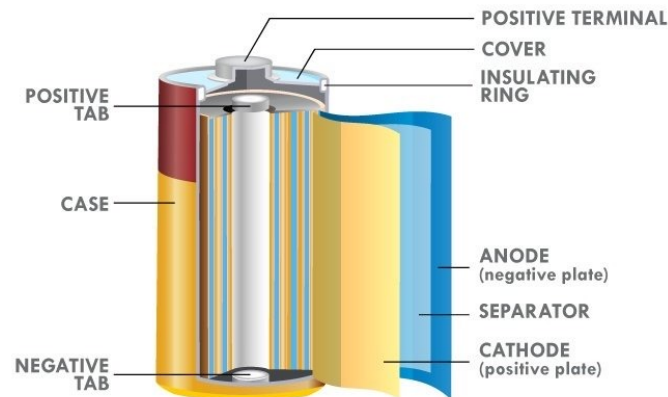
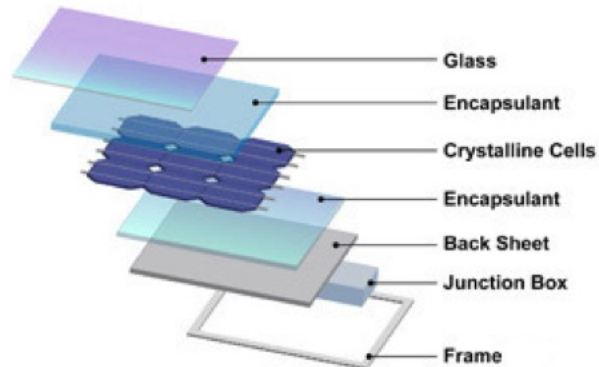




The opportunity for SiC in the UK supply chain
Prepared for Centre for Power Electronics Annual Meeting
July 2021

About Exawatt

Strategic consulting and market analysis in industries that support **decarbonization** through electrification



Focus of this presentation

Power electronics (not RF)

Markets where SiC value justifies increased cost (vs silicon)

How SiC market share will grow as its cost falls

Overview of the UK SiC supply chain (current and prospective)

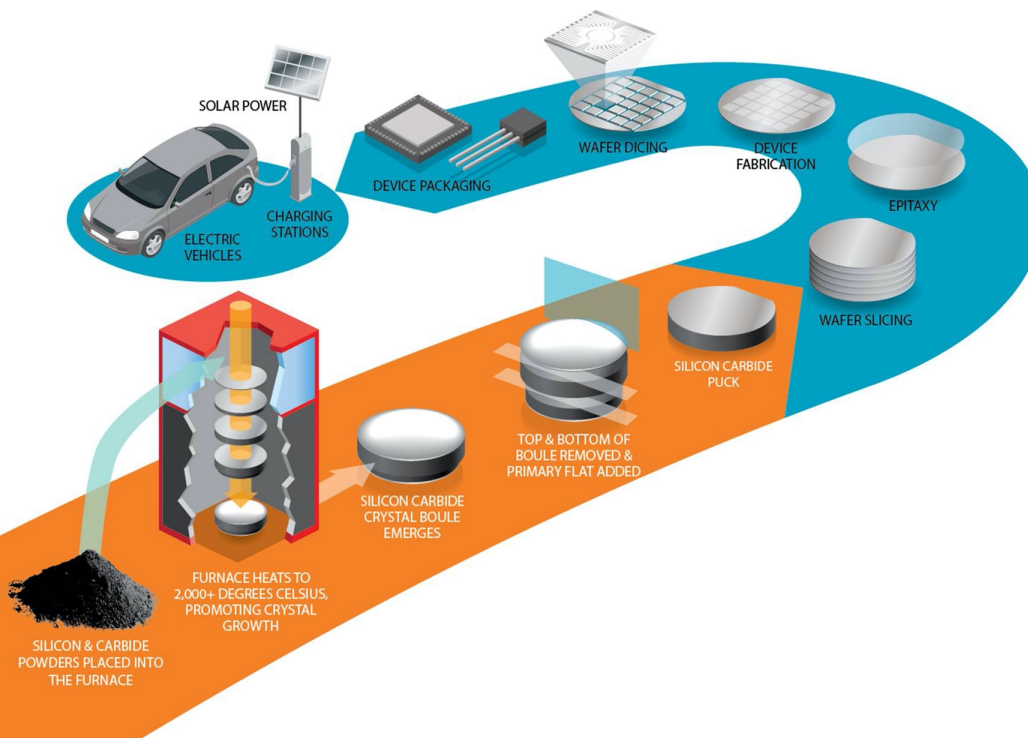
How the UK can establish capability in SiC

Exawatt activity in SiC

Exawatt has applied its PV research methodologies to the global SiC power electronics market, beginning with applications in EVs

Models include:

- SiC **crystal growth** cost
- SiC **die cost**
- SiC **device cost** and **performance** tracker (MOSFET and Schottky diode)
- SiC **device** and **wafer demand** analysis and forecasts for EV and PV markets
- EV **core technology analysis** (inverter, DC-DC converter, on-board charger, charging station) and demand forecasts
- Global **EV sales** tracking and forecasting

