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From 10-years of ETI research, what do we know about why policy-makers should value CCS?

Andrew Green

Programme Manager – CCS

GCCSI European CCS Forum

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TEN YEARS OF INNOVATION 2007 – 2017

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- Why should policy makers value CCS
  - and what are the challenges?
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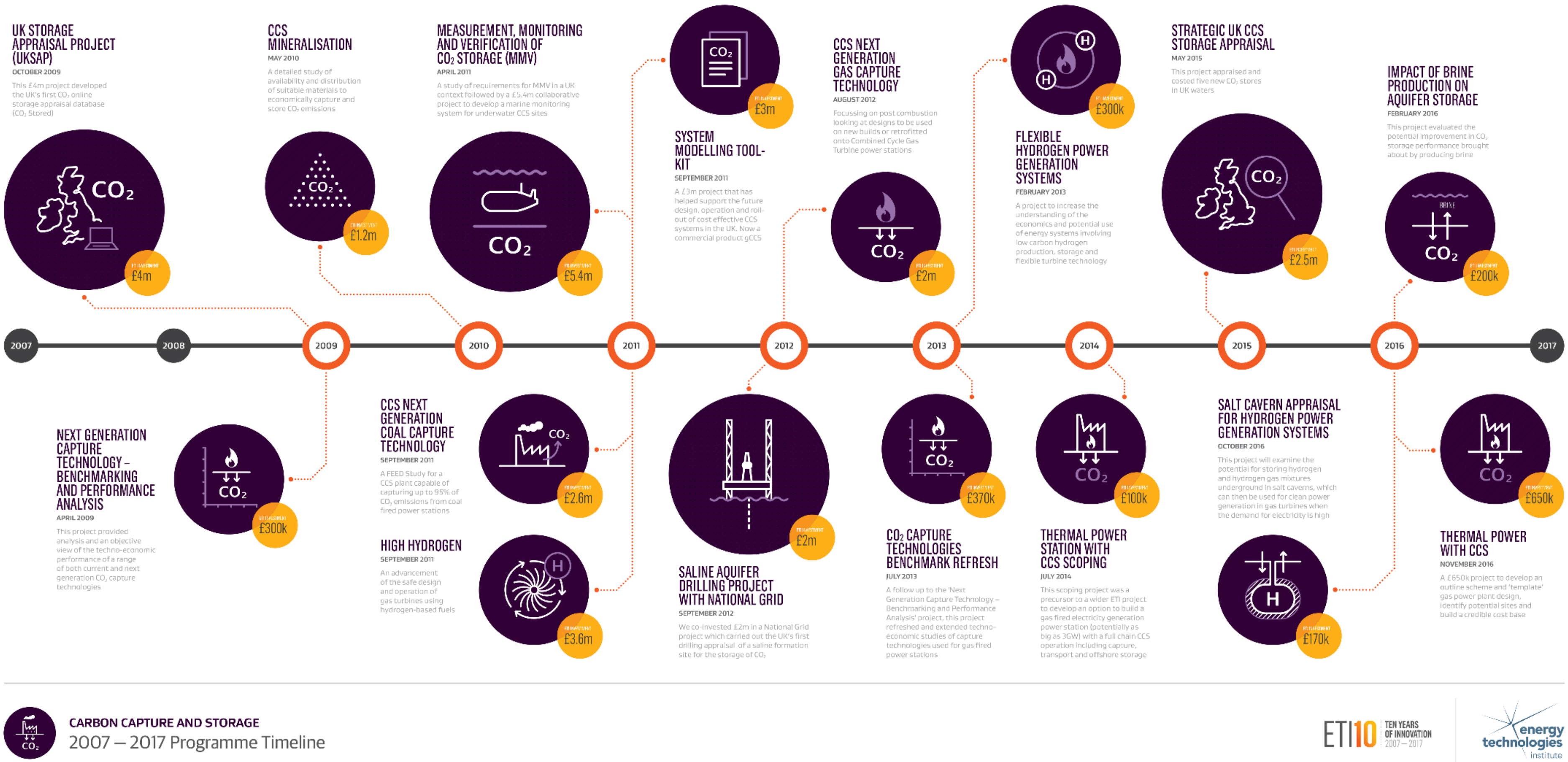
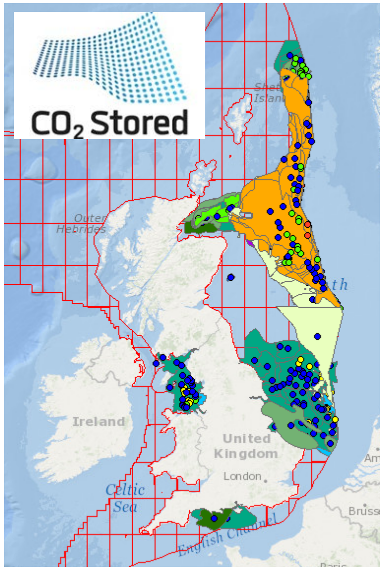
ETI CCS Programme – in One Slide



