REX-CO_2 PROJECT OVERVIEW 2022.05.19

REX-CO_2 Re-using Existing wells for CO_2 storage operations

Presentation: Bill Carey (Los Alamos)

Project Coordinator: Maartje Koning (TNO)

This project has received funding from ADEME (FR), Ministry of Economic Affairs and Climate Policy (NL), RCN/CLIMIT (NO), UEFISCDI (RO), BEIS (UK), and DOE (USA), under the EU Horizon 2020 programme ACT, Project No. 299681. The contents of this publication reflect only the author's view and do not necessarily reflect ERA-NET ACT's position. ERA-NET ACT is not liable for any use that may be made of the information contained here.

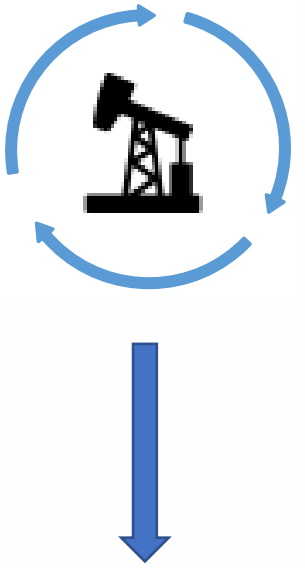
What is REX-CO2?

Re-using Existing wells for CO2 storage operations

- International research project, funded through the ACT (Accelerating CCS Technologies) programme (http://www.act-ccs.eu/)
- Six Countries: Netherlands (Project lead); USA, France, UK, Norway, Romania
- 13 research partners; 4 stakeholders; 6 R&D organizations
- Duration: September 2019 – August 2022
- Project website: https://rex-co2.eu/

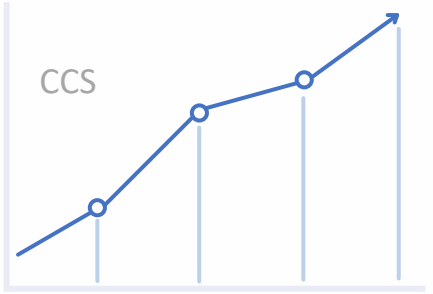
Motivation: facilitate CCS in hydrocarbon fields

- Applies to on-shore but especially off-shore
- Potential re-use modes
  - Re-use without modification
  - Workover with modification
  - Side-track from a portion of the well
  - Deepening or milling to access a shallower target
  - Partial plugging of well sections
  - Re-entry of abandoned well
- Objective: Screening methodology (not an engineering solution)

