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Clean Flexible Power using H2 Storage

Den Gammer, New Energy Forum, 17/07/14



What is the ETI?

- The Energy Technologies Institute (ETI) is a public-private partnership between global industries and UK Government

Delivering...

- Targeted development, demonstration and de-risking of new technologies for affordable and secure energy
- Shared risk
- Leverage for Members - funding, expertise and market access
- Accelerated development schedules - in advance of market

ETI Members

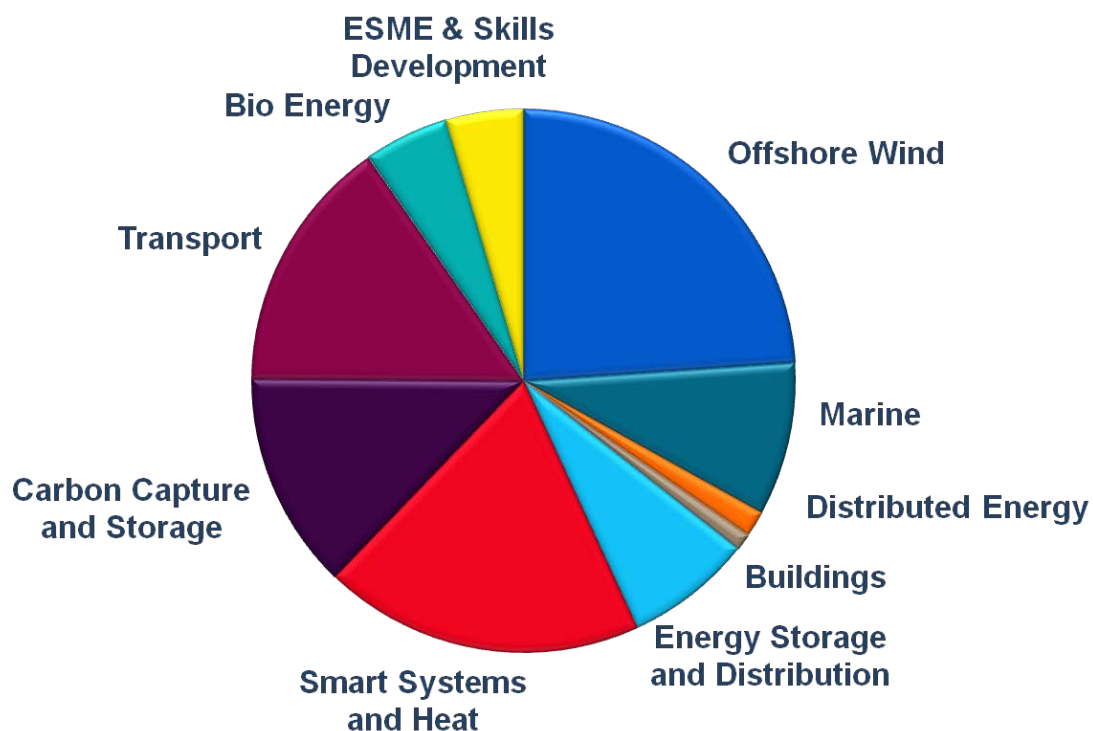
	
	
	
	
	

ETI programme associate





ETI Project Portfolio – total £400m



9 Technology Programme areas

Delivering...

New knowledge

Technology development

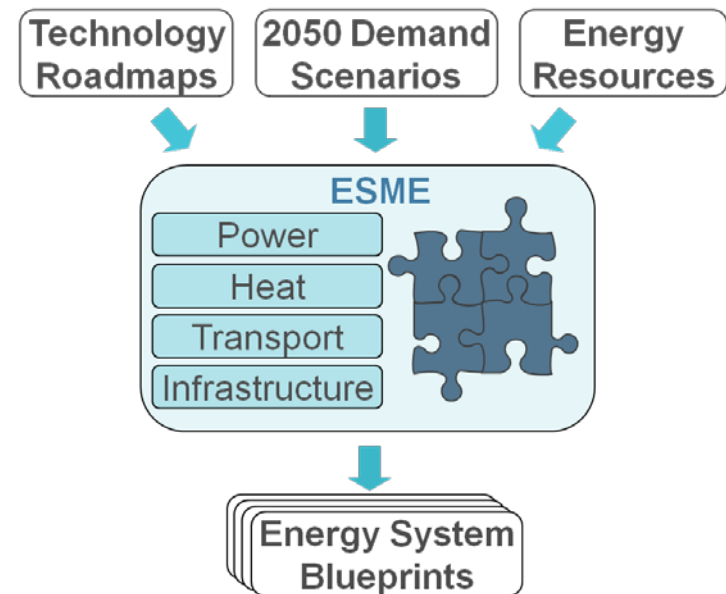
Technology demonstration

Reduced risk



A national energy system design tool with sufficient detail to understand system engineering challenges

