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Global Automakers' Battery Strategy

Racing to build battery hubs

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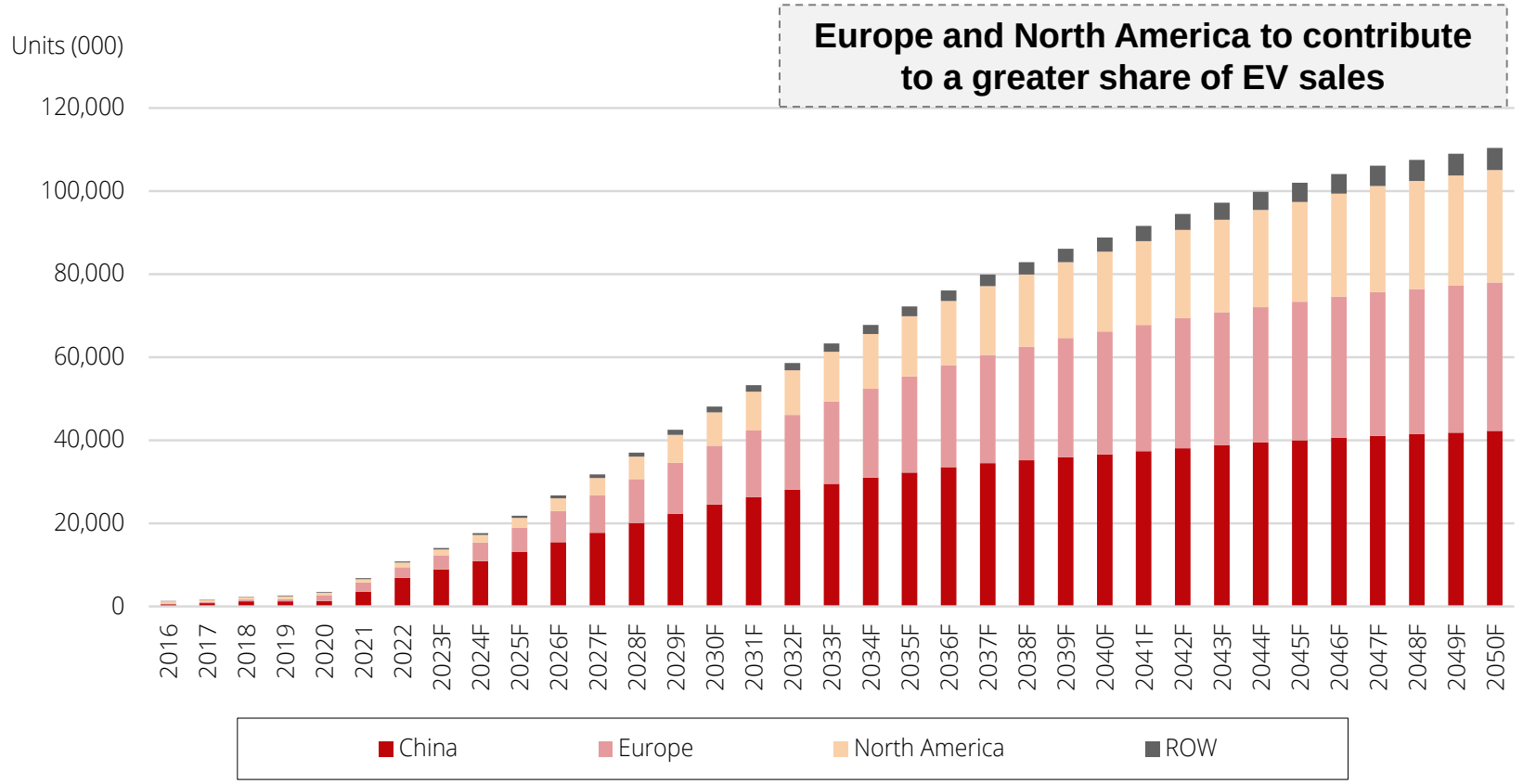
Global EV market sales projections

Europe and North America rising rapidly on vehicle electrification…

Global Electric Vehicle (EV) sales forecast



Source: CEIC, ACEA, Bloomberg Finance LP, DBS Bank Ltd

Drivers include:

1. **Green transition and electrification**. Subsidies and incentives e.g., US Inflation Reduction Act (IRA), EU Net Zero Industry Act promote greater green transition and the development of the EV industry.

2. **EVs are becoming an affordable option for consumers which spurs greater adoption**, contributed by EV tax incentives, robust investments by global automakers, declining battery costs and more.

3. **Changing consumer behaviour** as EVs become more desirable on the back of rising ESG awareness, preference to reduce reliance on fossil fuels and more.

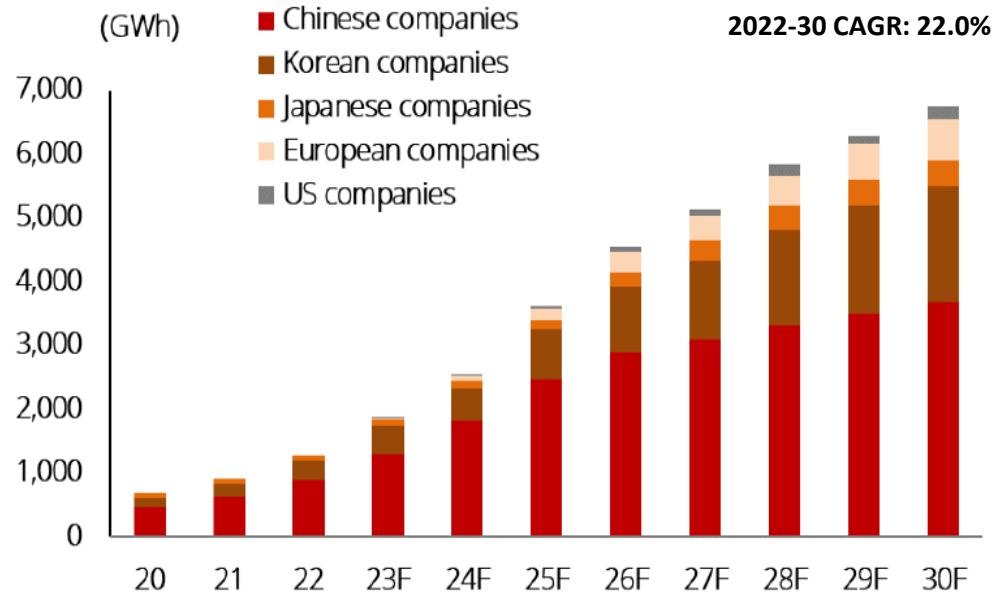
Global EV market sales projections

…. Which spurs aggressive battery capacity investments by OEMs

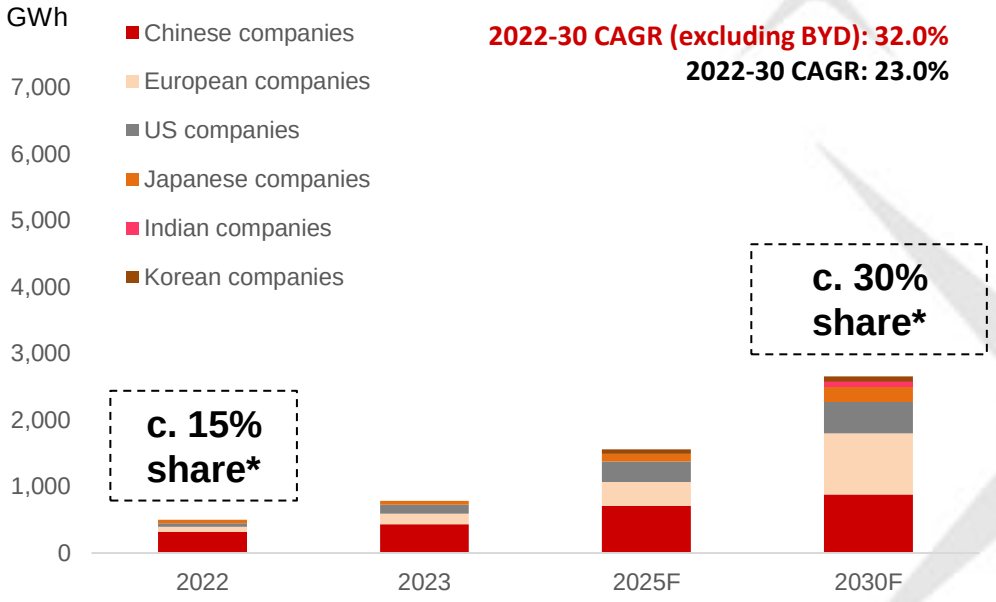
By 2030F, OEM's battery capacity is expected to see greater contribution at **40%** of total global battery capacity. Excluding BYD, OEM's share is expected to reach **30%** by 2030F, up from 15% in 2022.

