

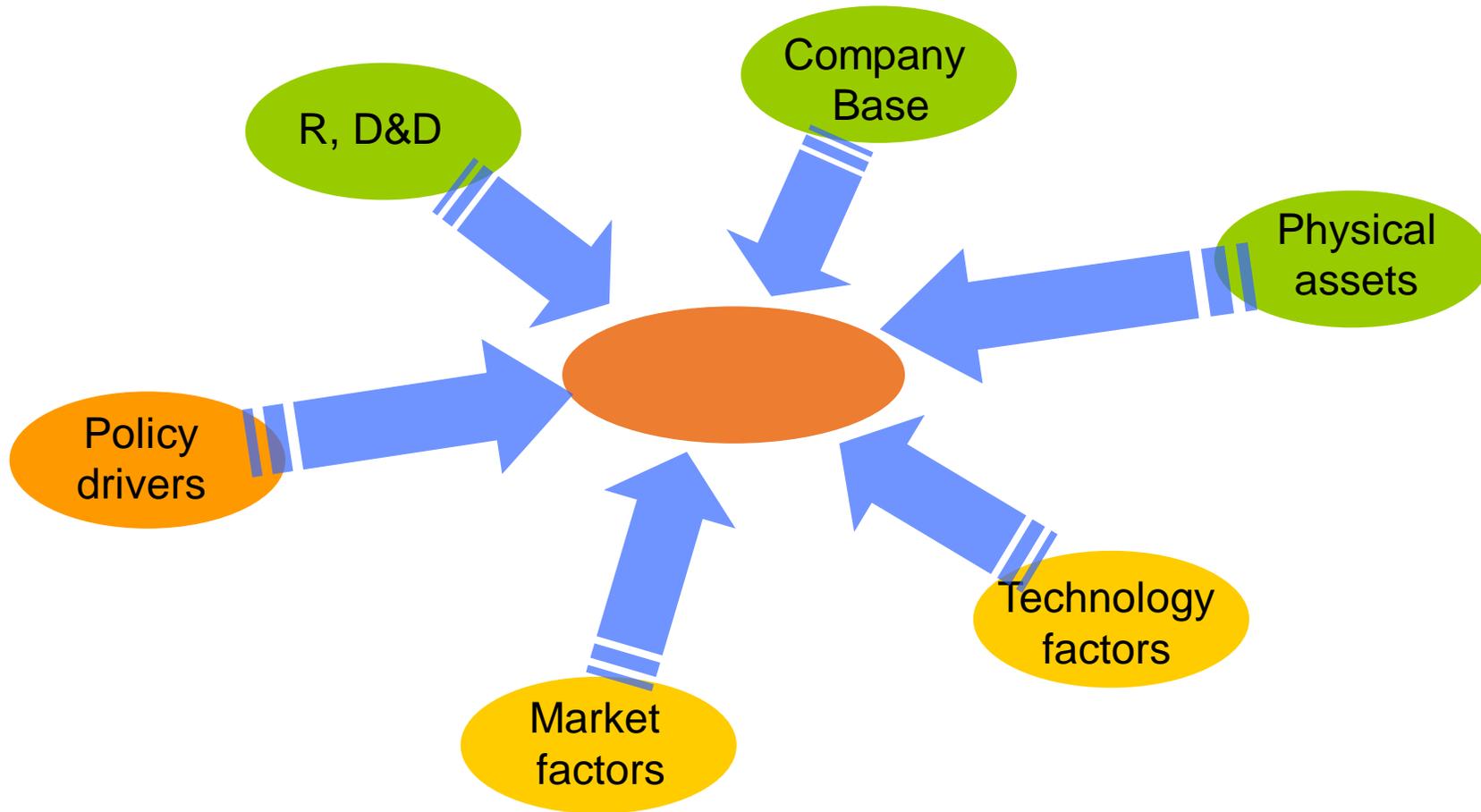
An aerial photograph of a large cable-stayed bridge with white pylons and cables, crossing a wide body of water. In the background, a red truss bridge is visible. The surrounding landscape includes green hills, a town, and a marina with many boats.

