Pre-ACT status

Peder Eliasson, SINTEF

ACT Knowledge Sharing Workshop 2018

2018-11-13

Outline

- Introduction to the Pre-ACT project
  - Background
  - Facts
  - Objective and scope
- Work packages and first year results
- Reach-out, collaboration, and ACT synergies

Background

- Identify and address main storage-related challenges for accelerated deployment of CCS in collaboration with industry.
- Crucial storage challenges: capacity, confidence, and cost
- Least common denominator: pressure

Pressure control and conformance management for safe and efficient CO_2 storage - Accelerating CCS Technologies (Acronym: Pre-ACT)

Pre-ACT facts

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

The Pre-ACT approach

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

Questions from industrial operators	Pre-ACT approach to answer questions
How can we most effectively extract pressure from direct and indirect measurements?	Experimental setup for pressure and saturation discrimination (WP2)
What is sufficient pressure monitoring?	Novel conformance criteria to limit the required measurement effort (WP3)
How can we quantify site conformance?	Analysis of uncertainty by a closed modelling-monitoring loop (WP3)
How can we detect migrated CO_2 at indicator horizons?	Pressure-sensitive passive-active monitoring concept (WP2)
How can a cost-saving prevention concept be practically implemented?	Effective injection strategies as pressure management (WP1)
How can we measure and verify the stability of a reservoir in the post-closure phase?	Continuous calibration of models with real data under inclusion of geomechanical features (WP1)
Does dispersal of hypersaline pore water require environmental management?	Novel hypersaline hydrodynamic scenario modelling (WP1)

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Field data (Data owner)	Relevance to Pre-ACT	Work to be performed in Pre-ACT related to data	Data request to operat from Pre-ACT consorti
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 GN110 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.

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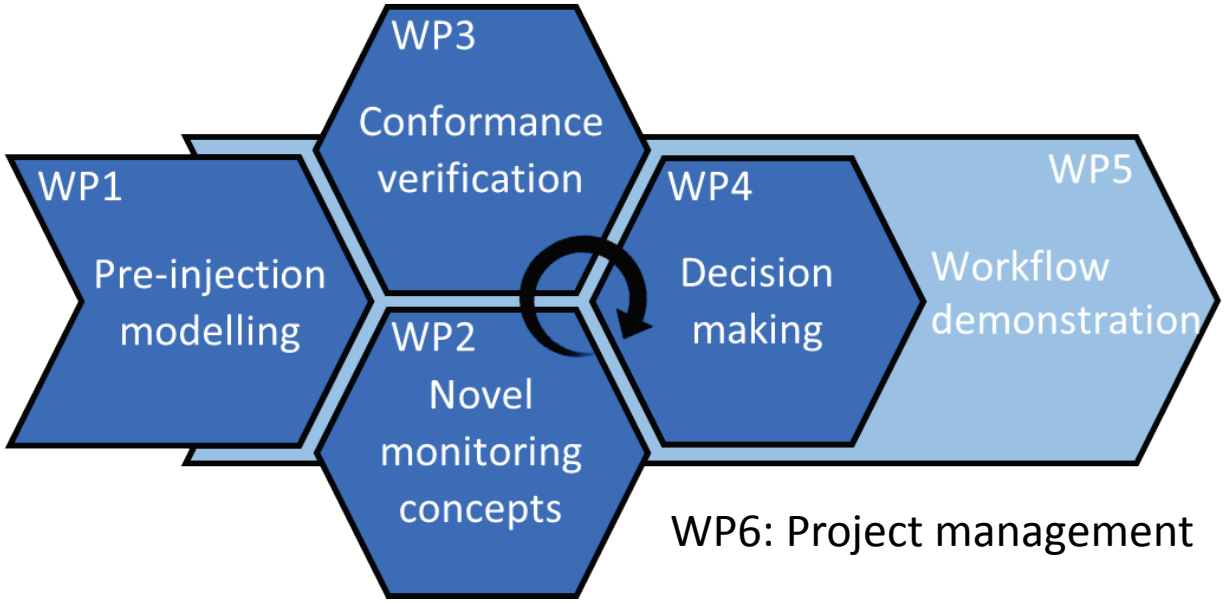
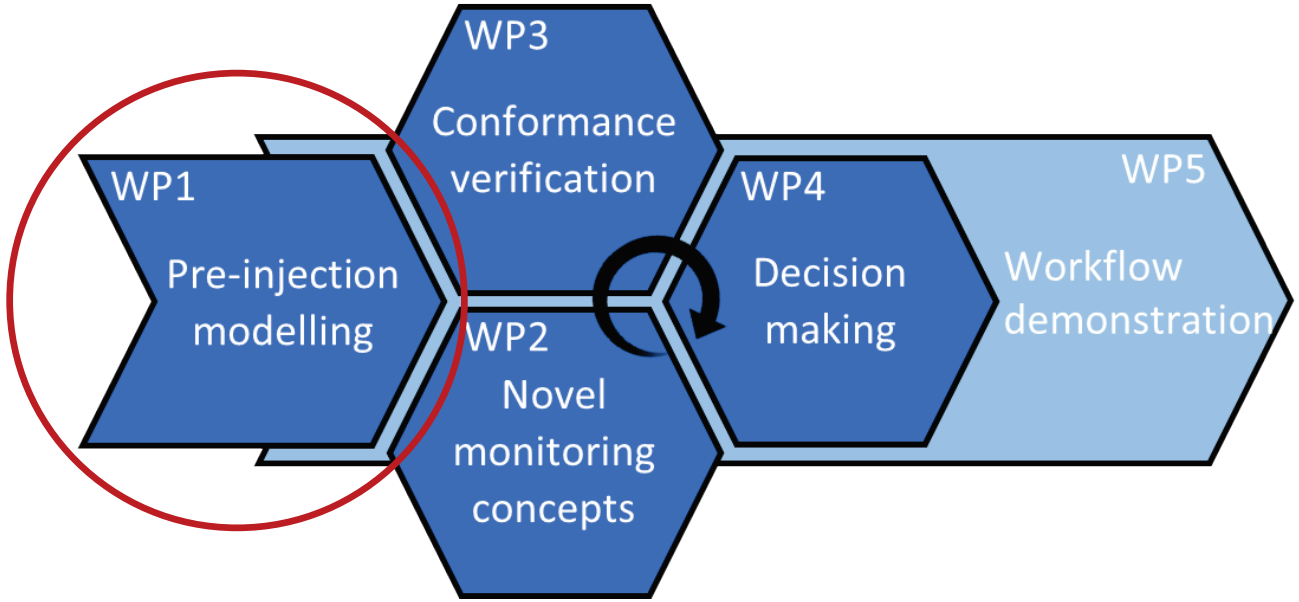
Pre-ACT objective and scope

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.



