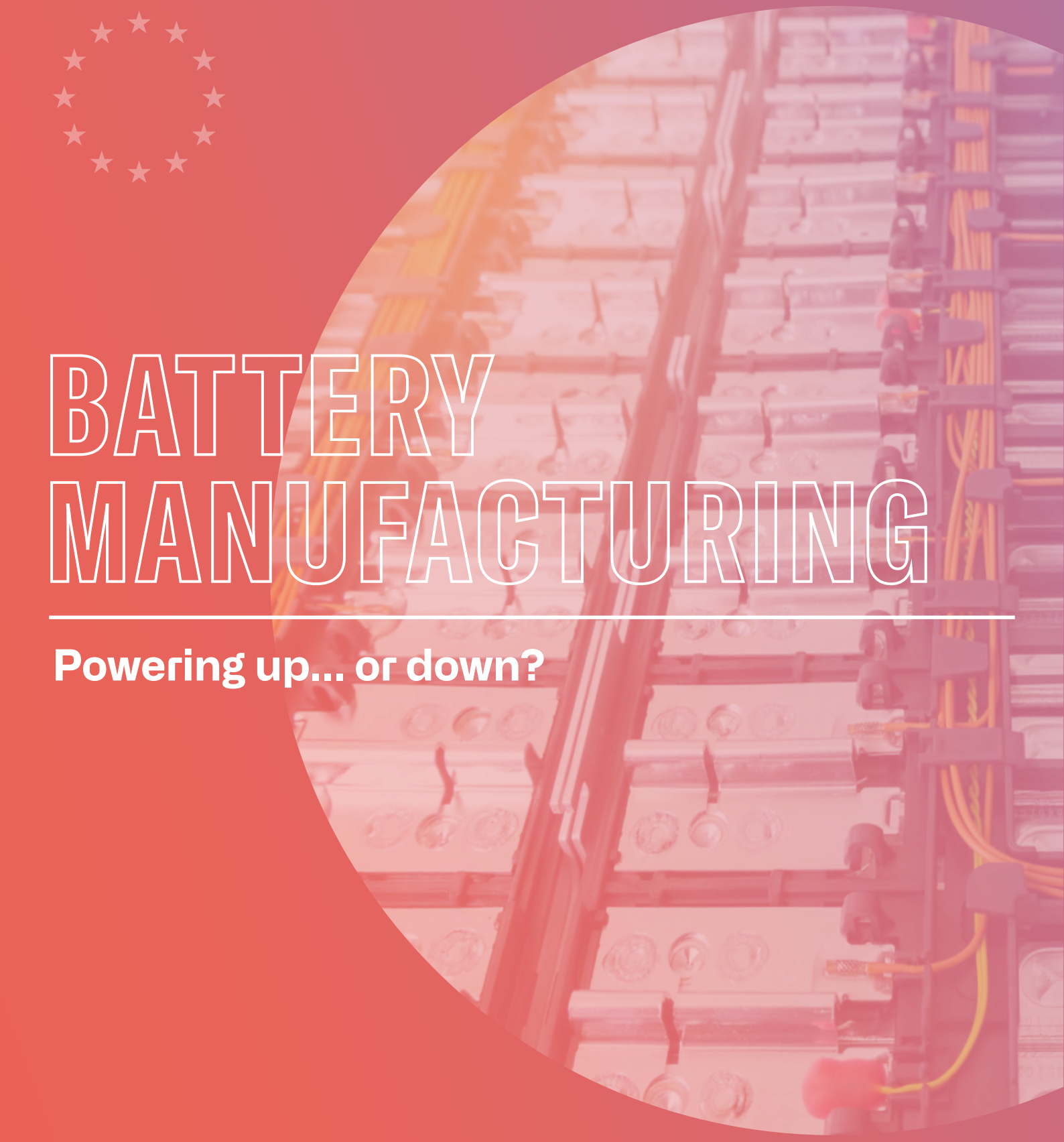
Breakthrough Energy

Cleantech for Europe

With analyses led by SYSTEMIQ

CLEANTECH REALITY CHECK



BATTERY MANUFACTURING

Powering up... or down?

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BATTERY MANUFACTURING

Powering up... or down?

What are batteries?

