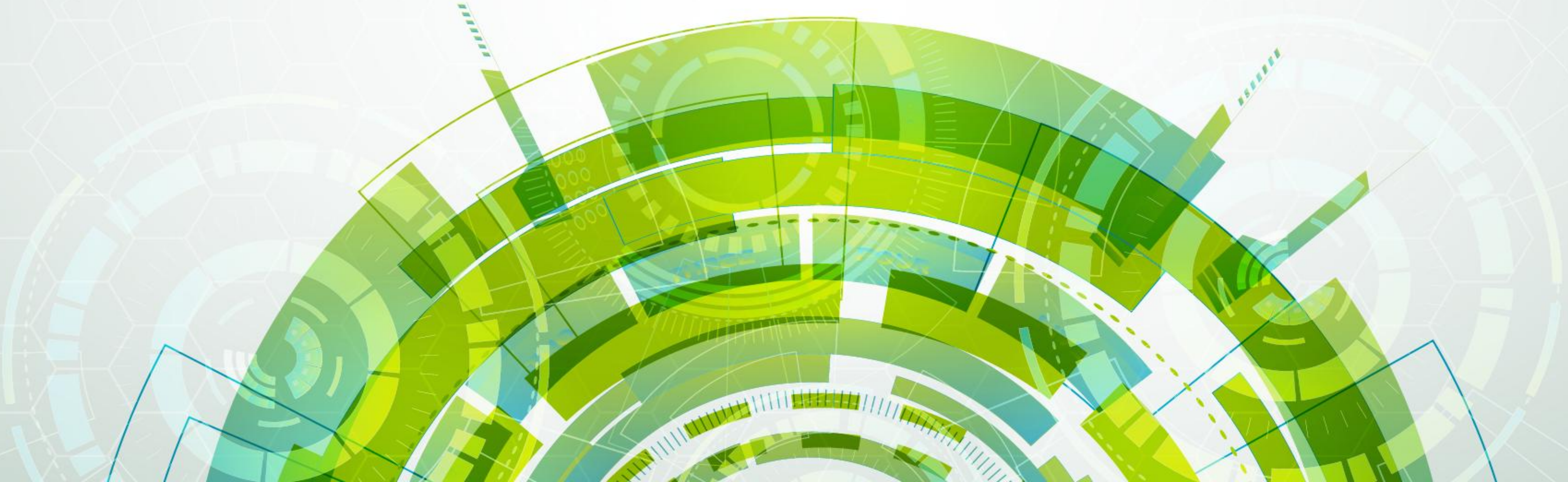
(1) The "Train and Trainer" program is applicable to the high-skilled workforce as well

SUB-SECTION SIX

FINANCING & TAXATION



Financing | INR 0.80 to 1.54 Lakh Cr would be required during 2025-30 to achieve 50% cost-competitive indigenisation across the solar value chain, build a cohesive R&D ecosystem and train the required workforce

Government funding of INR 26,000-43,000 Cr would be required across demand acceleration, R&D, workforce skilling and subsidies on capex and interest by 2030 to achieve these goals

