Offshore Wind and CCUS Co-Location Forum - Myth-buster event presentation slides

13th June 2023

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Offshore Wind Slide Deck

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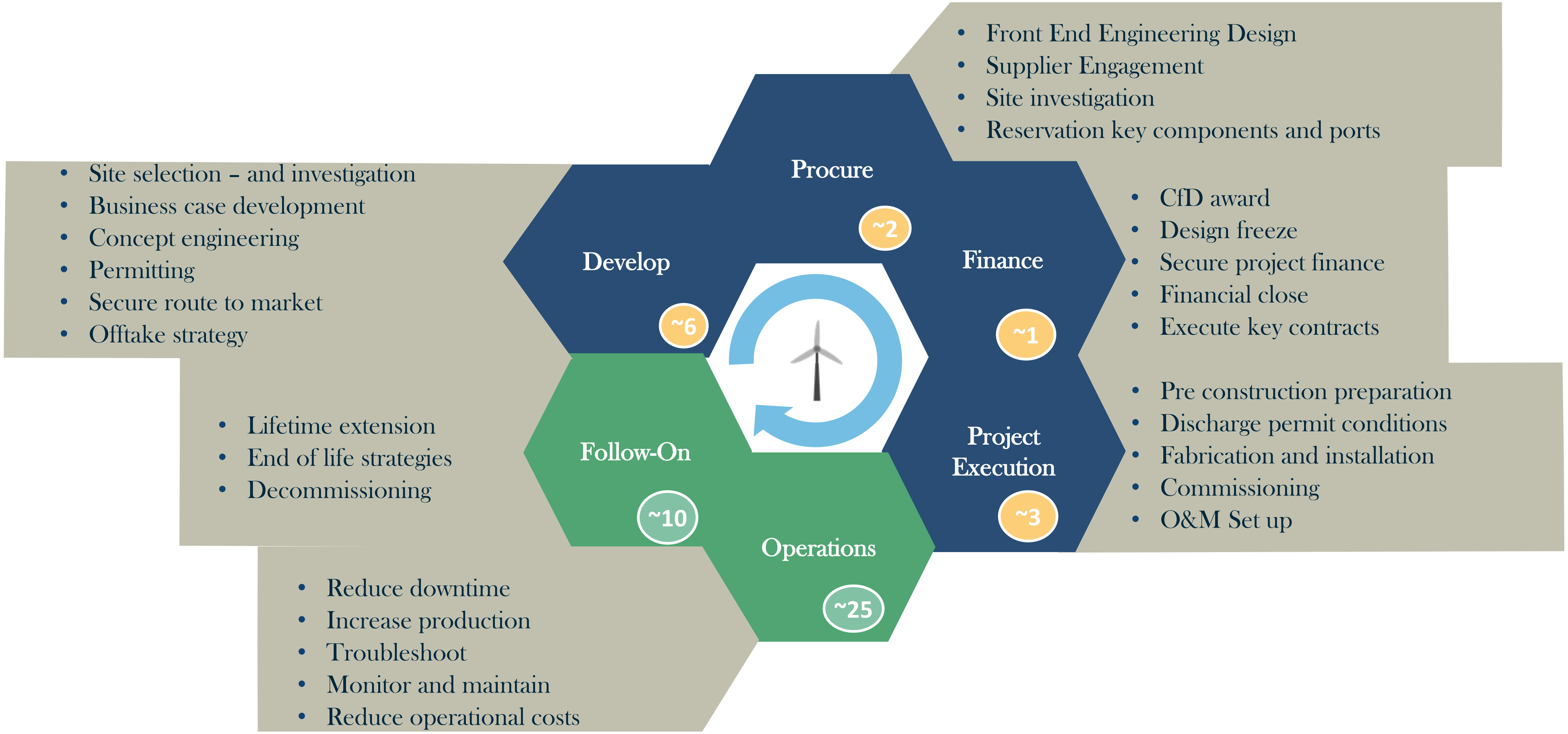
LIFECYCLE OF AN OFFSHORE WIND FARM & MYTHS

Developers will employ a varying strategies depending on pipeline and market sentiment



