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Vehicle Technologies for Minimising Carbon Emissions

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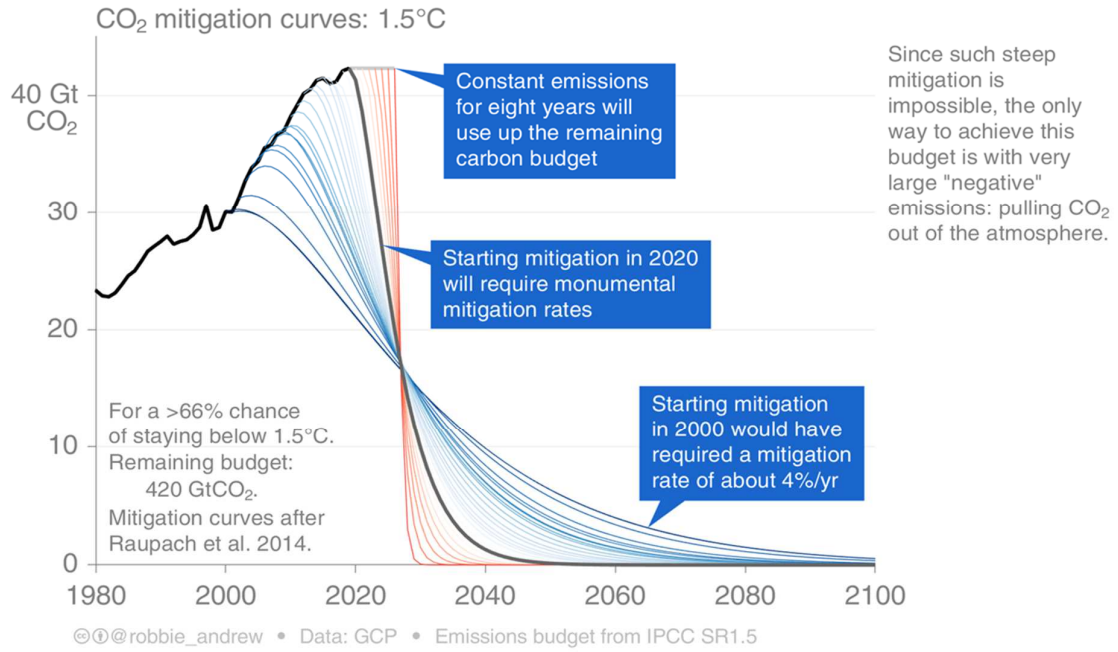
October 2020

