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Modelling of potential of new climate neutral energy project in Solotvyno (Trans Carpathian region, Ukraine)

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SUMMARY

The energy transition demands for the Ukrainian economy are very actual due to the great chance to build a new, carbon-neutral industry while resetting after the war. Lunching of the decarbonization (carbon reduction) projects demands detailed geological modelling of perspective sites to assess the potential impacts on the environment and infrastructure, and create an investment plan and project outline.

One of the examples is Solotvyno gas field which was found in early 2000's but has limited production because of gas composition rich with CO_2 and N_2. This site has three essential features which make it a prospective target for the decarbonization project: high CO_2 content in natural gas, depleted reservoir formations and regionally high heat flow. We aim to estimate the possibility and risks of creating a climate neutral (by the the Scope I and Scope II projects there. Solotvyno site is estimated as highly prospective area to developing of green energy projects with integral mark of 0. 85. We are focused the first activities on combination of geothermal energy (heating) with CCS and synthetic methane generation with parallel hydrogen-methane blending. Preliminary assessment we done allowing us to start pre-feasibility study of the project.

Introduction

The energy transition demands for the Ukrainian economy are very actual due to the great chance to build a new, carbon-neutral industry while resetting after the war. Lunching of the decarbonization (carbon reduction) projects demands detailed geological modelling of perspective sites to assess the potential impacts on the environment and infrastructure, and create an investment plan and project outline.

Several directions are now being inspected to be developed: carbon capture, storage and utilization (CCS/CCSU), geothermal energy, green or blue hydrogen production and blending with natural gas, synthetic and bio-methane production, and synthetic methanol production. Some of them could be combined into complex projects to develop new low-carbon energy facilities.

One of the examples of such conception discussed below is Solotvyno gas field which was found in early 2000's but has limited production because of gas composition rich with CO_2 and N_2. This site has three essential features which make it a prospective target for the decarbonization project: high CO2 content in natural gas, depleted reservoir formations and regionally high heat flow. We aim to estimate the possibility and risks of creating a climate neutral (by the Scope I and Scope II) (*US EPA, 2022, The Greenhouse Gas Protocol, 2004*) projects there. Another moment connected to Environment-Social-Government (ESG) principle is defining potential customers for the new clean facilities. We recognised a project of new industrial park construction (*Order No. 453, 2022*) with at least 2000 new job places as potential consumer of new energy. Also, the proximity of the Ukrainian-Romanian border opens the door for export if any existing or new pipelines/electric lines are used.

Methods and data

To provide a complex assessment of potential project site we are outlined the following goals:

- Estimation of reservoir's porous volume using 3D modelling based on available geological, geophysical and production data;
- Estimation of heat production potential by 3D modelling of heat flow and geothermal gradient based on the structural model, well data and previous regional geothermic surveys;
- Hydrodynamic modelling for different fluids (methane, carbon dioxide, hot brine) with mixed purposes of CCS and geothermal energy production;
- Hydrogeological modelling to investigate the carbon dioxide storage impact on the reservoirs;
- Assessment of potential installation of synthetic and/or bio-methane production facilities to convert the exceeding CO_2 into CH_4 by using hydrogen electrolyse. The energy sources for hydrogen generation could be mixed (geothermal, gas power; solar or wind plant also be estimated);
- Assessment of infrastructure technical risks related to CO_2 and hot water transportation;
- Development and evaluation of the project economics and life cycle;

Basically, the country-wide geothermal resources assessment was used (*Gordienkoet al., 2002)*. The Transcarpathian region has the highest heat flow density up to 140 mW/m2 (figure 1). Solotvyno area has an average potential: approx. 80 mW/m^2 heat flow density and about 32 Celsius degree/km vertical geothermal gradient. In numbers of the integrated equivalent of geothermal energy density calculated as convention tons of fuel per square meter (figure 2) the study area has a significant value of more than 6 $eq.t/m^2$.

