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**CO₂ Sinks
in Oil/Gas Fields & Aquifers**

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CO₂ Capture and Sequestration
In Future International R&D Programmes

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Outline

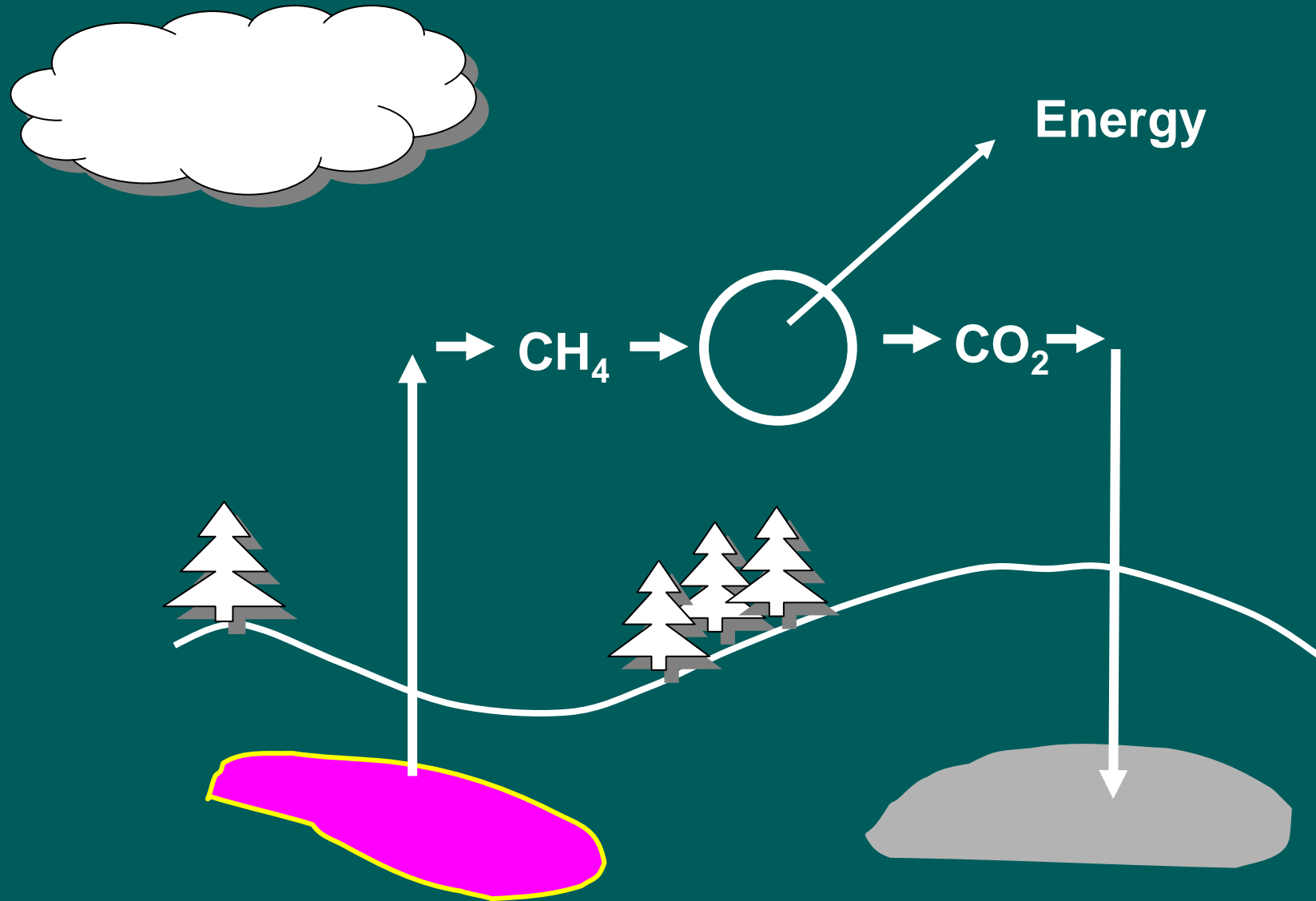
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Introduction

