



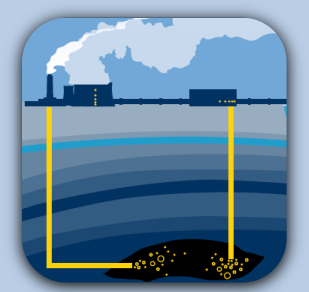



elementenergy

CCS sector development in the UK

Keeping CCS moving in the EU

25th February 2015

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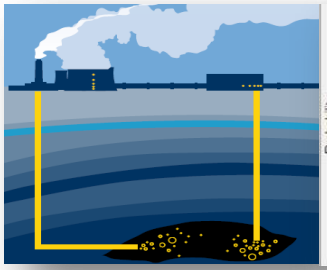
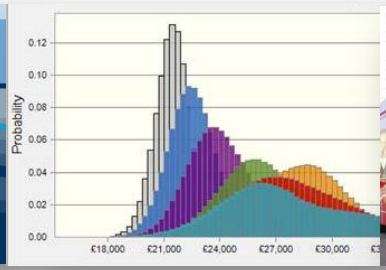
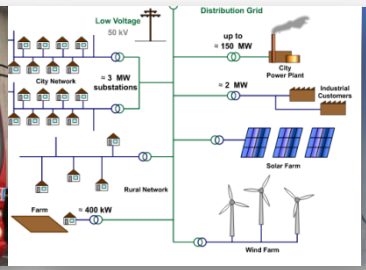
About Element Energy – a consultancy focussed on the energy sector

- Element Energy is a **specialist energy consultancy**, with an excellent reputation for rigorous and insightful analysis across a wide range of low carbon energy sectors
- These include: **Carbon capture and storage, energy systems, energy networks**, **renewable energy systems, the built environment, hydrogen** and **low carbon vehicles**
- We consult on both **technical and strategic issues** – we believe our technical and engineering understanding of the real-world challenges support our strategic work

Energy technologies modelling	**Consumers behaviour modelling**	**Energy networks modelling**	**Advanced geographic modelling**	**Project management**
Policy recommendations	**Strategic market analysis**	**Commercialisation strategies**	**Techno-economic studies**	**Project financing**







Recent Element Energy publications in the CCS sector

- Energy Technologies Institute (2015), "CCS Sector Development Scenarios" – to be published in March 2015
- The CCC (2015), "CCS cost reduction" – to be published later this year
- The CCC (2014), "Infrastructure in a low-carbon energy system to 2030: CCS", available at: http://www.theccc.org.uk/wp-content/uploads/2013/12/CCC-Infrastructure-CCS-report-290114.pdf
- SCCS CO_2-EOR JIP (2014) , "Analysis of Fiscal Incentives", available at: http://www.sccs.org.uk/expertise/reports/sccs-co2-eor-joint-industry-project
- DECC and BIS (2014) "Demonstrating CO_2 capture in the UK cement, chemicals, iron and steel and oil refining sectors by 2025", available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/311482/Element_Energy_DECC_BIS_Industrial_CCS_and_CCU_final_report_14052014.pdf
- Scottish Enterprise (2014) ,"CCS Hub Study for Scotland and the Central North Sea", available at: http://www.element-energy.co.uk/publications/
- Scottish Enterprise (2012), "Economic impacts of CO_2 enhanced oil recovery for Scotland", available at: http://www.scottish-enterprise.com/knowledge-hub/articles/publication/co2-enhanced-oil-recovery

Background to material presented

This talk draws on insights from:

- Energy Technologies Institute, “CCS sector development scenarios”
- Committee on Climate Change, “CCS Cost Reduction”

