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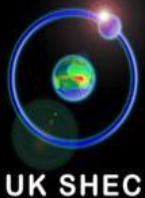
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# Forecasting future visions of a hydrogen economy

Interim conclusions from the UK Sustainable  
Hydrogen Energy Consortium (UKSHEC)

***Nick Hughes***

***25.5.06***



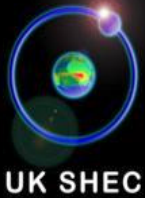
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## Background to the UKSHEC consortium

EPSRC funded until March 2007

- University of Bath
- University of Birmingham
- University of Glamorgan
- Greater London Authority
- University of Nottingham
- University of Oxford
- Policy Studies Institute
- Queen Mary's University of London
- University of Salford
- Production
  - Biological
- Storage
  - Including porous carbons, carbon nanofibres, light metal hydrides
- Socio-economics
  - Public acceptability, economic and policy analysis

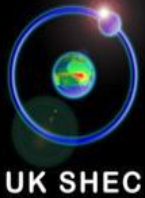


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## PSI Work

- Economic characterisation
  - Literature review
  - Stakeholder consultation
- Scenario development
  - Stakeholder workshops
  - Multi-criteria mapping process
- Modelling
  - MARKAL (cost optimisation model)
- Policies and institutions
  - Final workpackage



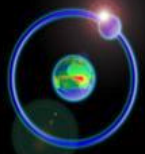
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## Emerging messages

- Not one 'hydrogen economy' but many
- Back-casting and forecasting:
  - Developing visions
  - Understanding current and future technical possibilities
  - Degree of iteration between the two



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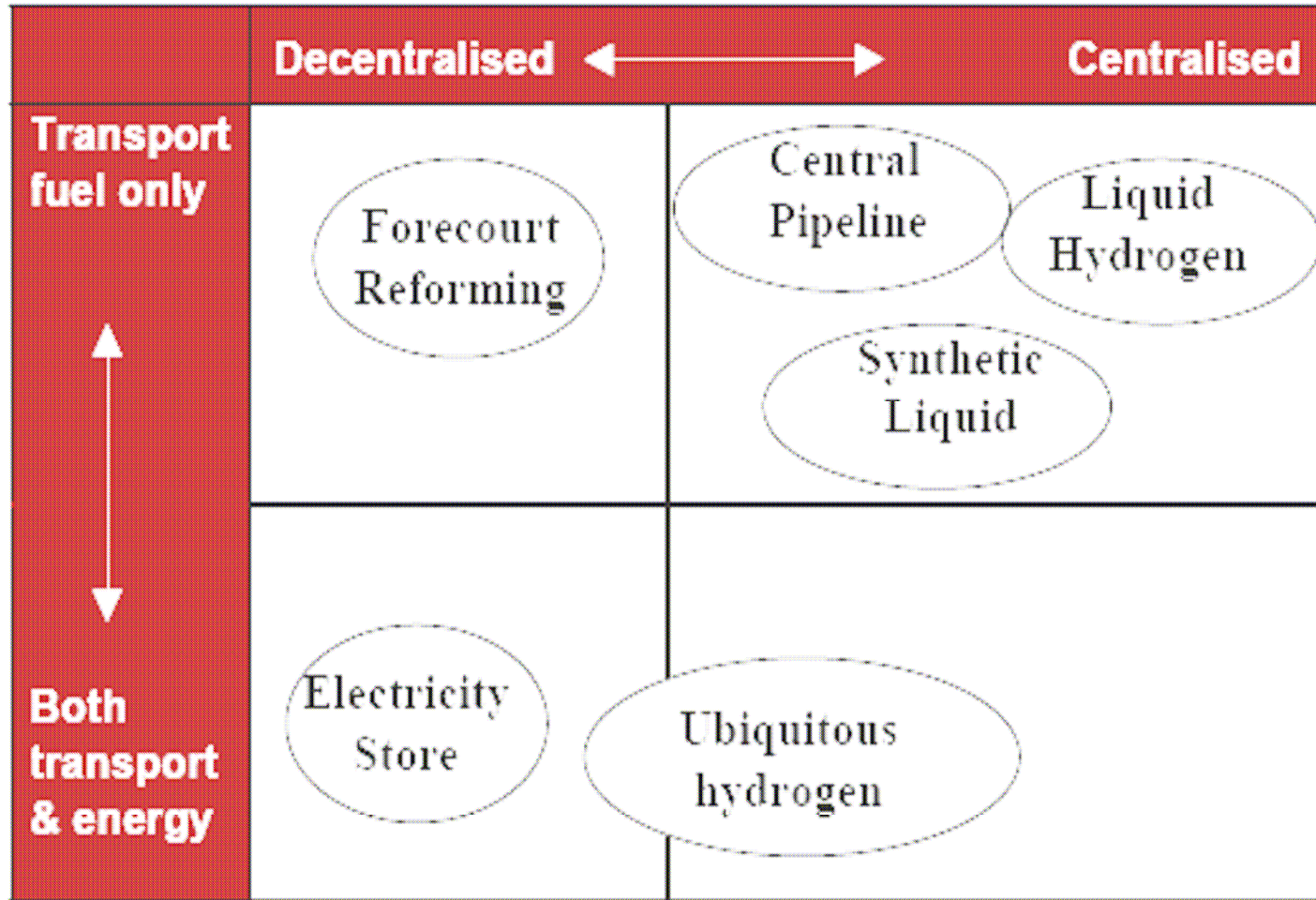
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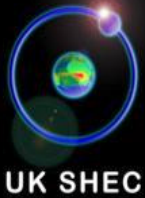
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## UKSHEC Hydrogen visions Eames and MacDowall, 2005

