Bharat Cleantech Manufacturing Platform: Demand and Market Architecture

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]

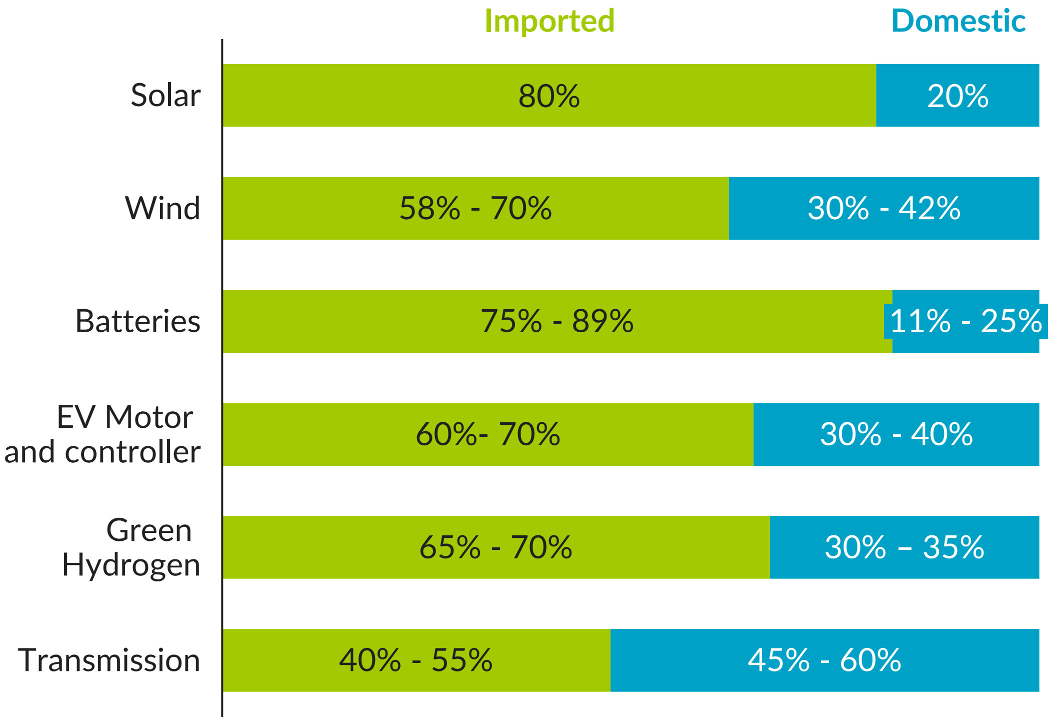
30% EV *sales penetration*[2]

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)***	*Detailed ahead*
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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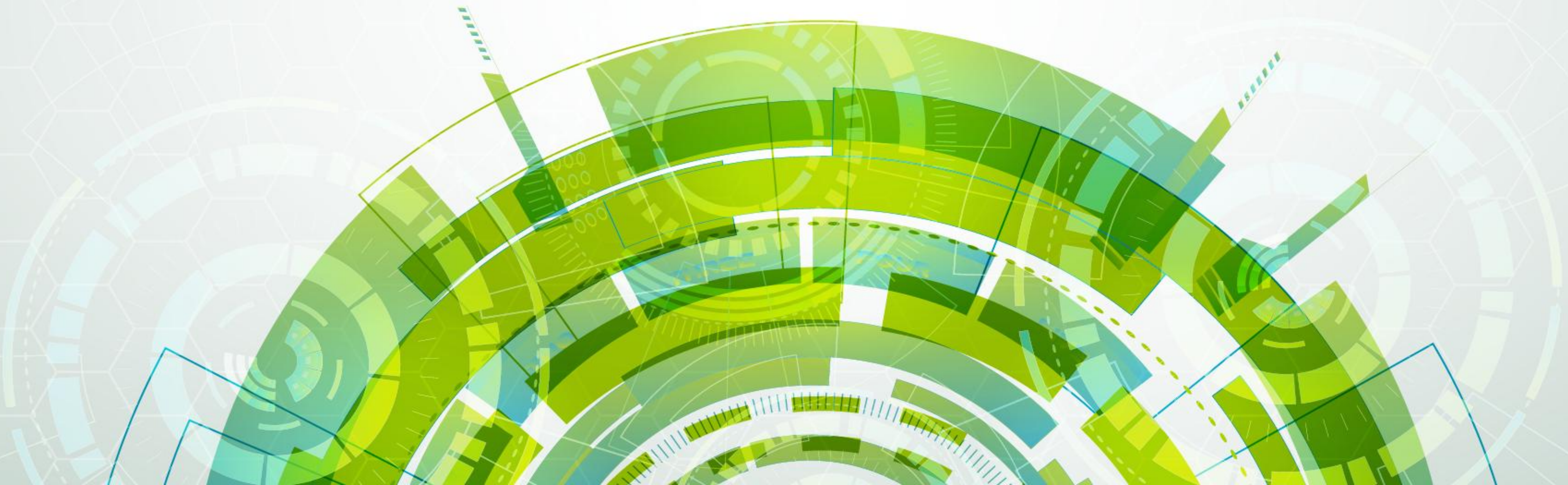
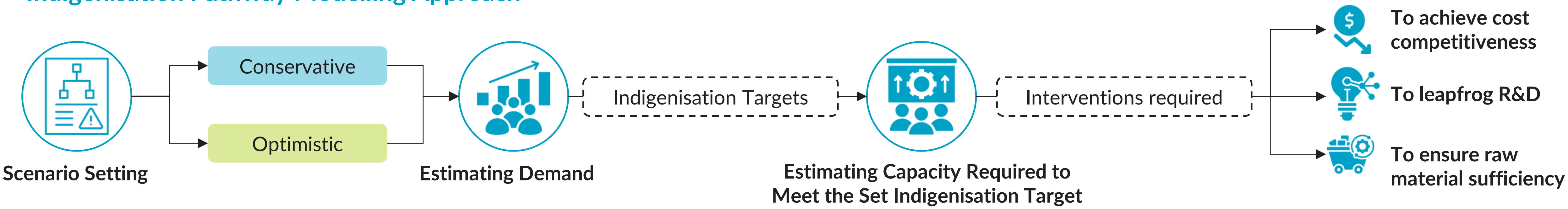
SECTION ONE

DEMAND ACCELERATION 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

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 Setting → Conservative / Optimistic → **Estimating Demand** → Indigenisation Targets → **Estimating Capacity Required to Meet the Set Indigenisation Target** → Interventions required →

- **To achieve cost competitiveness**
- **To leapfrog R&D**
- **To ensure raw material sufficiency**

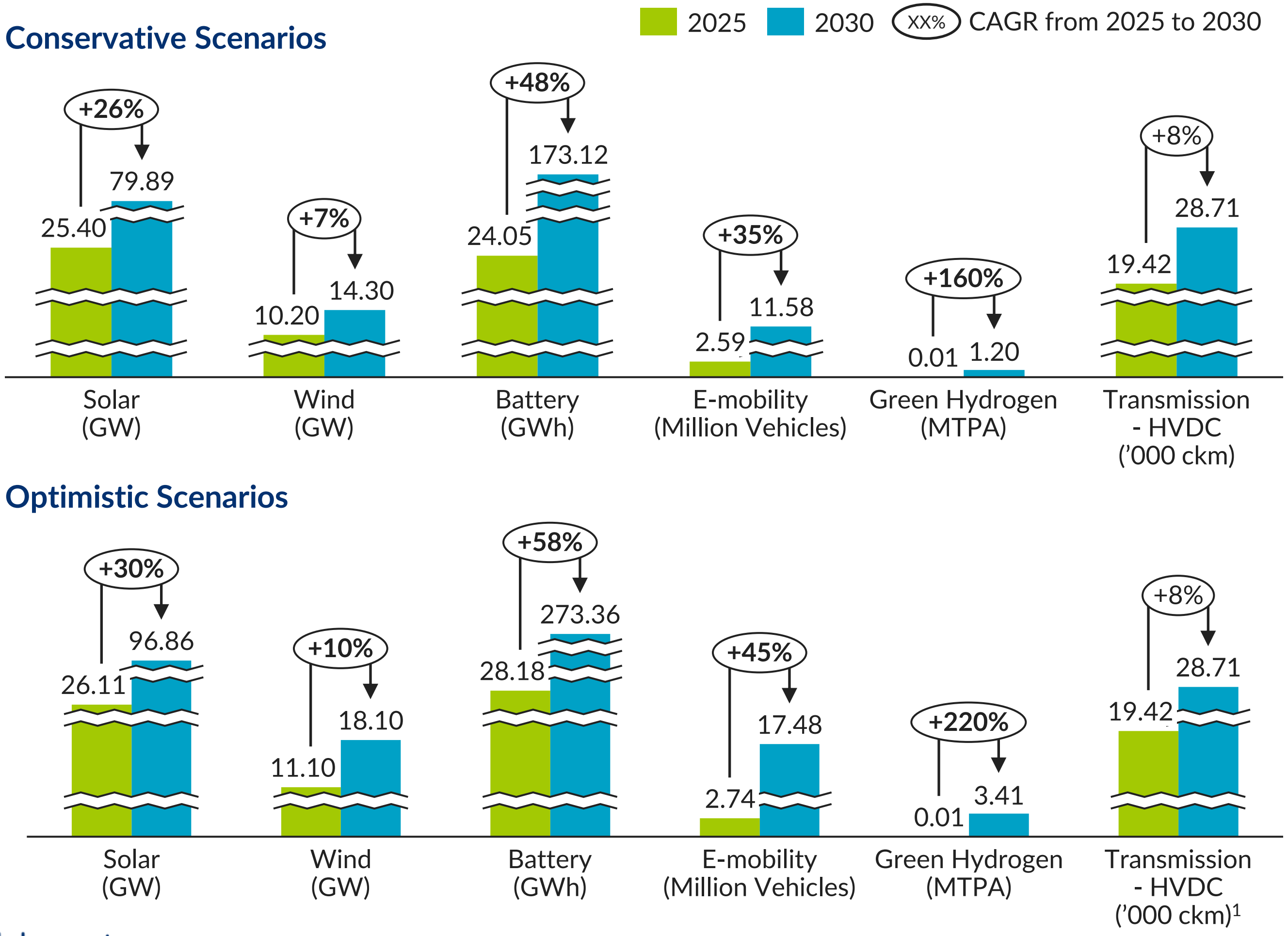
Scenario criteria	CONSERVATIVE SCENARIO – E-mobility	CONSERVATIVE SCENARIO – Green Hydrogen	OPTIMISTIC SCENARIO – E-mobility	OPTIMISTIC SCENARIO – Green Hydrogen	Transmission
1 Government policy landscape	No additional subsidies on EVs beyond existing subsidies under PM E-DRIVE		Extension of subsidy schemes beyond 2026, especially for 2W, 3W, Bus and Trucks		*Demand for Transmission sector is **primarily government driven** and estimated to reach **6.5 lakh ckm by 2032***
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	
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 cleantech demand is large and growing, but domestic industries capture only 20-35% due to limited domestic cleantech manufacturing capacity

India's cleantech demand could grow significantly across sectors by 2030

India's current and projected annual cleantech demand, by technology, 2025-2030



However, import dependence and limited adoption could restrict demand for India-made cleantech

High import reliance for cleantech components could curtail demand for India-made cleantech components

- Nearly **65-80% import reliance** across cleantech manufacturing value chains, especially for system and sub-system components (e.g., **Gearbox**, **Polysilicon**)

Limited cleantech adoption could further hinder domestic demand

- Across **E-mobility**, while overall vehicle penetration could achieve 30% targets by 2030, **penetration in E4Ws, E-buses** and **E-trucks** could **remain limited**
- **Green Hydrogen** adoption is limited by **prohibitive DISCOM charges** (compared to thermal power) and **high production costs** (compared to grey hydrogen)

Cleantech exports is a critical market – currently untapped

- Exports could represent **15-20% of annual Solar Module**, **38-48% of Wind Turbine**, and **44-55% of Green Hydrogen** demand by 2030
- Thus, exports of Indian-made cleantech could represent attractive markets

(1) Transmission demand has been defined by the government, aligned with the expected transmission capacity required by 2030. Government estimates have been extrapolated to estimate current and 2030 demand, assuming linear growth.

