The Automotive Battery Supply Chain

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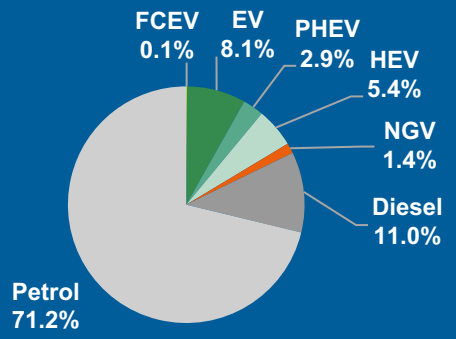
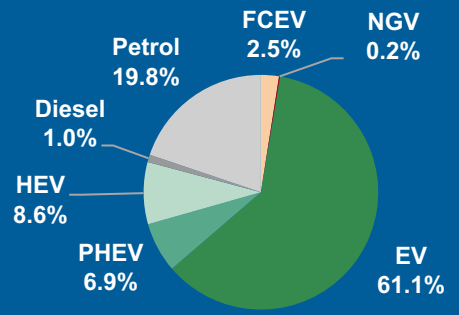
The Context: EV Demand Forecast

Global EV production will grow by ~20% a year from 6.2m units in 2022 to 28m units in 2030 and reach 63.5m units in 2035, a 61.1 % share.

