

Electrification: More than Batteries

Caroline Guest
Innovation Manager, WMG



High Value Manufacturing Catapult

- Consortia of 7 world-class research centres
- Drive growth in manufacturing
- Accelerate & de-risk innovation
- WMG centre founding member
- Focus on Low Emissions Mobility...



ENERGY
STORAGE AND
MANAGEMENT



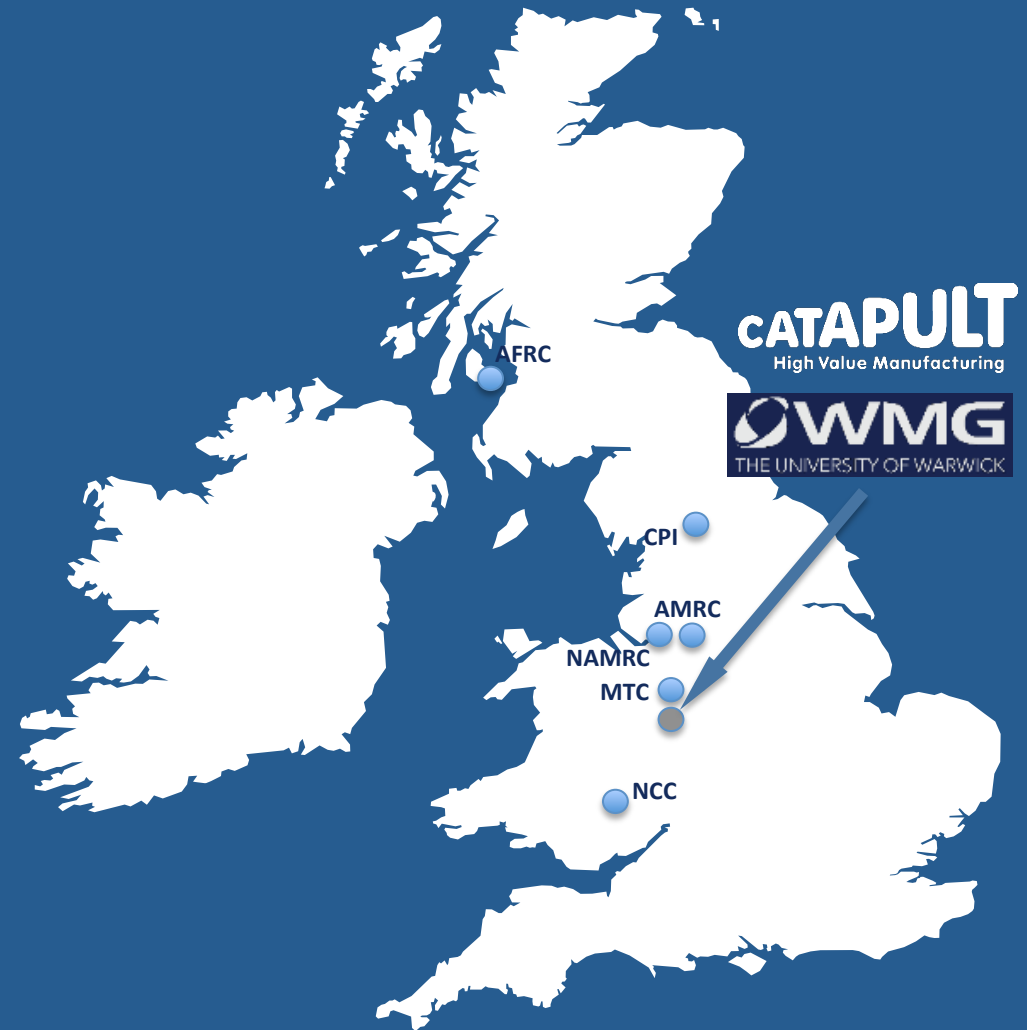
LIGHTWEIGHT
STRUCTURES



CONNECTED AND
AUTONOMOUS
VEHICLES



ADVANCED
PROPULSION



Our mission - Make more in the UK

- Develop, grow and anchor supply base capability
- Make UK manufacturing businesses grow faster
- Make innovation / R&D stick:
 - OEMs are only as good as their supply chains

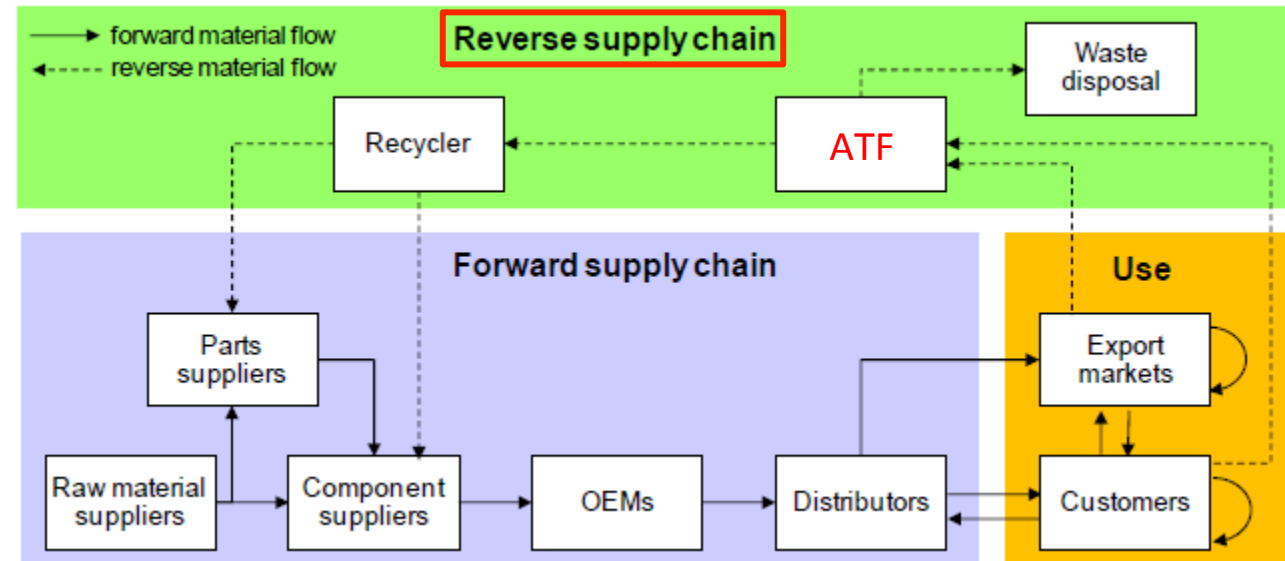


Image from:

"The role of electric vehicles for supply chain sustainability in the automotive industry" Gunther, 2015, <https://doi.org/10.1016/j.jclepro.2014.11.058>

