Webinar 6 - Onshore CO_2 storage in Spain: an overview of geological, technical, economic and social assessments

Ebro Basin region

14th November 2024

Online

The PilotSTRATEGY project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101022664

Agenda

14:00 **General overview of the project and Ebro Basin** (*Paula Canteli, IGME-CSIC)*

14:10 **Offshore permit overview** (*Francisco Pángaro, Repsol*)

14:15 **Lopín: geological model** (*Jesús Garcia Crespo*, IGME)

14:20 **Onshore CO2 storage possible development** (*Manuel Ron, Repsol*)

14:30 **Social acceptance** (*Christian Oltra, CIEMAT-CISOT*)

14:40 **Questions** *(Ebro basin team available)*

15:00 **Webinar session closure**

Ebro Basin Core Team for PilotSTRATEGY


Paula Canteli


Jose Mediato


Jesús García Crespo


Iván Moreno

CSIC | IGME


Christian Oltra


Lila Gonçalves


Ana Prades


Sonsoles Eguilior


Yolanda Lechón

Ciemat

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas


Francisco Pángaro


Manuel Ron

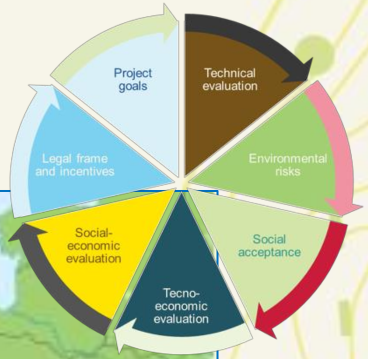
REPSOL

General overview of pilotSTRATEGY project and Ebro Basin

Paula Canteli (IGME-CSIC)
Coordinator of Ebro Basin work

PilotSTRATEGY

- **Funded by EC** – R&I H2020
- 10 M€ budget & 5 years (2021-2026)
- 21 partners (**Research & Industry**)
- To **support development** of carbon capture and storage (CCS) in **Southern and Eastern Europe by detailed study of 3 CO2 geological storage pilot sites** in selected areas of interest, and lower detail in other 2.
- **Pre-investment proposal** for the **3 pilots** in **France, Portugal and Spain**, and development concept proposal for Poland and Greece regions.
- **Deep saline aquifers:** large capacity for storing CO2.



The five-year pilotSTRATEGY project, which commenced in 2021, has received funding from the European Union´s Horizon 2020 research and innovation programme under grant agreement nº 101022664.

PilotSTRATEGY

WP1 – Coordination & Management (BRGM)

WP2- Geo-characterisation
Leader: UEDIN
Co-Lead: REPSOL
T2.1 Compilation of existing data and choice of pilot locations
T2.2 New geophysical surveys and reprocessing of existing 2D seismic
T2.3 Conceptual geological models.
T2.4 Geomechanics properties
T2.5 Geochemical assessment
T2.6 Understanding the regional hydrogeological system
T2.7 West Macedonia
T2.8 Upper Silesia, Skoczów reservoir.

WP3 – Static and dynamic simulations
Leader: IFPEN
Co-Lead: BRGM
T 3.1 Static modelling with uncertainties
T 3.2 Storage capacity optimization
T 3.3 CO_2 fate on the long-term
T3.4 Quantification of phenomenological impacts

WP5- Safety and Performance
Leader: BRGM
Co-Lead: CIEMAT
T5.1 Methodological guidelines
T5.2 "Experimental design"
T5.3 Computation
T5.4 Decision analysis
T5.5 Stakeholders dialogue
T5.6 Recommendations

WP4 – Pilot Development and Implementation Plan
Leader: IGME
Co-Lead: REPSOL
T4.1 Development concept definition and optimization
T4.2 Optimized pilot design
T4.3 Environmental Impact Assessment (EIA)
T 4.4 Economic evaluation of selected concept scenarios and priorization of opportunities
T 4.5 Investment Proposal (incl. pre-FEED)

WP6 - Social Acceptance
Leader: Fraunhofer
Co-Lead: CIEMAT
T 6.1 Policy Context & Alignment
T 6.2 Community profile of the five regions
T 6.3 Survey of community public acceptance
T 6.4 Citizen engagement
T 6.5 Stakeholder engagement workshops: regional committees
T 6.6 Public engagement guidelines and recommendations

WP7 - Public communication and project impact management (Leader: UEDIN & Co-Lead: IGME)

To be a model for future investors/operators

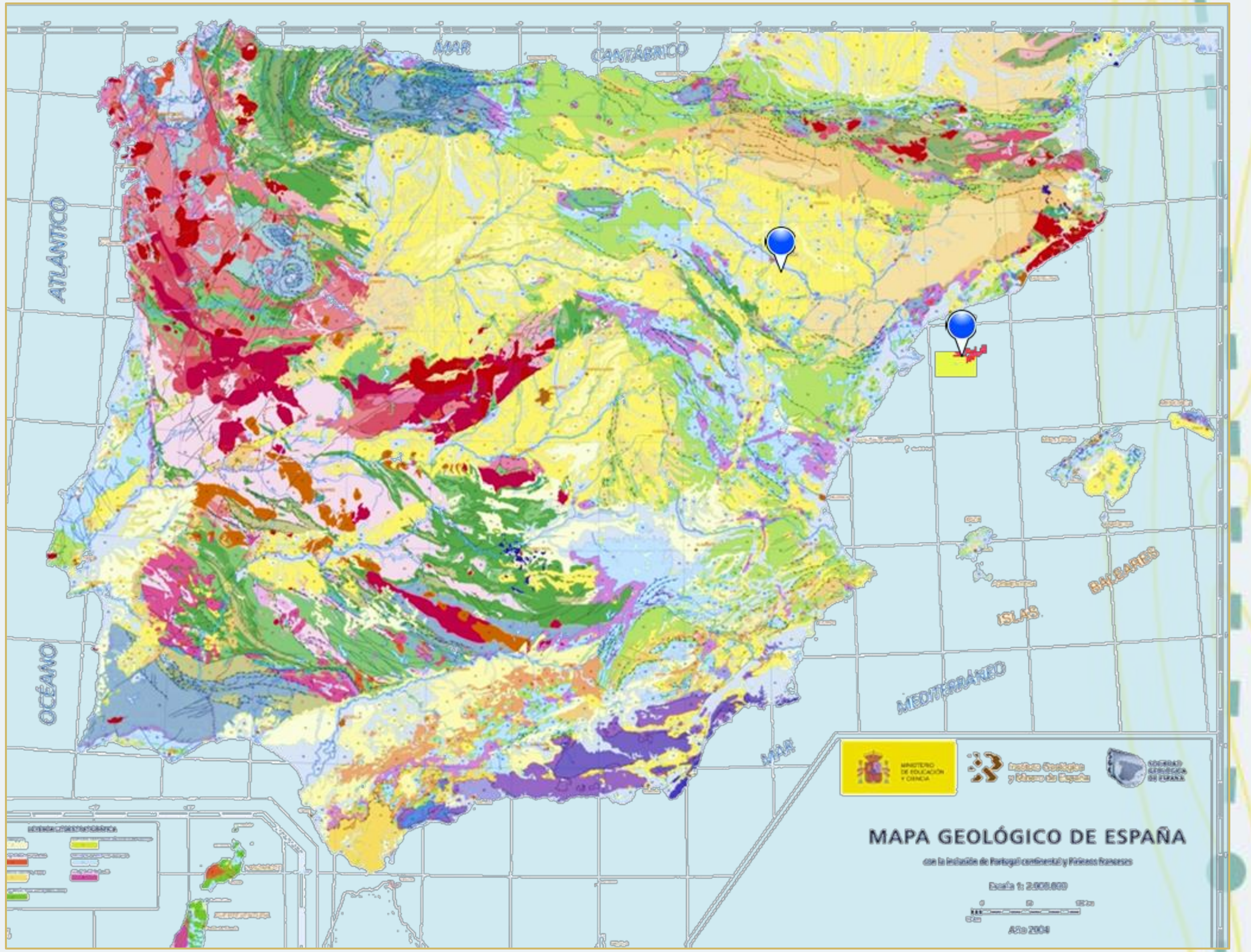
To identify gaps for CO2 storage implementation (regulation/legislation)

To build confidence in society

PilotSTRATEGY

Ebro Basin (Spain)

- Ebro basin region proposed **two sites** - Onshore (Lopín) vs Offshore (Tarragona cost)- **to select one** (M18, Sept2022) to end.
- These sites proposed based on **ALGECO2 and STRATEGY CCUS results** (Ebro Basin)- onshore- and **knowledge of potential offshore** (former exploitation **area** by Repsol).
- **2 absolutely different sites**: geology, number and quality of data, industrial possibilities, infrastructure, …
- First months compiling as much information as possible to take a decision.



Ebro Basin decision workflow

- **Objective:** Identify PROS and CONS of both sites from each criteria and multicriteria evaluation for a complete overview to select the best option for the project objective (qualitative and only if it is needed, quantitative):
  - ❖ Structures review
  - ❖ Environmental risk evaluation
  - ❖ Social acceptance
  - ❖ Preliminar-economic evaluation CCS implementation
  - ❖ Fit to project objective (call)
  - ❖ Multicriteria evaluation (based on Portuguese team)

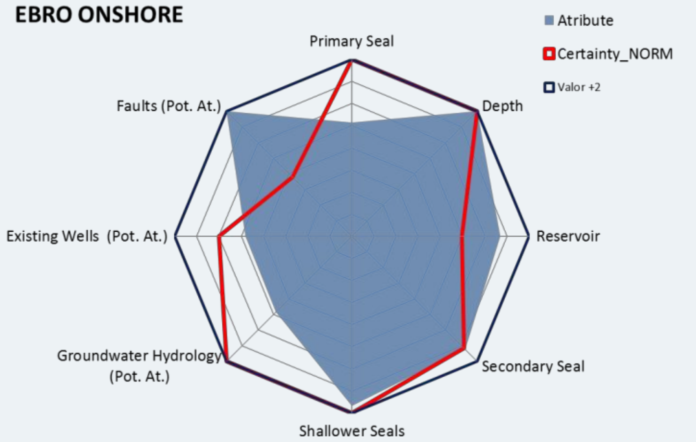
➢ 17 September 2022: Ebro Basin workshop and final decision: **consensus in final decision**.

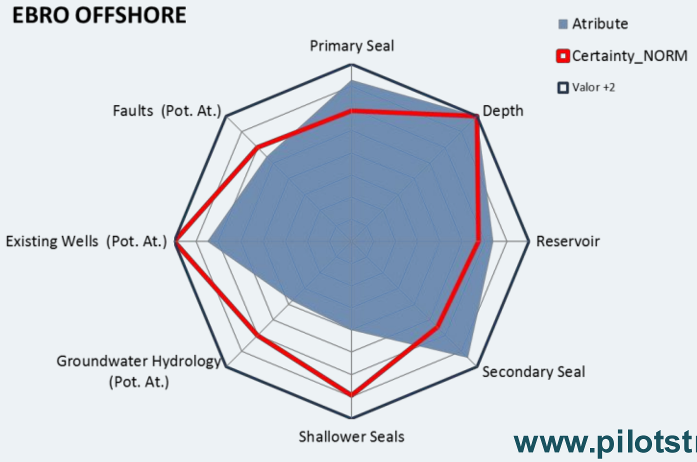
Environmental Risk Assessment

Comparing sites against their HSE risk. Two values are assigned to each attribute (p) based on:

- Relationship to **risk** (blue);
- **Confidence** in that value (red)

Function	Represented by	Attributes (p)
Prevent CO_2 leakage	Primary containment	Primary seal
		Depth
		Reservoir
Prevent CO_2 leakage from reaching the environment.	Secondary containment	Secondary seal
		Shallower seals
Attenuate the flow of CO_2 into the environment or disperse it in such a way that high concentrations that could cause damage do not occur.	Attenuation Potential	Groundwater hydrology
		Existing wells
		Faults



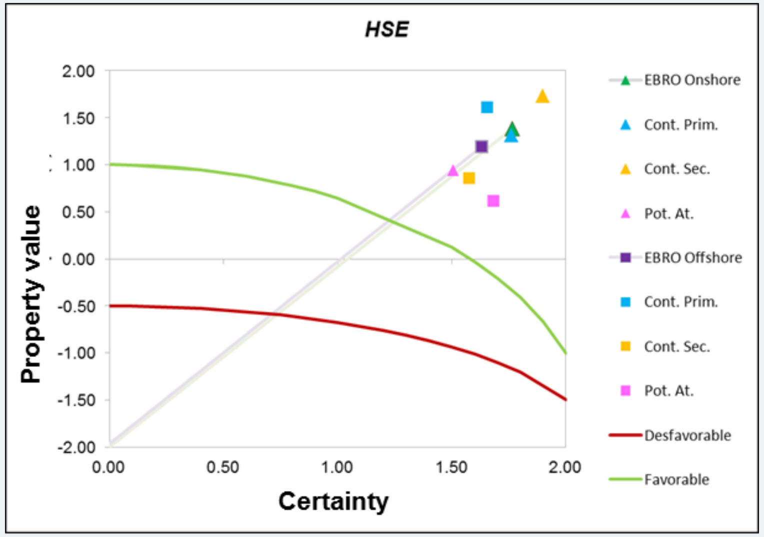


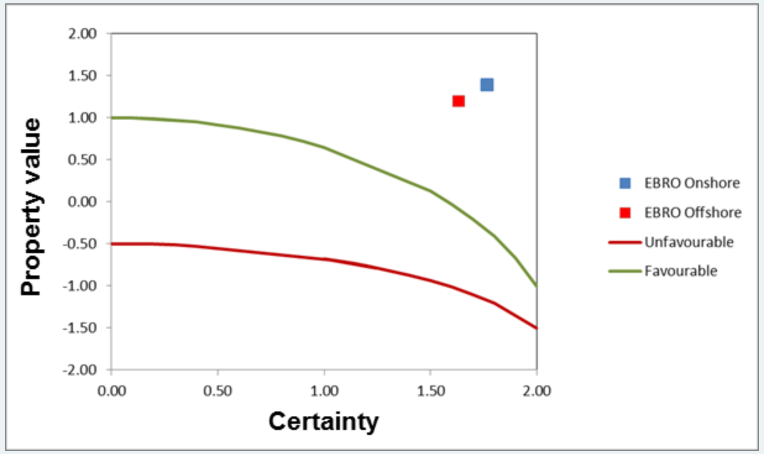
Environmental Risk Assessment

- Case studies with major differences from the point of view of geological structure and their HSE implications.

- From the safety side, **both structures are valid** from the point of view of their HSE Risk level, with EBRO ONSHORE being slightly better (5.14%).

- Two main components can be distinguished in these assessments:
  - **Certainty**: The degree of certainty is higher in the structure of the Ebro Onshore despite there is significantly less data available, which is justified by its lower structural complexity (difference of 6.62%);
  - **Property value**: Overall similar in both, although slightly better in Ebro Onshore (difference of 4.76%).





Ebro Basin Team Decision
(site to be developed to the end of the project)

- **From the PilotStrategy Project's perspective Ebro Basin Team recommends proceeding with the onshore site. Basis for this are:**
  - Technically, both sites could be selected considering the level of uncertainty: no identified stoppers.
  - Social acceptance is slightly more favorable on the onshore area.
  - Onshore site has more chances of progressing towards a pilot or technology-testing project due to lower costs, simplicity in development, operability, monitoring and regulation (*e.g.* drilling, 5-10 M€ versus 35-40 M€ in offshore).
  - It is interpreted that onshore activity would have a more direct impact on PIB and local job-generation.
  - Visibility towards society & institutions would be more direct and easier to extrapolate to other areas of Spain.
  - Onshore replication could unlock potential for CO_2 need for inland industries.

Peñas Royas (Teruel, España)- **onshore Lopín analogue**
www.pilotSTRATEGY.eu

PilotSTRATEGY

The Repsol Commitment
Net Zero Emissions
by 2050

REPSOL

TarraCO2-Storage Project

Repsol Exploración S.A.

14-11-2022

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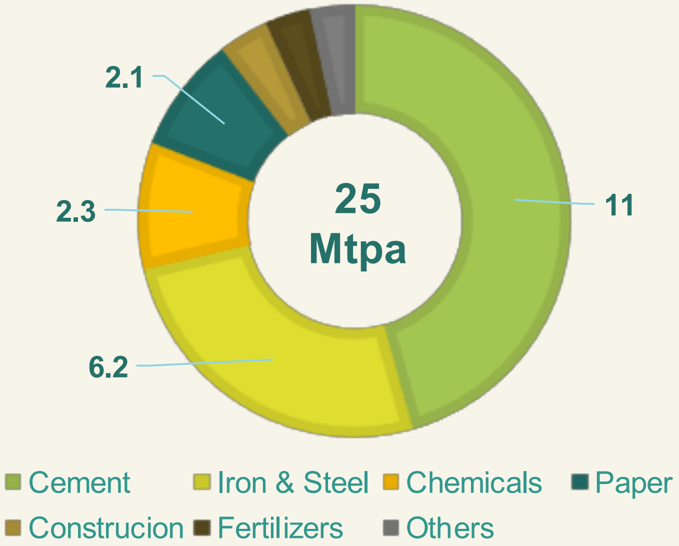
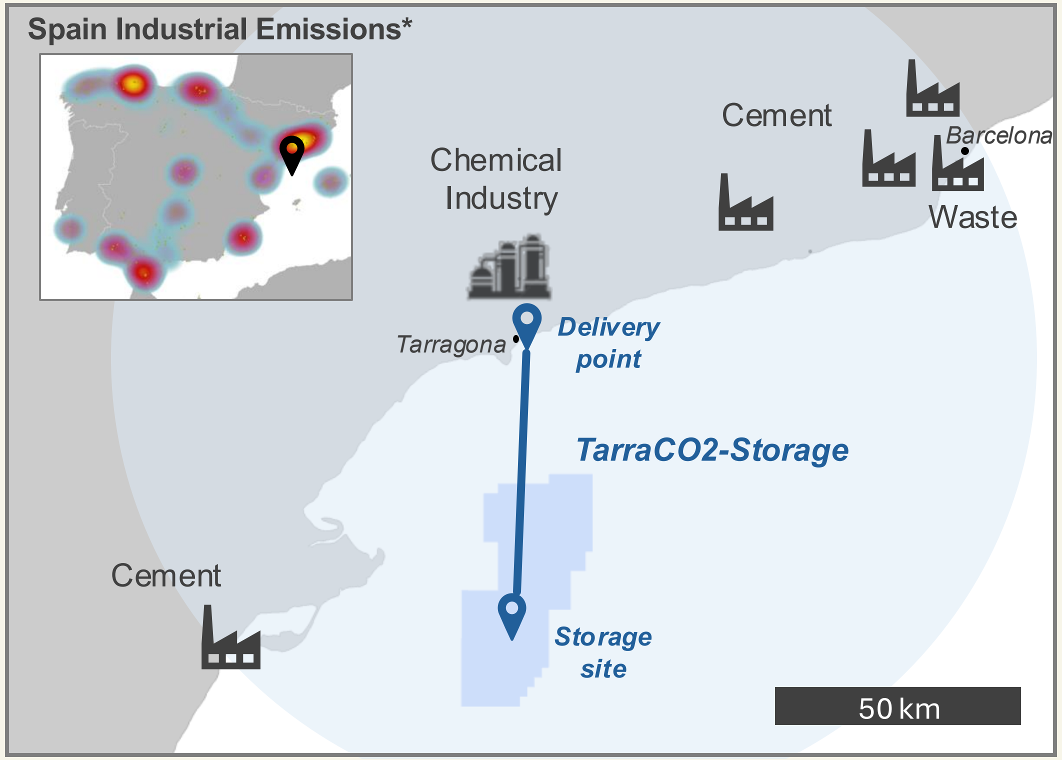
TarraCO$_2$-Storage Project: Why offshore Tarragona?