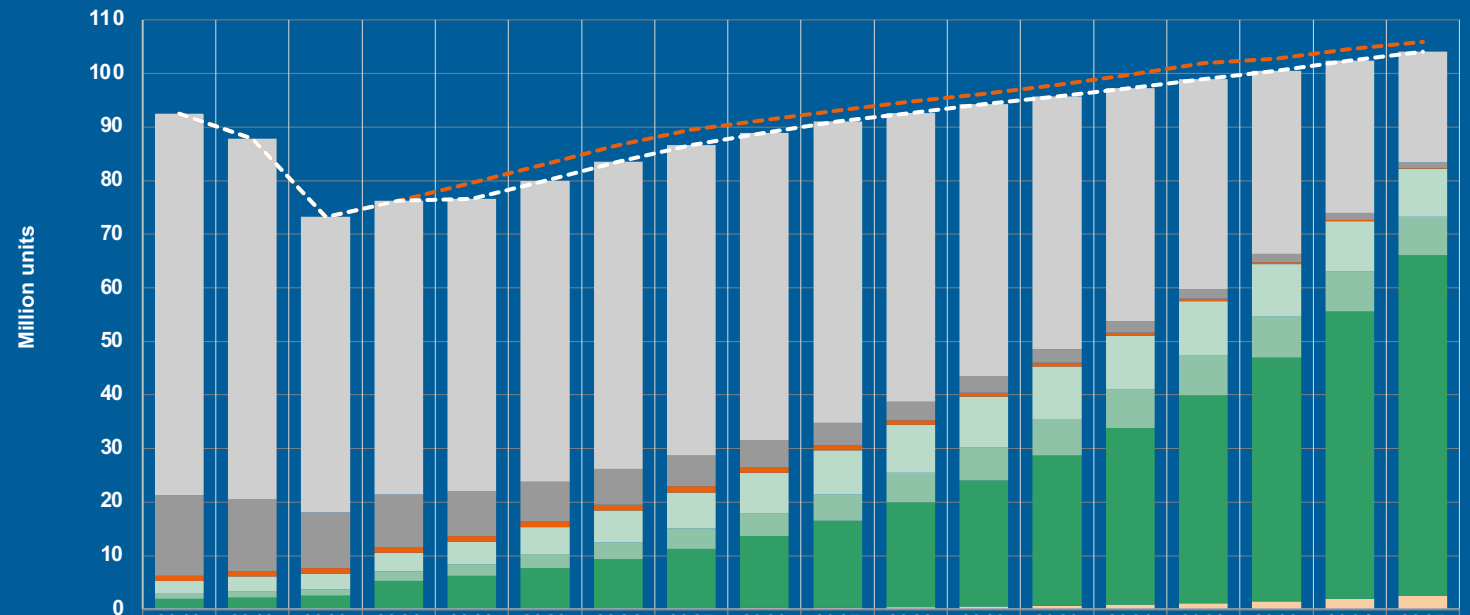
Global Powertrain Mix 2022 %



Global Powertrain Mix 2035 %



Global Light Vehicle Production Forecast by Powertrain 2018-2035



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	71.1	67.2	55.2	54.8	54.5	56.0	57.4	57.8	57.4	56.2	53.8	50.8	47.2	43.5	39.3	34.2	28.4	20.6
Diesel	15.1	13.6	10.4	9.8	8.4	7.4	6.6	5.8	5.0	4.2	3.6	3.0	2.5	2.1	1.8	1.5	1.3	1.1
NGV	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.3	0.2
HEV	2.4	2.8	2.9	3.4	4.1	5.0	6.0	6.7	7.5	8.2	8.9	9.5	9.9	10.1	10.1	9.9	9.3	8.9
PHEV	0.9	1.1	1.2	1.8	2.2	2.6	3.1	3.8	4.3	5.0	5.6	6.1	6.8	7.2	7.5	7.6	7.5	7.2
EV	2.0	2.2	2.5	5.2	6.2	7.5	9.2	11.1	13.4	16.2	19.5	23.6	28.0	33.0	38.7	45.5	53.7	63.5
FCEV	0.03	0.04	0.04	0.06	0.08	0.10	0.14	0.18	0.23	0.30	0.40	0.52	0.69	0.89	1.16	1.51	1.97	2.57
Pre-war	92.5	87.8	73.2	76.2	79.6	83.1	86.6	89.5	91.3	93.1	94.7	96.2	97.9	99.8	101.9	102.8	104.6	105.9
Global	92.4	87.8	73.2	76.2	76.6	79.9	83.6	86.6	88.9	91.0	92.6	94.3	95.8	97.3	99.0	100.5	102.4	104.1

Source: Automotive from Ultima Media

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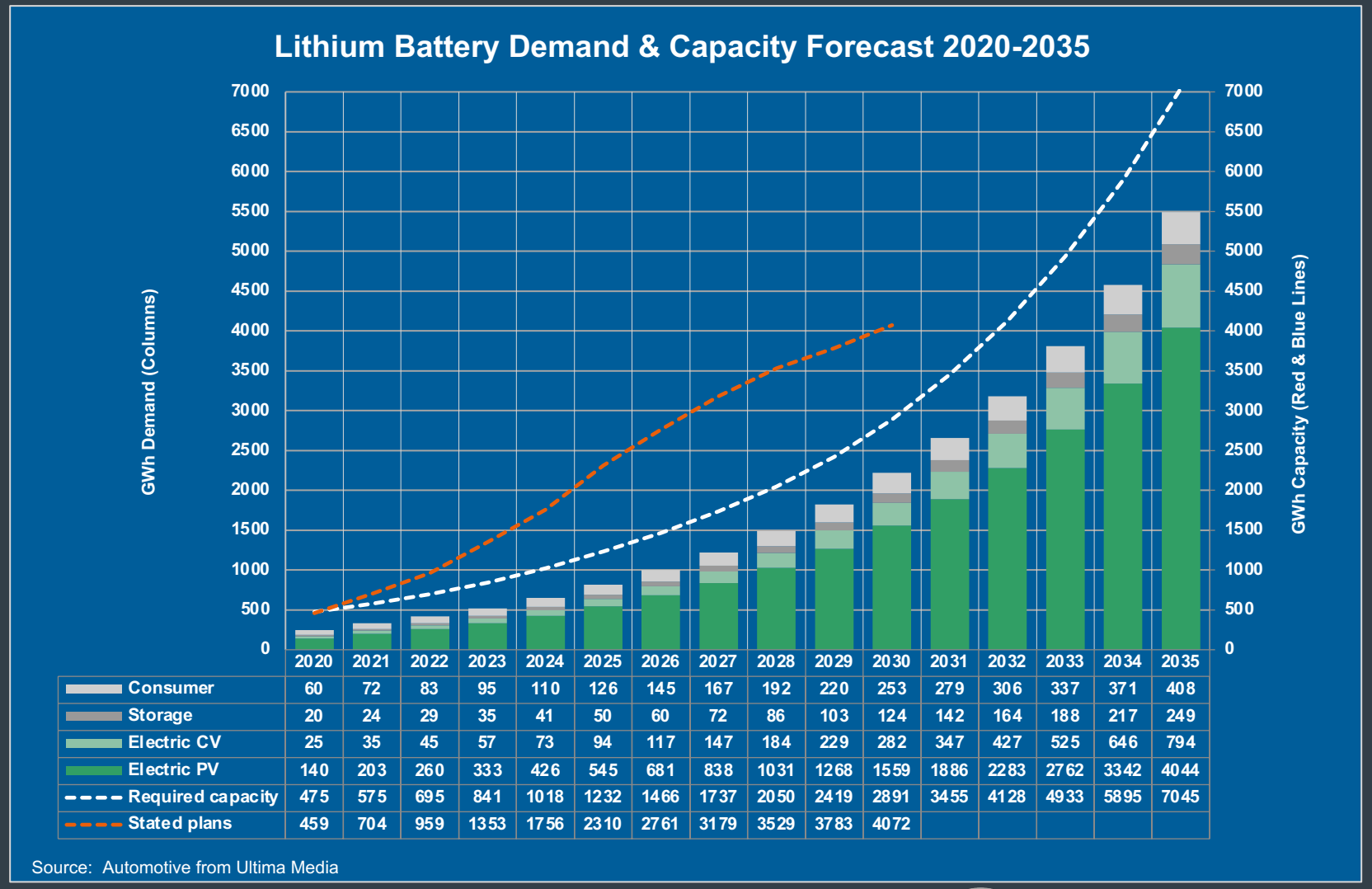
Lithium Battery Demand & Capacity Forecast

