



Hydrogen for Transport;

Context setting for Hydrogen Research and Funding Priorities

Robert Evans, CEO, Cenex

Future Hydrogen Production, Supergen DoSH₂,
Birmingham; 18th October 2011

UKH2Mobility: Roll-Out Scenario Assumptions



Short-term scenario

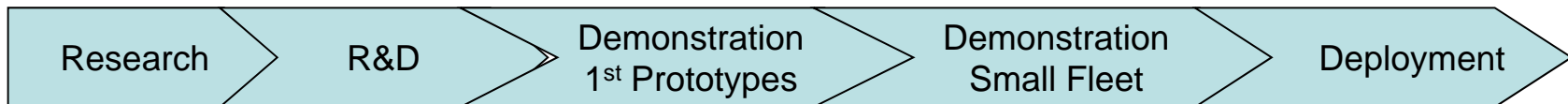
- Centralised hydrogen production
- Brown hydrogen
- National/trans national distribution

Medium-term scenario

- Decentralised hydrogen production
- Brown and green hydrogen
- Local distribution
- Long-term storage

Inward Investment

Innovation Opportunities



UK R&D Interests

- PEMFC
- Bio-hydrogen production
- Advanced electrolyzers
- Advanced hydrogen storage materials
- Coal gasification + CCS
- Light-weighting for H2FCEV

Realising a transport-related hydrogen economy requires answers to some interesting questions



- **Production**
 - Where is all the hydrogen we need in the UK going to come from and how will the profile of sources change over time?
- **Distribution**
 - How is the hydrogen going to be distributed to the point of use?
- **Storage**
 - Where are we going to be storing hydrogen and how might the profile of hydrogen storage change over time?
 - What role will new (disruptive) storage technologies play?
- **Use**
 - Who is going to be the hydrogen customer and why?
 - How will they pay for it?
 - What will hydrogen cost and how will it be taxed?
- **Business models**
 - Who is going to invest in establishing what we need to realise a hydrogen economy?
 - What learning can we transfer from the Electrification of Transport sector to aid the transition to a Hydrogen Economy?

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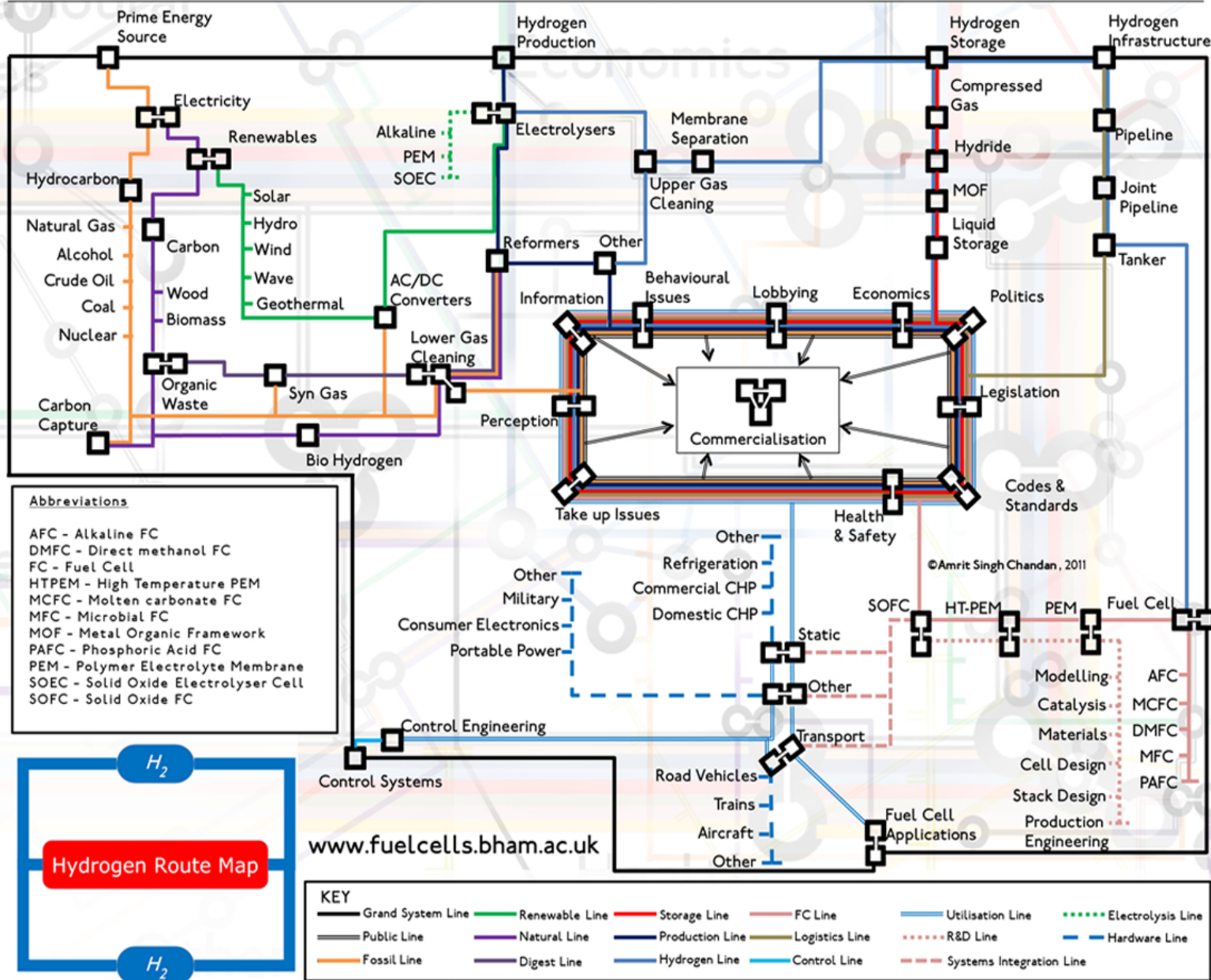
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Technical
R&D