- Central pipeline
  - Hydrogen centrally produced; large scale pipeline infrastructure
- Forecourt reforming
  - Reliance on existing gas infrastructure
- Liquid hydrogen
  - Transportation by tanker and truck; centrally produced
- Synthetic liquid fuels
  - Less infrastructure improvement required; carbon delivered from industries or biomass
- Ubiquitous hydrogen
  - Renewable H<sub>2</sub> production for heat and power as well as transport; pipeline grid serves most buildings; mix of centralised / decentralised production
- Electricity store
  - Smoothing variability of renewables; H<sub>2</sub> production is flexible and onsite

# UKSHEC Hydrogen visions



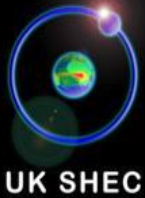


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## UKSHEC Hydrogen visions: Emerging messages

- Likely sustainability of alternative hydrogen futures deeply contested
- Reflects strongly value-laden construction of technological expectations [e.g. about social implications of certain technologies]
- The broad interest coalition promoting hydrogen is fragile - significant potential for future social conflict over shape and direction of hydrogen systems
- BAU / market alone unlikely to deliver



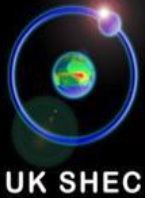
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## Current directions in UK Hydrogen / Fuel Cell policy

- Hydrogen unlikely to provide competitive CO<sub>2</sub> reductions for stationary power and heating, except in some niche applications (E4 Tech at al, 2004)
- Stationary and portable applications may still use fuel cells but with fuels other than hydrogen
- Focus on vehicle applications, particularly fleets
  - London aims for 70 'hydrogen powered' vehicles by 2010-12
  - Clean Urban Transport for Europe (CUTE)
    - 27 H<sub>2</sub> buses across 9 European cities
  - California Fuel Cell Vehicle Partnership
    - Another 300 FCVs by 2007

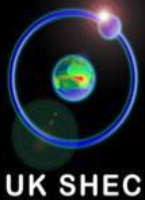


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## Progress with FCVs

- US DOE targets for automotive PEMFC systems
  - **\$ 45 / kW by 2010**
  - **\$ 30 / kW by 2015**
- 2005 status: \$ 108 / kW (TIAX, 2005)
- Need significant technical improvements, as well as mass production, to reach goals



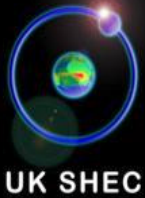
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# Commercial announcements

Source: Fuel Cell Today Market Survey, 2006

- GM
  - 'Commercial viability' by 2015
- Ford
  - 'Commercial readiness' by 2015
- Daimler Chrysler
  - Mass market by 2015
- Honda
  - 50, 000 vehicles in US by 2020
- Toyota
  - FCV for \$50,000 by 2015
- BMW
  - Commercial H2 ICE by 2008

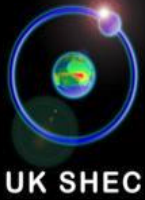


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## Meeting demand for infrastructure

- Chicken and egg: can't invest in infrastructure before there's a demand
- However, want to be able to respond to growing demand to improve economies of scale...
- ...or move if get it wrong!
- Therefore, early infrastructure should be small but easily scaleable, and moveable