Global OEMs are expected to be a major player in EV battery

Global EV battery production capacity



OEM EV battery production capacity outlook



Left figure: Source: SNE Research, DBS Bank Ltd.
*Right figure: Note: Based on latest database and company announcements. *OEM share % of total global battery capacity excludes BYD's share, which includes battery production for its OEM business and battery shipment business. Including BYD's share, OEM share % in 2022 versus 2030F will be 36% and 39% respectively. Source: DBS Bank Ltd estimates.*

Influx of new EV battery projects by global automakers

Global automakers are shifting their EV investment focus in recent years, why?

With rising global electrification as the backdrop, global automakers are racing to invest in EV battery capacity in recent years. We attribute the recent shift to the factors below:

1. **Government policies to develop domestic EV value-chain** as part of transport decarbonisation journey via boosting new EV investments through EV subsidies or incentives.

2. **Supply chain resilience** – While supporting domestic automakers to grow, foreign governments also want to reduce the over-reliance on a single country for critical parts and components for EV assembly - e.g. the US government's Inflation Reduction Act (IRA) and Europe's Critical Raw Materials Act.

3. **Deeper vertical integration allows automakers to drive down product costs**, as EVs are more expensive compared to internal combustion engine (ICE) vehicles.

4. **Localisation of supply chains –** Aim to establish a more secured and sustainable local-market focused supply chain management system

Building a more secure EV supply chain through vertical integration

Most EV projects are not profitable; global automakers are emulating Tesla and BYD strategy

Observation #1: Over time, deeper / higher levels of vertical integration

- Generally, automakers start with battery cell production and later, expand through the entire battery supply value chain, and even all the way to raw material recovery
- Global automakers are investing in critical minerals to support their battery factories, e.g. through direct stakes into mines or supply contracts. Cathode active materials (consist of nickel, lithium and other materials) accounts for about 40% of the cost of a battery cell.

Observation #2: Global automakers are concurrently scaling their supply chain (including cell production) and EV assembly capacity

- Automakers are building security into their supply chain network by securing long-term supply contracts with mineral companies for battery separators, anodes, cathode active materials (high-grade manganese sulphate) and precursor as well as onshoring production to support the domestic supply base

Observation #3: Unified cell design

- Achieve economies of scale and lower costs, as this approach can accommodate more upcoming EV models for the mass market while the customised solution will cater to the premium EV segment. Volkswagen expects to simplify its battery packs with one cell design that works across 80% of its products, of which VW believe they can lower cell cost by about 50%

Global automakers' EV supply chain investment strategy

American automakers are the most aggressive in EV battery investment

American automakers: Concurrent expansion in both EV production and battery capacity

More comprehensive approach on EV supply chain investments.

- Riding on massive government support to build new battery capacity
- Investing in battery cells, critical minerals and components to ensure a more secure and sustainable value chain
- Opt for Joint Ventures (JVs) for battery plants investments, of which key JV partners include Korean/Japanese players

European automakers: Electrification pace driven by policy

Piecemeal policy causing automakers to invest in specific segments to meet regulatory compliance.

- Directional initiatives – shifting away from single country supplier and probe on China EV subsidy
- Standardization of battery cell strategy to drive economics of scale and lower EV cost
- Partnerships and regional sourcing strategy
- Opt for in-house battery plant investments over JVs

Asian automakers: Playing catch-up on electrification

Except for China, Japanese and Korean automakers are rolling out more EV models from mid-2020s.

- Japanese & Korean automakers' electrification strategy includes battery and fuel cell technology, hence affecting their EV battery investment flows
- Self-development of battery technology (solid state batteries) and partnership on battery projects
- Opt for JVs for battery plants investments, of which key JV partners include Korean/Japanese players

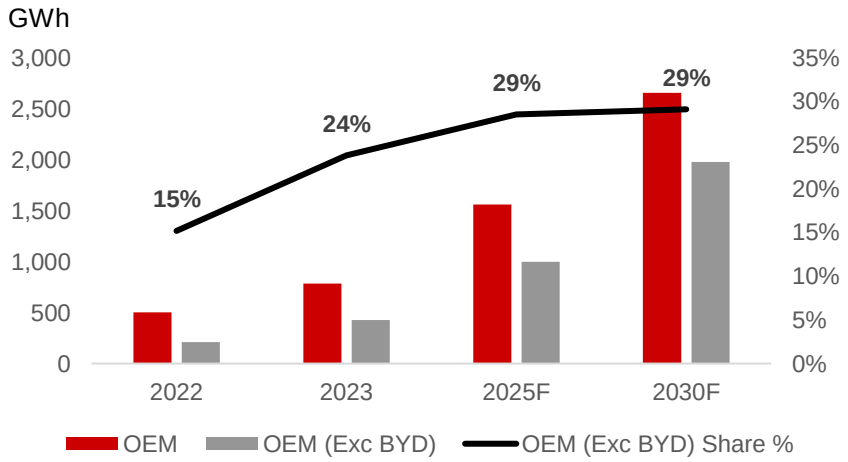
Global OEMs emerging as a major player in EV battery capacity

By 2030F, global OEM battery manufacturing capacity (GWh) is forecasted to expand by 20%-30% CAGR

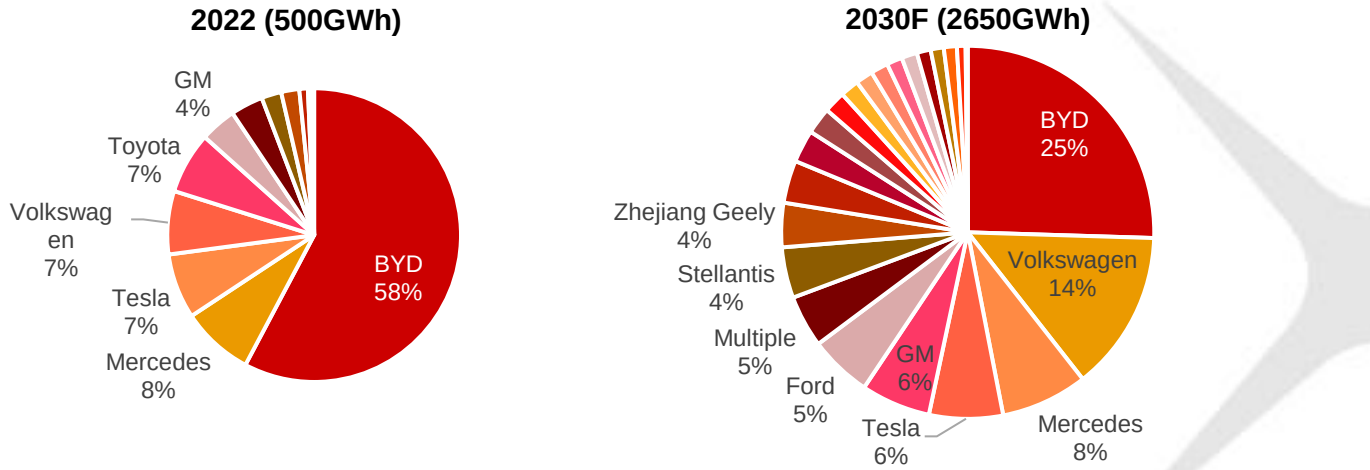
- By 2030F, OEMs is expected to be a **major player in EV battery capacity**, contributing to **40%** of total EV battery capacity (i.e., OEMs and independent battery suppliers). Excluding BYD, OEMs is expected to contribute **almost one-third** of total capacity at 29% market share, up from 2022's contribution at 15%.

- By 2030F, OEM battery manufacturing capacity is expected to expand from the current 500GWh into c. 2,650GWh, which translates into **23% CAGR** p.a., based on latest battery capacity expansion plans laid out by global OEMs. Excluding BYD, **OEM battery capacity is expected to grow by 32% CAGR** by 2030F.

OEM capacity and % contribution to total battery capacity*



OEM battery manufacturing capacity, current and forecast



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North America & Europe's growth estimated to double that of APAC

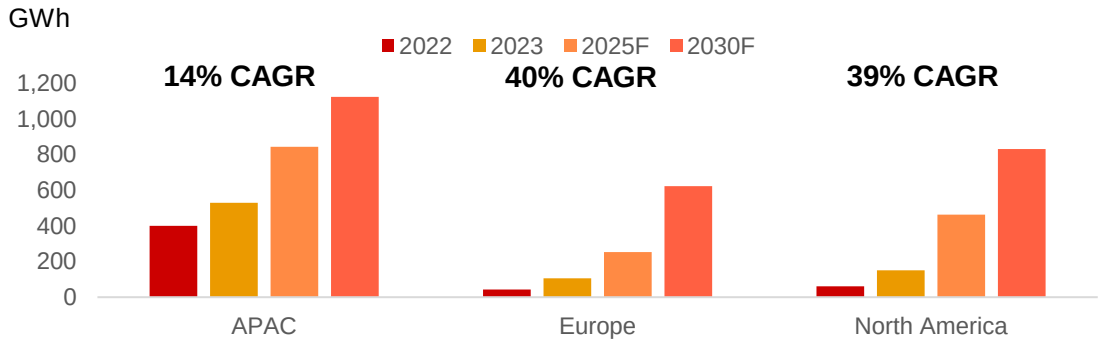
Driven by (i) policy incentives and (ii) rising focus to reduce reliance on selected countries

- Global OEMs are **setting up more battery manufacturing plants in North America (NA) and Europe**, wherein battery manufacturing capacity in both regions are expected to see **c. 40% CAGR** between 2022 to 2030F, **double the growth rate of OEM battery plants set up in APAC.**
  - OEMs with battery expansion plans in NA and Europe include GM, Ford, Tesla, BMW, Mercedes, Stellantis, Volkswagen, Volvo, Jaguar, Renault Group.
  - Even Asian OEMs such as Honda, Nissan, Toyota and Hyundai are aiming to set up battery manufacturing plants in NA and Europe.

