

Hydrogen for Mobility

Hydrogen for Mobility – Heavy Duty Freight; how can it help transport decarbonise?

December 2024



Mike Copson – Associate Director; Energy Advisory
 mike.copson@arup.com

A history of innovation

Arup was born of our founder's conviction that a more collaborative and open-minded approach to engineering would lead to work of greater quality and enduring relevance. Sir Ove's legacy is an organisation that continues to be recognised for bravely imaginative solutions to the world's most challenging projects. In 1970 he set out 6 main aims of the firm in what is known to us as the Key Speech:



Quality of work



Total architecture



Humane organization



Straight and honourable dealings



Social usefulness



Reasonable prosperity

Global Presence



95 offices

34 countries

£2.2bn revenue

77 yrs of independent ownership

18,000+ people

**Revenue for 2022/2023 financial year (in GBP) for Arup Group Limited*

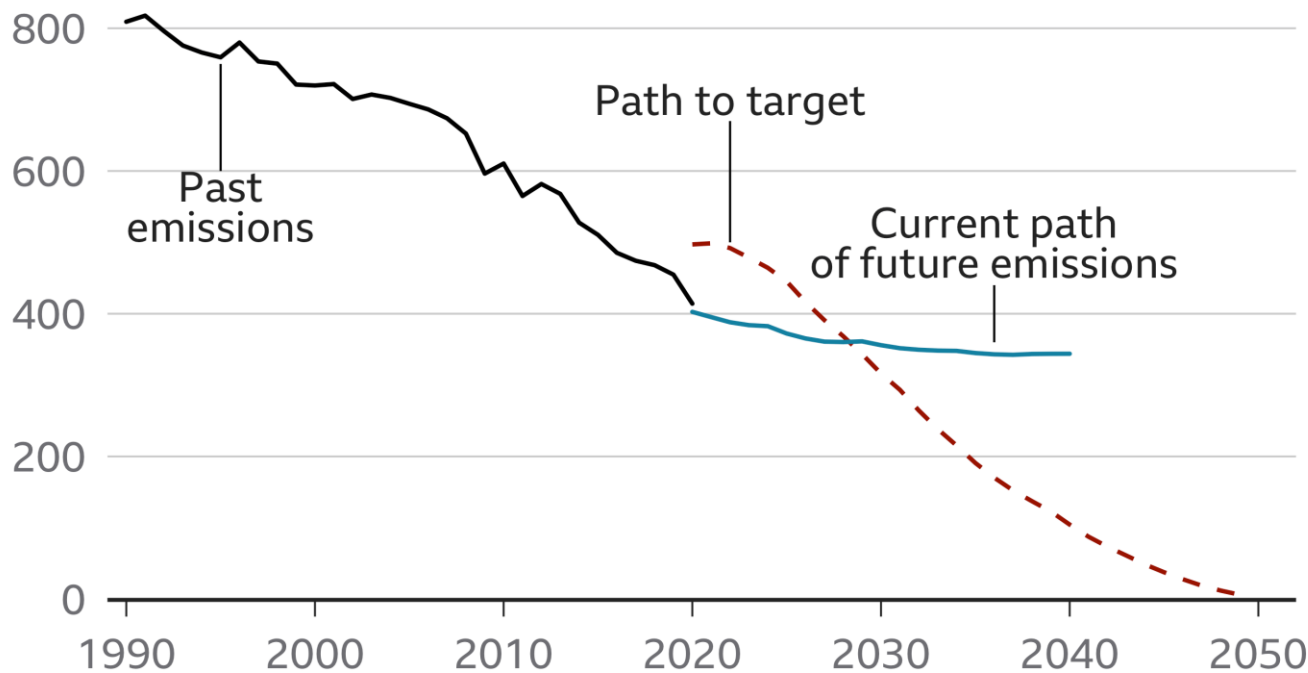
Context

Context

United Kingdom Net Zero Journey

UK will miss targets without more action

Megatonnes of greenhouse gas emissions a year



Emissions data for 2020 is provisional. Future emissions could be higher or lower. Past and future emissions from UK gov, target path from Climate Change Committee