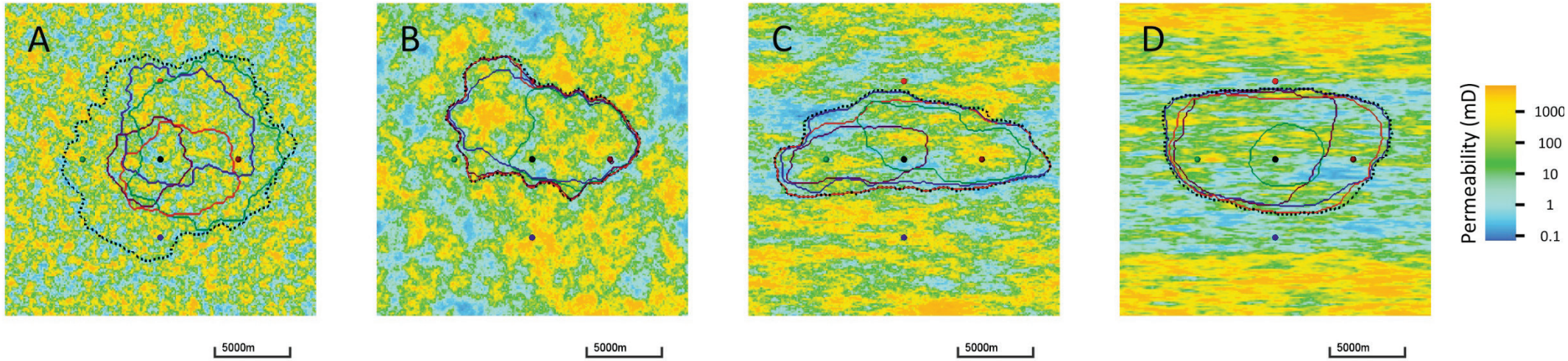
WP1: Pre-injection modelling

- 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



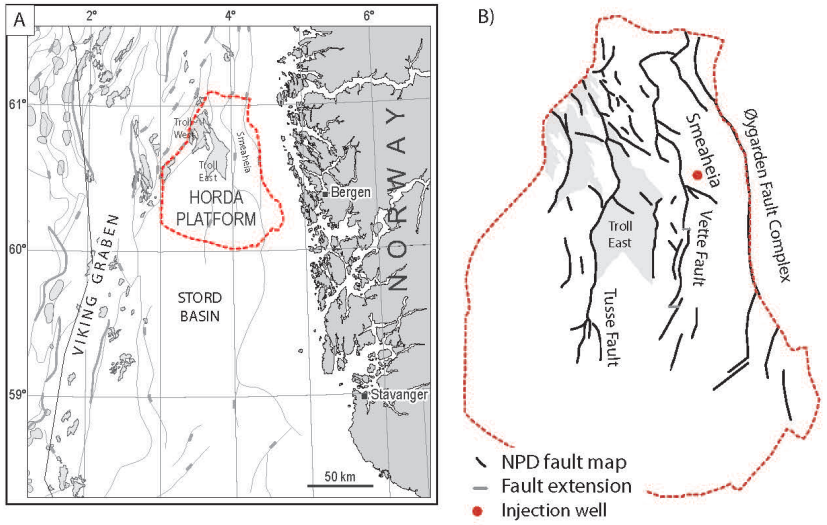
WP1: Pressure modelling

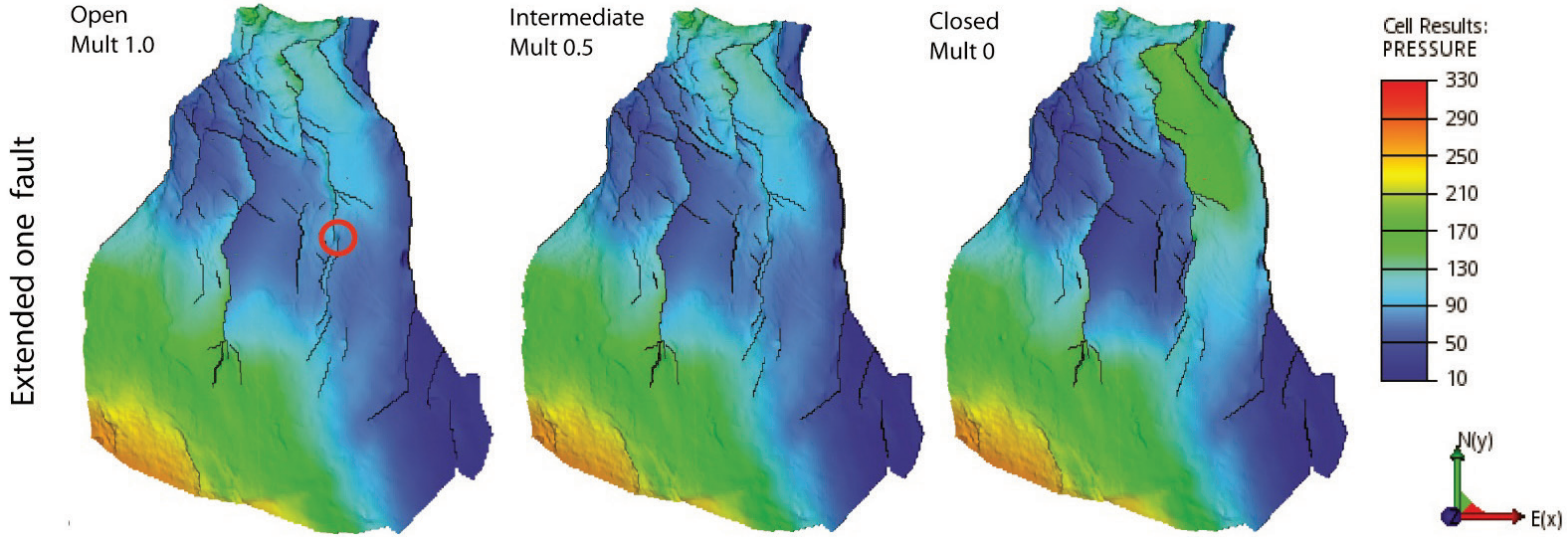
- Effect of geological heterogeneities on pressure distribution studied
- Four different production well locations compared
- Various orientation and degree of heterogeneity (A, B, C, D)
- Influence of connectivity on pressure propagation is clear