- By 2030F, half of OEM battery capacity will be located in NA and Europe, a significant increase from <20% in 2022.

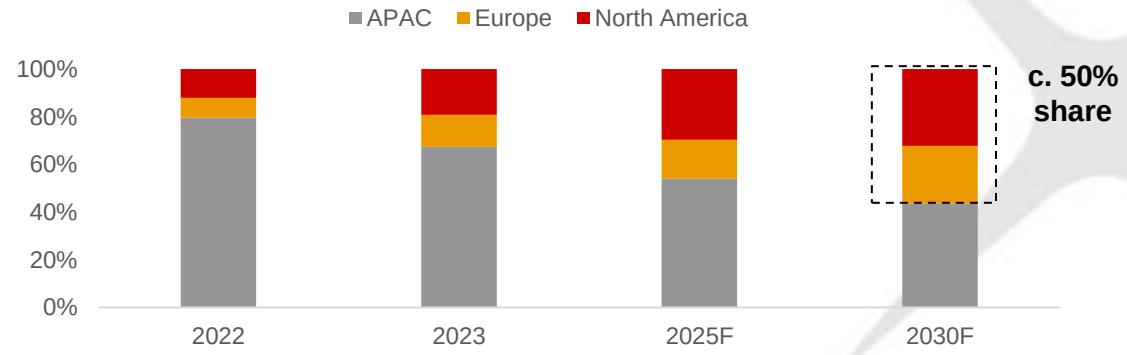
- **Key drivers** behind strong battery capacity growth in US/Europe:
  - **Attractive government policies that incentivises OEMs to localise their EV value chain** e.g., US EV tax credits incentives under the US Inflation Reduction Act (IRA), EU Critical Minerals Act (CRMA)
  - **Rising concerns over the EV industry's reliance on selected countries** for battery raw materials and parts, such as China and Russia

OEM battery manufacturing capacity (GWh), based on location of plants



Source: DBS Bank Ltd estimates

OEM battery manufacturing capacity share %, based on location of plants



North America outlook: Key drivers

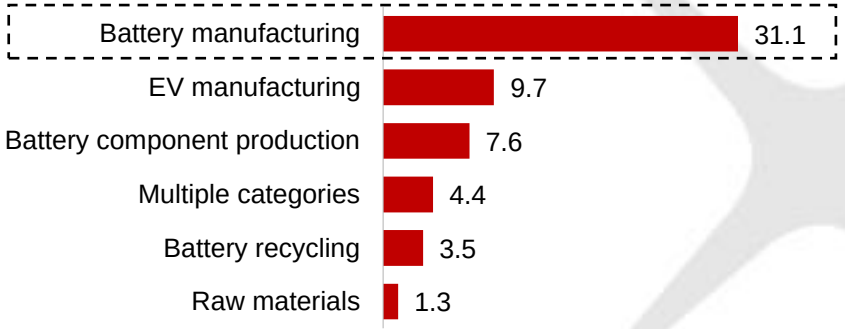
US IRA provides EV tax credits of US$3,750 – US$7,500, if eligible OEMs can meet conditions related to EV raw materials and battery components. Conditions are aimed at incentivising domestic EV raw material and battery industry.

US IRA EV tax incentives eligibility

	Requirements	Details	Threshold
Consumer requirements	Income	Eligible consumers need to have modified adjusted gross annual income that does not exceed certain threshold	US$150k – US$300k
Automaker requirements	Retail price (MSRP)	Qualifying vehicles must not exceed manufacturer's suggested retail price threshold, depending on vehicle type	Van: US$80k SUV: US$80k Pickup truck: US$80k Others: US$50k
	Final assembly	Only EV models assembled in NA are eligible	North America: Canada, US, Mexico
	Critical minerals	To qualify for US$3,750 of EV credit, must have **certain value of applicable minerals extracted or processed in US or in a country wherein US has a Free Trade Agreement (FTA) with**	2023: 40% 2024: 50% 2025: 60% 2026: 70% 2027: 80%
	Battery components	To qualify for US$3,750 of EV credit, must have **certain value of components manufactured or assembled in NA**	2023: 50% 2024, 2025: 60% 2026: 70% 2027: 80% 2028: 90% 2029: 100%

- **Tax credits could amount up to 10% - 15% of EV MSRPs**, based on threshold limits on Manufacturer's Suggested Retail Prices (MSRPs).
- Since the release of the IRA, automakers have invested US$58bn in US EV supply chain to take advantage of these tax credits, with **most investments centred on battery cell manufacturing** (see below).

North America investments (US$bn) post-IRA



Note: US FTA countries include Australia, Bahrain, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Israel, Jordan, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, Singapore and South Korea. Japan is also added to the qualifying list through critical mineral agreement (CMA) with the US. Investment amounts include investments in NA region announced post-IRA up until April 2023. MSRP = Manufacturer's Suggested Retail Price. Source: Bloomberg NEF, state.gov, DBS Bank Ltd

North America outlook: Future growth

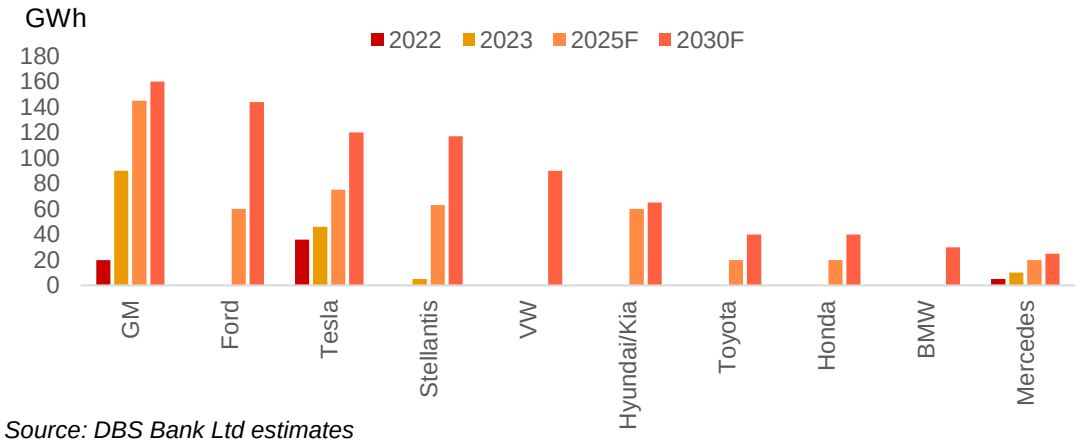
By 2030F, North America is expected to see the largest additions in battery capacity globally, at **39% CAGR growth**

- By 2030F, North America's OEM battery manufacturing capacity is forecasted to grow from the current c. 60GWh to c. 850GWh by 2030F, which translates into **39% CAGR growth**, **led by GM, Ford and Tesla.**

- Historically, Tesla has dominated battery manufacturing capacity in North America, followed by GM.
  - Going forward, other companies such as Ford, Stellantis, Volkswagen, Hyundai, Toyota and Honda will also be setting up their own battery manufacturing plants either via in-house or under joint ventures.
  - BMW currently has a partnership with Envision AESC for a 30GWh battery manufacturing plant in South Carolina, USA. BMW will also be setting up its first North American battery plant in Woodruff which is expected to commence in 2026.

