



Characterisation of European CO₂ storage



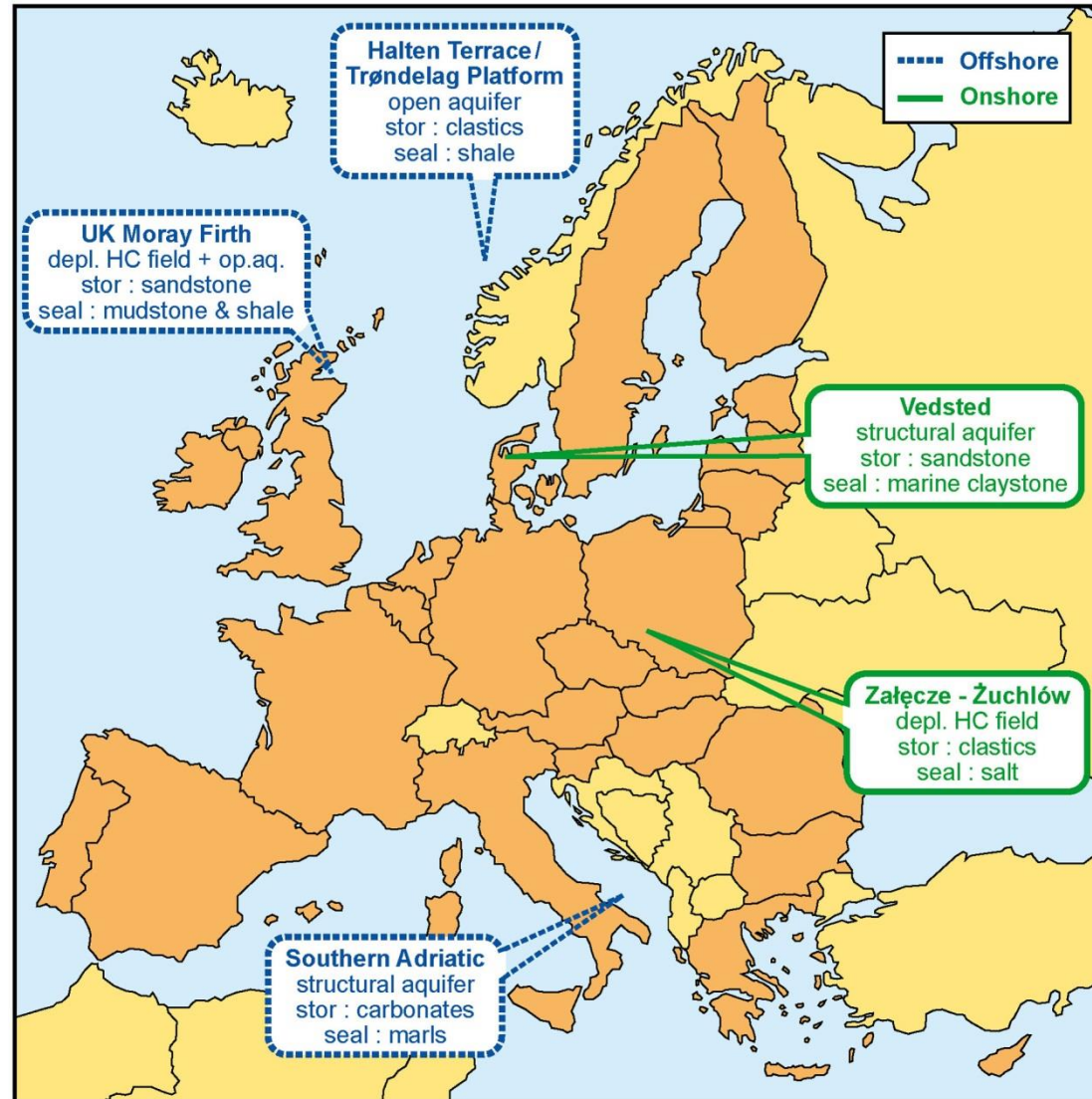
The aim of *SiteChar*

Provide the key steps required to make on-time effective large-scale implementation of CO₂ storage in Europe