Because of increasing EV battery capacities (average ~60 KWh now increasing to ~82 KWh in 2030), overall battery production capacity will actually need to increase slightly faster than EV volumes, i.e. by 24% a year.

Battery production capacity also needs to be kept well above actual battery demand to mitigate against supply chain and production issues.

Based on stated plans, global lithium-ion battery production capacity is expected to grow from 183 plants with 959 GWh capacity in 2022 to 320 plants with 4,072 GWh capacity by 2030.



	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Consumer	60	72	83	95	110	126	145	167	192	220	253	279	306	337	371	408
Storage	20	24	29	35	41	50	60	72	86	103	124	142	164	188	217	249
Electric CV	25	35	45	57	73	94	117	147	184	229	282	347	427	525	646	794
Electric PV	140	203	260	333	426	545	681	838	1031	1268	1559	1886	2283	2762	3342	4044
Required capacity	475	575	695	841	1018	1232	1466	1737	2050	2419	2891	3455	4128	4933	5895	7045
Stated plans	459	704	959	1353	1756	2310	2761	3179	3529	3783	4072					

Source: Automotive from Ultima Media

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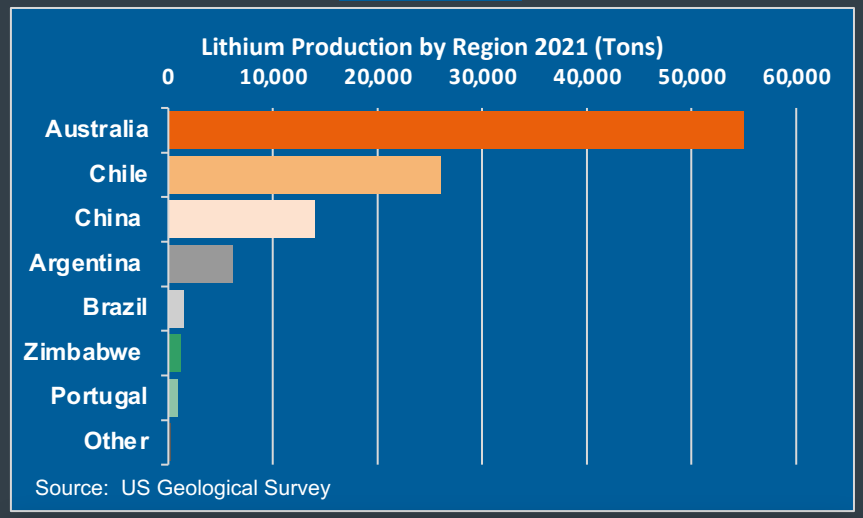
Upstream – Mining & Refining of Raw Materials

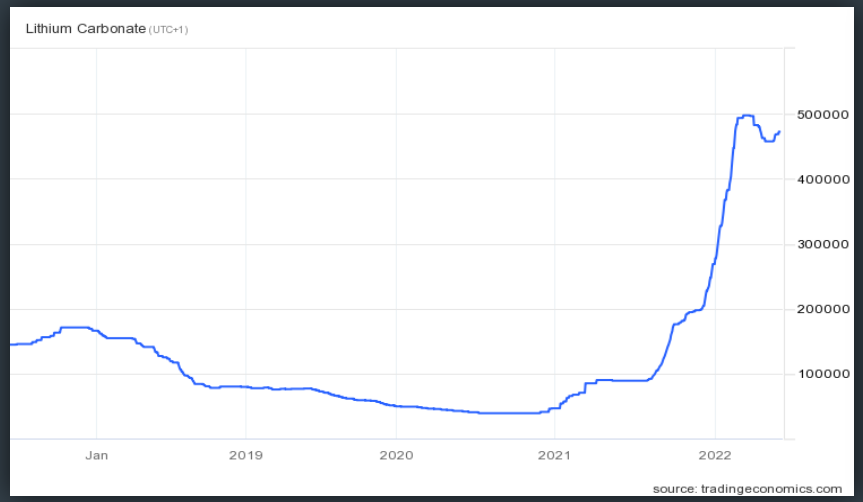
Upstream mining & refining of lithium & cobalt remains highly concentrated in Asia Pacific, South America & Africa – so there will be a growing need to regionalise.