Both projects are work in progress and being delivered in partnership with Poyry

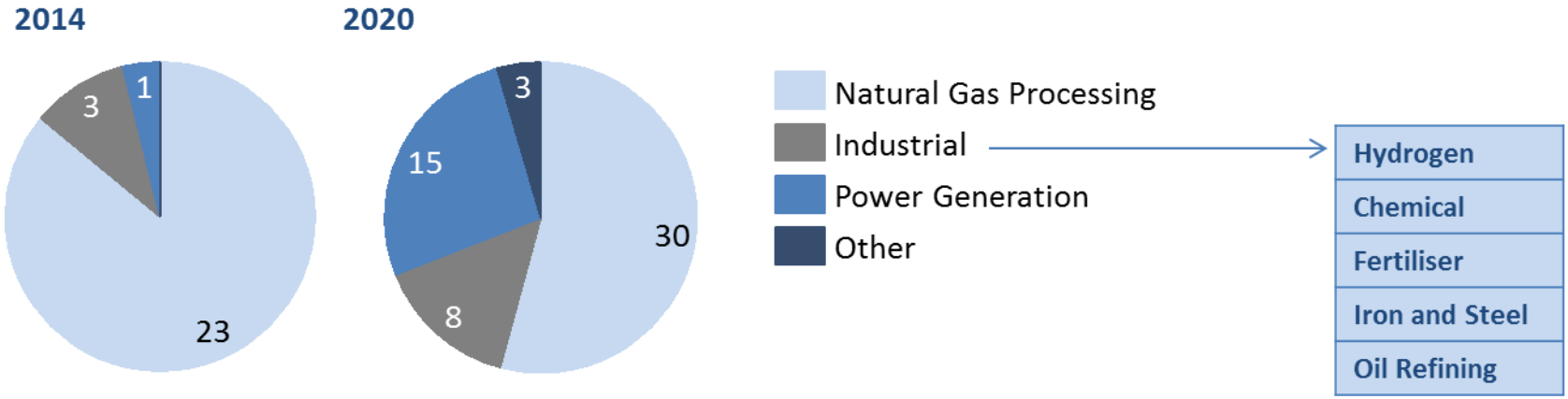
DISCLAIMER - all material presented today represents the view of the author, not clients, partners or stakeholders

Agenda

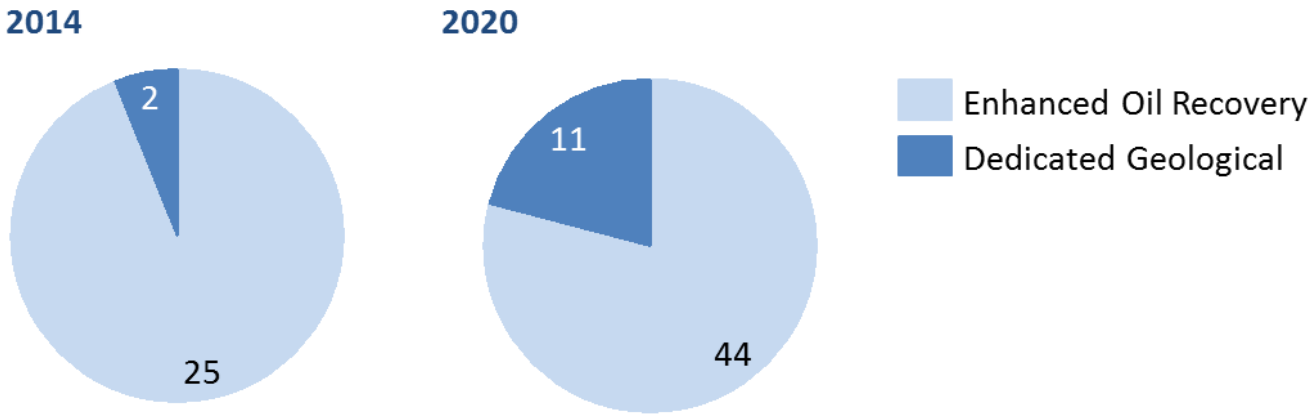
- Review of current international CCS developments
- CCS sector development scenarios
- Key requirements for CCS roll-out

CO_2 capture capacity in the power generation sector is expected to increase from 1 Mt/yr in 2014 to 15 Mt/yr by 2020: the highest increase among all CCS sectors