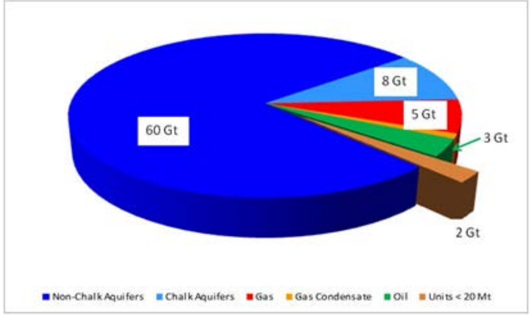
- 32 Projects commissioned and delivered, total value £32.5M
- 109 documents publically available through the ETI Knowledge Zone (so far)
- 4 Insights documents published to date, 3 more planned

Key Highlights - Storage

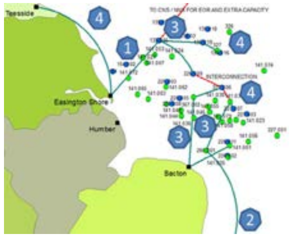


UKSAP: £4m investment to produce realistic, defensible & fully auditable assessment of potential CO_2 storage capacity in the UK

- 570 potential stores
- 78Gtonne storage capacity

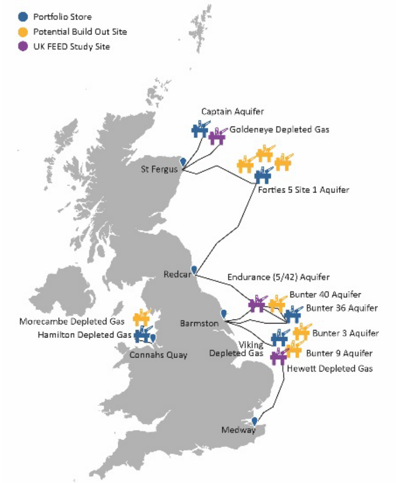


CO2Stored: £1m invested by BGS and The Crown Estate to host and turn UKSAP into the definitive UK storage database



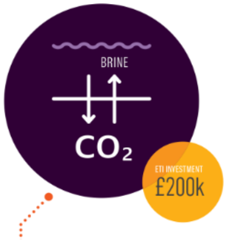
CO2NomicA: storage network design tool

NG Aquifer: £2M investment to enable appraisal drilling of strategic UK store



Strategic Storage Appraisal Project: Managed £2.5M DECC/BEIS investment to develop five strategic UK stores

Aquifer Brine: increasing capacity and derisking stores through brine production

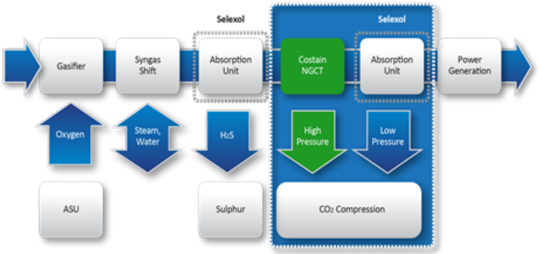


Key Highlights - Capture

Benchmarking & Performance Analysis: creating objective baselines to judge next generation technologies

