

Regional business case for CO₂-EOR and storage - the subsurface solution toolbox

Roman Berenblyum, NORCE at COP24



(thanks to GCCSI for the picture!)

Acknowledgement



To many of my colleagues:



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Setting the scene: CO₂ utilization and storage

Humanity produces CO₂ which is a greenhouse gas

If an industrial unit is emitting CO₂ and not capturing it:

CO₂ is stored in the atmosphere

This is our default and worst way of storing CO₂!!

Any other storage solution is a lot better

Additional benefit can be realised from utilisation of CO₂ including energy it contains after compression!

You can't kill two birds with one stone...



... or can you?

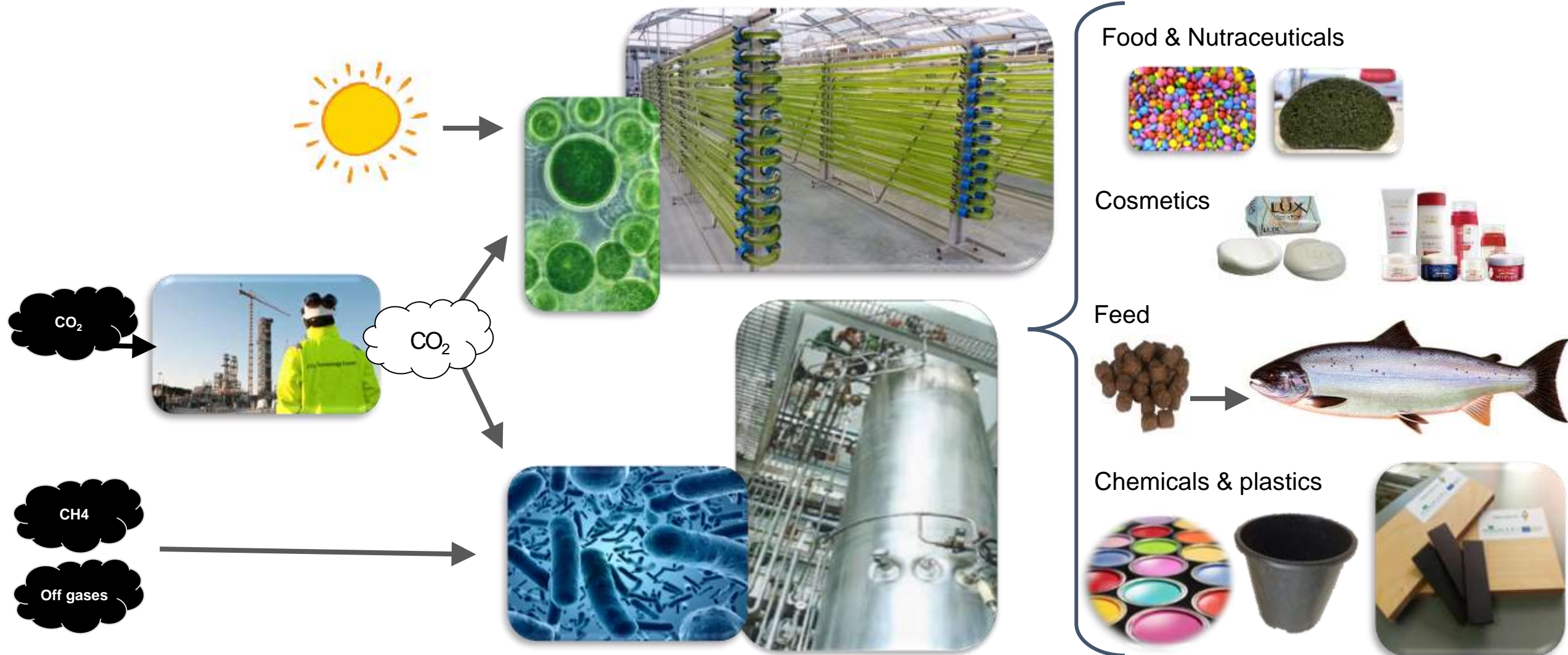
CO₂ capture and transport is definitely a cost. Does storage need to be a cost as well?