Batteries are essential for storing electricity (particularly from intermittent renewable energy sources) and powering an electrified economy. Batteries are anticipated to be deployed mostly for the mobility sector (~70% of demand) and grid balancing (~25% of demand), with the remainder for consumer electronics and industrial applications. There are several affordable battery chemistries on the market. Each serves a different purpose:

- Lithium iron phosphate battery (LFP) has a lower energy density (Wh per kilogram) but is made from more abundant materials, making it the affordable choice in the market. It is mainly used in affordable electric vehicles (EVs) and stationary storage.
- Lithium nickel manganese cobalt oxide (NMC) offers higher energy density but at a higher cost than LFP as it requires more expensive materials that carry higher supply chain risks.
- Other chemistries, such as sodium-ion and flow batteries, are emerging as a low-cost option for stationery storage. For EVs, novel battery technologies such as solid-state batteries show promise with higher energy density and safety.

For this series we focus on the main commercial volume lithium-ion battery chemistries, LFP and NMC.

Key take-aways

- The EU battery demand is expected to reach ~1,000 GWh by 2030. Currently only ~200 GWh of battery manufacturing capacity is operational and the EU relies heavily on Chinese imports of materials to support the capacity.
- To meet the Net Zero Industry Act (NZIA) goal of fulfilling 40% of EU demand domestically, an additional 200 GWh/year of manufacturing capacity must be operational by 2030[1].
- Achieving the European Battery Alliance (EBA) target of 550 GWh/year will require an even larger increase—around 350 GWh/year in additional capacity.
- The announced project pipeline suggests that meeting these targets is feasible, as the low-risk projects far exceed the required capacity. However, a significant portion of this pipeline is under non-EU ownership, indicating a need for an onshoring strategy.
- European plants face intense cost competition, with Chinese battery cells expected to remain materially lower cost.[2] Over half of Europe's operational and planned battery cell assembly still depends on imported materials, highlighting a vulnerability in the supply chain.
- The lack of a circular value chain for recycling materials exacerbates this issue. Production scrap during factory ramp-up is often exported to Asia, missing opportunities to recover critical materials within Europe.

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STRATEGIC IMPORTANCE FOR EUROPE

- **Enable the transition.** Increasing battery manufacturing capacity is crucial to enable a clean energy system that can achieve the EU's net-zero goals. The sectors with the greatest demand for batteries, power and mobility, currently account for ~35-40% of the region's total GHG emissions.[3]
- **Reduce the EU's reliance on battery imports.** The EU currently imports 10-15% of its annual demand.[4] Battery imports expose the automotive industry to supply chain risks (as demonstrated during COVID), reduce opportunities for regional value creation, and threaten long-term competitiveness, as batteries account for ~15–30% of an EV's total cost.[5]
- **Increase EU green jobs.** The battery sector is projected to grow from employing ~500,000 people today to ~1.5 million in 2030, potentially reaching ~5 million by 2050. This will be driven by growth in EV manufacturing, recycling, and raw materials.[6]
- Capture the €40–60 billion economic opportunity that the battery manufacturing value chain represents for the EU.[7]

CURRENT PROGRESS OF ELECTROLYSERS MANUFACTURING IN THE EU

OFF-TRACK — ON-TRACK

STATUS : AT RISK With planned capacity expansions, the European battery manufacturing sector demonstrates potential to achieve the Net Zero Industry Act's 400GWh/yr domestic demand target by 2030. However, realising this potential requires a doubling of manufacturing capacity from the 200GWh/yr operational today and addressing significant challenges that are reversing momentum: project cancellations and delays, a persistent cost gap with China and the US, a technological disadvantage, and slowing demand from the automotive sector all threaten EU competitiveness.

REQUIRED :

400-550 GWh/yr production capacity by 2030[1]

PROGRESS :

150-200 GWh/yr operational today[8]

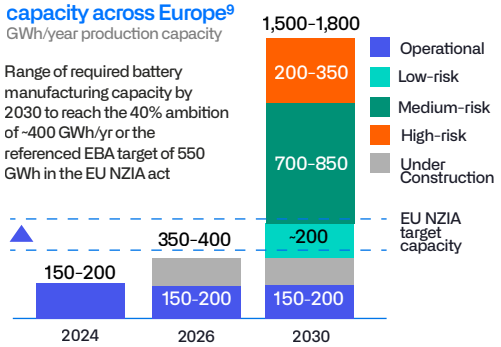
350-400 GWh/yr expected total to be online by 2026

1,500-1,800 GWh/yr total capacity inc. announced to be operational by 2030[8]

THE EU BATTERY MANUFACTURING SECTOR FACES SIGNIFICANT CHALLENGES, COMPOUNDED BY A LIMITED DOMESTIC RECYCLING VALUE CHAIN.