WP1: Pressure modelling

- Study of the effect of uncertain fault characterisation
- NPD's Horda platform reservoir model used
- Varying sealing properties in assumed fault relay zones has a major impact on pressure propagation

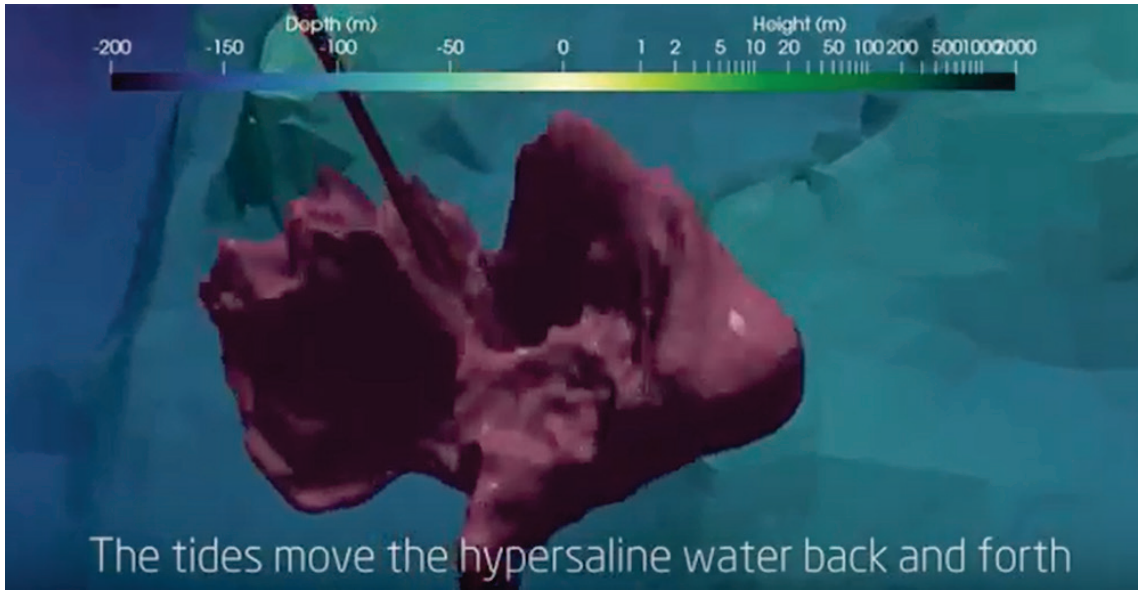




Lothe et al., 2018

WP1: Hypersaline discharge

- Currently modelling impact of large-scale discharge of produced (hypersaline) reservoir brines into the marine environment
- Video of such modelling created by PML scientist Pierre Cazenave in Pre-ACT has won an award in the ARCHER Competition 2018