EU Battery Regulation around sustainability and rules of origin is imminent which will stimulate an EU battery supply chain.

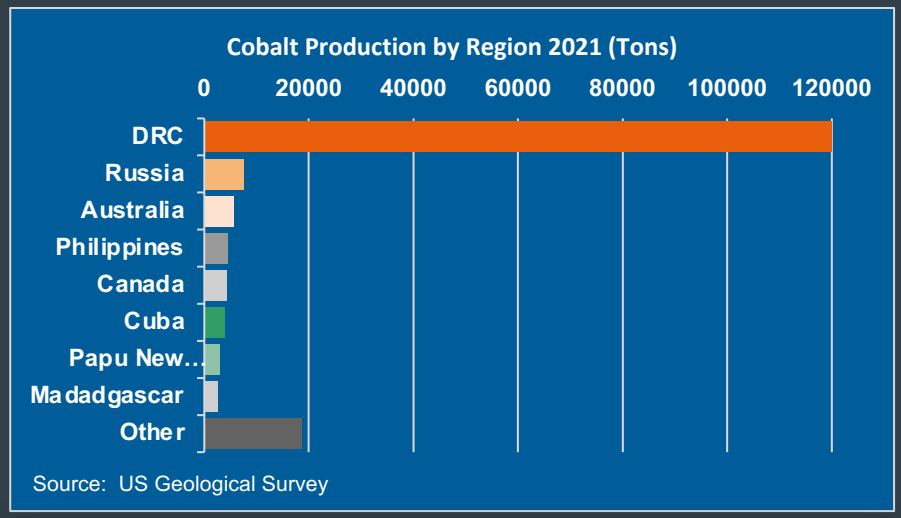
The Russia-Ukraine war has compounded material shortages leading to price spikes leading to higher battery & EV prices - and ultimately risks battery supply chain investments.

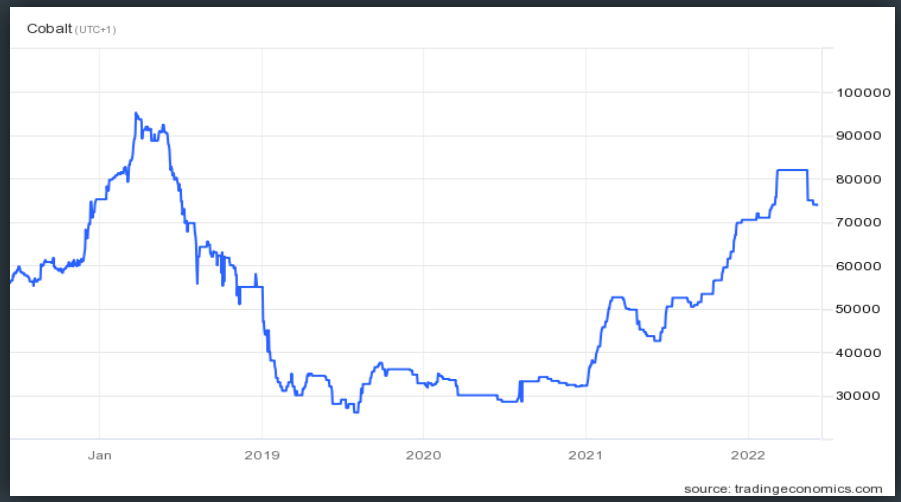
Lithium





Cobalt





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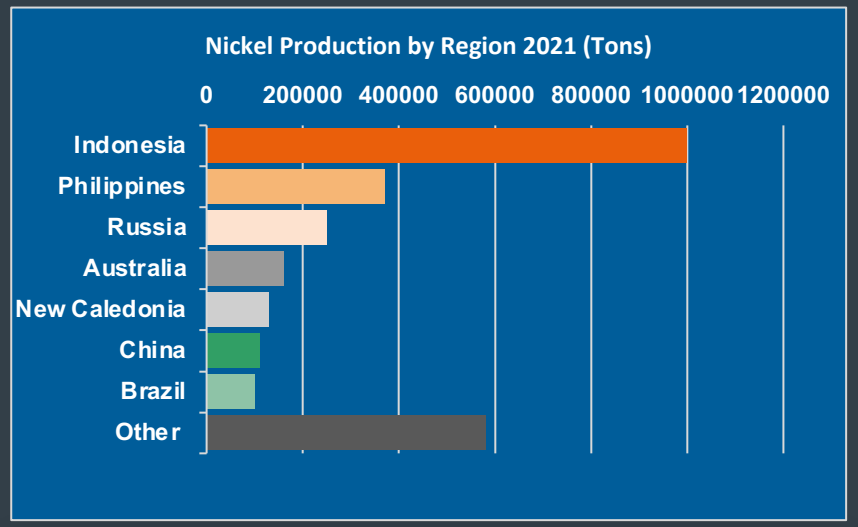
Upstream – Mining & Refining of Raw Materials