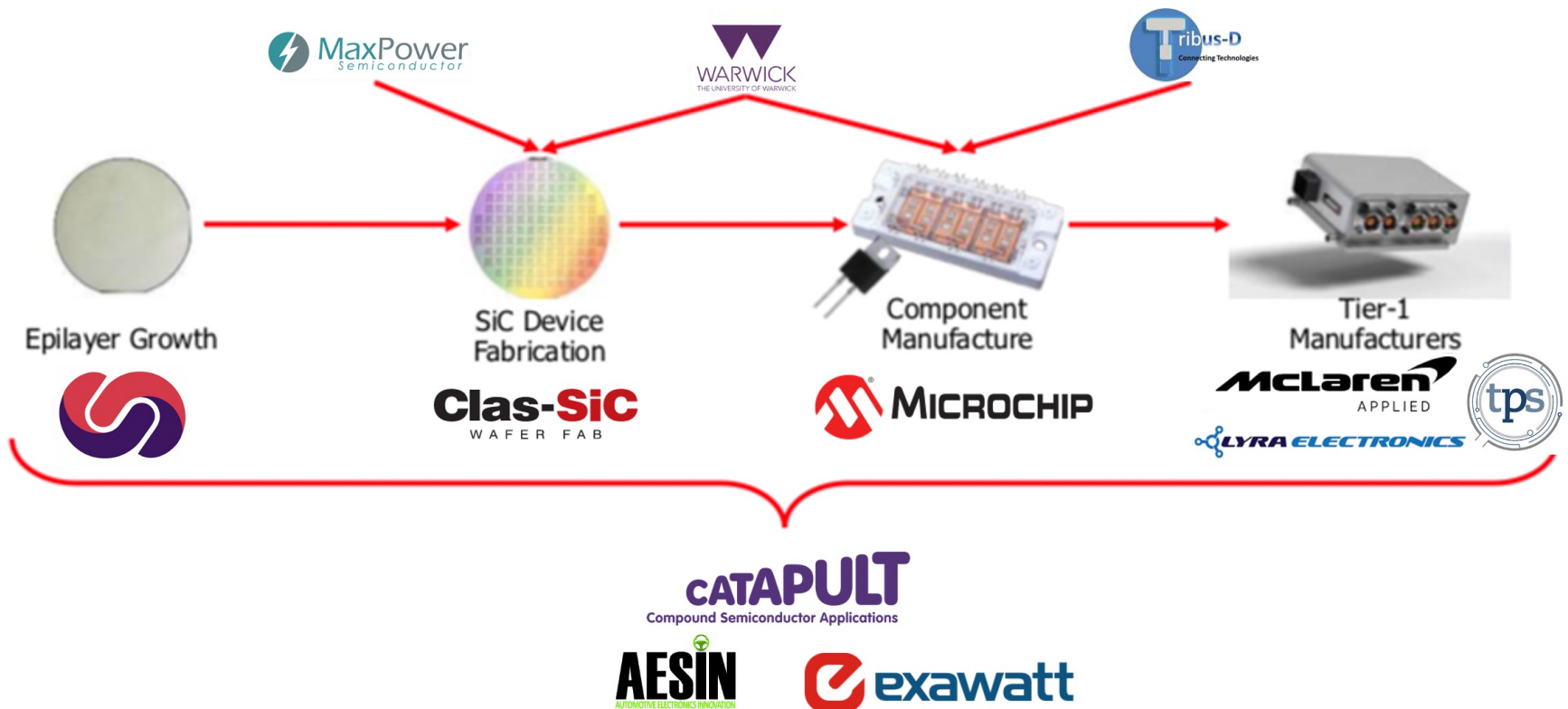


Source: GT Advanced Technologies

Exawatt research partnerships: ESCAPE project

Exawatt is part of the UK-based ESCAPE project (End-to-end Supply Chain development for Automotive Power Electronics). The project started in October 2019

Focus is on developing a supply chain for silicon carbide in automotive applications

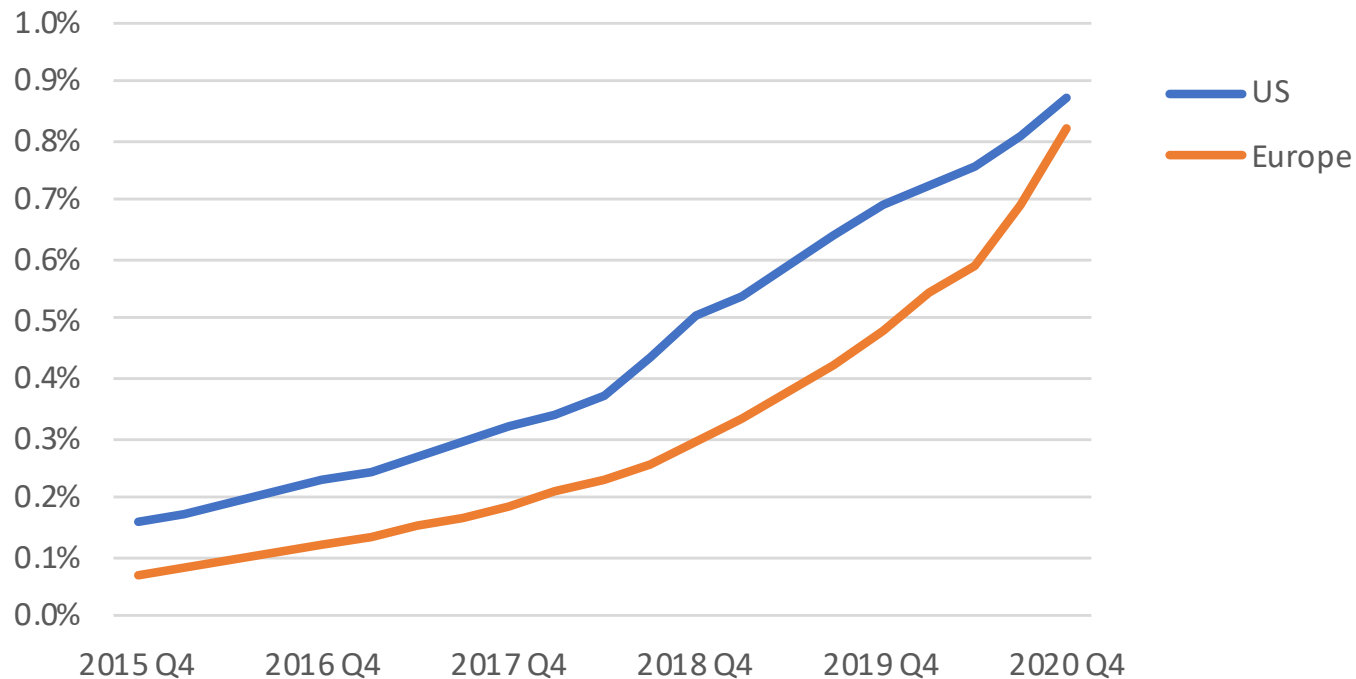


The BEV revolution is gathering momentum

We believe BEVs – not hybrids – will dominate the vehicle market by 2030

This presents a huge opportunity for SiC: lots of device-hungry vehicles with big, expensive batteries – and **SiC can help to reduce battery pack size and cost**

