

Global Battery Supply-Chain Market Outlook

The 10th Global Battery Forum, IEVEXPO Jeju

Dr. Ali Izadi

May 4, 2023



BNEF coverage

Strategies for a cleaner, more competitive future

BloombergNEF

Commodities



Gas & LNG



Power



Oil



Carbon & offsets



Coal



Metals



Chemicals



Agriculture

Sector transitions

Clean power



Solar



Wind



Storage



Advanced nuclear



Power systems & networks

Advanced transport



Electric vehicles



New mobility services & tech



Commercial transport



Aviation & shipping



Renewable fuels

Buildings & industry



Low-carbon heating & cooling



Circular economy



Green steel & aluminum



Sustainable plastics & chemicals



Low-carbon cement

Sustainable agriculture



Sustainable proteins & fats



Green agrochemicals



Sustainable intensification



Carbon-smart farming



Biodiversity markets & finance

Cross-cutting technologies



Industrial digitalization



Hydrogen



Bioenergy



Carbon capture, utilization, storage & removal (CCUSR)



Energy efficiency

Sustainability



Corporate carbon & climate action



Regulation & reporting



Sustainable finance & ESG



Financial institution transition



Climate risk

Technology & innovation

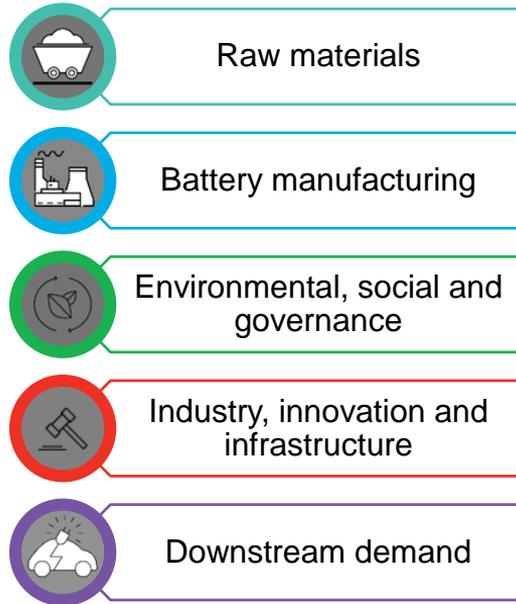
Forecasts & scenarios

Countries & policy

Finance & economics

Consumers

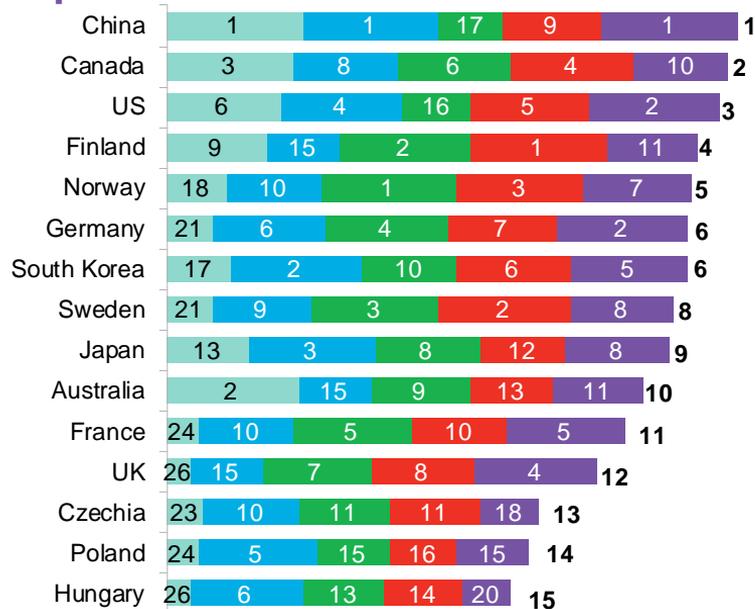
Evaluating countries on their competitiveness in the battery manufacturing supply chain



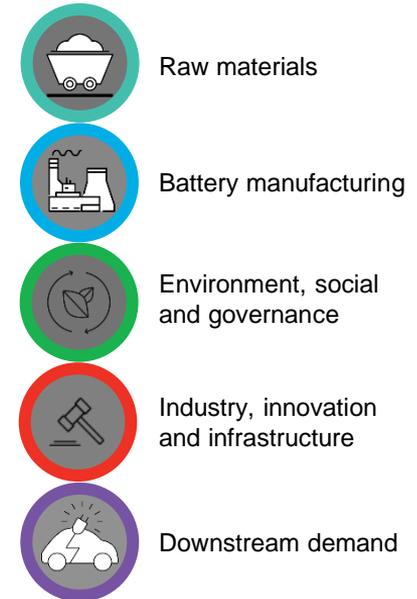
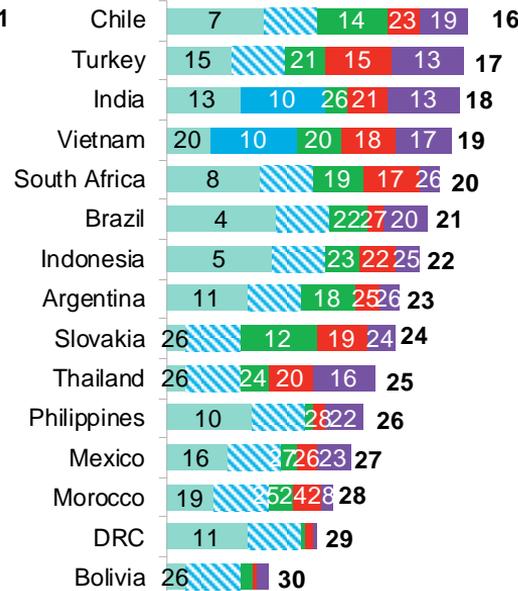
Source: BloombergNEF

Global battery supply chain rankings summary: 2022

Top 15

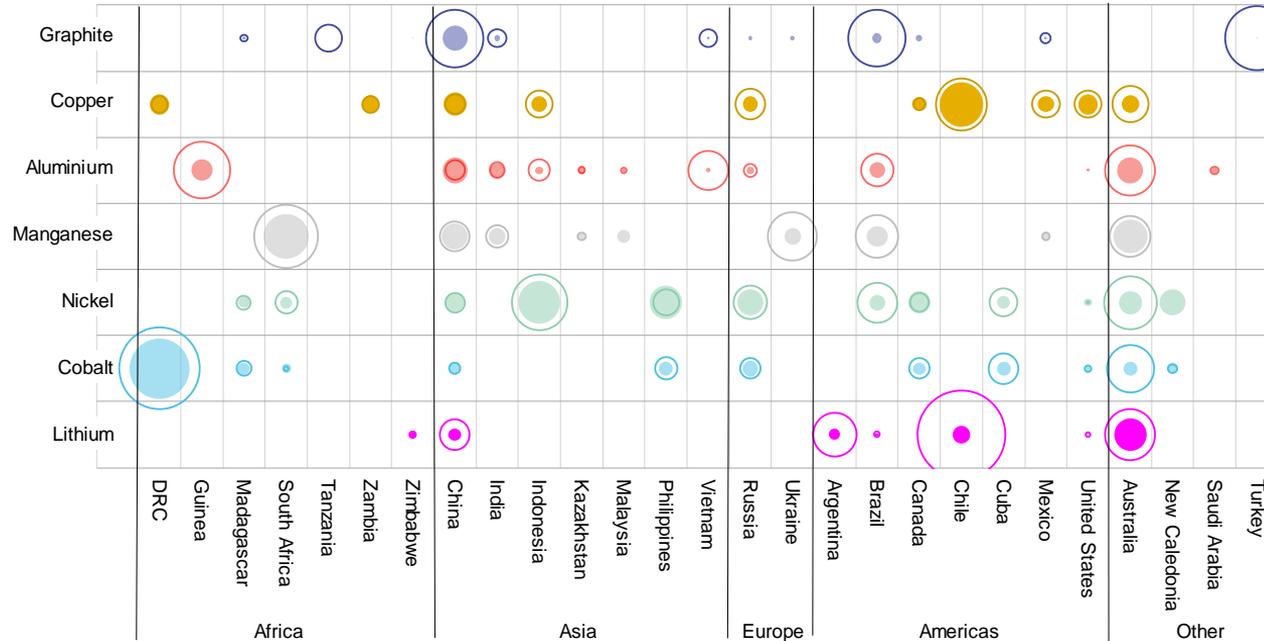


Rank 16 - 30



Source: BloombergNEF. Note: Segment bars represent inverse of rankings, e.g. Rank 1= 30. Shaded areas for manufacturing indicate that the country has no capacity and comes joint last in the rankings with other countries. Final rankings are an average of the scores in the five categories and are indicated by the labels at the end of the bars.

