Assessment of trans-boundary effects at LBr-1 CO$_2$ storage pilot site and regulatory solutions

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Abstract

The national transpositions of the EU CCS Directive do not fully address trans-boundary issues of CO$_2$ storage, which creates hurdles for utilization of promising storage sites situated on or near Member States boundaries. To understand how these hurdles could look like in practice, a study was carried out using the practical example of the LBr-1 potential CO$_2$ storage pilot site in the Czech Republic. LBr-1 – one of the research sites of the ENOS European H2020 project – is an abandoned hydrocarbon field situated in the Czech part of the Vienna Basin, close to the Czech-Slovak border. Because of this, it represents a very suitable case for studying various trans-boundary issues related to geological storage of CO$_2$. LBr-1 is now the subject of continued detailed site assessment, with the ambition to turn the field into a research CO$_2$ storage pilot site with or without CO$_2$-EOR.

The main objective of the study was to evaluate any trans-boundary issues that might arise from geological storage of CO$_2$ in the LBr-1 field, identify aspects that are difficult to handle, including those where existing legislation and regulations are unclear or lacking, and suggest solutions. The assessment was focussed on three potential storage scenarios: small-scale storage pilot, large-scale storage and CO$_2$-EOR with permanent storage.

As a first step, present national legislations relevant to CO$_2$ geological storage in the Czech Republic and Slovakia were examined and several legislative and regulatory barriers for CCUS were identified. In general, the current status of CCUS legislation in both countries reflects the position of the technology in their decarbonisation strategies: this position is currently weak and the technology is not considered as a priority for the use of the subsurface. As a consequence, the relevant legislation and regulations create barriers and obstacles, rather than supporting CCUS deployment. This needs to be changed if the potential of the technology to decarbonise the national economies is to be utilised.

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In the Czech Republic, the identified barriers (especially limitation of the amount of stored CO₂ per site per year and missing provisions for the financial security) can be removed by relatively easy and simple adaptations of current legislation. In Slovakia, however, the overall regulatory approach needs to be changed to enable CO₂ storage in its territory. In particular, the priorities for subsurface use and the approach to the solution of conflicts of interest would need to be addressed.

In both countries there are unclear or missing regulations governing CO₂-EOR and possible transformation of the oilfield from a CO₂-EOR site into a CO₂ storage site, which represents a big uncertainty for possible investors and operators.

In the second step, implications of current legislation and regulatory regimes on the LBr-1 site itself were studied. The most important finding is that both the storage site and storage complex are located entirely on the territory of the Czech Republic (see the CO₂ predicted plume extent in Fig. 1). However, several trans-boundary issues were identified, including those that are related to the risk of (even if highly unlikely) leakage of CO₂ from the storage complex.

![Figure 1: Maps showing predicted CO₂ plume extension for the base case storage pilot scenario after injection of 11,500 t of CO₂ in year 1 (left) and 23,000 t at the end of year 2 (right). Warmer (more reddish) colours indicate greater vertical thickness of plume and higher CO₂ concentration. Structural maps of the top of the Lab horizon are displayed in the background (depths contours in meters below mean sea level). Geological faults are drawn in violet. The dashed line depicts the estimated original water-oil contact according to results of dynamic history matching using data obtained during oil production. The injection well Br-89 is marked by the red circle. Approximate position of the northern spill point is marked by a dark-violet circle. The Morava river also represents the state boundary between the Czech Republic and Slovakia.](image-url)
Four possible types of trans-boundary issues related to CO2 storage were examined in detail – pressure build-up, possible leakage through boreholes, possible leakage through geological faults and possible migration of fluids out of the reservoir due to exceeding spill points. While pressure build-up and leakage through faults would not be expected to cause trans-boundary issues, the other two phenomena need to be carefully considered. If CO2 leakage were to appear either through abandoned wells or due to exceeding the southern spill point, analysis of possible leakage pathways shows that the CO2 could migrate into the territory of Slovakia. There are three main factors that limit the level of concern: the probability of significant leakage occurring is low, the amount of possibly leaked CO2 would be very limited, and the spill point would only be reached if the reservoir were filled up to its limit.

Nevertheless, the study implies that a cooperation of regulatory authorities from both Czech and Slovak Republics will be necessary to prepare and operate the storage site. The main reason is that many aspects of the site preparation, injection, closure and post-closure phases will have trans-boundary components, particularly the risk assessment, monitoring (all phases) and corrective measures plan (as required by the CCS Directive). This represents a significant complicating factor for possible injection of CO2 at LBr-1.

Despite this, the realisation of a CO2 storage project on the site is considered viable, particularly the basic pilot storage scenario, which would provide valuable learnings to advance CCUS in the Vienna Basin region and potentially more widely in Europe. This case avoids the spill-point related concerns (because of the limited extent of the CO2 plume) and involves only a limited number of abandoned wells that need to be assessed and potentially re-completed. The lack of experience with CO2 storage sites and absence of any regulatory precedents in both countries would mean that any project will require a lot of pioneering work do be carried out by both the project developer and the relevant authorities. This process, however, cannot be avoided; both sides need to gain the necessary experience that can be utilised in future, when preparing, operating and regulating the next generation of CO2 storage projects.

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Keywords: EU CCS Directive; CO2 storage; CO2-EOR; trans-boundary issues; regulatory barriers; CO2 plume; pressure built-up