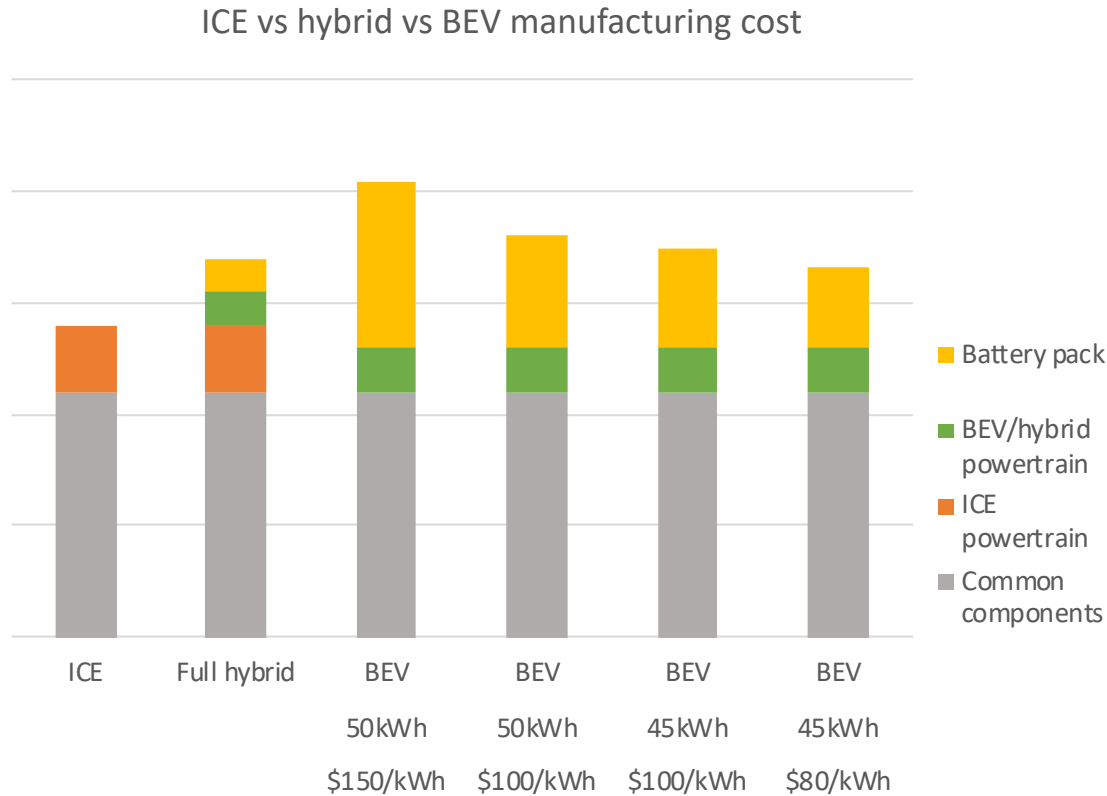
BEV household share



Source: Exawatt

BEV cost drivers: range, battery cost/kWh, efficiency

SiC enables **either** a 5-10% increase in range – **or** a smaller battery for the same range