Translating sector growth into demand for Indian-made cleantech will require pushing cleantech adoption while also creating strong demand for domestically manufactured components

A

Driving Adoption and Demand for Cleantech

- Facilitating adoption of domestically produced cleantech products by
  - Mandating Domestic Value Addition in utility scale applications
  - Creating an enabling ecosystem for cleantech adoption
- Drive additional demand for indigenous cleantech by tapping export markets

B

Supporting Domestic Component Manufacturing

- Building demand for domestic component manufacturing facilities (Battery cell, Polysilicon, etc.) by
  - Integrating Domestic Value Addition in incentive schemes
  - Improving cost competitiveness through attractive customs policies
  - Supporting off-take for domestic production

A Driving Adoption and Demand for Indigenous Cleantech | Develop demand for domestically produced cleantech by supporting cleantech adoption and building an export market

1. Integrating Domestic Value Addition requirements into utility-scale projects and incentive schemes

To support cleantech adoption and drive system-level offtake for domestically produced cleantech

- **Integrate phased DVA[1] requirements in utility scale projects:**
  - **Solar:** DVA requirements for modules in green hydrogen projects using solar/solar-wind as a source of energy
  - **Battery:** Across EVs, increase DVA requirements by 5pp by 2028 and up to 8-10pp by 2030
    Apply phased DVA requirements for utility scale BESS[2] colocation (35% by 2028, 45% by 2030)
- **Adopt cleantech across government enterprises:**
  - **Green Hydrogen:** Mandate 10-50% green hydrogen usage in Refineries, City-gas distribution systems
    Extend SECI[3] tenders and expanding support under SIGHT[4] schemes
  - **Battery:** Increase coverage of BESS co-location to 100% of incremental Solar and Wind utility scale deployment and explore increasing storage duration mandate from 2 to 4 hours

2. Creating an enabling ecosystem for cleantech adoption

To establish requisite supporting facilities (charging infrastructure) and facilitate cleantech transition

- **Offer financing support for E-bus and E 4W adoption** – e.g., a cumulative Viability Gap Funding of INR 4,500-6,500 Cr for domestic E 4Ws from 2027 to 2030, to minimize impact of indigenisation on TCO[5]
- **Supporting product innovation in E-trucks** to drive development of commercially feasible Medium and Heavy-Duty E-trucks
- **Providing financing and administrative support to CPOs[6]** to enable EV charging infrastructure expansion

3. Cultivating export demand

To expand demand for domestically produced cleantech

- **Leverage USD 1.75 Bn EXIM Line of Credit[1]** at interest subvention of INR 700–800 Cr to expand solar module exports to Kenya, Morrocco, Nigeria, South Africa
- **Develop international trade agreements to expand exports to** priority countries (strong cleantech demand, trade relation, supportive RE policy):
  - **Solar:** EU and Middle East
  - **Green Hydrogen:** EU, UK, Japan, Singapore, South Korea
- **Consider long-term exports** of domestically produced Green Hydrogen components (membranes, PTLs[7], electrodes, bipolar plates), beyond 2030

(1) Domestic Value Addition; (2) Battery Energy Storage System; (3) Solar Energy Corporation of India; (4) Strategic Interventions for Green Hydrogen Transition; (5) Total Cost of Ownership; (6) Charging Point Operators; Power Transmission Lines

B Supporting Domestic Component Manufacturing | Drive deeper indigenisation across the value chain by supporting off-take for domestic component manufacturing via DVA mandates and favourable duties

1. Use Domestic Value Addition rules to create demand for Indian-made components

To boost demand for cleantech components and discourage only domestic assembly of components

- **Gradually raise minimum share of Indian-made content** in Solar, Battery, Transmission and Electrolyzer projects – e.g.,
  - **Solar:** Apply DVA targets of 30% by 2027, 40% by 2028, and 50% by 2029 into ALMM[1] policy
  - **Transmission:** Apply phased Minimum local requirements for Valves in turnkey HVDC[2] projects
- **Use a consistent scoring system** (like weighted DVA) in incentive schemes to provide greater benefit to companies investing more deeply in manufacturing across the value chain
- **Introduce PLI[3]-type incentives for HVDC** specific components like valves and switchgear
- **Create an Approved List** of Indian Battery Pack and Cell Manufacturers to guide battery procurement

2. Adjust duties so Indian manufacturers become more competitive

To reduce cost differential between imported and domestic components, facilitating demand for domestic cleantech

- **Reduce inverted duty effect on System and Sub-system level components:**
  - **Solar:** Increase Basic Customs Duty on ancillary components to drive cost competitiveness of domestic producers
  - **Wind:** Reduce duties on gearbox and generators, duty waivers for concast steel
- **Consider Anti-Dumping Duties** (ADD) for ancillary components in Solar modules (encapsulants, junction box, etc.) in response to global price fluctuations as needed
- **Attract global suppliers** of components to set-up manufacturing facilities in India via phased duty relaxations, tied to DVA targets and investment mandates
  - e.g., Scheme to Promote Manufacturing for Electric Passenger Cars in India

(1) Approved List of Models and Manufacturers; (2) High Voltage Direct Current; (3) Production Linked Incentive

SECTION TWO

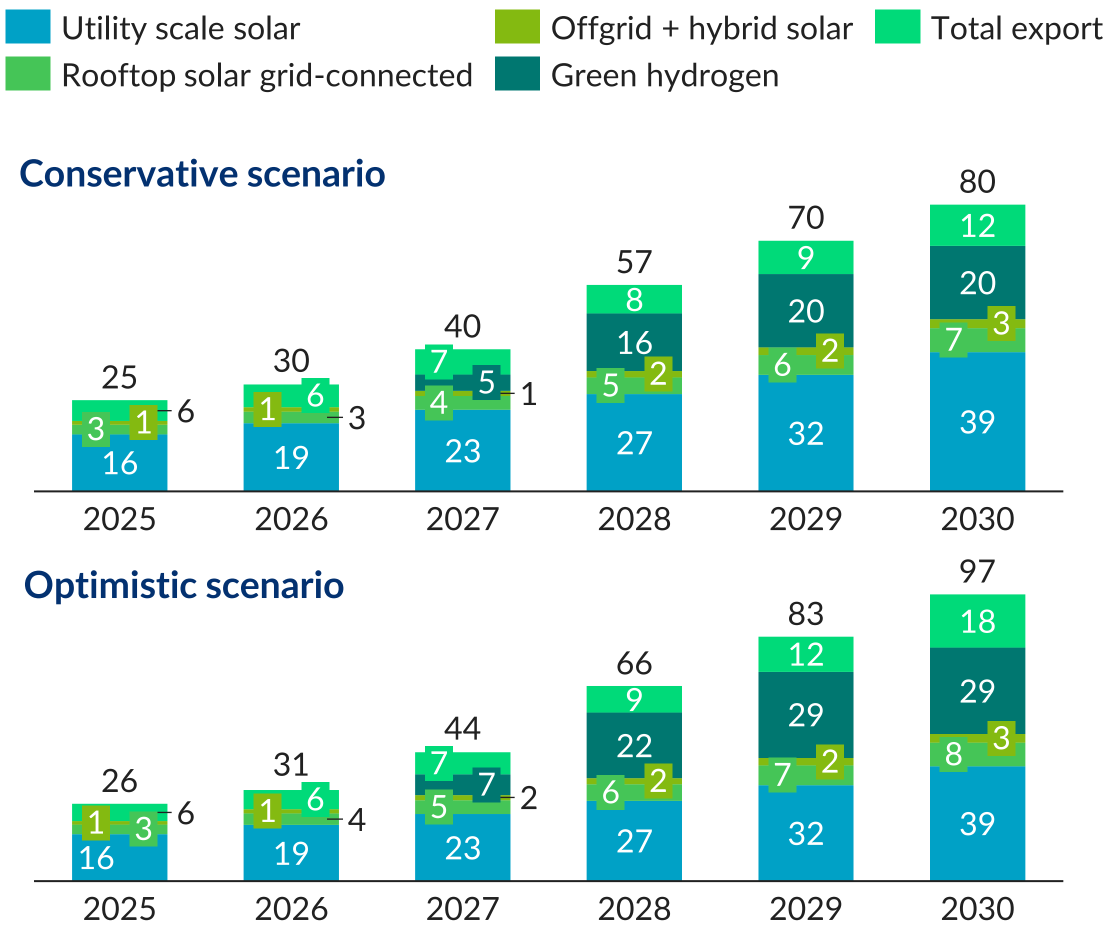
ANNEX:
SECTORAL DEMAND ACCELERATION PATHWAY DEEP DIVES

SECTION TWO, SUB-SECTION A

SOLAR INDIGENISATION PATHWAYS

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)**

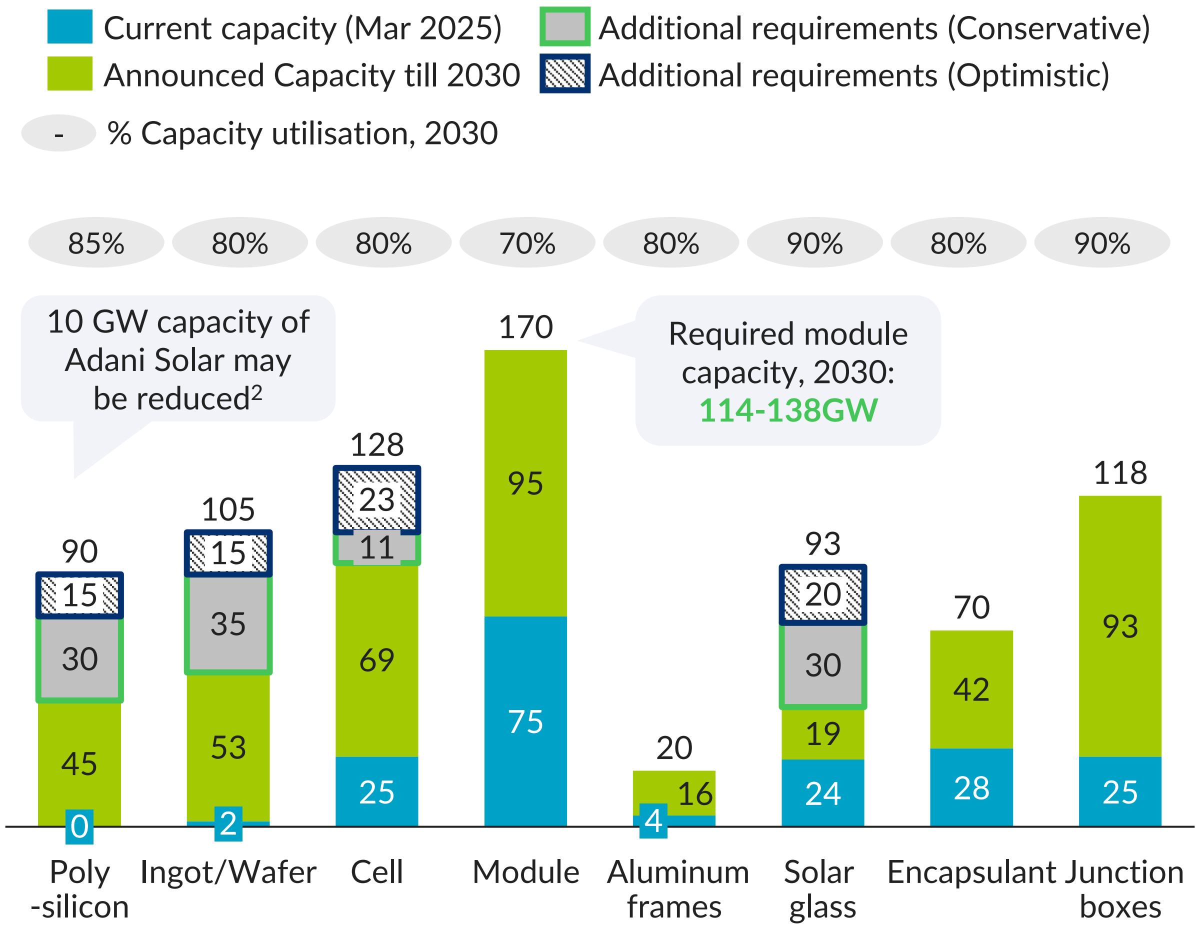
Optimistic scenario assumes:

- **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]



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 prioritization 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

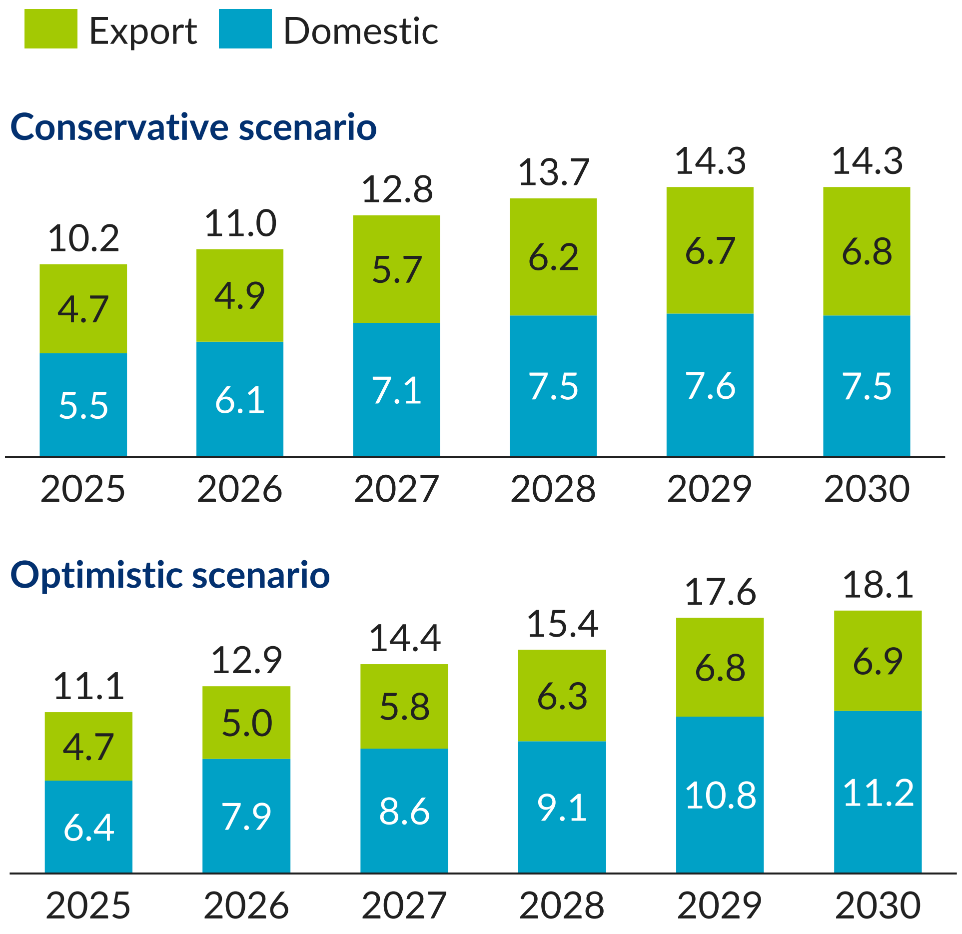
(1) India announced USD 2 Bn support to solar projects in ISA member countries in 2018 of which only USD 250 Mn has been allocated, USD 1.75 Bn remains unused
Source: ISA, India EXIM bank; Sustainable Energy for all, Africa Renewable Energy Manufacturing – Opportunity and Advancement, 2023; Dalberg analysis