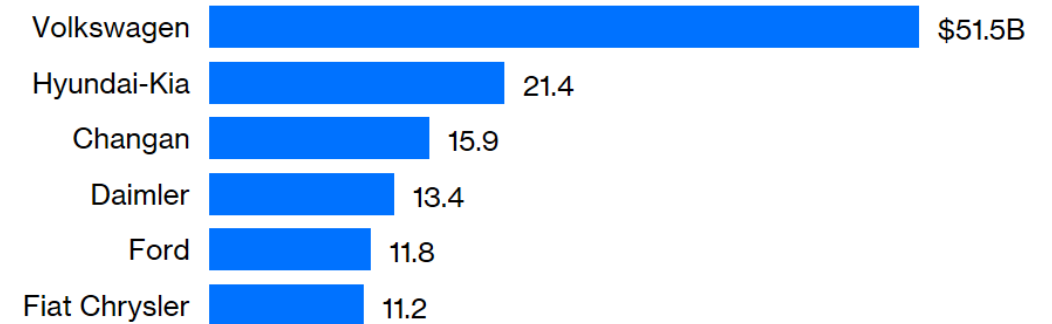
Two passions

1. Sustainability
2. UK manufacturing

Link to Electrification

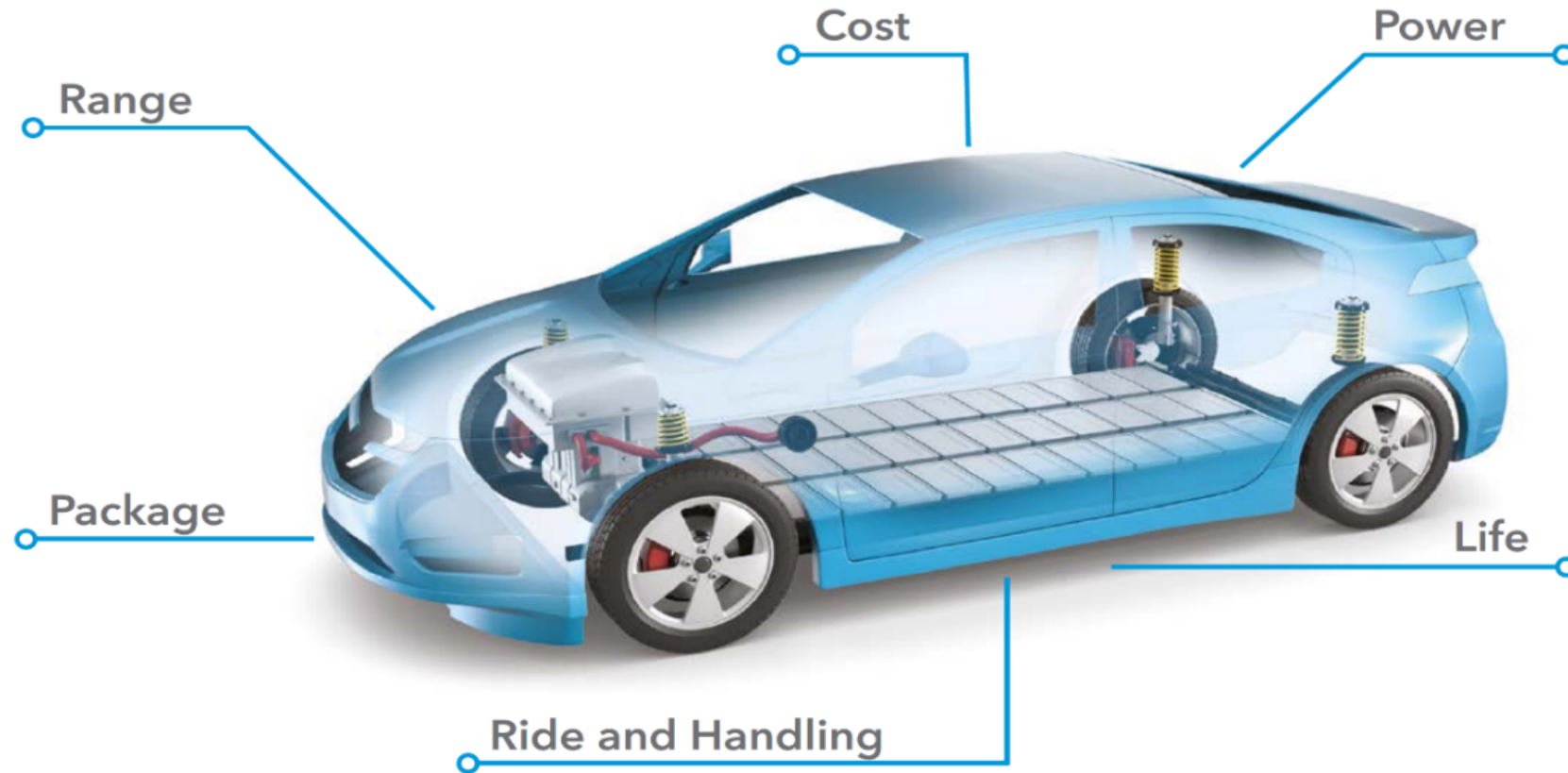
- No longer niche, entered mainstream
- Market growing exponentially
- All OEMS have an electrification plan

Carmakers have committed to spend at least \$141 billion on electrification

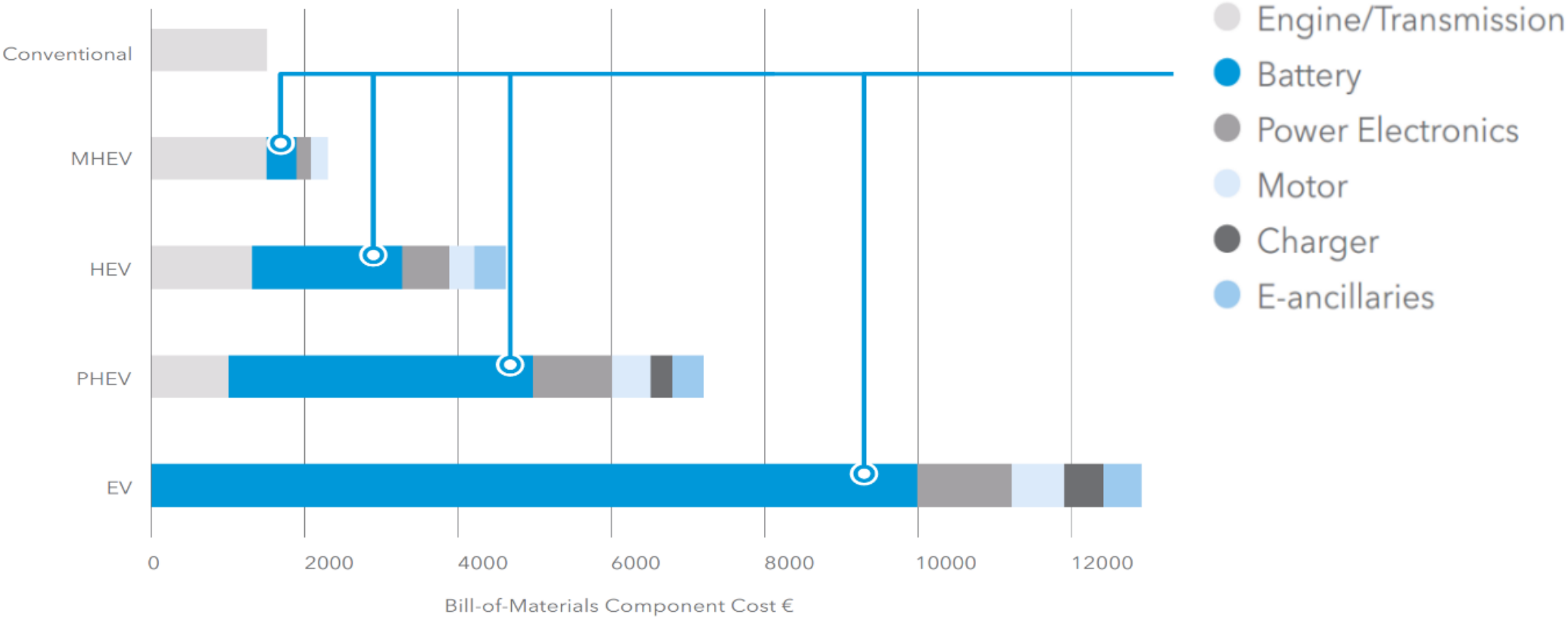


Source: Bloomberg New Energy Finance

The battery is the defining component of an electric vehicle



Component Costs for Electrification of Powertrain

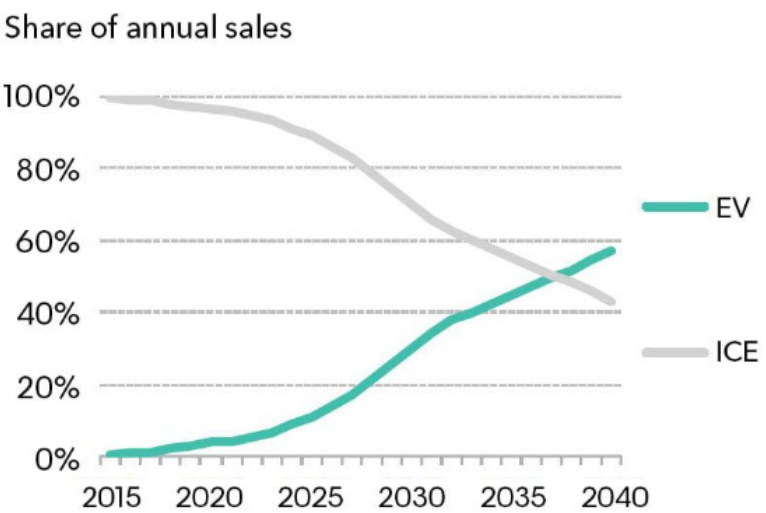


So we know why batteries are important...

