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Managing geological uncertainty in CO_2-EOR reservoir assessments

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Recently the European Parliament has agreed that an atlas for the storage potential of CO_2 is of high importance to have a successful commercial introduction of CCS (CO_2 capture and geological storage) technology in Europe. CO_2-enhanced oil recovery (CO_2-EOR) is often proposed as a promising business case for CCS, and likely has a high potential in the North Sea region. Traditional economic assessments for CO_2-EOR largely neglect the geological reality of reservoir uncertainties because these are difficult to introduce realistically in such calculations. There is indeed a gap between the outcome of a reservoir simulation and the input values for e.g. cost-benefit evaluations, especially where it concerns uncertainty.
The approach outlined here is to turn the procedure around, and to start from which geological data is typically (or minimally) requested for an economic assessment. Thereafter it is evaluated how this data can realistically be provided by geologists and reservoir engineers. For the storage of CO_2 these parameters are total and yearly CO_2 injection capacity, and containment or potential on leakage. Specifically for the EOR operation, two additional parameters can be defined: the EOR ratio, or the ratio of recovered oil over injected CO_2, and the CO_2 recycling ratio of CO_2 that is reproduced after breakthrough at the production well.
A critical but typically estimated parameter for CO_2-EOR projects is the EOR ratio, taken in this brief outline as an example. The EOR ratio depends mainly on local geology (e.g. injection per well), field design (e.g. number of wells), and time. Costs related to engineering can be estimated fairly good, given some uncertainty range. The problem is usually to reliably estimate the geological parameters that define the EOR ratio. Reliable data is only available from (onshore) CO_2-EOR projects in the US. Published studies for the North Sea generally refer to these data in a simplified form, without uncertainty ranges, and are therefore not suited for cost-benefit analysis. They likely result in too optimistic results because onshore configurations are cheaper and different.
We propose to translate the detailed US data to the North Sea, retaining their uncertainty ranges. In a first step, a general cost correction can be applied to account for costs specific to the EU and the offshore setting. In a second step site-specific data, including laboratory tests and reservoir modelling, are used to further adapt the EOR ratio values taking into account all available geological reservoir-specific knowledge. And lastly, an evaluation of the field configuration will have an influence on both the cost and local geology dimension, because e.g. horizontal drilling is needed (cost) to improve injectivity (geology). As such, a dataset of the EOR field is obtained which contains all aspects and their uncertainty ranges. With these, a geologically realistic basis is obtained for further cost-benefit analysis of a specific field, where the uncertainties are accounted for using a stochastic evaluation. Such ad-hoc evaluation of geological parameters will provide a better assessment of the CO_2-EOR potential of the North Sea oil fields.