Confederation of Indian Industry

# India's RE Mission 500: Capturing the India opportunity

August 2024

# Approach to developing the report

## Industry perspectives

**25+** CXOs interviewed across the RE value chain

- Manufacturers
- Developers
- Investors
- MDBs

## Prioritizing themes

Deep-dive into each factor using data from the sources listed below:

*…other industry experts*

## Generating potential steps/ unlocks

Meetings on prioritized themes with industry representatives to provide potential options/steps.

1. Meeting #1: Solar Manufacturing
2. Meeting #2: Wind manufacturing
3. Meeting #3: Storage (manufacturing, market design, development, finance, etc.)
4. Meeting #4: RE project development (land, evacuation, enablers etc.)

## Synthesis and enabling action

Prioritize steps based on impact potential, ease of implementation, and other relevant factors..

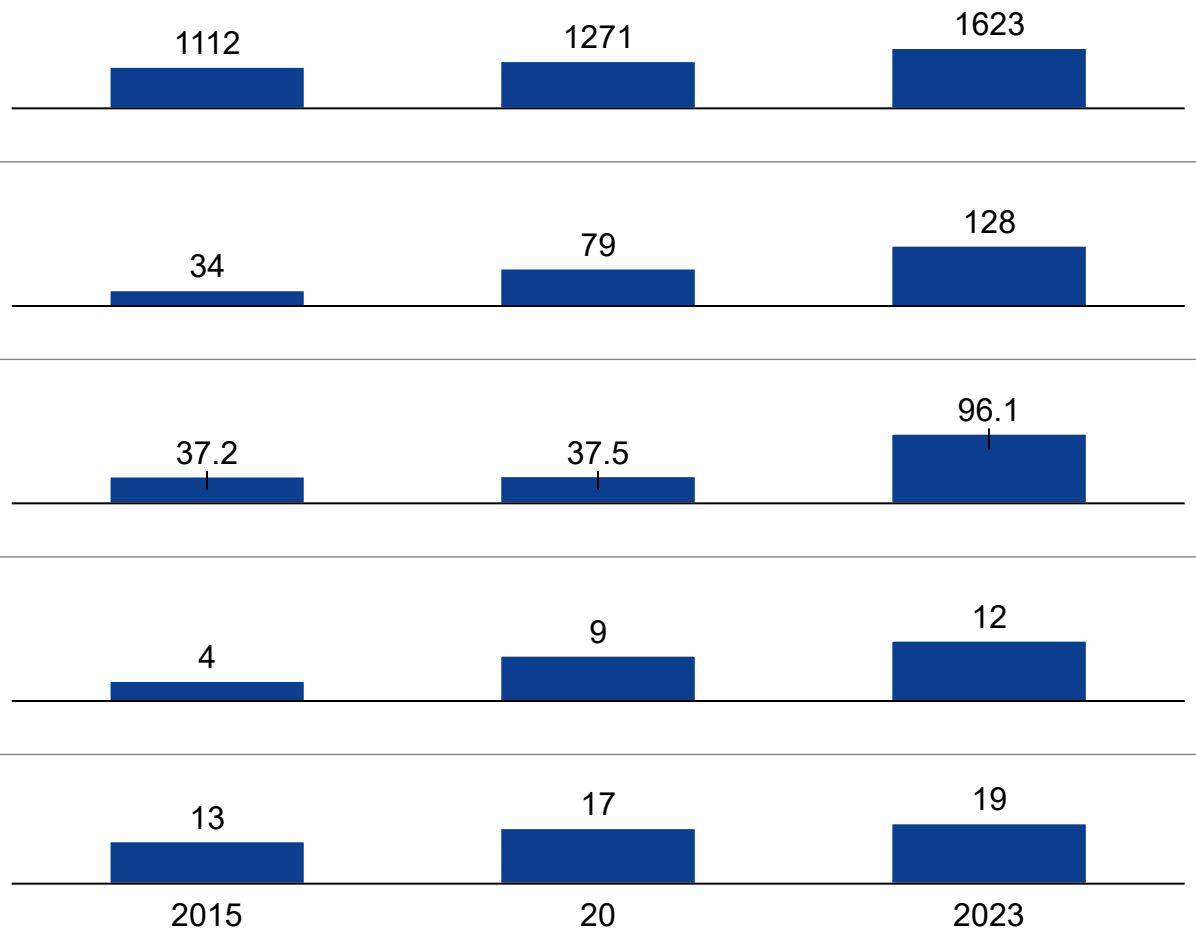
**13** key potential steps and interventions proposed across manufacturing, project development and execution, and possible enablers to ensure India could meets its 500 GW target.

Outreach and dissemination to key stakeholders in industry and policy.

We are here

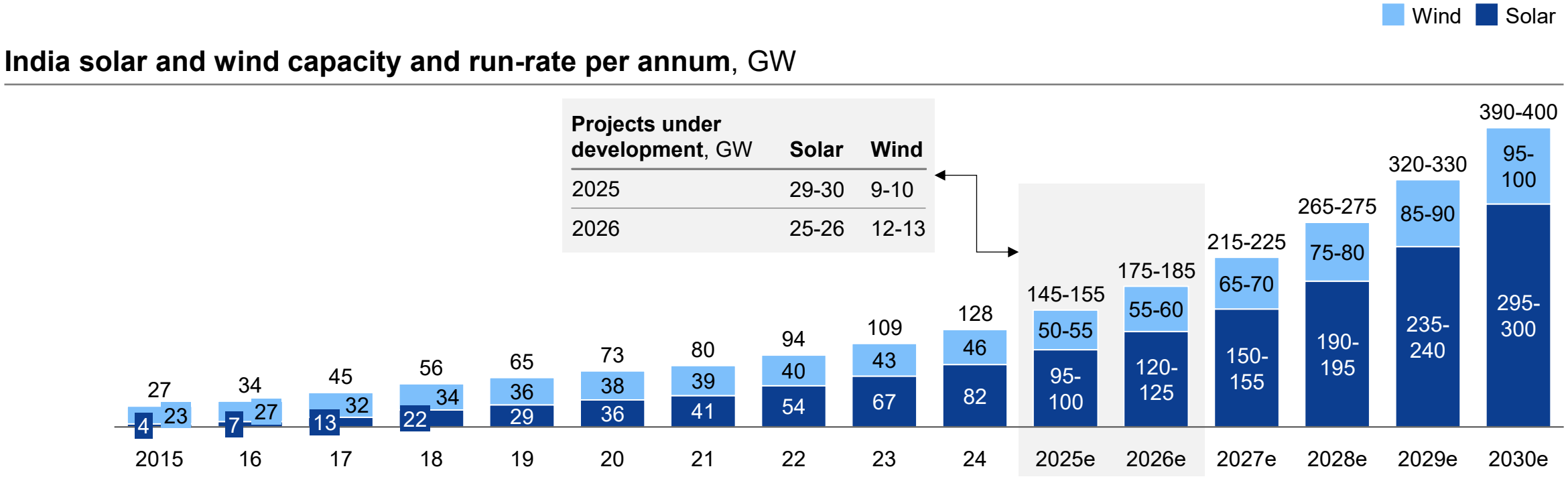
# India has accelerated RE capacity addition in the last decade

| | | Growth since 2015 |
|---|---|---|
| **Power consumption,** TWh[2] p.a.[1] | 1112 → 1271 → 1623 | ~1.5x |
| **Installed RE[3] capacity,** GW[4] | 34 → 79 → 128 | ~4x |
| **RE capital requirement,** INR '000 Cr, p.a. | 37.2 → 37.5 → 96.1 | ~2.6x |
| **Share of RE in generation mix,** %, p.a. | 4 → 9 → 12 | ~3x |
| **Average CUF[5] for Solar and wind** %, p.a. | 13 → 17 → 19 | ~1.5x |




1. Only solar and wind are included in RE, 2. TWh – terawatt hour; 3. RE – renewable energy, 4. GW – giga watt, 5. CUF – capacity utilization factor
Source: Niti Aayog, CEA

# To meet RE 500[1] GW mission, annual capacity additions on solar and wind would need to rise ~3x by 2030




1. 500 GW target includes – additional 59 GW from hydro, 15 GW from biomass, and 1 GW from waste-to-power; hydro and biomass are on track

Source: MNRE, CEA, MoP, Bridge to India

# Factors to accelerate renewable energy in India (1/5)

Insights based on inputs from industry experts

X Prioritized

| | Factors | Details |
|---|---|---|
| **Solar manufacturing** | 1 **Capacity**: India likely to be over capacity on modules, balanced on cells, but short on wafers, polysilicon due to large size of min-viable capacities, high capex needs and gestation period | Shortage in polysilicon (~25 GW) and wafers (~10 GW), excess capacity in cells (~10 GW) and modules (~45 GW) |
| | 2 **Price**: Indian cells are more expensive than Chinese equivalents; ALMM[1] effectively just shifts imports upstream | Indian cells and wafers are both 25-30% more expensive than Chinese equivalents (25% BCD[2] on cells, no protection on wafers) |
| | 3 **Ancillary materials:** Need for strong supporting market. Demand signals required for capacity set-up of solar glass, encapsulants, back-sheet, junction box, aluminium frame, and copper interconnect | Currently only ~15 GW solar glass mfg. capacity, which satisfies current demand but needs to scale for the 2030 target |
| | 4 **Quality**: Developers questioned consistence in quality of domestic manufacturing given smaller facilities | Tier 1 manufacturers comprise ~24 GW p.a. (~60% of ALMM list) and expected to reach ~42 GW p.a. (>50% of expected capacity) by 2030 |
| | 5 **Dependence on China** for capital equipment and expertise required for manufacturing | |

1. ALMM – approved list of modules and manufacturers, 2. BCD – basic custom duty

# Factors to accelerate renewable energy in India (2/5)

Insights based on inputs from industry experts

X Prioritized

| | Factors | Details |
|---|---|---|
| **Wind manufacturing** | 6 **Insufficient demand indicators** to support investments in additional and/or newer capacity | |
| | 7 **Need for R&D:** Commercializing and scaling of new technology with larger capacity and rotor diameter | ~10 GW currently of 3+ platform manufacturing capacity of overall ~15 GW manufacturing capacity |
| | 8 **Offshore wind:** Higher support and participation in pilot projects needed to support offshore wind development | |
| | 9 **Large scale up in storage capacity** needed to meet 2030 targets | ~6 GW currently (5.8 from pumped hydro storage, <1 GW from BESS[1]) to ~60 GW (8-10 GW p.a. with ~2/3rd from BESS) |
| | 10 **Upstream value chain** for manufacturing storage components is **yet to be built out** with most upstream components imported from China | |
| | 11 **Lack of clarity on storage use cases** (duration, power vs energy, etc.) and applications of storage required | |

1. BESS – battery energy storage system

# Factors to accelerate renewable energy in India (3/5)

Insights based on inputs from industry experts

X Prioritized

| | Factors | Details |
|---|---|---|
| **Storage** | 12 **Challenge in price discovery** due to wide variation in prices | Tariff range of INR 5-9 over last 2 years |
| | 13 **Limited raw material availability** in India | Limited mature reserves for Lithium ion |
| **Land** | 14 **Delays** in acquisition and price negotiation | 2-3 of 27 GW of UMREPP[1] under-construction solar parks delayed by up to 5-7 years due to land acquisition issues |
| | 15 **Disputes** with landowners pre and post-acquisition | |
| | 16 **Cumbersome approval process** for land use conversion, incl. state level nuances | |
| **RoW**[2] | 17 **Law and order** disruptions despite negotiations with farmers/ landowners | |
| | 18 **Lack of standardized charges;** variations within districts/ states leading to cumbersome negotiation, allotment process | |

1. UMREPP – Ultra Mega Renewable Energy Power Parks, 2. Right of Way

# Factors to accelerate renewable energy in India (4/5)

Insights based on inputs from industry experts

X Prioritized

| | Factors | Details |
|---|---|---|
| **T&D** | 19 **Commissioning delays** due to sub-station construction delay and cumbersome connectivity approvals process | 4-5 GW of 27 GW under construction solar parks under UMREPP[1] scheme delayed due to transmission delays |
| | 20 **Lack of visibility** on spare/ upcoming substation capacity available during the tender stage at a national/ state level | |
| | 21 **Reactive transmission planning** leading to commissioning delays | 2.5+ year completion time for transmission vs ~1.5 year for RE; some states ahead in planning e.g., Maharashtra have started transmission planning |
| | 22 **Lack of understanding** of differentiation between vanilla solar/ wind and RTC[2] tariffs | |
| | 23 **PPA signing** delays of 3-6 months from DISCOMs[4] in anticipation of better tariffs | Some states e.g., Gujarat able to achieve lower time between bid to PPA[3] of <3 months, compared to others at 4-6 months |
| **DISCOM bank-ability** | 24 Low bankability of DISCOMs due to high days payables and high debt | Avg. days payables improved from 175 to 126 in last 2 years driven by LPS[5] rules; some RE rich state DISCOMs e.g., Karnataka, TN, MP, Telangana still have payables >150 days |

1. UMREPP – Ultra Mega Renewable Energy Power Parks, 2. RTC – round the clock, 3. PPA – power purchase agreement , 4. DISCOM – distribution company,
5. LPS – late payment surcharge

# Factors to accelerate renewable energy in India (5/5)

Insights based on inputs from industry experts

X Prioritized

| | Factors | Details |
|---|---|---|
| **Human Capital and R&D** | 25 **Availability of skilled** technical manpower (including designers, techno-commercial engineers, etc.) currently sparse coupled with high levels of attrition | |
| **Others** | 26 **HVDC[1]: Limited suppliers:** only Siemens and GE manufacturing and installing HVDC lines | |
| | 27 **HVDC: Supply chain constraints** in upstream value chain | E.g. semi-conductor valves in short supply |
| | 28 **Financing:** debt and equity volumes needs to scale up 3x | Volumes needed are $45-50 bn p.a. vs current volume of $10-12 bn p.a. |

