JAGUAR

LAND ROVER

Routes Towards Low Carbon Luxury Vehicles

Dr Mike Richardson 4th December 2014

Brand Requirements

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Showroom



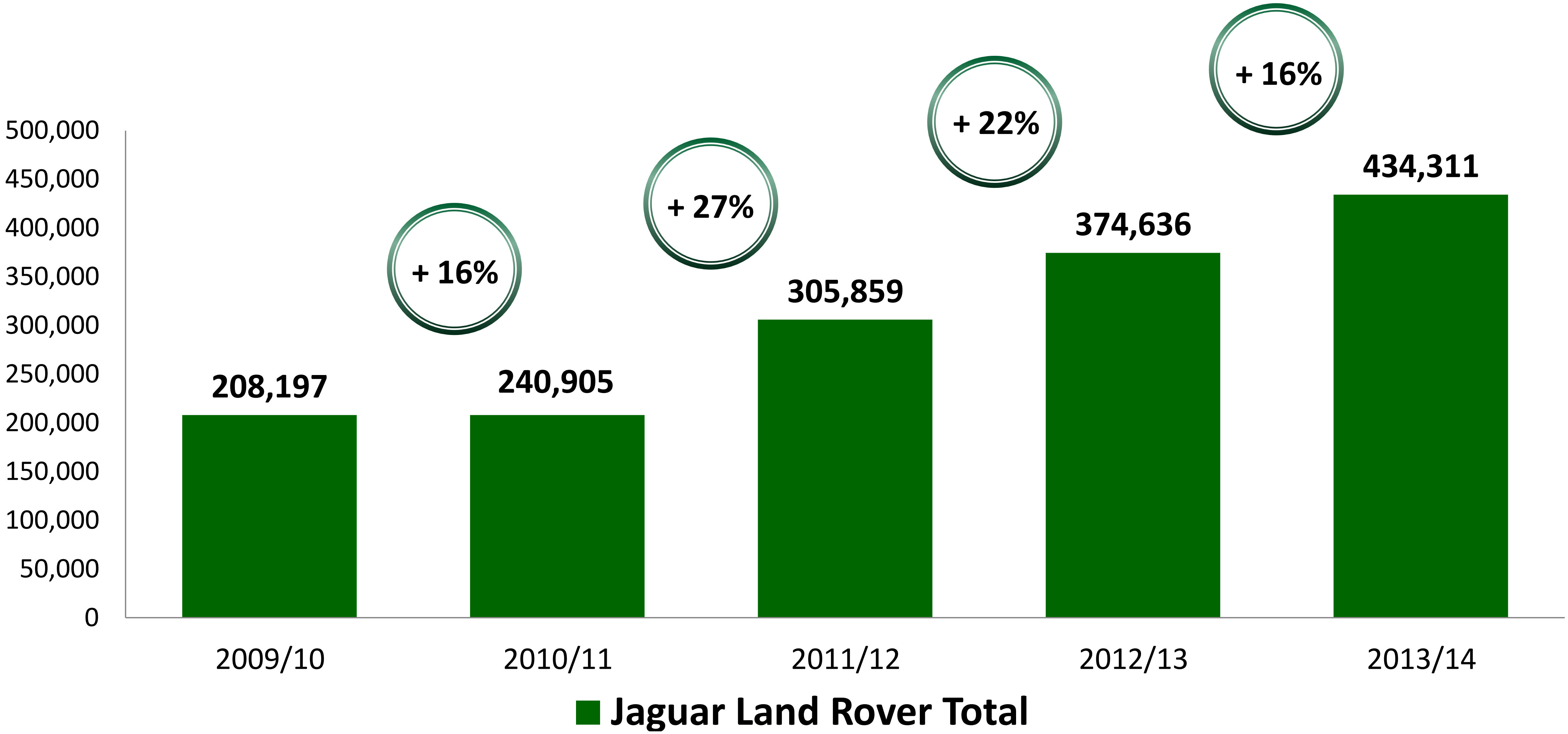

2014



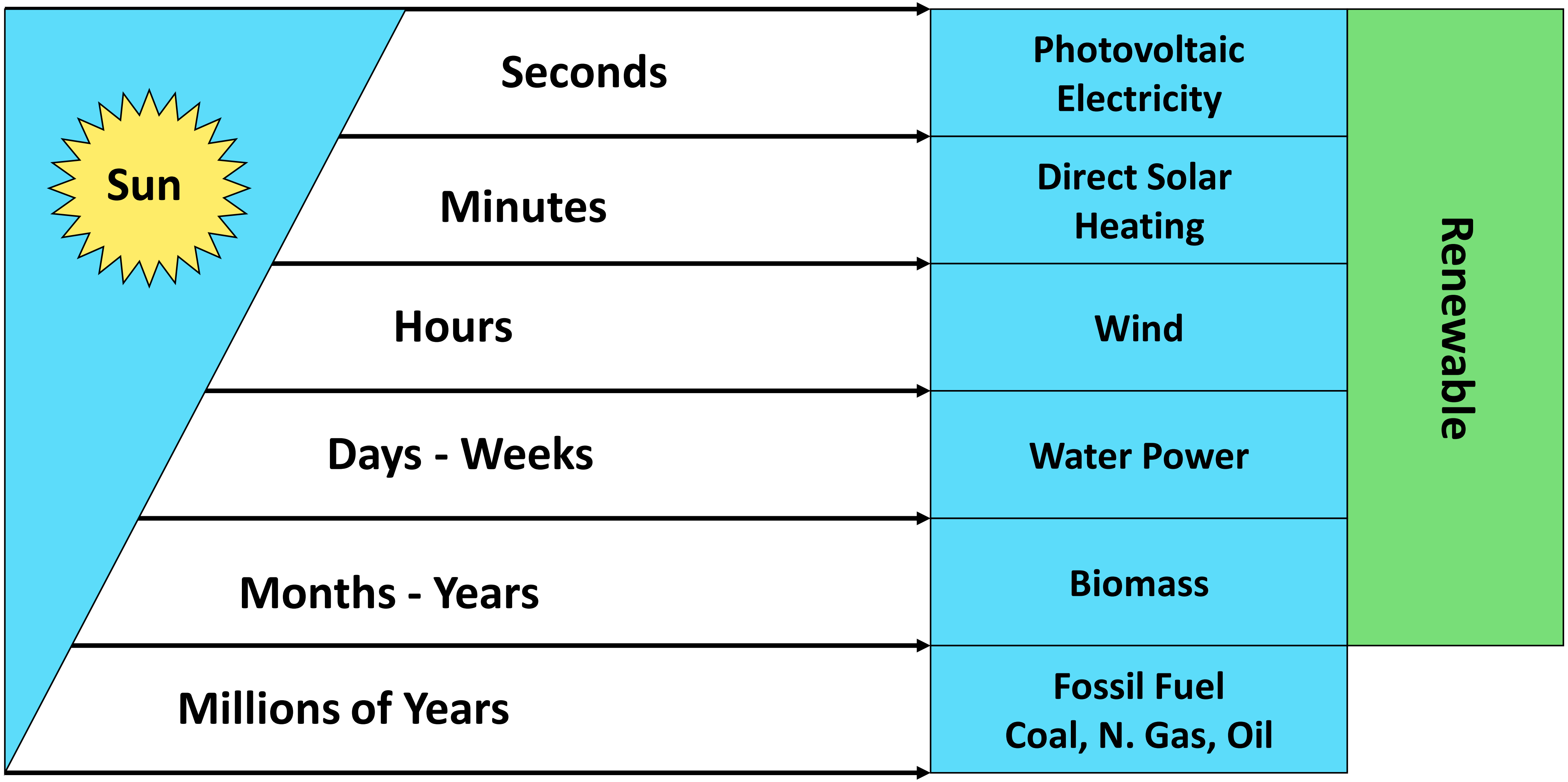




Global Sales Growth



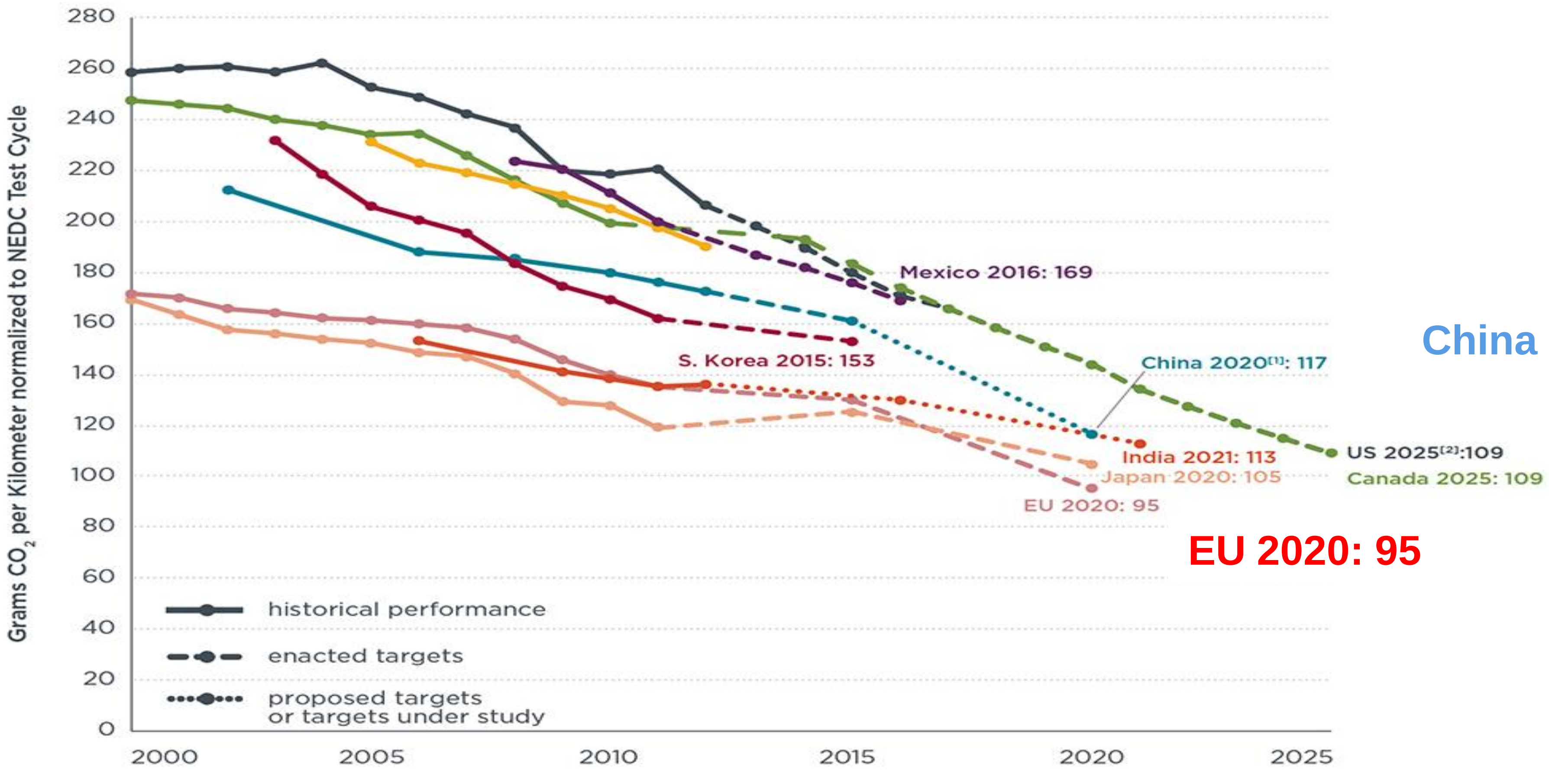
Sources of Energy: Timescales



http://www.apsenergyconservation.org/PDF/MS-FormationOfFossil.pdf

Worldwide Greenhouse Gas / CO2 / Fuel Economy Regulations to 2025

NEW B



[1] China's target reflects gasoline vehicles only. The target may be higher after new energy vehicles are considered.
[2] US, Canada, and Mexico light-duty vehicles include light-commercial vehicles.
[3] Supporting data can be found at: http://www.theicct.org/info-tools/global-passenger-vehicle-standards

