



Pre-ACT

Peder Eliasson (SINTEF) ACT Knowledge Sharing Workshop 2017-10-24, Bucharest



Outline

- Introduction
- The Pre-ACT approach
- Scope and objective
- Work package descriptions
- Deliverables and milestones
- Status and first results



Introduction

- Discussions around ACT project related to monitoring started late 2015.
- Wish to identify and address main storage-related challenges for accelerated deployment of CCS led to early involvement of industry.
- Crucial storage challenges: capacity, confidence, and cost
- Least common denominator: pressure





Introduction

Pre-ACT facts

- Budget: ~ 5.2 MEuro
- Duration: 1/9 2017 31/8 2020
- Partners: SINTEF (coordinator), BGS, GFZ, TNO, NORSAR, PML
- Industry: Shell, Statoil, TAQA, Total





British **Geological Survey** IATURAL ENVIRONMENT RESEARCH COUNCII

Plymouth Marine PML Laboratory



GFZ

Helmholtz Centre POTSDAM









Pre-ACT

ACT Knowledge Sharing Workshop, Bucharest, Oct. 2017



The Pre-ACT approach

- Answering to industry needs
- Learning from demonstration, pilot, and field lab data
- Deliverables with focus on industry uptake



ACT Knowledge Sharing Workshop, Bucharest, Oct. 2017

The Pre-ACT approach

- Answering to industry needs
- Learning from demonstration, pilot, and field lab data
- Deliverables with focus on industry uptake

Field data (Data owner)	Relevance to Pre-ACT	Work to be performed in Pre-ACT related to data	Data request to operators from Pre-ACT consortium
Smeaheia (Gassnova)	Example of aquifer. Challenges in pressure response due to the connection to Troll.	WP1: Build a reservoir model, case study. Interpretation of pressure history. WP5: Case study.	3D seismic cube GN1101 All interpreted horizons Interpreted faults Information on existing wells
Snøhvit (Statoil)	Experience with pressure issues during injection. Example of a single pressure measurement.	 WP1: Tubåen pressure, pressure propagation. WP2, T2.3: Calibration of quantitative pressure monitoring technique. WP 3, T3.1: Demonstrating convergence WP4: Analysis of decision making. 	3D seismic data from 2003, 2009, 2011 and 2012. Downhole pressure history: Injection data, pressure history (daily curves) Interpreted faults, seismic horizons, sediment model of Tubåen formation
Goldeneye (Shell)	Example of depleted gas field. Production history available.	WP3: Verification of conformance methodology WP5: Case study.	Pressure depletion and recovery data. Lab data, seismic 3D cube.
Rousse (TOTAL)	Depleted natural gas field in the Pyrenees, 30 km from Lacq, depth ~ 4.5 km.	WP1: Representative example of geomechanical impact on the storage case; deployed in WP1. WP2, T2.1: Identification of pitfalls and promising approaches in existing data sets.	Passive seismic data Downhole pressure history: Injection data, pressure history (daily curves)
P18-4 (TAQA)	Example of a depleted gas field where seismic cannot tell much and pressure monitoring will be central.	WP3: Verification of conformance methodology with little seismic data. WP5: Case study.	Front-end Engineering design data available on pressure management and model. (WP5)
Q16-Maas (ONE)	Example of a condensate field where seismic cannot tell much and pressure monitoring will be central.	WP3: Verification of conformance methodology with little seismic data. WP5: Case study.	Front-end Engineering design data available on pressure management and model. (WP5)
Sleipner (new data) (Statoil)	Longest example of coupled modelling- monitoring loop.	WP1, T1.2: Pressure build- up, propagation and dissipation. WP3: Test/demonstrate conformance/convergence.	Latest 3D seismic data: 2010 and 2012. Interpreted seismic horizons on the newest seismic, interpreted faults.

ACT Knowledge Sharing Workshop, Bucharest, Oct. 2017

Accelerating

echnologies

27.8



Pre-AC1

Pre-ACT scope

- Pressure control and conformance management for safe and efficient CO₂ storage - Accelerating CCS Technologies (Pre-ACT)
- Pressure management crucial when addressing the main storage challenges: capacity, confidence and costs.

The objective of Pre-ACT is to equip operators and regulators with pressure-driven decision support protocols (Pre-ACT Protocols) that enable them to establish a safe and efficient monitoring system and to assess quantitatively site conformance.