Theme	Total Funding Required (INR Cr)	Government Funding Required (INR Cr)	Key Activities	Potential outcomes
Demand & Market Architecture	700- 800	700- 800	EXIM Line of Credit[2] interest subvention for solar module export (Africa)	Boost solar modules export and reduce risks of dependency on the US as the main export market
R&D & Product Innovation	1,350-2,100	675-1,050	R&D infrastructure: INR 750-910 Cr for upgrades/ set up across 14-17 R&D labs; and R&D grant funding: INR 600-1,200 Cr	Prototyping to commercialization of high-potential 10-20 solar tech indigenously with industry-academia-government collaboration
Upstream Raw Materials & Critical Inputs	18,500-34,000	Detailed in cost competitiveness below	Capex for additional capacity to develop domestic polysilicon refining	Meet two-third of polysilicon demand for solar and semi-conductor sectors through domestic refining capacities
Capital Equipment & Infrastructure ①	34,000-75,000[1]	Detailed in cost competitiveness below	Invest in capex expansion across the value chain; Support MSMEs to build select solar equipment domestically	Reduce import dependence for capital equipment where feasible; Ensure accelerated capacity expansion to meet 50% indigenisation
Talent & Workforce	5,000 -7,200	4,200-6,000	Training additional 60,300 low-skilled workers across solar value chain (polysilicon – module) and set up demo training facility at ITIs	Ensuring a stable supply of workers, reducing attrition and lowering training costs for manufacturers
Cost Competitive-ness ②	20,000-35,000[3]	20,000 - 35,000[3]	Input subsidies on capex and interest subvention till 2030 and import duty exemption[4], GST rate reduction to 5% from 12% leading to potential tax revenue impact of INR 26,000-29,000 Cr	Increased cost competitiveness of domestic cells – potentially bringing within 5% of Chinese landed costs
TOTAL	80,000-154,000	26,000-43,000		

ⓧ *Detailed ahead*

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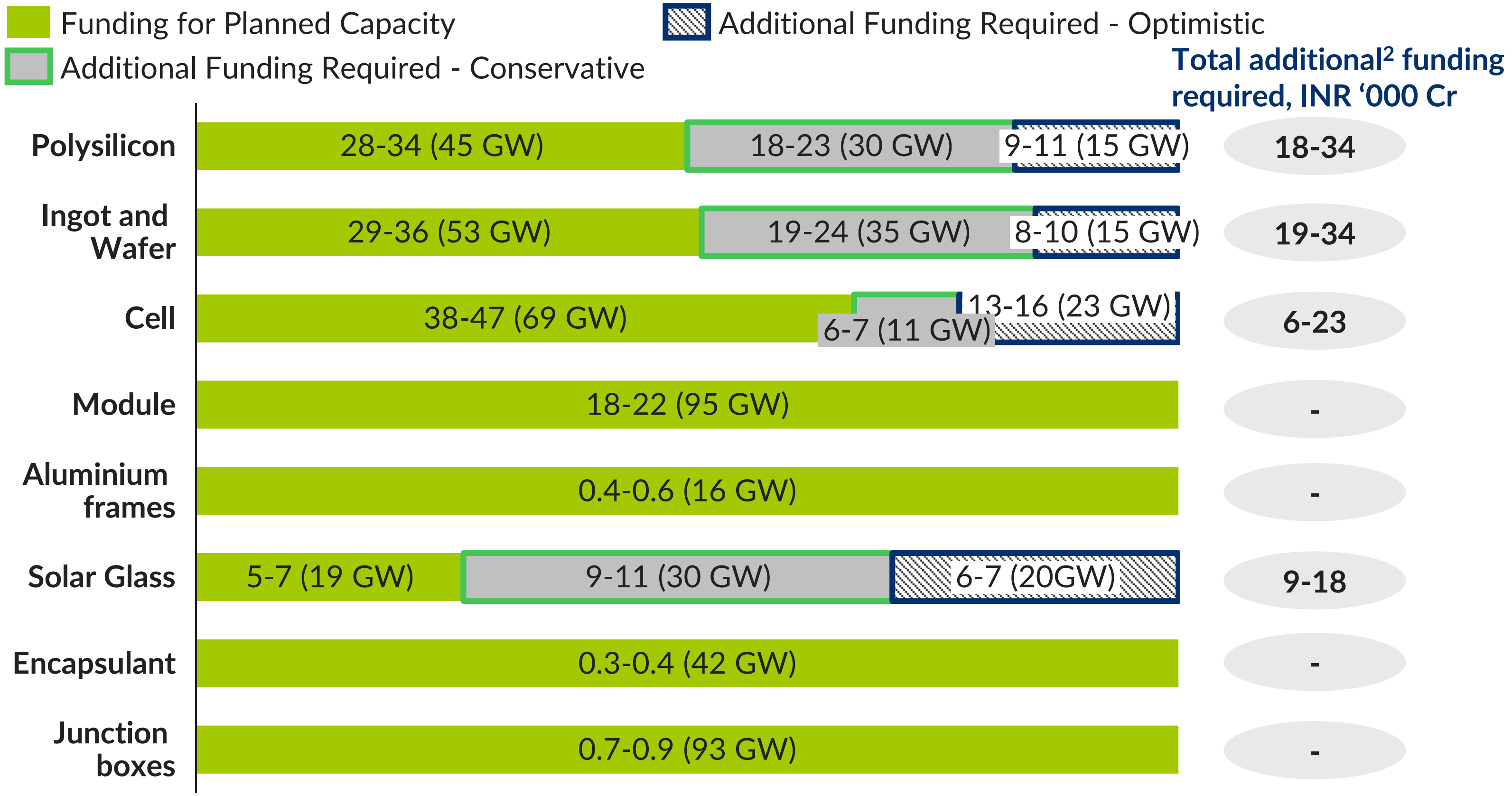
(1) Does not include capex for polysilicon; (2) India announced USD 2 Bn support to solar projects in ISA member countries in 2018 - USD ~250 Mn has been allocated, USD 1.75 Bn remains unused; (3) Includes Input side capex subsidy and interest subvention till 2030; (4) On select raw materials – quartz crucible and graphite

