Q4 2022 Automotive industry demand forecast

March 2023

ADVANCED PROPULSION CENTRE UK

Accelerating Progress

Q4 2022 – Automotive industry demand forecast

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This demand forecast covers

Markets	Global; European; UK
Vehicles	Light Duty Vehicles (LDVs) Heavy Goods Vehicles (HGVs) 
Materials	Lithium; Cathode Active Material (CAM); Battery foils; Electrolyte and Separator Material

Our process

The data in these demand graphs is based on APC insight gathered from UK OEMs on xEV production; APC and Automotive Council PEMD traction specifications; and powertrain split forecasts from S&P Global Markit. Rho Motion, BloombergNEF (BNEF) and Wood Mackenzie have also guided the demand forecast.

Quarterly updates

Any developments in the sector will change and influence these forecasts. APC will update these on a quarterly basis in line with the impacts of those announcements.

Disclaimer

These forecasts provide an estimate of electrified powertrain demand and are by no means an accurate statement of future markets and industry intentions. The data should be used in good faith and APC UK cannot be held liable for any inaccuracies in the data, views expressed or underlying assumptions.

Q4 2022 – Summary

Summary – Changes to projected demand by region

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Global demand update	• Supply chain issues have eased but risk remains both in supply chains and global economics • OEMs are predominantly focussing on producing fewer higher margin vehicles as this has proved a successful strategy during supply chain bottlenecks. Therefore, we are not currently seeing a boost to production numbers despite supply chain recovery.	page 8
European demand update	• The United States' Inflation Reduction Act is accelerating interventions and localisation of supply chains across Europe	page 6
UK demand update	• HGV demand revision, based on APC insight, provides a demand uplift	page 20

Summary – Trends insight

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Q4 2022

Lithium supply and demand scenario for 2035	**Lithium supply and demand scenario for 2035 modelled** **Supply and demand modelled:** • Mining and recycling supply • Mitigation by increasing FCEV share and substituting lithium for sodium	pages 13-21
Recycling supply modelled from 2030-2035	**Recycling supply modelled:** • Gigafactory scrap and personal electronics modelled • Three xEV retirement scenarios considering different vehicle retirement ages	pages 15-19
Mitigation strategies for OEMs modelled	**Demand side mitigation modelled** • Substituting lithium ion batteries with sodium ion in smaller segments • Increasing share of FCEV based on future modular electrified platforms	page 21

Source: APC analysis
*Notes: *LDV/Light Duty Vehicle segments only as defined by S&P Global Markit – see slide 16 for examples*

Summary – Supply chain activity

Q4 2022 notes

- The graph refers to Europe's capability to supply battery cells and sub-components that arise from local vehicle production
- It assumes Europe is a self-sustaining bloc with no imports or exports
- Updated to reflect 2027 and 2030 supply. 2027 and 2030 are important milestones with rules of origin deadline and the ban of sale of pure ICE vehicles.

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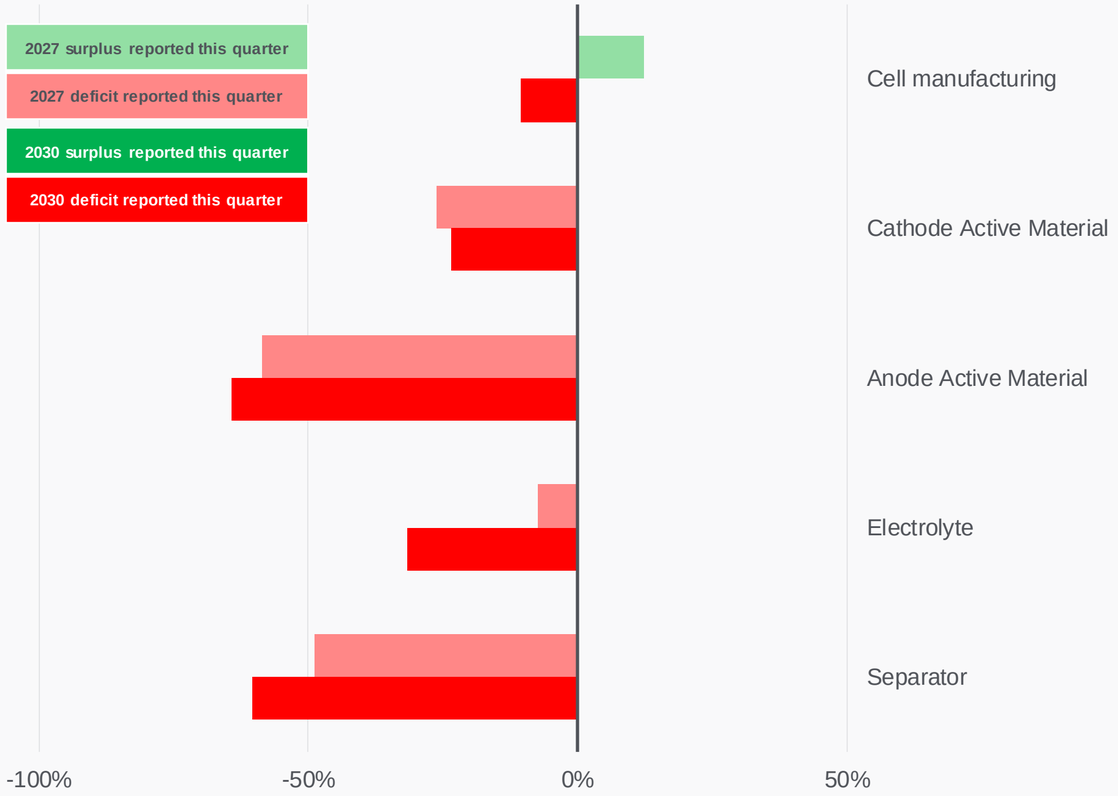
2027 and 2030 European[1] capacity vs demand balances



Status of regional capacity* v demand balance in 2030	Value** (%)	UK supply chain status
Significant plans for cell manufacturing capacity but significant risk of investments moving to USA. This forecast is a snapshot in time considering current risk, the situation is an evolving one.	18%	A gap remains between confirmed gigafactory plans and demand creating an opportunity for investment
Investment in supply stream is largely focused on CAM which is likely to have a positive impact on reducing CAM deficit but unlikely to fully close the gap	**46%**	Required to be made in the UK from 2027 for UK cells to qualify as local and to avoid EV tariffs in the EU
Anode active materials continue to be underinvested in. Introduction of new anode materials may change this.	9%	Expected to be the next 'big thing' after CAM. Access to low-cost renewable energy is key to manufacturing competitiveness.
Electrolyte capacity likely to reduce relative to demand due to lack of investment	8%	Value in today's liquid electrolyte is relatively low, but solid state electrolytes are a key investment consideration.
Separator materials remains an area of underinvestment	7%	Significant opportunities to localise in UK even though typically manufactured in Eastern Europe

Source: APC internal analysis, BNEF forecasts (Accessed: 09.02.2023)
1) Europe region includes non-EU countries such as Turkey

**Risk-weighted capacity based on APC internal assessment of announced and under construction projects*
***Value in terms of cost contribution to total cell cost based on an NMC811 cell*

Q4 2022 – Demand update

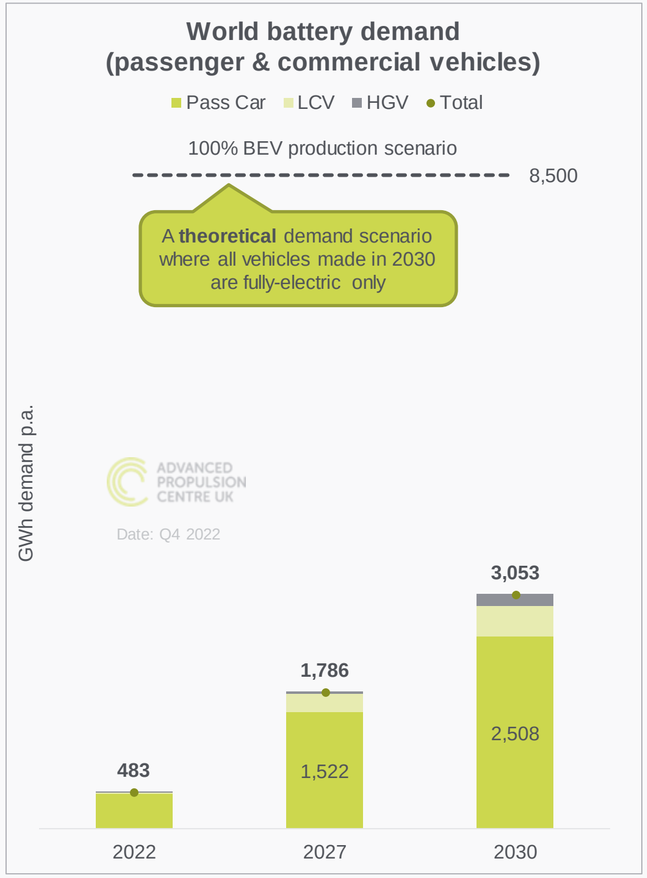
The following section includes battery demand from both Light Duty Vehicles (LDVs) and Heavy Goods Vehicles (HGVs)

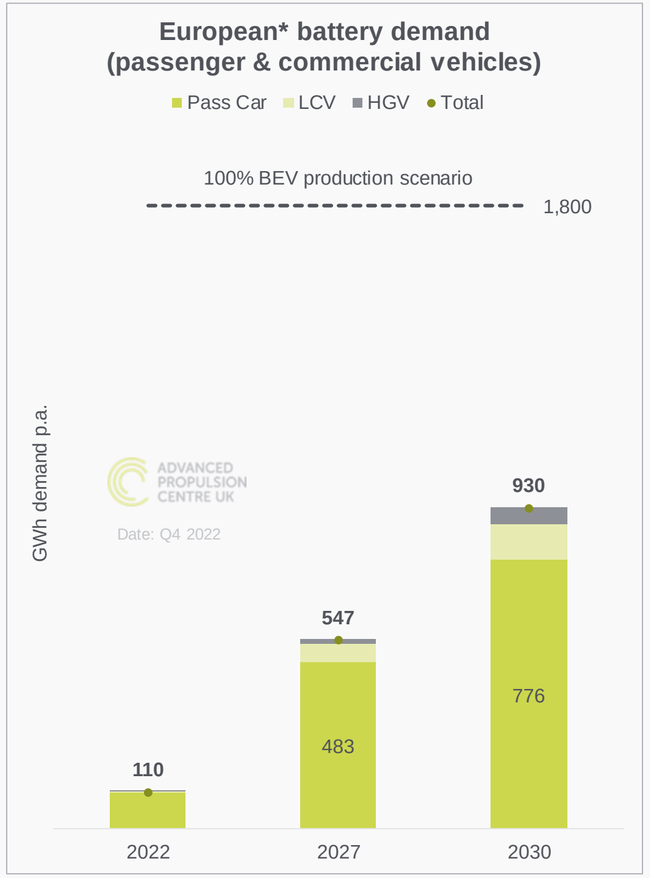
Battery demand forecast

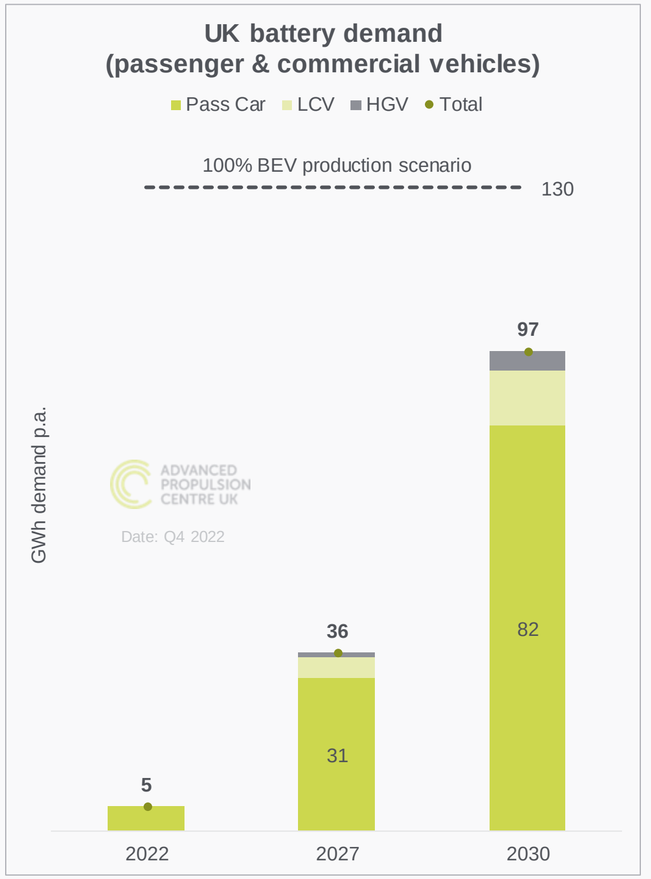
LDVs and HGVs

Q4 2022 notes

- HGV demand reworked in this forecast and increases the battery demand in UK
- Global battery demand in 2030 boosted by stronger demand in the US and Europe







