



British
Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

A horizontal banner at the top of the slide is composed of several rectangular panels. From left to right, the panels show: a close-up of a rocky surface, a vibrant, colorful landscape with orange and red hues, a mountain valley with a rainbow in the distance, a close-up of a dark, textured rock formation, a city skyline with a prominent skyscraper, and a rocky hillside with sparse vegetation.

Gateway to the Earth

Developing a national portfolio of CO₂ storage in the UK

Michelle Bentham

BGS activity in storage capacity mapping

1993

2015

nzecc
carbon capture & storage



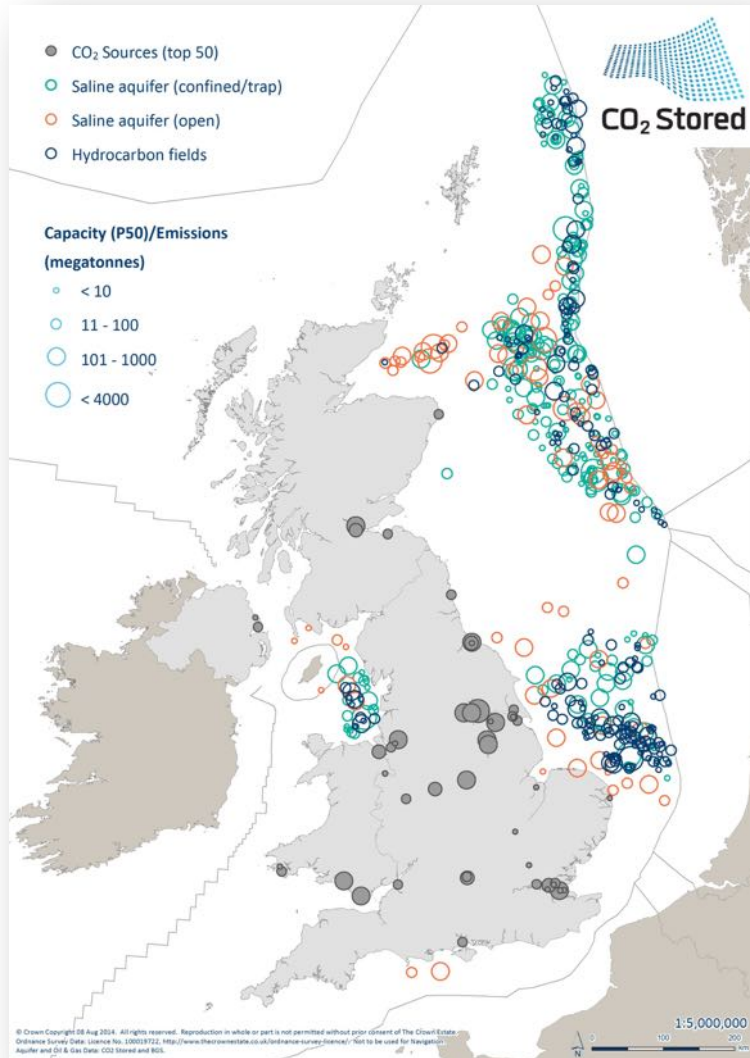
UKSAP

CO₂ Stored



CO₂ Stored –state of the art

www.co2stored.co.uk



- Hosted and under development by **The British Geological Survey (BGS)** and **The Crown Estate (TCE)**.
- Based on the database produced in the UK Storage Appraisal Project.
- CO₂ Stored provides access to world-leading overview data on CO₂ storage.
- Through the website, users can view and interrogate over 500 potential CO₂ storage sites around offshore UK.

Capacity data & calculations



The screenshot displays the 'CO₂ Stored' web application. The top navigation bar includes links for Home, About, Search Units, Map, Help, Exports, Admin, and Contact Us. The user is logged in as Michelle Bentham. The main content area shows the unit ID 139.019 (Bunter Closure 39) with a description and a 'Pore Volume' section. A table lists various characteristics with their units, minimum, most likely, and maximum values, along with the source and confidence level.

Description	Units	Min	Most Likely	Max	Source	Confidence (L,M,H)
Area	[km ²]	65.97	73.30	80.63	BGS Shapefiles	medium
Average Gross Thickness	[m]	243.56	250.91	259.24	PGS Surfaces	medium
Estimated Relief	[m]		538.19		PGS Surfaces	medium
Shape Factor			1.000			
Average Areal Net Sand	[frac]	0.98	0.99	1.00	BGS Shapefiles	medium
Average Vertical NTG	[frac]	0.71	0.91	1.00	BGS held wells	medium
Average Porosity	[frac]	0.05	0.14	0.24	BGS held wells	medium
Gross Rock Volume	[10 ⁶ m ³]		18392			
Pore Volume	[10 ⁶ m ³]		2320			
Aspect Ratio						

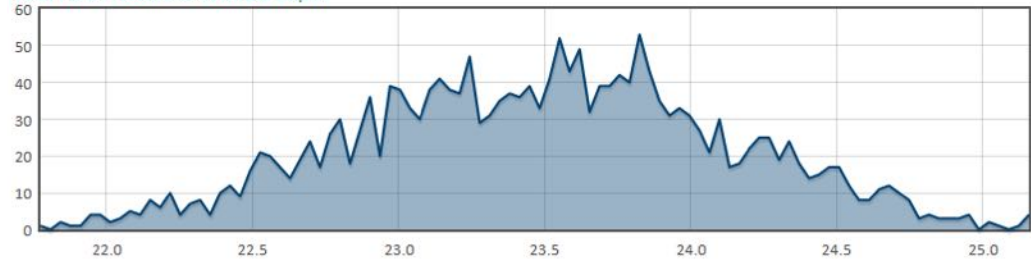
- Theoretical capacity
- Pressure capacity
- Dynamic capacity