1. HVDC – high voltage direct current

# Summary of potential options

Insights based on inputs from industry experts

| | Considerations for near-term | Considerations for mid-term |
|---|---|---|
| **Manufacturing** | | 1 PPP[1] to scale upstream solar value chain, specifically Polysilicon manf.<br>2 Protection (e.g. CVD[2]) and DCR[3] to expand solar ancillary and storage value chain<br>3 Export credit support to enable solar module and wind turbine exports |
| **Project development** | 4 Accelerating wind repowering<br>5 Leverage government owned barren-land for RE projects | 6.1 Grid flexibility roadmap with view on annual targets and use-cases<br>6.2 Fast-tracked implementation of ancillary services in storage<br>7.1 Project monitoring, review, and debottlenecking through national and state, and district level war-rooms<br>7.2 Fast-tracking implementation of RE projects in top 100+ prioritized districts<br>8 Digitization for process improvement and ease of doing business (e.g. 30+ years historic land records and of approval processes)<br>9 Bottom-up transmission planning at state level |
| **Enablers** | 10 Power Council to streamline implementation of policies across states | 11 Enabling PPP between RE private players and ITIs for skilling<br>12 50-50 JV green innovation fund to scale alternate and future tech (e.g. sodium ion batteries, non-silicon solar modules, etc.)<br>13 Rationalizing of ISTS waiver to encourage RE growth across states |

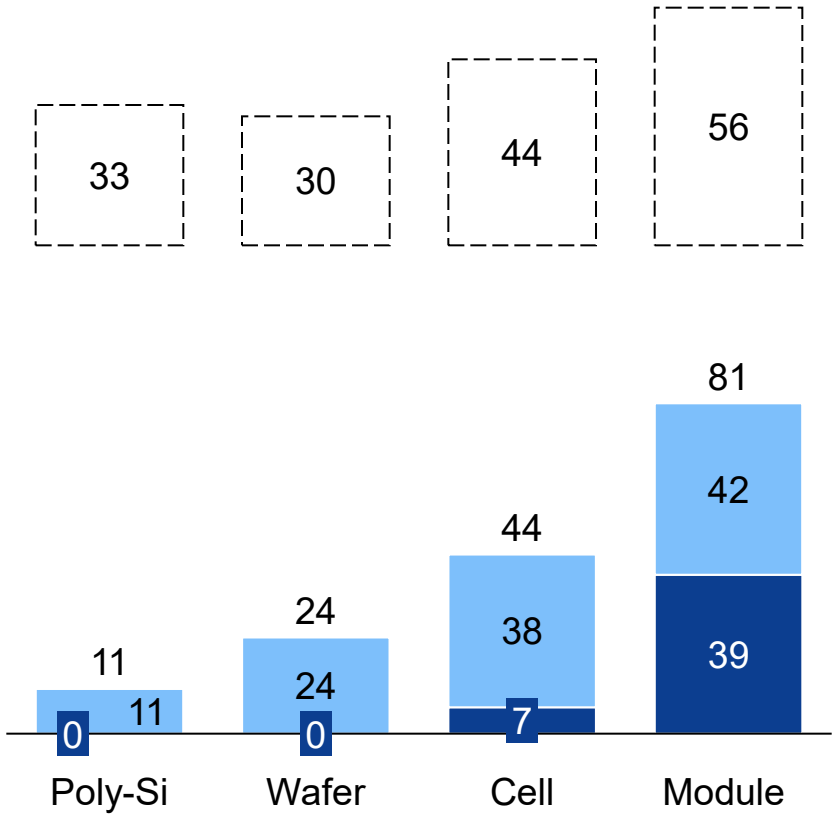
1. PPP – public private partnership, 2. CVD – countervailing duty, 3. DCR – domestic content requirements

# 1. Scaling upstream solar value chain through public-private-partnership

Insights based on inputs from industry experts

Announced future capacity (not assured) | Capacity addition probable by 2030[1] | Existing capacity

## Solar value chain, GW




To meet 2030 targets, **35 GW of** annual expected demand is expected domestically

## Potential steps

- **A feasibility study and business plan suggested for a 50-50 joint venture** involving public sector entities (such as IOCL, BHEL, etc.) and private parties to acquire and scale technologies with high capex and high gestation periods (e.g. 5-7 GW **polysilicon manufacturing unit**, sodium ion batteries, etc.)
- **Consider alternative models to reduce cost of electricity for** high-power consuming industries such as poly-silicon **(e.g., bulk consumer classification, deemed distribution)**

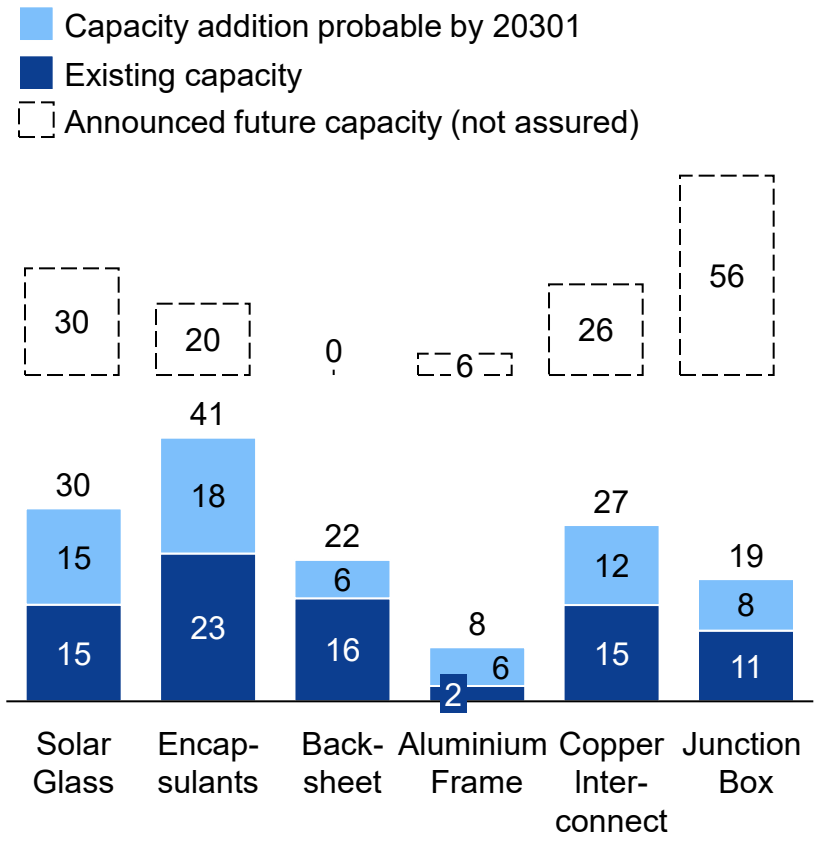
.1. Based on analysis of announced capacities of top 5 players that account for ~90% of total announced capacities; numbers are name-plate capacity and production numbers are ~60% of nameplate capacity

Source: press search, industry inputs

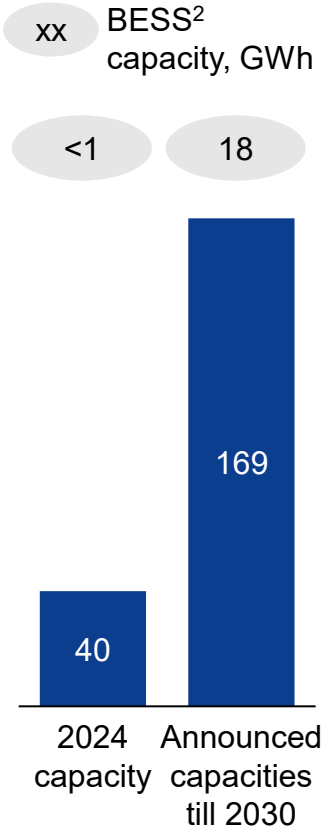
# 2. Scaling solar ancillary and storage value chain through protections and domestic content requirements

Insights based on inputs from industry experts

## Solar ancillaries manufacturing, GW




## Battery manufacturing, GWh




## Potential steps

**Products that can be focused on:** batteries, solar glass, encapsulants, back-sheet, junction box, aluminium frame, and copper interconnect

- **Develop an approach to apply countervailing duties (CVD)** on items from countries that subsidize production of ancillary components (for modules to be consumed in India)
- Once sufficient domestic manufacturing is built, CVDs to be eased and **Domestic Content Requirements** (DCR) to be imposed in ALMM[3] compliant solar modules for non-cell related ancillaries at ~60%[1]
- **Consider alternative models to reduce cost of electricity for** high-power consuming industries such as solar glass **(e.g., bulk consumer classification, deemed distribution)**

1. Solar glass, encapsulants, back-sheet, and copper interconnect account for ~63% of non cell-BOM of modules and there is sufficient manufacturing capacity upcoming for these;

Source: press search, industry inputs; 2. BESS – battery energy storage systems, 3. ALMM - Approved list of modules and manufacturers

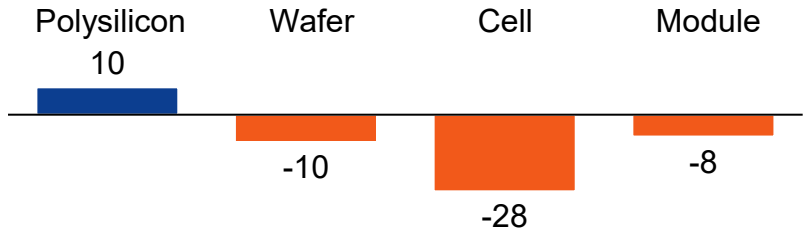
# 3. Facilitate export credit to unlock INR 50-60k Cr of solar module and wind turbine exports p.a.

Insights based on inputs from industry experts

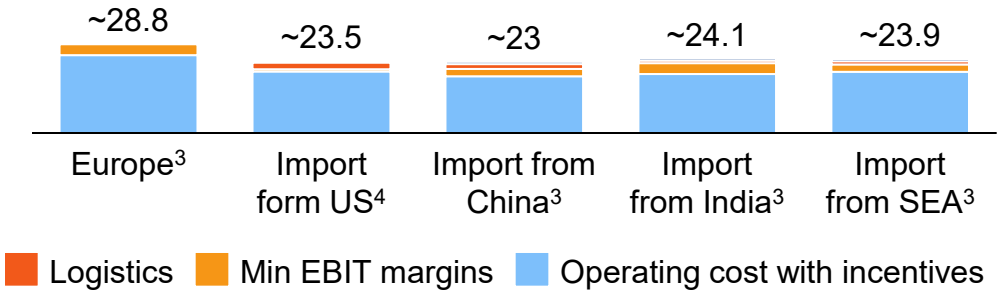
AS OF MID 2023

## Export opportunity from India by solar and wind OEMs[1]

**Demand-supply imbalance in EU by 2026,** (GW)




**Landed cost in EU[2],** c/Wp




**Wind production capacity India**, GW


**~10 GW** annual expected demand for wind turbines = 2-3 GW export potential

## Opportunity and potential steps

**Potential export opportunity** of 25-30% by both solar and wind OEMs amounting to INR 50-60k Cr p.a. ($ 6-7 Bn), fast-tracked with implementation of IRA[2] and upcoming rules in EU

**Considerations:**

- Industry could create **business case** to increase export credit financing to RE sector
- MNRE could write a **letter to MoF requesting increase in EXIM bank allocation of export credit to RE sector** (net loans sanctioned overall in FY22-23 ~INR 15k Cr)
- MNRE could propose to MoF to encourage PSBs with significant presence outside India to provide project financing to developers in foreign countries who use Indian manufactured equipment

1. As of mid 2023; 2. Considering for 10 GW scale; Based on 13-15% ROCE; 3. Considering all operating costs above EBIT including depreciation, with depreciation adjusted for ~90% supply util; 4. Integrated across W+C+M, sourcing Poly-Si from China; 5. Considering only module manufacturing, while sourcing cells from China (owing to shortage of wafers and cells in the US)

Source: press search, industry inputs; 1. OEM – original equipment manufacturer, 2. IRA – Inflation Reduction Act, 3. PSB – public sector banks

# 4. Wind repowering can potentially increase installed capacity by 50% to 60 GW+ in <2 years, unlocking ~INR 20k Cr of electricity consumption p.a.

Insights based on inputs from industry experts

**1** MNRE could consider conducting a 3-month study to **identify wind sites built before 2007** based on project age, turbine size, evacuation capacity, ownership, off-taker, wind speeds. Key outputs could include:

- Identify 2-3 sites for repowering pilots and collect technical and financial metrics. Prioritise Tamil Nadu and Madhya Pradesh, which have some of the oldest sites.
- CEA could consider grid connectivity options for additional capacity at repowered plants (STU or CTU)

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**2** MNRE could collaborate with industry (IPPs[5]) to **determine the appropriate commercial model and incentives** to support repowering:

- Coordinate with IPPs and energy departments to expedite repowering pilots, gathering technical and commercial learnings
- Conduct 3-4 stakeholder discussions with IPPs to share and modify available financial concessions for each category. Existing incentives, e.g. 0.25% interest rebate and repayment period of 20[1]-years, may not be sufficient
- Conduct tariff discovery and provide feed-in tariffs (equivalent to last three vanilla wind tenders) for 3-4 years to increase IRR
- Implement new PPAs[6] based on revised tariff guidelines

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**3** Consider updating the National Repowering & Life Extension Policy for Wind Power Projects to **limit residual life extension to 5 years** and encourage IPPs to repower