Contents

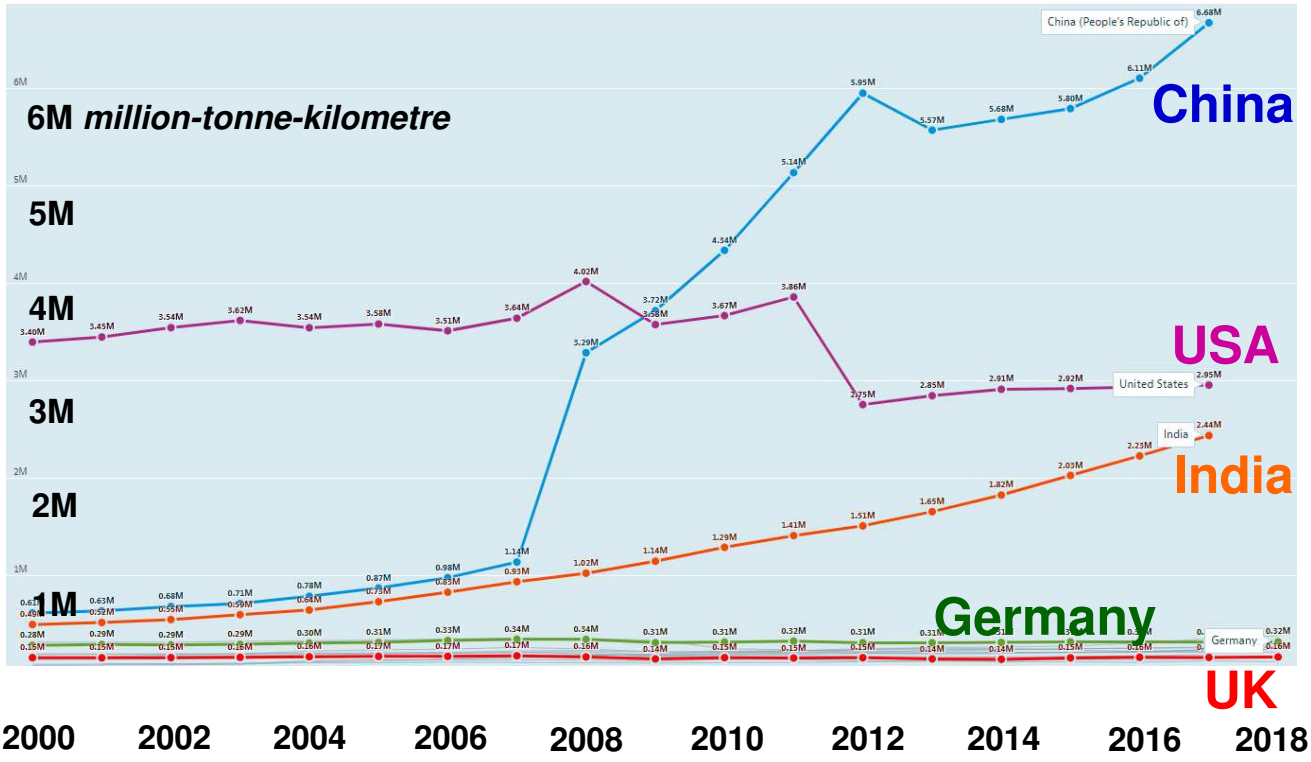
Background

Urgency

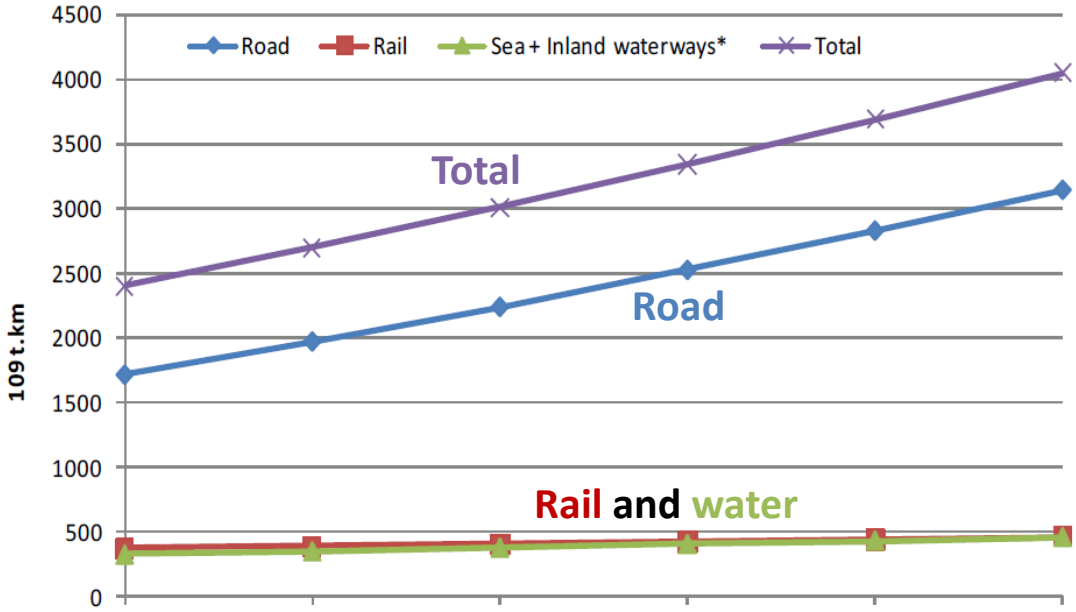


Andrew, R. Center for International Climate Research (CICERO), Norway

World Freight Transport (OECD, 2020)



Freight Growth in the EU-25 (10^9 t.km)



- Global transport CO2 emissions increasingly dominated by road freight…
- Difficult to decarbonize…

➔ What are the options for decarbonizing road freight?