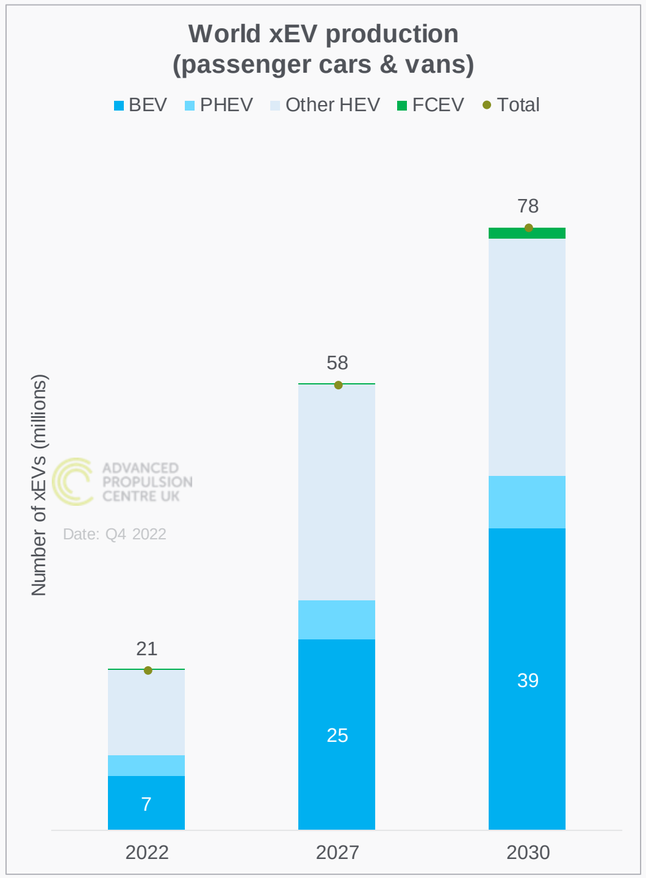
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (Mar, 2023), BNEF (Mar, 2023), LMC (Mar, 2023)
*Note: LCV = Light Commercial Vehicles < 3.5t, buses not included. *European forecast includes non-EU countries such as Turkey*

World xEV production

Passenger cars and vans

Q4 2022 notes

- World vehicle production would require more than 3,000 GWh of batteries, with 39 million battery-electric cars and vans produced globally by 2030



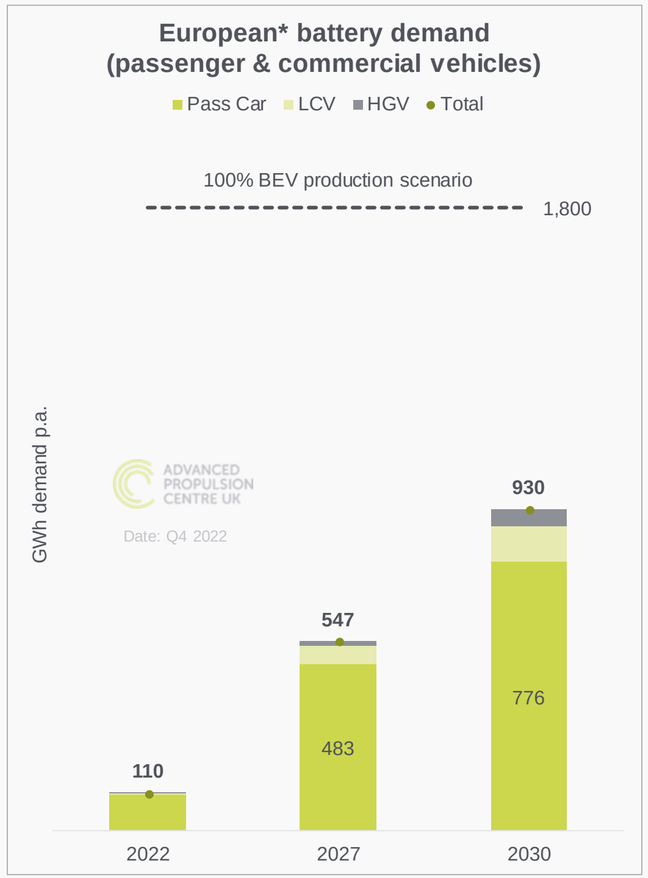
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (2023), BNEF forecasts (2023), LMC (2023)
Note: LCV = Light Commercial Vehicles < 3.5t, buses not included.

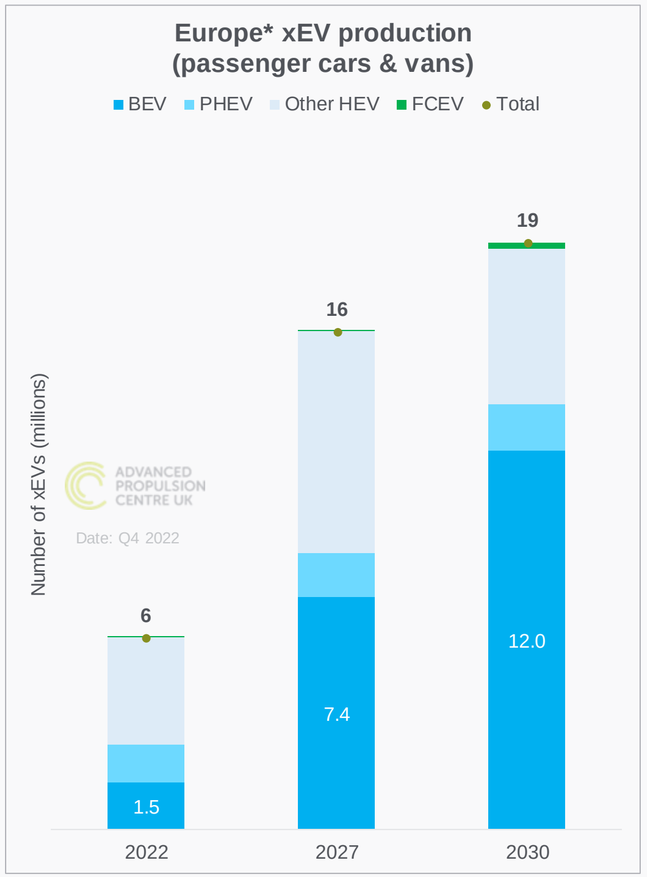
European xEV production

Passenger cars and vans

Q4 2022 notes

- 12 million electric vehicles to be produced in Europe in 2030
- Battery demand to approach 1,000 GWh as Europe push to accelerate localisation of battery supply chains in response to US Inflation Reduction Act





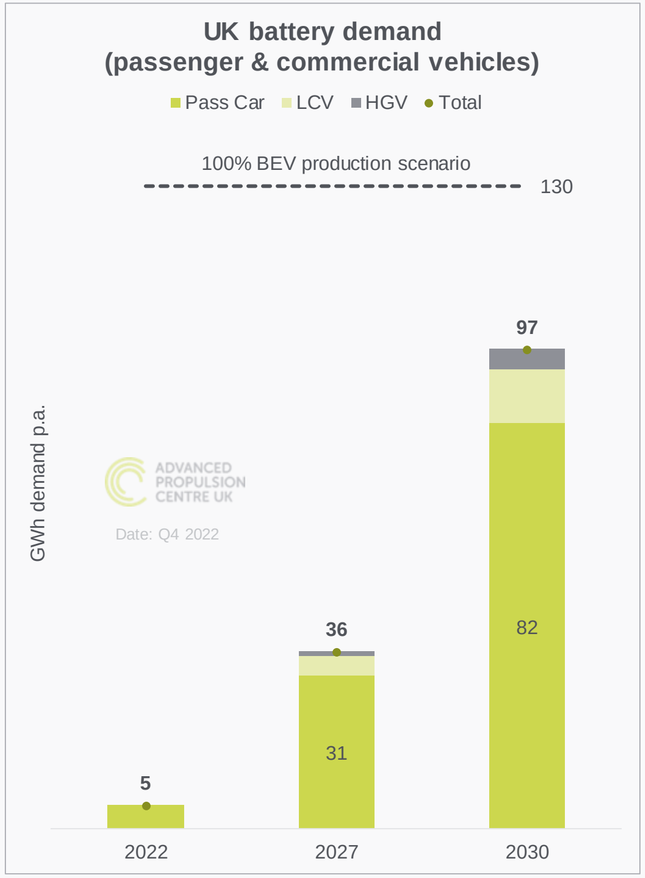
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (2023), BNEF (2023), LMC (2023)
*Note: LCV = Light Commercial Vehicles < 3.5t, buses not included. *European forecast includes non-EU countries such as Turkey*

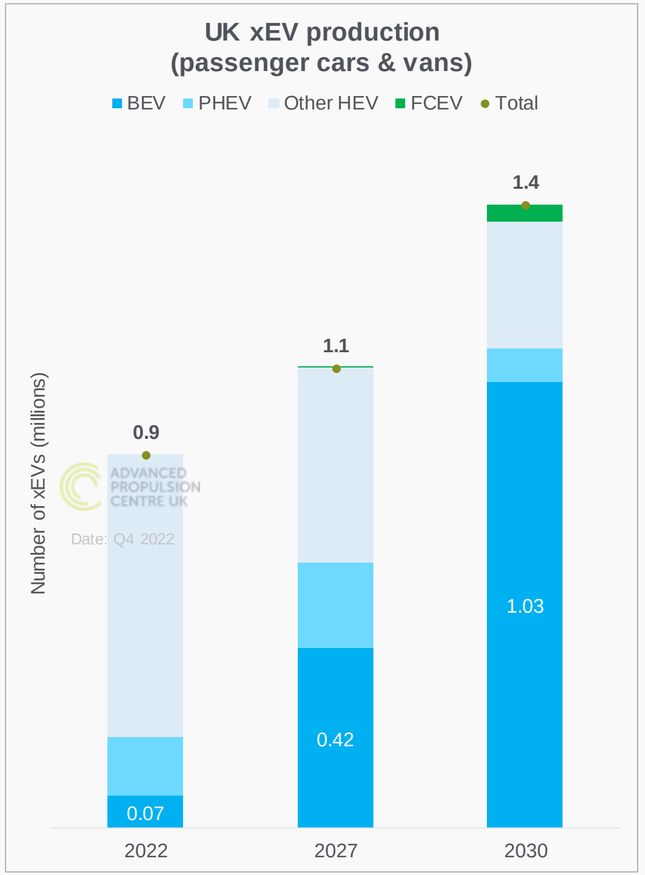
UK xEV production

Passenger cars and vans

Q4 2022 notes

- BEV production expected to be over 40% of output in 2027 when new rules of origin come into force
- Expected increase in demand from HGV and potential fuel cell powertrain production place the UK battery demand forecast at 97 GWh in 2030
- UK expected to produce 1 million BEVs in 2030





Source: APC Demand Databases using S&P Global AutoTechInsight (Mar. 2023), BNEF forecasts (2023)
Note: LCV = Light Commercial Vehicles < 3.5t, buses not included.

Q4 2022 – Trends insight

Lithium supply mitigation looking ahead to 2035

Increase lithium supply

Investment incentives in sustainable Li extraction

Recycle Li from various sources

Decrease lithium demand

Manufacturing smaller & modular batteries

Moving from Li-ion to Sodium-ion batteries

Shifting production to other powertrains

This trend update focuses on modelling the potential demand side responses that could be carried out by vehicle manufacturers

Source: APC analysis

Increased supply from recycling?

Q4 2022 notes

- Recycling supply modelled from xEV retirements, gigafactory scrap and portable electronics

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The following section details potential lithium supply from recycling in the timeframe 2030-2035

Assumptions used in modelling the potential lithium supply from recycling

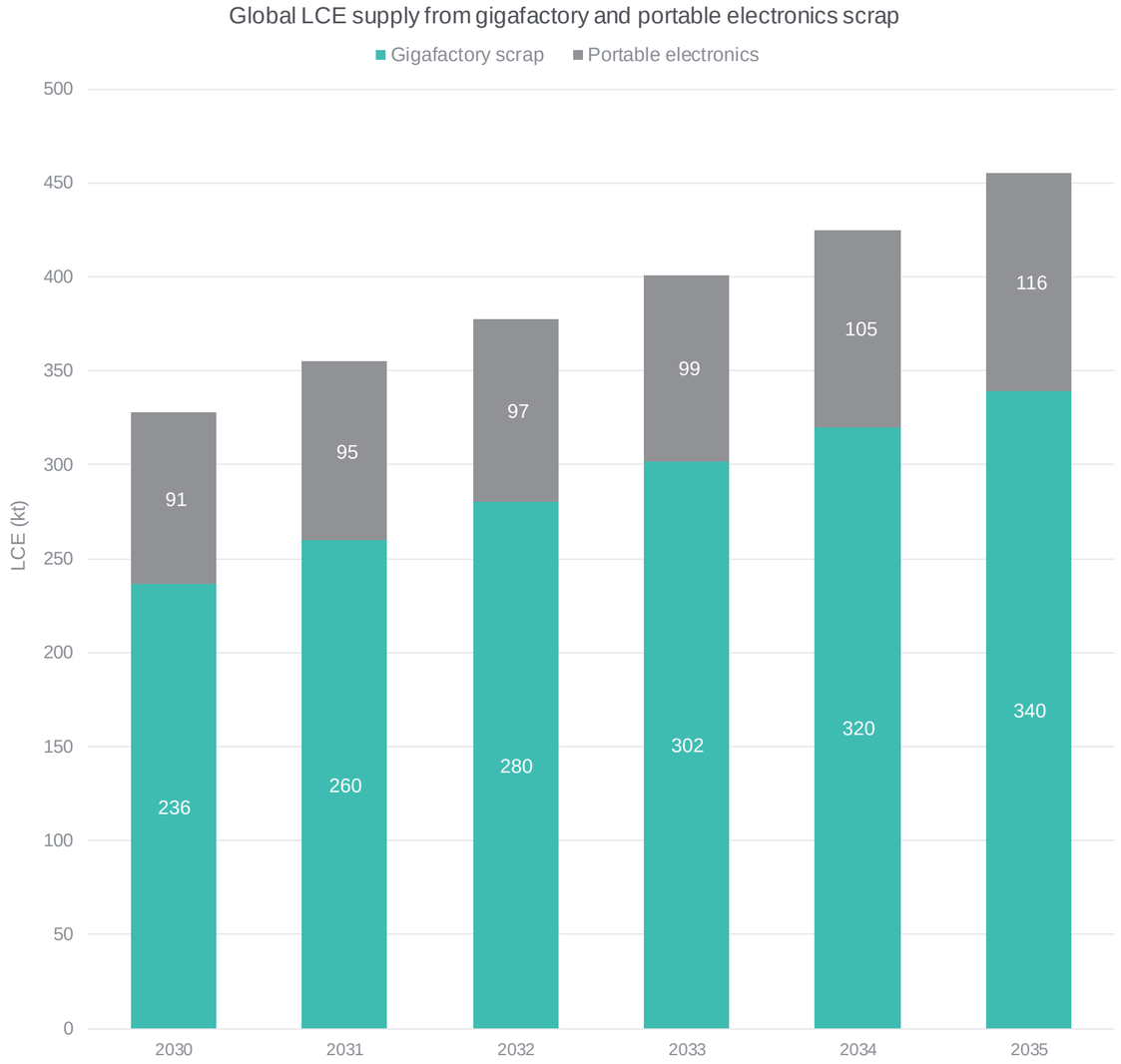
Parameter	Notes and assumptions
Gigafactory scrap	• Assume global gigafactory capacity matches global battery demand for 2035 and an average scrap rate of 8%. This is based on the blend of gigafactories going through scale-up in this period. It is assumed that 100% of scrap is recycled. • Scrap rates vary significantly from region to region and between gigafactories. The maturity of production plays a large role, many new facilities are expected to be built in the next decade as demand grows, these new facilities could increase the scrap rate. • In Europe the requirement for minimum recycled content could encourage gigafactories to keep scrap levels higher and meet their own needs with at-site recycling from a single scrap pool. Having a single scrap pool with a single chemistry greatly simplifies the recycling process. This assumes manufacturing process scrap is allowable under the regulation.
Battery Energy Storage Systems (BESS)	• BESS is configured as a time-variable demand in the model. Residential demand is not included although globally could add a small demand. Of the remaining demand it is assumed that 50% could be serviced by xEV batteries at end of vehicle life. • BESS retirements are not included in supply, whilst some systems will need repair or replacement in this timeframe it is reasonable that those could find a second/third life in other BESS projects.
Portable electronics	• Assume 20% of portable electronics are collected globally, from those collected 90% are recycled with the rest going to landfill. The European Union has set a 73% collection rate for portable electronics from 2031. • Whilst, eventually, the material available from portable electronics sources will be dwarfed by that available from xEV retirements a short-term focus on improving collection rates and building recycling capacity would provide a significant short-term gain.
xEV retirements	• Three scenarios modelled with a 10, 12 and 15-year vehicle retirement age. Assume 100% of vehicles are collected. From this the BESS demand is removed before assuming 60% of remaining batteries are recycled. This assumption is based primarily on chemistry mix and current recycling trends regarding chemistry mix. • Note that the 100% collection rate is considerably higher than the 61% proposed by the European Union from 2031, globally xEV retirements may present a smaller opportunity for recycling however higher recovery rates should be achievable in UK and Europe.
Recycling efficiency	• For all recycling, apart from gigafactory scrap, an 80% recovery rate of lithium is used based on European Union targets. For gigafactory scrap a 95% recovery rate is used based on a model of close connection between gigafactory and recycler emerging and enabling higher recycling efficiency.