What else is there in an electric vehicle?

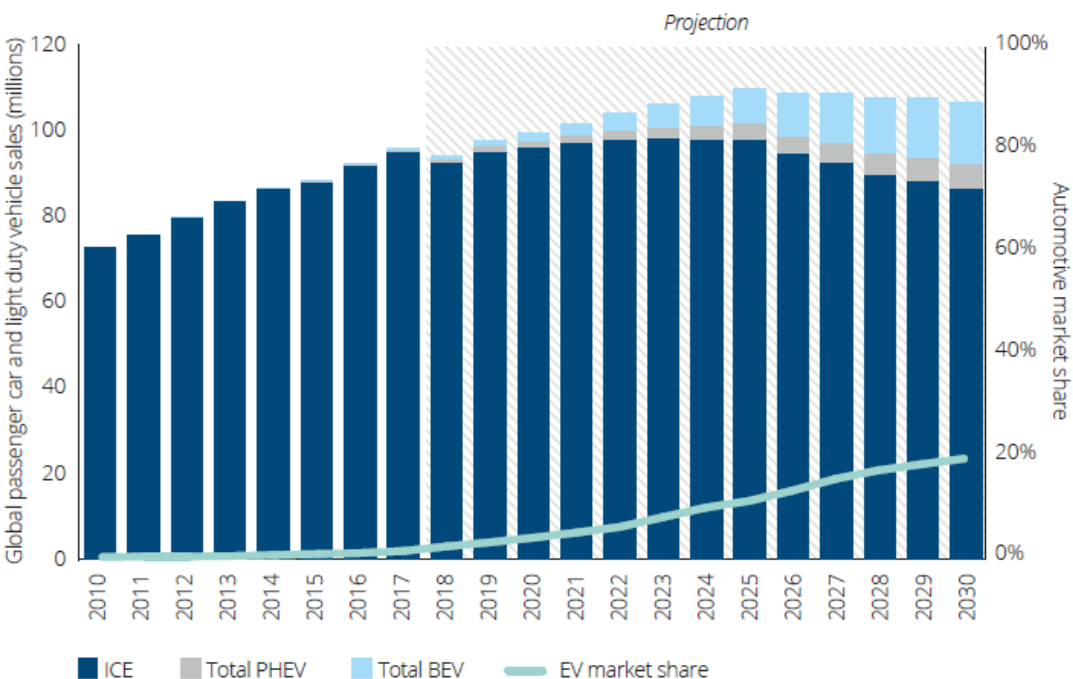
Reminder: Engines are here for a while

Global EV and ICE share of long-term passenger vehicle sales



Source: BloombergNEF

Figure 2. Outlook for annual global passenger car and light duty vehicle sales



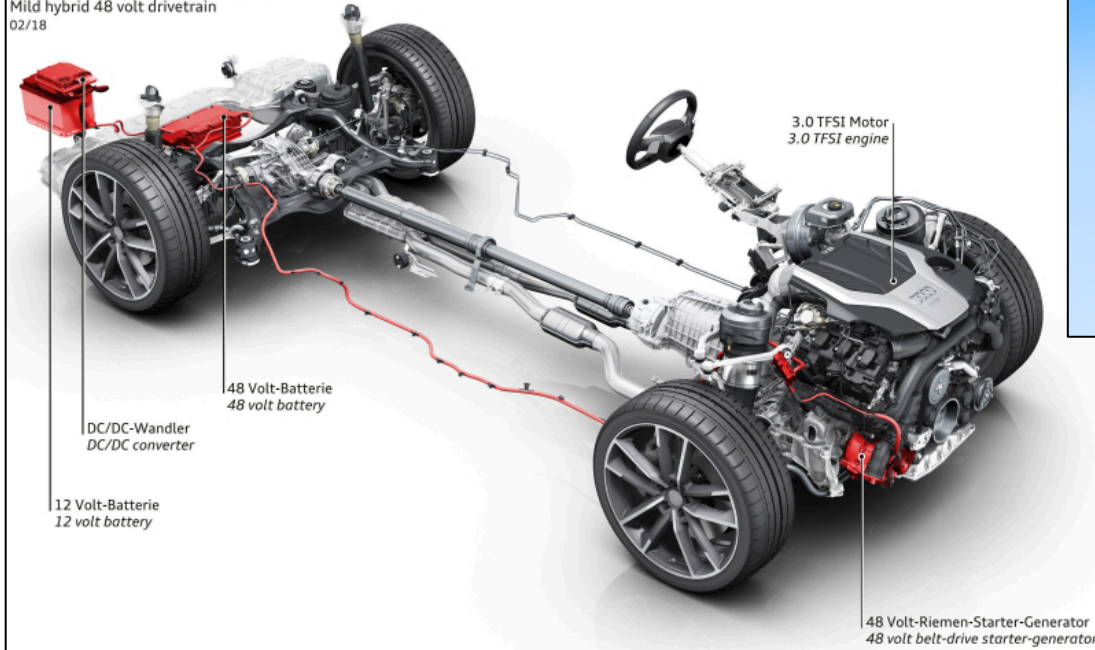
Source: IEA, IHS, Deloitte analysis

Vehicle Architectures

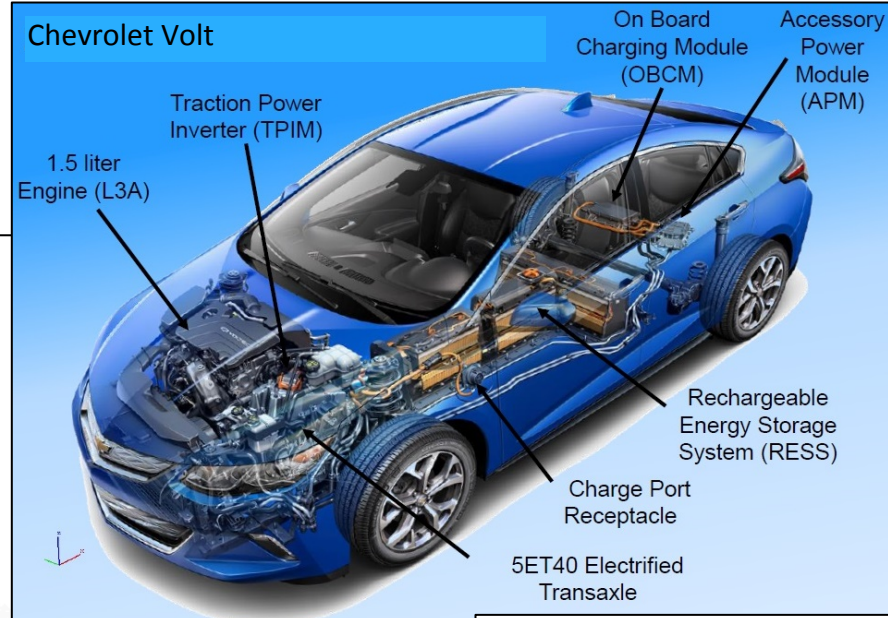
48V MHEV

Audi A6 Limousine

Mild-Hybrid 48 Volt-Antriebsstrang
Mild hybrid 48 volt drivetrain
02/18



PHEV

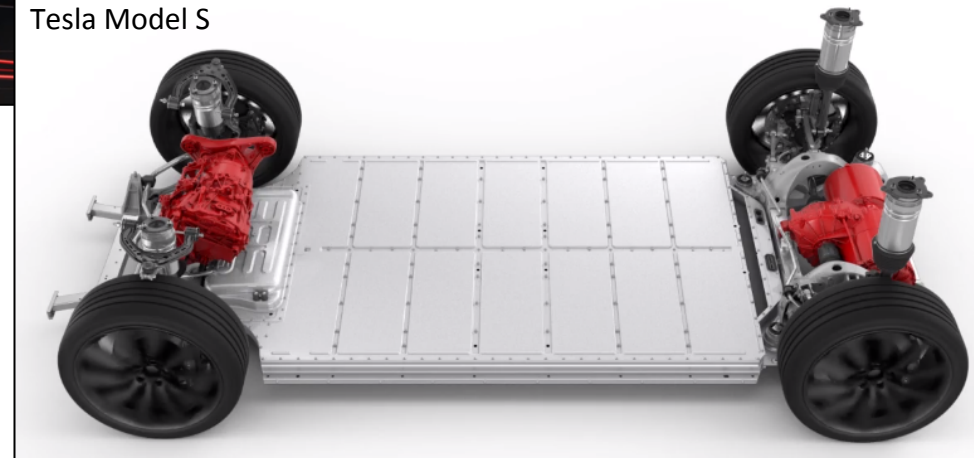


All have:

- Battery
- Electric Motor
- Power Electronics
- HV cables

BEV

Tesla Model S




Electric Motors and Generators

Vehicle Parts Opportunity:

- £1k to £10k

Free postage




2017 Tesla Model-X Electric L2S-X60 Front Motor Drive Unit 4,323 Miles


