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Ortenauhalle Congress 1
Deep geothermal energy

Unlocking Geothermal Potential for Resilient Greenhouse Heating in Lviv, Ukraine: A Pathway to Sustainable Agriculture and Energy Security

Erschließung des geothermischen Potenzials für eine widerstandsfähige Gewächshausheizung in Lviv, Ukraine: Ein Weg zu nachhaltiger Landwirtschaft und Energiesicherheit

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The Lviv region of Ukraine, with its strong agricultural base, faces significant energy challenges linked to its dependence on imported fossil fuels, particularly Russian gas. These vulnerabilities have been aggravated by the ongoing war, which has destroyed over 40% of Ukraine's energy infrastructure and led to soaring energy prices. This has forced approximately 35% of greenhouse farms in the region to cease operations, directly threatening food security and local economic stability. In this context, geothermal energy presents a transformative opportunity. As a local, renewable energy source, geothermal heat can offer an alternative for greenhouse heating, supporting both Ukraine's agricultural productivity and its strategic objectives of energy independence, and support climate goals.

The project has assessed the geothermal heat potential for greenhouse heating in Busk (western Ukraine). By evaluating the geothermal resources and their technical, market, and regulatory feasibility, the project seeks to provide Ukrainian and Dutch agro-entrepreneurs with insights into the viability of geothermal solutions. The project directly contributes to Ukraine's clean energy transition, fosters local economic recovery, and supports the Sustainable Development Goals (SDGs).

Project Background and Problem Analysis

The Lviv region has geothermal potential but a systematic assessment has not been performed. The war has highlighted vulnerabilities, with high energy costs and greenhouse closures threatening Ukraine's food security. While local awareness of renewable energy is increasing, knowledge gaps, technology access, market immaturity, and insufficient investment frameworks

limit geothermal uptake. Furthermore, data access remains challenging due to outdated, paper-based archives, language barriers, and commercial or regulatory restrictions on spatial data. Inaccurate or incomplete data could negatively impact geothermal resource assessments, delaying or deterring private investment.

Project Description and Results

The project focused on a regional assessment of the geothermal potential in the Lviv region, including the integration of geological, geophysical, and hydrothermal data to develop a comprehensive understanding of the subsurface. Extensive data was collected from 93 hydrothermal and hydrocarbon wells (Figure 1). The well data originated from 12 regional oil and gas fields.

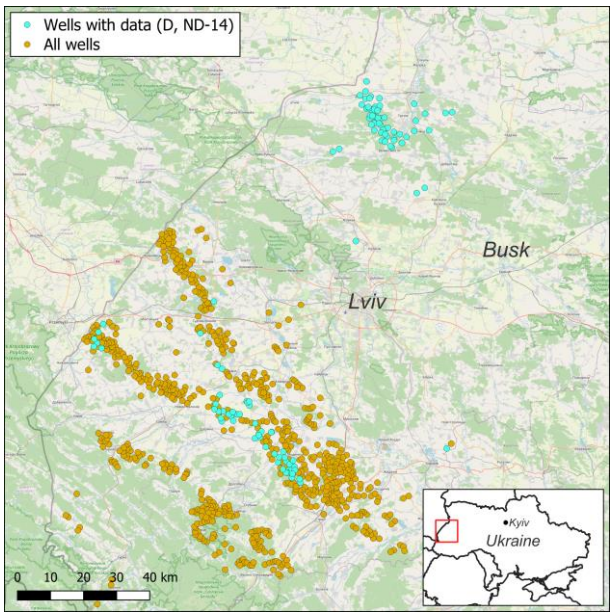

Figure 1: Target well locations Lviv region.

A review of available geological surveys, historical reports, geophysical data, production records from existing wells and litho-stratigraphical columns led to the identification of two promising geothermal horizons. The Neogene (ND-14) is located primarily in the Pre-Carpathian Depression southwest of Lviv. The Devonian (D), located in the East European Platform, is found north of Lviv.

A detailed well database was developed for these two geological layers. Key parameters included in the database are depth, layer thickness, net-to-gross ratio, porosity and permeability, and formation temperature. Given the project's focus on geothermal applications for greenhouse and urban heating, a minimum target temperature of 50 °C was established as the lower threshold for viable geothermal wells. A key challenge in this study is the limited availability of permeability data, which, with temperature, is considered to be the most determining factor determining the geothermal potential. In such cases, general estimations were applied based on analogous wells and regional geological understanding.

The temperature distribution at a depth of 2,000 meters shows a gradual increase from northeast to southwest across the Lviv region, with temperatures ranging from 40 °C to 60 °C. In the northeastern and eastern parts of the Lviv Paleozoic Depression, temperatures generally remain between 40–45 °C, whereas in the fold development zone they rise to 50–55 °C. This trend is linked to the increasing thickness of the sedimentary layer toward the southwest.