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

China 2020: 117

US 2025: 109

EU 2020: 95

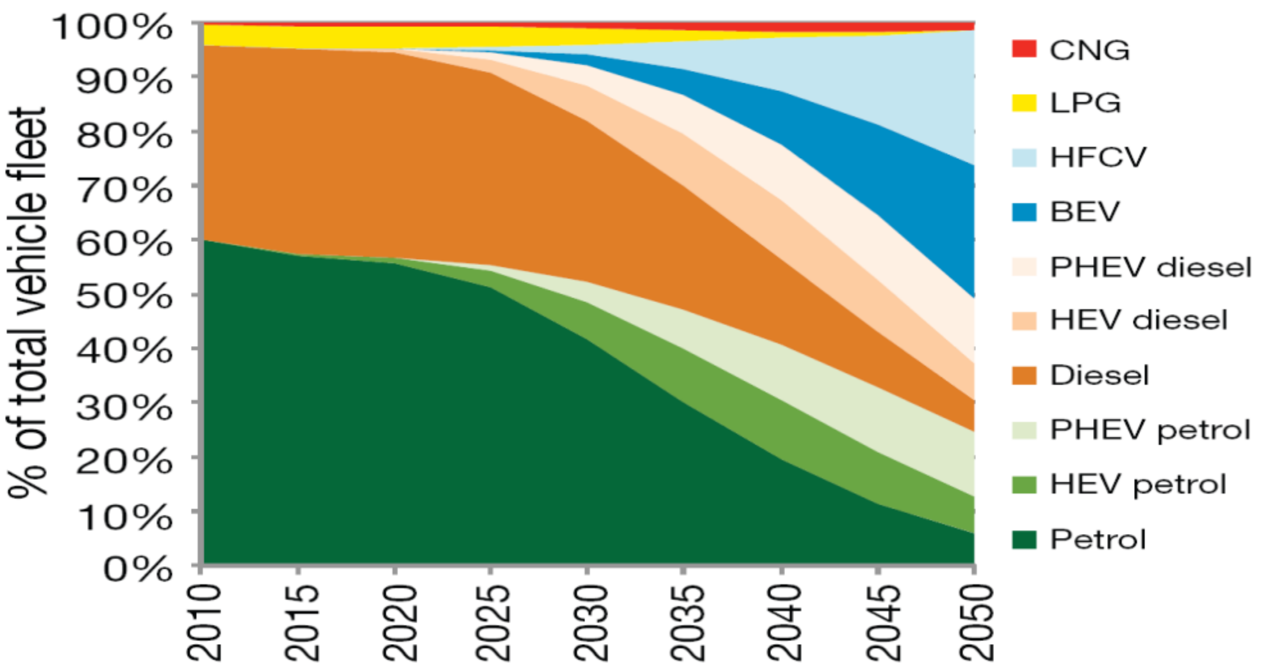
Passenger car fuels roadmap

In the medium term fossil fuels will predominate :

Petrol/diesel falls gradually

- 90% in 2030 to 50% in 2050
- EV / Hydrogen share will grow
- Liquid fuels continue to be majority with low to moderate uptake of biofuels
- 2nd generation biofuels will complement or replace 1st generation as land and food issues continue

