Sustainability assessment of biofuels production in Uruguay

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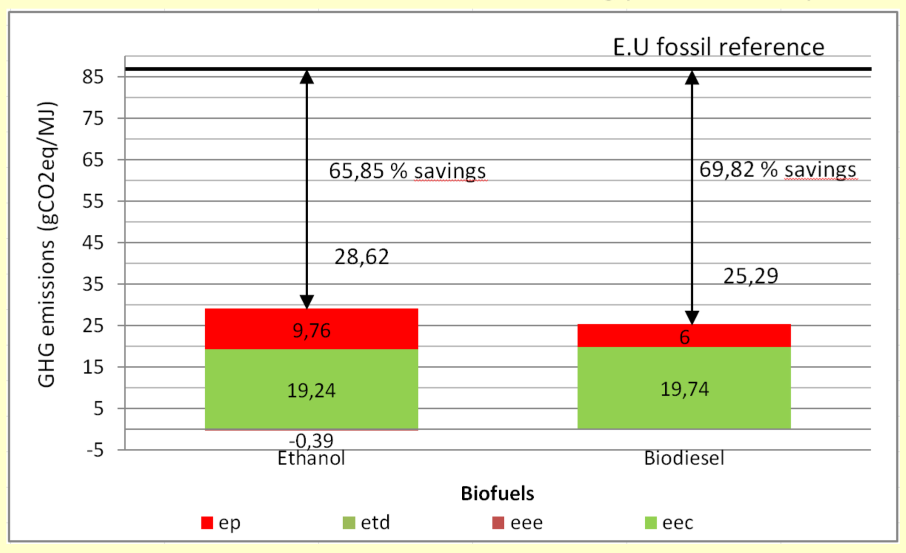
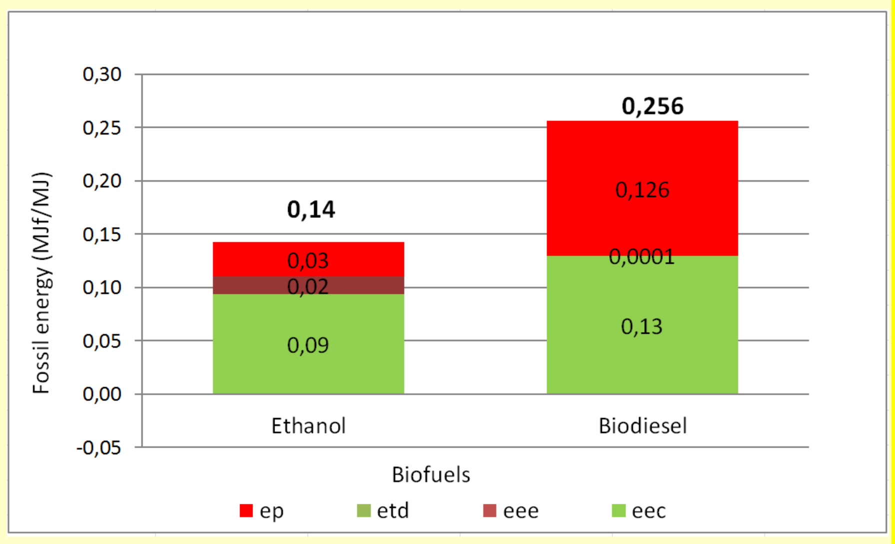
Introduction:

Uruguay is following a low carbon emission alternative path for the transport sector which includes the use of biofuels. Currently, biodiesel and ethanol -with a share of 7% and 10%, respectively-, are blended with fossil fuels. This work presents a sustainability life cycle assessment of biofuels production supply chain. The assessed pathways include biodiesel production from a mix of oil seeds (soy and canola), fats and used oils as well as bioethanol production from sugar cane and course sugar [1, 2]. In this sense, the objective of this work was to perform a Life Cycle Sustainability Assessment of the biofuels production in Uruguay, specifically ethanol from sugar-cane and biodiesel from soybean, rapeseed, and waste vegetal and animal oil. An Environmental Life Cycle Assessment was conducted to assess environmental impacts with a special focus on GHG emissions and fossil energy consumption. Additionally, an estimation of the associated socioeconomic impacts in terms of job creation and effects on the economic activity has also been performed by using and Input Output (IO) approach. Finally, an estimation of the environmental and socioeconomic externalities is conducted. This work used some typical and default GHG emissions values for several biofuel processes [3].

