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To cite this version:
Guillaume Calas, Jeff M. Bielicki, Minh Ha-Duong, Richard S. Middleton.. Simulated CO2 pipeline networks for CCS in France.. 6th Trondheim CCS Conference (TCCS6), Jun 2011, Trondheim, Norway. 2011. hal-00835520

HAL Id: hal-00835520
https://hal-enpc.archives-ouvertes.fr/hal-00835520
Submitted on 18 Jun 2013

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Simulated CO₂ pipeline networks for CCS in France

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The study

France has practically no CO₂ pipeline infrastructure today. Using SimCCS, a CO₂ system model developed by Middleton and Bielicki (2009), we asked:

- Considering a couple of plausible scenarios for the future of the technology in the country, do we find any common pipeline corridors to all solutions?
- How does an optimal network changes when doubling the storage goals?

Simulations consider storage goals varying from 10 to 60 MTCO₂/yr, include the forty largest CO₂ sources in France, which together emit 80 MTCO₂/yr, and contrast two storage policies:

- An “onshore scenario”, where storage is permitted only in the Paris basin aquifers;
- An “offshore scenario” exports CO₂ towards the North sea through Normandy and toward an hypothetical storage option reachable off the Mediterranean shore.

Summary of results

The model builds about 2 500 km of pipelines for the 60 MTCO₂/yr target. Reaching this number in 30 years would require about 83 km of new pipeline per year. We found that the average system cost in the “onshore scenario” is about 52 €/CO₂.

The qualitative optimal strategy is to call the sources in the order of increasing capture cost, and connect those to the available sinks. This is because capture costs represent 70% to 90% of capture costs.

Three pipeline corridors are common in all cases if CCS is deployed in France. Small-scale network layouts are compatible with larger-scale ones, although the capacities (i.e. pipeline diameters) differ: it may be socially interesting to oversize some corridors at the early stages.

Figure 1 compares the two scenarios for a common 30 MTCO₂/yr target, while Figure 2 compares two targets (30 MTCO₂/yr and 60 MTCO₂/yr) for the same “onshore scenario” (left on Figure 1). Three segments of network are always apparent: one is in the East of France (Lorraine region = A on figure 1), another one is in the North of France (Nord-Pas de Calais region = B). Also, scenarios with targets over 20 MTCO₂/yr use a corridor along the Seine river between Paris and Le Havre (C).

About the SimCCS model

A cost surface, i.e. a raster grid of the cost to lay a pipeline across each grid cell, was estimated using geographical datasets including protected areas, existing gas pipelines, rivers, railroads, highways, land cover, and population densities. Given the location of sources and reservoirs as network nodes, the model generated a set of potential routes between all possible close node pairs (Figure 4). Based on these potential routes, given the costs of capture, building and operating pipeline, storing and exporting CO₂, the model minimized the total cost to meet a given target quantity of CO₂ stored.

Figure 4. Potential pipeline routes (grey) between CO₂ sources (red) and sinks (blue).

References


LA-UR-11-10248