Global CO_2 capture capacity by sector, $MtCO_2$ / yr



Global CO_2 capture capacity by storage type, $MtCO_2$ / yr



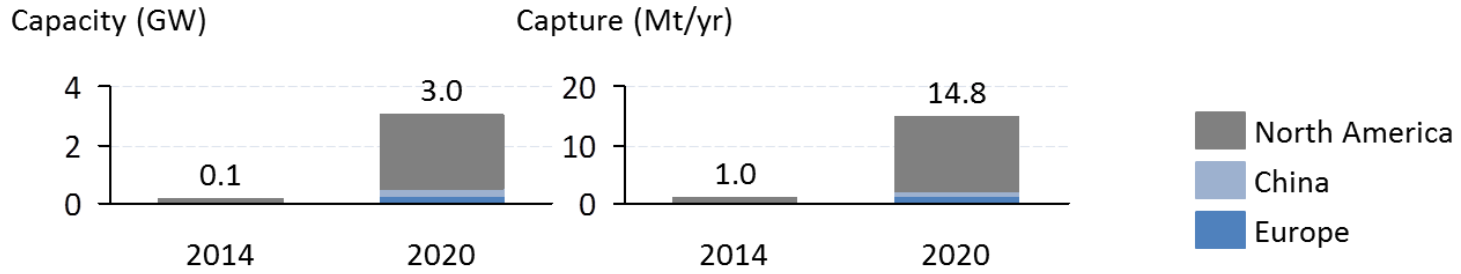
Source: Element Energy and Poyry for the CCC, CCS cost reduction (work in progress) – using the projects, which are in the "Define", "Execute" or "Operate" phases in the Global Status of CCS report (GCCSI, 2014)

Coal CCS projects (mainly in North America) are projected to make up 95% of the global power CCS capture capacity by 2020

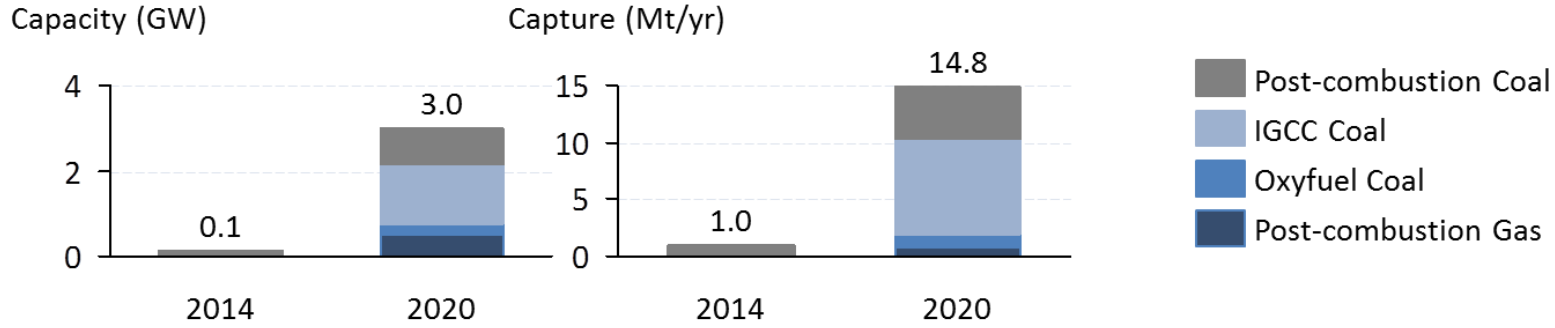
Overview

- Currently Boundary Dam, with a power capacity of 139MW, is the only operating power CCS scheme, however by 2020 there will be a total of 9 (expected) power generation projects which will globally capture 14.8MtCO_2 per annum (~3 GW).
- Coal CCS projects (mainly in North America) are projected to make up 95% of the global power CCS capture capacity by 2020 and more than 85% of the captured CO_2 is expected to be used in CO_2-EOR operations.

Power CCS projects by location



Power CCS projects by capture type



Source: Element Energy and Poyry for the CCC, CCS cost reduction (work in progress) – using the projects, which are in the "Define", "Execute" or "Operate" phases in the Global Status of CCS report (GCCSI, 2014)

International learning has a role to play; however, most of the CCS cost reduction mechanisms in the UK are driven by UK specific actions and deployment

Cost reduction mechanisms in the UK	Potential impact of global learning
Capture plant technology learning and economies of scale	**Medium to high impact** for post-combustion coal and IGCC coal **Limited** for oxyfuel coal and post-combustion gas as these are already being tested in the UK
Transport and storage economies of scale	**No impact** – UK driven
Improved financeability	**Limited impact –** mostly UK driven
Enhanced Oil Recovery	**Limited impact** – UK drequires UK based deployment

Source: Element Energy and Poyry for the CCC, CCS cost reduction (work in progress)