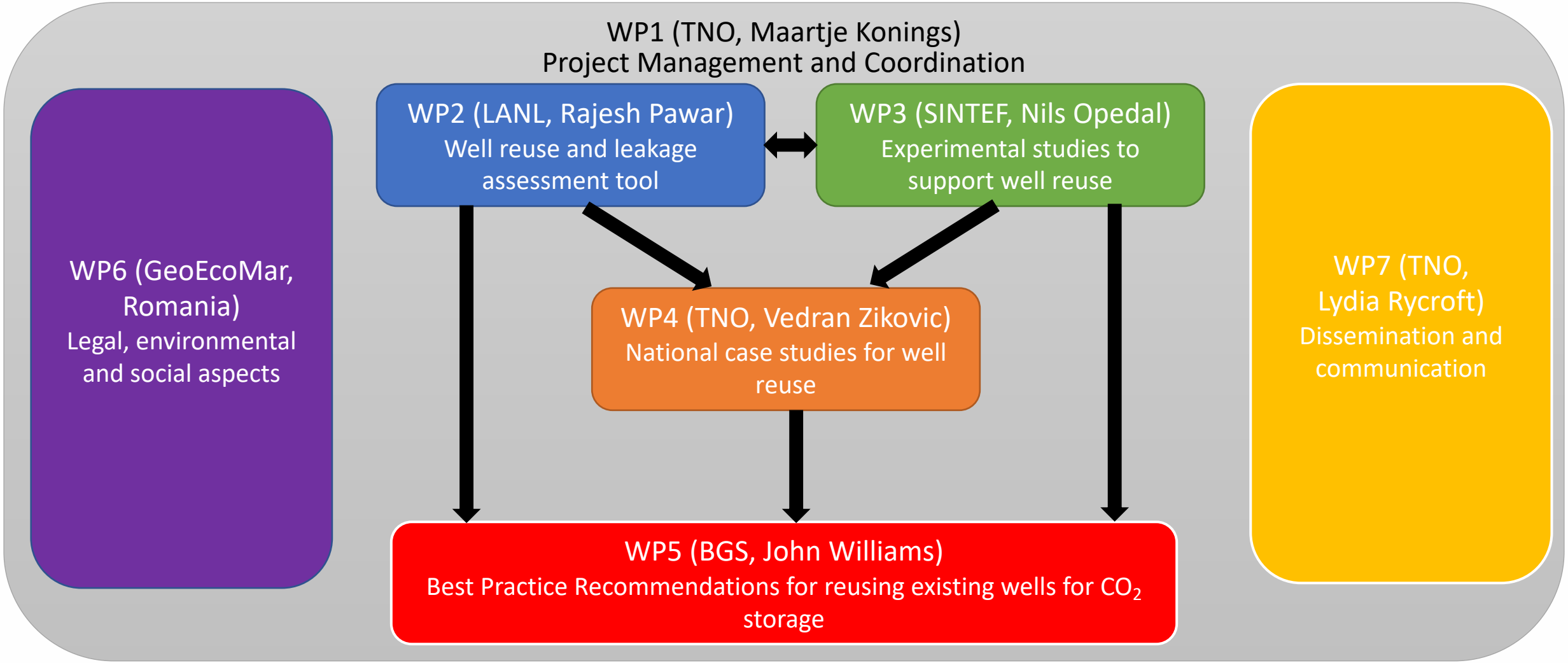


Challenge: All wells have to be assessed → time consuming and subject to inconsistency / incompleteness

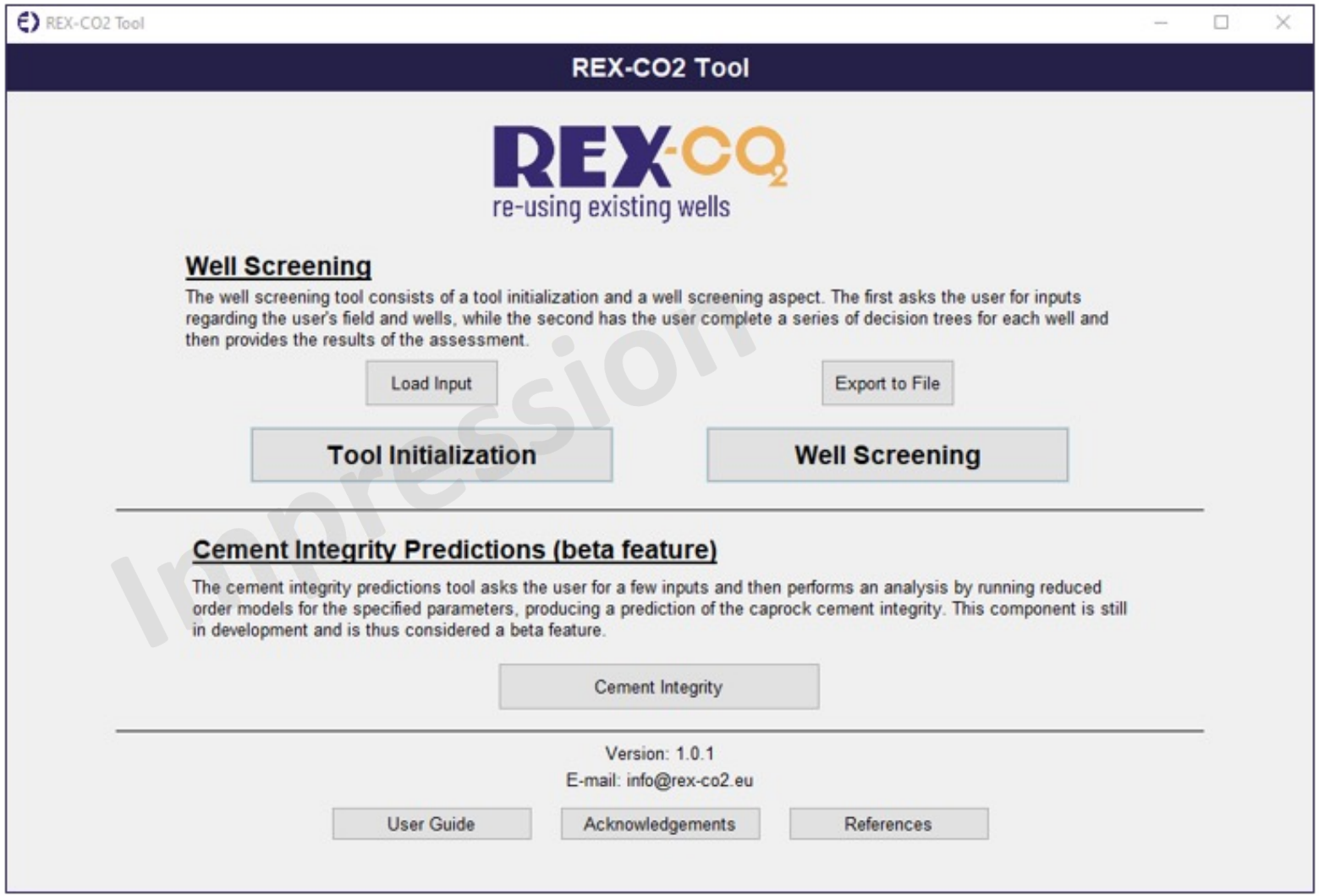
A structured & independent well screening process is required