Availability of lithium-ion battery raw materials varies by location

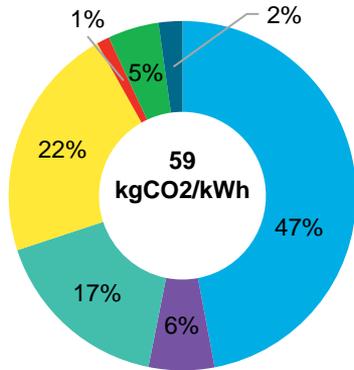


Source: US Geological Survey 2021, BloombergNEF. Note: The solid spheres represent production, the outer circle represents the total reserves. Size of spheres and circles denote proportionality of the resource between countries.

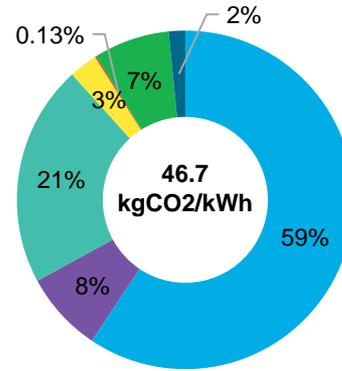
Impact of grid intensity on batteries' carbon footprint



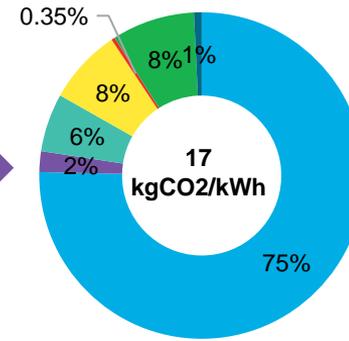
Supply chain and manufacturing in central China



Cell & pack manufacturing in Nordics, upstream supply chain in central China



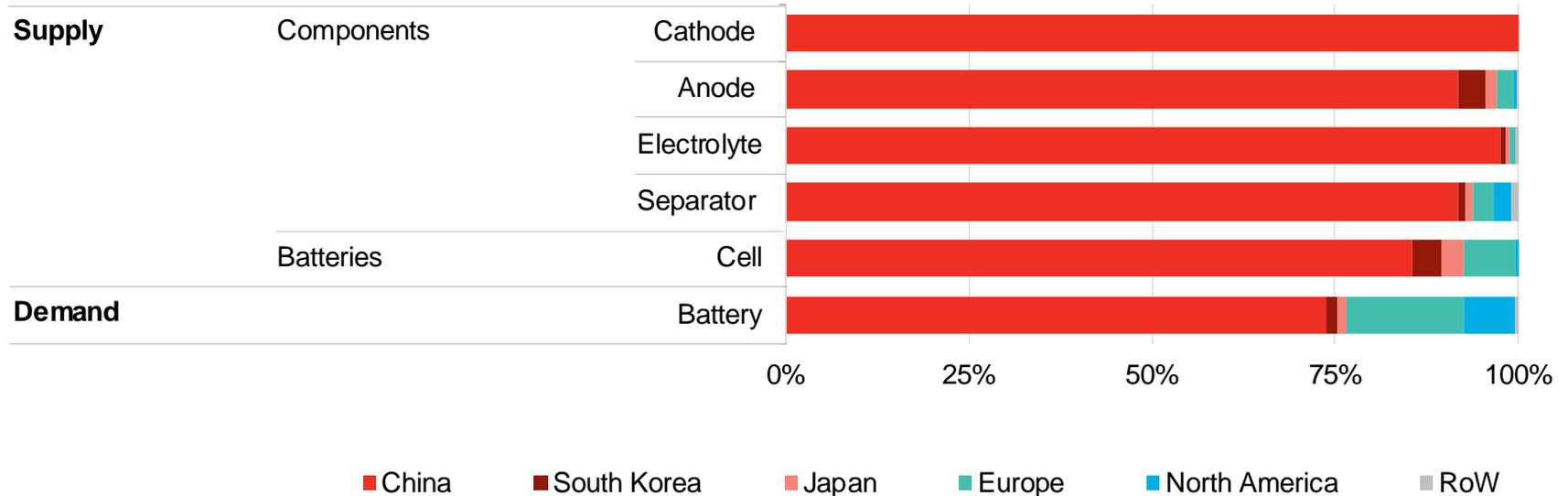
Supply chain and manufacturing in Nordics



- Raw materials
- Precursor
- Active material
- Cell manufacturing
- Pack manufacturing
- Transport
- Ancillary equipment

Source: BloombergNEF.

Global commissioned battery and component manufacturing capacity overlaid by battery demand by location

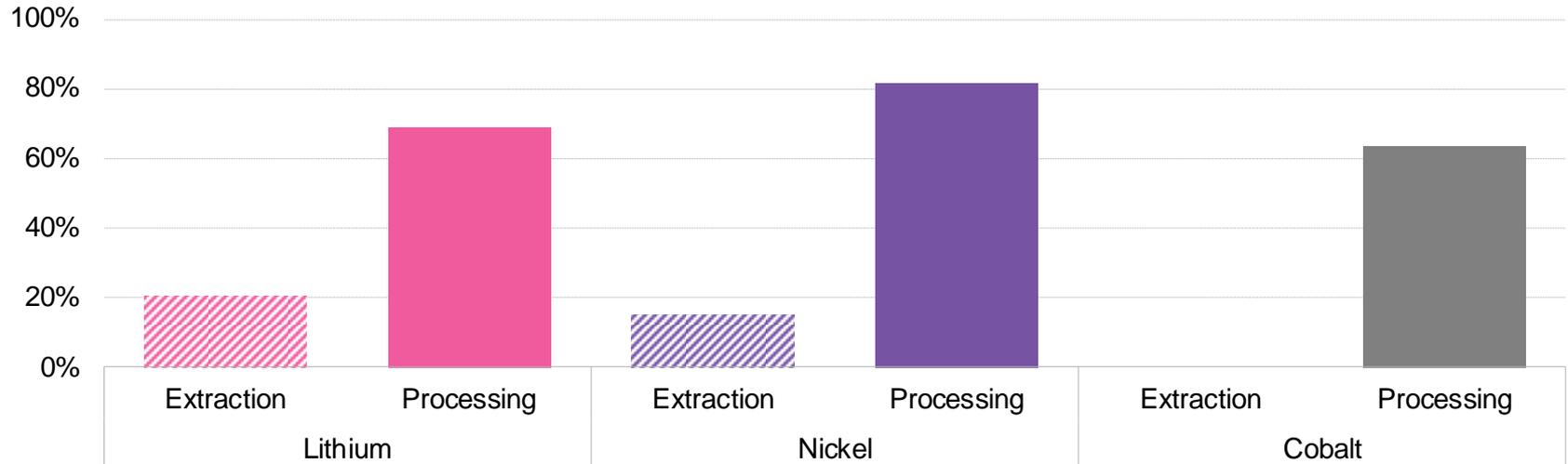


Source: BloombergNEF. Note: Data as of November 2022. RoW refers to rest of world.