- Not really! The answer is utilization!
 - It can create local jobs
 - It can serve local industry
 - Waste to product
 - Greenhouses
 - CO₂-EOR (with potential expansion to gas, therefore EHR)
 - It can pay part of the storage costs!

Subsurface utilisation should be considered as enabler or accelerator of the storage

CO₂-EOR – currently the only commercially ready process allowing for simultaneous utilisation and storage (CCUS) of industrial-scale volumes

Utilization: from CO₂ to valuable products



Enhanced oil recovery (EOR)



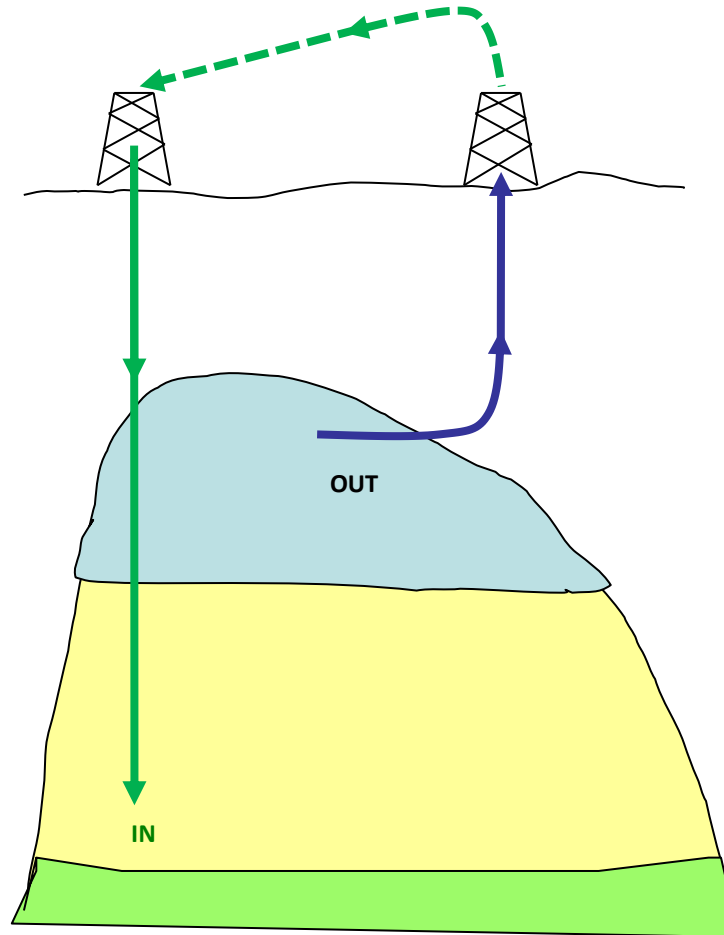
Extending field lifetime and utilising existing infrastructure: saving on materials and energy use

CO₂ stream is compressed: important to at least utilise this energy!

Compared with other fluids used for EOR (nitrogen, hydrocarbon) CO₂ is typically the most effective!

In short: we will continue to need hydrocarbons as a raw material in the future (and for energy at least until 2050 according to IEA). Why don't make them greener (with CCUS) and pay at least part of the bill to store CO₂?

Traditional Enhanced Oil Recovery



Classical EOR

Maximise:

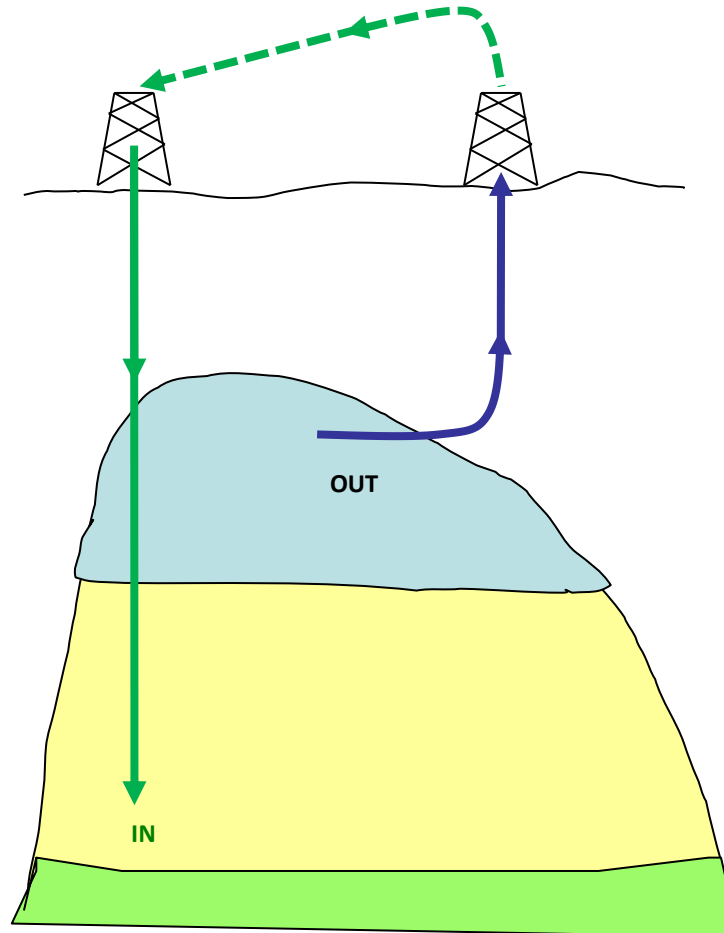
- Total “Out”
- Rate of “Out” recovery
- Profit

At the same time **minimise:**

- Total “In”
- Purchased “In”
- Expenses

I. EOR + Storage (CCUS)

EOR + Storage = CCUS



Maximise:

- Total “Out”
- Rate of “Out” recovery
- Profit
- Total “In”

Optimise

- Purchased “In”

At the same time **minimise:**

- Expenses

II. EOR + Storage (CCUS)



Carbon neutral hydrocarbons?

Out:

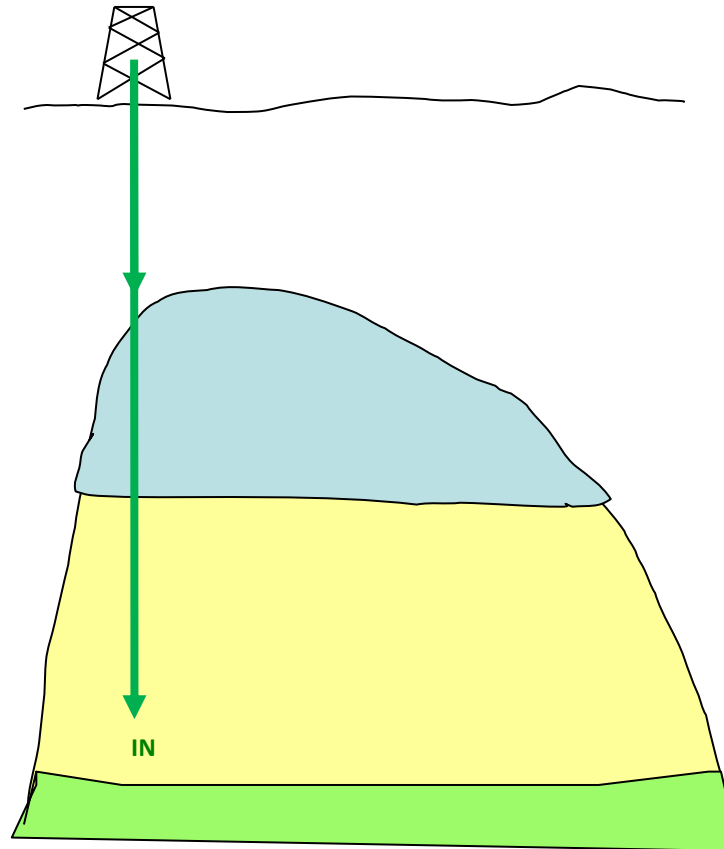
Energy + H_xC_y

In:

CO_2 + Energy

BALANCE is the key:

Energy + H_xC_y - CO_2



Simulated case study



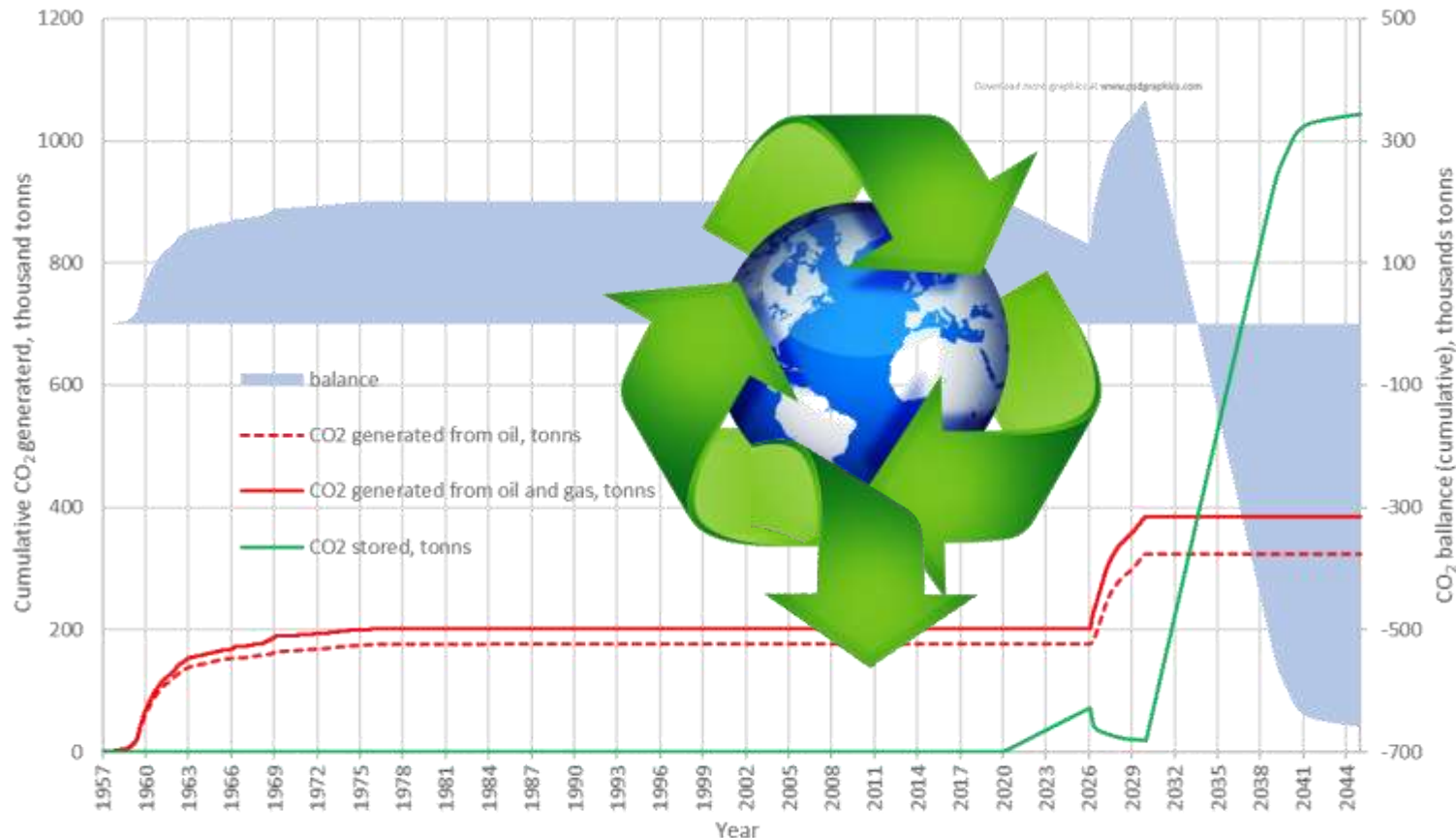
CO₂ pilot 2020-2026; CO₂-EOR 2026-2029;
Fullscale CO₂ storage 2030 – 2040

Total oil (both historical and EOR) recovery ~ 800 thousand barrels

CO₂ generated:
from oil ~ 320 ktonns
From gas ~ 60 ktonns

Total stored: volume 1 million tonnes (more storage volume available)

CO₂ negative with respect to entire hydrocarbon production!



