Negative emissions in sustainable transition : Which role for bioenergies and CCS?

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Abstract content
Carbon Capture and Storage (CCS) is a technology that aims to capture CO2 coming from static emitters such as coal-fired electric plants, then to transport it by pipelines until a geological reservoir (e.g. saline aquifers), where the CO2 is stored definitively. It is then an “end-of-pipe” technology, so it avoids to release pollution in the environment, but does not change the production process itself, contrary to renewable energies or improved energy efficiency. Besides, CCS needs additional energy – named energy penalty – and could reinforce the current technological lock-in in fossil energy. However, CCS could also allow a rapid decline of emissions on existing production facilities by the end of the century, when alternatives (such as renewable energies) will be fully deployed. In this case, the current sociotechnical regime based on fossil energies could be maintained for a while.

BECCS (Bioenergy and Carbon Capture & Storage) is a CCS niche that adds a CCS process on a bioenergy production unit.. Industrial sectors such as biofuels, electric generation from biomass (or coal and biomass) or paper production are concerned. BECCS could change our point of view on the CCS role into the sustainable transition, as it could provide negative emissions, which means that more GHG emissions are avoided than emitted during a production process. Instead of being released into the atmosphere during biomass transformation, carbon is definitively stored. If biomass transformation is assumed nearly carbon neutral, BECCS should effectively lead to negative emissions. This has been checked in a few cases in academic literature (IEA GHG, 2009; Laude et al., 2011). In addition, a synergy between BECCS and geothermal energy recovery has been recently explored in the CO2-DISSOLVED project (Kervévan, Beddelem, & Neil, 2013). This process is adapted to small or medium emitters, like BECCS emitters are in most cases. It could reduce significantly the energy penalty due to CCS.

The aim of this paper is then to investigate the specific role of BECCS into the sustainable transition, and more precisely its impact on its timing. This issue has been discussed mainly through Integrated Assessment Models (IAM), which compute the evolution of the worldwide energy system under climate constraint until the end of the century. IAM modeling is one of the main tools used by IPCC for its forecasts and recommendations. It is then widely considered that CCS and BECCS could be key technologies to keep temperature increase below 2°C, especially if worldwide actions are delayed.

We use here a different point of view to deal with this issue: the Multi-Level Perspective (MLP). This conceptual framework analyses transition as a mutation process from one sociotechnical regime to another, under the pressure of macro-level forces (named the landscape), and the emergence of market niches that could provide the basis of the new regime (Geels & Schot, 2007). Here, climate change could be seen as a macro pressure (with economic and social aspects), that requires a deep change of the global energy system, i.e. the socio-technical regime. It is important to point out that both CCS and BECCS remain technological solutions, even if they require policy incentives and social acceptance. According to the typology of Arundel, Kareva, and Kemp (2011), they belong to the “techno-fix” innovations, while other solutions are available, grounded on changes in user, market, and institutional practices, as Social Innovation (change in social uses) or Transformative Innovations (both changes in social uses and technology). On the contrary “techno-fix” innovations allow preserving past habits and institutional practices through the development of new techniques, and so could contribute to the lock-in effect.

Unlike CCS, BECCS competes no more with renewable energies and could help to get a low-carbon society. Actually, BECCS is likely to become available in the second part of the century. If mitigation is delayed, it could be used to fix an overshoot of CO2 emissions in the first part of the century, thanks to negative emissions. Given the uncertainties regarding CCS and BECCS development, this last strategy could be a dangerous bet (Fuss et al., 2014). Moreover, BECCS concerns involve also biodiversity damages and the risk of higher biomass and food prices. This contribution will discuss more deeply the challenges connected to BECCS until 2100.