China accounts for over half of the processing of lithium, nickel and cobalt

China's share of global extraction and processing of key battery metals, 2022

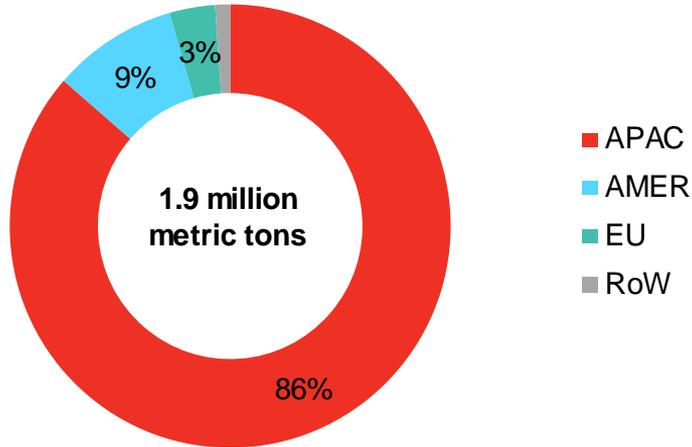
Percentage



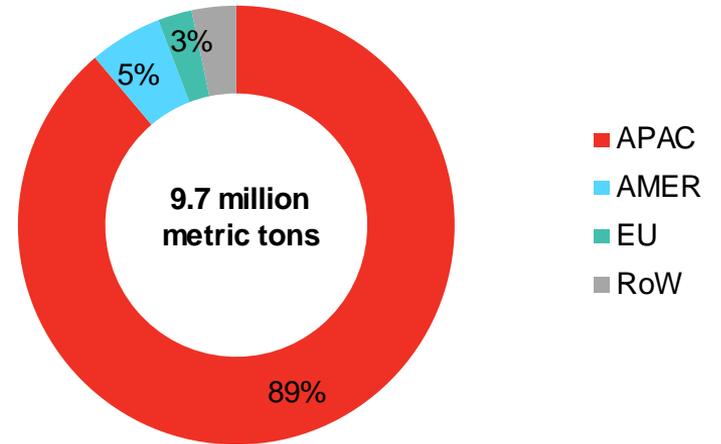
Source: BloombergNEF

Battery recycling capacity is concentrated in APAC

Global battery metal recycling capacity in 2022



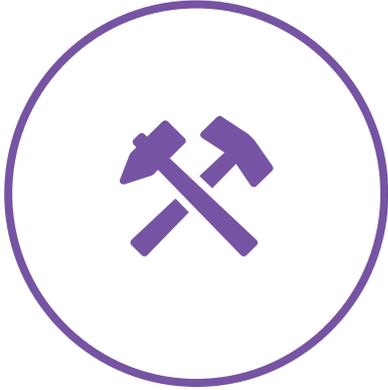
Global battery metal recycling capacity in 2030



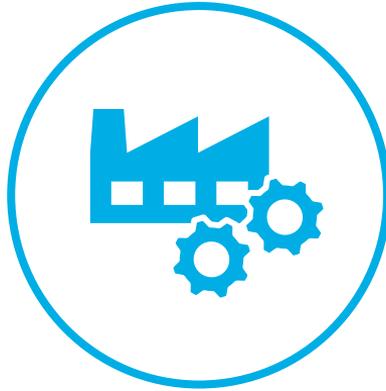
Source: BloombergNEF. Note: APAC is Asia Pacific, AMER is the Americas and RoW is rest of the world.

Inflation Reduction Act

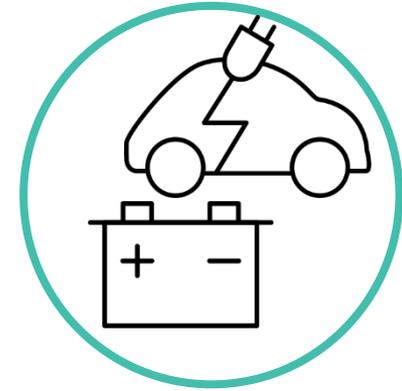
Major items supporting batteries



10% critical material costs
10% electrode active material costs



\$35/kWh cell costs
\$10/kWh module costs



\$7,500 EV credit*
6% ITC for stationary storage**

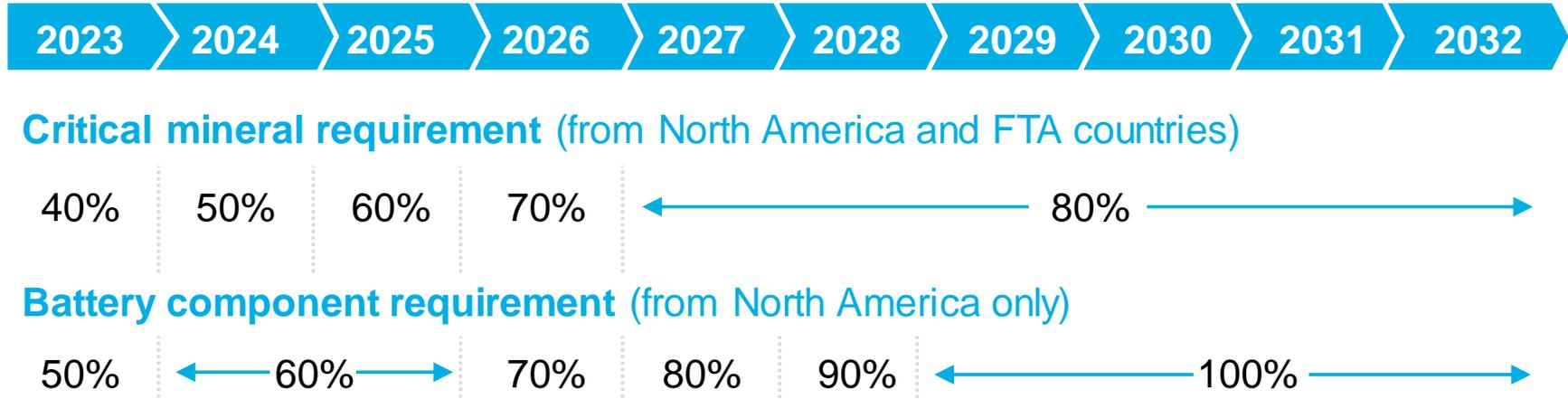
Manufacturing incentives

Demand/deployment incentives

Source: BloombergNEF. Note: *\$7,500 credit is split, each \$3,750 is reliant on materials and cells respectively being sourced/produced in the US or FTA countries.

**ITC for stationary storage can go up to 30% if they follow prevailing wages.

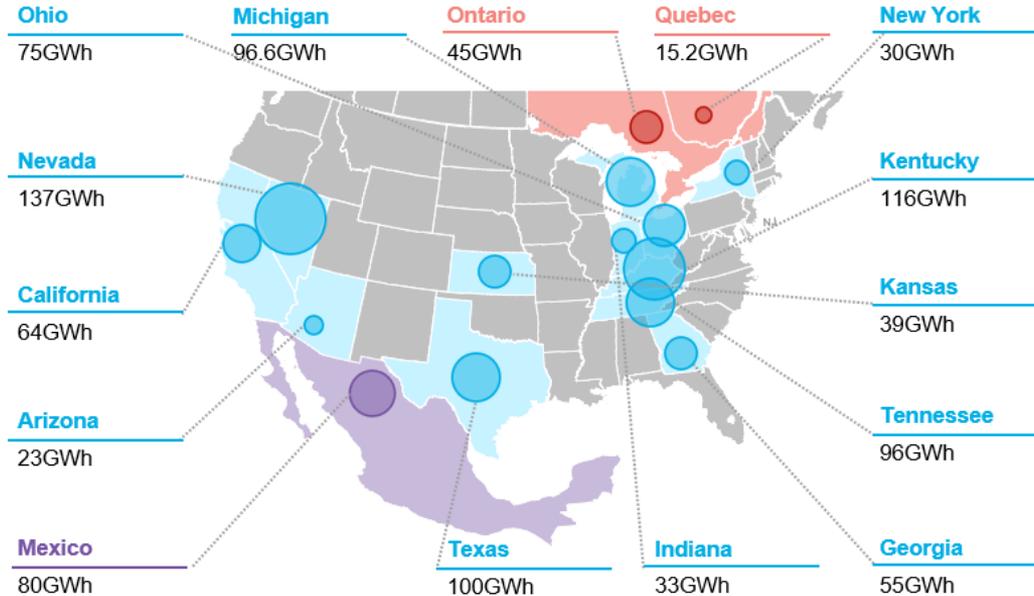
Critical mineral and battery component requirements to access EV tax credits