Spanish Industrial Emissions*
(individual sources >0.4 Mtpa)

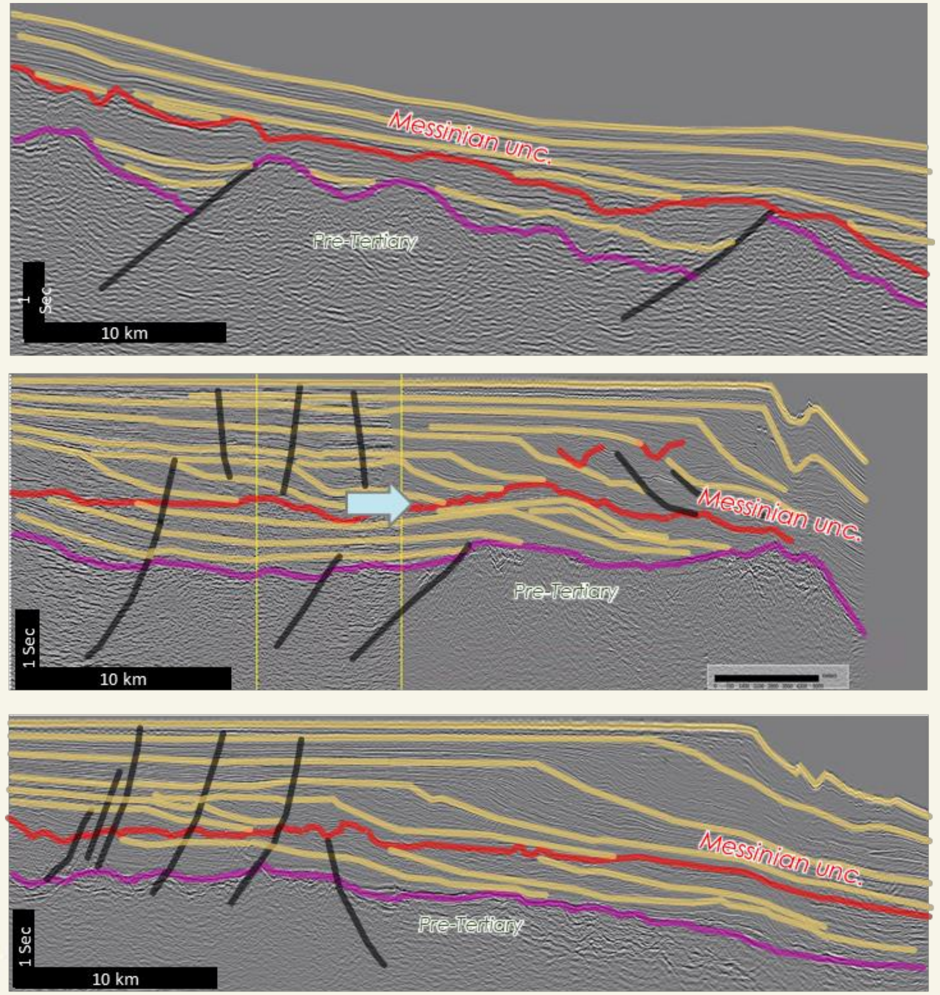


* Refining & power generation excluded

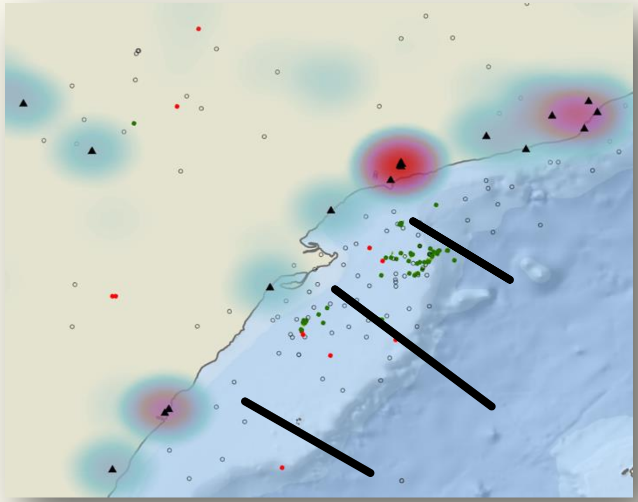


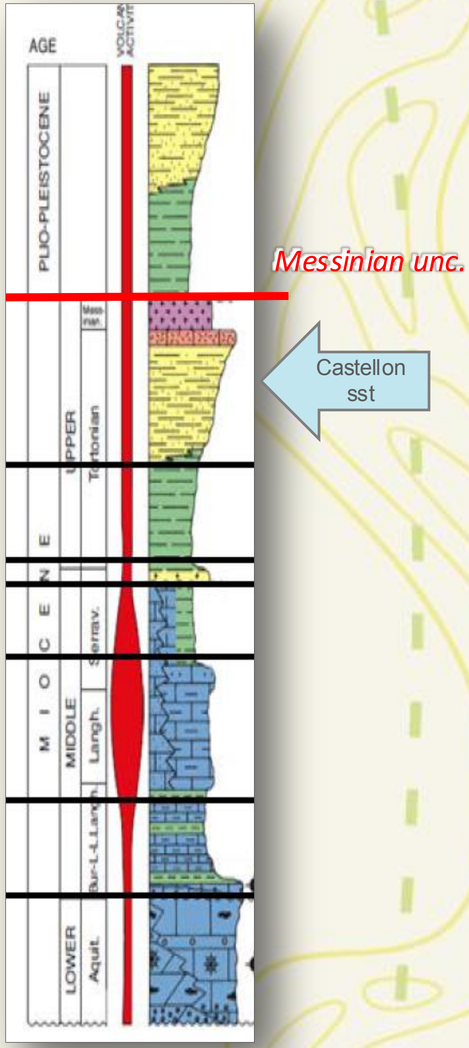
- Hard to abate industry cannot fully decarbonise solely through energy efficiency and zero emissions feedstock.
- CCS provides the additional abatement volume required to comply with emissions targets.

TarraCO$_2$-Storage Project: Why offshore Tarragona?



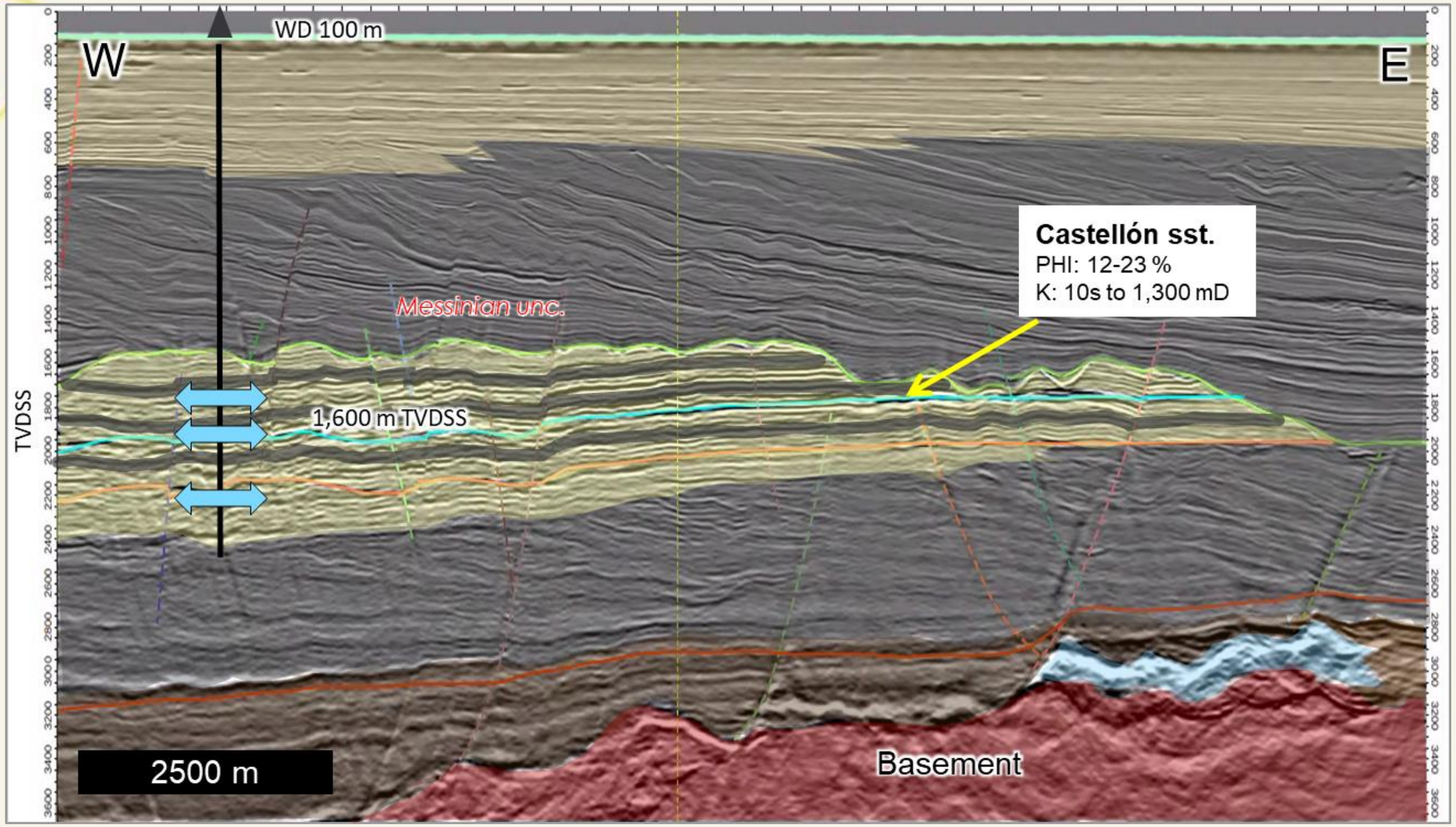
- Passive margin.
- >2 km sediments sourced by Ebro river.
- Deep erosion during Messinian provides containment.



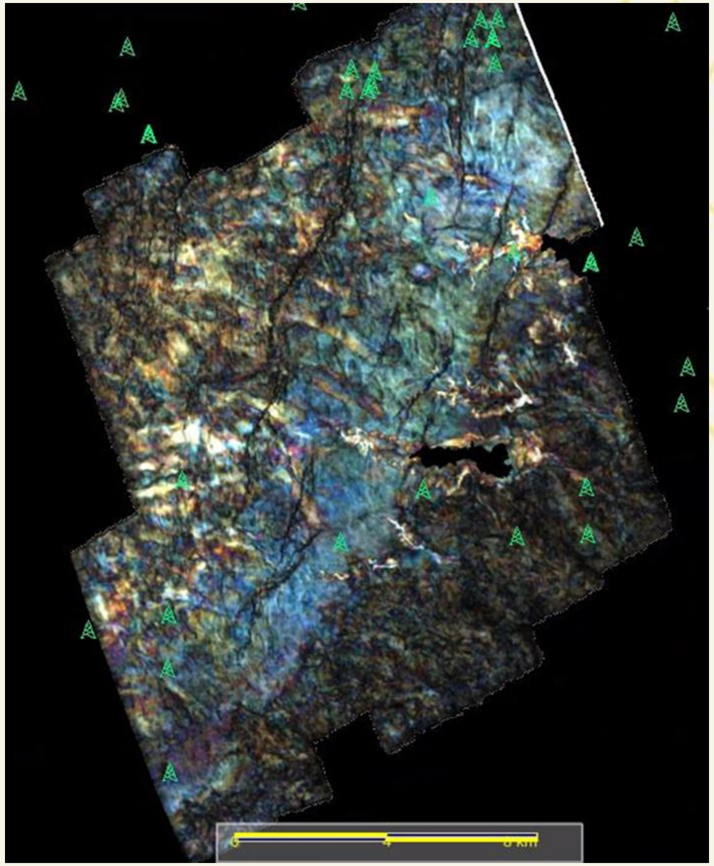


TarraCO$_2$-Storage Project: Storage site characterization

Seismic line across storage site



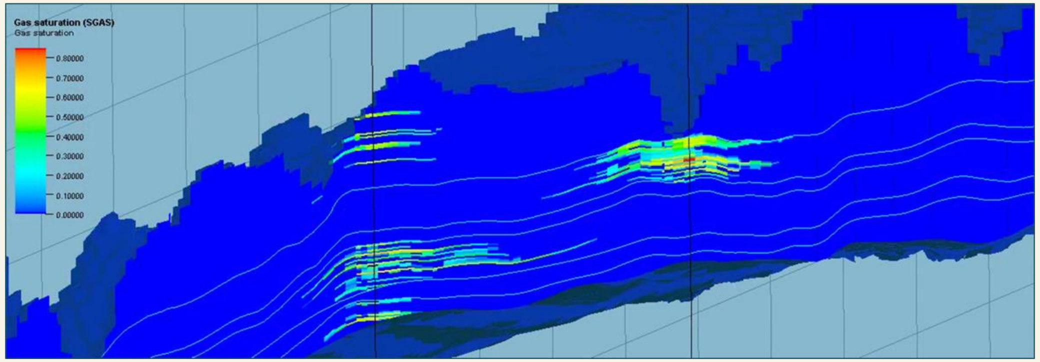
Spec-decom reservoir interval



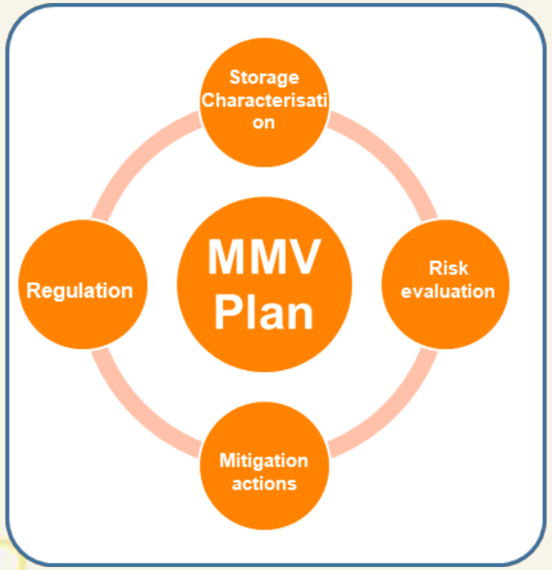
- Storage is capped and underlain by +1 km thick fine-grained sediments that provide sealing and geomechanical integrity.
- Shallow marine – good-quality reservoirs were documented through drilling.

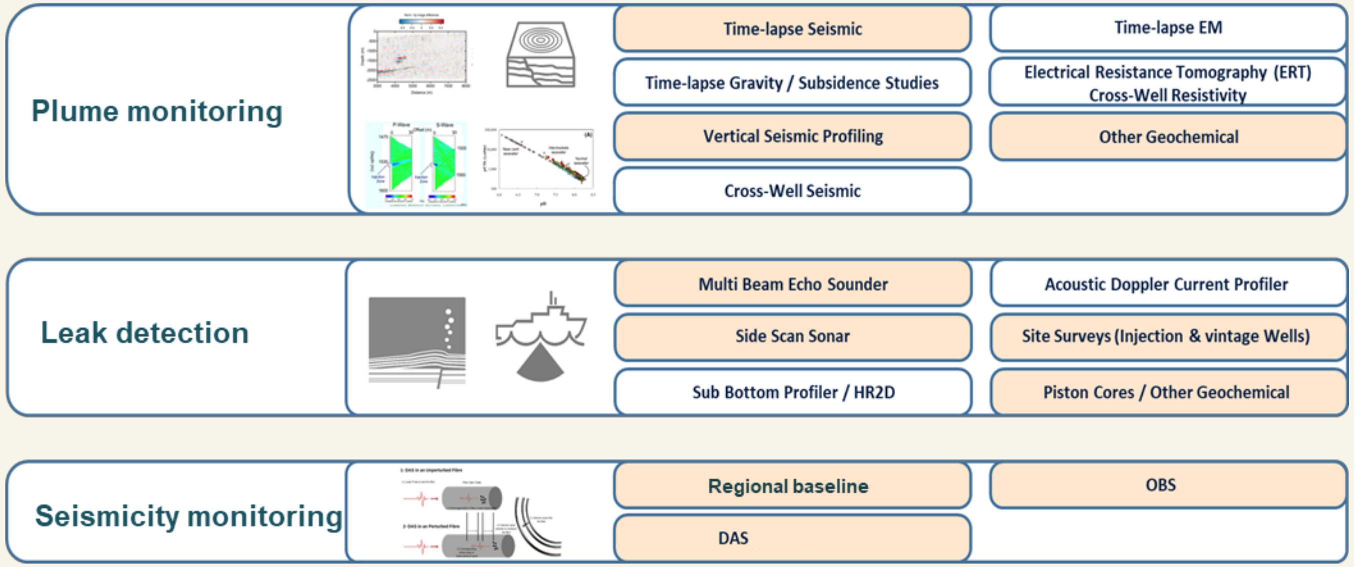
TarraCO₂-Storage Project: Dynamic modelling & MMV

CO_2 saturation at end of injection period (year 30)



- **Dynamic simulations** indicate plume stabilization is enhanced by the multi-layered reservoir storage.
- **MMV** project visualization includes several technologies aimed at: - monitoring plume evolution, ensuring containment, leak detection, etc.