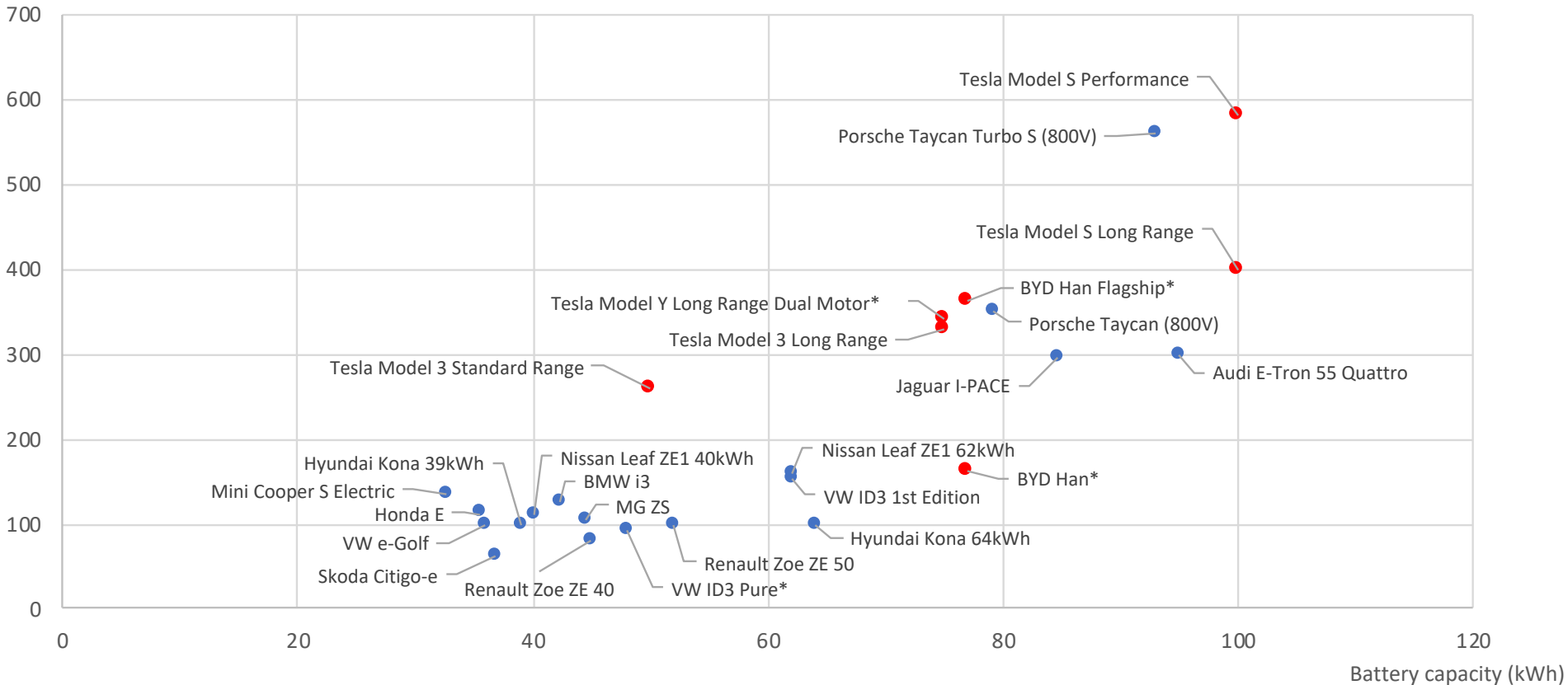


Source: Exawatt, incorporating estimates from TUM, ICCT, EPA, CARB, NHTSA, company data, Morgan Stanley

SiC benefit is greatest in long-range cars

EV battery capacity vs motor power

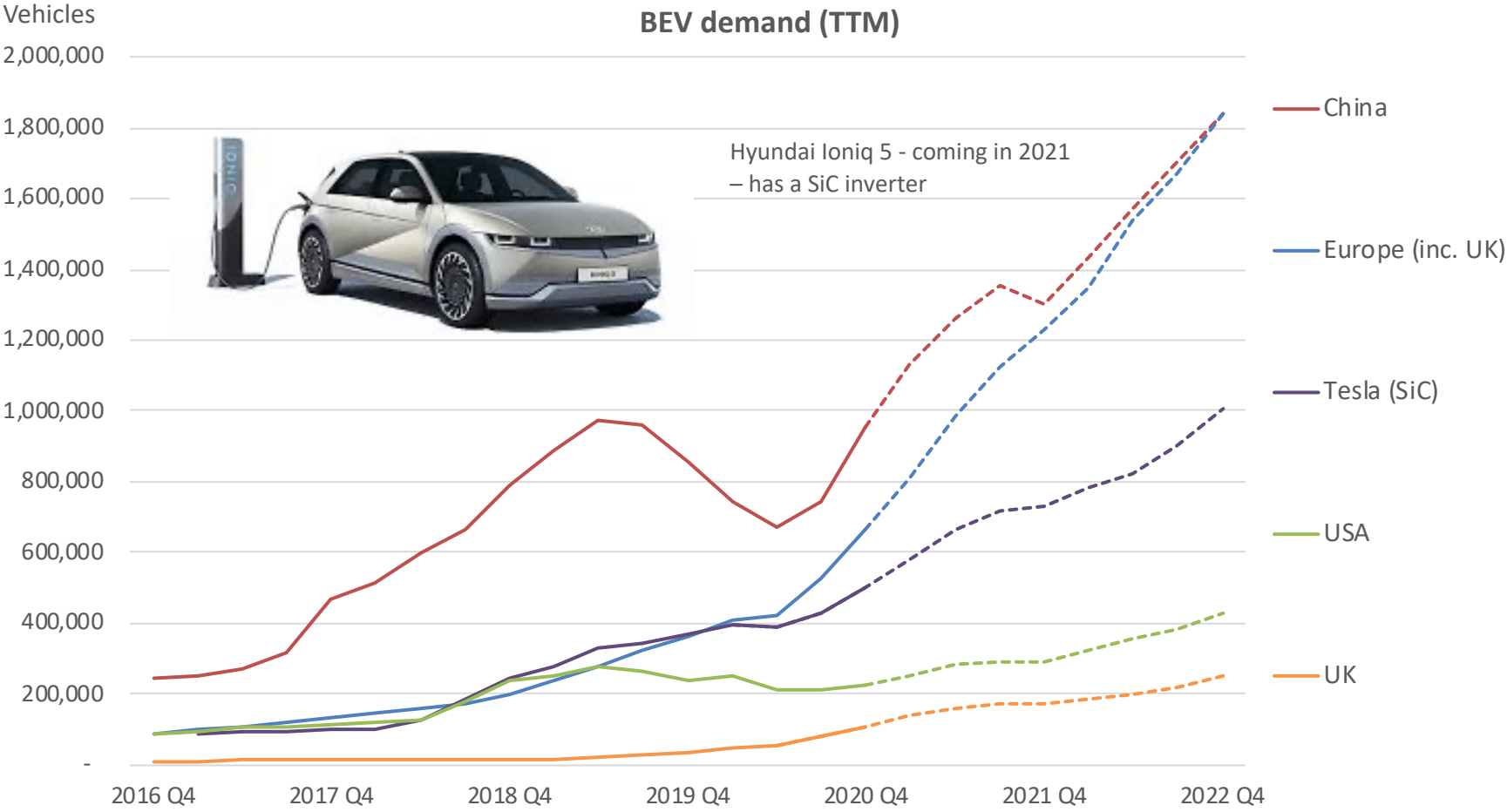
Motor power (kW)