Risk classification of planned battery manufacturing capacity across Europe[9]

GWh/year production capacity



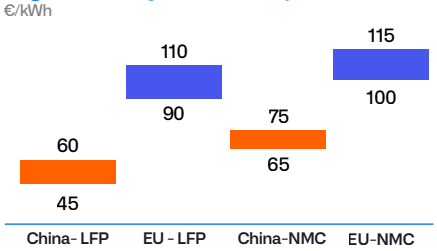
Risk classification based on assessment of key factors such as secured funding, secured location, construction status & permits, investments from EU OEMs /support from EU institutions, planned projects in the US, cooperation with the US OEMs.

- The EU Net Zero Industrial Act (NZIA) has stated two targets for batteries: EBA's 550 GWh/yr target that was set in 2022, and an ambition of meeting 40% of EU battery demand in 2030, equivalent to ~400 GWh/year, with domestic manufacturing capacity.[1]
- To meet the stated ambition and target in the NZIA, only ~15-25% of the additional 1,300-1,600 GWh/year manufacturing pipeline must be operational by 2030. More than 90% of this capacity is based on NMC technology, while the rest focuses on LFP chemistry.[10]
- Although the EU is on track to meet the conservative ambition of 400 GWh/yr, there are ongoing headwinds when considering factory building challenges (for example for Northvolt, ACC) and weakening demand (e.g., BMW cancelling a €2.1bn offtake deal).[11] [12] [13]
- The EU recycling infrastructure is inadequate to harness the material potential and must be scaled up to improve the recovery rate of domestic critical raw materials.[14] Gigafactories experience a 15-30% scrap rate during ramp-up, producing "black mass" containing recoverable critical raw materials. This valuable scrap is often exported to Asia, representing a missed opportunity for domestic material recovery.[15] Acting now would enable the EU to benefit from the imminent ramp-up of factory capacity.

TO COMPETE EFFECTIVELY IN BATTERY MANUFACTURING WITH CHINA AND THE US, THE EU MUST CLOSE THE GAP ACROSS PUBLIC FUNDING, SCALE AND SUPPLY CHAIN INTEGRATION.

Regional battery cell cost comparison[16]

€/kWh



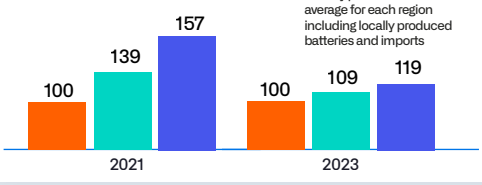
Based on Volta Foundation's LFP & NMC cell manufacturing cost model, using Chinese manufacturing technology and regional energy price

EU
USA
China

Regional battery prices and average pack costs [17]

Battery Prices. Indexed, China = 100

Battery prices refer to the average for each region including locally produced batteries and imports



Average battery pack costs

$94/kWh CHINA ↑ **+31%** US ↑ **+48%** EU

Average across multiple battery end-uses, including different types of electric vehicles and stationary storage projects

- EU battery cell production costs are significantly higher than in China (e.g., LFP: €90-110/kWh vs. €45-60/kWh). On average, cells make up 75-85% of the total battery pack cost structure. [16]
- The regional price gap for batteries has converged in recent years, highlighting how batteries are an increasingly globalised product. EU battery pack costs are, on average, 48% higher than in China.[17]
- China benefits from economies of scale, lower energy and labour costs, and a well-integrated value chain.
- The EU's cathode active material (CAM) manufacturing capacity lags significantly behind China (50 GWh/year vs. 200 GWh/year in 2024). Although this ratio is expected to improve by 2030 (700 GWh/year CAM vs. 1,500-1,800 GWh/year cell capacity), the EU's fragmented supply chain remains a disadvantage.[18]

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ENABLERS – WHAT IS GOING WELL

TARGETS FOR PHASE OUT OF ICE CAR SALES

Mandates are accelerating EV adoption, surpassing 20% of total new car sales across Europe in 2023 despite a slowdown in the automotive sector. Leading countries include Sweden (60% EV share) and the Netherlands (43%), though reduced incentives have tempered growth.[20]

OFFTAKE COMMITMENT FROM AUTOMOTIVE INDUSTRY

Long-term offtake agreements from automakers provide critical stability for battery manufacturers during market volatility. These agreements ensure predictable cashflows and meet financing requirements for greenfield projects and scale-ups.[21]

STRONG EU-LEVEL SUPPORT FOR THE SECTOR

The EU has implemented robust support mechanisms for battery manufacturing under the Green Deal Industrial Plan, allocating €3 billion annually to green manufacturing and attracting investments like CATL's plant in Hungary.[22] Initiatives such as InvestEU, the European Battery Alliance (EBA), and Important Projects of Common European Interest (IPCEI) aim to unlock additional funding.[23] The Battery Regulation further strengthens the EU's leadership position, though enhancements are needed to support the sector fully.