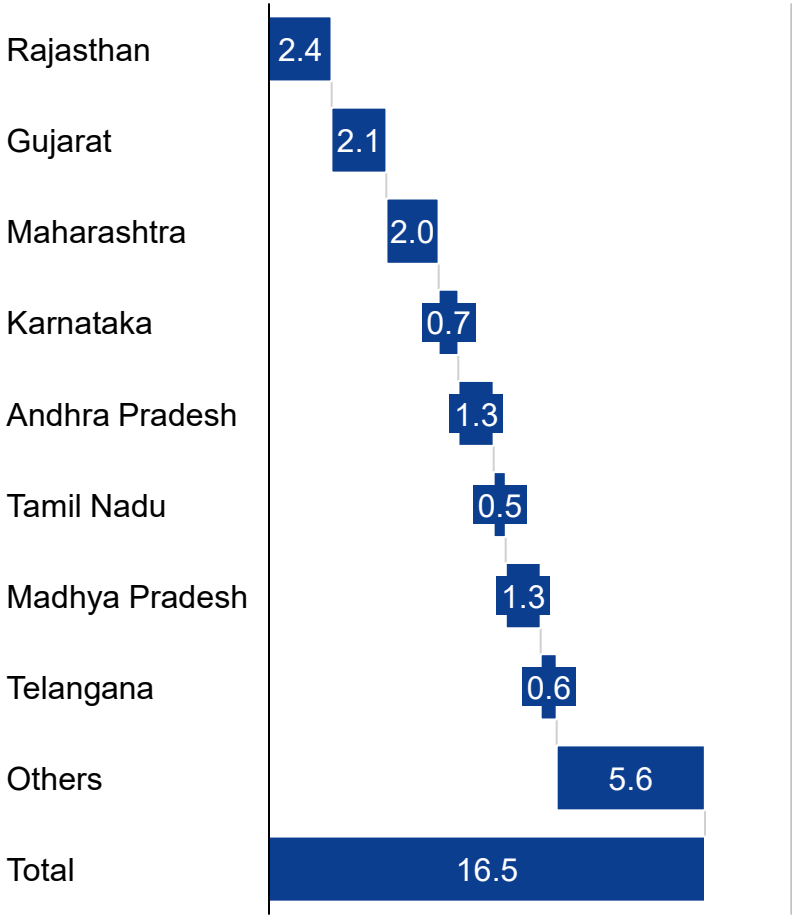
1. IWPA calculations, as reported by IndiaSpend

2. CEA – central electricity authority, 3. CTU – central transmission utility, 4. STU – state transmission utility, 5. IPP – independent power producer , 6. PPA – power purchase agreement

# 5. Government owned barren-land could be auctioned to private developers for RE projects

Insights based on inputs from industry experts

**Barren-land availability in RE-rich states,** Mn Ha[2]




## Potential steps

**Rationale:**

- **~2.5 Mn Ha** land required by 2050 and **~0.5 Mn Ha** by 2030
- **~5%** of the country's **~306 Mn Ha** of land is barren and **2/3rd** of total barren-land is in **8 RE-rich sates**
- **Only 11-12%** of current ~0.2 Mn Ha used in RE[1] projects is barren-land
- **1/6th** of India's barren land could meet the 2050 RE land requirements

**Steps at state level:**

- **Study could be commissioned by state RE development department** (e.g., GEDA[3], MEDA[4], etc.) to identify pockets of barren-land that can be utilized for RE projects – DMs[5] to help facilitate data collection at district level
  - **Study to include** RE potential, land parcel size, ownership, accessibility to airports, sub-station availability, soil conditions, status of any disputes, etc.
- **Revenue department could aggregate** the barren-land and identify parcels of adequate size and potential that can be utilized by developers
  - Aggregators can be hired wherever land acquisition is required
  - **Revenue department to enact change of land use**
- **Energy/ power ministry could conduct auction** amongst developers to provide barren-land on 99-year lease basis

1. Solar and wind

Source: CEA, ORF, NIWE, expert interviews, 2. Ha – hectares, 3. GEDA – Gujarat energy development agency, 4. MEDA – Maharashtra energy development agency, 5. DM – district magistrate

# 6. Consider developing a plan for national and state grid flexibility, including annual targets and technologies, to align with manufacturers (1/2)

Insights based on inputs from industry experts

## Need for flexibility to ensure grid stability and flexibility

1. **Intermittency:** RE sources are dependent on weather conditions, with unpredictability
2. **Frequency control:** Integration of renewables owing to its variability, intermittency, and asynchronous generation patterns, can create stability issues in terms of voltage and frequency control
3. **Energy shifting** from peak generation to demand time

## Solutions across current and emerging technologies; an integrated roadmap may be important for India's energy transition

1. **Battery storage:** BESS[1] as part of hybrid solutions can help stabilize the grid while offering support, with lower cost potential than variable cost of coal by 2030
2. **Pumped hydro-storage**: 3 GW+ of pumped hydro-storage operational as of March 2023
3. **Demand response**: Consumers incentivized to reduce peak hour consumption. India could implement AI-led smart grid solutions (especially with smart meters) and create new business models and revenue opportunities.
4. **Flexible generation**
   - i. Coal cycling: May lead to increased maintenance costs and reduced plant life
   - ii. Gas peaking plants: Offer flexible generation by quickly ramping output, gas pricing remains a challenge
   - iii. Storage-hydro plants: With market reforms and changes to current hydro generation PPAs[2] (scheduling flexibility), these may be leveraged to offer flexible generation
5. **Market mechanisms**: Creating an active and open trading market is critical for accelerated adoption of grid flexibility solutions. Creation of an ancillary services market can shape development of storage ecosystem (globally, 60%+ of storage system revenues from ancillary services), accelerating payback period to less than 5 years
6. **Others**: Vehicle-to-Grid (V2G) and Hydrogen are expected to be commercially unviable in short to medium term

1. BESS – battery energy storage systems, 2. PPA – power purchase agreement

# 6. Consider developing a plan for national and state grid flexibility, including annual targets and technologies, to align with manufacturers (2/2)

Insights based on inputs from industry experts

| Considerations | Develop the long-term grid flexibility vision | Define the grid flexibility roadmap | Cost-benefit analysis for major initiatives | Implement & monitor |
|---|---|---|---|---|
| **Activities** | **Analyze long-term grid flexibility vision being adopted by leading countries**, covering current and emerging technologies and market-based solutions<br><br>**Develop the vision for India** considering overall renewable energy vision and projected capacity buildout; consequent grid flexibility infrastructure and funding requirements; and global good practices | **Define a clear roadmap of** outcomes and timelines. These include supportive policies, regulatory mechanisms, funding support, research initiatives, pilot programs etc.<br><br>**Highlight steps to develop manufacturing and supply-chain ecosystem**, e.g., Production Linked Incentive (PLI) Schemes[1], policies to ensure domestic and international supply security of battery inputs; development of battery recycling, market-based mechanisms etc. | **Cost-benefit analysis** to attract and facilitate investments from private developers, funding institutions and multilateral entities<br><br>Identify initiatives that may require **partial government funding support** (VGF[2], market development assistance, fiscal incentives, etc.) and build detailed case for seeking the same from Department of Expenditure | **Develop detailed implementation plan** covering:<br>• Set of commercially viable **projects** that can be bid out, with clear outcomes and timelines<br>• Timelines for critical **interventions** (policy reforms, fiscal and monetary support, regulatory mechanisms etc.) to enable participation of high-quality bidders.<br>• Steps required to enable access to **emerging technologies**, skilled manpower etc. |

**Elements**

- Cost and emissions benchmarking across different flexibility technologies at national level by NITI/ MNRE
- Short-term and long-term targets for storage across different technologies at central level, with incentives including VGF, PLI2 with specific focus on BESS, new technologies
- Targets cascaded at state level with timelines
- Market mechanisms and framework for monetization of ancillary markets (e.g., grid stabilization, reactive power, etc.)

1. In addition to the one for Advanced Chemistry Cell

2. VGF – viability gap funding

# 6. Implementation of ancillary services to be fast-tracked to unlock commercial viability of standalone storage

Insights based on inputs from industry experts

| Value pool | Source of value creation | Revenue opportunity (INR/kWh) | Potential business model |
|---|---|---|---|
| 1 **Arbitrage** | Trading margin on peak vs off-peak delta | 4-5 | Operate discretionary capacity to capitalize on off-peak and peak price differences |
| 2 **Ancillary services** | Frequency/voltage regulation and spinning reserves | 7.5-8.5 | Offer capacity for primary and secondary reserves to stabilize the grid |
| 3 **RE Integration** | RTC[1]/Time shifting | 4.5-5.5 | Enter agreement with renewable energy generator who will leverage capacity for RTC/Time shifting |
| 4 **DSM Penalty** | Avoid DSM[2] penalties | 2-2.5 | Utilities can leverage excess capacity to avoid DSM penalty |

## Potential steps

- Globally, ancillaries account for around 60% of storage potential
- Accelerate implementation of ancillary services market
- Grid code and regulations for storage as a transmission element

1. RTC – round the clock, 2. DSM – demand side management

# 7. National RE acceleration program: national and state, and district level war-rooms could be considered for monitoring and de-bottlenecking RE projects (1/2)

Insights based on inputs from industry experts

| War-room | Frequency | Chair | Center-level | State-level | District-level | Industry |
|---|---|---|---|---|---|---|
| **National-level** | Quarterly | Secretary, MNRE | CEA[1], JS[2] transmission, MoeFCC[3] nodal officer, MD[4] PGCIL[5], central agencies (SECI[6], NTPC[7], NHPC[8]), JS Wind, JS Solar | ACS power of RE-rich states | - | Developers |
| **State-level** | Monthly | Chief Secretary | - | ACS[9] Power, PWD, MD of STU[10], Revenue dept., Energy SDA[11] | DMs | Developers |
| **District-level** | Fortnightly | DM | - | - | Chief Engineers, Local Engineers, Panchayat (by invitation) | Developers |

**Key Outcomes:**

- Drive faster implementation of critical projects by debottlenecking key issues causing delays
- Visibility to relevant stakeholders regarding progress, exchange of best practices to strengthen the collective capabilities of utilities

**Expectations:**

- Progress tracking of priority projects
- Escalating key issues and resolving cross sectors/ ministerial conflicts
- Fast-track approval, wherever required
- Drive a sense of urgency in the work being done

1. CEA – central electricity authority, 2. JS – joint secretary, 3. MoeFCC – ministry of environment, forest, and climate change, 4. MD – managing director, 5. PGCIL – power grid corporation of India, 6. SECI – solar energy corporation of India, 7. NTPC – national thermal power corporation, 8. NHPC – national hydroelectric power corporation, 9. ACS – additional chief secretary, 10. STU – state transmission utility, 11. SDA – state designated agency

# 7. National RE acceleration program: 100+ districts with upcoming RE projects could be prioritized for fast-tracking implementation (2/2)

Insights based on inputs from industry experts

## Examples of top districts across RE rich states could be targeted for pilot projects[1]

| State | District/ City | Total RE auctioned capacity (GW) |
|---|---|---|
| **Rajasthan** | Jaisalmer<br>Bikaner<br>Barmer<br>Jodhpur<br>Sikar<br>Baran | 22.6 |
| **Gujarat** | Kutch<br>Rajkot | 6.3 |
| **Karnataka** | Gadag<br>Koppal<br>Tumkur<br>Belgaum<br>Bellary<br>Davanagere | 4.4 |
| **Madhya Pradesh** | Agar<br>Neemuch<br>Shajapur<br>Indore<br>Khandwa | 1.7 |
| **Maharashtra** | Nashik<br>Dhule<br>Jalna<br>Chandrapur<br>Thane | 0.9 |
| **Tamil Nadu** | Thoothukudi | 0.4 |

25 districts account for **>30% of total auctioned capacity**

## Focus areas at district level

MNRE could **conduct study to make list of districts comprehensive** (e.g. 100+ prioritized districts)

Priority districts' DMs[2] can be informed on the importance of the RE 500 mission and encouraged to facilitate RE initiatives in their districts:

- Take **fortnightly updates on project progress and de-bottleneck** (including transmission construction as per state plan)
- **Maintain law and order and enable smooth RoW**[3] (both for developers and DISCOMs[4])
- **Mapping of barren-land and title ownership of land** for RE projects
- Assist state/ central IT departments in **digitization of land records** (past 30+ years) by fast-tracking data collection
- **Increase outreach of skill development programs** by ITIs[5]
- Act as **single point of contact for grievances redressal** from developers or DISCOMs

1. Non-exhaustive list of districts based on ongoing tenders – to be commissioned post 2024; actual upcoming capacity in districts could be much higher

Source: Bridge-to-India RE navigator, GlobalData; 2. DM – district magistrate, 3. RoW – Right of Way, 4.. DISCOM – distribution company, 5. ITI – industrial training institute

# 8. Digitization of 30+ years historic land records and of all approval processes with deemed approvals in-case of delays

Insights based on inputs from industry experts

## Digitization of land records

- **As-Is case:** 94%+ land record digitization of current ownership status
- **Industry requirements:** 30+ years historic land record digitization
- **Potential steps:**
  - MNRE could co-fund 30+ years historic land records digitization in collaboration with DIC[1] and NIC[2], and state IT departments
  - (to be implemented in prioritized districts)

## Digitization of approval processes

- **As-Is process:** single window clearance exists but approvals require manual follow-ups
- **Potential steps**:
  - District level approvals required to be digitized through an investor portal
  - Deemed approvals if not provided within the promised time-frame
  - Similar approach to be created for state-level approvals
  - (to be implemented in prioritized districts)

1. DIC – digital India corporation, 2. NIC – national informatics center

# 9. Bottom-up transmission planning at state level to match central plan

Insights based on inputs from industry experts

## Bottom-up transmission planning for states

- **Rationale:**
  - Avoid mismatch between tenders for capacity building and transmission availability
- **Steps:**
  - **STU[1] could create granular 3-5 year rolling transmission plan,** integrated with central targets
    - Plans to be revised every 1.5 years based on progress
    - Next 5-year plan to be published within 3 months
    - CEA can provide support in creation of the plans
  - **STUs could proactively develop transmission capacity** in sync with RE generation capacity being commissioned
    - Transmission construction to start before tendering of RE projects to be connected as beneficiaries
    - (to be implemented in prioritized districts)

1. STU – state transmission utility

# 10. Consider creating a Power Council to streamline implementation of policies across states

Insights based on inputs from industry experts

## Potential steps:

- **Power Council** (similar to GST council) could be set up to **streamline state-wise implementation** of policies
  - Forum of regulators can be repurposed to Power Council
- Power council could be a **constitutional body that could provide guidance for making recommendations** on issues related to implementation of policies across states
- **Vote based mechanism** can be followed to provide both center and states to contribute in implementation of policies
- Topics that can be covered during Power Council meetings:
  - Implementation of Green Open Access Rules (e.g. Gujarat has favorable OA[2] policies but Andhra Pradesh does not)
  - Enforcement of Renewable Purchase Obligations
  - Resource adequacy study for long term planning
  - Study on grid balancing and innovations that can aid this
  - Capability building along with private players on topics such as ToD[3] tariffs, mode tariff order, framework for cost pass-through to customers, etc.
  - Creation of standard setting mechanism for ancillaries in central and state tenders