Results 1: Environmental analysis

GHG emissions and fossil energy consumption for Biofuels in Uruguay





eec= emissions from the extraction or cultivation of raw materials

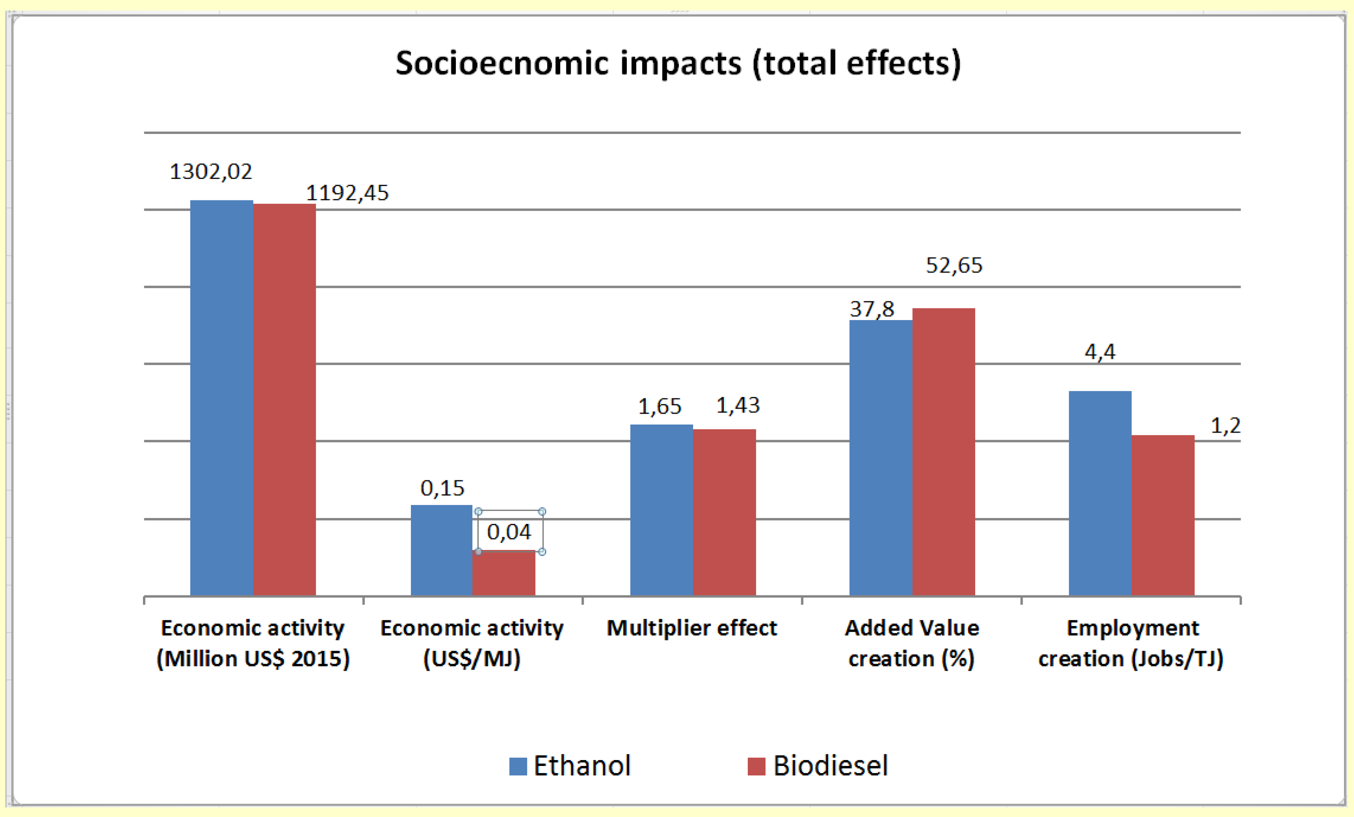
eee= emission saving from excess electricity from cogeneration

etd= emissions from transport and distribution

ep= emissions from processing

Results 2: Socioeconomic analysis

Economic activity, multiplier effect, Added value creation, job creation



Discussion:

Results show that biodiesel presents a very important GHG emissions reduction (around 70%) in comparison to the fossil fuel comparator used in the European legislation on biofuels. In the bioethanol system, this reduction is also relevant (near to 66%). Cultivation of the raw materials is the most relevant contributor to the total GHG impact.

Fossil energy ratio in ethanol production amounts 0.14 $MJ_{fossil}/Mj_{ethanol}$ while, in the case of biodiesel, this ratio amounts 0.25 $MJ_{fossil}/MJ_{biodiesel}$.

All the sensitivity analyses (SA) result in higher emissions per MJ of bioethanol produced and also higher fossil energy consumption. In some cases (SA2 and SA3) the sustainability of biofuel produced is challenged and questioned.