SECTION TWO, SUB-SECTION B

WIND INDIGENISATION PATHWAYS

Demand growth to be driven by strong domestic targets and rising export potential to global markets

Wind Domestic and Export demand 2026-2030, GW



Basis the analysis of existing and expected domestic demand trends, we anticipate cumulative wind installations will fall short of the 2030 targets

Scenario description

Conservative scenario assumes:

- **Strong existing pipeline:** Driven by the recent upswing in tender volumes in the past few years
- **State RAP alignment:** Expected to be capped at 26.3 GW as per resource adequacy plans announced by top states till 2030
- **C&I wind installations:** Expected to increase from current levels, though at a slower pace compared to the ambitious scenario.
- **Export:** Same share of global demand as observed in 2024

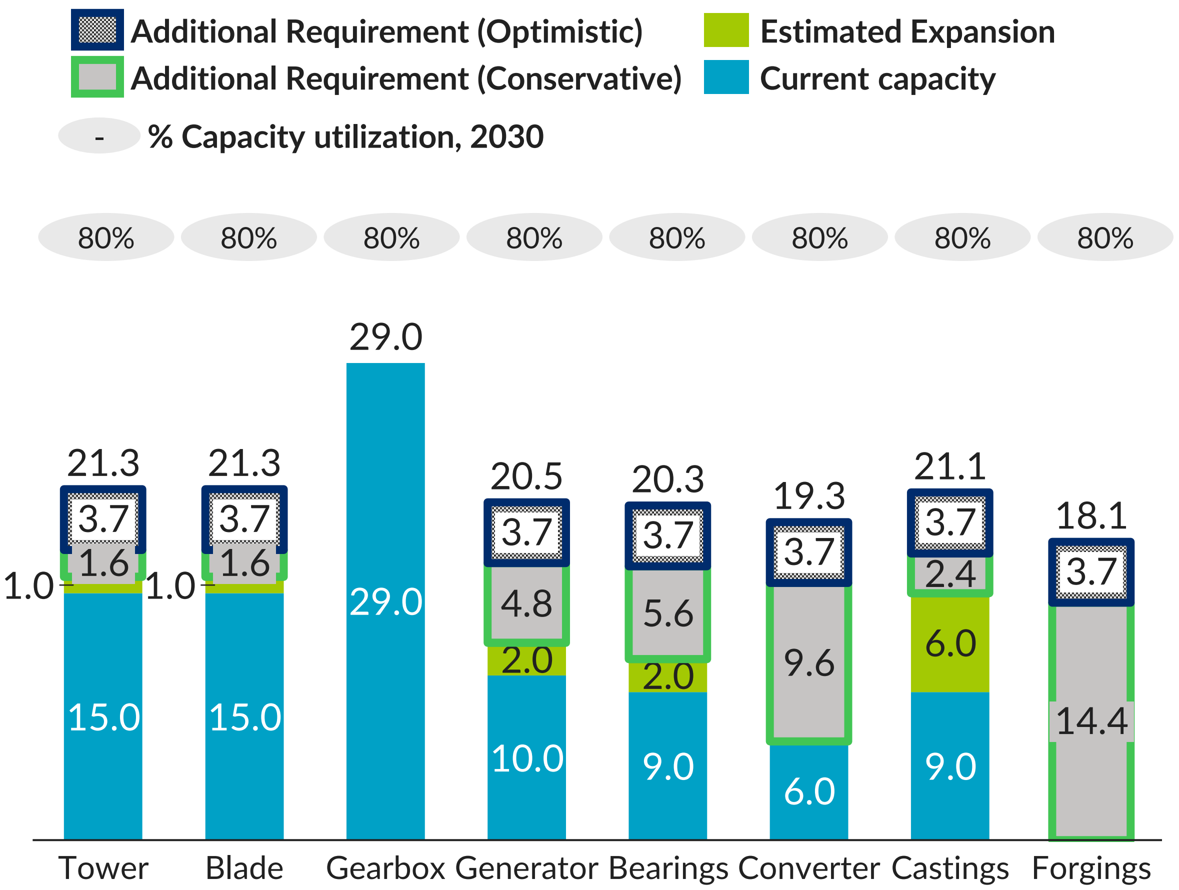
Optimistic scenario assumes:

- **State RAP alignment:** Wind requirement of all state as per resource adequacy plans will be met
- **Grid availability:** Assumed at the current pace of 15–16 GW augmentation year-on-year with no constraint on installation
- **C&I wind installations:** Further acceleration is expected as corporates adopt cost-competitive hybrid power to achieve net-zero emissions and RE100 targets by 2030.
- **Export:** Same share of global demand as observed in 2024 for US & Europe with a higher share for ME and Africa region

Source: GWEC 2025 report, mec+ analysis

Meeting demand indigenously would be enabled by improved existing utilization levels along with capacity expansions across components to cater to higher size WTGs (3MW+)

Manufacturing capacity required to achieve demand targets, 2030, GW



Key Insights:

- India has considerable manufacturing capacity across major WTG components, however some of these components like gearbox, generator, converter currently operate at capacity utilization of less than 40%
- With increase in demand, the capacity utilization of these components is expected to increase before additional capacity additions are done by the players
- In terms of size, over the last 3 years the industry has witnessed a shift towards high capacity 3MW+ turbines, with the same trend expected for future demand, capacity additions of components would be to cater to such higher capacity WTGs
- To build scale and reduce import dependence, it is critical to strike a balance between cost competitiveness and the effective utilization of domestic capacity

Source: NITI Aayog, mec+ analysis

Policy interventions such as local content requirement, duty structures alignment along with policies to attract global suppliers of components could drive WTG components demand

	Recommendations	Rationale
Manufacturing		
Value chain demand driver	• Develop and implement across components local content requirement roadmap in a phased manner • Align duty structures to create domestic pricing competitiveness of sub-system level components • Policy to attract global suppliers of components who are not currently present in India to set-up manufacturing facilities in India (for e.g. policy introduced by MoHE for investments by global manufacturers for passenger EV cars)	• Encourages gradual localisation, allowing time for ecosystem development • Brings in advanced manufacturing technologies and global quality standards • Encourages price competitiveness, fostering a stronger domestic manufacturing base

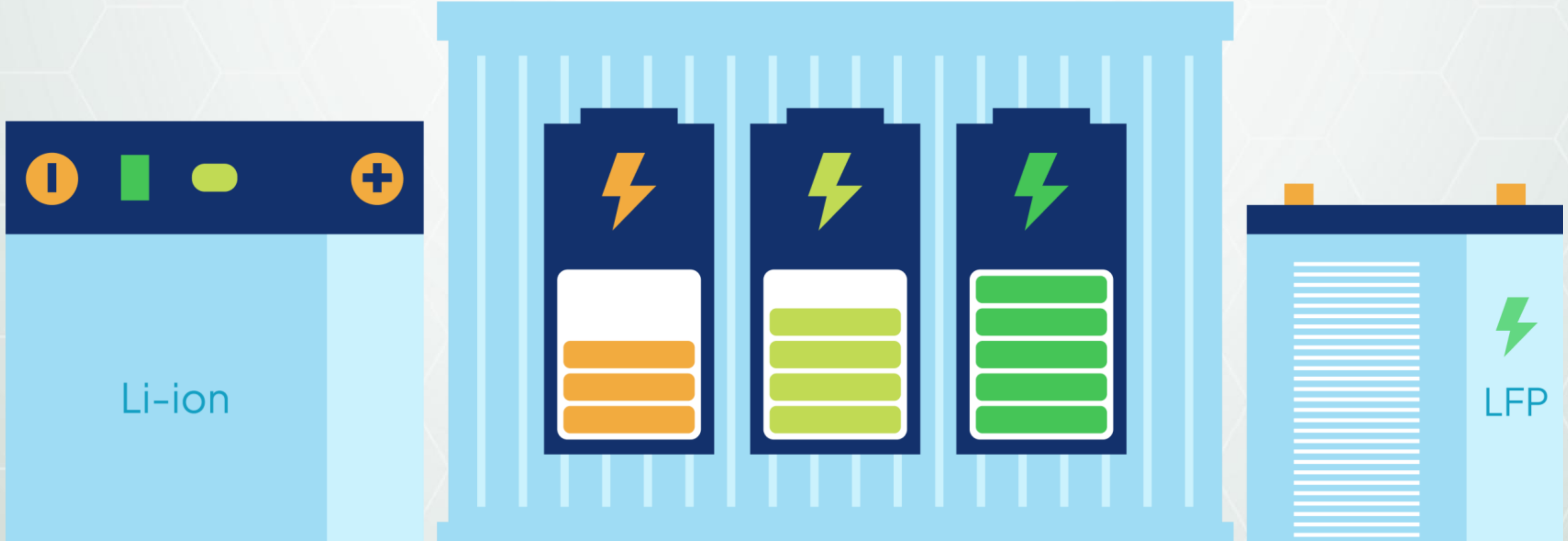
Category	Intervention type	Inputs and assumptions	Key recommendations	Total Impact, INR Cr: Conservative Scenario	Total Impact, INR Cr: Optimistic Scenario
Duty structure alignment	Reduce inverted duty effect on gearbox and generators Duty waivers for concast steel	• Contributes 15% on import of raw materials such as concast steel and electrical steel • Existing 5% and 10% on imports of parts and full generator /gearbox	• Address inverted duty structure by reducing duty on concast and electrical steel at a level lower than duty on parts (such as core etc.) and full generator/gearbox • Increase duties of assembled gearbox, generator, casting and forging products by 2.5%	~350	~400

Note: Leveraging INR 15,050 Cr (USD 1.75 Bn) EXIM Line of Credit1 at the interest subvention of INR 350– 400 Cr to boost wind exports to key African countries, APAC excludes India and China

Source: ET, Renewable watch, EV policy

SECTION TWO, SUB-SECTION C

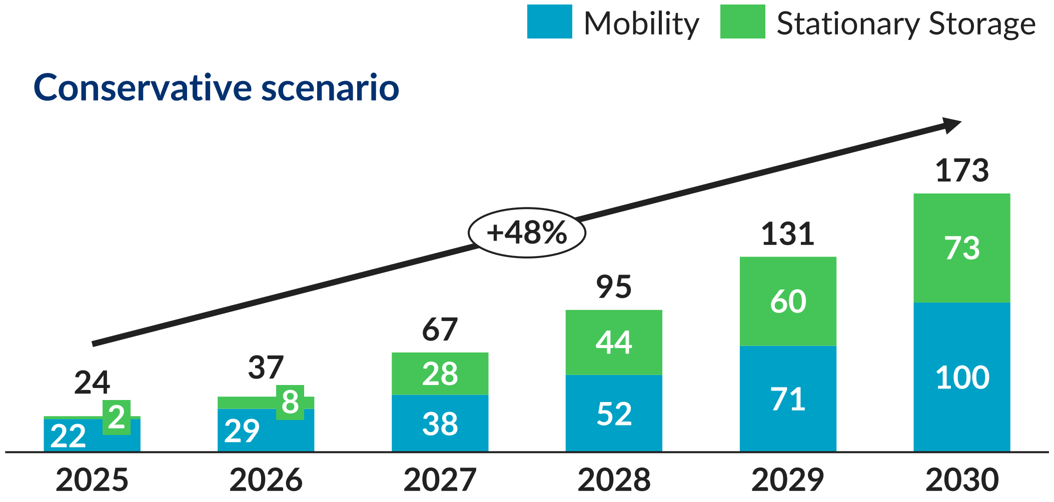
BATTERY INDIGENISATION PATHWAYS



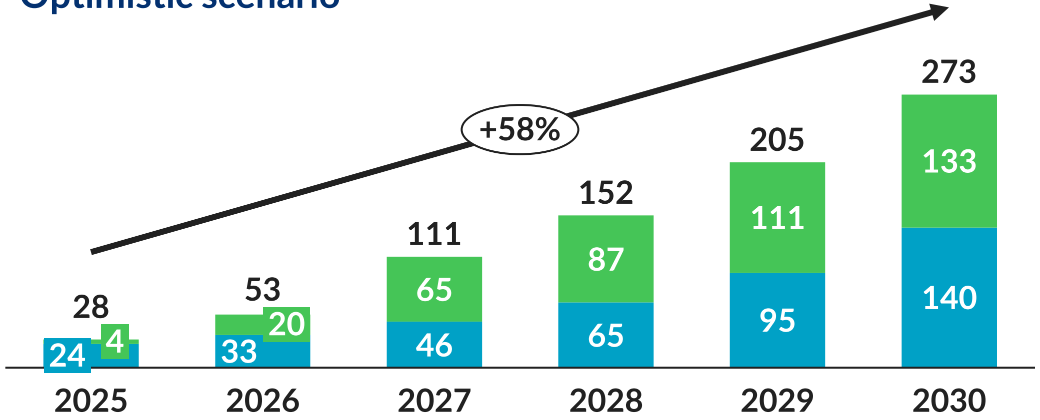
Annual demand for indigenous battery packs could increase to 173-273 GWh by 2030 driven by growing EV sales penetration, utility scale RE storage mandates and grid stabilization and peak load management needs

