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Hydrogen Refuelling Station Requirements for UK Long-haul Decarbonisation

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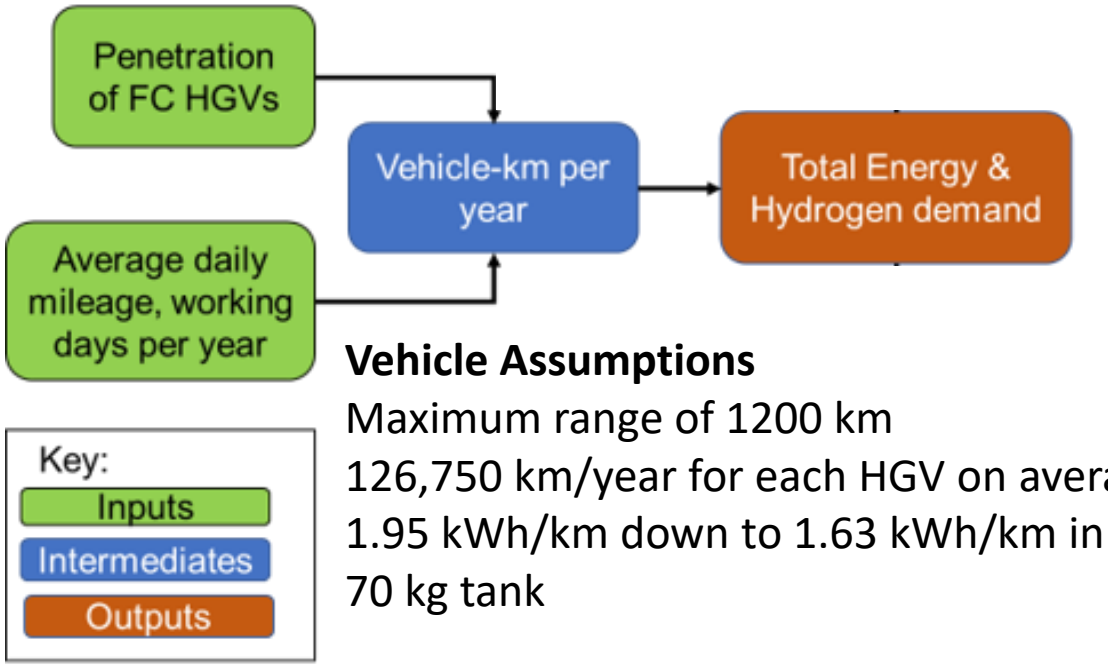
Background

- Understanding the long-term economics of replacing internal combustion engines
- General assessments of HRS requirements have been published for the UK
  - More detailed analyses are available for other countries such as Germany
- More detailed work has been done for other future fuel vectors in the UK, such as an ERS

- **Project Goals**
- What are the HRS requirements within the UK based on traffic density?
- How does that translate to production and consumer costs?
  - Low- and high-density areas
  - Centralised and decentralised scenarios

Station Distribution Model

- Approx. 530 000 HGVs by 2050
- Phase 1: 30% - 2030
- Phase 2: 80% - 2040
- Phase 3: 100% - 2045