BARRIERS – WHAT IS NOT GOING WELL

LOSS OF MOMENTUM IN EV REGISTRATIONS AND PROJECT CANCELLATIONS

The EU is experiencing a slowdown in EV adoption, with a 5% year-on-year decline in registrations.[18] This has led to weakened automotive battery offtake commitments, contributing to gigafactory project cancellations and downsizing. These trends reflect a fiercely competitive market and declining demand for EVs across key regions.

COST GAP WITH CHINESE MANUFACTURED BATTERIES

European battery production costs remain materially higher than China's due to limited manufacturing scale, higher labour and energy costs, and expensive raw materials. Additionally, tax credits in the Inflation Reduction Act (IRA) for U.S. manufacturers make EU cell costs 10-15% higher than those in the US.[24] This lack of cost competitiveness, coupled with disparities in subsidies and scale, puts European manufacturers at a disadvantage against global competitors.

RELIANCE ON IMPORTED BATTERY MINERALS

Europe remains heavily dependent on imports for key battery minerals including lithium and cobalt, primarily sourced from China, exposing it to geopolitical risks and supply chain disruptions. Gaps in cathode active material (CAM) production and limited domestic R&D for recycling technologies exacerbate this reliance.

ACTION AGENDA – WHAT NEEDS TO BE DONE

1. **De-risk strategic battery manufacturing investments**
Establish a dedicated fund to provide loan guarantees, insurance, and equity investments for projects that demonstrably reduce the EU's reliance on imported battery components and materials. Focus "Net-Zero Acceleration Valleys" on vertically integrated manufacturing clusters that incorporate raw material processing, cell production, and recycling, offering incentives for companies to co-locate and share infrastructure. Implement accelerated permitting processes specifically for projects that align with EU circular economy goals and utilize sustainable manufacturing practices.

2. **Implement EU-wide EV subsidy schemes and procurement policies** that prioritise EU-made batteries with low-carbon footprints and high recycled content, aligning with the EU's Battery Regulation. Develop a robust EU-backed incentive scheme, similar to France's conditional incentives for EU-made batteries, to sustain demand from the automotive sector.

3. **Strengthen raw material supply resilience through domestic sourcing, diversification and recycling infrastructure**
Enhance raw material supply resilience by supporting domestic sourcing, building local black mass processing capabilities, securing end-of-life batteries within Europe, and establishing strategic reserves of critical raw materials. Prioritise the expansion of recycling infrastructure to meet the Critical Raw Materials Act benchmarks, targeting 25% of domestic mineral needs through recycling by 2030 in parallel with domestic extraction, processing, and diversification.

"Europe has immense potential to build a competitive and sustainable battery and circular recycling ecosystem by leveraging its strengths in R&D and high-tech capabilities. To unlock this, policymakers must ensure strict implementation of key regulations like the battery regulation or the critical raw materials act, robust financial support for scaling innovative ventures, and a balanced focus on advancing critical technologies. Trust in the long-term viability of the ecosystem is essential to secure Europe's position in the global energy transition"