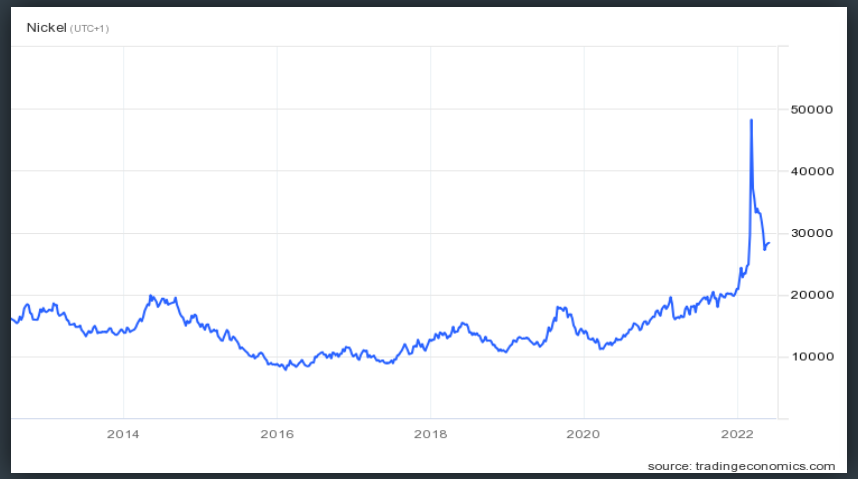
Upstream mining & refining of nickel & manganese remains highly concentrated in Asia & Africa – so again there will be a growing need to regionalise.

However, manganese has not witnessed a price spike - yet – although the very high purity required for EV batteries means there are relatively few suppliers.

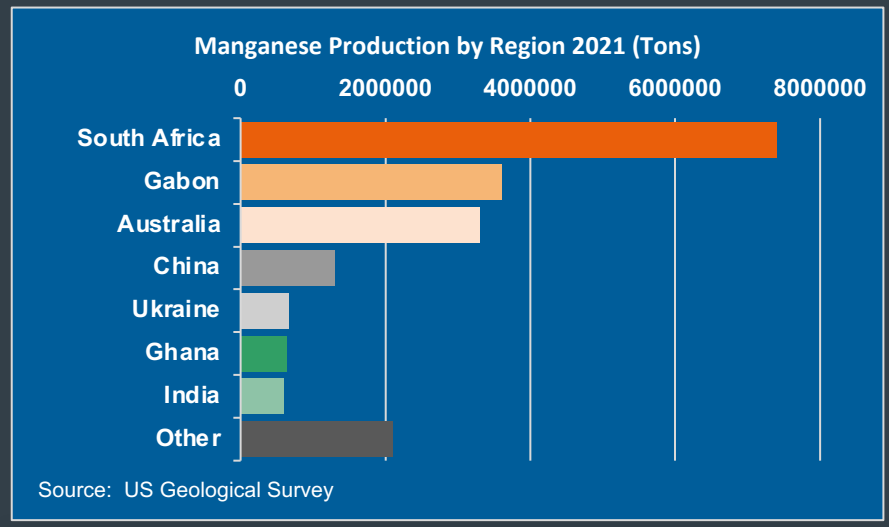
OEMs are increasing 'semi-vertical integration' across all parts of the battery value chain to improve supply chain security.

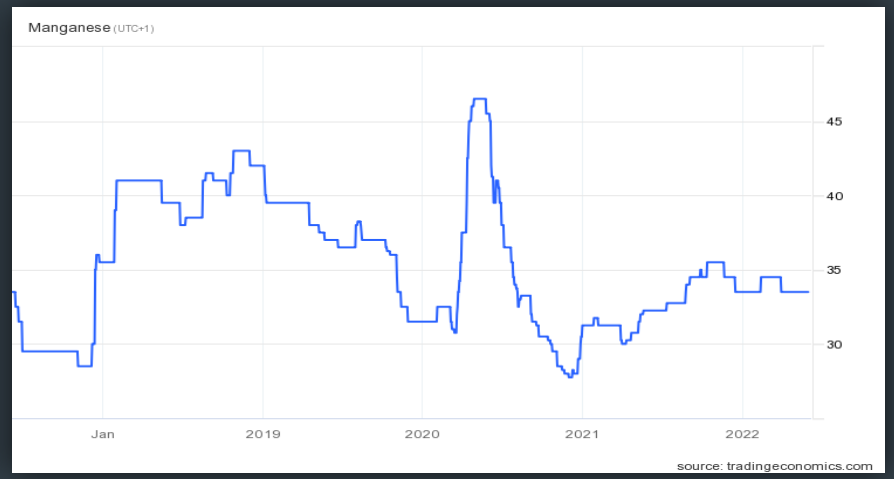
Nickel





Manganese





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Midstream – Component Manufacture

The midstream manufacture of cathodes, anodes, electrolytes and separators is extremely highly concentrated in Japan and China.