The geothermal gradient in the Lviv region ranges roughly between 2.0 and 3.0 °C/100 m. The Precambrian and Early Paleozoic zones (East European Platform) are characterized by relatively low heat flux values, typically between 35 and 55 mW/m². In contrast, the Late Paleozoic and Early Mesozoic formations (Pre-Carpathian Depression and surrounding areas), display significantly higher heat flux values, ranging from 50 to 70 mW/m².

Assessments results

The results of the data inventory were used to calculate the geothermal potential using the method defined by ThermoGIS (www.thermogis.nl). Using maps of net depth, thickness, temperature and permeability, an assumed generalized well layout, and a fixed return temperature of 30 °C, the potential flow rate and geothermal power are calculated.

For the Devonian, the expected geothermal prospectivity is poor. Not only is the geothermal gradient relatively low (~19 °C/km), meaning the reservoir is cool (about 50 °C), but the (scarce) permeability data indicate that the target reservoir is very tight (~1 mD), meaning that no significant flow rate can be expected.

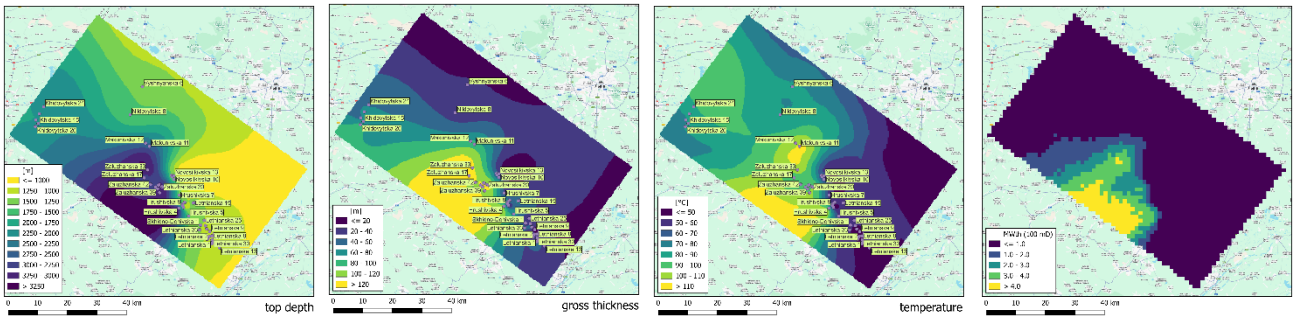

Figure 2: ThermoGIS results ND-14: top depth – gross thickness – temperature – geothermal potential

For the Neogene, the expected geothermal potential is better, but there is also a large uncertainty in the permeability. The geothermal gradient is good (between 28 and 40 °C/km), resulting in a mid-reservoir temperature of around 80 °C. Most permeability data indicated that this reservoir is tight, but some wells show fair to good permeabilities up to 100 mD. Given the scarcity of the permeability data, it is not clear where the higher permeability areas are located. Whereas the gross reservoir thickness is up to about 120 m, the average net thickness is only about 25, resulting in a low transmissivity. Under the assumption that the permeability is 100 mD, and that the net reservoir thickness is higher when additional layers below the ND-14 are considered, the geothermal power may be up to about 4 MWth. Little information of the additional layers is known because they were not previously targeted and analysed by the O&G industry.

Conclusions

The project successfully delivered comprehensive insights into the geothermal heat potential of the Lviv region, with detailed geothermal mapping focused on the promising Neogene (ND-14) and Devonian (D) layers. This work significantly enhanced the understanding of local subsurface resources. A thorough feasibility assessment was completed for sustainable geothermal heating at the Busk pilot site, demonstrating its practical viability for greenhouse operations. While the geothermal potential for the Devonian layers is likely low, potential for the Neogene is locally promising, probably allowing a geothermal doublet power up to about 4 MWth. Because the analysis was based on a quick screening of limited well data, the prediction of the geothermal potential has considerable uncertainty. A more detailed (petrophysical) analysis of available well data, in combination with additional well data that are not in the currently analysed set of wells and possibly extending to other Neogene layers, may further improve the reliability of the prediction.

Overall, the project made a valuable contribution to advancing Ukraine's transition towards a modern, resilient, and low-carbon agricultural sector, supporting long-term energy independence, sustainable development, and climate goals.

Project Partners

The project is implemented by a consortium including TNO Geological Survey of the Netherlands, DTESS (the Netherlands), NGO Geothermal Ukraine, and FoodVentures, a leading Dutch greenhouse grower and constructor. This project (PST25UA01) is supported by the Embassy of the Kingdom of the Netherlands in Ukraine and financed by the Private sector development program of the Netherlands Enterprise Agency (RVO.nl); under the International development Policy of the Government of the Netherlands.