Solution toolbox



ENOS
Enabling Onshore CO₂ Storage

Sub-surface optimisation

Economics

CO₂-EOR

Trans-boundary

Buffer storage

Local and regional networks

ECOBASE

ENOS Q16 Maas – buffer storage



- Support **CO₂ buffering concept**
- Focus on **technical and economic feasibility**
 - Strict **CO₂ specifications for greenhouses** (high purity)
 - Injection/production in a **buffer site case**
 - **Economic uncertainties**
- Connect to ongoing **stakeholder dialogues and public perception**

ENOS Work Package 4: Creating **incentives** for CCS and **new jobs** by integrating storage technology with other activities



Safe and permanent storage in combination with EOR



Based on LBr-1 site in Czech Republic



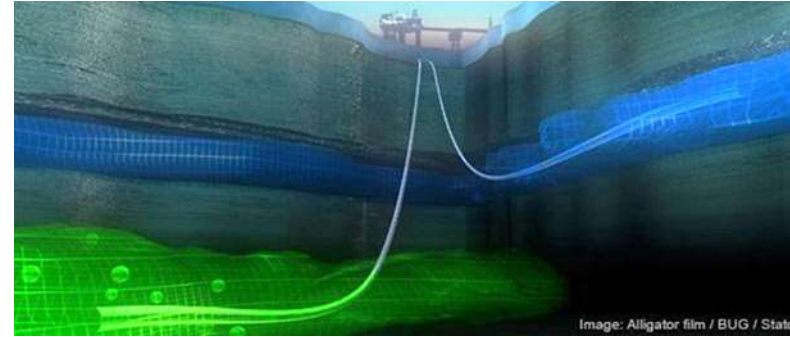
Relevance for local community

Synergies of storage and utilisation

International collaboration:
LBr-1 <-> Wellington field

Building on ENOS sites

Upscaling synergies (Vienna basin)



Novel EOR concepts (EOR + storage)

Modelling of concepts designed

Transboundary: issues, regulations,
(Czech-Slovak border)

CO₂-EOR pilot design

Building the socio-economic case



CO₂-EOR Regional business cases: ECO-BASE



Flexible
optimization
framework

Cost model

Legal framework:
input to
regulations and
incentives

Roadmaps for
specific clusters

Site development
plans for best
candidates



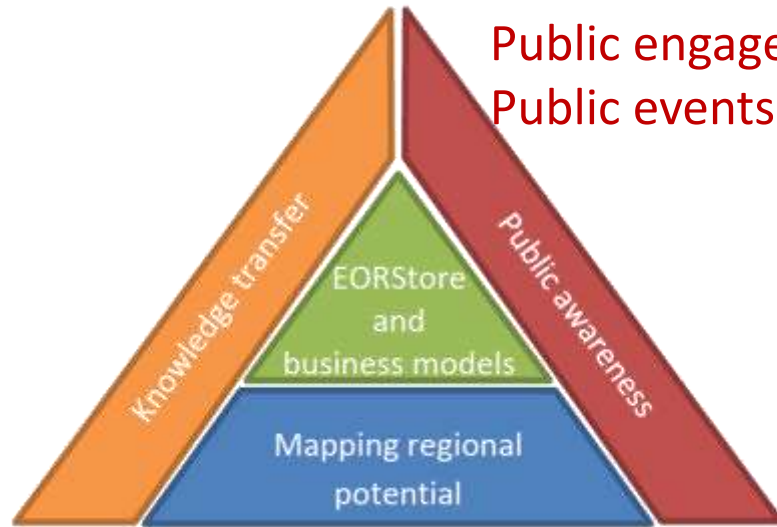
Inventory of storage sites
(sinks) and sources

EOR case studies as a
reference of country-
wide and regional
potential

CCS roadmaps (technical
and legal)

Knowledge transfer

CO₂-EOR Regional business cases



Public engagement and awareness, liaison with ENOS H2020 project

Public events in South Eastern Europe: collaboration with local communities

Synthesis: lessons learned, similarities / peculiarities, best practices / guidance

