Department of Environmental Systems Science

“Trojan horse or horn of plenty”? Integrative technology assessment to analyse Carbon Capture and Storage, CCS

egu24-6674

Thomas Flüeler[1,2]
[1]Institute for Environmental Decisions, ETH Zurich, CH-Zürich, thomas.flueeler@env.ethz.ch
[2]Commission de suivi, République et Canton du Jura, Mont Terri Underground Rock Laboratory, CH-Delémont

1 Introduction

CCS promises a – relatively – quick and technical, narrowly located but high-potential solution with no need for extensive efficiency improvement in dispersed facilities, equipment, appliances or “software” such as institutions and behaviour. Is it a useful “quick fix” or rather a long-term leakage risk and paving the way for carbon lock-in? A “Trojan horse or horn of plenty”?[1]

2 Method

The present approach to tackle these questions, laid out in Flüeler 2023[2]/2024[3], is a combination of disciplines and perspectives from systems theory, risk assessment, technology assessment and management. Six criteria address issues proven to be crucial in technology policy debates: #1. Need for deployment and benefits compared to competing technological options, 2. Total-system analysis and safety concept, 3. Internationally harmonised regulation and control, 4. Economic aspects, 5. Implementation along technology readiness levels, and 6. Societal issues.

3 Appraisal

#1. Need for deployment

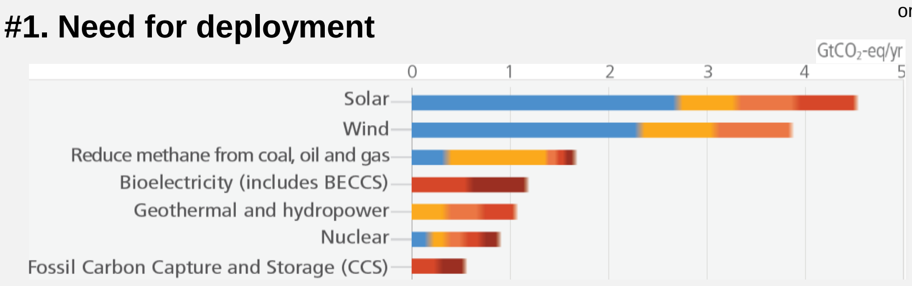


Fig. 1. IPCC’s assumptions of the potential of mitigation options in the near term (by 2030) broken down into cost categories (coloured) relative to an emission baseline consisting of current policy (around 2019) reference scenarios from the AR6 scenarios database. Source: IPCC 2018, 27-28

The global technical geological storage capacity is believed to be “on the order of 1000 Gt CO_2” (IPCC 2023, 21), more than required until 2100 to keep the limit of 1.5°C. IPPC assume that the energy sector removes >500 Mt/yr CO_2 by 2030 (Fig. 1).

#2. System analysis and safety concept

- CCS an ambiguous lever in the transition away from carbon-intensive economies
- 10 to 40 % increase in resource use: currently 45% system efficiency
- Constraints in transportation, distance and means
- Consider all components: CO_2 capture, plant lifetime, logistics, storage volume, facility
- CCS as a geoengineering tool not to hamper the development of renewables and efficiency measures
- System analysis may reveal unintended consequences, abandoned and depleted oil/gas fields not really compatible with dedicated mined storage locations

#3. Internationally harmonised regulation and control

- CCS is an international issue and, thus, needs international regulation. It is insufficient even by industry’s standards (Fig. 2). Decisions are critical in cases where host country regulatory capacities are deficient.

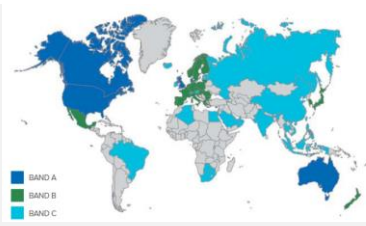


Fig. 2. Legal situation around the world: requirements (Band A, specific legislation) and reality. Source: Global CCS Institute 2020

If sub-seabed storage will be subject to stricter or laxer regulations than national landbased options remains to be seen (i.a. monitoring, oversight, financing, liabilities).

#4. Economic aspects, #5. Implementation, #6. Social issues

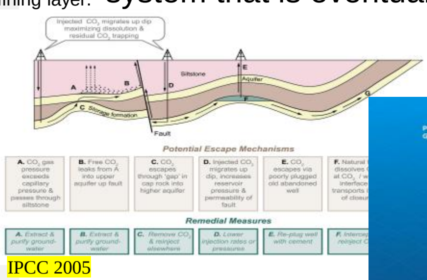
Projects by major players such as Equinor, Shell or BP were shelved due to insecure financing, lacking public subsidies and inadequate tax incentives and carbon trading. Recent assessments confirm this view (IEA 2021). There are just 16 dedicated storage projects worldwide with a capacity of 10-30 Mt/yr, 39 facilities are operational (2024, www.statista.com)

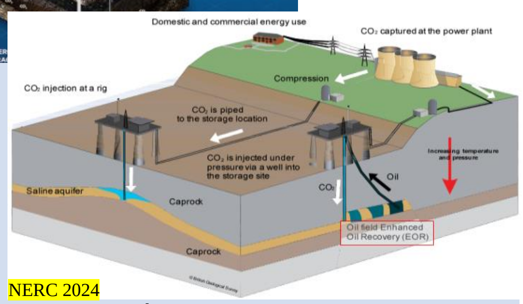
4 Results and Discussion

As a whole, CCS scores acceptable as the emission reduction requirements are enormous and its overall potential is quite good compared to other options and not linked to a specific baseline technology. Internally, however, there is a competition between bioenergy and fossil CCS, and CCS as a whole is in competition with other CO_2 abating technologies.

CCS is not “just” a technical innovation but also a sociotechnical system that is eventually to be implemented on a large scale. The caprock approach ever since used does not comply with the defence-in-depth principle in other waste fields (Fig. 3).

Fig. 3. Safety concept of CO_2 storage: CO_2 gas is injected into a “storage formation” or “gas reservoir” with a supposedly tight caprock as the only barrier or confining layer.





5 Conclusions

#1. Need for deployment

- CO_2 (reduction, management) not tied to a specific technology
- CCS in competition with other CO_2 abating technologies

#2. System analysis and safety concept

CCS to:
- demonstrate defence-in-depth safety concept
- intensify R&D and produce transparent, peer-reviewed state-of-the-art risk appraisals

#3. Internationally harmonised regulation and control

- demand internationally set up regulations
- be monitored during adequate period
- secure sufficient funding in case of failure

References (further sources available at the author’s)

1. de Coninck, H. 2008. Trojan horse or horn of plenty? Reflections on allowing CCS in the CDM. Energy Policy. 36/3. 929-936 https://doi.org/10.1016/j.enpol.2007.11.013.
2. Flüeler, T. 2023. Governance of radioactive waste, special waste and carbon storage. Literacy in dealing with long-term controversial sociotechnical issues. Series Springer Textbooks in Earth Sciences, Geography and Environment. Springer Nature Switzerland, Cham. https://doi.org/10.1007/978-3-031-03902-7 (Chapter 2).
3. Flüeler, T. 2024. From caprock integrity to system integration. Lessons for siting of CO_2 storage locations. 1st Caprock Integrity & Gas Storage Symposium at the Mont Terri Rock Laboratory, 24-25 Jan 2024, CH-St-Ursanne, Switzerland (invited key presentation). https://www.cigss.ch.