http://www.archer.ac.uk/about-archer/news-events/events/image-comp/gallery-2018/

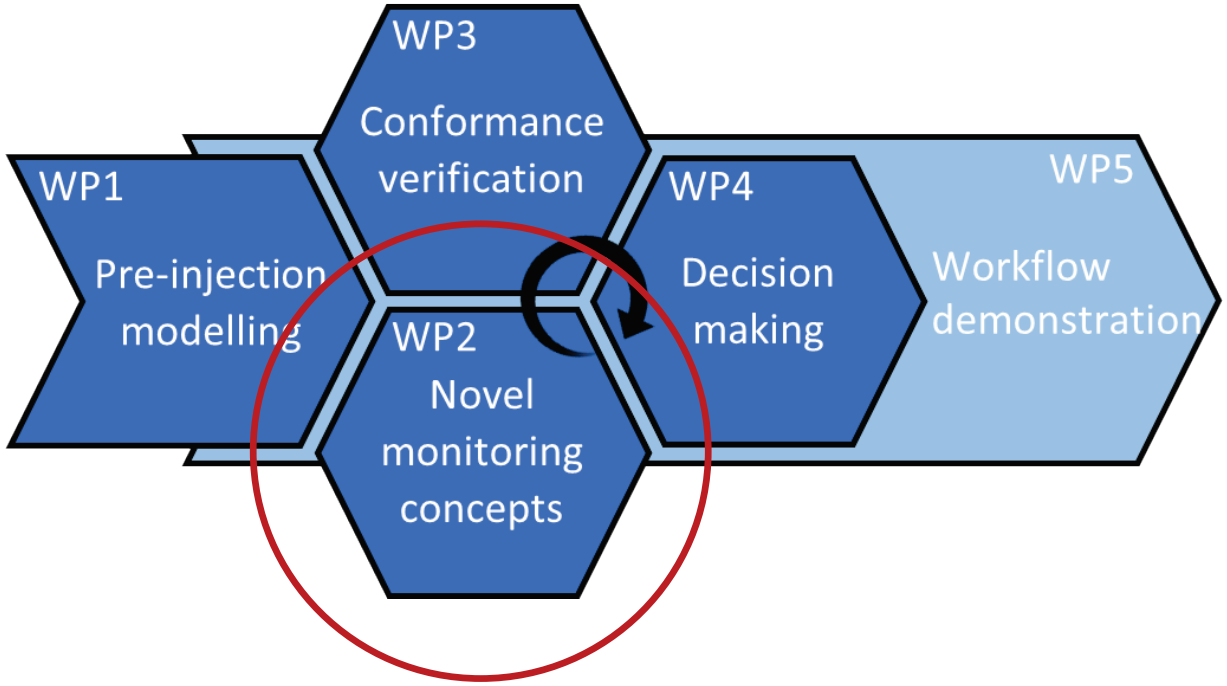
https://youtu.be/EmQv4qk0kUo

WP1: Geomechanical experiments

- Investigating at the core scale the consequences of pressure change on formation integrity and micro-seismicity potential
- Experimental plan and setup ready. Tests have been initiated using SINTEF new true-triax cell.

WP2: Novel monitoring concepts

- 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



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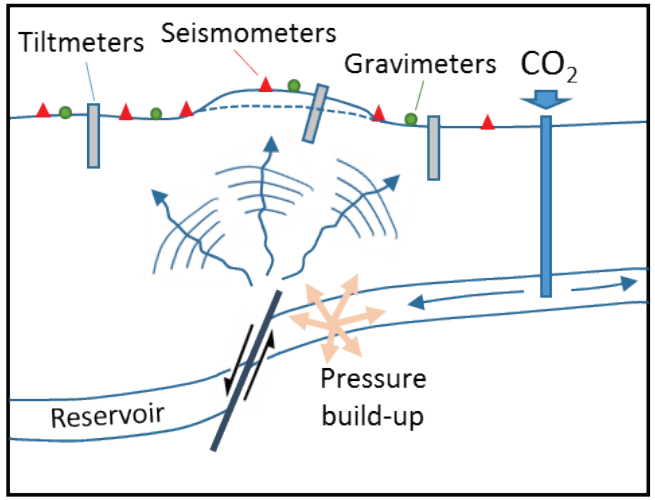
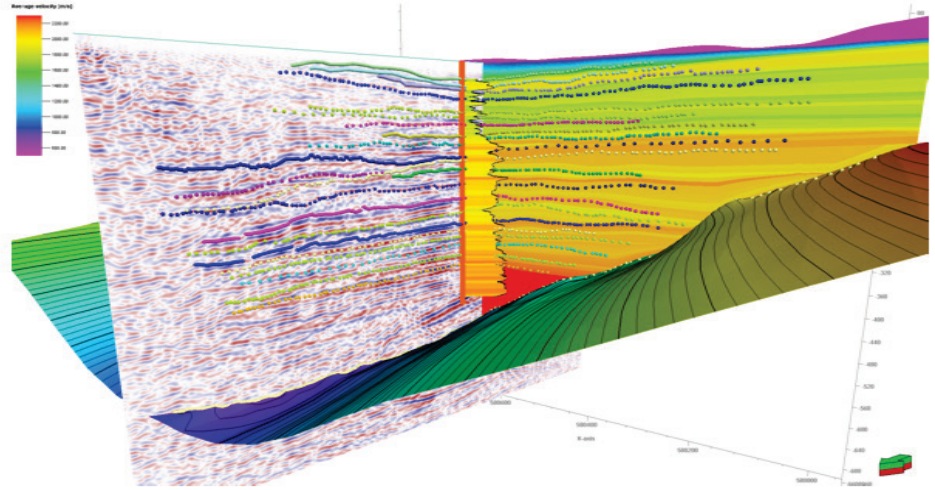


Passive-active monitoring strategy based on pressure

Svelvik



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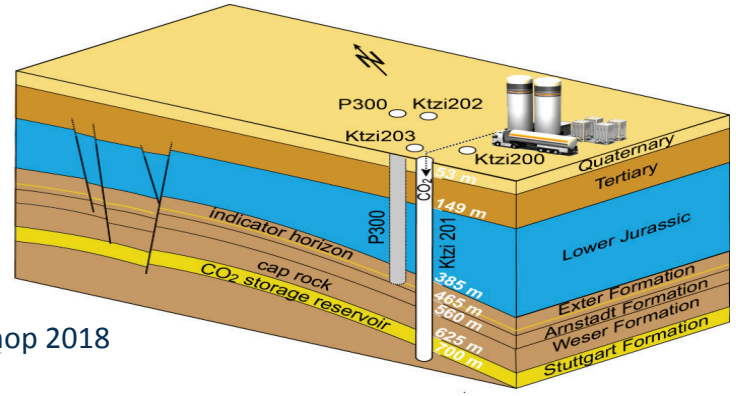
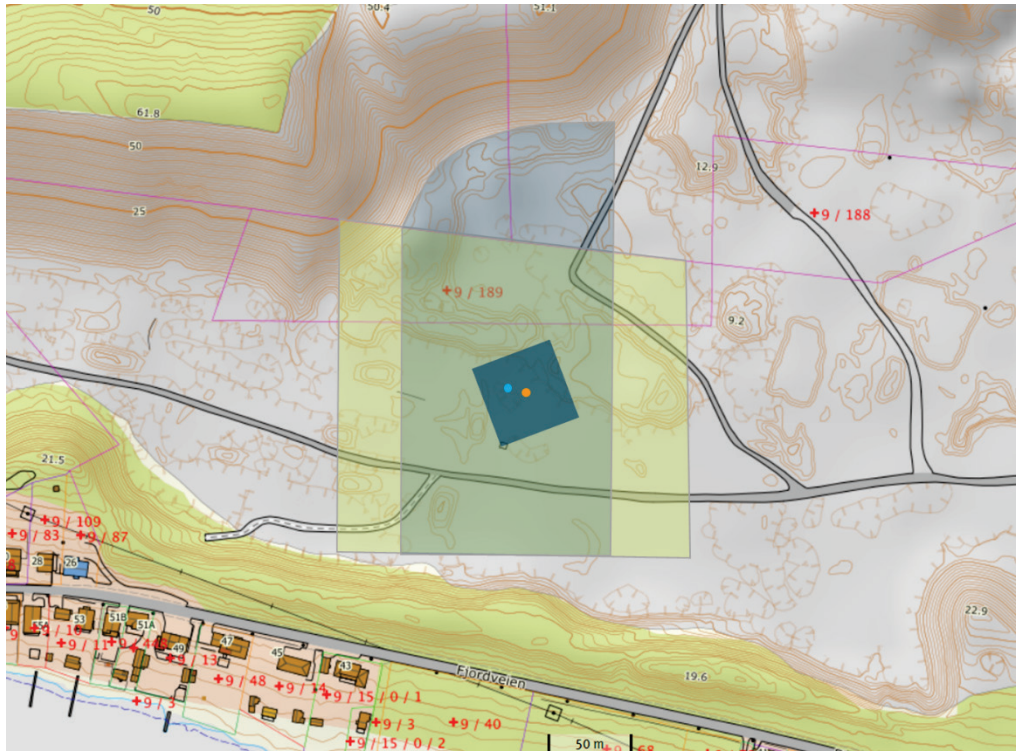