Dr. Lilian Schwich, CEO & Co-Founder, **Cylib**

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References

[1] 550 GWh was a target that NZIA referenced, based on European Battery Alliance's 90% target and demand projections made in 2022, as per line (16) of the NZIA act: "...For battery technologies this would mean contributing to the objectives of the European Battery Alliance and aim at almost 90% of the Union's battery annual demand being met by the Union's battery manufacturers, translating into a Union manufacturing capacity of at least 550 GWh in 2030..." However, the NZIA also stated an ambition that 40% of battery annual deployment needs by 2030 to be manufactured in the EU should be adopted considering supply chain and manufacturing capacity, as per line (17) in the NZIA act: "Considering those objectives together, while also taking into account that for certain elements of the supply chain, such as inverters, as well as solar cells, wafers, and ingots for PV or cathodes and anodes for batteries, the Union manufacturing capacity is low. In order to help tackle import dependency and vulnerability concerns and to ensure that the Union's climate and energy targets are met, while striving towards a similar benchmark for net-zero technologies. The Union net-zero technologies annual capacity should aim to approach or reach an overall annual manufacturing benchmark of at least 40 % of annual deployment needs by 2030 for net-zero technologies considered as a whole." For this ambition, we used McKinsey's analysis on 2030 battery demand in EU, totaling at ~1,000 GWh annually. This means the 40% ambition in the EU will need to supply 40% of that annual demand, at 400 GWh/yr.
[2] Cell cost average is derived from Fastmarket's cell-cost-teardown model, not a price survey cost from manufacturers.
[3] EU emissions are based on Power sector emissions are projected to be around 500-600 MtCO2e in 2023, based on Amber Energy (2023) and road mobility (e.g., cars) are responsible for 13% of EU emissions in 2022, and 59% of overall road transport emissions (Transport & Environment, 2023).
[4] EU imported 1.1bn USD worth of battery cells. Assuming cost of production of battery cells are at 40-50 $/kWh, EU imported ~25 GWh of batteries. Using EU's 2023 production capacity at 100-150 GWh, around 15% of EU's full annual Battery production capacity was imported. Data from from TrendEconomy's Open Data Portal and T&E Battery risk report and from IEA: Global EV Outlook 2024, which highlights that imports supply over 20% of Europe's EV battery demand due to insufficient local production.
[5] Based on average battery capacity (78 kWh), range of global battery price (110-160 $/kWh), and average price of EV in EU for 2023, from Electric vehicle model statistics | European Alternative Fuels Observatory
[6] Based on the Centre for Research on Multinational Corporations and projected from announced capacity by 2030.
[7] Derived from 215 billion USD global market revenue pool, with 30-40% of demand coming from EU region, the battery cell component opportunity in Europe and North America (McKinsey, 2024).
[8] Based on Volta Foundation's 2024 Battery Report in "EU battery manufacturing capacity", there are 1,500 GWh of announced manufacturing capacity by 2030 in the EU, of which 50-60% are fully owned by European-based company, and 40-50% having partial or full ownership from international battery manufacturers, as well as Market Analysis Update Q2 2024 - Battery Cell Production In Europe: Status Quo And Outlook (IPCEI, 2024) and Powering the EU's future: Strengthening the EU battery industry from European Parliamentary Research Service (2025)
[9] Transport & Environment: An Industrial Blueprint for Batteries in Europe. The T&E methodology assigns a risk category (low, medium, high) for each announced gigafactory plant. The risk category is calculated based on a scoring system that factors in six factors, each with a rating of 0 to 2 (0 is low risk, 2 is high risk). A cumulative project scoring of 0-4 total points gets a low-risk rating, while 8-12 points are considered high- risk. The risk factors considered by T&E are: Secured funding, Secured location, Construction status & permits, Investments from EU OEMs or support from EU institutions, Planned projects in the US, Cooperation with the US OEMs.
[10] Based on IEA analysis on battery chemistry market per region, NMC batteries are more common in the European and American electric car markets, while LFP is the most prevalent chemistry in the Chinese electric car market. IEA: Global EV Outlook 2024
[11] Based on 'Huge losses': Sweden fears for future of batterymaker Northvolt (The Guardian, 2024).
[12] In June '24, ACC paused battery plant construction in Germany and Italy to consider transitioning to cost-effective LFP chemistries. Based on "ACC Puts work on battery factories in Kaiserlautern and Termoli on hold" (Electrive, 2024) https://www.electrive.com/2024/06/05/acc-puts-work-on-battery-factories-in-kaiserslautern-and-termoli-on-hold/
[13] Based on BMW cancelling $2bn cells contract with Northvolt (Reuters, 2024) (BMW cancels $2 bln battery cells contract with Northvolt (Reuters)
[14] Based on Payables for NCM Black Mass in South Korea pick up in March (Fastmarkets, 2024) Payables for NCM black mass in South Korea pick up in March - Fastmarkets
[15] Battery recycling in Europe – a reality check (Circular Energy Storage Online, 2024)
[16] Volta Foundation's 2024 Battery Report
[17]Based on indexed global battery pack cost comparison with China as index (China=100) from Global EV Outlook (IEA, 2024) and Lithium-Ion Battery Pack Prices See Largest Drop Since 2017, Falling to $115 per Kilowatt-Hour: BloombergNEF (BNEF, 2024)
[18] Q42024 Market update: Weakening European Electric Vehicle Market - Challenges and Opportunities for the Battery Industry (IPCEI, 2024)
[20] Transport&Environment's EV market watch dashboard and New registrations of electric vehicles in from European Environment Agency, data as per November 2024
[21] Based on company media release from Verkor: Renault Group and Verkor: a long-term commercial partnership for high-performance, low-carbon batteries (Verkor, 2023)
[22] Making a Success of the Clean Industrial Deal (Institute 4 Climate Economics, 2023
[23] European Commission and EIB announce new partnership to support investments in the European battery manufacturing value chain at the end of 2024 https://www.eib.org/en/press/all/2024-484-european-commission-and-eib-announce-new-partnership-to-support-investments-in-the-european-battery-manufacturing-value-chain?utm_
[24] $369 billion in investment incentives to address energy security and climate change, UN Trade and Development (UNTAD) Investment Policy Monitor (2022)