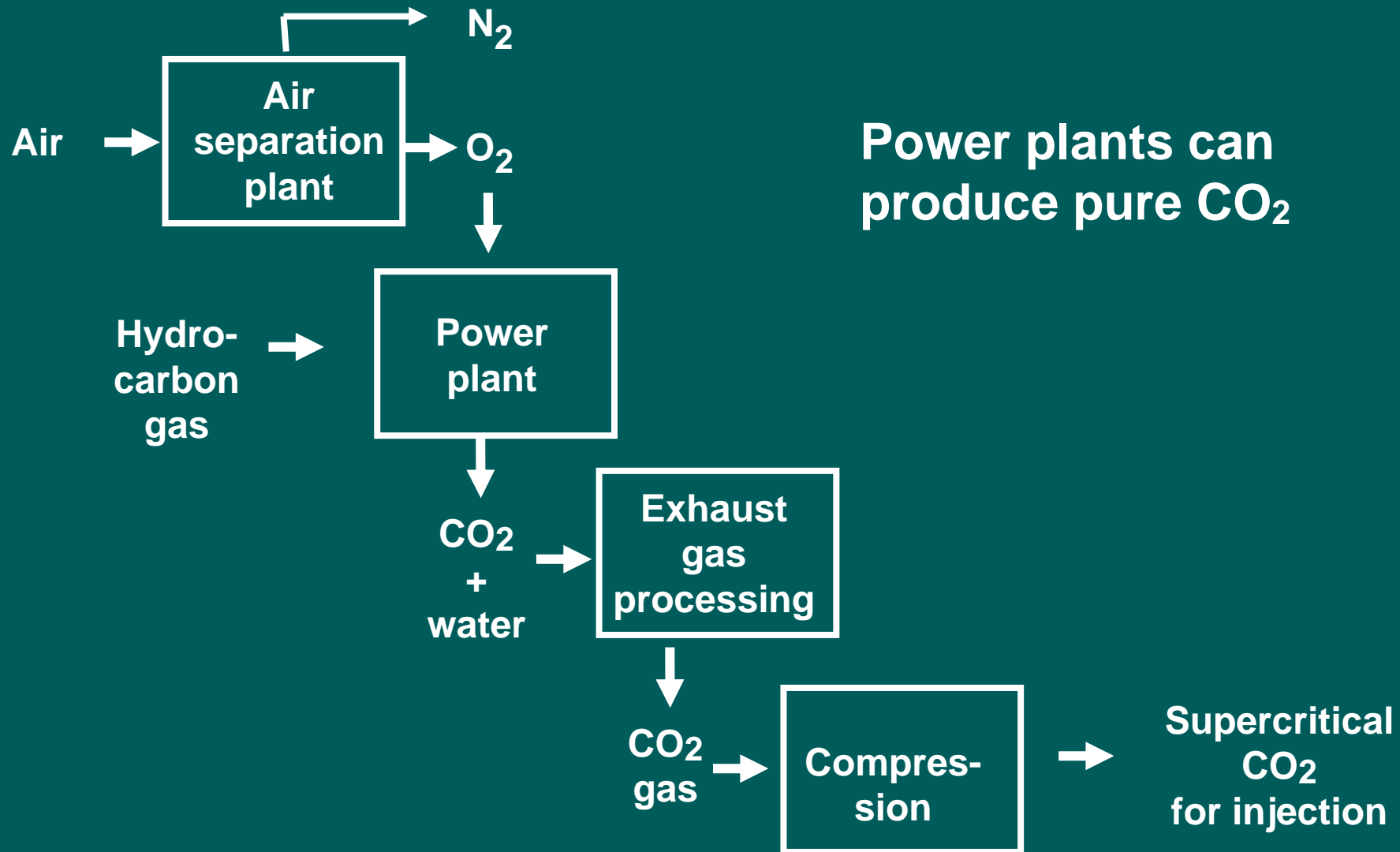
- 85% of the world's energy is supplied by fossil fuels
- More than 60% is provided by crude oil and HC-gas
- Oil & gas reserves are available for 200 years at least
- Fossil fuels will be further used during the next 50 to 100 years