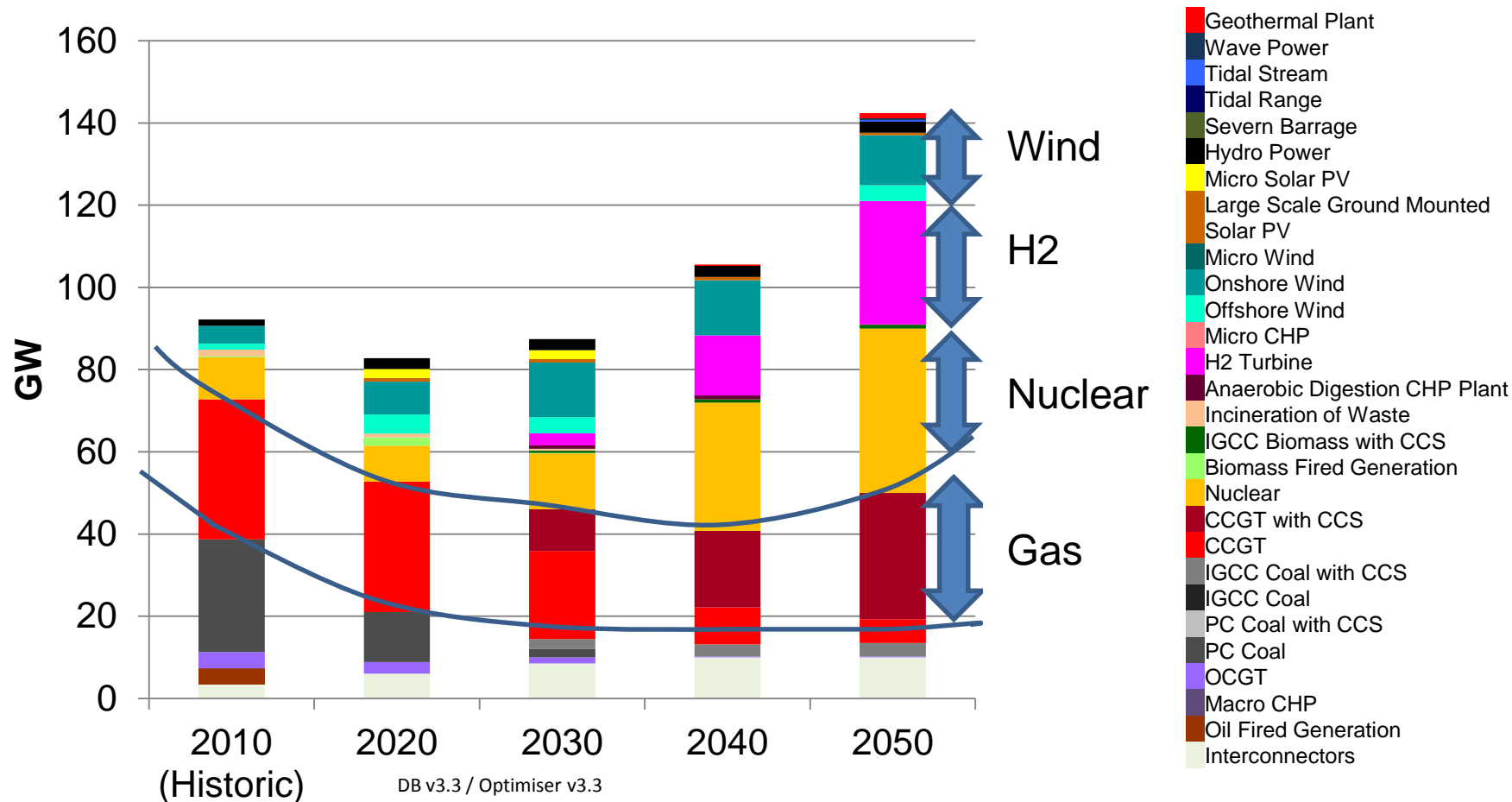
- Deployment & utilisation of >150 technologies
- Pathway and supply chain constraints to 2050
- Spatial and temporal resolution sufficient for system engineering
- Least cost optimisation
- Probabilistic treatment of uncertainties