Source: Exawatt

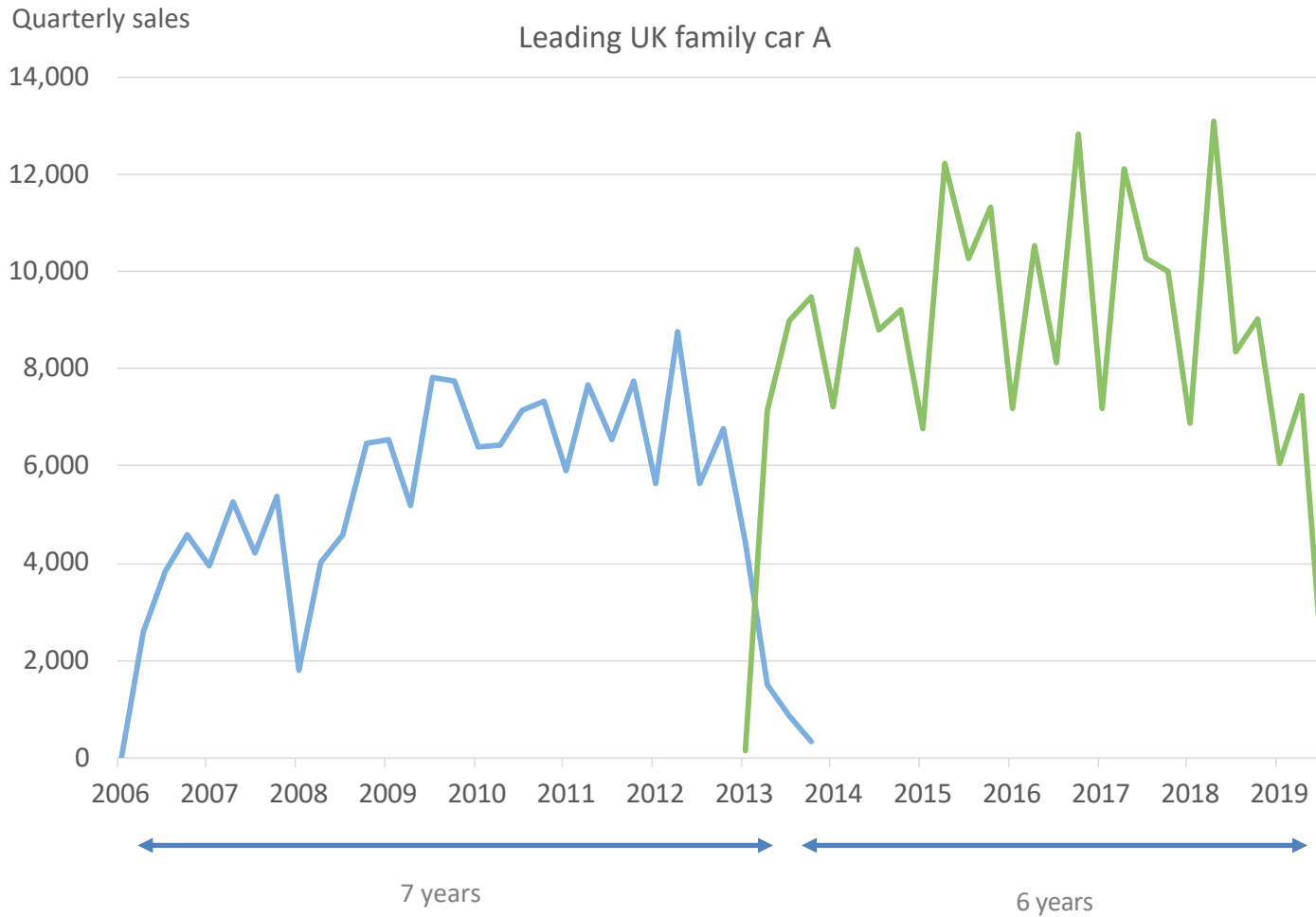
- Inverter uses SiC MOSFETs
- Inverter uses Si IGBTs

