LITHUANIAN RENEWABLE ENERGY LANDSCAPE : CCUS, HYDROGEN STORAGE AND GEOTHERMAL

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CARBON CAPTURE UTILIZATION AND STORAGE (CCUS)

Introduction

- Reducing CO_2 emissions is a key to greenhouse gas emission reductions, and it is expected to achieve 14-19% of the reductions needed by 2050. Carbon Capture, Utilization, and Storage (CCUS) is considered one of the most effective methods to remove the anthropogenic CO_2 from the atmosphere.
- The long-term geological storage of CO_2 is possible in the following locations:
  - Coal seams or Salt accumulations, Deep saline aquifers, Depleted oil and gas reservoirs.

Study Area: CO_2 storage potential in reservoirs in Lithuania

- Deep saline aquifers: Syderiai and Vaskai.
- Depleted hydrocarbon reservoirs of Gargzdai oil zone considered as one single unified model in Lithuania.

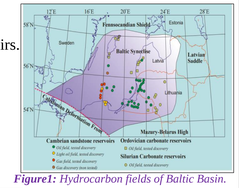

Figure1: Hydrocarbon fields of Baltic Basin.

Methodology

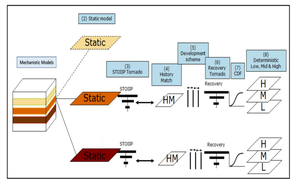

Figure2: Uncertainty Management Workflow.

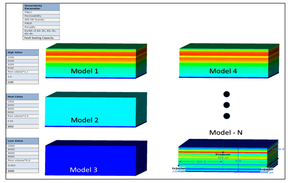

Figure3: A sample sector/mechanistic model (conceptual plot).

Results

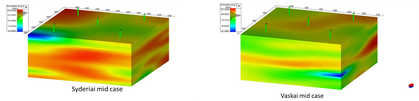

Figure4: Mid-case permeability distribution for Syderiai and Vaskai mechanistic models.

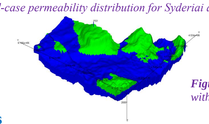

Figure5: Part of Gargzdai oil zone model with CO_2 injection.

Table1: CO_2 storage potential in Syderiai, Vaskai and Gargzdai Oil Zone for high, mid and low cases, after 30 years of injection.

Cases / Reservoir	Low	Mid	High
Syderiai (Mt)	181	268	870
Vaskai (Mt)	166	252	719
Gargzdai Oil Zone (Mt)	749	1135	1352

Conclusions

- The 3D numerical simulation results shows that the combined capacity of CO2 storage in two deep saline aquifers ranges from 347 –1589 Mt of CO_2, and the storage volume ranges from 749–1352 Mt of CO_2 for Gargzdai oil zone.
- This clearly shows that large volumes of CO_2 can be stored within the boundary of Lithuanian territory.
- However, these are high level estimates based on 3D modeling that do not consider the aspects of mineral trapping and leakage etc., which would require additional work to be quantified.

References

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3. Pal, M., Malik, S., Karaliūtė, V., Makauskas, P., and Sharma, R., 2023; Assessing the Feasibility of Carbon Capture and Storage Potential in Lithuanian Geological Formations: A Simulation-based Assessment, Expanded Abstract, 84th European Association of Geoscientists and Engineers (EAGE) Annual Conference & Exhibition, Vienna, Austria. DOI: https://doi.org/10.3997/2214-4609.202310502.

HYDROGEN PRODUCTION AND STORAGE

Overview

Hydrogen energy is key to the shift towards a more sustainable future for humans, which will also enable tackling climate change issues.

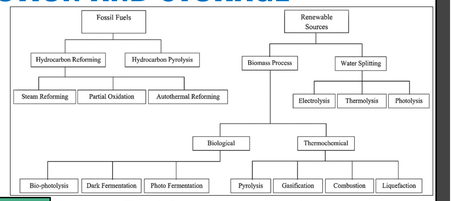

Figure1: Routes to hydrogen production.

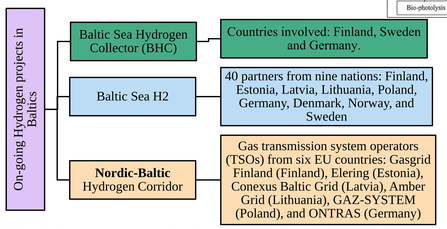

Figure2: On-going Hydrogen projects in Baltics.

Hydrogen Potential in Baltic Region

- The on-going Hydrogen projects in Baltic region (Fig. 2) are going to help achieve the ambition to produce 10 million tonnes and import 10 million tonnes of renewable hydrogen in the EU by 2030.
- The aim of these projects is to increase hydrogen production and improve the hydrogen transportation opportunities.