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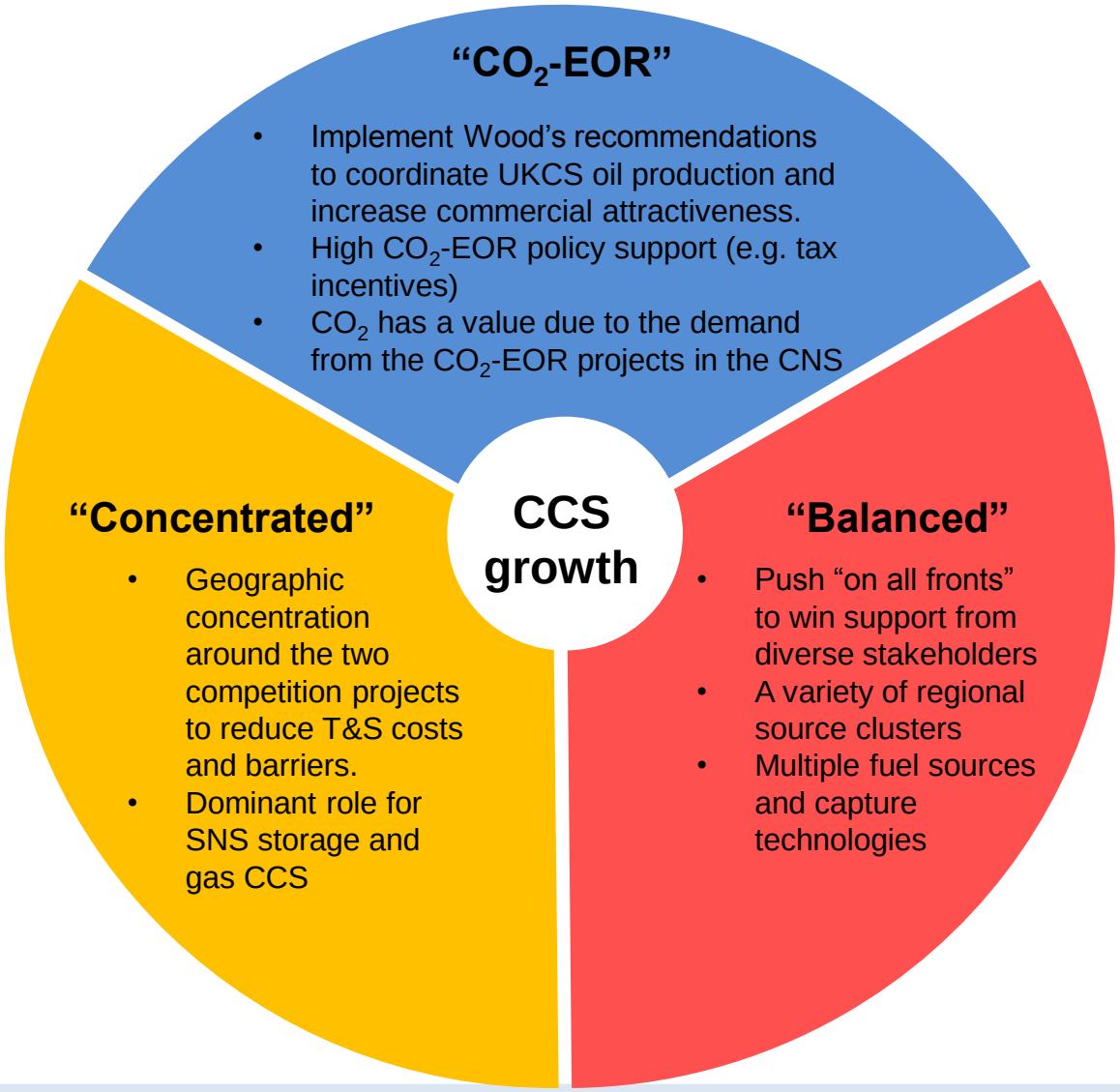
CCS sector development scenarios: Project background