Source: Dept. for Business, Environment & Industrial Strategy, CCC



UK signed up to Net Zero as a legal requirement in 2019

First G7 country to do so

UK is ahead of carbon budgets, but **behind** on its 2030 emission targets

Transport accounts for 22% of greenhouse emissions*

*Source - DESNZ

Context

Two Key Problems that need to be solved

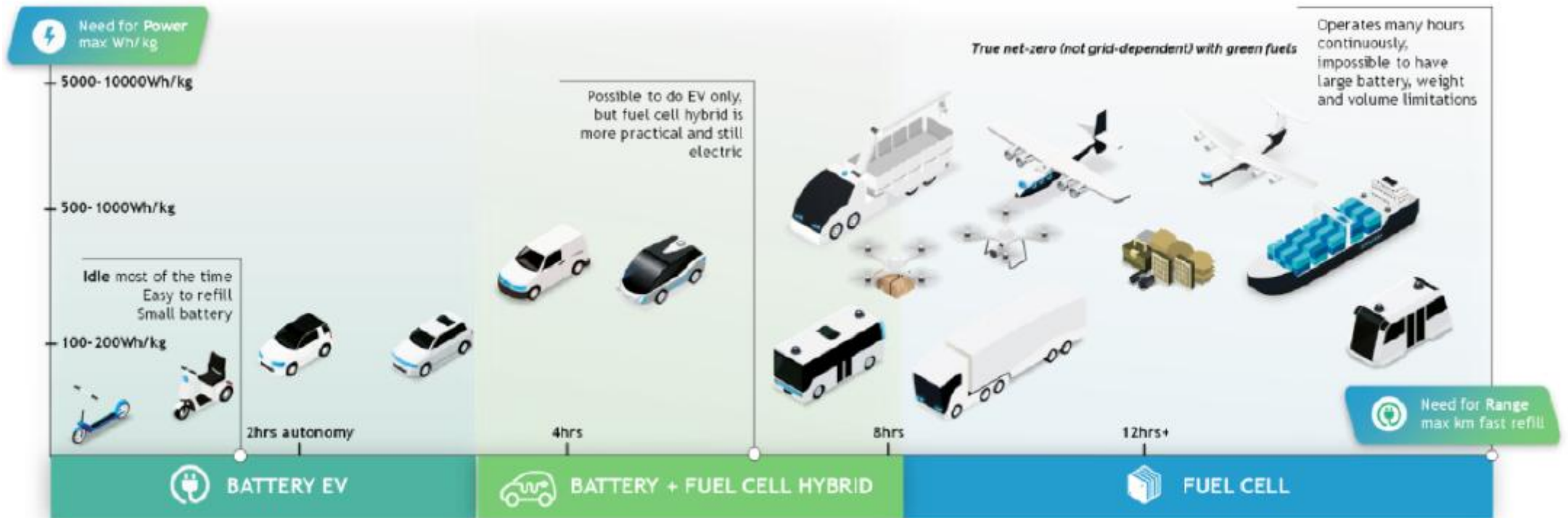
How is the future fleet decarbonised?



How is the *existing* fleet decarbonised?