The EV revolution - opportunities and challenges

David Butler

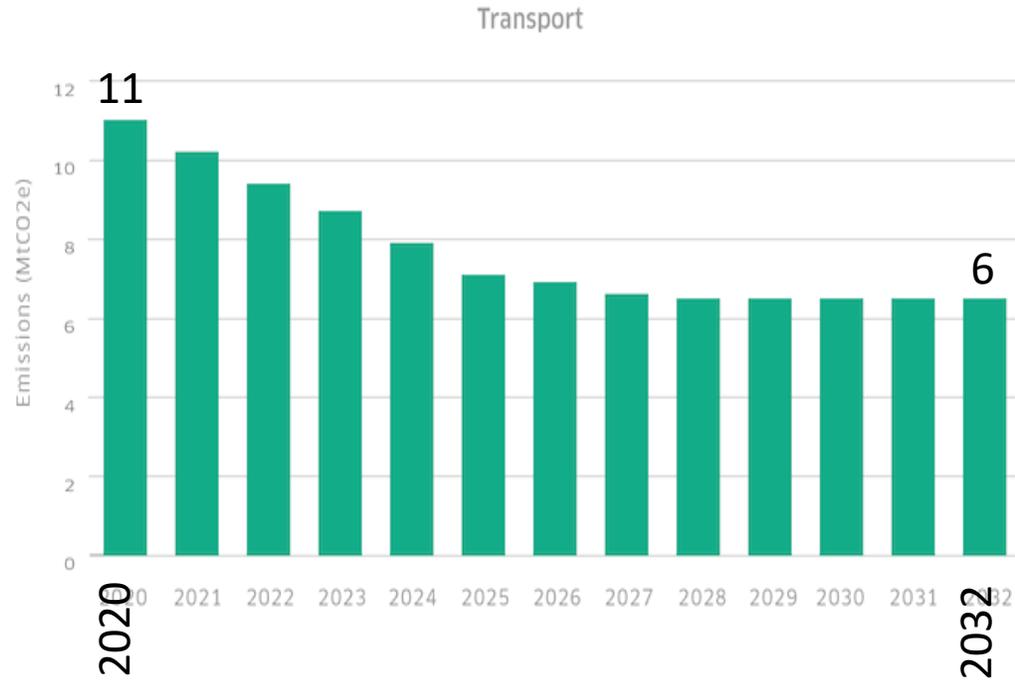
May 2023

Why focus on Zero Emission Vehicles ?