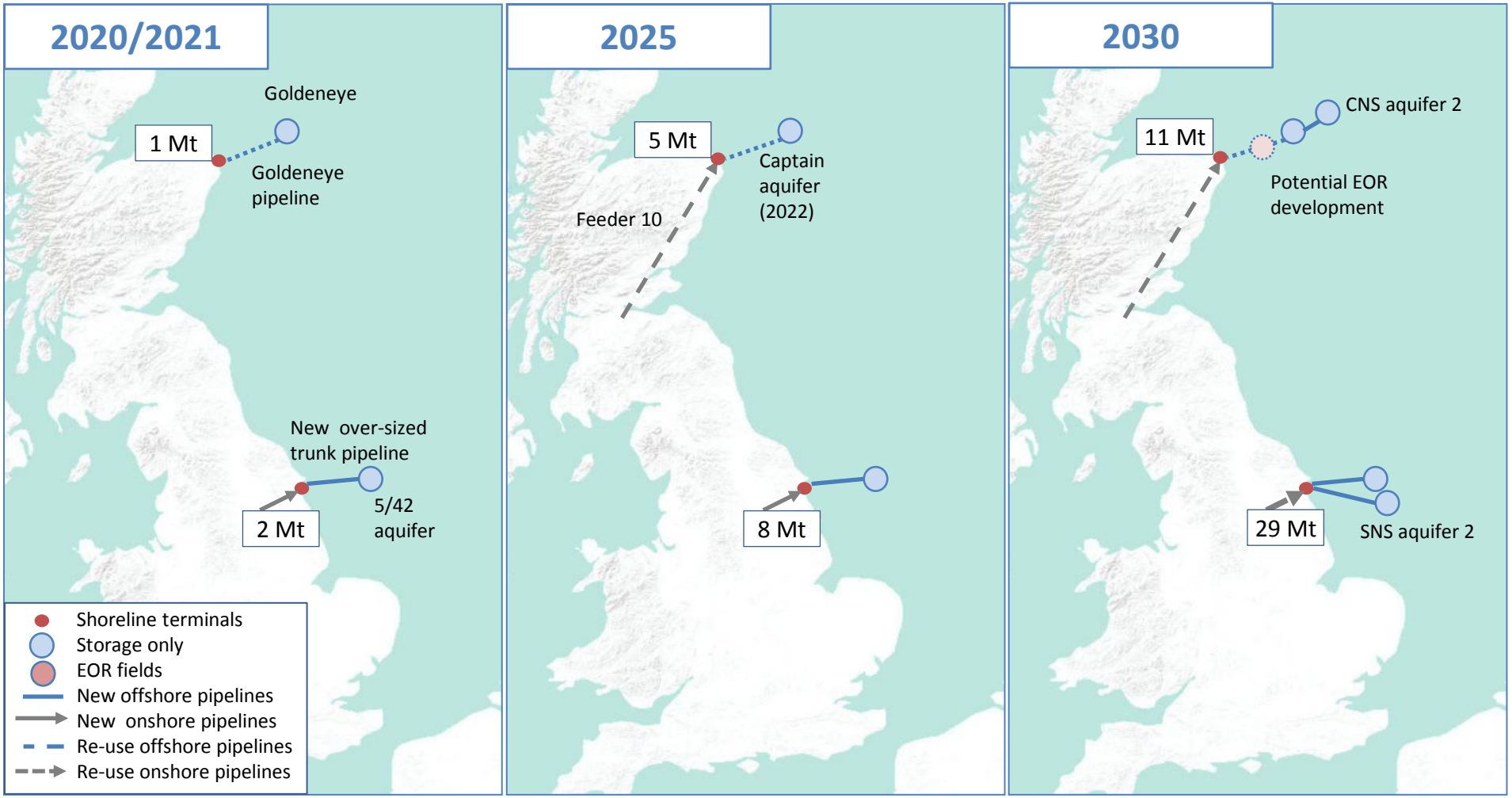
- CCS can play a critical role in enabling low cost decarbonisation of the broader UK energy system including industrial CCS.
- Without CCS, the cost of reaching UK Climate Change targets will double from a minimum of around £30bn per year in 2050*
- ETI ESME scenarios suggest that a cost-optimal 2050 energy system in the UK would require building a sector storing ca. 100 million tonnes of CO_2 by 2050.
- To reach this target requires the establishment of a CCS sector and associated infrastructure by 2030, storing ca. 50 million tonnes of CO_2 with ~10 GW of power CCS and contribution from industrial sources.