ESME – a place for H2 in power capacity

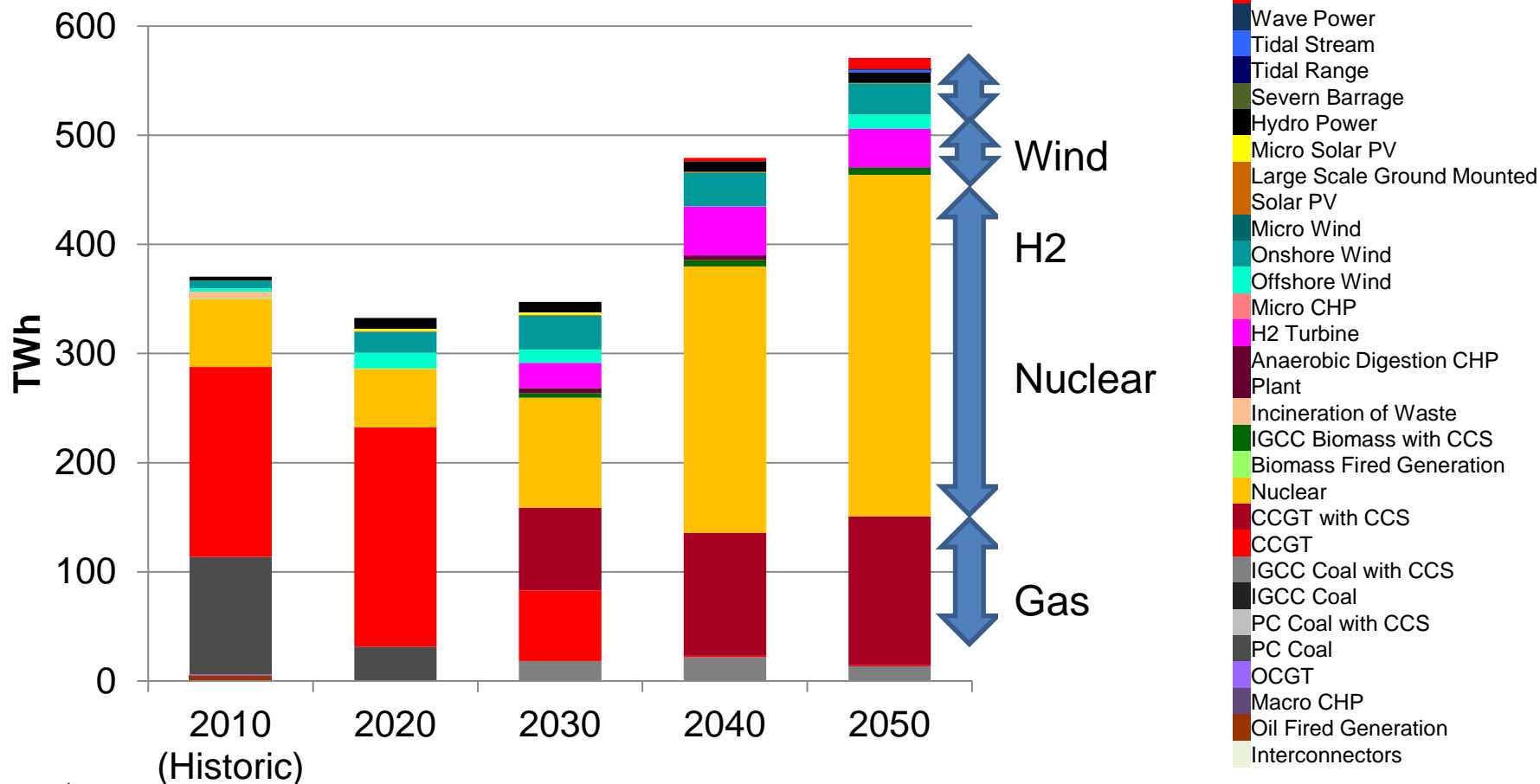
Electricity Generation Capacity





ESME - H2 role is not base load by 2040

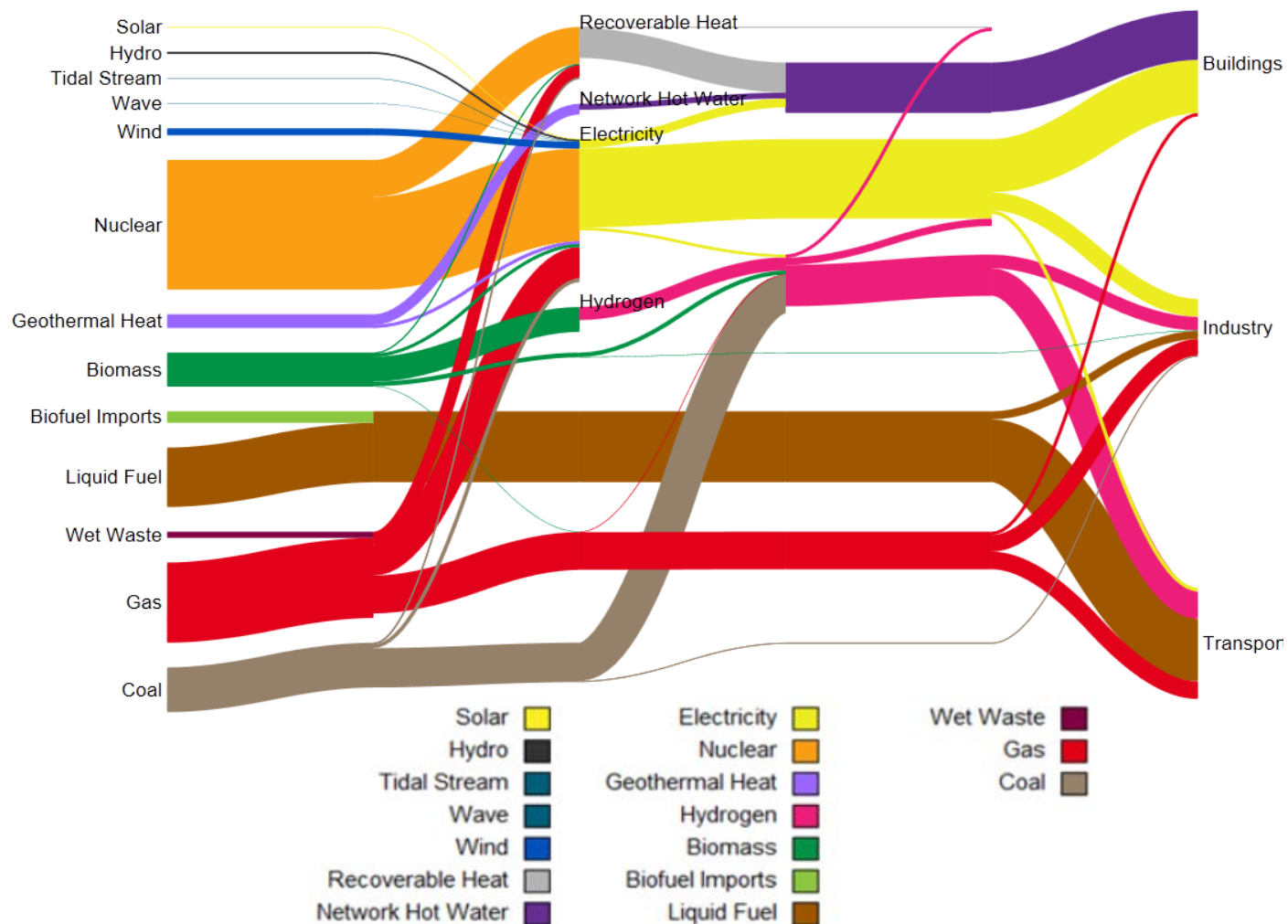
Electricity Generation



DB v3.3 / Optimiser v3.3



ESME - 2050 Sankey Diagram





ETI's H2 Storage with flexible turbines study 2012/2013



Recognising

- Superior costs of salt caverns compared to other bulk H2 storage options
- Already used for H2 in the UK (Teeside)
- Keyed into ETI work on CCS and H2 turbines

Purpose

- To improve the capital and operating costs used in ESME modelling
- To investigate the UK potential for storing H2 in salt caverns
- To understand the cost structure of such schemes in the UK, when focussed on power.
- To provide a storage cost model which could be used with other H2 sources and H2 usages