Risk, injectivity and economics & Monte Carlo simulation

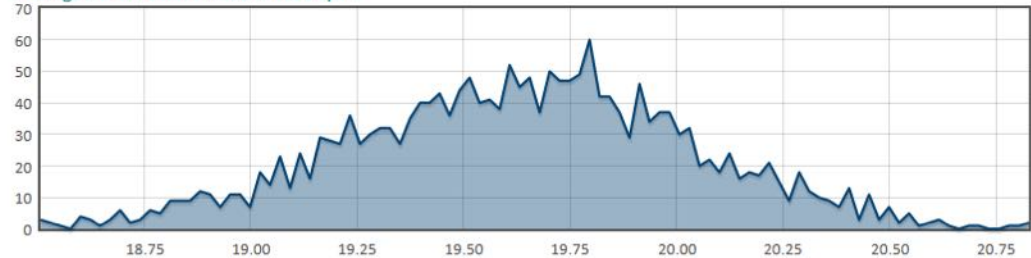
Capacity

Severity of impact	Low	Seal chemical reactivity Mineralogy of grains and cements Mechanical integrity		Salinity
	Medium	Fracture pressure capacity Dip direction Rugosity Transnational migration Stratigraphic compartmentalization vertical Stratigraphic compartmentalization horizontal	Structural trend Structural/fault compartmentalization Diagenesis	Depositional/diagenetic fabric Dip
	High	Seal degradation	Density Throw and fault seal	Fault vertical extent
		low	medium	high
		Likelihood		

Final Pore Pressure at Centroid Depth



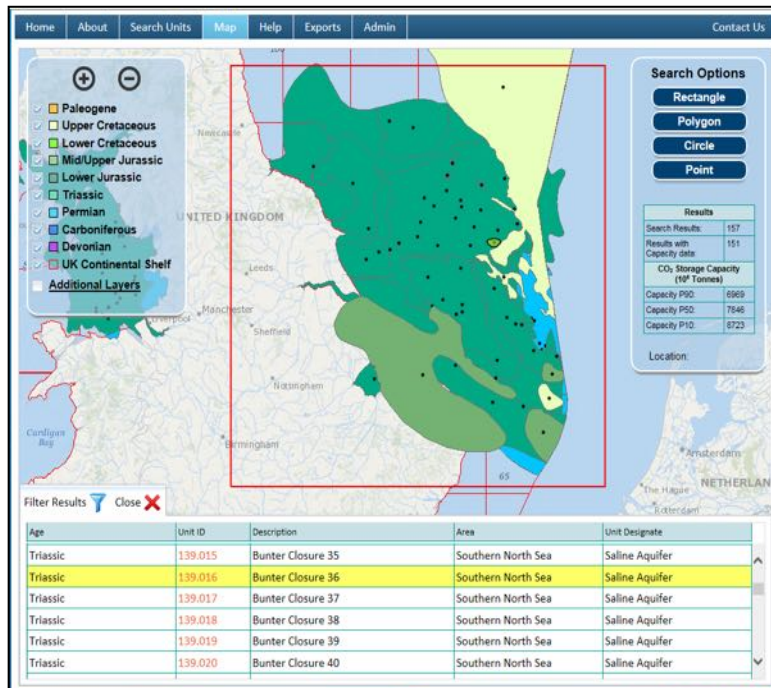
Average Pore Pressure at Centroid Depth



Storage capex/ £millions

CO ₂ Injection Rate [10 ⁶ Tonnes/yr]	Injection Duration (yr)			
	10	20	30	40
2	86	97	108	119
5	180	202	235	NC
10	274	NC	NC	NC
15	403	NC	NC	NC
20	NC	NC	NC	NC
40	NC	NC	NC	NC
60	NC	NC	NC	NC

Searchable



Welcome Michelle Bentham | [Logout](#) | [My Account](#)

CO₂ Stored

Database version: v2.1

Search Unit

Unit Designate	Not Selected	Age	Not Selected
Group	Saline Aquifer Oil & Gas Gas Gas Condensate	Unit ID	
Formation	Not Selected	Maximum Water Depth [m]	
Member	Not Selected	Permeability [mD]	
Area	Not Selected	Porosity [fraction]	
Storage Unit Type	Not Selected	CO ₂ Theoretical Capacity [10 ⁶ Tonnes]	