1. As on May 2023

Source: press search, industry inputs; 2. OA – open access, 3. ToD – time of day

# 11. Enabling public-private-partnership between RE private players and ITIs for skilling manpower

Insights based on inputs from industry experts

## Public-private-partnership (PPP) for skilling manpower

- **Potential steps:**
  - Private players and Industrial Training Institutes (ITIs) could co-invest on skill development courses on energy transition themes such as solar manufacturing, wind manufacturing, operations and maintenance, designing (specifically for firm and dispatchable RE, round-the-clock power, storage), techno-commercial roles, etc.
- **Steps:**
  - **MNRE could write to MSDE[1] to launch scheme inviting private players** (OEMs, developers, etc.) to set up skilling institutes
  - **State technical education agency could co-invest** along with private companies in PPP model to develop curriculum and faculty for training manpower
  - **Secretary technical education could enable fast-track creation of institutes** by enabling approvals from DGT[2] and coordinating with DMs for acquisition of land; NSDC[1] to monitor and coordinate at a central level
  - (to be implemented in prioritized districts)

1. MSDE – ministry of skill development and entrepreneurship, 2. DGT – directorate general of training, 3. NSDC – national skill development council

# 12. Set up of a 50-50 JV green innovation fund to invest in scaling alternate and future technologies

Insights based on inputs from industry experts

## Green innovation fund

- **Potential steps:**
  - 50-50 JV[1] between MNRE and private sector could be considered to invest in long-term technologies that can be accelerated and scaled in India
- **Steps:**
  - **MNRE could consider a study on up-coming technologies** such as sodium-ion based storage, auxiliary chemistry batteries, non-silicon dependent solar modules, offshore wind, etc.
  - MNRE could conduct analysis to **make business case** for acquisition of these technologies
  - MNRE could create roadmap for green innovation fund to scale these technologies in India

1. JV – joint venture

# 13. Rationalizing of ISTS waiver to encourage RE growth across states

Insights based on inputs from industry experts

## Rationalizing ISTS[1] waiver

- **Implication of ISTS waiver:**
  - RE-rich states with marginally lower tariffs (such as Rajasthan and Gujarat) have bulk of new projects with electricity being transmitted to other states (including other RE-rich states) – disincentivizing even distribution on new projects across the country
- **Recommendation:**
  - System-wide **study by MNRE on true cost benefit of ISTS waiver** as installed capacity of solar and wind goes up
  - Each state is allowed a quota of solar and wind generation for ISTS waiver, after which certain ISTS charges are applicable for projects
  - Mid-term roadmap to be published on ISTS waiver for the period from 2025-2030

1. ISTS – Inter State Transmission Charges

Confederation of Indian Industry

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# Tailwinds: Strong policy support and attractive government incentives and have been key drivers for growth for solar manufacturing

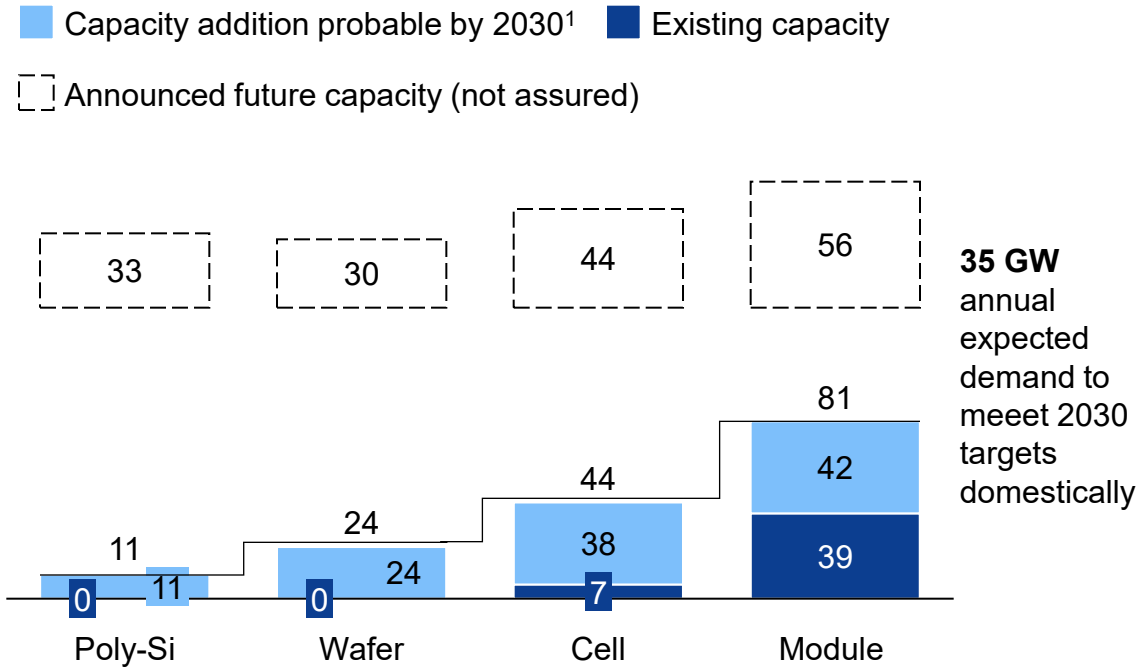
| What has worked well | Description | |
|---|---|---|
| 1 **PLI schemes for solar** | **$ 2.75 Bn** | Outlay for solar and storage domestic value chains |
| 2 **Customs duty protection** | **25-40%** | Basic customs duty on solar modules and 25% on cells |
| 3 **ALMM[1]** | **41 GW p.a.** | Capacity identified under approved list of local solar module manufacturers |
| 4 **Ultra mega solar projects in India** | **51** | Solar parks sanctioned across India with aggregated capacity of ~38 GW across 12 states in India |
| 5 **Import restrictions in USA** | **15-240%** | Anti-dumping and countervailing duties imposed on imported solar PV cells and modules produced in China |

1. As on Apr 2024

Source: CXO discussions

# Capacity and price: India expected to have in-sufficient upstream capacity especially Poly-Si and wafers; need protection against Chinese imports

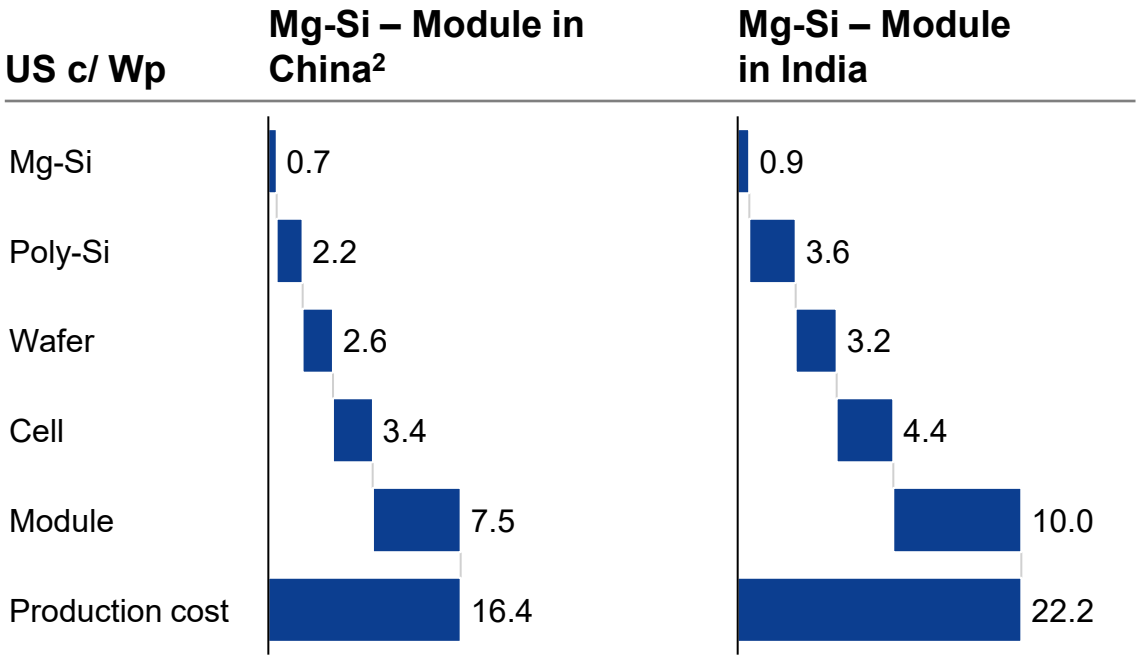
## Solar manufacturing capacity across value chain, GW




**35 GW** annual expected demand to meeet 2030 targets domestically

**40%+** of value-chain capacity announced is under development and expected, having PLI support granted, financing raised, and/or land acquired for the project

## Cost breakdown, US c/ Wp*




**25%** BCD on cells but no protection for wafers for Indian manufacturers

* As of May 2023

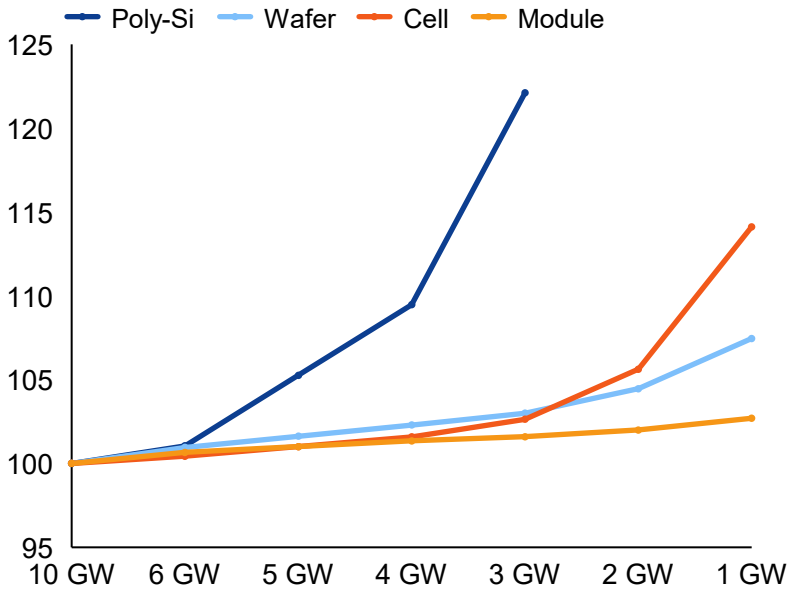
.1. Based on analysis of announced capacities of top 5 players that account for ~90% of total announced capacities; 2. Assuming 30k MT scale for Poly-Si (Modified Siemens) and 5GW each for wafer – module (n-type TopCon bifacial)

Source: McKinsey PV Module Manufacturing Cost Model

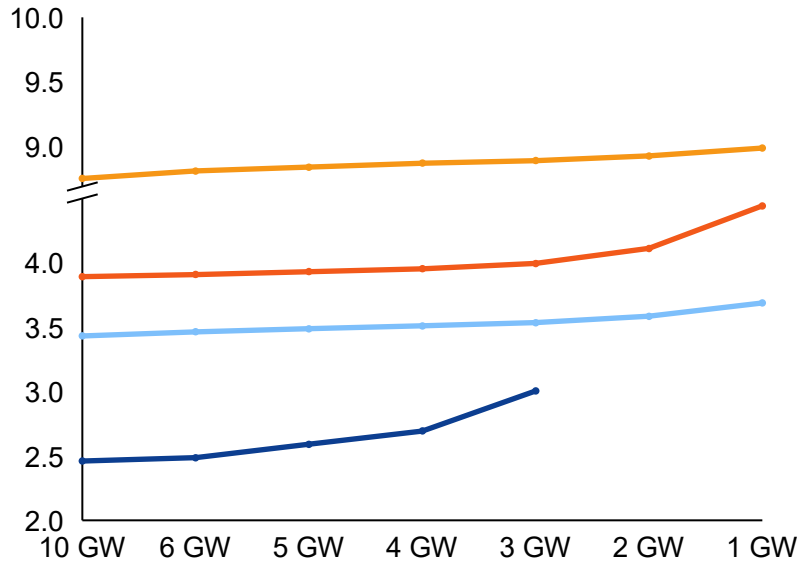
# Scale: 5 GW scale optimum for WCM play; P-Si requires minimum 10 GW scale to be efficient

## Cost across PV module value chain basis scale up

**% Increase indexed to 100 for 10GW to capacity in GW**




**C/Wp vs capacity in GW**




**Reduction in cost with scale driven by:**

- Depreciation, Labor and SG&A synergies
- Plant design (footprint) optimization
- Efficiencies in procurement of equipment, raw materials

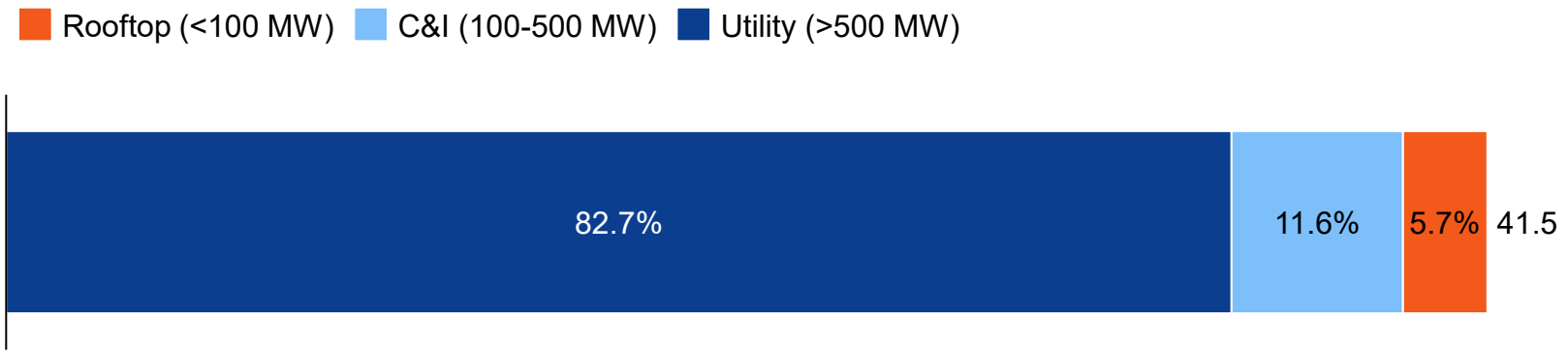
Source: Expert Interviews

## Key insights

- P-Si requires **minimum 10 GW scale** to be efficient- ~$500M capex and extremely complex manufacturing capabilities
- Minimum efficient scale of **~2-3.5 GW scale for wafer and cells**
- **1 GW min scale sufficient for modules**- only raw material procurement economies can be realized beyond efficient scale