Policy drivers

Scottish Government emissions targets

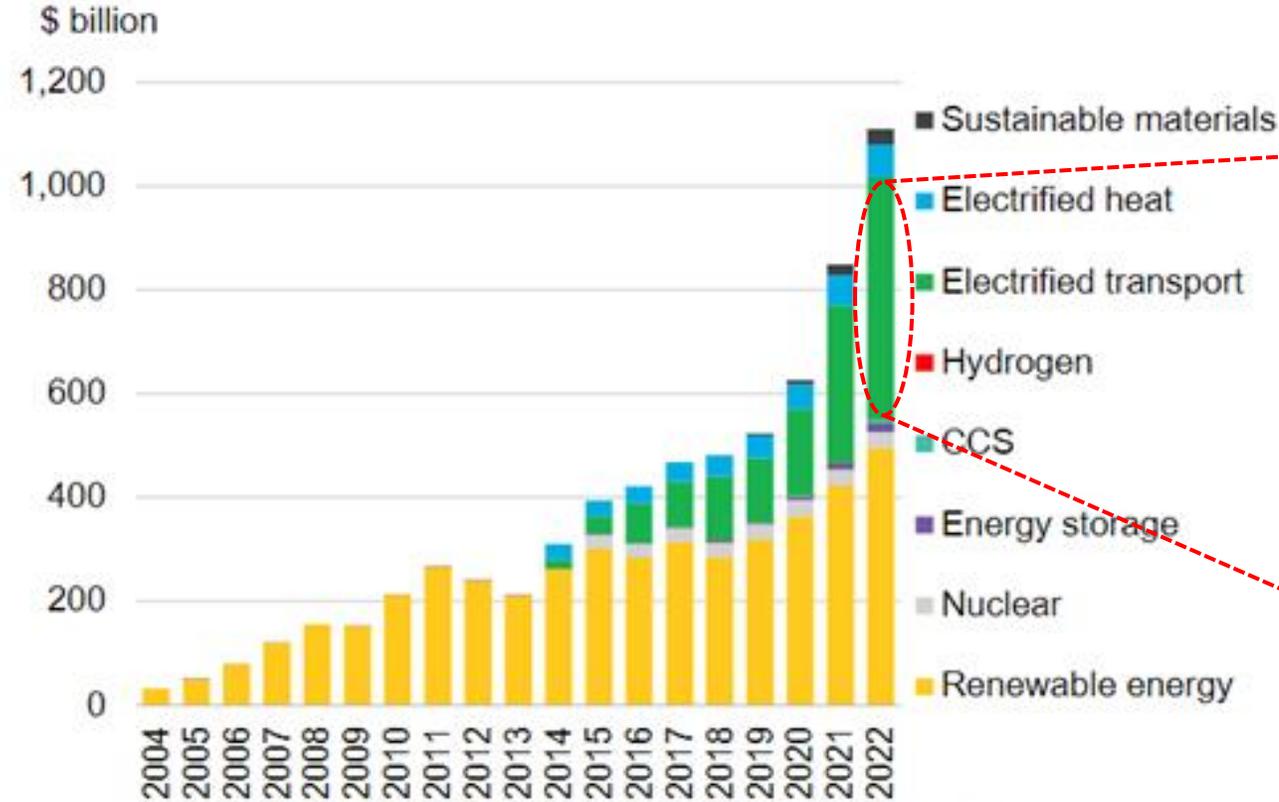


Planned Internal Combustion Engine (fuel) ban dates

National Atmospheric Emission Inventory sector	Fuel	Non Zero Phase Out
Cars	Petrol/ diesel	2030
Buses & Coaches	DERV	2030
Vans	DERV	2035
Air support vehicles	Red diesel	2035
Rigid HGVs	DERV	2035
Articulated HGVs	DERV	2040
Non Road Machinery	Red diesel	2040
Railways	Red diesel	2045
Agriculture	Red diesel	2045

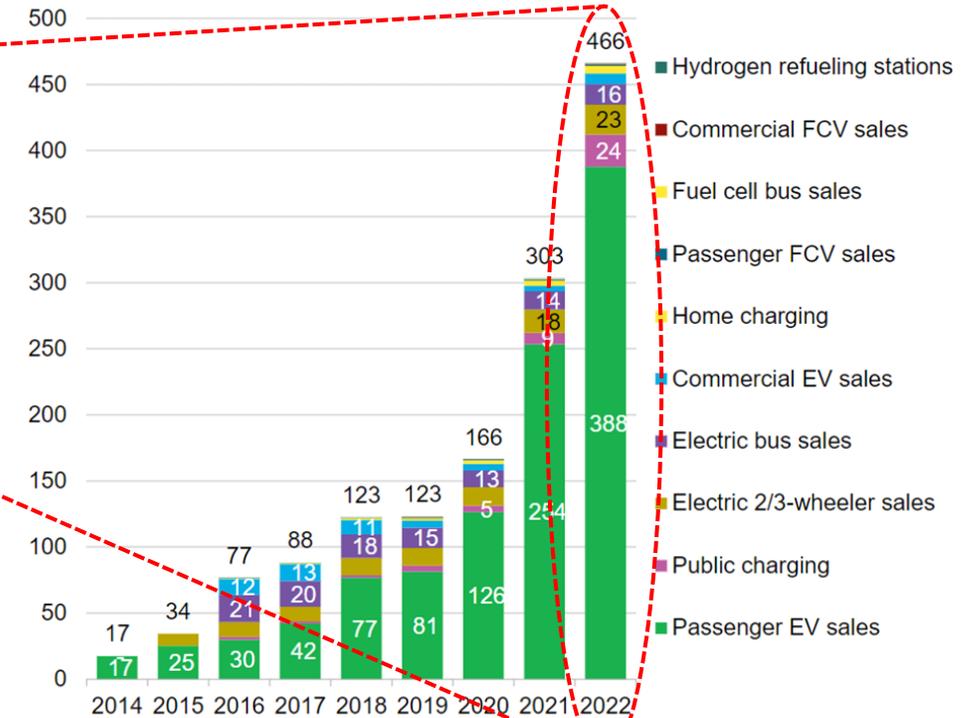
Market factors - transition to Net Zero

Global energy transition investment by sector



Source: BloombergNEF. Note: start-years differ by sector but all sectors are present from 2019 onward; see Appendix for more detail. Nuclear figures start in 2015.

Global electrified transport investment by type (\$ billion)



Source: BloombergNEF. Note: * Electrified transport investment includes spending on vehicles and