Also the stone age was not over
because of a shortage of stones

Give the Carbon Back to the Earth



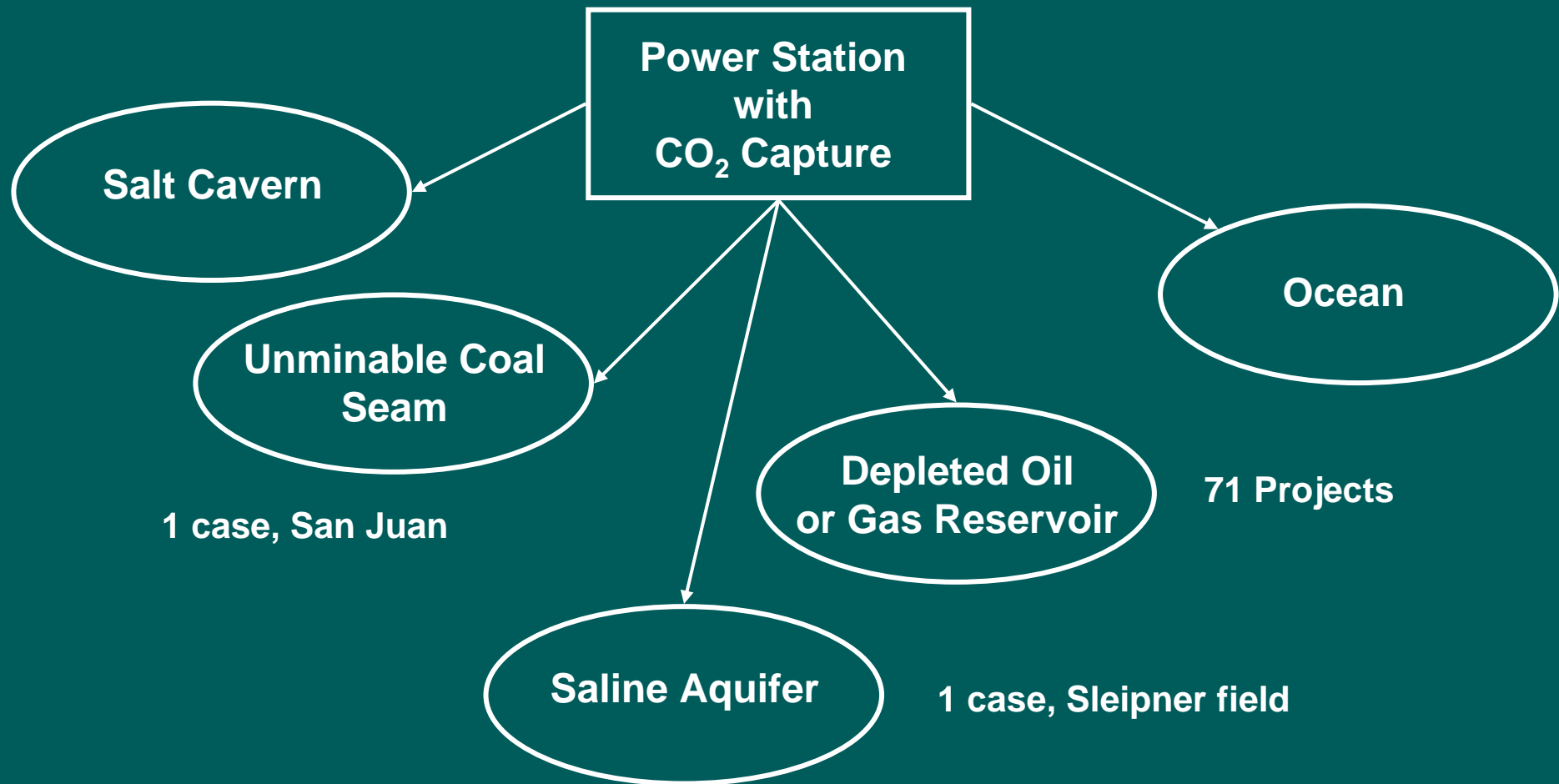
Pre-combustion Separation of CO₂



Pure CO₂ Behaves Like a Liquid!

- CO₂ is a supercritical fluid at
 - a temperature > 31.1 °C
 - a pressure > 74 bar,with a density of
 - 400,...500,...600,...800,...1000 kg/m³
- In the ocean at 3000 m depth the density of CO₂ is higher than the density of water.
- Underground, the density of CO₂ is independent from depth between 680-700 kg/m³
- **1 ton CO₂ requires 1¹/₂ m³ pore volume to be stored**

