Clean Technology Partnerships Initiative

EU Energy Supply Chains Analysis

March 2026

catalyse europe

Context: Securing the EU Clean Technology Supply Chains

- Demand for clean technology components will grow sharply as the EU accelerates power sector decarbonisation and industrial transformation.
- The EU cannot achieve self-sufficiency across critical clean energy supply chains – China controls 70-90% of batteries, 75-95% of solar PV, and 60-94% of rare earth processing, creating single-source disruption risk and 30-50% cost disadvantages for European manufacturers.
- Recent EU initiatives (Clean Industrial Deal, Net-Zero Industry Act, Wind Power Package) set direction but deployment lags targets. For example, Wind Europe projects a 74 GW shortfall against the 425 GW wind target by 2030.
- This work identifies priority technologies and partnership pathways to strengthen the EU's industrial base, energy resilience, and security to meet clean energy deployment goals.

Our Purpose: Connecting supply chain risks for key clean energy technologies to strategic partnerships

	Market context	Key questions
①	**Concentrated supply chains create strategic vulnerabilities** Critical mineral processing and clean technology manufacturing remain highly concentrated, with China accounting for 75-90% of processing capacity across batteries, solar PV, and electrolysers – while rapidly expanding in wind and grid equipment.	**Where are our greatest supply chain concentration risks?** Which technologies and supply chain segments face the greatest concentration risk – and where should governments prioritise action?
②	**The clean energy transition requires unprecedented capital mobilization** Global clean energy investment must nearly triple from $1 trillion to $2.7 trillion annually by 2035 to meet net zero pathways.	**How do we mobilise capital at the required scale and pace?** What combination of public investment, private finance, and policy de-risking can unlock the trillions needed to meet net zero timelines?
③	**Competitiveness in clean energy industries determines who benefits from the transition** Global renewable capacity additions over 2025-2030 will total 4,600 GW—double the previous five years—while nuclear capacity is set to more than double by 2050, adding over 450 GW of firm clean power.	**Where can we compete – and where must we partner?** In which areas can the EU build or defend competitive advantage, and where must we secure reliable country and commercial partnerships?

Our initiative

Extensive data and analysis exists on supply chain risks –**what's missing is a consistent framework that prioritises gaps** and connects diagnosis to **actionable partnerships across key technologies**

Sources: IEA World Energy Outlook 2024; IEA Energy Technology Perspectives 2024; IEA Renewables 2025; IEA The Path to a New Era for Nuclear Energy 2024

Program Overview : Bridging EU Supply Chain Gaps

- Clean Technology Partnerships address critical supply chain gaps through coordinated sourcing, investment, and manufacturing arrangements with like-minded countries.
- Partnerships complement domestic strategy – anchored in EU industrial, energy, and security priorities while leveraging international markets where full self-sufficiency is impractical.
- Approach aligns with emerging models like the EU's Clean Trade & Investment Partnerships (CTIPs), which integrate domestic objectives with coordinated international action.
- Delivery requires cross-government coordination across EU member states and Directorates-General (DGs) including DGs ENER, GROW, TRADE, INTPA, CLIMA and key entities including the EIB, among others.

Our analysis identifies where partnerships most effectively reinforce EU priorities and strengthen resilience in strategically important clean energy technologies

Project Approach: Analytical effort builds on existing data and industry research to develop a uniform approach to evaluate supply chain risks of key energy technologies

1 Define analytical scope

Create a replicable framework to assess market context and vulnerabilities **across supply chain for given clean energy technology**

2 Identify priority technologies

Synthesise **EU/UK strategy documents and stated goals** into a focused shortlist of technologies and supply chains for assessment

3 Convene expert workshops

Engage subject matter experts to validate analytical approach and **address knowledge gaps**

4 Develop insights and perspectives

Map **end-to-end supply chains for key technologies**, assess market dynamics and vulnerabilities, and **identify strategic partnership opportunities**

5 Stakeholder engagement

Engage EU, UK, and other key country partners to validate findings, inform diplomatic and domestic policy, and build coalitions to advance recommendations

Analytical working group

bruegel
CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE
CFE
iea International Energy Agency
IPPR
Kaya Partners
MISSION POSSIBLE PARTNERSHIP
Net Zero Industrial Policy Lab
RMI
Rhodium Group

To organise the clean energy and decarbonisation priorities, technologies are evaluated across three domains

Category	Focus	Goal
Energy Resilience	Secure materials and components for a reliable energy system	Reduce dependence on vulnerable fuel and material imports by ensuring reliable access to the technologies, components, and inputs required to operate a secure, affordable clean energy system.
National Security	Build trusted supply of defence-relevant and critical technologies	Prevent adversarial dependence while preserving defence capability and securing trusted supply of critical technologies.
Economic Growth	Maximise value creation and industrial competitiveness	Prioritise strengths in manufacturing, innovation, and advanced services for energy technologies – targeting sectors where investment generates high-quality jobs, export growth, and technological breakthroughs

EU's government-wide strategies for manufactured energy technologies and industrial decarbonisation