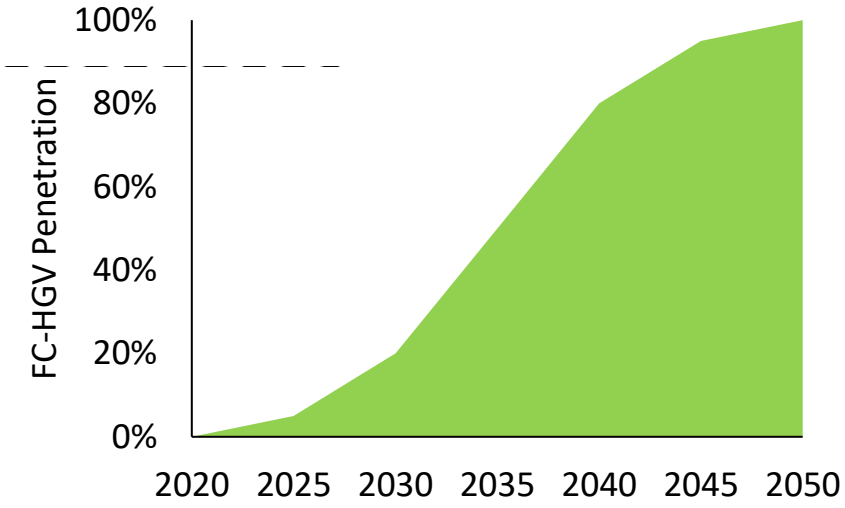
Vehicle Assumptions

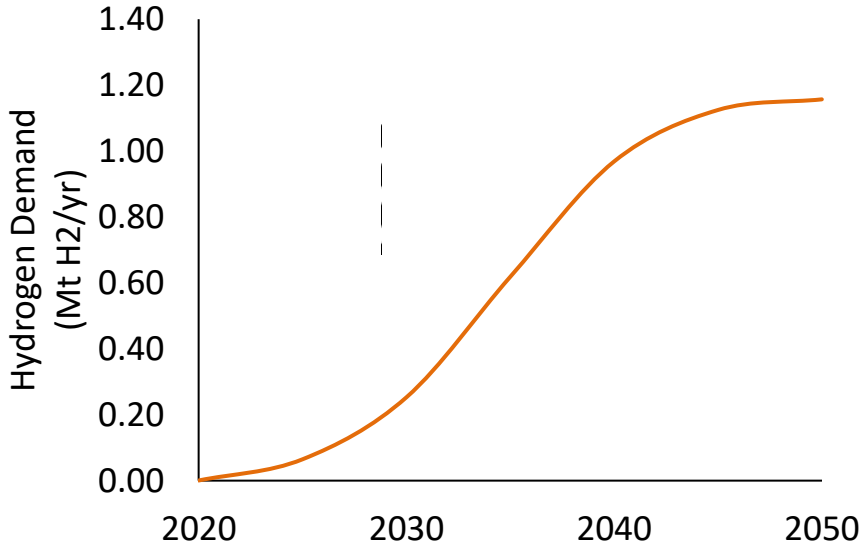
Maximum range of 1200 km

126,750 km/year for each HGV on average

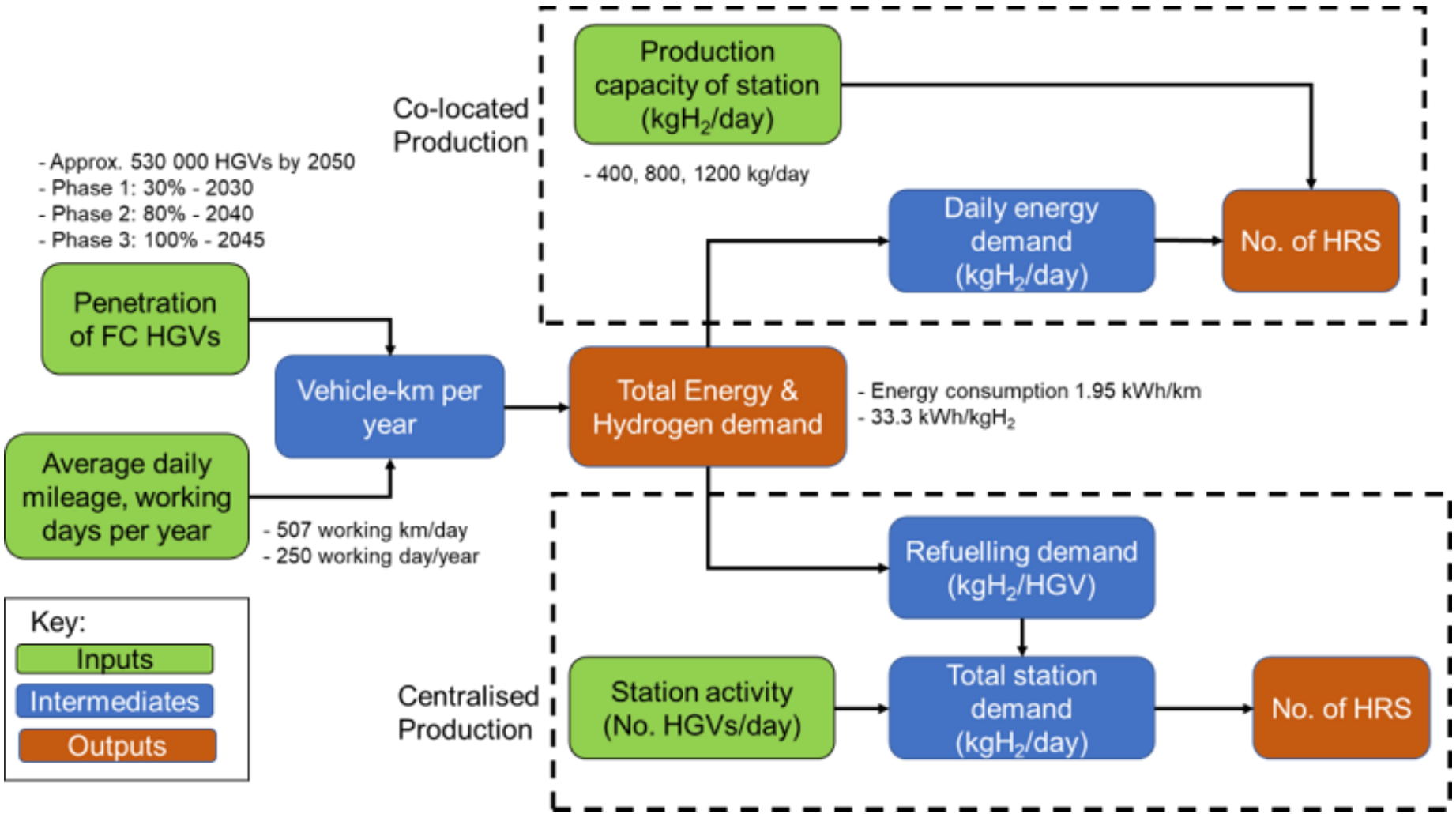
1.95 kWh/km down to 1.63 kWh/km in 2050

70 kg tank





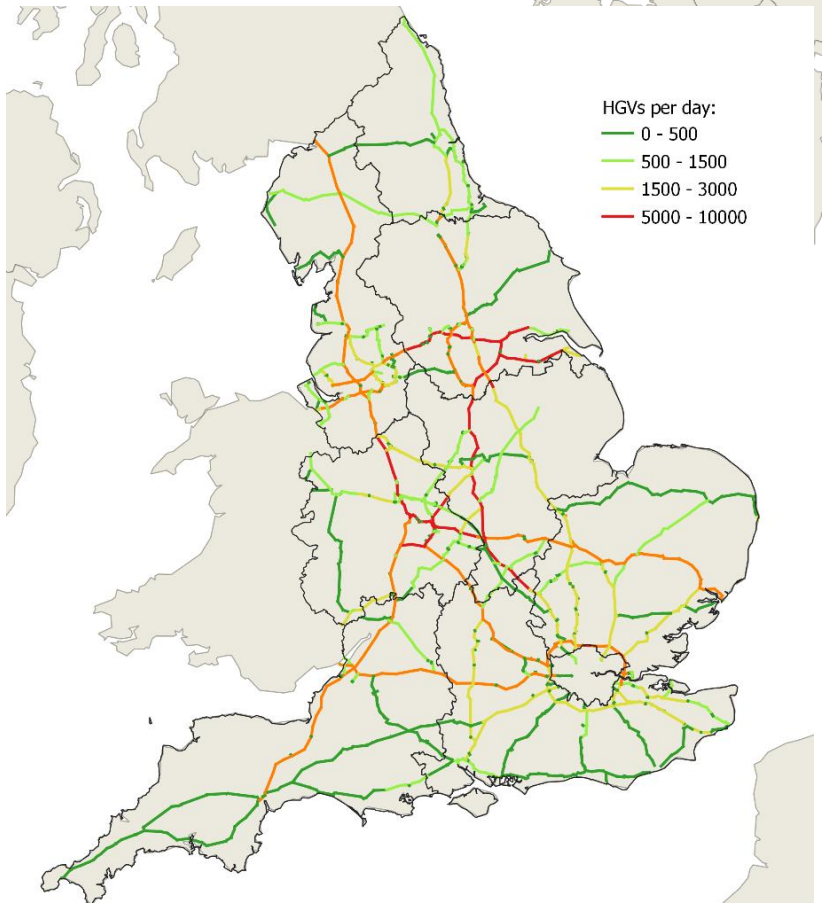
Station Distribution Model