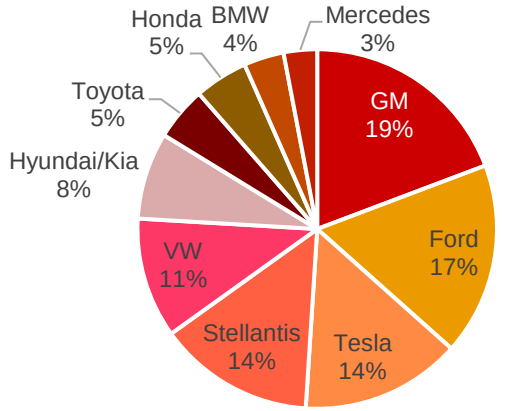
- **These plants will help these OEMs qualify for the battery component requirement (US$3,750 EV tax credit) under the US IRA.**

OEMs battery manufacturing capacity located in North America



Source: DBS Bank Ltd estimates

OEMs battery manufacturing capacity located in North America (2030F), by %

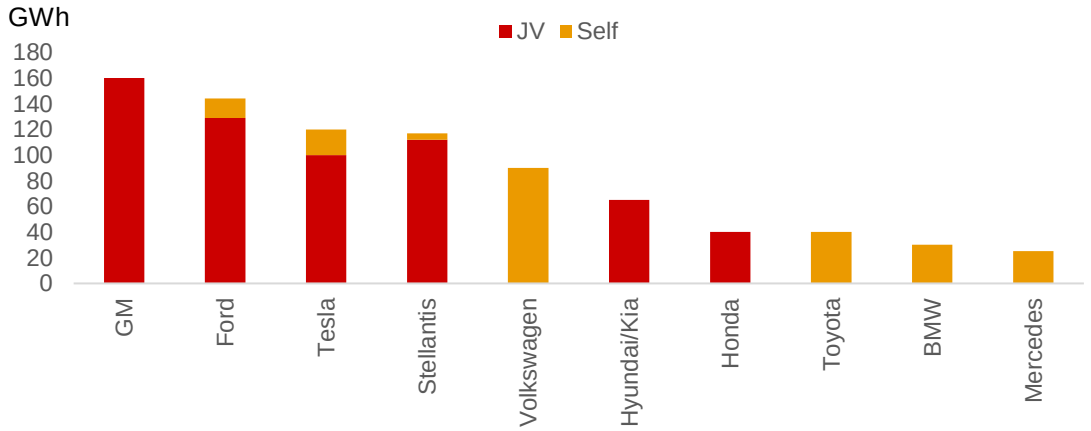


North America outlook: Future growth

Most battery plants will be formed under JVs with Korean/Japanese battery makers

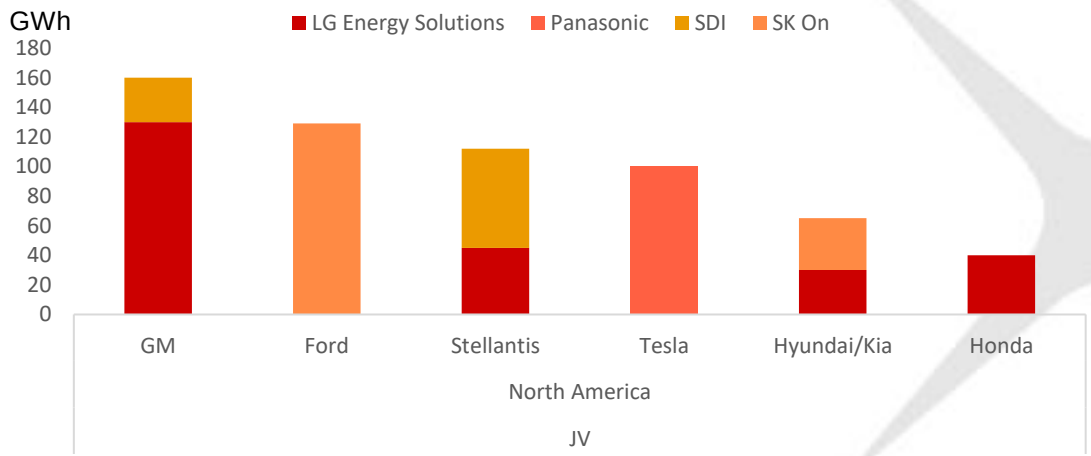
- By 2030F, almost **75% of OEM battery capacity will be formed under JVs** whilst the remaining 25% will be formed in-house, with **Korean/Japanese battery makers as key partners**. South Korea and Japan are friendly US Free Trade Agreement (FTA) parties.
- Most OEMs will (i) prepare, provide and manage the land, buildings and utilities, and (ii) focus on cell assembly (i.e., taking cells manufactured by battery maker partner and assembling them into packs).
- Battery makers typically focus on (i) cell manufacturing, given their technology and manufacturing expertise, whilst providing (ii) specialised equipment such as cell assembly equipment, and (iii) talent and training.

OEMs battery manufacturing capacity in North America, by structure (GWh)



Source: DBS Bank Ltd estimates

JV partners for North American OEM plants (GWh)



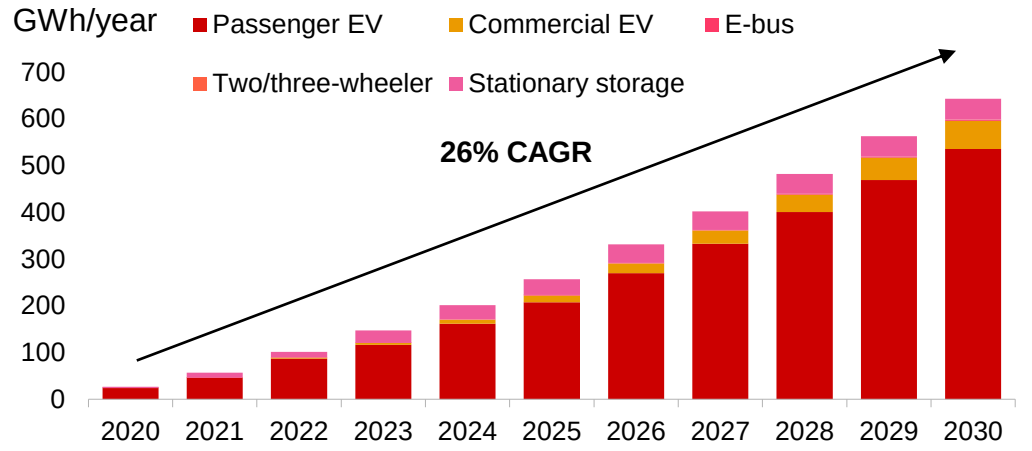
North America outlook: Future growth

In the short term, North America will continue to rely on battery imports; Over the long-term, there is likely an oversupply of batteries, which is positive for OEM gross margins as battery costs decline.

- By 2030F, **battery demand** in North America is expected to rise to 643GWh, up from 2022's levels of 101GWh, which translates into **26% CAGR growth by 2030**, according to Bloomberg NEF's estimates.
  - Battery demand will be led by passenger EVs (accounting for 80% of annual demand), followed by commercial EVs and stationary storage demand.

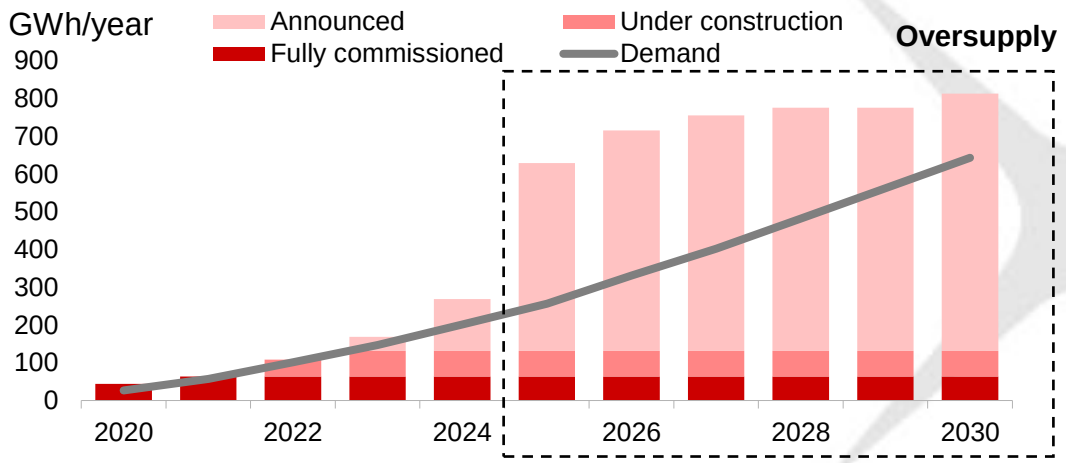
- From 2025 onwards, assuming that planned ramp up in domestic capacity is on schedule, NA is expected to see an **oversupply of batteries,** based on Bloomberg NEF estimates.

North America total battery demand



Source: Bloomberg NEF, DBS Bank Ltd

North America battery cell capacity versus demand



Europe outlook: Future growth

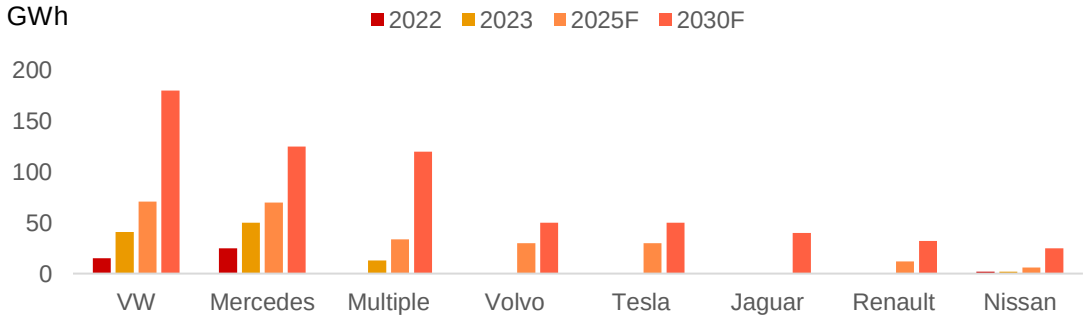
By 2030F, Europe OEM battery manufacturing capacity is forecasted to grow by **40% CAGR**

- By 2030F, Europe OEM battery manufacturing capacity is forecasted to grow from the current c. 40GWh to c.600GWh by 2030F, which translates into **40% CAGR growth**, led by Volkswagen and Mercedes, assuming that all plans come online.

