Bharat Cleantech Manufacturing Platform: Capital Equipment and Infrastructure

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 *Aatmanirbhar* and *Viksit Bharat*

India has national targets and projections across renewable energy and e-mobility for 2030…

300 GW Solar *installed capacity*[1]

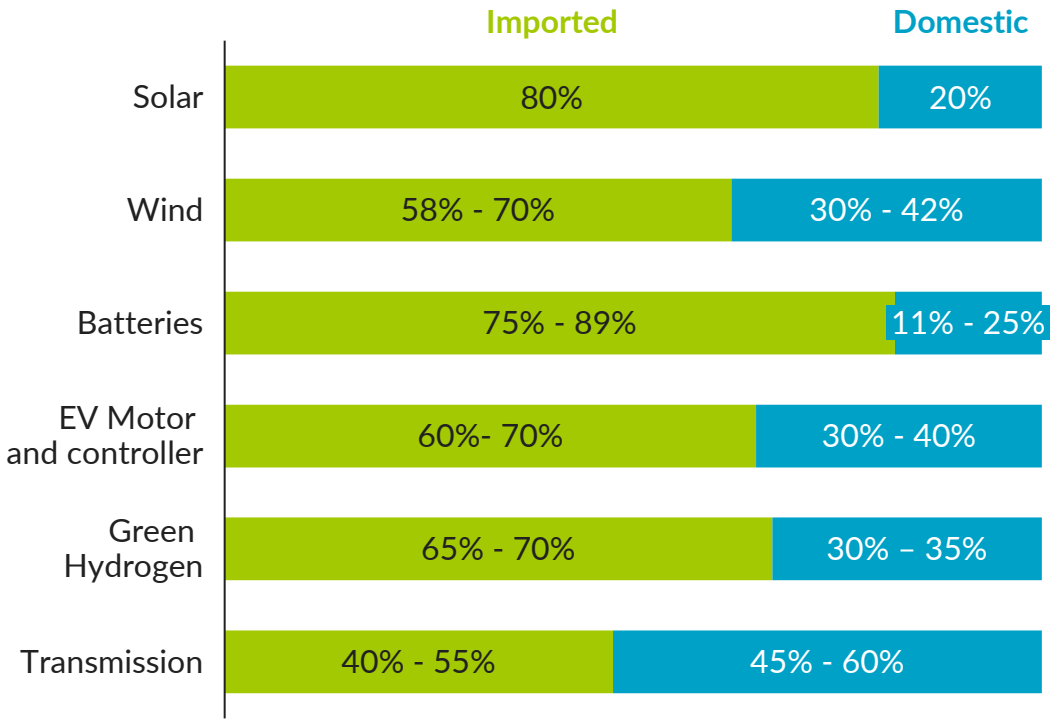
30% EV *sales penetration*[2]

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 Aatmanirbhar 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*

Detailed ahead

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TABLE OF

Contents

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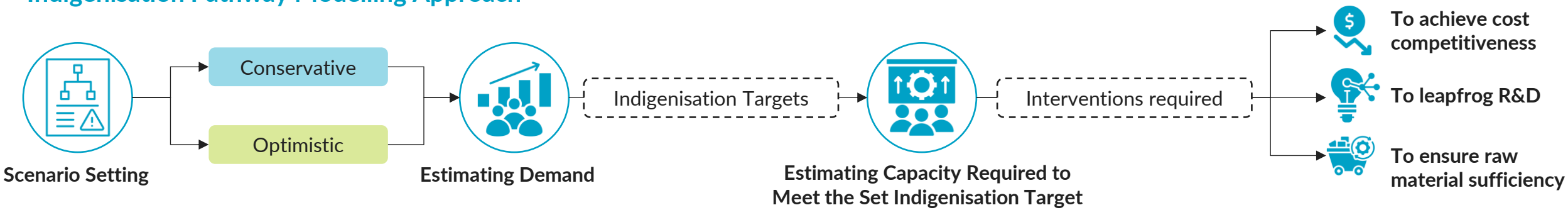
SECTION TWO

