Transition risks and opportunities in Brazil in a low-carbon world

Authors

Mariana Império[1*], Gerd Angelkorte[1], Bruno Cunha[1], Rafael Garaffa[2], André Lucena[1], Alexandre Szklo[1], Roberto Schaeffer[1], Pedro Rochedo [1]

[1]Energy Planning Program, COPPE, Universidade Federal do Rio de Janeiro, Centro de Tecnologia, Sala C-211, Cidade Universitária, Ilha do Fundão, 21941-972 Rio de Janeiro, RJ, Brazil

[2]European Commission, Joint Research Centre - JRC. Calle Inca Garcilaso, 3 - Edificio Expo 01/51 - 41092 - Seville / Spain

*Corresponding author. E-mail address: marianaimperio@ppe.ufrj.br

Summary

Transition to climate neutrality poses different challenges. This study assesses risks and opportunities for agriculture, biofuels and the oil and gas sector in Brazil under different climate ambitions. Results show a sharp reduction in oil consumption, replaced by advanced biofuels associated with carbon capture and storage (BECCS). Refineries experience overcapacity, which is overcome by coprocessing biomass, with the biofuels and land use sectors taking it as an increasing opportunity. Biofuels production allied with BECCS leads to additional USD 10 billion in investments per year in a NetZero scenario, which can only be achieved halting current deforestation rates.

1. Introduction

The current energy transition is driven by the shift from fossil-based systems of energy production and consumption to renewable energy sources. Inadequate climate action until 2030 can cause long-term implications, such as: lock-in into carbon-intensive infrastructure and high risk of stranded fossil fuel-related assets; higher dependence on CO_2 and higher demand for negative global emissions; higher commitment to global warming and associated climate impacts and risks; and missed opportunities to achieve benefits for sustainable development (UNEP, 2020).

According to TCFD (2017), climate risks can be divided into physical and transition risks. Physical risk represents real changes in the environment, such as extreme weather conditions and/or sea-level rise. Transition risks relate to the shifts in asset values, higher costs of doing business, including liability costs, or disruptions in value chains driven by climate and energy policies. In order to address these issues, we developed a series of national scenarios to assess the risks and opportunities of the transition to a low-carbon economy for the agriculture, electric utilities, oil and gas (O&G) and biofuels sectors in Brazil, for different climate ambitions.

2. Methods

We depart from a reference scenario framed within the Shared Socioeconomic Pathway 2 (SSP2) rationale. We use short-term economic projections of the COVID-19 pandemic impact from IMF (2020) to update the reference scenario, reflecting the most recent economic disruptions in the TEA model1. We perform a calibration process in the BLUES (Brazil Land Use and Energy Systems model) national bottom-up IAM model (Koberle, 2018; Rochedo et al., 2018), considering food and energy services' demands in 2020 and the economic recovery for the post-COVID period from the TEA model.

After recalibrating the BLUES model, two scenarios are designed: (i) a Current Policies scenario (CurPol), which considers the Brazilian NDC, including mainly zero illegal deforestation from 2030 onwards, and (ii) a net zero scenario (NetZero), considering the NDC by 2030, and a climate neutralization of greenhouse gas (CO_2, CH_4 and N_2O) emissions by 2050 for the country. Moreover, a sensitivity analysis is developed based on the NetZero scenario, in order to represent the non-compliance with the NDC zero illegal deforestation target by 2030. Thus, in the NetZero_Int scenario, Brazil would have an intermediate environmental governance, with annual deforestation rates of 1.8 Mha/year between 2025-2050, while in the NetZero_Weak rates would be 2.7 Mha/year. It is worth mentioning that in both sensitivities assessed deforestation rates are lower than the current level of 2.9 Mha/year.

The CurPol and NetZero scenarios' results (which follow the premises arising from the Brazilian NDC) are initially compared, in order to evaluate the risks and opportunities of different sectors in the Brazilian energy transition. Subsequently, we evaluate the impacts related to the non-compliance of the country's NDC.