NOT EXHAUSTIVE

🟢 Both 🔵 Net-Zero Industry Act ⚪ REPowerEU 🟨 CTP priorities

Technology		Summary of goals and objectives
🟨 **Batteries**	🟢	Achieve 40% domestic mfg. target for strategic technologies; strengthen EU Battery Regulation sustainability requirements.
Biomethane/Biogas	⚪	Expand to 35 bcm by 2030 under REPowerEU to replace fossil gas and reduce Russian import dependence.
CCUS	🔵	Develop 50 Mt/yr CO_2 injection capacity by 2030; oil & gas producers are expected to contribute to storage targets in proportion to their production volumes.
Electrolysers / Hydrogen	🟢	Scale electrolyser manufacturing to support 10 Mt domestic renewable hydrogen production by 2030.
🟨 **Geothermal**	🟢	Expand geothermal for firm renewable power, industrial heat, and district heating; create European Geothermal Alliance.
🟨 **Green Steel**	🔵	Transition steel sector to EAF and H_2-DRI while maintaining strategic capability; leverage CBAM for demand pull.
🟨 **Grid Equipment**	🟢	Execute €584bn grid investment this decade for transformers, cables, and HVDC to enable REPowerEU targets.
Heat Pumps	🟢	Deploy 30 million units by 2030; expand EU manufacturing capacity (currently 25 GW, 20% global share).
Hydropower/Storage	⚪	Maintain and expand hydropower and pumped storage for baseload generation and grid balancing services.
Industrial Decarbonisation	🔵	Decarbonise cement, chemicals, and refining via electrification, hydrogen, and CCUS; €1bn Innovation Fund heat auction.
🟨 **Nuclear (incl. SMRs)**	🔵	Maintain reactor manufacturing and fuel-cycle capabilities; deploy 15 GW SMRs by 2050 via European SMR Alliance.
Solar PV	🟢	Deploy 592 GW by 2030; achieve 40% domestic manufacturing despite current <1% cell/wafer production share.
Sustainable Alternative Fuels	🔵	Scale e-fuels (e.g., green ammonia, methanol) and SAF production under ReFuelEU Aviation and FuelEU Maritime mandates.
🟨 **Wind**	🟢	Deploy 425 GW by 2030 (~100 GW offshore); maintain EU competitive position as net exporter of nacelles.

Sources: EU Net-Zero Industry Act; REPowerEU Plan.
The EU's Industrial Accelerator Act proposal includes requirements for technology components to originate in the EU. The proposal is yet to pass through the European Council and European Parliament and is therefore not yet reflected.

Prioritising energy technologies with most supply chain risk

While EU strategies (CID, NZIA, RPEU) address a broad clean technology portfolio, we focus on **seven where supply chain vulnerabilities are most acute and where industrial competitiveness, national security, and energy resilience objectives converge**. Each technology meets all three criteria.

These include technologies that already have **mature supply chains with market concentration** (batteries, wind, grid equipment, heat pumps) and technologies where **supply chains are evolving due to reinvestment or new technological deployment** (geothermal, green steel, nuclear).

Batteries/storage enable electric vehicles, grid flexibility, and stationary storage – EU targets 40% domestic manufacturing under NZIA while deploying 592 GW solar and 510 GW wind requiring massive storage expansion

Grid equipment underpins renewable deployment, electrification, and cross-border integration – €584bn investment needed this decade with **HVDC, transformers, and power electronics** facing 2–5-year lead times

Heat pumps targeted at 30 million units by 2030 under REPowerEU with EU manufacturing capacity expansion (currently 25 GW, 20% global share) to reduce 95% compressor dependence on China

Wind goals of 425 GW by 2030 under REPowerEU; EU maintains competitive position as net exporter of nacelles while addressing rare earth magnets (90%+ China refining) and offshore supply chain gaps

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Geothermal offers vast untapped resources for industrial heat and district heating, with limited deployment to date but significant potential as Enhanced Geothermal Systems unlock deep resources across the EU

Green steel underpins decarbonisation of construction, automotive, and wind supply chains but faces 40-50% cost premium vs. conventional steel; H_2-DRI technology and scrap recycling offer pathways to maintain competitiveness while cutting emissions

Nuclear critical for baseload power and energy security with focus on conventional fleet life extension and SMRs for 15 GW by 2050 under European SMR Industrial Alliance; HALEU fuel supply diversification priority

Sources: EU Net-Zero Industry Act; IEA Energy Technology Perspectives 2024; IEA Global Hydrogen Review 2025; IEA Renewables 2025; Mission Possible Partnership.

Focus Energy Matrix 1/4

🔴 Economic Growth
🔵 National Security
🔹 Energy Resilience
🟢 Export Opportunities

Sources: BNEF; EU Net-Zero Industry Act; IEA Energy Technology Perspectives 2024; IEA World Energy Outlook 2025; Wood Mackenzie.

Technology	Context	Summary: Global Supply Chain	Example Partnerships
Batteries 🔵🔹	Batteries underpin clean power, transport electrification, and grid stability, but EU manufacturing faces 40-50% cost disadvantages vs. China. European OEMs remain largely committed to NMC chemistry for EV range, while LFP (up to 30% lower cost) dominates stationary storage – a gap now attracting direct Chinese investment, including the €4.1bn CATL-Stellantis JV in Spain (50 GWh LFP, 2026). EU grid storage must scale substantially to meet REPowerEU targets of 592 GW solar and 510 GW wind by 2030.	• China 70-90% dominance across battery value chain (cathode 90%, anode 85%, cells 75%) • EU battery production costs 50% higher than China • Sourcing battery metals from Western countries feasible in 3-4 years with policy support	• **Japan/Korea JVs** to build integrated EU supply chains • **Strategic JVs with China** (e.g., CATL) for grid storage tech (LFP chemistry) • **Australia, Canada, US** for critical mineral supply agreements
Grid Equipment 🔴🔵🔹🟢	The EU faces €584bn grid investment needs this decade to enable REPowerEU renewable targets. Demand for cables, transformers, and HVDC equipment is outstripping supply, with lead times reaching 2-4 years. Unlike solar and batteries, China is not yet dominant (30% of transformer exports) but grids remain the critical backbone of electrification.	• Europe holds strong industrial base for grid equipment and components • Lead times: 120 weeks for transformers (vs. 50 weeks pre-2021), 5+ years for HVDC cables • Copper scarcity forecast from late 2020s; EU imports 100% of refined copper • Power semiconductor scarcity constrains HVDC and inverter production	• **UK** for joint grid investment and interconnection (Celtic, Viking Link) • **Turkey and Korea** for transformer manufacturing capacity partnerships • **Chile, Peru, Indonesia** for copper and critical minerals supply agreements

Focus Energy Matrix 2/4

🔴 Economic Growth
🔵 National Security
🩵 Energy Resilience
🟢 Export Opportunities

Sources: BNEF; EU Net-Zero Industry Act; IEA Energy Technology Perspectives 2024; IEA World Energy Outlook 2025; Wood Mackenzie.