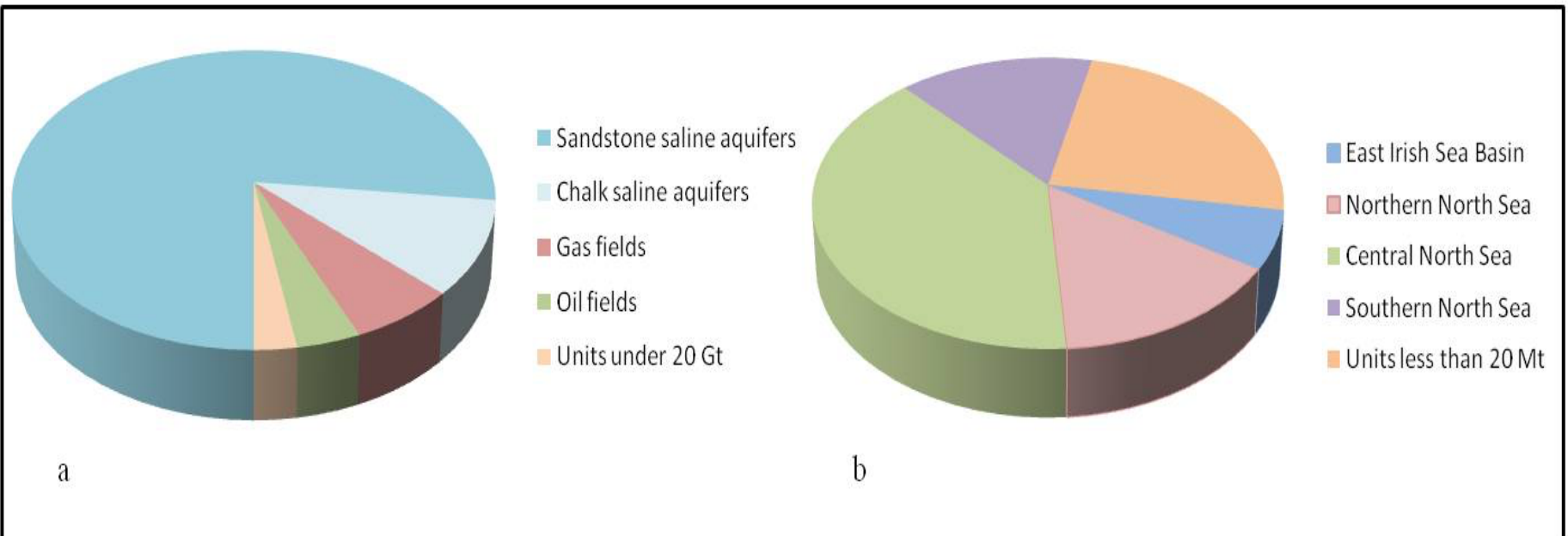
Capacity Data Results

Description	Units	Measurements
Total Number of Storage Units		574
Number of Storage Units With Results		505
Preliminary Overall Theoretical Capacity (P90)	[10 ⁶ Tonnes]	62845
Preliminary Overall Theoretical Capacity (P50)	[10 ⁶ Tonnes]	69172
Preliminary Overall Theoretical Capacity (P10)	[10 ⁶ Tonnes]	75499

Storage Unit Results (574)

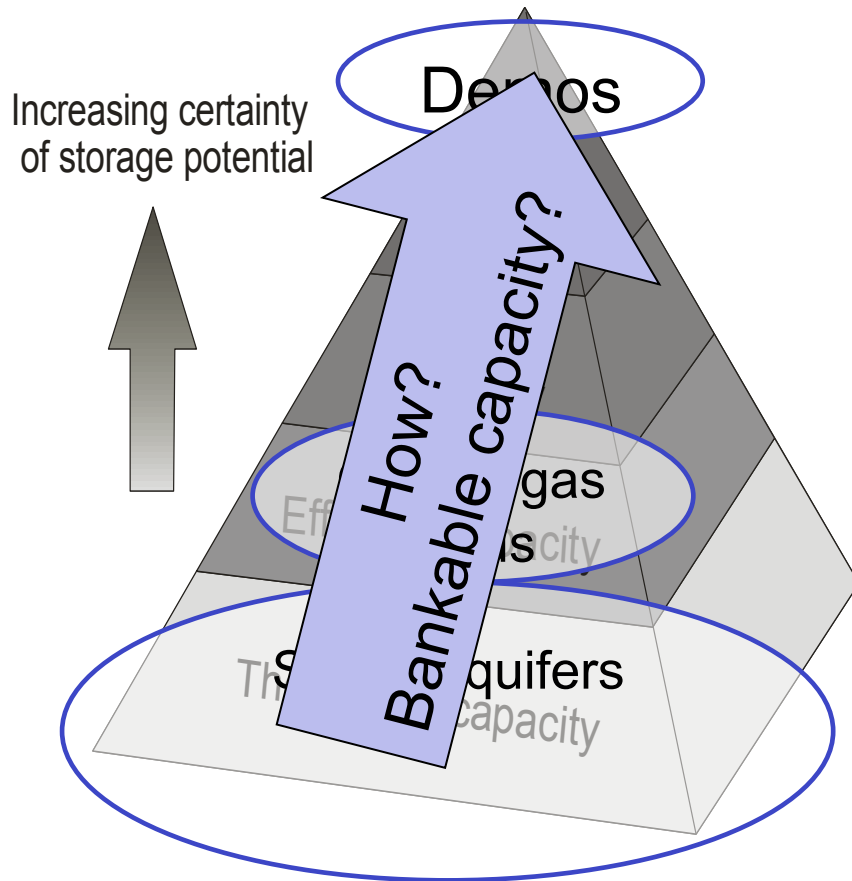
[More Results](#)

CO₂ Stored - 78 Gt dominated by saline aquifer storage

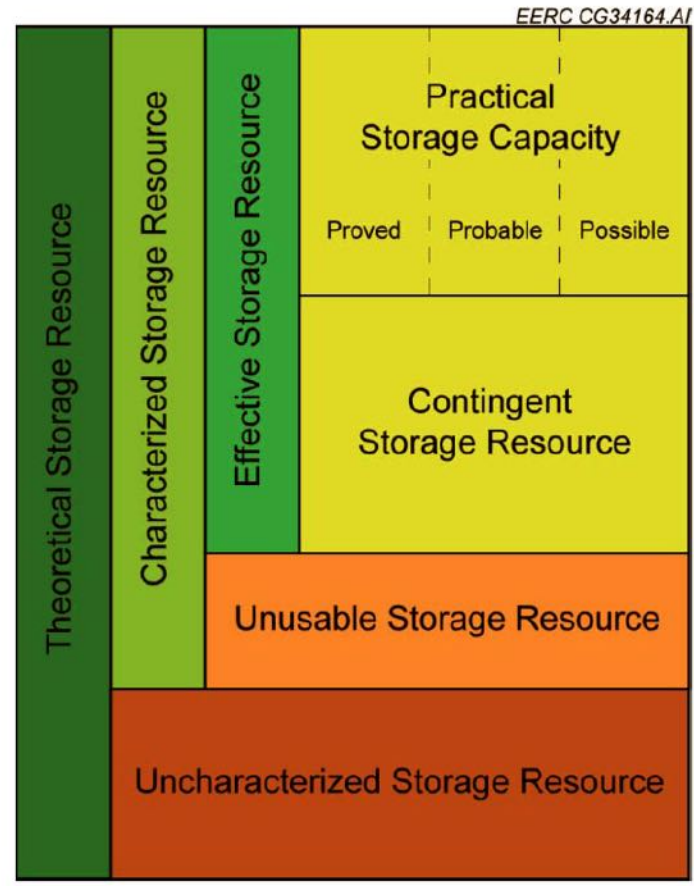


What does that mean?

- CSLF

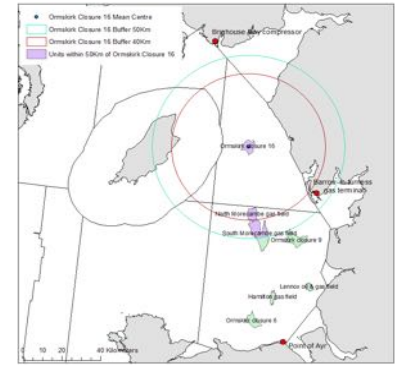


- IEA



Site Portfolio

Funded by The Crown Estate



Aim: To identify an initial portfolio of first opportunity sites for development post DECC commercialisation phase 1.