🔥 1 viewed per hour

Motor Drivetrain Engine Rear TESLA MODEL S 38d AWD

🔥 1 viewed per hour




ELECTRIC ENGINE MOTOR EM57 092938A 291A03NFA F5J210027 1827 FOR NISSAN LEAF 2015



Mouse

Free postage



Renault Zoe Dynamique 2012-> Electric Motor Engine Assembly Unit 5AM450 87BHP

★★★★★ Be the first to write a review.

Condition: Used

"Genuine used part. Parts have will be cleaned, inspected and tested. 3 months parts warranty" ... Read more

Compatibility: See compatible vehicles

£1,200.00

(£1,200.00 / Unit)

From £57 per month for 24 months

Buy it now

Add to basket


Make offer


👁 Watch this item


Free postage


Posts from United Kingdom


30-day returns

 Collect 300 Nectar points [Redeem your points](#) | [Conditions](#)



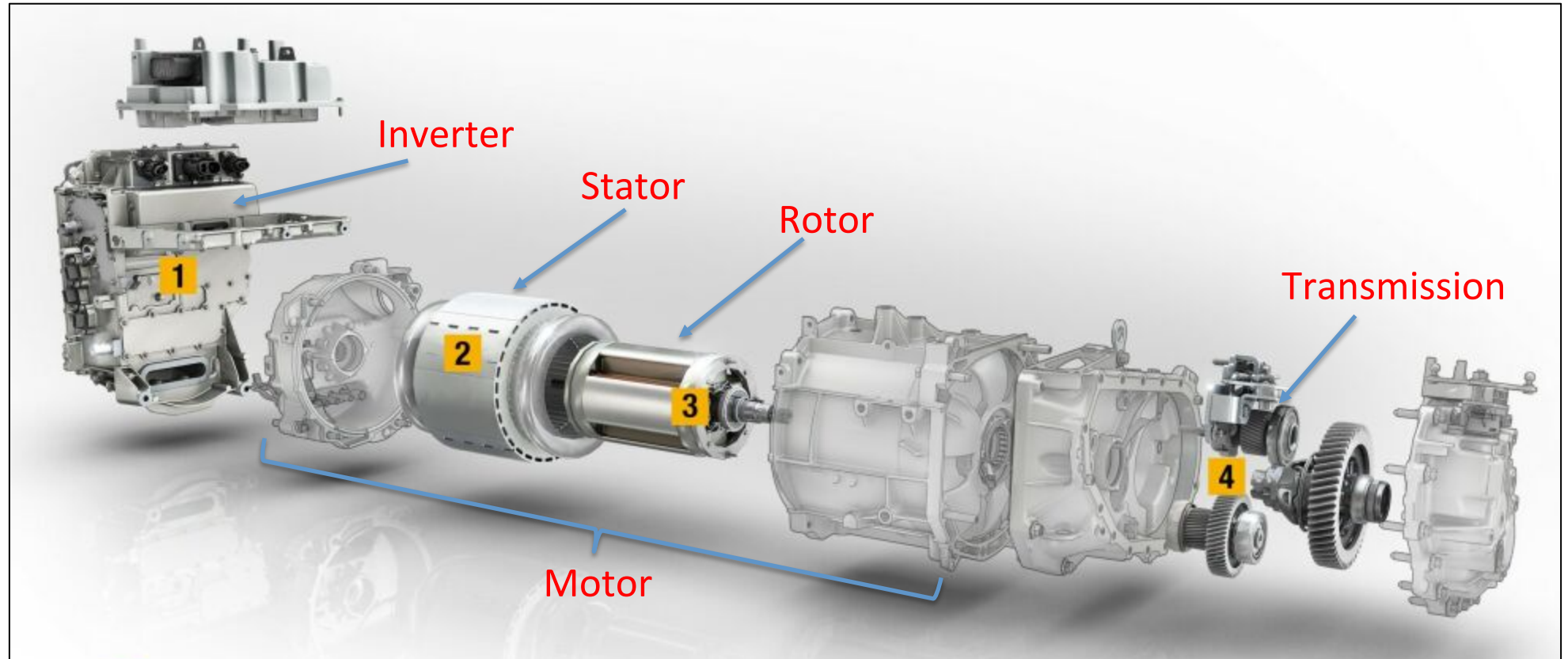






What's inside an electric motor?