Annualized Battery Pack demand 2025 -2030, GWh

Conservative scenario



Optimistic scenario



Scenario description for first life applications

Conservative scenario

Mobility

- Achievement of EV30@30 target with **30% EV sales penetration** of total annual new vehicle sales by 2030 with policy support from PM E-Drive, SPMEPCI[1]

Stationary Storage

- **2-hour BESS colocation** covering 40% of incremental installed VRE[2] capacity in line with **current mandates** and **NEP[3]** BESS targets
- **Grid stabilization and peak load management (PLM)** based on existing electricity generation and peak demand
- C&I demand for storage not included – assumed to import dependent or under second life applications for batteries

Optimistic scenario

Mobility

- **Exceeding EV30@30 targets** with higher EV penetration among 2 and 3-wheelers (both 47%) with **overall EV new vehicle sales penetration at 38%** by 2030 through additional policy support

Stationary Storage

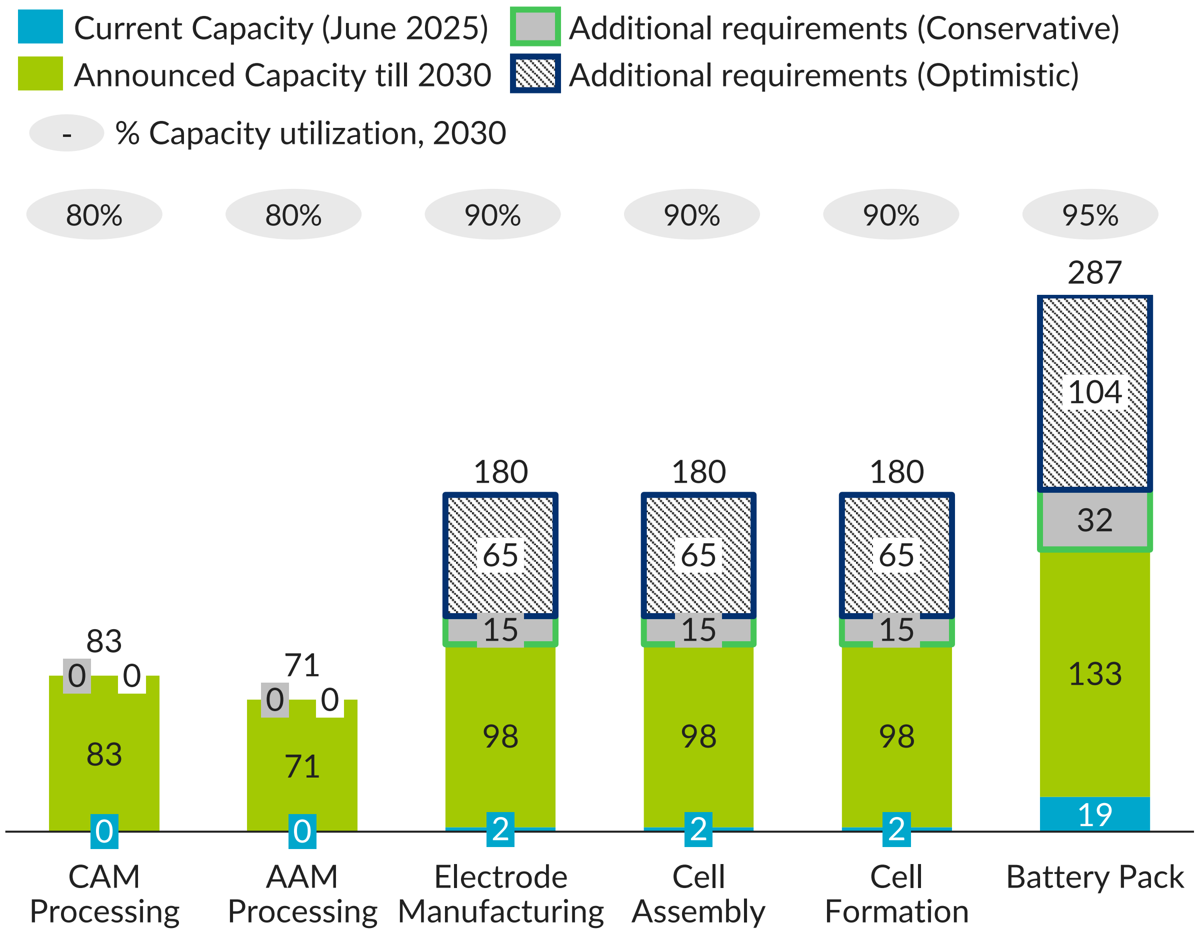
- Coverage of **100% of Solar and Wind utility scale generation** with 2-hour BESS co-location by 2030
- No change for grid stabilization, PLM and C&I demand **as conservative scenario**

(1) SPMEPCI - Scheme to Promote Manufacturing of Electric Passenger Cars in India offering global EV makers customs duty concessions on import of CBUs in return for setting up domestic manufacturing capacity within 3 years; (2) VRE – Variable Renewable Energy; (3) National Electricity Plan

Source: PIB Press Release, December 2024; CEA Advisory Notice, Feb 2025; PIB Press Release, May 2025; Industry experts (industry associations; Dalberg analysis

Cumulative 287 GWh domestic battery pack capacity of which 180GWh would be integrated capacity along with 71-83 GWh CAM/AAM processing could help achieve 45% indigenisation across the value chain by 2030

Manufacturing capacity required to achieve 45% indigenisation, 2030, GWh[1,2]



Key insights

India needs large-scale **integrated gigafactories** from electrode to cell to pack manufacturing, and other facilities focusing on **cathode and anode active material processing** to achieve 45% indigenisation by 2030

Demand drivers required:

- **Approved list of battery manufacturers** to ensure domestic players are prioritised (**like ALMM for Solar PV**) in stages as domestic manufacturing capacity increases
- **Mobility:**
  - **Phased extension of Domestic Content Requirements** in PM E-Drive to include battery components (cells, electrodes),
  - Introduction of **DVA mandate for 4W** with potential Viability Gap Funding (VGF) of INR 4500-6500 Cr to reduce TCO impact
- **Stationary storage:** Extending **BESS co-location to 100%** of incremental utility scale RE deployment with integration of **phased DVA requirements** for utility scale BESS

Detailed on next slide

(1) CAM and AAM refer to Cathode Active Material and Anode Active Material; (2) Have assumed 2–3-year delay in announced timelines due to global market conditions and that Cell capacity announcements refer to 'cell to pack' manufacturing

Source: Company announcements; Ministry of Heavy Industries, PM E-Drive Portal; CEA, National Electricity Plan Vol I; Industry experts; Dalberg analysis

Policy interventions such as an approved list of pack and cell manufacturers, phased DVA requirements in existing policies and extending BESS mandates for utility scale RE could fuel domestic battery demand

	Recommendations	Rationale
Manufacturing		
Value chain demand drivers	• Introduce **Approved List of Pack and Cell Manufacturers** (like ALMM for Solar PV) in stages (pack by 2028, cell by 2030)	• Could enable prioritization of domestic firms, driving demand for domestic packs and cells
	• **Phased Domestic Value Addition (DVA) requirements** as integrated capacities increase (from 35% in 2028 to 45% in 2030)	• Could drive deeper indigenisation progressively across the value chain
	• **Increase BCD** on battery raw materials and components (e.g., BMS, Electrodes, CAM, AAM) over time	• Could enhance the cost-competitiveness of domestic manufacturers and develop ecosystem
Deployment		
Mobility	Increase DVA requirements by **5pp by 2028** and up to **8-10pp by 2030** across EVs as per targets below: (see table below)	• Phased Manufacturing Program under PM E-Drive mandates only domestic assembly of battery packs without specific DVA requirement for components • VGF for e4W conditional on global battery price difference vs. domestic to minimize TCO impact
	• **Domestic e4W** to be supported with cumulative VGF[2] of **INR 4500-6500 Cr from 2027 to 2030** to minimise TCO impact	• Existing DVA requirements under SPMEPCI (25% in Y3, 50% in Y5)
Stationary Storage	• Increase coverage of **BESS co-location to 100%** of incremental Solar and Wind utility scale deployment and explore increasing **storage duration mandate from 2 to 4 hrs**	• Currently estimated 2032 ESS requirements (80 GW/411 GWh) cover ~40% of incremental utility scale solar and wind capacity
	• Integrate **phased DVA requirements** for utility scale BESS colocation (35% by 2028, 45% by 2030)	• No DVA requirement in current storage mandate

EV type	DVA (2028)	DVA (2030)	Supportive Policy
e2W/3W/Buses	55%	60%	PM E-Drive
e4W: Domestic OEM	55%	60%	-
e4W: Global OEM	No change		SPMEPCI

(1) Based on 50% localisation rate required under FAME II; (2) VGF – Viability Gap Funding based on assumption of 50% coverage of price difference between domestic, imported cells, covering domestic OEM share of e4W demand (assumed 70%), estimated from 2027 to 2030
Source: Ministry of Heavy Industries, PM E-Drive Portal; CEA, National Electricity Plan Vol I; Industry experts; Dalberg analysis

SECTION TWO, SUB-SECTION D

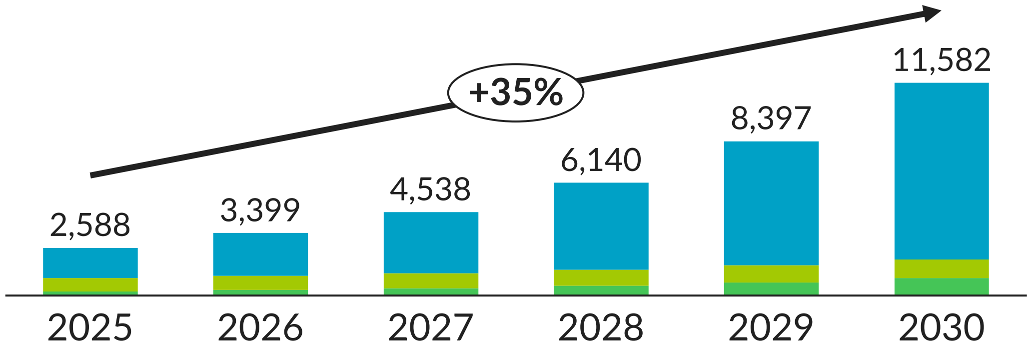
E-MOBILITY INDIGENISATION PATHWAYS

India's annual EV registrations are expected grow to 4X by 2030, with the potential for ~6X growth by 2030, driven by recent policy support measures and active market innovation

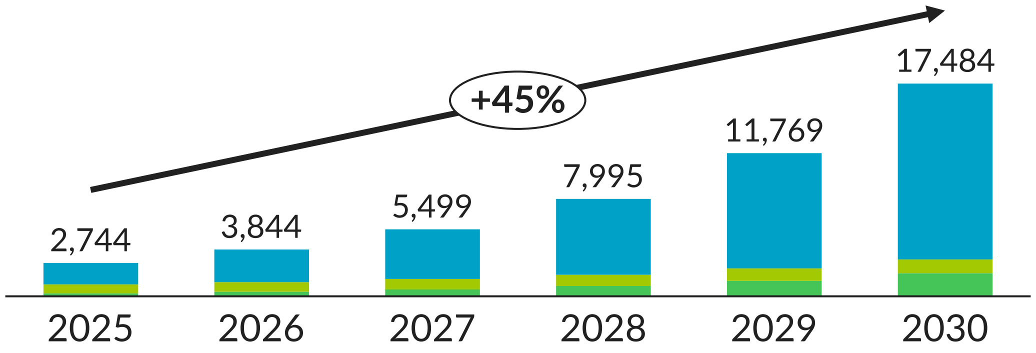
Projected annual EV registrations, '000 vehicles, 2025 – 2030

EV - 2W | EV - 3W | EV - 4W | E-Bus | E-Trucks

Conservative Scenario



Optimistic Scenario



Scenario Descriptions

Conservative scenario assumes:

- **No additional subsidies** announced beyond PM E-DRIVE, and the existing schemes are just extended
- **Limited advancement in Total Cost of Ownership** across vehicle segments
- **Limited product innovation** and therefore limited model availability across all EV segments and limitations on range of EVs (particularly in E4Ws, E-Buses & E-Trucks)

Optimistic scenario assumes:

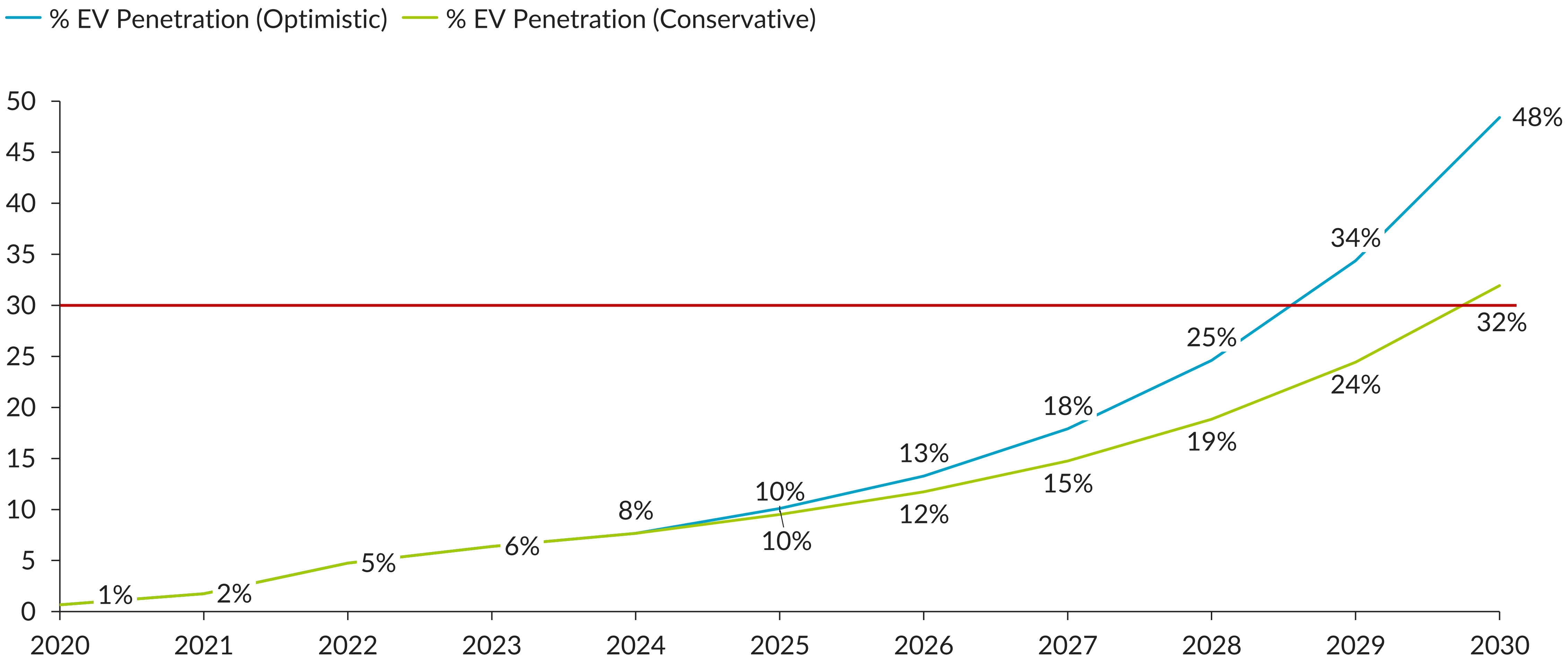
- **E2Ws & E3Ws**: **Electrification** of **high speed 2Ws** & continued subsidies beyond 2026
- **E4Ws**: ACC PLI helps boosting **R&D** in batteries **bringing down the battery costs** and more models in the entry level segment for 4Ws
- **E-buses**: Gross Cost Contract **(GCC) Models** and other alternative financing solutions driving up the penetration in **private bus market** & **SRTUs**
- **E-trucks: Product innovation** enables the **right price point** for operators to transition, and additional subsidies announced on top of the existing subsidies under PM E-DRIVE scheme
- **Charging Infrastructure:** Adequate **fast and ultra-fast** charging infrastructure is built in **top 5 Metros** by EV adoption and **top 20** high volume **freight corridors**

Source: Dalberg Analysis, Industry Reports, VAHAN Dashboard

India is expected to reach 32-48% EV penetration in EV sales, exceeding its target of 30% penetration by 2030

From an overall EV sales view across vehicle segments, India is well placed to meet its EV 30@30 target

Annual sales penetration of EV, %, 2020 – 2030

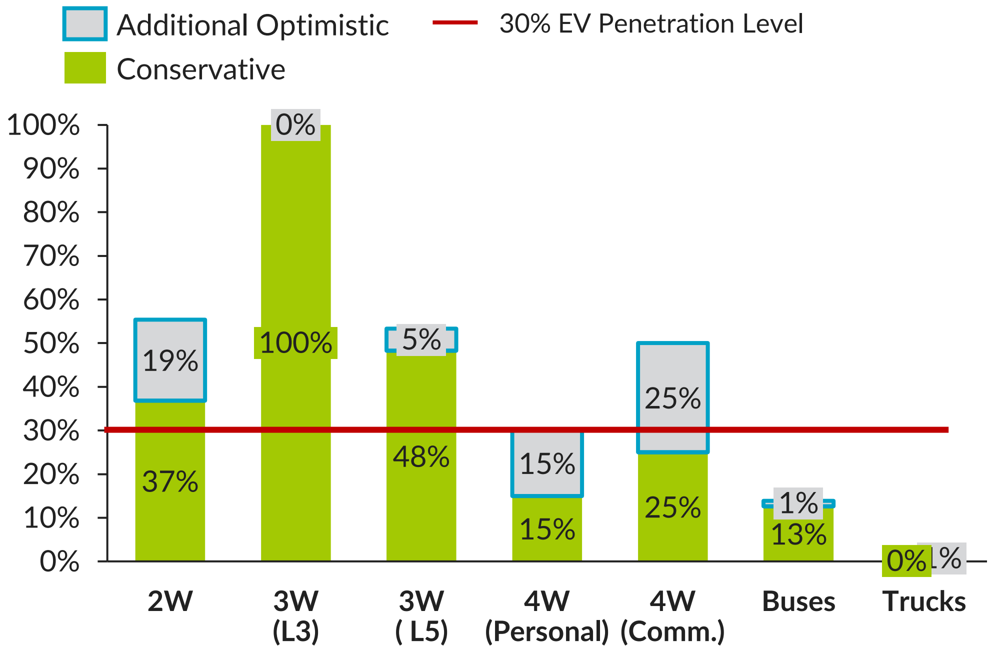


Source: Dalberg Analysis, Industry Reports, VAHAN Dashboard

While adoption momentum in 2W and 3W segments will drive progress in the 4W segment, penetration in buses and trucks segment is expected to remain limited

4Ws, E-Buses & E-Trucks to see slowest adoption and therefore lower penetration

Segment wise EV Penetration by 2030, %



Total Cost of Ownership by Segment, INR/km

Segment with TCO for EV > ICE

	2W	3W (L3)	3W (L5)	4W (Personal)	4W (Comm.)	Buses	Trucks
EV	0.7-2	2.94	1.87	19	4.5	33	9-73
Non-EV	2.5-3.3	4.25	3.6-4.5	12-15	6.3-7.2	40	7-48

Driving adoption beyond conservative scenario needs focus on segment specific challenges (e.g., cost of ownership, financing etc.)

E2Ws

- Electrification is mostly limited to mopeds and low-speed E-2Ws, not high-speed bikes
- Rider safety concerns in low-speed E-2Ws category for last mile delivery solutions and Q-Commerce Industry
- Uncertainty in resale value leading to higher loan premiums and interest rates for E-2Ws

E3Ws

- Fragmented market compared to highly concentrated ICE market making it highly competitive
- Nascent battery-swapping infrastructure, critical to reducing charging time in commercial uses

E4Ws

- Higher Total Cost of Ownership for personal use case compared to CNG/ICE models due to lesser utilization
- Exclusion of private use case E-4Ws in key schemes (FAME II scheme, PM E-DRIVE scheme)
- Competition from SHEVs[1] and HEVs[2] given their higher efficiency

E-Buses

- Significantly higher upfront cost (1.3~2.5x of ICE equivalent models)
- Limited number of intercity bus models meeting required benchmarks for daily operations
- Financing risks and high bank guarantees required for Gross Cost Contract models
- Reluctance in private bus market for lack of assured revenues and adoption roadmap

E-Trucks

- Significantly higher upfront cost (2~3x of ICE equivalent models)
- Battery weight reduces range-per-charge creating a payload penalty

(1) Self-Charging Hybrid Electric Vehicle; (2) Hybrid Electric Vehicle;
Source: Dalberg Analysis, Industry Reports, VAHAN Dashboard

Boosting EV adoption would require addressing existing demand blockers such as gaps in product offerings and expectations, lack of charging infrastructure but also mitigating the impact of higher DVA on EV prices

Existing demand blockers

Persistent challenges including inadequate **charging infrastructure** (~ **100K deficit** of charging points as of Aug 2025) limited availability of **finance** for commercial segments (up to **7%**[1] **higher interest rates** as compared to equivalent ICE Buses and Trucks)

Increasing localisation will raise EV prices and dampen demand

At 50% localisation, domestic manufacturing of batteries, motors, and electronics could raise EV prices by **15–25%** despite current subsidies and PLI Schemes

Landed cost of **Batteries** will **primarily drive this increase** in EV prices – *Domestically produced Batteries could be* ***40% costlier*** *than imported batteries.*

This could result in a need for **Viability Gap Funding** worth **INR 4,500 - 6,500 Cr**, particularly for **E-4Ws**, as proposed in the Battery Indigenisation Pathways – not covered in this document to avoid duplication.

(1) 7% higher interest rates on a percentage points basis. For e.g., Interest rates on Diesel trucks are around 10%, whereas on E-Trucks are 17%

Source: Dalberg Analysis, RMI and CoEZET, Comprehensive Guide to Financing the ZET Transition in India, 2024

To promote further EV adoption, the next push has to come from building adequate charging infrastructure, enabling product innovation & financing to reduce the upfront costs and adoption incentives

	Pathway	Investment Required	Target outcomes	KEY ENABLERS
A	**Supporting product innovation in E-trucks & financing interventions in E-buses**	**INR 4,900-5,500 Cr[2]**	• ~65,000 E-Buses & ~27,000 E-Trucks to be added by 2030	• Enabling tech transfer in MHDT[6] segment and launching innovation challenges for OEMs for new products • Outlining an additional ~INR 3,000 Cr as guarantee pool fund under the existing PM E-Bus Sewa PSM Scheme to support adding ~32k more buses
B	**Offering Viability Gap Funding to offset price increase in E4Ws due to improved localisation**	**INR 4,500-6,500 Cr** *Capped at 4W OEMs; already included in Battery Indigenisation Pathways, not proposed as additional investment within this document*	• Potential to add ~5.1 Mn E4Ws till 2030	• Extending existing subsidies (e.g., FAME II), spread over the next 4 years and linked at various stages of the EV production to offset the 15-25% price increase in E4W segment • Addressing the key challenges with the design and execution of subsidy disbursement to improve the effectiveness of policy
C	**Enabling CPOs[1] to expand charging infrastructure by improving business viability of setting up and operating charging stations**	**INR 4,000 Cr[3]**	• Supporting establishment of ~7.5 Lakh additional charging points by 2030, with focus on top 5 Metro cities[4] (by EV adoption) in India, and top 20[5] high volume freight corridors	• Subsidizing EVSEs and upstream charging infrastructure for depot CPOs • Building a one window system for CPOs for the entire end-to-end process of setting up a charging station • A centralized end-consumer app built on the existing capabilities of BEE and e-AMRIT with features such as locations of charging stations, waiting time, etc.

*Additionally, **~INR 31,700 Cr** available undisbursed funds under **PM E-DRIVE** and **PM E-bus Sewa** and **INR 4,800-5000 Cr private sector investment** will be required to support higher adoption of E-trucks and E-buses, and accelerate charging infrastructure development*

(1) Charging Point Operator; (2) Detailed ahead; (3) Refers to incremental investment required for scaling charging infrastructure. Detailed ahead, (4) Delhi, Bangalore, Mumbai, Hyderabad, Pune, (5) MHI, PM E-DRIVE: Draft guidelines on EV PCS, 2024; (6) Medium and Heavy-Duty Trucks

Despite strong policy momentum, the growth of commercial segments such as E-trucks and E-bus segments lags critically behind E2Ws and E3Ws in terms of penetration

A

Multiple policies, subsidies and initiatives have been launched to expedite the E-bus and E-truck adoption

E-Buses

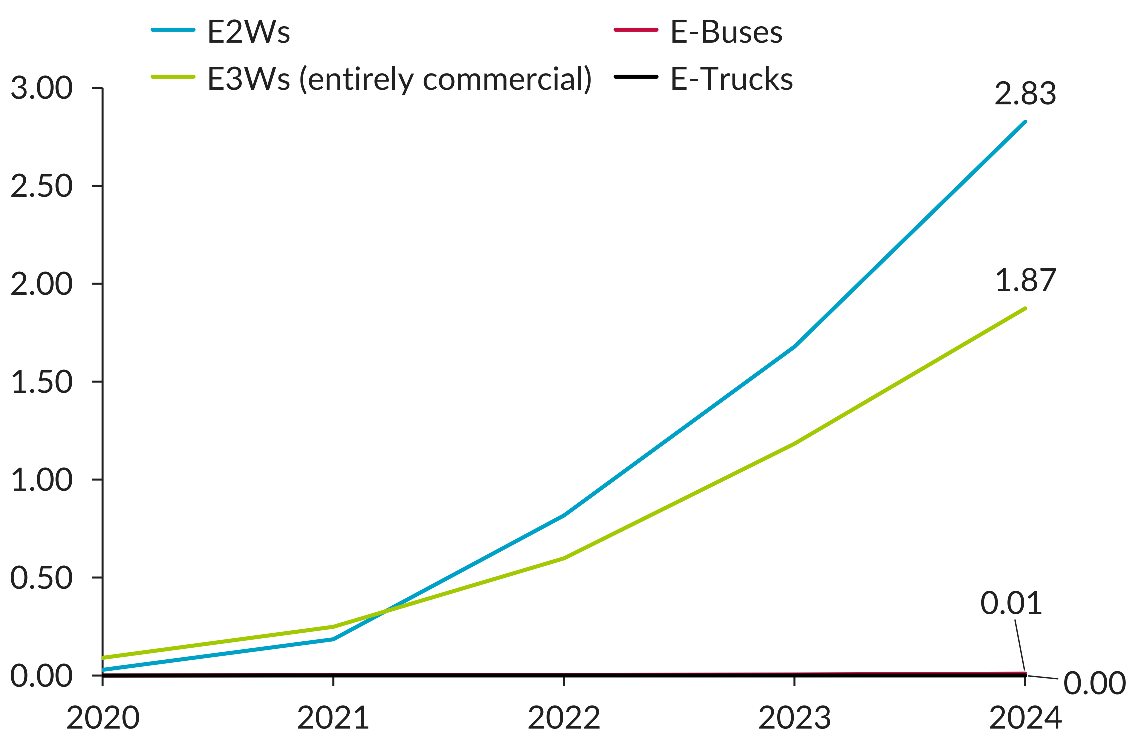
- Under **FAME II** (2019-24), **6,862 E-buses** were sanctioned for intra-city public transport
- In the subsequent **PM E-DRIVE** scheme an additional outlay of **INR 4,391 Cr** was dedicated for E-buses
- Parallelly, a dedicated **PM E-Bus Sewa** scheme was launched to enable deployment of **38,000 E-buses** with a **INR 3,435 Cr** between FY 2024-25 & 2028-29