CAPITAL EQUIPMENT AND INFRASTRUCTURE INDIGENISATION PATHWAYS

The cleantech indigenisation pathways have been built on two demand scenarios – conservative and optimistic – to identify potential pathways and key enablers to achieve sectoral indigenisation targets (1/2)

Indigenisation Pathway Modelling Approach

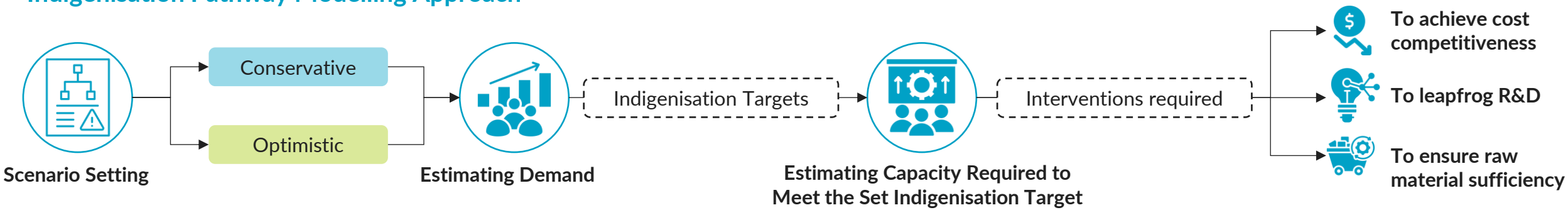


Scenario criteria	CONSERVATIVE SCENARIO			OPTIMISTIC SCENARIO		
	Solar	Wind	Battery	Solar	Wind	Battery
1 Government policy landscape		Upswing in tender activity, top states to meet RAP targets	Extension of ACC PLI and support for implementation		All states meet RAP targets; augmentation of grid at current pace	Extended support to battery manufacturers across value chain
2 Adoption Trajectory	Solar & hybrids meet **70%** of green H_2 energy demand **50%** off-grid & C&I adopt domestic modules	C&I levels expected to increase from current levels	**40 GWh** BESS by 2030 + additional for grid stability; **EV 30@30** to be achieved	Solar & hybrids meet **100%** of green H_2 energy demand **70%** of off-grid & C&I adopt domestic modules	Corporate shift to hybrid power accelerates to meet RE100 by 2030	Coverage of all additional VRE under 2-hour BESS; adoption of E2W/E3W beyond 30@30 goals
3 Export growth	**Africa**: Offer credit to 4 countries on use of Indian modules **US**: Deployment grows at 8% CAGR	**US/Europe/ME & Africa**: Existing share of 15% in global exports to these countries to be maintained		**Africa**: Offer credit to all countries on use of Indian modules **US**: Deployment grows at 10% CAGR	**US/Europe**: Existing share of 15% in global exports to be maintained **ME & Africa**: Increase in total share considered	

Source: MNRE, Physical progress; MNRE, Press release; : ISA, India EXIM bank ; PV Magazine, Industry experts (industry associations; Source: GWEC, Global Wind Report, 2025 report; Ministry of Heavy Industries, PM E-Drive Portal; CEA, National Electricity Plan Vol I; Company announcements; Industry experts; mec+ analysis; Dalberg analysis

The cleantech indigenisation pathways have been built on two demand scenarios – conservative and optimistic – to identify potential pathways and key enablers to achieve sectoral indigenisation targets (2/2)