- Pre-combustion/post-combustion/oxyfuel; coal and gas

Next Generation Pre-Combustion: CO_2 capture by physical separation. Technology developed and project led by Costain. Projected reduction of LCOE by 6.5%

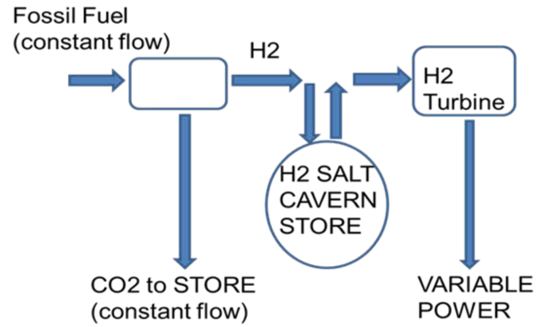


Next Generation Post-Combustion (Gas): Post-combustion CO_2 capture by solid adsorption. Novel technology based on rotating bed. Project led by Inventys (Canadian SME), supported by UK engineering. Canadian demo now proceeding with Husky

Definitive UK Costing for a CCS Plant: Created 'template' CCGT with CCS plant and developed benchmarked costing for multiple configurations at multiple sites around the UK

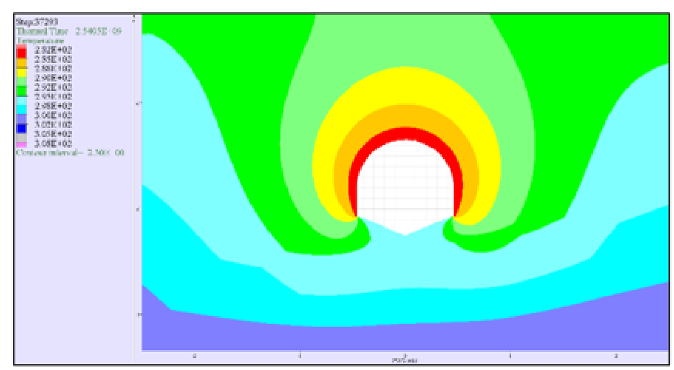
Key Highlights – Hydrogen

Flexible hydrogen and gas turbine systems: £1m investment to identify and assess the performance of potential low carbon gas and hydrogen-powered systems that can meet flexible generating demands



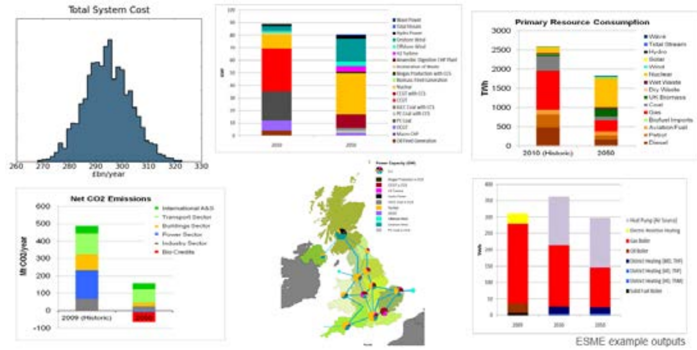
High Hydrogen: £4M investment to understand risks and identify safe operating conditions for turbines burning high concentration hydrogen mixtures