# Policy changes: Frequent change e.g., ALMM affecting investor sentiment

## Breakup of existing module capacity (ALMM), GW




**~60%** of ALMM capacity (GW) is part of BNEF Tier-1[1] list

## Frequent changes in ALMM policy

- **2019** — Original order
- **2020** — Clarifications: definition of "model" & eligibility of BIS-exempt manufacturers
- **2021** — List 1 release delayed; Amendment: include all govt electricity projects
- **2022** — Amendment: include all open access and net-metering projects
- **2023** — Implementation put in abeyance; increase in registration fees
- **2024** — Implemented on 1st pr; List 2 not released

1. BNEF Tier 1 is a list of module manufacturers released by Bloomberg, basis bankability, efficiency and quality

Source: MNRE, press search

# Ancillary materials: Supply of critical raw materials for WCM play dependent on China

**Availability** Good Medium Limited

| Key RM / Consumables | % of BoM | c/Wp |  |  |  |  |
|---|---|---|---|---|---|---|
| Hot zones | 18% | 0.6 c/Wp | | | | |
| Diamond wire consumables | 10% | 0.4 c/Wp | | | | |
| Crucibles | 9% | 0.3 c/Wp | | | | |
| Argon | 1% | <0.1 c/Wp | | | | |
| Chemicals | 0.3% | <0.1 c/Wp | | | | |

Dependency on China persists for Hot Zones, Diamond wire consumable and Crucibles (medium availability in US/EU)

Source: Expert interviews, desktop research

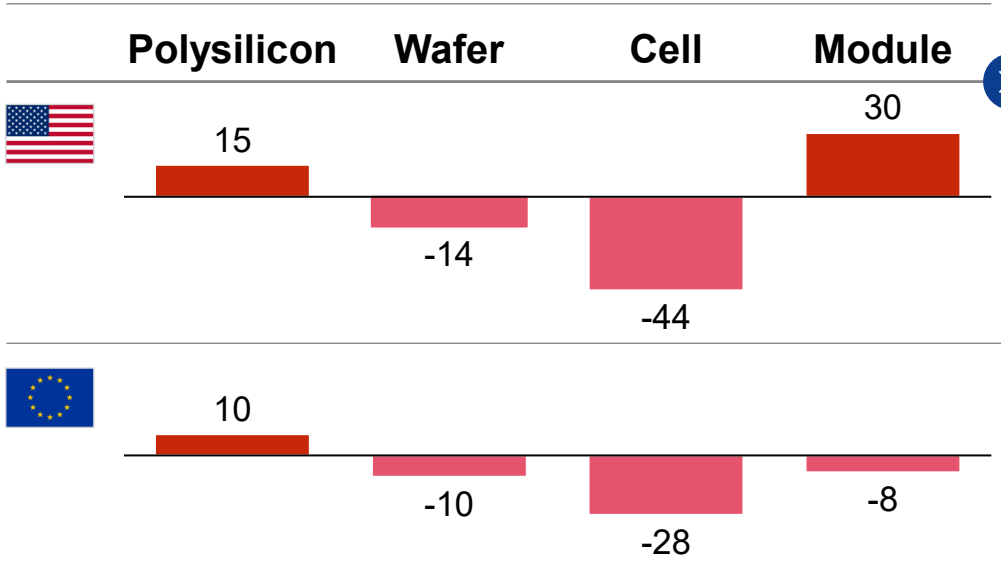
# Export opportunity: Ex-China supply chain to be short on wafers and cells, realistic module shortage expected only in Europe based on D-S outlook

As of mid 2023

Supply shortage  Oversupply

## Demand-supply imbalance[1], 2026

(in GW based on adjusted announcements)




## Key Takeaways and implications for an Indian player

**Limited opportunity** to export modules given **oversupply in the US** (~73 GW supply vs ~43 GW demand)

US expected to depend on imports for cells and wafers (although current gap will be shortened with more announcements expected over next 6 months)

Expected to be **net importer** across most parts of the value chain

Based on demand and supply outlook, there is an opportunity to **export modules to EU** (40 GW supply vs 48 GW demand) especially in aggressive demand of ~100 GW

EU NZIA matching provisions can accelerate domestic capacity announcements especially for cells and wafers

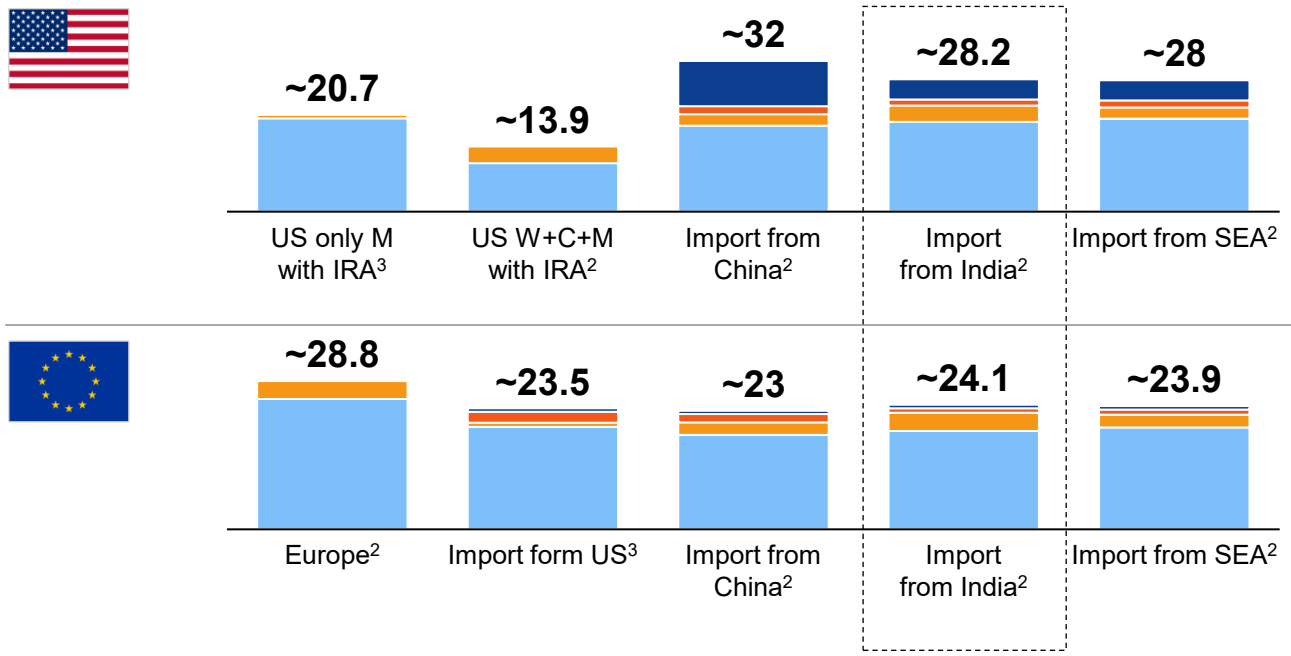
1. Based on adjusted demand-supply view from current announcements

For not fully integrated, considered W+C+M with Poly-Si imported from China; Calculated for 10 GW capacity

# Export opportunity: Additional cost competitiveness may be required to tap into export opportunities

**As of mid 2023**

## Landed cost in geography[1] (c/ Wp)




## Key takeaways

**Domestic** module manufacturing emerges **25–50% cost competitive** than other options owing to **IRA incentives**

**SEA** is most cost competitive owing to **lower tariffs vs China** imports, and marginally **cheaper operating cost** than India

**Importing** modules is **4.5 – 5.5 c/ Wp** cost competitive **than domestic** manufacturing owing to Europe's:

- High operating costs
- Absence of incentives
- Low import tariffs

1. Considering for 10 GW scale; Based on 13-15% ROCE; Considering all operating costs above EBIT including depreciation, with depreciation adjusted for ~90% supply util
2. Integrated across W+C+M, sourcing Poly-Si from China
3. Considering only module manufacturing, while sourcing cells from China (owing to shortage of wafers and cells in the US)

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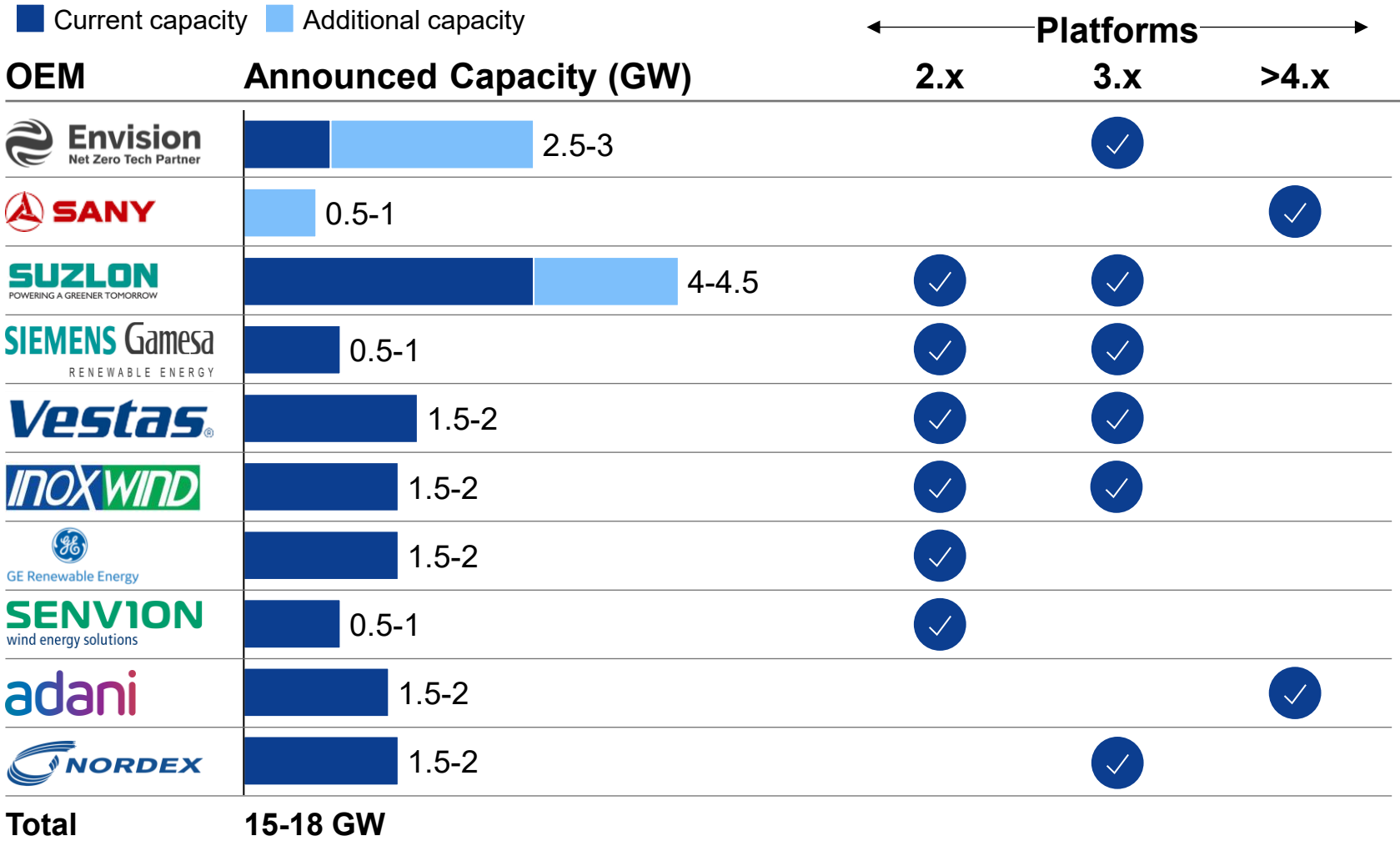
# Tailwinds driving wind manufacturing growth in India

## Key tailwinds

1. **India has sufficient WTG manufacturing capacity** (~15 GW per annum) to meet 2030 targets. >3 MW platforms to account for ~2/3$^{rd}$ of manufacturing capacity within next 1-2 years

2. **MNRE has announced National Repowering & Life Extension Policy for Wind Projects** to maximize energy yield per sq. km of project area. ~25 GW old wind turbine capacity identified across 8 states