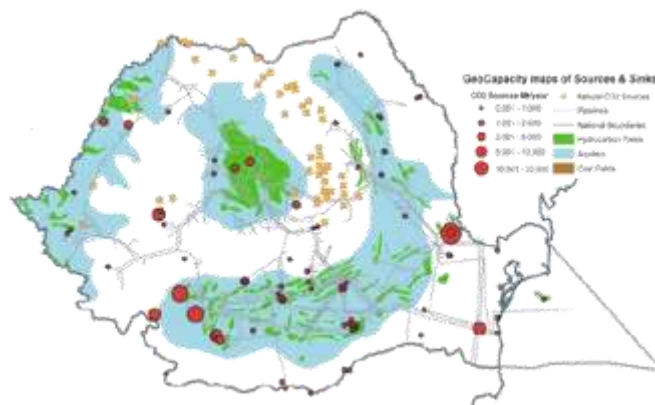
Business cases: Modelling, risks, monitoring, licensing, revenue streams

EORStore case study: Optimisation approach, selection of best candidates

CO₂-EOR roadmaps: Clustering, Environmental, Legislation / incentives, roadmaps

Inventory of sources and sinks: Review data, Inventory, Mapping sources/sinks

Knowledge transfer across regions, dissemination, courses and training

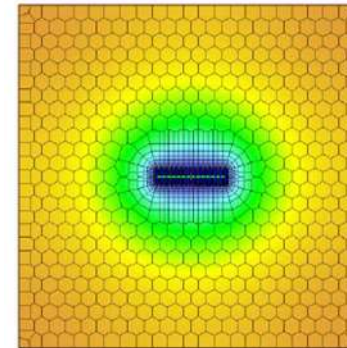


Technology toolbox

- In need of unification of «Reserves estimation»: SPE (<http://www.spe.org/industry/docs/SRMS.pdf>), ISO (<https://www.iso.org/committee/648607.html>)

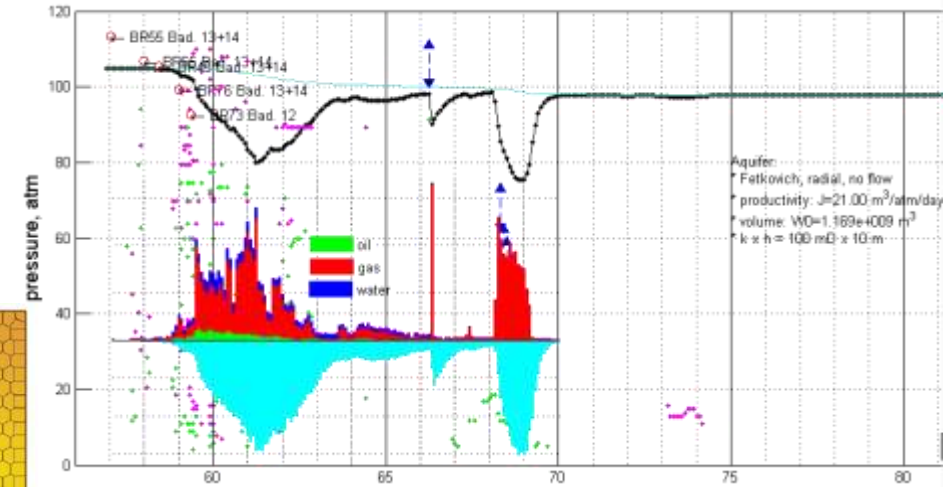
- Analytical and material balance models

Quick dynamic estimations under data uncertainty



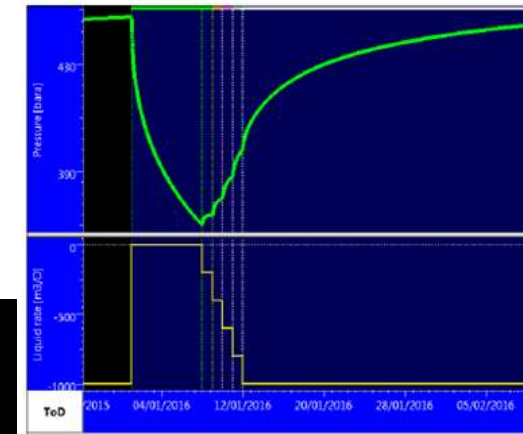
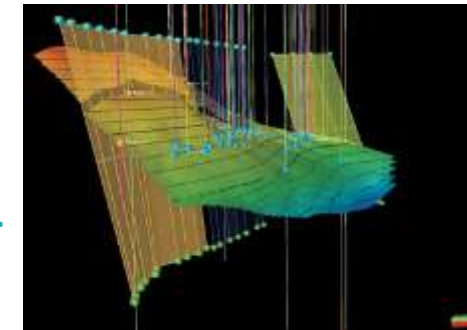
- Pressure analysis