TarraCO$_2$-Storage Project: Why offshore Tarragona?

✓ Hard-to-abate industry concentration

✓ Appetite for additional decarbonization vehicles beyond energy efficiency

✓ Favourable geologic context

✓ Operational experience by Repsol

The Repsol Commitment
Net Zero Emissions
by 2050

REPSOL

Ebro Basin Geological Model

Spanish team

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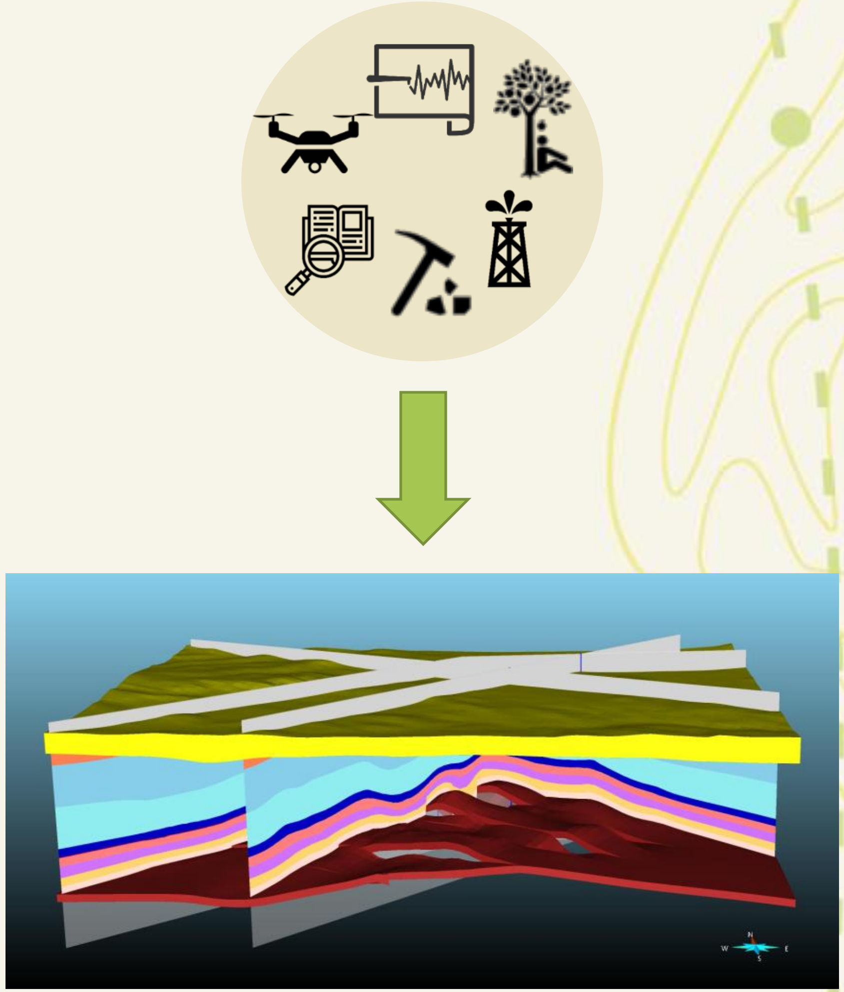
Conceptual model and simulation

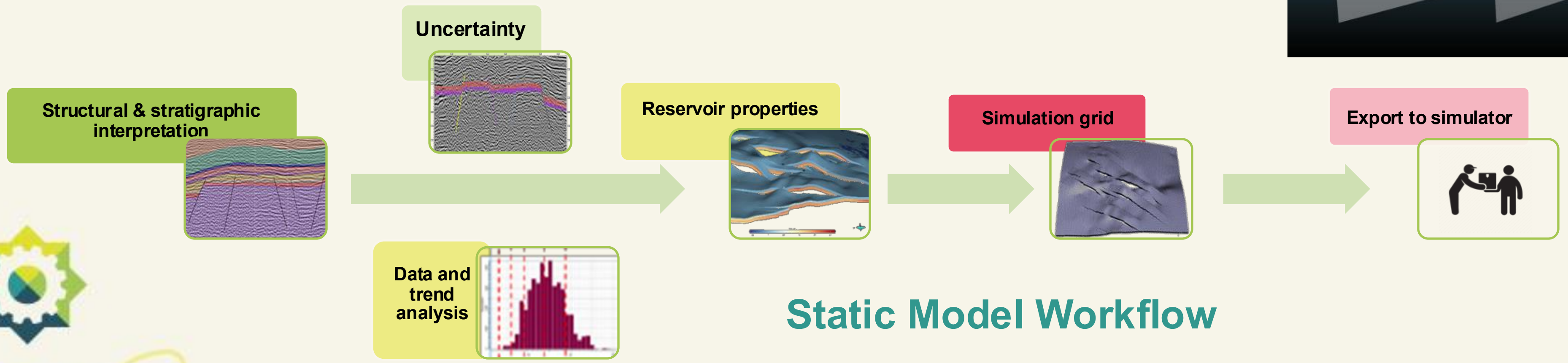


WP2 Geo-characterisation

- Compilation of existing data (seismic sections, wells, literature)
- New surveys (gravimetry, regional seismicity, analogues, drone)
- Conceptual Geological Model
    - Petrophysics (mineralogy, porosity, permeability)
    - Facies analysis
    - Geomechanical assessment
    - Geochemical assessment

WP3 Static and Dynamic Simulations

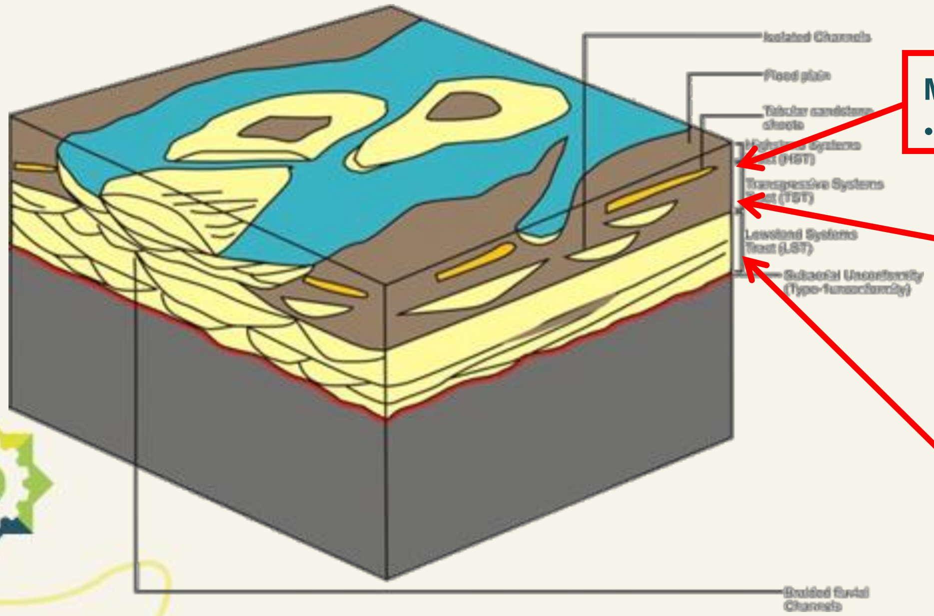
- Static modelling with uncertainties
- Dynamic modelling (storage capacity optimization, scenarios, minimization of risks, CO_2 fate on the long-term, etc.)



Static Model Workflow

Conceptual model

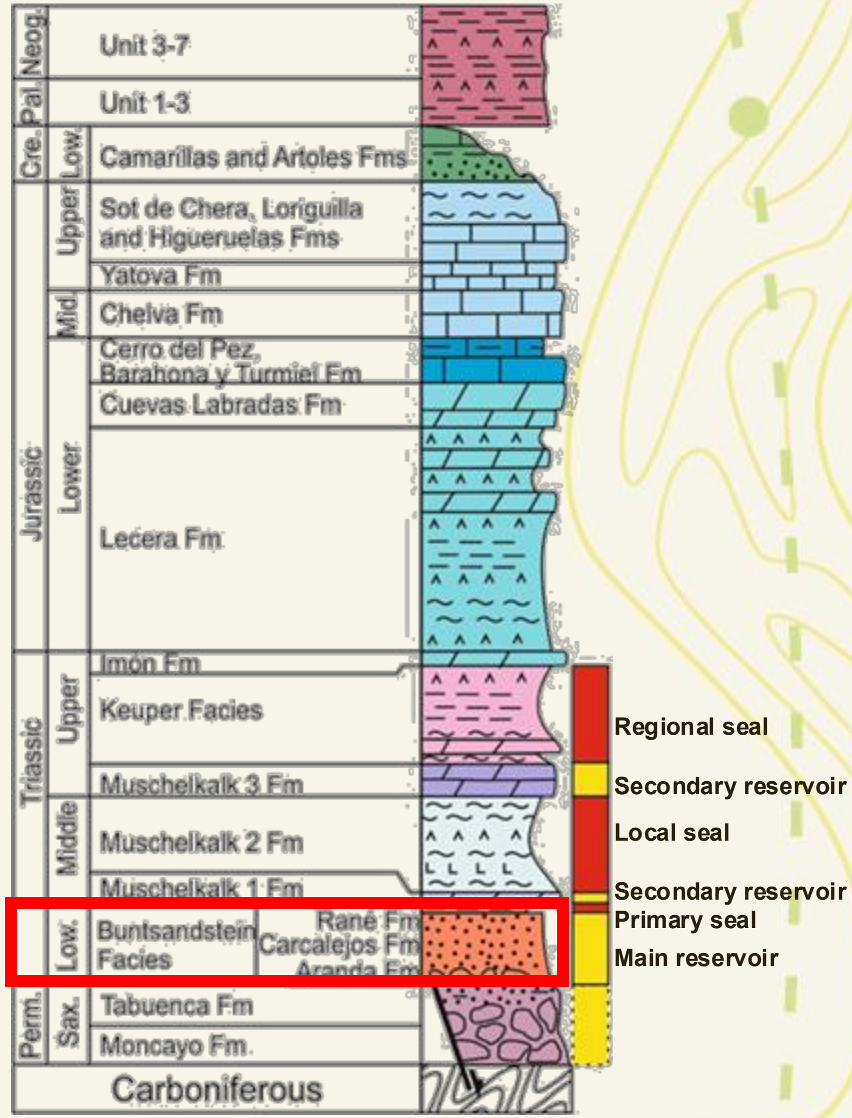
- **Paleozoic Basement** (metamorphic rocks).
- **Triassic:** *Buntsandstein* sandstones, *Muschelkalk* dolomites and evaporites, and *Keuper* evaporites and shales.
  Three sealing evaporitic sequences:
  (i) Buntsandstein top
  (ii) Middle Muschelkalk facies=M2)
  (iii) Keuper
- **Jurassic** dolomite and anhydrite. Platform carbonate sequences.
- **Cretaceous:** Continental carbonate and detrital deposits.
- **Cenozoic** unconformable continental evaporitic and detrital rocks.



Mb. Rané/Fm. Cálcena (B3)
- Sea flooding (HST)

Fm. Carcalejos (B2)
- Channel fill
- Floodplain

Fm. Aranda (B1)
- Channel fill
- Sheetflood
- Eolian
- Floodplain



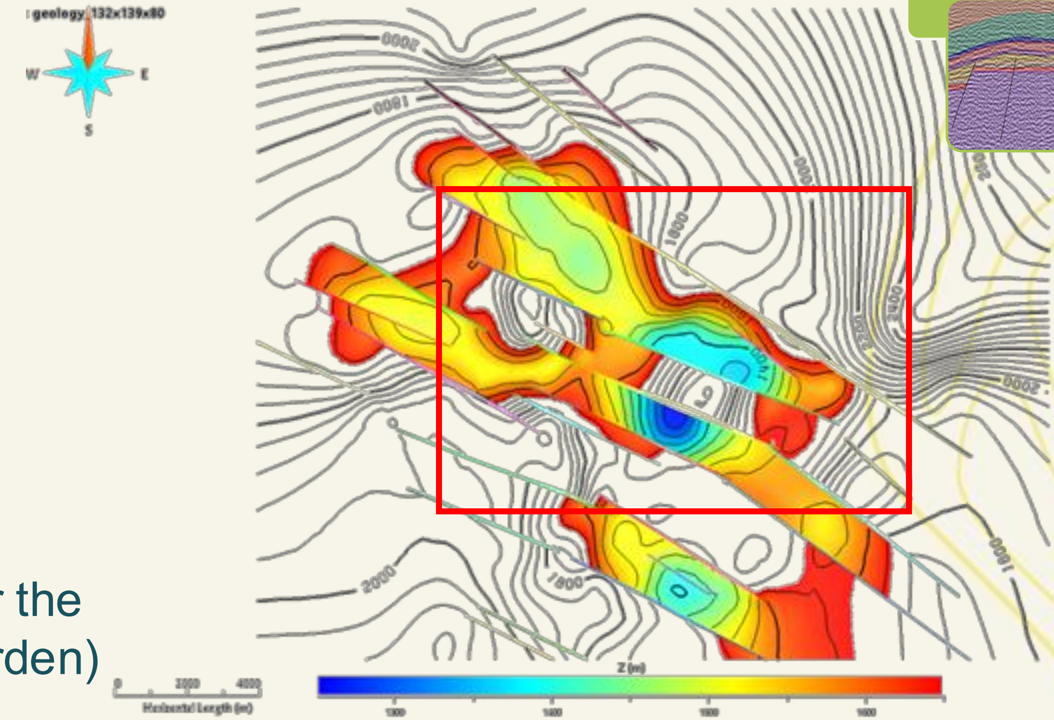
Braided system + fluvial + floodplain
Dividided into 3 members: B1, B2 y B3

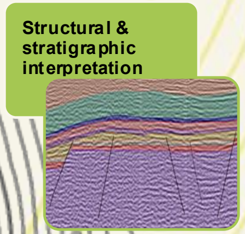
Modelling

Structural modelling *Aspen SKUA Structure and Stratigraphy Workflow*.

Feedback with interpretation task.

Isobath map. Structure closure at about 1,650 mbsl.

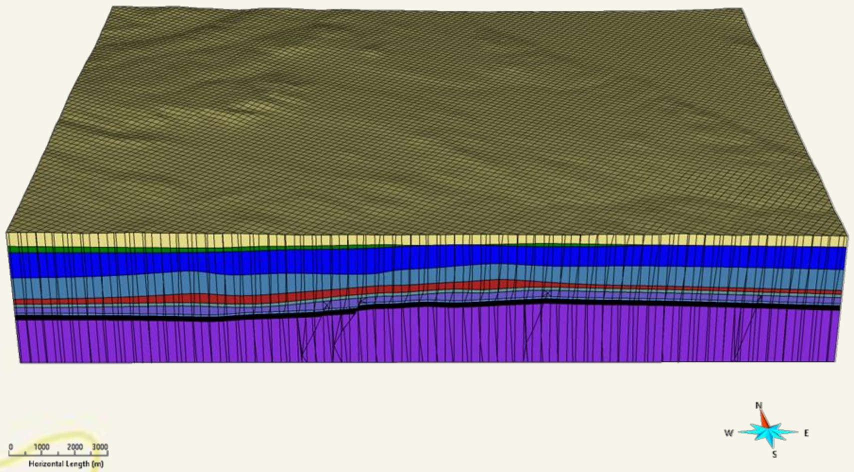


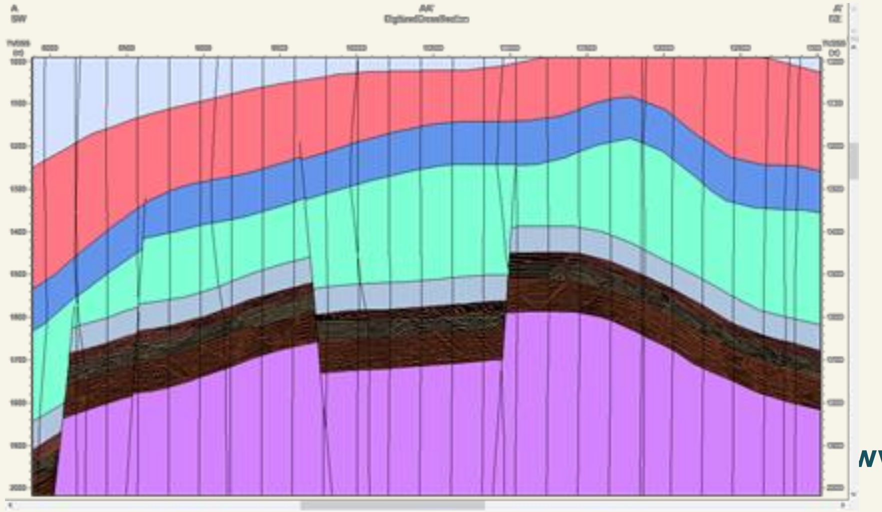


3D Grid *Aspen SKUA Grid Workflow*.

