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Toward a common method of cost-review for carbon capture technologies in the industrial sector: cement and iron and steel plants

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ABSTRACT

Carbon capture and storage (CCS) remains an important pathway to reach deep cuts in CO_2 emissions coming from carbon intensive industries. A sound evaluation and comparison of the costs figures of carbon capture technologies applied to the industrial sector are key to guide research activities and inform decision makers. However, each organisation assesses CCS technologies through a different cost methodology, which makes the comparison of cost results difficult. Moreover, the differences are not always evident and can generate misunderstanding and misinterpretation of CCS cost figures.

This work is part of a bigger initiative to evaluate carbon capture technologies for the industrial sector and this paper is a first stab at identifying some issues related to techno-economic assessments of carbon capture in cement and iron and steel manufacturing. In this work, a review of transparent economic studies on carbon capture technologies in cement and steel and iron sectors was done to identify cost assumptions and cost methods in the public literature. Secondly, a further analysis of transparent cost methods was done to clarify the impact of terminology and heterogeneous mathematical steps on the differences between cost figures from different sources. With the objective of fairly comparing carbon capture technologies, this paper delivers an explicit cost-review method and guide on how to use it to calculate CO_2 capture, CO_2 avoidance and products costs, based on an aggregation process where capital and operational costs (CAPEX and OPEX) are assessed. A list of elements to make cost figures comparable is provided. Finally, limitations of this cost-review method are identified and given.

1. Introduction

Carbon capture and storage (CCS) has been widely recognised as one of the few key technologies available to achieve deep CO_2 emission reductions in the industrial sector. In the below 2 °C scenario of the International Energy Agency (IEA, 2017a, b), CCS accounts for as much as 23% of the global cumulative CO_2 emission reductions in the industrial sector over the period 2015-2060. A good understanding of the costs of CO_2 capture technologies is important to inform various stakeholders on the economic potential of CCS and guide research activities to improve the performance of promising capture configurations across industrial sub-sectors, such as iron and steel, and cement.

Investments are directly linked to policies, technologies, engineering performance, cost estimations, and market forces. Uncertainties on cost estimations will impact on the risk of investments, and the consequences of getting these investments wrong can be detrimental on the success of CCS (Middleton and Yaw, 2018). As identified in the past in the power sector (Rubin et al. 2012), there are substantial differences between cost methods used by different organisations and initiatives to evaluate CCS technologies for the industrial sector. Additionally, tentatively, the cost methods for the power sector could be used, however the industrial sector is different. Firstly, the industrial sector involves many different production processes, each of them with one or multiple CO_2 emissions points, CO_2 volume and CO_2 concentration in the fluegas to be treated. Secondly, the integration of CO_2 capture systems is site specific, meaning that the production facilities have different heat and energy profiles, for example, with different energy/steam production source (offsite/onsite and with higher/lower CO_2 emissions factor in the electricity grid) and different waste heat available for the CO_2 capture system. Thirdly, the CO_2 captured and avoided can be very different in the industrial sector. Additionally, while the CO_2 capture cost and LCOE (Levelized Cost Of Electricity) are the main cost metrics in the power sector, in the industrial sector the CO_2 avoidance cost and (increase in) production cost will be key.

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