# The socioeconomic impacts of electrolytic ammonia in Brazil: an input-output analysis

Topic:
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Decarbonizing ammonia production could contribute to the transition to a low-carbon economy. Traditionally, ammonia is produced through the Haber-Bosch synthesis process, which consists in a chemical reaction between hydrogen (H2) and nitrogen (N2). This process is highly polluting, since the H2 used is produced by natural gas steam reforming, corresponding to 2% of annual global greenhouse gas (GHG) emissions. About 77% of global ammonia production is used to produce nitrogen fertilizers such as urea. For Brazil, changing ammonia production technology is particularly interesting since ammonia supply has become heavily dependent on imports, due to logistical and tax issues in the sector, Petrobras inactivated its fertilizer factories, as well as the rise in natural gas prices. However, with the recent announcement of Petrobras' Strategic Plan for the 2024-2028 five-year period, the possibility of resumption ammonia production in Brazil and replacing the use of fossil hydrogen with low-carbon hydrogen has emerged. In literature there are few works that applying input-output analysis for the hydrogen value chain, and the most part focuses in the transportation sector. There is a lack of works that analyses the economic impact of the low-carbon hydrogen production and use, especially in Brazil. The present work aims to analyze the socioeconomic impacts of decarbonization and nationalization of ammonia imports in Brazil. For this, two scenarios were evaluated using a demand-driven Leontief model based on the Brazilian Input-Output Matrix for the year 2018, with a disaggregation level of 68 sectors/sectors. The matrix was obtained from the Center for Regional and Urban Economics at the University of SÃ£o Paulo (NEREUS). The scenarios were designed based on a data survey from literature on investment (CAPEX) and operational (OPEX) costs for an ammonia plant construction and operation, as well as data available in the databases of Brazilian government agencies. For this analysis was considered an ammonia plant with a capacity of 219.2 thousand metric tons (kt) per year and the hydrogen used would be produced by water electrolysis using renewable energy. The ammonia plant capacity was defined based on the amount of ammonia imported in Brazil in 2018. To supply the ammonia plant, annual hydrogen production must be 38.6 thousand tons, which means an electrolyzer with a capacity of 232 MW. The first scenario evaluates socioeconomic effects with the increase in final demand from the investment in the infrastructure necessary for the synthesis of renewable ammonia production (construction phase). Due to the lack of available data, it was considered that the technologies used to produce ammonia and H2 are manufactured in Brazil, which means that the results obtained for the first scenario may be overestimated. The second scenario aims to represents the operational phase of the new plant and is constructed by altering the technical coefficient matrix using data tecno-economic analysis data renewable ammonia prices. With the new Brazilian input-output matrix, a shock in the final demand was applied to evaluate new industry impacts on economy (operation phase). In this scenario was considered that all ammonia produced will be consumed to produce nitrogen fertilizers (chemical sector). The analysis of the results was carried out using conventional indicators as Gross Domestic Product (GDP), number of jobs, output multipliers, backward (BL) and forward linkages (FL). The results show that in the construction phase there was an increase of BRL 696 million in GDP (0.01% of 2018 GDP) and an increase of 9.80 thousand jobs, with 74% having been generated by direct effect. In the operation phase, the electrolytic ammonia sector was responsible for an increase of BRL 398 million in GDP and 2.95 thousand jobs, 67% of which were generated by indirect effects. The production multiplier of the ammonia sector was 2.51, which implies that it can contribute to the economic growth in Brazil. Furthermore, BL and FL are greater than 1, meaning the ammonia sector is a key sector for the economy. The results demonstrate that at all stages the implementation of a renewable ammonia

sector will result in positive socioeconomic impacts.