SiC is already mainstream



Source: Exawatt

New car model lifetime is typically 5-8 years



Source: Exawatt analysis of DfT data

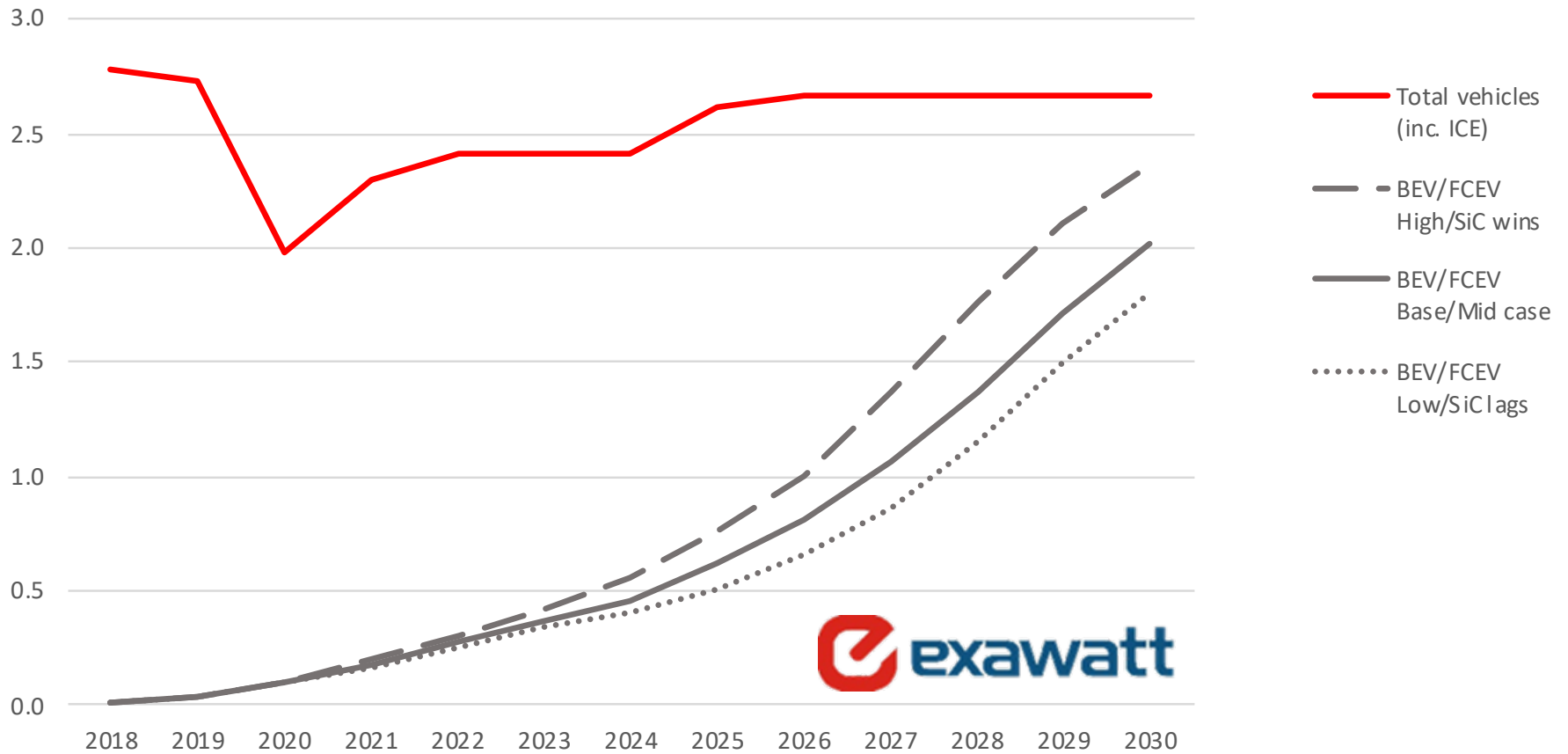
When will the last mainstream passenger ICE car be sold?

Event	Aggressive	Conservative
BEVs reach tipping point*	2024	2026
Last mainstream ICE car model launches	2025	2027
ICE version production lifetime	5 years	8 years
Last mainstream ICE car is produced in UK	2030	2035

* functionally equivalent for needs of average user, and competitively priced

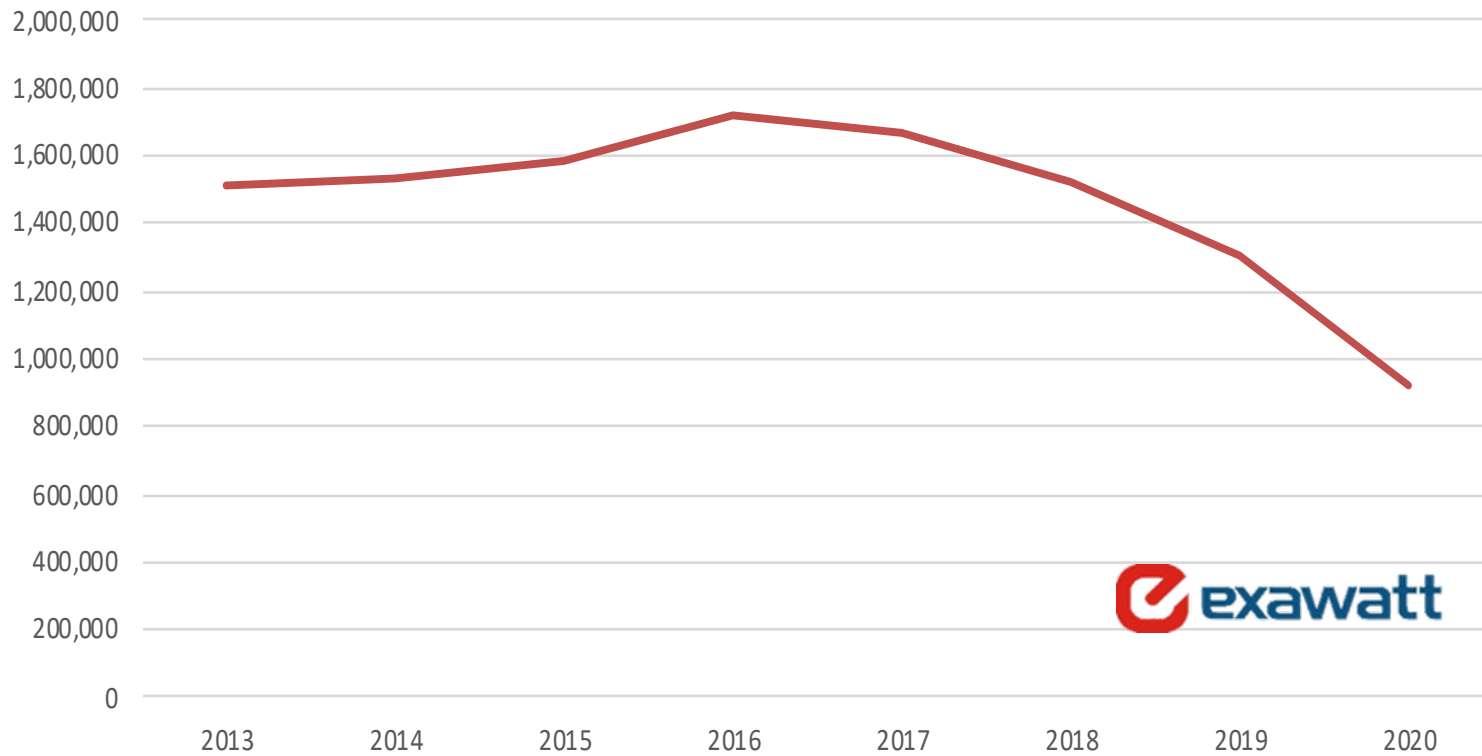
UK BEV sales will grow...