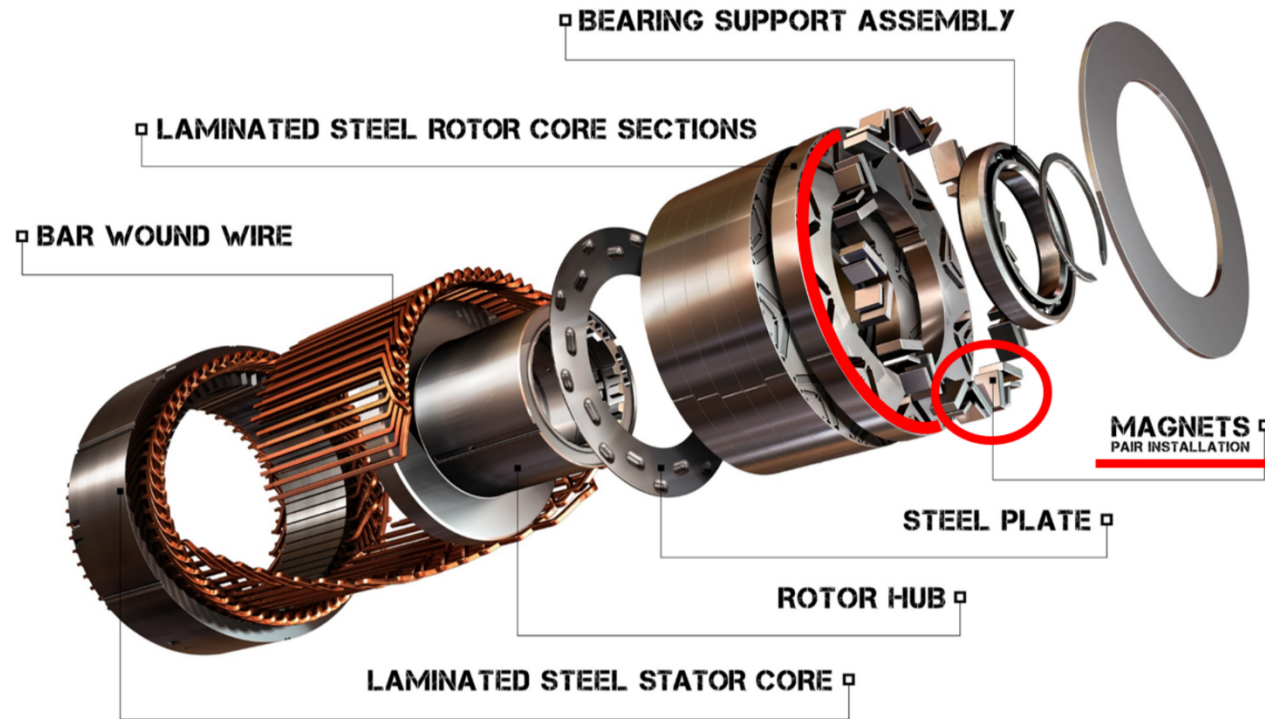
This is an Electric Drive Unit



What's inside – part 2



General Motors
Permanent Magnet Electric Motor



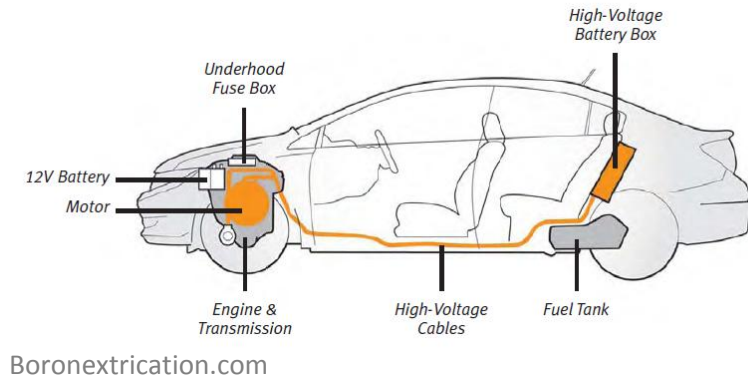
Remanufacturable

- Most valuable assembly (rotor) does not have a useful life restriction
- Similarities to alternator/starter motor remanufacture

Key materials:

- Electrical Steel laminations
- Aluminium and steel parts
- Copper wires
- Rare earth magnets

Recycling example: 2010 Honda Insight

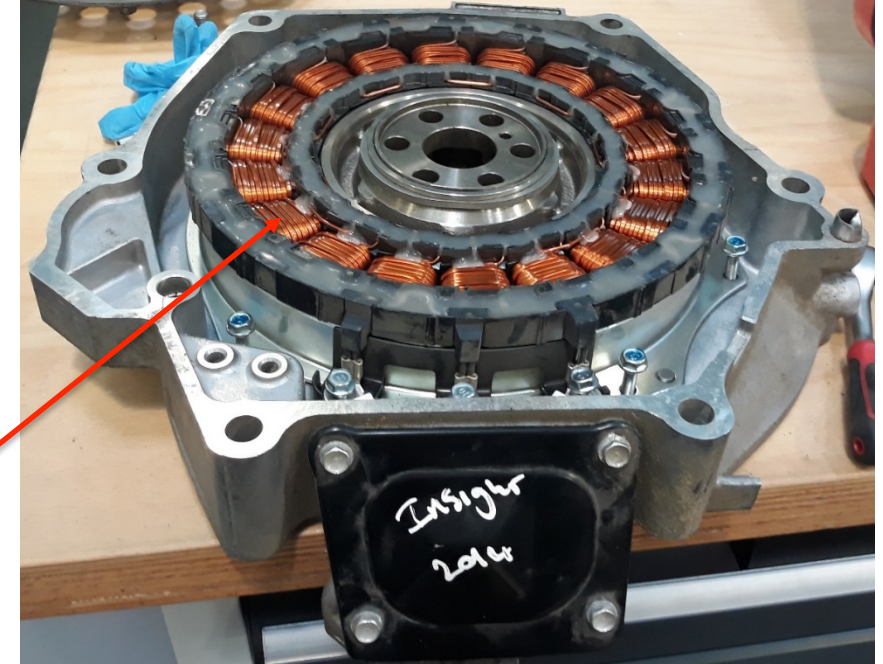


94% of this motor is metal:

- 12 kg steel
- 2.5 kg Aluminium
- 2.5 kg Copper

144m of copper wire

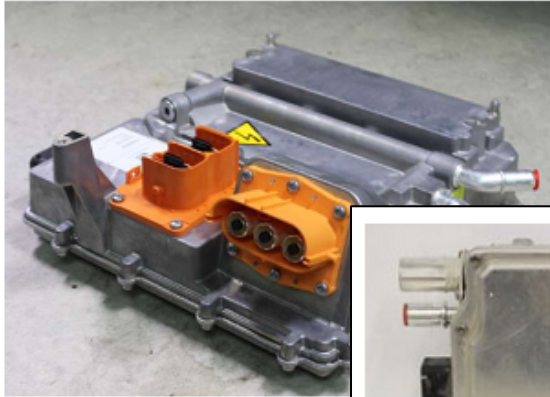
10 kW electric motor
Total weight: 18 kg



Magnets:

- Over 0.5 kg
- Cost up to \$100/kg depending on grade
- Hard to recover

Power Electronics



Genuine Volvo Inverter IEM Rear Axle Drive Module XC90 2016-Up Hybrid

Questions about this item? Be the first to ask here.

Your Price: \$3,066.62



www.myvolvoparts.com



Genuine Volvo OBC On-Board Charger Module Battery Charger for Hybrid XC90 2016-Up

Questions about this item? Be the first to ask here.



www.myvolvoparts.com

Vehicle Parts Opportunity:

- At least £2,000

Remanufacturable

- Electronics remanufacturing is commonplace



HIGH VOLTAGE INVERTER Tesla Model-S 70D 4WD Hatchback 2016 On WARRANTY-11145464

Condition: Used

“**6 MONTHS WARRANTY** Item in great used condition, please see images carefully before purchase.” ... [Read more](#)

£1,200.00

From £57 per month for 24 months

[Buy it now](#)

[Add to basket](#)

[Watch this item](#)

Delivery est. in 2-3 days

30-day returns

Posts from United Kingdom

What's in power electronics?

