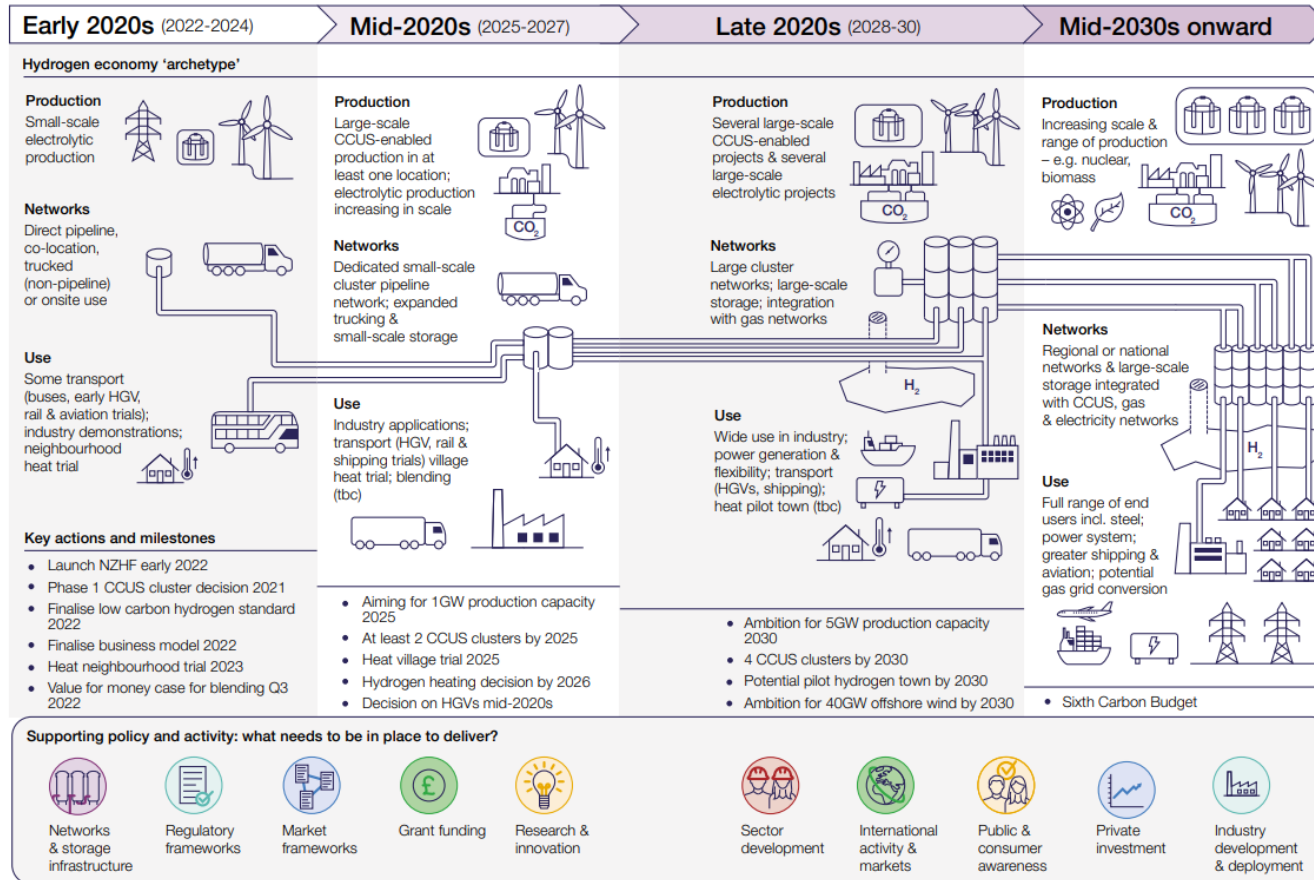


Doncaster Hydrogen – Progress with Hydrogen Heavy Goods Vehicles

November 2022

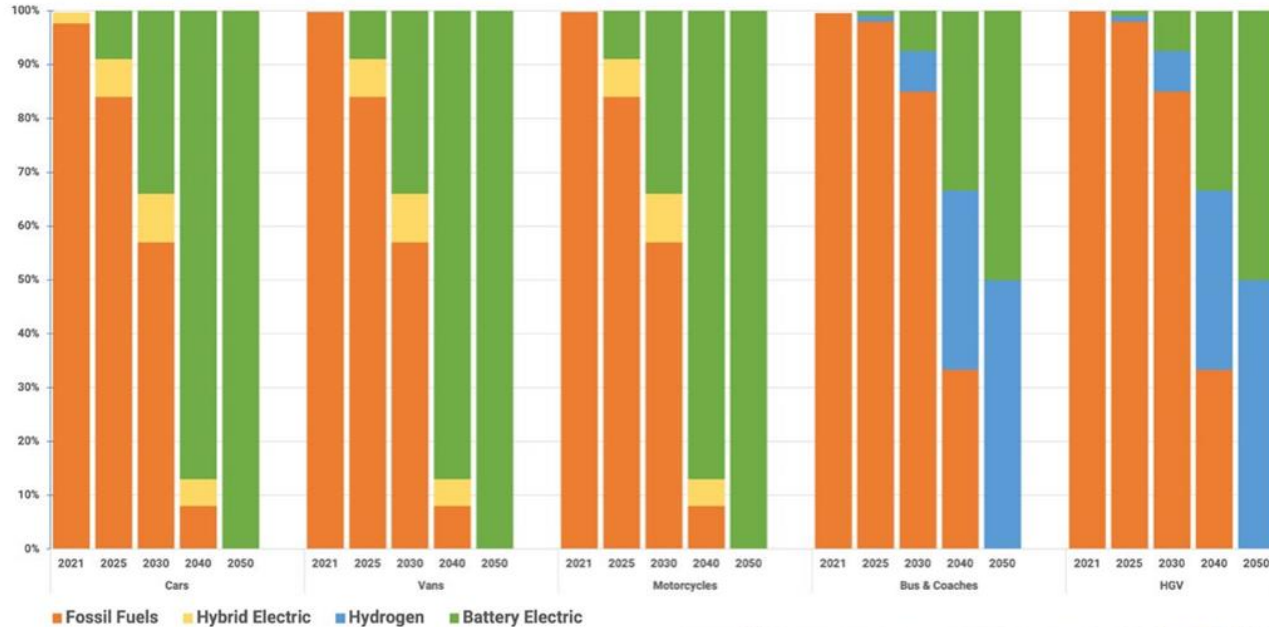


National Perspective



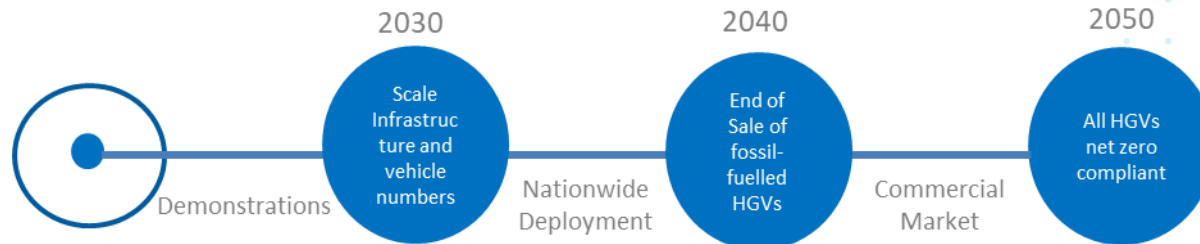
- UK Government policy support hydrogen as key enabler to net-zero emissions
- 10 GW by 2030
- Green growth agenda
- Ban of non ZE vehicle sales (cars 2030, HGV<26t 2035, all HGVs 2040)
- Focus on hard to electrify areas
- Pre-commercial phase

National Demonstration Funding



- Innovate UK's Transport Vision forecasts a 100% penetration of ZE HGVs by 2050 and estimates a split of 50% hydrogen and 50% battery electric trucks.
- ZERFT Initiative provided nearly £20m funding for feasibility and EV truck demonstration
- Next step large scale demonstration trials of solutions for ZE HGVs (incl. H2)
- Feed in to UK strategy exp. 2025

Zero Emission Road Freight Demonstrator (ZERFD)