Cell size 200x200x2m in the storage formation

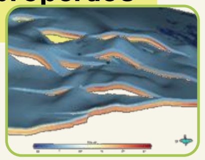
Model with **1,467,840 cells**. 132x139x80 cells (70 for the storage formation, 10 for the overburden and overburden)

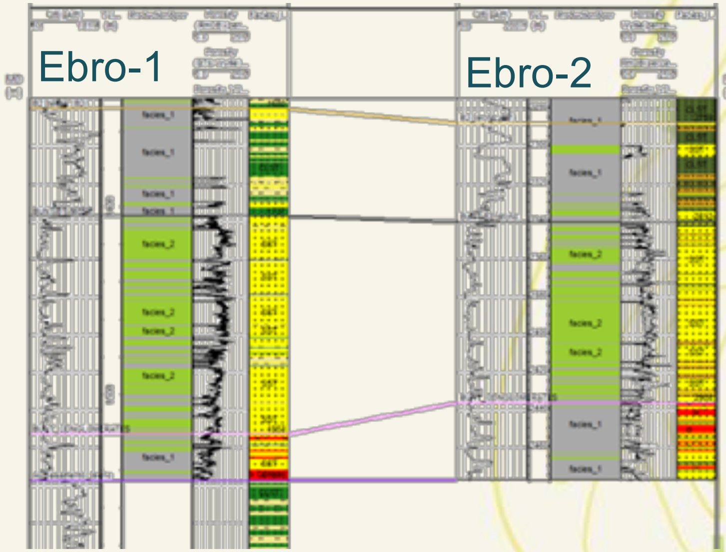




Fluvial formations modelling

Reservoir properties





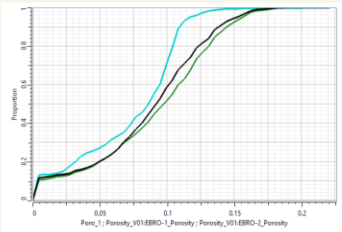
Three members of Buntsandstein Fm. (B1, B2 and B3). Very constant thickness. Heterogeneity:

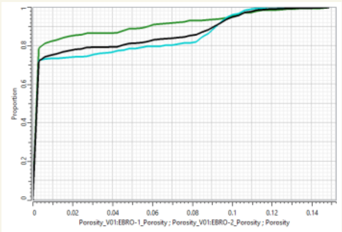
- Vertical: EBRO-1 and EBRO-2 wells.
- Horizontal: *Aspen SKUA FLUVSIM workflow*. Wells, outcrops and literature (channels proportion, orientation, sinuosity, width, thickness, overlapping)

Two **facies**:

- Channels. More than 8% of porosity
- Shales. Less than 8% of porosity

- Several simulation runs
- Channel parameters calibrated until input distribution matching.



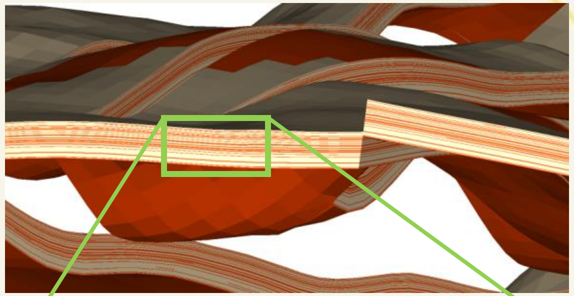


Members
B1
B2

Facies
Channel
Shales
FLUVSIM

Channel porosity
FLUVSIM

Shale porosity
Sequential Gaussian Simulation (SGS)



Goal: reproduce reservoir heterogeneity

Simulation Grid

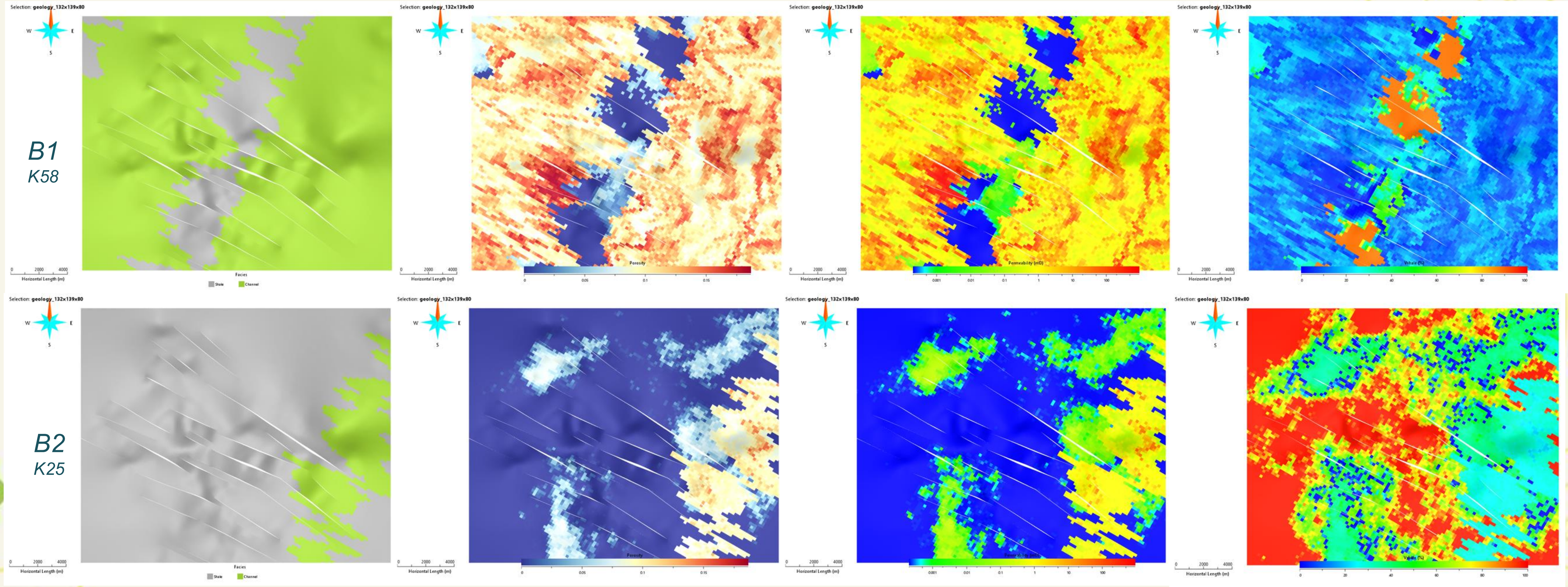
Properties population

Facies: facies of the corresponding scenario by region.

Porosity: *FLUVSIM / SGS*

Permeability and shale volume (Vsh): porosity dependent.

Facies *Porosity* *Permeability* *Vsh*



Static model results

Pilot site area

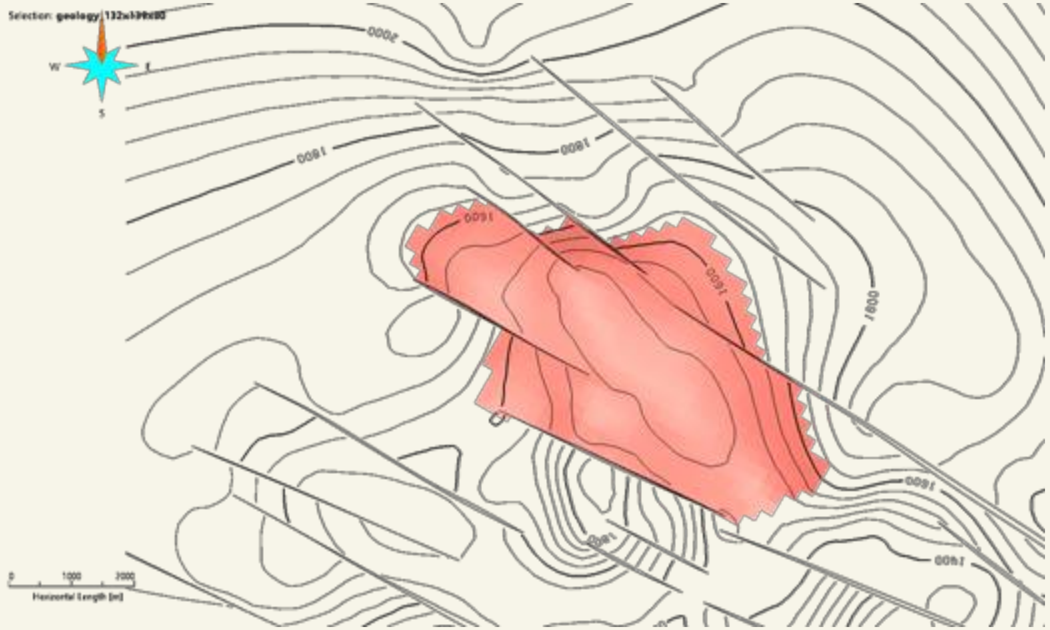
Volume	Vol (Mm^3)	Vol. Por. P50 x NtG (Mm^3)
B1	945	62
B2	693	10
Total	1640	72

Capacity	Vol x Por x NtG (Mm^3)	Mt CO_2
P10	41	7
P50	72	13
P90	125	23

Efficiency factor = 30%, CO_2 density = 600kg/m^3

Area of interest

Channels	Porosity B1	Porosity B2	NtG B1	NtG B2	Vol B1 (Mm^3)	Vol B2 (Mm^3)
P10	8,72%	8,35%	45,93%	5,01%	28.120	14.860
P50	**11,05%**	**9,65%**	**59,72%**	**14,93%**	28.470	15.170
P90	14,75%	11,39%	75,66%	25,07%	28.830	15.490



Webinar. Ebro Basin, Lopin structure. Onshore CO_2 storage possible development.

Manuel Ron Martín. Repsol Exploración S.A.

14-11-2022

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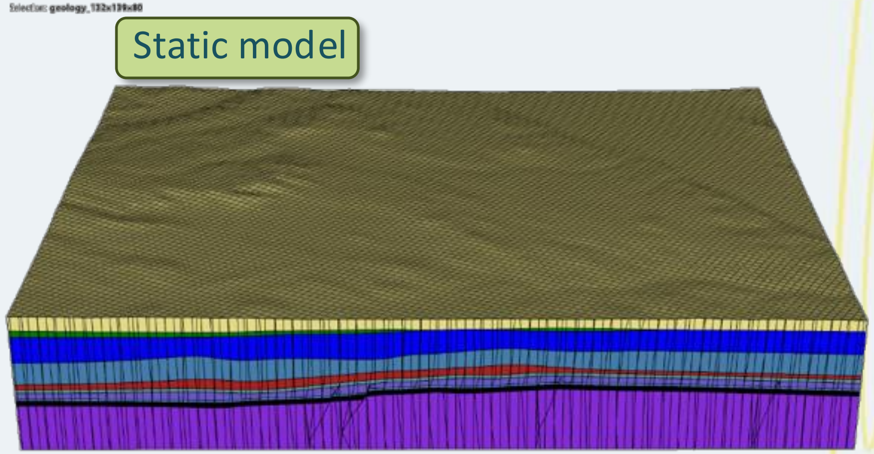
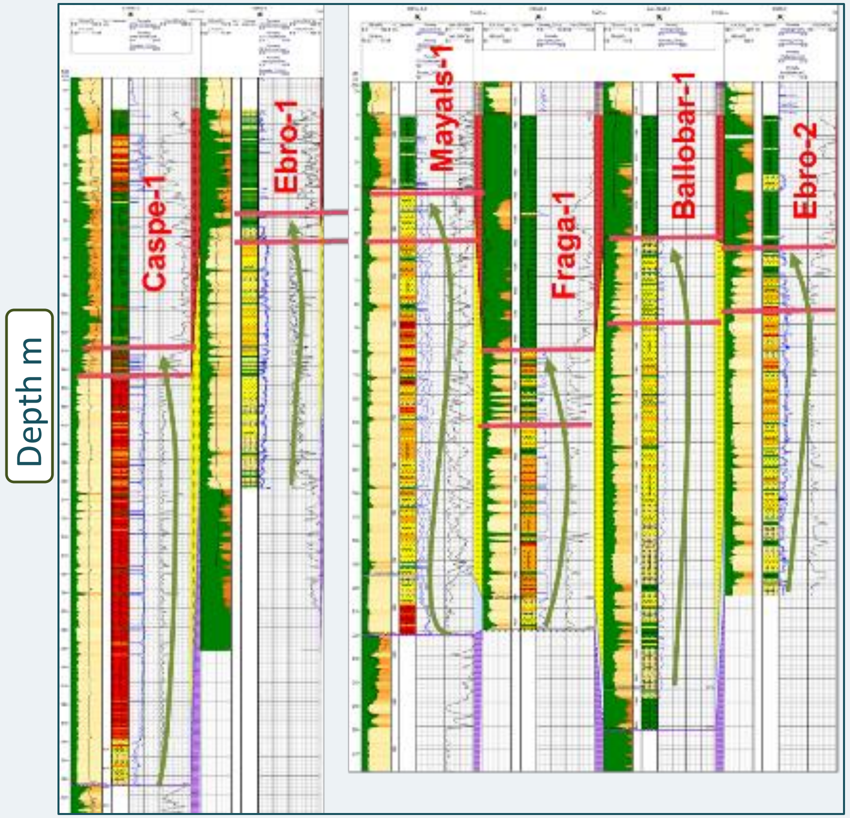
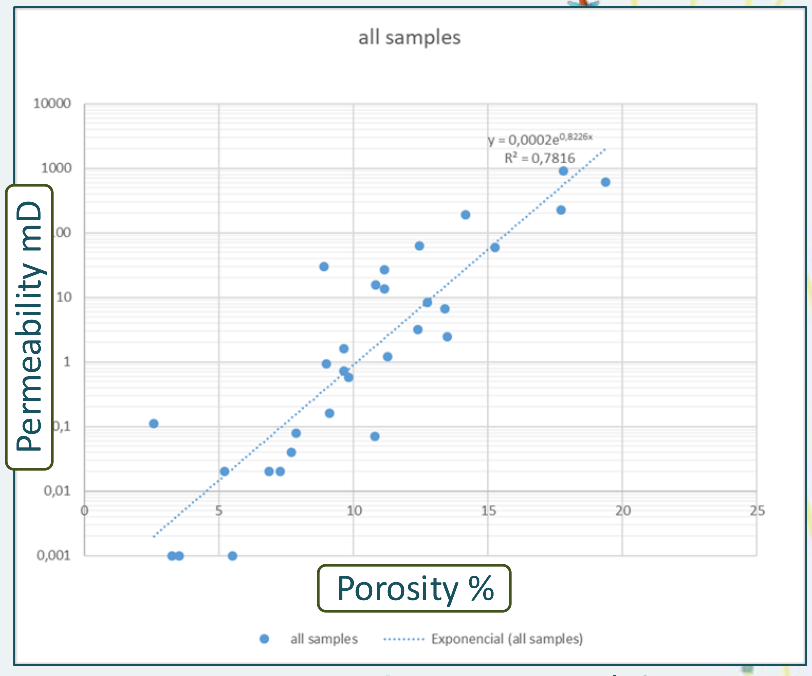
PilotSTRATEGY – Dynamic Model Inputs

1. Geological model

- Rock properties (ease of flow).
- Structural configuration.