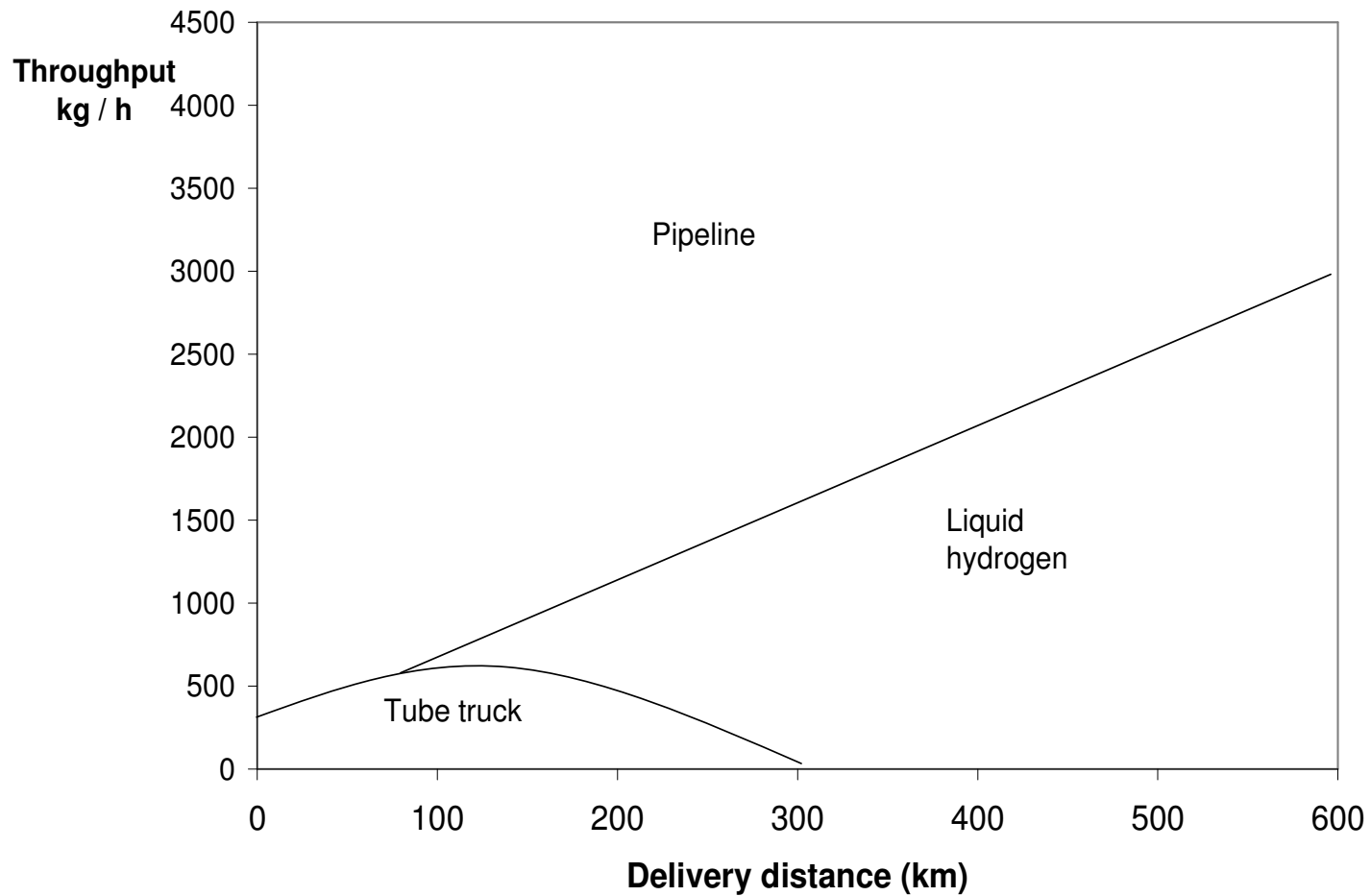


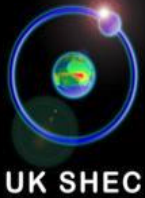
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## Least cost options with distance and capacity (Yang and Ogden, 2004)



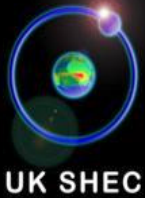


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## Rolling out early hydrogen infrastructures

- Regional approach
  - Fleet networks, depot refuelling
  - Socio-economic reasons
    - Public acceptability- demonstration
    - Pre-existing infrastructures or production capabilities
    - Regional experience & local pride

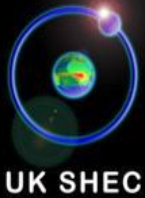


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## Ongoing expansion

- Expand from depot to 'modular infrastructures'
- When demand is established, a 'short fat pipeline' infrastructure
- The big leap- after regional infrastructures are established, investments in connecting them up may become a more realistic option

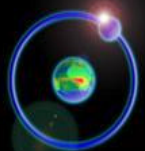


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## Issues to be addressed

- Public procurement is vital
  - Joint procurement
- Generating investor confidence- the effects of regulatory and fiscal policies should be considered, particularly in terms of how the various vehicle technologies compete or co-exist. Are some being considered transition technologies for another?
- Legal / institutional framework
  - EC legislation
  - HSE
- Be open to be integration with a variety of fuel cell and other technologies
- Importance of production, and its relationship to regional structures



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