Source: US Treasury, BloombergNEF

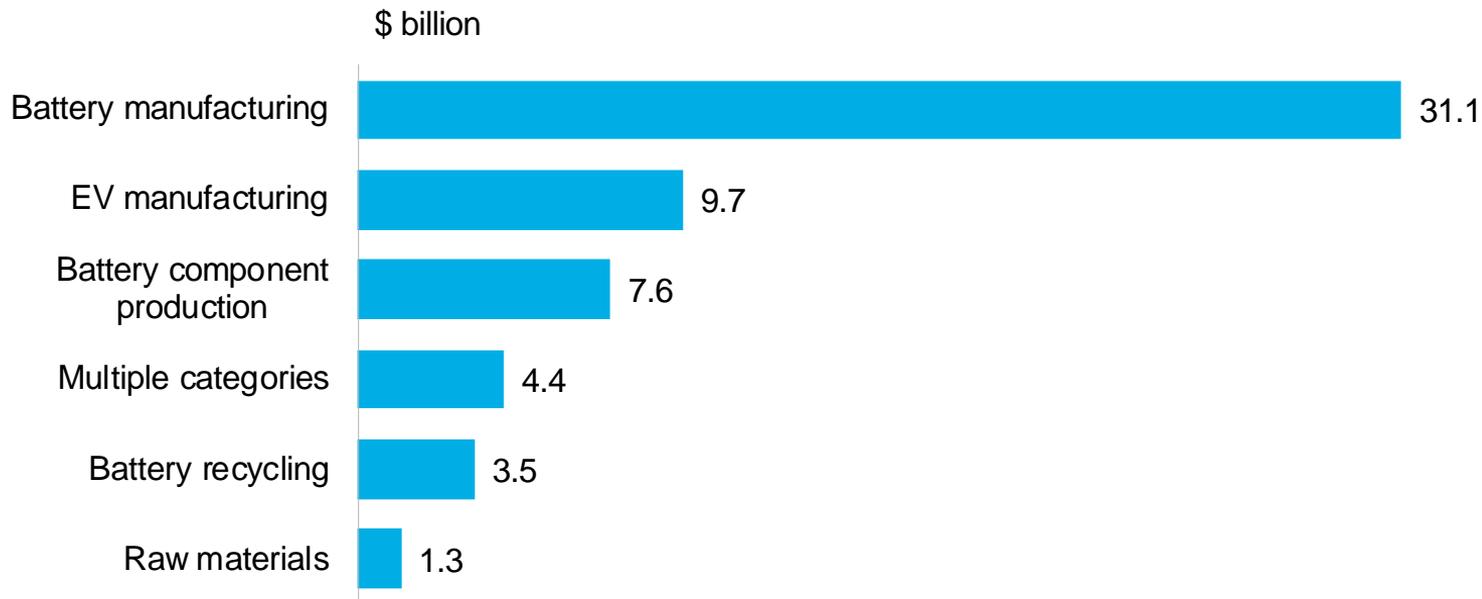
North American battery-making has already attracted \$57.6bn of new investment post-IRA

North America's cell manufacturing activity



Source: BloombergNEF. Note: Dates for fully commissioned plants correspond to the data when the last phase was commissioned. Bubble size corresponds total capacity commissioned, under construction and announced. Data as of January 2023.

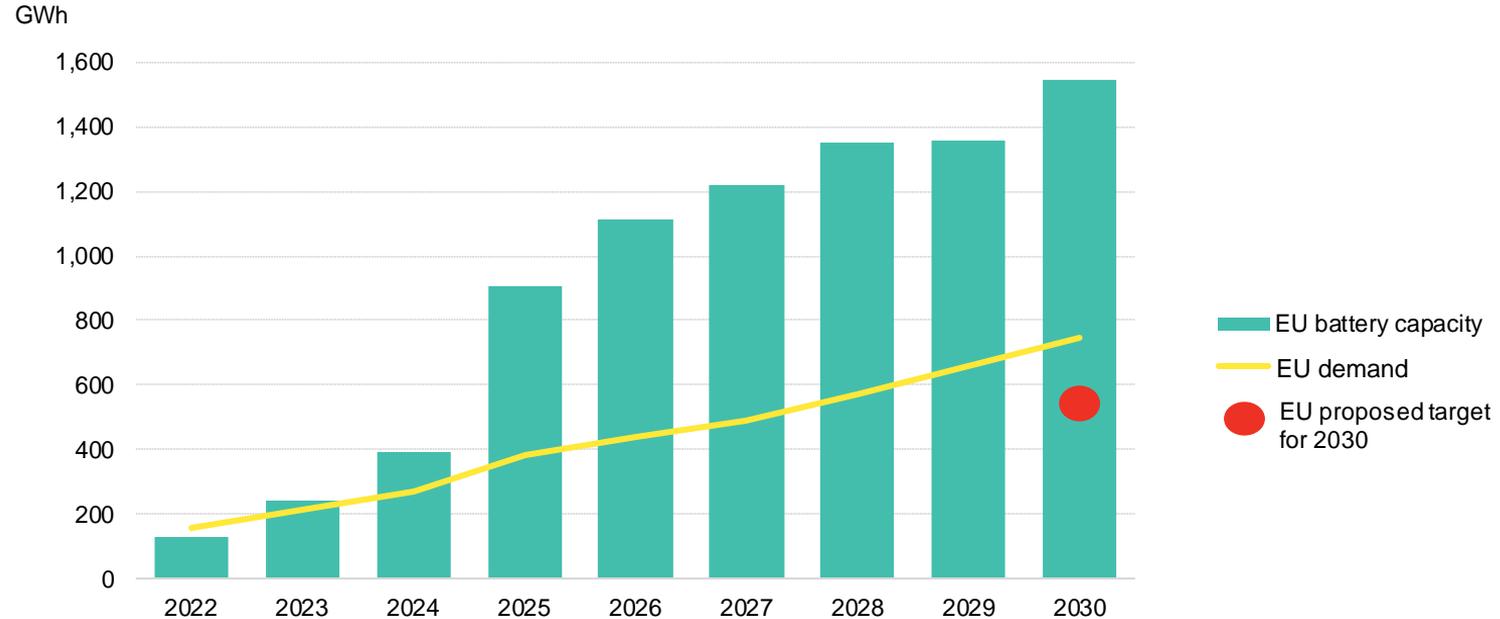
North America EV, battery investments planned post-IRA



Source: BloombergNEF, company press releases. Note: Includes investments in the North America region through April 3, 2023. 'Multiple categories' investments do not disclose how much is dedicated to each category.

EU targets for local battery manufacturing look achievable...