Behavioural
&
Business
R&D

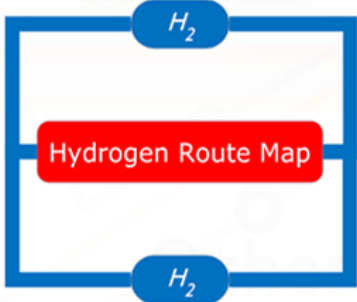
ACTIVITIES ROUTE MAP

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Abbreviations

- AFC - Alkaline FC
- DMFC - Direct methanol FC
- FC - Fuel Cell
- HTPEM - High Temperature PEM
- MCFC - Molten carbonate FC
- MFC - Microbial FC
- MOF - Metal Organic Framework
- PAFC - Phosphoric Acid FC
- PEM - Polymer Electrolyte Membrane
- SOEC - Solid Oxide Electrolyser Cell
- SOFC - Solid Oxide FC



www.fuelcells.bham.ac.uk

Hydrogen Production Options

- Numerous but many are still pre-commercial



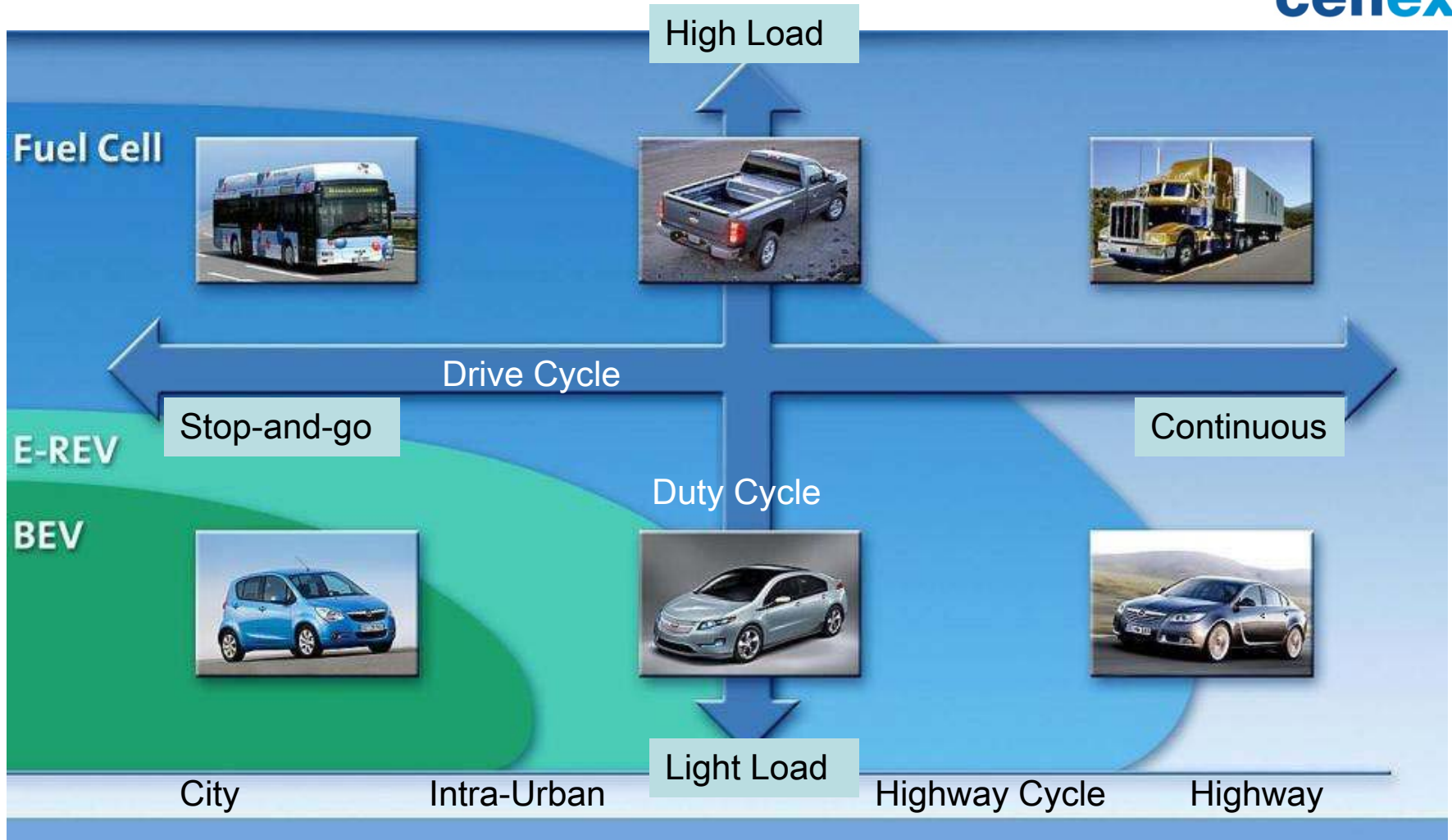
- Steam Reforming of methane
- Chloralkali off-gas

Brown H₂
Present

- Coal or biomass gasification (with CCS)
- Electrolysis using grid, renewable or nuclear generated electricity
- Photo-electrochemical
- Photo-biological
- Fermentation
- Biomass pyrolysis
- Solar thermochemical

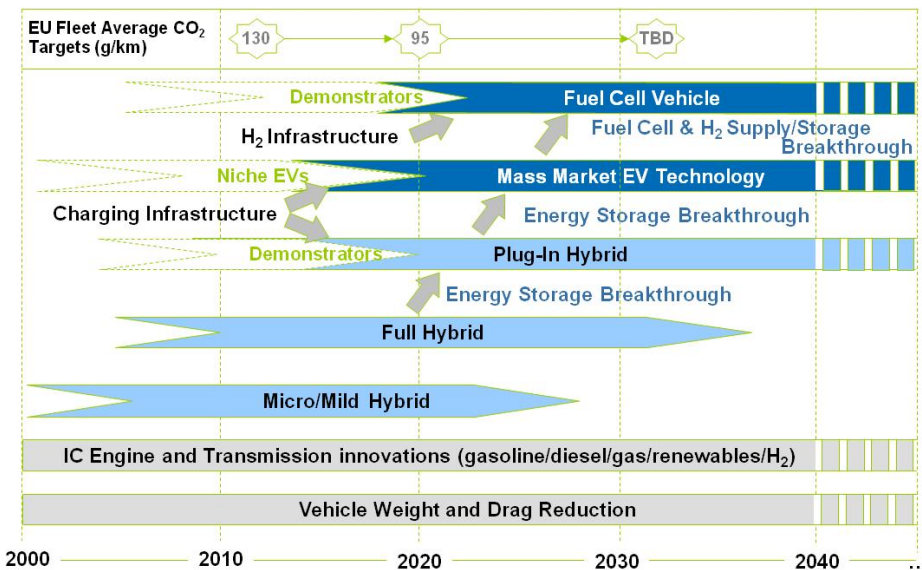
Green H₂
Future

The motor industry has its perspective on where Fuel Cell Vehicles fit in the product mix