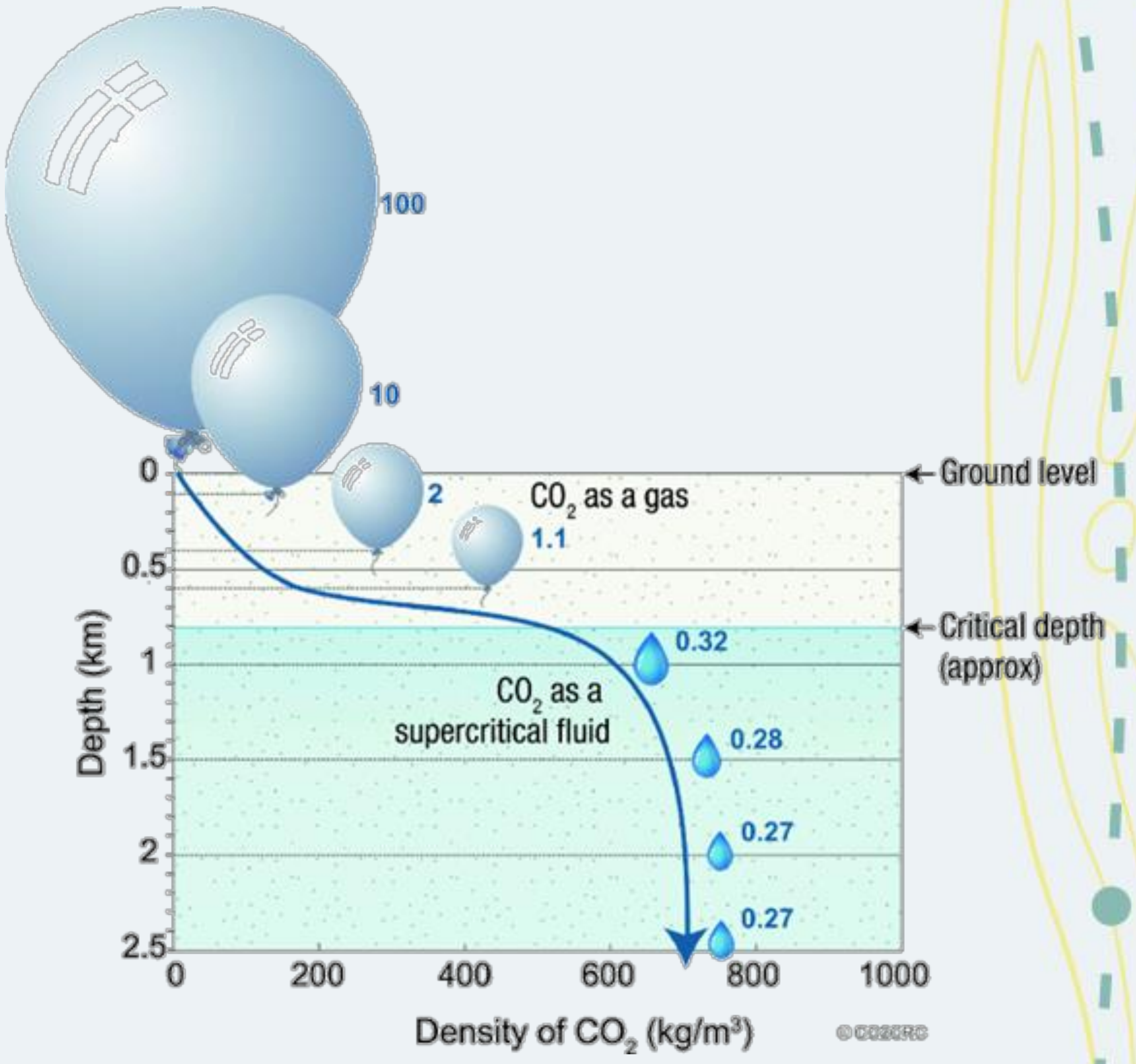




PilotSTRATEGY – Dynamic Model Inputs

1. Geological model
- Rock properties (ease of flow).
- Structural configuration.

2. Reservoir conditions
- Pressure 219 bar – 1760 m SS.
- Temp: 15 C Surface, 69 C 1760 m SS.



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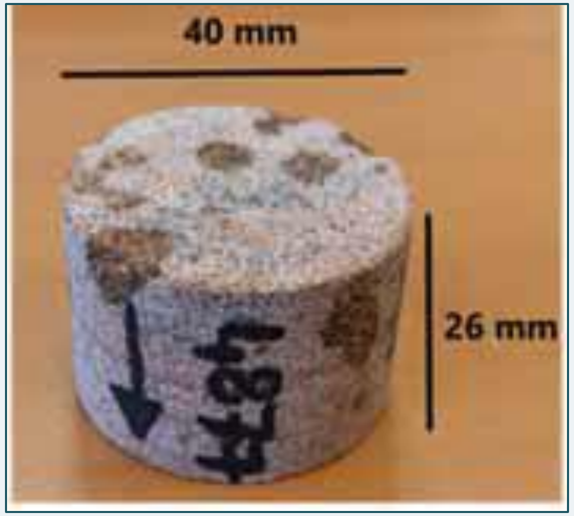
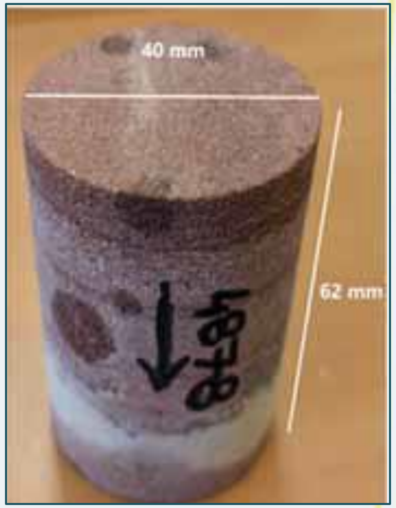
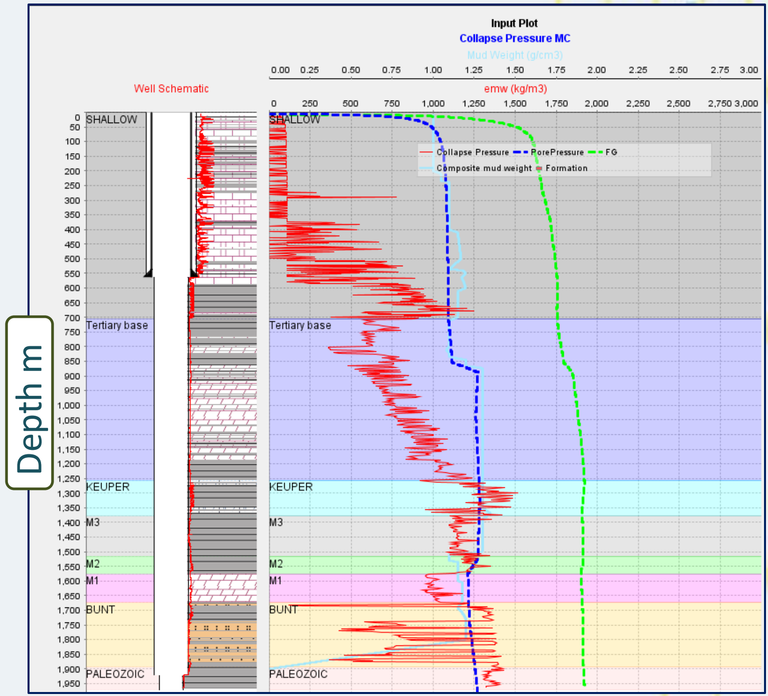
3. Geomechanics
- Rock Physics- Well logs.
- Laboratory analysis.







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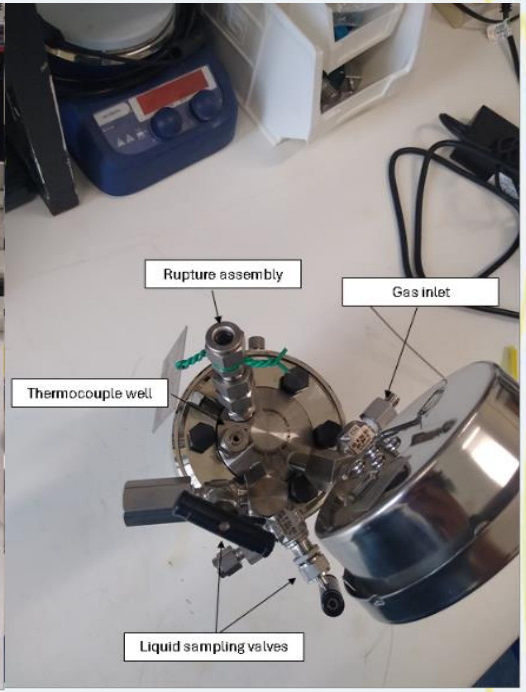
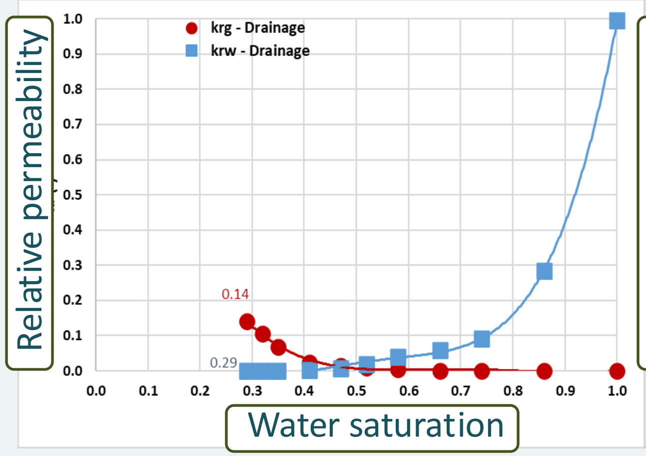
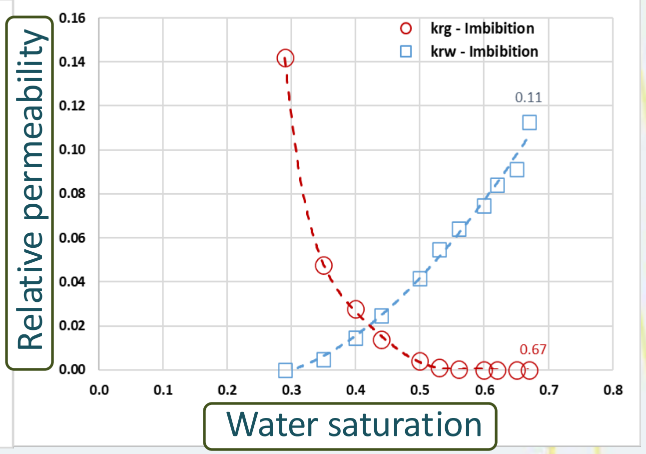
4. Rock – fluid model
- CO_2 composition.
- Rock chemistry.







PilotSTRATEGY – Dynamic Model Inputs

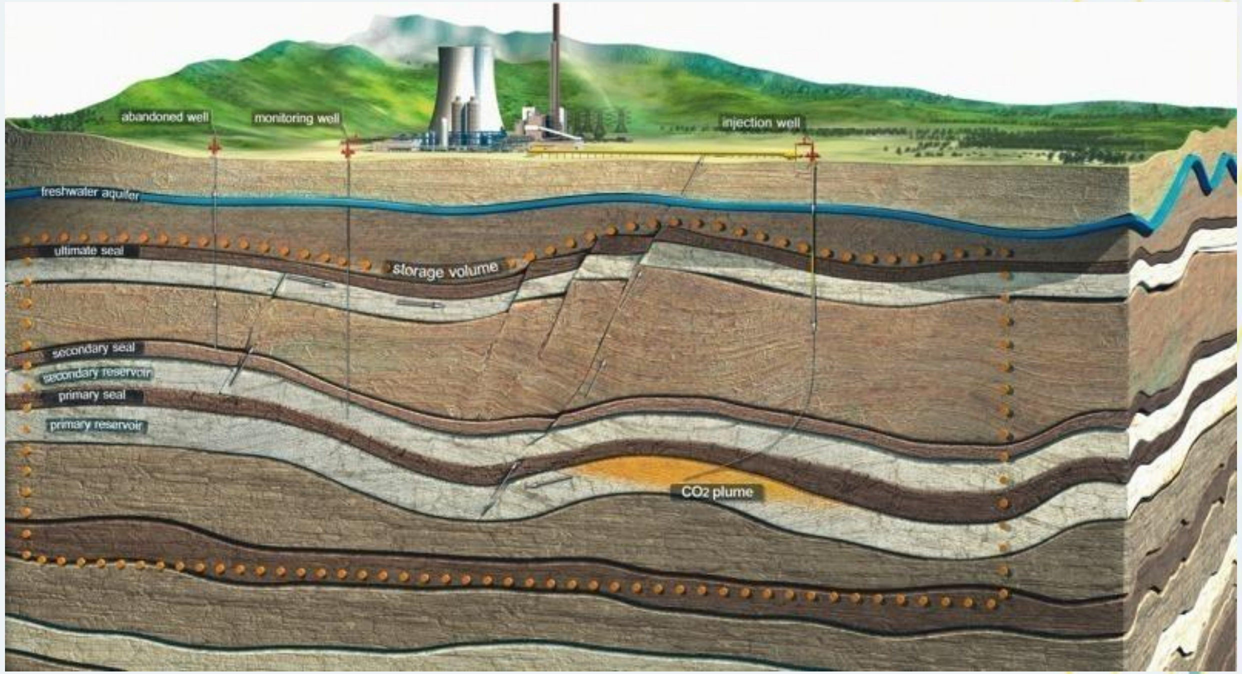
1. Geological model
- Rock properties (ease of flow).
- Structural configuration.

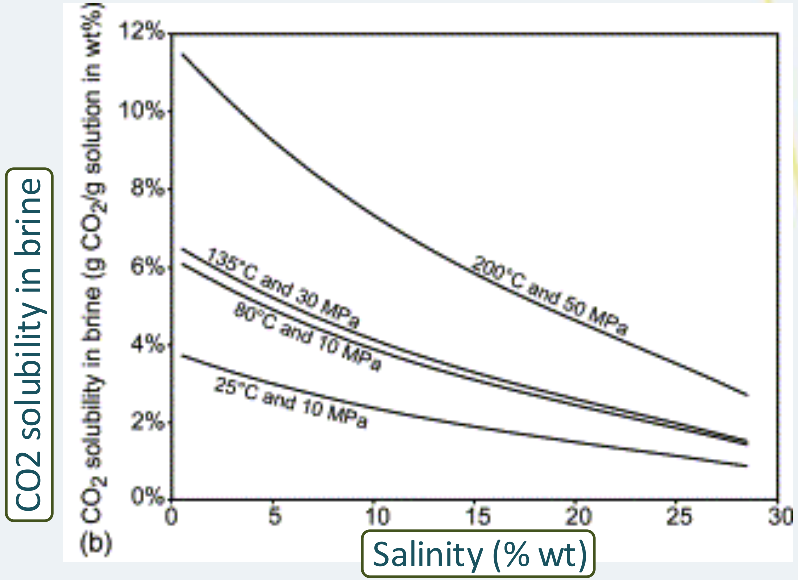
2. Reservoir conditions
- Pressure 219 bar – 1760 m SS.
- Temp: 15 C Surface, 69 C 1760 m SS.

3. Geomechanics
- Rock Physics- Well logs.
- Laboratory analysis.

4. Rock – fluid model
- CO_2 composition.
- Rock chemistry.

5. Fm. water salinity
- Sea water ≈ 35000 ppm.
- Fm. Water salinity 100000 – 250000 ppm.

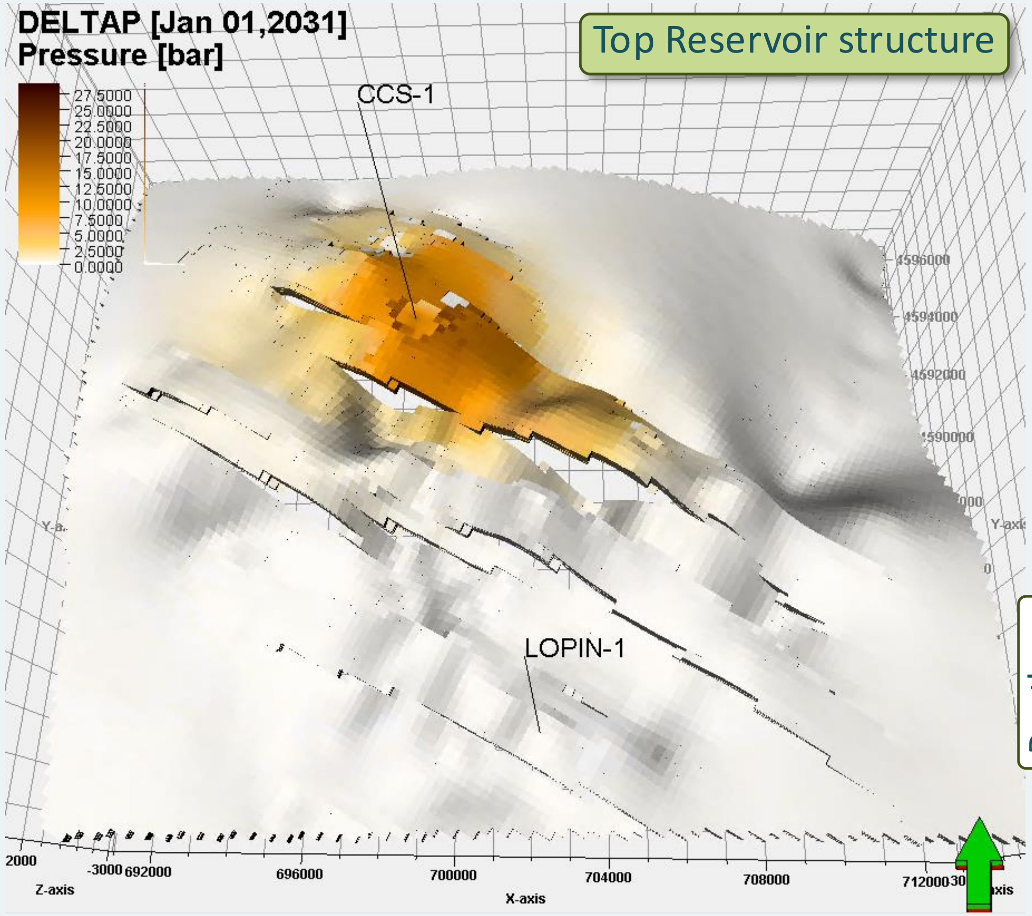


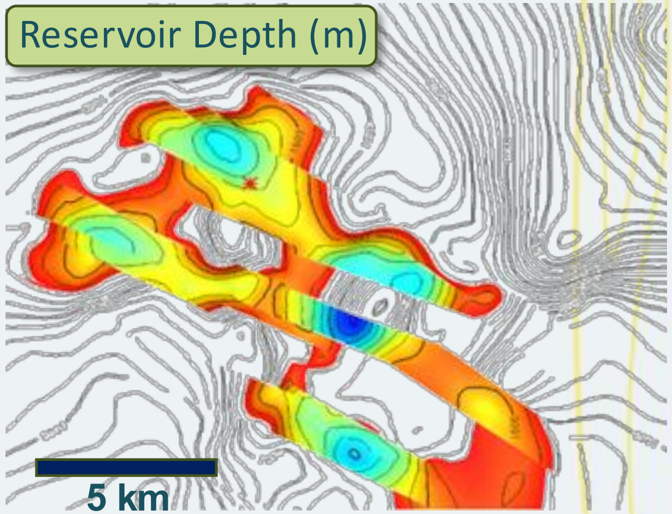


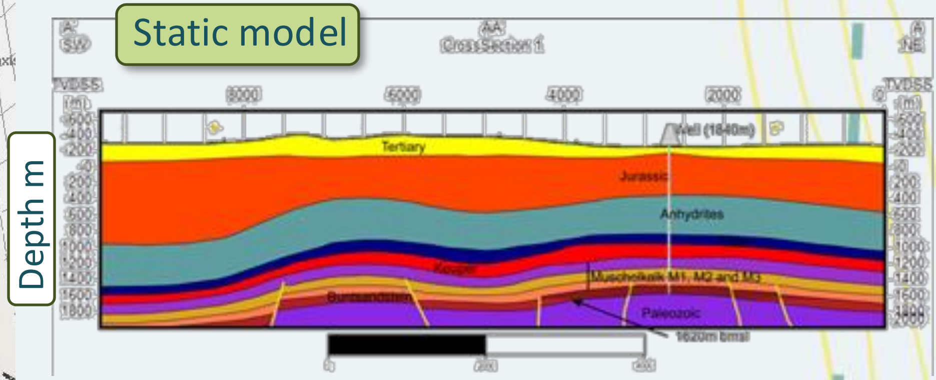
PilotSTRATEGY – Dynamic Model Outputs

1. Sensitivities

- Static properties
- Boundary conditions
- Fault behaviour
- Relative permeability
- Water salinity
- Rock compressibility
- Reservoir pressure