# Wind mfg.: India has sufficient manufacturing capacity of requisite technology for domestic needs




## Key insights

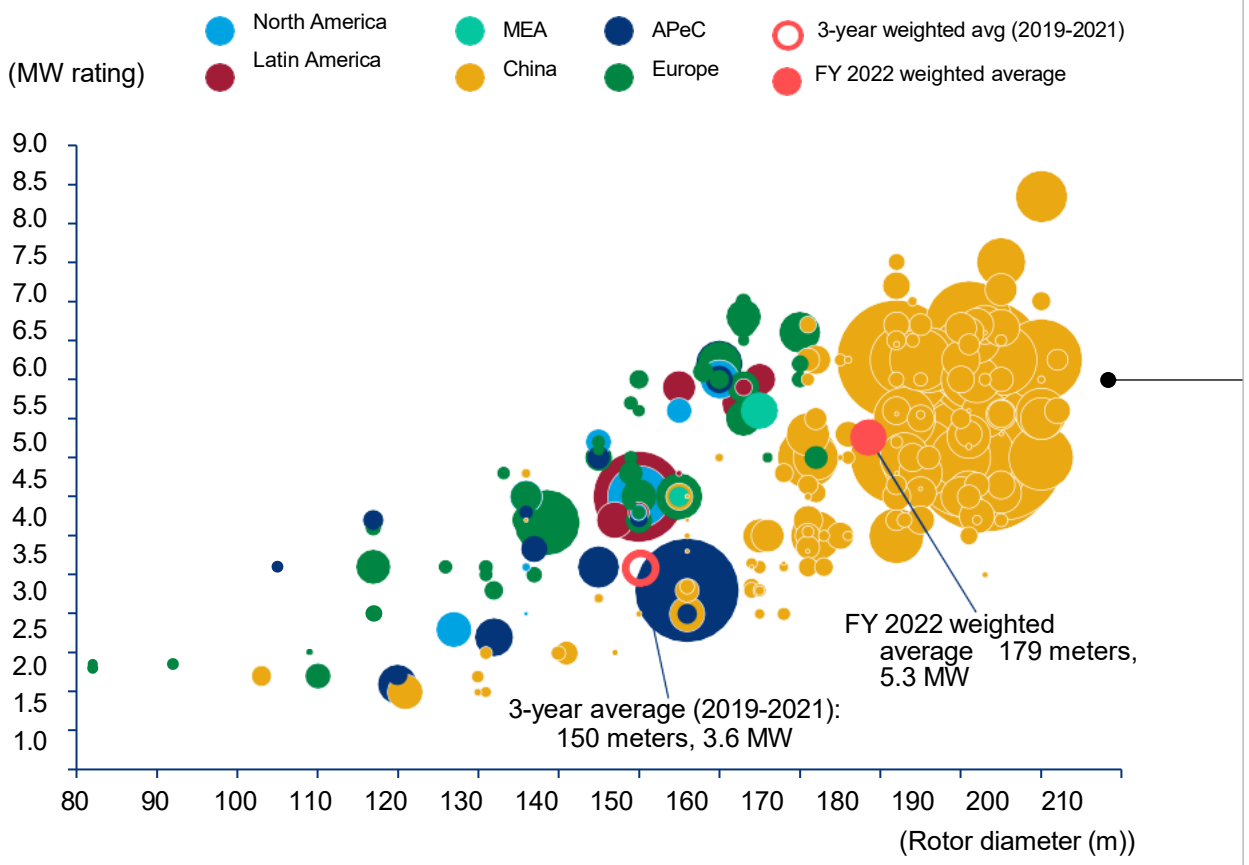
- Multiple players have **6.x+ platform,** could need customizations according to Indian wind resources
- **~4 GW additional capacity** expected to be online in the next 1-3 years
- Some OEMs are targeting exports markets (**~3 GW p.a. exports** to SEA, UAE)

Source: MNRE RLMM, expert conversations

# Globally, onshore order mix is moving towards 5+ MW turbines on average, China is leading the trend

## Onshore order mix by rating and rotor diameter

FY 2022, global markets




## Global onshore market order intake deep-dive, FY22

| OEM | Total order volume (MW) | Average MW Rating |
|---|---|---|
| Envision | 18,644 | 5.4 |
| Goldwind | 15,860 | 5.6 |
| Windey | 12,072 | 5.2 |
| Mingyang | 10,556 | 5.2 |
| Vestas | 10,440 | 4.6 |
| GE | 7,784 | 3.9 |
| SANY | 6,864 | 5.3 |
| CRRC | 6,850 | 5.0 |
| Nordex | 6,324 | 5.3 |
| DEC | 5,727 | 5.0 |
| Siemens Gamesa | 3,780 | 5.4 |
| SEwind | 3,254 | 5.6 |
| CSSC Haizhuang | 2,930 | 5.1 |
| United Power | 2,567 | 5.0 |
| Enercon | 1,141 | 3.6 |

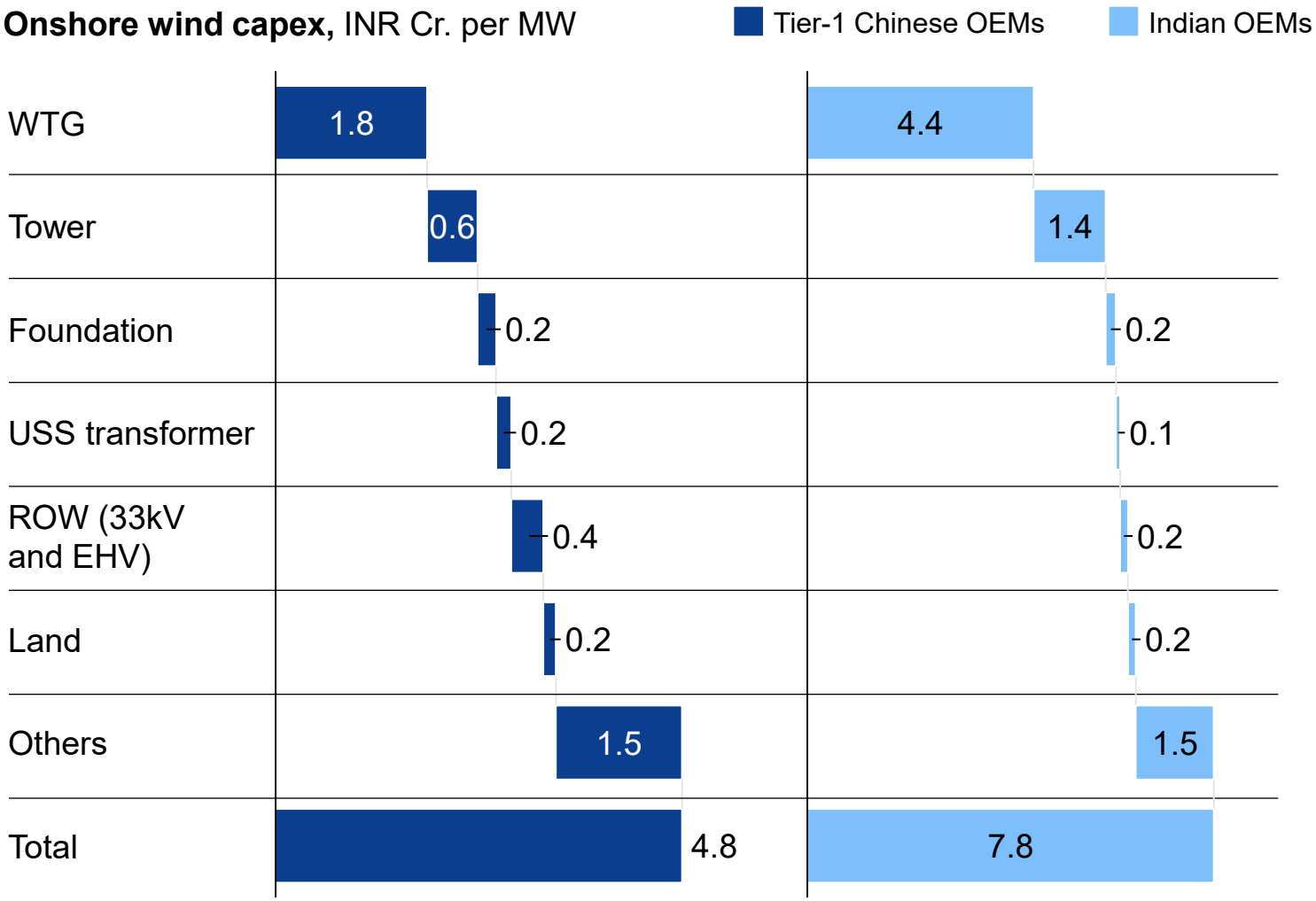
Note: Each bubble corresponds to the number of turbines ordered with a certain rotor diameter and MW rating and can comprise multiple orders. Graphic data only consists of announced orders and orders in which MW rating, rotor diameter and number of turbines is known. Prototype orders are not included.

Source: Wood Mackenzie, Global wind turbine order tracking, team analysis

# Chinese players are leading cost position in wind turbine market, with ~50% lower costs per MW than Indian OEMs

Outside-in

**Onshore wind capex,** INR Cr. per MW




Source: Expert calls , Team analysis

**Key drivers for cost differences**

- China has well established **cost-competitive domestic supply chain** for 90%+ components used in WTGs e.g., steel is 15-25% cheaper compared to India
- Chinese OEMs have **very large scale operations** with leading players having 10GW+ scale
- **Localized and less stringent WTG standards** enabling faster value engineering
- Chinese OEMs are moving towards **modular designs and standardization**

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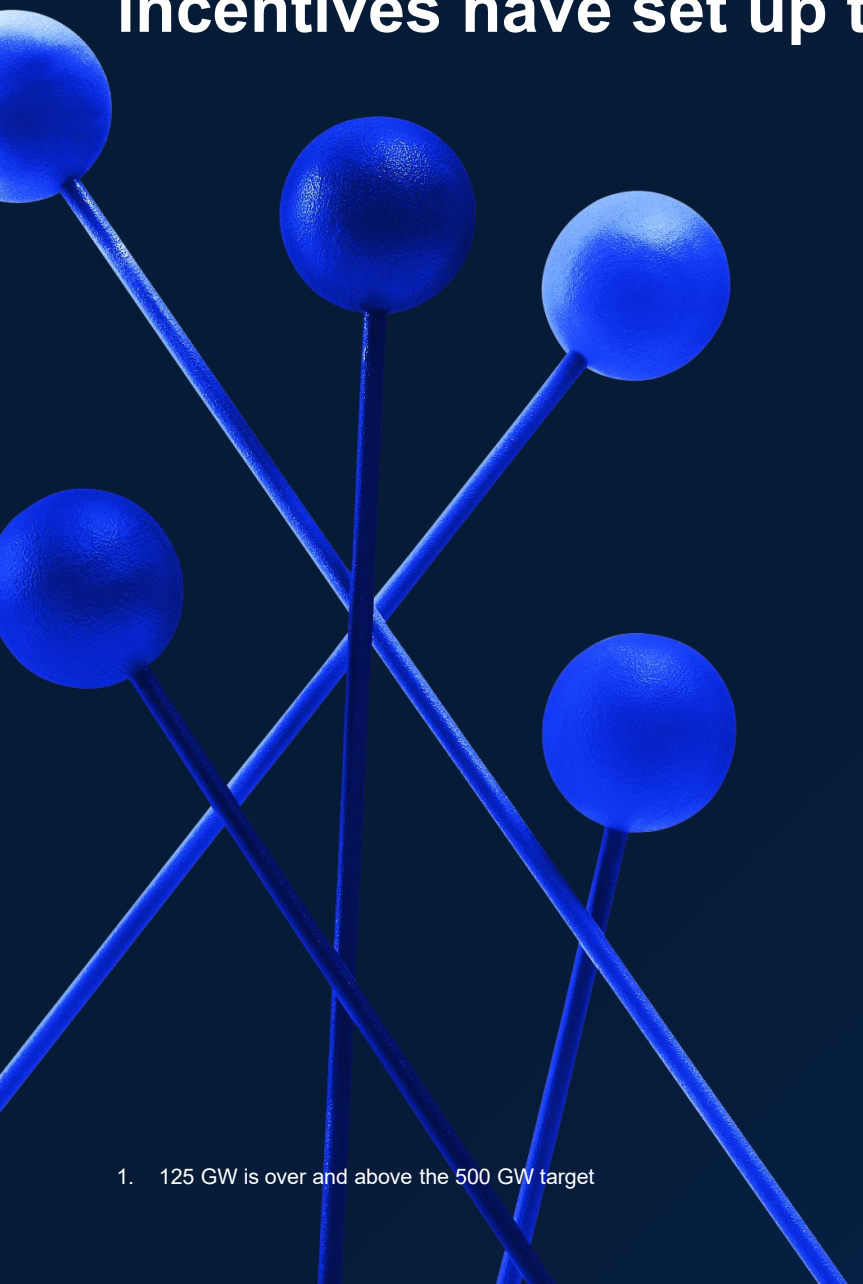
# Tailwinds: Strong policy support and attractive government incentives have set up the country for growth



Demand growth:

**8-9%** YoY electricity demand growth

**125 GW**[1] demand from green H2

**~43 GW** RPO by 2030

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Upto **100%** ISTS waiver *(till 2025)*

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**15-17%** CAGR in C&I and RTC tenders