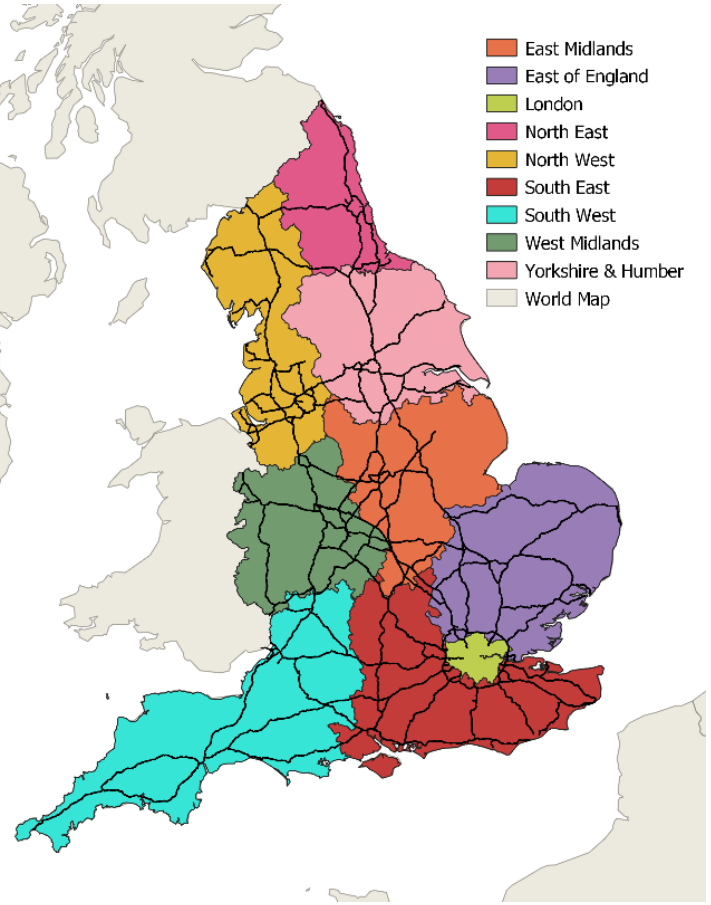


Station Distribution Model

- Based on traffic count
- Determines areas of energy concentration
- Regions define with SRN in black
- Percent utilisation of M and A roads for England
- Determined HRS size requirement based on daily energy demand for that specific area