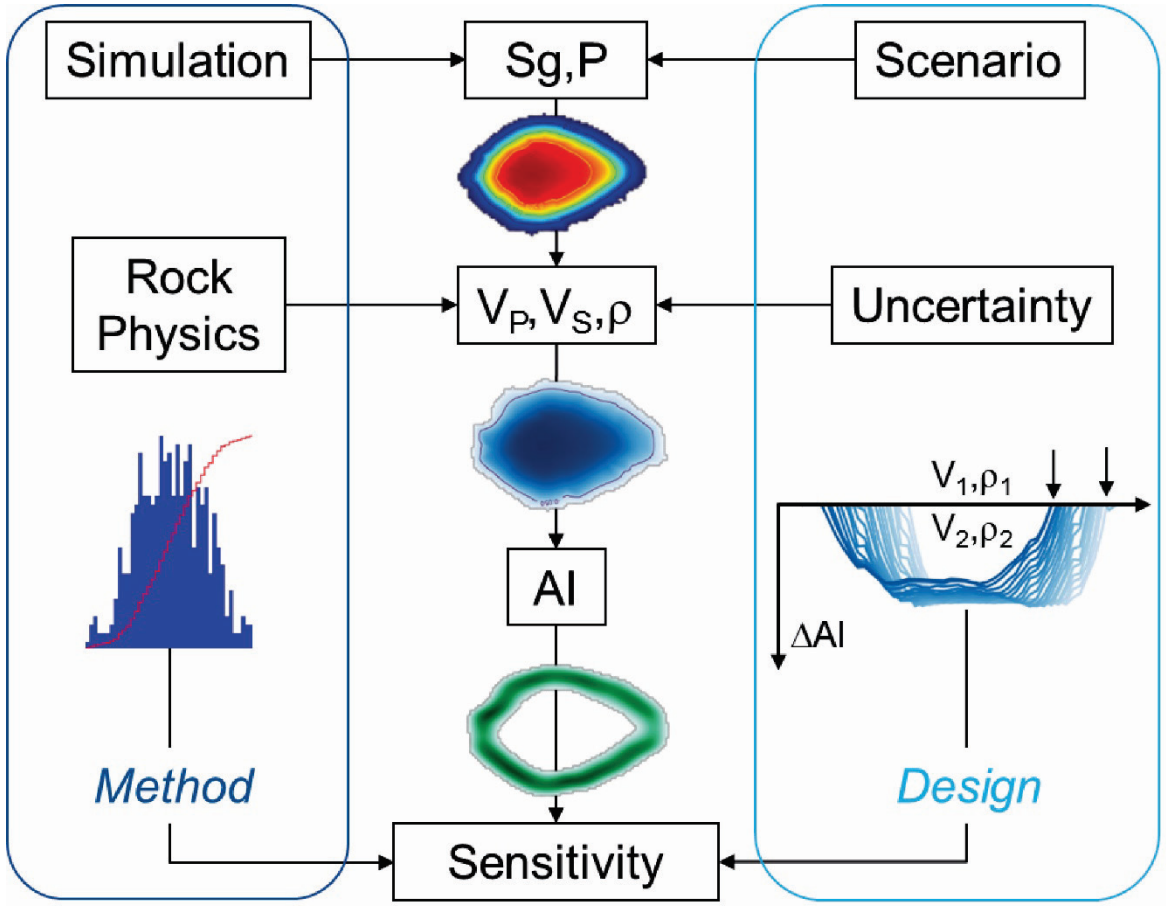
WP2: Svelvik planning

- Experimental campaigns at Svelvik CO_2 Field Lab currently being planned
- In close collaboration with ECCSEL Svelvik upgrade project
- New wells to be drilled in spring, instrumentation about to be ordered