3. Results

Results show a significant impact in all sectors due to the COVID-19 pandemic in 2020. The Brazilian economy recovers from 2025 onwards, but the impact from the pandemic contributes to reduce GHG emissions in both CurPol and NetZero scenarios, mainly by reducing activity (exogenous demand) in the BLUES model.

Comparing the long-term trajectories (Figure 1), the CurPol shows a small decrease in oil consumption, whereas the NetZero scenario shows a substantial reduction of fossil fuels by 2050, specially oil, which was corroborated by the NetZero scenarios recently launched by the IEA (2021). Furthermore, the NetZero scenario shows the necessity to expand biomass utilization to produce advanced biofuels in order to replace fossil fuels in the transportation sector.

[1] Total-Economy Assessment (TEA) is a multi-regional and multi-sectoral model computable general equilibrium model that tracks the production and distribution of goods, capturing industry-to-industry linkages, in the global economy (Cunha et al., 2020).

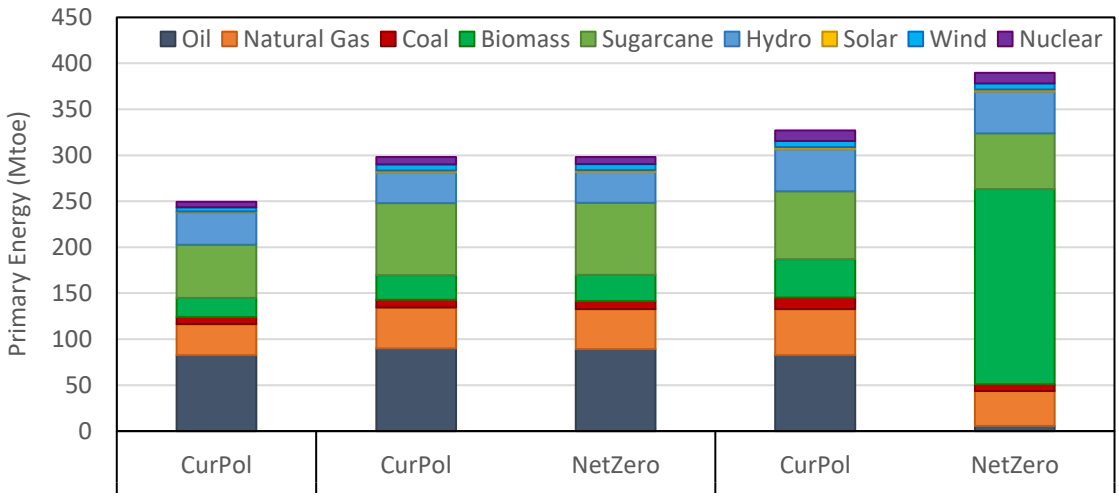

Figure 1 - Primary energy in the CurPol and NetZero scenarios

Figure 2a highlights the changes on the oil and gas trade dynamics. Since domestic consumption drops off, we can observe, at the same time, multiple effects, such as a reduced need for oil imports and a greater focus on oil exports, which leads to a decrease in oil production. Hence, this induces a sharp decrease in the utilization factor of refineries (Figure 2b), starting in 2040 and achieving 6% in 2050, potentially generating stranded assets and increasing the sector's risk.

However, NetZero presents an opportunity to produce advanced biofuels (Figure2c), which can be used as drop-in fuels in existing infrastructure and vehicles. Their production associated with CCS is a way to generate net negative emissions and achieve climate neutralization but 2050. Therefore, whilst the oil demand reduction can pose a challenge to conventional refineries, the increased demand for advanced biofuels represents new opportunities for biorefineries processing biomass to produce fuels for the transportation sector.

On the land-use side (Figure 2d), there are several opportunities for pasture recovery, integrated systems, planted forests, productivity gains and more sustainable practices. On the other hand, Brazil’s image as seen by the international community poses a potential risk for the agricultural sector, since the country may face international sanctions related to international trade and reduction of funding if it keeps high deforestation rates.