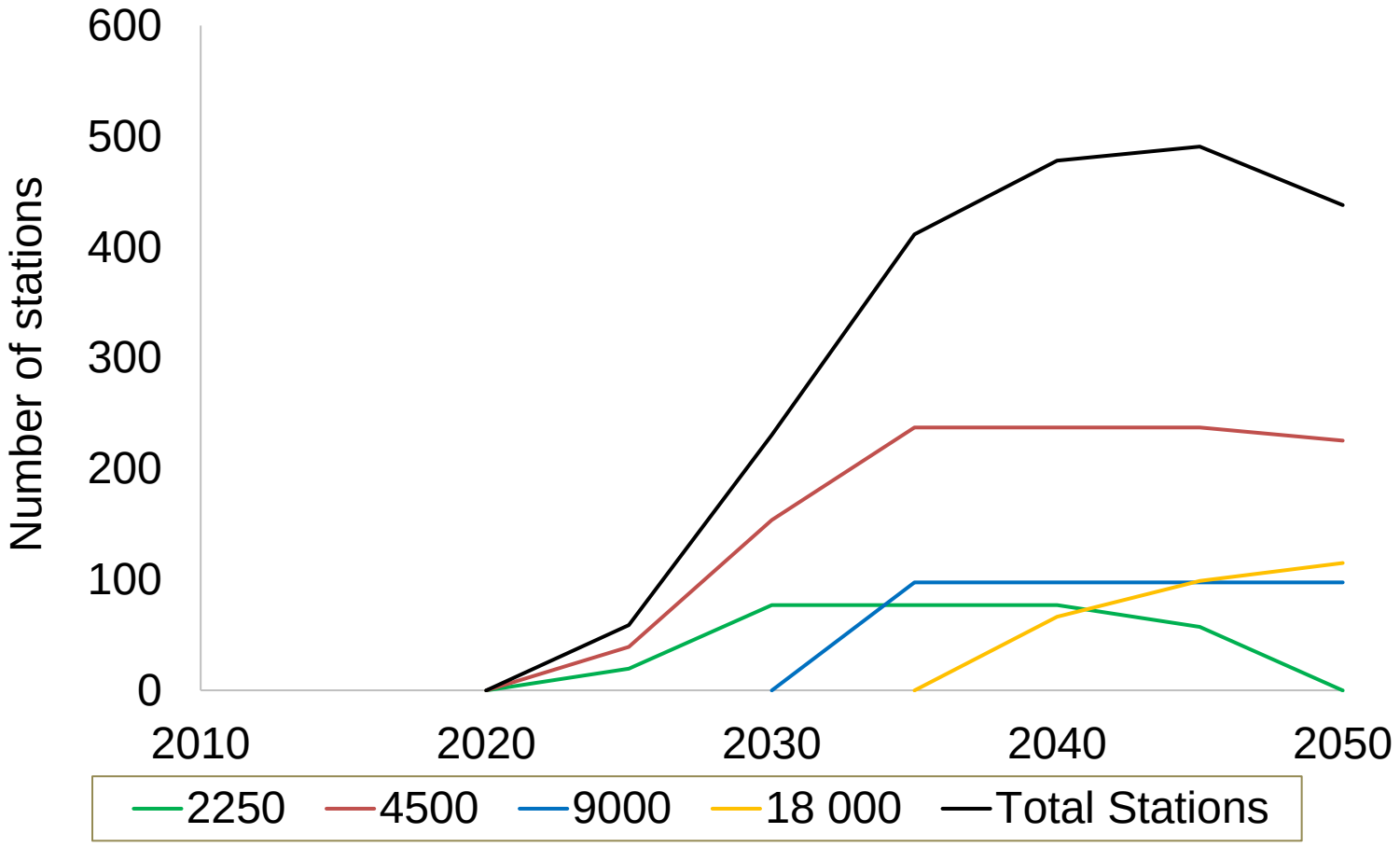
Traffic Count



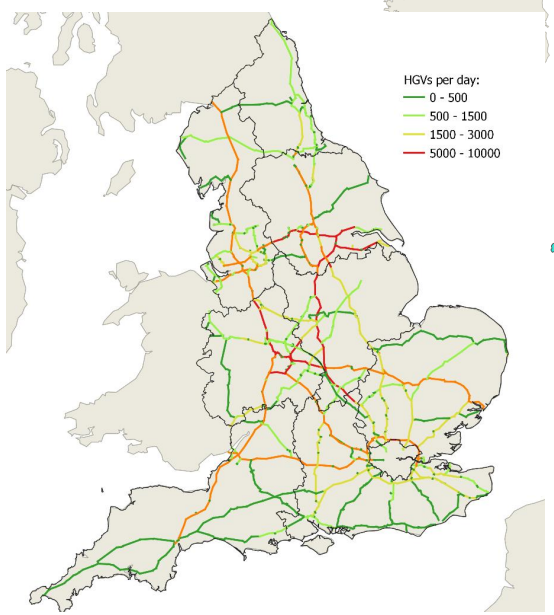


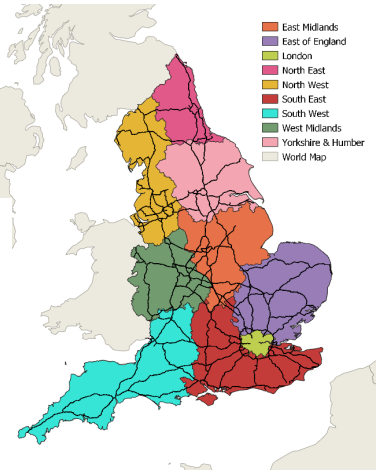
Regions and SRN

Station Distribution Model



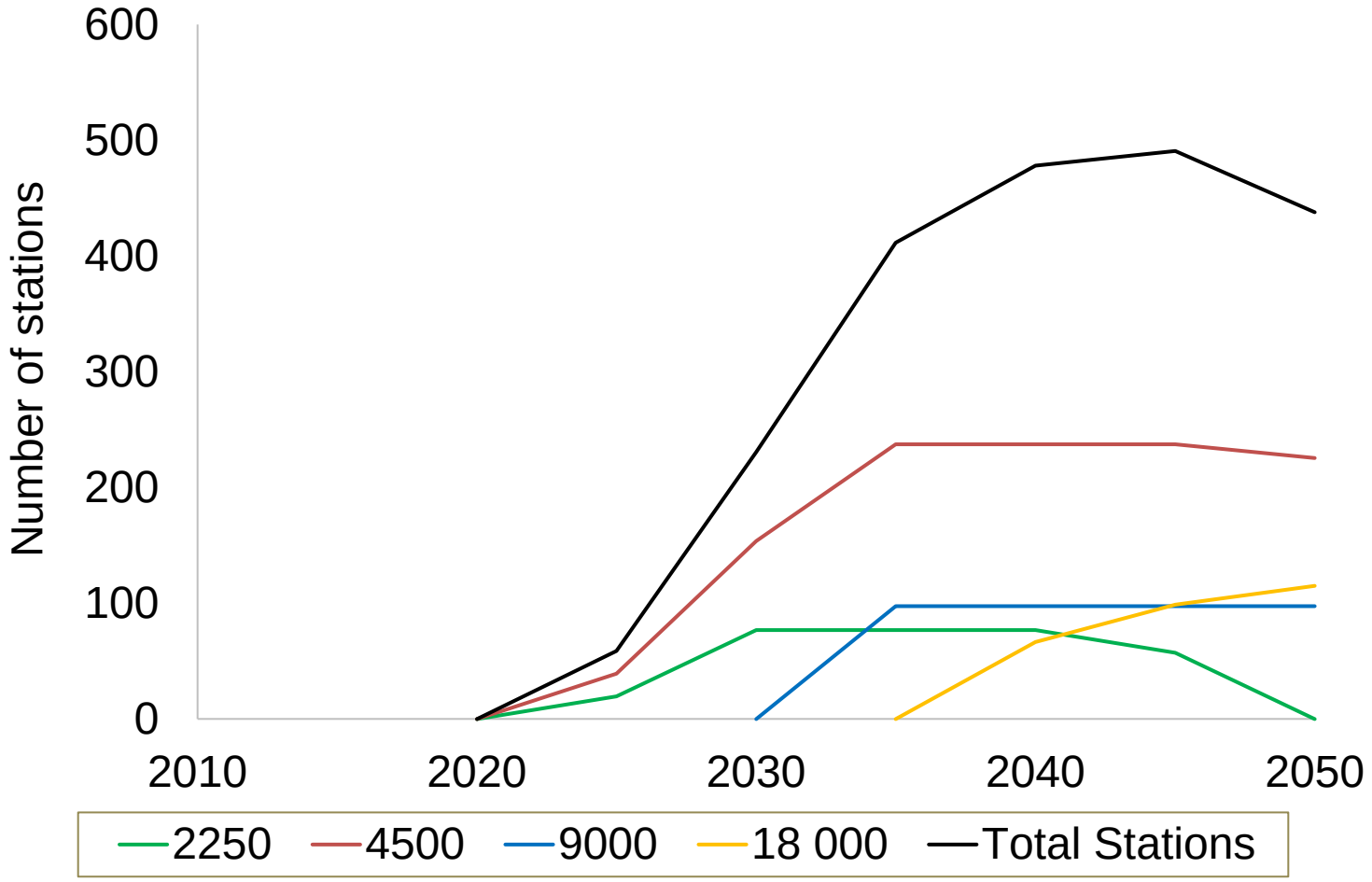
Traffic Count