Objective of REX-CO_2: Provide decision makers with mechanisms and information to evaluate re-use potential of existing oil and gas well infrastructure



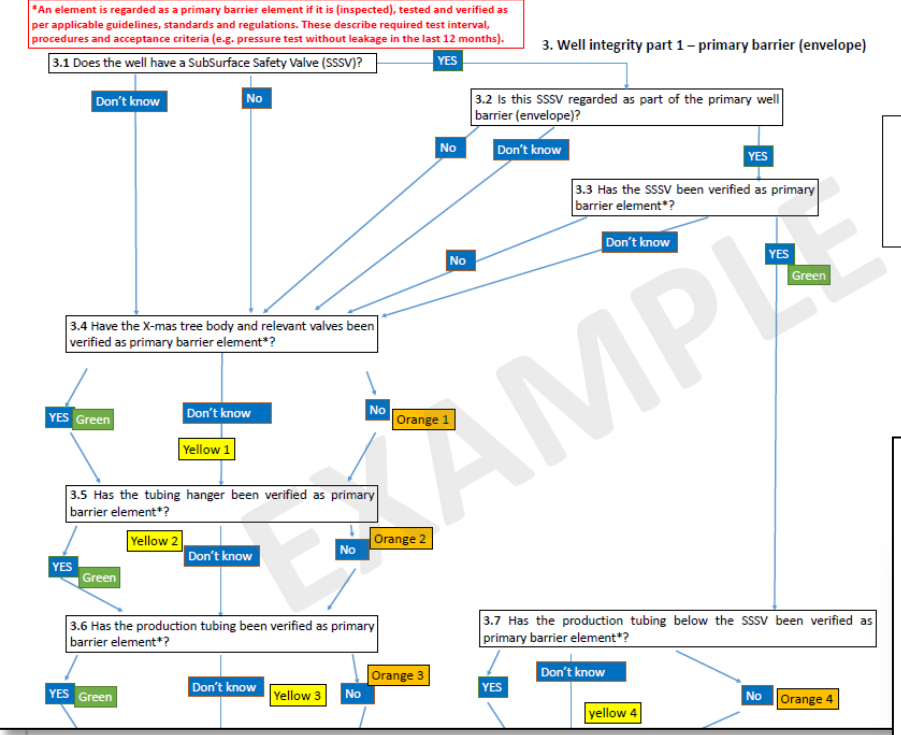
REX-CO2 Well Screening Tool

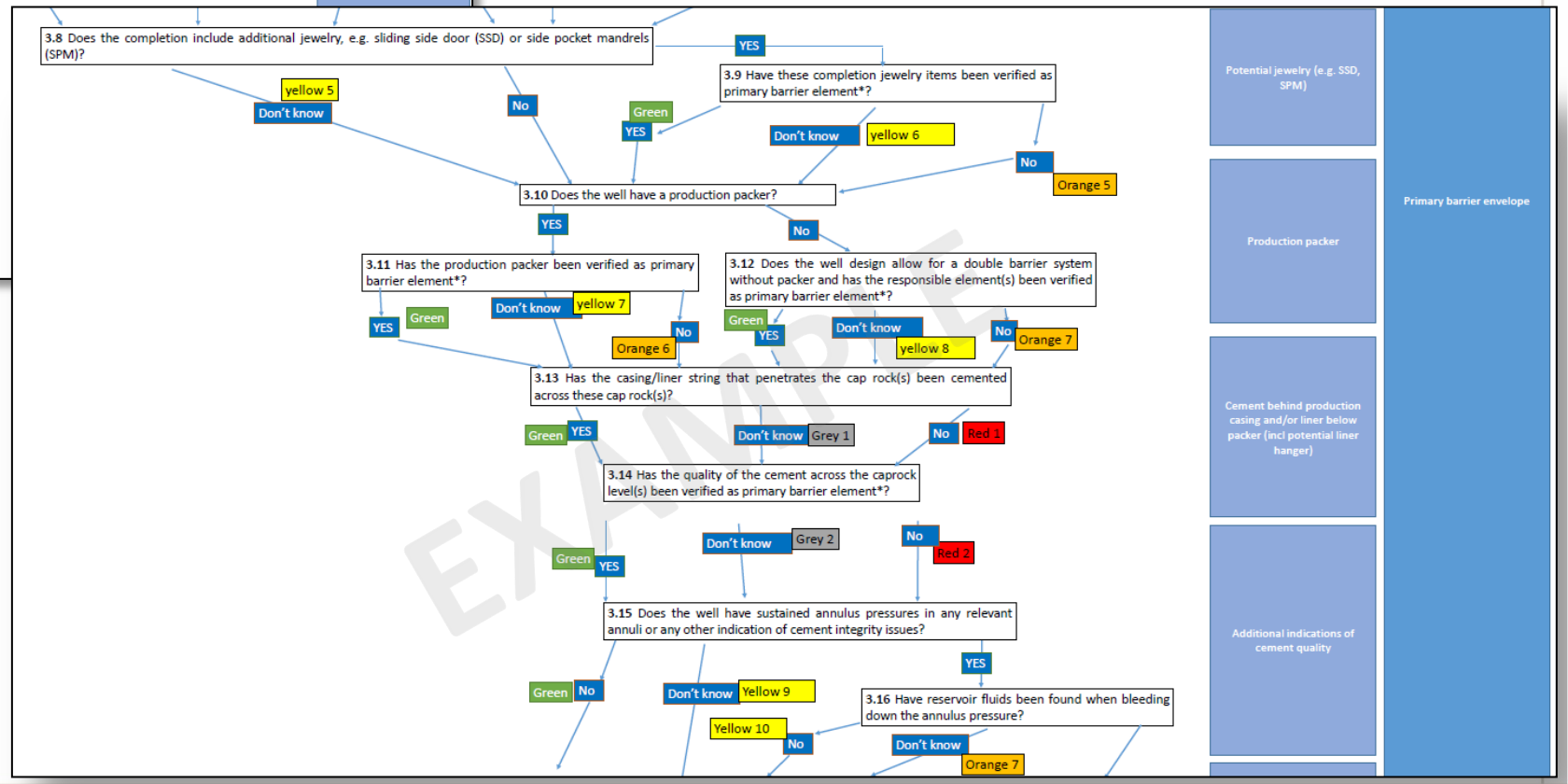


Category	Data
Reservoir and caprock	Target formation
	Caprock
	Current and expected pressure and temperature
	In-situ fluid composition
	Production history
Well construction and history	Drilling history and completion
	Well design and configuration
	Workover history
	Side-tracks
	Cement composition
	Cement evaluation logs
Well integrity record	Well barrier schematics
	Abandonment plan (if applicable)
	Completion reports or End of well report
	Mechanical integrity test
	Formation integrity/leak-off test
	Annular pressure
	History of well performance and issues
	Well maintenance history
	Load history

Well screening

- Decision trees for 5 integrity components
- Relevant for any well design
- Evaluation per question





