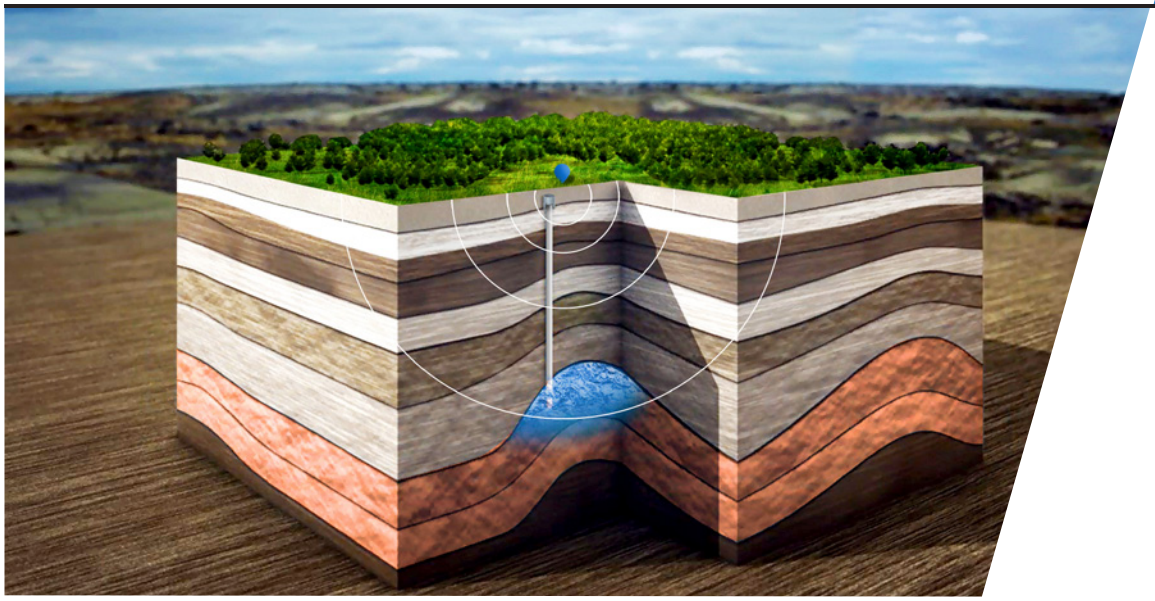
CO_2 SITE CLOSURE ASSESSMENT RESEARCH

CO_2CARE



The EU project CO_2CARE...

CO_2CARE aims to support the large-scale demonstration of the CO_2 Capture and Storage (CCS) technology by addressing the research requirements of a specific part of the chain: **CO_2 storage site abandonment and transfer of responsibility.**

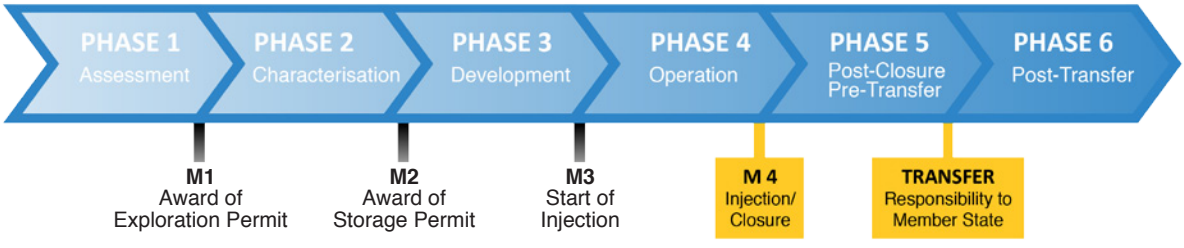
To guarantee the safe and long-term storage of CO_2, three main requirements- or 'high-level' criteria, must be demonstrated*:

High level criteria

- **Observed behaviour of the injected CO_2 conforms to the modelled behaviour**
- **No detectable leakage**
- **Storage site is evolving towards a situation of long-term stability**

CO_2CARE has an important role to play: identify and deliver technologies and procedures to guarantee that these criteria can be met, thus ensuring the post-closure safety and long-term stability of storage sites.

CO_2CARE within a bigger picture…
CO_2 Storage Life Cycle, broken down into Phases and Milestones*.
CO_2CARE's scope covers the end of phase 4, phases 5 and 6.



Ultimately, CO_2CARE will formulate robust procedures for site abandonment that will ensure long-term integrity of the storage complex.

** Source: EC Guidance Document 3 "Implementation of Directive 2009/31/EC on the Geological Storage of Carbon Dioxide"*

CO_2CARE is grateful for the funding from the European Commission under the FP7 and from its industrial partners RWE, Statoil, Shell, Total, Vattenfall, and Veolia Environment.