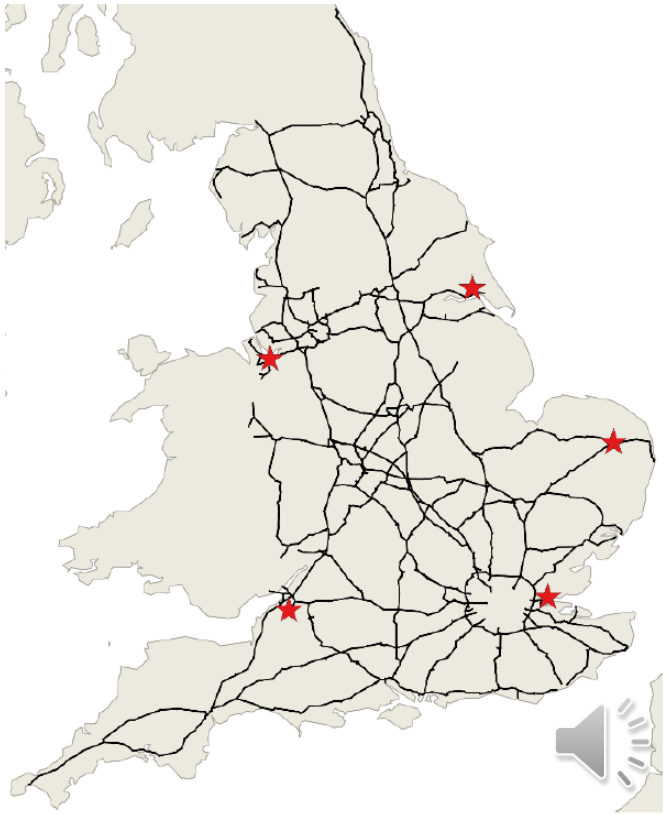
Regions and SRN

438 Stations of Various Sizes to Meet Demand



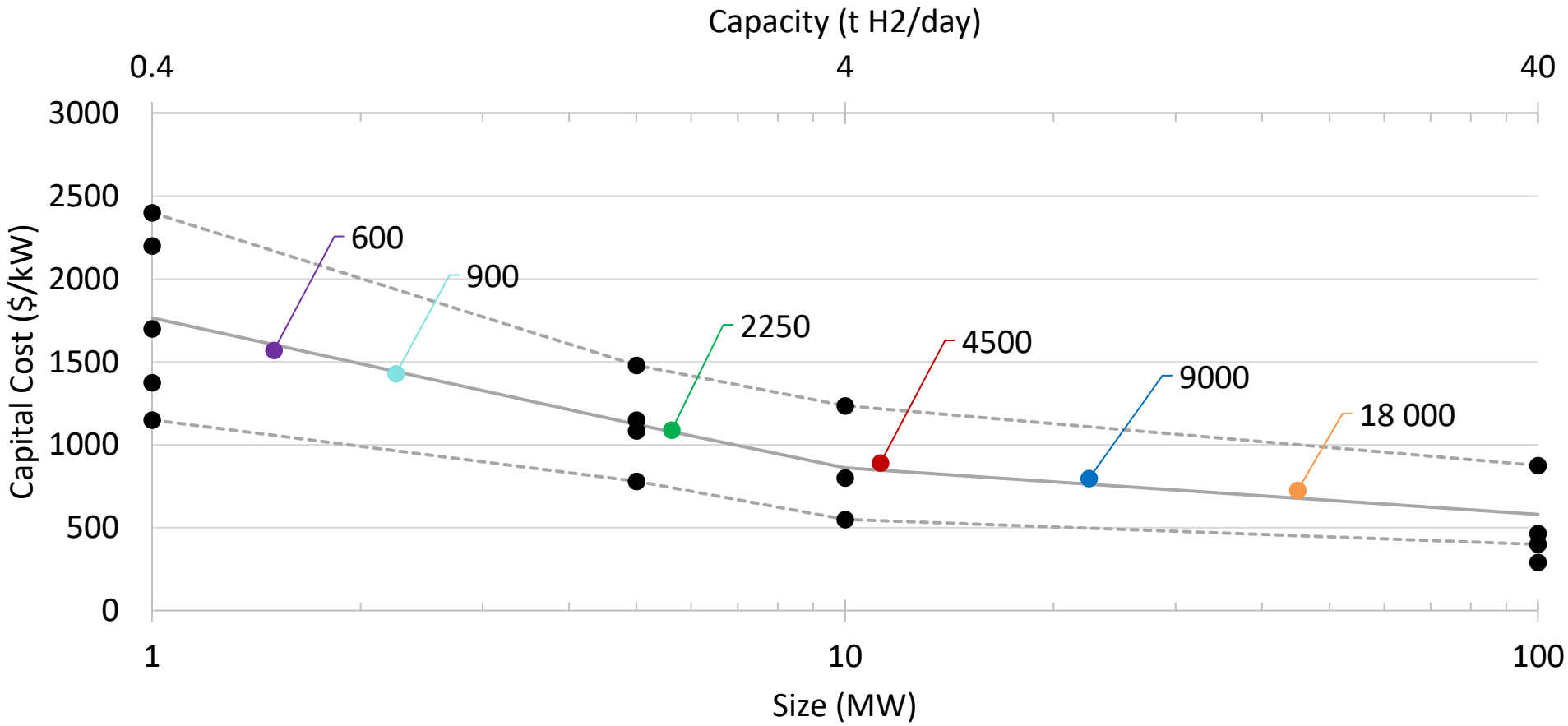
H_2 Production Scenarios

- Decentralised Electrolysis
- Centralised
  - Electrolysis
  - SMR with CCS