Five integrity components

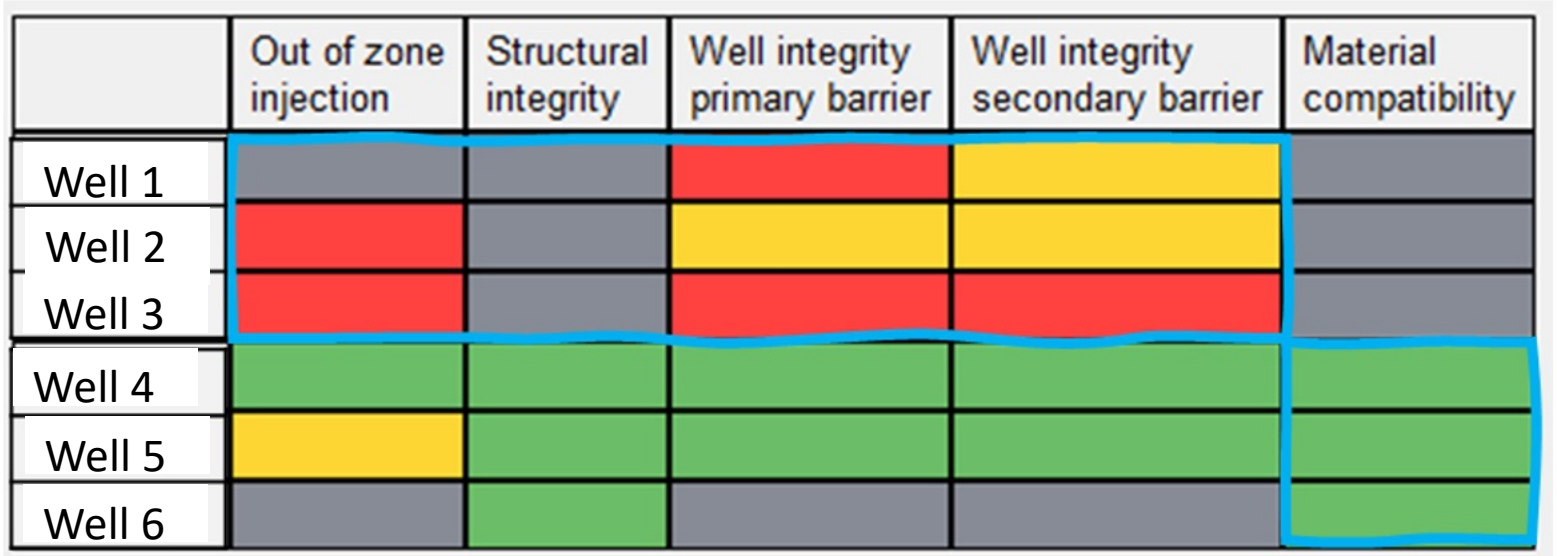
1. Out of zone CO_2 loss
2. Structural integrity
3. Primary well barrier
4. Secondary well barrier
5. Material compatibility

Well Evaluation Results

Results of well screening provided in the form of traffic light recommendations

Recommendation	Explanation
	No or only minor remediation could be expected
	Moderate remediation or additional verification efforts could be expected
	Severe remediation or a **comprehensive risk management strategy** on retrievable/replaceable items could be expected.
	Severe remediation or a **comprehensive risk management strategy** on non retrievable/replaceable items could be expected.
	Critical information is missing

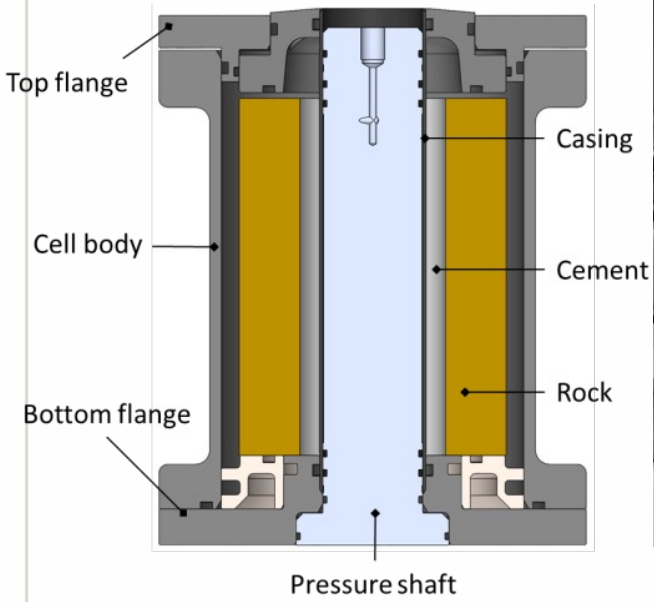
Example Application



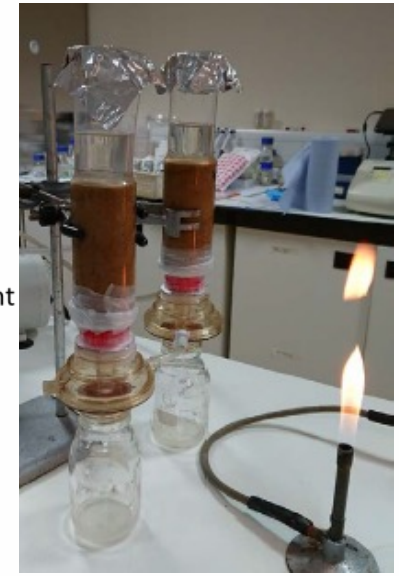
Experimental investigations for re-using wells for CO_2 storage