Options for decarbonising?

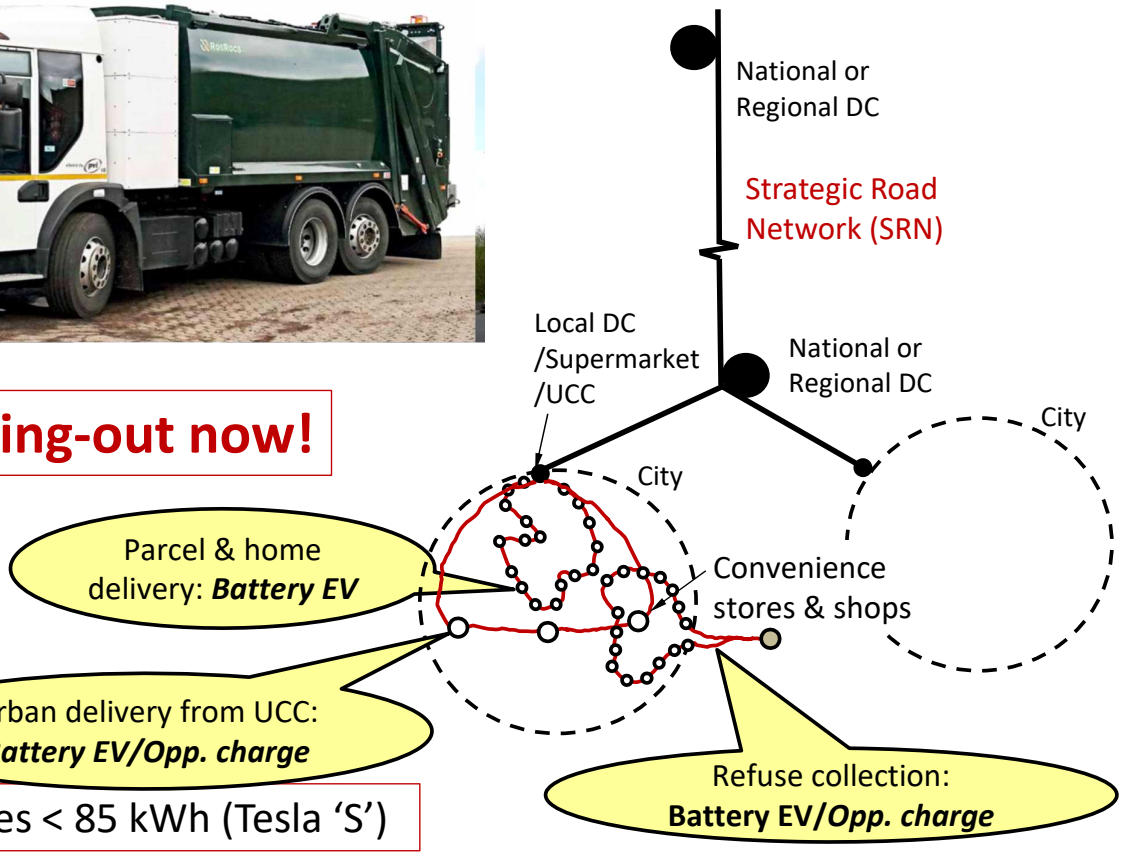
Options for decarbonising?

1. Reduce demand
2. Improve logistics efficiency
3. Improve vehicle energy efficiency
4. Cleaner vehicle energy sources

Urban Delivery

Urban Delivery

Rolling-out now!