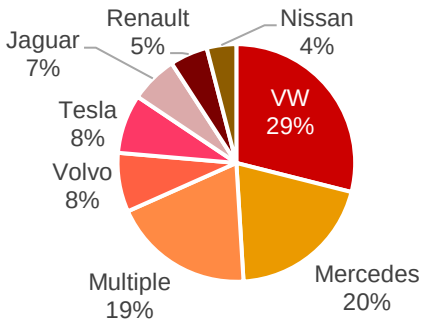
- Historically, **Mercedes and VW has dominated** battery manufacturing capacity in Europe. Going forward, other companies, including US/JP OEMs (Tesla, Nissan), will also be setting up their own battery manufacturing plants in EU either via in-house or under joint ventures. BMW continues to mainly rely on external suppliers via long-term supply partnership arrangements with CATL, EVE Energy and Envision AESC.

- In Europe, there are several planned battery manufacturing plants that **entails the sharing of production capacity with multiple OEMs.**
  - **Automotive Cells Company (ACC)**, of which Mercedes, Stellantis and Total Energies has equal stakes in, has 120GWh in capacity planned by 2026, of which battery supply off-takers will be Mercedes and Stellantis.
  - There are also multiple long-term supply arrangements between OEMs and EU battery plants. Off-takers of Envision AESC's 30GWh battery supply will be Renault Group and other customers, whilst that of CATL 100GWh will be Mercedes, BMW, Stellantis and VW. BMW is also expected to form long-term supply partnerships with CATL and EVE Energy on 40 GWh worth of capacity in Europe.

OEMs battery manufacturing capacity located in Europe



OEMs battery manufacturing capacity located in Europe (2030F), by %



*Note: *Multiple refers to battery manufacturing plants with plans to share capacity/production across a wide range of OEM brands e.g., Mercedes, Stellantis, BMW, Renault Group, VW and others.*
Source: DBS Bank Ltd estimates

Europe outlook: Future growth

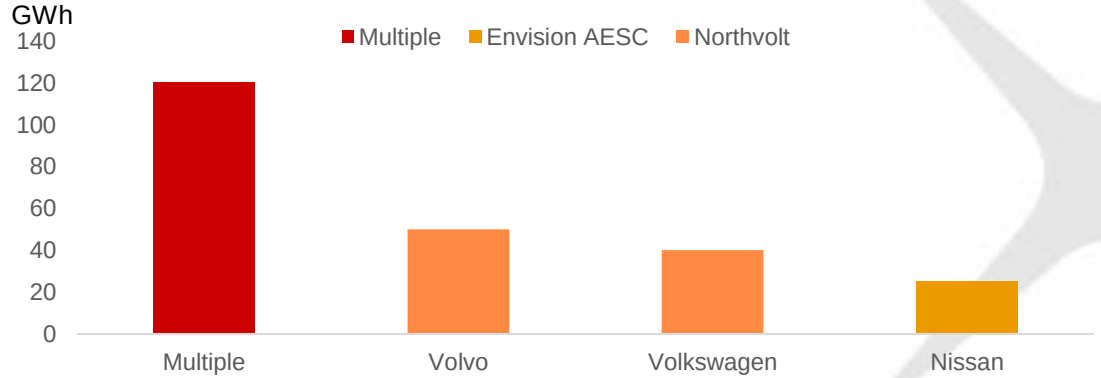
Most battery plants will be formed in-house, which is different from US's approach. For those under JVs, Northvolt is the key JV partner.

- Contrary to the US, **60% of OEM battery capacity will be formed under in-house arrangements** whilst the remaining c. 40% will be formed via joint ventures, with Northvolt as a key partner. VW owns a 20% stake in Northvolt.

- The focus on in house battery plants is on the back of **strategic battery investment plans** outlined by major EU OEM players i.e., VW, Mercedes:
  - **VW** has formed a subsidiary, PowerCo SE, a separate battery company, to build the Group's global battery business across the entire value chain, from raw material supply and development to the construction and operation of gigafactories. By 2030, PowerCo aims to operate 6 cell factories with a combined production capacity of 240 GWh, of which we assume 120GWh would be located in Europe (VW has currently outlined plans for 80GWh in EU).
  - **Mercedes** has announced 2 battery cell factories which will be built in Europe amounting to 50GWh, which will be built by self. Mercedes also has a 33% stake in ACC (captured under 'Multiple' in chart below) as well as a partnership with CATL.

OEMs battery manufacturing capacity in Europe, by structure (GWh)

JV partners for Europe OEM plants (GWh)



*Note: *Multiple refers to battery manufacturing plants with plans to share capacity/production across a wide range of OEM brands e.g., Mercedes, Stellantis, BMW, Renault Group, VW and others. Ford cancelled its planned Turkey battery plant (45GWh). Source: DBS Bank Ltd estimates*

Global outlook: OEMs are encroaching further onto the EV value chain

Notable breakthroughs in battery cell and other EV-related investments

Tesla

Tesla's proprietary **4680 battery cells** (which is based on NCM chemistry) was developed in-house since 2020. Recently, Tesla's 4680 battery cell has won 4 patents. Tesla's 4680 battery cell is set for mass production (partnering with Panasonic), in which 4680 cells will be used in all future Tesla models (including the Cybertruck).

Tesla has made plans to bring LFP battery supply chain into the US in Jan 2024 as reported by Reuters.

Volkswagen

During VW's Power Day 2021, VW Group has unveiled targets, which will be executed by its subsidiary **PowerCo SE**:

- In-house development and production of battery cells
- Target to develop unified cell
- Invest and set up cell factories with total capacity of 240GWh by 2030
- Vertical integration (including the production of cathode material and primary materials)

Investments in battery cell development: QuantumScape, a battery start-up company

Other investments: Invested in mining company ACG, alongside Stellantis

GM

In terms of battery plant investments, GM and LGES formed a joint venture known as **Ultium Cells**, and also a JV with SDI.

Investments in battery cell development:

- Operates its own R&D centres focused on battery cell development e.g., lithium-metal, silicon, solid-state batteries.
- Start-up investment into LFP cell technology (i.e., Mitra Chem), to develop more efficient LFP batteries
- Investments in other start-ups to develop cheap EV batteries (e.g., OneD Battery Sciences start-up)

Ford

In terms of battery plant investments in North America, Ford and SK On formed a joint venture known **as BlueOval SK**. Under the BlueOval SK JV, SK On will train Ford's employees on its proprietary technical, quality and manufacturing processes.

Investments in battery cell development:

- New JV with EcoProBM and SK On focusing on cathode/cathode active material

Though, amid ongoing EV demand headwinds, Ford has recently cancelled its JV with LGES/Koc Holding, which was planned for a 45GWh battery plant in Turkey, Europe.

Mercedes

Investments in battery cell development:

- Mercedes invested in Sila, a next-generation battery materials company, in 2019. Mercedes-Benz will be incorporating Sila's silicon anode chemistry in its EVs from 2022 onwards, which offers higher energy density by 20-40% as compared to existing cells' format.
- Mercedes has also set up its own R&D campus which focuses on research, design and production of battery cells.
- 33% stake in **Automotive Cells Company (ACC)** (with Stellantis and TotalEnergies) which focuses on the development and production of next-generation high-performance battery cells and modules

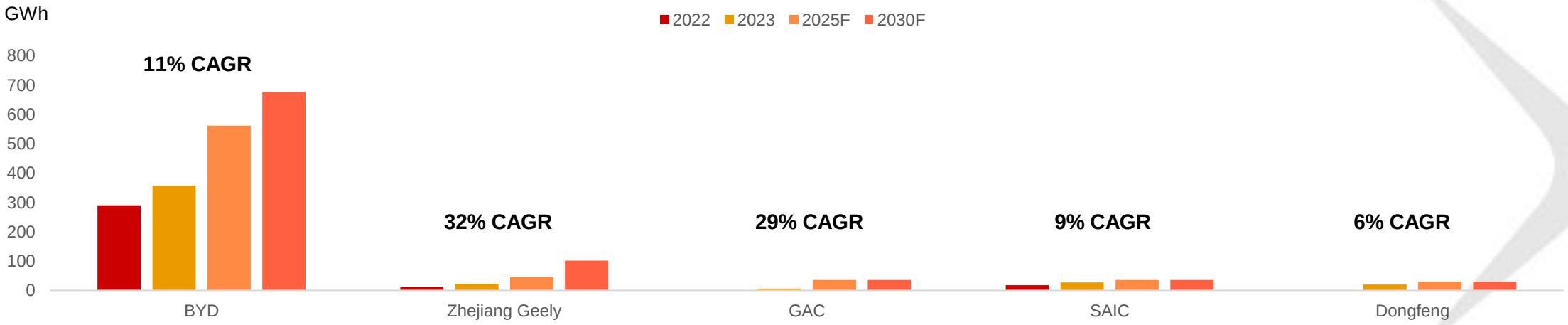
Source: Company reports, Reuters, DBS Bank Ltd