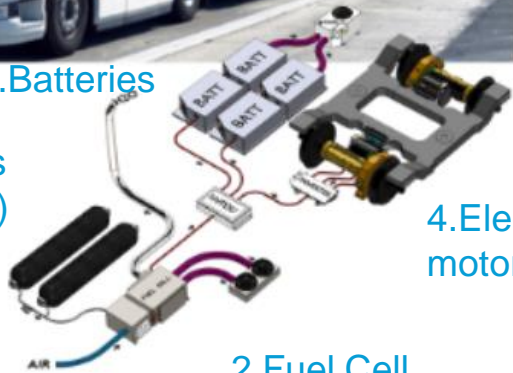


Hydrogen Vehicles



3. Batteries

1. Hydrogen Tanks
(350/700/LH2 bar)



4. Electric motor

2. Fuel Cell

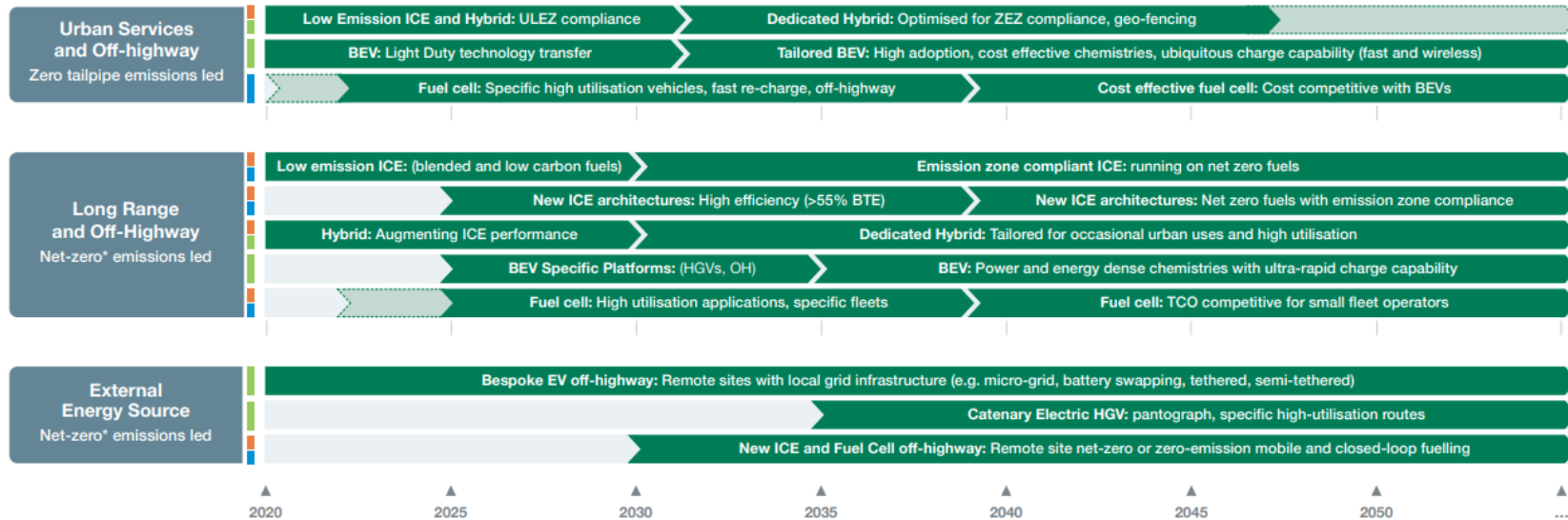
Transport Type	EU Future Market Potential
Cars	Large scale trials in EU, but most manufacturers / govts. now favour BEV
Vans	Most manufacturer / govts. favour BEVs. Some products expected over coming years for hard-to-electrify applications
Trucks	Early products becoming available. Widely considered critical for net zero targets
Buses	Product demonstrated over last 5 years, deployments growing with grant funded support
Off-road	Early products becoming available. Widely considered critical for net zero targets. Materials handling FC Forklifts have been available for many years.