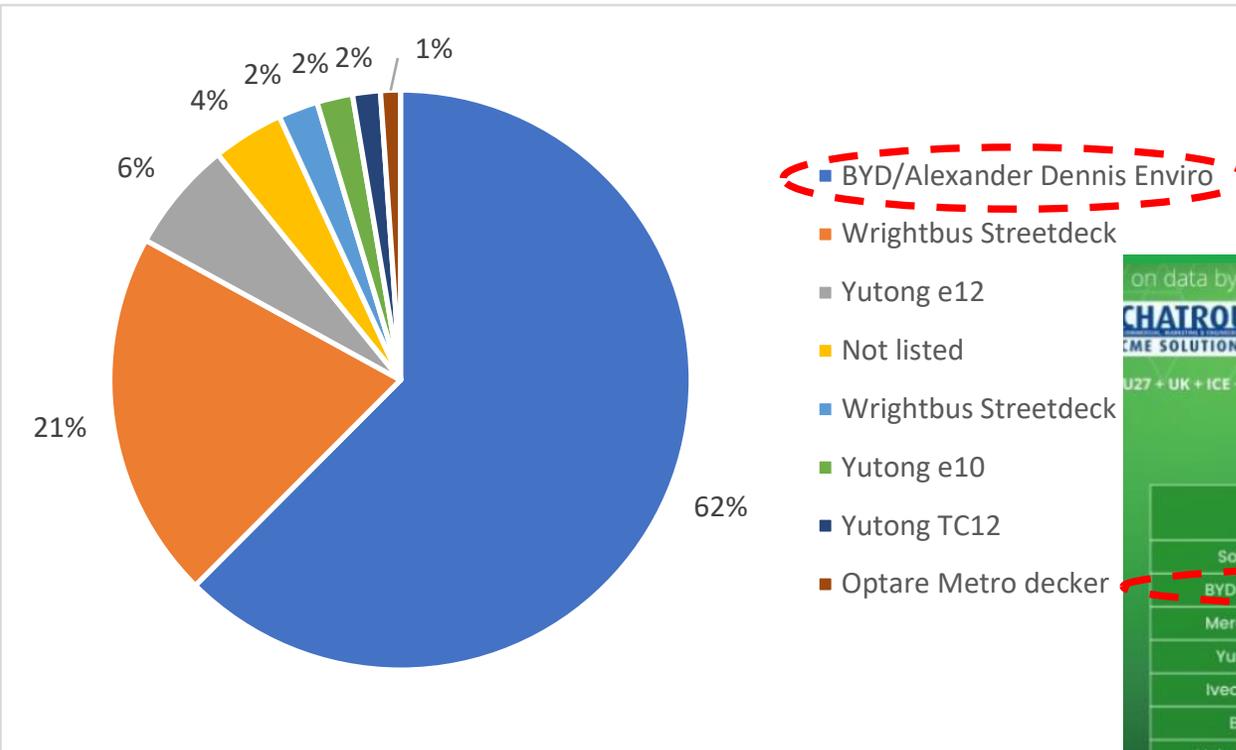
Zero Emission vehicle markets are international

UK EV and FCEV bus registrations 2022 by model



ALEXANDER DENNIS
£600M turnover

BYD
£20BN turnover



EU ebus registrations 2022 by brand

on data by CHATROU TIME SOLUTIONS

EU27 + UK + ICE + NO + CH

EUROPEAN E-BUS MARKET LEADERS 2021

Brand	E-bus registrations 2021	E-bus registrations 2020	Trend registrations 2021 on 2020 (%)	Market share 2021	Market share 2020	Trend market share 2021 on 2020
Solaris	390	416	-6,3	11,9	18,8	-6,9
BYD - ADL	375	190	+97,4	11,4	8,6	+2,8
Mercedes	333	99	+236,4	10,1	4,5	+5,6
Yutong	303	164	+84,8	9,2	7,4	+1,8
Iveco Bus	274	114	+140,4	8,3	5,2	+3,1
BYD	257	424	-39,4	7,8	19,2	-11,4
Volvo Buses	211	217	-2,8	6,4	9,8	-3,4
Irizar	201	24	+737,5	6,1	1,1	+5
VDL	178	127	+40,2	5,4	5,7	-0,3
MAN	134	25	+436	4,1	1,1	+3
Ebusco	132	109	+21,1	4	4,9	-0,9

Sources: Department of Transport & Chatrou 2022

Zero Emission vehicle markets are being driven by innovation and investment



AMTE Power partnered with Cosworth to develop 3 new battery power cells. The project cost £4M and took 3 years to complete. AMTE Report & Accounts 2022

£2M
turnover

£74M
turnover



AMTE website - Thurso: powering our growth plans – ‘Now, as AMTE Power enters a new phase of production scale up to commercial volumes, we’re investing further in our Thurso site. Crucially we’re improving the site’s manufacturing capabilities to ramp up production of two of our core cells: Ultra Prime and Ultra Safe’.
March 27th, 2023