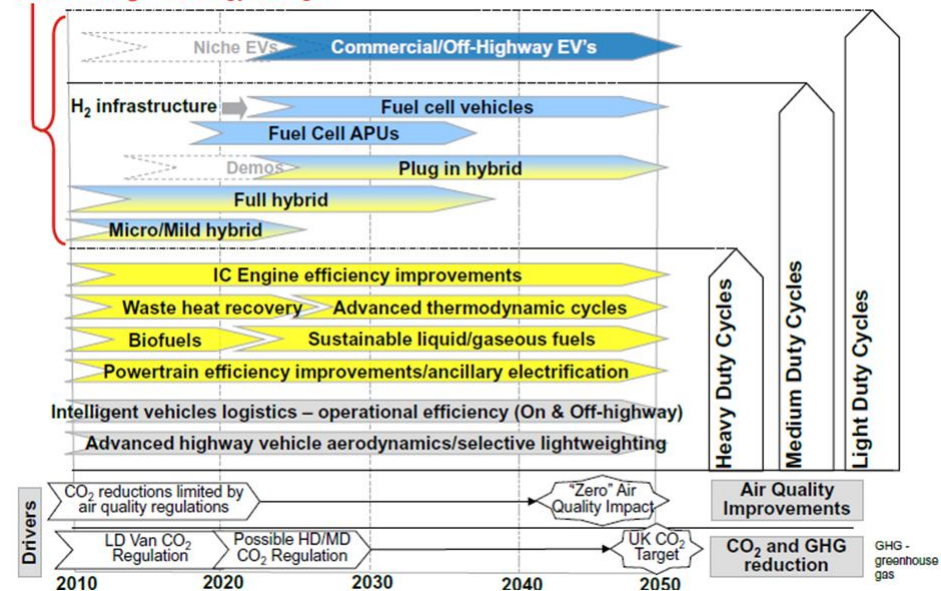


Source: General Motors presentation to Hydrogen Technical Advisory Committee

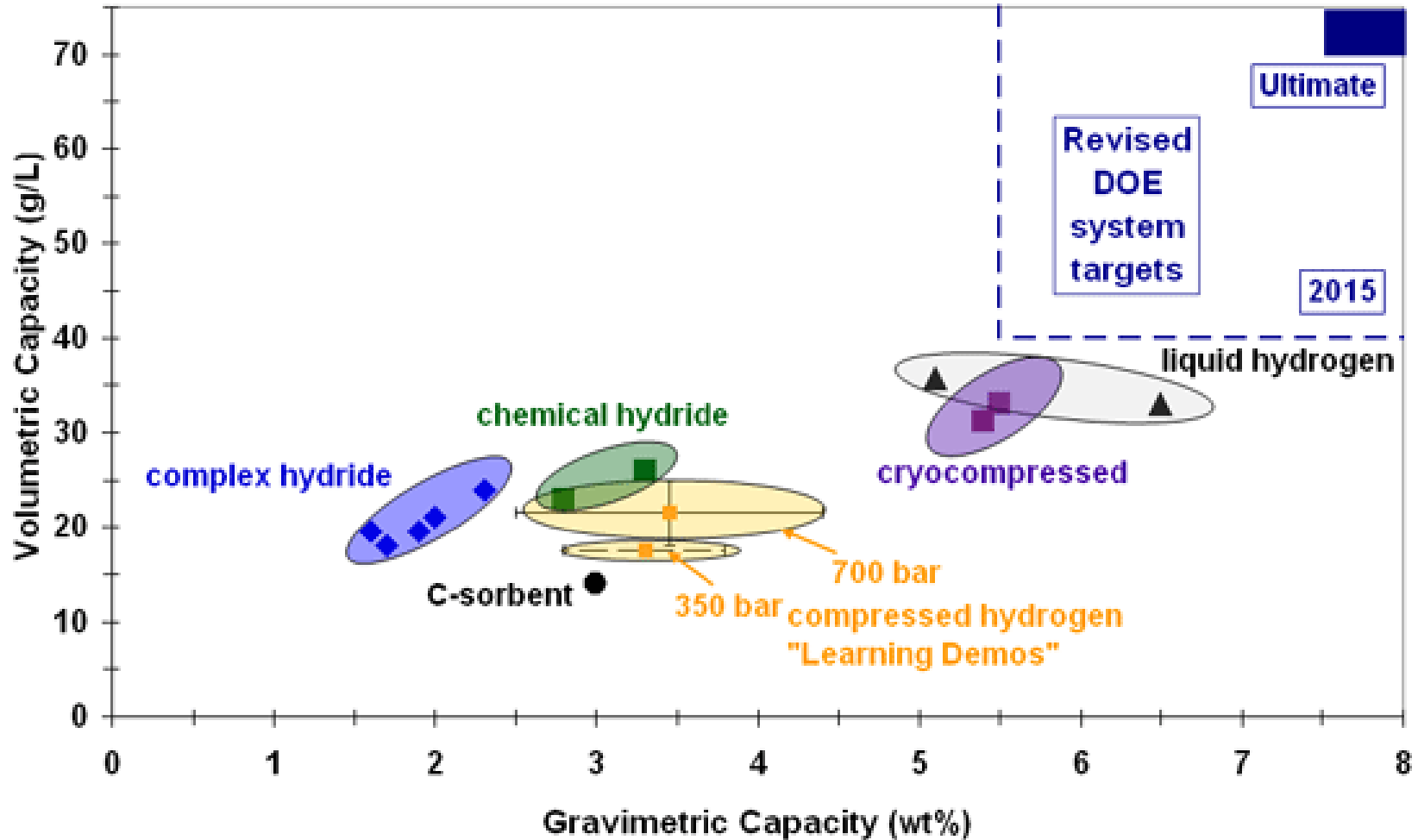
Motor Industry Technology Roadmaps stress the need for breakthroughs in hydrogen storage