Context

Current thinking on battery / hydrogen split across all transport sectors*



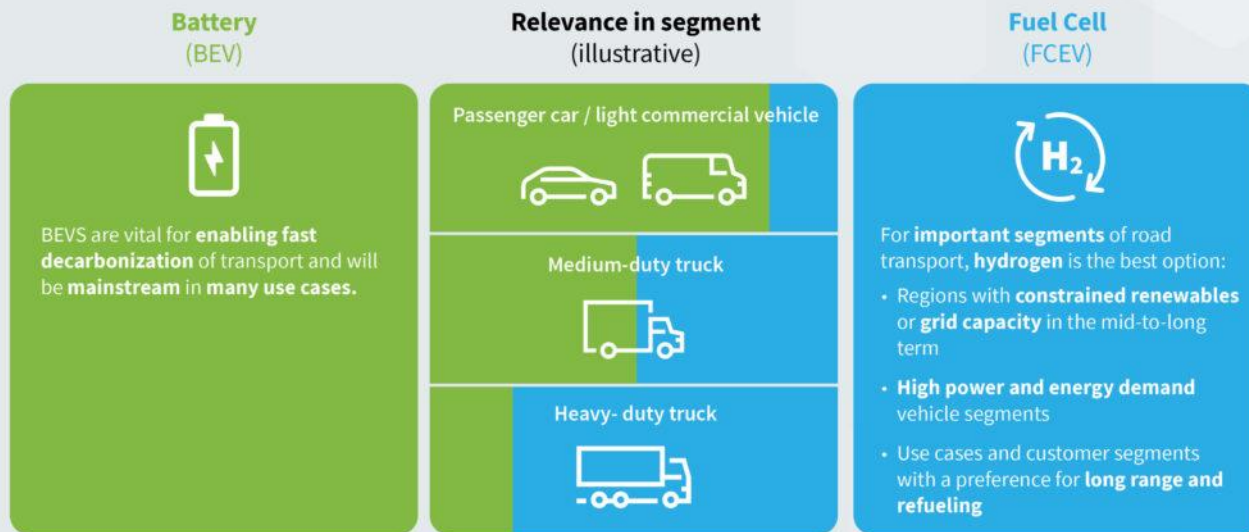
*Note: this slide does not include eFuels as a decarbonisation vector

Context

Decarbonisation is an ‘and, and, and’ conversation rather than ‘either/or’

Greener, Faster, Cheaper

Battery and fuel cell electric vehicles *working together* are the right path to net-zero