Source: APC analysis, Wood Mackenzie

Global LCE from gigafactory scrap and portable electronics

Gigafactory scrap is the dominant supply of lithium from recycling

If low collection rates for portable electronics could be improved up to the European Union target of 73% portable electronics would be the dominant source



LCE from xEV retirements

Three scenarios modelled:

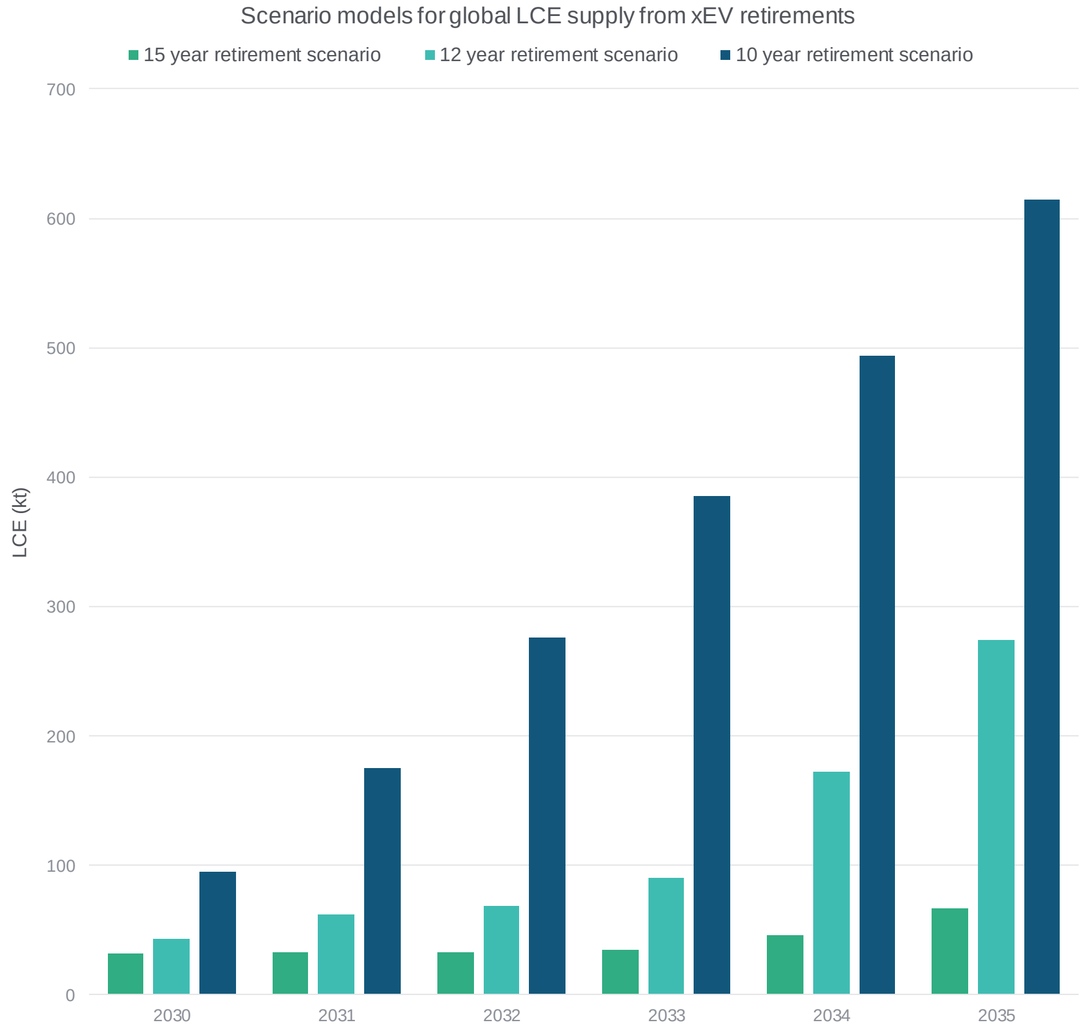
10-year vehicle life
12-year vehicle life
15-year vehicle life

Due to rate of increase in xEV sales the vehicle life has a significant impact on batteries available for recycling

In a 10-year retirement scenario xEV retirements become the primary LCE source from 2033

However this scenario is unlikely as ownership behaviours change towards keeping vehicles for longer

The 12-year scenario is used in this report



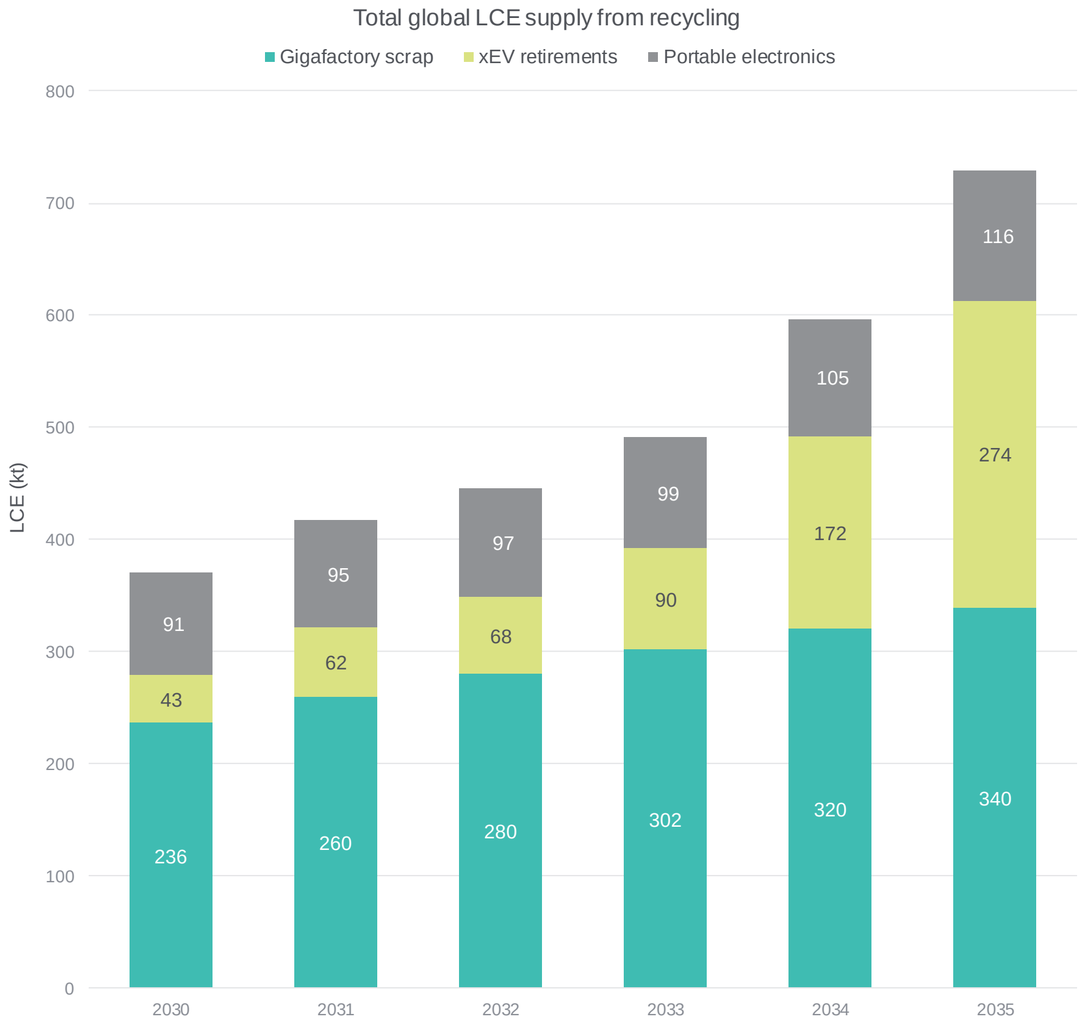
Total LCE using the 12-year vehicle life scenario

Based on this modelling the global total of recycled LCE available for 2035 is 729 kt

Based on a 12-year vehicle life xEV retirements look likely to overtake gigafactory scrap as the primary feedstock for recycling between 2035 and 2040

Forecasting this is important to enable timely scale-up of recycling facilities for xEV batteries and collection facilities to feed those facilities

Meeting European recycled content targets will be challenging if xEVs are kept in use for longer, either in vehicles or stationary storage.



Lithium demand savings from a partial shift in production to FCEVs

Q4 2022 notes

- Future modular electrified platforms expected to enable cost-effective shift to FCEV variants in larger SUVs and vans

Increase lithium supply

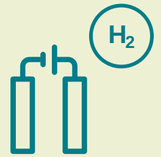
Investment incentives in sustainable Li extraction

Recycle Li from various sources

Decrease lithium demand

Manufacturing smaller & modular batteries

Moving from Li-ion to Sodium-ion batteries



Shifting production to other powertrains

The following section looks at the potential for modular electrified platforms in SUVs and vans to reduce future lithium demand

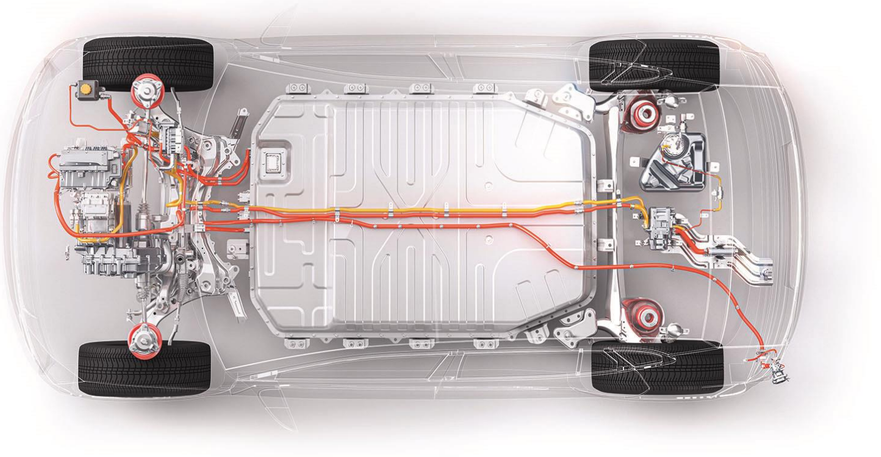
Developing a modular electrified platform allows greater adaptability

Q4 2022 notes

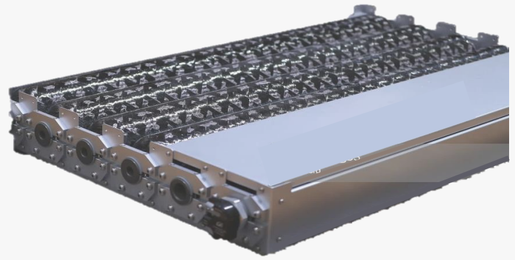
- Major investments in BEV platforms have preceded FCEV production, but some OEMs could consider a modular electrified platform with interchangeable energy storage options to future-proof vehicle production

Battery

?



Advanced hydrogen tank system



Future FCEV models likely to have a fuel cell system in the front or back of the vehicle, and that the hydrogen tank system would be designed to fit where the battery normally would in a BEV.