UK BEV and FCEV sales (millions of vehicles)



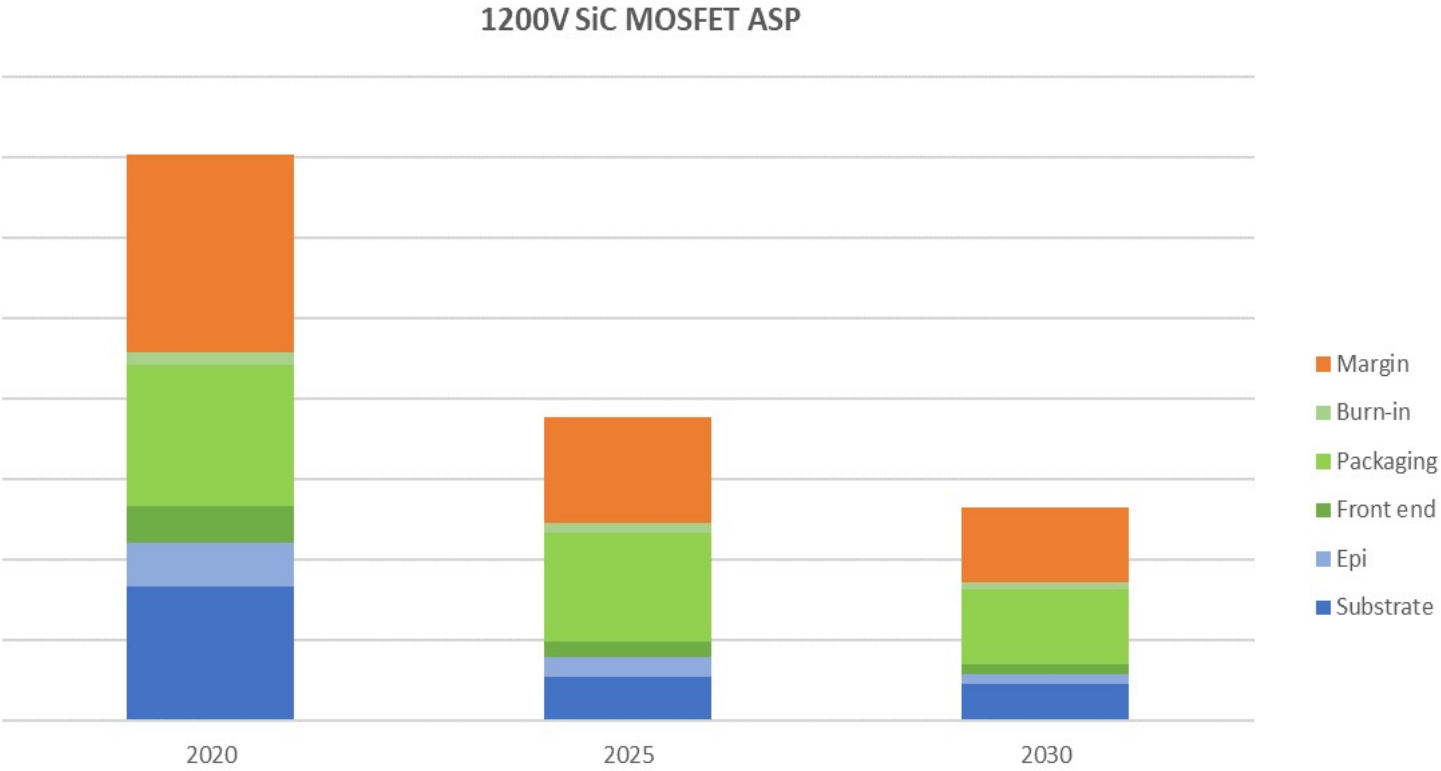
... but UK manufacturing must take advantage