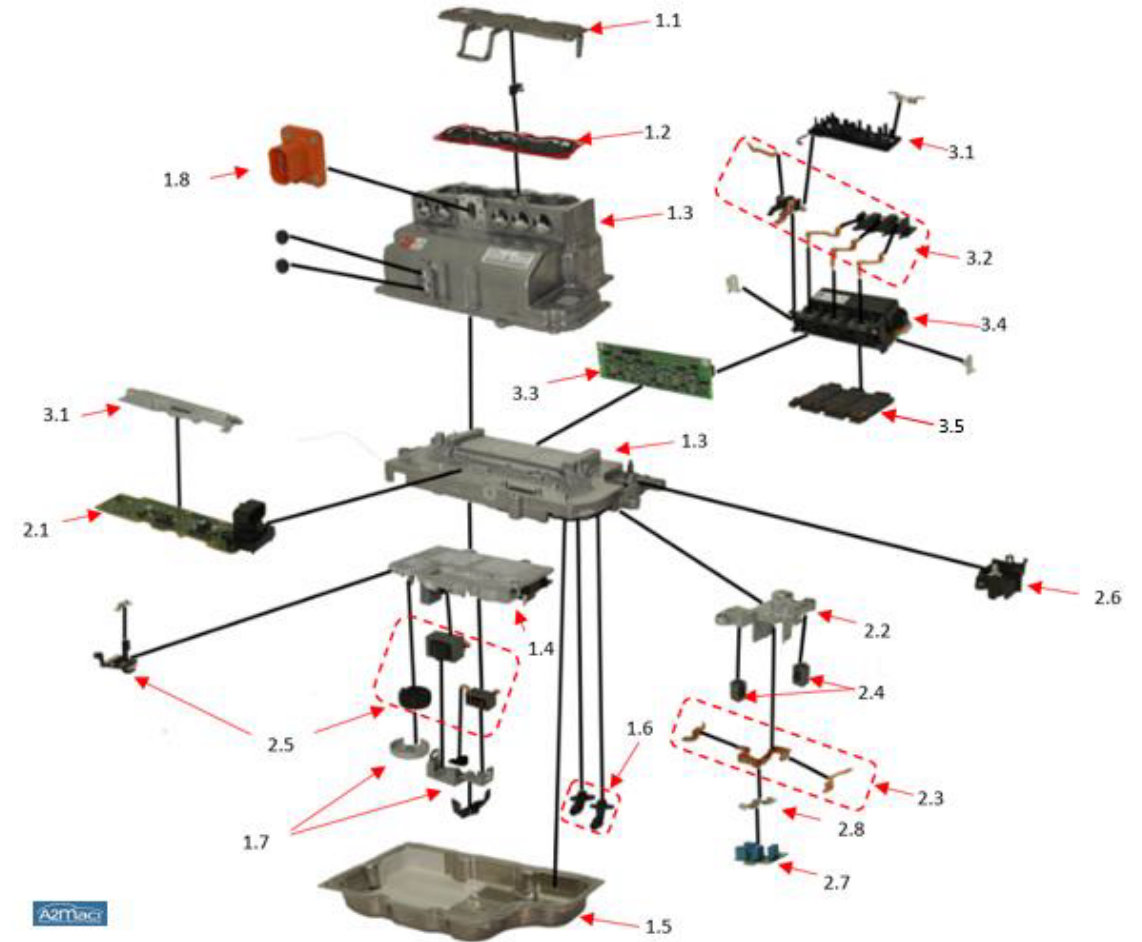
Key power electronics modules in a vehicle:

- Inverter
- DC-DC Converter
- Onboard Charger

Key Materials:

- Aluminium – housings and covers
- Copper – busbars
- Ferrites
- Electronics (semiconductors etc)

Audi A3 e-Tron Inverter Module



High Voltage Cables

Value of HV cables in a vehicle:

- At least £1,200
- (up to say 15 cables of varying values)

Tesla Model 3 GEN3 HV Ancillary Tunnel Wiring Harness Charge Port Cable Assembly

Condition: New other (see details)

Quantity: 2 available

HIGH VOLTAGE WIRING CABLE for 2018 AUDI A3 A1 e-tron VW GOLF MK7 GTE 5Q0971449A

Condition: Used

"VERY GOOD CONDITION! LOC#1ST."

FRONT BATTERY CHARGE CABLE CHARGING PORT UNIT 296B13NF1A FOR NISSAN LEAF 2015

Condition: Used

£249.00

From £12 per month for 24 months

Buy it now

Add to basket

Watch this item

Click & Collect

Posts from United Kingdom

5 watchers



Collect 249 Nectar points [Redeem your points](#) | [Conditions](#)

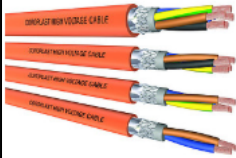
Collection: Click & Collect - Select store at checkout.

What's inside?



FHL2G

- › SIR
- › -40 °C to +180 °C
- › 0,50 mm² to 120,00 mm²
- › Unscreened
- › Copper
- › HV aggregates and electric engines (max. 600 V AC / 1,000 V DC)



FHL2GCB2G / FHRL2G-CB2G

- › SIR
- › -40°C to +180°C
- › 2x0,50 mm² to 5x6,00 mm²
- › Foil and braided screen
- › Copper
- › Charging cables for electric vehicles and HV aggregates (max. 600 V AC / 1,000 V DC)



FHLAL2GCB2G / FHLAL-R2GCB2G

- › SIR
- › -40 °C to +180 °C
- › 2,50 mm² to 120,00 mm²
- › Foil and braided screen
- › Aluminium
- › HV batteries and electric engines (max. 600 V AC / 1,000 V DC)



FHL2GCB2G/FHRL2G-CB2G

- › Silicone-insulated
- › -40 °C to +180 °C
- › 2,50 mm² to 95,00 mm²
- › Foil and braided screen
- › Copper
- › Connection of HV batteries and electric engines (max. 600 V AC / 1,000 V DC)



FHL2G2G/FHRL2G2G

- › SIR
- › -40 °C to +180 °C
- › 2x0,50 mm² to 5x6,00 mm²
- › Unscreened
- › Copper
- › Charging cables for electric vehicles and HV aggregates (max. 600 V AC / 1,000 V DC)



FHLAL2G

- › SIR
- › -40 °C to +180 °C
- › 0,50 mm² to 120,00 mm²
- › Unscreened
- › Aluminium
- › HV batteries and electric engines (max. 600 V AC / 1,000 V DC)

Key materials:

- Aluminium
- Copper



High voltage cable, single-core, shielded HV-2GCB2G, 70 mm²

Images from www.coroplast.de

Future Electrification Trends to watch out for

General:

- Using plastics/composites for non-structural components in motors, power electronics, batteries
- More integration of the different assemblies (reduces cabling)

Motors:

- Remove magnets
- Increased power density – smaller motors

Impact on:

- Recyclability
- Remanufacturing and Recycling revenue

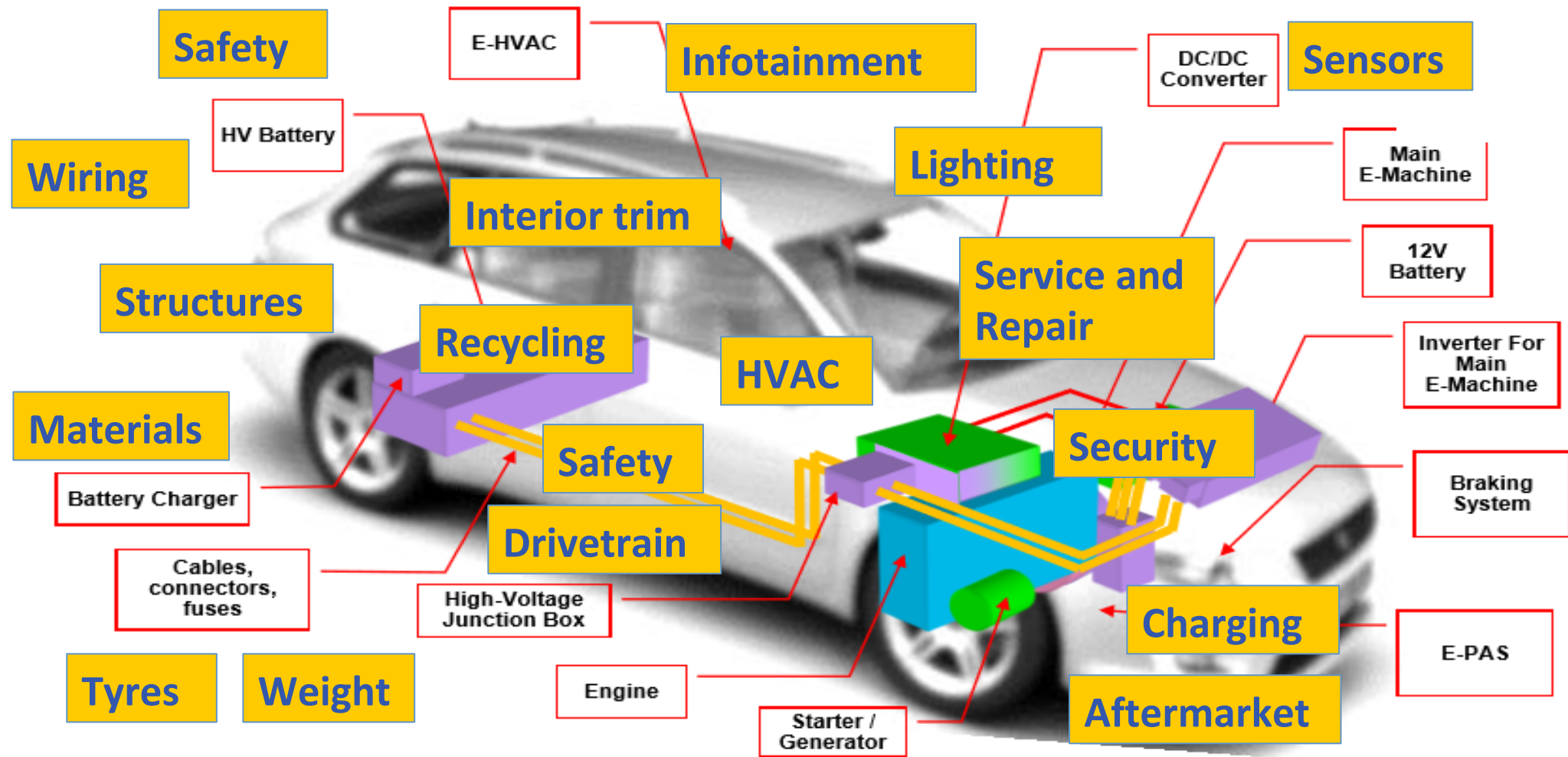
Power Electronics

- Higher cost semiconductors
- Reduces overall system cost by reducing battery size and cost

HV Cables

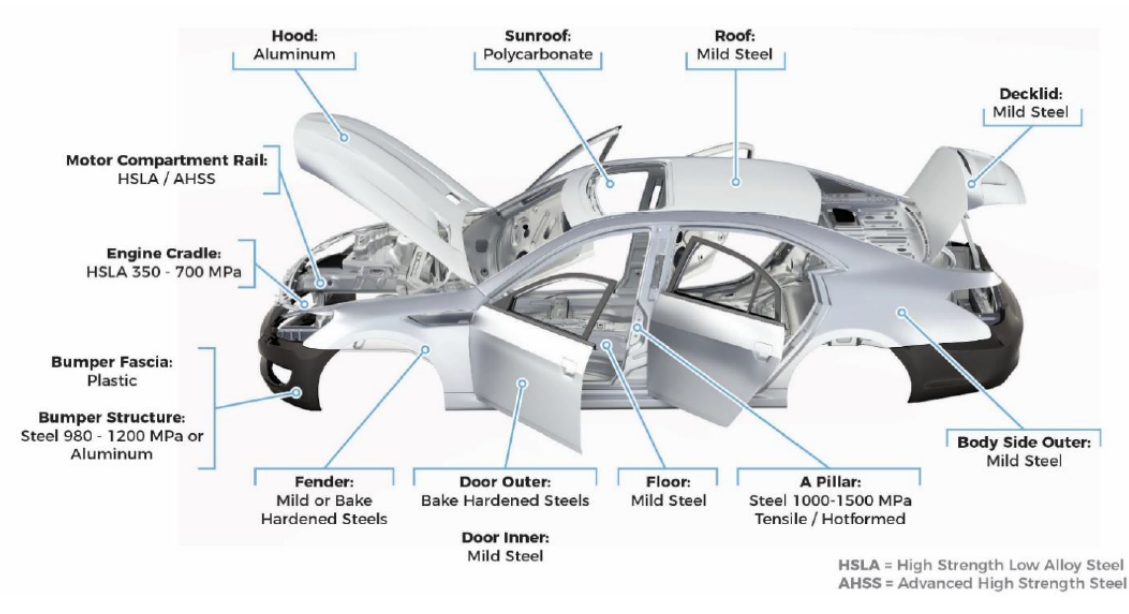
- Moving from copper to aluminium
- Getting shorter

And the rest of the vehicle?

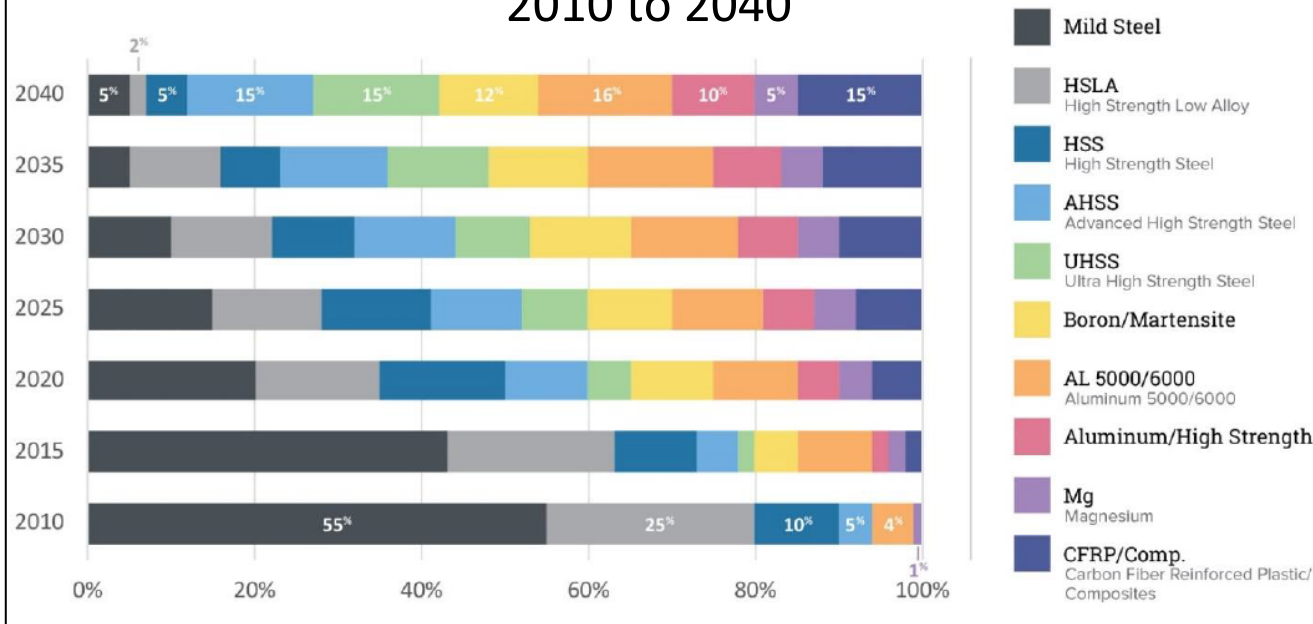


The material breakdown is changing

Materials most commonly used now



Material Distribution in the US Fleet (BIW plus closures), 2010 to 2040



Figures from:
Smith, Brett, Adela Spulber, Shashank Modi, and Terni Fiorelli. (2017). *Technology Roadmaps: Intelligent Mobility Technology, Materials and Manufacturing Processes, and Light Duty Vehicle Propulsion*. Center for Automotive Research, Ann Arbor, MI.