Technology	Context	Summary: Global Supply Chain	Example Partnerships
Heat Pumps 🔵 🩵 🟢	REPowerEU targets 30 million heat pumps by 2030 (10M additional by 2027). The EU has ~25 GW manufacturing capacity (20% global share) but faces 55% cost disadvantage vs. China ($253/kW vs. $114/kW). Over 95% of compressors – the key cost driver (~30% of heat pump cost) - are manufactured in China, creating critical component dependency.	• China dominates compressors (95%) and refrigerant feedstock (62%) • EU: two-thirds domestic production, one-third imports (up from net exporter pre-2019) • $3bn+ in new EU factory investments announced, though a market adjustment in 2023-24 led to temporary workforce restructuring across some EU manufacturers • EU cost premium 55% vs. China; 27% vs. US	• **Japan/Korea** for compressor technology JVs and HVAC manufacturing • **Thailand/Malaysia** for AC-to-heat pump manufacturing pivot ($4.5bn AC exports) • **US** collaboration on natural refrigerant (propane) technology
Offshore Wind 🔴 🔵 🩵 🟢	REPowerEU targets 425 GW wind capacity by 2030 (~100 GW offshore). Unlike solar and batteries, the EU remains competitive in wind manufacturing, covering ~85% of blades and 100% of nacelles/towers domestically. The EU is a net exporter of nacelles (25% of global trade). However, Chinese OEMs (6-14x overcapacity) increasingly target European markets.	• EU incumbent leader: 19% nacelle capacity, 14% blade capacity globally • Offshore supply chain gap: announced capacity 11 GW nacelles vs. 20 GW/yr need by 2030 • Rare earth magnets: China controls 60% mining, 90%+ refining and magnet production • The EU is evaluating competitive dynamics in the wind turbine market under existing trade and subsidy frameworks	• **Australia, Brazil** for **rare earth mining** • Offtake agreements with **Japan, US** for rare earths processing • **Brazil, India, South Korea,** and **UAE** for cost-competitive manufacturing of nacelles and monopiles • **UK** for joint offshore wind supply chain development

Focus Energy Matrix 3/4

● Economic Growth
● National Security
● Energy Resilience
● Export Opportunities

Sources: BNEF; EU Net-Zero Industry Act; IEA Energy Technology Perspectives 2024; IEA World Energy Outlook 2025; Wood Mackenzie.

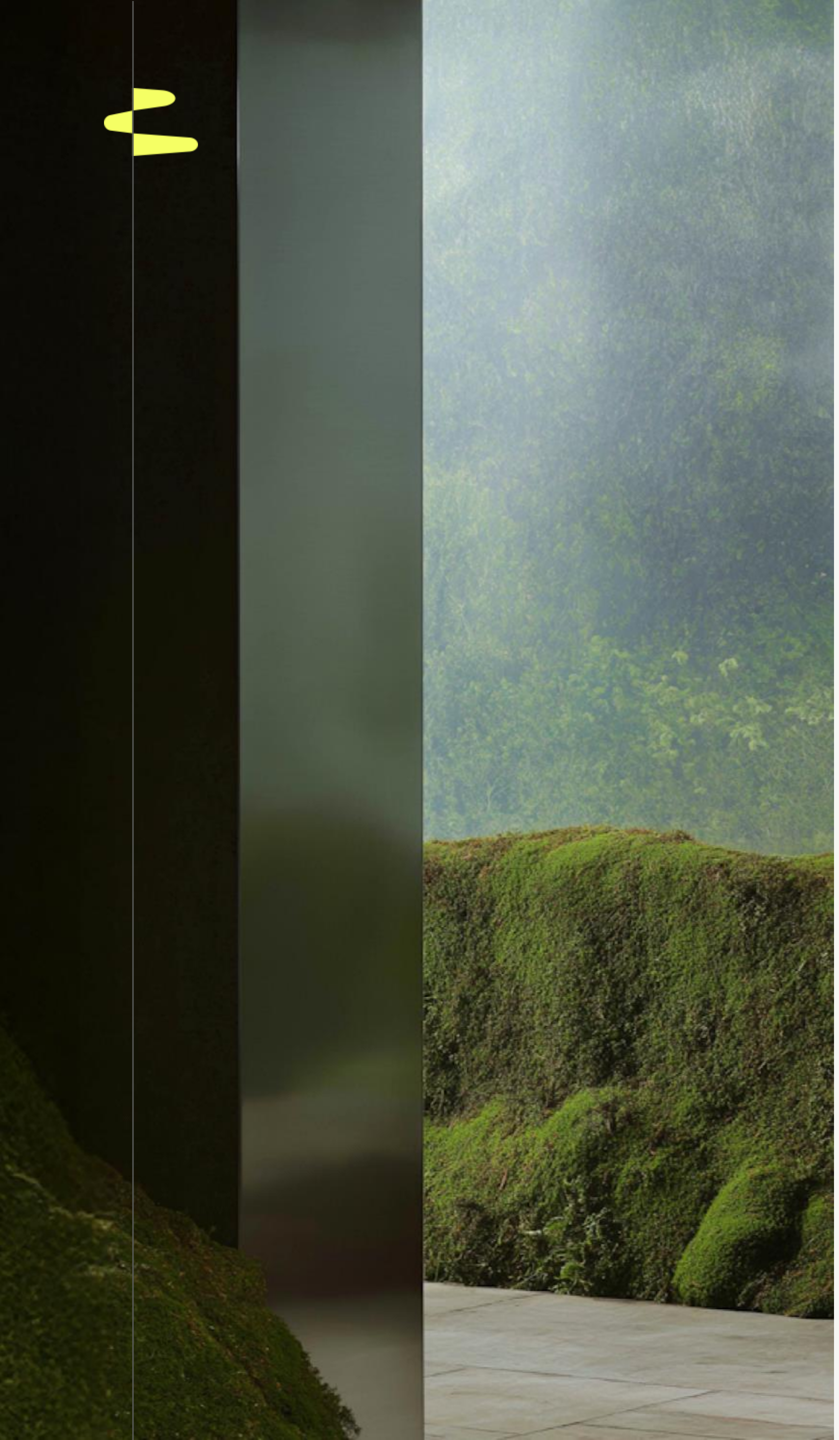
Technology	Context	Summary: Global Supply Chain	Example Partnerships
Geothermal ●●●●	The EU aims to expand geothermal as a source of firm renewable power and zero-carbon heat, with the European Council calling for faster deployment and creation of a European Geothermal Alliance. At-scale EU geothermal potential lies at depths >3 km with efforts needed to bring down drilling costs to be economical.	• Enhanced and closed-loop systems can unlock deeper resources • Strong industrial base with majority of turbines manufactured in Italy • Limited capacity for drilling rigs and specialised equipment • Drilling technology and risk insurance key to scaling	• **Iceland** world leader in geothermal; technology transfer and expertise • **US** collaboration on enhanced geothermal systems drilling technology • **Kenya, Indonesia, Turkey** for technology exchange on high-enthalpy power generation
Green Steel ●●●	Green steel underpins EU priorities for construction, automotive, offshore wind infrastructure, and defence while reducing industrial emissions. The EU steel sector must transition from blast furnace-basic oxygen furnace (BF-BOF) to electric arc furnace (EAF) and hydrogen-based direct reduction (H_2-DRI). CBAM creates demand pull, but industrial strategy considerations and employment impacts shape the political context for iron import decisions.	• Green hydrogen-based steel 20-60% more expensive than conventional in Europe • EU has limited existing EAF capacity compared to integrated BF-BOF facilities • H_2-DRI production in EU: $1,020/t vs. Brazil import $870/t (incl. transport + CBAM) • Possibility of an 'iron gap' in 2028-2032 due to rising carbon prices	• **Brazil** to import green DRI or hot briquetted iron (HBI) at $870/t delivered • **Morocco, Oman, Mauritania** for low-cost renewable hydrogen ($3/kg vs EU €4.1-16.1/kg) • **Australia** for green iron with large DR-grade ore reserves and H_2 ambitions

