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This report remains confidential and its distribution is restricted to the project partners and to the ANR until the end of the project (04/30/2016).

By the end of the project (from 05/01/2016), the status of this report will become public.

Executive Summary

The CO_2 dissolved project proposes a different approach to CO_2 Capture and storage by focusing on a cheaper solution to target small emitters.

The main concept is to inject the fumes into a special storage well. CO_2 would, with the help of increasing pressure into the well, dissolve into the aquifer water. This solution has been proposed, designed and patented by Pi-Innovation[1]. This capture strategy makes mandatory to use a water/brine movement. Therefore, the CO_2 dissolved concept consists in coupling this CO_2-Brine dissolution technology with a geothermal loop. Through this loop, storage and heat for the processes can be provided. Due to the limited amount of CO_2 that can be dissolved in a geothermal loop (about 10 ton/h), it is adapted solely for small emitters.

For this conceptual analysis, a case previously studied for CCS[2] application has been selected.

The Artenay sugar beet refinery has been previously studied for a CCS application. The CCS application provided excellent environmental results with negative emission thanks to the production of the bioethanol. However, on the economic standpoint, the performance of the project was poor due to the small volume of emission stored that could not offset the huge CAPEX.

Using the results of the CO_2 dissolved project and CPER Artenay project, the objective of this report is to analyze both the economics and carbon and energy footprint (CEF) of a CCS coupled with a geothermal loop for the Artenay sugar beet refinery:

The Artenay sugar beet refinery CO_2 capture and coupling with a geothermal loop can manage to reduce both emissions by 25 to 60% and energy by 5 to 30% depending on the assumptions.

As compared to the CCS case, the CO2-Dissolved study shows that an emission reduction of 15 to 50% of the CCS one can be achieved. The corresponding non-renewable energy consumption can be reduced by 5 to 30% as compared to the CCS scenario. The CO_2 emission reduction is bigger than the non-renewable energy consumption reduction, because of the compression energy needed for the process (the first stages of compression are consuming a lot).

[1] http://www.pi-innovation.com/

[2] Carbon Capture and Storage

On the economic stand-point, the CPER Artenay project was quoted around 42 $MM€_{2013}$ whereas the CO_2-Dissolved process is estimated between 12 and 20 $MM€_{2015}$. That is to say, to reach an emission reduction 15% to 50% higher, the “CCS only” project costs between 100% and 350% more.

The cost per ton of CO_2 saved (stored + not emitted by the combustion due the use of geothermal energy), the range of performance of the project is between 39 and 72 $€_{2015}$/ton saved over 30 years lifetime (at 6% WACC[3]). This is still higher than the current CO_2 price level in Europe. However, the project reduced natural gas consumption thanks to the geothermal loop which improves significantly the economics of the project.

The internal rate of return (IRR) of the project for the average scenario is between 2 and 18%. For the High scenario, the average IRR is around 18% but it can go as high as 30%.

The probabilistic distribution of the Net Present Value of this project ranges between -5 $MM€_{2015}$ and +20 $MM€_{2015}$ with an average value of 8 $MM€_{2015}$. This wide range is linked to the wide range of CO_2 prices used in the model (5 to 50€/ton of CO_2). It shows that the project can be reasonably profitable at 6% discount rate (WACC) for the average scenario. Considering the best efficiency scenario, the project can be profitable in the current market conditions.

It is also interesting to mention that from 12.5€/ton onward, the CO2-Dissolved project is worth doing as compared to a pure geothermal project. This shows that this approach should be seriously envisaged for future geothermal projects provided local conditions make the project technically feasible (CO_2 sources and storage integrity).

Even if this study is at a conceptual stage, the CO2-Dissolved concept seems really worth investigating for small CO_2 sources. It can contribute to reduce CO_2 emission at significantly lower cost than CCS. It is however noteworthy to mention that very specific conditions have to be fulfilled to be able to develop such a project such as CO_2 availability, and subsurface favorable context (geothermal and storage).

[3] Weight Average Cost of Capital