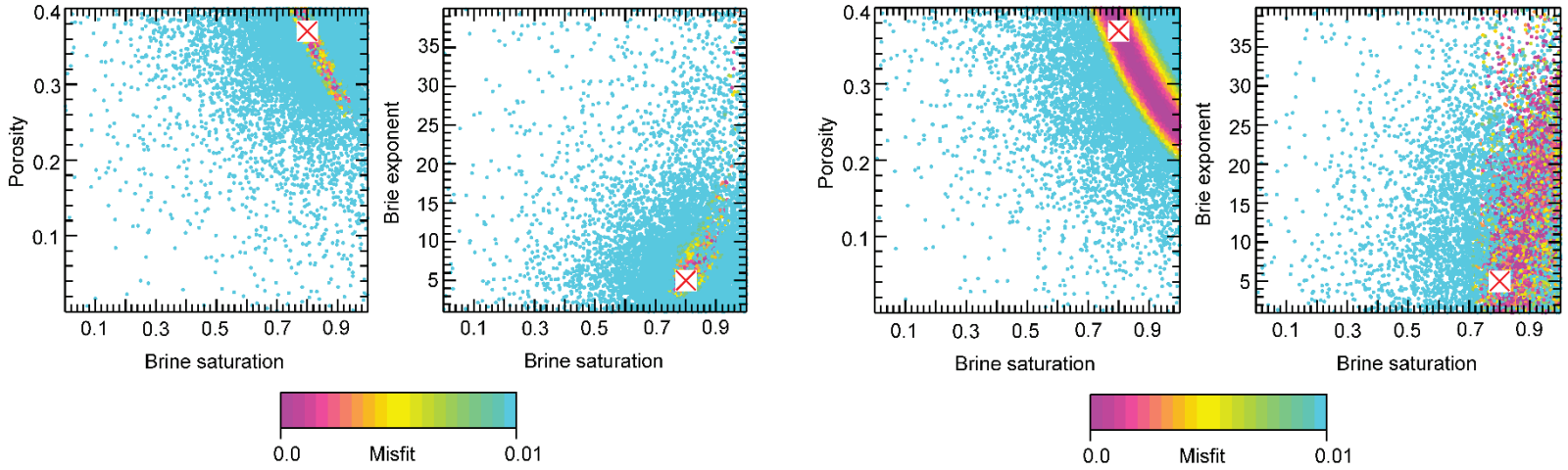
WP2: Svelvik planning

- Synthetic feasibility studies (Weinzierl et al., 2018, Romdhane et al., 2018) carried out
  - Effect of pressure and saturation changes on geophysical parameters
- Approach of separating those effects being developed



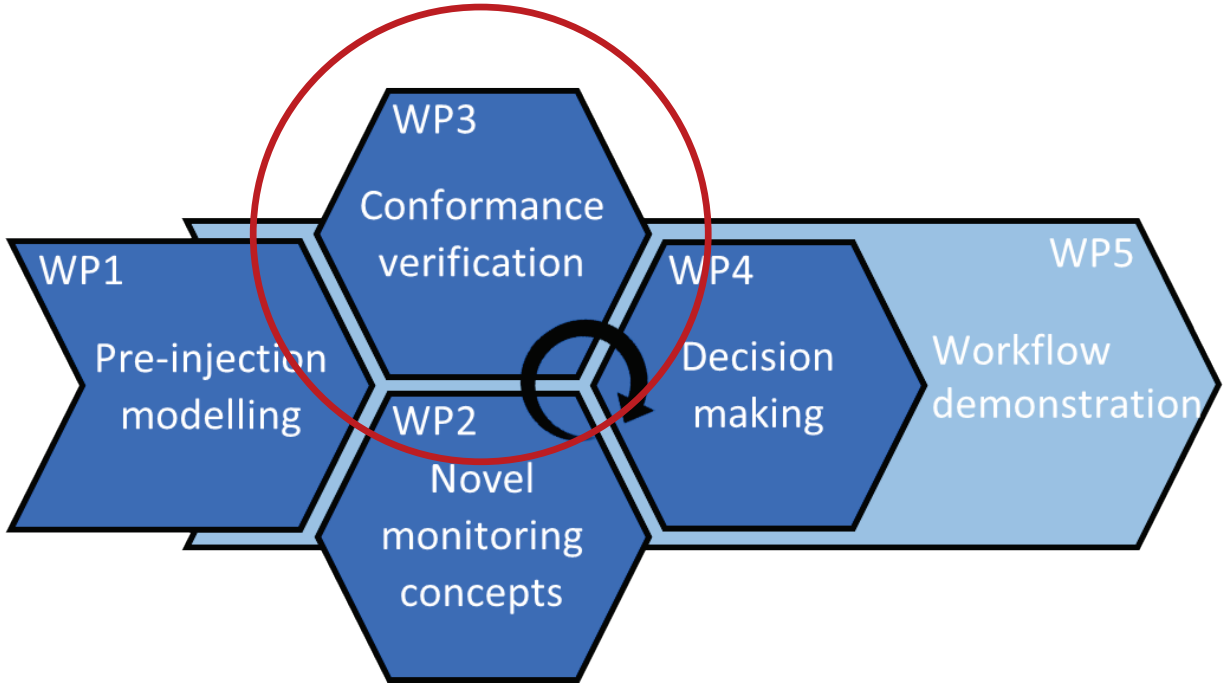
WP2: Rock physics inversion

- An integrated methodology for quantitative CO_2 monitoring using a Bayesian formulation is under development
- Multiple data sets used to quantify e.g. pressure and saturation
- Preliminary results are promising (see Dupuy et al. poster at EAGE workshop in Utrecht)