- *Demonstrate the level of geological characterisation and the assessment of long-term storage complex behaviour in accordance with the regulatory requirements (EU Directive)*
- *Develop a methodology for the preparation of storage permit applications, accounting for all the technical and economic data, as well as the social dimension*
- *Raise public awareness and enable informed opinion formation*

The *SiteChar* sites portfolio

- Representative EU sites where CCS is most likely to develop in the near term
- Allowing to test and improve the *SiteChar* methodology for site characterisation in different geological contexts



Two sites to perform a full-chain characterisation suitable for a storage permit application



■ The North Sea Outer Moray Firth site, UK

■ A multi-store site, comprising

- A hydrocarbon field: near-term storage capability
- The host saline aquifer sandstone: greater storage potential, later in the storage cycle

- ➔ *Submission of a 'dry-run' permit to the Scottish Government*
- ➔ *Relationship between a producing hydrocarbon field and the host saline aquifer*



■ The Vedsted site, Denmark

■ An onshore saline aquifer

- Processed by Vattenfall till late 2011 to be an industrial scale CCS demo project
- ➔ *Different ways to supplement sparse data*
- ➔ *Impact on the surrounding region*
- ➔ *A monitoring plan ensuring the best risk management*



Three sites to overcome specific barriers related to the site characterisation methodology



■ The Załęcze-Zuchlów site, Poland

■ An onshore gas reservoir

→ *Application of the workflow from the first stages*

→ *Geomechanical and geochemical behaviour of reservoir and caprock during CO₂ injection*

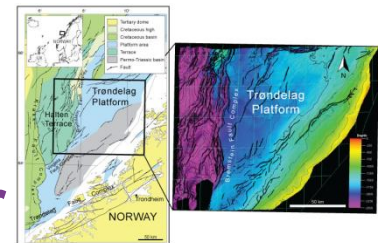


■ The Trøndelag Platform, Mid Norway

■ An offshore multi-compartment saline aquifer

→ *Basin to individual compartment scale evaluation of storage capacity and injection strategy*