WP objective:

- Provide experimental data that describe how well degradation and well design influence potential re-use as CO_2 injectors
  - Input to well modelling tools
- Provide experimental data on potential self-healing and remediation strategies



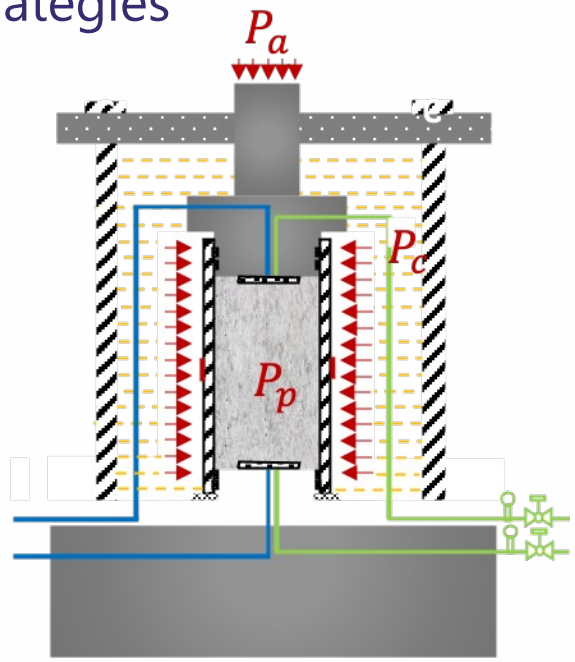
SINTEF



BGS

IFPEN

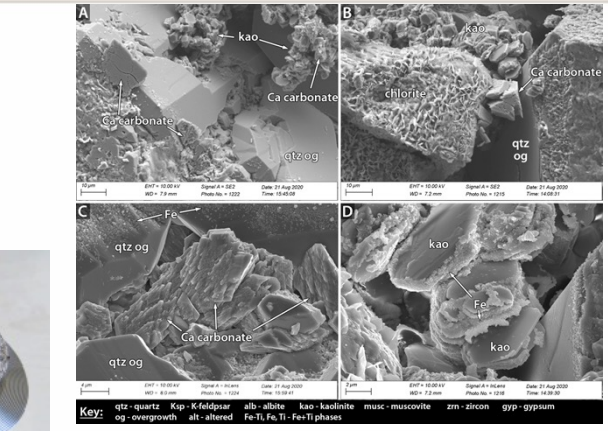
TNO

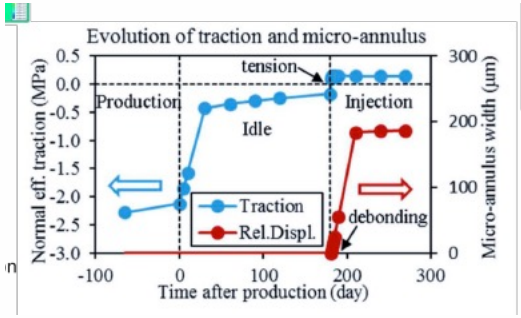


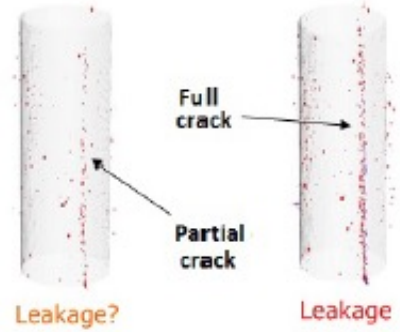
LANL

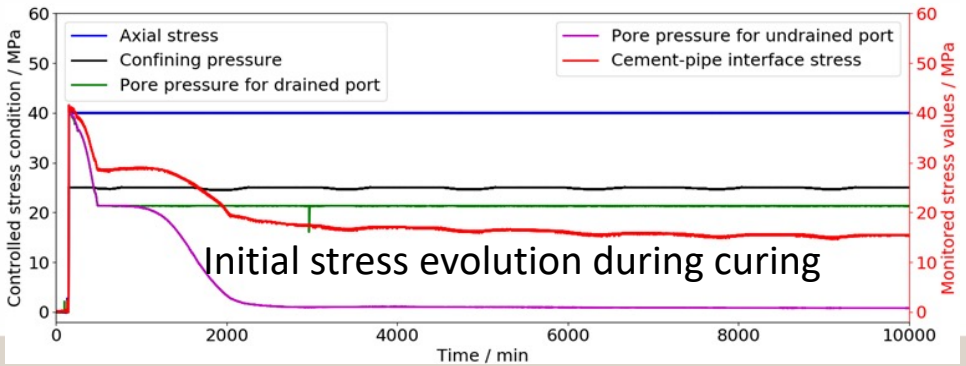
Highlights of Experimental Investigations

- Initial stress state of cement (LANL)
  - Not zero; anisotropic; much less than cement column
- Impact of mechanical and thermal stress (TNO)
  - Measured μ-annuli ≤ 15 μm
  - Modeled field operation impacts
- Impact of formation rock during stress (SINTEF)
  - "Soft" rock increases cement damage
- Strength of cement-steel/cement-formation bond (IFPEN)
  - Higher confining stress helps but generally weak
- Self-healing by carbonate precipitation (SINTEF)
  - Does occur but function of cement type
- Remediation using microbial precipitation (BGS)
  - Carbonate precipitation by Sporosarcina pasteurii









Regulatory, environmental and social aspects

- Non-technical aspects that influence the implementation of well re-use application, from regulatory (legal) aspects to public acceptance
  - Assessment of national legal frameworks
  - Workshop with regulators and others
  - Guidelines for permitting process
  - Public perception and acceptance of well re-use for CCS

Application of tool: international national well re-use case studies

Ref.: based on Google Earth

Case study name	Country	Onshore/offshore	Type	Reference
P18-2 (Porthos)	Netherlands	Offshore	Depleted gas field	Zikovic and van der Valk (2021)
Vaccum	USA	Onshore	CO_2-EOR field	Chen (2021)
Gullfaks Sør and Visund	Norway	Offshore	Oil fields	Grimstad et al., (2022)
Bunter Sandstone Closure 36	UK	Offshore	Saline aquifer	Williams and Hoskin (2021)