WP1: Pre-injection modelling

- WP leader: Jim White (BGS)
- Study optimal injection planning via effective pressure control
- Focus on understanding propagation and control of pressure increases following injection through a program of modelling and laboratory work



Structural storage capacity of 2.0 Gt



High perm. (0.5-10 D), 3.5 Gt CO2 injected

Structural storage capacity of 5.2 Gt



Low perm. (0.05-1 D), 7 Gt CO2 injected

WP2: Novel monitoring concepts

Tiltmeters Seismometers Gravimeters CO₂ Pressure build-up



Passive-active monitoring strategy based on pressure

- WP leader: Conny Schmidt-Hattenberger (GFZ)
- Establish novel concepts for quantitative monitoring of pore pressure and saturation
- Minimize cost by using passive-active monitoring strategy
- Provide input for real-time conformance verification

9



WP3: Conformance verification

- WP leader: Stefan Carpentier (TNO)
- Develop and evaluate approaches for verification of site conformance
- Establish detection limits and find measure of conformance for consistency between monitoring data and modelled CO₂ behaviour

ACT Knowledge Sharing Workshop, Bucharest, Oct. 2017





WP4: Decision making

WP5: Workflow demonstration

- WP leader: Alv-Arne Grimstad (SPR)
- Investigate options for an operator if a pressure-based conformance test fails
- Study how to control CO₂-induced pressure increase to avoid leakage and costly remediation

- WP leader: Ane Lothe (SPR)
- Demonstrate developed methodology for storage scenarios at realistic sites (Smeaheia, P18-4, Q16-Maas, UK case)
- Communicate results also to authorities, regulators, policy and decision makers, etc.

Accelerating CS Technologies



Pre-A

WP6: Project management

- WP leader: Peder Eliasson (SPR)
- Ensure that the project delivers according to the work plan and the contract with ACT.
- Manage the legal, financial and administrative aspects of the project, both towards the Consortium, the Executive Board (EB) and ACT

- Project management team:
 - Peder Eliasson (PL)
 - Pierre Cerasi (Ass. PL)
 - Anouar Romdhane (QA)
 - WP leaders
- Executive Board with representatives from each party

Deliverables and milestones (WP1-WP3)



WP1: Pre-injection modelling	01	02	03	04	05	O6	07	08	09	010	011	012
T1.1: Effect of heterogeneities				M1.1.1					~			
T1.2: Pressure propagation and control				M1.2.1				M1.2.2				
T1.3: Stress path			M1.3.1	M1.3.2								
T1.4: Acoustic emission studies		M1.4.1										
T1.5: Impact of hypersaline discharge				M1.5.1						M1.5.2		
												-
		- ¹		·	- '	,		- '''''	- '-	- ¹		
WP2: Novel monitoring concepts	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
T2.1: Review of available techniques	M2.1.1	M2.1.2										
T2.2: Passive-active monitoring strategy							M2.2.1					
T2.3: Quantitative pressure monitoring							M2.3.1					
T2.4: Time-lapse pressure tomography							M2.4.1					
T2.5: Micro-seismic monitoring											M2.5.1	
WP3: Conformance verification	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
T3.1: Conformance for industrial scale operations		M3.1.1										
T3.2: Conformance and detection limits				M3.2.1								
T3.3: Conformance with multiple data types									M3.3.1			
T3 A: Criteria and measures of conformance												

ACT Knowledge Sharing Workshop, Bucharest, Oct. 2017

Deliverables and milestones (WP1-WP3)

WP1: Pre-injection modelling	Q1	Q2	Q3	Q4
T1.1: Effect of heterogeneities				M1.1.1
T1.2: Pressure propagation and control				M1.2.1
T1.3: Stress path			M1.3.1	M1.3.2
T1.4: Acoustic emission studies		M1.4.1		
T1.5: Impact of hypersaline discharge				M1.5.1
WP2: Novel monitoring concepts	Q1	Q2	Q3	Q4
T2.1: Review of available techniques	M2.1.1	M2.1.2		
T2.2: Passive-active monitoring strategy				
T2.3: Quantitative pressure monitoring				
T2.4: Time-lapse pressure tomography				
T2.5: Micro-seismic monitoring				
WP3: Conformance verification	Q1	Q2	Q3	Q4
T3.1: Conformance for industrial scale operations		M3.1.1		
T3.2: Conformance and detection limits				M3.2.1
T3.3: Conformance with multiple data types				
T3.4: Criteria and measures of conformance				