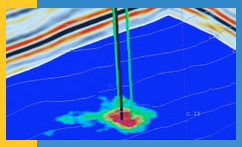
Well abandonment

Aim - Elaboration of procedures for safe well abandonment

- Laboratory experiments and numerical modelling studies to evaluate post-injection and long-term processes at wellbore
- Monitoring techniques for abandoned wells
- Field case studies on well abandonment
- Laboratory wellbore test rig designed and constructed to investigate the behaviour of rock-cement-casing interfaces subjected to CO_2 — brine fluxes under simulated downhole conditions. Long-term experiments will continue until completion of the project

Reservoir

Aim - Post-closure to long-term management



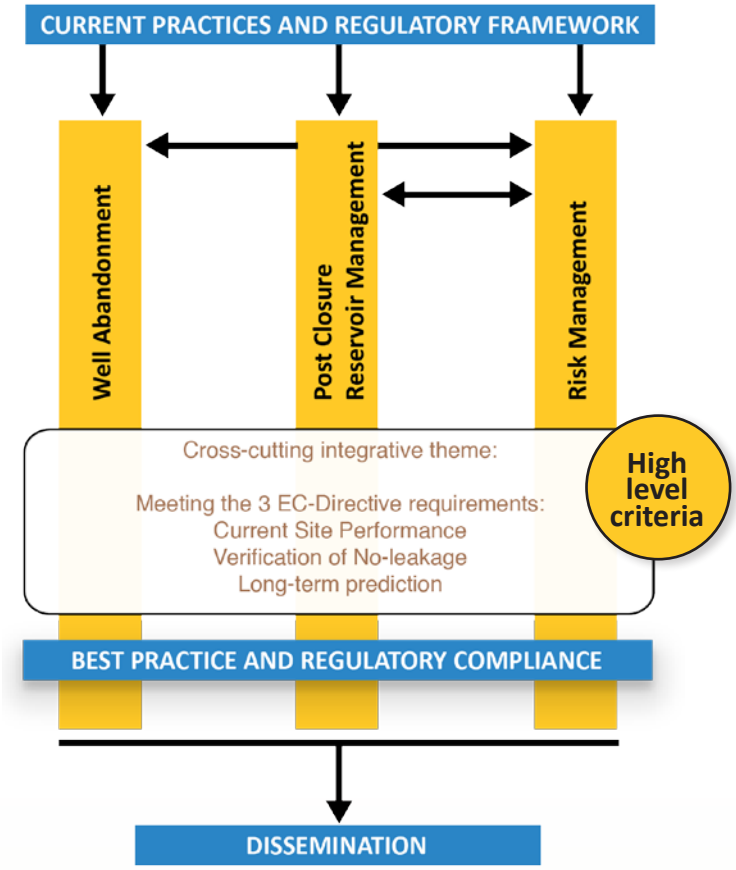
- Understanding issues crucial to long-term storage integrity
- Study of conformity between monitored and simulated site behaviour (short and long term)
- Development and implementation of monitoring and remediation techniques

Risk management

Aim - Assessment and mitigation of the risks related to CO_2 storage

- Procedures and criteria for site abandonment
- Methods and tools for long-term safety
- Decision-aid tools for transfer of responsibility (traffic light system)

The objectives of CO_2CARE will be achieved through six interrelated work packages concentrating on key topics



CURRENT PRACTICES AND REGULATORY FRAMEWORK

Aim - Provide a review of international practices and regulations

- Report on International Regulatory Requirements on CO_2 Geological Storage and Site Abandonment, focussing on phases 5 + 6 after the end of CO_2 injection.
- Current Site Abandonment Methodologies in Relevant Industries: an overview of current practices in relevant industries (mainly oil & gas).

BEST PRACTICE AND REGULATORY COMPLIANCE

Aim - Distill the results from the research work packages, to test the guidelines for regulatory compliance and to develop Best Practice guidelines (BPG) for site abandonment

Starting in August 2012

BPG will be established and disseminated to key stakeholders (operators/regulators/NGOs) via workshops and the website.
A series of 'dry run' applications will be developed for site closure and abandonment, based on a range of existing storage and injection sites with different geological and geographical (surface) conditions.

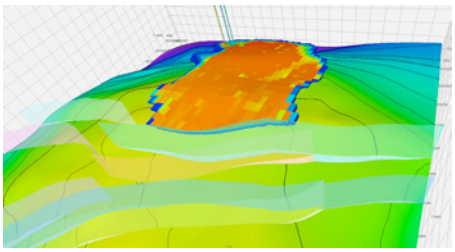
DISSEMINATION

Aim - Dissemination of results to stakeholders and the public

- Target groups: Scientific and technical communities; administrative and political leaders; general public.
- Tools: Web portal with public & member areas; scientific conferences & workshops; project brochures; media interaction (TV, radio, newspaper); actions at the Ketzin pilot site information centre (Germany).