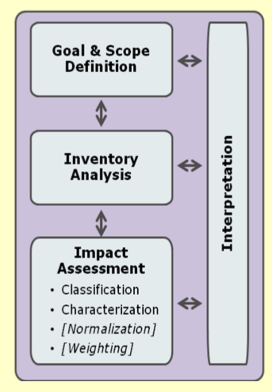
In the case of biodiesel GHG emissions, in all the studied scenarios, emissions savings with respect to the fossil fuel comparator are higher than 70%. This behavior is also observed in fossil energy consumption.

Regarding socioeconomic analysis, ethanol production gives rise to a larger economic activity and job creation but biodiesel results show a higher multiplier effect and added value creation. The externalities analysis show that both, the substitution of gasoline by ethanol and gas-oil by biodiesel, results in large external benefits. This is remarkable when it comes to socioeconomic benefits in terms of added value creation.

Materials and methods:

Life cycle analysis (LCA), Input output analysis (IO) and Externalities assessment have been used in order to develop this study. The methodology follows ISO 14040/44 and methods described in the Annex V of the Directive 2009/28/CE.

Life Cycle Analysis



Goal & Scope

Function & functional unit: Produced biofuels & 1MJ

Raw materials extraction, manufacturing and associated co-products and wastes, storage and distribution.

Inventory Analysis

Data from private and public companies as well as governmental institutions.

Raw materials, transport and its contribution to the Uruguayan biofuels mix

Economic allocation was assumed for reference case

Impact assessment

LCA – Environmental impacts: Greenhouse gas emission (gCO2eq); Fossil energy consumption (MJfeq)

IO – Socioeconomic impacts: Economic activity/ multiplier effect; Added value and job creation

Interpretation

Several sensitivity analyses have been carried out to identify how the different raw materials mixes and the allocation criteria might influence on the result

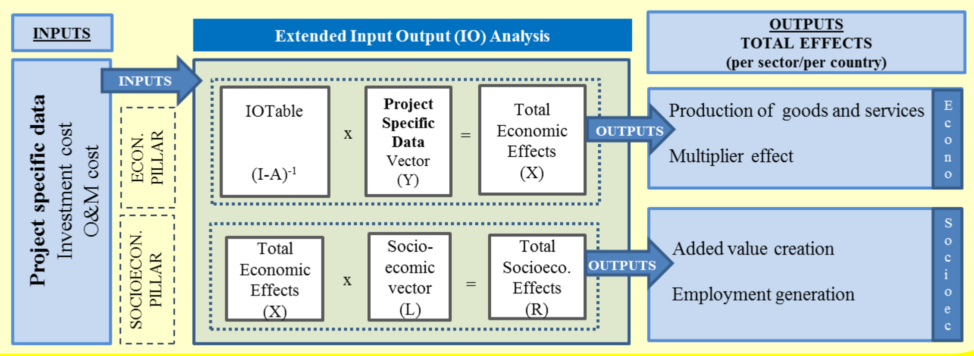
Externalities

The estimation of the environmental external benefits of substituting fossil fuel by the studied biofuels has been conducted following the ExternE methodology and the approach of CASES project (http://www.feem-project.net/cases/).

