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Kickstart CCS in Eastern Europe

Achievements, Opportunities and Challenges

March 26, 2025 – K. HUETTER – VIENNA/NORWAY

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02 The Legal Frame in Romania

03 Public Awareness regarding CCS as a Technology

04 1st Onshore Demo Project

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Intro

Name: Kurt Hütter

Background: PM & IT @ University of Applied Sciences bfi Vienna

With OMV since: 06/2005

Career:

Advisor Opportunity Management CCS (OMV)

HoD New Technology (CCS & GT) (OMV Petrom)

Sen. PM CCS (OMV Petrom)

DM Project Services and Planning & Risk Management (OMV Petrom)

PM Well Automation, Oil Field Redevelopment, Facilities, EOR, Well Hookups (OMV)

Project Planning Engineer/Project Controls (OMV)

How the CCS journey started

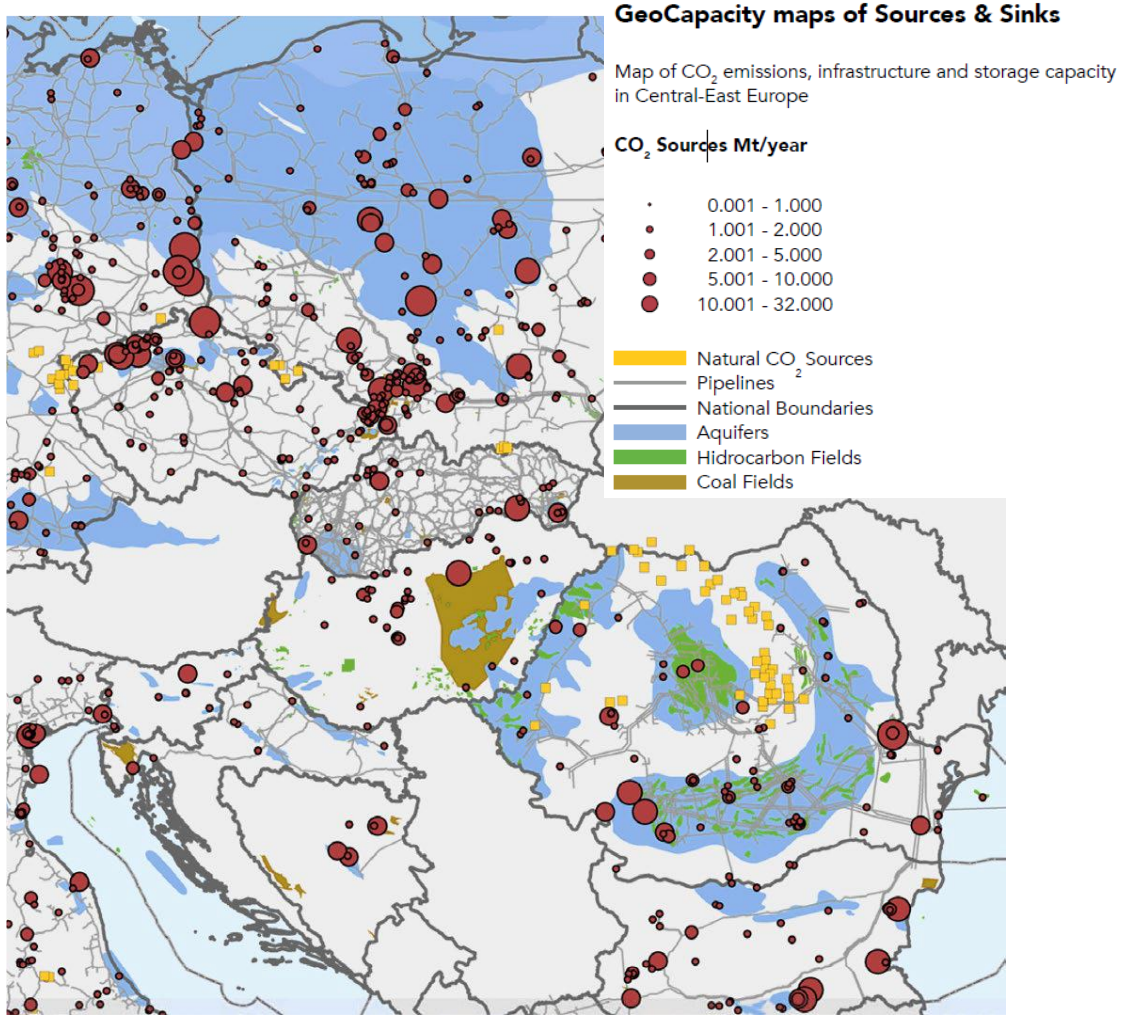
Map of potential emitters and CO2 storage potential in Romania

According to the EU GeoCapacity Report, based on a study conducted from 2006 - 2008 the theoretical storage potential of Romania amounts at 9-22 Gt (saline aquifers + depleted hydrocarbon fields)

This gives an encouraging starting point for conducting the screening and studies required to work out the technical feasibility on Romania's geological storage potential; however saline aquifer structures require intense exploration activities before CO2 storage concepts can be developed and projects matured

Romania's top CO2 emitters which are under the ETS system are located near Gorj, Galati, Ploiesti, Constanta, Targu Mures and Bucharest

In 2021 OMV Petrom was approached by a global cement manufacturer and proposed to collaborate on CCS to support stringent decarbonization targets