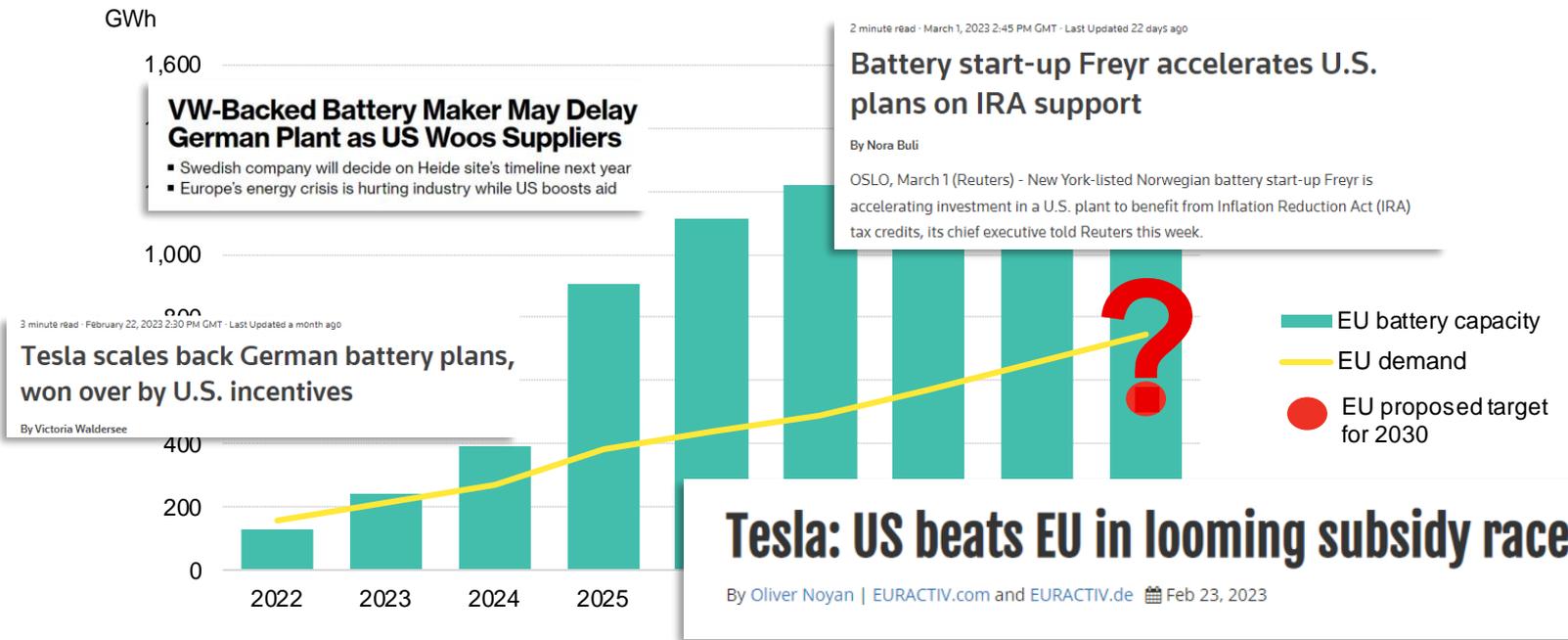
Announced battery cell manufacturing capacity in EU



Source: BloombergNEF.

...but fears of investments shifting to the US are growing

Announced battery cell manufacturing capacity in EU



Source: BloombergNEF, Euractiv, Reuters, Bloomberg News.

EU clean tech manufacturing targets under Net-Zero Industry Act

Technology

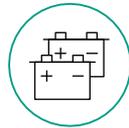
Wind



2030 target

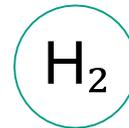
36GW/year

Batteries



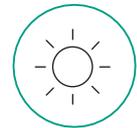
550GWh/year

Hydrogen electrolyzers



40% of demand

Solar



30GW/year

Implied growth
over 2022-30

X1.7

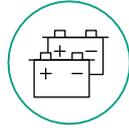
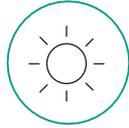
x3.8

x17.3

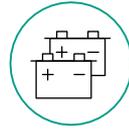
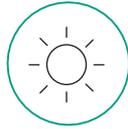
x20.0

Source: BloombergNEF.

Resilience built into auction design



Resilience built into auction design...or is it?



Waived if equipment **10%** of more expensive

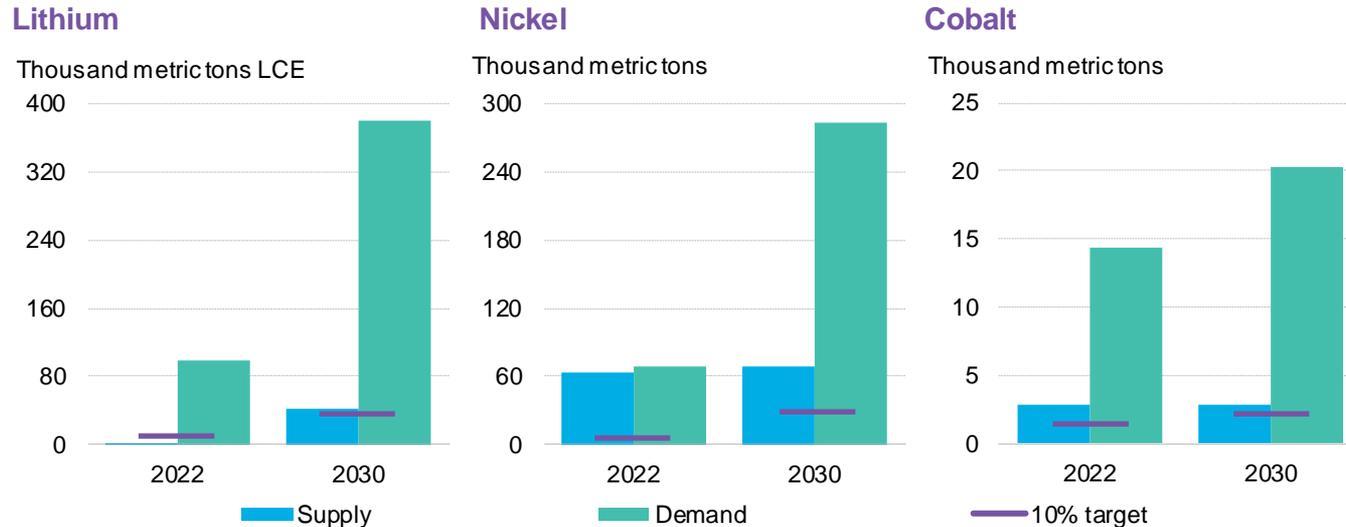
Wide coverage of critical minerals

1 H Hydrogen																	2 He Helium
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulphur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Caesium	56 Ba Barium	57-71 See Below	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89-103 See Below	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Uut Ununtrium	114 Fl Flerovium	115 Uup Ununpentium	116 Lv Livermorium	117 Uus Ununseptium	118 Uuo Ununoctium
			57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium	62 Sm Samarium	63 Eu Europium	64 Gd Gadolinium	65 Tb Terbium	66 Dy Dysprosium	67 Ho Holmium	68 Er Erbium	69 Tm Thulium	70 Yb Ytterbium	71 Lu Lutetium
			89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Source: BloombergNEF, Creately, European Commission. Note: Elements that are considered 'critical' because they are 'strategic' are bordered with bold lines. Carbon represents both coking coal and natural graphite.

Extraction targets do not encourage investment

Battery metal mined supply and demand versus domestic supply targets in the Critical Raw Materials Act



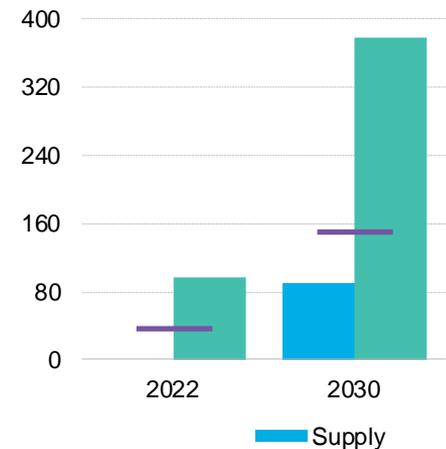
Source: BloombergNEF, European Commission. Note: LCE is lithium carbonate equivalent. .