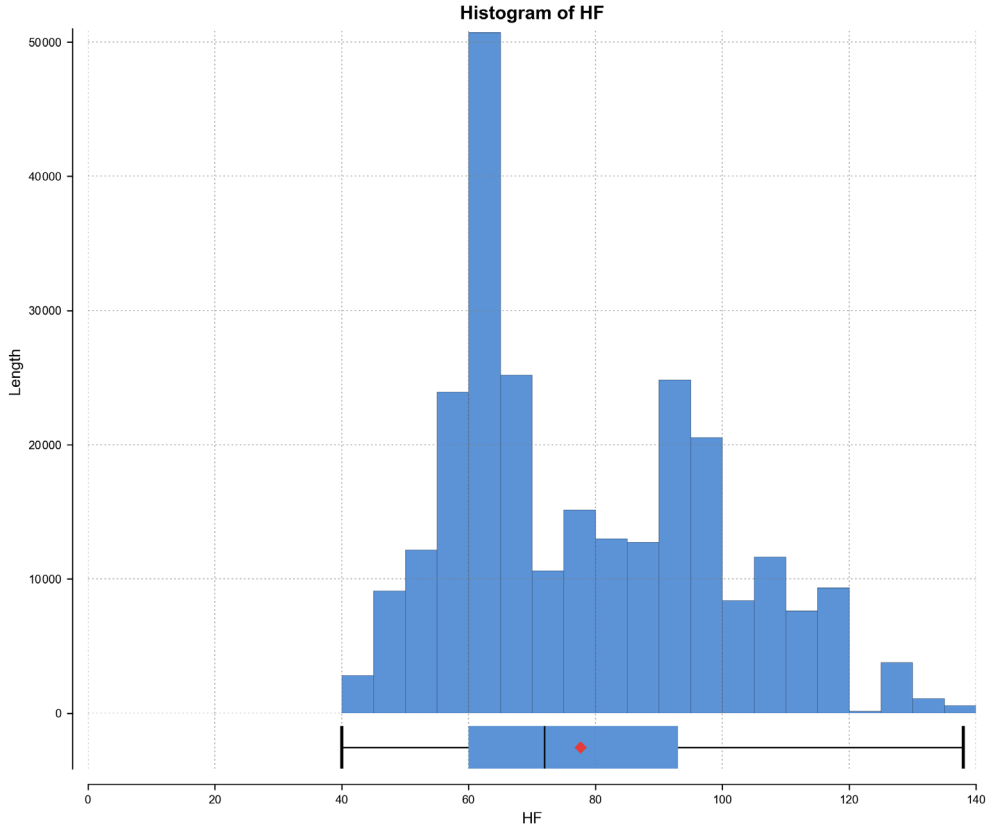

Figure 1 *Histogram of heat flow density (in mW/m2) built by data well geothermal survey of Carpathian and TransCarpathian regions (Gordienko et al., 2002; Zavgorodnya et al., 2005). The red dot is showing the average value*

In study region the preliminary block model of heat flow density distribution has been built in Sequent Geo software (figure 3). For the further detailing the Sequent Geothermal model is planned with connection to the next Schlumberger Petrel and Eclipse modeling.

At the current moment, we have the mixed preliminary reconnaissance and detailed exploration stage with low-cost expenses for modelling but risks are slightly reduced by good data coverage from gas exploration and production wells (figure 4). That allows for starting several different modelling (geothermal, hydrogeological and hydrodynamic) without new drilling. Also, the spatial analysis for the environmental impact and infrastructure planning is possible with the experience of the existing gas project. Comparison to the well-developed geothermal energy sector in Hungary (*Geothermal Information Portal, 2022)* reduces our risks due to the availability of good geological knowledge of this region. On the other hand, active gas field data provide us with the major stratigraphic and structural features, such as geological formations succession, salt dome contours, faults, etc.

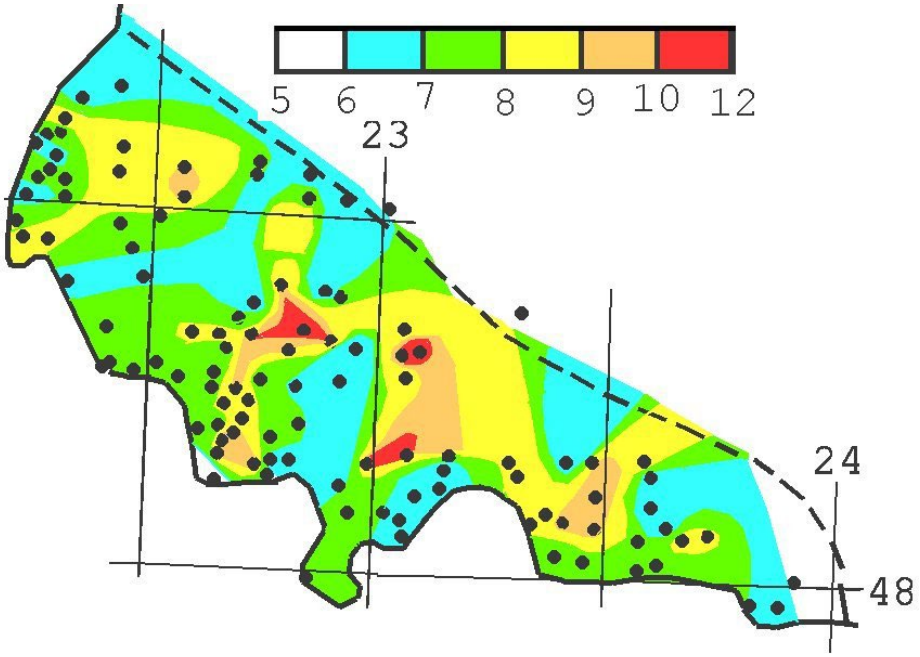

Figure 2 *Spatial distribution of the geothermal potential to the depth of 6 km (in equivalent of tons of fuel / km^2) built by data well geothermal survey of Carpathian and TransCarpathian regions (Gordienko et al., 2002; Zavgorodnya et al., 2005)*