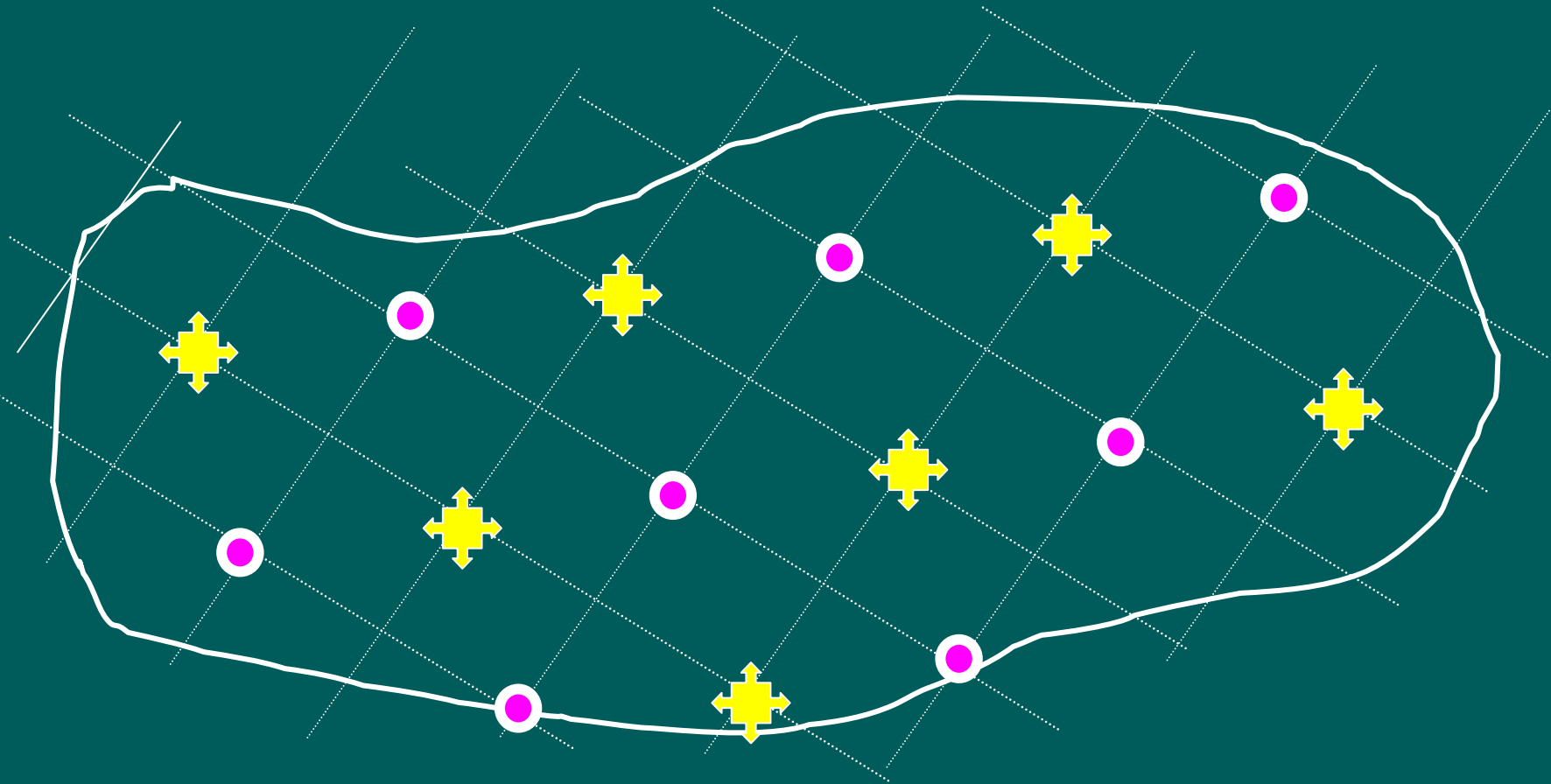
Possible CO₂ Sinks



Enhanced Oil Recovery – CO₂ Flooding

- CO₂ injection has been used as a commercial process for Enhanced Oil Recovery (EOR) since the 1950's.
- Recently 71 of such projects were reported worldwide.
- Currently ~20 Million t/year are injected into 4500 wells,
- Producing ~ 200.000 barrel of oil /day (30.000 m³/d).

Injection-Production System



Wells:



Producer



Injector

CO₂ Displacement



All Projects are Unique

- It is impossible to find general relationships between oil and rock properties, displacing gas composition, operation conditions and the additional oil recovery.
- The parameters influencing the effectiveness of CO₂ flood must be individually determined for each project.
- The average additional oil recovery is 8-16% of the original oil in place (OOIP).

An Important Facts

- CO₂ sequestration in geological formations is rather a political and economical question than a technical one:
- All necessary technologies are matured including the safety and environmental questions.
- The petroleum industry possesses all knowledge and methods to select the best sites, plan and conduct the injection processes.
- The location and the movement of the CO₂ phase within the formation can be monitored by geophysical methods (4D seismic).