Split of total vehicle fleet by powertrain technology



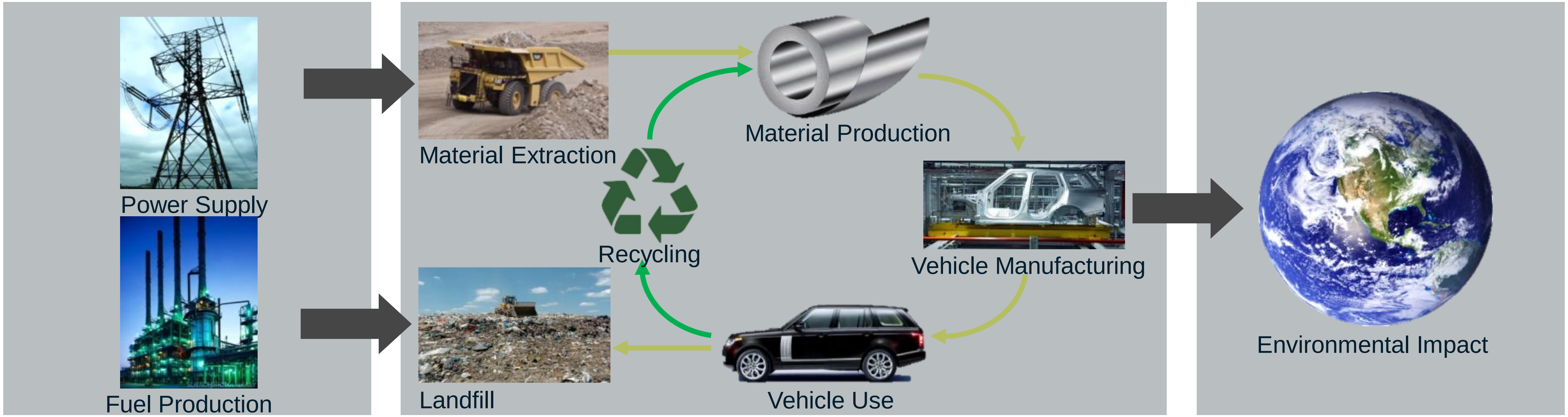
Source: Ricardo-AEA analysis

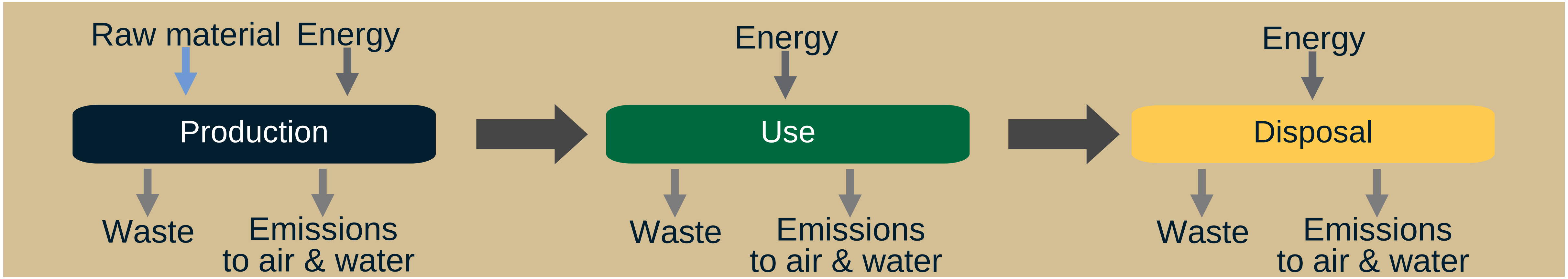
Land Rover Carbon Reduction Philosophy

3 areas:

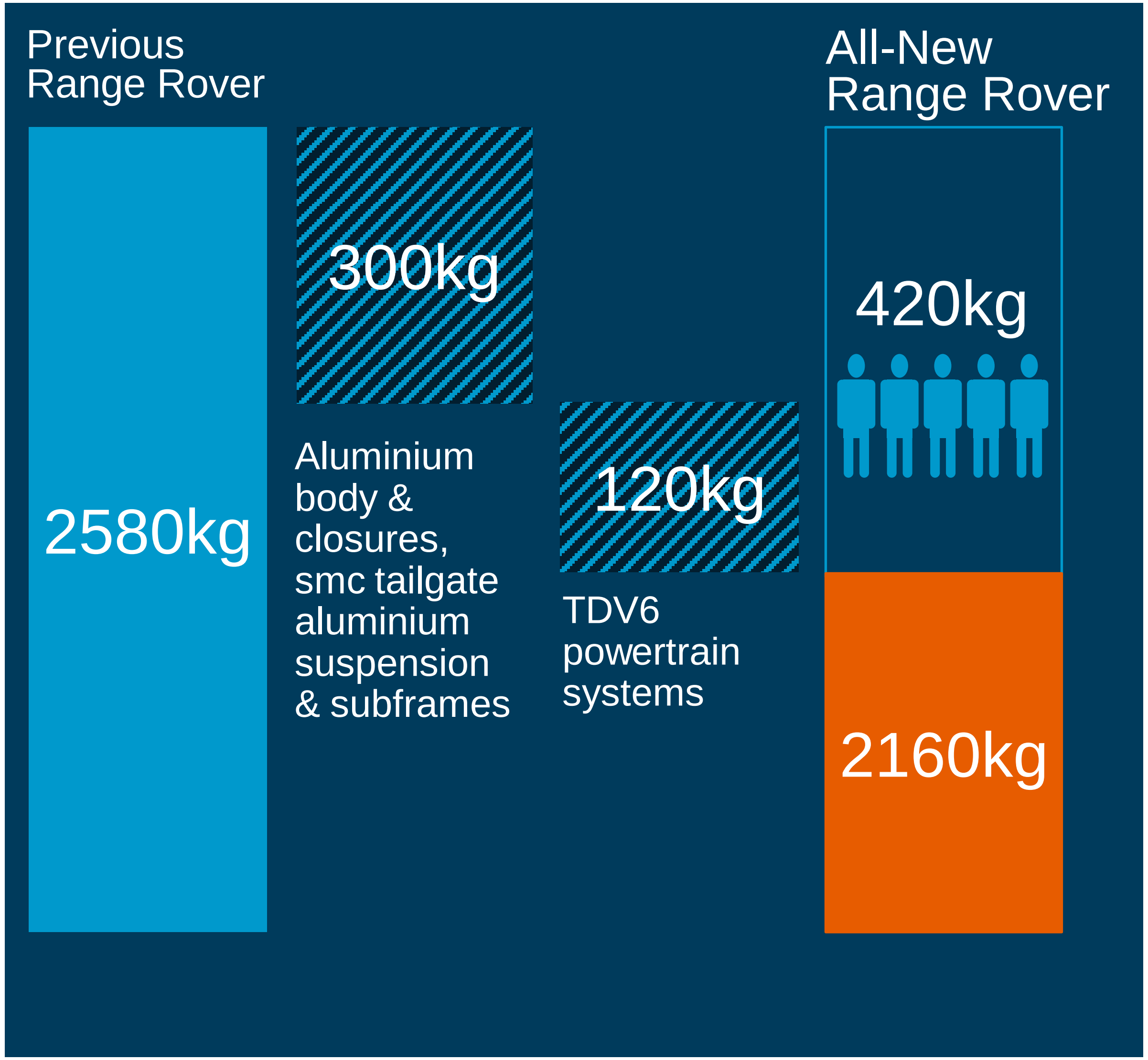
- Weight Reduction
- Powertrain Innovation
- Parasitic Loss Reduction

Life Cycle Design





Virtuous Circle of Weight Reduction



Achieved weight saving of 420kg – equivalent to the weight of five adults

Reduced weight improves vehicle dynamics and contributes to more agile and responsive handling

