Combining low-carbon economic development and oil exploration in Brazil?
An energy–economy assessment

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❶ Introduction

Brazil NDC objective: strengthening **low-carbon economic development** beyond cuts in emissions from deforestation (includes limiting domestic oil consumption and increasing energy efficiency and biofuel use in the transport sector);

BUT Brazil also aspires to become **a key oil producer** (reserves of '*pre-salt*' oil);

<u>Research questions</u>

- Under what conditions up to 2030 low-carbon economic development and oil exploration can possibly be combined in Brazil?
- What would be the energy system, environmental and macroeconomic implications of enabling policies for doing so?

❷ Methods

IMACLIM-BR model

A single region (Brazil) multi-sector **CGE model** in open economy:

- emphasizes **energy–economy interactions** through physical/economic flows double accounting (to incorporate technical information from energy scenarios);
- generates **medium-term projections** considering changes of the main energy–economy growth determinants;

<u>Transport sector and fuel demand modelling</u>

Reflects the specifics of the transport sector in Brazil:

- Currently 90% of passengers and 60% of freight on roads
- Light-duty vehicles (LDVs): 50% of passenger transportation, 85% of the fleet is expected to be 'flex-fuel' (running on both gasoline and ethanol) in 2030
- Modelling endogenous gasoline/bioethanol market shares for LDVs (65% - 35% today)

<u>Oil sector modelling</u>

- Future Brazilian oil production is an exogenous policy parameter (reflecting a given production objective);
- Domestic oil demand responds to markets and the balance is exported;
- Oil production costs reflect the specifics of Brazilian oil fields including '*pre-salt*';

Scenarios

Table 1. Main assumptions of the three scenarios.

	GOV	OIL int	DD
Active population growth	1.1% per year (2005–2030)	Id	Id
Labour productivity growth	1.0% per year (2005–2030)	Id	Id
World oil price in 2030	US$85/bbl	Id	Id
Domestic oil production in 2030	5 mb/d	Id	Id
Fuel policy	41 bl bioethanol demand target in 2030 through oil-based / biofuel tax rates adjustments (constant public budget)	27 bl bioethanol demand in 2030 through oil-based fuel tax rate cut (compared to 2016 rate – financed by public deficit)	Same fuel tax conditions as GOV
Carbon tax policy	None	None	$100/tCO₂ carbon tax on final energy demandᵃ
Biodiesel blending mandate in 2030	10%	8%	15%
Energy efficiency improvement LDVs	1% per year (2005–2030)ᵇ	0.6% per year (2005–2030)ᶜ	1.9% per year (2005–2030)ᵈ
Energy efficiency rest of transport	1% per year (2005–2030)	0.6% per year (2005–2030)	1.4% per year (2005–2030)
Freight intensity of the economy in 2030	Same as 2005	Same as 2005	−10% compared to 2005ᵉ

ᵃThe carbon tax is applied on energy-related CO_2 emissions linked to final energy consumption (transport, agriculture, industry, services and residential sectors) and carbon revenues are recycled into a general sales tax reduction with neutral budget. $100/tCO₂e is a value considered in other existing studies for Brazil (La Rovere, Gesteira, Grottera & Wills, 2015; La Rovere et al., 2016) and reflects ambitious climate action until 2030. It is consistent with 2°C global scenarios (Edenhofer et al., 2014) and the recent work of the Stern-Stiglitz commission (Stiglitz & Stern, 2017).
ᵇCorresponding to an average 1.52 MJ/km energy efficiency of the fleet in 2030.
ᶜCorresponding to 1.68 MJ/km.
ᵈCorresponding to 1.22 MJ/km (EU target).
ᵉCorresponds to a decrease of the freight needs of the economy owing to better social and economic organization and optimized logistics.

❹ Conclusions

- Low-carbon development goals will strongly interact with oil policy in Brazil;
- **The 2030 energy-related NDC target should be easy to achieve** considering the new economic reality of the country;
- **Deeper domestic decarbonization is achievable with very limited GDP loss and significant oil exports**, while being aligned with a cost effective 2°C global pathway;
- But, **increasing oil exports can be seen as a perverse effect** and significant oil revenues **could hinder the necessary diversification of the economy**;
- **A broader strategic vision is needed** to reconcile climate policy, energy policy and other economic development objectives in Brazil;

❸ Results

GOV reference scenario - 2030

- GDP: + 2.2% / yr - Energy intensity: -0.8% / yr (2015-2030)
- 8.5% decrease of biofuel / oil-based fuels relative prices (through tax transfers) to reach **41 bl bioethanol domestic demand**
- **2.8 mb/d crude oil exports** = 2.7% of GDP - 2.2 mb/d oil domestic consumption
- Energy-related emissions: **531 MtCO2** (23% lower than the energy NDC indicative target)
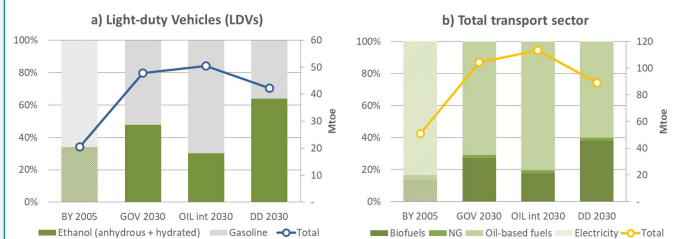
Alternative scenarios: energy demand and oil balance

Figure 1. (a) Fuel consumption of LDVs and (b) final energy consumption of the total transport sector
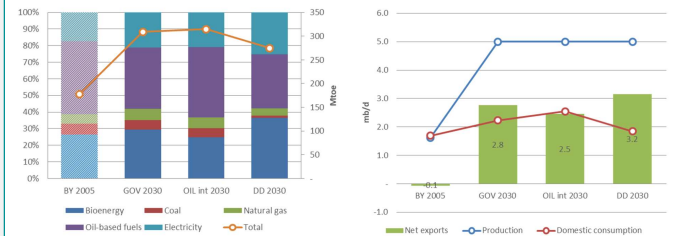

Figure 2. Total final energy consumption (TFEC) by energy carrier

Figure 3. Balance of crude oil
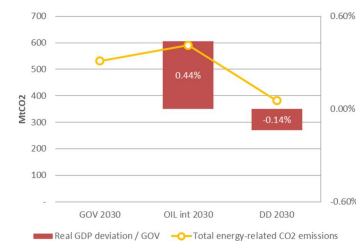
Macroeconomic and environmental implications

Figure 4. Total energy-related CO2 emissions and real GDP deviations from the *GOV* scenario.

Table 2. Macroeconomic results of the *OIL int* and *DD* scenarios compared to the *GOV* scenario.

	GOV	OIL int	DD
Real GDP deviation (% GOV)	–	+0.44	−0.14
Real exchange rate deviation (% GOV)	–	−1.5	+3.0
HH real expanded income deviation (% GOV)	–	+0.3	+0.9
Average real wage deviation (% GOV)	–	+0.4	+1.9
Industry exports deviation (% GOV)	–	+0.8	−1.8
Industry output deviation (% GOV)	–	+0.9	−1.5
Oil exports revenues (% GDP)	2.7	2.5	3.0

References

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