Focus Energy Matrix 4/4

● Economic Growth
● National Security
● Energy Resilience
● Export Opportunities

Sources: BNEF; EU Net-Zero Industry Act; IEA Energy Technology Perspectives 2024; IEA World Energy Outlook 2025; Wood Mackenzie.

Technology	Context	Summary: Global Supply Chain	Example Partnerships
Nuclear ●●●●	The EU aims to maintain reactor manufacturing and fuel-cycle capabilities, with SMR deployment planned from the 2030s targeting 15 GW by 2050 under the European SMR Industrial Alliance. France leads EU efforts with plans to build six EPR2 reactors and the EDF-backed NUWARD SMR, supported by €1 bn through the France 2030 Investment Plan. Enrichment capacity remains a strategic vulnerability, while EU-aligned suppliers are expanding capacity through 2030.	• HALEU fuel: Russia currently only commercial supplier; US/EU capacity by early 2030s • Enrichment highly concentrated: Rosatom 40%, Urenco 33%, Orano 12% • France expanding enrichment 30% (Georges Besse 2); UK funding Urenco facility • SMR factory-based production could reduce costs 40-50% versus on-site construction	• **UK** for Rolls-Royce SMR deployment and Great British Nuclear partnership • **US** for HALEU supply chain (Centrus) and advanced reactor technology • **Canada** for uranium supply and SMR expertise • **South Korea** for APR1400