Every 100kg saved in the vehicle mass saves around 2% in fuel consumption

8% better fuel efficiency overall as a result of the weight saving

Whole Vehicle Efficiency

Intelligent Power Management & Smart Regenerative Charging

Optimised aerodynamic design and Active Vanes

Lightweight body construction

Uprated Auto Trans

8 Speed Transmission

Transmission Idle Control

Torque converter lock-up strategy

Friction optimised common rail diesel engine

Electric cooling fan

Efficient Alternator and AC compressor

Electric Power Assisted Steering

Low Rolling Resistance Tyres

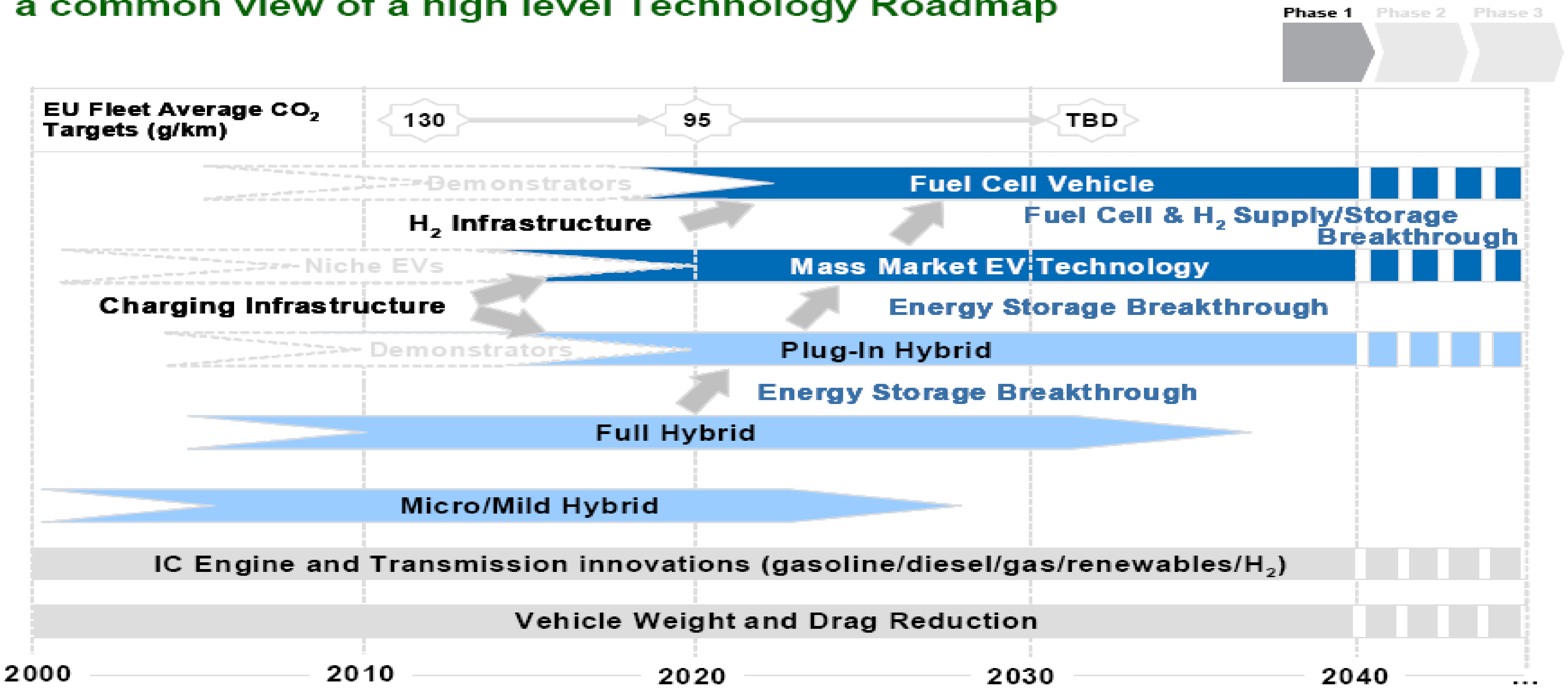
Driveline optimisation

Stop-Start technology

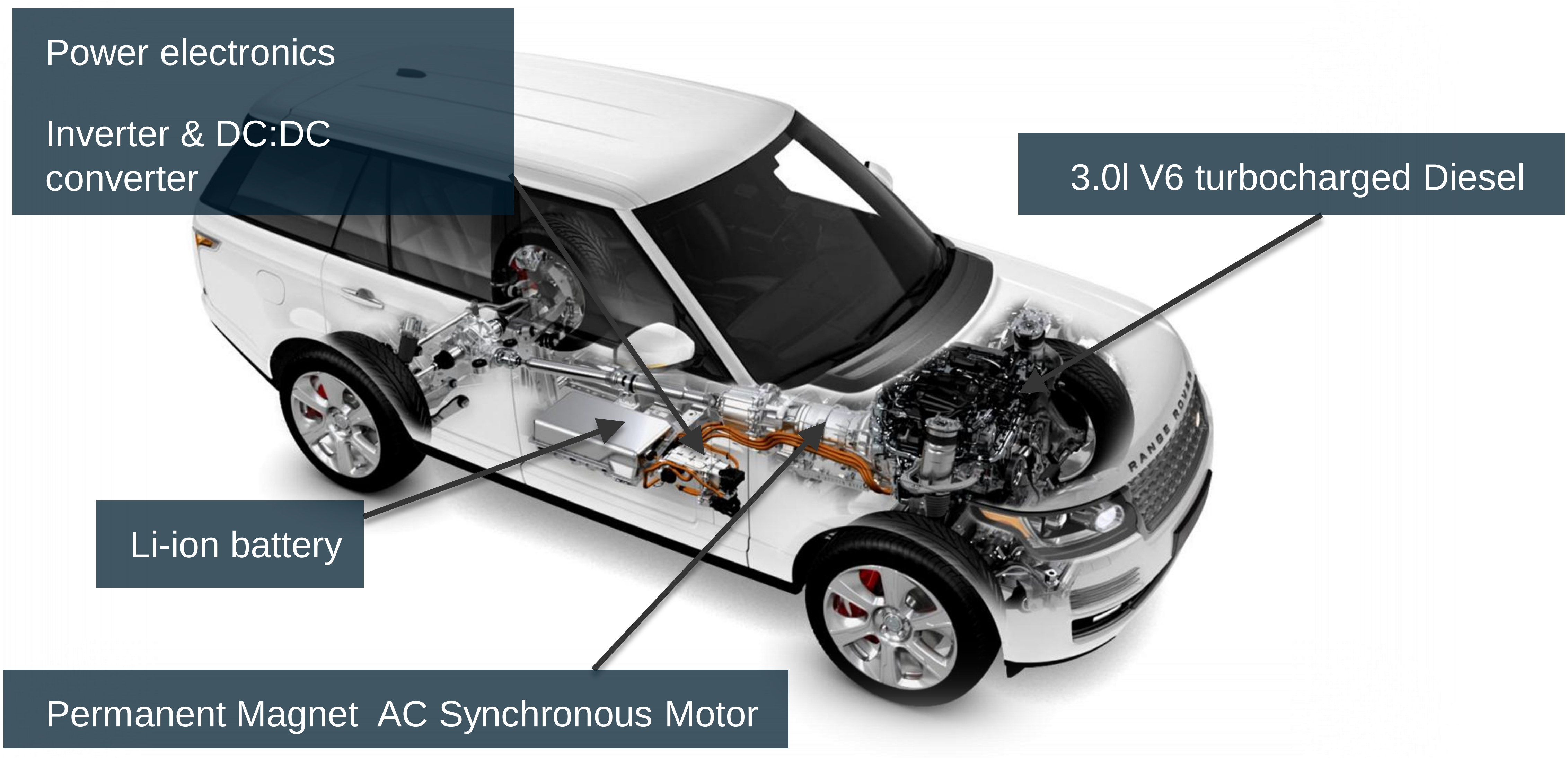
Down-sized turbo-charged engine

Low Carbon Technology Roadmap

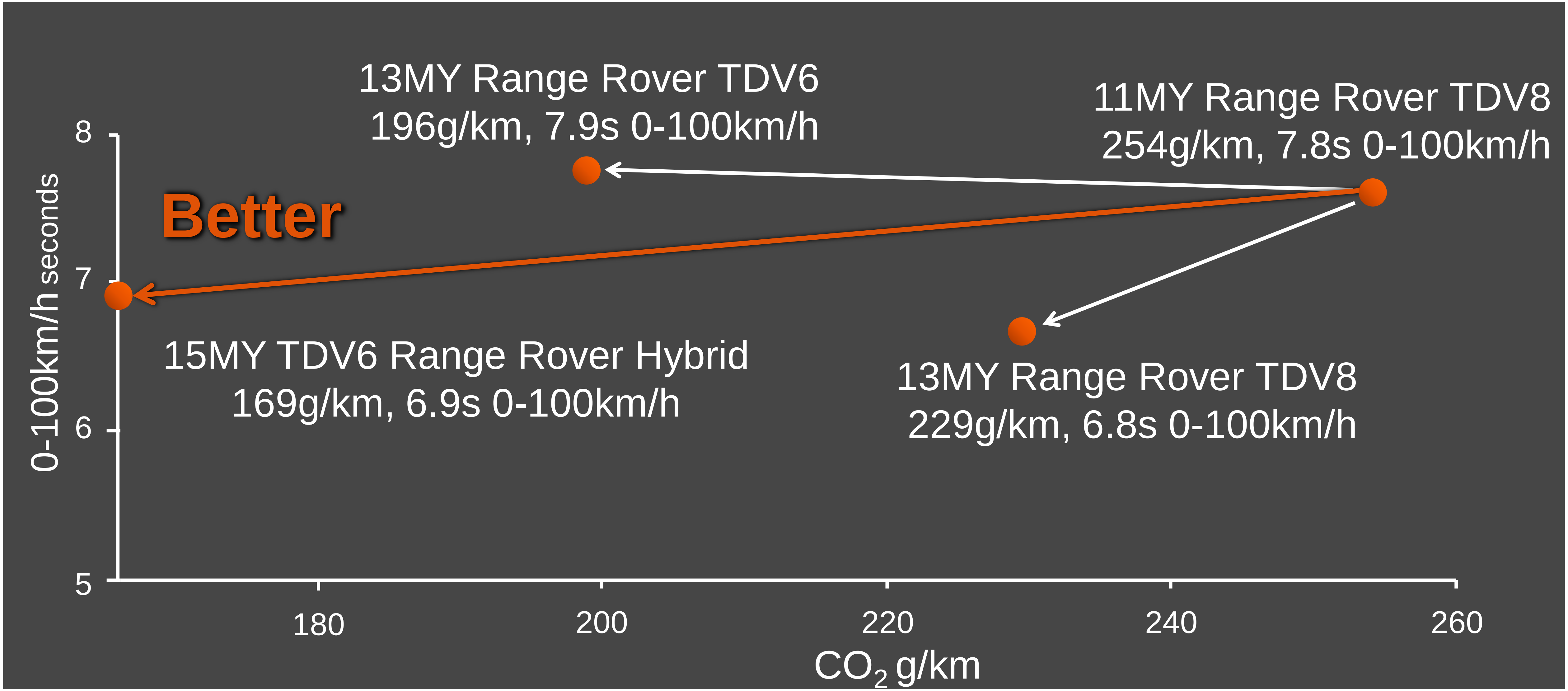
– Individual manufacturers will prioritise certain technologies to fit with brand values, but OEMs share a common view of a high level Technology Roadmap