→ *Monitoring and remediation strategies*

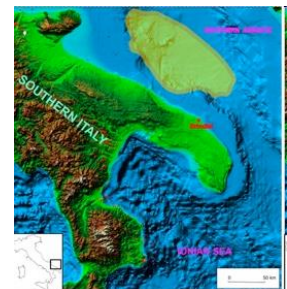


■ The South Adriatic site, Italy

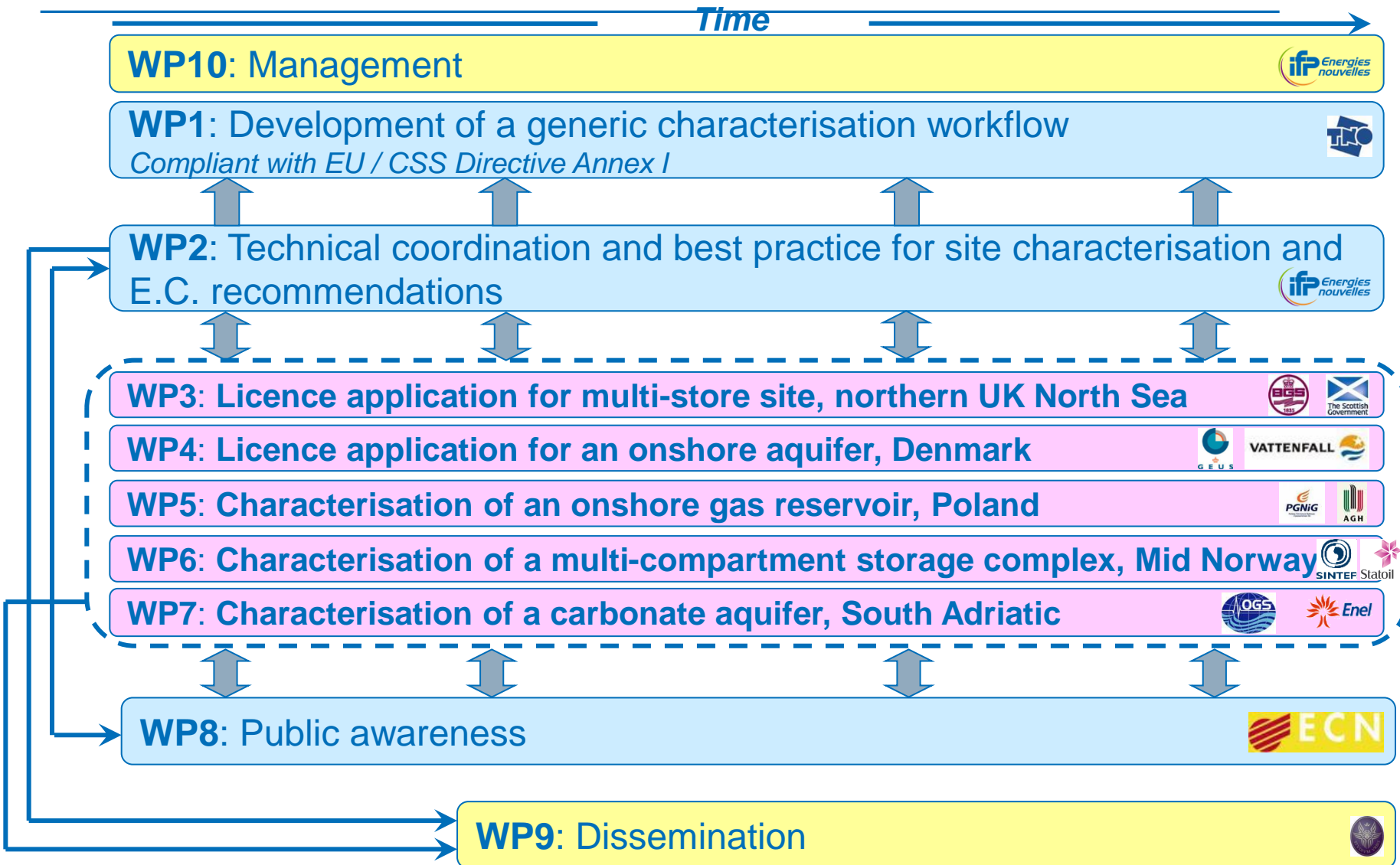
■ A structural trap in an offshore saline aquifer

