Manufacturing of Batteries in ASEAN

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ASEAN countries are moving towards net-zero, ~$100 bn opportunity arises from low carbon mobility and clean power

ASEAN countries are making Net Zero Commitments

<table>
<thead>
<tr>
<th>In policy document</th>
<th>Declaration/ pledge</th>
<th>Proposed/ Target under discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laos</td>
<td>Singapore</td>
<td>Cambodia</td>
</tr>
<tr>
<td>Thailand</td>
<td>Vietnam</td>
<td></td>
</tr>
<tr>
<td>Malaysia¹</td>
<td>Indonesia</td>
<td>Brunei</td>
</tr>
</tbody>
</table>

2030 ESTIMATED SUSTAINABILITY REVENUE POOLS⁴, $B

- **60 - 100**
  - Low Carbon Mobility
- **35 - 40**
  - Clean Power
- **55 - 60**
  - Others

Electrification of vehicle power trains – 2W and 4W
Charging infra and energy services
EV financing and maintenance
Fleet electrification

- Renewable power generation (solar PV, wind, geothermal, hydro)
- Microgrids and resiliency
- Flexibility and energy storage

- High efficiency buildings
- Industrial decarbonization
- Hydrogen
- Low Carbon agriculture
- Bio-energy
- CCUS, NCS

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1. Carbon neutral target
2. Reduction v. BAU target
3. Energy sector only
4. Defined as (annualized) revenue pools across the themes which is distinct from and smaller than capex investment pools which apply across the lifetime of projects. For example, the clean power revenue pool is estimated by taking the LCOE of renewable energy generation sources ($/MWh) multiplied by the installed capacity by 2030, assuming 25 year project lifespan.

Source: Energy & Climate Intelligence Unit- Net zero tracker, UNCC- Nationally Determined Contributions Registry
Li-ion battery demand is expected to grow by ~33% p.a. reaching 4.7 TWh by 2030, while most demand is concentrated in China (~40%).

Global Li-ion battery cell demand by sector, 2020-2030, GWh

- Mobility 1
- ESS
- Consumer electronics

Global Li-ion battery cell demand by region, 2020-2030, GWh

- CAGR

Key insights:
- ~90% of demand driven by the mobility sector
- ~40% of demand to come from the China market
- Significant growth in US & EU due to regulation and localization

~18x
growth in GWh battery demand from 2020 to 2030

Source: McKinsey Battery Insights Demand Model

1. Incl. Passenger cars, Commercial vehicles, 2-3 wheelers, off highway vehicles and aviation
Large growth of revenue pools along battery value chain expected with revenue for cell production reaching USD 375 bn by 2030

<table>
<thead>
<tr>
<th>Global value added pool¹</th>
<th>Raw material and refining</th>
<th>Active material production</th>
<th>Cell production</th>
<th>Battery packaging &amp; integration</th>
<th>Recycling &amp; second-life</th>
<th>Total value added</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD bn</td>
<td>10</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>&lt;5</td>
<td>~85</td>
</tr>
<tr>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 2030                     | 100                      | 250                        | 375             | 450                             | 10                     | ~1200            |

1. Each value pool calculation is irrespective of the previous value chain step (not cumulative)

Source: McKinsey Battery Insights, Securities research, Expert interviews, Yano Research, Press search
Fast growth of announced battery production capacity (CAGR 30%) with increasing share of Europe and North America

Announced battery production capacities, GWh, 2020 - 2030

Europe
- Europe: 35% growth
- 1,240 GWh in 2030

China
- China: 28% growth
- 4,170 GWh in 2030

North America
- North America: 31% growth
- 807 GWh in 2030

Rest of World
- Rest of World: 20% growth
- 387 GWh in 2030

Key insights
- Announced battery supply reaching 6.6 TWh by 2030, exceeding expected battery demand (~4.8 TWh)
- Fastest growth in production capacity in Europe (CAGR 35%) and North America (CAGR 31%) driven by localization trends
- China to remain largest producer of battery cells with share of ~60%, followed by Europe (~20%) and North America (~10%)

Source: McKinsey Battery Insights – Supply Model, Team Analysis
Localization of battery production is incentivized by different regulations around the globe

<table>
<thead>
<tr>
<th>Incentive program</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation reduction act (IRA)</td>
<td>Provides subsidies to EV buyers, given that a predefined share of battery raw materials and battery manufacturing was done in the US or a country with free-trade agreement. Additional tax credit for cell, module, and active material producers manufacturing in the US.</td>
</tr>
<tr>
<td>Product Linked Incentive (PLI)</td>
<td>Subsidy for up to 50GWh of cell production for participating companies. Amount of subsidy tied to share of domestic value creation and technical performance of cells (i.e., cell energy density and cycle life).</td>
</tr>
<tr>
<td>Access to raw materials (i.e., Nickel)</td>
<td>Limiting exports of large domestic nickel resources (e.g., through export bans and taxes) to incentivize local downstream processing. Setting up local battery production in JV with leading global incumbents and government owned battery company.</td>
</tr>
</tbody>
</table>