Cars manufactured in the UK



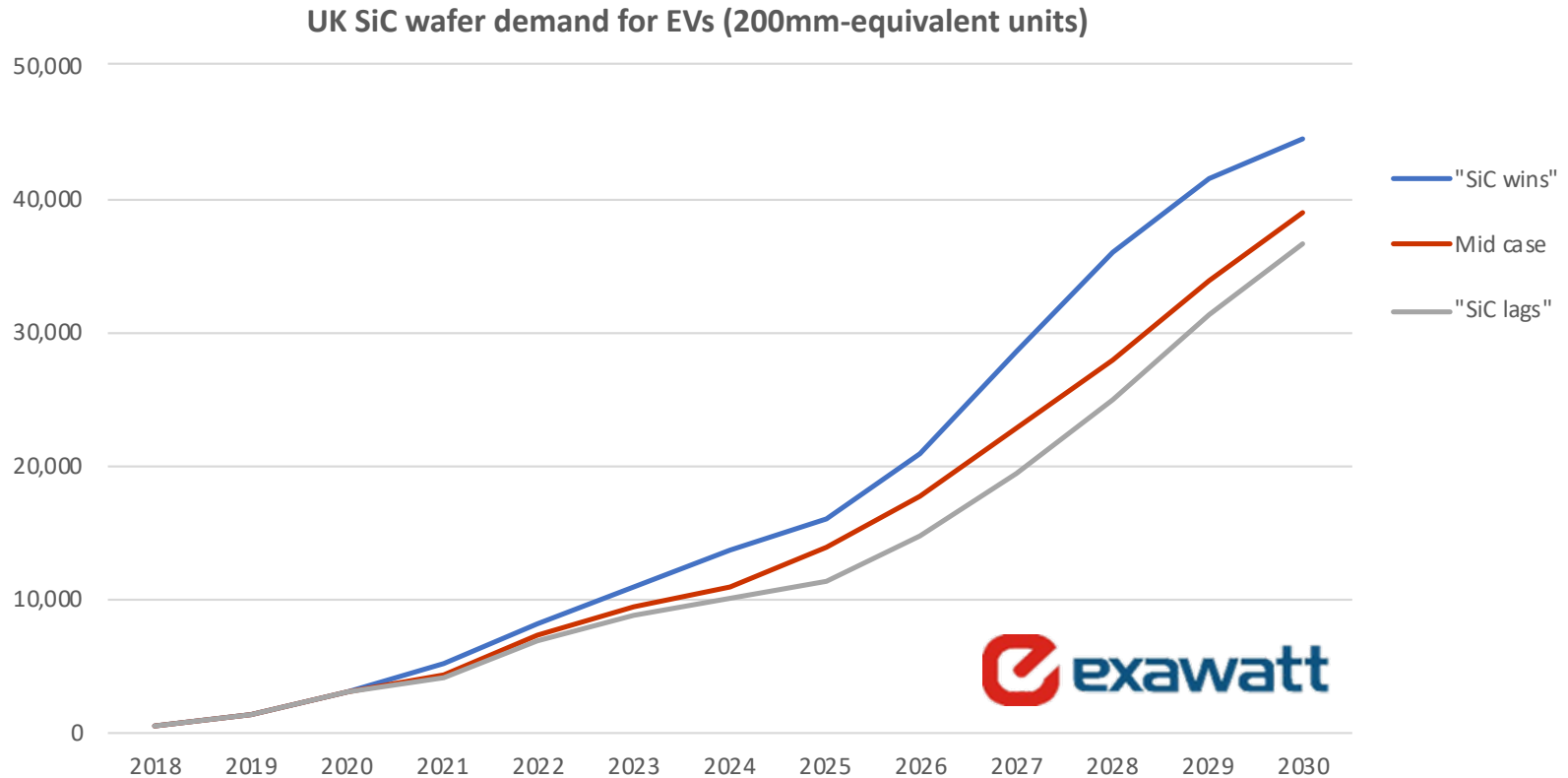
Source: Exawatt analysis of SMMT data

SiC is getting cheaper...



Source: Exawatt

... which will accelerate SiC demand in BEVs



Opportunities: BEVs and beyond

New power electronics enable more efficient, cheaper vehicles with lower running costs

Battery supply chain benefits from reduced materials requirement per kWh

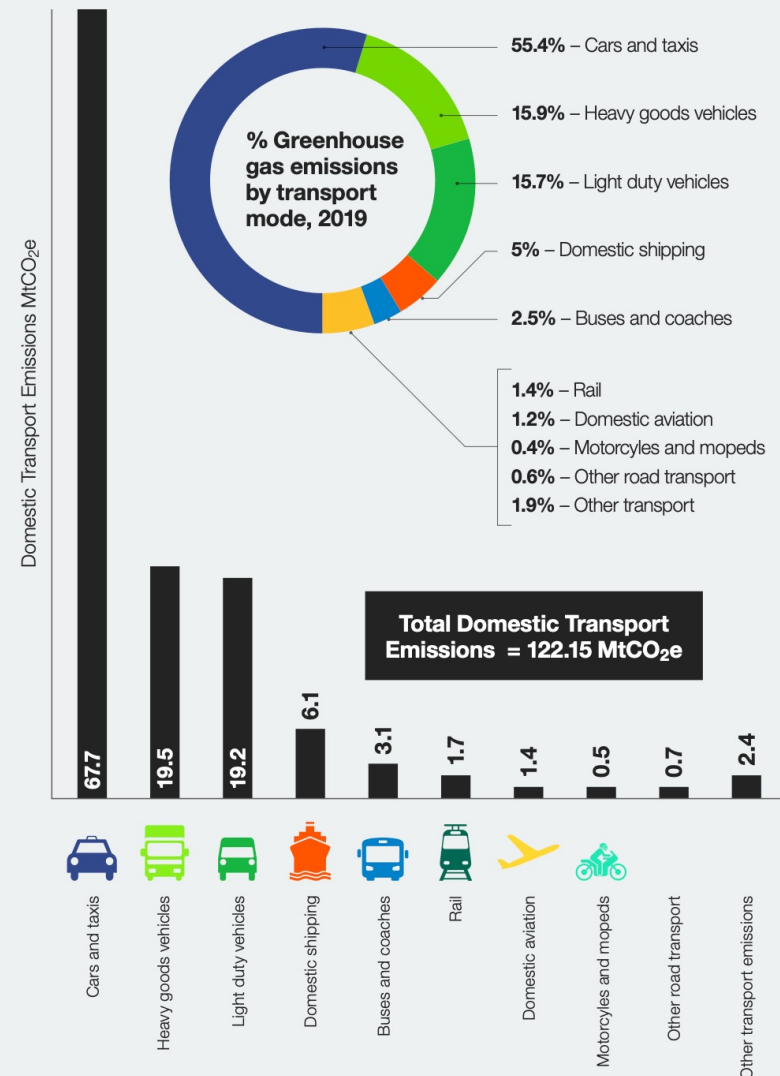
The above offer savings at the grid level

Large-scale EV manufacturing enables cost reductions that can be leveraged in other applications that require power converters

Other transportation forms also benefit from SiC power electronics, including:

- Rail (efficiency and size)
- Aviation (efficiency, size and weight)
- Maritime (efficiency)
- Grid (efficiency)

UK domestic transport emissions 2019⁶



Summary

What do we need to ensure a robust UK SiC industry?

- True end-to-end supply chain (inc. crystal growth)
- Early action to develop position in emerging markets (aviation, rail, maritime, grid)
- Commitment to mass market, not just niche
- A UK “five-year plan” with SiC at the heart and a common roadmap

Need to make SiC part of government thinking >>>



New report: market for SiC in electric vehicles

Second edition (Q2) published in July 2021

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