Reminder: The Waste Hierarchy

The EU Waste Hierarchy

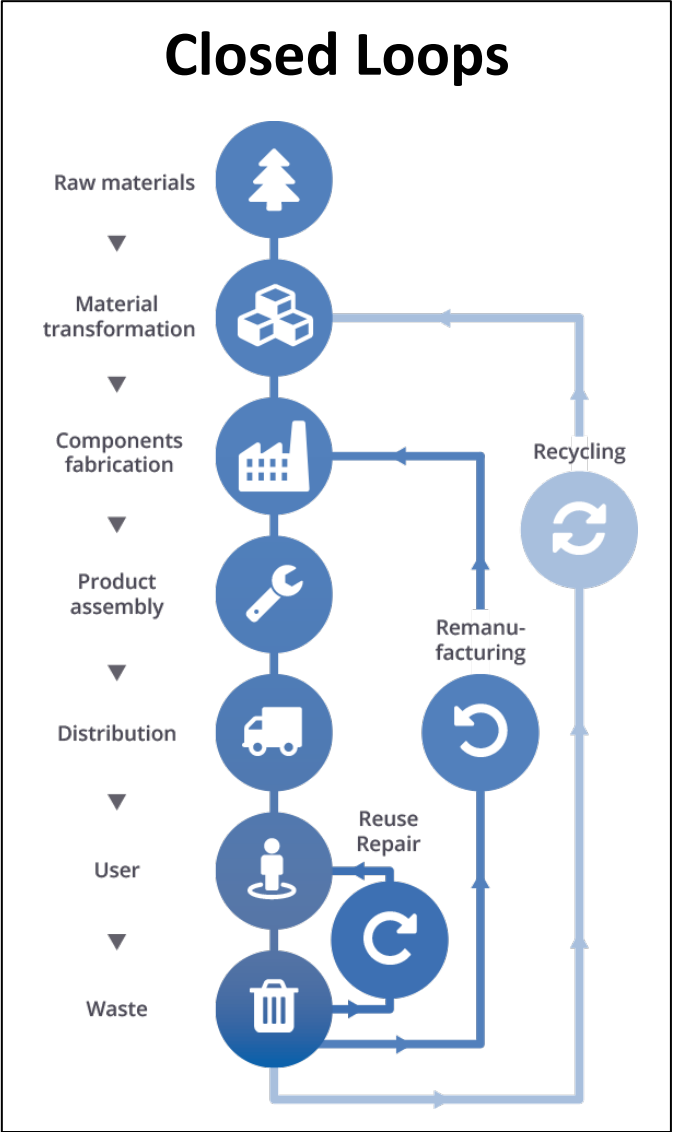
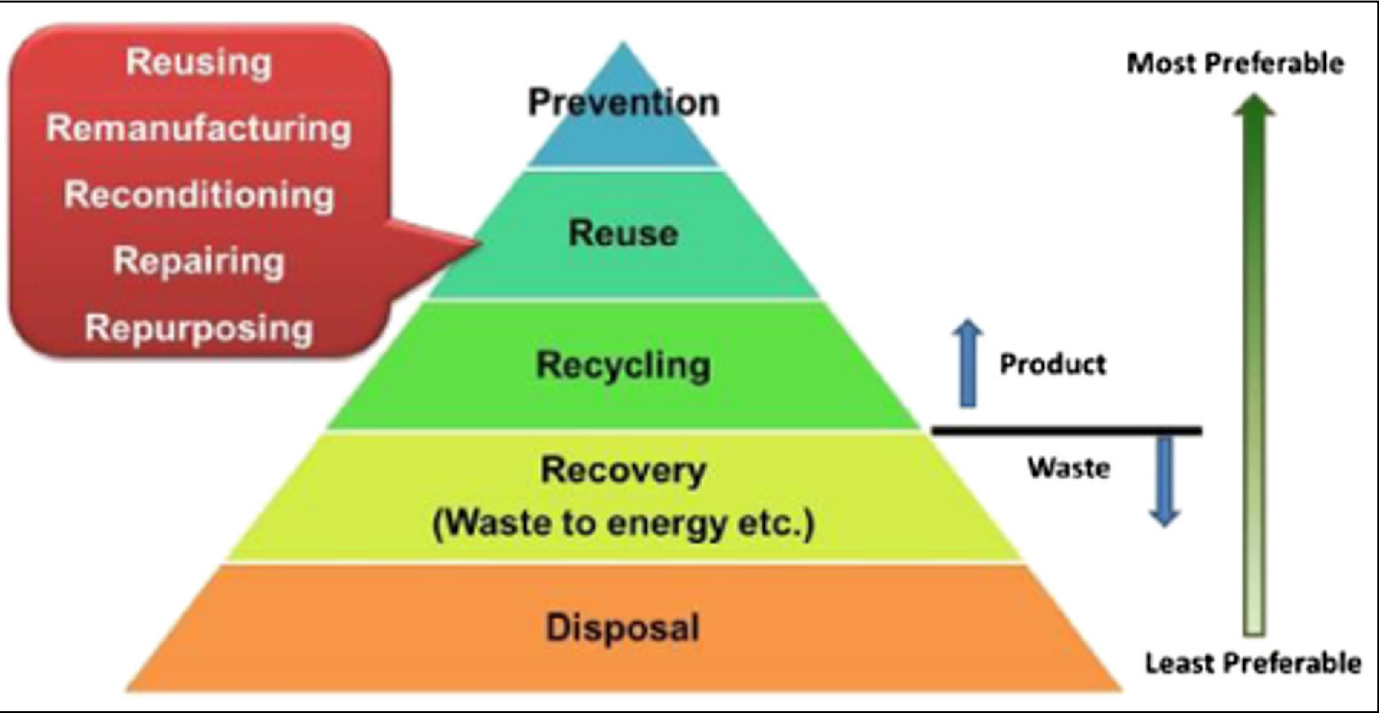


Diagram from: <https://www.remanufacturing.eu/about-remanufacturing.php>

Remanufacturing is:

“returning a used product to at least its original performance with a warranty that is equivalent to or better than that of the newly manufactured product”

British Standards Institution Definition

BS 8887-20 provides an internationally recognised standard for terminology and kite-mark for remanufactured products

From a customer perspective: remanufactured products can be considered to be the same as new products



Autocraft Drivetrain Solutions:
JLR Lion 2.7l Remanufactured engine

Value of Remanufacturing in the Automotive Industry

The automotive parts remanufacturing industry is the world's largest remanufacturing sector

- Accounts for almost 2/3 of global remanufacturing

Globally:

2015: \$32 billion

2022: \$50 billion

UK & Ireland:

2015: €770 million

Other benefits:

- Reduced raw material consumption
- Reduced energy consumption
- Reduction in CO2 emissions
- Reduction of material sent to landfill

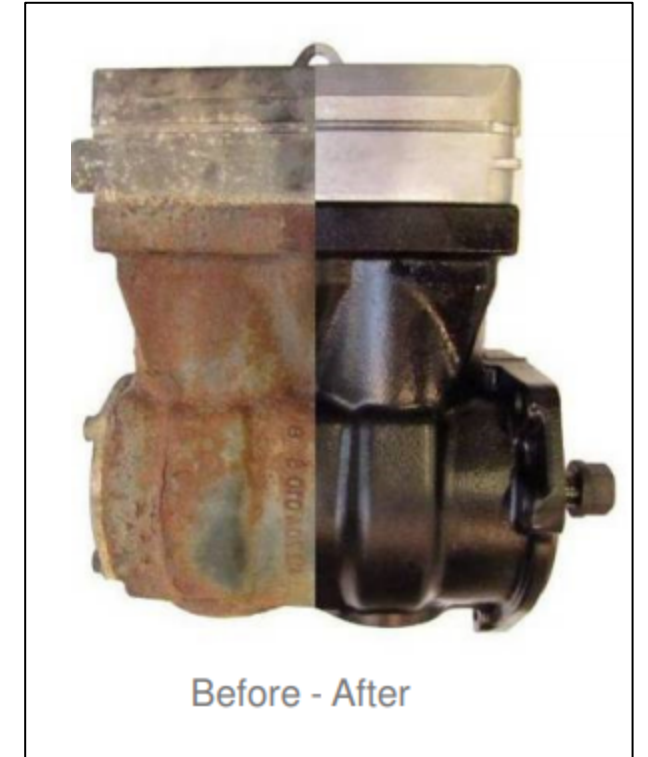


Image from apra, 6th China Remanufacturing Summit

Key Business Reasons to Remanufacture

- New revenue streams
- Brand quality
- Reduce costs of service and warranty provision
- Protect against resource scarcity
- Oversight of performance of product throughout lifecycle – to inform future designs

Two Key Messages:

1. There are lots of other revenue opportunities in Electric Vehicles
2. Don't sell yourself short

Thank You

Caroline Guest

Innovation Manager

caroline.guest@warwic.ac.uk