	Deliverables and milestones during first year	Month
	M1.1.1: First model test case varying heterogeneities in storage complex. (SINTEF)	12
١	M1.2.1: Short memo on flow modelling with pressure propagation monitored in heterogeneous reservoirs to demonstrate progress. (BGS, SINTEF)	12
J	M1.3.1: First results of thermal stress experiments during CO ₂ production. (SINTEF)	9
	M1.3.2: First acoustic emission experiments underway with memo. (SINTEF)	12
24	M1.4.1: Confirmation of delivery and usability of microseismic data from Decatur/Ketzin/Rousse. (NORSAR)	4
L.1 2.1	M1.5.1: Tested fully functional hypersaline fluid dispersion model and test simulations. (<i>PML</i>)	12
3.2 5.1	D2.1.1: Industry uptake deliverable [*] on selected data (direct and indirect pressure measurements), their quality and suitability for reliable pressure and saturation quantification, and conformity study. (<i>GFZ, TNO, NORSAR, SINTEF</i>)	6
	D2.2.1: Workshop with operators on scenarios of pressure irregularities, and necessary active surveys as counter-acting measures. (SINTEF, GFZ, TNO, BGS, NORSAR)	12
	M2.1.1: Access to all relevant direct and indirect pressure data from other sites is feasible and guaranteed. (GFZ)	3
	M2.1.2: Correlation and quality assessment of the selected data sets is finished. (GFZ, BGS, SINTEF)	6
	D3.1.1: Workshop on quantitative measures of conformance. (TNO)	6
	D3.1.2: Industry uptake deliverable [*] on monitoring-modelling convergence and conformance assessment for industrial-scale operations. <i>(BGS)</i>	12
2.1	D3.2.1: Workshop on monitoring technologies and their relative merits for conformance verification in different settings. (TNO, GFZ)	12
	M3.1.1: Inventory of potential quantitative measures of conformance (outcomes of Workshop D3.1.1 and input for Task 3.2.	6
	M3.2.1 : Assessment of monitoring technologies and their application to conformance verification	12

Deliverables and milestones (WP4-WP6)



WP4: Decision making	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	
T4.1: Review of demonstration and pilots		M4.1.1											
T4.2: Actions for pressure non-conformance										M4.2.1			
T4.3: Recommendations for decision-making												M4.3.1	
WP5: Workflow demonstration	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	
T5.1: Case studies						M5.1.1-2	M5.1.3		M5.1.4				
T5.2: Stakeholder workshops					M5.2.1								
WP6: Project management	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	
T6.1 Legal issues													
T6.2 HSE													
T6.3 Project planning and execution	M6.3.1-2												
T6.4 Outreach			M6.3.3										

Deliverables and milestones (WP4-WP6)



					Deliverables and milestones during first year	Month
WP4: Decision making	Q1	Q2	Q3	Q4	D4.1.1: Workshop with operator and industry experts, discussing the methodology used for decision making in ongoing CO ₂ injection operations (in Europe or worldwide)	4
T4.1: Review of demonstration and pilots T4.2: Actions for pressure non-conformance T4.3: Recommendations for decision-making		M4.1.1			 M4.1.1: Identification and classification of historical non-conformance issues in closed operations, making input material for alternative action proposal 	6
					D6.2.1: Risk assessment with revision	6
WP5: Workflow demonstration <i>T5.1: Case studies</i> <i>T5.2: Stakeholder workshops</i>	Q1	Q2	Q3	Q4	 D6.3.1: Project master plan including full transparency of resources, schedule and cost/performance, with yearly updates D6.4.1: Pre-ACT landing website (monthly updated) 	3, 10 3
WP6: Project management	Q1	Q2	Q3	Q4	D6.4.2 : Pre-ACT webinar with latest project results	6, 12
T6.1 Legal issues T6.2 HSE		2			M6.3.1: Project launched	3
T6.4 Outreach	IVI6.3.1-	2	M6.3.3		M6.3.2: First EB meeting	9
					M6.3.3: Necessary committee and panels established	6

Status and first results

- All contracts in place early October. Some activities started in September and for GFZ already in July.
- GFZ hired new geophysicist for the project
- GFZ initiated stability study for coupled hydrogeophysical inversion (Task 2.4)
- SINTEF did first QC of available Smeaheia data
- GFZ and TNO in dialogue with CO2CRC about experiments at Otway



Smeaheia 3D seismic cube GN1101

Status and first results

- Svelvik Field Lab upgrade initiated
- Pre-ACT kick-off planned near Oslo:

7 November

- Svelvik workshop and field lab visit
- ACT programme information and Pre-ACT dinner

8 November

- Pre-ACT kick-off meeting
- Pre-ACT dinner

9 November

Pre-ACT Work Package 4 workshop



Svelvik field lab area indicated in dark grey (300m x 150m).

Shallow injection (at 20m) of 1.7 tonne CO₂ (in CO2FieldLab project 2011).



Kick-off venue: Sem gjestegård, 20 min. from Oslo



Acknowledgements

This presentation has been produced with support from the ACT Pre-ACT project (Project No. 271497). This project has received funding from RCN (Norway), Gassnova (Norway), BEIS (UK), RVO (Netherlands), and BMWi (Germany) and is co-funded by the European Commission under the Horizon 2020 programme, ACT Grant Agreement No 691712. In addition, we like to acknowledge the following industry partners for their contributions: Total, Statoil, Shell, TAQA.