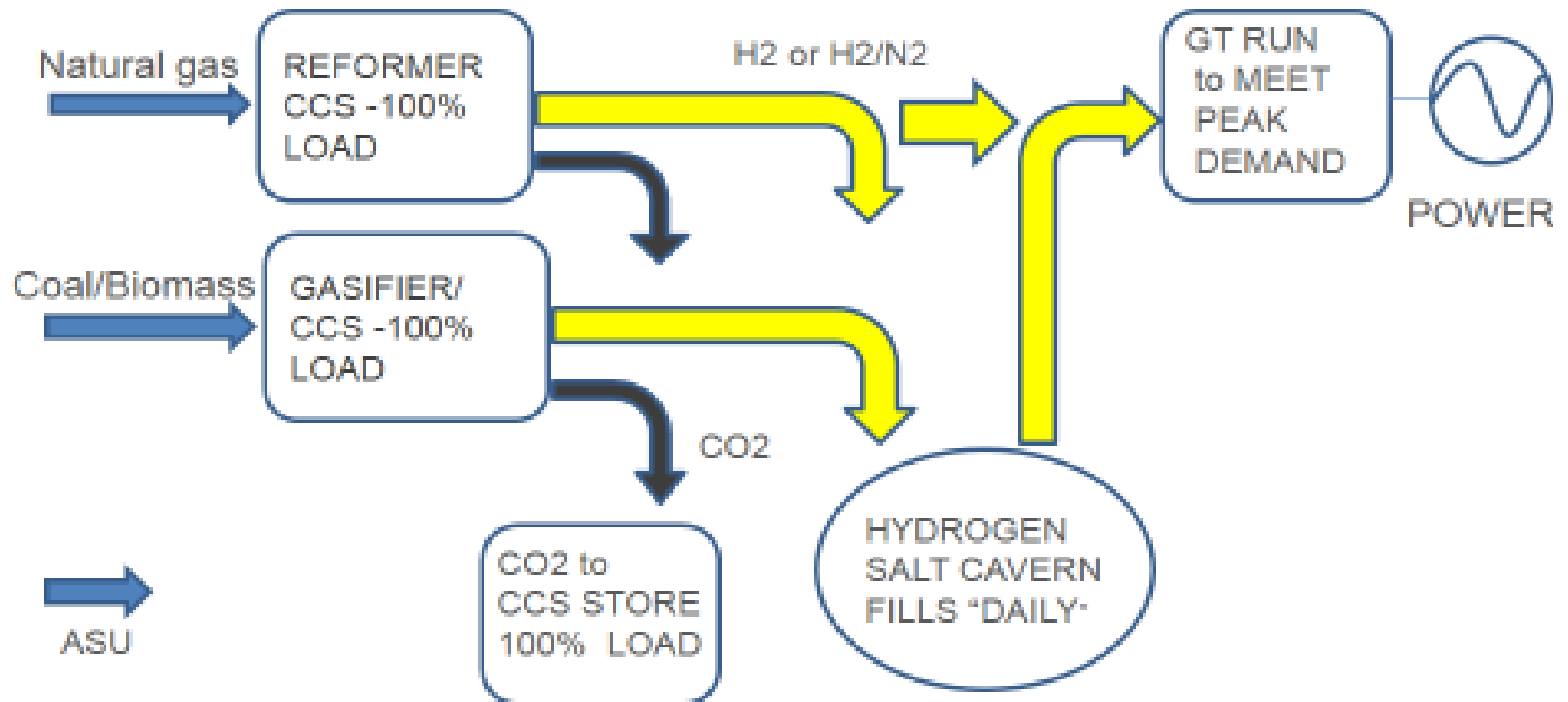


**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL



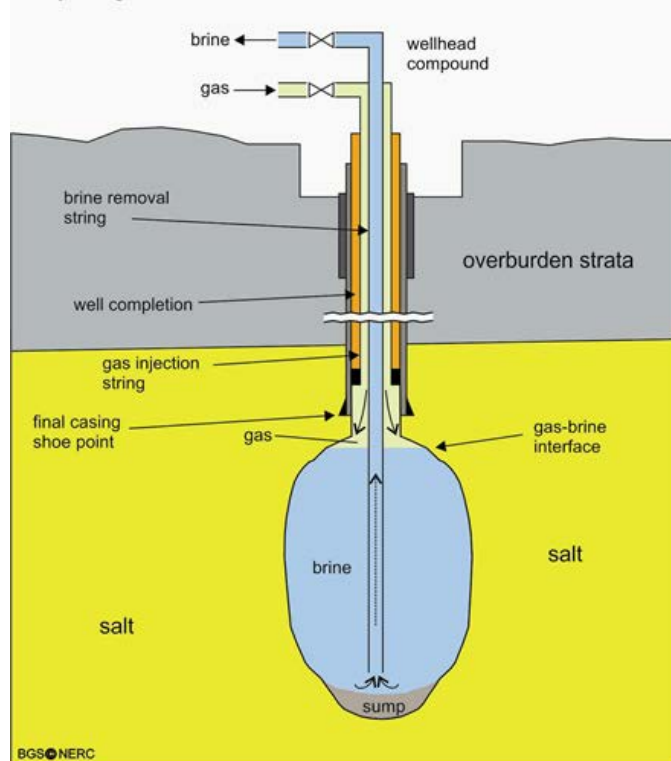
H2 Storage in Salt Caverns - Configurations



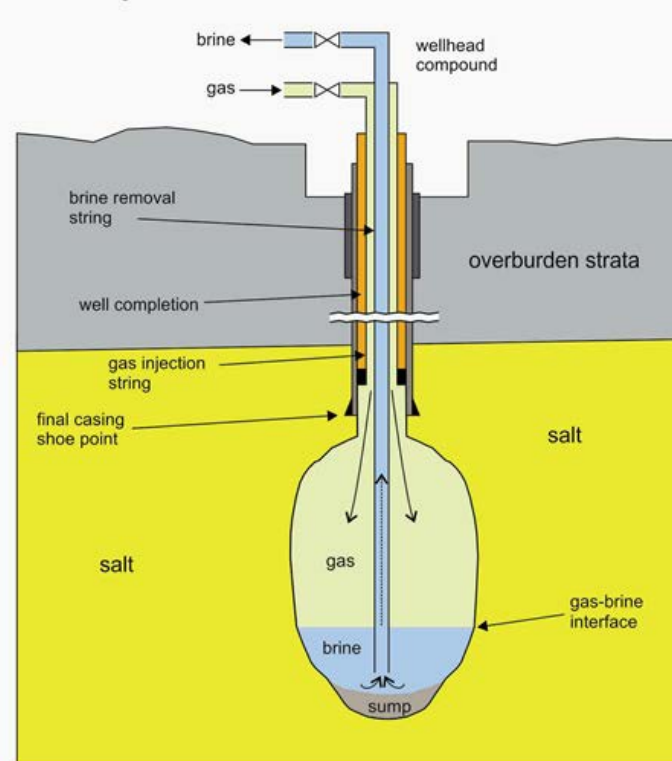


Creating Caverns

Early stage fill



Later stage fill

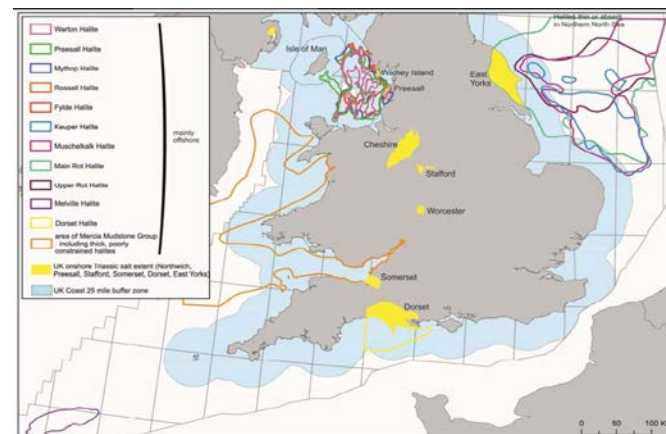


Initial Fill of a Cavern (BGS©NERC)