Battery component manufacture is a highly specialised business area with a relatively small number of specialised companies.

For this reason, the midstream is going to be one of the most challenging to develop and regionalise to the EU and North America. (and other regions)

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Cathodes

Company	Locations
Umicore	South Korea, China, Poland
Nichia	Japan
Toda Kogyo	Japan
Beijing Easpring	China
Ningdo Jinhe	China

Anodes

Company	Location	Clients
Hitachi Chemicals	Japan	Samsung SDI, LG Chem, Panasonic, Hitachi
BTR Energy	China	Samsung SDI, LG Chem, Panasonic, Sony, BYD
Nippon Carbon	Japan	
Ningbo Shanshan	China	LG Chem, Sony, Lishen, BAK and BYD
Hunan Shinzoom Technology	China	BYD, CATL and Far East First
Jiangxi Zeto New Energy Tech	China	BAK Battery

Electrolytes

Company	Location	Clients
CapChem Technology	China	Samsung SDI, Panasonic, Sony, BYD, Lishen, BAK, Coslight
Tinci Materials Tech	China	Sony, BYD, CATL, Guoxuan, Wanxiang, Coslight
Guotai-Huarong GTHR	China, Poland	Samsung SDI, LG Chemicals, ATL, Lishen, Panasonic
Panax-Etec	China	Samsung SDI, LG Chemicals
Ningbo Shanshan	China	LG Chem, Sony, Lishen, BAK and BYD

Separators

Company	Location	Clients
Asahi Kasei	Japan	Samsung SDI, LG Chem, Panasonic, Sony, Hitachi, AESC
Toray Tonen	Japan	Samsung SDI, LG Chemicals, Sony
SKI	Japan	Samsung SDI, Sony
Celgard	US	LG Chem, Panasonic, AESC Envision
Senior Technology Material	China	LG Chem, BYD, Guoxuan, Lishen, CALB

Downstream – Cell Manufacture 'Gigafactories'

In 2022 China dominates the global capacity with 73% share (703 GWh).

Base upon states plans, Europe is expected to achieve 36% share by 2030 or comparable to Asia Pacific .

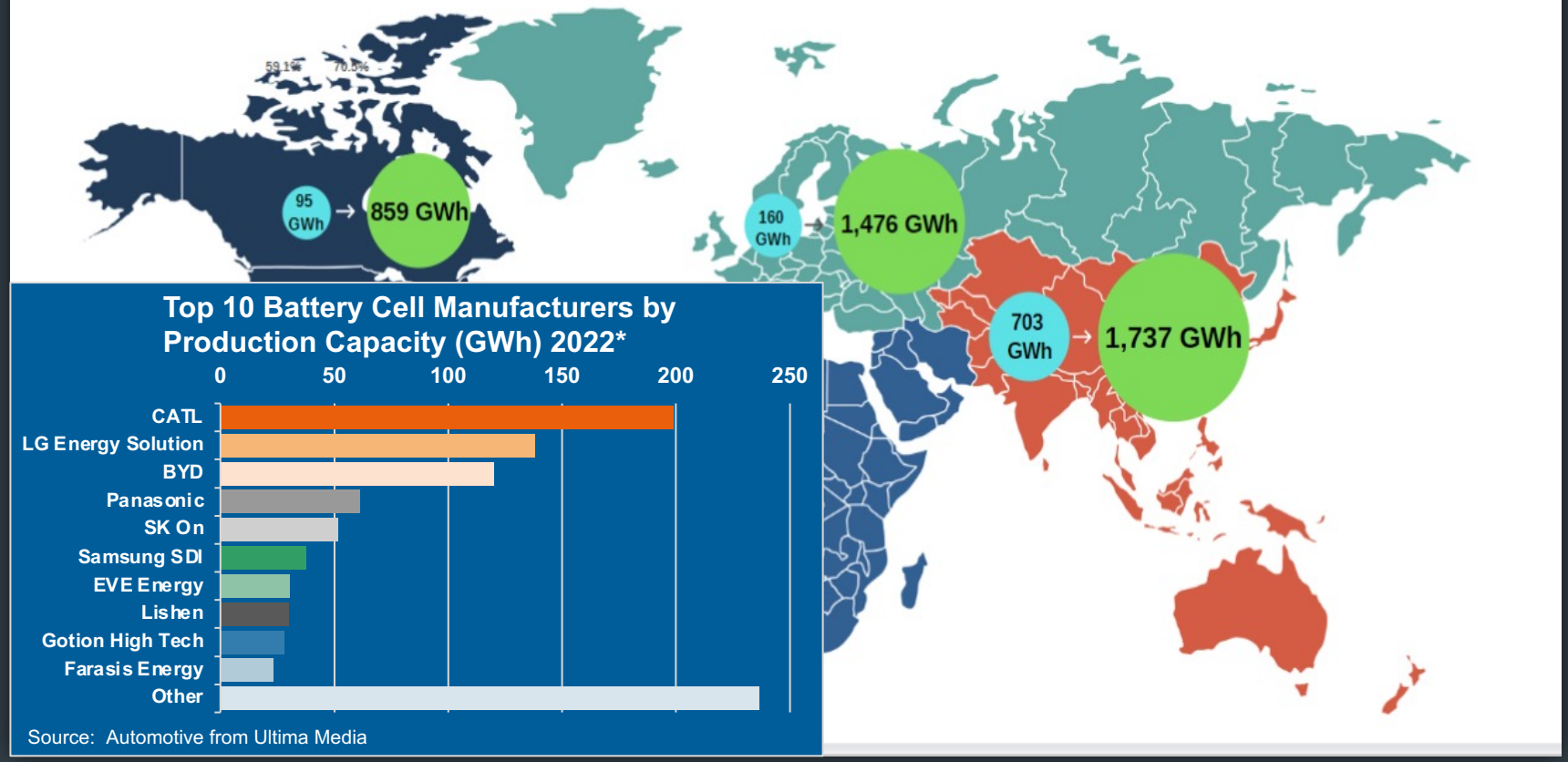
North America will also increase it's share to 21% (859 GWh) by 2030.