Hamilton	UK	Offshore	Depleted gas field	Williams and Hoskin (2022)
Rousse	France	Onshore	Depleted gas field and pilot CO_2 storage site	Guy and Cangemi (2022)
Salonta	Romania	Onshore	Depleted gas field (abandoned)	Dudu et al., (2022)

- Location: on- and off-shore
- Applications: Saline, depleted gas and CO_2 EOR
- Depths: 1400-5000 m
- Reservoir rock: sandstone and carbonate
- Reservoir type: gas field, oil field, saline aquifer
- Reservoir capacity: 37 – 280 Mt CO_2
- Number of available wells >100

Key findings from Case Studies

- Intervention required to re-purpose all wells
  - A rig or workover is usually required to repurpose wells
  - Remediation can be achieved via coiled tubing interventions (i.e. logging)
- Primary barrier components and completions are subject to cooling and may not be fit for re-use
- Structural integrity may be costly and technologically challenging to assess
- Quality of cement sheath and casing corrosion uncertainty
  - New logs may be necessary
  - Dual-cased sections may be difficult due to logging challenges

Conclusions: Recommendations for re-using wells

- A report will be published to present recommendations developed throughout the project
- Provide some insights about how to address the need to ensure that re-completed wells comply with CO_2 storage ISO 27914
- Data requirements and availability will form a key component of the report
  - Data requirements and data gaps
  - Data availability, knowledge transfer and access

REX-CO2

re-using existing wells

Thank you for your attention

https://www.rex-co2.eu

This project has received funding from ADEME (FR), RVO (NL), RCN/CLIMIT (NO), UEFISCDI (RO), BEIS (UK), and DOE (USA), under the EU Horizon 2020 programme ACT, Project No. 299681. The contents of this publication reflect only the author's view and do not necessarily reflect ERA-NET ACT's position. ERA-NET ACT is not liable for any use that may be made of the information contained here.