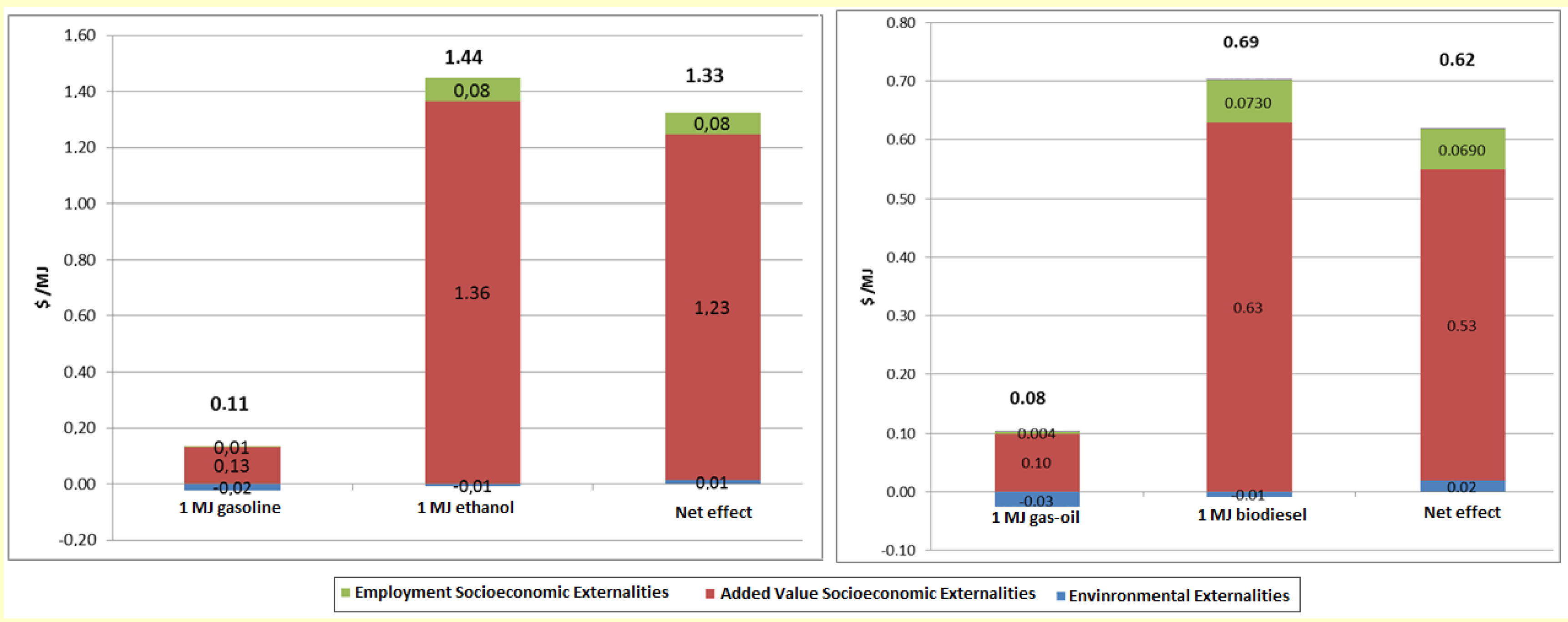
Socioeconomic net externalities considered were the added value creation and the monetarization of net job creation using the avoided expenditure of the government in the form of unemployment subsidies.

Input output analysis (IO)

IO methodology has been used to estimate direct and indirect effects in the economy originated by the supply chain production of biofuels. Only domestic effects have been considered in 56 economic activity sectors. Total economic activity, added value, job creation and multiplier effects are the estimated impacts. The job creation vector has been calculated using the average data publised in the Microdatos de Encuesta Continua de Hogares by the National Statistical Institute.