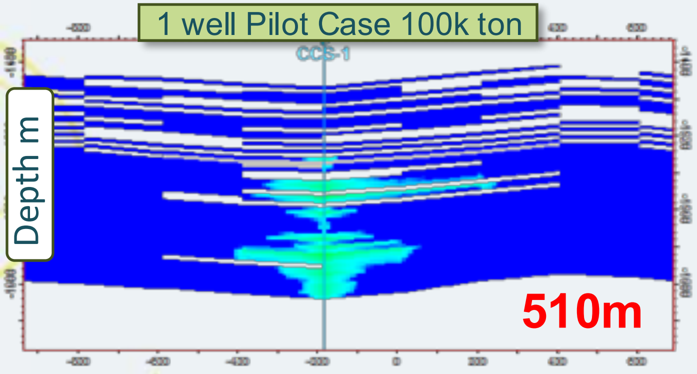


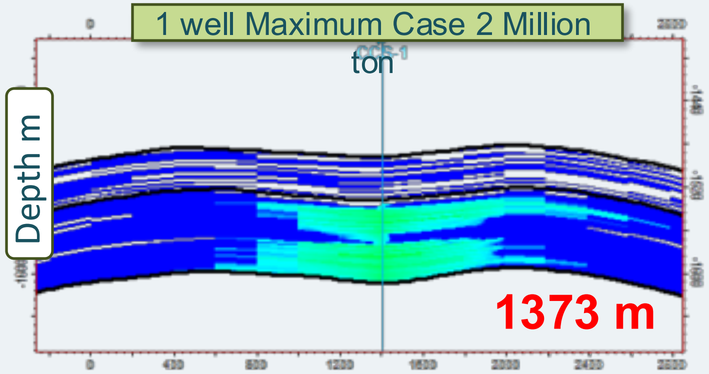


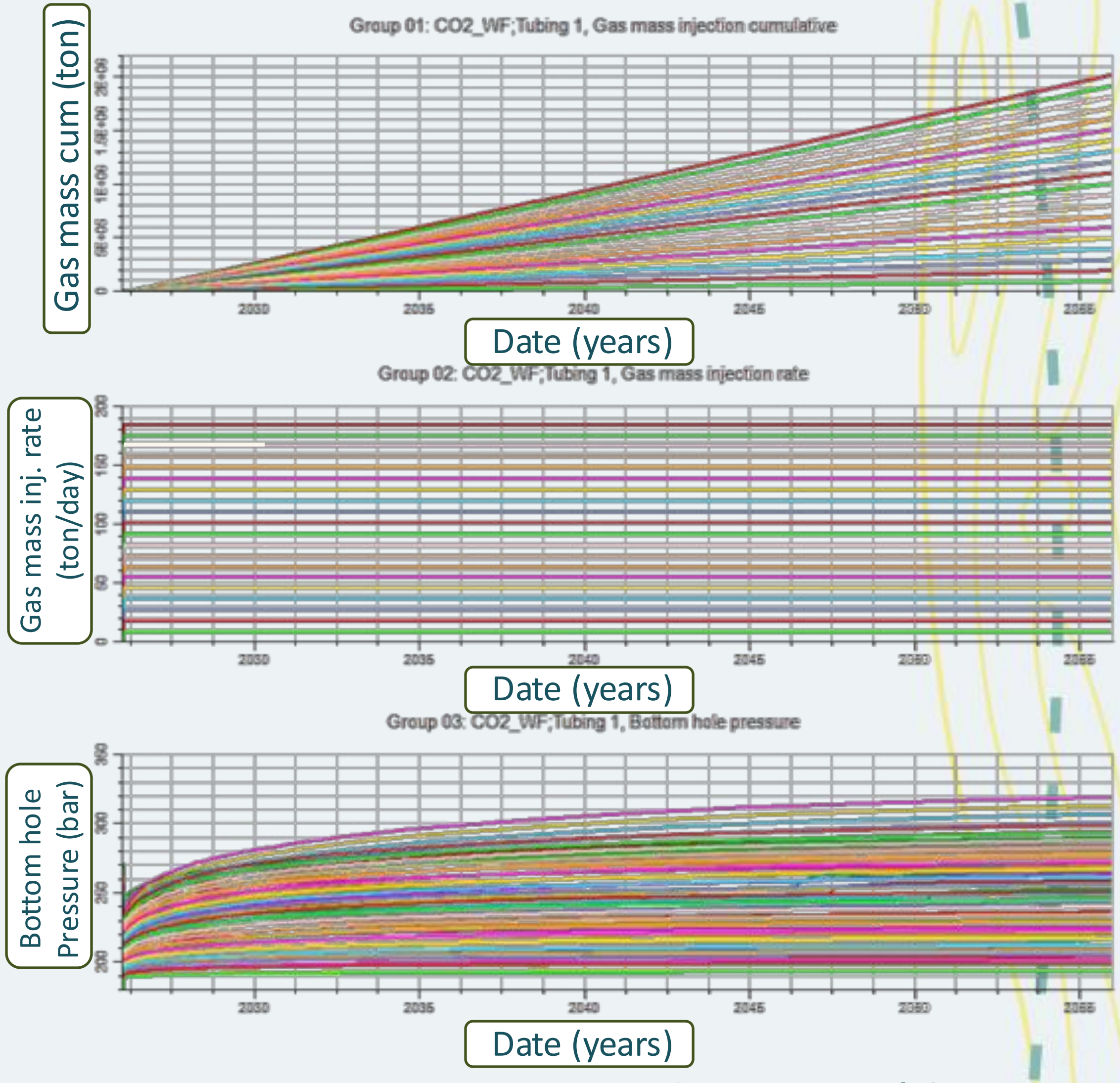
PilotSTRATEGY – Dynamic Model Outputs

1. Sensitivities → **2. Rates-Target**

- Simulation runs: Injection rate from 5k to 150k kton/yr up to 30 yrs
- Displays :
  - Time VS BHP
  - Time VS Cumulative injected CO_2 mass
  - Time VS Injection rate



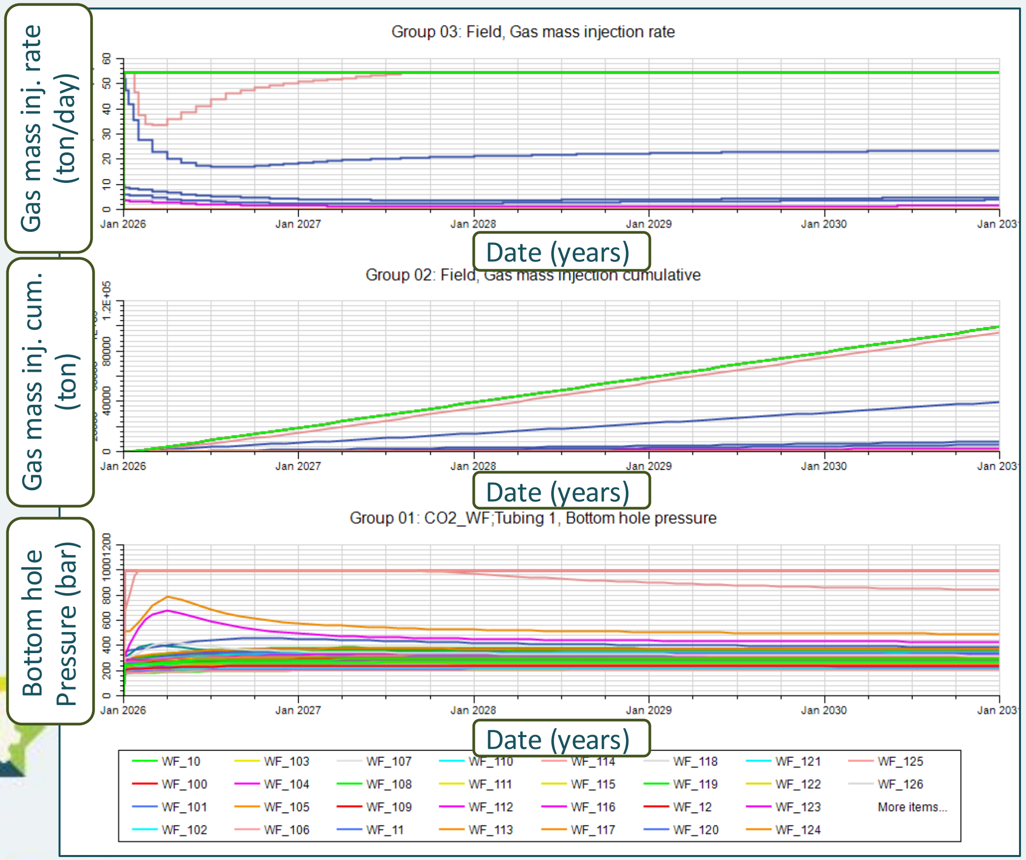


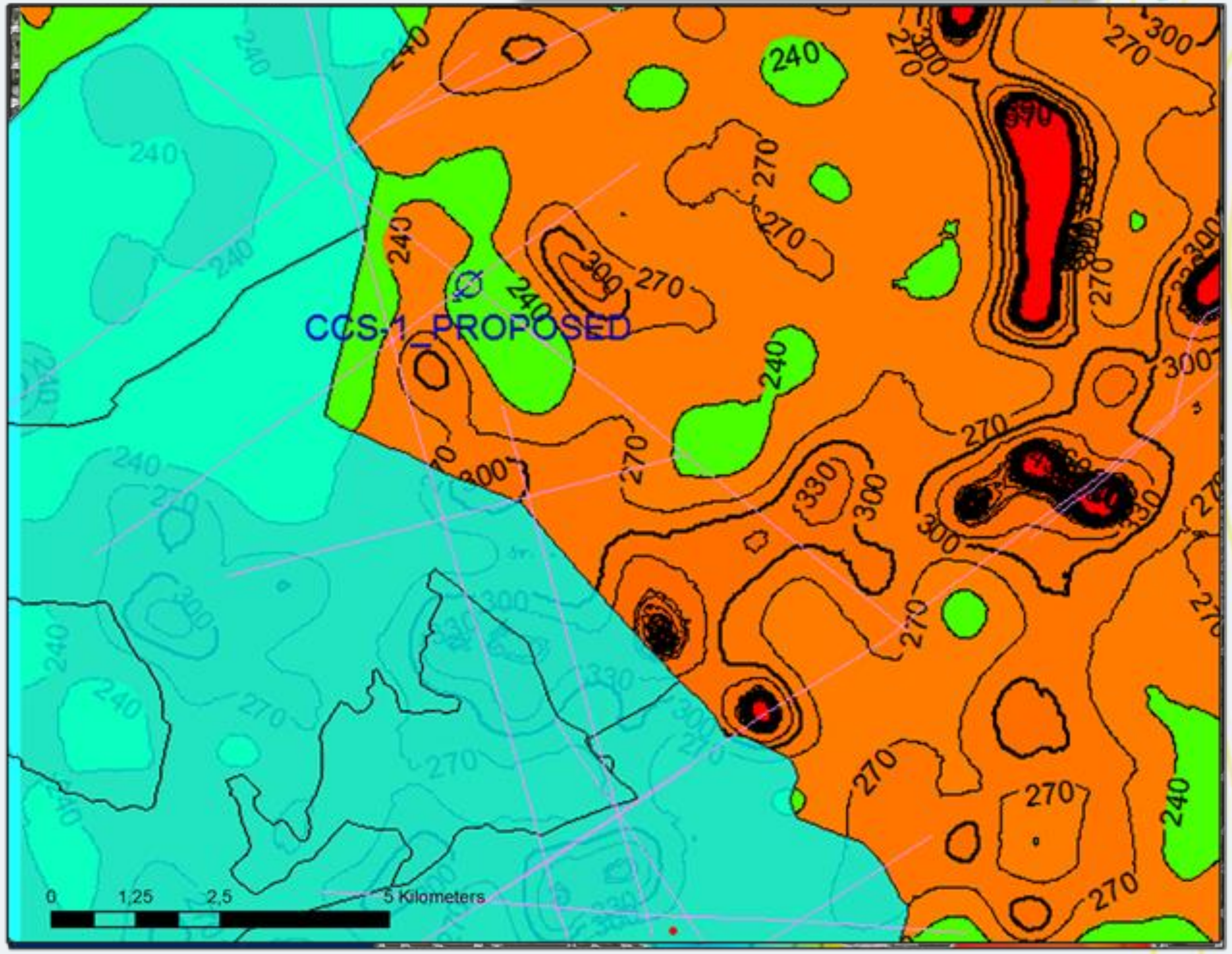


PilotSTRATEGY – Dynamic Model Outputs

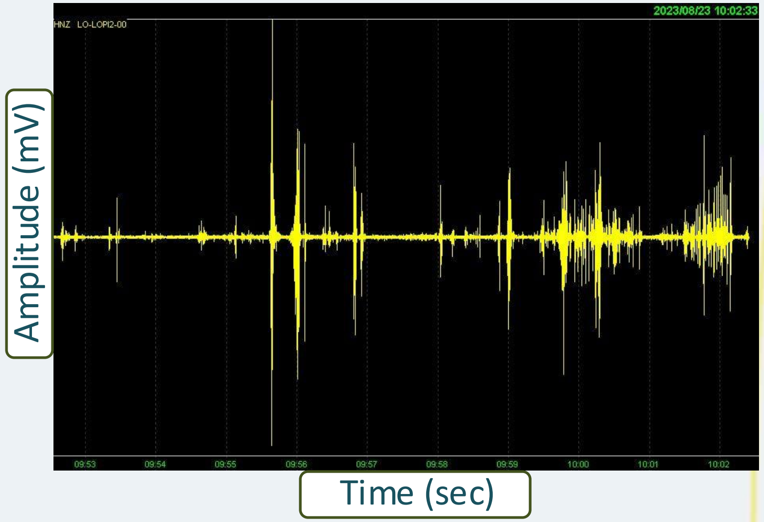
1. Sensitivities
2. Rates-Target
3. Well Location
4. Long term simulation