APAC outlook: Chinese OEMs

By 2030F, APAC OEM battery manufacturing capacity is forecasted to grow by 14% CAGR, dominated by Chinese OEMs

- By 2030F, APAC OEM battery manufacturing capacity is forecasted to grow from the current c. 400GWh to c. 1,100GWh by 2030F, which translates into c. **14% CAGR growth**, led by **BYD.**
  - Certain Chinese automakers e.g. GAC are strengthening their control over the EV supply chain by self-developing EV batteries
  - BYD through its respective battery business unit, supply EV batteries to other automakers as well. BYD is also expanding overseas to reach more global OEMs
  - On the other hand, Dongfeng and Geely have set up JVs with battery companies to co-develop EV batteries
- Chinese OEMs rely on both in-house battery investments and joint venture investments (see next two slides)

OEMs battery manufacturing capacity under Chinese OEMs



Source: DBS Bank Ltd estimates

APAC outlook: Chinese OEMs

In-house battery investments

GAC

Largest battery and energy storage project in Guangzhou

Location:
Guangzhou – 36GWh by 2025, at total investment of US$1.56bn

Battery technology:
LFP battery

BYD

Invested on battery & battery components production, battery assembly

Location:
Xuzhou, Wenzhou, Zhengshou, Fufeng, Inner Mongolia, Chile and Hungary. Total capacity of 75GWh for about US$4bn

Battery technology:
Blade battery (LFP)

Geely

Geely group (which includes self and other auto brands) is targeting in-housing a large part of capacity in battery cells, battery packs and battery management system.

Total planned investment of US$19.1bn to build 190GWh battery capacity, though **plans may likely see some slowdown** amid excess battery capacity in the market.

Location:
Anhui, Jiangsu, Tangshan, Jiangxi, Hunan, Zhejiang, Quzhou, Ganzhou.

Battery technology:
LFP battery, ternary pouch and parismatic battery, lithium-ion battery

GWM (SVOLT)

SVOLT was seeking an IPO to speed up its capacity expansion with total planned investment of US$15.7bn for capacity of 296GWh.

IPO plans are currently pending.

Location:
Changzhou, Huzhou, Suining, Chengdu, Jiangxi, Anhui, Nanjing, Jaingsu, Germany, Thailand.

Battery technology:
LFP battery, ternary battery, cobalt-free battery, short-blade battery

APAC outlook: Chinese OEMs

Battery JV investments

BYD

XCMG (Xuzhou Construction Machinery Group)

Manufacture and sell batteries, perform recycling of traction power battery

Total investment: US$0.145bn

Commenced in Apr-23

FAW

Focus on R&D, manufacturing and sales of power battery and battery system

Total investment: US$1.88bn

Total capacity: 45GWh

GEELY

Sunwoda, Jirun Auto

Focus on development, manufacturing and sales of power and storage batteries (lithium-ion, lithium polymer), battery packs and BMS. Total capacity: 800k units of battery

BASF, Zijin Mining

Build production line for ternary precursor (100k tons/year) and old lithium battery recycling (150k tons/year)

Farasis Energy

Conduct R&D, manufacturing and sales of lithium battery products, BMS, materials for cathode and anode, electrolyte and separator

Total capacity: 54GWh

CATL

Zeekr models will adopt CATL's Qilin battery. Total capacity: 15GWh

DONGFENG

CATL

Total investment: US$0.01bn

Total capacity: 9.6GWh

Sunwoda

Produce battery, battery module, battery pack and battery management system

Total investment: US$1.67bn

Total capacity: 30GWh

APAC outlook: Korean/Japanese OEMs

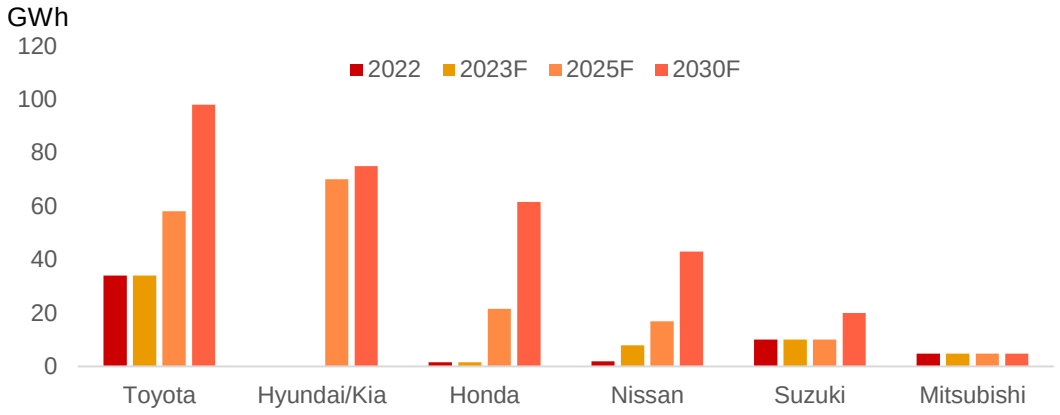
Korean/Japanese OEMs are ramping up their battery capacity, expected to grow by **25% CAGR**

- By 2030F, OEM battery manufacturing capacity by Korean and Japanese OEMs are expected to grow **25% CAGR yoy**, up from c. 50GWh in current battery capacity to c. 300GWh by 2030F, led by **Toyota, Hyundai/Kia and Honda**.

- By 2030F, 85% of Korean/Japanese OEM battery manufacturing capacity will be set up via JVs, of which key JV partners include:
  - Korean partners: LG Energy Solution and SK-On
  - Japanese partners: Panasonic, GS Yuasa, Envision AESC (Nissan owns a 20% stake)

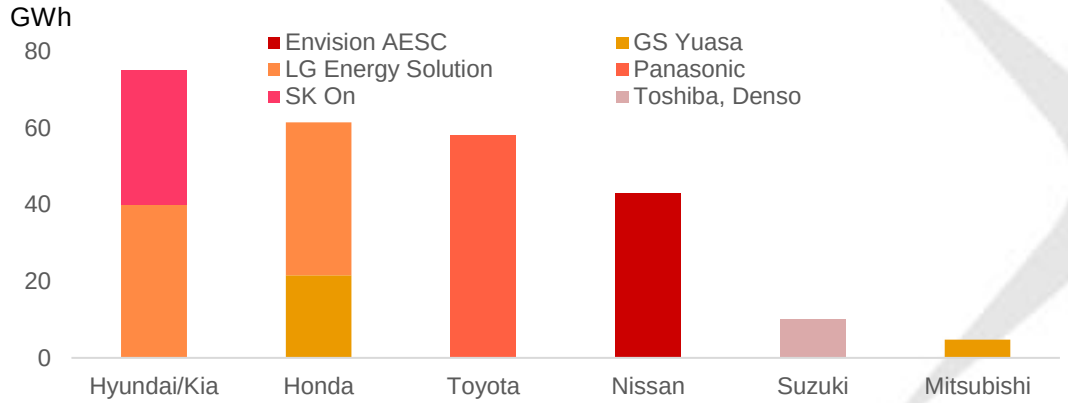
- KR/JP OEM's roles within JVs are largely **centred around assembling of packs** e.g., obtaining cells from battery makers and assembling into battery packs
  - **Toyota is an exception** given its expertise in battery development stemming from its legacy battery-related operations; Toyota and its JV partner Panasonic is **jointly** developing prismatic lithium-ion batteries, solid-state batteries and next-generation batteries

OEMs battery manufacturing capacity under KR/JP OEMs



Source: DBS Bank Ltd estimates

JV partners for KR/JP OEMs (GWh)



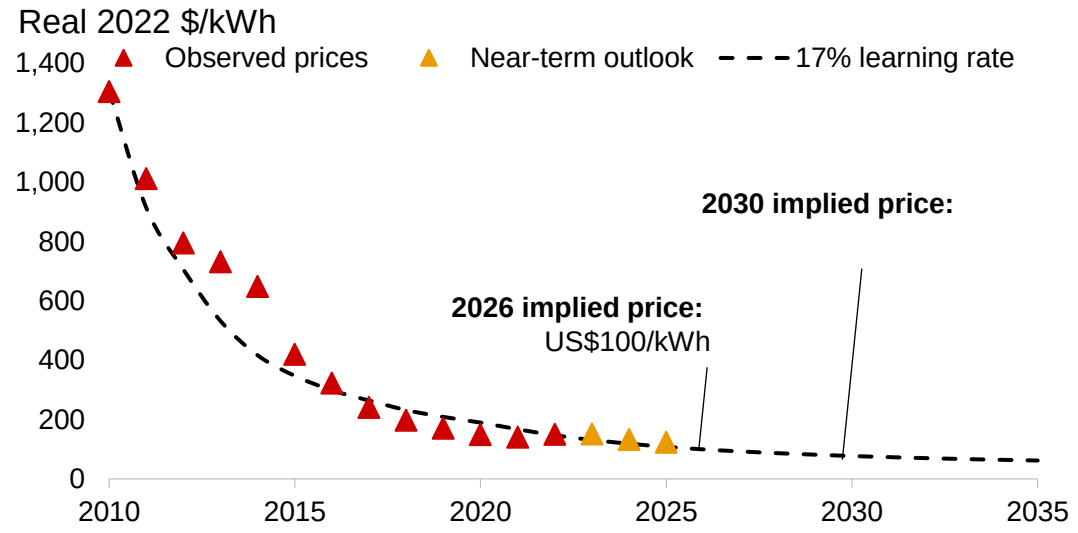
Global outlook: OEMs as potential winners from declining battery costs