Disposal in Depleted Oil Reservoirs

- Until now strong reservoir engineering design effort has gone into reducing the total amount of CO₂ required to recover each ton of oil.
- Future objective will be to increase the amount of CO₂ left behind at the end of the recovery process,
- Only few investigations were made in this direction.

Storage Capacities in Oil and Gas Reservoirs

Today:

- Austria: 400 MM t of CO₂
- Worldwide: 325.000 MM t of CO₂.

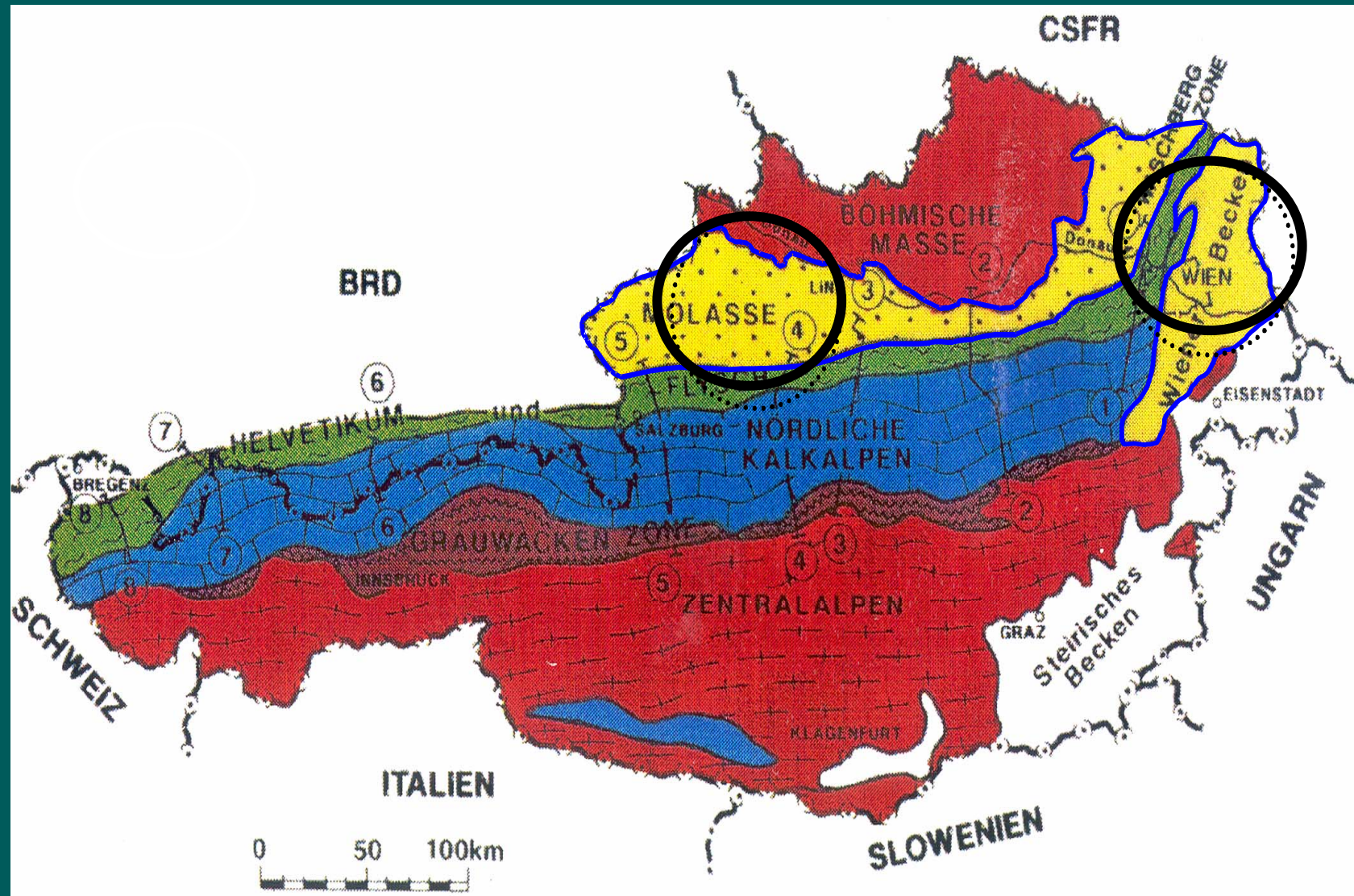
Until ultimate recovery:

- Austria: 510 MM t of CO₂
- Worldwide: 1.000.000 MM t of CO₂.