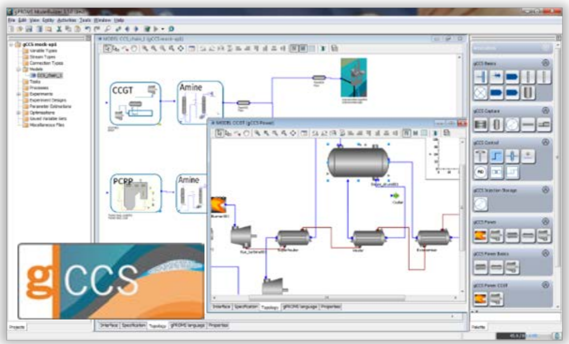
Salt Cavern Storage: £250k investment to confirm integrity of salt cavern stores for rapid churning with hydrogen



Key Highlights – CCS Systems

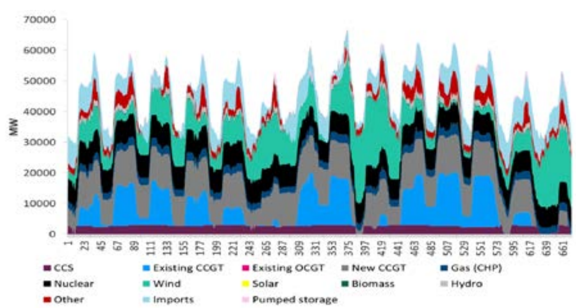
ESME: Understanding the place – and value – of CCS in a whole energy system context: our constant guiding light over the last 10 years





System Modelling Toolkit: £3M investment to develop whole (CCS) system modelling tool: now available through PSE as a commercial product (gCCS)

Dispatch Modelling: Understanding where CCS fits into the future electricity system