Source: AMTE website

Scottish vehicle company base examples

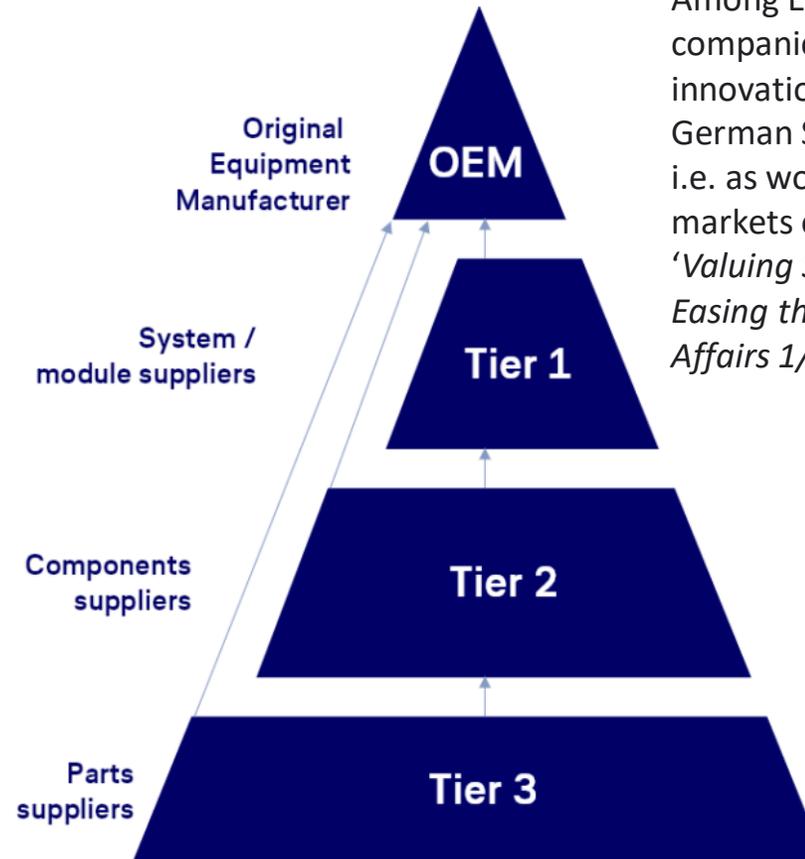


Company	Turnover (£m)	Direct employees (Scotland)
Alexander Dennis (buses)		
Allied Vehicles (taxis)		
Gray and Adams (trailers)		
Rokbak (earth movers)		
Farid Hillend (waste collection)		
Penman (military vehicles)		
Emergency One (emergency)		
McPhee Mixers (concrete mixers)		
Munro (offroad light EV)		
HVS (FCEV trucks)		
Total	960	2,500



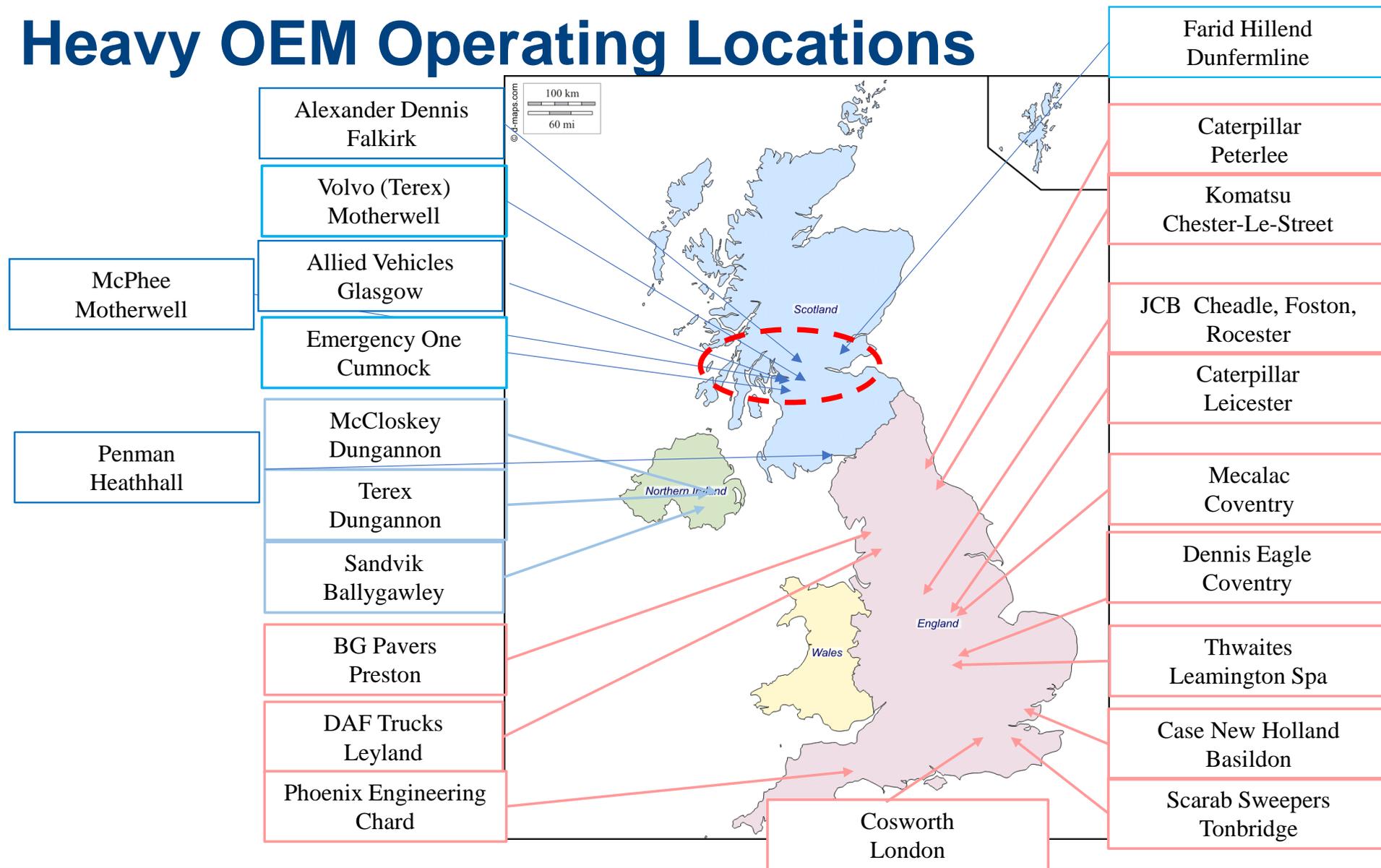
Company	Turnover (£m)	Direct employees (Scotland)
Denchi		
Amte		
CTS Corporation		
Verlume		
MEP Technologies		
Plug Life		
Total	15	160