Indigenisation Pathway Modelling Approach



Scenario criteria	CONSERVATIVE SCENARIO		OPTIMISTIC SCENARIO		
	E-mobility	Green Hydrogen	E-mobility	Green Hydrogen	Transmission
1 Government policy landscape	No additional subsidies on EVs beyond existing subsidies under PM E-DRIVE		Extension of subsidy schemes beyond 2026, especially for 2W, 3W, Bus and Trucks		
2 Adoption Trajectory	Limited TCO[1] and product innovation – overall penetration[2] across vehicle segments expected to reach ~32% by 2030	Fertilizer sector – corresponds to tendered green ammonia capacity Refinery sector – 5% to 15% green H_2 blending in 2027-2030 for refiners with >50KTPA H2 consumption	Charging infra scale up, product innovation and financing mechanisms could enable ~48% penetration by 2030	Fertilizer sector - 100% import substitution of ammonia from 2027 Refinery sector – 5% to 30% green H_2 blending in 2027-2030 for refiners with >50KTPA H2 consumption	*Demand for Transmission sector is **primarily government driven** and estimated to reach **6.5 lakh ckm by 2032***
3 Export growth		**EU, Japan, Singapore, South Korea, UK**: India could capture 10% of this market by 2030		**EU, Japan, Singapore, South Korea, UK**: India could capture 20% of this market	

(1) Total Cost of Ownership; (2) Penetration refers to % share of EVs in total annual vehicle sales; Sources: VAHAN Dashboard ; RMI, Niti Ayog, Harnessing Green Hydrogen, 2022; SECI, Clarification for setting up Production facilities for Green Hydrogen under SIGHT scheme, 2024; Bain, RMI, From Promise to Purchase: Unlocking India's Green Hydrogen Demand, 2025; MoP CEA, National Electricity Plan, Volume II – Transmission, 2024; Company announcements; Industry experts; Dalberg analysis

India's clean energy sectors face significant import dependence for capital equipment – creating strategic vulnerability and necessitating clear pathways to reduce this reliance

Current import dependence across clean energy sectors

Sectors	Import Dependence[1] *% share*	Description
Solar	65 – 100 %	Capital equipment required to manufacture components like polysilicon and wafers, etc.
Wind	96 – 99.5 %	Casting and forging machines being imported to manufacture flanges/gear/shaft (components/sub-components)
Battery	~100 %	Capital equipment imported to manufacture components such as electrolyte filling, calendaring, and tab welding systems
E-mobility	70 – 80 %	Capital equipment machines used in PCB[2] Assembly/motor Assembly/ cell formation assembly (SMT[3] machine manufacturing, hairpin coil winding tech, and motor manufacturing equipment)
Green Hydrogen	40 – 100 %	Capital equipment imported to manufacture components and electrolyzers (solution and melt casting heavy equipment, large-scale coating and sintering machinery)
Transmission	40 - 80 %	Capital equipment machines used to manufacture transformers, GIS[4] & converter valves (foil winding machine, low-pressure die-casting cell, SMT line)

Potential pathways for catalyzing India's capital equipment manufacturing

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

- Prioritize domestic manufacturing for equipment:
  - Displaying synergies with other sectors
  - Having tech expertise to build machines in-house
- Leverage potential to attain global competitiveness through efficiency and costs improvements

2 Import *highly specialized, advanced capital equipment*

- Diversify imports for equipment:
  - Displaying no synergies with other sectors
  - Portraying lack of tech expertise and long lead times in building domestic know-how compared, to global competitors like China
- Leverage greater tech and cost-efficiencies from imported equipment, compared to domestic production

(1) A high-level approximation, based on Dalberg estimate of number of machinery types required for each sector and potential machinery available in India; (2) Printed Circuit Board; (3) Surface Mount Technology; (4) Gas-Insulated Switchgear

1 **Domestic Manufacturing** | Capital equipment manufacturing in India would need to overcome challenges such as limited economies of scale, technical expertise, efficiency and cost gaps and long lead times

Key challenges in developing domestic capital equipment manufacturing:

Limited economies of scale

Nascent, small-scale domestic specialized manufacturing in India (*e.g. Solar 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 technologies; **India currently lacks** this and could require a **long time to ramp-up** (*e.g. Electrolyzer & transmission IP would take* approx. *5 – 10 years to develop in-house*)

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**
(e.g., 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**
(e.g., In oil refining sector, government incentives target local machine sourcing increase from 20% to 50% over 10 years (2017-26))

*Considering the priorities for renewable energy 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[1])
  - 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