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 CO_2 behaviour



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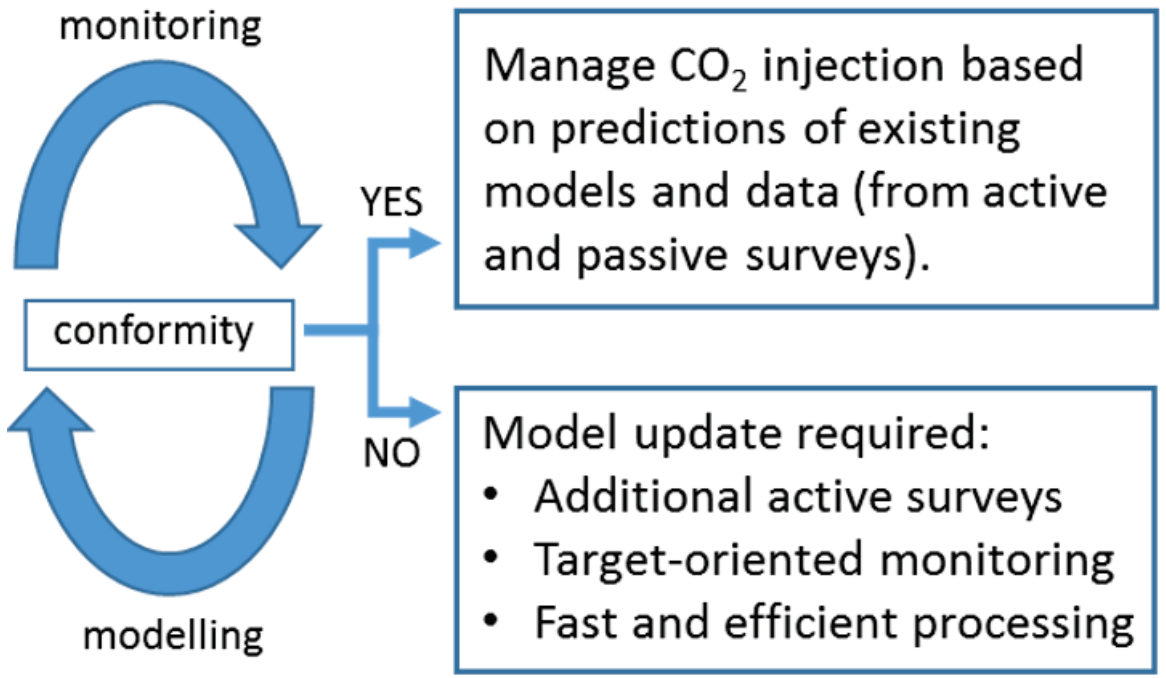
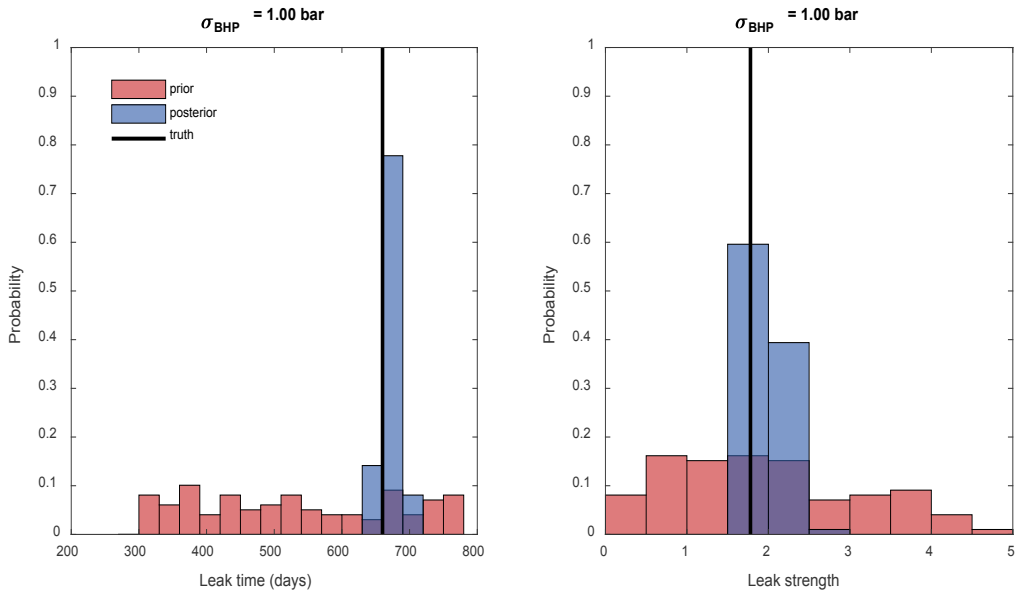


WP3: Conformance assessment

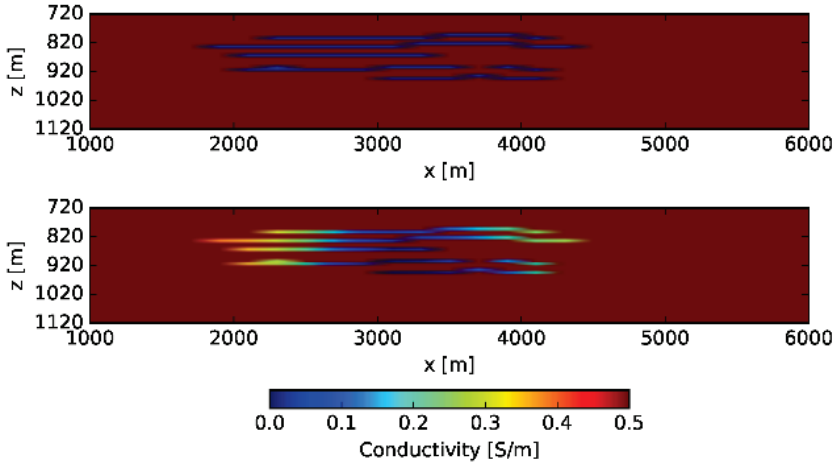
- A conceptual Value of Information (VOI) assessment tool has been developed
- Used to assess value of monitoring strategy for conformance verification
- In example used to assess VOI for determination of leak onset time and strength