E-Trucks

- First policy support came in July 2025 under the PM E-DRIVE scheme with incentives ranging from **INR 2.7 - INR 9.6 lakh based** on the Gross Vehicle Weight (GVW) for scrapping an old diesel truck and buying an E-truck
- An estimated **5,643 E-Trucks** across the **N2 & N3 categories** to be supported with a focus on **1,100 E-trucks in Delhi** considering the urgent need to improve air quality in the city

However, the segment wise stock penetration for E-buses & E-trucks stands at a nominal 3.12% & 0.01% respectively

Total EV stock for E2Ws, E3Ws, E-buses & E-trucks (2020-2024), Mn units



Source: Dalberg Analysis, PIB MHI, Current status of FAME-II scheme, 2025, MHI, Operational Guideleines for PM E-DRIVE, 2024, PIB MHI, Implementation of E-buses Scheme, 2024, MOHUA, PM E-Bus Sewa Scheme Guidelines, 2023, MHI, PM E-DRIVE: Amendment in Innovative Vehicle Enhancement, 2024

While several challenges hinder adoption across these segments, financing remains the key barrier for E-buses, whereas product readiness poses the main challenge for E-trucks

LEVERS	E-BUSES	E-TRUCKS
Product	• Heavy battery packs reduce cabin and luggage space, lowering passenger capacity, range and ground clearance • Limited model diversity (9–12 m standard buses dominate; smaller feeder / mini-bus variants scarce) • Issues with battery management system software and batteries in extreme operating conditions	• Few models exist in heavy-duty long-haul trucking, which is currently responsible for 49% of transport sector emissions • Increased weight from batteries can reduce the payload capacity by 15-20% thus lowering potential revenue • Existing battery capacity and degradation over time further reduces range limiting route options
Financing	• 1.3 – 2.5X more expensive than diesel buses • Delayed or irregular payments from STUs / PTAs under Gross Cost Contracts (GCC) • Concession tenure (10–12 years) often mismatched with loan tenure (6–7 years), creating negative cash flows • Limited participation from private financiers and NBFCs; dependence on sovereign or blended finance	• 2–3X more expensive than diesel trucks • Financiers hesitant due to lack of proven business models Lenders charge higher premiums and interests up to 7 percentage points higher than ICE variants • Covered by few insurers due to limited operational data and uncertainty about repair/replacement costs, and residual value • Lag in subsidy announcement and disbursal render public efforts disadvantageous – cause misguided price expectations
Charging – infrastructure related	• Slow charging and poor depot infrastructure cause more downtime therefore ~1.2 E-buses needed to replace 1 diesel bus • Depot electrification is expensive and grid dependent with High Tension (HT) lines costing ~ INR 10 Cr	• Limited access to charging stations along highways; existing ones can prioritize cars, lack fast and ultra-fast charging points • Limited charging infrastructure prevents economic feasibility for Heavy-duty long-haul trucking – typically requires a single charge cycle to last almost an entire day for feasibility • High charging costs – rates of INR 18–23/kWh increase operational expenses
Operations	• Route scheduling due to range and charging downtime affect reliability • Low charger-to-bus ratio and limited driver/technician training	• Charging adds downtime thereby increasing the overall operational costs as trip time increases • Limited driver/technician skills and fragmented logistics ecosystem

Source: Expert Interviews, ITDP India, Status of Electric Buses in India, 2022; CEEW, Road ahead for Private E-buses in India, 2024; WRI India, Real world electric bus operation: Trend in technology performance, degradation, and lifespan of batteries, 2024; ICCT, Charging infrastructure needed to support India's full transition to battery electric trucks by 2050, 2025; CEED India, Decarbonizing India's trucking sector: Potential for Zero-emission trucks, 2025; CPI, Just transition to Zero-emission Trucking in India, 2024; Office of PSA, ZET Adoption in India and its Impact on Emission and Energy Report, 2025;

A Action is needed across multiple fronts to expedite adoption of e-buses and e-trucks with spends totalling INR 4,900-5,500 Cr

LEVERS	E-BUSES	E-TRUCKS
Product	• Fund OEM–tier-1 partnerships and pilot grants to bring missing variants (mini/midi, hill-city configs, high-heat battery–thermal packages)	• Create a Heavy-Duty E-truck technology access window to boost tech transfer between global E-truck innovators and Indian OEMs for licensing/CKD kits, validation for Indian duty cycles (heat, grades, axle loads) • Launch an innovation challenge for OEMs to engineer e-trucks tailored to Indian conditions
Financing	• Allocate an additional INR 2,900–3,000 Cr as a guarantee / risk-pool fund to back PPP / GCC contracts to support 32K more buses under PM E-Bus SEWA PSM scheme • Classify E-buses under priority sector lending and associated charging and upstream infrastructure under infrastructure financing[1]	• Set up a national performance-registry / guarantee fund with capital of INR 2,000-2,500 Cr to support underwriting and risk sharing for NBFCs / insurers underwriting e-truck fleets • Extend and increase the subsidy cap under PM E-DRIVE for the first 10,000 E-trucks
Charging – infrastructure related	• Plan depots to a 1:3 charger-to-bus benchmark and budget HT grid works upfront • Piloting charging pads embedded at bus stops to enable wireless charging for buses during the stoppage time	• Target ~2 GW truck charging by 2030 in 5 key states (>70% charging demand), clustering ≥350 kW chargers with rest/parking at toll-proximate sites; align roadmaps with site-level grid agreements and anchor rollout along Ministry of Power's 12 E-highway corridors • Develop a clear framework to standardize battery packs for E-trucks to enable battery swapping infrastructure
Operations	• Mandate telematics, predictive maintenance, and charger-queue management in GCC KPIs, with standardized state-level driver and technician training to optimize schedules and charging	• Require shipper-fleet-CPO tripartite MOUs for guaranteed volumes and SLAs, plus algorithmic route and charge scheduling to maximize payload-time economics

Critical Solution

(1) Infrastructure financing: Refers to the multifaceted process of securing capital for the development, construction, maintenance, and upgrading of large-scale public and private infrastructure projects; Source: Dalberg Analysis, Expert Interviews, MHI, SOP for PM E-Bus Sewa Payment Security Mechanism Scheme, 2025, SmartcitiesDive, Wireless charging for electric transit buses, 2024, MoP, Annexure on EV Charging Infra guidelines, 2022; Office of PSA, ZET Adoption in India and its Impact on Emission and Energy Report, 2025

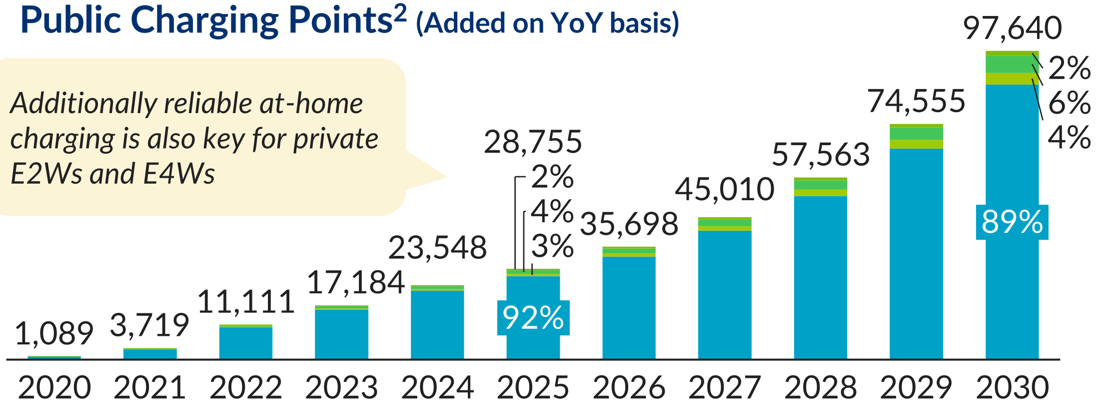
Building more than 8.5 lakh charging points (public & depot) in India is necessary for meeting energy needs of growing EV stock and drive further adoption by boosting consumer confidence

India will need to have 3.95 lakh public charging points & 4.75 lakh depot charging points in an optimistic scenario[1]

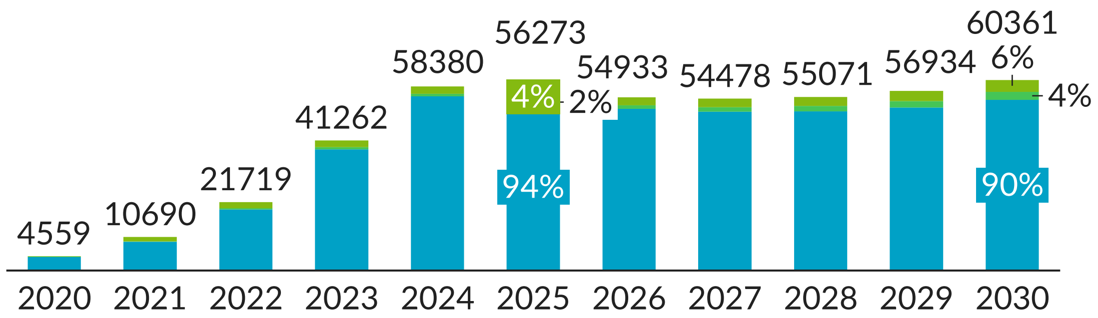
CCS II (120 kW) | Type II AC (22 kW) | CCS II (60 kW) | Type II AC (7.4 kW)

Public Charging Points[2] (Added on YoY basis)

Additionally reliable at-home charging is also key for private E2Ws and E4Ws



Depot Charging Points (Added on YoY basis)



Investment in charging infrastructure is an urgent priority since it is a critical enabler for demand acceleration

Industry reports indicate positive correlation between uptake in demand and charging infrastructure

- **29%** prospective EV buyers need **gas station-equivalent coverage** of charging stations and **24%** want **higher charging speeds** as their **tipping point** to buy an EV
- **24%** of hybrid EV buyers cite **charging station availability** as a barrier in buying an EV

Building charging infrastructure has further driven the EV adoption

- A US study shows that on **adding one charging station** per 1k people, there will be a **2% increase** in **EV adoption**
- Building residential charging infrastructure has led to a **15% increase in EV ownership** among residents within the first year

(1) PHEVs have been excluded from the analysis on charging infrastructure requirements, due to minimal charging requirements and preference of at-home/office charging; (2) Charging Station: A site with one or more charging points which can provide charging to more than one vehicle at a time; Source: Dalberg analysis; McKinsey and Company, New twists in the electric-vehicle transition: A consumer perspective, 2025; Oliver Wyman Forum, Why electric vehicles are here to stay, 2025; Iowa State University, Effects of Charging Infrastructure on EV Adoption: US Study, 2024, AMPPAL, Percentage of increase in EV sales when charging station installed at apartment building, 2025

However, meeting 2030 charging infrastructure targets will require overcoming key challenges such as poor CPO business models, complex approvals, and grid load management

1 Poor business proposition for CPOs due to under utilization

- **Under utilization:** Public charging infrastructure globally remains severely underutilized making the time for **cost recovery** for CPOs in some cases as long as **48 months**
- **High Upfront Cost**: The equipment cost of setting up a charging station (2 fast charger and 2 slow charger) is around **INR 30 lakh.** Additionally, setting up large scale public and depot charging stations in metro cities is a problem due to lack of plot area and higher leasing costs
- **Electricity Tariffs**: Electricity tariffs in high load areas are high for CPOs despite the subsidized tariffs. Ex: High tariffs in port areas

2 Complex regulatory approvals for setting up Charging Stations

- **Complex Regulatory Landscape:** CPOs find it difficult to coordinate with multiple different stakeholders (Land Dept., Finance Dept., DISCOMs) at the same time and meet their requirements in tandem
- **Asynchronous Policies:** Persistent misalignment between state and central fire safety guidelines means resident societies often deny NOCs for EV charging installation, citing unresolved fire safety concerns
- **Longer Subsidy Disbursement Timelines:** CPOs have reported delays in tendering, implementation and post implementation phase with the disbursement of subsidy on charging equipment and upstream infrastructure taking place in tranches and spread over a timeline of 52 weeks

3 Grid load due to congested energy demand

- **Increase Grid Load At Peak Charging Times:** During peak charging times (night-time in residential areas and day-time at industrial areas) there is significant load on the installed grid load capacity leading to higher tariffs
- **Limited Informational Awareness:** Limited information about the real-time availability of charging guns and expected wait times at stations often causes EV users to crowd popular locations, increasing overall wait times and inefficiency

Source: Expert Interviews, Cyril Amarchand Mangaldas, State v/s Residential Societies on fire NoCs, 2025; MHI, Operational Guidelines for EV Public Charging Stations, 2025; ICCT, Barriers and policy opportunities for public charging infrastructure in Haryana, 2024; Cars24, EV Charging Station Cost in India, 2025; Energy Strategy Reviews, Financial Feasibility of EV charging stations in Thailand, 2025; EV Blogs, EV Charger manufacturing process in India explained, 2025