(1) Plasma-Enhanced Chemical Vapor Deposition; 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

1 Domestic Manufacturing | Leveraging existing industrial synergies across sectors can catalyse India's clean energy manufacturing ambitions enabled through investments, global partnerships and policy framework

SECTOR	POTENTIAL SYNERGIES[1]
Solar	• **Leverage synergies with other industries**, e.g., diamond wire cutters with stone crushing industry; Submersible Electric Arc Furnace (EAF) with Steel EAF etc. • **Leverage same sector synergies for other applications**, e.g., glass industry equipment for low-iron solar glass, aluminium frame from metal casting and shaping industry etc.
Wind	• **Leverage synergies with other industries**, e.g., arc furnace in steel and metallurgy, railways, heavy engineering etc; moulding equipment in construction, agriculture etc. • **Leverage same industry synergies for other applications**, e.g., casting & forging machinery can be used for Wind turbine components tower, gearbox, generator, bearing
Battery	• **Leverage synergies with sectors to repurpose existing capacity**, e.g., like solar, ceramics, aerospace, and pharma for battery machinery • **Focus on technologies where India already has production strengths** such as calcination furnaces, grinding mills, coating machines, drying ovens, and laser welders
E-mobility	• **Develop equipment manufacturing for components displaying synergies** with electronics healthcare, defense sectors, **e.g.,** PCB[2] Assembly (SMT[3] lines), Motor Assembly • **Domestic manufacturing of charging infra equipment** (EVSEs[4], connectors, cables) under FAME & PM e-Drive can be integrated with **broader electronics manufacturing**
Green Hydrogen	• **Promote retrofitting for PVD/CVD[6] coating, forming units and power electronics** from other industries such as automotive, aerospace, electronics, automation • **Domestic manufacturing of power electronics and sensors** can be **integrated with broader electronics manufacturing** policies (e.g. India Semiconductor Mission)
Transmission	• **Domestic manufacturing already covers 20–30% of critical transformer machinery** (CNC press brake, CNC HV/LV[7] wire-winding machine, vacuum drying oven) and GIS[8] (heat-treat ovens, floor-type horizontal boring & milling, large-envelope VTL[9]) production machinery creating a strong base to scale up manufacturing as demand increases

Policy Enablers and Pathways Needed

Drive large investments to build local capital equipment manufacturing:

- ***Example: INR 2,000-3,600 Cr[5] Capex subsidies to enable*** **INR 8,100–14,300 Cr** investment into local capital equipment manufacturing for EV components

Facilitate global technology partnerships with key manufacturers:

- **Tap into existing global capital equipment expertise** via co-development agreements and shared R&D facilities
- **Explore partnerships with other countries to support domestic manufacturing (e.g. Taiwan** & **South Korea** for SMT machine manufacturing, and **Germany** for motor manufacturing equipment for EVs)

Accelerate domestic manufacturing for equipment with cross-sector synergies:

- **Target developing equipment manufacturing capacity to leverage synergies with other sectors domestically** (e.g. PCB Assembly and Motor Assembly equipment to leverage synergies with electronics, healthcare, defense, etc.)

(1) Dalberg estimation based on high-level understanding of the machinery equipment across sectors (2) Printed Circuit Board; (3) Surface Mount Technology; (4) Electric Vehicle Supply Equipment; (5) Offering 25% capex subsidies, in line with Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS) ; (6) Physical Vapour Deposition/Chemical Vapour Deposition ;(7) Computer Numerical Control High Voltage/Low Voltage; (8) Gas-Insulated Switchgear; (9) Vertical Turning Lathe Source: IDC, India Software Market to hit USD 18.4 Bn, 2025

2 Import Diversification | Strategic import diversification across multiple geographies can reduce supply chain risks while enabling cost-effective access to specialized clean energy manufacturing equipment