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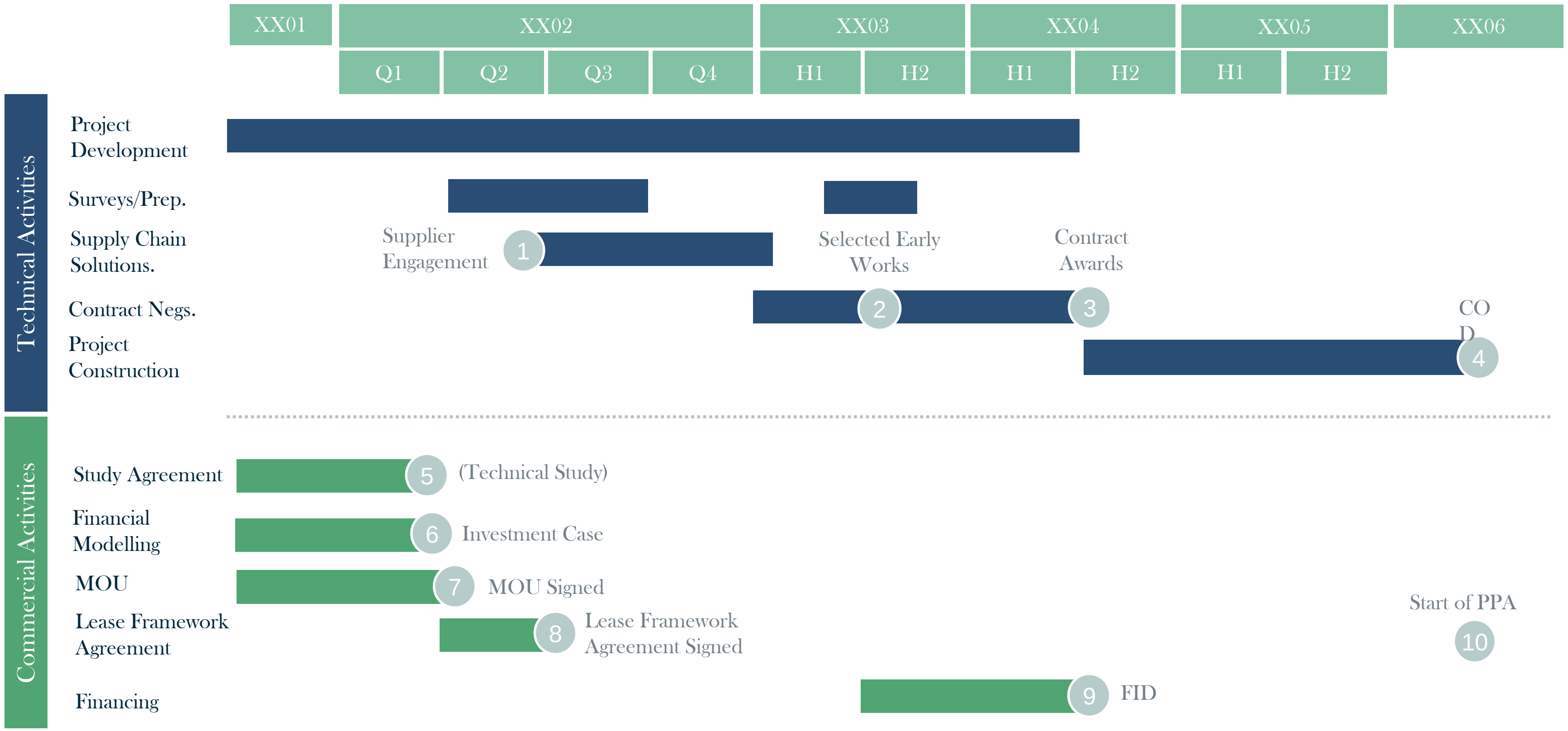