CATL has become market leader in the past year with 21% of capacity.

Cell manufacturers are consolidating with the top 5 companies accounting for 60% of global capacity.

To mitigate against supply shortages, OEMs are diversifying cell suppliers, moving from a single to a multi-sourcing model.

Region	Current plants	Future plants*	Total current + future plants*	2022 capacity (GWh, % share)	2030 capacity (GWh, % share)
Asia Pacific	141	61	202	703 GWh (73%)	1,737 GWh (43%)
Europe	27	46	73	160 GWh (17%)	1,476 GWh (36%)
N. America	15	30	45	95 GWh (10%)	859 GWh (21%)
Total	183	137	320	959 GWh	4,072 GWh



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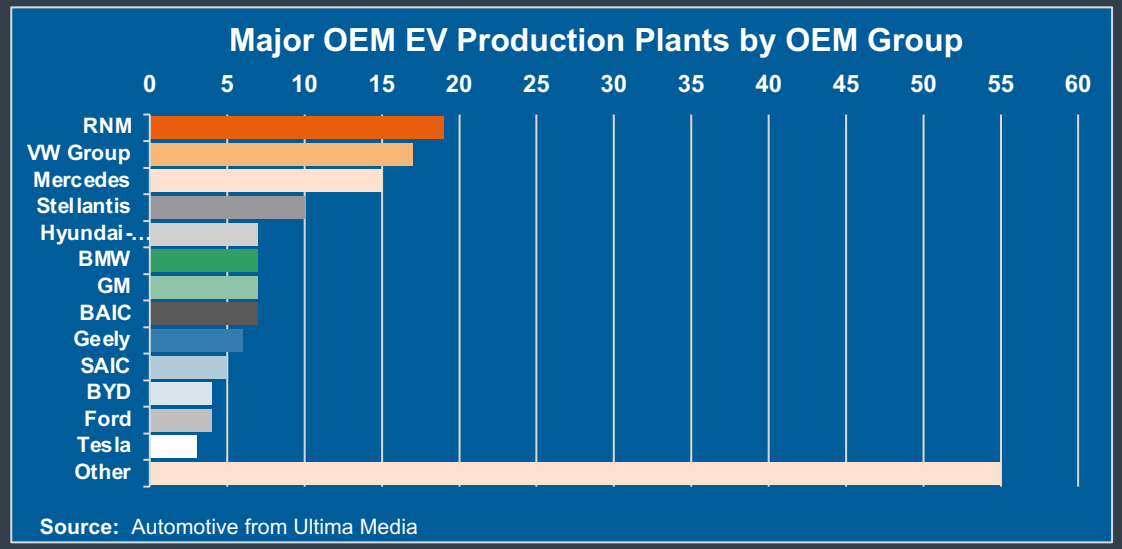
Battery Integration & EV assembly