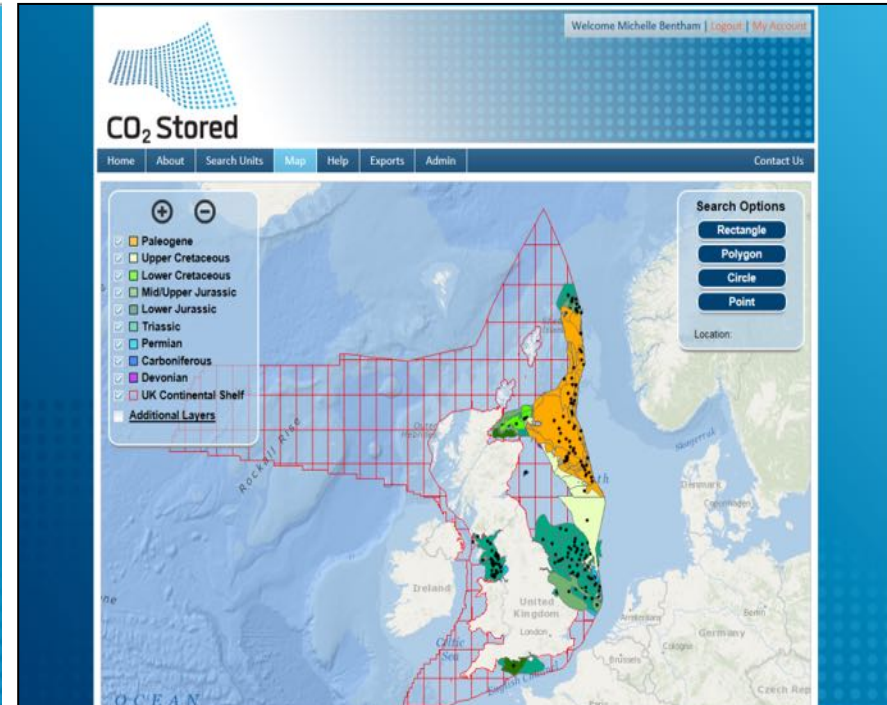
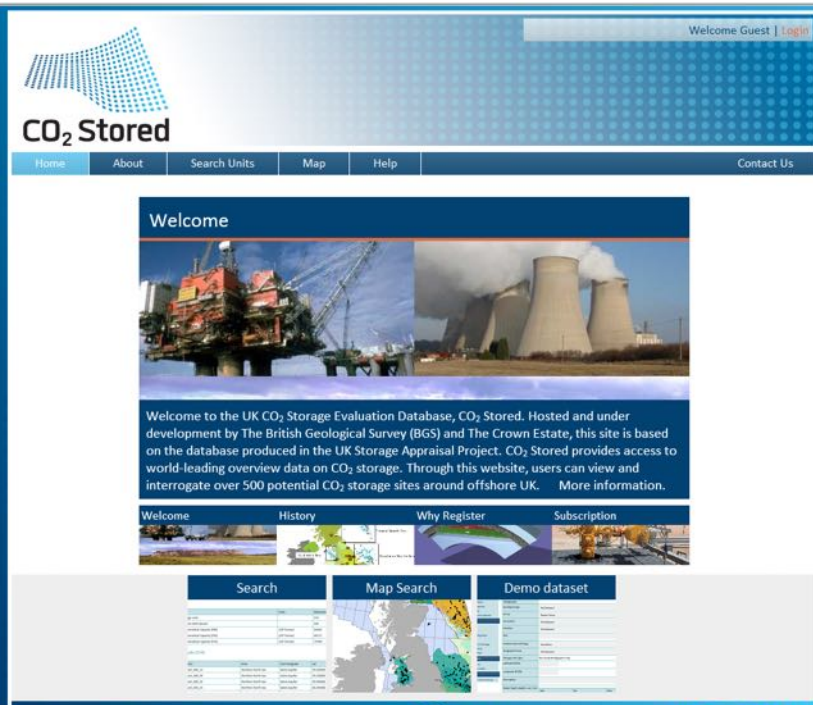
- Develop screening processes and criteria to be applied to the UK offshore storage resource
- Apply screening criteria to over 500 UK offshore storage sites (www.co2stored.co.uk)
- Establish the initial ranking and short list of sites for second and third phase storage projects
- This is an initial selection and storage sites are likely to change after further analysis.
- Tested the sites using four scenarios
- Desk top geological review of scenario storage sites

Criteria selection

- BGS expert workshop
- An initial 74 (mainly geological) criteria were listed with description and metrics
- 7 categories of criteria were identified
 - Capacity (22 criteria)
 - Containment (24 criteria)
 - Injectivity (17 criteria)
 - Cost (11 criteria)
 - Confidence in the data/results (6 criteria)
 - Conflicts with other users/resources (17 criteria)
 - Licensing (9 criteria)
- Some criteria relate to more than one category
- The criteria were grouped into three phases of 'application'