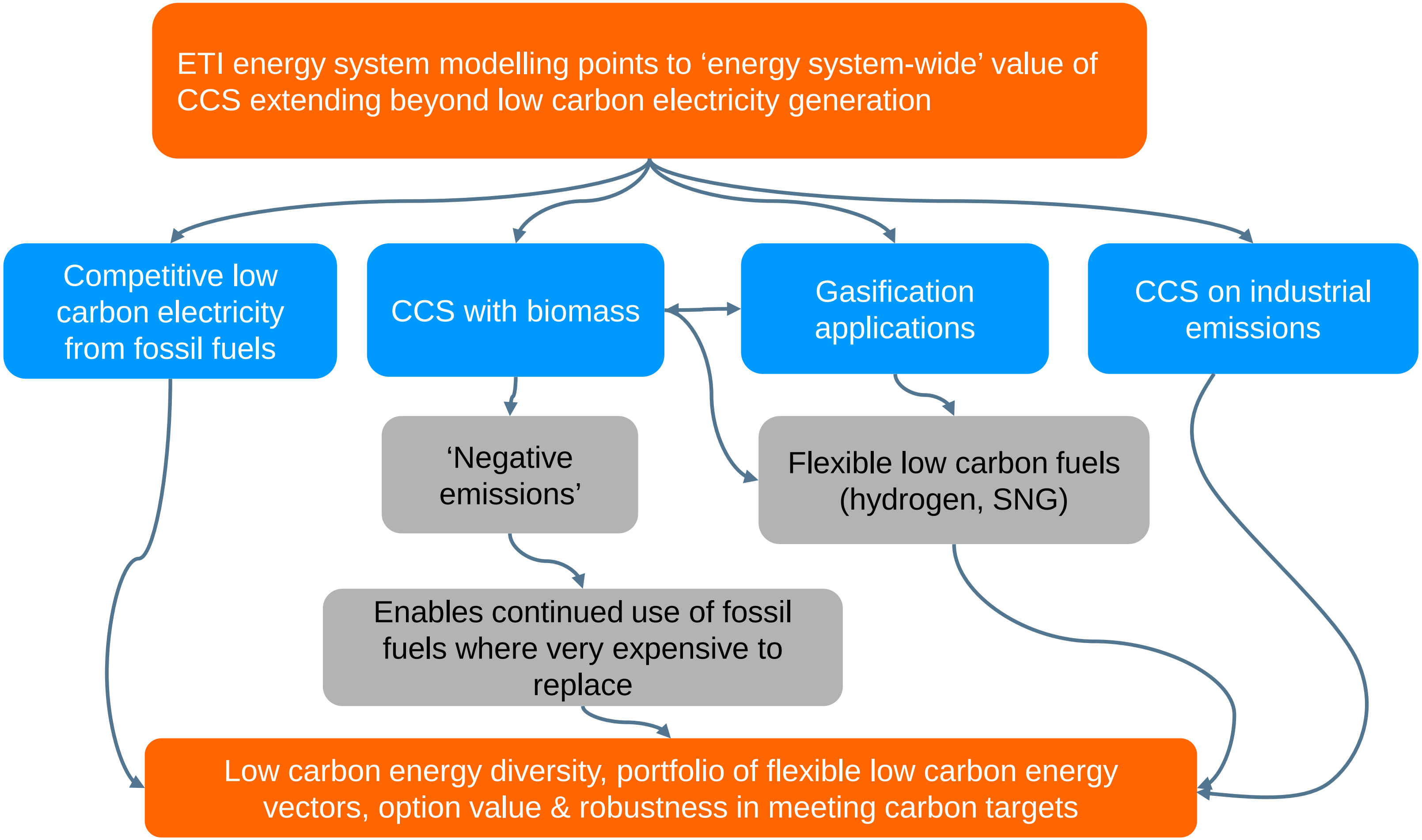


- Own kit
- Displaced generation
- Network
- Balancing / reserves
- Capacity / adequacy

Valuing CCS: Understanding the value of CCS in the power sector – not just the cost. It's not just about LCOE

WHY SHOULD POLICY MAKERS VALUE CCS?

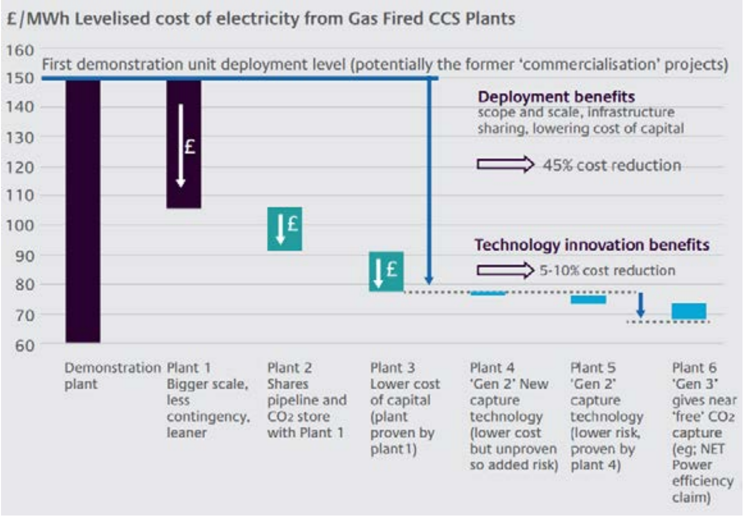
CCS maintains multiple options and delivers significant value at a whole-system level



ETI ESME analysis consistently shows doubling of cost of meeting UK 2050 targets without CCS: 1 – 2% GDP