expected to be **30-40%** of total RE

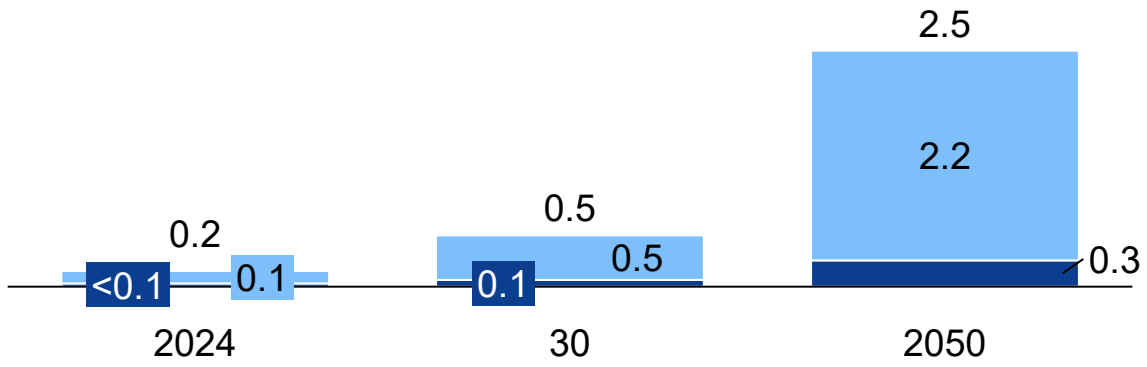
---

Late Payment Surcharge rules

1. 125 GW is over and above the 500 GW target

# Land: ~0.5 Mn hectares of land is required to meet 2030 targets; barren-land provides untapped opportunity

**Land requirement for solar and wind projects,** Mn Ha

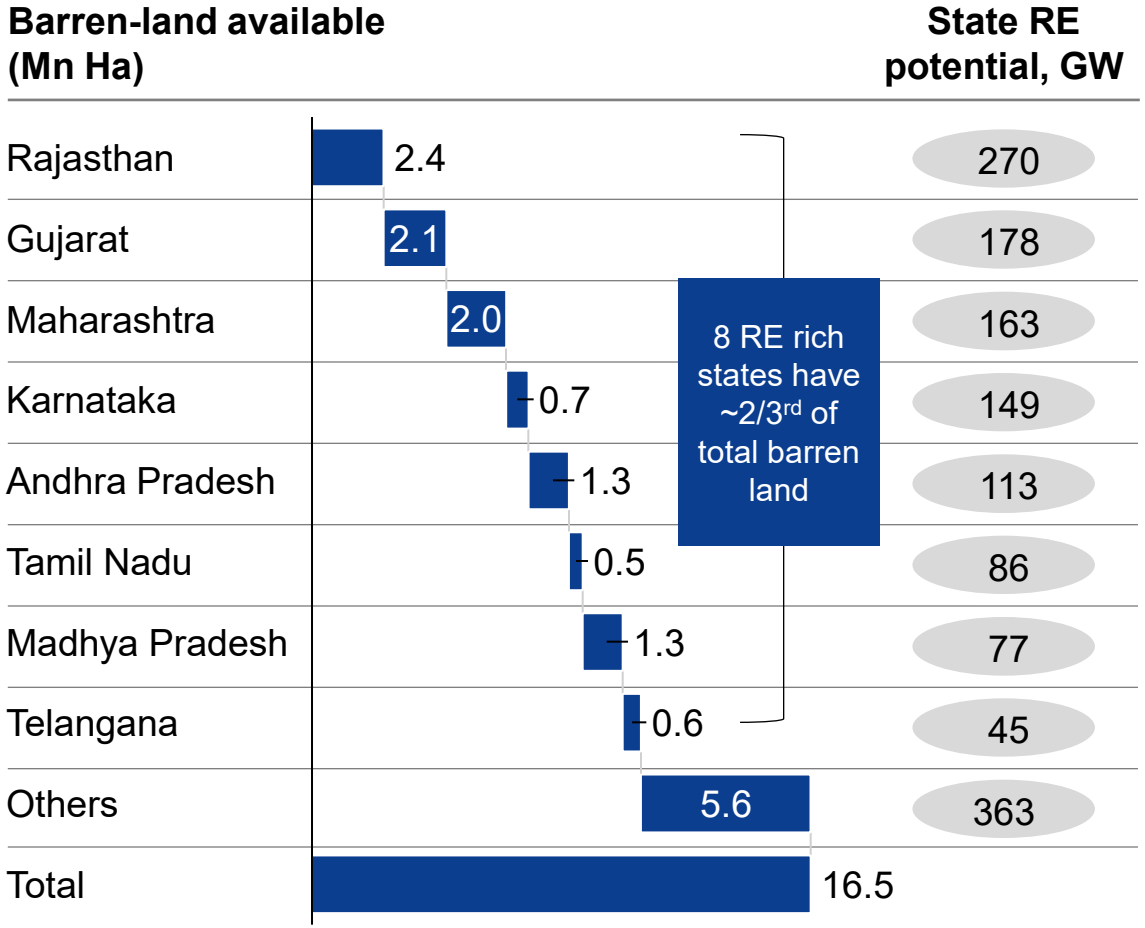



**16-17 Mn Ha** of the country's total ~306 Mn ha of land is barren-land

**11-12%** of current ~0.17 Mn ha used in RE[1] projects is barren-land

**1/6th** of India's barren land could meet the country's 2050 RE land requirements

**Barren-land availability in RE-rich states,** Mn Ha




1. solar and wind

Source: CEA, ORF, NIWE, expert interviews, team analysis

# Transmission: Avg 6 months time from bid to PPA; Gujarat much lower than peers at both state and central level

| Average time from bid to PPA (2023, 33 tenders)[1] | Solar | Wind | Hybrid |
|---|---|---|---|
| **States** | | | |
| Gujarat | 1.2 | 2.6 | 1.0 |
| Punjab | ~5 | ... | ... |
| Assam | ~5 | ... | ... |
| Rajasthan | ~5 | ... | ~5 |
| Jharkhand | ~5 | ... | ... |
| Tamil Nadu | ~5 | ... | ... |
| Maharashtra | ~5 | ... | ~5 |
| Madhya Pradesh | ~5 | … | ... |
| **Central agencies** | | | |
| NHPC | ~5 | ... | ~5 |
| PFCCL | ~5 | ... | ... |
| SECI | ~6 | ~5 | ~5 |
| NTPC | 6.5 | ... | ~5 |

1. Bid to PPA time has been declining over the years from 2020 to 2024

Source: Bridge-to-India RE navigator, GlobalData

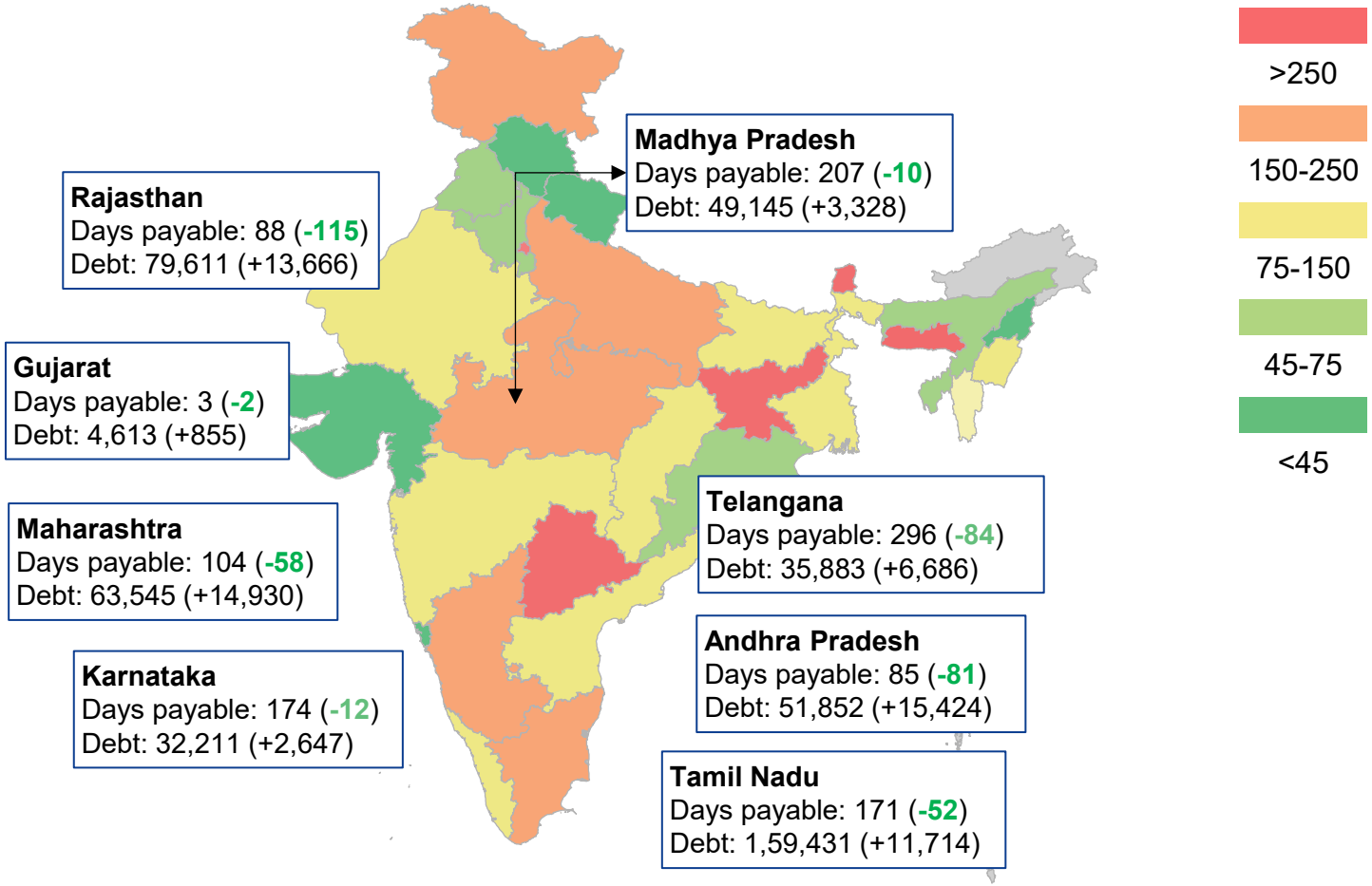
## Learnings from Gujarat

- **Top-down push** from Gujarat government through GEDA (Gujarat Energy Development Agency) to setup RES and minimizing delays
- Many state DISCOMs delay signing of PPAs due to expectation of decrease in solar prices

**Potential to save 2-3 months** since land acquisition and financing (parallel to PPA signing) will continue to take time

# Bankability of DISCOMs: 4 RE-rich states have DISCOMs with lower bankability

## State-wise days payable for FY23[1]




## Key insights

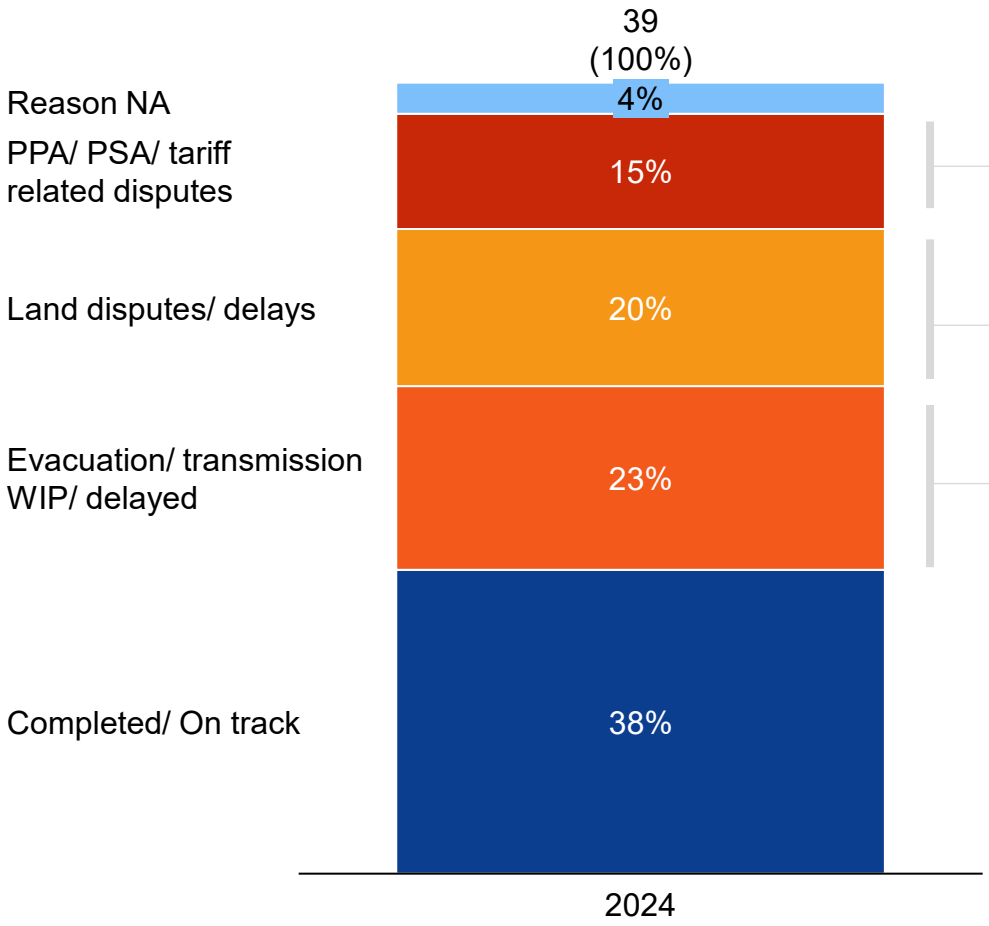
- Ministry of Power issued **Late Payment Surcharge** rules have significantly improved DISCOMs payables to GENCO's
- 4 RE states: **Gujarat, Rajasthan, Andhra Pradesh, Maharashtra** have payables <100 days
- **Tamil Nadu, Karnataka, Madhya Pradesh, Telangana** have shown improvement YoY but still have payables >150 days
- Debt for most DISCOMs is increasing – could imply that DISCOMs are taking longer term debt to reduce payables

1. Debt in INR Cr; number in brackets are change since FY22

Source: 11th Annual Integrated Rating & Rankings: Power Distribution Utilities; Basis FY23 data collected for 67 Utilities – excluding Surat, Ahmedabad, Jammu, Kashmir and 4 PDs

# Case study of UMREPP projects: ~60% of capacity is delayed/ stalled due to land, transmission, PSA disputes

**Break-up for delays/ disputes under UMREPP scheme**, GW




**Examples of delays in select projects**

- **Tariff bid:** 0.4 GW stalled since 2018 in Dholera Solar Park Ph-I (Gujarat) due to bid not being accepted by GERC (matter is sub-judice in APTEL for resolution of PPA issue)
- **Land:** Total 3.2 GW stalled since 2020 in Jalaun, Lalitpur, Jhansi, and Chitarkoot solar parks (Uttar Pradesh) awaiting land acquisition/ transfer of right to use (sub-stations not yet set up either)
- **Transmission:** 0.5 GW delayed by 5+ months in Neemuch Solar Park (Madhya Pradesh) due to delay in handing over of the land for sub-station from RUMSL to PGCIL

Source: CEA, press search

# Regulatory landscape, trends and approach towards open access varies across RE-rich states

AS ON MAY'23

Favourable — Unfavourable

| State | Charges (including exemptions, waivers etc.) | Stance towards OA | Regulatory Risks | Retail Tariff Trajectory | Future Outlook | Current Verdict |
|---|---|---|---|---|---|---|
| Gujarat | | | | | | |
| Tamil Nadu | | | | | | |
| Karnataka | | | | | | |
| Rajasthan | | | | | | |
| Maharashtra | | | | | | |
| Madhya Pradesh | | | | | | |
| Andhra Pradesh | | | | | | |
| Telangana | | | | | | |

## Key highlights

- Low regulatory risks and strict implementation
- Favorable policies, but some benefits likely to be withdrawn
- Favorable regulations, but liberal policies being slowly withdrawn
- Moderate OA environment; current policy proposals likely to increase OA landed costs
- High OA activity; but high charges and tough application process
- Relatively moderate OA environment, but no exemptions are provided to promote RE OA
- High regulatory risks with most benefits being withdrawn and increased bureaucracy
- High regulatory risks with increased bureaucracy

Source: State open access regulations, SERCs, expert interviews, press search, team analysis
Note: Analysis based on research by McKinsey as on May'23

