CO_2 capture technical potential in the sugar and ethanol sector in the São Paulo state

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Existing concerns about climate change have motivated the quest for low carbon technologies. In this context, bioenergy systems with carbon capture and storage (BECCS) are technologies that combine energy production from biomass with carbon capture and storage. Such systems combine the carbon absorption in the photosynthesis process with the additional capture of CO_2 from the biomass conversion process, showing a better carbon balance (even a negative carbon footprint) (RASSOL, 2019). These systems are essential to achieve the CO_2 emission targets assumed by the signatory countries of the Paris Agreement, not only by reducing CO_2 emissions into the atmosphere, but also by removing it from the environment. It is important to note that the Brazilian NDC (National Determined Contribution) aims to reduce carbon emissions by 50% in 2030 but all emissions are increasing due to deforestation and the use of fossil fuels in the energy matrix (UFCC, 2022).

Brazil, as the world's biggest producer of sugarcane and ethanol, has an important contribution to the reduction of global CO_2 emissions and also to its removal from the atmosphere. In the 2021/22 harvesting season, according to CONAB (2022) - National Supply Company - Brazil produced 578.8 million tons of sugarcane, of which 254 millions were destined for the production of 33.9 million tons of sugar and the remainder 324.7 million tons were destined for the production 26.4 billion liters of ethanol. The state of São Paulo was responsible for approximately 50% of the sugarcane production, which was destined for the production of 21.4 million tons of sugar and 11.9 billion liters of ethanol (CONAB, 2022).

The magnitude of these numbers show the importance of Brazilian contribution, more specifically from the state of São Paulo, to reduce fossil CO_2 emissions to the atmosphere, but also to remove it from the environment if BECCS technologies are used.

In this context, the objective this study is estimated the amount of CO_2 generated and captured by the sugar-energy sector in São Paulo in each phase of the industrial process of ethanol production. In addition, it will estimate the potential CO_2 emissions to be captured in the biogas produced from the anaerobic biodigestion of vinasse and filter cake, residues of the process. The results will be applied to define storage locations, transport modes and costs.

Considering only bagasse burning and fermentation process, the results show that the theoretical potential for CO_2 capture and storage for Brazil are respectively 214.15 and 20.06 million tons of CO_2 in the selected harvesting season. For the state of São Paulo, also for bagasse burning and fermentation process, these values are respectively 107.08 and 9.04 million tons of CO_2 in the season. Comparing the CO_2 emissions of the Brazilian energy sector in the year 2021 with the capture potential of the sugar and alcohol sector in Brazil and São Paulo, these potentials represent respectively 57.3% and 28.3% of the CO_2 emissions of the Brazilian energy sector in 2021.

The results show that the figures are huge for the Brazilian sugar and ethanol sector, especially for the state of São Paulo, showing that this sector has the greatest potential for biogenic carbon capture and storage. Because of this, the geological sites and the different rocks types that correspond to the Rio Bonito Formation, located in the Paraná Sedimentary Basin, in the state of São Paulo, were selected to be evaluated in terms of their capacity to store the CO_2 emissions generated in the sector.

It should be noted that CO_2 emissions are being estimated in a disaggregated form by sugar and energy mills, since this information is important to define storage locations, transport modal and costs. In addition, considering the perspective of using filter cake and vinasse for biogas production, CO_2 emissions are also being estimated for each mill, considering the final use of biogas for generating electricity or producing biomethane. The use of these residues for the production of biogas will make it possible to capture significant amounts of CO_2.

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Bibliography

CONAB - COMPANHIA NACIONAL DE ABASTCIMENTO. Acompanhamento da safra brasileira de cana-de-açúcar, Brasília, DF, v. 9, n. 2, agosto 2022.

MACEDO, I.C. et al. Greenhouse gases emissions in the production and use of ethanol from sugarcane in Brazil: The 2005/2006 averages and a prediction for 2020. Biomass and Bioenergy 2008, 32, 582–595.

MOREIRA, J. R. *et al.* BECCS potential in Brazil: Achieving negative emissions in ethanol and electricity production based on sugar cane bagasse and other residues. *Applied Energy*, v. 179, p. 55–63, 2016.

RESTREPO-VALENCIA, S.; WALTER, A. Techno-economic assessment of bio-energy with carbon capture and storage systems in a typical sugarcane mill in Brazil. Energies 2019, v. 12, n. 6, p. 1129, 2019.

UFCC. (2022). Brazilian Updated - First NDC . Available in: https://unfccc.int/sites/default/files/NDC/2022-06/Updated%20-%20First%20NDC%20-%20%20FINAL%20-%20PDF.pdf . Accessed on November 17, 2022.