Appendix:
Batteries Deep Dive

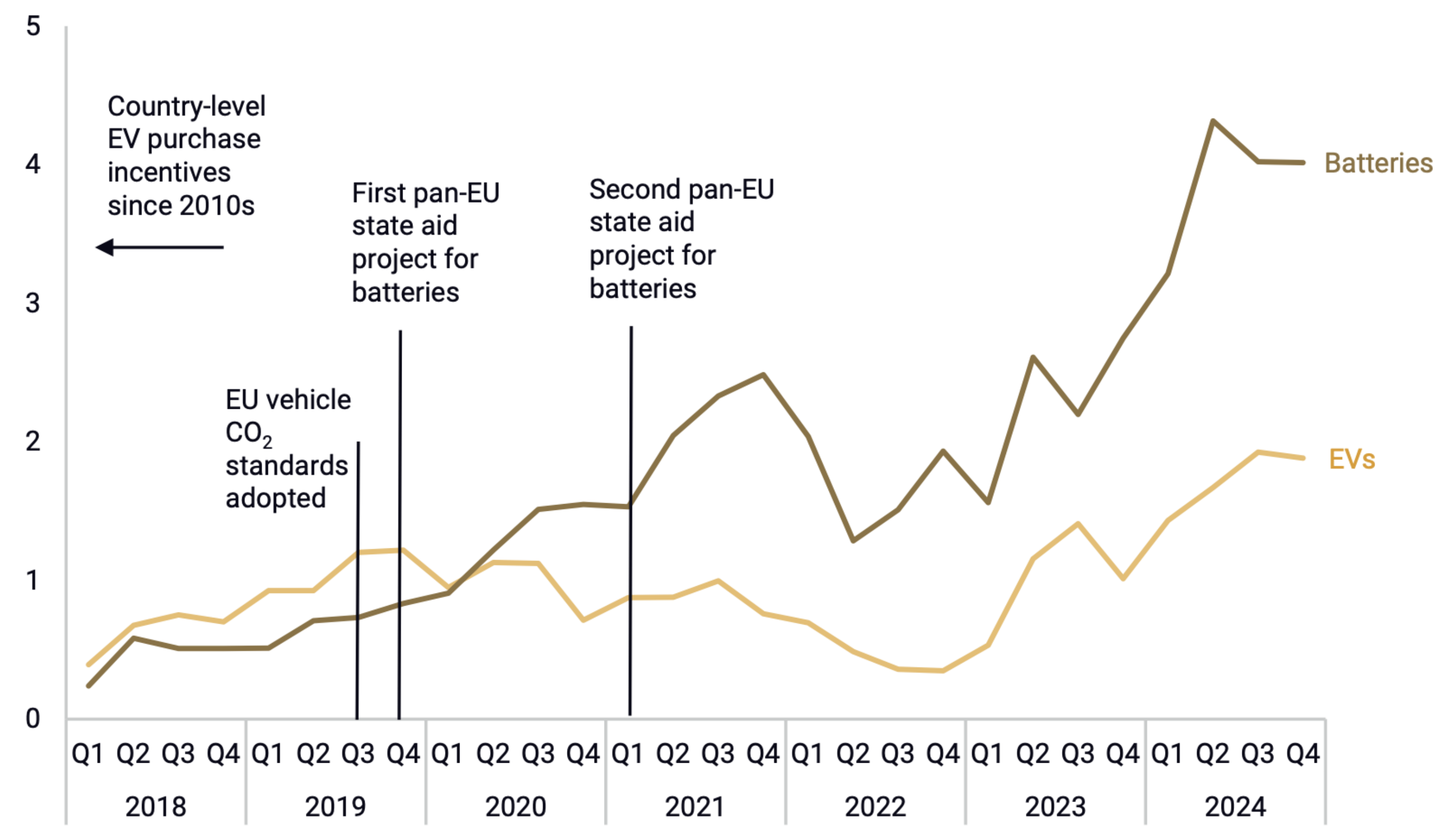
Batteries: Europe and Western economies have challenging pathway to scale to compete against China’s strength in the battery supply chain

Key themes	Summary
Highly concentrated supply chain limits near-term diversification	• China controls entire battery supply chain – 90% cathode, 98% anode, 77% cell capacity with 2030 projections maintaining significant concentration – no alternative suppliers exist at scale
Rapid technology shifts create headwinds	• European economies locked on wrong chemistry – NMC premium cost for inferior stationary performance. China shifted to LFP (30% cheaper, 6,000+ cycles, 75% market by 2030) • EU manufacturers face a strategic choice: transitioning from NMC forfeits €10bn+ investments; while maintaining NMC means accepting a 30-40% cost penalty with lower durability for stationary storage
Limited toolkit for BESS deployment	• EU needs significant scale-up in stationary storage, but merchant-only revenue models provide no offtake guarantees – unlike generation assets with CfDs • BESS gap has resulted in no at-scale manufacturing capacity and reliance on Chinese batteries. China's mandated quotas (20-30% renewable coupling) create domestic demand
Recycling creates opportunity for domestic industrial base	• EU’s limited raw material reserves for battery metals make recycling only scaling opportunity with added push from battery regulation / recycling requirements • Recycling makes circularity a longer-term play without competing on manufacturing economics – China exposure drops from 90% to 50-60% by 2030-35, not eliminated
Strategic JVs likely only viable pathway	• Three broad pathways exist: fully domestic manufacturing, strategic joint ventures that bring technology and capacity to the EU, or scaled imports – each with different implications for cost, industrial value, and supply security • Assembly JVs only viable commercial path to balance cost competitiveness and scale (e.g., EU battery costs 80-100% more expensive vs. China) to preserve domestic value creation

Sources: BNEF; IEA Energy Technology Perspectives 2024; RMI; Kaya Partners; U.S. Department of Energy; Benchmark Mineral Intelligence; CRU Research.

Batteries: EU policy has been a catalyst for increasing manufacturing capacity for EVs and batteries

Standards and subsidies for EV and battery manufacturing
Europe's EV and battery manufacturing investments ($bn, 2023)



Sources: Rhodium Group, Global Clean Investment Monitor; Bruegel European Clean Tech Tracker.

Key considerations

- **EU policy drives investment timing:** Battery investment announcements quadrupled in 2022 following the second pan-EU state aid project; EV announcements spiked after each CO_2 standards milestone
- **Capacity gap persists:** Europe's planned 9m vehicle capacity may still fall short of 8-11m projected 2030 demand; battery module capacity covers only ~50-70% of projected needs
- **Investment gap closing, but cost headwinds remain:** Europe's quarterly EV investment now rivals China's ($1.9bn vs. $2.1bn in Q4 2024), yet Chinese EVs remain ~40% cheaper—limiting Europe's ability to scale domestic production profitably

Batteries: EU's projected battery manufacturing capacity likely to fall short of projected demand to sizeable amount of high-risk projects