Processing targets reveal a value-add priority for the EU

Battery metal processed supply and demand versus domestic supply targets in the Critical Raw Materials Act

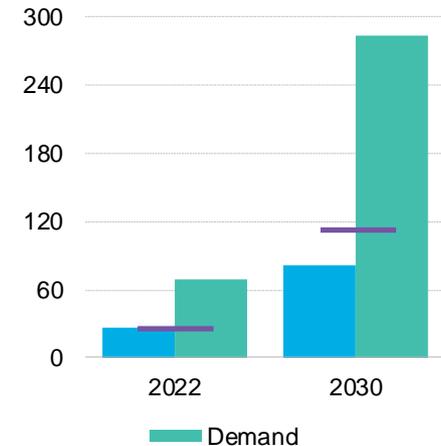
Lithium

Thousand metric tons LCE



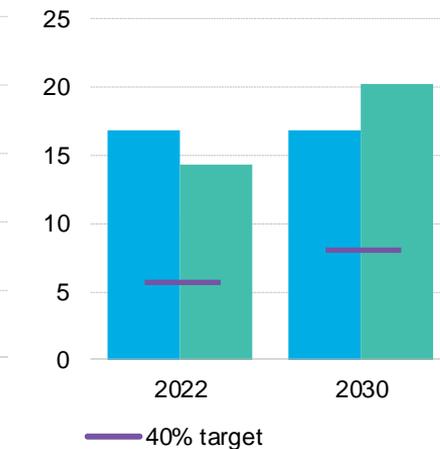
Nickel

Thousand metric tons



Cobalt

Thousand metric tons



Source: BloombergNEF, European Commission. Note: LCE is lithium carbonate equivalent. .

Critical materials strategies compared

Benchmarking the EU Critical Raw Materials Act, the US Inflation Reduction Act and the Canadian Critical Minerals Strategy

Theme	EU Critical Raw Materials Act	US Inflation Reduction Act	Canadian Critical Minerals Strategy
Strengthening domestic supply capabilities	Red	Green	Green
Diversifying supply chains	Yellow	Yellow	Yellow
Accelerating project implementation	Red	Green	Green
Championing sustainable practices	Green	Red	Green
Improving risk monitoring and mitigation	Green	Red	Red

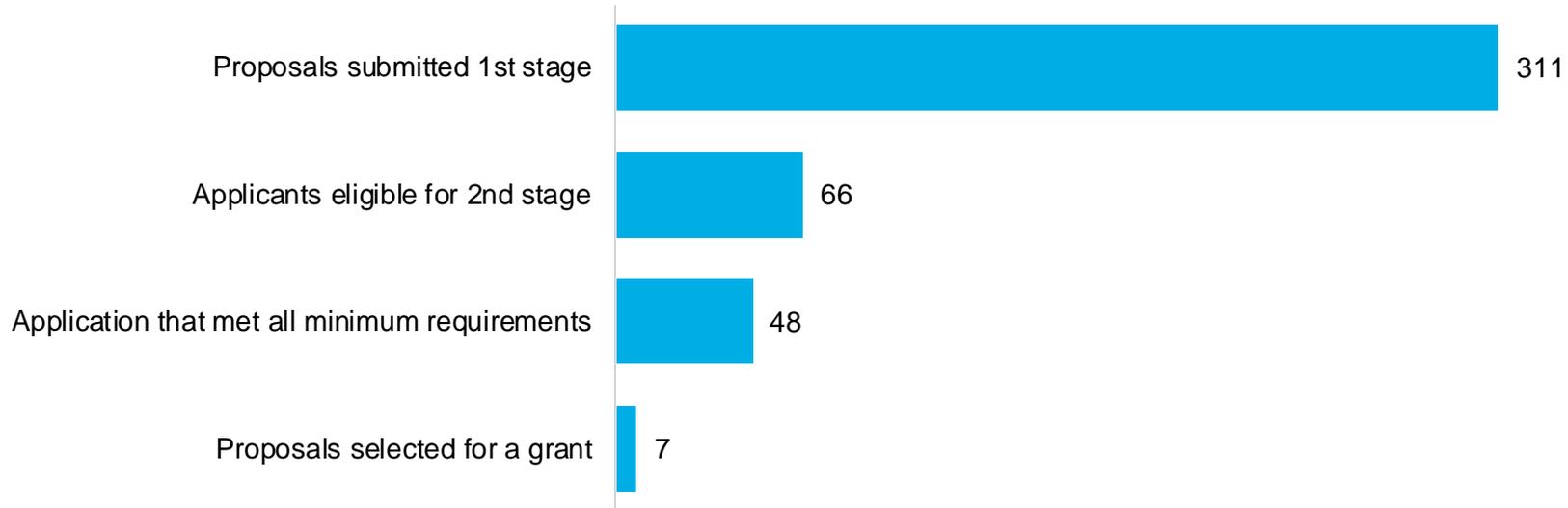
Source: BloombergNEF, European Commission, the White House, the US Treasury, Government of Canada. Note: The critical mineral requirement-related measures considered as part of the US Inflation Reduction Act are based on draft guidance published by the US Treasury. The EU Critical Raw Materials Act is the benchmark for comparison.

**No new funding has been introduced
to support targets in the EU...**

€0

...and accessing existing pots is highly competitive

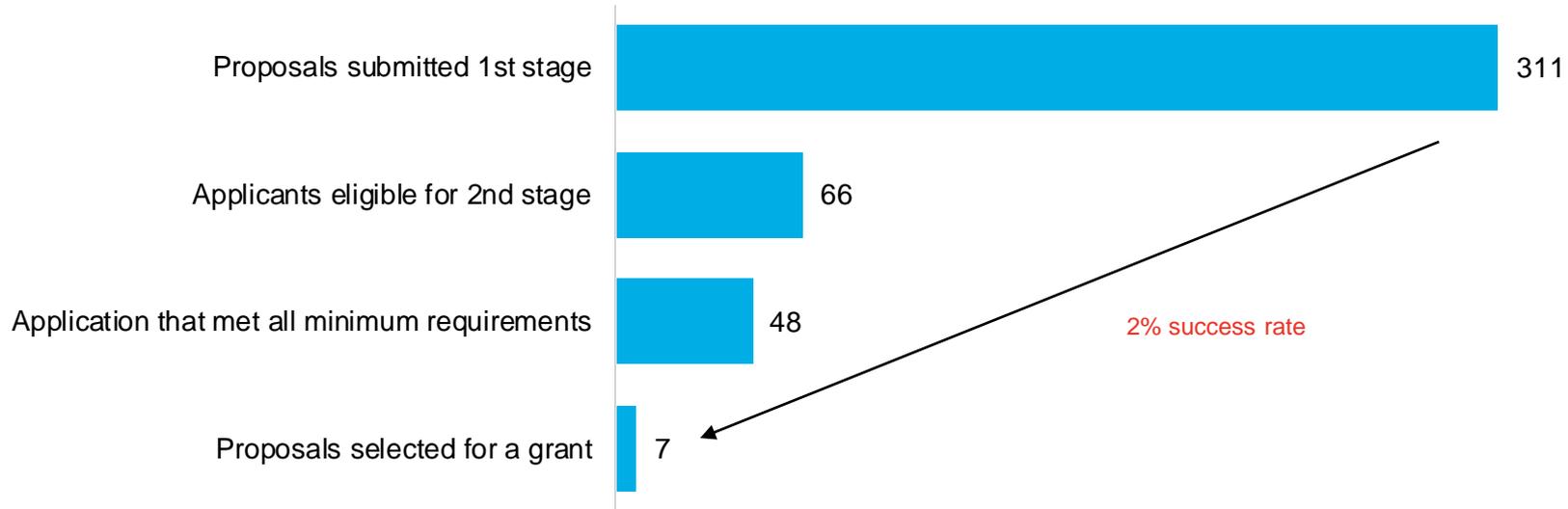
EU Innovation Fund first call for large-scale projects, launched July 2020



Source: ERCST, CEEP, European Commission, BloombergNEF. Note: Process carried out through June 2021. Successful project types included green and blue hydrogen, recycling, clean power, and carbon capture and storage.