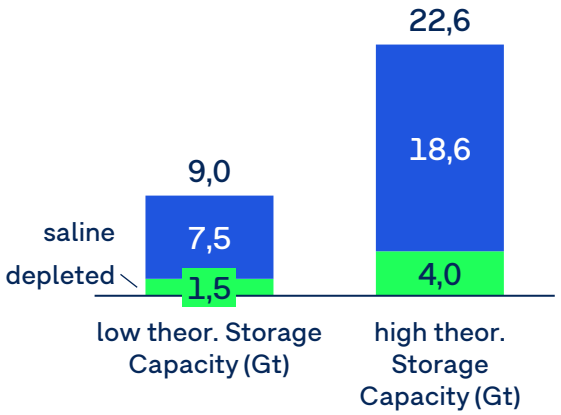


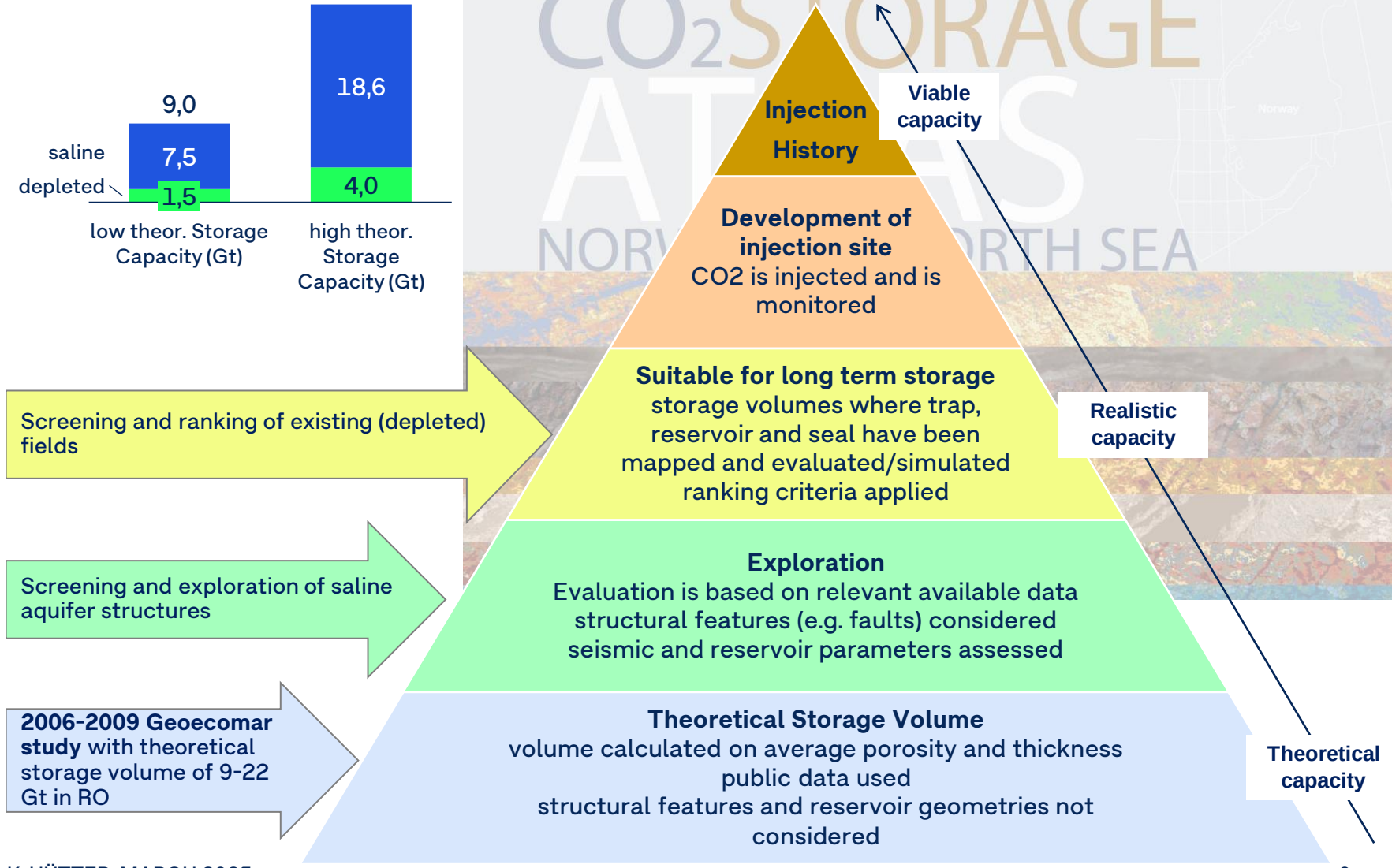
Theoretical vs. feasible storage capacity

NO Petroleum Directorate

The pyramid model

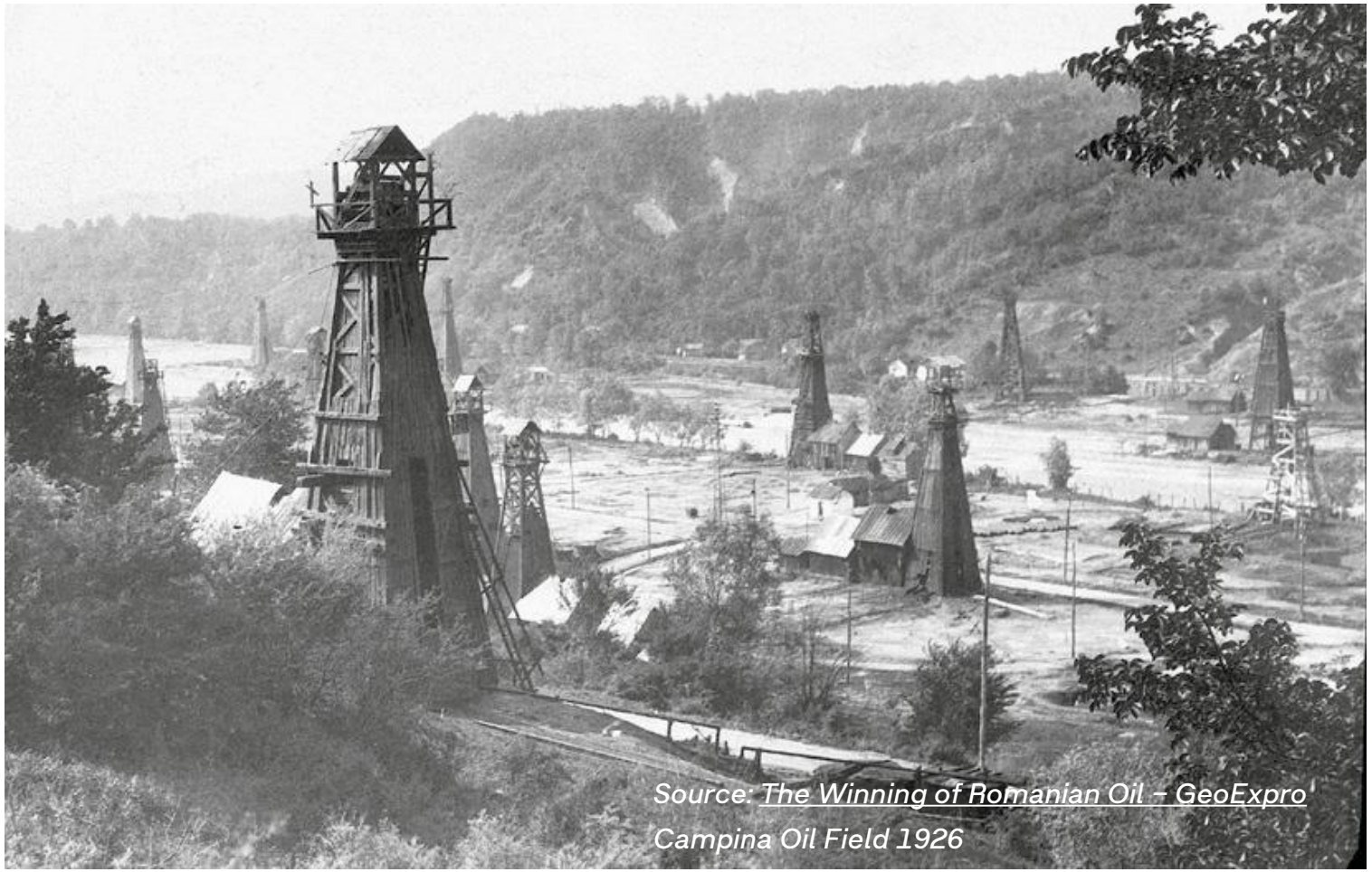
- The NO Petroleum Directorate defines the geological CO2 storage stages in a pyramid model
- In this model national studies and OMV Petrom projects can be mapped in terms of maturity
- The EU Geocapacity Study estimated first theoretical storage volumes in EU member states based on public regional data
- In-depth geological and reservoir related information is required to mature theoretical capacities to realistic capacities
  - Existing seismic lines
  - Production and well data
- Operators can only cover a small part of a potential RO-wide storage atlas as
  - Data needs to be repurposed from O&G to CCS studies
  - Only for own and open license blocks