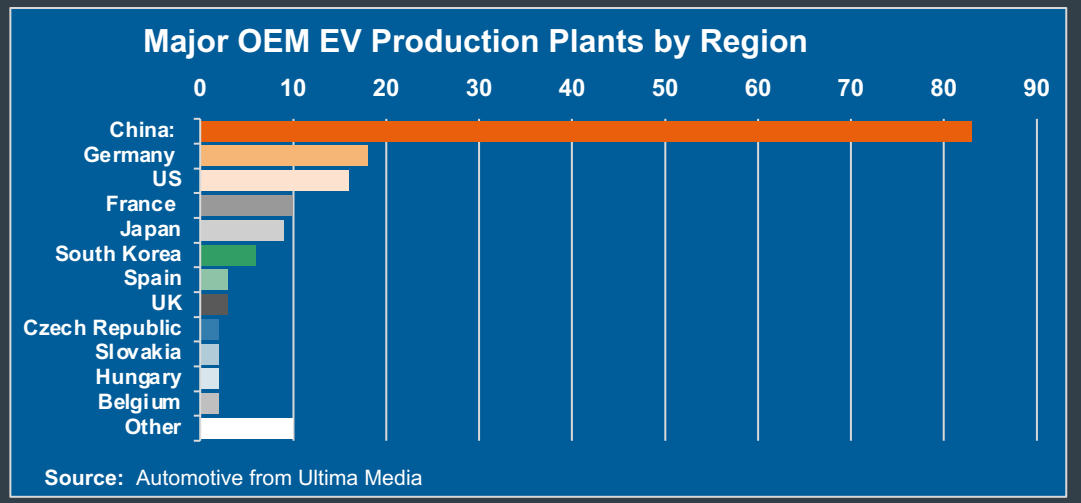
'Battery integration' refers to taking the raw cell and forming them into modules, which are then combined with a BMS and TMS, plus casing to form the complete battery pack.

Battery integration is vital and results in a very sophisticated piece of hardware, chemistry, as well as software, all of which plays a critical role in battery and EV performance.

Battery pack integration is increasingly being localised or 'hyper-localised' to the specific OEM assembly plant.

The location of EV assembly plants is increasingly important. Battery weight, logistics costs, regulation, and supply chain security are all critical factors intertwined with plant localisation.





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Key Findings

Automotive industry success will be synonymous with battery supply chain strategy. Batteries are not only about meeting rising EV demand, it is also an economic race for OEMs as well as individual countries. Those who succeed in the battery sector and EV race will depend on commanding a well-managed, agile, flexible, multi-sourced and resilient battery supply chain.

Big rewards are tempered by risk. Investment in the battery supply chain continues apace but the elevated and volatile raw material prices pose a real risk to the unprecedented battery supply chain investments being made, potentially undermining OEM's EV business models and ultimately jeopardising wider electrification targets and climate objectives.

Building supply chain resilience. The industry is anticipating potential upstream battery raw material shortages from the mid to end of the decade, which could overshadow current chip shortages. OEMs are rapidly implementing supply agreements, joint ventures and partnerships to increase 'semi- vertical integration' across all parts of the battery value chain to improve supply chain security. Ramping up recycling capacity will also help plug the expected gap in raw materials.

The whole battery supply chain must expand. Expansion must occur not only at the gigafactory level, but also with midstream components and upstream raw materials, plus recycling of the raw materials to create a true 'closed loop'.

Governments have a crucial strategic role in developing the battery supply chain through regulation and public funding. To that end, many battery cell suppliers are adapting their plants and production processes to be carbon neutral.

Implications for Manufacturing

Complexity: despite rapid EV growth, the next decade will be an increasingly complex mix of powertrains produced often on the same assembly line, adding to the number of variants, the number of parts and ultimately the overall complexity.

Modular, flexible adaptable manufacturing: the multiple variants, plus the likely rapid technological change that advancing battery and electrification technology will bring, requires considerable flexibility in manufacturing processes.

Automation & robotics: The increasing drive to reduce battery and EV costs will necessitate major economies of scale that only automation and robotics can provide.

Partnerships & collaboration:. Stakeholders across the supply chain are increasingly collaborating to share investment costs, share technical knowledge and accelerate time to market e.g. OEMs <> cell suppliers <> tier suppliers (powertrain).

Sustainability: The increasing focus on the carbon footprint of the entire lifecycle of vehicle production will mean that every aspect of manufacturing and supply chains will come under scrutiny and requite a transformation. For example, access to renewable energy for gigafactories will become central to both environmental goals but also for reducing battery costs.

Regionalisation / localisation: to achieve those sustainability goals, reduce costs and increase supply chain security, it will inevitably lead to regionalisation and localisation of the supply chain. However, clearly the existing (both ICE & EV) supply chains cannot be changed overnight. This is going to be a gradual process of change.

Automotive Battery Supply Chain 2022

https://bit.ly/batterysupplychain2022

Thank You

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