Value as a source of low carbon electricity

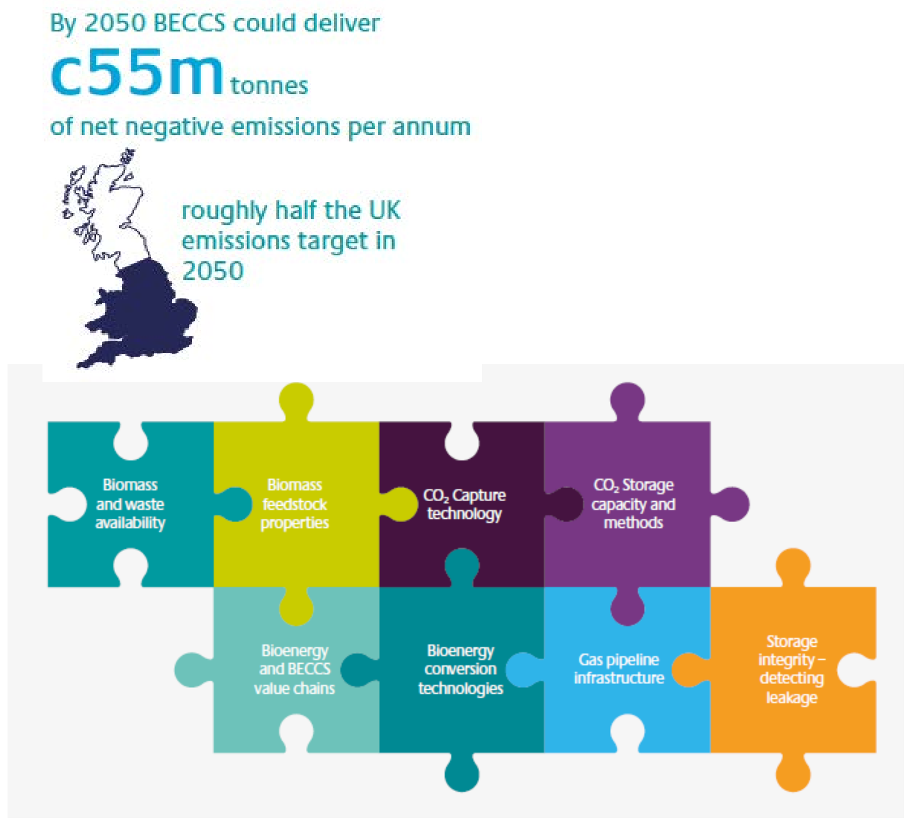
- Potentially competitive at LCOE/Strike Price level
  - dependent on fossil fuel price
  - £75 - £95/MWhr achievable
  - Cost-saving primarily driven by project design, scale & deployment – not technology
- Other electricity system benefits:
  - Firm capacity
  - Flexibility (load following)
  - System inertia
  - Diversity as part of a renewables-heavy fleet
- Value beyond the electricity system, e.g.
  - Shared infrastructure
  - Supply chain
- Challenges to policy makers
  - Early projects less economically attractive
  - Need to share risk, particularly storage
  - Falling renewables costs make ‘simple’ LCOE comparisons appear less attractive



	Shared infrastructure	Shared skills and supply chain	Shared use of resources	Innovation and knowledge externalities	Energy externalities	Environmental / health externalities
CCGT	✗	✗	✗	✗	✓	✓
OCGT	✗	✗	✗	✗	✗	✓
Nuclear	✗	✗	✗	✗	✓	✗
CCGT CCS	✓	✓	✗	✓	✓	✗
Biomass CCS	✓	✓	✓	✓	✓	✓
Onshore	✗	✗	✗	✓	✗	✓
Offshore wind	✗	✗	✗	✓	✗	✓
Solar	✗	✗	✗	✓	✗	✓
Storage	✗	✗	✗	✓	✗	✗
Interconnectors	✗	✗	✗	✗	✗	✗
DSR	✓	✗	✗	✓	✗	✗

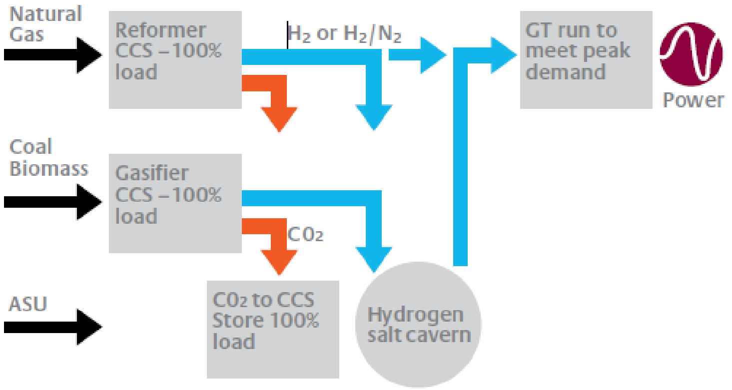
Value of Biomass with CCS (BECCS)