Depleted fields and technical feasibility

- Romania has a long tradition in oil & gas exploration & production with the first oil refinery in the world opening in Ploiesti in 1856
- For CCS (Transport & Storage) Romania can repurpose these competencies and experience gained throughout the last 170 years
- Depleted fields can potentially be repurposed and used as CO2 storage
- A lot of information is available from the Exploration, Development, Production & Operations phase
- **Note that extensive studies are required before a reservoir can be declared suitable for storing CO2!**
- **Condition of existing wells is critical!**

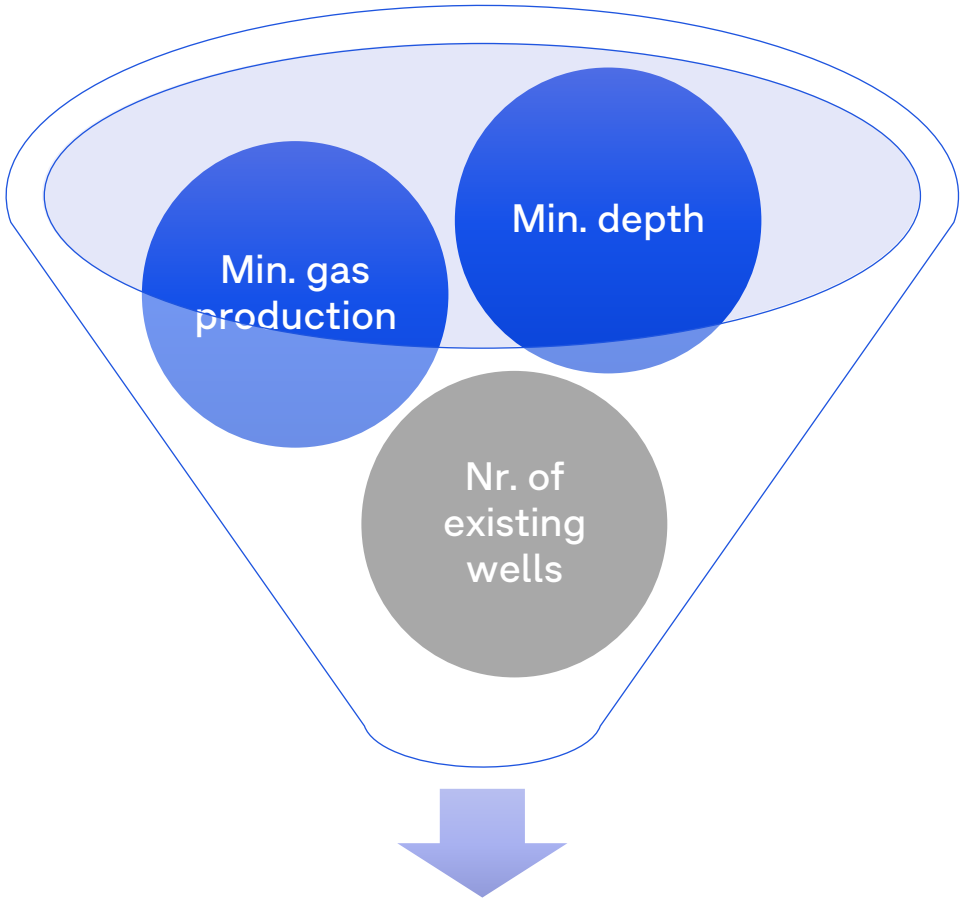


Source: The Winning of Romanian Oil – GeoExpro

Campina Oil Field 1926

Reservoir ranking criteria

- Data availability seems high for existing fields; however great effort is needed to QA/QC historic subsurface and well data
- Screening criteria are defined to short list the vast number of reservoirs to the ones potentially suitable for CO2 storage
  - Depth greater 800mTVD
  - Cum. Gas production greater 1bnm^3
  - Calculated storage volume
  - *Nr. of existing wells*
  - *Distance to emitter*



