Modeling CO_2 Pipeline Systems: An Analytical Lens for CCS Regulation

Adrien Nicolle,[a] Diego Cebreros,[b] Olivier Massol,[c] and Emma Jagu Schippers[d]

1. Motivations underlying the research

The deployment of CCS projects is increasing, with around 200 projects at various stages of development in 2022, representing a significant increase in capacity compared to previous years. However, the success of these projects relies heavily on the installation of costly CO_2 transportation infrastructure, which often takes the form of a pipeline system connecting a carbon capture facility to a storage site. The deployment of a CO_2 pipeline infrastructure depends critically on the institutional framework governing its provision. In the US, Norway, the UK, and the European Union, new regulatory frameworks are currently emerging to organize the provision of these infrastructures. However, there is no consensus on the pricing mechanisms that can be used to ensure the socially optimal economic regulation of CO_2 pipelines. examines how the legal frameworks governing CO2 pipeline networks affect society and the environment.

2. A short account of the research performed

This paper first reviews the different regulatory approaches envisioned for CO_2 infrastructures in these jurisdictions and then adopts an analytical perspective to examine the social and environmental impacts of CO_2 pipeline regulation. The authors prove that the engineering equations governing CO_2 pipeline transportation implicitly define a Cobb-Douglas production function and that the associated cost function is subadditive and thus verifies the technological condition for a natural monopoly. Because it lessens the information asymmetry between the regulator and the pipeline operator, this technical representation offers valuable insights to practitioners interested in preventing regulatory distortions.

That analysis then evaluates the substantial deadweight losses that are incurred in the absence of regulation. Lastly, the authors assess the impact of different pricing schemes for the transportation of CO_2 emissions in CCS systems. Unsurprisingly, marginal cost pricing cannot allow the pipeline operator to break even. That said, imposing a second-best pricing scheme such as average cost pricing results in an important efficiency gap since only 69% to 75% of the socially desirable volume of CO_2 emissions are ultimately captured and sequestered.

3. Main conclusions and policy implications of the work

Overall, the paper highlights the importance of regulatory frameworks for CCS pipeline systems and suggests a new representation of the system that can assist regulators, policymakers, and academics in their deployment. The numerical analysis supports the idea that economic regulation and environmental regulation are interrelated since the imposition of uniform, non-discriminatory pricing on a pipeline operator results in substantial efficiency gap.

Future research could explore the heterogeneity of emitters' demand for transportation to determine the optimal pricing scheme. The authors suggest that price discrimination may be a relevant option for regulators to maximize social welfare.

In future research, the technical representation of pipelines described in this work could be integrated into dynamic models to provide more detailed policy recommendations, such as the timing of regulatory interventions. Finally, although the paper does not discuss social issues such as public

a Corresponding author. Email: adrien.nicolle@chaireeconomieduclimat.org
b Email: diego-manuel.cebreros-saettone@centralesupelec.fr
c Email: olivier.massol@ifpen.fr
d Email : emma.jagu@centralesupelec.fr

acceptance or right-of-way, it shows that defining a clear regulatory framework and coordination among stakeholders are mandatory to reduce the social cost of achieving carbon neutrality.