Protected areas - Bottom Well Pressure

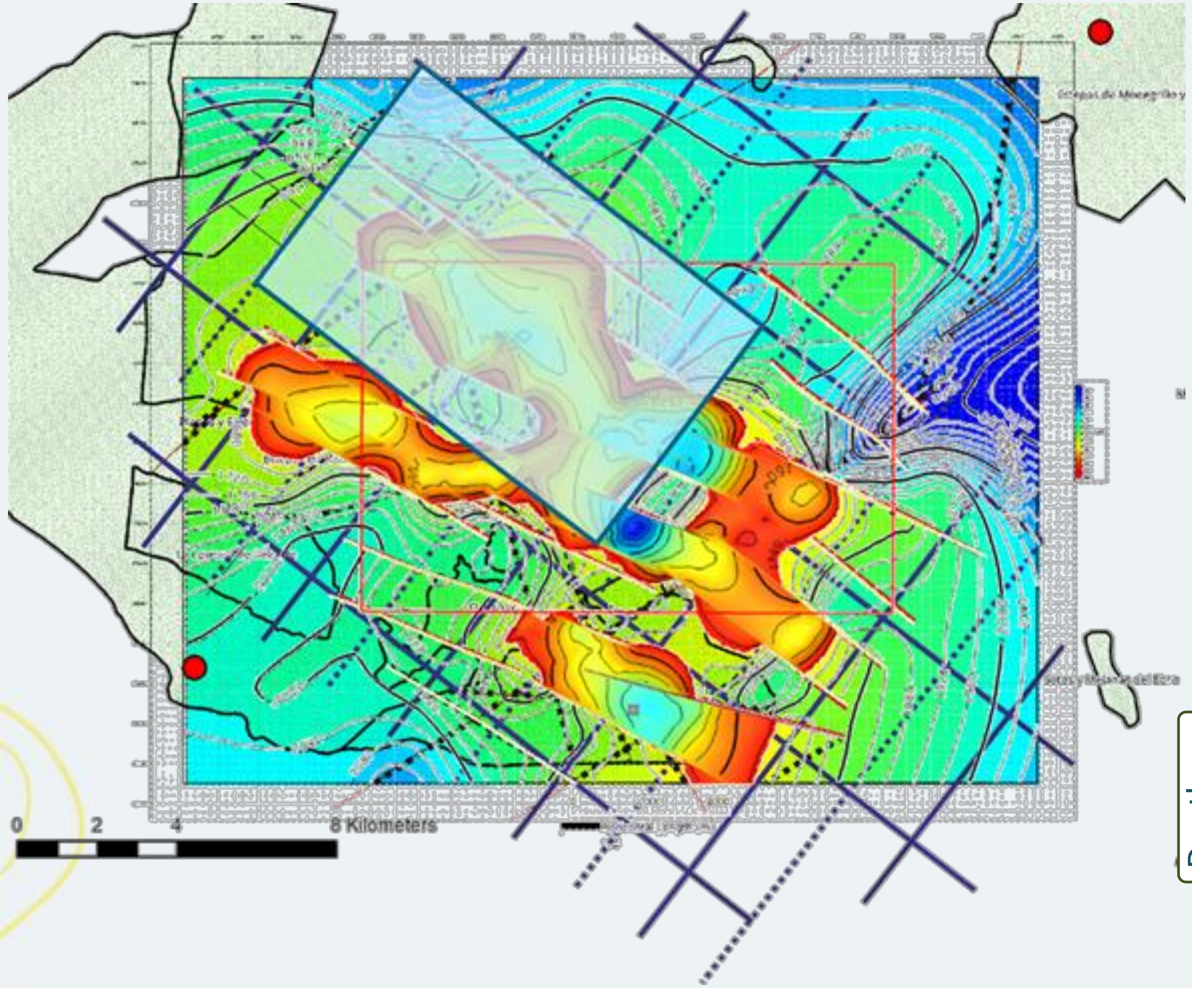


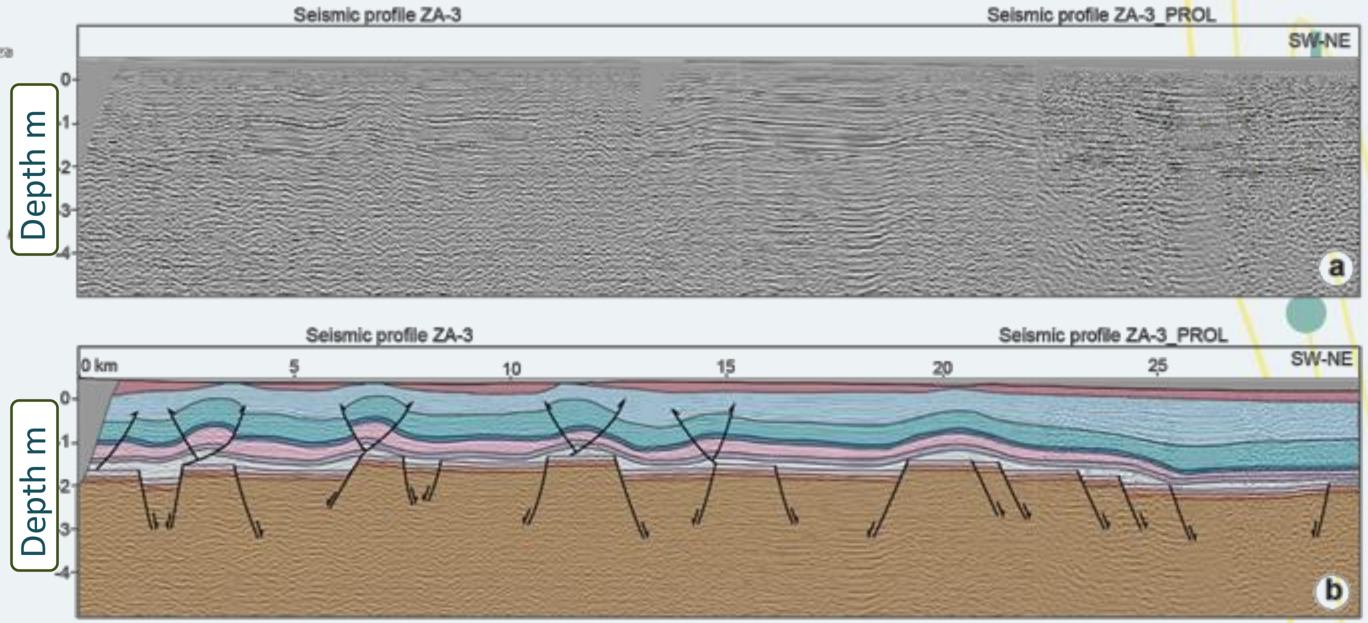


PilotSTRATEGY – Natural seismicity



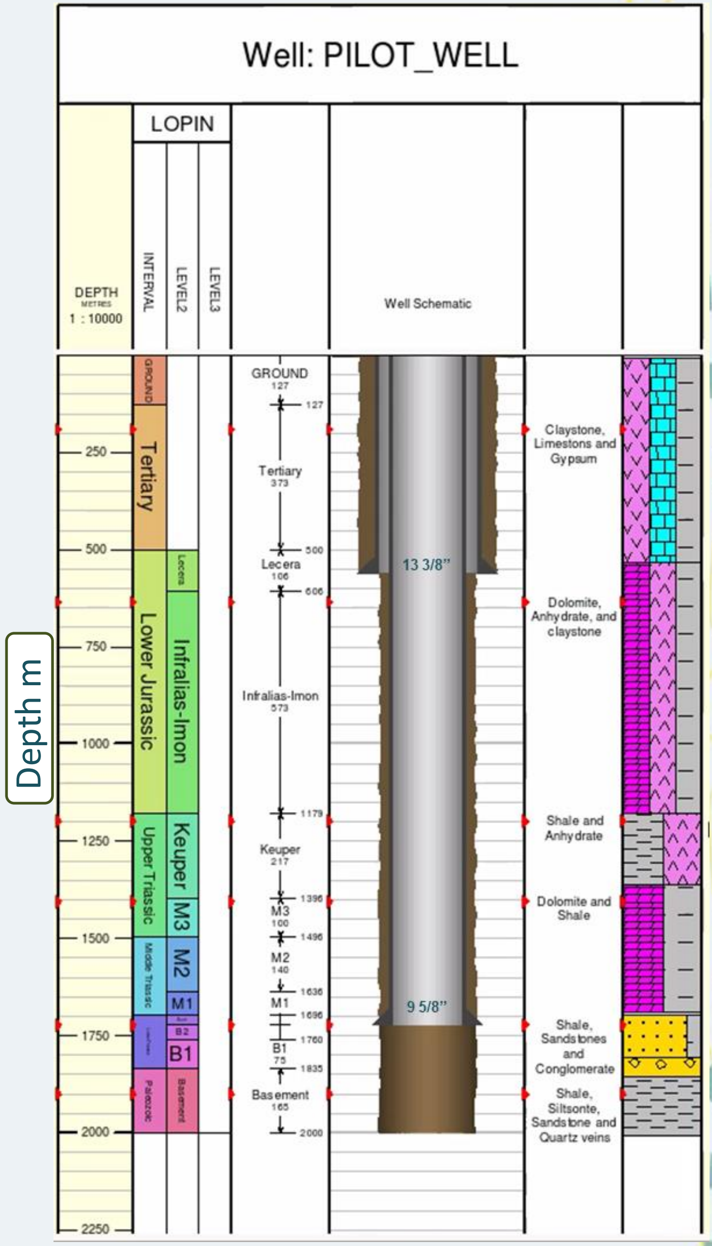
PilotSTRATEGY – Seismic Acquisition





- 2D Seismic. 1,5 MUSD – 3 MUSD
- 3D Seismic. 2,7 MUSD – 5,2 MUSD

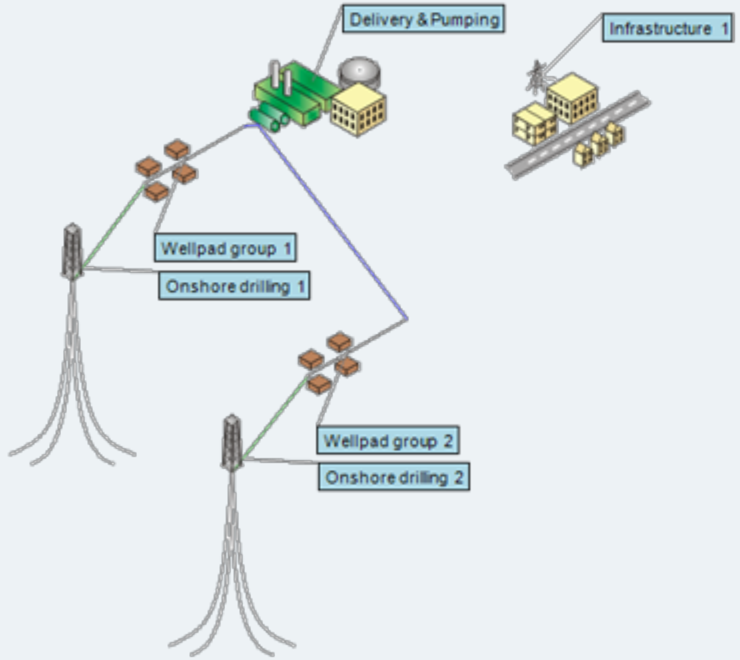
PilotSTRATEGY – Well Design

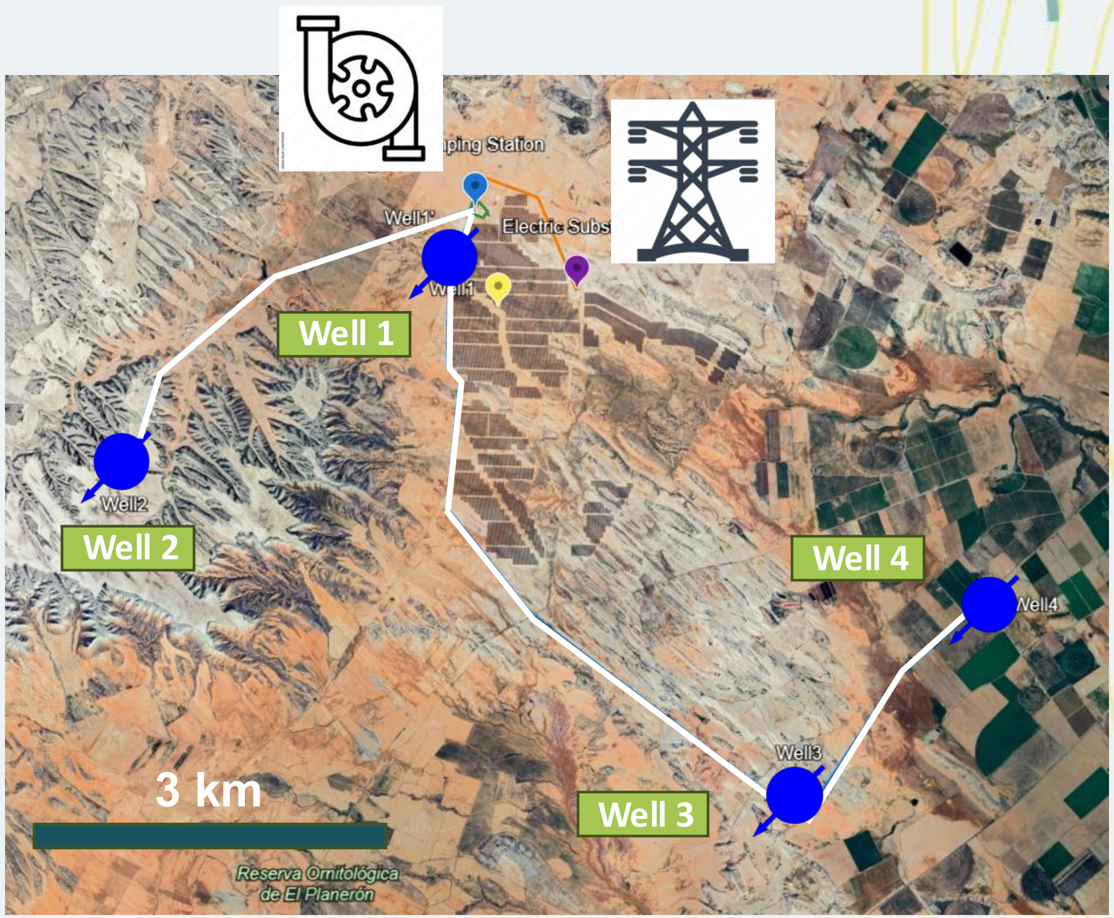


- Drill + DST: Conventional well. TD 2000 m, ≈ 5,1 MUSD
- Chrome completion. 2,8 MUSD

PilotSTRATEGY – Facilities

	CAPEX (M$)	OPEX (M$)	ABEX (M$)
1 well. Pilot case. 100 k ton.	17,5	2,7 per year	3,5
	25 M$		
2 wells. High case. 23 M ton.	42	7,3 per year	7,6
	268 M$		





PilotSTRATEGY – Development Scenarios

Scenarios	Exploration	Monitoring	Well number	Injection rate	Other data
Minimum investment **Ensures security at minimum cost**	2D seismic + 1 exploration well	All technologies available to guarantee CO_2 sequestration.	1	0,5 Mt/year	To be abandoned by 2064 17 Mt stored
First of its kind **Similar as other European projects. Focus on monitoring**	3D seismic + 2 exploration wells	Special attention on CO_2 fate monitoring.	2	1 Mt/year	To be Abandoned by 2051 23 Mt stored
Green development (solar panels) **Lowering carbon footprint**	3D seismic + 2 exploration wells	Special attention on environmental monitoring	2	1 Mt/year	To be abandoned by 2051 23 Mt stored

Study in progress

The Repsol Commitment
Net Zero Emissions
by 2050

REPSOL

Social acceptance

November 2024

Christian Oltra and Lila Gonçalves (*Sociotechnical research at* CIEMAT)

The PilotSTRATEGY project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101022664


NO CO2
NO EMINENT DOMAIN


Barendrech
NEE TEGEN CO_2


Fossil Fuel FANTASY
CARBON CAPTURE & STORAGE
CLIMATE ACTION NOW
togetherwecanmovement.org.au


NO CARBON MARKETS
NO FALSE SOLUTIONS
NO TO CCUS and other false solutions
NO TO FALSE SOLUTIONS

Socially Acceptable Projects

Socially acceptable projects tend to (1) be locally embedded, (2) provide local benefits, (3) establish continuity with existing physical, social and cognitive (values) structures and (4) apply good communication and participation procedures.

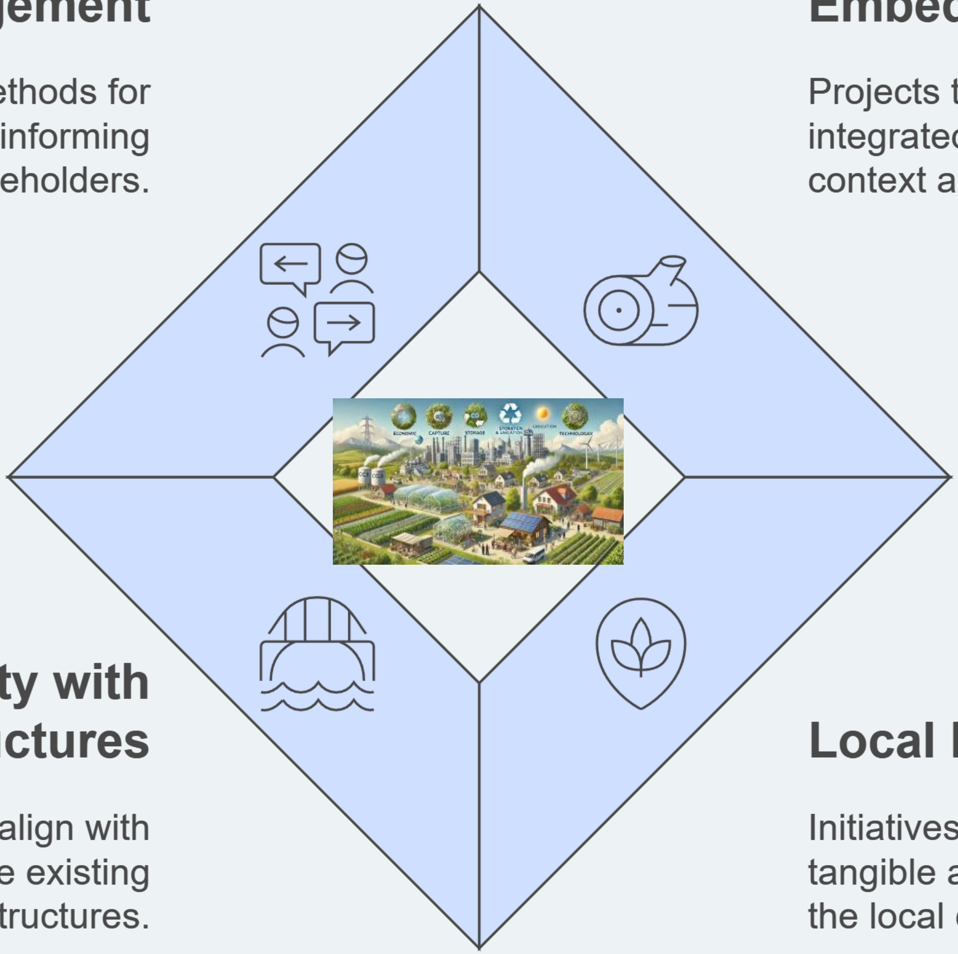
Heiskanen et al., 2008

Public engagement

Effective methods for engaging and informing stakeholders.

Local Embeddedness

Projects that are integrated into the local context and culture.



Continuity with Structures

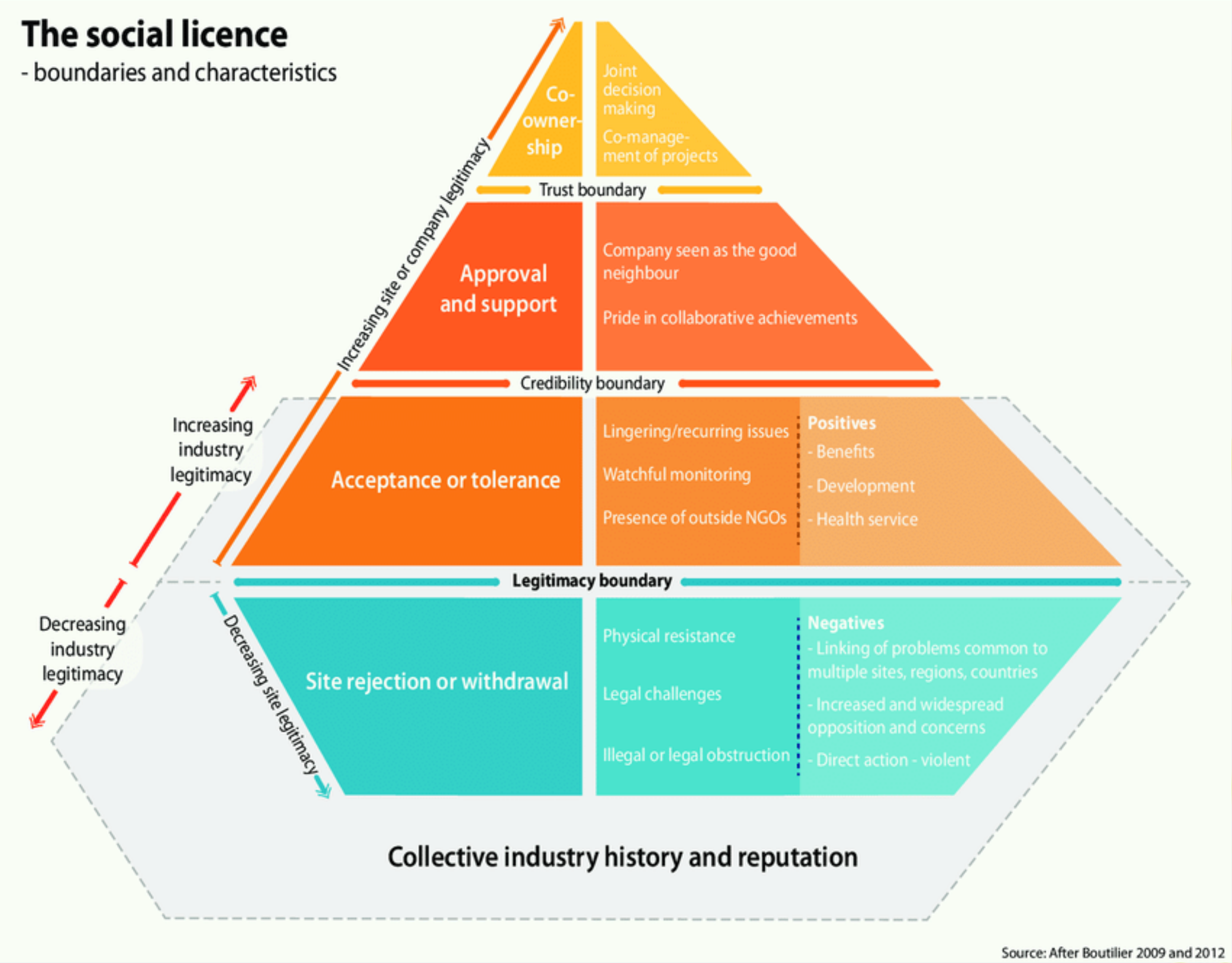
Projects that align with and enhance existing systems and structures.

Local Benefits

Initiatives that provide tangible advantages to the local community.