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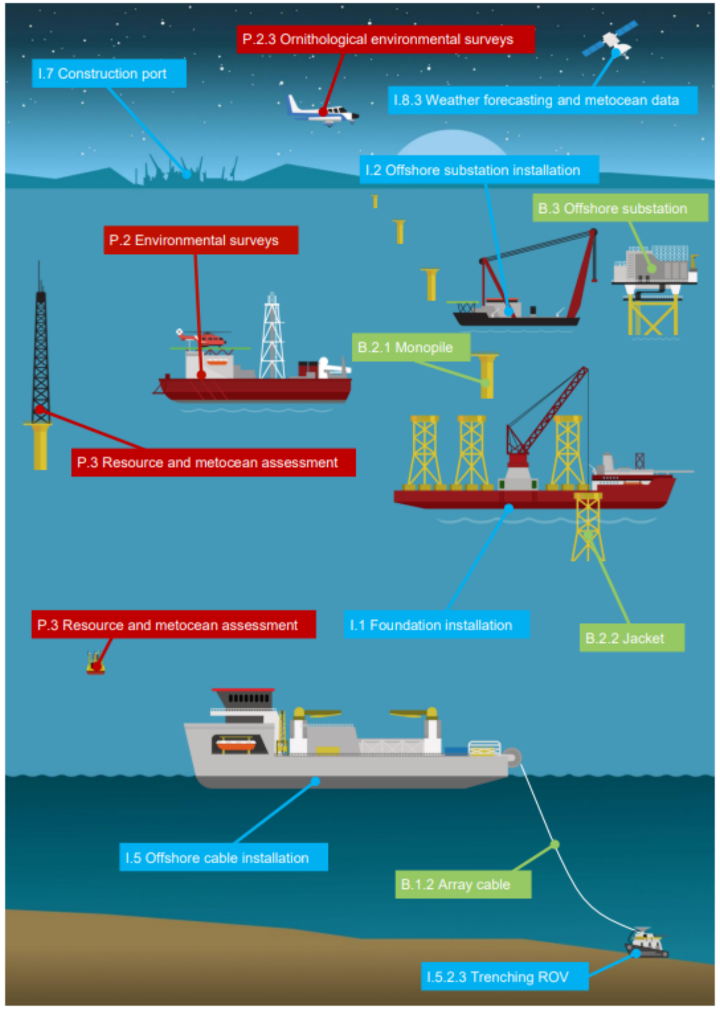
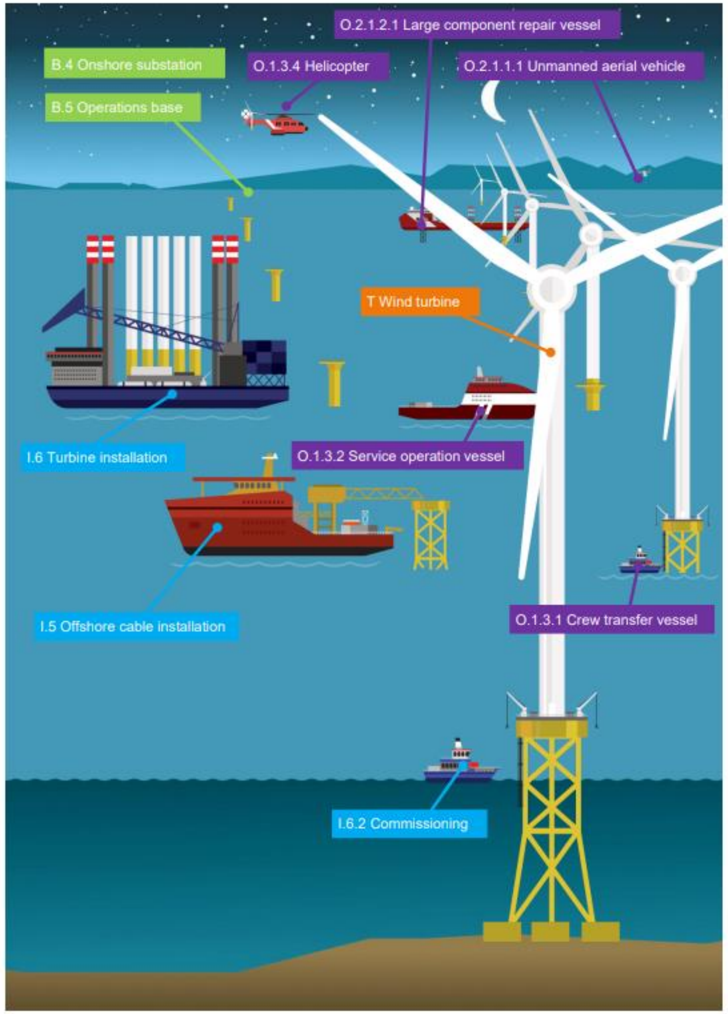
OFFSHORE WIND FARM ACTIVITIES MYTHS