✓ GREENER

- Superior system efficiency
- More renewables
- Reduced material needs

✓ FASTER

- Accelerated decarbonization
- Customer buy-in
- Meet diverse regional needs

✓ CHEAPER

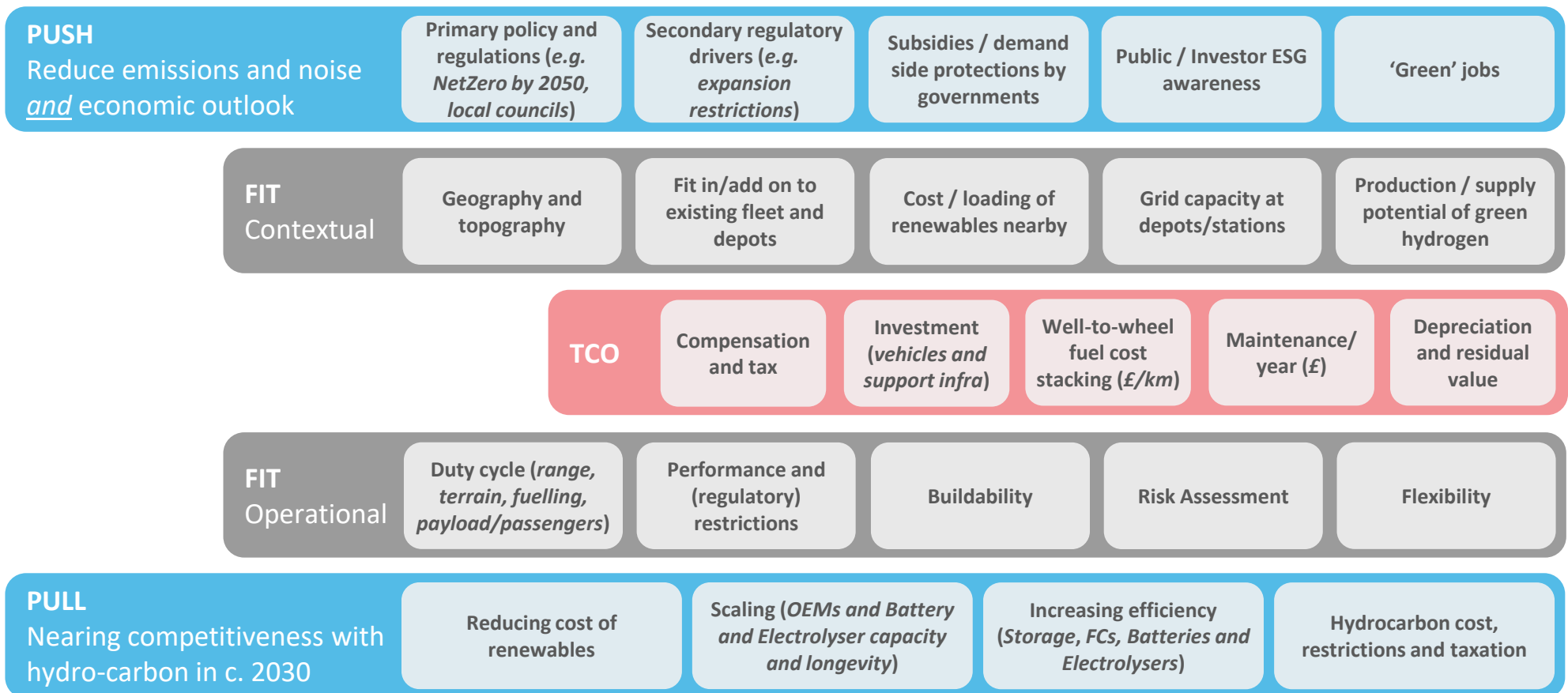
- Two infrastructures more cost-effective than one
- Reduced grid load
- Ease the transition to electric