*Source: The Energy Technologies Institute's (ETI) modelling of the UK energy system

Three CCS sector development scenarios

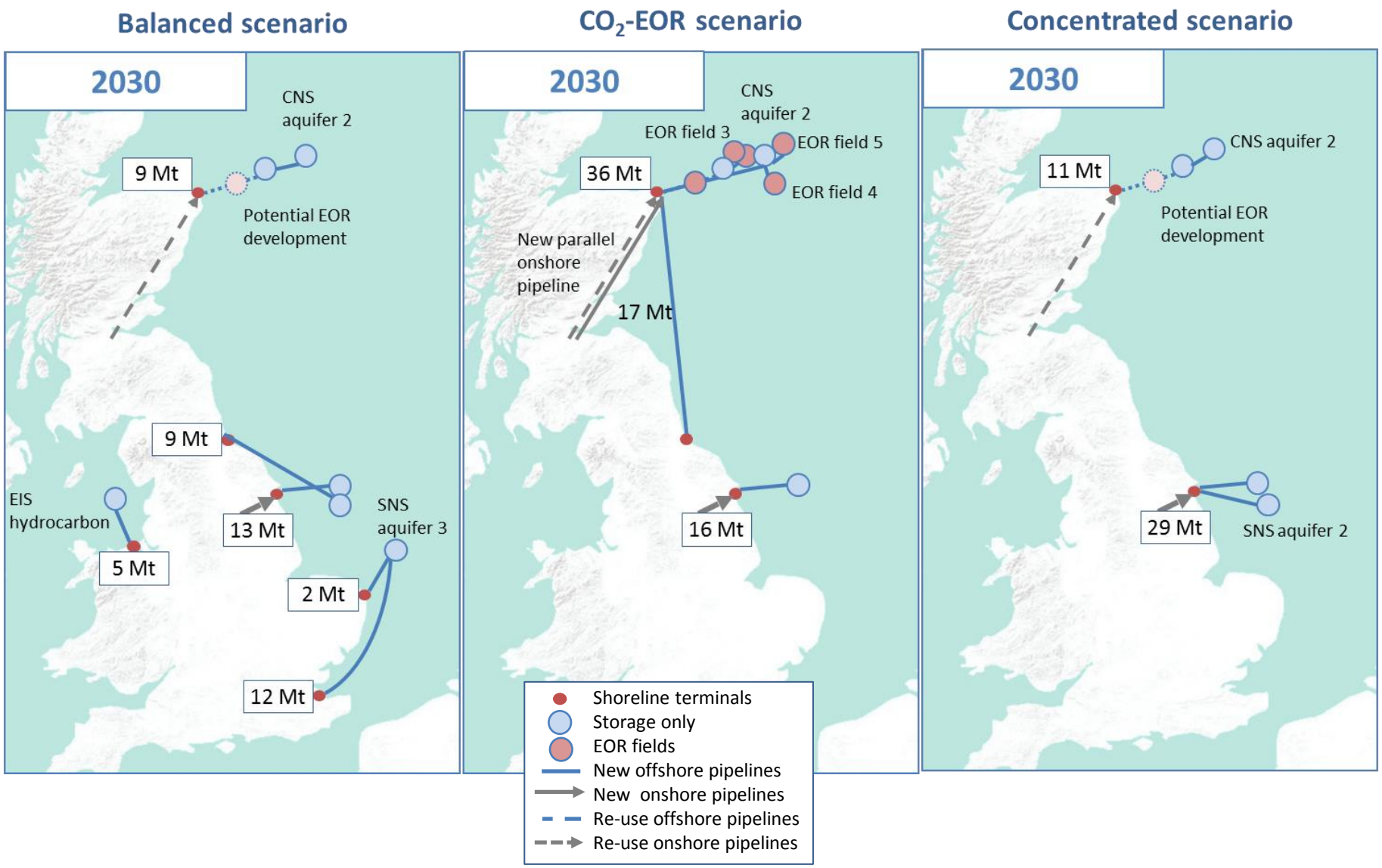


“Concentrated” scenario: Transport and storage network development



Source: Element Energy and Poyry for the Energy Technologies Institute, CCS sector development scenarios (work in progress)

Comparison of the scenarios: Transport and storage network development



Source: Element Energy and Poyry for the Energy Technologies Institute, CCS sector development scenarios (work in progress)