All batteries < 85 kWh (Tesla 'S')

Long Haul

Evaluating Decarbonisation Options

1. Re-energising time
2. Vehicle Range
3. Flexibility
4. Costs
   - Infrastructure
   - Vehicles
   - Energy
5. CO2 emissions

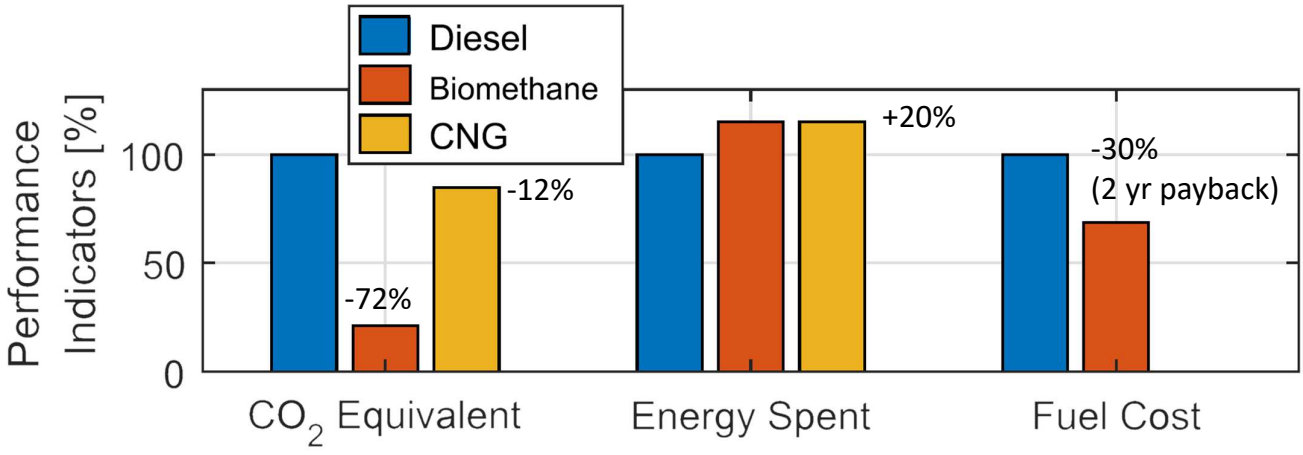
Diesel vs Gas (long-haul)