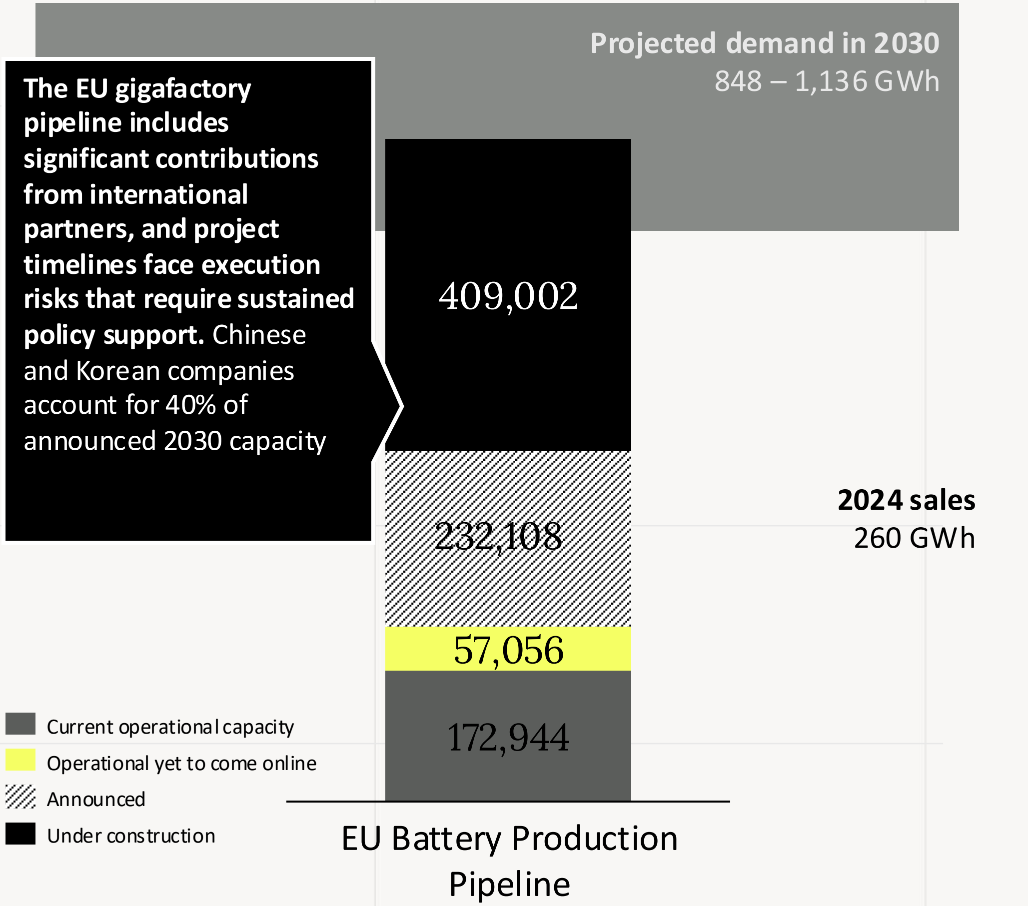
Global supply chain overview

- **Massive Chinese overcapacity:** 3.1 TWh cell manufacturing capacity vs. ~1.2 TWh demand (2.5x oversupply); LFP cells at $49-66/kWh in China vs. $80-100/kWh Western producers
- **LFP shift favours China:** LFP is 30% cheaper than NMC and sufficient for most applications; dominates China (60%+ share) and stationary storage while Western gigafactories built around NMC face demand mismatch
- **Vertically integrated supply chain locks in dominance:** China controls 80% cell production, 85% cathode, 90%+ anode; integrated producers pay less for lithium/nickel than Western competitors

EU industrial competitiveness

- **EU battery cell tariff levels (1.3%) differ significantly from other major markets (US: 58%), creating different competitive dynamics for domestic manufacturers.** 15% of EVs sold in Europe in 2024 were Chinese brands at significant cost advantage
- **No commercial LFP production, NMC-focused strategy limits cost competitiveness:** EU factories target premium NMC chemistries while China dominates LFP cells preferred for mass-market EVs / BESS; CATL's Hungary, Spain plants will be first major LFP source in Europe
- **Recycling advantage, but capacity lags:** EU Battery Regulation mandates lithium recovery and recycled materials could supply 14-25% battery metals demand by 2030; however, existing recycling capacity is 10x below 2030 requirements and most announced projects remain uncertain

EU Battery Cell Pipeline vs. 2030 Projected Demand[1] (GWh)



The EU gigafactory pipeline includes significant contributions from international partners, and project timelines face execution risks that require sustained policy support. Chinese and Korean companies account for 40% of announced 2030 capacity

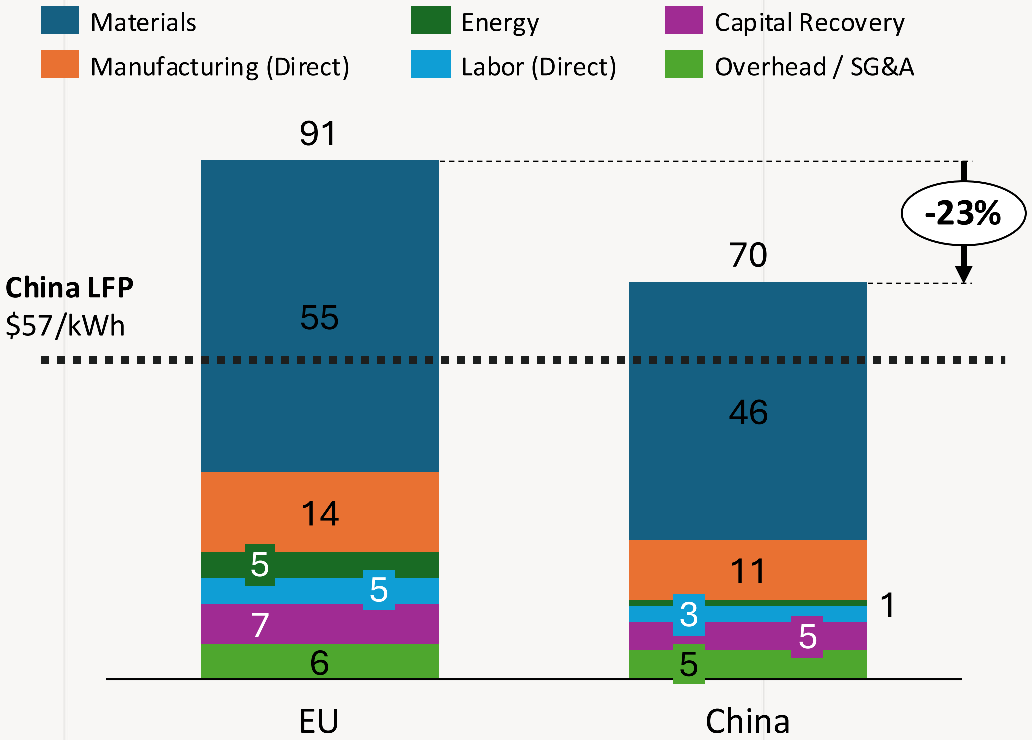
1. Demand figure aggregates EV battery demand GWh projections from Faraday Institution's research and BESS estimates from 2030 Clean Power Action Plan. BESS converts GW to GWh by 2:1 ratio.