In-Situ Hydrogen Production

- In this method naturally occurring "Thermotoga petrophila" bacteria in hydrocarbon reservoirs are used to produce hydrogen through bio-refinement of crude oil. Basically, bacteria eats crude oil and produces hydrogen as a bi-product.

Assessment of In-Situ Hydrogen Production in Lithuania

-Gargzdai structure in Lithuania, which has many depleted hydrocarbon fields, has a residual oil zone containing close to a billion barrels of residual oil. All the residual oil could be a potential target for hydrogen production using the "Thermotoga petrophila" bacteria strain.

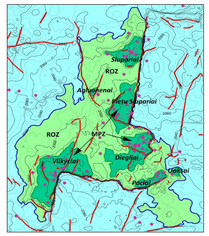

Figure3: Gargzdai Residual Oil Zone - Approximately 200 sq. km and 50 m thick.

Table 1: Table showing estimates of hydrogen production from Gargzdai residual oil zone.

H2 produced	H2 production 1 liter of crude	H2 (Liters) produced from 1 bbl. of crude	H2 (liters) produced from 1 Billion bbl. of crude	H2 produced from 1 Billion bbl. of crude in Trillion Cubic Feet	H2 produced from 1 Billion bbl. of crude in Million tons
Low Case	1170	185913	1.85913E+14	6.6	184
Mid Case	1300	206570	2.0657E+14	7.2	200
High Case	1495	237555.5	2.37556E+14	8.3	231

- Gargzdai oil zone reservoir properties:
  - Temperature: 85-90°C
  - Depth: 2Km
  - Pressure: 150-180 bars.
- Similar pressure and temperature zone have shown potential for hydrogen production using thermophilic bacteria

References

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GEOTHERMAL ENERGY POTENTIAL

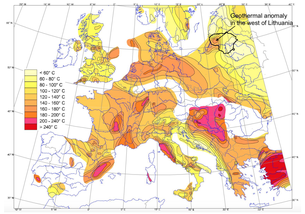


Figure 1: Map of Europe showing temperature at 5 km depth (modified after Hurtig et al. 1992).

Overview

Lithuania has a geothermal anomaly despite its location in the stable thick ancient tectonic plate that existed from the Cambrian Period. The anomaly is situated in the SW of the country and it is related to Middle Proterozoic cratonic granitoid intrusions rich in radiogenic heat producing elements Th, U and K [2].

Geothermal – Historic overview (Lithuania)

- 1989 — First Geothermal Well – Vydmantai -1
- 1992 — Baltic Geothermal Project initiated
- 1993 — Second Geothermal Well – Vydmantai -2
- 1993-99 — Further geothermal exploration wells drilled (19)
- 1995-96 — KGDP conceptualized – Devonian waters
- 2000 — KGDP starts operation (700 m³/h @ 40°C)
- 2002-2010 — KGDP operational issues (re-injection)
- 2010-16 — Injection remediation work – unsuccessful
- 2017 — Financial issues and plant ceases operations

Direct use of heat from Hydrothermal Sedimentary Aquifers

- Identified hydrothermal complexes: Cambrian Deimena sandstones (T<95°C), Middle-Lower Devonian Pärnu–Kemeri sandstones (T<46°C);
- The 3D numerical simulation models are currently built to assess the potential of various possible geothermal sites within Cambrian formation with T>60°C. Top 3 sites are chosen and then used put through a geological uncertainty modelling workflow to perform a techno-economical modelling.

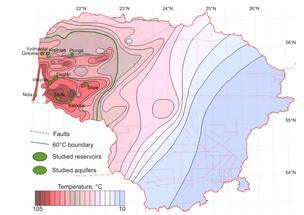
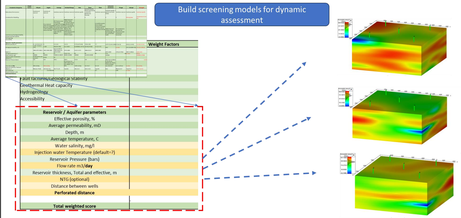


Figure 3: Depth map for the 150°C isotherm (from Ciuraite, 2009).



Electricity production potential: EGS

- The temperature of 150°C is at a depth of 4.4-4.5 km in western Lithuania, at a depth of 9 km in eastern Lithuania. The temperature of 200°C in western Lithuania is about 6.4 - 6.5 km deep [3].
- Shallow depths create opportunities for geothermal electricity production in Western Lithuania. The most promising for geothermal energy are the granitoid area of Žemaičiai Naumiestis and the Vilkyčiai area.

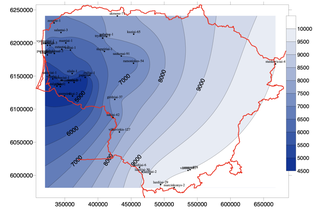


Figure 4: Depth map for the 150°C isotherm (from Ciuraite, 2009).

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