UK Salt fields

- Used for natural gas and hydrocarbons
- Offshore twice the cost of onshore
- Screening led us to focus in 3 areas



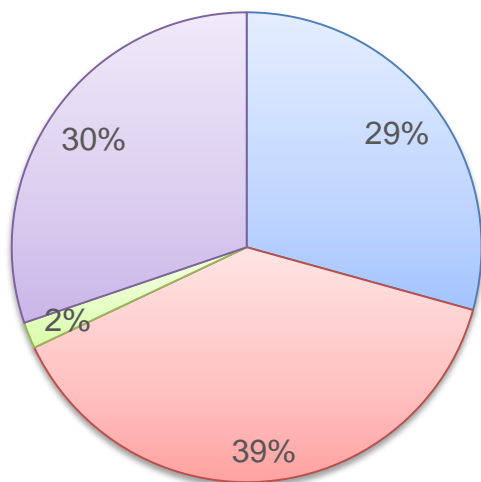
Region	Typical Depth, m	Bed Thickness, m	Cavern size, 000m3	Pressure bara
Teesside	300	35	70	45
E Yorkshire	1800	175	300	270
Cheshire	800	200	300	105



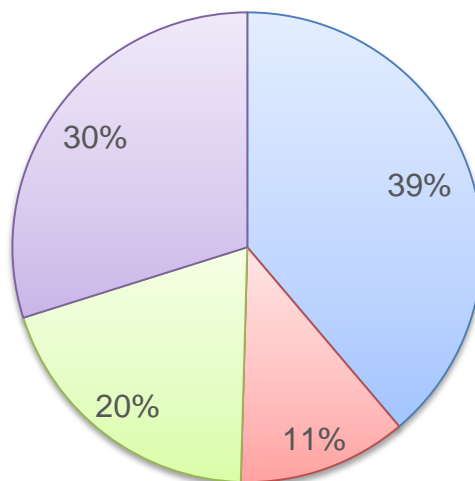
Cost structure varies with store depth

- Although the component costs change, overall costs are similar
- Deep stores have a round trip energy hit (2% points off an efficiency of 34% for Yorkshire)
- Shallow stores unlikely to provide strategic storage

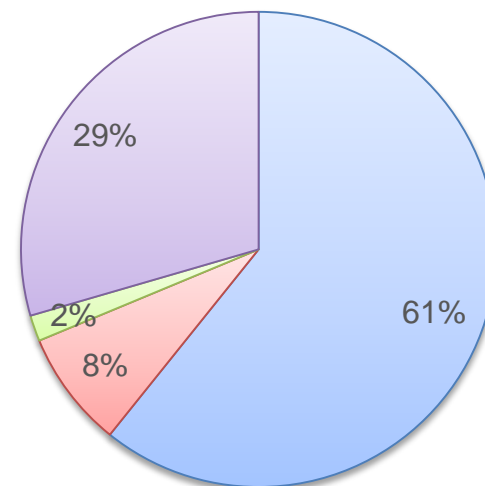
TEESIDE, 370m



CHESHIRE, 680m



YORKSHIRE, 1800m

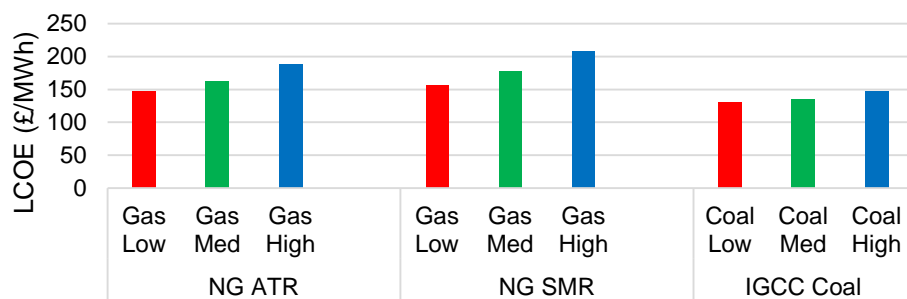


■ topsides ■ cavern ■ pipe ■ others



Power complex cost structure

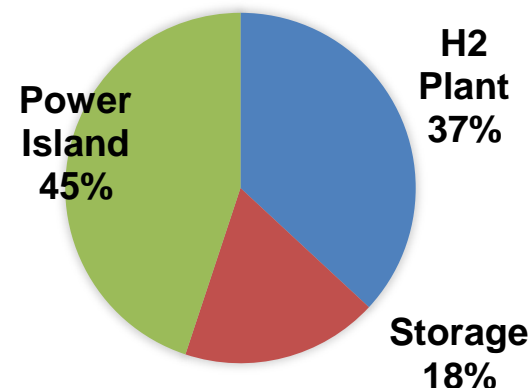
Coal IGCC + NG ATR + NG SMR at DECC
High, Medium and Low Fuel Prices at 36%
Load Factor



- Technology selection for H2 production not as important as primary fuel price
- Coal price less volatile, less impactful