Short list of potential reservoirs having a certain potential storage capacity

119 fields under relinquishment

3 fields meeting requirements

360 fields screened

25 fields analyzed in-depth

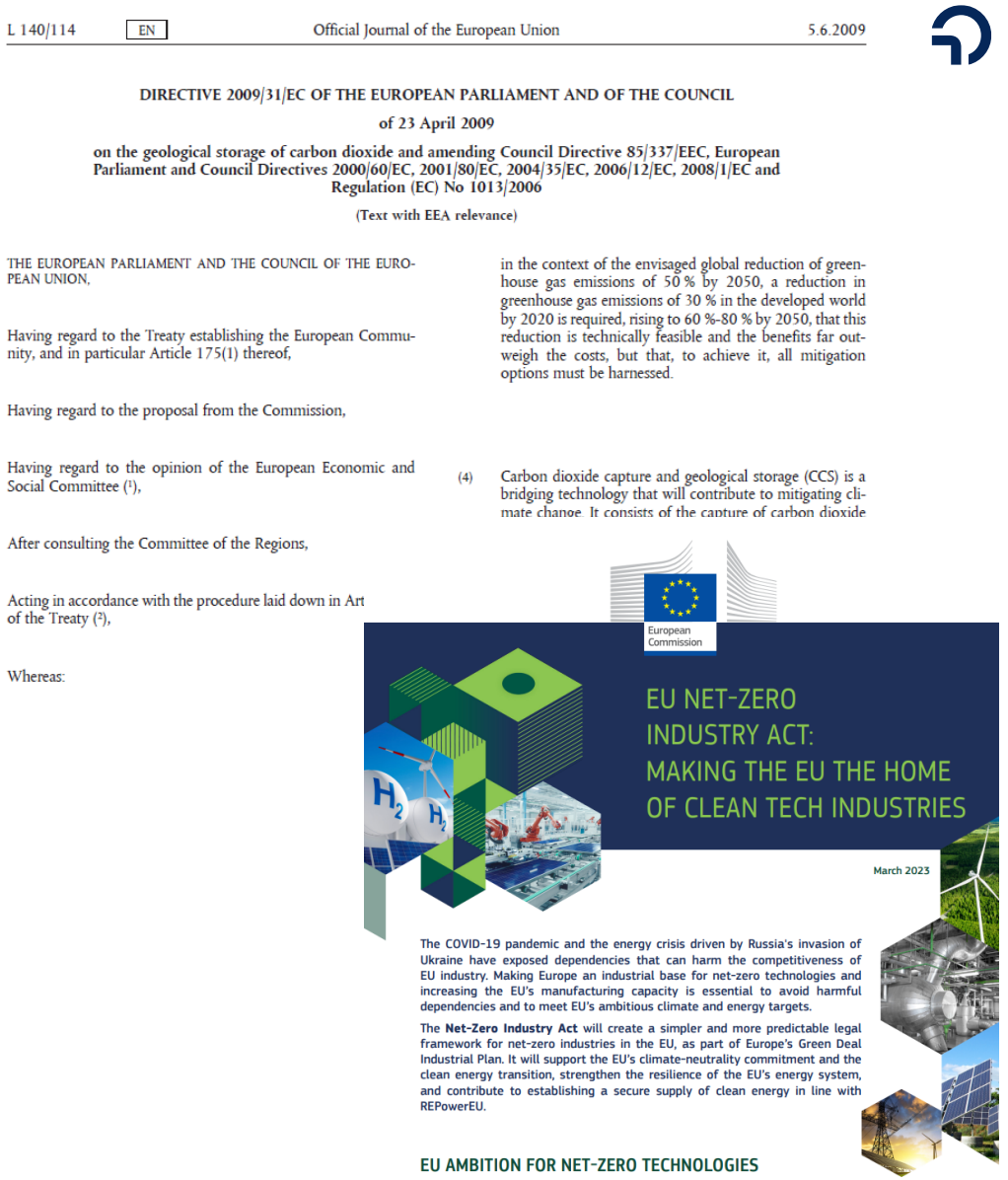
3-4 fields meeting requirements

The Legal Frame in Romania

EU Framework on CCS

Legal Framework

- **The CCS Directive** - EU Directive 2009/31/CE regulates the development of geological CO2 storages
  - Exploration and storage permit
  - Operations
  - Closure and post-closure obligations
- **Guiding Docs (GD) 1-4** are complementing the directive
  - Risk management
  - Site characterization, composition and monitoring
  - Transfer of responsibility to competent authority
  - Financial security and mechanism
- **Net Zero Industry Act**
  - Proposed in 03/2023, in effect since 06/2024
  - Aiming at expanding the capacity of “net-zero technologies” incl. CCS
  - EU target: 50Mtpa of CO2 by 2030
  - Hydrocarbon producers shall contribute to storage capacity on pro rata basis of their oil & gas production



L 140/114 EN Official Journal of the European Union 5.6.2009

DIRECTIVE 2009/31/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 23 April 2009

on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006

(Text with EEA relevance)

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 175(1) thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Economic and Social Committee (1),

After consulting the Committee of the Regions,

Acting in accordance with the procedure laid down in Art of the Treaty (2),

Whereas:

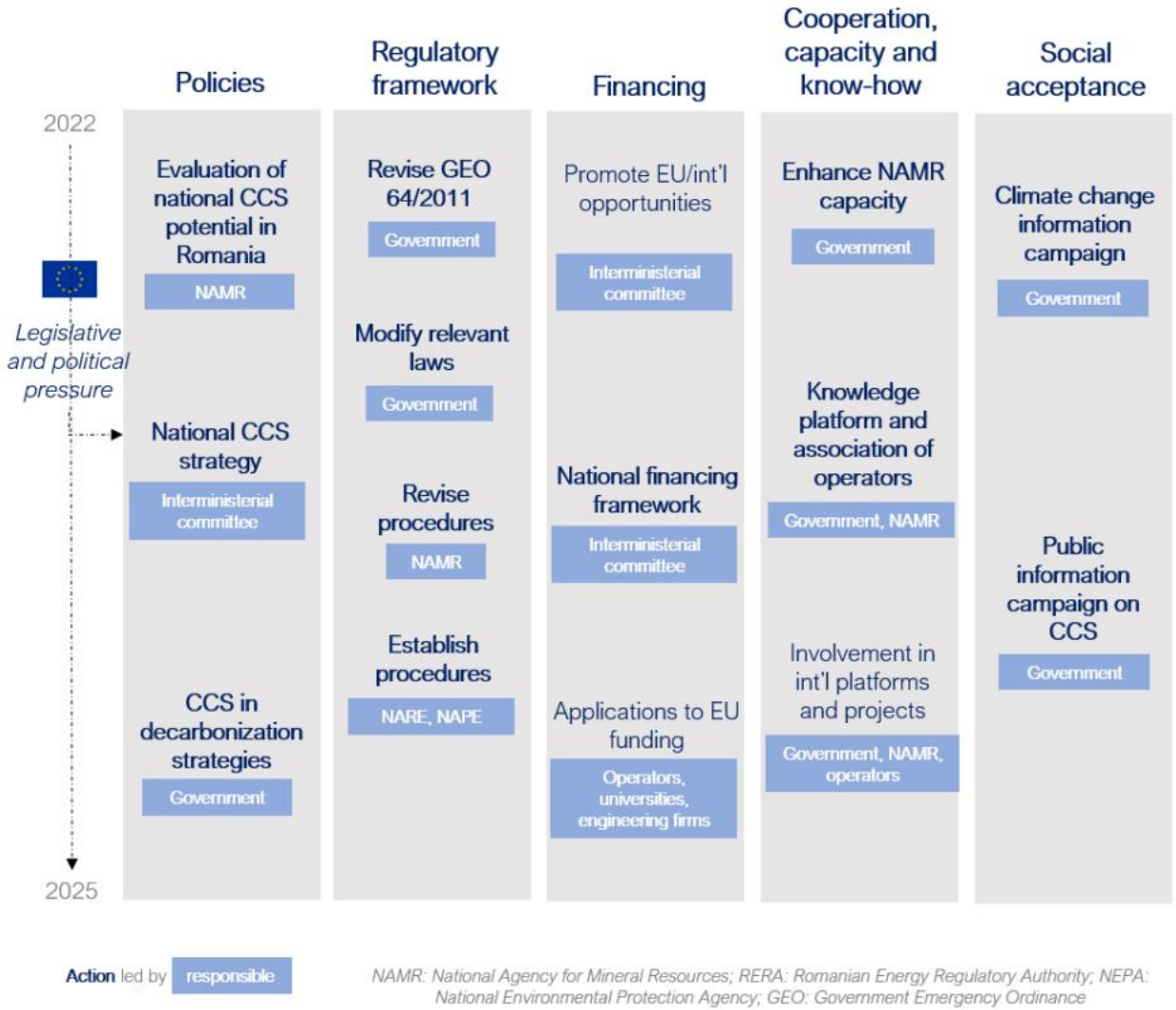
in the context of the envisaged global reduction of greenhouse gas emissions of 50 % by 2050, a reduction in greenhouse gas emissions of 30 % in the developed world by 2020 is required, rising to 60 %-80 % by 2050, that this reduction is technically feasible and the benefits far outweigh the costs, but that, to achieve it, all mitigation options must be harnessed.

(4) Carbon dioxide capture and geological storage (CCS) is a bridging technology that will contribute to mitigating climate change. It consists of the capture of carbon dioxide

Source: NZIA Factsheet

Legal Framework - Development of Geological Storage of CO2

- **EU Directive 2009/31/EC – Directive on the geological storage of carbon dioxide**
- **In RO put in effect via GEO 64/2011 (government emergency ordinance)**
- **Still a great number of 2ndary legislation to be developed (currently ongoing), e.g.:**
  - Exploration/Storage license procedures
  - 3rd party access to infrastructure and storages
  - Method to setup financial guarantee
  - Technical norm for CO2 transport pipelines
  - How to setup tariffs (e.g. transport)
  - Technical instructions
- **Offshore law needs amendment for CCS**
- **Often the industry makes 1st step via the National Energy Federation**



Source: Roadmap for advancing CCS in RO

Legal Framework - Development of Geological Storage of CO2

Legal Framework

- EU Directive distinguishes between
  - Exploration (Permit)
  - Storage (Permit)

EXPLORATION Permit: 210+ Days (as per RO Geo 64/2011) w/o competitive process

STORAGE Permit: 300+ Days (as per RO Geo 64/2011) w/o competitive process

- Currently Storage Permit process doesn't foresee a direct award to the current Petroleum License Holder → proposed amendment to the primary legislation! → **new Geo64 proposal, currently in the 2nd chamber of the parliament for approval**
- Current Petroleum License Holder might not need Exploration as subsurface and well data is available from HC operations; in RO we started working on CCS Onshore (depleted gas fields) w/o Exploration Permit → **new Geo64 proposal**

Public Awareness regarding CCS as a Technology

Public Awareness regarding CCS as a Technology

- Perception survey regarding CCS in community concerned, suggests:
  - Rural communities very much linked to traditional values
  - Agriculture
  - Investments needed in infrastructure, schooling, local markets, local jobs, childcare…
  - Villages facing sharp demographic decline
  - CCS as a technology is hardly known by population
  - Storage of CO2 is considered something necessary for carbon reduction but not in the community
  - CO2 is seen as “garbage”
  - Trust in big companies limited
  - In this case, no gas production/operations in the past 20 years

1st Onshore Demo Project

Project Basics

CCS Onshore Demo Project

Opportunity Statement

- By 2031 the CCS Demo Project is on stream and safely transport and store ~800.000 tpa 3rd party CO2 into a depleted onshore gas field with a total estimated volume of 10.8 mn tons resulting in an injection period of ~13-15 years.
- The project will be the first-of-its-kind in Romania and will pave the ground for other CCS projects.
- Significant funding unlocked from the EU Innovation Fund, thus opening new E&P decarbonization opportunities and unlocking further CCS opportunities in Romania.