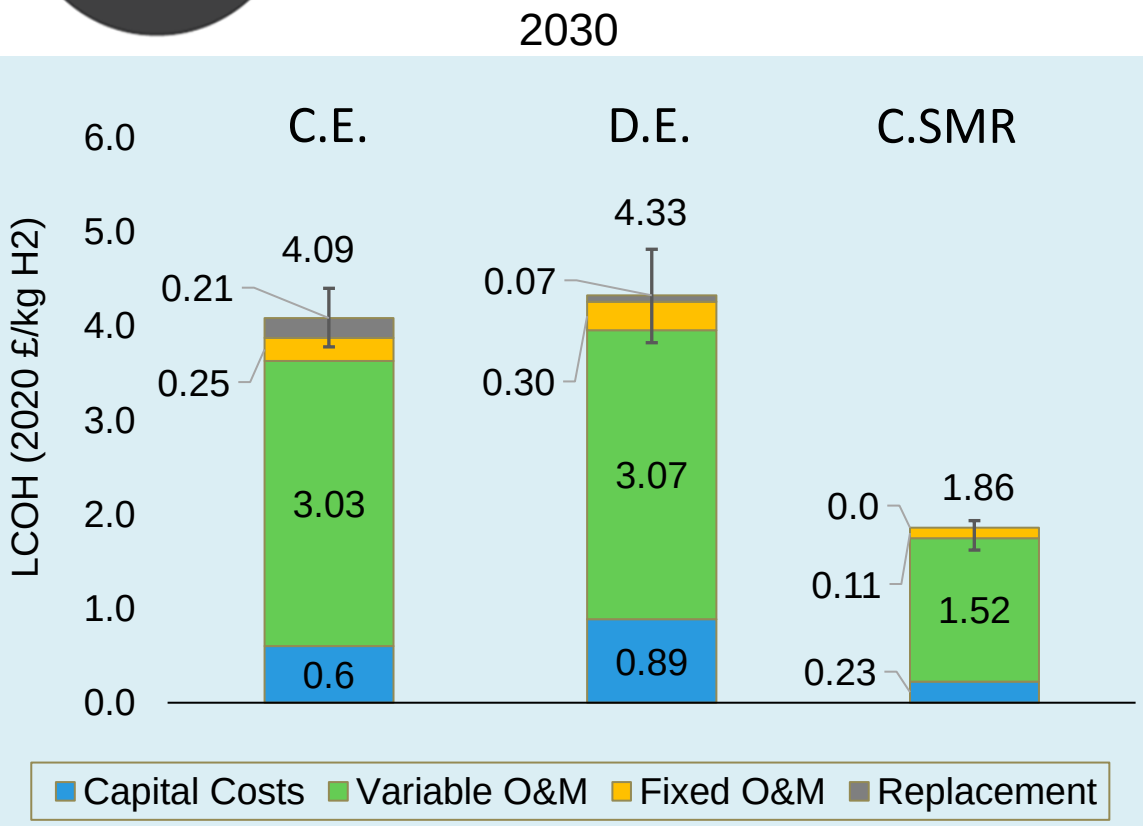


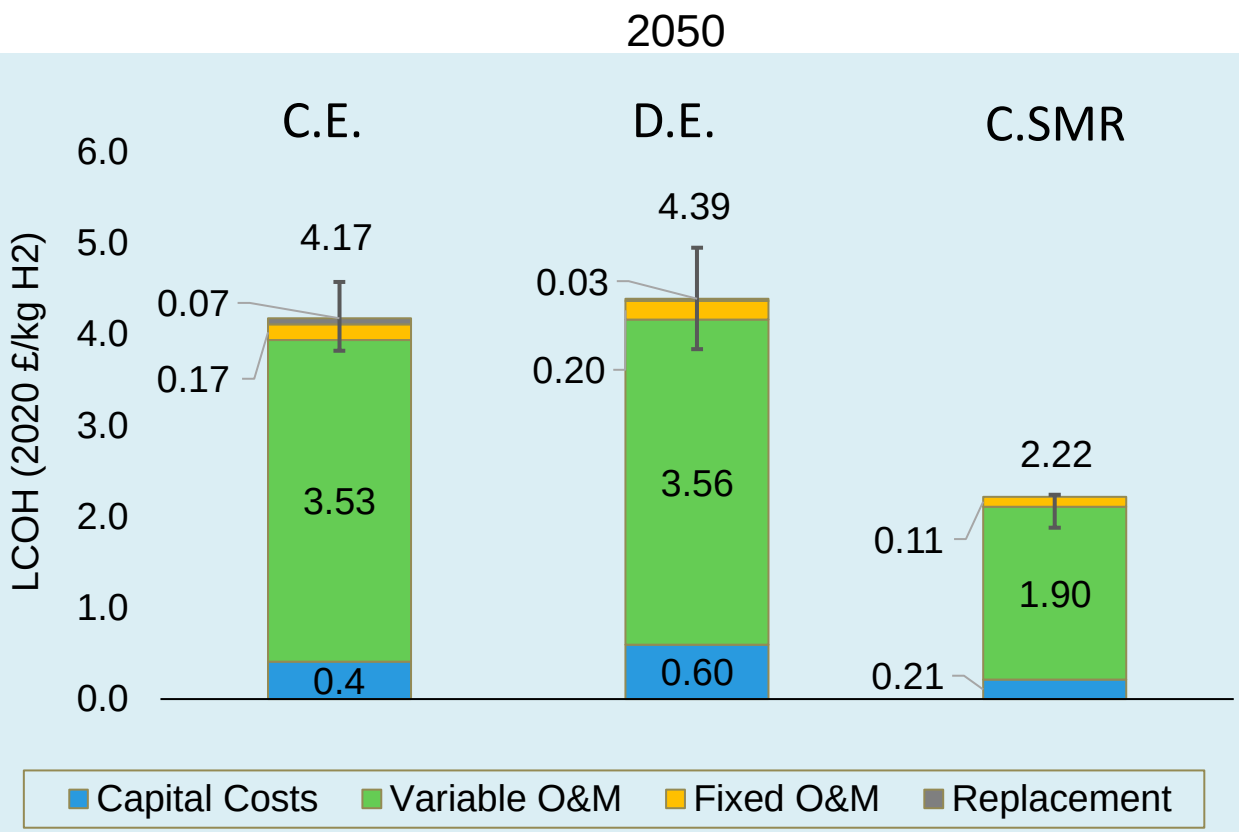
Total cost depends on how the hydrogen arrives at the station

Electrolyser Cost by Size for Hydrogen Production



Production Costs (18,000 kg/day capacity facility)