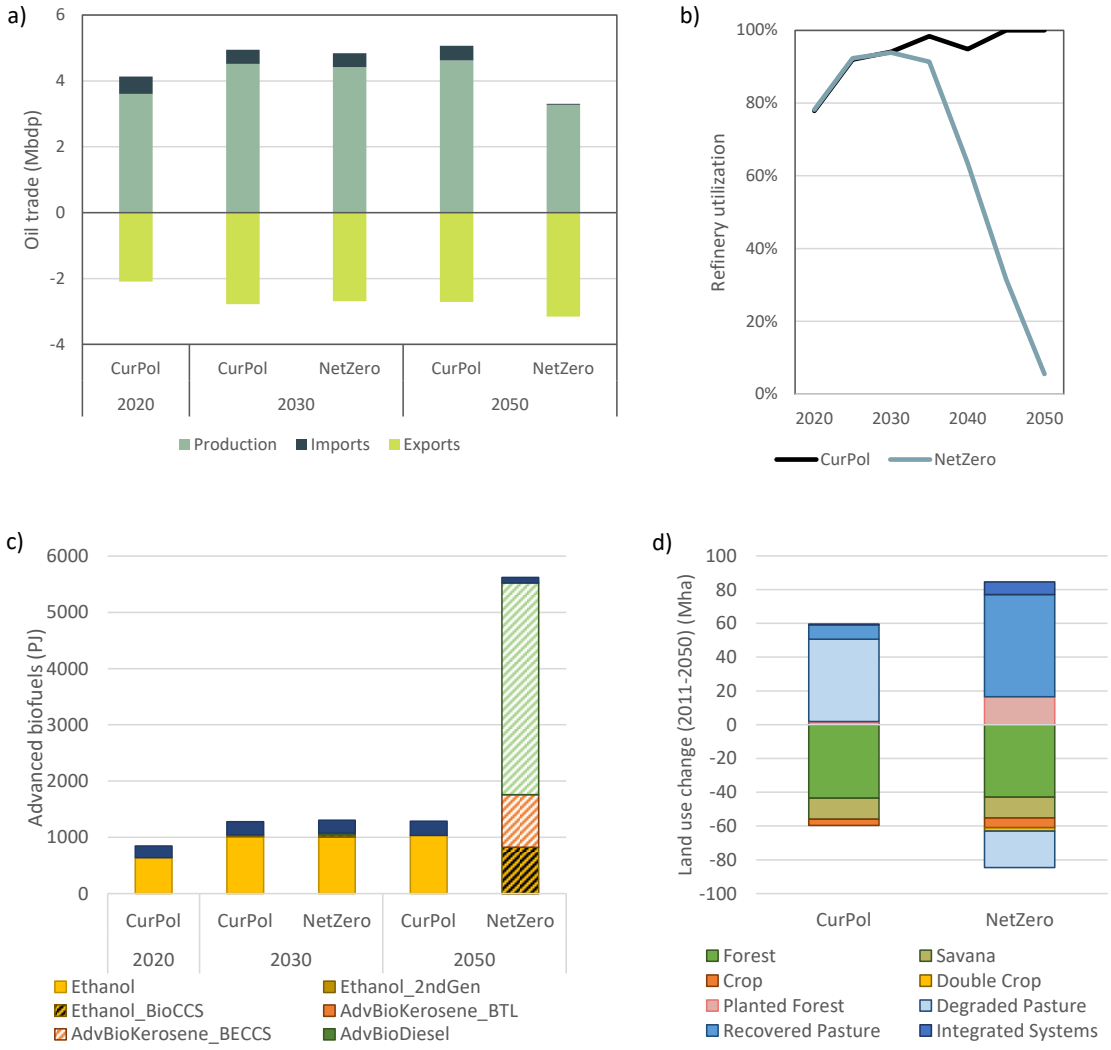

Figure 2 - (a) Oil trade, (b) refinery utilization, (c) biofuels production and (d) land use change

Finally, sensitivity analyses presented greater challenges for Brazil to achieve climate neutrality by 2050. In the NetZero_Int scenario, we observe an intensification of the results of NetZero, that is, higher volumes of advanced biofuels with CCS (Figure 3a). Major changes in land-cover for carbon storage in soil and intensification of agricultural production systems to meet the need for agricultural inputs for the bioenergy production are also observed. However, in the NetZero_Weak scenario deforestation rates make it impossible to achieve climate neutrality by 2050, at least with the technological options and energy demands accounted for in BLUES.