1 **Capex Equipment & Infrastructure** | Despite announced capacity additions, additional capital investment of up to INR 1.1 Lakh Cr required to achieve 50% indigenisation across Solar PV value chain (optimistic scenario)

Availability of subsidized financing and clear demand signals across the value chain are required to catalyze additional capital investment required to meet 50% 2030 indigenisation target

Cumulative capital investment required by 2030[1], INR '000 Cr (Capacity in GW)



Key initiatives required

- Non-fiscal demand driving incentives such as introducing progressively higher DVA requirements in ALMM
- Domestic market rate protection from global price fluctuations through BCD, with ADD as per global market conditions
- **Ancillaries:** Mix of BCD and DVA requirements under ALMM required for solar glass, encapsulants and aluminium frames

Incremental capex investment required, 2026-30

Conservative Scenario:
INR 52,500-64,500 Cr
Optimistic Scenario:
INR 89,000-109,000 Cr

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(1) Chart excludes ancillaries such as Silicon sealant, Interconnects, Backsheets due to limited information available and lower contribution to value addition. Module capacity as per ALMM April 2025

(2) Assumed that planned capacities have already been funded

Source: MNRE, MEC+, RE Supply Chain Report 2024, Company announcements, Industry experts (industry associations, key manufacturing players), Dalberg Analysis

2 **Cost Competitiveness** | INR 20,000-35,000 Cr of targeted capex subsidies and low-cost financing, could improve cost competitiveness for indigenous Indian solar cells to within 5% of Chinese cells landed costs today

Indigenisation of upstream components, subsidized capex and interest subvention could reduce domestic cell costs by 26% vs. current costs, ensuring no impact on LCOE and cost competitiveness with current landed costs for Chinese cells

Current landscape indicate strong need for cost competitiveness

- **Global prices** for solar modules **reduced** significantly due to geo-political shifts and over-capacity in China leading to a wider cost-gap of up to 75% for Indian modules (Latest Chinese modules cost: 8-8.5 Cents/Watt)
- Limited impact of existing **State-level incentives** on capex, interest subsidies for large manufacturers due to **low ceilings**