“Concentrated” scenario: Timelines for capture and storage deployment

Power Plant Roll-out	Storage Location	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1 - Peterhead	CNS								0.3										
2 - White Rose	SNS									0.3									
3 - Forth Coal CCS 1	CNS										0.6								
4 - Yorkshire Gas CCS 1	SNS											0.3							
5 - Yorkshire Coal CCS 1	SNS												0.5						
6 - Yorkshire Gas CCS 2	SNS													0.6					
7 - Forth Gas CCS 1	CNS														1.2				
8 - Yorkshire Coal CCS 2	SNS															0.8			
9 - Yorkshire Gas CCS 3	SNS																0.6		
10 - Peterhead Gas CCS 2	CNS																0.6		
11 - Yorkshire Gas CCS 4	SNS																	1.2	
12 - Yorkshire Gas CCS 5	SNS																	0.6	
13 - Yorkshire Gas CCS 6	SNS																		1.2
14 - Yorkshire Gas CCS 7	SNS																		1.2

Industrial CCS Roll-out	Storage Site	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1 - Forth - Refinery Pilot	CNS																		
2 - Forth - Cement Pilot	CNS																		
3 - Yorkshire - Steel 1	SNS																		
4 - Forth - Refinery 1	CNS																		
5 - Forth - Cement	CNS																		
6 - Forth - Chemical	CNS																		
7 - Yorkshire - Chemical	SNS																		
8 - Yorkshire - Steel 2	SNS																		
9 - Forth - Refinery 2	CNS																		

Storage Site Roll-out	Location	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1 - Goldeneye gas field	CNS																		
2 - 5/42 aquifer	SNS																		
3 - Captain aquifer	CNS																		
2a - 5/42 expansion (illustrative)	SNS																		
4 - CNS aquifer 2	CNS																		
5 - SNS aquifer 2	SNS																		

Key

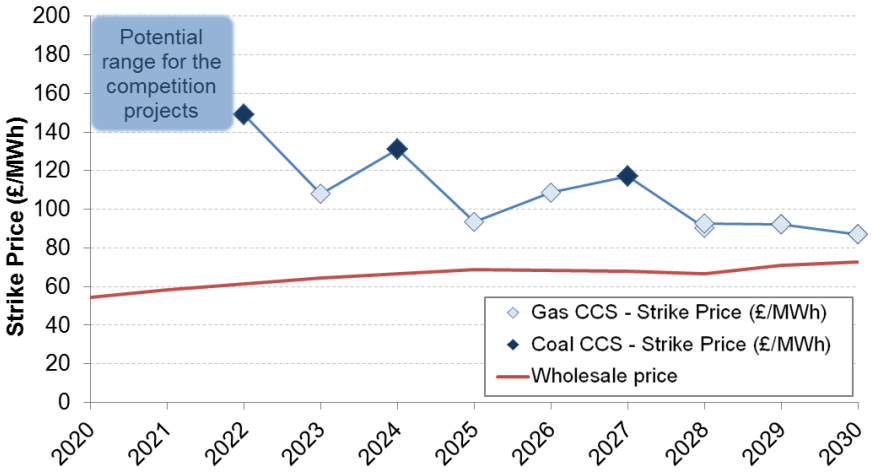
- Screening and exploration
- Appraisal
- Development (planning and design)
- Construction
- Commissioning
- Store expansion
- FID

- Phase 2 projects need to take investment decisions quickly in order to achieve 10 GW power CCS by 2030, and cost reduction through momentum building and economies of scale.

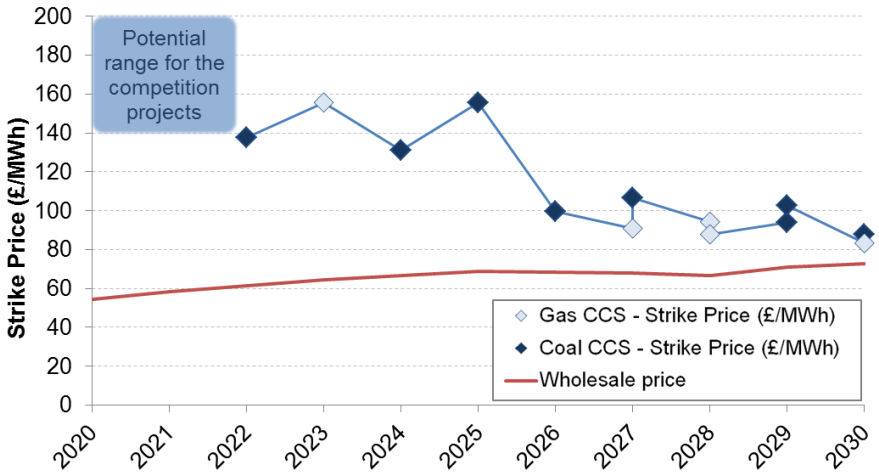
Source: Element Energy and Poyry for the Energy Technologies Institute, CCS sector development scenarios (work in progress)