In terms of investments needs (Figure 3b), the NetZero scenario comes with an investment 66% higher compared to CurPol scenario, mostly for biofuels production allied to BECCS, which represents additional 10 billion USD per year. On top of that, NetZero_Int would require extra 10 billion USD, compared to NetZero, representing the cost of compensating higher deforestation rates.

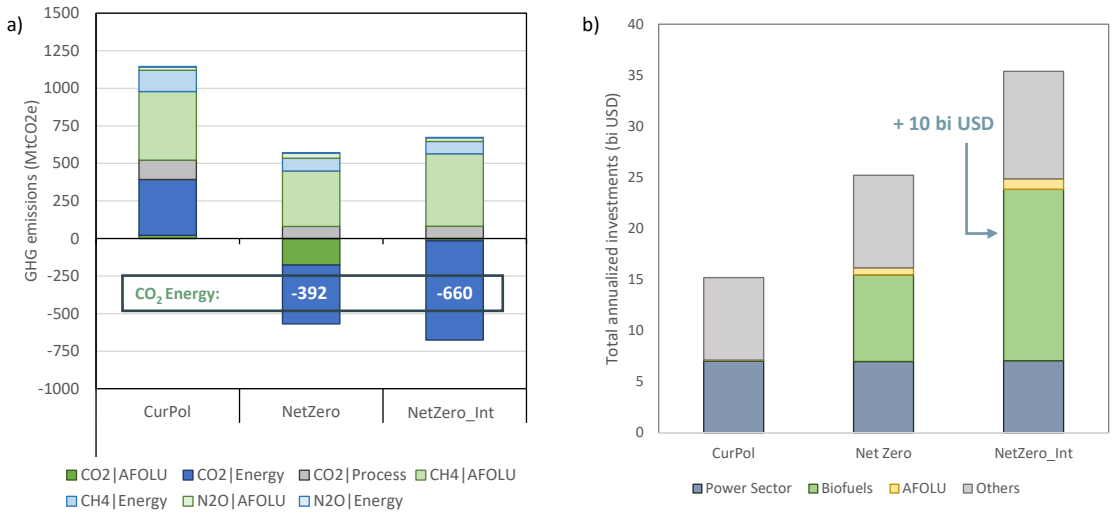

Figure 3 - (a) Emissions and (b) investment needs

References

Cunha, B. S., Garaffa, R., Gurgel, A. C., 2020, "TEA Model Documentation". Technical report, FGV/EESP. Available at https://hdl.handle.net/10438/28756.

IEA, 2021. Net Zero by 2050 – A Roadmap for the Global Energy. International Energy Agency.

IMF, 2020. World Economic Outlook – A Long and Difficult Ascent (Issue October). International Monetary Fund.

Koberle, A. C., 2018. Implementation of land use in an energy system model to study the long-term impacts of bioenergy in Brazil and its sensitivity to the choice of agriculture greenhouse gas emission factors. Doctoral thesis, Rio de Janeiro, UFRJ, COPPE.

Rochedo P. R. R., et al, 2018.The threat of political bargaining to climate mitigation in Brazil. Nat Clim Change;8(8):695e8. https://doi.org/10.1038/s41558- 018-0213-y.

TCFD, 2017. Recommendations of the Task Force on Climate-related Financial Disclosures. Task Force on Climate-related Financial Disclosures. https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf

UNEP, 2020. Emissions Gap Report 2020. United Nations Environment Programme