Criteria applied to CO₂ Stored

www.co2stored.co.uk



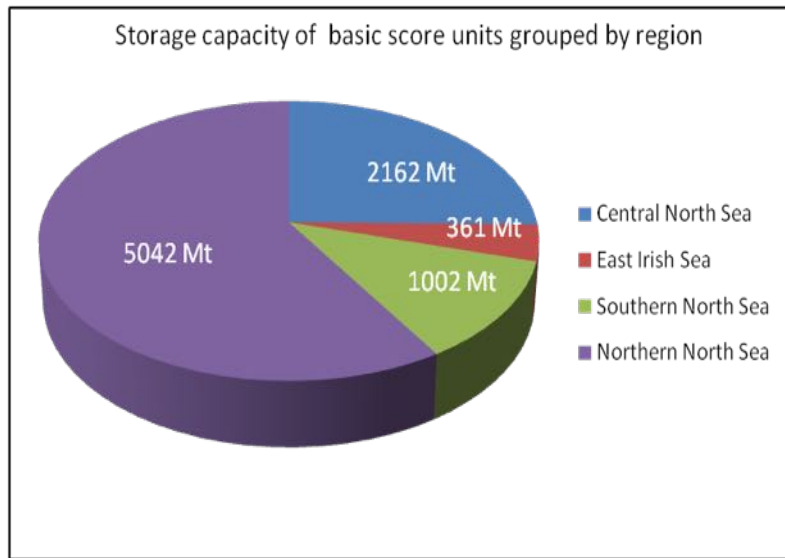
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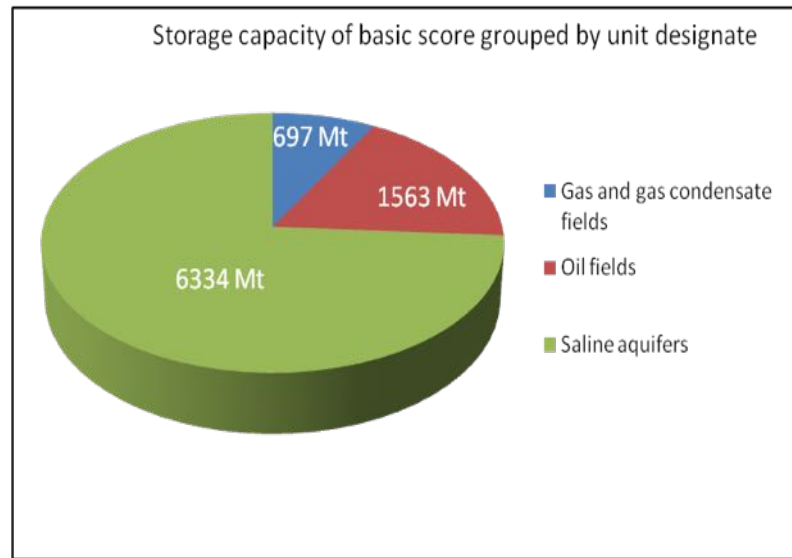


Capacity after application of criteria

Region

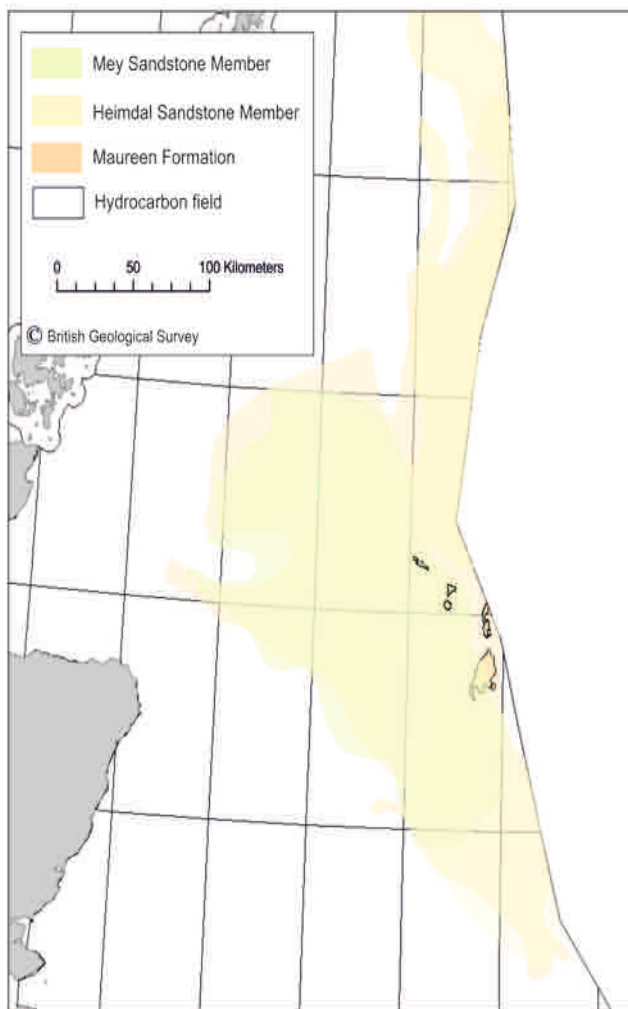
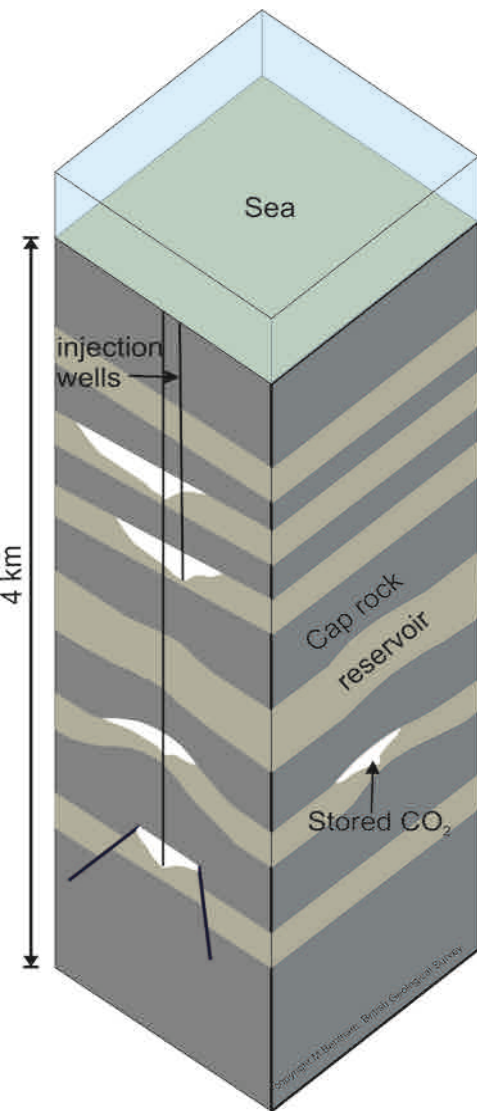


Unit 'type'