Disposal in Aquifers

- Storage in shallow formations:
 - Huge pore volumes necessary
 - Water reserved for drinking water
 - Danger of overpressuring formation
- Storage deep aquifers:
 - Large amounts can be stored due to high density in supercritical state
 - High salinity water not fit for industrial or agricultural use.
 - CO₂ migrates back to the surface due to buoyancy in terms of thousands of years

Austrian Oil and Gas Fields



Six Potential Candidates

1. Schönkirchen Tief (OMV) - Oil reservoir
2. Höflein (OMV) - Condensate reservoir
3. Schönkirchen Übertief (OMV) - Sour-gas reservoir
4. Reyersdorfer Dolomit (OMV) - Sour-gas with oil rim
5. Atzbach-Schwanenstadt (RAG) - Gas reservoir
6. Voitsdorf (RAG) - Oil reservoir

Become available between 2010-2025

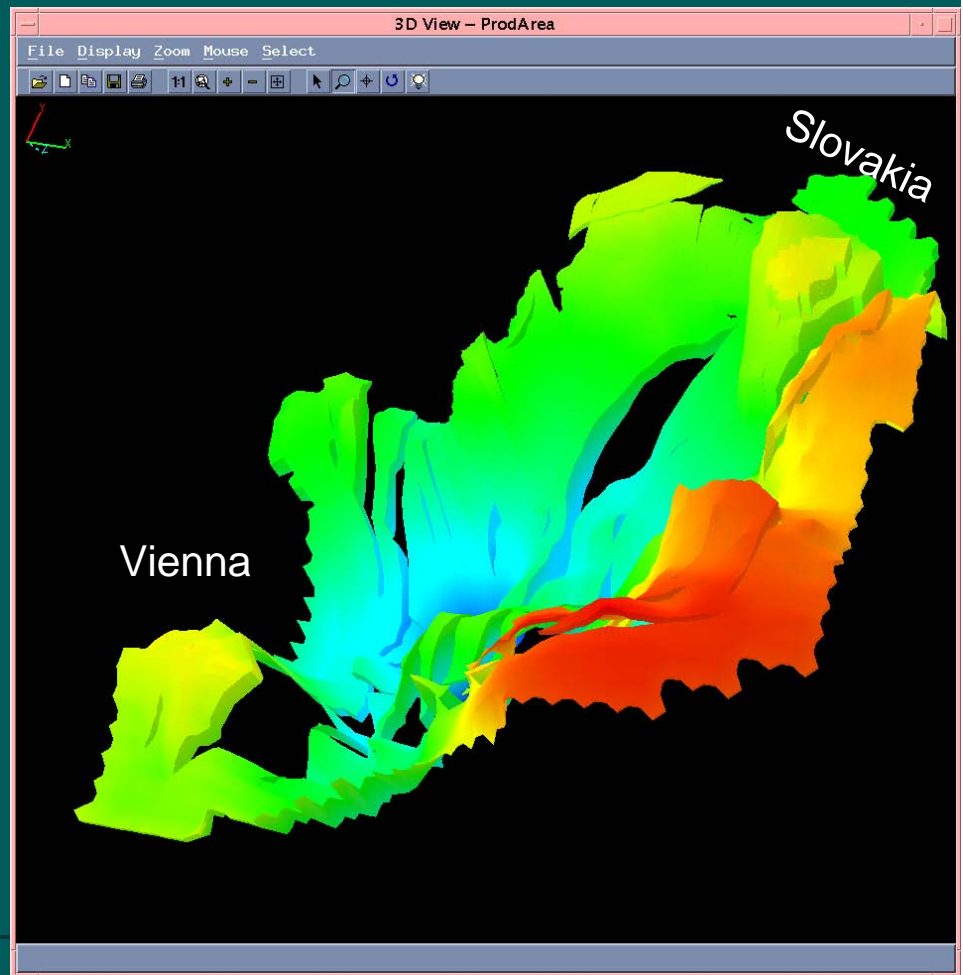
Cost of compression, pipelining and injection:

11.0-12.5 €/t

Possibility for Aquifer Storages in Austria

The only known suitable aquifer is the Aderklaa Conglomerate!