C Although, the Government has already taken steps in the right direction with several initiatives, following interventions with incremental ~INR 4,000 Cr of investment in charging infrastructure can help address gaps

	Support Business Economics for CPOs	Improve Ease of Doing Business for CPOs	Managing Grid Load
Current initiatives	• Govt. agencies encouraged to **lease sites** at concessional rates via a standard **10-year** model agreement with minimum **revenue-share of INR 1/kWh** • EV charging **tariffs capped** at DISCOM's **Average Cost of Supply (ACoS)**: 0.7× ACoS during solar hours and 1.3× ACoS otherwise • **GST** on EV **chargers/stations** reduced to **5%** from 18%	• **No electricity trading license required** to set up & operate a charging station • DISCOMs **must provide new connections** to CPOs within a specified number of days depending on the charging station's location • Customer friendly and an **online single-window system** for **application** and **granting electricity** connection to CPOs • **Standardized safety** and **inspection norms** for EVSEs	• 2024 EV Charging Guidelines **incentivize charging during "solar hours"**, smart charging, V2G technology integration for CPOs • Bureau of Energy Efficiency, e-AMRIT portal and **several** other CPOs have individual **end-consumer apps** for charging infrastructure
Proposed future interventions	• **Subsidizing** EVSEs and upstream **charging infrastructure** for **depot CPOs** *(Prioritized Solution)* • **Standardizing** the **subsidized rates** for land as a percentage of the property value • **GST** on **charging services** to be reduced **from 18%** to a lower tax slab (preferably **5%** or a tax exemption) • Facilitating/Building a **CPO focused portal/app** to help them **track** the utilization rates and other key **business metrics**	• Building onto the existing **one window system** by several state DISCOMs for electricity connection, a portal for the **entire end-to-end process** for CPOs (including application for land-lease, procurement of EVSEs, DISCOM connection, green meter conversion, etc.) *(Prioritized Solution)*	• A **consumer centric app** built on the existing capabilities of BEE and e-AMRIT with features such as locations of charging stations, waiting times at a particular station, estimated cost of charging, route planning, etc. *(Prioritized Solution)* • **Special power lines** for public and depot charging stations to have uncongested demand with concessional tariffs
Investment Required	• Government already allocated INR 2,000 Cr in subsidies, **additional subsidies** worth **INR 4,000 Cr** needed to reach **8.7 Lakh** Charging points		

Prioritized Solution

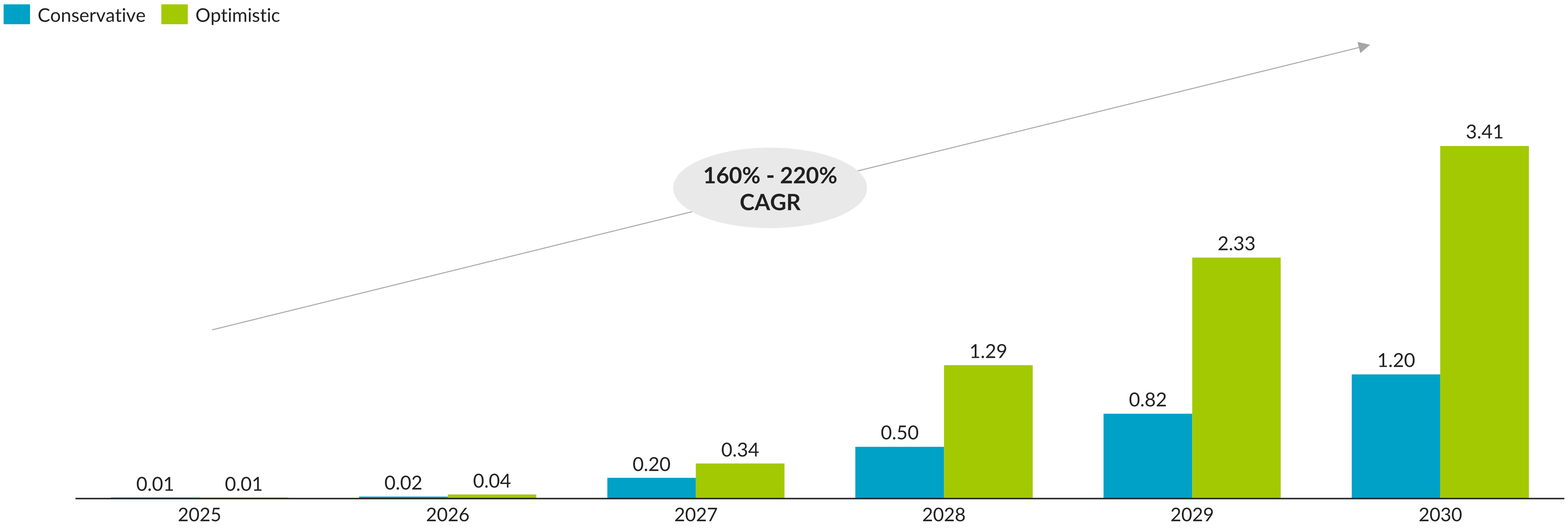
Source: Expert Interviews, MHI, Operational Guidelines for EV Public Charging Stations, 2025 ; Cars24, EV Charging Station Cost in India, 2025, Energy Strategy Reviews, Financial Feasibility of EV charging stations in Thailand, 2025, CEEW, What is the cost of charging EVs?, Energy Reports, Empowering E-mobility: Day ahead dynamic time of use tariff for EV charging, 2024 , MoHUA, Amendments in Model Building Bye-laws for Charging Infra, 2019, PIB MoF, GST rate on EVs reduced from 12% to 5%, 2019, PIB MHI, India accelerates National EV Charging Grid under PM E-drive, 2025

SECTION TWO, SUB-SECTION E

GREEN HYDROGEN INDIGENISATION PATHWAYS

Total green hydrogen demand from domestic and export markets could grow to reach ~1.2 – 3.4 MTPA by 2030

Green hydrogen total projected demand including domestic and exports – Conservative and optimistic scenarios
MTPA, 2025-2030

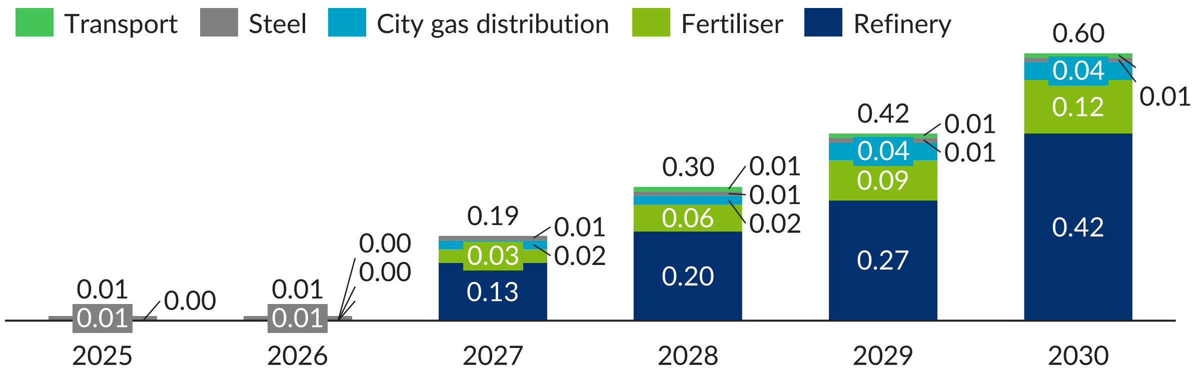


Source: CEEW and Dalberg analysis

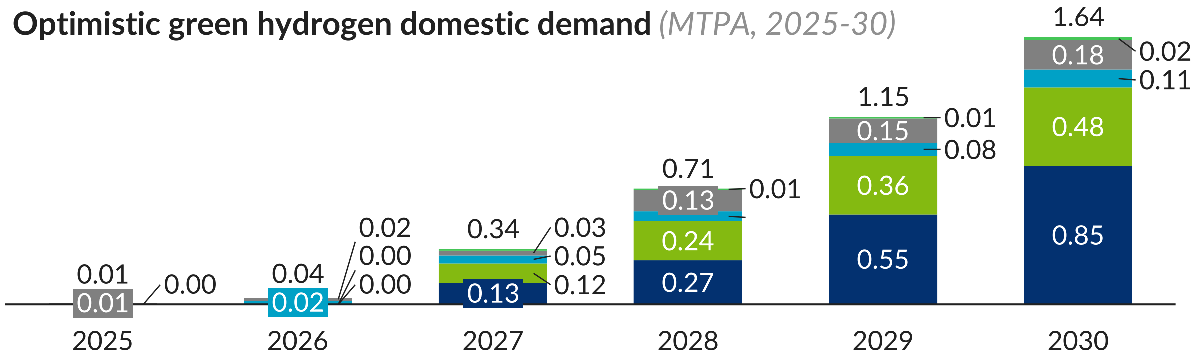
As opposed to the government's 5 MTPA target, domestic demand is projected to reach only ~0.6 MTPA conservatively, and ~1.6 MTPA optimistically by 2030

Domestic demand could grow to 0.6 MTPA conservatively, and 1.6 MTPA optimistically by 2030, with refinery forming a major sector

Conservative green hydrogen domestic demand *(MTPA, 2025-30)*



Optimistic green hydrogen domestic demand *(MTPA, 2025-30)*



Primary reason for domestic demand lagging the expectations is the prohibitive costs

- **The projected domestic demand for green hydrogen by 2030 would still fall short of the intended 5 MTPA target**
- **This can be mainly attributed to the currently prohibitive costs…**
  - Current production costs—**$3.5–$5 per kg** of green hydrogen vs. $2.3 - $2.5 per kg of grey hydrogen typically are not yet competitive
  - Driven by RE electricity that forms 50-70% of the green hydrogen production costs
- **…and insufficient demand surety in high-potential sectors like oil refining**
  - Only a small capacity of ~42 ktpa tendered by refineries as of August 2025

Notes: 1. Conservative scenario for fertilisers corresponds to tendered green ammonia capacity; optimistic scenario assumes 100% import substitution of ammonia starting 2027. 2. Refinery sector was assumed to reach 309 Mtpa of capacity by 2030 from 256 in 2024; conservative scenario corresponds to a gradual green H2 blending from 5% in 2027 to 15% by 2030 for refiners with >50KTPA H2 consumption; optimistic scenario corresponds to a gradual blending from 5% in 2027 to 30% by 2030 for refiners with >50KTPA H2 consumption. 3. Additional 6,800 TPA authorised to JSW Energy under the SIGHT scheme has been factored in 2025 demand over and above the built 3,800 TPA

Source: Harnessing Green Hydrogen, NITI Aayog, RMI, 2022; Financing Green Hydrogen in India, BNEF, CEEW, 2024;Financing Green Hydrogen in India, BNEF, CEEW, 2024; How can Hydrogen Electrolysers be made in India, CEEW, 2024; SECI, 2024; From Promise to Purchase: Unlocking India's Green Hydrogen Demand, Bain, 2025; Dalberg analysis

Even to reach the ~0.6–1.6 MTPA by 2030 in domestic demand, a phased approach to mandating green hydrogen usage in refineries and city gas networks would be crucial

Key recommendations

Refinery:

- Introduce gradual mandates, starting with **5% of total H2 usage to be green in 2027 to 15% in 2030 in the conservative scenario**; gradual mandate starting with **5% of total H2 usage to be green in 2027 to 30% in 2030 in the optimistic scenario**
- Mandate to be introduced for refiners with total >50KTPA H2 consumption; refiners would have the flexibility to pick the refineries where economies of scale can be achieved, as long as total portfolio blending %s are achieved
- Even a 30% green hydrogen blend (at USD 4.5/kg), would only lead to a <2% average increase in the price of petroleum products, making this the most suitable sector for demand acceleration

Fertiliser:

- Tenders for green ammonia in non-urea fertiliser plants will lead to a **25% import substitution (conservative)**; additional tranches can lead to a **100% import substitution (optimistic)** of ammonia
- Lesser potential to increase blending as sector is already heavily subsidized due to its link with farming
- However, the record-low green ammonia prices discovered in the 2025 SECI tenders rely on subsidies worth **INR 1500 Cr** from the SIGHT scheme covering 724 KTPA of green ammonia; an additional ~**INR 5000 Cr** would be required for the optimistic scenario

City gas distribution:

- Mandate **2% of green H2 blending by 2030 conservatively**, and **5% optimistically**, based on proven use cases of blending piped natural gas in city gas distribution with hydrogen. Blending to be done for PNG (commercial & industrial) and CNG.
- For blending, target the **top 10 states**[1] basis the **pipeline/CNG station density** and **CGD sales volume** to strategically locate green hydrogen plants that can supply multiple high-volume CGD networks
- A 2% blend (by volume) would lead to a ~1% increase in the price of natural gas ; a 5% blend would cause a ~4% increase

Source: Dalberg and CEEW analysis; Harnessing Green Hydrogen, NITI Aayog, RMI, 2022; Financing Green Hydrogen in India, BNEF, CEEW, 2024; Charting the future: Green hydrogen expansion and PNGRB's pivotal role, ICF, The World Bank, PNGRB, 2024; Charting the Future: Green Hydrogen Expansion and PNGRB's Pivotal Role, ICF, 2024; SIGHT Scheme 2A Guidelines, MNRE, 2024; SIGHT 2A Amendments, MNRE, 2024 Notes: 1. Basis internal Dalberg analysis the top 10 states for CGD blending in decreasing order of priority are: Gujarat, Delhi, Haryana, Uttar Pradesh, Maharashtra, Karnataka, Punjab, Rajasthan, Tamil Nadu and Telangana