Sources: BNEF; IEA; RMI; U.S. Department of Energy; Benchmark Mineral Intelligence; CRU Research; Rhodium Group, Global Clean Investment Monitor.

Batteries: EU production costs are at a 23% premium compared to China for nickel-based battery cells

Cost of production stack for NMC battery cell

NMC811, $/kWh



Modeling Assumptions: Cost comparison reflects NMC811 prismatic cells at tier-1 Chinese producers (100+ GWh scale) vs. emerging EU gigafactories (10-20 GWh). Material costs assume Q3 2024-Q2 2025 commodity prices. Energy costs reflect industrial electricity of $0.06-0.08/kWh (China) versus $0.15-0.25/kWh (EU). China utilisation of 60-70% and scrap rates below 10% compare to EU utilisation of 25-40% and scrap of 30-40%. Policy lever savings assume full implementation by 2028-2030.

Sources: S&P Global Mobility, BloombergNEF, FastMarkets, Argonne National Laboratory BatPaC v5.1.

Key insights

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Production advantage: Chinese Tier-1 producers operate at 100+ GWh scale with 60-70% capacity utilisation and scrap rates below 10%; EU gigafactories operate at 10-20 GWh with 25-40% utilisation and 30-40% scrap rates – a maturity gap that compounds across manufacturing efficiency, capital recovery, and overhead absorption.

Potential EU policy levers

Materials

- Scale domestic supply by ramping cathode / anode production under the Critical Raw Materials Act
- Increase battery recycling to meet EU mandates
- Establish partnerships for upstream supply

Capital

- Lower cost of capital through grants and concessional finance to cover 20-30% of capex
- Mobilise EIB concessional lending with loan guarantees
- Accelerate permitting

Energy

- Reforms industrial electricity pricing by establishing dedicated renewable PPA frameworks
- Enhance industrial electricity support program
- Prioritise grid connections for gigafactories

Batteries: Strategic joint ventures offer the most viable near-term pathway to competitive EU battery manufacturing

Lithium-Ion Battery Supply Chain & Key Risks

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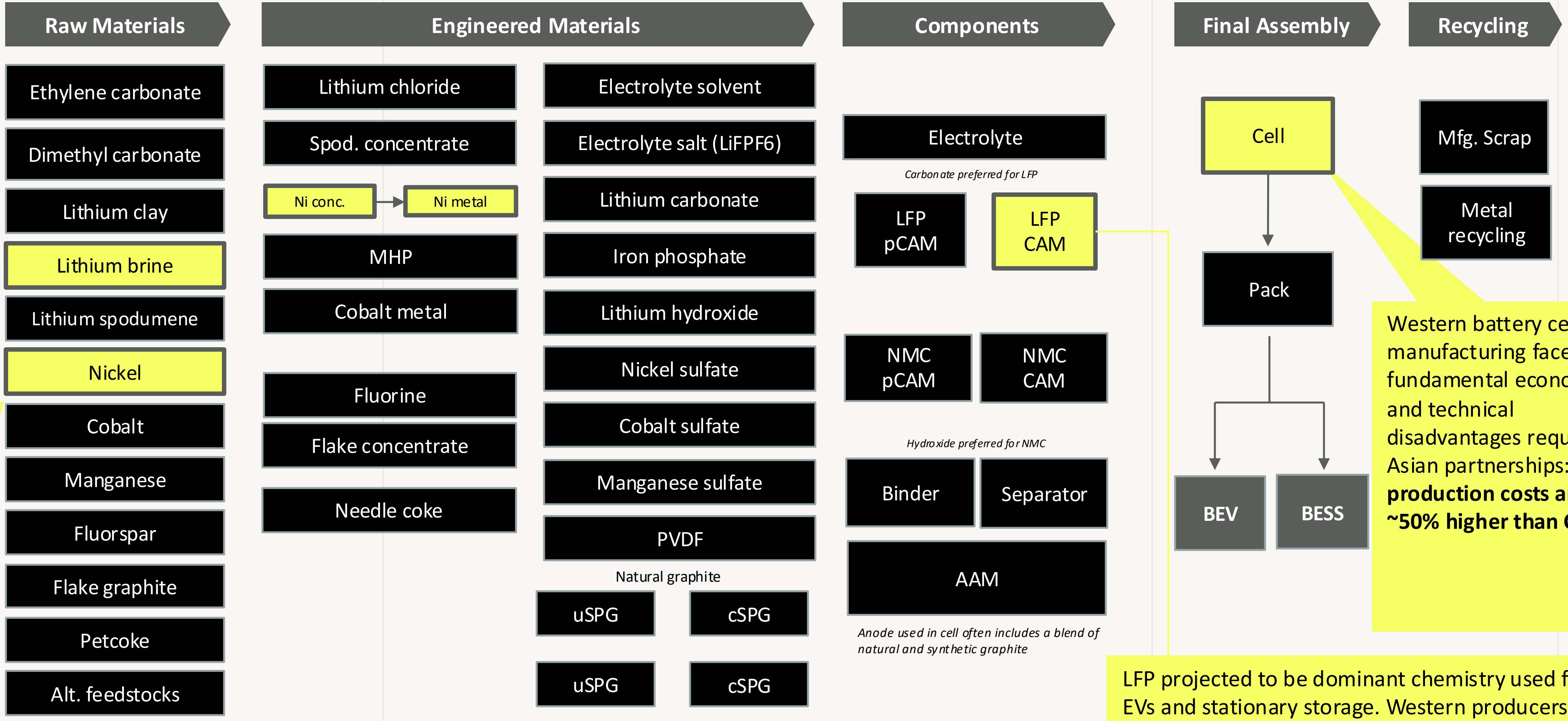
Direct lithium extraction technology from Western producers significantly reduces supply chain risk