Scope

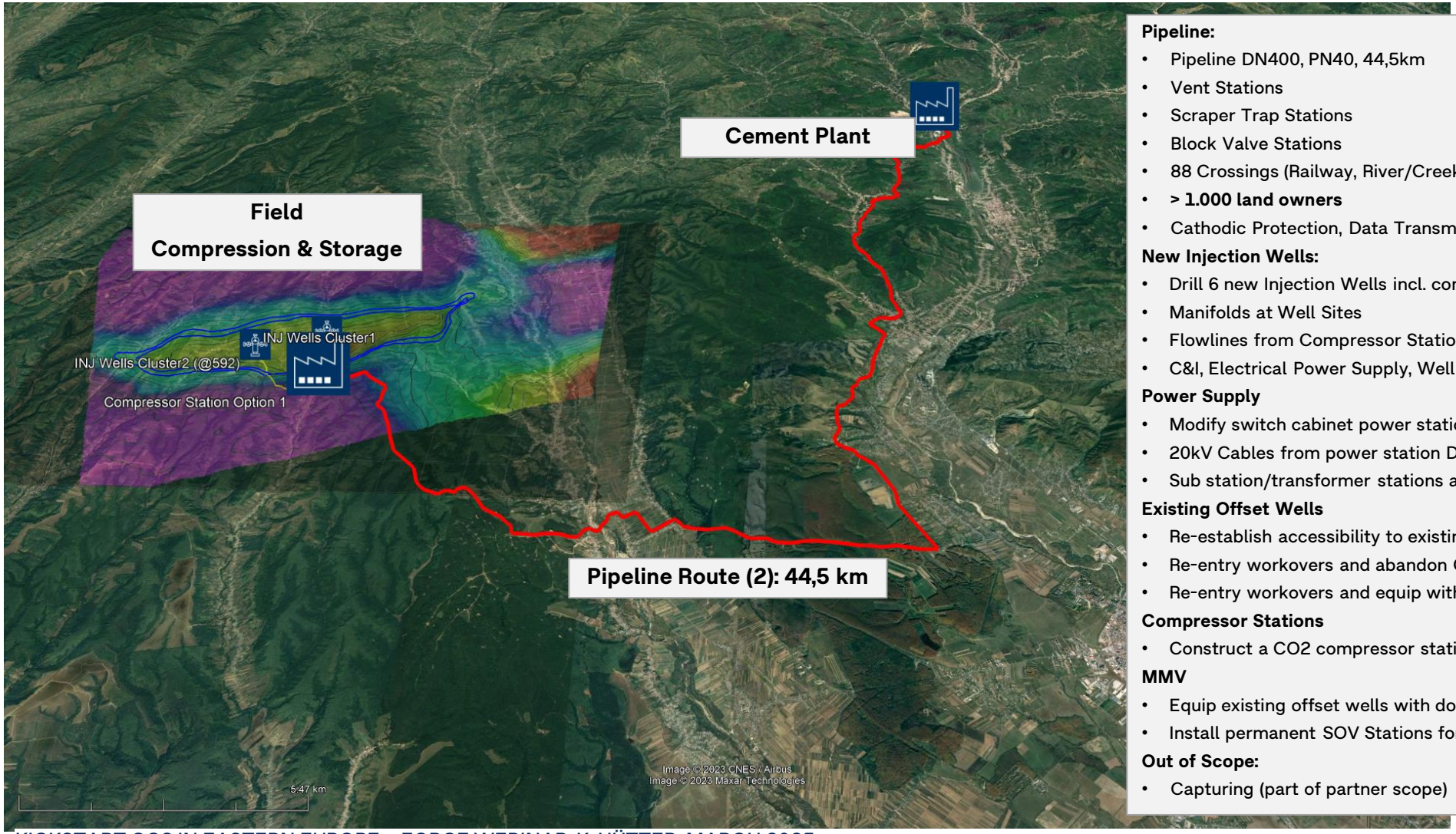
- Drill up to 6 new CO2 injection wells and tie them back to injection manifolds via injection lines
- Build a new CO2 transport pipeline from the cement factory to the field
- Build a new CO2 compressor station in the field, incl. power supply
- Perform re-entries in existing offset wells for data acquisition, abandonment or recompletion for monitoring purposes
- Submit the project to the EU Innovation Fund by 04/2024 as one of the first of-its-kind projects in Eastern Europe
- Establish a monitoring and surveillance plan for the CO2 storage reservoir acc. to EU and national regulations
- Ensure public acceptance and management of key stakeholders from the early phase of the project on and close gaps in legal framework

Key Figures

- **EU Innovation Fund Submission: 04/2024**
- **TG2: Q4/2026**
- **Storage Permit Submission: Q4/2026**
- **TG3/FID: Q1/2028**
- **First CO2 in: Q3/2031**
- **ML Storage Volume: 10,8 mn t**
- **~14 years**

Project Scope

CCS Onshore Demo Project



Pipeline:

- Pipeline DN400, PN40, 44,5km
- Vent Stations
- Scraper Trap Stations
- Block Valve Stations
- 88 Crossings (Railway, River/Creek, Private Property, Road, Forest)
- **> 1.000 land owners**
- Cathodic Protection, Data Transmission

New Injection Wells:

- Drill 6 new Injection Wells incl. completion
- Manifolds at Well Sites
- Flowlines from Compressor Station to 2 cluster sites
- C&I, Electrical Power Supply, Well Automation System

Power Supply

- Modify switch cabinet power station Dragaesti
- 20kV Cables from power station Dragaesti
- Sub station/transformer stations at compressor site

Existing Offset Wells

- Re-establish accessibility to existing offset wells
- Re-entry workovers and abandon CO2 proof
- Re-entry workovers and equip with downhole sensors for Monitoring

Compressor Stations

- Construct a CO2 compressor station; rate: 1.300.000m^3/d

MMV

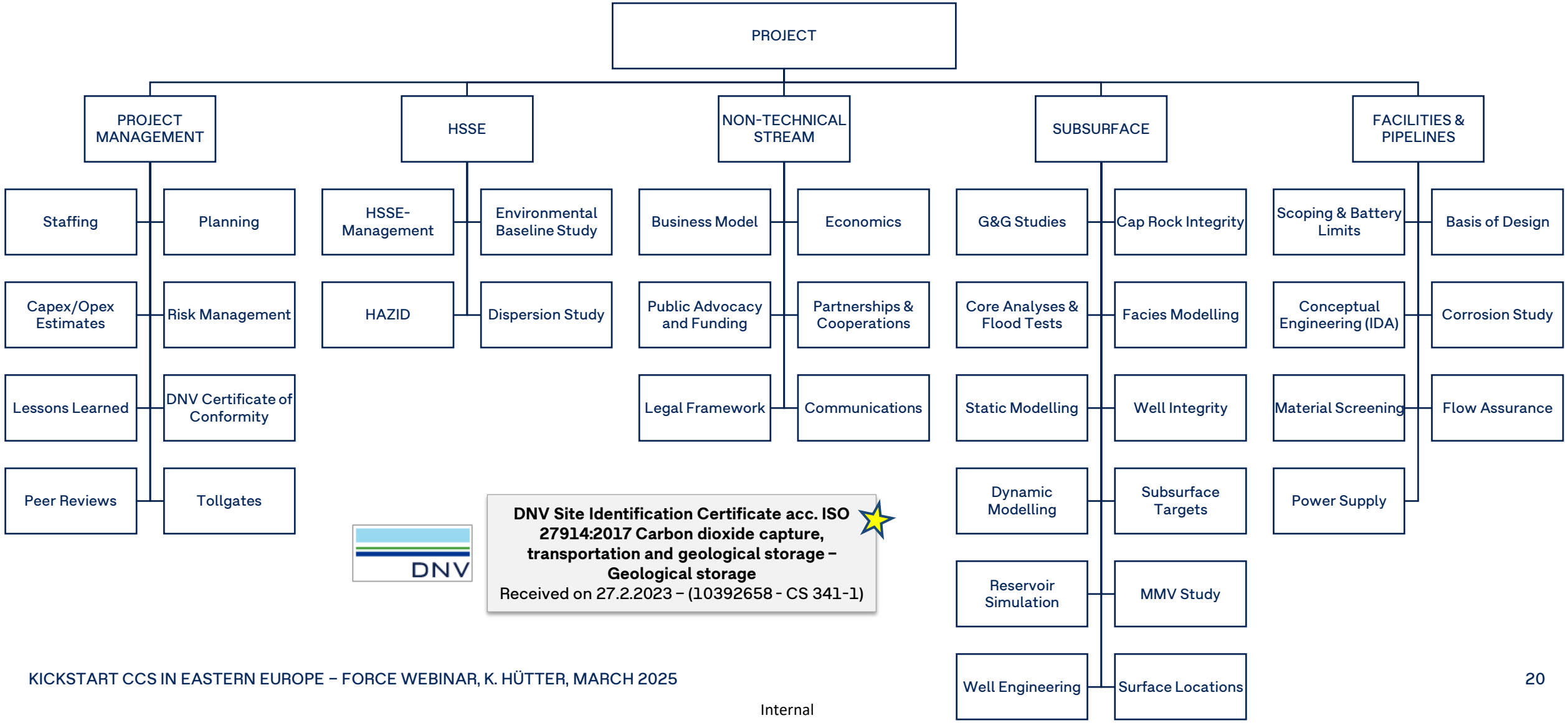
- Equip existing offset wells with downhole sensors for CO2 plume monitoring
- Install permanent SOV Stations for CO2 plume monitoring and cap rock monitoring