Potential import partners for key machineries across cleantech sectors

SECTORS	KEY MACHINERY	PROPOSED SOURCES OF CAPITAL EQUIPMENT
Solar	CVD reactors, PECVD systems, Solar Cz pullers, etc. to manufacture polysilicon, ingots, wafers, cells, modules and glass	
Wind	Casting & forging machinery such as ring rolling mills, forging presses, etc. to manufacture wind turbine components (tower, gearbox, etc.)	
Battery	Complex machinery such as electrolyte filling, calendaring, and tab welding systems	
E-mobility	SMT machine manufacturing, hairpin coil winding tech, and motor manufacturing equipment	
Green Hydrogen	Solution and melt casting heavy equipment, large-scale coating and sintering machinery, large-scale machining/forming equipment for bipolar plate manufacturing	
Transmission	Machinery to manufacture transformers (e.g. foil winding machine, mobile VPD service plant), GIS (e.g. low-pressure die-casting cell, APG press), converter valves (e.g. fiber harnessing benches, SMT line)	Concentrated within countries such as Germany, Switzerland, Italy due to focused tech know-how required and low global volume demand; hence, it is difficult to diversify machinery sources

Pathway towards Import Diversification

- **Leverage existing foreign capabilities** to procure at effective costs and diversify supplier base
- **Explore G2G partnerships** with key equipment manufacturers
- **Enable trans-shipment** as a source for specialized machines by building a diverse supplier base
- **Ensure quick access to capital equipment** to support rapid production ramp up

Source: SolarPower Europe, Solar Production Equipment – EU 2025 ; SaurEnergy; Industry experts; RE Supply Chain Report, 2024; GWEC Report on global wind energy supply chain; MEC+ analysis; Industrial market places (IndiaMart and Alibaba); MEITY, : Toray; NewEra; von Ardenne ; Ionbond; Hauzer; Feintool; Schuler Group

SECTION TWO

ANNEX: SECTORAL CAPITAL EQUIPMENT AND INFRASTRUCTURE DEEP DIVES

Solar Sector | India could reduce its capital equipment import dependence by supporting domestic production of select equipment, covering ~50% module manufacturing costs domestically

India's solar module manufacturing expansion is constrained by 65-100% import dependence for capital equipment and key machines

Solar capital import reliance 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

- This high equipment import reliance is partially **enabled by customs duty exemptions** on cells and module manufacturing equipment
- As Module capacity rises from 75 to 170 GW[3], **equipment dependence** along with **after-sales needs** like maintenance, spares, parts, etc., could drive **long-term reliance** on **foreign suppliers**

India could reduce import reliance for select equipment by leveraging synergies in existing capital equipment capacities

1. Develop domestic manufacturing for select, non-specialized equipment:

- **Identify equipment synergies for solar equipment with other sectors** and support R&D into modification of equipment for Solar sector, to cover 20–30% of solar equipment demand (and up to 50% in module assembly).
- **Synergies with other industries**, e.g., Diamond wire cutters with stone crushing industry;
- **Synergies in same industry for other applications**, e.g., Glass industry equipment for low-iron solar glass,

2. Import and localise highly specialized advanced equipment:

- **Explore G2G partnerships with key equipment manufacturers** (Germany, Japan, South Korea and Southeast Asian countries) to access specialized machines (CVD reactors, PECVD systems, etc.)
- **Enable trans-shipment** as a source for specialized machines by building a diverse supplier base

(1) Components adding ~80% value based on respective share in total Bill of Materials (BOM); (2) Refers to total manufacturing capacity for solar; (3) As per public announcements;

Wind Sector | India could reduce its capital equipment import dependence for Casting & Forging processes (~15% localisation potential) by building equipment domestically

Sub-Component level import reliance limits localisation of Wind sector, driven by inadequate infrastructure for Casting and Forging processes