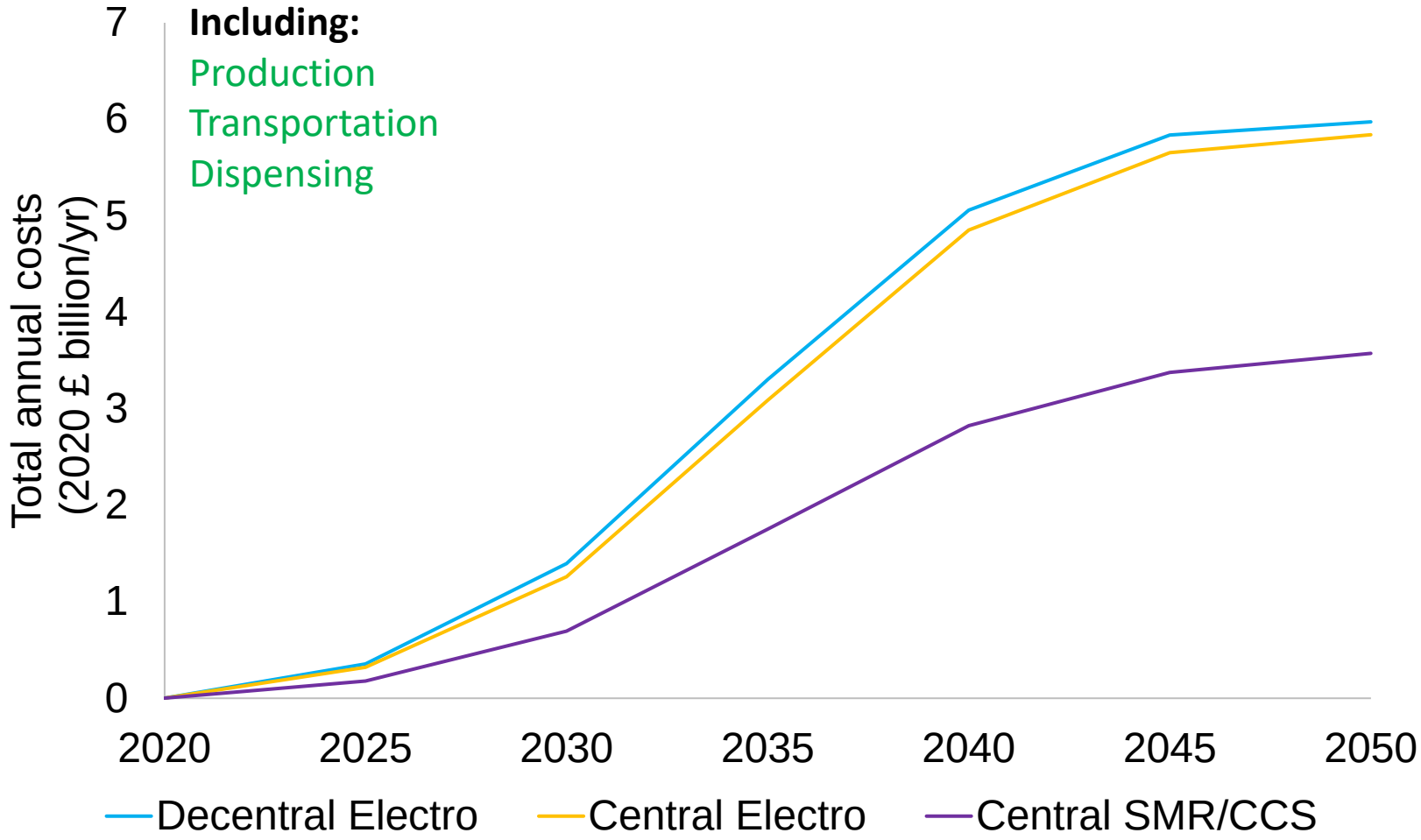




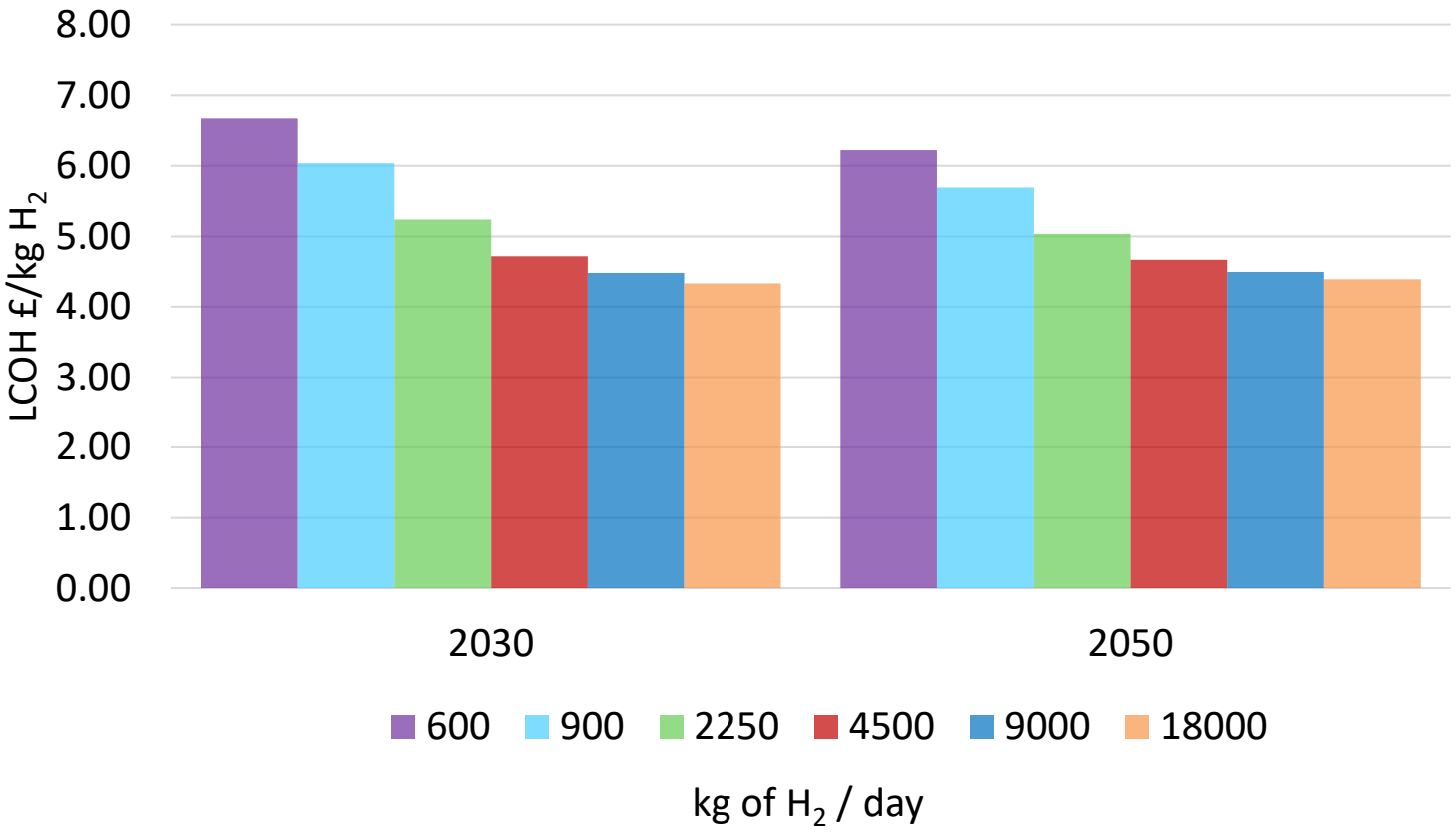
H_2 Production Scenarios

- Centralised Electrolysis (C.E)
- Decentralised Electrolysis (D.E)
- Centralised SMR with CCS (C.SMR)

Total Annual Cost



Total Cost Difference by Station Size



HGVs refuelling from a 600 kg/day HRS will pay ~50% more on fuel than at a 18,000 kg/day HRS in 2030

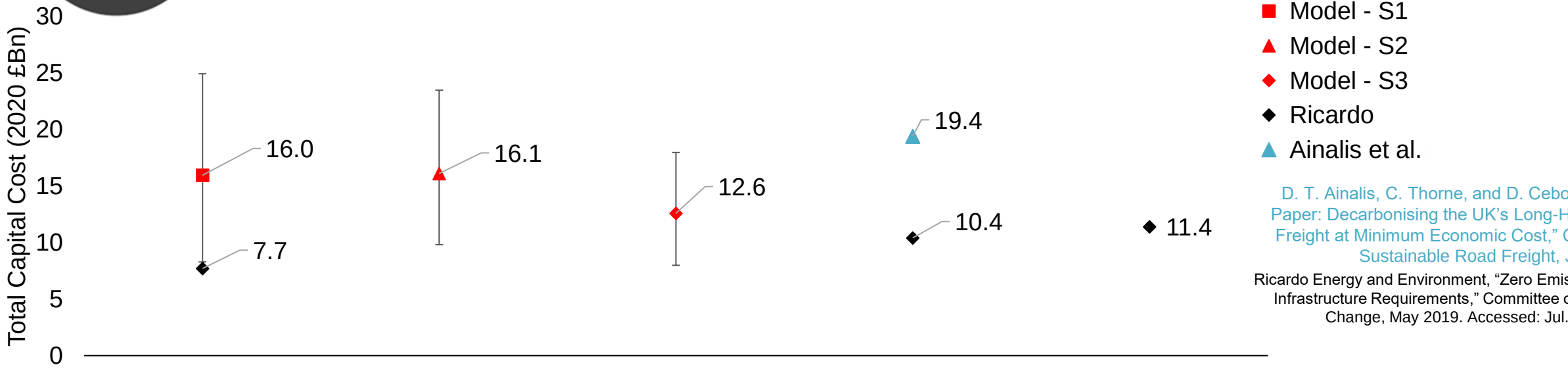
126,750 km/year

~£17,000/year difference in 2030

HGVs at 9000 kg/day HRS will spend 5% less on fuel than HGVs at 4500 kg/day HRS

~£1800/year difference in 2030

Comparison to Other Work



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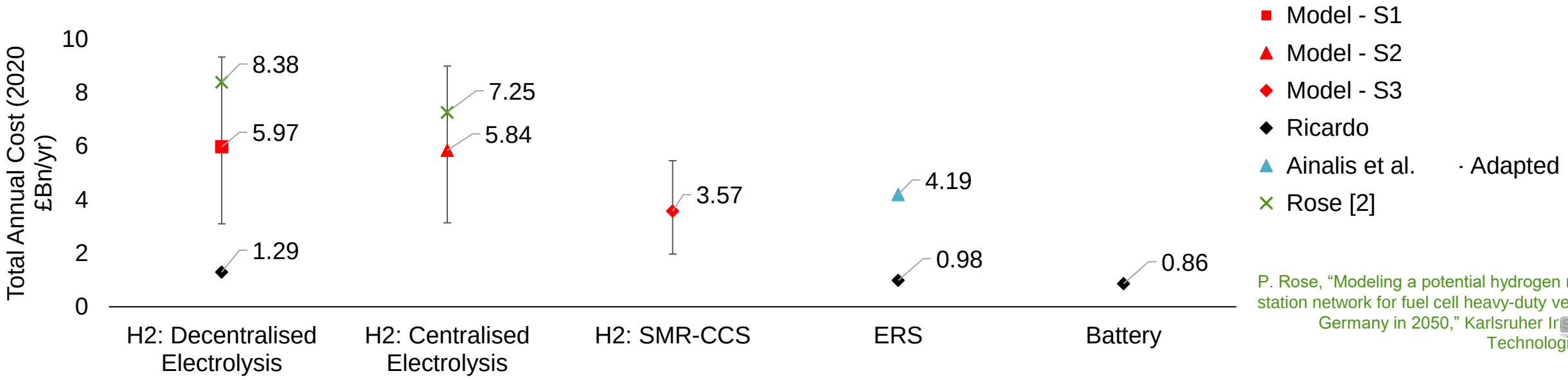
Ricardo Energy and Environment, "Zero Emission HGV Infrastructure Requirements," Committee on Climate Change, May 2019. Accessed: Jul. 20, 2021.



P. Rose, "Modeling a potential hydrogen refueling station network for fuel cell heavy-duty vehicles in Germany in 2050," Karlsruher Institut für Technologie, 2020.

Conclusions

- Methodology for allocating hydrogen-refuelling stations across the UK

- Annualised and levelized cost of hydrogen
  - Including production, transport and distribution for 3 scenarios
  - Centralised SMR with CCS, centralised electrolysis or decentralised electrolysis
- Comparison to other future fuel analysis

- Future work:
- CO_2 comparison between three scenarios
- Grid requirements for the two electrolysis scenarios
- Energy storage requirements at each HRS to maintain system resilience

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