Comparison of the scenarios: CCS cost reduction

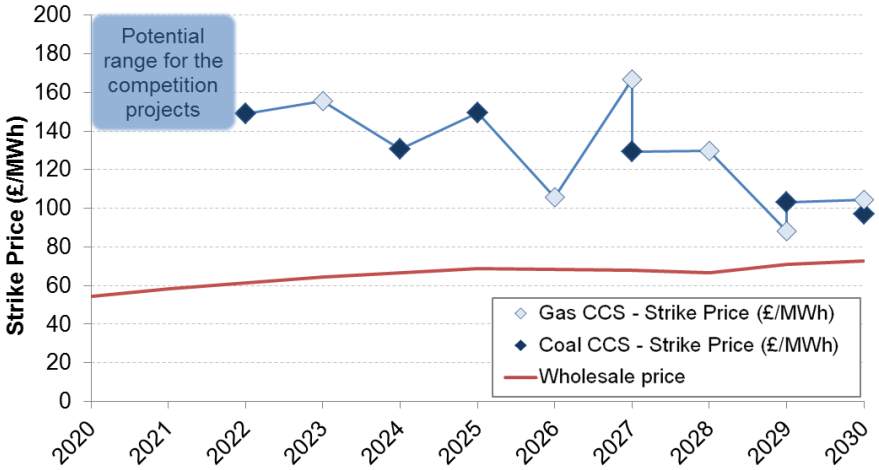
Concentrated scenario



CO_2-EOR scenario



Balanced scenario



- All scenarios achieve significant cost reductions through a variety of mechanisms with CCS costs less than £100/MWh by 2030 for some CCS technologies - scale of cost reductions vary by technology and scenario (as well as implied policy choices)
- 10 GW scale power CCS sector with a number of industrial CCS projects storing ca. 50 Mt/yr by 2030 can be delivered by creating a supportive policy environment with early action on critical issues to bring forward timely investment

Source: Element Energy and Poyry for the Energy Technologies Institute, CCS sector development scenarios (work in progress)

Agenda

- Review of current international CCS developments
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- Key requirements for CCS roll-out

Key requirements for CCS roll-out based on the CCS scenarios

- **Timely implementation of both CCS Commercialisation Programme projects**
- **Early investment in physical appraisal to expand the promising 5/42 and Captain aquifer stores and appraise further sites**
- **Enable early investment decisions by phase 2 projects by awarding a further 3 appropriately designed CfDs by 2020**
- **Stimulate a robust project development pipeline by delivering clear signals to investors and project developers about the scale and strength of policy (levy control framework support) commitment to developing CCS**

Source: Element Energy and Poyry for the Energy Technologies Institute, CCS sector development scenarios (work in progress)

Other issues to be resolved

- **Governance for infrastructure sharing:**
  - A purely negotiated incremental cost approach would have very different strike price implications to a more regulated network charging framework.

- **Strategy for capture readiness:**
  - a wave of investment in unabated gas-fired capacity may be needed by the early 2020s – i.e. ahead of CCS sector development

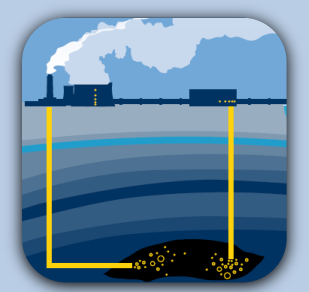
- **Financial incentives for industrial CCS:**
  - clear potential for cost-efficient CO_2 capture from industry before 2030
  - need early resolution of financial incentives.

- **Risk management and governance for CO_2-EOR:**
  - How to kick-start a CO_2-EOR market in the North Sea and manage oil-price risks,
  - Greater complexity in cross-sector co-ordination and public support

- **Reflecting strategic value in CfD allocation decisions:**
  - No clear case for government to pick technologies, fuel types and locations, but how will policy on CfD allocation take these issues into account?

Source: Element Energy and Poyry for the Energy Technologies Institute, CCS sector development scenarios (work in progress)







Thank you for your attention

If you have questions, please contact:

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