Attributional and consequential life cycle assessment of bioethanol-based PVC

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Literature suggests that the most concerning environmental impact category in the life cycle of the polyvinyl chloride (PVC) is the depletion of non-renewable resources, mainly due to the fossil feedstock for ethylene. For this reason, bioethanol is considered as another source for ethylene in the PVC production chain. The objective of this paper was to perform a cradle-to-gate attributional and consequential life cycle assessment (LCA) of bioethanol-based PVC resin, and compare it to its reference product (fossil-based PVC). In the attributional approach we created two scenarios for bioethanol-based PVC, based on current data (2010) and on prognosis for 2018, and compared them with fossil-based PVC; while in the consequential approach, we compared solely the prognosis of the bioethanol-based PVC from 2018 with the fossil-based PVC. For the life cycle inventory we used primary data from Solvay S.A. and secondary data from literature. We used several midpoint indicators and the Recipe Endpoint H/A for the impact assessment. In the attributional approach, at midpoint level, bioethanol-based PVC from 2010 and 2018 presented better results than fossil-based PVC for non-renewable resource use and climate change, but worse results for other environmental impact categories (e.g. biodiversity and ecotoxicity). At single score endpoint level, the two bioethanol-based PVC scenarios showed better results than fossil-based PVC (up to 66% lower). Within the bioethanol-based PVC scenarios, the results for 2018 were better than for 2010 for all environmental impact categories, corroborating that higher efficiency (at the crop field and bioethanol production) and reduction of burnt harvest ought to reduce environmental impacts. In the consequential approach, at midpoint level, the environmental impact categories responded differently for the different degrees of indirect land use change (iLUC), and some of them generated gains to the environment in the three scenarios, including non-renewable resource use. At single score endpoint level, the results showed environmental gains if iLUC was kept below 5.7% of the sugarcane cultivation area. Even though bioethanol-based PVC had better results in comparison to fossil-based PVC at the attributional approach, improvements should be sought to minimize other environmental impact categories, e.g., biodiversity, eutrophication and ecotoxicity. The effects of iLUC, assessed through the consequential approach, were based on assumptions and therefore subject to uncertainties, but the assessment performed was important to provide quantitative information for the stakeholders on how the environmental gains of the bioethanol-based PVC should not be nullified by iLUC impacts.

Acknowledgements: The authors thank the European Commission for financing a PhD scholarship grant by the project "Euro Brazilian Windows II (EBWII)", from the program Erasmus Mundus External Cooperation Window (EMECW); Prof. Dr. Aldo Roberto Ometto, from Escola de Engenharia de Sao Carlos (EESC) - Universidade de Sao Paulo (USP), and Dr. Otavio Cavalett, from the Brazilian Bioethanol Science and Technology Laboratory (CTBE), for their important contributions at the sugarcane and bioethanol production systems. This work was partly supported by the EU-funded PROSUITE (full title: "Development and application of a standardized methodology for the PROspective SUstaInability assessment of Technologies