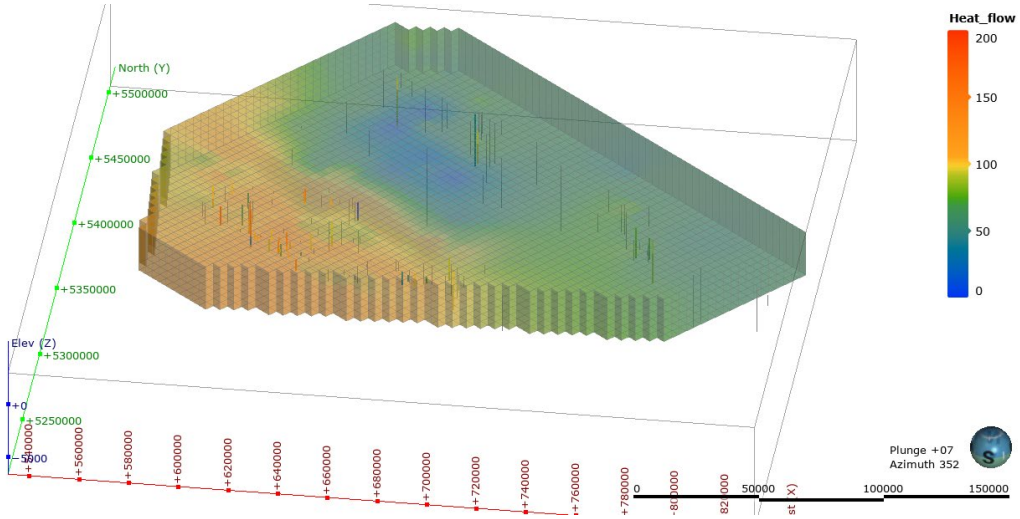

Figure 3 *Preliminary regional block model of heat flow density (in mW/m2) (Gordienko et al., 2002; Zavgorodnya et al., 2005)*

Conclusions

Solotvyno site is estimated as highly prospective area to developing of green energy projects with integral mark of 0.85. We are focused the first activities on combination of geothermal energy (heating) with CCS and synthetic methane generation with parallel hydrogen-methane blending. Preliminary assessment we done allowing us to start pre-feasibility study of the project.

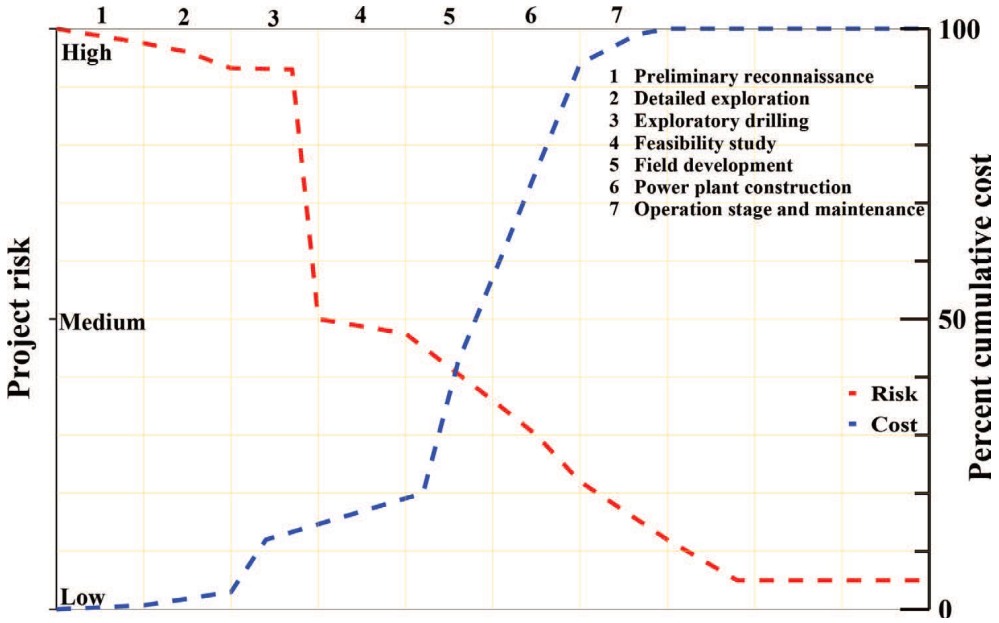

Figure 4 *Time-Chart of project risks and cost of an geothermal project by (Aragyn-Aguilar et al., 2019; Comparative analysis, 2016)*

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