Sourcing and challenges in sub-component localisation for Wind turbines

Component	Sub-component	Source	Process capability	Challenges in sub-component localisation	Local content impact
Tower	Flanges	Imported	Forging	Flange forging capabilities limited to 3m diameter while WTG tower needs 4.5m flanges	~2-3%
Gearbox	Gear/Shaft	Imported	Forging	Forging capabilities exist, but cost and quality remain concerns	~3-4%
Gearbox	Housing	Imported	Casting	Lack of dedicated facilities impact cost, quality & availability	~1%
Generator	Shafts	Imported	Forging	Forging capabilities for bearing and shaft are limited in India	~0.5%
Generator	Housings	Imported	Casting	Casting capabilities for housing & enclosures are limited in India	~0.5%
Castings	Hub/main-frame	Imported	Casting	Capability is focused on 2 MW+ turbines and is limited for 3MW+	~2-3%
Main shaft forging	Shafts	Imported	Forging	Forging shafts of capacity more than 2.5 MW are not possible due to dimension and specification requirements	~1-2%
Bearings	Rings	Imported	Forging	Limited ring forging and heat treatment capability drives costs	~2-3%

*Inadequate domestic manufacturing infrastructure for **Casting and Forging** limit indigenisation by **~15%***

Source: RE Supply Chain Report, 2024; GWEC Report on global wind energy supply chain; MEC+ analysis

India could reduce import reliance by up to 80% in casting and 10% in forging by domestically manufacturing key equipment

1. Develop domestic manufacturing for select, non-specialized equipment:

- **Identify equipment synergies for wind turbine manufacturing equipment with other sectors** and support R&D into modification of equipment for Wind sector – potential to source 80% of casting and 10% forging equipment domestically (by cost)
  - **Synergies with other industries,** e.g., arc furnace in steel and metallurgy, railways, heavy engineering etc; and moulding equipment in construction, agriculture etc.
  - **Synergies in same industry for other applications**, e.g., casting & forging machinery can used across Wind turbine components tower, gearbox, generator, bearing

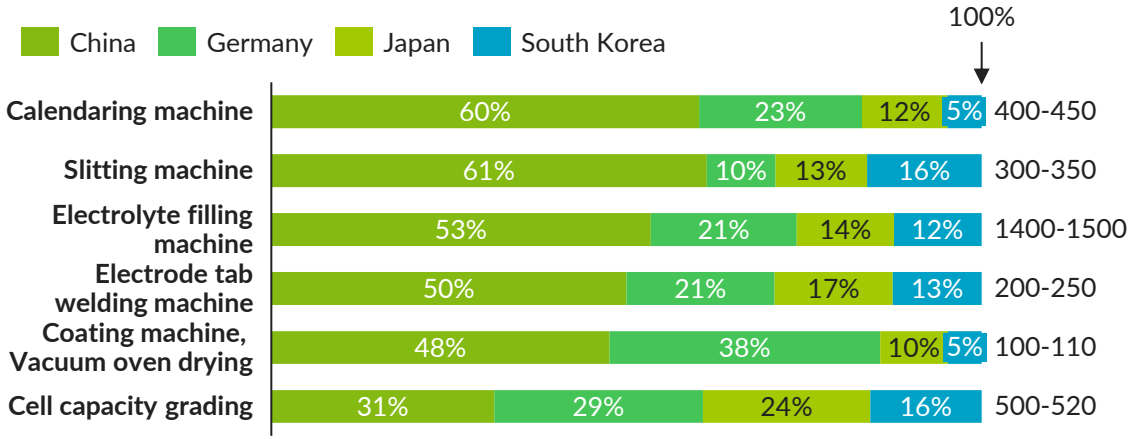
2. Import and localise highly specialized advanced equipment:

- **Explore G2G partnerships with key equipment manufacturers** (Germany, Japan, Italy, USA, South Korea) to access specialized machines (Ring rolling mills, Forging presses, etc.)