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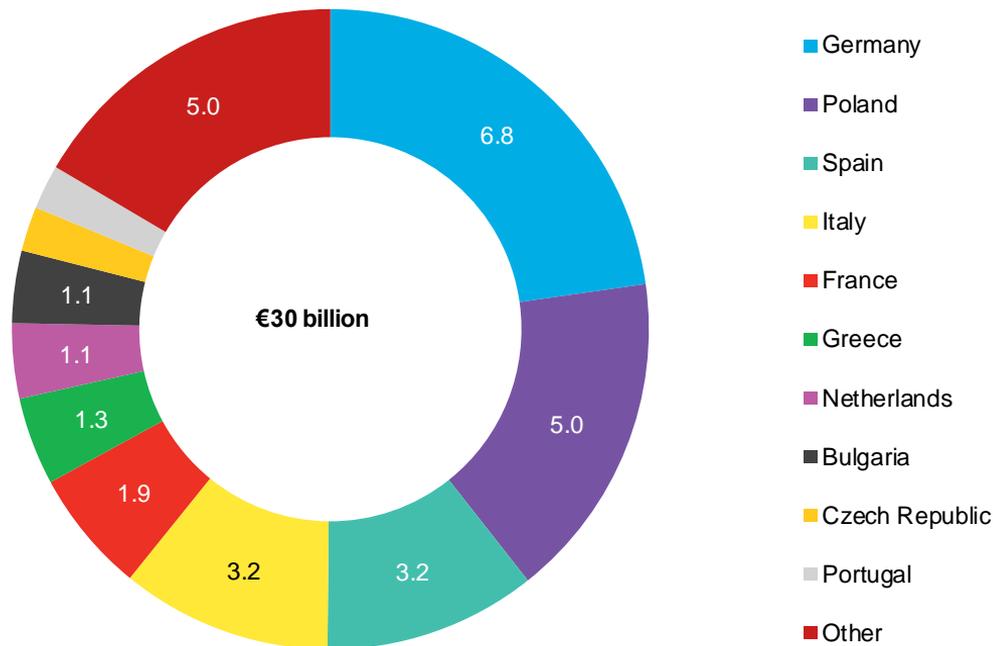


Source: ERCST, CEEP, European Commission, BloombergNEF. Note: Process carried out through June 2021. Successful project types included green and blue hydrogen, recycling, clean power, and carbon capture and storage.

Relaxed state-aid rules and redirection of ETS revenues are the only glimpse of new funding

2022 EU Emissions Trading System revenues by member states

Total revenue (€ billion)

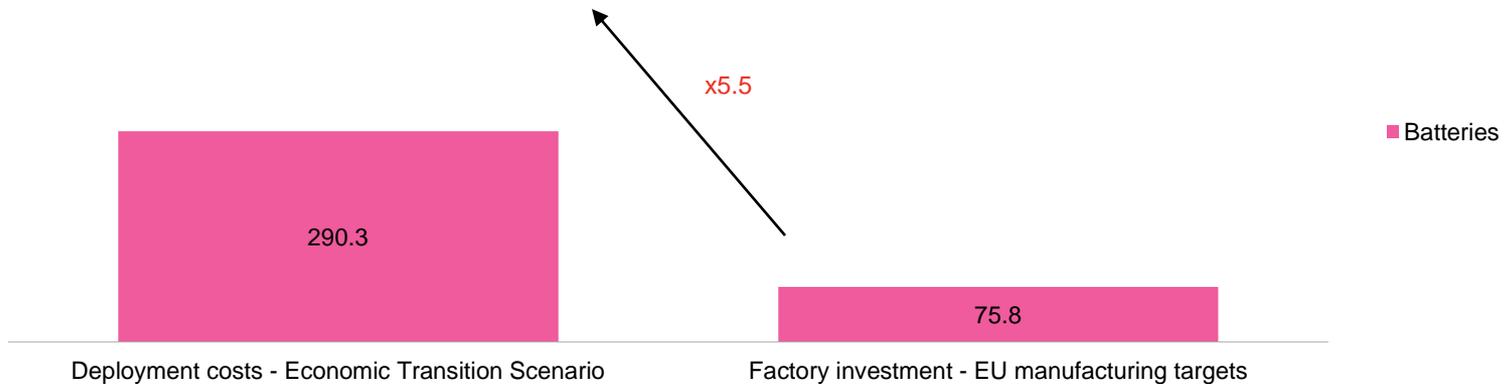


Source: BloombergNEF.

...but the factory bill is dwarfed by overall transition costs

EU energy transition costs compared across deployment and manufacturing, batteries over 2023-30

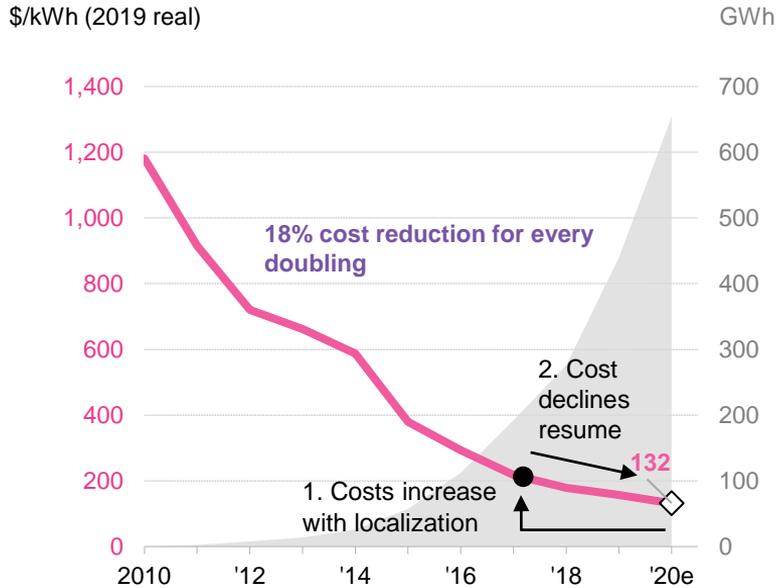
\$ billions



Source: BloombergNEF. Note: Factories for upstream components such as polysilicon and cathodes included in capex total.