John Lewis Partnership

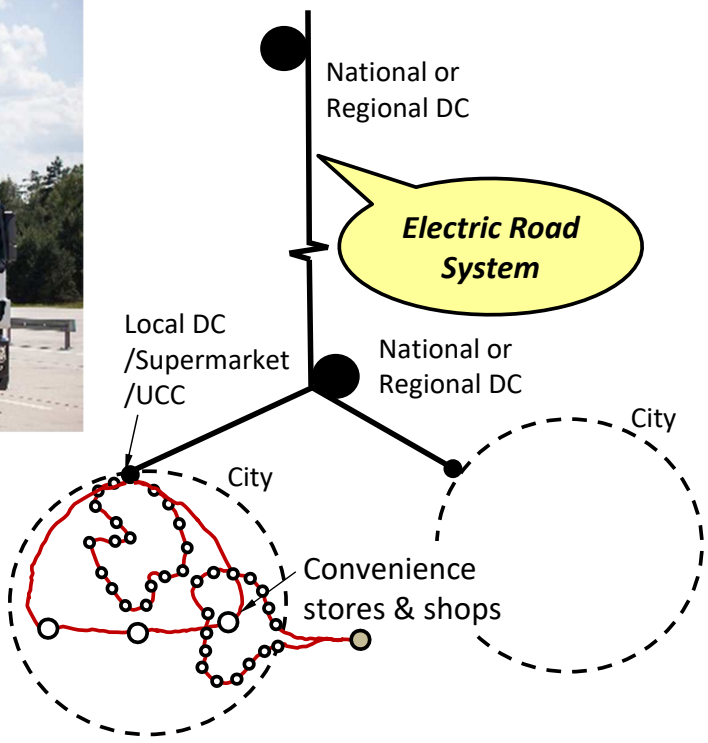
Innovate UK

CNG FUELS

In-service trial of 40 bio-gas trucks



Electrification of Major Roads



Hydrogen Power

Vehicle

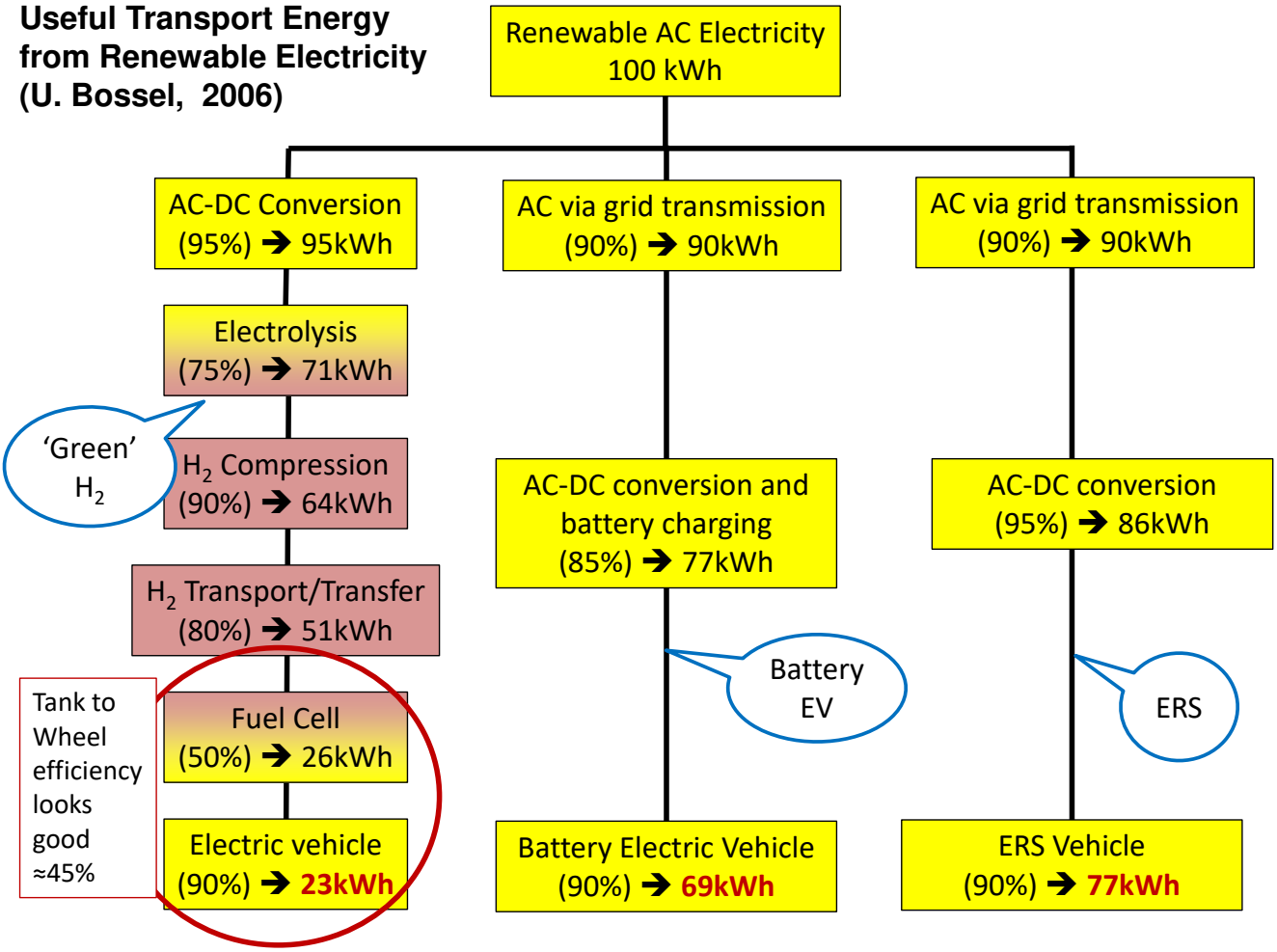
- Fast refuelling
- Good range
- Logistics models as now