Development

Construction

BoP

Operation

WTG

TCE – Guide to an offshore wind farm (2019)

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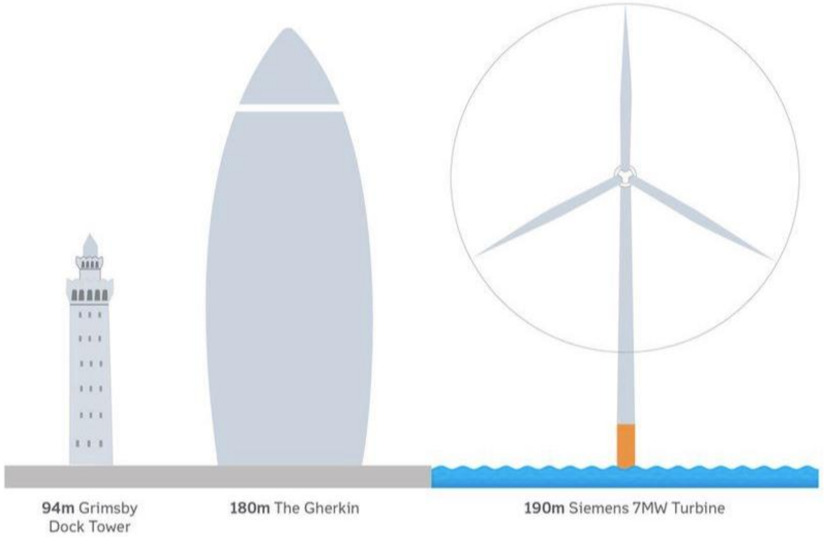
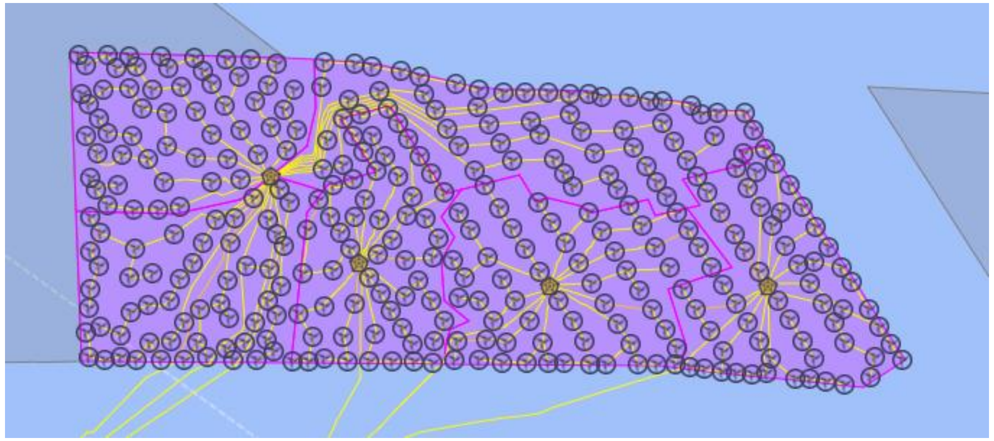
SPACING OF TURBINES & MYTHS

- TCE density requirements
- Production and wake effects
- Marine Safety
- LCoE
- Array cable voltages
- Seabed condition
- Other seabed users





COLLABORATION, COEXISTENCE & MYTHS

Useful Links

Offshore Wind

Guide to Floating Offshore Wind (2023)

A Guide to Offshore Wind Farms (2019)