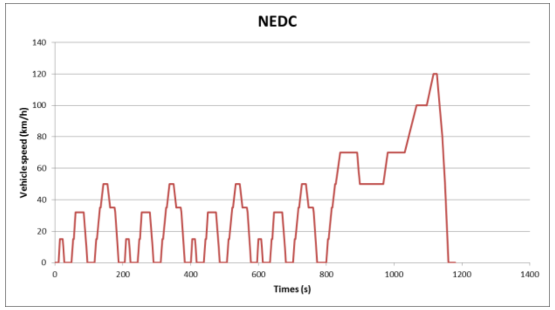
Range Rover Hybrid Technology

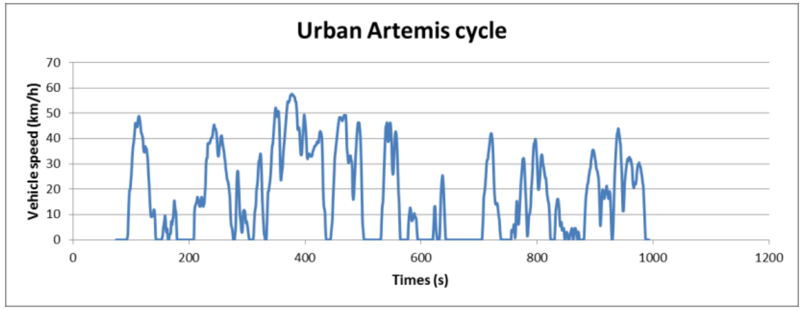


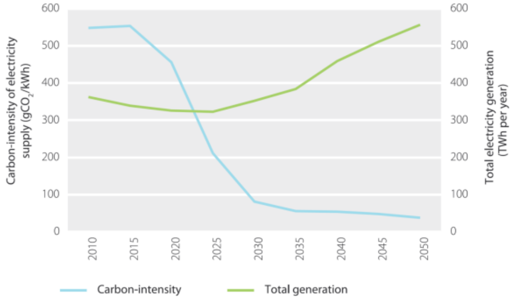
Performance vs Economy - Diesel

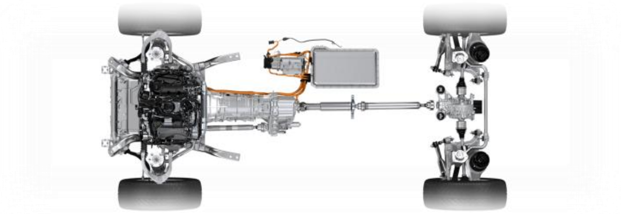


Vehicle Energy Consumption



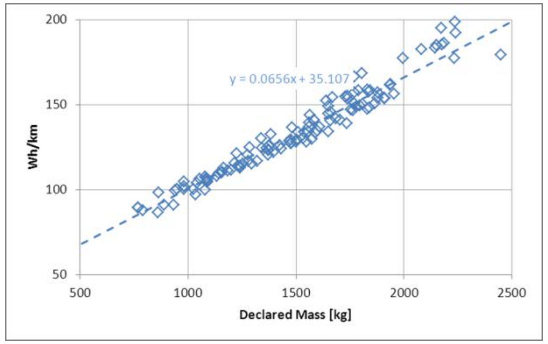


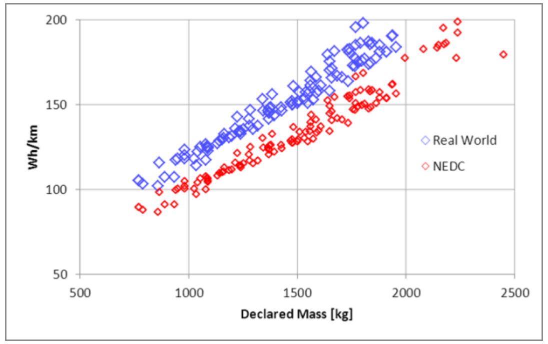




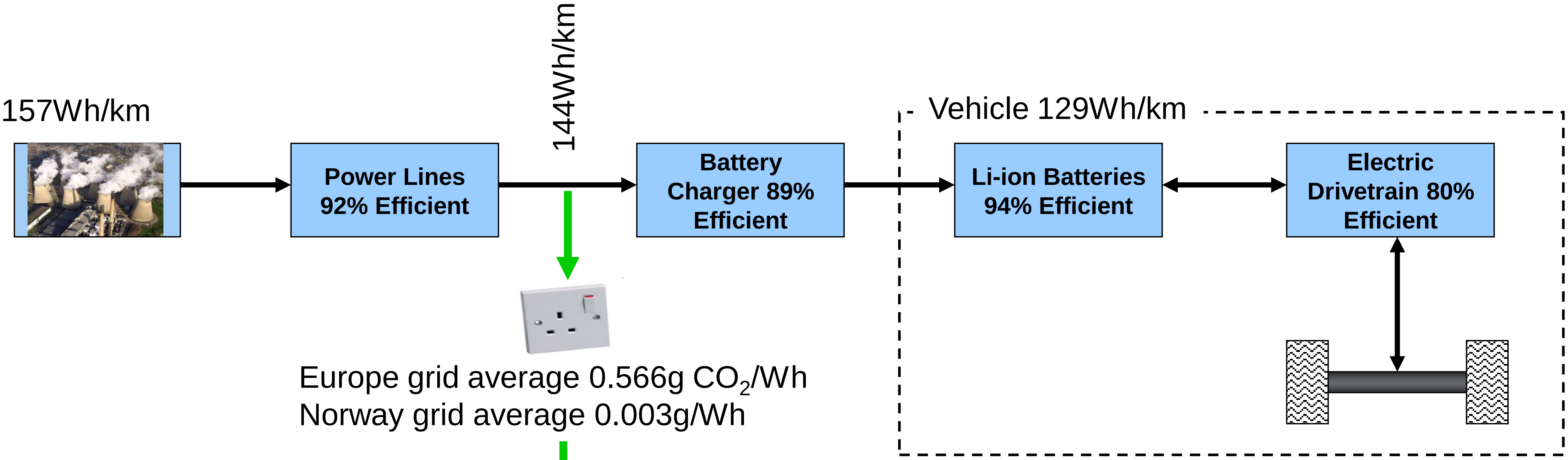
Energy required to drive vehicle over cycle.
Powertrain independent - Wh/km