Hydrogen Council

Source: Hydrogen Council, McKinsey - Roadmap towards zero emissions: The complementary role of BEVs and FCEVs

Context

The **Push** and **Pull** to Make Hydrogen **Fit** to an optimal **TCO**



Current Situation

Current Situation

Hydrogen refuelling stations & considerations

Either 350 bar, 700 bar or both. Liquid H₂ is in its infancy.

HD Freight refuelling should employ 350 bar.

Hydrogen refuelling stations can be deployed within either a depot-based environment or on land dedicated for a refuelling hub, and it is likely that in a city-wide refuelling network both scenarios will be required.

Choice of producing hydrogen onsite or supplied through a 3rd party. Correct sizing against CAPEX remain key challenges, with operational reliability and OPEX.



Current Situation

Hydrogen refuelling stations & considerations

UK is lagging behind Europe as no stations are currently in build*.

Germany's picture is misleading, as majority of sites are for LD vehicles

On a global stage, China and USA are leading for HD H₂ infrastructure.

Satisfying domestic needs is necessary, with a natural link to international H₂ fuelled freight in future.



*HAR1 allocations excluded and HAR2 allocations pending

OEM Offerings

Current OEM Proposals

More OEMs entering the market in a short time frame

Fuel Cell*:

- Daimler
- Nikola
- Hyundai
- Toyota
- Tevva
- Scania



Hydrogen for Combustion:**

- Volvo
- Cummins
- ULEMCO



e-Fuels

- Any manufacturer

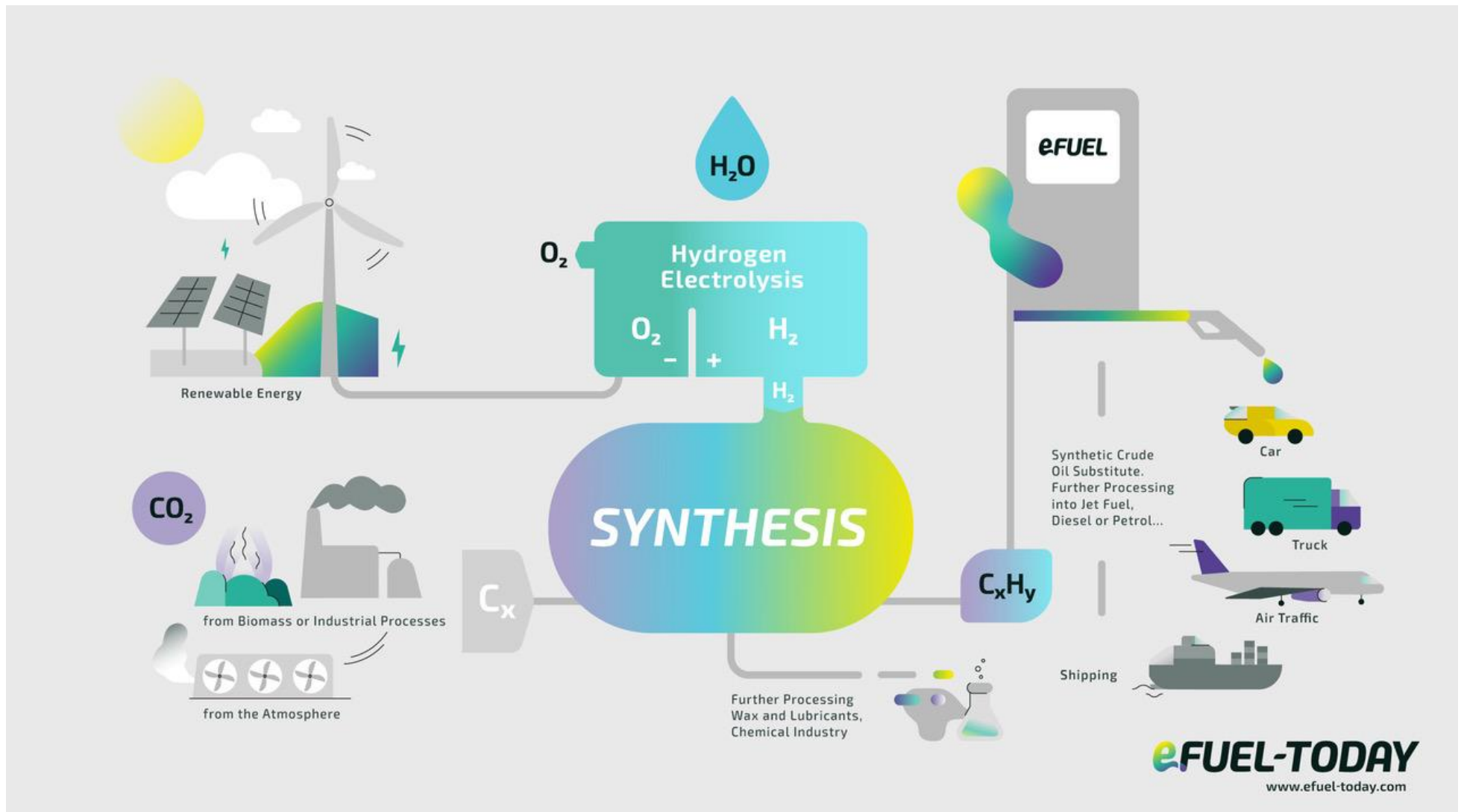


*Plus multiple Chinese OEMs – Foton and Hyzon are key players & could enter the UK market.

**Retro fitting by other companies will emerge

Future Solution?

Are e-Fuels worth the hype?



Next Steps

Next Steps

What will move the needle for Hydrogen Mobility in Freight?

Collaboration

- Both in business and politically – consistent policy drives private investment.
- Look beyond UK Borders for best practices.
- Co-locate e-charging and Hydrogen refuelling to cover all zero-carbon freight mobility.



Scale

- Linking refuelling hubs will create greater demand. Demand creates more hubs, which stimulates demand.
- Ideally an integrated national plan to roll out Hydrogen stations over a defined time period with a secure supply of low carbon hydrogen & subsidised vehicles is the ideal scenario.