- **3 Fields connected to one aquifer**
- **30 x 40 km**
- **50 years history**



Central Part of Aderklaa Conglomerate

- Connected to the largest oil reservoir (16. Torton) and the largest gas reservoir (Zwerndorf) in Austria.
- Proved as isolated (closed)
- Storage Capacity: at least 10 MM t
- If water is produced, up to 1 Gt storage volume is possible! (1 Giga ton = 1000 Million ton)

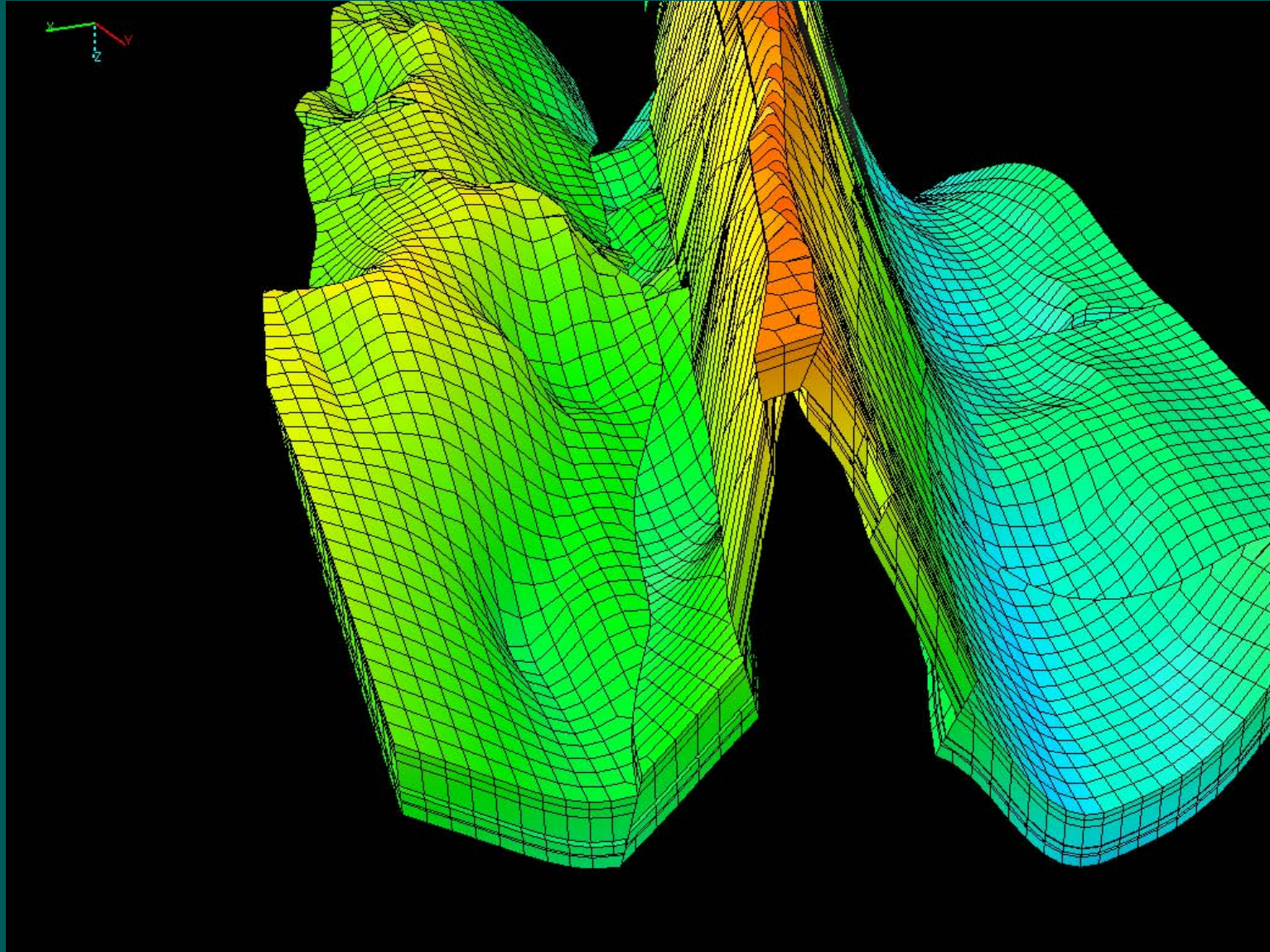
Conclusions

- The Austrian oil industry possesses all geo-scientific and technical knowledge necessary for safe and cost-effective disposal of CO₂.
- The numerous underground gas storage operations qualify both OMV and RAG.