Source: APC Technology Trends | Images: secondlife-evbatteries.com, Bloomberg

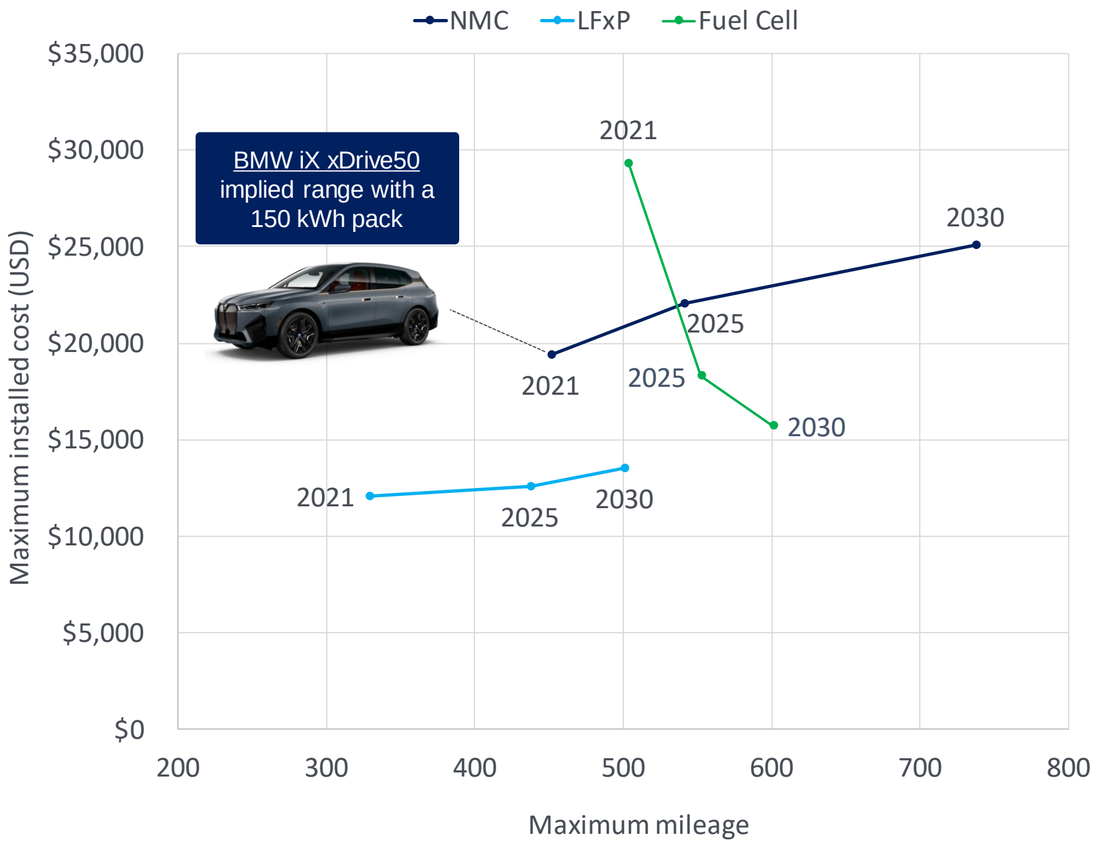
Download our new insight report to find out more

NMC, LFxP and fuel cell technology choice in optimised modular electrified platforms

Q4 2022 notes

- By 2030, we expect LFMP batteries will be preferred over high-Ni NMC and fuel cells in most large premium SUVs. Hydrogen fuel cells are likely to be more widely adopted in vans.

‘Best case’ maximum ranges and cost by powertrain type



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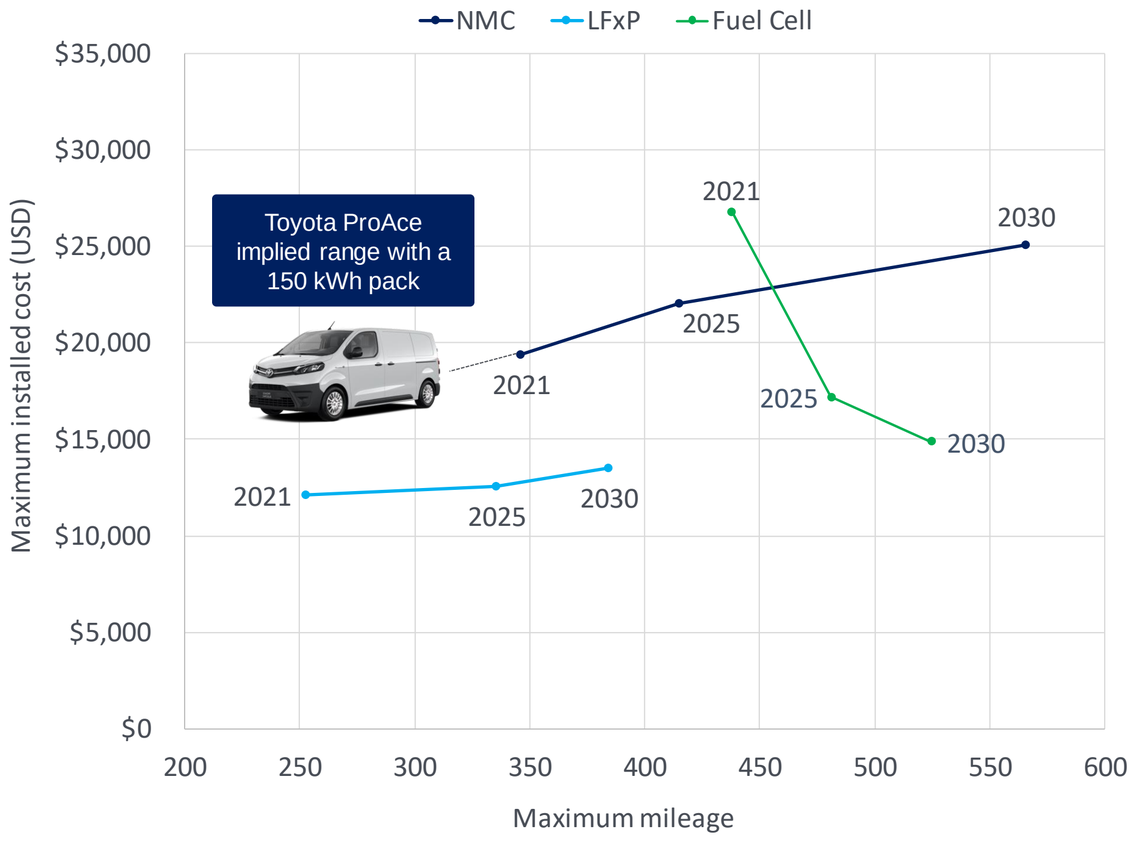


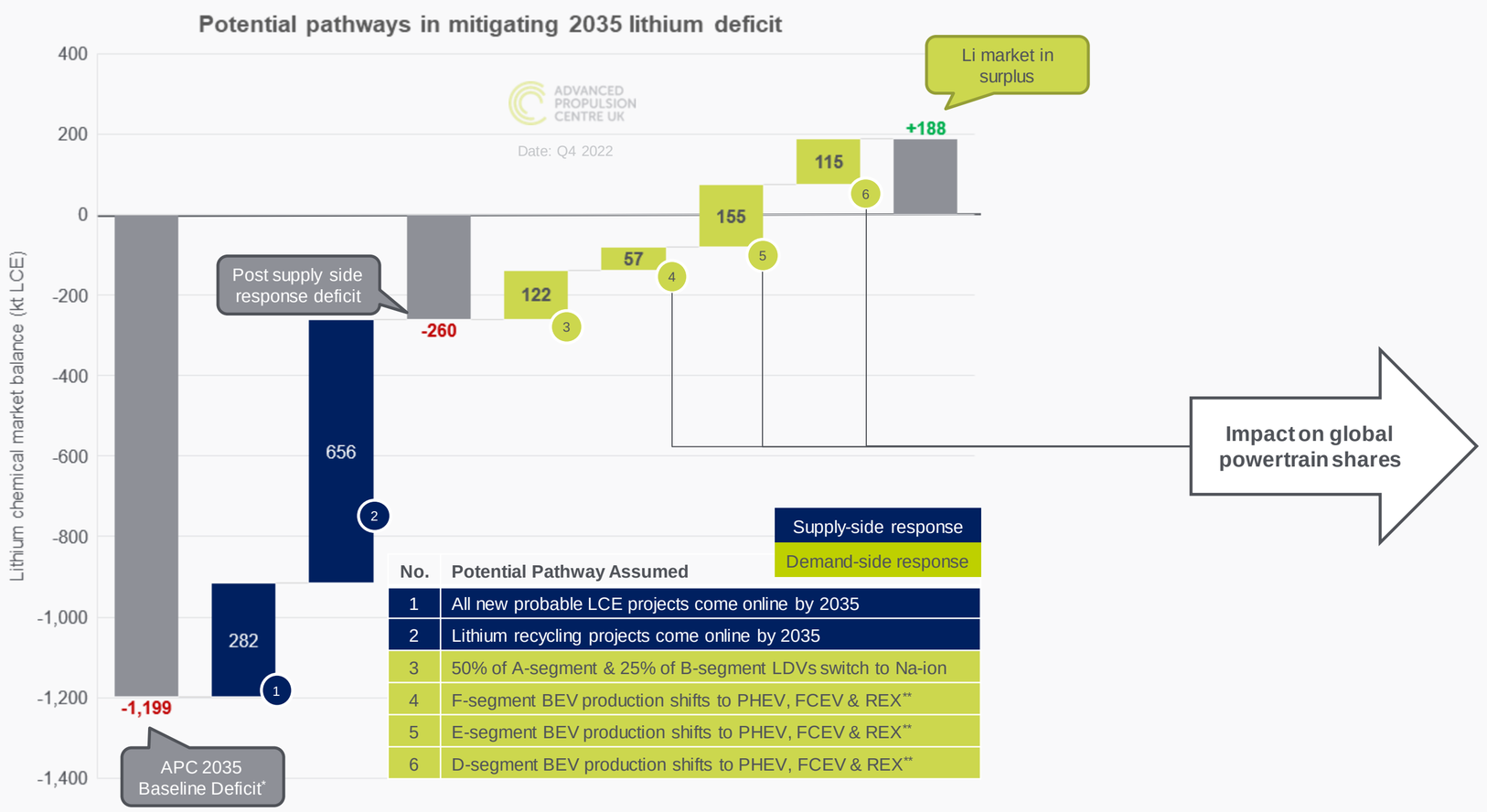
Download our new insight report to find out more

Source: APC Technology Trends (March, 2023) | Fuel cell system cost includes: fuel cell stack, balance of plant, hydrogen storage system and supporting battery pack

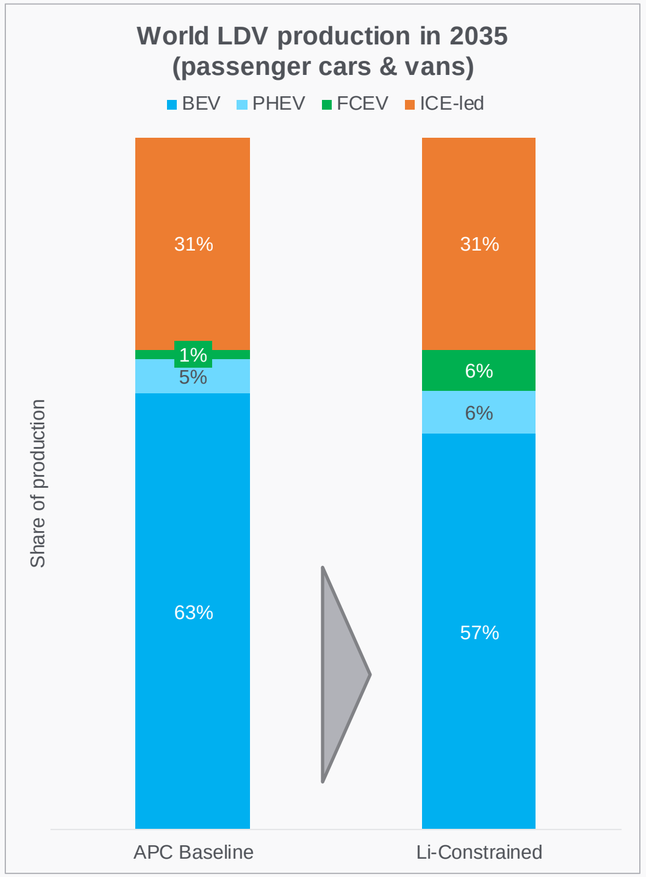
Potential pathways in mitigating a lithium shortage in 2035

Q4 2022 notes

- Modular electrified platforms in SUVs and vans expected to play an important role in FCEV production, leading to a more favourable lithium balance in 2035



Impact on global powertrain shares



Source: APC analysis based on Wood Mackenzie Lithium Forecast Q4 2022, APC Demand Databases
*Notes: Passenger Cars & Light Commercial Vehicles < 3.5t only, *Assuming only 'Baseline Li Supply' including highly probable projects on top of existing operations and expansions thereof, ** REX = Fuel Cell Range Extender*

Summary of the relative impact for each of the identified five solutions to a potential lithium shortage in 2035

Q4 2022 notes

- Investment in extraction could fall short due to squeeze on lithium pricing
- Recycling requires investment and standards to be developed globally
- Risk of xEV feedstock being lower due to vehicles being kept for longer than anticipated along with development of secondary use market – this could make meeting European battery directive recycling content for new batteries challenging
- Modular electrified platforms in SUVs and vans to facilitate FCEV production, reducing lithium demand in larger light duty vehicles

Increase lithium supply

Investment incentives in sustainable Li extraction

Recycle Li from various sources

Decrease lithium demand

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Relative impact	Low	High
Summary	Li shortage 24% better if all probable extraction projects come online by 2035	Significant supply from xEV retirements and gigafactory scrap could account for 50% of shortage

Low	Mid	High
Smaller batteries expected ahead of 2035 timeline	Na-ion in smaller BEVs account for 5% of battery electric cars and vans	Can enable a 27% improvement in Li market balance for cars and vans