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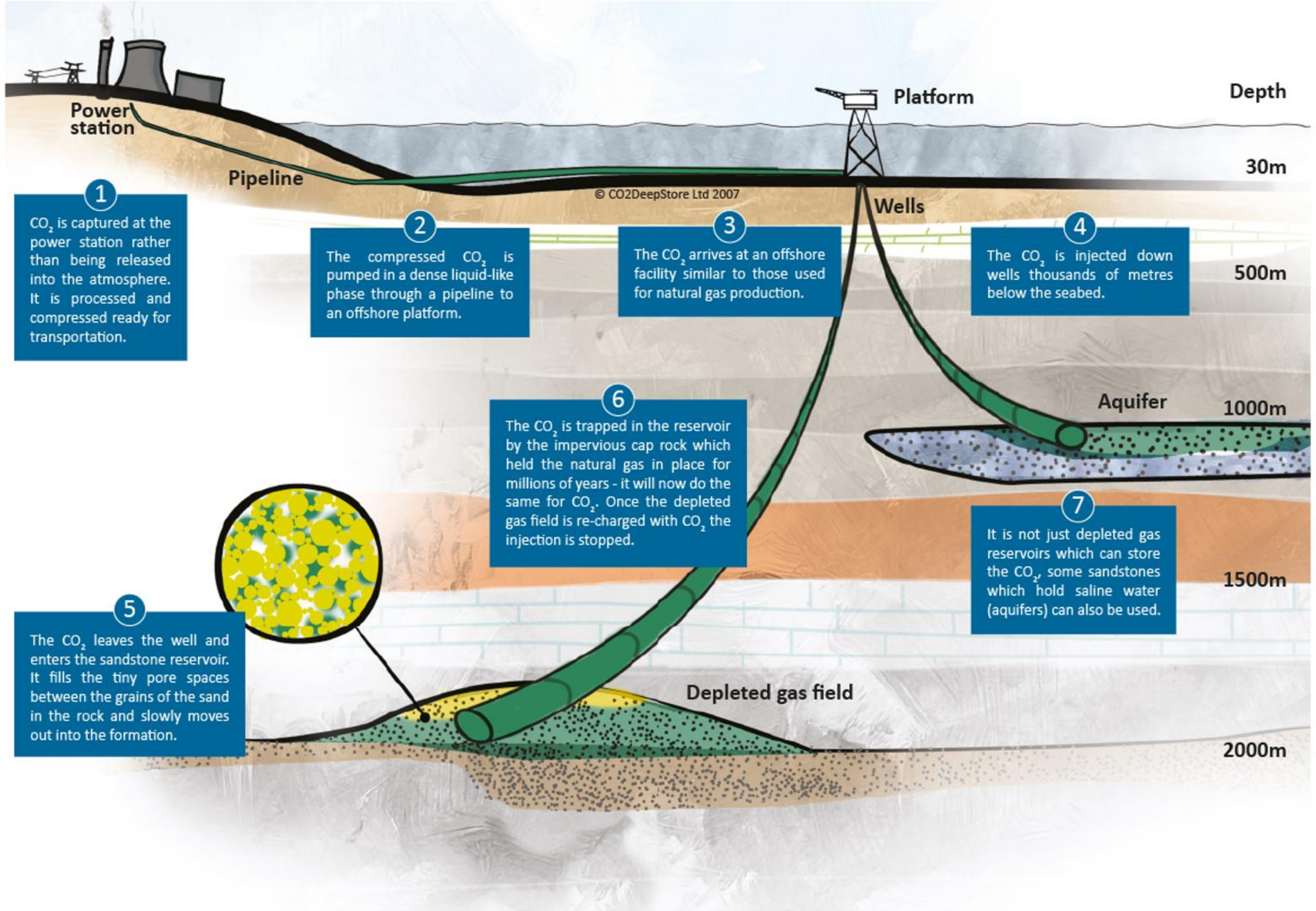
Basic CO_2 Storage Myth busting



- CO_2 is not stored in old oil and gas wells.
- CO_2 is not stored in underground caverns.
- Only 10% of UK depleted oil and gas fields are large enough for commercial scale CO_2 storage.
- The remaining 90% of storage potential is saline aquifers, which require a larger area.
- While every option for infrastructure reuse must be carefully evaluated, most platforms and wells are unsuitable for CO_2 storage operations.
- Heavily depleted gas fields in the SNS and EIS often require gas phase injection which requires much larger pipelines.
- CCS in the UK is not about power generation, although it can support it.
- While UKCS storage resource potential is evaluated to be 78GT, probably less than 25% is likely to be developable at “commercial” scale.
- CO_2 is typically stored at a depth of around 1-2km.

Primary CO2 Storage and offshore wind interactions

Regulatory assurance demands monitoring of injected CO2 inventory at regular intervals post-injection

Leasing fees driven by business model maturity drive policy

Access to all areas required for potential remediation work – especially around high- risk old wells

Impact of injection induced seabed deformation on fixed turbines

Most significant offshore installations seek to deploy in summer months

Potential for shared power and data telemetry

What would a fully co-located development look like?