China controls 90-95% of nickel mining and processing through domiciled and majority ownership in Indonesian producers



Raw Materials

Ethylene carbonate
Dimethyl carbonate
Lithium clay
Lithium brine
Lithium spodumene
Nickel
Cobalt
Manganese
Fluorspar
Flake graphite
Petcoke
Alt. feedstocks

Engineered Materials

Lithium chloride
Spod. concentrate
Ni conc. → Ni metal
MHP
Cobalt metal
Fluorine
Flake concentrate
Needle coke

Electrolyte solvent
Electrolyte salt (LiFPF6)
Lithium carbonate
Iron phosphate
Lithium hydroxide
Nickel sulfate
Cobalt sulfate
Manganese sulfate
PVDF

Natural graphite
uSPG
cSPG
uSPG
cSPG

Components

Electrolyte

Carbonate preferred for LFP

LFP pCAM
LFP CAM
NMC pCAM
NMC CAM

Hydroxide preferred for NMC

Binder
Separator
AAM

Anode used in cell often includes a blend of natural and synthetic graphite

Final Assembly

Cell
Pack
BEV
BESS

Recycling

Mfg. Scrap
Metal recycling

Western battery cell manufacturing faces fundamental economic and technical disadvantages requiring Asian partnerships: **EU production costs are ~50% higher than China**

LFP projected to be dominant chemistry used for EVs and stationary storage. Western producers lack at-scale LFP technology and production facilities

Sources: U.S. Department of Energy; RMI; BNEF; Benchmark Mineral Intelligence; CRU Research Group.

Batteries: Supply chain matrix

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Supply Chain Segment	Supply Chain Vulnerabilities	EU Competitive Position
Graphite Raw & Engineered Materials	• China controls 98% synthetic graphite, 89% natural graphite processing for battery-grade materials • Zero Western commercial-scale alternatives operational; 2–3-year lead time for new processing facilities • Synthetic graphite energy-intensive (3,000°C); low-cost electricity regions have structural advantage	• Zero domestic production or commercial-scale processing capability • Emerging projects limited: Talga (Sweden) developing European supply but sub-scale • Recycling opportunity: EU Batteries Regulation targets could enable graphite recovery to supply 10-15% of demand by 2035
Lithium Raw & Engineered Materials	• Chile, Australia, China control 85%+ mining; China controls 65% of global refining capacity with significant price volatility from 2021-24 • Battery-grade lithium hydroxide requires complex refining; 3–5-year project development timelines • Western tech scaling (direct lithium extraction) that is more economical than traditional mining	• Minimal domestic reserves (Portugal, Germany small deposits) • Emerging refining: Vulcan Energy (Germany) geothermal extraction; AMG (Germany) lithium hydroxide • CRMA targets 10% extraction, 40% processing by 2030 – currently far off track
Nickel Raw & Engineered Materials	• Indonesia dominates Class 1 battery-grade nickel through Chinese-owned processing facilities • High-purity nickel sulphate for NMC cathodes requires complex processing; China controls 70%+ capacity • ESG concerns: Indonesian HPAL processing uses coal power; EU/UK battery passport may restrict sourcing	• Finland (Terrafame) only major European source; limited scale • Non-China supply available but Indonesian oversupply depresses prices, undermining investment economics • Strategic misalignment: EU focused on NMC chemistry while China shifts to lower-cost LFP
Cathode Active Materials Components	• Complex manufacturing requires lithium, nickel, cobalt, manganese integration; scale economics favour incumbents • China controls 70%+ cathode active material production across all chemistries (NMC, LFP, NCA) • LFP gaining share (60% of China market); Western CAM focused on NMC now facing demand shift	• ~0% EU market share currently; 100% import dependent • BASF (Germany), Umicore (Belgium) have capacity but sub-scale; NZIA targets 40% domestic by 2030 • LFP chemistry gap: EU lacks experience with lower-cost chemistry dominant in China
Cell Manufacturing Final Assembly	• China holds 82-85% global capacity; CATL and BYD control 50%+ market; Chinese LFP cells now <$50/kWh • Cost gap: UK/EU batteries 48-176% more expensive than China; Recent European manufacturer restructurings highlight the challenges of scaling battery cell production against established competitors • UK lacks deployment mechanism for BESS – no offtake certainty	• EU production costs 20-30% higher than China for NMC cells; maturity gap compounds across efficiency, capital recovery, and overhead • EU gigafactories operate at 10-20 GWh with 25-40% utilisation and 30-40% scrap rates; • Current ~170 GWh capacity covers only 50-70% of projected 2030 needs; pathway requires JVs, sustained subsidies, or import dependency

Sources: BNEF; IEA Energy Technology Perspectives 2024; RMI; Kaya Partners; U.S. Department of Energy; Benchmark Mineral Intelligence; CRU Research.