8567 Mt

Characteristics of UK storage - Stacked and co-located capacity



- Occurs in most of the UK storage regions
- e.g. Northern North Sea
- Units overlie
- In direct contact
- Dynamically/hydraulically connected (evidence from the oil industry)

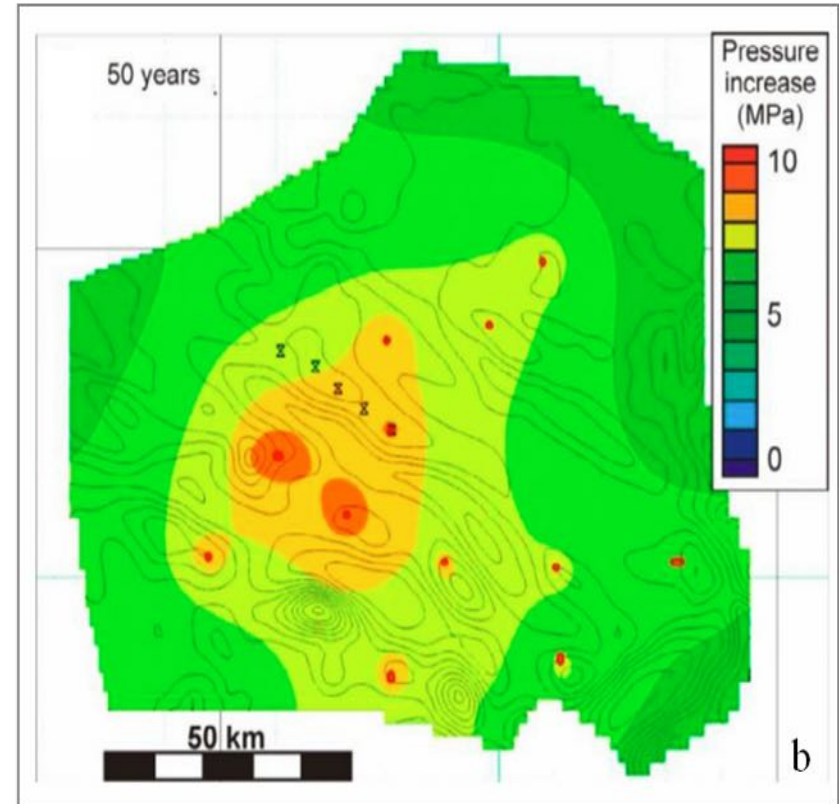
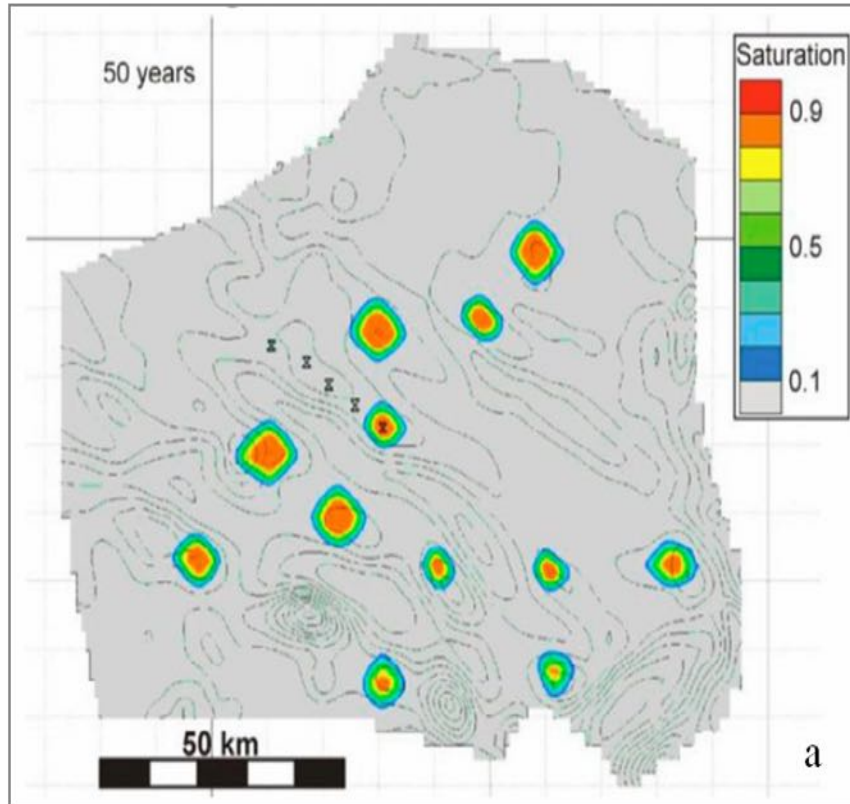
Stacked Capacity-