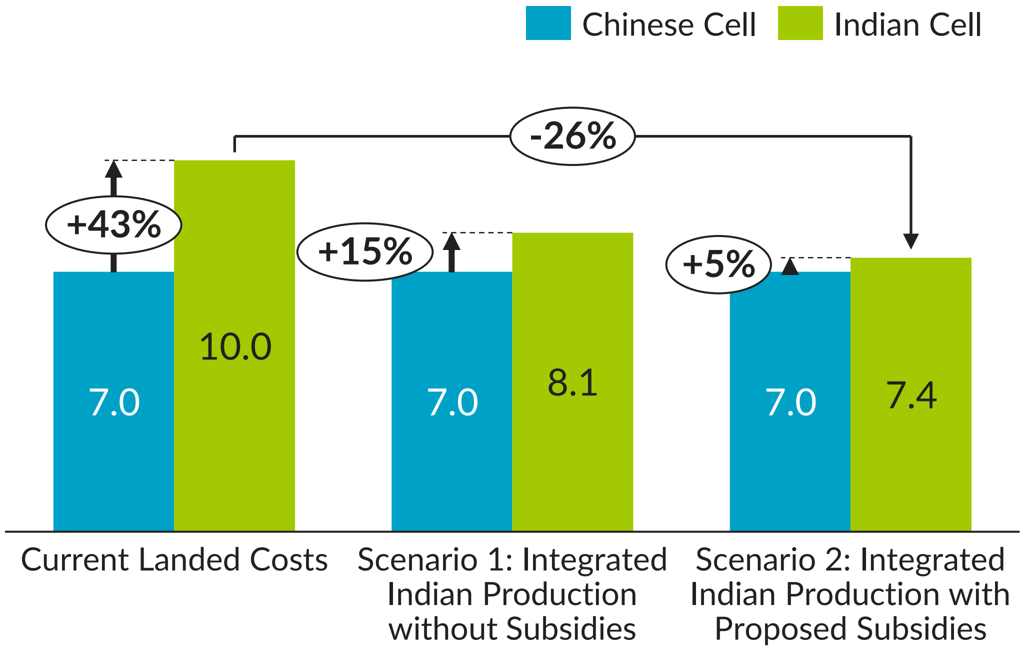
50% indigenisation could increase LCOE by 1-2% (3-5p/kWh), proposed subsidies could keep LCOE flat at current level:

- **Upfront capex subsidy** of **25%** up to **INR 10,000-22,000 Cr**
- **Interest subvention** of **25%** up to **INR 9,500-13,000 Cr**

Proposed interventions:

- **Import duty exemption** on **quartz crucibles (23%)** and **graphite for graphite hotzones (7.5%)** up to **INR 3,500-4,500 Cr till 2030**
- Reduce GST rate on modules from **12% to 5%** - potential tax revenue impact of up to **INR 22,000-25,000 Cr till 2030**
- Improved EODB policies could also lower risk perception and improve attractiveness for financiers, potentially at better cost

Comparison of Chinese and Indian Cell Landed Cost[1], US cents/ Watt, ex-GST



	Chinese Cell	Indian Cell
Current Landed Costs	7.0	10.0
Scenario 1: Integrated Indian Production without Subsidies	7.0	8.1
Scenario 2: Integrated Indian Production with Proposed Subsidies	7.0	7.4

Targeted subsidies on capex and interest subvention

INR 20,000-35,000 Cr till 2030

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(1) Chinese solar cell landed cost is assumed to remain consistent through interventions like BCD, ALMM for cells etc. to ensure demand for domestic manufacturing

Source: MEC+, RE Supply Chain Report 2024, CSTEP, Feasibility Analysis for c-Si PV Manufacturing in India, Economic Times, Press Report, December 2024, Industry experts (industry associations, key manufacturing players), Dalberg Analysis

2 Capex and financing costs, and key raw materials are key cost drivers targeted for subsidies and duty waivers along with restoring GST rate on modules to 5% from 12%