Powertrain efficiency, CO_2 g/Wh





Energy discussion



Equivalent to
Eu 82gCO_2/km
Norway 0.432 g/km)

22kWh battery needs ~10400kWh of energy to make.
10 years at average of 40km/day (95% population) =146,000km.
Equivalent CO_2 : Eu Grid 40g/km; Norway Grid 0.21g/km

Research Activities

Leander

REHEV

CX75

Range_e

REEVolution

Catapult

Limo Green

Evoque_e

Future Electrification

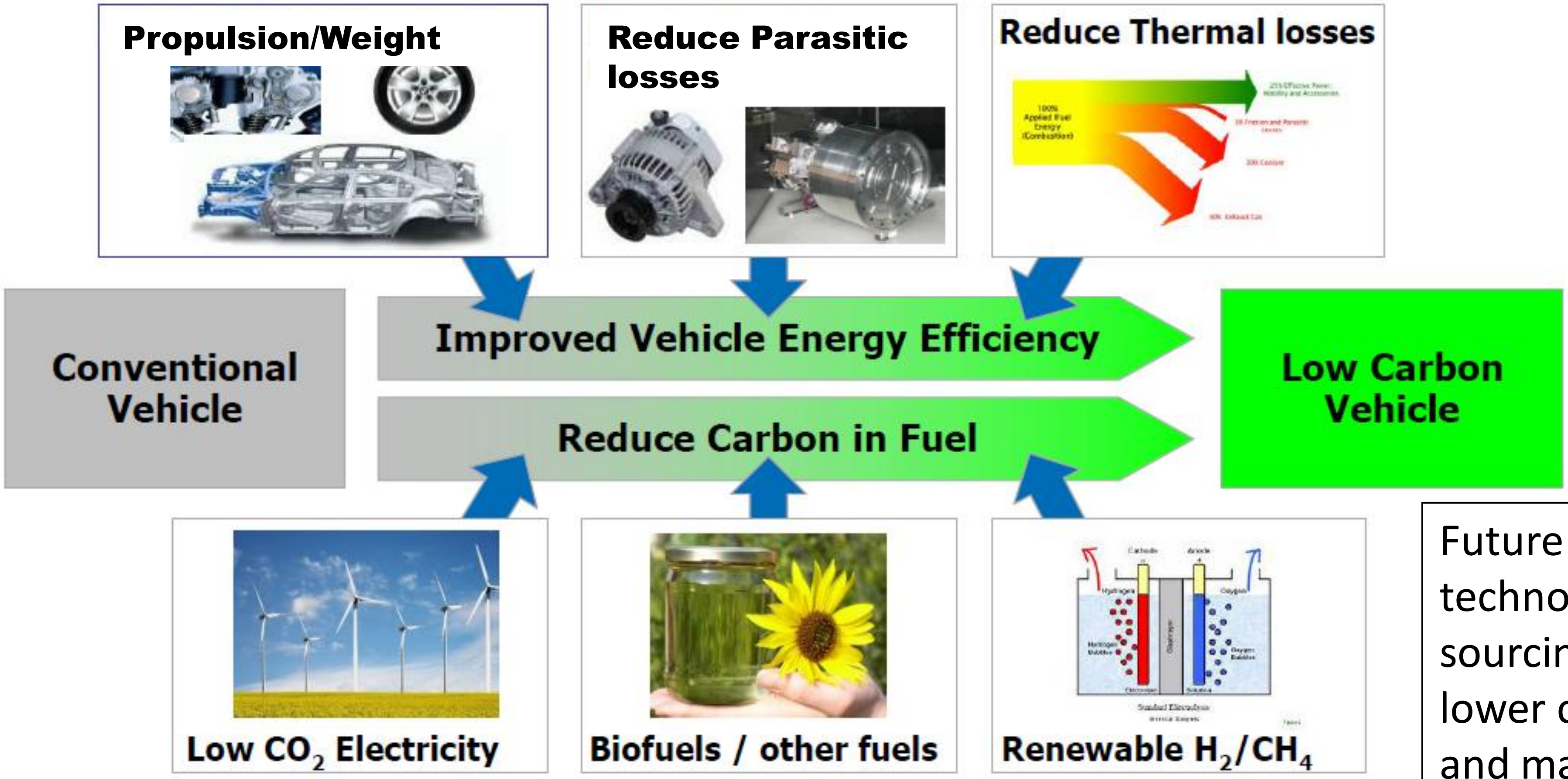
- Evoque_e project in conjunction with the Technology Strategy Board & partners is investigating several electrification options.
- 3 vehicles are being developed:
  - Full EV Battery Electric Vehicle
  - Plug-in Hybrid Electric Vehicle
  - Mild Hybrid Electric Vehicle.
- A broad range of additional technologies will be applied across these vehicles to further advance our experience in optimising the electrification of our vehicles.

Closing Remarks

- Luxury customers are unlikely to compromise their requirements. This means that luxury vehicle manufacturers have some interesting challenges ahead.
- Fossil fuels will be here for a while. We need to make the best possible use of these through improvements in vehicle and propulsion system efficiency.
- JLR has plans to drive down CO_2 emissions in all areas of the business as well as lifetime CO_2
- Electrification is a key enabler, with many different architecture options available, however decarbonisation of the grid and reduction of the embedded energy in the battery are important requirements.

Backup

Paths to Low CO_2



Courtesy ERTRAC - Energy Carriers for Powertrains 2014

Future vehicles' technology will permit sourcing energy from lower carbon options and manage energy more frugally (thermal, kinetic and losses).