Source: Dunn and Bradstreet



Among European SMEs, German Mittelstand companies have been found to be very strong on innovation. Indeed a huge number of high-tech German SMEs are classed as 'hidden champion', i.e. as world market leaders their respective niche markets or in supply chains for large companies. *'Valuing SMEs - Strengthening Opportunities - Easing the Burden'* Federal Ministry of Economic Affairs 1/10/2019

Heavy OEM Operating Locations



Public sector support examples

- Support for innovation
 - CAN DO Zero Emissions Heavy Duty Vehicles (R&D feasibility) challenge Autumn '22 - £720k 15 projects
- Public procurement
 - ScotZeb Phase I Spring '22 - £62m towards 276 battery-electric buses and their associated infrastructure
 - SFRS in May 2022 received a new electric fire appliance with a £500k R&D contribution by SE towards Emergency One's £1.7m R&D investment
- Support for test and demo sites eg Michelin Innovation Parc



Tech trends - EV batteries cost and performance

Forecast trends for EV battery costs

For pack level battery costs, OEMs are converging around \$100/kWh in 2025 and \$80/kWh in 2030



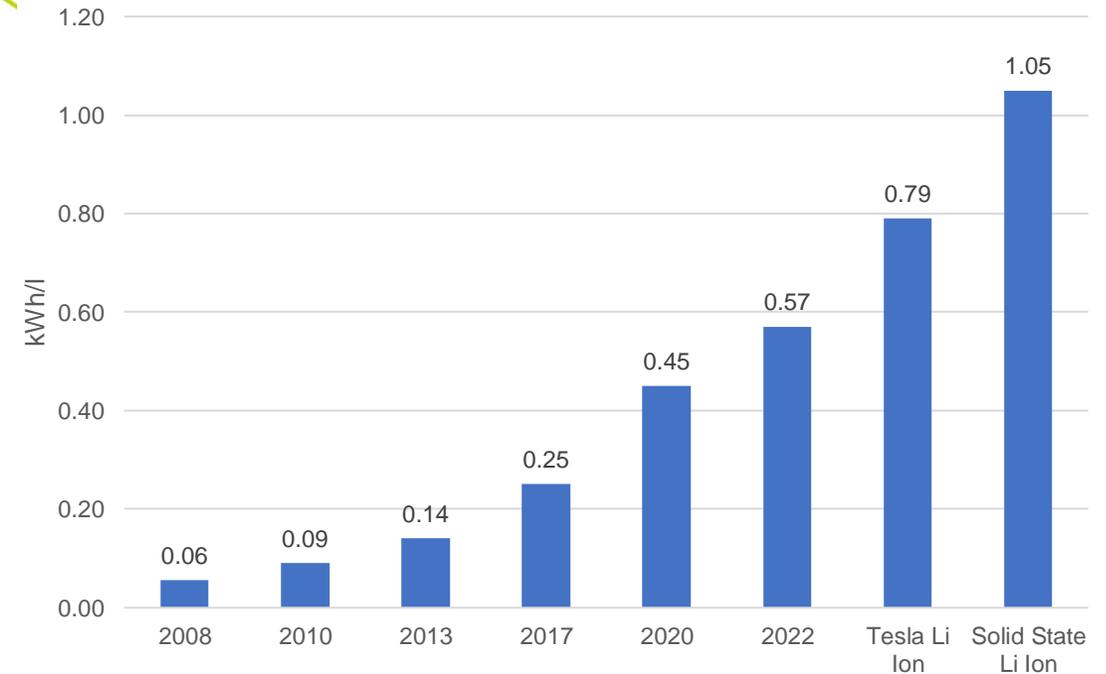
Battery Costs \$/kWh	Source 2020	2020		Source 2025	2025		Source 2030	2030	
		Pack	Cell ¹		Pack	Cell ¹		Pack	Cell ¹
	Link	137	102 ²	Link	92	65 ²	Link	58	42 ²
	Link	143	107	N/A	-	-	Link	80	60 ²
	Link	125	85 ²	Link	97	70 ²	Link	77	58 ²
	Link	165	123	Link	100	75	Link	80	60
	Link	150	113	Link	100	75	Link	80	60
	Link	150	113	Link	100	75	N/A	-	-
	Link	133	100 ²	N/A	-	-	Link	67 ³ 93 ³	50 70
	Link	129	97	Link	73 ⁴	55 ⁴	N/A	-	-