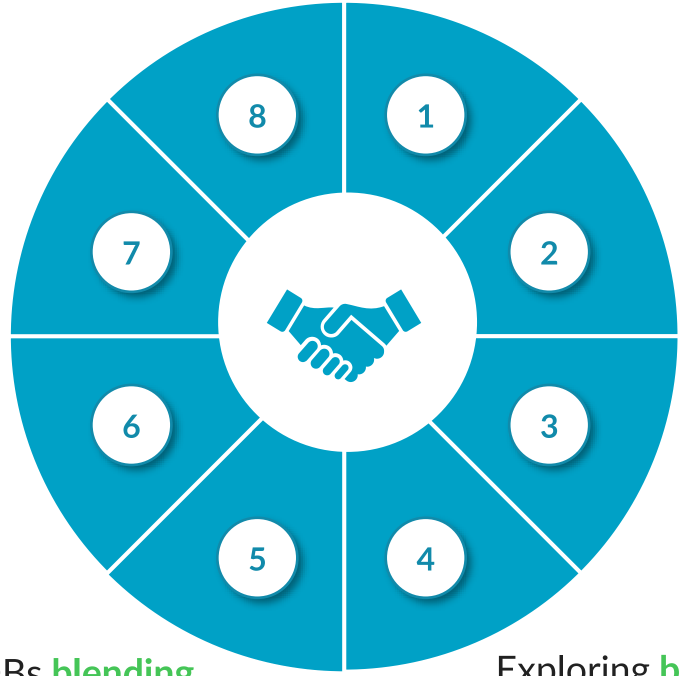
Category	Intervention type	Inputs and assumptions	Key recommendations	Total Impact, INR '000 Cr	
				Conservative Scenario	Optimistic Scenario
Input Subsidy	CAPEX Subsidy	• INR 53,000 – 109,000 Cr additional capex required • Cost contribution ranges from 1-15% across value chain	• **25% capex subsidy** proposed • Covering incremental capacity required for Polysilicon, Ingot and Wafer, and Cell manufacturing	10,000-12,500	18,000-22,000
	Interest Rate Subsidy	• Interest rates assumed at 11% p.a. • Cost contribution ranges from 1-16% across value chain	• **25% interest subvention** proposed • Effective rate of 8.25% p.a. • Proposed for announced and additional capacity required	~9,500	~13,000
Tax Revenue Impact	Import Duty Waiver on Quartz Crucibles and Graphite	• Contributes 15-20% of Ingot and Wafer cost • Import duty of 23% (Crucibles) and 7.5% (Graphite)	• BCD, CVD, ACD waiver proposed at 8-digit HS Code level • Covering all Ingot and Wafer manufacturing	~3,500	~4,500
	GST Reduction	• 12% GST on Modules currently	• Proposed GST reduction to 5% • Covering all module manufacturers	~22,000	~25,000

2 Financing costs could also be lowered via concessional capital from DFIs, MDBs, bilateral funding, and lowering domestic borrowing costs through credit guarantees, concessional lines of credit, among others

ILLUSTRATIVE

NON-EXHAUSTIVE

Government must create an enabling environment to facilitate tapping of domestic and international capital sources at concessional rates – targeted policies for solar and other cleantech manufacturers required



Structured guarantee instruments and **grants to reduce guarantee fees** to promote green bond issuances among first time issuers

Leveraging DFIs and Multilateral concessional capital potentially backed by EU, bilateral guarantees E.g. EU Global Gateway strategy, India-ETFA TEPA

Extending Priority Sector Lending and **concessional line of credit** to banks for solar manufacturing (similar to China's CERF program)

Utilising GIFT-IFSC's regulatory flexibility and lower transaction costs for green/transition bond listings and attracting foreign equity

Establishment of proposed **National Green Finance Institution** with dedicated corpus and relevant enablers to provide low-cost financing for solar deployment and manufacturing

Easing access to equity capital by **relaxing exchange listing requirements** on profitability for solar manufacturers to reflect their longer path to profitability

Developing **structured bonds** with DFIs and MDBs **blending INR and foreign currency** denominated tranches to fund projects requiring significant imports of capital machinery

Exploring **bilateral concessional funding with Middle Eastern nations** for setting up overseas manufacturing and deepening trade partnerships

Source: Industry experts (industry associations, key manufacturing players), Dalberg Analysis

bharat
CLIMATE FORUM

Thank you!

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