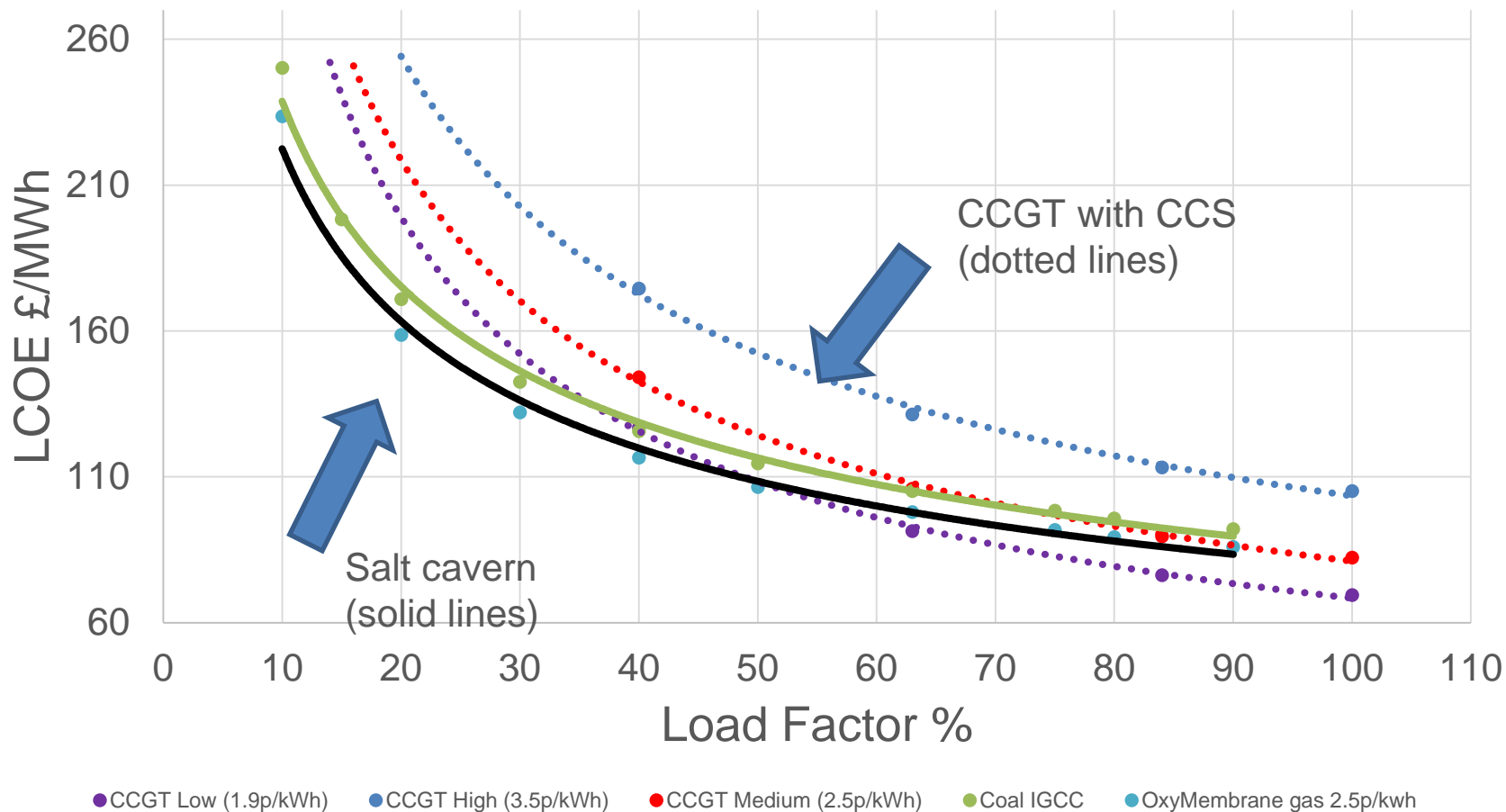
- Marked reduction in relative size of H2 plant costs
- CCS pipeline and storage costs are not included
- Often need to store N2 for large H2 Turbines