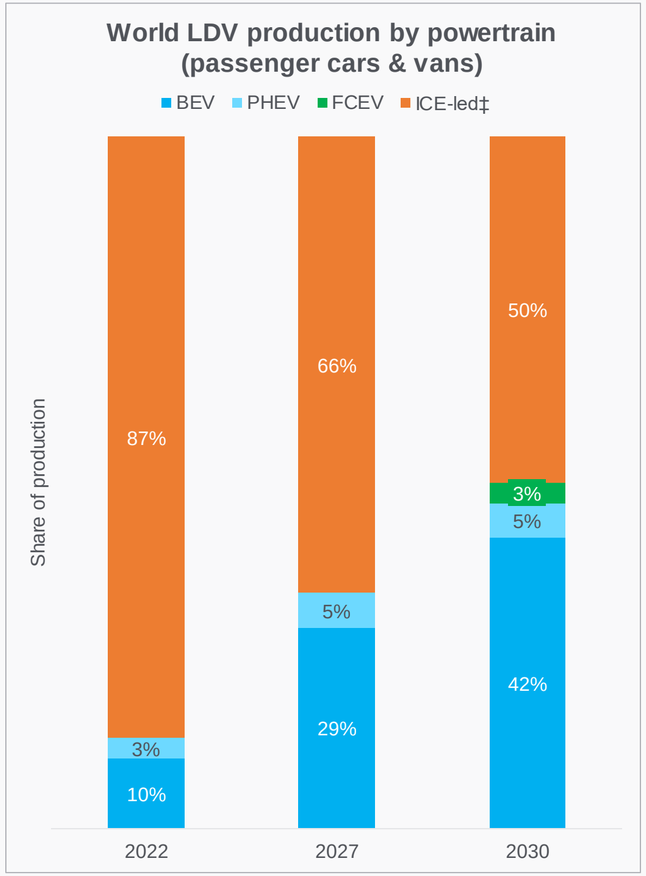
Source: APC analysis

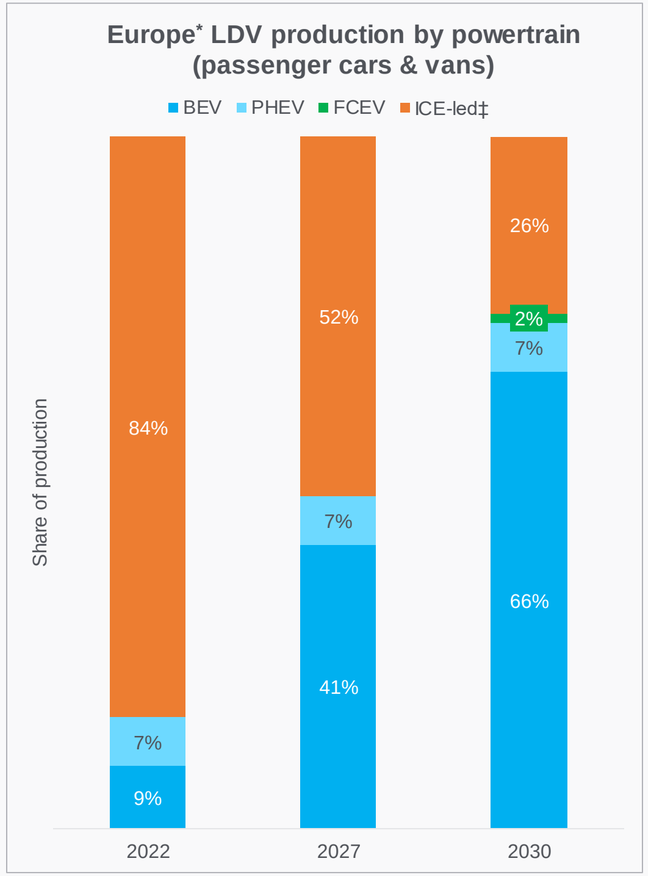
Q4 2022 – Electrified components data

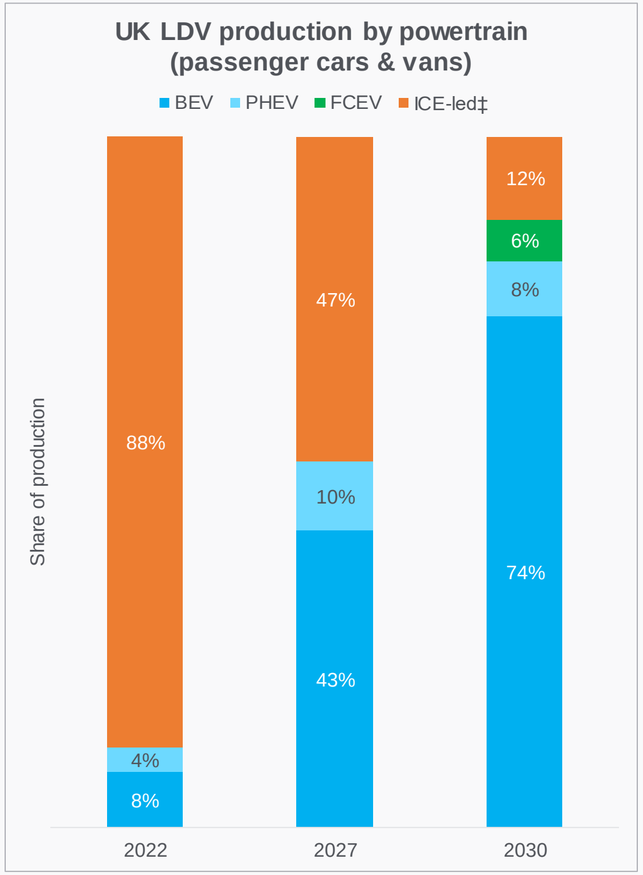
Forecasts for LDV production by powertrain

Q4 2022 notes

- Impact of Inflation Reduction Act on world powertrain mix yet to flow through in baseline data
- Slight increase in FCEV production forecast based on APC insight





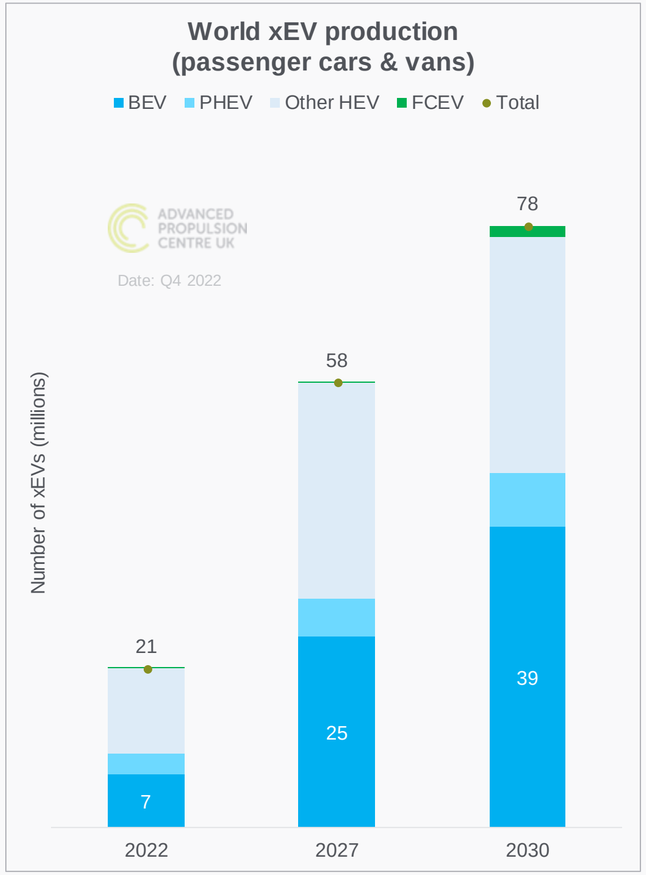


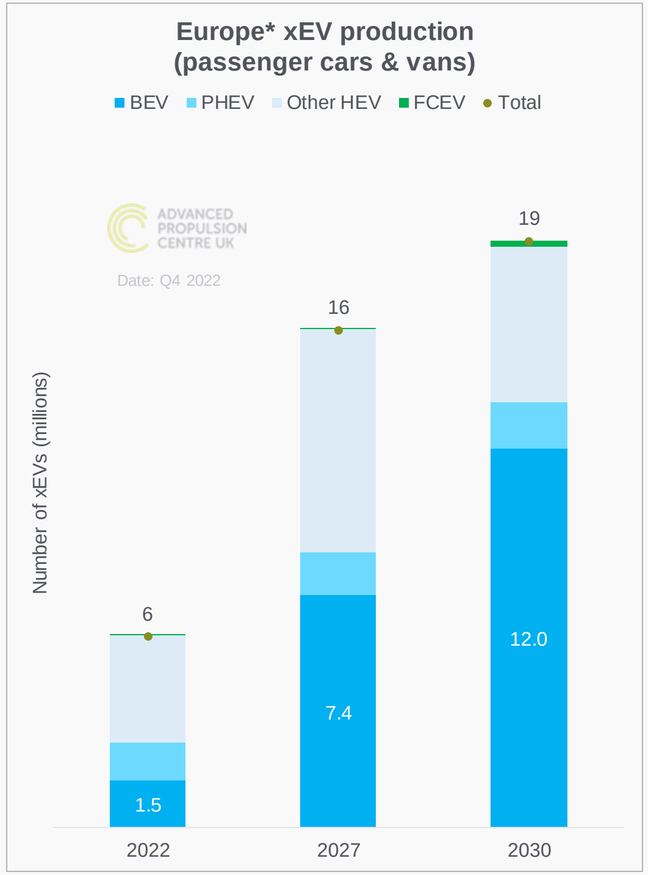
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), BNEF forecasts (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey, ‡Includes non plug-in HEVs & ICE*

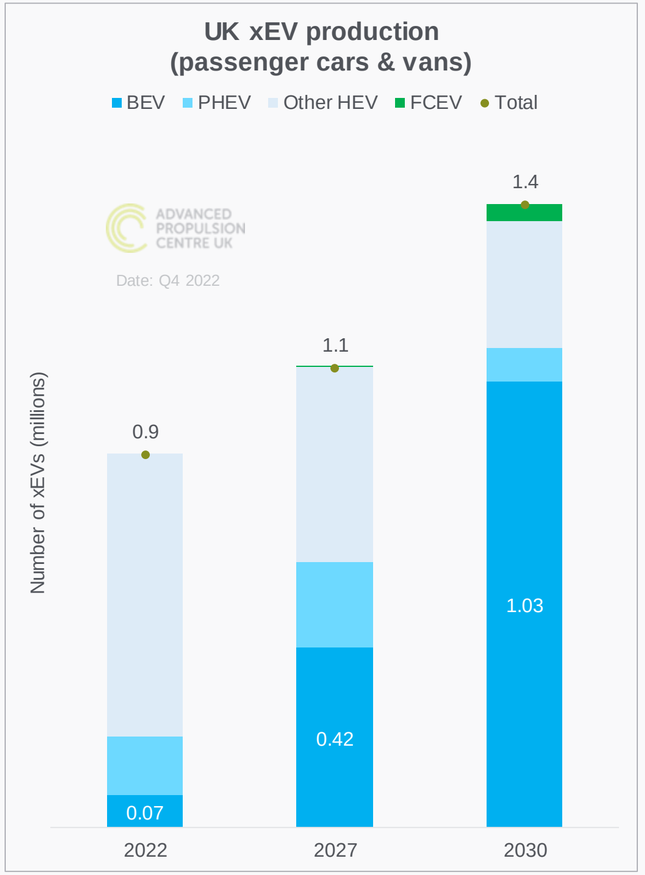
Forecasts for light duty xEV production

Q4 2022 notes

- Despite producing less than 1 million light duty vehicles total in 2022, the UK is forecast to be producing more than 1 million BEVs by the end of the decade
- Europe is expected to produce 12 million BEVs by the end of the decade, having produced 6 million cars and vans total in 2022





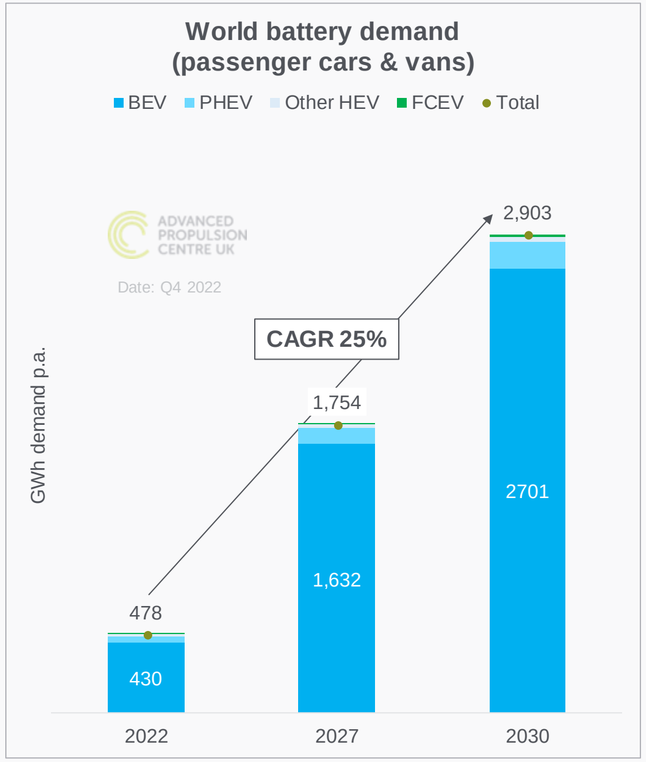


Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), BNEF forecasts (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey*