Potential for shared seabed and environmental surveys

Potential to use CO2 monitoring technology to support infrastructure security

One Sector precluded

Operational inconvenience Cost escalation

Operational Synergy Cost reduction

Both Sectors Enhanced

Negative Interaction

Positive Interaction

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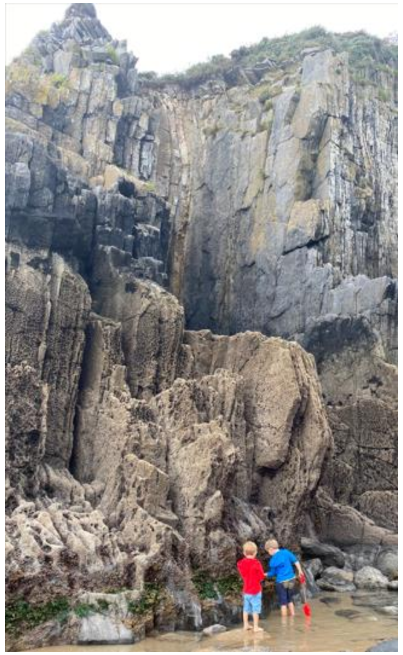
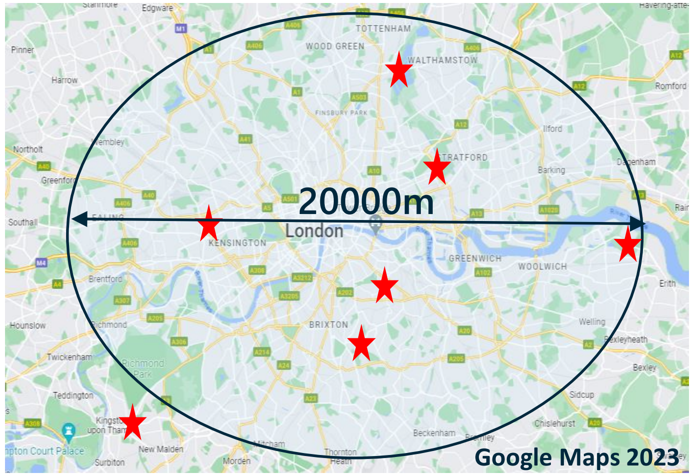
Key Differences between OW and CCUS

1. **Business maturity**
    - UK government has still not finalized commercial models to operate CCUS in the UK.
2. **Commerciality**
    - CCUS will rely on government subsidy to take off and build commercial scale.
3. **Uncertainty**
    - The development of saline aquifers carries irreducible risk and uncertainty, which can only be reduced with data from the dynamic system during injection. The speed and direction of the CO_2 migration within the store is impossible to predict without uncertainty before injection starts.
    - The total volume that can be stored in each area also carries an uncertainty range that can only be lowered with dynamic data.
    - There are not many global analogues or benchmarks to learn from yet.

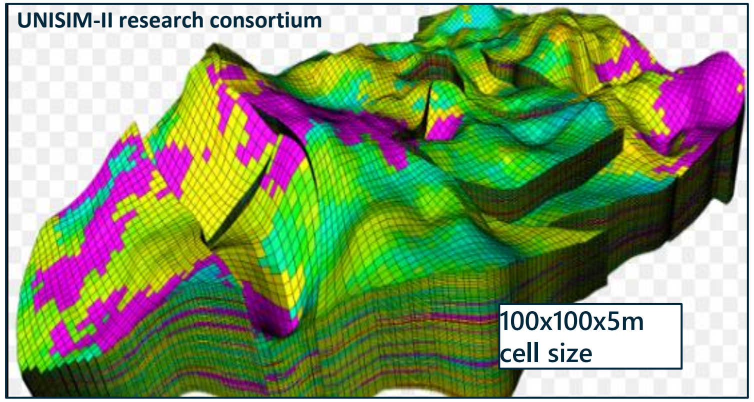
Subsurface Uncertainty



- Real rock = heterogeneities on the mm, cm, metre and km scale
- This is the scale that the CO_2 responds to in the store
- But the store is buried 1-2km beneath the seabed.