Out of Scope:

- Capturing (part of partner scope)

Technical Studies (Site Screening & Site Identification)

Onshore Demo Project

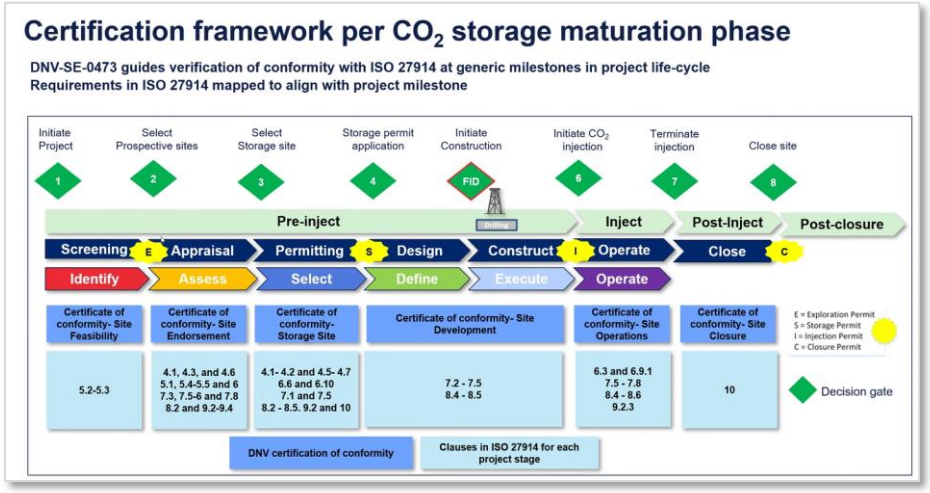


DNV Site Identification Certificate acc. ISO 27914:2017 Carbon dioxide capture, transportation and geological storage – Geological storage
Received on 27.2.2023 – (10392658 - CS 341-1)

DNV Certification Program

CCS Onshore Demo Project

- DNV offers certification framework along the maturation phases of the development of geological CO2 storages
- Verifies conformity to ISO 27914 – "Carbon dioxide capture, transportation and geological storage — Geological storage"
- Project development phases' work packs are mapped to chapters in ISO standard
- Certification at milestones in CO2 storage development projects
- **OMV Petrom's onshore demo project was acquiring the Certificate of Conformity – Site Feasibility on the works performed in Identify & Assess – as first CCS project in OMV**



DNV

CERTIFICATE OF CONFORMITY - SITE FEASIBILITY

Statement No:
10392658 - CS 341-1

Project proponent(s):	**OMV Petrom S.A.**
Prospective storage site(s):	**field, an onshore dry gas reservoir of Meotian age located about 40km north-west of the city of . The lateral boundaries of the storage complex coincide with the contour of the field structure, or initial Gas-Water Contact. The storage unit is comprised of Meotian sands, and a sliver of Sarmatian sands. The primary seal and secondary seal are both sections of Pontian shales. The vertical extent of the storage complex extends from the bottom of the Meotian, or where present, Sarmatian sands, to the top of the Pontian shales.**
Screening basis:	**Nominal capacity for 10.8 megatonnes CO2. Nominal injectivity per well to enable injection of 600 kilotonnes CO2 per annum, on average, through 3 to 6 injection wells. The injection will each year occur over a nominal period of 312 days. Current plans include a 3-month period following start-up of injection operations where injection rate is 50% of nominal rate.**

This is to certify:

That site screening and selection has been performed in accordance with /1/. DNV considers that /3/ demonstrates that long-term geological storage of **10.8** megatonnes to be injected over a period of **18** years in the prospective storage site(s) is conceptually feasible as defined in /2/, and thereby suited for further site characterization and qualification according to /1/ and /2/.

Certification involvement

DNV has verified that site screening and selection has been performed in accordance with /1/ and /2/, and checked conformity with the screening basis. The verification report /4/ includes a description of the verification process, conclusions from the evaluations, and deviations, if any, from the screening basis.

Validity

This statement is valid on the date of issue.

Reference documents

/1/ ISO 27914:2017 Carbon dioxide capture, transportation and geological storage – Geological storage.
/2/ DNV-SE-0473 Certification of sites and projects for geological storage of carbon dioxide.
/3/ Screening report **is considered comprised of all reports listed in Section 2.4 of /4/** Rev. **-**, "**-**", **-**.
/4/ Verification report **GLO-23-1888** Rev. **A**, "**Verification Report - Feasibility of Botesti Field for CO2 Storage**", **2023-02-27**.