Breakthrough in energy storage



Onboard Hydrogen Storage is a priority area for R&D

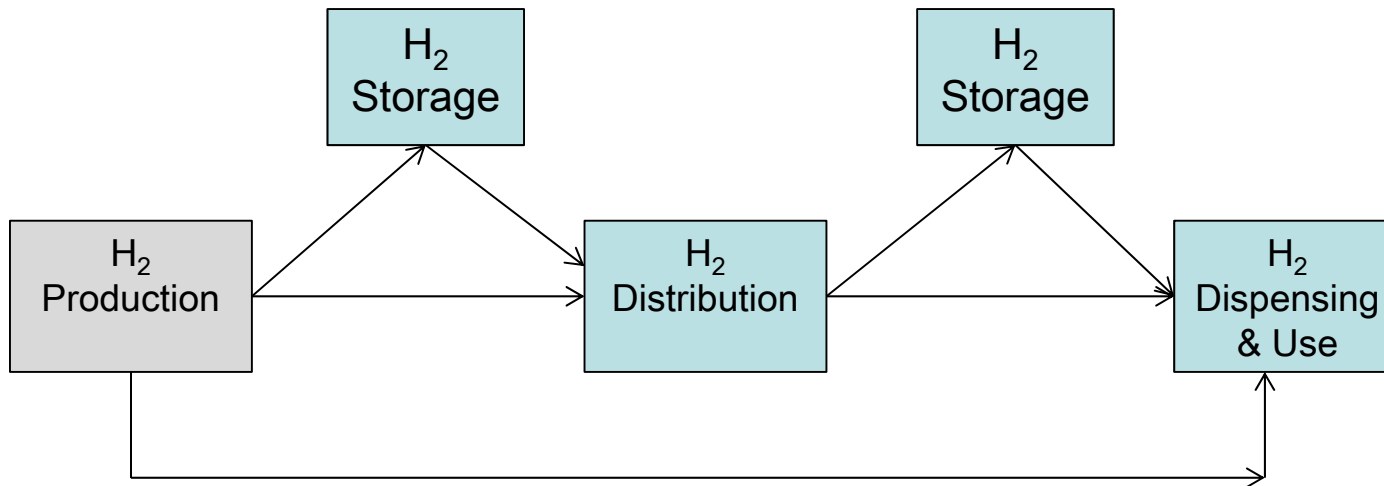


But how will hydrogen be stored within the wider distribution system?