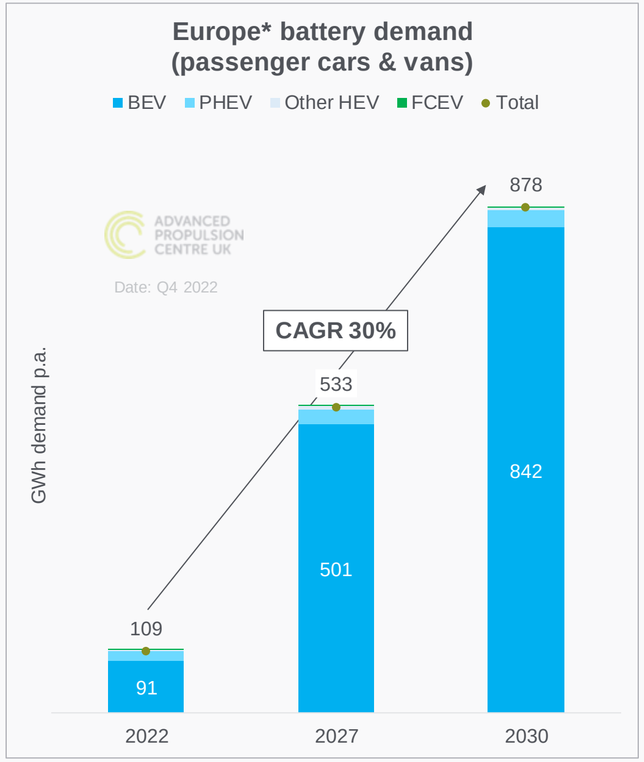
World battery demand for LDVs

Q4 2022 notes

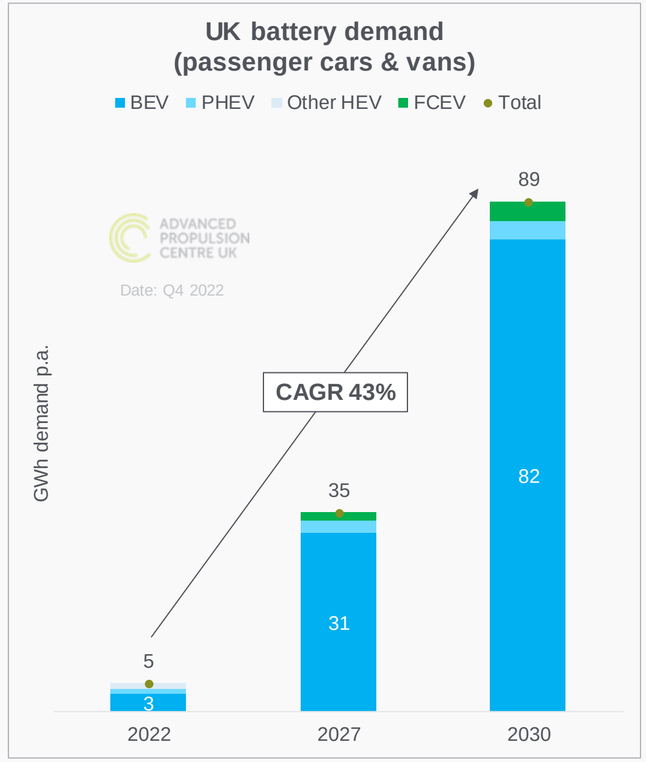
- World and Europe battery demand stronger in 2030 on the back of higher battery pack sizing and announced policies, such as the US IRA
- UK demand remains high with larger than global average battery packs used in the luxury and performance markets



- Relative to APC's Q3 2022 demand forecast, 2030 demand increased significantly from 2,769 GWh previously



- European battery demand accounts for 30% of global battery demand by 2030
- Relative to APC's Q3 2022 demand forecast, we have seen a 25 GWh increase in demand for 2030



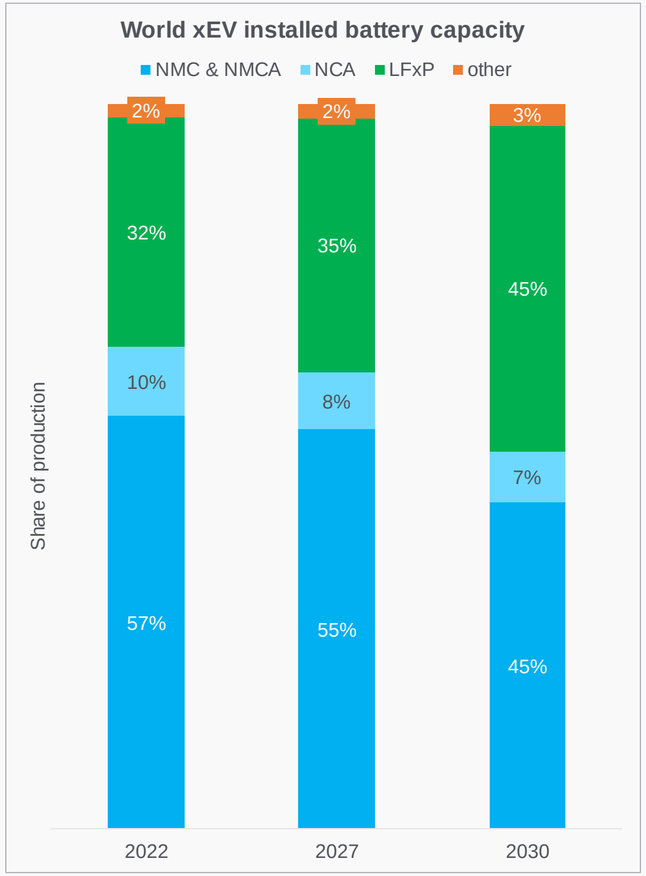
- UK battery demand forecast to account for 13% of European battery demand in 2030
- Relative to APC's Q3 2022 demand forecast, demand from LDVs reduced by 5 GWh in 2030

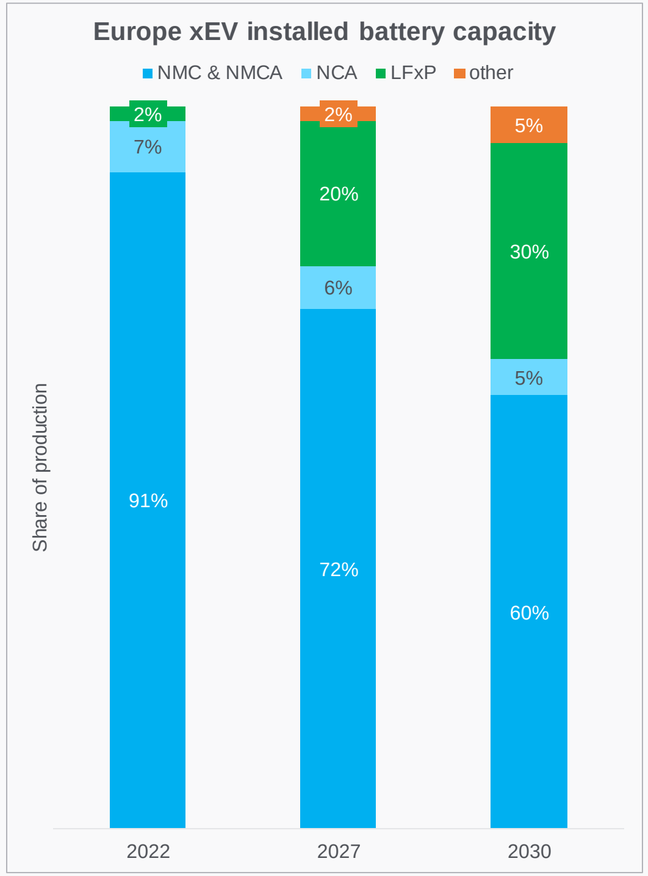
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), BNEF forecasts (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey*

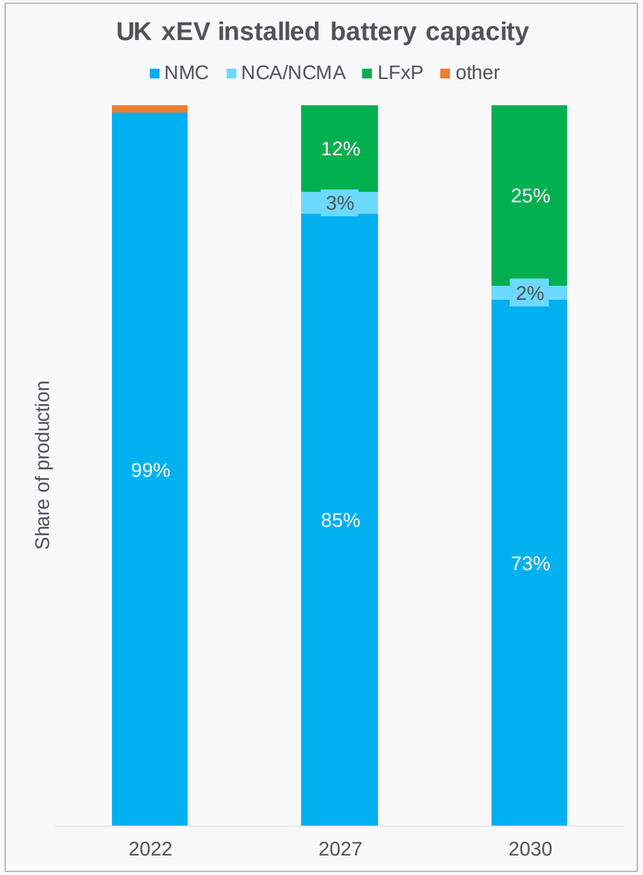
Forecasts for automotive battery production by chemistry

Q4 2022 notes

- Introduction of automotive battery chemistry production forecast
- Globally growth of LFxP pushes NMC share to below 50% by end of this decade
- In Europe and UK NMC continues to dominate for this decade





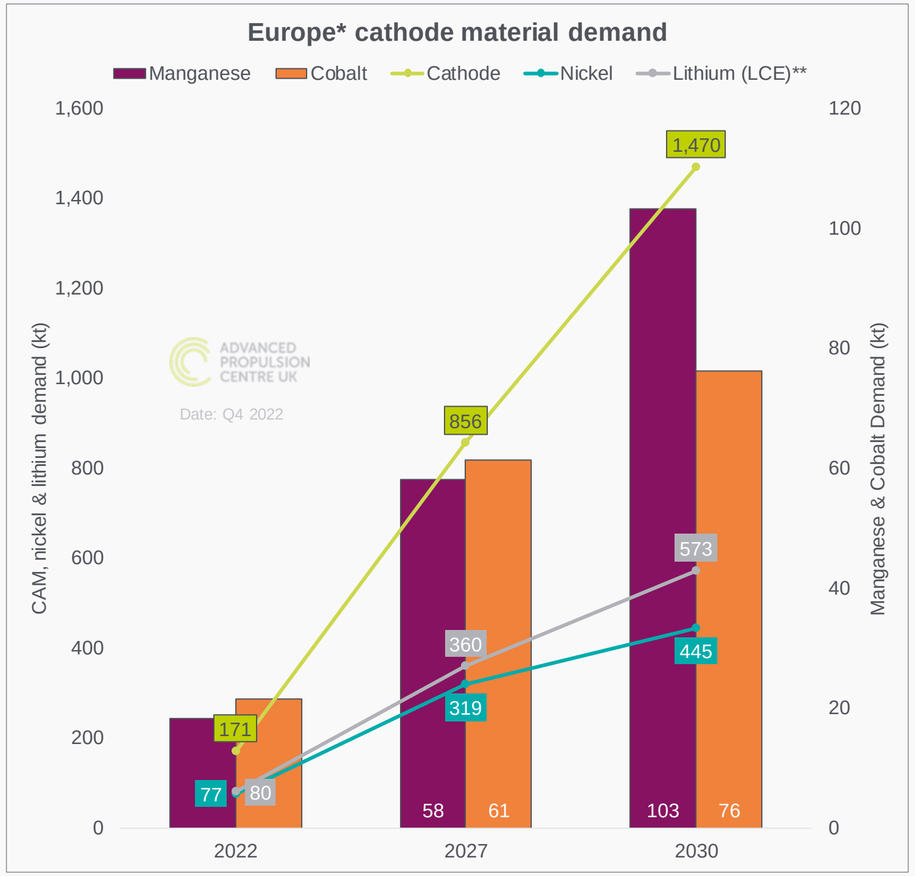


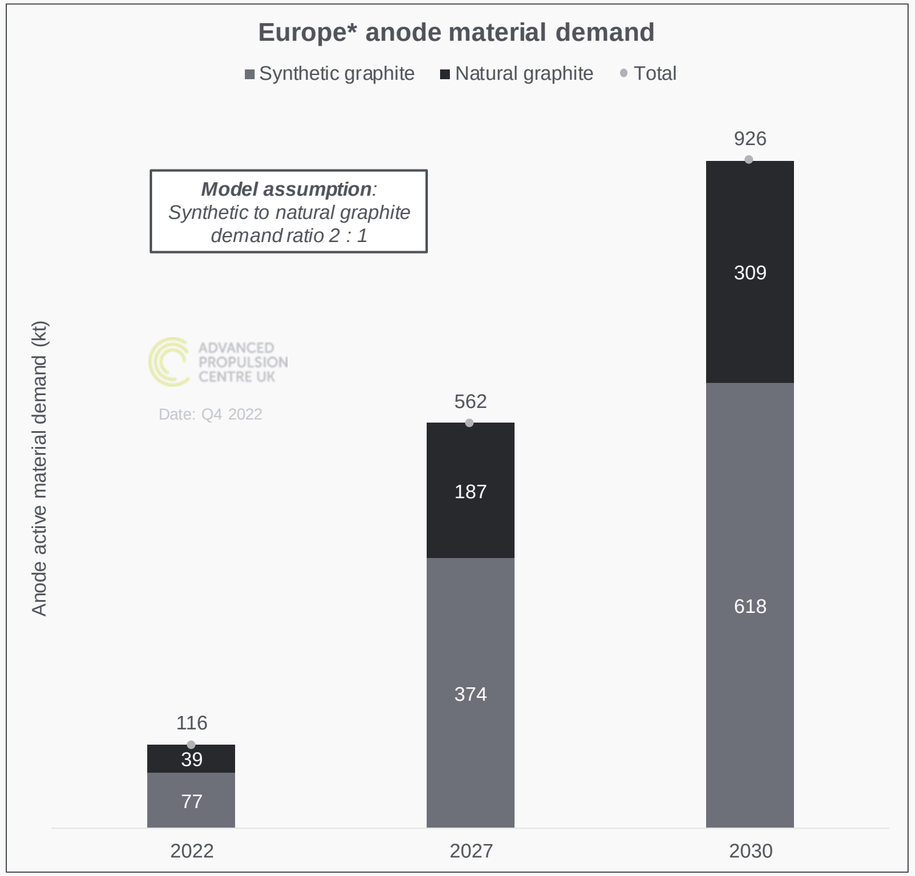
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), BNEF forecasts (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey, ‡Includes non plug-in HEVs & ICE*