Achievements in shaping CCS in Romania

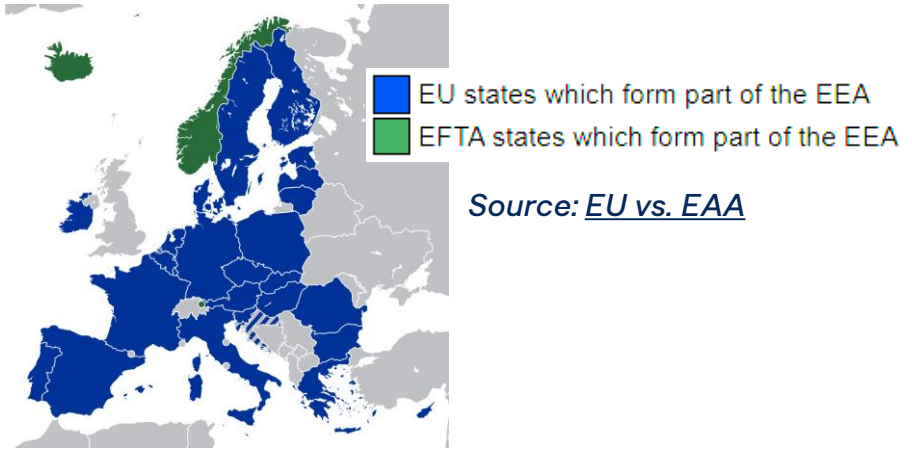
Achievements in shaping CCS in Romania

- **CCS** has been **anchored in the company's strategy**
- **Policy paper on CCS compiled** and presented to the government
- **Gov. workgroup on CCS set up**, headed by the advisor to PM
- **Information campaign and National Roadshow on CCS initiated** by the Romanian government (top-down approach) → create Public Acceptance for the technology
- First onshore demo project early concept work received the **DNV Site Identification Certificate as first project in OMV**
- **International CCS network established** and OMV Petrom is seen as competent partner in CCS in the industry
- We are **actively contributing to shaping the legal frame** via FPE
- **A distinct Low Carbon Business organization and team** is being established in OMV Petrom
- **CCS capacity building workshop brought to Bucharest** (02/2025) to give a floor to exchange to the industry, authorities and gov. reps.
- **Saline aquifer study offshore shows promising opportunities**

Challenges in shaping CCS in Romania

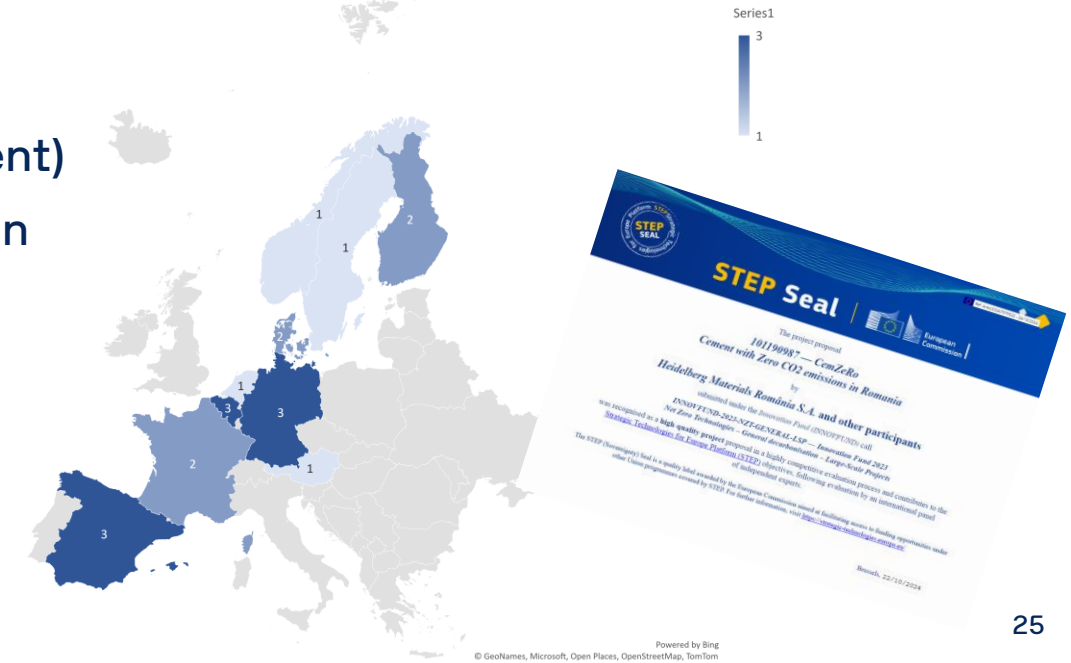
Challenges in shaping CCS in Romania

- **Romania is going to get a huge NZIA obligation** on storage capacity (ca. 9 Mtpa)
- **Secondary legislation needs to be developed**
- **There is no coordinating body** synchronizing the value chain (transport!!!)
- NO or UK storage capacities would not count for NZIA
- **Not a single CCS project has received an EU IF funding in the 2024 call in Eastern Europe…**
- **… instead received a Step Seal Certificate** for preferred procedure in local **Modernization Fund…**
- **…not yet accessible for CCS** (CCS scheme under development)
- **Public acceptance** stopped the data acquisition workovers on the onshore demo project → top-down approach communications campaign
- **All subsurface data is GDPR and needs to be disclosed (authority approval) and acquired** for CCS studies → compilation of a storage atlas challenging



Source: EU vs. EAA

EU IF Large Scale Funding Call '23
Nr. of funded projects by country - Eastern Europe no funding!



Conclusion

- Romania's theoretical storage potential is huge.
- Skills and experience from the oil & gas industry is existing and can be upskilled for CCS.

- A lot of data available from existing fields.
- However, only a part is meeting screening and ranking criteria.
- Onshore depleted fields are the starting point and use case for shaping the frame.
- Saline aquifer structures need intense studies and exploration (studies ongoing).

- Required CCS study works are intense, but requirements are known.
- External reviews and certification systems available to confirm all risks are addressed.
- Knowledge exchange cross industry is ongoing already.

- NZIA is demanding challenging storage capacity targets from the hydrocarbon producers.
- Very diverse level of maturity on CCS in EU countries.
- Average timeline of CCS development not in line with 2030 target.
- Shares in 3rd party storages only on EU territory yet.
- State support is needed to make CCS happen (legal frame, public acceptance, coordinating value chain).

We have the opportunity to contribute to climate targets by helping decarbonizing the hard-to-abate industry and create new business streams along the CCS value chain

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Thank you!


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