Sample players setting up production:
- Ultium Cells
- LG Energy Solution
- CATL
- IBC
- Hyundai
- SK On
- Envision
- Reliance Industries Limited
- Mahindra
- OLA
- LG Energy Solution
- EcoPro

Source: McKinsey Battery Insights, Press search, Team Analysis
Demand expected to accelerate in some Southeast Asian economies post 2025; >125 GWh of cell capacity announced

<table>
<thead>
<tr>
<th>Country</th>
<th>2022, GWh</th>
<th>2035, GWh</th>
<th>Manufacturing capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vietnam</td>
<td>0.2</td>
<td>26</td>
<td>Graphite: ~5 (&lt;1%), Manganese: ~120 (&lt;1%)</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.1</td>
<td>6</td>
<td>Nickel: ~1,000 (37%), Cobalt: ~2 (1%)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.3</td>
<td>21</td>
<td>Manganese: ~360 (2%)</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.1</td>
<td>61</td>
<td>Nickel: ~370 (14%), Cobalt: ~5 (3%)</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.1</td>
<td>&lt;1.8</td>
<td>Manganese: ~250 (1%)</td>
</tr>
<tr>
<td>Other SEA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEA total</td>
<td>~2</td>
<td>~175</td>
<td></td>
</tr>
</tbody>
</table>

1. EV demand is estimated based on company announcements on production plans, analysis of historic growth, customer demand, regulatory trends and EV cost projections in a current trajectory scenario. BESS demand is estimated bottom up (for residential), least cost optimization for meeting power requirement, and company announcements on production plans, battery demand, mineral reserves, and production output; 2. Cambodia, Myanmar, Laos, Singapore, Brunei are excluded due to limited battery demand, mineral reserves, and production output; 3. Thousands of metric tonnes (MT); 4. Based on company announcements where information on capacity output and start of commercial operations are known; does not account for delays and unrealized plans. Excludes any unannounced projects / future developments as of Feb 2023; 5. Limited production across SEA in 2023 with the exception of Vietnam (2k MT cathodes)

**Strong momentum from manufacturers, however 5 key success factors needs to address their pain points**

Not exhaustive

### Example of announced projects

<table>
<thead>
<tr>
<th>Country</th>
<th>Packs (capacity not announced)</th>
<th>Cells (capacity not announced; planned)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indonesia</strong></td>
<td>Mining, processing, cathodes, cells, recycling</td>
<td>Cells (10GWh; planned)</td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td>Packs (5GWh; planned)</td>
<td>Cells (1GWh)</td>
</tr>
<tr>
<td><strong>Vietnam</strong></td>
<td>Packs (capacity not announced)</td>
<td>Cathodes (2k tonnes)</td>
</tr>
<tr>
<td><strong>Malaysia</strong></td>
<td>Packs (5GWh; planned)</td>
<td>Cells (capacity not announced; planned)</td>
</tr>
<tr>
<td><strong>Philippines</strong></td>
<td>Packs (capacity not announced)</td>
<td></td>
</tr>
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### Manufacturer's pain point

- **Scale of domestic demand:** Only selected countries have strong domestic EV market demand, driven by government policy to sustain 1-2 giga factories.
- **Export potential:** Clear aspiration to serve exports, however, poor ESG standards may be a barrier.
- **Cost competitiveness:** Selected countries have nickel reserves and availability of upstream partners with established plan for upcoming refining capacity and tax benefits; however, limited talent availability, equipment suppliers, lack of infrastructure leads to higher costs.
- **Policy support:** Room for improvement in policy development transparency and a comparatively lower world Bank score on ease of doing business.

### Key success factors

- **Early aspiration alignment at national level to go “all-in”**
- **Government’s role in proactively initiating and promoting policies that stimulate demand and encourage manufacturing investment**
- **End to end value chain integration** – to enhance cost competitiveness
- **Partnership development with global players** – allowing further global market expansion and operation improvement
- **Continuous policy evaluation** to ensure effectiveness of implementation

Source: Government announcements, Company announcements

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**Player type**
- [ ] Foreign player
- [ ] Local player
Li-ion battery demand is growing globally by ~30% CAGR 2020-2030, driven by rapid electrification of mobility and increasing need for stationary storage, expected to reach total market size of ~4.7 TWh by 2030.

There is an increasing trend toward localizing battery value chain, reducing the dependency of battery imports driven by subsidies (e.g., US IRA, Indian PLI scheme) and securing privileged access to raw materials (e.g., access to Nickel in Indonesia).

Battery demand expected to accelerate in some Southeast Asian economies post 2025; >125 GWh of cell capacity announced from ~1 GWh today.

Key success factors e.g. government's proactive approach and alignment at national level, end to end value chain integration, partnership with established players needed to be implemented to address manufacturers concerns on scaling the battery production capacity.