→ *Characterisation of carbonate formations*

→ *Geomechanical and dynamic behaviour of the complex storage*

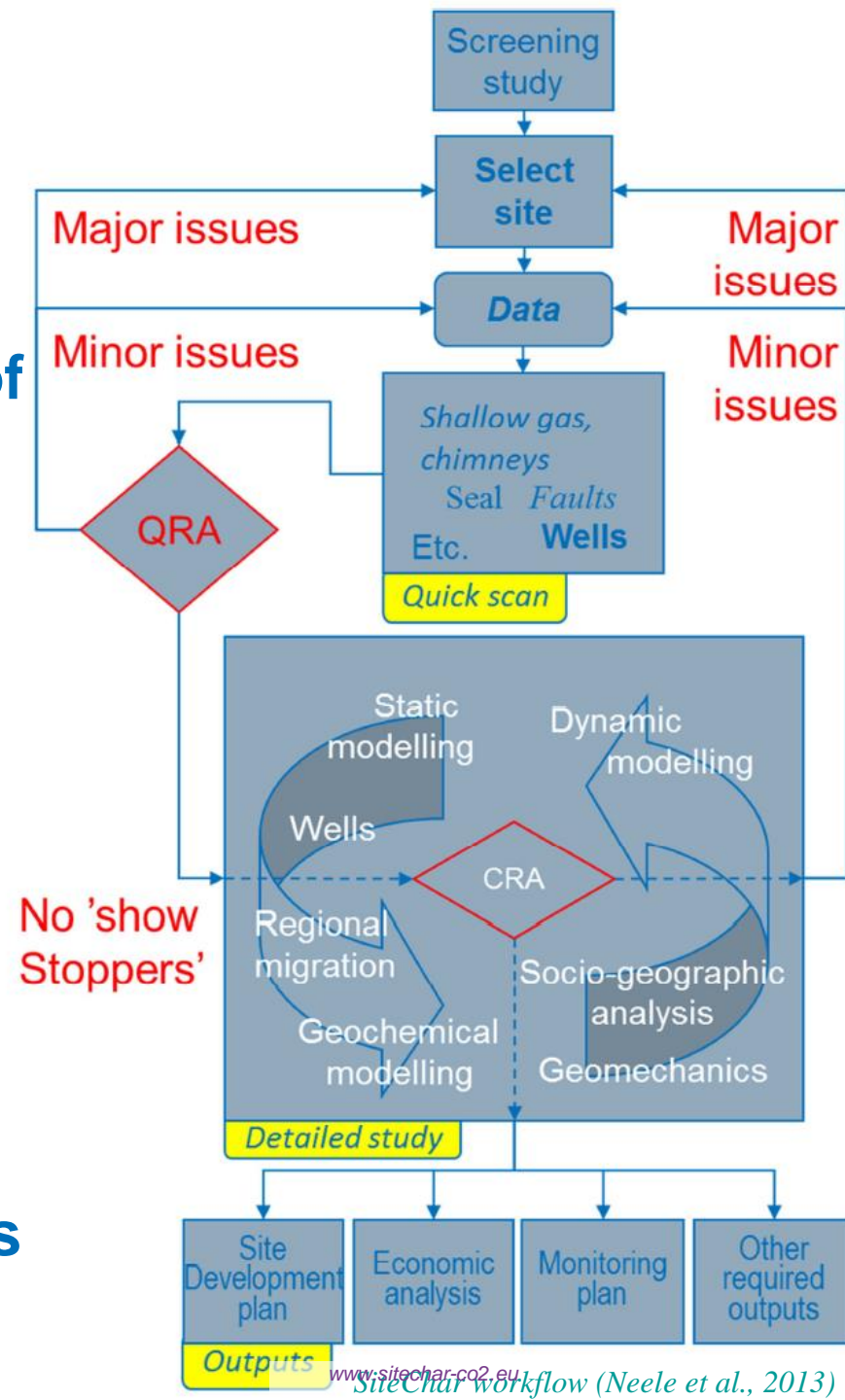


The SiteChar project



The *SiteChar* workflow

- Demonstrate understanding of the site for a CO₂ storage permit
- Convince Competent Authority that
 - Permit applicant has sufficient understanding of the site
 - Proposed site operation will securely contain CO₂
- Comply with regulatory issues



The SiteChar workflow

■ Site-specific

■ Risk-based aiming at

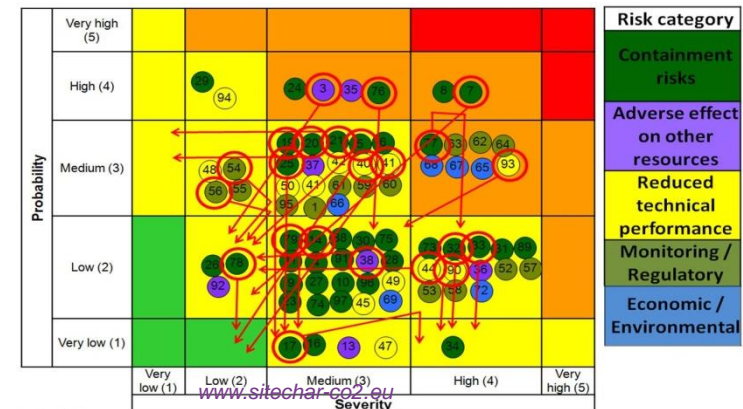
- Anticipate risks
- Reduce risks
- Mitigate risks
- Monitor unmitigated risks