Hydrogen Technology Development

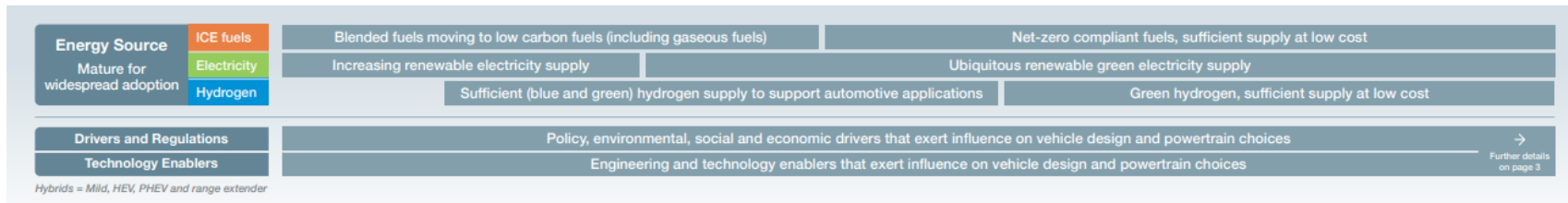
This roadmap represents a snapshot-in-time view of the global automotive industry propulsion technology forecast for mass market adoption. Specific application-tailored technologies will vary from region to region.

Solid colour bar:
Technology adoption for mass-market applications

Dotted line bar:
Technology exists in international markets, but less prevalent in Europe



- Roadmaps collate insight, foresights and predictions from across industry, academia and government
- H2 vehicles used in urban, off-highway and island energy supply
- Co-development of ICE and Fuel Cell vehicles
- Deployment support subsidies to 2035 (ish)



Hydrogen Trucks

Introduction

- Early product appearing on the market in response to demand signals from fleets and governments
- Technology entering demonstration phase supported by government funding
- Considered as key enabler for ZE HGVs

Vehicle Availability (UK) e.g.

- Diesel trucks can be converted to operate on hydrogen and diesel (H₂ DF) from ULEMCo
- Hyzon Motors supply rigid and artic trucks
- Ballard Motive supplying 19 FC RCVs to Glasgow City Council
- Product availability increasing this decade
- OEM product (Daimler, Volvo, Iveco) expected from 2023 – 2025 +

Infrastructure

- Limited public infrastructure.
- Current infrastructure subsidised through national and EU funded programmes.



Ballard Motive FC 26t RCV

- 70 kW FC
- 20 – 30 kgs H₂ @ 350 bar
- 30 kWh battery
- 10 min refuel
- 10 tonne payload
- 160 km range



Hyzon HyMax-450

- 6 x 2 (44t)
- 30 kgs H₂ @ 350 bar
- 120 kW FC
- 70 kWh battery
- 450 kW Motor Power
- 300 – 500 km range



700 bar and Liquid H₂ being developed for range improvement

Hydrogen Buses

Introduction

- Hydrogen buses are a developing technology, with limited, but growing, model availability.
- Key markets expected to be long range coaches and buses
- Government funding (ZEBRA) has recently covered 75% of bus and infrastructure costs
- UK Gov targets 25% ZE Buses by 2030

Vehicle Availability (UK)

- Two suppliers (Wrightbus and Caetano)
- 60 FCEV buses currently operational in the UK

Infrastructure

- Limited public infrastructure.
- Current infrastructure subsidised through national and EU funded programmes.

Single decker

Manufacturer	Model	Fuel Type	Battery Capacity/Fuel Tank size	Claimed Range	No. of Seats (Capacity)
CaetanoBus	H2 City Gold	FCEV	Up to 37.5 kg	500 km	31 (65)
Wrightbus	GB Kite Hydroliner	FCEV	35 – 50 kg	700 – 1,000 km	45 (90)

Double decker

Manufacturer	Model	Fuel Type	Battery Capacity/Fuel Tank size	Claimed Range	No. of Seats (Capacity)
Wrightbus	Streetdeck Hydroliner	FCEV	27 kg	450 km	65 (86)

Go-Ahead forges ahead with plans to launch hydrogen buses in the UK this summer

Public transport operator Go-Ahead Group has completed 15-year hydrogen supply deal, as it strives for a fossil-fuel-free fleet of buses in the UK by 2035.

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