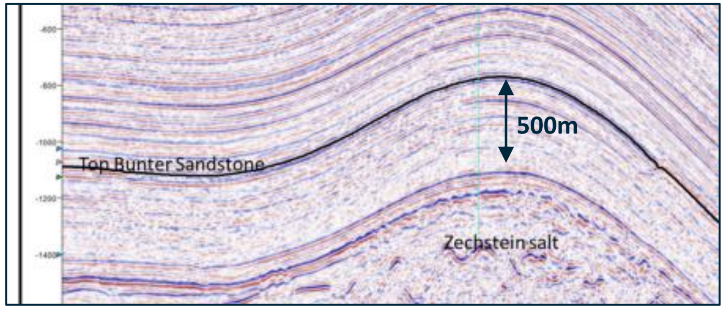


Scale of saline aquifer with limited wells to calibrate model



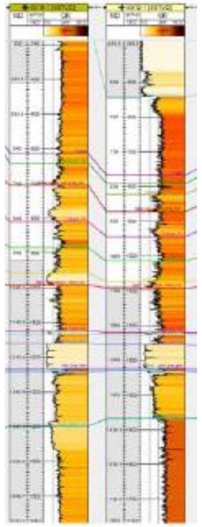
3D reservoir model of the store

- **Because we cannot 'see' the store, many types are data are integrated to build a model.**
- **This is the workflow used in oil and gas industry for many years around the world**

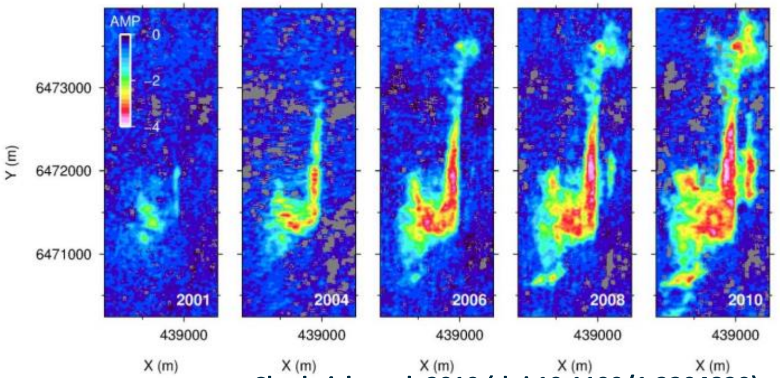


NS051-SS-REP-000-00013 NEP Key Knowledge Document

3D seismic data for structure and some understanding of the store



Gibson-Poole, C. Et al, 2023



Chadwick et al, 2010 (doi 10.1190/1.3304820)

Monitoring data as the store gradually fills with CO_2

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Overall Timeline

Seabed access requirements will be often: habitat and environment surveys, pipeline routing surveys, shallow hazard assessments, new 3D seismic surveys and appraisal well drilling may all be required and often have restricted access due to weather/environmental concerns

Seabed access requirements will be often if new subsea equipment and pipelines need to be installed, plus drilling and hook up of injector wells. Additional baseline data may also be required

Seabed access requirements will reduce but well workovers may be required once per year and monitoring of the site must begin

Years	1	2	3	4	5	6	7	8	9	10	

Pre- appraisal studies, writing license application, waiting for NSTA decision

Appraisal data collection (e.g. seismic, wells, core, fluid samples), baseline data (environmental and subsurface), risk assessment, uncertainty analysis, store permit application

Construction and commissioning of onshore and offshore facilities, drilling injectors

Injection starts

Licenses awarded in the first UK carbon storage round are not likely to progress to CO_2 injection until 2030 or later

Seismic Surveying

Towed Streamer		Ocean Bottom Node	
Pros	Cons	Pros	Cons
Lower cost (~£5M)	Large open water area for streamers	Vessel for seismic source is small	Expensive (~£20M)
Good shallow coverage	Large turning circles outside of AOI	Less access restrictions	In shallow water, top ~500m is not imaged
			More shots (noise)