Analysis of reservoir dynamics based on actual well behavior
in the operating wells (in the same formation, but different fields)



- Reservoir simulation

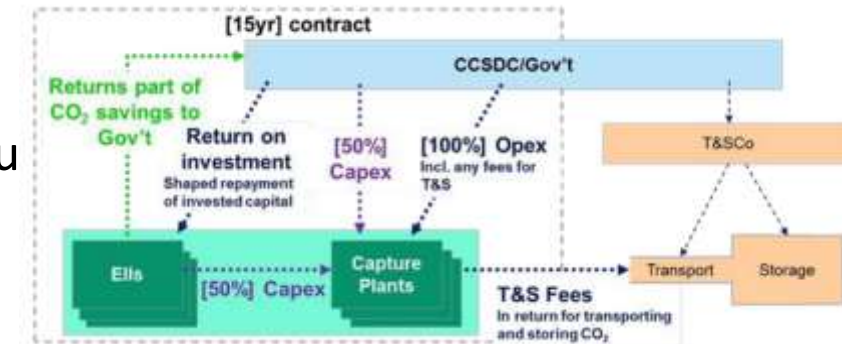
Simulating whole field on different scales / fit for purpose models.



Way forward: We need **more** game makers!



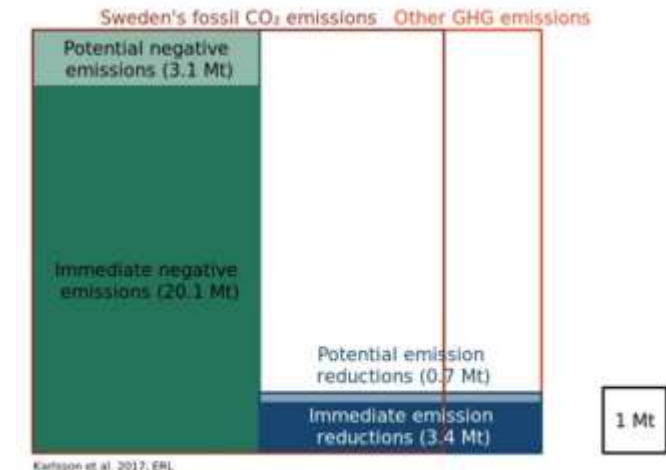
Fit-for-purpose CCS solutions workshop during CO₂GeoNet Open Forum
<http://conference2017.co2geonet.com/>



Tees Valley Collective (UK) developed cost effective CCS model

Biorecro (Sweden) – BECCS potential with storage

Gassnova – Norwegian storage site



The way forward



CO₂ – EOR is a **proven and working** technology (since early 1970's)

None of the engineering questions in CCUS are **show stoppers**.

Incentives to transition CO₂-EOR to storage project are, in principal, **clear**

Project proponents **need regulatory clarity** for CO₂ storage and EOR to meet the IPCC inventory guidelines for CCS!



NORCE

**KEEP
CALM
AND USE
THE
NORCE**

Way forward and ideas in the pipeline



- EEA Grants – consortia building via CO₂GeoNet / ENERG

Deployment of CCUS (carbon capture utilisation and storage) projects is hindered by legal, cross-border, awareness and political issues rather than just technical questions.

Utilisation will focus on subsurface usage. CO₂-EOR, energy storage.

- Norway Grants: CO₂EOR business cases: Poland, Czech Republic, Romania

Consortia in these countries are in place. Waiting for a call.

Key idea: create CO₂EOR business case to serve as demonstration and crystallisation point

- H2020: SET plan support action + ACT (?)

Support SET plan: towards Toolbox powered CCS GIS. First action is to build consortia and define practical actions to be taken