TYPICAL CAPEX DISTRIBUTION £M





H2 Salt Cavern costs vs CCGT with CCS





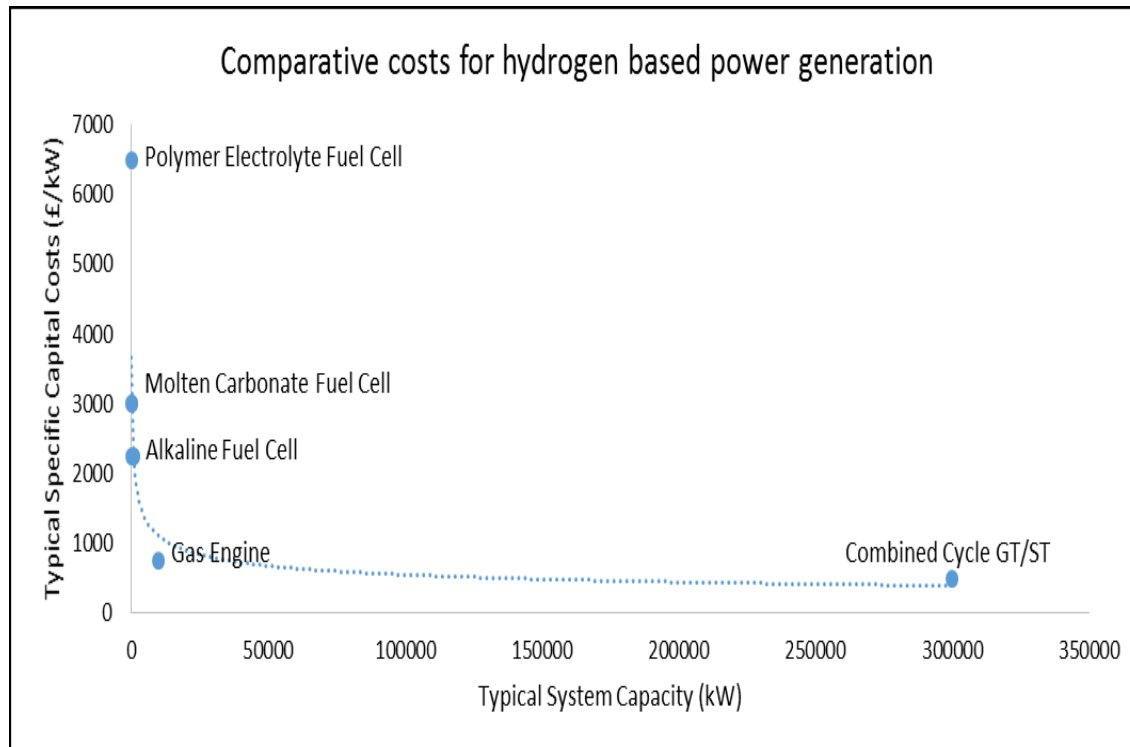
Other options

H2 Production

- Wind
- Solar
- Nuclear

H2 Conversion

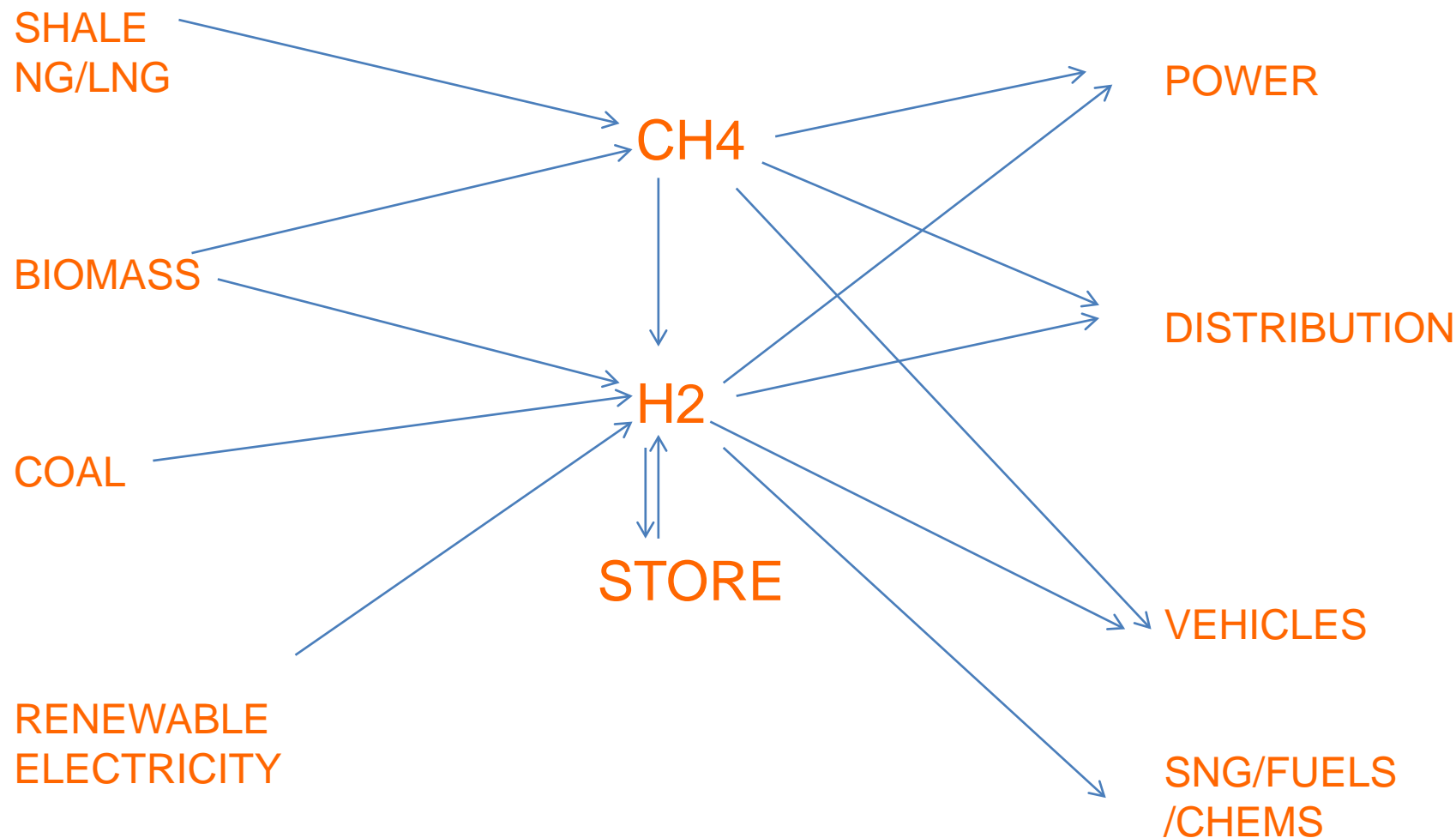
- Fuel Cells
 - Alkali
 - MCFC
 - SOFC
- Grid Injection
- Vehicles
- Industry



	Value of Hydrogen (£/GJ)
Domestic Fuel	4
Transportation Fuel	17-37 (Depending on fuel duty applied)
WP1 Cost	12 -14