– You can't use Hydrogen without effective storage solutions



Hydrogen Economy – Distributed Production and Use



Production at point of use

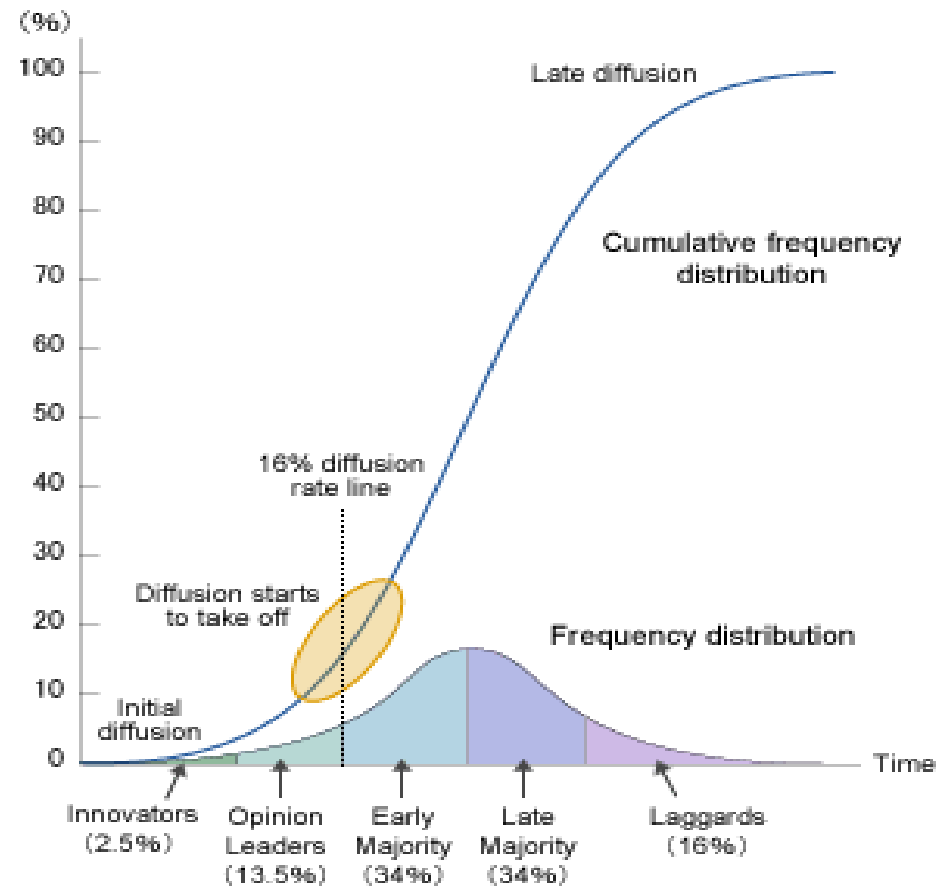


Factors will drive the transition to a Hydrogen Economy

....technology innovation influenced by the same factors



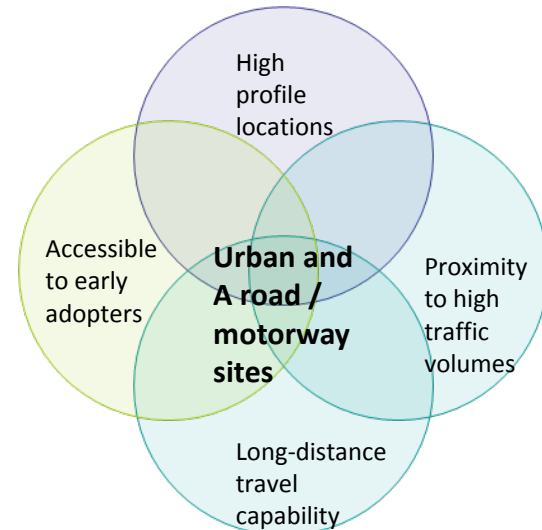
- Relative Advantage
- Compatibility
- Complexity or Simplicity
- Trialability
- Observability



'Hydrogen Communities' key to Transport Infrastructure Roll-out



Station location set by customer requirements (convenience) and investor requirements (throughput and payback)



Conclusions

- Next 25 years will see UK transition to hydrogen economy
 - Slow diffusion will open up opportunities for today's R&D to create tomorrow's disruptive technologies influencing future roll out scenarios for vehicles and infrastructure
- Hydrogen storage a key priority area
 - Not just Onboard storage – storage materials R&D will shape the infrastructure deployment for future of production, distribution and use
- Behavioural Research an important part of the scope of UK R&D
 - Diffusion of Innovation considerations will drive research questions and set criteria for evaluating the prospects for alternative production and storage technologies
 - Hydrogen communities will be where this transport research is undertaken
 - Relative advantage to be judged against alternative low carbon as well as hydrogen technologies
 - Interest (Cenex and others) to understand the potential role of advanced hydrogen production and storage technologies in the deployment phase of 'hydrogen community' research projects