Multi site storage in the same region

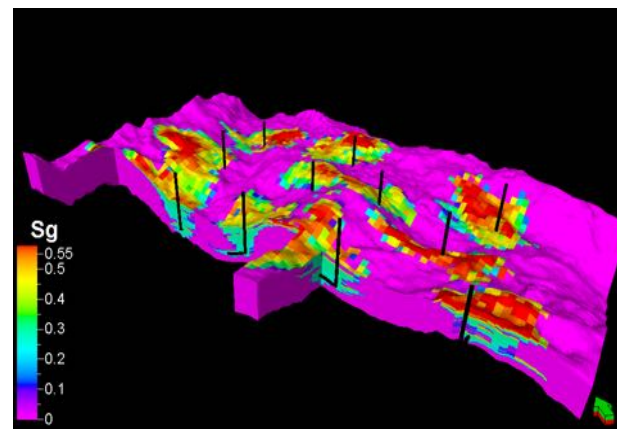
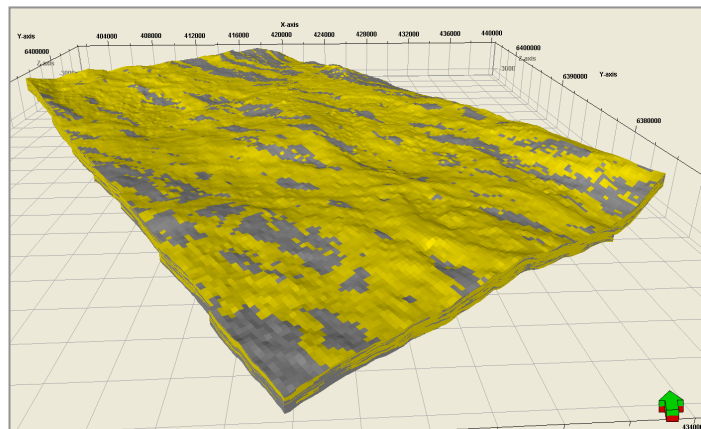
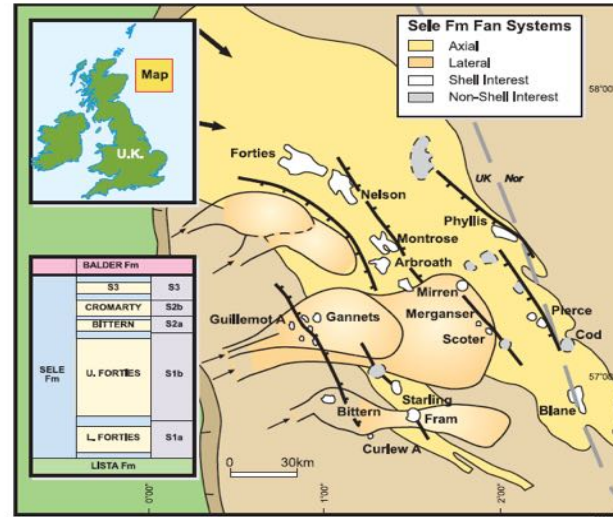
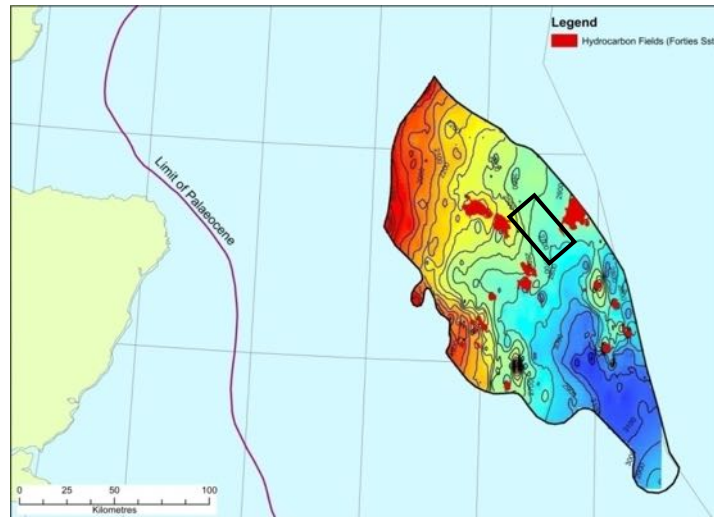
- Good for clustering – lots of storage in the same region
- Plan view of storage site may have overlapping storage complex boundaries
- Responses to CO₂ injection in one storage formation might be seen in connected storage formations
- May be more difficult to plan and manage