Battery Sector | India's battery manufacturing relies heavily on imported machinery and therefore building domestic equipment capacity is vital for cost and supply resilience

High import reliance and lack of incentives for capital equipment localisation constrain domestic equipment manufacturing

India's battery capital equipment import, USD Mn, 2024



- Over **60%** of capital equipment **imports** come from **China**, heightening exposure to **geopolitical** and **supply risks**
- **Domestic production is confined** to low-precision components and clean room infrastructure. Moreover, a **shortage of skilled engineers and technicians** in precision machinery and automation further limits capability development
- **PLI schemes overlook capital equipment localisation**, limiting upstream investment
- High costs and lower efficiency make Indian manufacturers uncompetitive against established East Asian suppliers

Strengthening coordination and building advanced R&D infrastructure, and key solutions accelerate battery R&D and commercialization

1. Develop domestic manufacturing for select battery equipment:

- Leverage synergies with sectors like solar, ceramics, aerospace, and pharma to **repurpose existing capacity** for battery machinery
- **Focus on technologies** such as **calcination furnaces, grinding mills, coating machines, drying ovens, and laser welders** where India already has production strengths
- Aim to **localise 50–60% of total capex across CAM** to pack assembly and up to **80% for CAM processing**

2. Import and collaborate on advanced high-precision equipment:

- **Continue importing complex machinery** such as electrolyte filling, calendaring, and tab welding systems from Germany, Japan, South Korea, and China
- Establish joint ventures, licensing, and co-development partnerships to build long-term domestic capability
- Maintain access to world-class technology while ensuring gradual transfer of expertise and manufacturing know-how to India

Source: Industry experts, Dalberg analysis

E-mobility Sector | INR 2,000-3,600 Cr government investment in domestic capacity for key machines for components can reduce import reliance, driving 50% DVA across EV value chain

India's EV scale-up is constrained by 60-80% import reliance for key capital equipment critical to EV component manufacturing

Capital equipment import reliance across EV components

Component	Import Reliance[1]	Key Machines that are import dependent
Power Electronics	**70-80%**	*Machines used in PCB[2] assembly - Surface Mount Technology (SMT[3]) Pick and Place machines, Power Module Die Bonder, Sinter Bonder*
Motors	**~60%**	*Rotor Magnet Insertion and Embedding machines, Rotor Balancing machines, and Coil Winding machines in line with emerging techniques (e.g., Hair-pin winding)*
Battery Management System (BMS)	**70-80%**	*BMS testing equipment and machines used in PCB assembly*
Battery Pack	**70-80%**	*Machines across CAM processing and Electrode formation – Coating machine, Calendaring machine, Electrolyte filling machine, etc.*

- **Long capacity development timelines** and **low-cost efficiencies** of domestically manufactured equipment exacerbate India's capital equipment import dependence
- Moreover, existing manufacturing sector schemes have **limited focus** on **capital equipment manufacturing** (relevant to EV components) – *e.g., Scheme for promotion of Manufacturing of Electronic Components and Semiconductors, focused on passive components (sensors, connectors, etc.)*

Reducing equipment import reliance requires development of domestic manufacturing capacity for synergetic machines

1. Facilitate global technology partnerships with key manufacturers:

- **Tap into existing global capital equipment expertise** via co-development agreements and shared R&D facilities
- **Explore partnerships with Taiwan** and **South Korea** for SMT machine manufacturing, hairpin coil winding tech, and **Germany** for motor manufacturing equipment

2. Accelerate domestic manufacturing for equipment with cross-sector synergies:

- **Target developing equipment manufacturing capacity for PCB Assembly (SMT lines)** and **Motor Assembly equipment** to leverage synergies with electronics healthcare, defense, and other sectors

3. Drive localisation of EV charging equipment through electronics integration:

- **Accelerate domestic manufacturing of charging infrastructure equipment** (EVSEs, connectors, cables) under FAME and PM e-Drive, integrating with broader electronics manufacturing

INR 2,000-3,600 Cr

Public funding required to support indigenisation, capex support across different TRL bands and structural modifications to Auto PLI scheme

(1) Based on number of machines that are imported amongst all relevant machines to manufacture a component; (2) Printed Circuit Boards; (3) Surace Mount Technology

Green Hydrogen Sector | Boosting domestic component manufacturing capabilities will need a significant scale-up of capital equipment across key electrolyser components

Need for heavy equipment for component manufacturing; existing equipment in adjacent industries can be used only to a limited extent