Hydrogen for combustion & e-Fuels

- These are potential game changers for Heavy Duty Freight.
- Attractive to operators and reduces reliance on fuel cells.
- Production of NO_x (through reaction of atmospheric nitrogen (N₂) and oxygen (O₂) molecules in combustion gas at elevated temperatures) needs to be managed with H₂ for combustion
- e-fuels should be transparent compared to conventional diesel.



Next Steps

Challenges for Hydrogen Mobility in Freight?

Consistent Policy:

- Business models – consistency of CfD models, funding for refuelling infrastructure.
- OEM commitments to UK
- Attractiveness of UK for private investment

CAPEX:

- For both refuelling sites and vehicles
- Look beyond UK Borders for best practices
- Co-locating e-charging and Hydrogen refuelling

Operational Excellence Impact:

- No major fuel retailer implementing Hydrogen
- Operational risk that needs to be managed.

Infrastructure:

- Grid restrictions (applies to both Green and Blue H₂ sites)
- Service stations and their ownership models

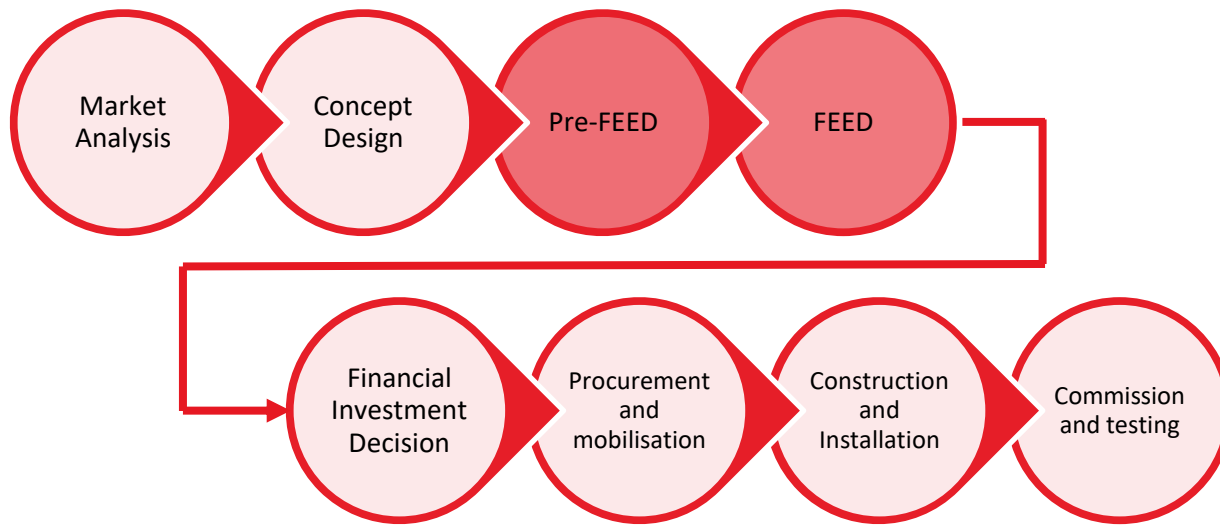


Department for
Energy Security
& Net Zero

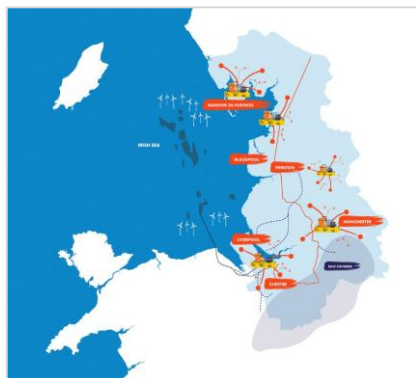


How can Arup assist you in Hydrogen for Heavy Duty?

We offer end to end project support:



- Procurement of Hydrogen vehicles
- Design of refuelling stations / distribution hubs
- Policy definition & direction
- Bid writing (HAR)
- Hydrogen Demand (bottom up and top down)
- Stakeholder engagement
- Business Models & Investments
- Engineering and financial due diligence



ARUP