European Cathode Active Material (CAM) demand

Q4 2022 notes

- European demand for lithium rises above 500 kt in 2030 with a global supply of 1,100 kt to 2,00 kt
- This is expected to drive adoption of alternative powertrains, such as FCEV and reduced battery sizes



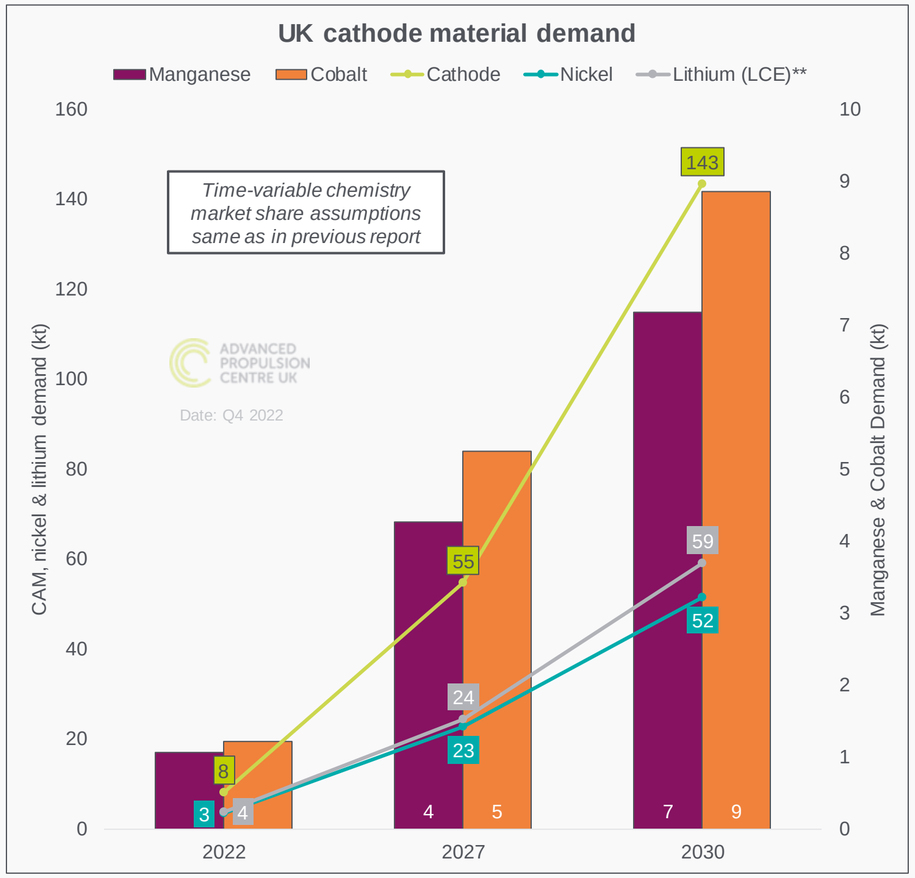


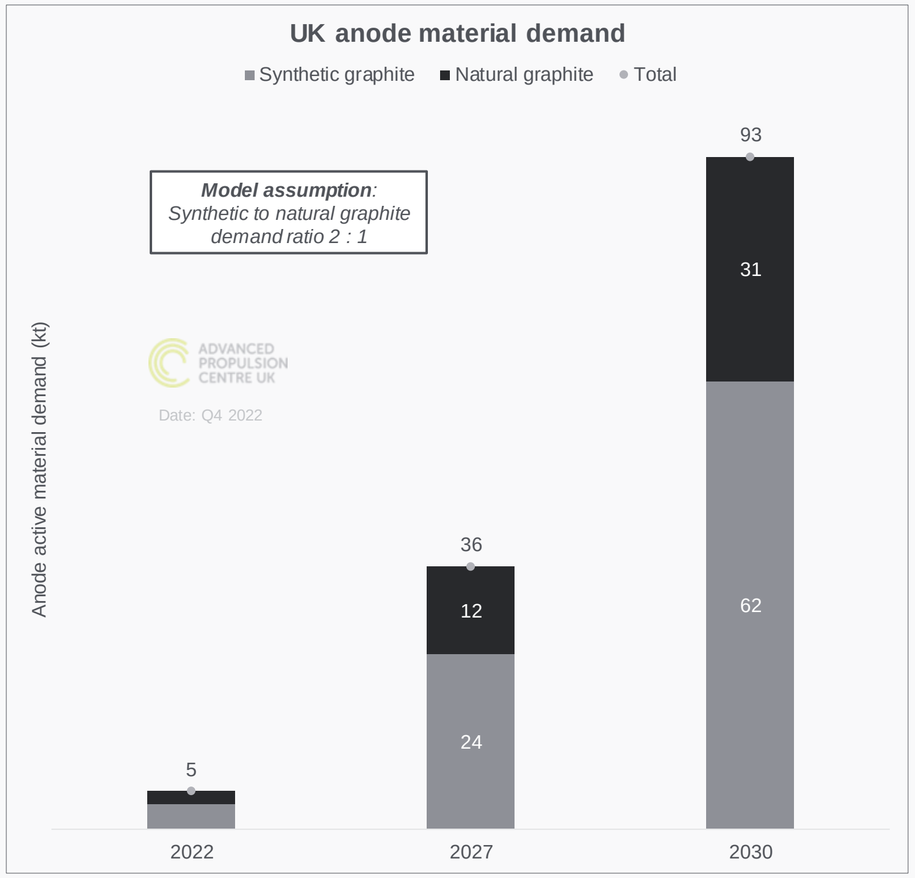
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (2023), BNEF forecasts (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey, **Contained Li metal would be 5.3x lower*

UK Cathode Active Material (CAM) demand

Q4 2022 notes

- UK-based Direct Lithium Extraction projects have the potential to supply at least 50% of 2030 lithium demand



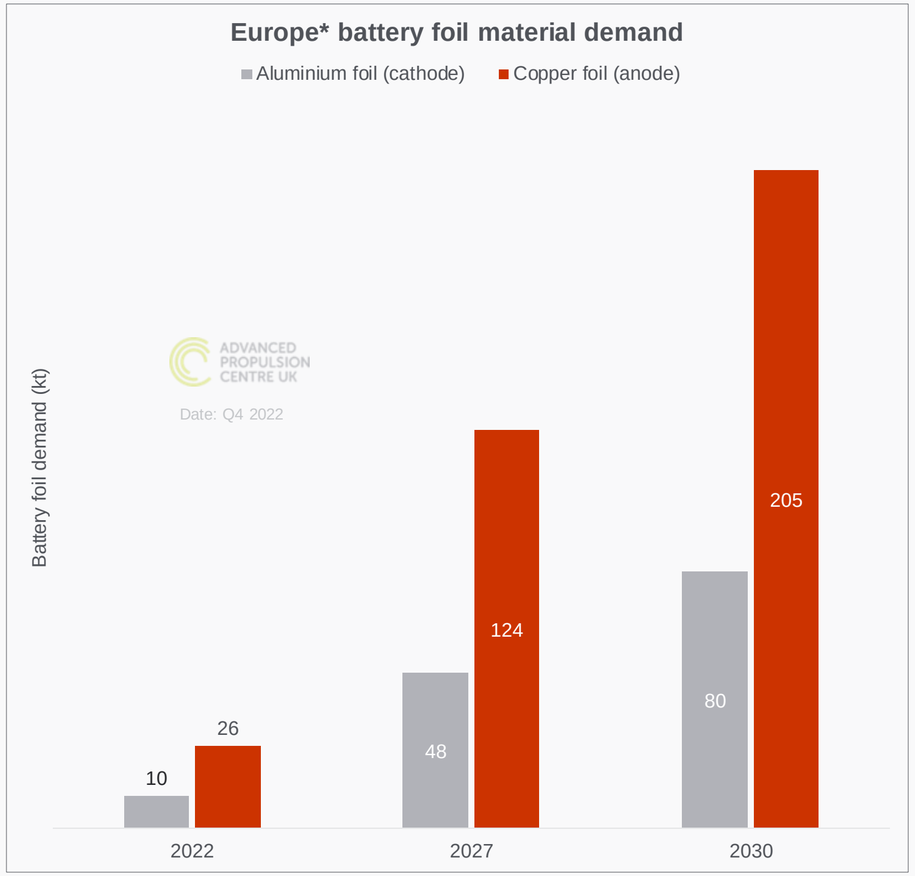


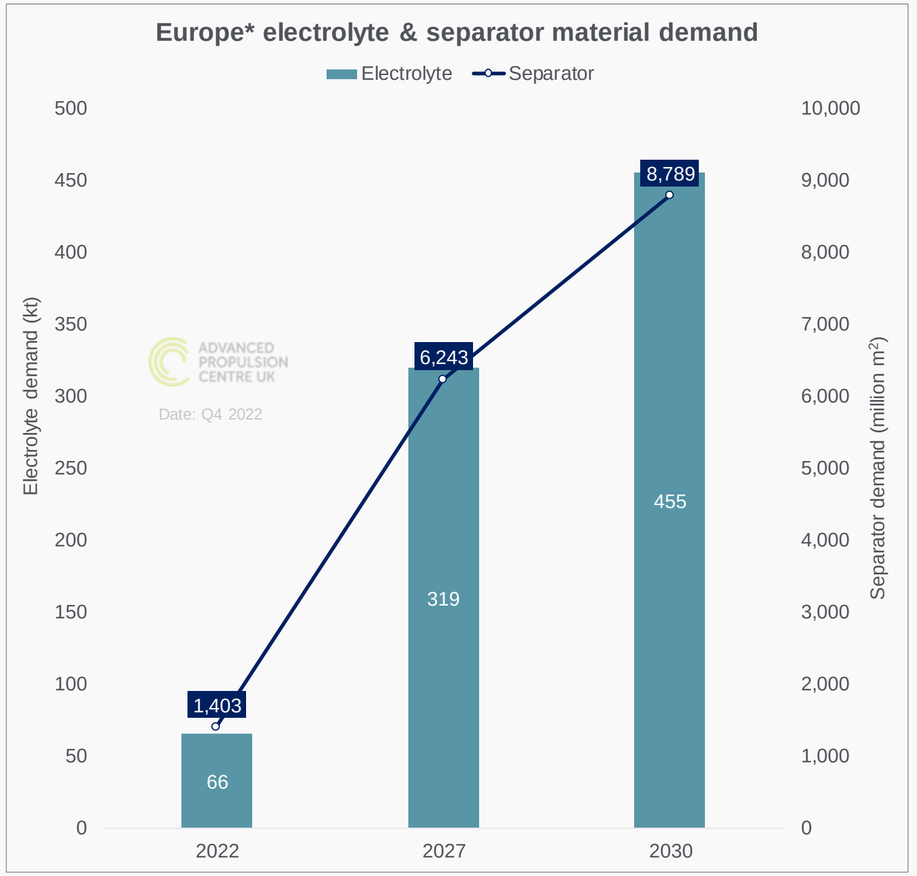
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, **Contained Li metal would be 5.3x lower*

European demand for battery foils, electrolyte and separator material

Q4 2022 notes

- Currently separators and electrolyte are an area of underinvestment in Europe. This could impact Europe's ability to produce locally-made cells.