- Negative emissions highly valued in carbon-constrained world
  - Allows continued emissions where difficult/ impossible to avoid
  - BECCS is only practical, scalable NET currently available
- All components of BECCS chain are proven – no technical barriers to deployment
- Most valuable use of a limited biomass resource (at a system level)
- Challenges to policy makers
  - Full chain demonstration needed
  - LCOE unlikely to be competitive against, e.g. gas with CCS
  - Need policy instrument which appropriately values negative emissions



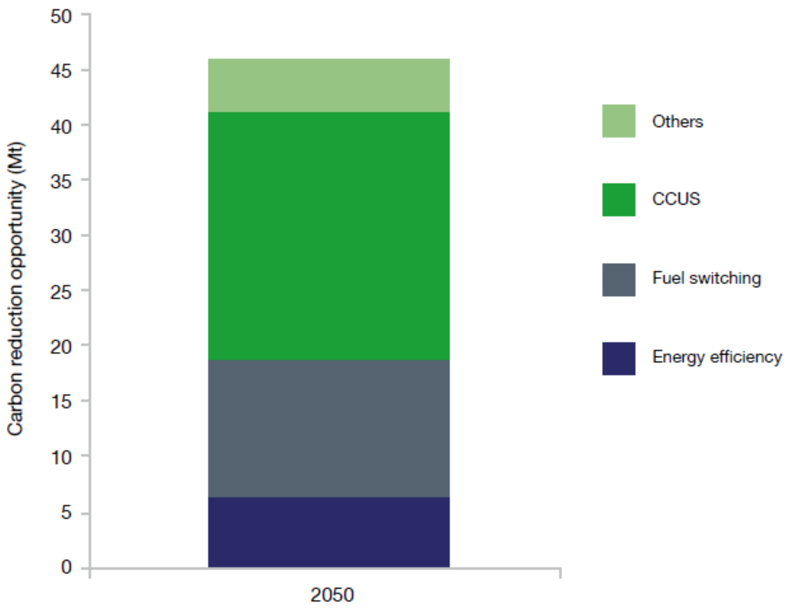
Value of Gasification Opportunities

- Most cost-effective low carbon route to hydrogen and other low carbon gases
- Multiple feedstocks
  - Coal, gas, biomass
- Gasification with hydrogen storage economically attractive for low carbon, mid-merit load following
- Hydrogen can decarbonise electricity, domestic heat, industrial heat and provide an industrial feedstock
- Challenges to policy makers
  - Need incentives for low carbon heat (without direct cost to industry/consumers)
  - Design of incentives for low carbon, mid-merit power challenging
  - Renewable routes, despite being much more expensive, are superficially attractive



Value of CCS for Industrial Emissions

- Only solution for many industrial applications
  - Required for 50% of emissions reductions in some scenarios
- Maintain strategic industrial base in carbon-constrained world
- Opportunity for 'green products'
- If industrial emissions not abated, need to abate much more expensive sources



Taken from BEIS 'Clean Growth Strategy', Oct 2017

- Challenges for policy makers
  - Cannot add costs to industrial production, otherwise may 'offshore' production
  - Taking risk of capital investment in capture
  - Investment in (and taking full risks of) transport & storage with no guarantee of long term CO_2 supply

Conclusions

- CCS provides options and delivers substantial value at a whole energy-system level
  - Power
  - Biomass with CCS
  - Gasification
  - Industry

- Each application area brings its own opportunities and challenges for policy makers and investors alike
  - An integrated approach is needed, not trading one off against the other

- Need close collaboration between industry and policy makers at national and international level to overcome the challenges and realise the prize that CCS offers

Registered Office
Energy Technologies Institute
Holywell Building
Holywell Park
Loughborough
LE11 3UZ

For all general enquiries telephone the ETI on 01509 202020

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