Multisite storage in the same formation

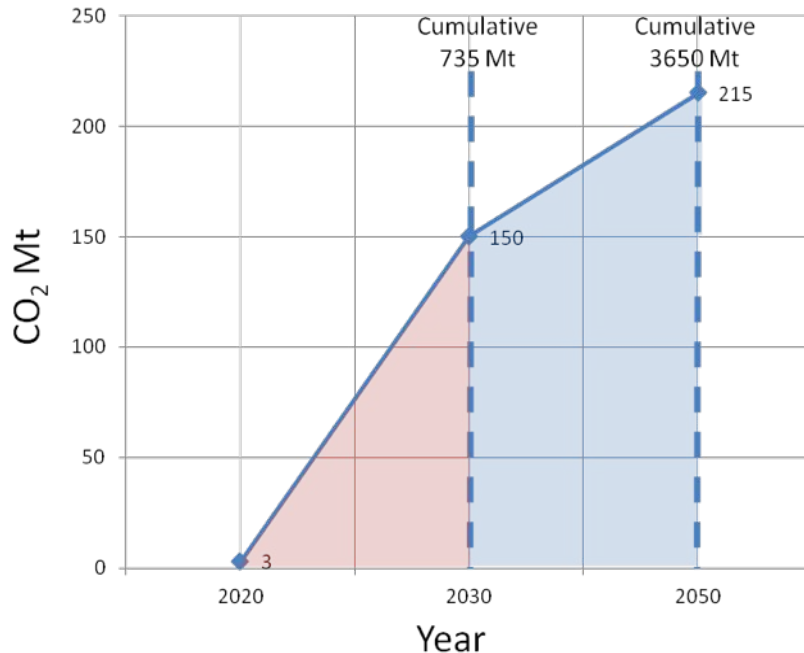
Bunter pressure response



Large storage units – Forties Sandstone



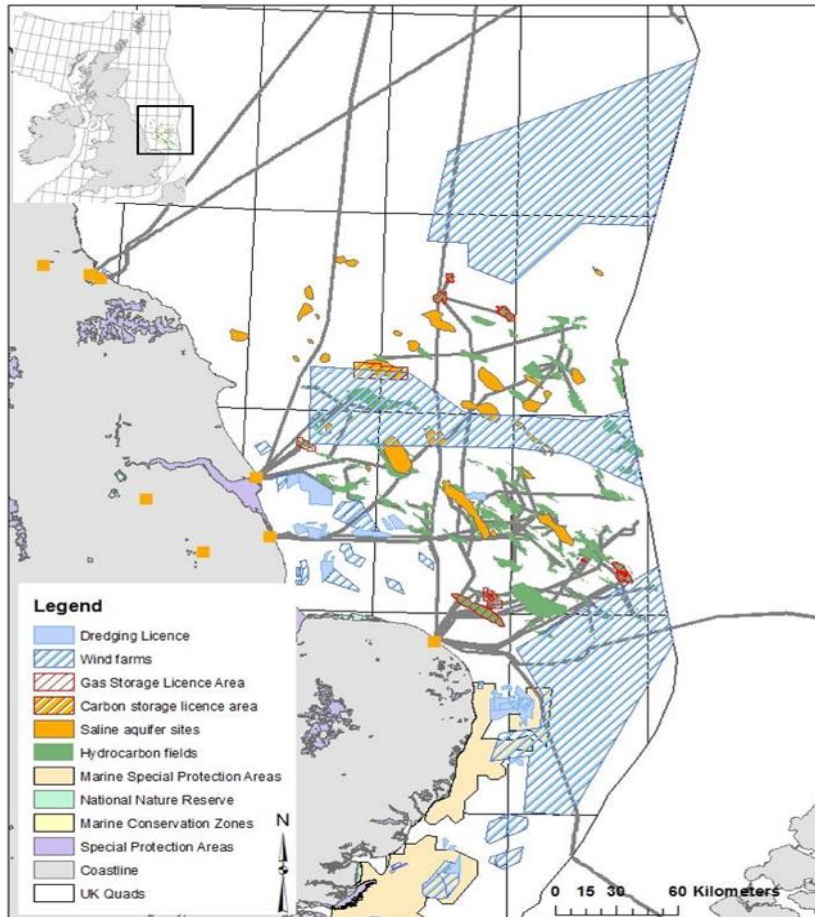
Scenarios



- We tested the storage potential using a range of scenarios
- Created a storage profile in 2030 and 2050
- Develop storage in 3 regions
 - Select geologically best sites
 - Step out from first projects
 - Develop clusters
 - Fewer larger sites

Region	CO ₂ emissions Mt in 2008	Percentage contribution	CO ₂ Stored per year by 2020 (Mt)	CO ₂ Stored from 2020 - 2030 (Mt)	CO ₂ Stored from 2030 to 2050 (Mt)
Northern	28	11	1	80	402
Eastern	172	69	1	507	2519
Western	51	20	1	147	730
Total	251	100	3	735	3650

Spatial planning

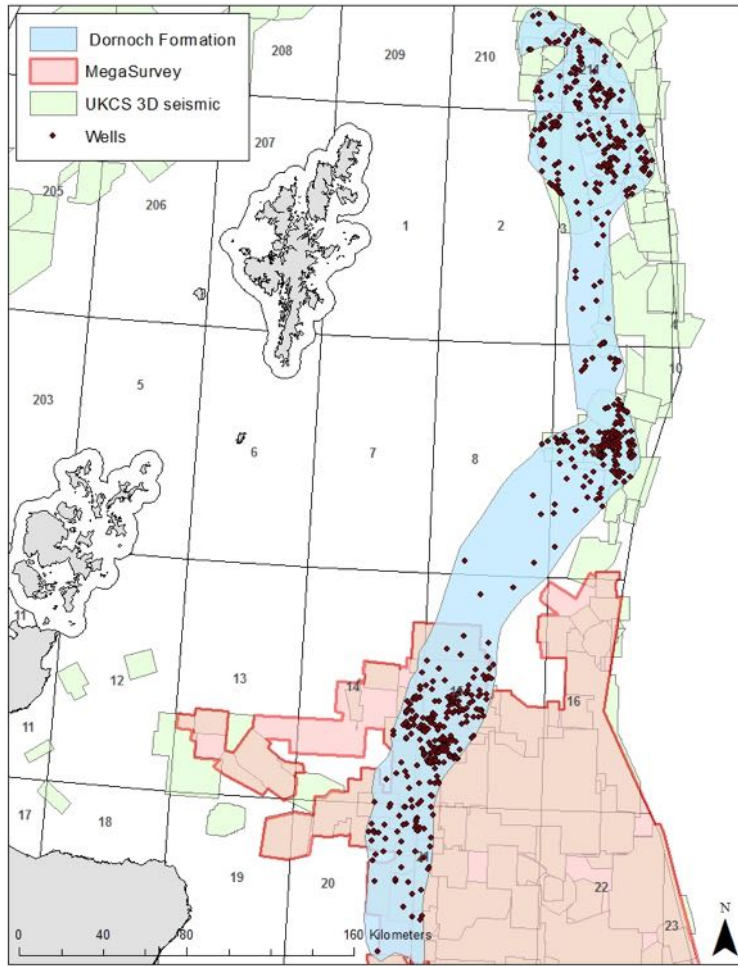


- multiple site storage need to consider subsurface and surface interactions
- This will require planning to:
 - Avoid negative interference with existing operations on the surface or subsurface
 - Optimise storage potential

Geological assessment

- High ranked storage
- Undertook geological assessment
 - Reservoir characteristics
 - Cap rock description
 - Risks
 - Available data
 - Additional information required
 - Expert opinion – is the storage option worth further investigation at this time?
- Did we then have enough storage to for fill the storage requirements of the scenarios?

Data availability



- variable from site to site
- depends on the type of storage site e.g. large open aquifer vs defined closure

Worth further investigation?	Comments	Data	Phase 1	Phase 2
No	Stacked reservoir with internal marries, isolated channel sequences. Far from UK CO ₂ sources	Good		X
Yes	Good capacity. Pressure of the unit, continuity of the caprock and potential barriers to flow should be investigated.	Good		X
Possibly	Good capacity. Continuity of reservoir and caprock may be an issue.	Poor - Fair		X
Yes	Good storage capacity. Too shallow in the western extent.	Fair		X
Possibly	Small storage capacity. Depth to the crest of the field is 822 m and hence PVT conditions should be investigated.	Good		X
Yes	Small capacity, already being considered for storage as part of the DECC commercialisation project.	Good		X
Yes	Good storage capacity. Close to onshore. Too shallow at the western extent.	Fair		X

Summary



- Offshore
- Plentiful
- It is finite
- There is a characterisation gap Theoretical to Matched capacity
 - This may slow down project development
- Could consider 'pre-characterisation' of storage sites
- Consider storage in the context of other surface and subsurface activities (medium to long term)
- Clustering may require 'less geologically suitable sites' to be used
- The process has identified high ranking site, these are still not 'assured' storage site, but could be used to focus further characterisation.

Thank you

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