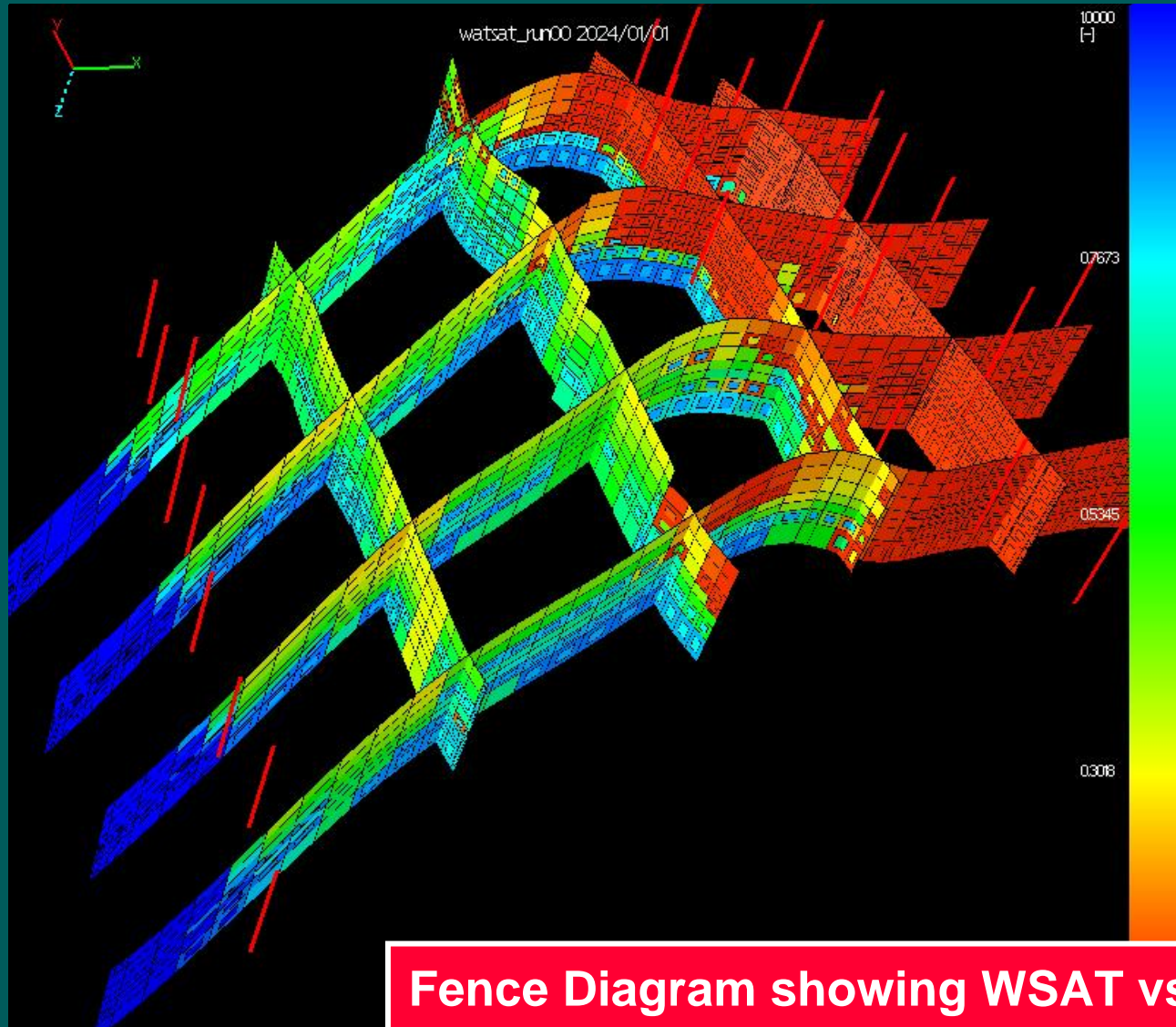
Austrian Expertise

- Successful CO₂ injection by RAG
- Successful CO₂ injection in Hochleiten by OMV 2004
- Sour gas production and processing from three fields
- Water sink in Aderklaaer Conglomerate,
- Development of a complex simulation software SURE, suitable for CO₂ sequestration projects by Heinemann Oil Technology (Leoben) since 1992.
- “Knowledge Transfer Program” for planning and modeling compositional operations including CO₂ sinks, offered by the Montanuniversität Leoben, 2004-2005.
- At this time two doctorate works are conducted at the Montanuniversität (2003-2006).

Carbonate Reservoir



Carbonate Reservoir



Fence Diagram showing WSAT vs. Time

My Suggestions

- A national research project should be launched
- At least two pilot applications should be conducted, one for an oil reservoir and the other for an aquifer.

Acknowledgements

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**Thank You
for your Attention!**