The real story is the impact on deployment costs

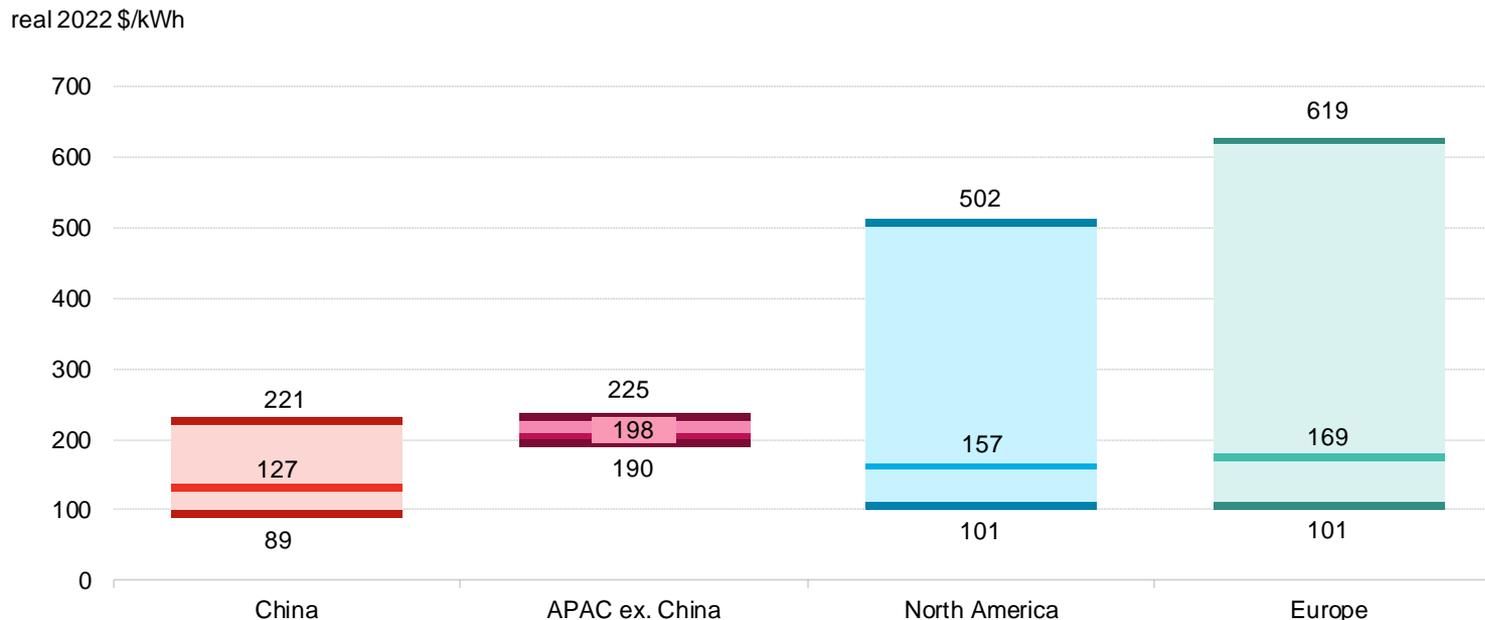
Lithium-ion battery pack price and demand



Source: BloombergNEF.

China average battery pack prices 33% lower than in Europe

Volume-weighted average pack price and range by region delivered



Source: BloombergNEF.

EU's ~85% battery onshoring target adds yearly \$11.9bn to deployment

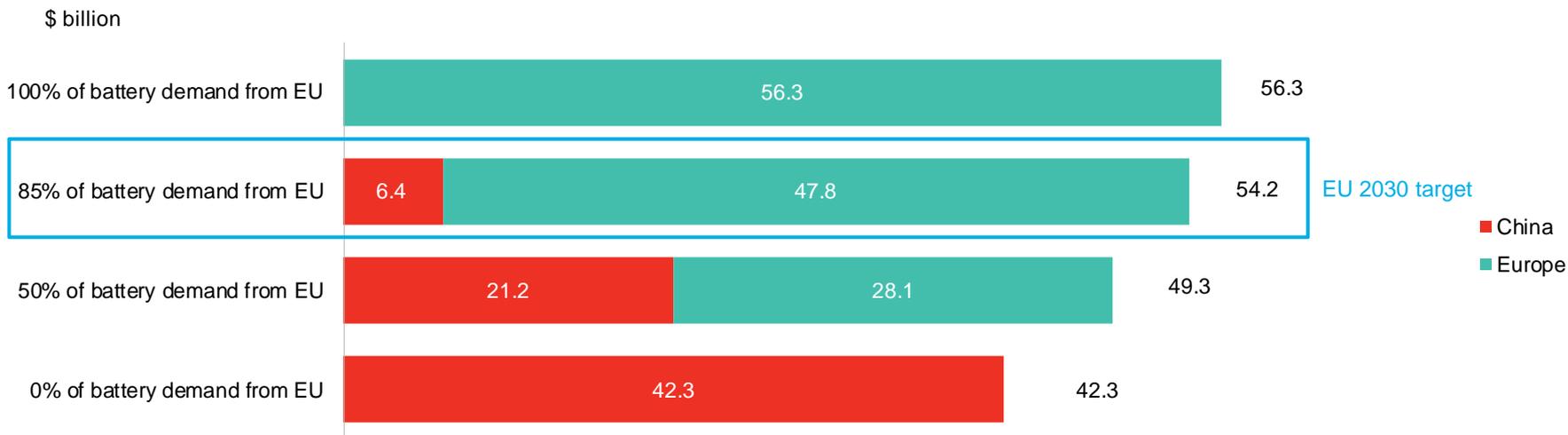
Yearly cost of meeting the EU's battery manufacturing target under different scenarios in 2030



Source: BloombergNEF. Note: Total cost of all batteries bought for EVs and storage. Uses European Commission demand forecast of 647GWh, which is lower than BNEF's 744GWh. Includes transport costs.

EU's ~85% battery onshoring target adds yearly \$11.9bn to deployment

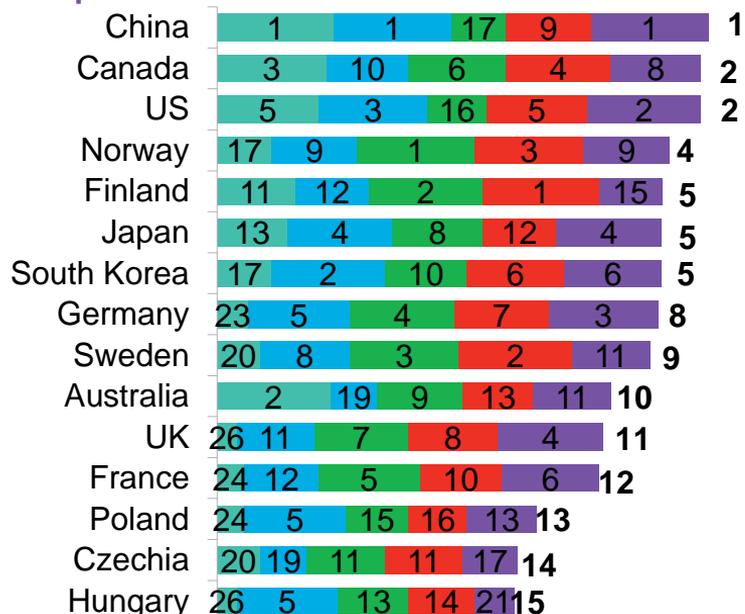
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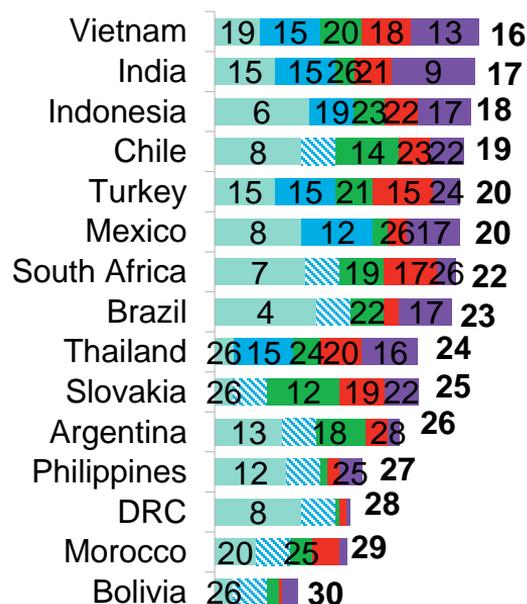
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Global battery supply chain rankings, 2027

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Rank 16 to 30



Source: BloombergNEF. Note: Segment bars represent inverse of rankings, e.g. Rank 1= 30. Shaded areas for manufacturing indicate that the country has no capacity and comes joint last in the rankings with other countries. Final rankings are an average of the scores in the five categories and are indicated by the labels at the end of the bars.

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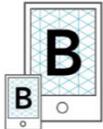
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