Highlights of results from the CO_2CARE teams so far…

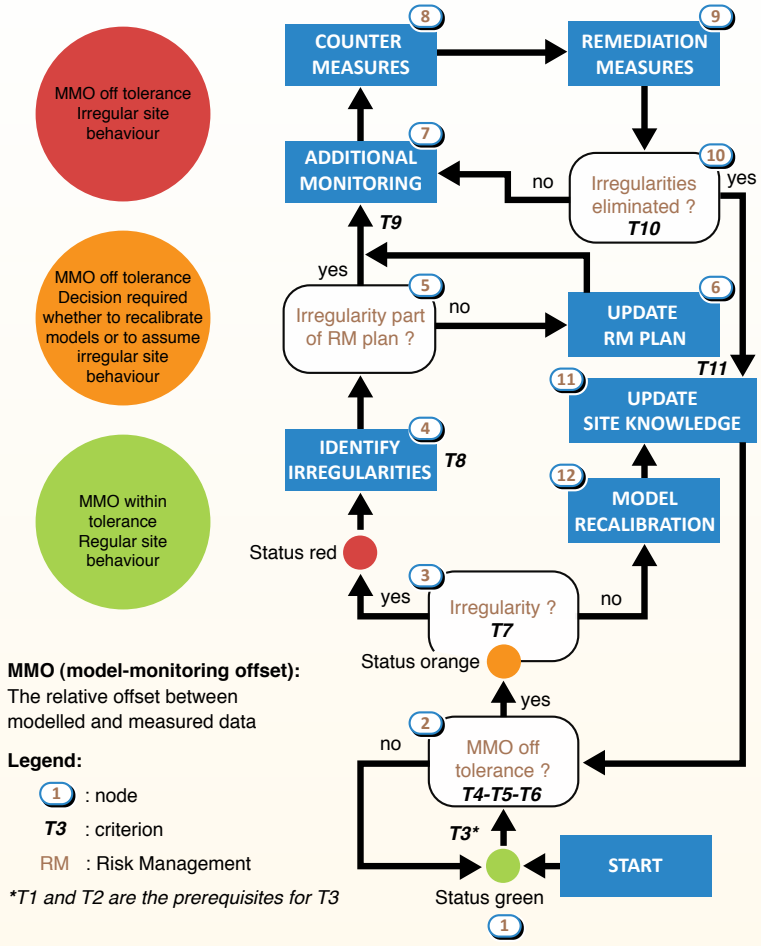
- Enhanced understanding of well abandonment
- More efficient reservoir management
- Assessment of seismic monitoring for Sleipner and Ketzin
- Assessment of modelled predictions
- Verification of convergence with time between monitoring and modelling at Sleipner
- Reservoir simulations assessing relevant trapping mechanisms
- Field experiments investigating long-term monitoring technologies



Simulated spatial distribution of the dissolved CO_2 plume in the Stuttgart formation for the year 2100 at the Ketzin pilot site

POST-OPERATIONAL RISK MANAGEMENT - TRAFFIC LIGHT SYSTEM TOOL

A first version of a decision-support system has been created using defined high-level (main requirements) and low-level criteria. The system provides instructions for operators on how to act in case of irregularities after site closure, with three risk levels – green, orange and red.



CO_2CARE traffic light system for decision-support and risk management in the post-operational phase

Achieved Outcomes

- Report on the international regulatory requirements on CO_2 geological storage and site abandonment
- Report on the current site abandonment methodologies in relevant industries (overview of current practices in relevant industries)

- Review of relevant trapping mechanisms based on site portfolio
- Traffic light system for decision making in site abandonment
- CCSModelCompare: a software tool that compares the plausibility of different models on account of a comparison measured data
- Review of abandonment plan and criteria