Battery costs are forecasted to go below US$100/kWh threshold point by 2026, benefiting OEM gross margins

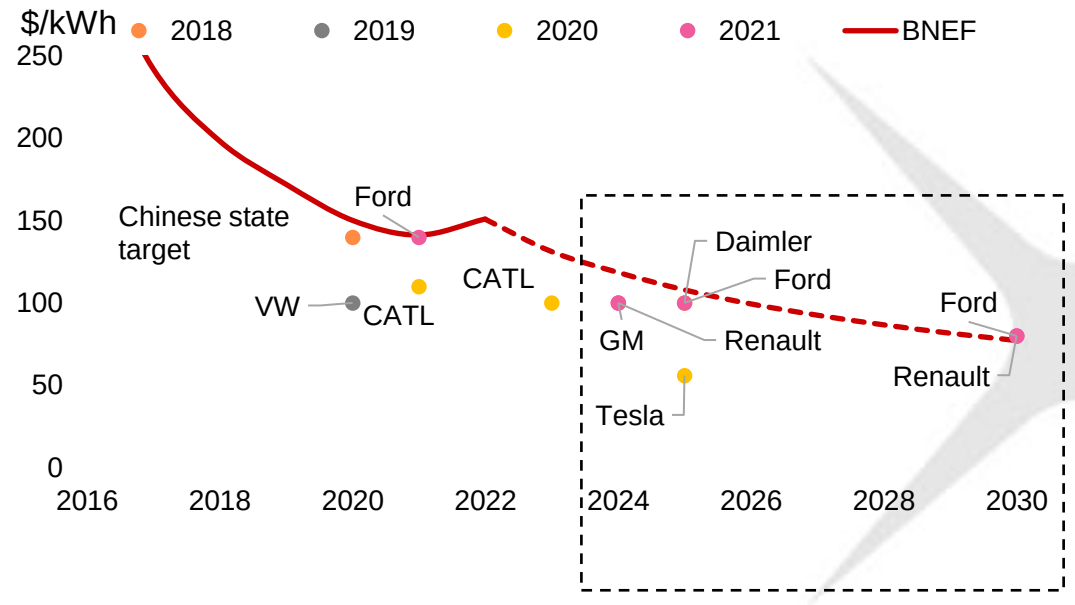
- The **US$100/kWh threshold** is often referenced to the point where EVs reaches **price parity** with internal combustion engine (ICE) models, although price parity varies across vehicle segment and region

- **Bloomberg NEF estimates that by 2026, battery costs will reach US$100/kWh** on the back of ramp up in battery capacity, continued technological process, manufacturing processes and more, which will benefit OEMs' gross margins
  - Based on latest public announcements, **major OEMs have targeted to reach <US$100/kWh as early as 2024**

Long term lithium-ion battery price forecast



Publicly announced lithium-ion pack prices, by OEMs



Source: Bloomberg NEF, DBS Bank Ltd

Business risks

Competition for raw materials, higher investment costs, talent availability and more

- **Competition for key battery materials from countries outside of China.** US FTAs will tilt supply decisions towards countries such as **Australia, Canada and Chile** for supply of lithium, nickel and cobalt, and away from China.
  - While Bloomberg NEF estimates that there will be sufficient metals supply capacity from US and US FTA countries to meet US demand through 2029, there is likely **greater competition for key battery materials from EU and other countries** as other countries also seek to reduce reliance on China.

- **Capital expenditure/investment costs** is more expensive in US and EU, as compared to APAC (especially China). Based on Bloomberg NEF's estimates, funding required to build a North American/European battery manufacturing plant averaged at US$100m/GWh, versus China at US$60m/GWh.
  - In the US/Europe, a lot of specialised equipment such as cell assembly equipment is imported from APAC, which incurs additional import costs. Majority of battery manufacturing equipment is manufactured in China, Japan and South Korea.
  - China is the cheapest as China has significantly stronger value chains (e.g., manufacturing equipment) and lower labour, land and permitting costs.
  - Further, there could be **looming equipment supply shortage** amid the aggressive gigafactory ramp-up in US/EU, noting that incumbent battery cell manufacturing suppliers are already **operating at more than 95% capacity**, leaving little room to increase output. This could result in upward pressure in capital expenditure/investment costs.

- **Talent availability.** Battery manufacturing requires specialised knowledge that takes decades to build. Even Chinese, South Korean and Japanese battery giants have faced talent shortage challenges. Some US OEMs have put in place training programmes e.g., GM with its Automotive Manufacturing Electric College programme.

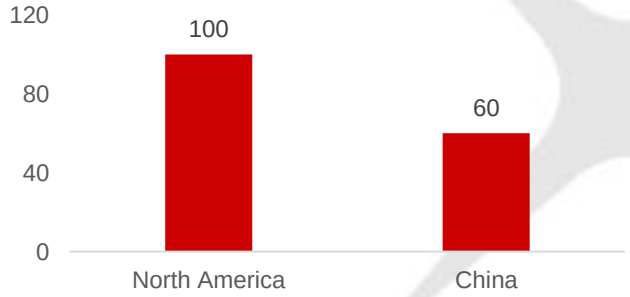
- **Race towards innovation**. Opportunity to invest in other battery technologies (e.g., solid state batteries, silicon anodes), new manufacturing processes and other segments such as recycling.
  - However, big battery makers like CATL, Samsung SDI and LGES have large-scale R&D efforts and will be better positioned to scale new technologies ahead of OEMs.
  - In terms of battery cell innovation, Chinese players (e.g., CATL, BYD) is currently leading the industry

Battery metals available in US and US FTA countries

	Lithium	Nickel	Cobalt
Australia	Yes	Yes	Yes
Canada	Yes	Yes	Yes
Chile	Yes		
Mexico	Yes		
Morocco			Yes
US	Yes		Yes

Source: Bloomberg NEF, DBS Bank Ltd

Battery plant investment costs (US$m/GWh)



Source: Bloomberg NEF, DBS Bank Ltd

Industry risks: Europe

A significant portion of Europe's battery gigafactory pipeline may not be realised

- Based on industry reports by Transport & Environment campaign group, **68% of Europe's battery gigafactory pipeline may not be realised** as companies weigh shifting their investments from Europe into US instead, amid the strong incentives provided by US IRA.
  - Tesla's gigafactory in Berlin is among the plants at risk of being deprioritised.
  - Other EU OEMs (e.g., VW) has also announced recent battery manufacturing expansion plans into NA.
- Presently, **EU's landmark policies is lagging the US IRA and Canada Critical Minerals Act** in boosting domestic supply chain capabilities
  - Net Zero Industry Act mainly focuses on simplifying permitting and approval processes for battery production projects
  - Recently announced EU Critical Raw Materials Act is predominantly focused on the raw material value chain
- More incentives may be needed to retain and attract battery manufacturing/supply chain investments into the EU

EU CRMA vs US IRA vs Canada CMA

	EU Critical Raw Materials Act	US Inflation Reduction Act	Canada Critical Minerals Act
Strengthening domestic supply capabilities	☹	☺	☺
Diversifying supply chains	😐	😐	😐
Accelerating project implementation	☹	☺	☺
Championing sustainable practices	☺	☹	☺
Improving risk monitoring and mitigation	☺	☹	☹

Source: Bloomberg NEF, European Commission, the White House, US Treasury, Government of Canada, DBS Bank Ltd

Industry risks: North America

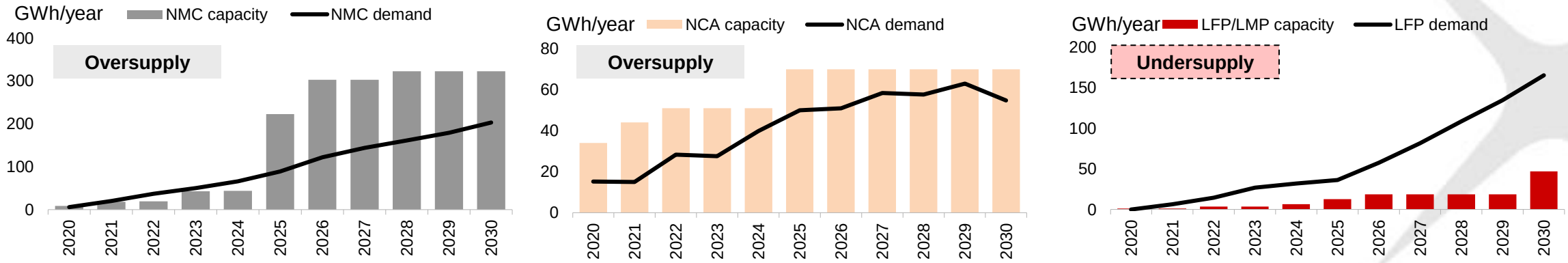
Mismatch in demand-supply dynamics across the different battery chemistries

- **Most of prospective capacities in US is focused on Lithium Nickel Manganese Cobalt Oxide (NMC) or Lithium Nickel Cobalt Aluminium Oxide (NCA).** US and EU automakers have historically placed a big bet on nickel-based chemistries, whose upstream value chain is easier to diversify even that such chemistries rely on additional battery metals beyond lithium such as nickel and cobalt.