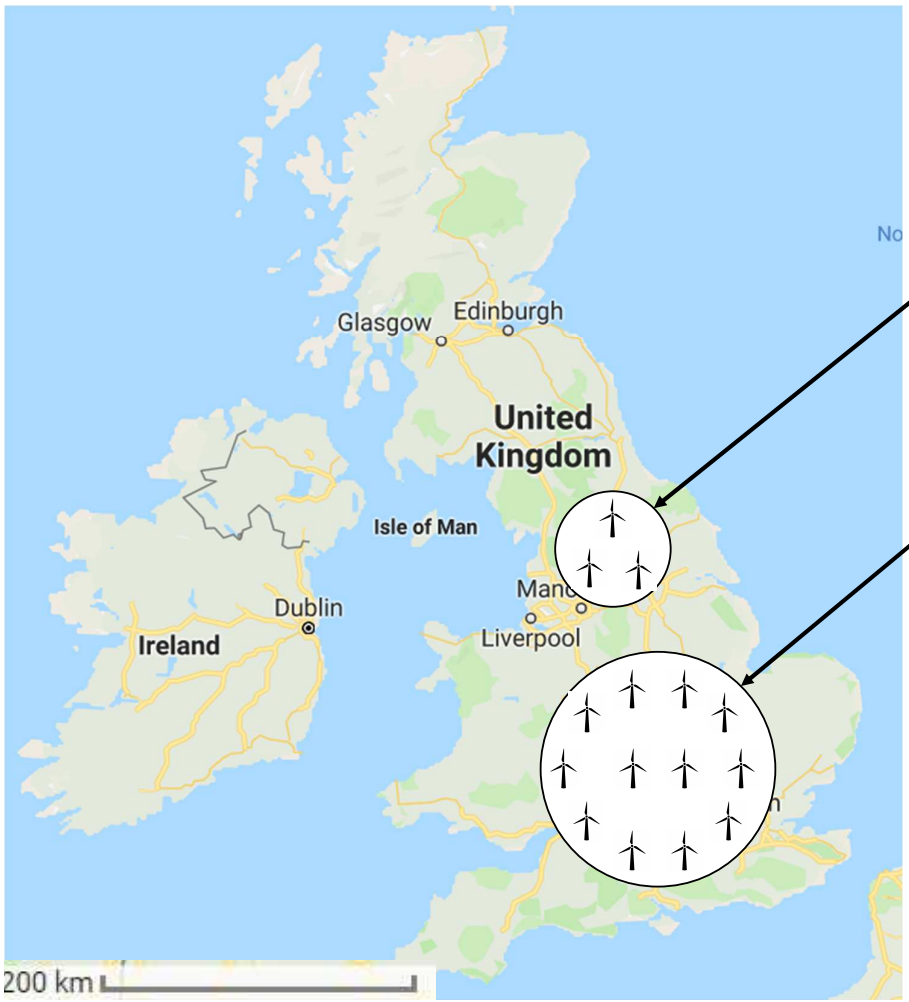
Fuel

- Green Hydrogen (Electrolysis)
- Blue Hydrogen (SMR + CCS)

‘Green’ Hydrogen by Electrolysis

Useful Transport Energy from Renewable Electricity (U. Bossel, 2006)





Land areas for electrification of UK Road Freight

ERS:

- 10.6 GW
- 3,500 wind turbines
- Land Area=5,300 km^2

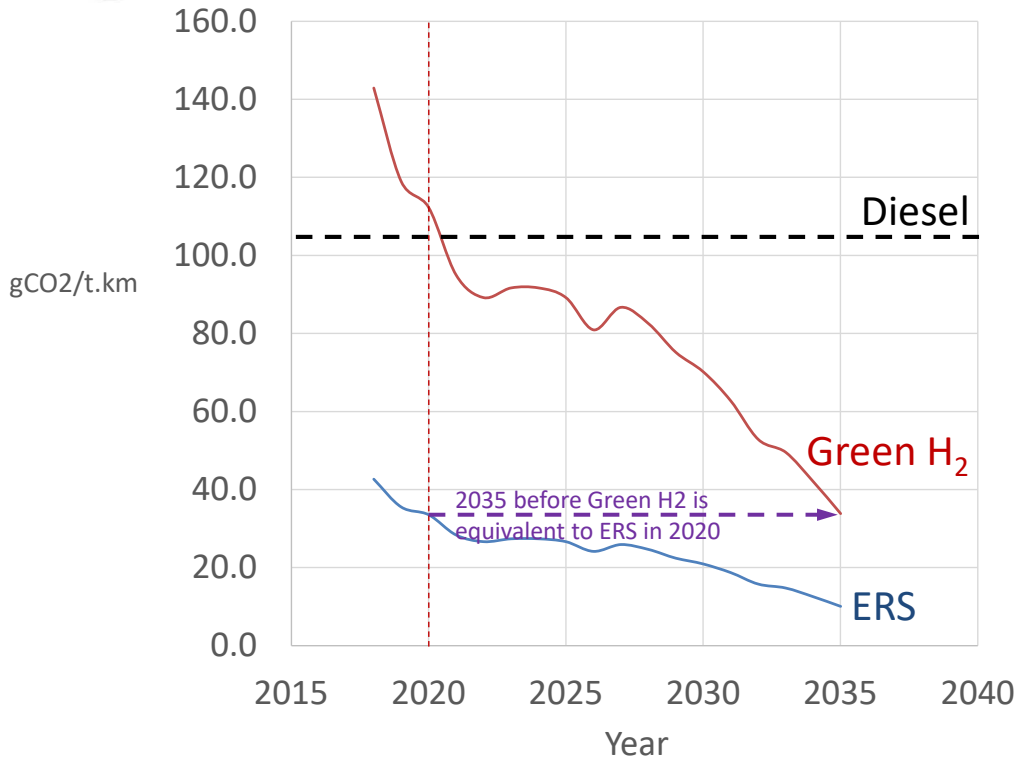
'Green' Hydrogen:

- 35.6 GW (31 GW = UK average)
- 12,000 wind turbines
- Land Area=18,000 km^2

Assumptions:

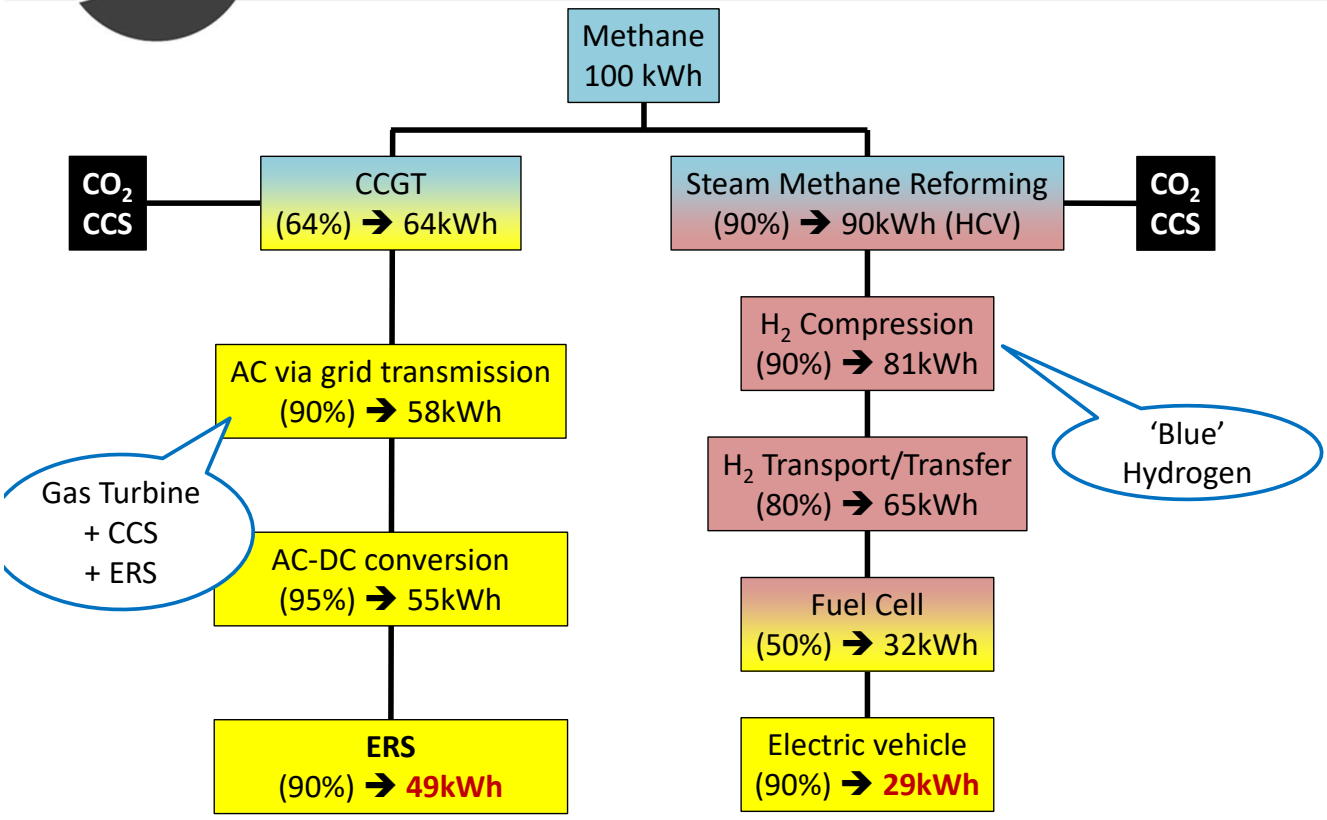
1. UK freight: 189b t.km per year
2. 0.19 kWh/t.km (44t), LF=0.75
3. Efficiencies:
   - 0.77 ERS
   - 0.23 H_2
4. Turbine power: 3MW
5. Wind power density: 2 W/m^2

CO2 generated by 44t Lorries (BEIS data)



‘Blue’ Hydrogen by SMR+CCS

Useful Transport Energy from Methane



ERS on Major Road Network

Key Features of Major Road Network

- 7500 km Motorways and key A-roads
- 2/3 Freight kms (rest mainly urban)

E-Highway Infrastructure:

- 4 motorway trials (Sweden, Germany, Italy)
- Cost for UK £20b
  (DfT roads budget £28b, 2020-2025)
- Share substations with cars at services
- Infrastructure share with 5G and CAVs
- Payback in 15 years
- Can be rolled-out by 2040

Vehicles:

- Series hybrid (transition, resilience)
- Batteries < 85 kWh (Tesla 'S')
- Vehicle payback 1.5 years

Full tax recovery for UK Government

Conclusions

1. All decarbonisation plans need best possible energy efficiency
2. Electric urban delivery is coming ➔ Supply chains for EVs
3. Gas: Interim solution, 12-15% decarbonisation
4. Green Hydrogen (electrolysis):
   - Inefficient ➔ excessive renewable electricity
   - High economic costs
   - Alternative electricity storage systems are more efficient
   - Questionable timescale
5. Blue Hydrogen (SMR + CCS)
   - 3.3 times higher volume flow needed ➔Replace gas grid
   - 70% more gas than [Power station + ERS] ➔Energy security + Trade deficit
6. ERS (eHighway)
   - Lowest energy and CO2 emissions
   - £20b (less than UK 2020-2025 budget for roads)
   - High TRL, Well tested, Implement immediately
7. National ERS + battery electric urban delivery:
   ➔Decarbonise most UK road freight operations by 2035-2040