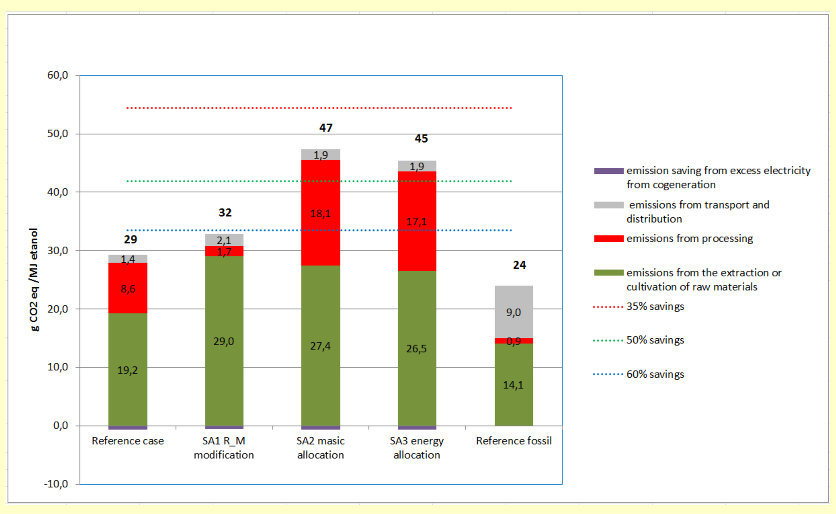


Results 3: External benefits from substituting fossil by ethanol and biodiesel

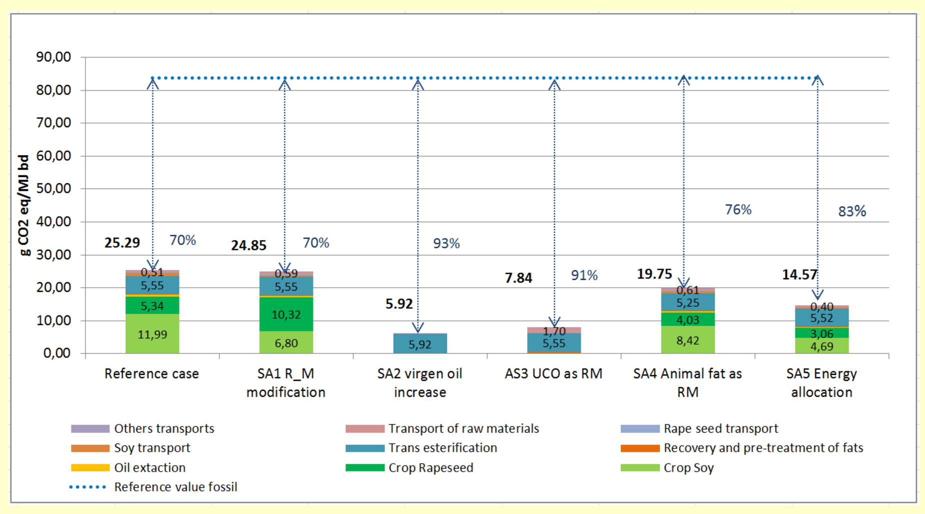


Results 4: Sensitivity analysis for GHG saving emissions

Ethanol. Sensitivity analysis GHG emissions results

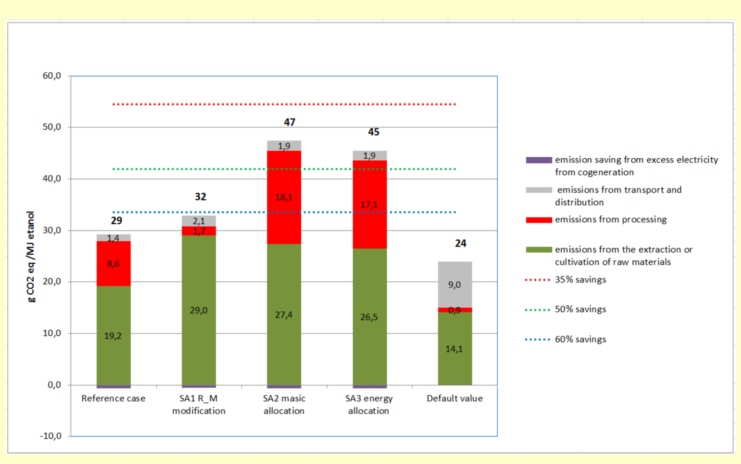


Biodiesel. Sensitivity analysis GHG emissions results

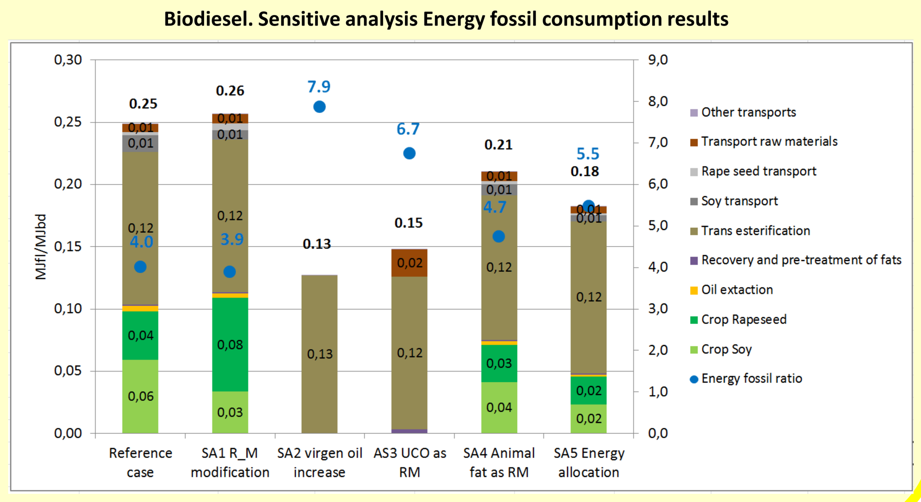


Results 5:Sensitivity analysis for fossil energy consumption

Ethanol. Sensitive analysis Energy fossil consumption results



Biodiesel. Sensitive analysis Energy fossil consumption results



Conclusions:

The Life Cycle Sustainability Assessment performed covers several aspects (GHG emissions, fossil energy balance, various socioeconomic effects and external benefits) of bioethanol and biodiesel production in Uruguay. According to our results, both biofuels are environmentally sustainable, give rise to important socioeconomic benefits in terms of added value and job creation and generate important net external benefits.

References

[1] Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure

[2] Herrera I., Lago C., Lechón Y., Saéz R. Spanish biofuels sustainability assessment, by means of life cycle analysis. 23rd SETAC Europe Annual Meeting. Glasgow (Scotland), 12-16 May 2013

[3] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

QR code to download the poster

Acknowledgements

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