Additionally, import substitution of grey ammonia with green ammonia in the fertiliser sector along with some adoption in the steel sector can be expected

Key recommendations

Steel:

- Hard to abate sector and hence green hydrogen adoption will have to be led by the government
  - The NGHM has already sanctioned pilot projects for the use of green hydrogen in steelmaking
  - The National Mission on Sustainable Steel envisions incentives worth INR 5000 crore till 2030 for emission intensity reduction
  - The Carbon Credits Trading Scheme also deploys market-based mechanisms to cap emission intensity and incentivize reductions year-on-year
  - These schemes, depending on their implementation, will lead to accelerated hydrogen use but likely beyond 2030

Transport:

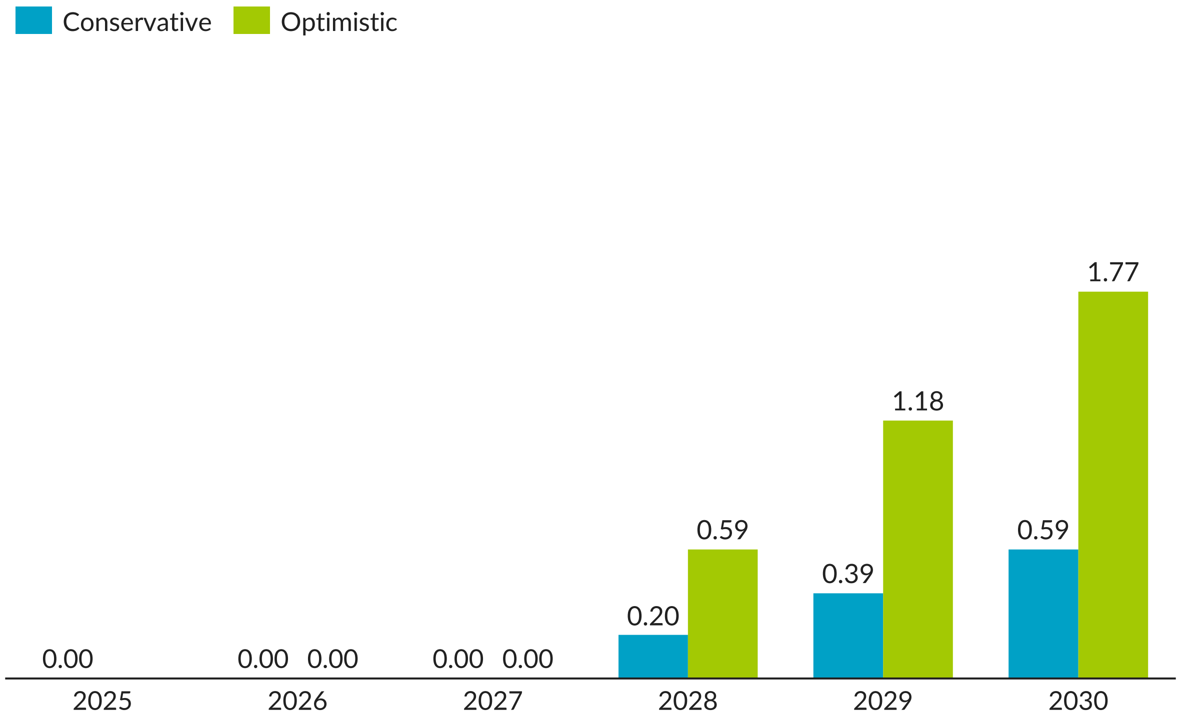
- H_2-powered vehicles are being trialled by various manufacturers and operators, with 37 testbeds sanctioned under the NGHM alone
- Several state-level green hydrogen policies provide financial support for around 1000 trucks/buses and 50 H_2 refuelling stations by 2030 amounting to over INR 500 crore
- The central government additionally targets the deployment of 1000 hydrogen-fuelled vehicles by 2030
- Beyond these initiatives, scope for market-driven growth may be limited by cost-competitiveness until well beyond 2030

Source: Harnessing Green Hydrogen, NITI Aayog, RMI, 2022; Financing Green Hydrogen in India, BNEF, CEEW, 2024; Dalberg and CEEW analysis

Exports could form another ~0.6 to 1.8 MTPA by 2030, based on green hydrogen commitments of global countries, especially from Europe

Export markets are expected to play a crucial role for making India a green hydrogen hub, complementing domestic demand

Green hydrogen export demand – Conservative and optimistic scenarios
MTPA, 2025-30



Trade agreements with major European importers of green hydrogen required to tap into this demand

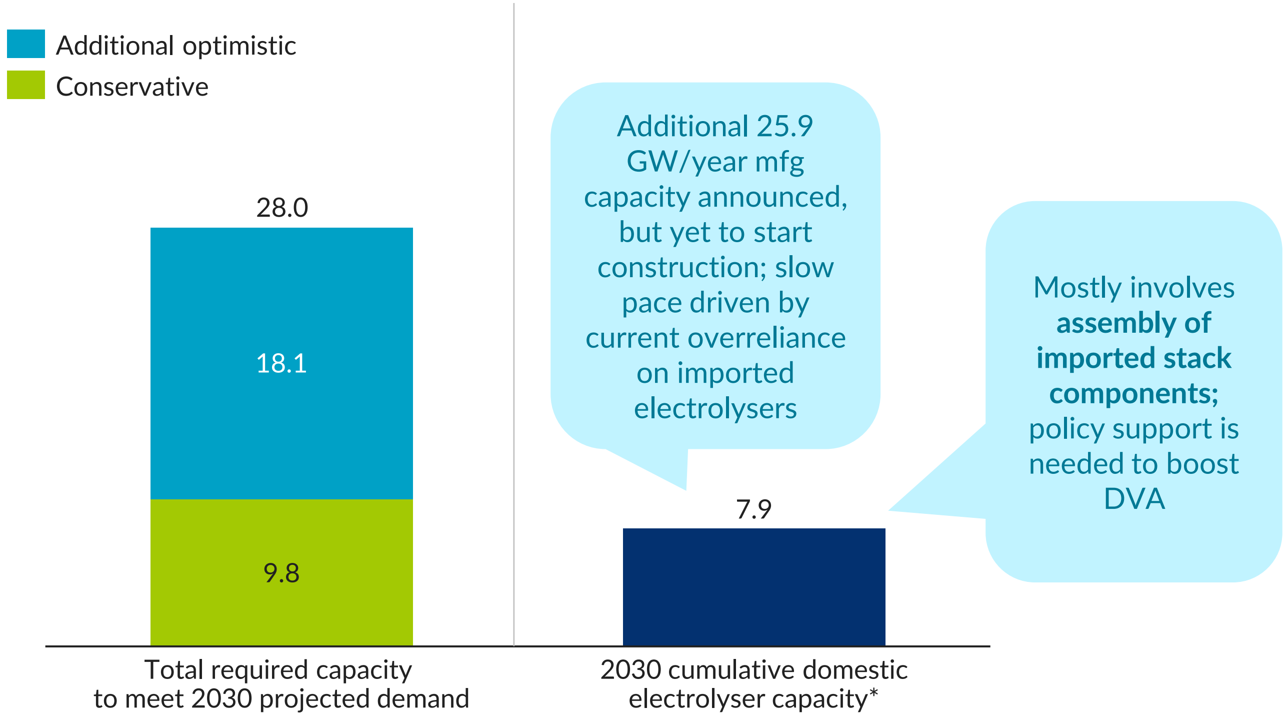
- **Establish trade agreements with major European importers of hydrogen**
  - International green hydrogen imports are expected to form **~6 MTPA** by 2030[1]; Europe, Japan, Singapore, South Korea and the UK could be major importers[2]
  - Our conservative scenario assumes we capture 10% of this market, while the optimistic scenario assumes a 30% of the market, giving us **0.6 MTPA – 1.8 MTPA**
  - Trade agreements with these countries would be important while setting up dedicated green hydrogen corridors to connect India's production clusters to European markets
- **Explore potential for long-term pathway on export of cell and stack components that can be produced in India**
  - Consider export of indigenously produced membranes, PTLs, electrodes, bipolar plates to above countries
  - However, this pathway may not materialize by 2030 owing to nascent supply chains and manufacturing

Note: Export potential calculated based on a meta-analysis of 2030 green hydrogen production and consumption targets for various countries. Those countries that project a higher consumption than domestic production were considered import-dependent.
Source: 1. Financing Green Hydrogen in India, IEA, 2024; 2. World Bank, WITS, accessed 2025; 3. Dalberg and CEEW analysis

Cumulative domestic electrolyser capacity at 7.9 GW with more announced projects; however, mostly involves imported stack components that are assembled in India

While domestic capacity to reach 7.9 GW with many more projects announced, policy shifts are needed to ensure true domestic value creation

Required electrolyser capacity vs. Cumulative domestic electrolyser capacity*
Gigawatts, 2030



Challenges in boosting domestic capacity

- While DVA requirements are specified for electrolyser incentives, **they are the same for manufacturers who make components in-house, as well as those who only assemble them**
- Moreover, **overall green hydrogen production incentives do not specify domestic electrolyser procurement requirements**
  - This means that projects could gain access to incentives **even without having a locally manufactured electrolyser**

Key recommendations

- Develop a **weighted DVA score for electrolysers** such that a higher weight is assigned to making components in house, thus discouraging only assembly
- Embed the **DVA metric into SIGHT Component-II** rules (which provide a per kg incentive to produce green hydrogen). The rules should require bidders to meet **a minimum DVA score** to qualify and offer additional incentive top-ups for higher localisation of strategic components
  - However, this could mean a tradeoff for the overall pace of growth of the green hydrogen projects

Notes: *2030 cumulative domestic electrolyser capacity considers 75% utilisation of current electrolyser factories with 2.1 GW/year capacity, between 2026-2030. An additional 25.9 GW/year manufacturing capacity is planned or announced, but may all not come live by 2030 due to meek demand and slow investments.
Sources: CEEW and Dalberg analysis; NGHM website, accessed 2025

SECTION TWO, SUB-SECTION F

TRANSMISSION EQUIPMENT INDIGENISATION PATHWAYS

Given the high import dependency, localising manufacturing of HVDC equipment could have commercial and strategic benefits for India

Why indigenisation is beneficial for India

Reductions in manufacturing cost

- Low voltage switch gear indigenisation (400KV) reduced costs by **30-40%** between 2015-2024[1] – can expect similar cost reduction for HVDC components if indigenised
- Licensing fee for **tech transfer could cost 4-5%[2]** of revenue, making effective **project costs to reduce by 20-25%** at least

Fewer project delays and reduced costs

- Material import constraints led to **delivery timelines** for converter transformers **increase by 2-3x** in the past 10 years
- Global **prices for switchgear** imported has risen by nearly **50% since 2020**, along with increasing lead times

Increased domestic value addition

- India **currently imports 50% of** HVDC substation components by cost
- **Indigenisation** of the value chain (switchyards and converter valves) could **increase DVA by 20-25%**

Detailed next

How China achieved economies of scale[3]

Timeline:

- Reduced import dependence for HVDC components from 80% to 10-15% between 2010-2020

Cost Reductions:

- 20-30% manufacturing cost reductions with 40% reduction in project delivery timelines

Levers implemented:

- Forced tech transfer from global OEMs early on[3]
- Created large domestic demand (10s of HVAC/HVDC projects identified)
- Government incentives for local manufacturing

1. Based on cost comparison of a 400KV switch bay in 2015 (Hitachi estimates) of 7-8 cr to recent 5-6 crore tender in 2024 (PGCIL)., and accounting for inflation in that period
2 .ABB India reporting in 2018 3.China required foreign OEMs(Hitachi, GE, Siemens) to form JVs with local firm, share designs, and meet local content rules, making tech transfer a condition for participation in national HVDC projects ; Sources: GEP.com, Market Publishers HVDC Report , Paulson Institute Report, Expert Inputs

While long-term HVDC transmission demand is robust, reforms are essential to make it predictable at component level for domestic manufacturers

Large scale, policy-driven demand exists:

- Transmission sector demand including HVDC is largely **government driven**
- Setting up **transmission planning rules** helped create a **long-term view** on the transmission capacity plan for India between 2022-2032
- CEA National Electricity Plan (NEP) announced **~1.91 lakh ckm** and **>1200 GVA transformation capacity** addition by **2032**
- Demand for transmission infrastructure is cyclical, with **project delivery taking ~5 years** & **planned asset life of 35 years** in India

However, OEMs lack component-level demand visibility to plan long-term investments

A **System & equipment design variations** across projects result in differing component needs with no aggregate demand visibility for OEMs

➡ **Standardize design templates** (HVDC topology, voltage levels, number of circuits etc.) & publish a 10-year component-level demand outlook parallel to the NEP

B Process issues like **delays in component eligibility screening** for projects & **RoW[1] reroutes** disrupt OEM order pipelines

➡ **Review & streamline approval processes** by standardizing component quality requirements and creating a unified RoW–environment clearance mechanism to reduce procurement uncertainties

Project developers also lack incentive to procure critical components locally

C **60% Minimum Local Content** (MLC) requirement for turnkey HVDC projects is **largely met through AC-side components**

➡ Launch **component-specific PLI** aligned with **MLC targets for DC-side equipment** such as valves and switch gear

D MLC thresholds for three recent HVDC projects **were relaxed to 25%** due to limited domestic manufacturing capacity

➡ Implement **phased, gradually increasing MLC requirements for valves** to build domestic manufacturing capability over time

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