1) Unless specified, cell costs are derived by multiplying the pack costs by 75%
 2) Cell \$/kWh provided in the literature
 3) 50% cost reduction by 2030 for the "Entry" Segment ; 30% for "Volume" by 2030
 4) Based on Tesla's Battery Day Announcement Sept 2020- 56% reduction before 2025

Reduction from 2020	34%	46%
142	94	76
Average	Average	Average

Source: UKAPC 2022

Energy density trends of EV batteries

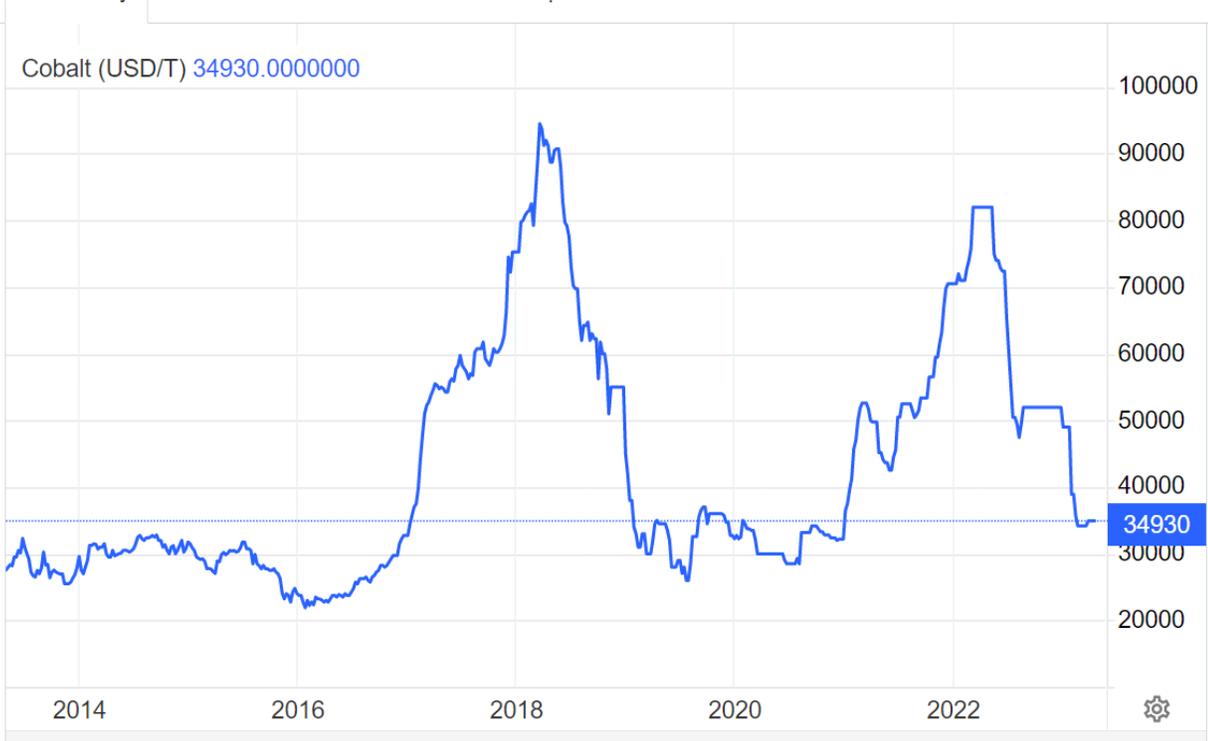
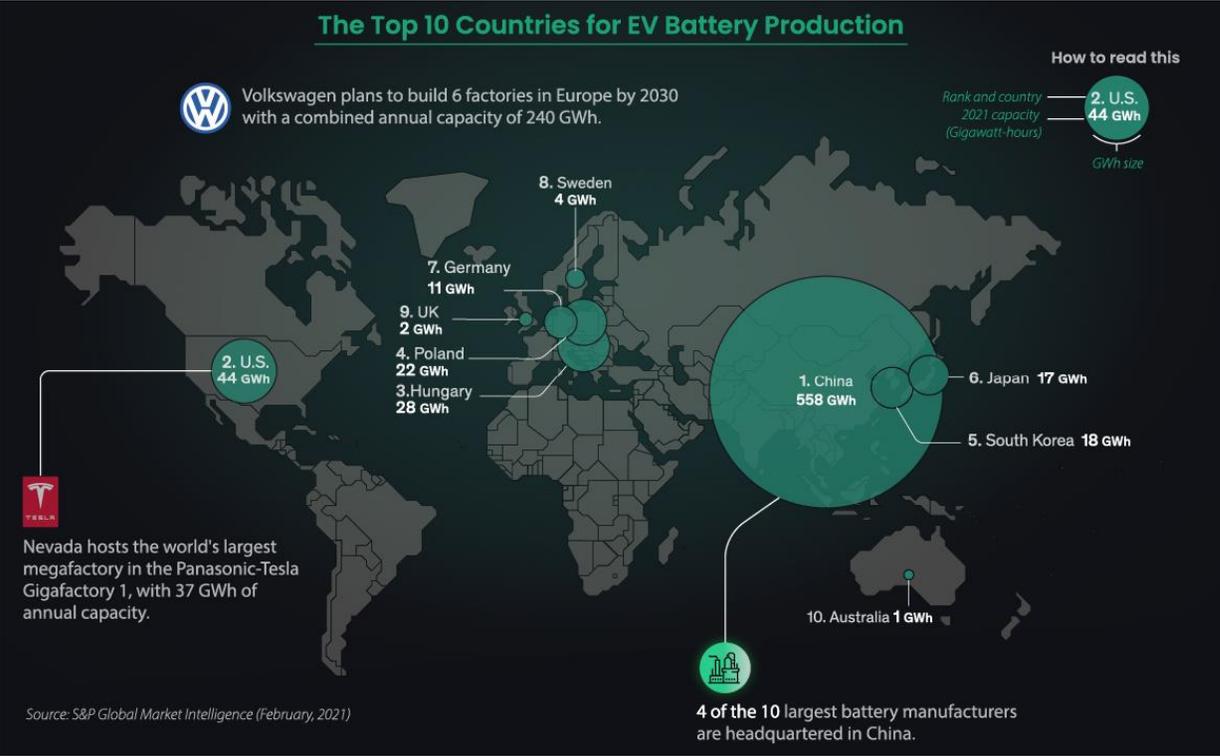


Source: US Vehicle Technologies Office 2022

EV batteries – some downside risks

Location of global production of EV batteries

Global price of traded cobalt



Source: Optimat 2022

Source: Trading Economics 2022

SE Performance Management Framework

2022/25 Performance Measurement Framework

Published outcomes

Planned jobs paying at least the Real Living Wage

Planned innovation investment £ (businesses, places)

Planned capital investment £ (businesses, places)

Growth funding raised by businesses £

Planned international exports £

Estimated CO2e savings (businesses & projects)

Supporting measures

Planned jobs:

- Green
- New
- Safeguarded
- Inward investors
- Scottish businesses

Net Zero:

- Number circular economy projects

Innovation:

- R&D investment £ (SE, private, other public)
- Other innovation investment £ (SE, private, other public)
- Number of innovation projects (product/service or process)
- Sales from innovation

Fair innovative & transformative work:

- Number of companies committed to/implementing fair, innovative & transformative work practices

Capital expenditure

- Leverage: (SE, private, other public)

Early stage, high growth entrepreneurship:

- Number of early-stage companies supported

Growth funding:

- Investment leverage £ (SE, private, other public)
- Number of companies supported to improve financial readiness
- Number of companies supported to improve financial readiness that secure growth funding

Sales:

- Exports: No of new products/services launched in new international markets (exported from the UK for the first time by supported companies)
- Exports: No new markets (countries) entered (by supported companies)
- UK sales

Thank you