Heavy equipment	*Potential for leveraging other industries*	*Total required investment*
Slot die roll-to-roll production and die cutting systems for membranes	**Low:** Know-how exists in **water filtration** & **battery** industries; however, customized equipment needed for electrolyser grade thickness and capacity	**INR 200 Cr**
Ni, Ti, gold coating & sintering systems for bipolar plates and PTLs	**Low - Medium:** Processes compatible with **automotive** & **aerospace** industry; however, additional capacity needed to serve electrolyser demand	**INR 380 Cr**
Large-scale stamping machines for bipolar plates	**Low:** Metal forming processes exist in **automotive** & **defense** industries; however, no bipolar plate specific stamping machines present at commercial scale	**INR 110 Cr**

India can promote cross-sector retrofitting for coating technologies, while importing other advanced equipment

1. **Retrofit and develop domestic manufacturing for select, non-specialized equipment:** Promote retrofitting for **PVD/CVD coating, forming**, and machining units from other industries to the extent possible, while establishing a steady domestic market for Indian component manufacturers

2. **Invest public and private funding of ~INR 688 Cr to import highly specialized advanced equipment :** Processes like membrane slot die **roll-to-roll production and large-scale bipolar plate manufacturing** currently have low domestic retrofitting potential and need capital investment for import and setup

3. **Diversify import partnerships for sourcing specialized equipment:** To reduce overreliance on China, India must diversify its import partnerships by engaging with **Germany, Japan, Netherlands, and Switzerland**, who hold advanced material science and high-precision automation capabilities required for these specialized systems

~INR 230 Cr

Public funding required to set up advanced equipment for electrolyser component manufacturing

Source: Industry expert interviews; CEEW & Dalberg analysis

Transmission Sector | Despite India's growing HV transmission market, limited machinery demand and technology concentration among few global companies constrain local manufacturing

High import reliance for capital equipment exists across the most cost intensive HV transmission components

Component	Import Reliance[1]	Key Machines
Transformers (Power & Converter)	70-80%	CNC press brake, CNC HV/LV wire-winding machine, vacuum drying oven, CNC plasma cutting table, column & boom welding manipulator, pressboard cutting Foil winding machine, Mobile VPD service plant, Step-lap core cutting line, offline/automatic core-stacking robot & software, automatic insulation taping machine
GIS	70-80%	Heat-treat ovens, floor-type horizontal boring & milling, large-envelope VTL, clean/dry room, Ag/Ni plating line Low-pressure die-casting cell, 5-axis gantry machining centre, filtration & storage skids, APG press, vacuum epoxy casting system, gas evacuation & recovery cart
Converter Valves	40-50%	Lightning impulse generator, HV AC/DC sources, clean assembly hall, vacuum brazing furnace, DI/UPW system Fiber harnessing benches, SMT line, IEC 60700-1 valve test bay, burn-in racks, precision hydraulic clamping rigs, PD measurement system

Two major challenges exist in localising capital equipment manufacture

Machinery already manufactured in India

- **20-30%** of transformer & GIS machinery is **manufactured domestically**. Machinery **demand base is small** as only **5-10 transformers** & **1-2 GIS** are required by 2032, but **cross-industry** use keeps domestic suppliers viable
- Converter valves are not yet manufactured in India**, but 50-60%** of required machinery is **domestically available**
- Existing domestic fabrication OEMs could **scale production** quickly with **limited investment** as build rate increases

Import dependent machinery

- **15-20%** machinery across the three components **can be manufactured domestically**, supported by **existing supply chains** for raw material/subcomponents**.** However, **low domestic & export demand volume** and **concentrated suppliers** create high barriers of entry for Indian manufacturers
- **45%** machinery has critical subcomponents based on **patented mechanisms** & **trade-secret softwares** which are not available without partnerships and would incur costs – potentially not viable for low volumes of demand

(1) Calculated by cost and volume required to fulfil component demand for 2032
Source: Company Announcements, Dalberg Analysis

Thank you!