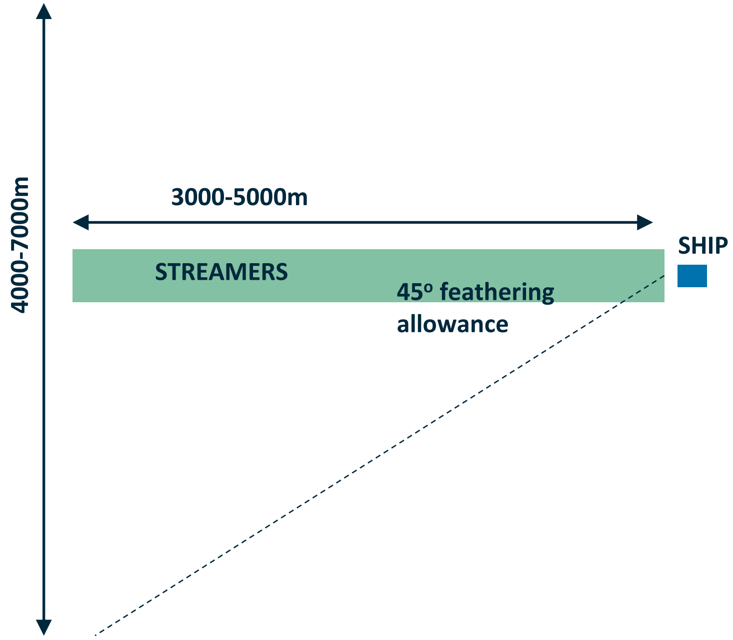
Ramform Vanguard - (File Photo: PGS)

Ocean bottom nodes are much more compatible with OW but:

1. Who pays the £15M difference in cost (per survey) – need a realistic solution
2. Can regulations allow the lack of shallow overburden imaging? – pragmatic solution

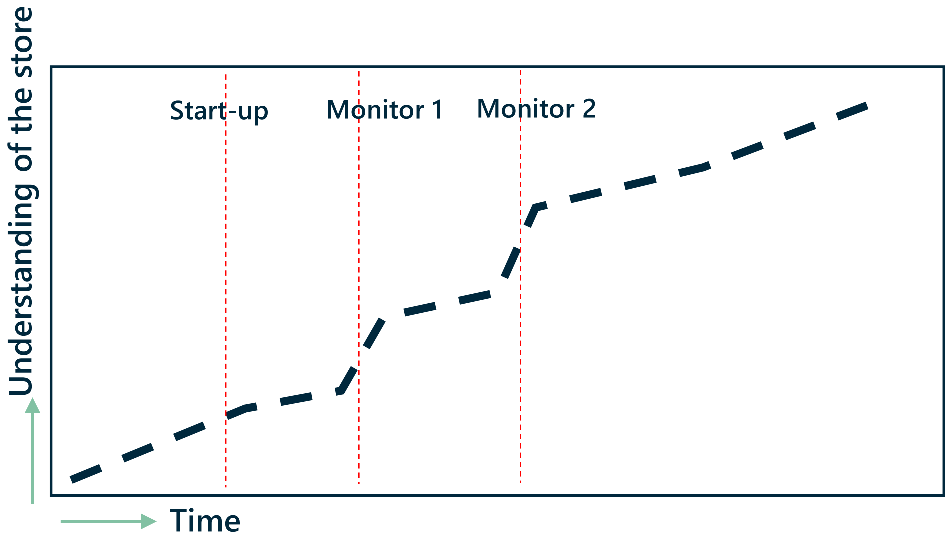
Feathering of streamers – to avoid hazards

No practical turbine spacing would allow for towed streamer seismic



Possible ways for co-existence

1. Timing
   - Acknowledge the overlap before either OW or CCUS are leased/licensed
   - Allow for extended timelines if necessary, without penalty
   - Consider a staged approach if the overlap is significant (e.g. develop first phase of CCUS, monitor, then develop OW later when uncertainty on CCUS has been reduced)
2. Financial compensation + some allowance for access
   - If extra spending/reduced capacity is required to enable co-existance, have a clear financial mechanism outlined to pay for this so individual companies do not directly incur these costs
   - Consider financial incentives to encourage compromise- for CCUS to have some constraint on seabed access and/or OW to leave some areas with greater access (e.g. within CfD/RAB models)



As the store is developed and more dynamic data is acquired the uncertainty reduces and this can allow for co-location with minimal monitoring if OW starts mid-way into store development

Useful Links

CCUS

CCS Explained: Storage - Global CCS Institute

Explore CCUS – CCSA Association

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