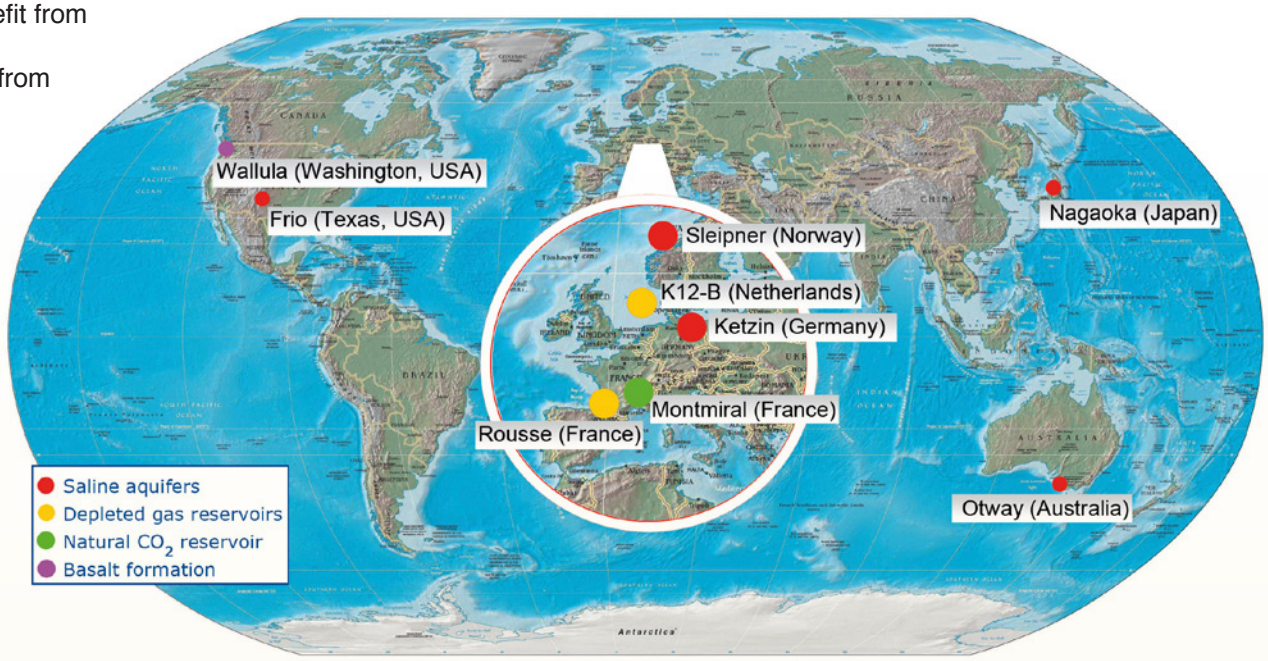
Forthcoming Outcomes

- Regulators workshop for Best Practice
- Dry-run documents for Sleipner, K12-B, Ketzin
- Follow-up project brochure
- Best Practice guidelines for:
  - Well abandonment requirements
  - Risk management procedures
  - Recommendations for the transfer of responsibilities
- New observation well at the pilot site in Ketzin, Germany (Ktzi 203/2012)
- Status reports for Ketzin, Sleipner, K12-B
- Final CO_2CARE conference

Different types of CO_2 injection sites studied in CO_2CARE

CO_2CARE is defining technical assessment criteria how to demonstrate that a CO_2 storage site meets the three EU Directive requirements for transfer of responsibility. To do this, the teams use:
- integrated laboratory research
- field experiments
- numerical modelling

…all of which benefit from privileged real site performance data from nine CO_2 storage or test sites:



	Site (*offshore)	Operator/ CO_2CARE partner	Current status	Injected CO_2	Depth m
Europe	Sleipner*	Statoil	injection	13.3 Mt (ca.1 Mt/y)	800 - 1000
	K12-B*	GDF Suez (TNO)	injection	80,000 t (ca.0.02 Mt/y)	3800
	Ketzin	VNG/GFZ	injection	60,000 t	650
	Montmiral natural CO_2 reservoir	AirLiquide	temporarily inactive	-	2400
	Rousse	TOTAL	injection	90,000 t (until 2013)	4200
USA	Wallula	Battelle-PNNL	planning	1,000 t	1200
	Frio	Univ. Texas at Austin	post-injection monitoring	1,600 t	1500
Asia-Pacific	Nagaoka	RITE	post-injection monitoring	10,400 t	1100
	Otway	CO_2CRC	injection	70,000 t (0.05 Mt/y)	1500

CO_2CARE Timeline

- **Jan 2011** — **CO_2CARE launch**; Kick-off meeting at GFZ, Postdam, Germany
- **June 2011** — General Assembly (GA), Potsdam, Germany
- **March 2012** — Annual scientific conference and GA, London, UK
- **Aug 2012** — CO_2CARE Midterm Review, Brussels, Belgium
- **Sept 2012** — Kick-off meeting of Best Practice and Regulatory compliance
- **Apr 2013** — Annual scientific conference
- **May 2013** — Review of abandonment plan criteria completed
- **July 2013** — Regulators workshop for Best Practice
- **Nov 2013** — Best Practice Guidelines and summary brochure
- **Dec 2013** — Annual scientific conference; Report on remediation techniques for site abandonment; **End of the project**

Project website and contact: www.co2care.org

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June 2012 - BRGM (Rowena Stead) - Brochure Design BL Communication