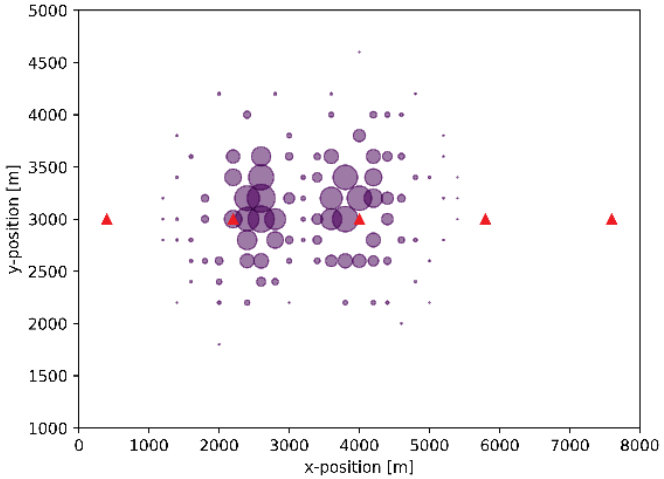


Barros et al. 2018

WP3: VOI - Survey optimization

- First strategy for survey optimization developed and tested (in collaboration with the Norwegian NCCS research centre)
- Used to minimize monitoring costs while preserving information content
- E.g. for determination of optimal lateral source positions for FWI or CSEM

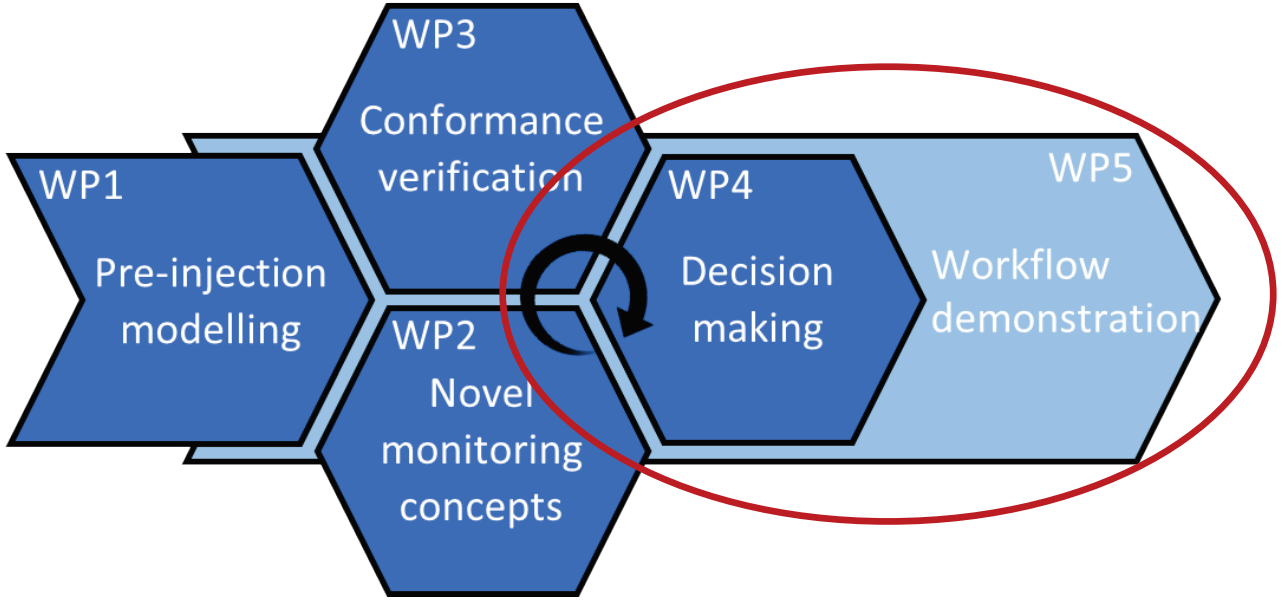




Romdhane and Eliasson 2018

WP4: Decision making

WP5: Workflow demonstration



WP4: Decision making

- WP leader: Alv-Arne Grimstad (SPR)
- Investigate options for an operator if a pressure-based conformance test fails
- Study how to control CO_2-induced pressure increase to avoid leakage and costly remediation

WP5: Workflow demonstration

- 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.

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First workshop with industry partners arranged November 2017!

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This work package is about to start up soon!

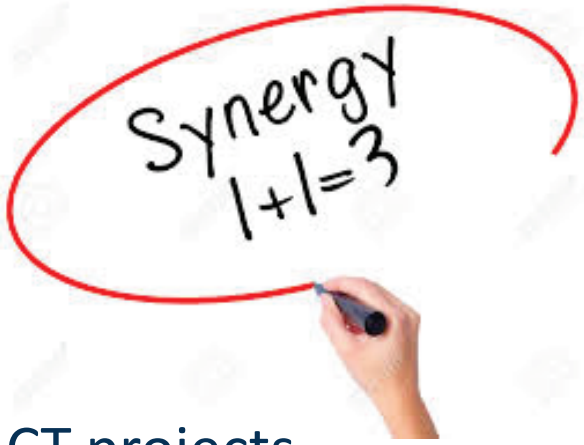
Pre-ACT reach-out

- Answering to industry needs (specific questions asked by industry)
- Involvement of NPD (in workshop and in WP1/WP5 work)
- Public web page
- Webinar series (not yet started)
- Common outreach efforts with Svelvik Field Lab
- Publications and presentations (EAGE, NSG, GHGT, SEG, EAGE Utrecht)
- Measure of effectiveness not considered

Pre-ACT collaboration

- Leader group meetings at the beginning of each quarter. Working well!
  - Status reports from each WP and input for traffic light report
  - General information exchange and planning of upcoming quarters
- Monthly meetings for each WP (for coordination of WP tasks) Needs improvement!
- Task specific meetings and workshops Working well! Part of the Pre-ACT approach.
- Annual meeting Working well!
- Using an "eRoom" for data/information sharing Working, but outdated technology…
- SharePoint available, but currently only used by SINTEF. Not used by partners…

ACT synergies



- Until now, limited synergy with other ACT projects.
- However, colleagues from ALIGN, ELEGANCY, and DETECT will participate in Pre-ACT workshop on monitoring and conformance verification next week in Utrecht.
- Common lunch with ECOBASE project in Utrecht.
- Good potential for exchange with ALIGN, due to some overlapping personnel.
- Pre-ACT may participate in final meeting of ACORN.
- A few new ACT projects are interested (if granted) in collaborating with Pre-ACT.

Acknowledgements

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