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# Tailwinds driving storage growth in India

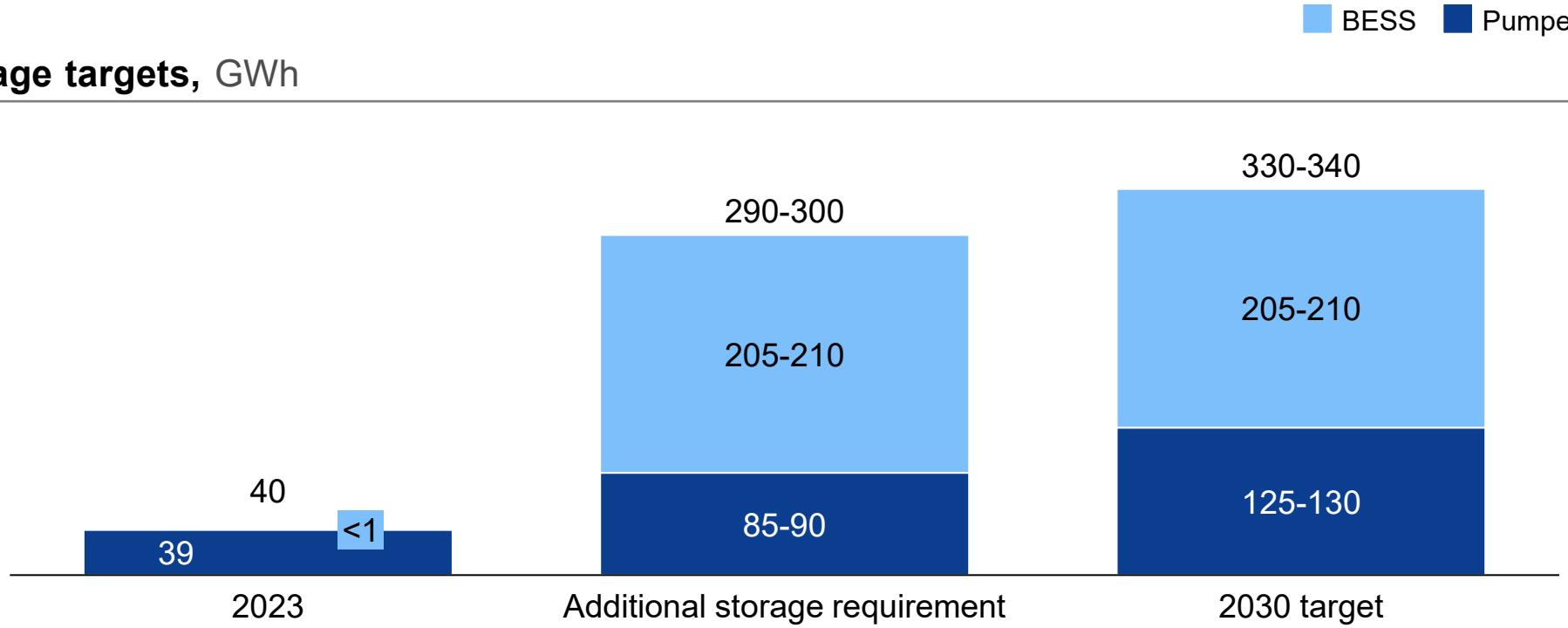
## Key tailwinds

1. **PLI scheme announced - National Program on Advanced Chemistry Cell (ACC) and Battery Storage** with outlay of ~18K crores to help strengthen electric mobility and battery storage ecosystem in the country
2. **Growth in RTC/ FDRE tenders**[1] – expected to be 30-40% of total tender volume by 2030
3. **Storage purchase obligations** up-to 4% of energy consumed by 2030
4. **Reduction in prices of lithium-ion battery pack** (60-70% of cost of BESS) from $780-800/ KWh to $100-120/ KWh in the last decade

# To meet the RE 500 GW mission, storage capacity additions need to scale 300x on BESS and 3x on PHES

## India energy storage targets, GWh

*Shared by CEA as of 2022*



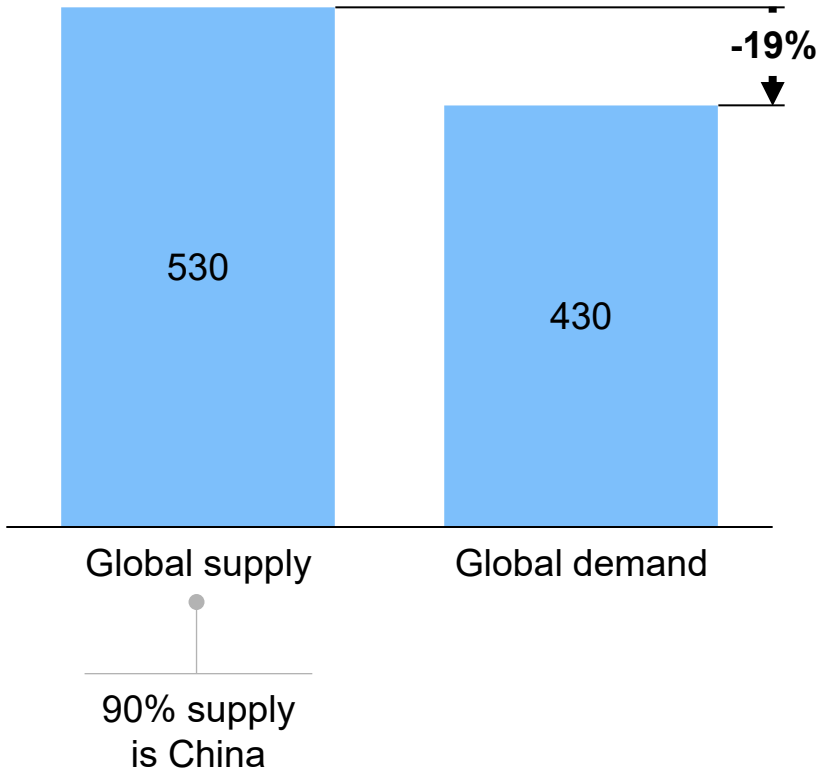

| | 2023 | Additional storage requirement | 2030 target | |
|---|---|---|---|---|
| **Pumped hydro storage[1], GW** | **5.8** | **13-15** | **15-20** | **3.2x** |
| **BESS[2], GW** | **<0.5** | **40-45** | **40-45** | **300x** |

BESS - Battery Energy Storage System; PHES - Pumped Hydro Energy Storage System

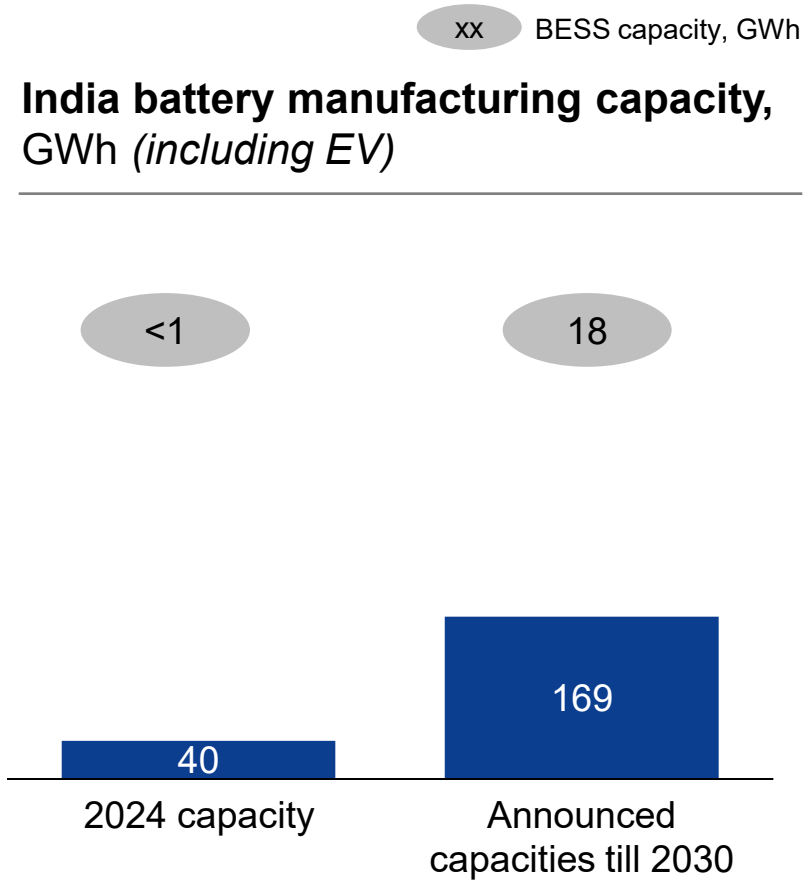
1 Assumption ~ 6.8-7 hours of pumped hydro storage. 2 Assumption ~ 5 hours of battery storage
Source: CEA, Niti Aayog, team analysis

# Storage manufacturing: Global battery supply concentrated in China, India could focus on downstream value addition

**Global battery supply vs demand,** 2023, GWh




**India battery manufacturing capacity,** GWh *(including EV)*




## Key insights

- Cell and battery pack are **60-70%** of BESS cost
- Potential for India to **add value downstream** including installations, system integration,power conditioning, software, etc.

Source: CEA,, Niti Aayog, team analysis

# Variance between BESS and PHES tenders, along with high variance within BESS tender rates

| BESS Procurer | Size | Backup hours | Project duration | Current status | % of VGF | Storage tariff discovered (INR/ kWh) |
|---|---|---|---|---|---|---|
| Kerala state (KSEB) | 10 MW/20 MWh | 2 | ~36+ m | Stuck at Regulatory Approval due to high-cost discovery at the tendering stage | 0% | 9.3 |
| National-level (SECI) | 500 MW/ 1000 MWh | 2 | ~48 m | High profile, central government led project, but stuck at regulatory approval due to lack of clarity on ancillary services value stream | 0% | 9.8 |
| UP state (UPPCL) | 5 tenders of 10 MW/ 40 MWh | 4 | ~24 m | Regulatory approval might be delayed due to quality and experience of winning bidder | 30% | 4.9 |
| New Delhi (BRPL& GEAPP) | 20 MW/40 MWh | 2 | ~12 m | LOA awarded by BRPL to winning bidder; tariff <30% than other projects | 17% | 4.4 |
| GUVNL | 250 MW/500 MWh * 2 cycles | 2 | ~12 m | LOA awarded by GUVNL to GENCO Engineering and Indigrid | TBC | 3.74 |

2 standalone PHP tenders have been executed in the country with storage-only tariff discovered at **INR 5/kWh**[1]

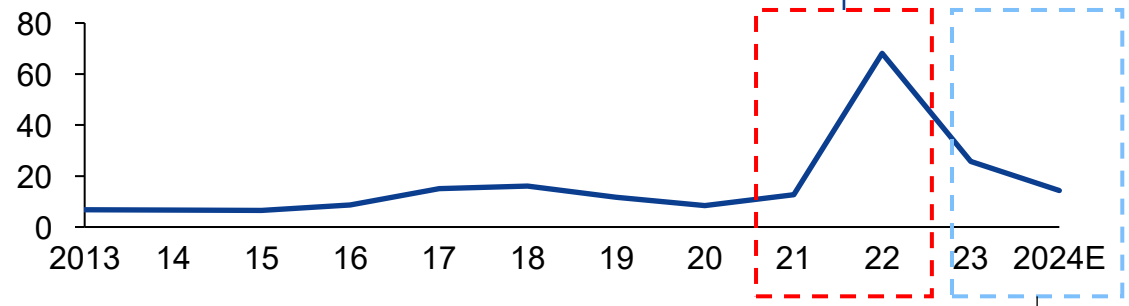
1. 1. NTPC 500 MW (6 hrs) tender; 2. Karnataka Discom 1000 MW (8 hrs) tender
VGF – Viability Gap Funding

## Key insights

- Limited BESS offtake due to:
  - High variance in prices (from INR 3.7 to >9) over last 2 years
  - Varying specifications (including time of storage)
  - Delays in regulatory approvals
- To ramp-up BESS, **financial and advisory unlocks necessary**:
  - **VGF from govt.** (to the extent of upto 40% of cost through 4GWh scheme) or philanthropic funding
  - **Set up primary ancillary market** to sell excess generation instantaneously

# BESS prices: Lithium carbonate prices have seen a spike in 2021-22, which have normalized now and expected to remain stable going ahead

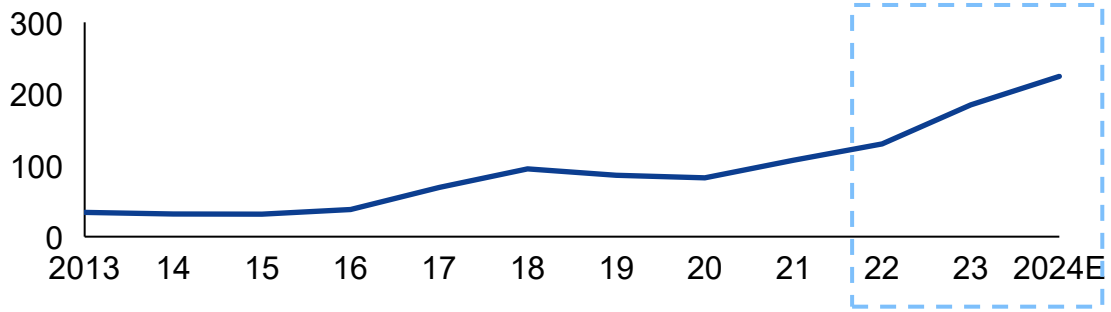
**Lithium carbonate prices,** $/MT




**Increase in prices for Lithium carbonate driven by:**

- **Supply chain disruptions** during COVID
- **High demand** driven by EV growth

**Worldwide production of lithium,** 000' MT




Decrease in prices for Lithium carbonate driven by:

- **Ramp-up in supply** in response to the demand
- **Dampened demand growth** (driven by EV policy changes in China) and economic slow-down
- Correction of supply-chain disruptions

## Key insights

- The current drop in lithium carbonate prices is partially sustainable due to a correction in supply chain disruptions
- Reduction in Chinese dumping may increase prices slightly (not as high as 2022 levels)