- However, there has been a **rising interest towards Lithium Iron Phosphate (LFP)** due to its lower costs, of which there is likely to be insufficient supply in the future.

- Based on announced battery manufacturing capacity, there is a **surplus for NCA and NMC**, with most NMC plants is expected to come online from 2025. On the other hand, there is a **deficit for LFP**, on the back of limited LFP manufacturing capacity in US which poses a risk.
  - Chinese players is currently leading the industry in terms of LFP battery manufacturing (owns 95% of LFP manufacturing capacity).
  - Tesla, VW, Ford and Rivian have announced that they aim to use LFP for their entry-level models with lower driving ranges, which do not require high energy density and long ranges. Tesla has recently announced plans to bring LFP supply chain into the US whilst Ford is expecting to launch its US LFP plant in 2026 (albeit at a smaller capacity than its earlier planned capacity at 40GWh based on latest announcements).

US battery demand-supply, by chemistries

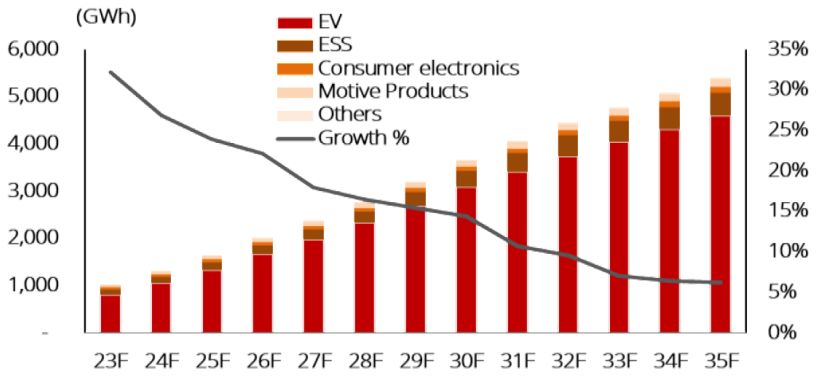


Source: Bloomberg NEF

Industry risks: Global

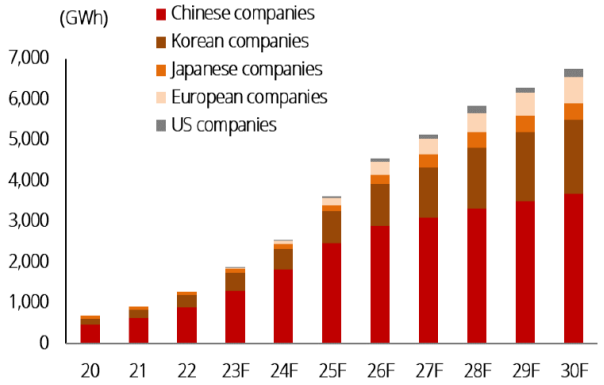
Over-capacity risks across markets

EV battery demand forecasts



Source: IEA, SNE Research, DBS Bank Ltd

EV battery production capacity outlook



Source: SNE Research, DBS Bank Ltd

EV battery demand
(84% of total in 2030)
2022-30F CAGR: 22.4%
3.1TWh in 2030

Total rechargeable battery demand
2022-30F CAGR: 21.1%
3.7TWh in 2030

Production capacity
2022-30 CAGR: 23.0%
6.8TWh in 2030

Effective production capacity
(Est. 70% of designed capacity)
4.7TWh in 2030

- 2030 **production capacity** is much higher than **demand** forecast
- 2022-30F CAGR of **production capacity** is also higher than that of **demand**
- However, if based on estimated **effective production capacity** of about 70%, effective production capacity will be 4.7TWh in 2030, translating to about **27% overcapacity over total rechargeable battery demand**

Overcapacity of batteries is a key risk to battery makers

Summary on risks

Faced by OEMs versus battery makers

OEMs

1. **Competition for key battery materials from countries outside of China**

2. **Investment costs** is more expensive in US and EU, as compared to APAC (especially China). There could also be looming battery cell manufacturing equipment shortage.

3. **Talent availability.** Battery manufacturing requires specialised knowledge that takes decades to build. Even Chinese, South Korean and Japanese battery giants have faced talent shortage challenges.

4. **Race towards innovation**. Big battery makers like CATL, Samsung SDI and LGES have large-scale R&D efforts and are likely to be better positioned to scale new technologies ahead of OEMs. Presently, Chinese players (e.g., CATL, BYD) are leading in terms of battery technology and innovation.

5. **Mismatch in demand-supply dynamics across the different battery chemistries**, where NCM/NCA chemistries are likely to see a surplus over the long-term, whilst highly-sought after LFP chemistries are likely to see a deficit. LFP chemistries are largely dominated by Chinese players e.g., CATL, BYD.

Battery makers

1. **OEMs are becoming a major EV battery player.** By 2030F, OEMs make up **40%** of total worldwide EV battery capacity. Excluding BYD, OEM's 2030F battery capacity stands at **30%** of total global battery capacity, up from c. 15% in 2022.

2. **Potential market share losses as OEMs may rely less on external battery suppliers.** Key for battery makers to protect their market share through cell/product/technology innovation and differentiation.

3. **Overcapacity over total rechargeable battery demand.** This could suggest downward pressures on plant utilization rates, especially for battery plants owned by battery makers, as OEMs are likely to prioritize their own in-house/JV plants over external suppliers.

Key takeaway

1. Global autos and their race in battery production ramp up will be positive for OEMs in the long run.

2. Though, there are some considerations that OEMs need to take note, include (A) business risks such as high investment costs, talent shortage and more, and (B) industry-related risks such as a mismatch in demand-supply dynamics across different battery chemistries.

3. Separately, for battery-makers, this would also result in over-capacity of batteries, and potential underutilisation of battery plants.

Conclusion

Global Autos & The Race in Battery Production

- **OEM battery capacity forecasted to grow by 25% CAGR by 2030, with North America and Europe capacity to double the growth rate relative to APAC.** Growth in North American and European EV battery industry is on the back of attractive government policies (e.g., US IRA) and rising focus of the US government to reduce reliance on China for key EV components.

- **North American and Korean/Japanese OEMs predominantly opt for JVs with battery makers, whilst EU OEMs prefer going in-house. Preferred JV partners include Korean/Japanese/European battery makers.** Except for some leading OEMs (e.g., Tesla, Toyota), majority of OEMs continue to rely on Korean/Japanese battery manufacturers for (i) cell manufacturing, (ii) technology (e.g., licensing of battery patents), (iii) supply of specialised manufacturing equipment, and (iv) expertise and know-how (e.g., specialised labour requirements). On the other hand, we see EU OEMs mostly opting for in-house arrangements for their battery production plans, on the back of their strategic battery investment plans. Though, we are seeing some selected OEMs (e.g., Toyota, Volkswagen) increasingly investing in the development of their own cell battery technology.

- **In the long run, OEM battery capacity expansion will benefit OEMs given an expected oversupply of batteries from 2025 onwards, though OEMs should note of ongoing challenges.** By 2026, Bloomberg NEF expects battery costs to decline below key US$100/kWh levels, which will be positive for OEM's margins. Though, ongoing challenges persists, such as (i) competition for raw materials, (ii) high battery investment costs, (iii) talent shortage, (iv) race towards other technologies. In the case of North America, industry expects a mismatch in demand-supply dynamics across different battery chemistries, with NCA/NMC seeing a surplus from 2025 onwards whilst LFP is expected to ongoing deficit on the back of limited LFP manufacturing capacity in US which poses a risk.

- **On the other hand, OEM battery capacity expansion may be negative to battery makers.** OEMs are becoming a major EV battery player, which may lead to headwinds to battery makers' market share. On a global level, we estimate about 27% overcapacity over total rechargeable battery demand. This could also suggest downward pressures on plant utilization rates, especially for battery plants owned by battery makers, as OEMs are likely to prioritise their own in-house/JV plants over external suppliers.

Thank You

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HOLD (-10% to +15% total return over the next 12 months for small caps, -10% to +10% for large caps)

FULLY VALUED (negative total return i.e. > -10% over the next 12 months)

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