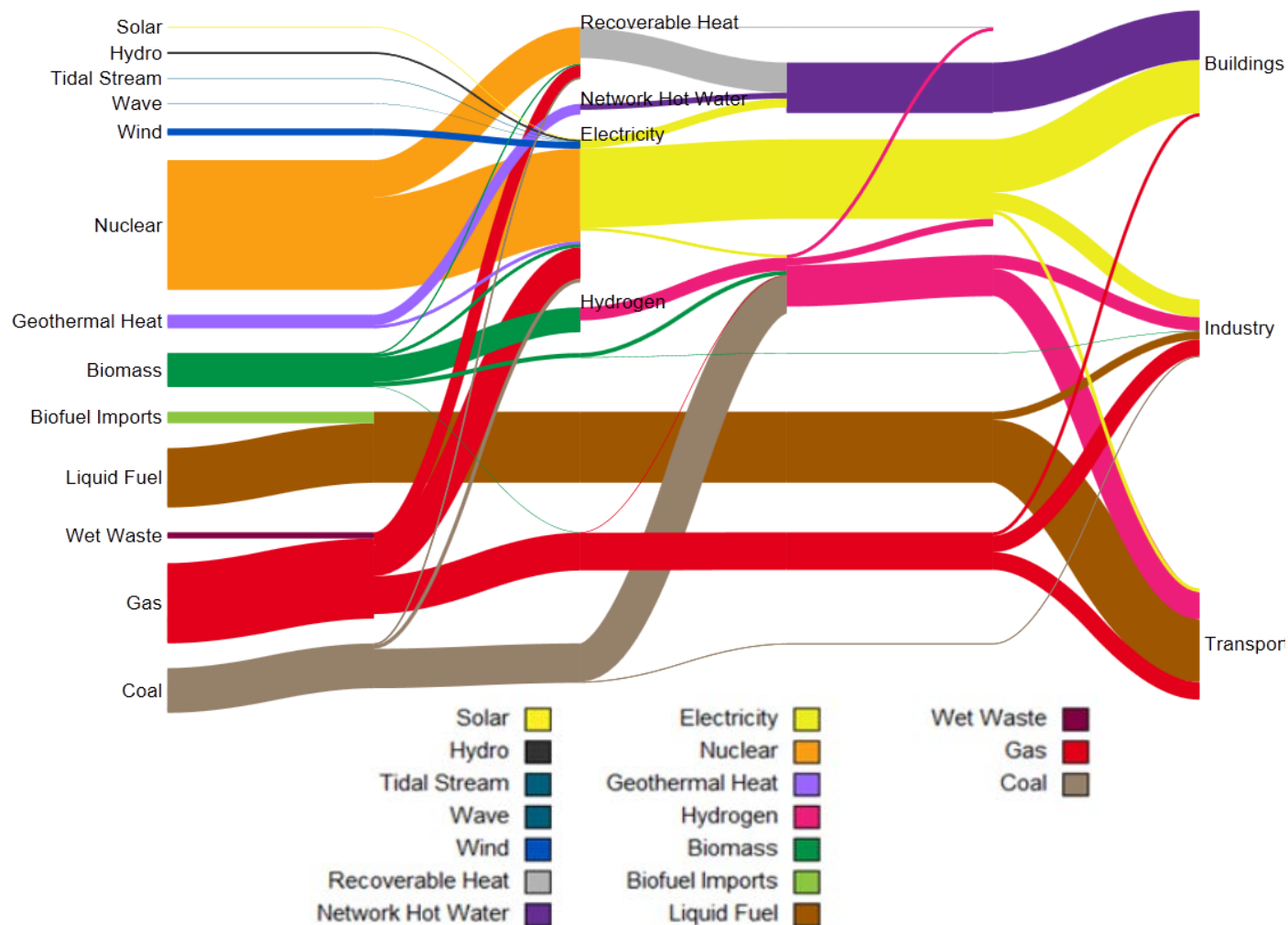


H2 potentially keys into many areas





ESME - 2050 Sankey Diagram





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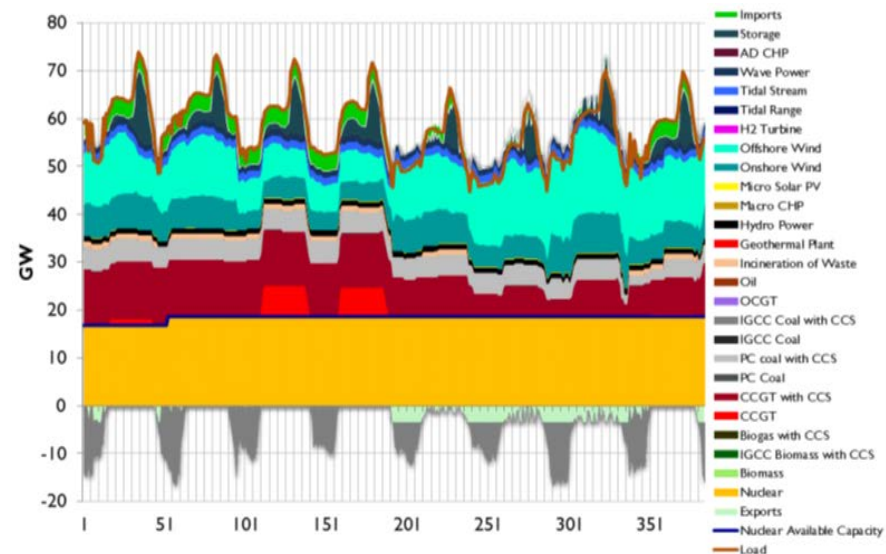
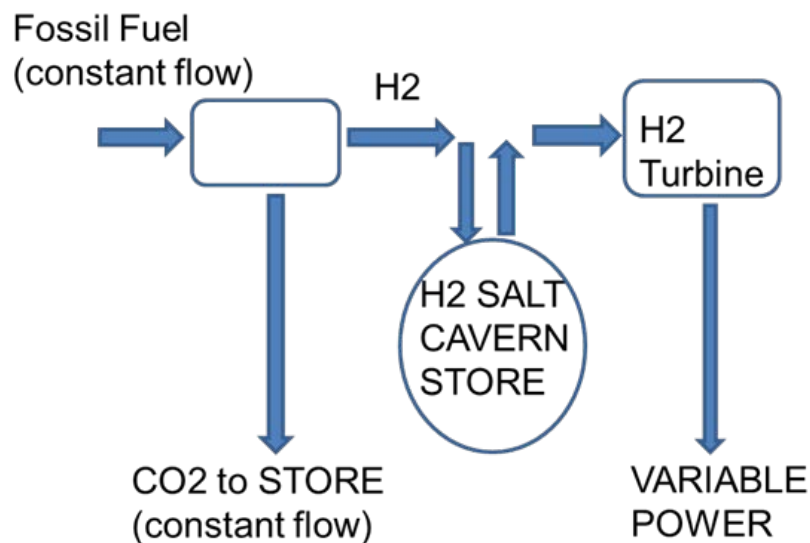
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H2 Storage/ flexible turbines FRP

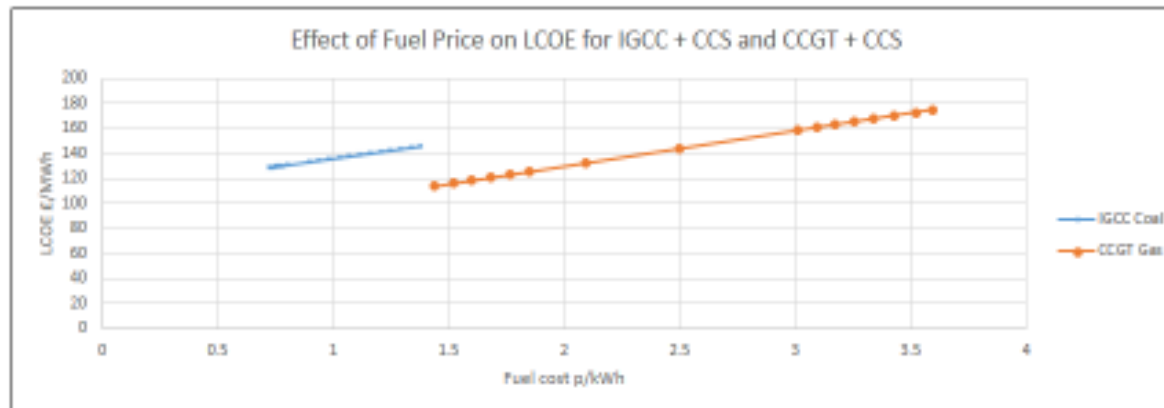
Purpose

- Provide ESME with better numbers for scheme based on salt caverns
- Explore cost and UK availability of power schemes using salt caverns for storage.
- Identify any technology needs to lower cost





Effect of Fuel costs on LCOE for IGCC+CCS and CCGT+CCS



IGCC

Load factor - 38%

Co-storage

Cavern Location—Yorkshire

(Cavern depth 1800m, cavern
storage 300,000 m3)

CCGT

Load factor -40%