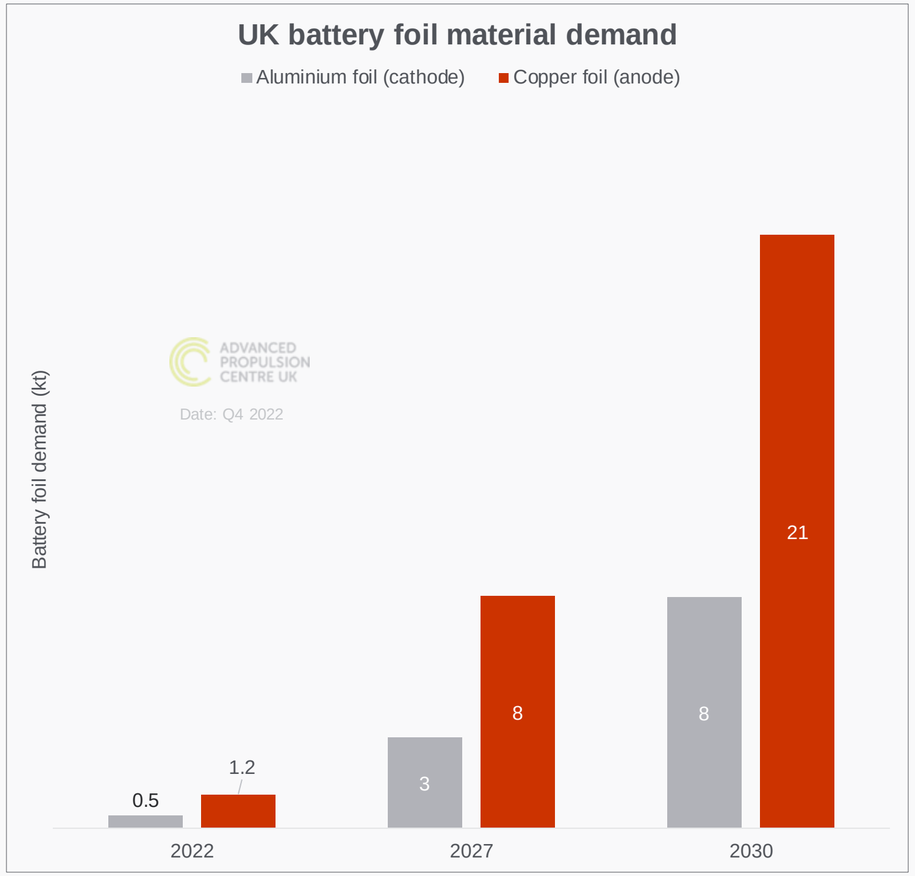


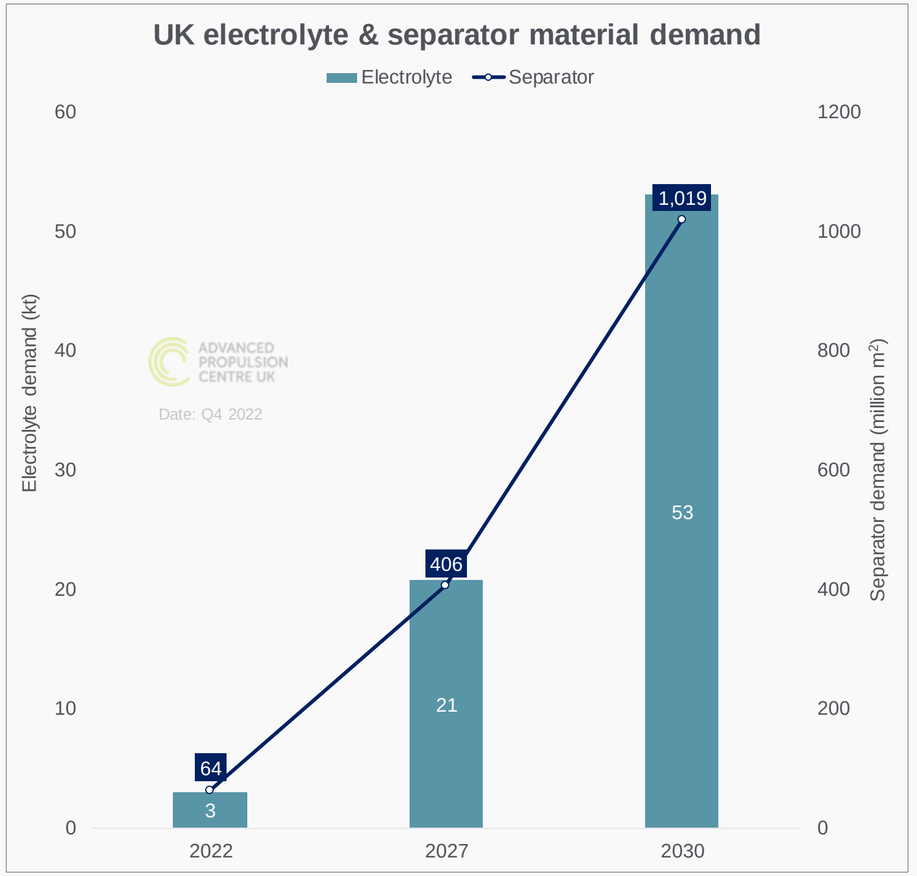
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (2023), BNEF forecasts (2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey*

UK demand for battery foils, electrolyte and separator material

Q4 2022 notes

- UK demand for battery foils, electrolyte and separator materials in 2030 reduced due to lower total UK vehicle production in 2030



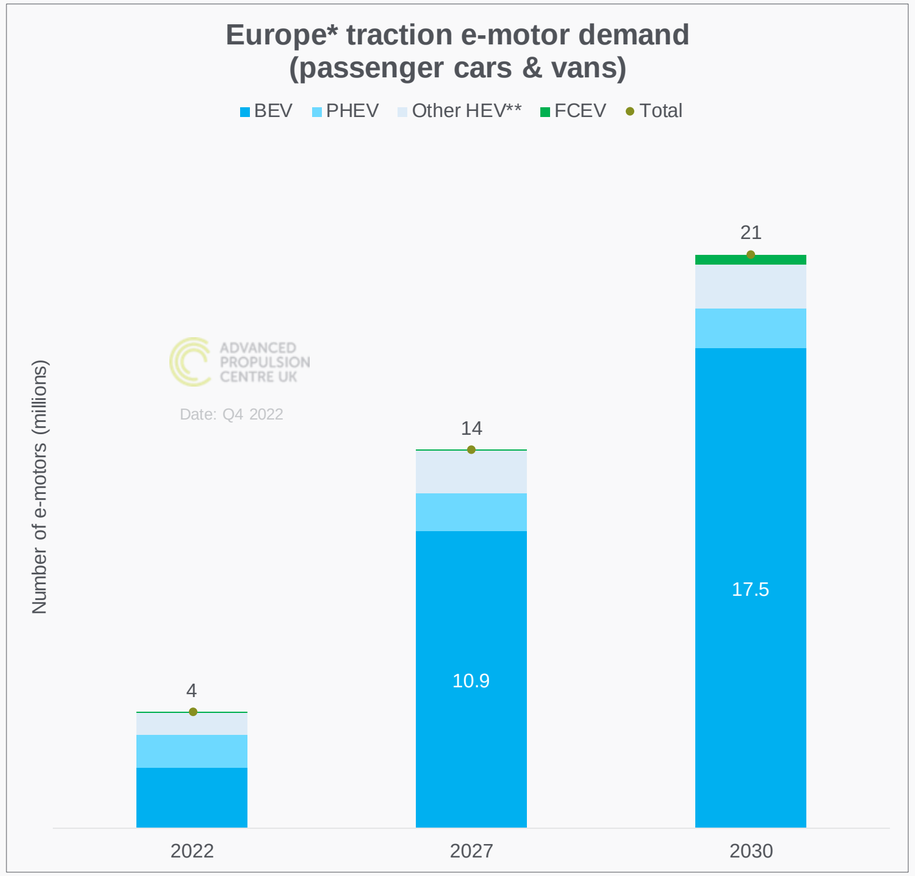


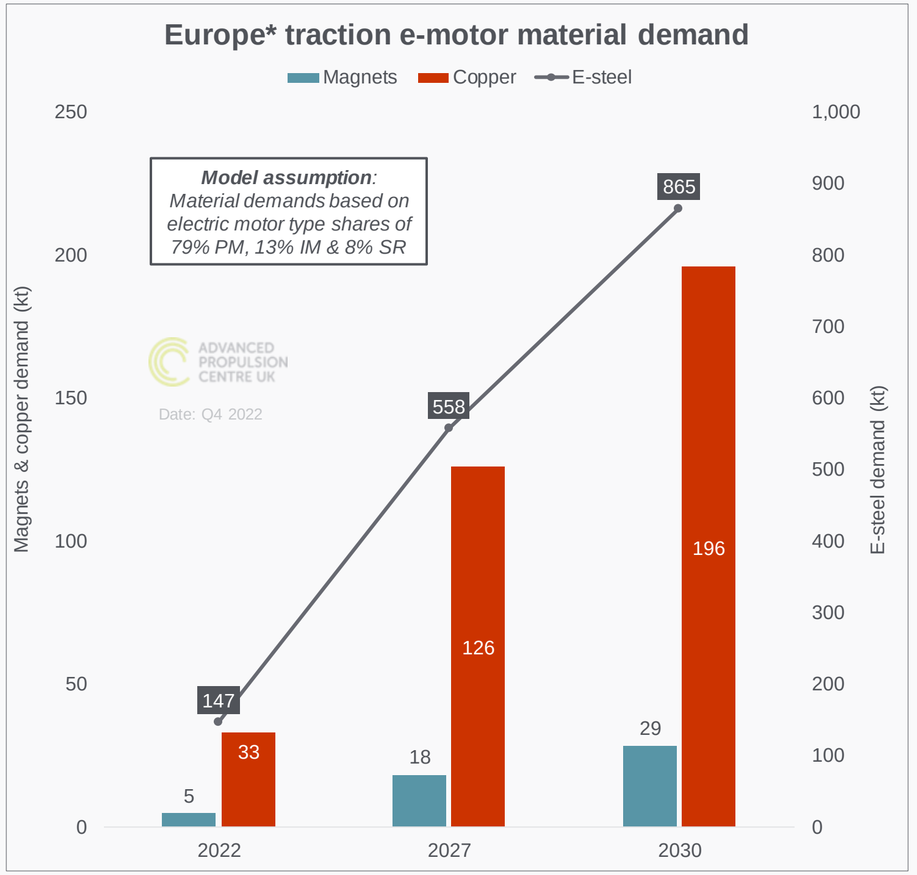
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023), Rho Motion data (2023)
Note: Passenger cars & Light Commercial Vehicles < 3.5t only

European demand for traction electric motors

Q4 2022 notes

- Europe still on track to require 21 million motors in 2030, which will require 29 kt of rare earth material for magnets



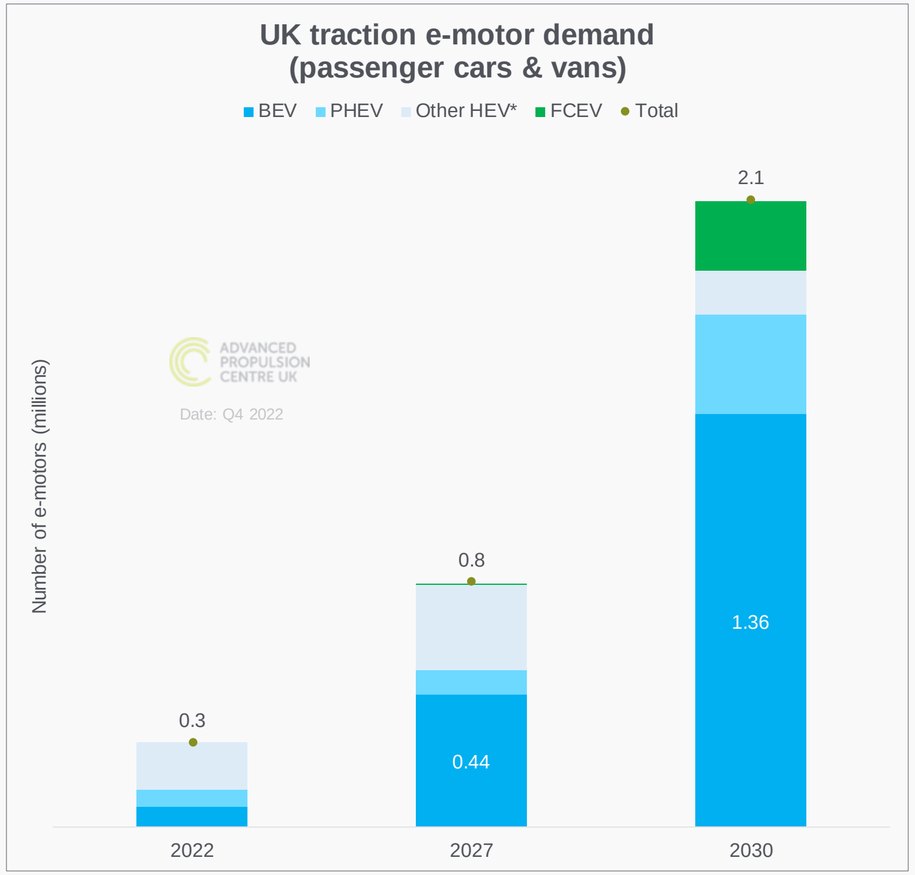


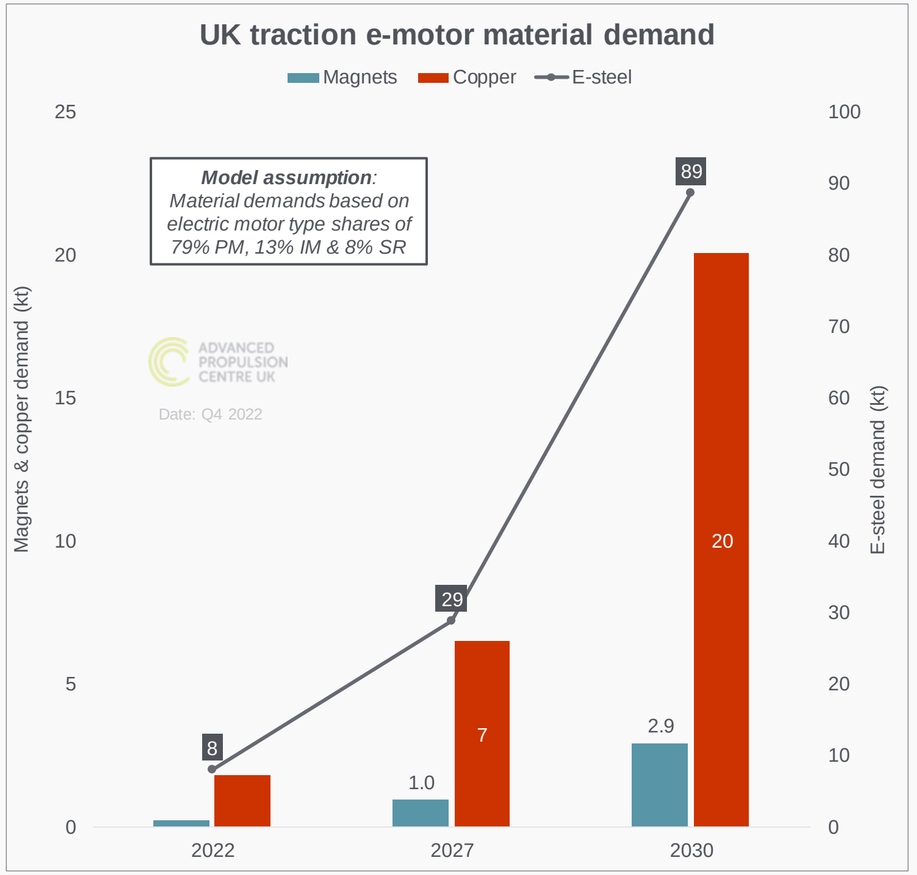
Source: APC Demand Databases using S&P Global AutoTechInsight (Mar, 2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *European forecast includes non-EU countries such as Turkey, **Excluding mild hybrid electric motors*

UK demand for traction electric motors

Q4 2022 notes

- UK on track to require more than 2 million motors in 2030, UK strength in manufacture of motors can be leveraged to supply both UK and for export.
- UK will require 2.9 kt, or more, of rare earth magnets for forecast motor demand in 2030.





Source: APC Demand Databases using internal insights and S&P Global AutoTechInsight (Mar, 2023)
*Note: Passenger cars & Light Commercial Vehicles < 3.5t only, *Excluding mild hybrid electric motors*

ADVANCED PROPULSION CENTRE UK

This Q4 demand forecast is provided by the Technology Trends team at the APC

If you have any questions or would like more detail on any of the graphs or data, email: info@apcuk.co.uk

March 2023