■ Fit-for-purpose characterisation research

- Determine what site characterisation activities are needed
- Ensure resources, time and effort are focused

Containment risks	Leakage of injected CO ₂ (28)
	Loss of injected CO ₂ to biosphere (3)
	Displacement +/- alteration of brines (7)
Adverse effect on other resources	Hydrocarbon fields (4)
	Others (2)
Reduced technical performance	Reduced injectivity (10)
	Reduced capacity (4)
Monitoring / Regulatory issues	Monitoring issues (10)
	Opposition (2)
Economic / environmental	Storage costs (5)
	Socio-Economic (3)
	Environmental (1)

SiteChar - Hannis et al., 2013



The *SiteChar* 'dry-run' permit applications

Outer Moray Firth

- Offshore
- Identified from previous regional reviews of UK northern North Sea storage targets
- 'Theoretical' study
 - Low risk – try different permitting scenarios
 - No acquisition of new data
 - Range of injection scenarios
- Risks addressed in *SiteChar*
 - Definition of storage complex
 - Caprock integrity
 - Potential for seismic monitoring

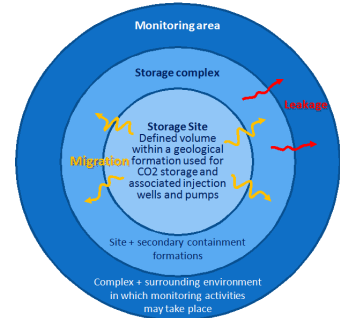
Vedsted

- Onshore
- Previously applied for permit prior to Directive to promote dialogue with Regulators
- Real project, now stopped
 - Application fits predefined concept & original permit appl.
 - Baseline monitoring data acquired
- Risks addressed in *SiteChar*
 - Oil well integrity and abandonment status
 - Regional pressure responses and management

Evaluated by a group of independent geological experts and regulators

Some challenging issues

- **Definition of the storage complex**
 - Interplay between plume migration, pressure response and management, and necessary monitoring
- **Assessing interaction with other users**
 - A key consideration for regulators but challenging for operators
 - Need for guidance from the Competent Authority
- **Pressure management and water disposal**
 - Volumes of produced water to be estimated
 - Disposal of produced water much more challenging onshore
- **Need for common understanding between developer and regulator of the site opportunities and risks**
 - Level of appropriate site characterisation necessary to secure storage permits
 - Range of metrics against which site performance can be measured





The *SiteChar* techno-economic analysis

→ Address the storage part on the full-life time of the storage

→ No meaningful average cost for CO₂ storage

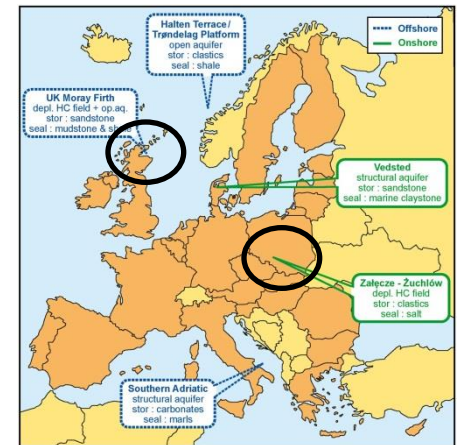
- Very heterogeneous structure of costs
- Site/Project dependent
- Choice of economic parameters

The *SiteChar* public engagement activities

- **Social site characterisation & advancing public awareness**
 - Raising public awareness and enabling informed opinion formation
 - Making available and comprehensive site-specific information

On two sites

- The *offshore* Scottish site
- The *onshore* Polish site



The *SiteChar* benefits

Technical recommendations for storage site characterisation and best practice guidance for storage permitting from the perspective of both applicant and regulator

For further use by storage site operators and regulatory bodies

Deliverables and deliverables summaries available at:

www.sitechar-co2.eu