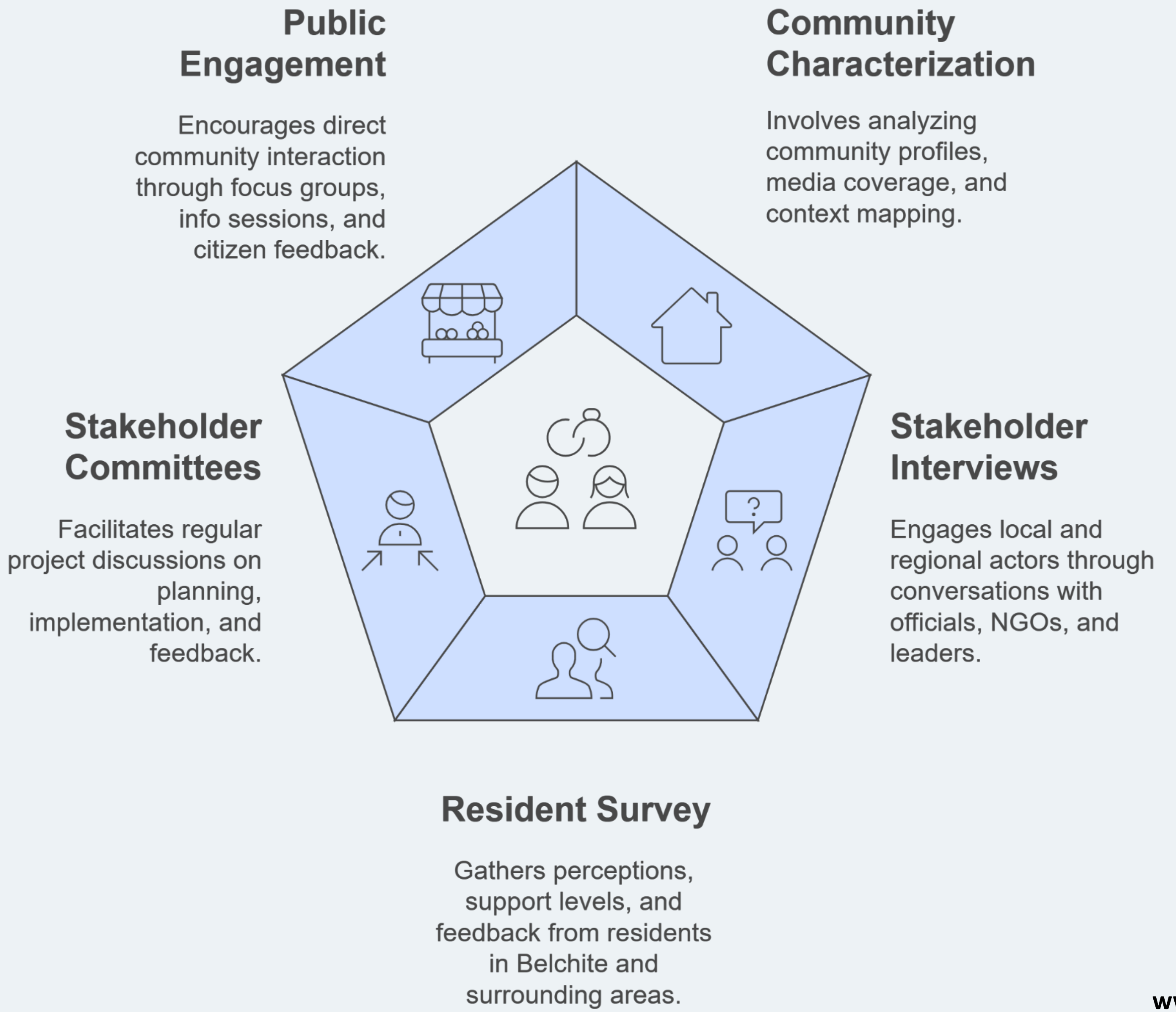
A new approach: From acceptance to co-ownership

- Social acceptance is not merely a hurdle to overcome, but a **fundamental pillar of successful CCS project** development.
- It encompasses public understanding, trust-building, and community engagement at every project stage - from planning through implementation
- But the **vision** of CCS projects should extend beyond seeking basic project approval. We should aim to foster a **dynamic partnership where both the project and local communities flourish together**. This means creating shared value through the project



PilotStrategy: Community engagement

This balanced approach tries to ensure we **listen to all segments of our community**, from individual leaders to the general public

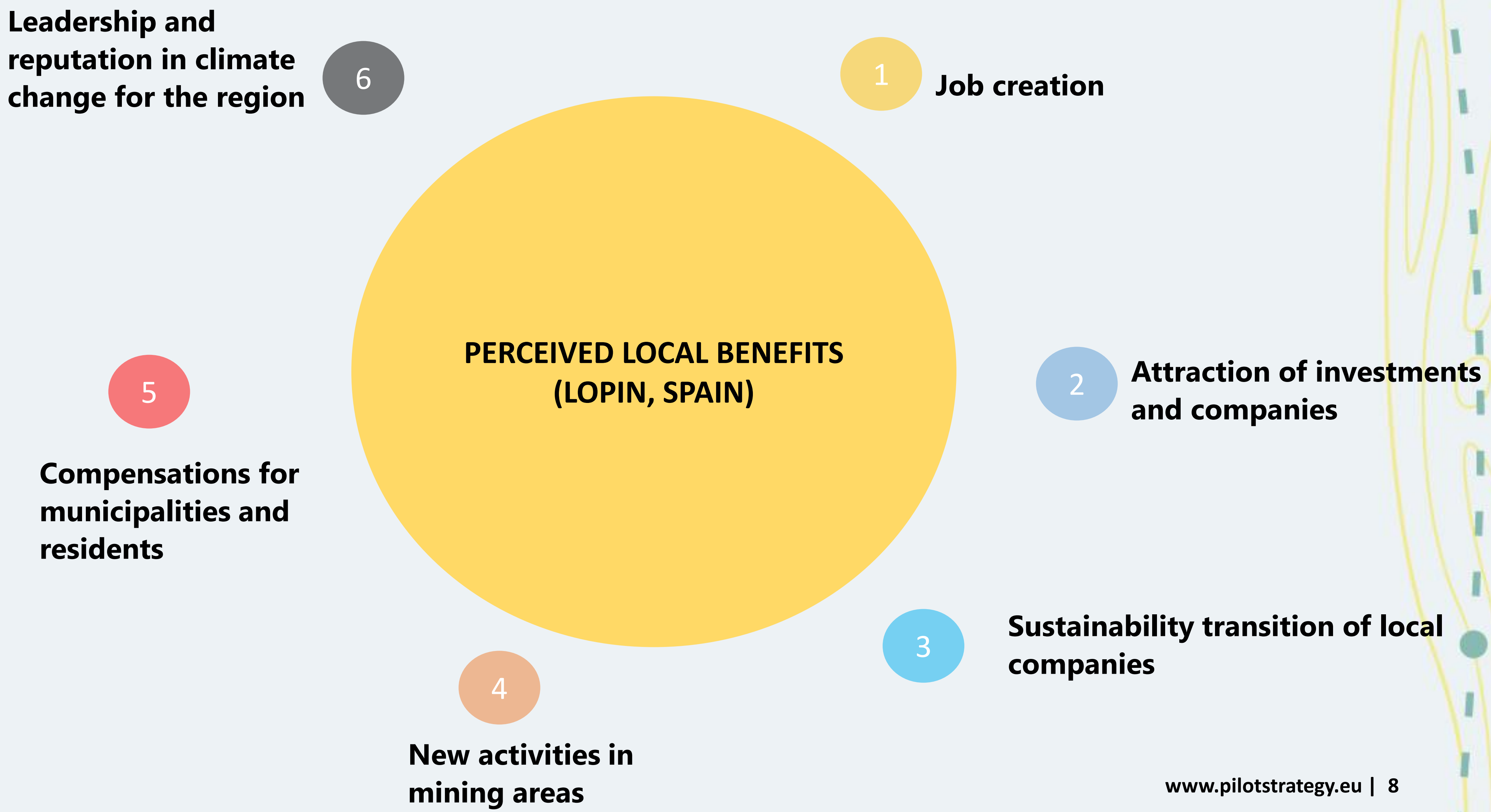


Community characterization

- Our first step was to develop a **comprehensive understanding of the community context** through **documentary analysis and media coverage review**. This research helped us:
  - Map the historical and socio-economic background of the region
  - Identify key community dynamics and existing social networks
  - Understand local concerns, aspirations, and previous experiences with similar projects
  - Track media narratives and public discourse around related initiatives
- This foundational work provided crucial insights that informed our entire engagement approach.

Interviews with stakeholders

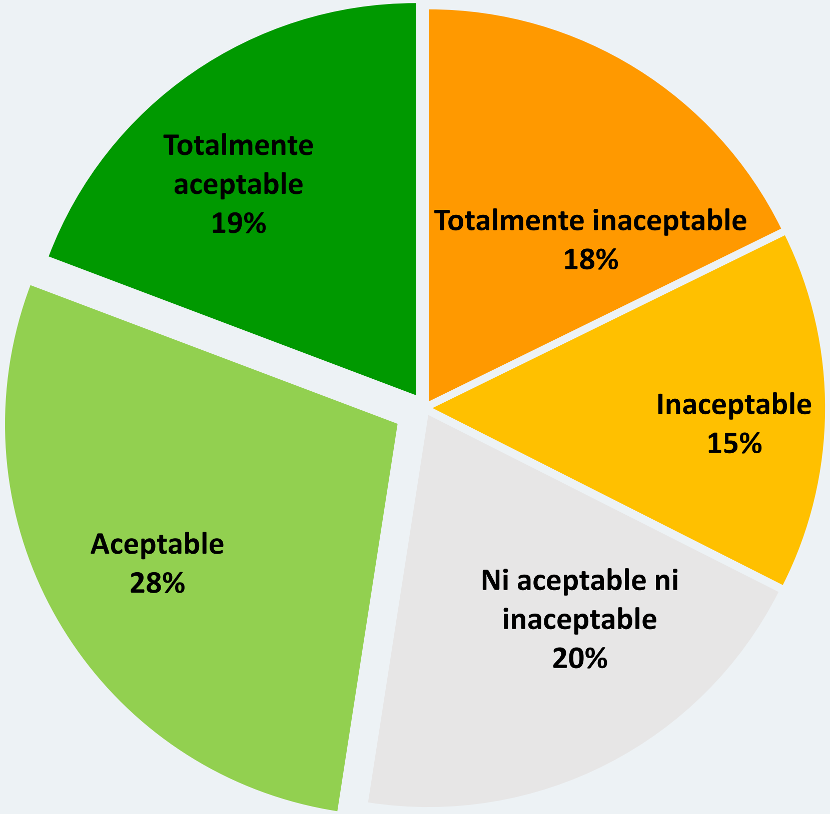
- We conducted semi-structured interviews with a diverse range of local and regional stakeholders to gather rich, qualitative insights. Our interview program included:
  - Local government officials and public servants
  - NGO representatives and community organizations
  - Industry leaders and business associations
  - Regional authorities and decision-makers
- These conversations revealed **stakeholders' perceptions on the project's potential impacts**, opportunities, and challenges, while helping build important relationships with key community figures.


PERCEIVED LOCAL BENEFITS (LOPIN, SPAIN)
1
Job creation
2
Attraction of investments and companies
3
Sustainability transition of local companies
4
New activities in mining areas
5
Compensations for municipalities and residents
6
Leadership and reputation in climate change for the region

Survey with residents

- To ensure broad community input, we implemented a survey across Belchite and surrounding localities. The survey:
  - Provided clear information about the proposed technology and project scope
  - Gathered data on community perceptions and concerns
  - Measured levels of project support and understanding
  - Identified specific areas requiring additional community engagement
- This quantitative data complemented our qualitative research, offering measurable insights into community sentiment.

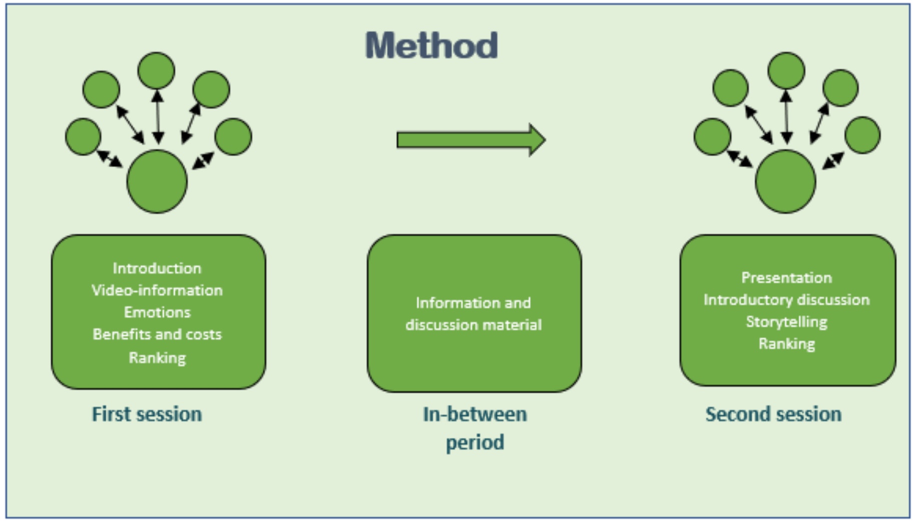
ACCEPTANCE



Acceptance = 47% (IC= 38-58%)
Rejection = 33%

Public engagement

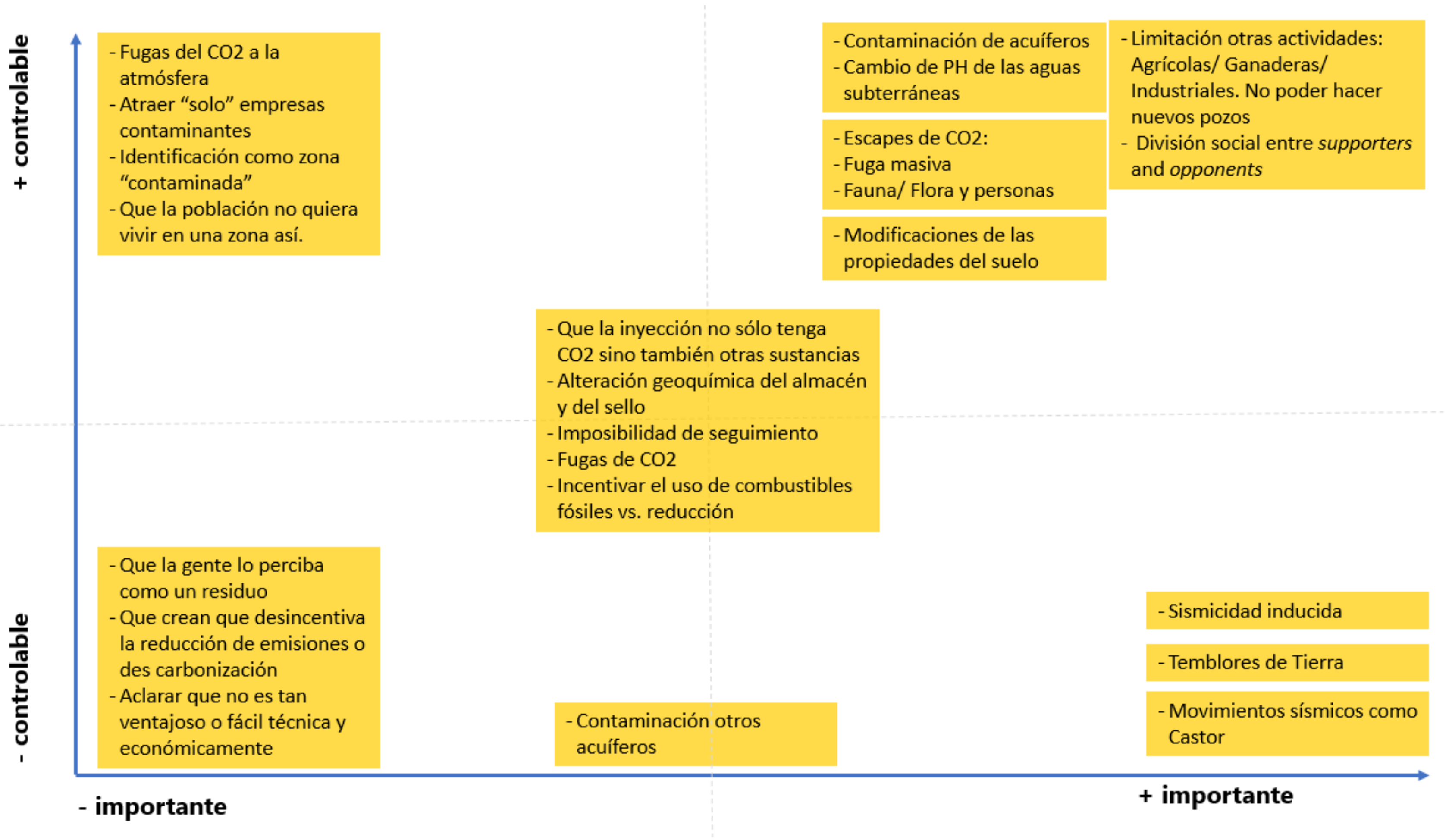
- In September 2023, a **citizen engagement activity** was held in Belchite (Zaragoza) to discuss CCS technologies and the Ebro Basin project. Nine residents participated, demonstrating limited knowledge of CCS technology and expressing a range of **emotions** and **perceptions**.
- Participants discussed **critical conditions of acceptance**, including accessible project information, economic and local benefits, prioritising safety, comprehensively addressing concerns, and establishing trust through transparent and open communication throughout the project's life.



Stakeholder Committees

- Our ongoing stakeholder committees serve as **dynamic forums for project dialogue** and collaborative decision-making. These committees:
  - Meet regularly to discuss crucial project aspects
  - Bring together diverse perspectives in a structured setting
  - Address emerging concerns proactively
  - Help shape implementation strategies
  - Ensure continuous community input throughout the project lifecycle
- These committees have become vital channels for maintaining **transparent communication and building trust** with the community.

How local stakeholders perceive the risks of CCS projects



Pilot as a social laboratory

Understanding of our community: We've worked to understand local values and carefully map out how residents and stakeholders view both the opportunities and challenges of our project

Two-way communication flow: We've created channels for ongoing dialogue between the project and the community, ensuring information flows both ways

Building trust: Our engagement strategy focuses on developing trust and establishing legitimate relationships with the community

Living laboratories: These communities serve as testing grounds for developing new ways to involve residents in carbon dioxide storage projects

Shaping the future: The insights and lessons from this process will be valuable in guiding future commercial projects facing similar social acceptance challenges

Thank you

christian.oltra@ciemat.es
lila.goncalves@ciemat.es

PilotSTRATEGY

Visit our webpage for future updates and Subscribe to our Newsletter!

https://pilotstrategy.eu/

Acknowledgements

The PilotSTRATEGY project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101022664