Assessment of Negative Emissions Technologies (NETs) for Brazil

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Assessment of Negative Emissions Technologies (NETs) for Brazil

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SUMMARY

1. Context
2. Opportunities for Brazil
3. Brazilian NETs Portfolio
4. NETs Potentials and Costs
5. Final Remarks
1. Context
NETs in IAMs Scenarios

• Negative emissions technologies are technologies developed for net removal of carbon dioxide ($\text{CO}_2$) from the atmosphere

• Role of NETs in a well-below 2°C world

IAMs scenarios relying on negative emissions to meet the stringent carbon budgets, especially in the second half of the century

   ➢ Need to deal with emissions that surpass the given carbon budget;
   ➢ Compensate for sectors hard to decarbonize, such as the transportation sector.
NETs in IAMs Scenarios

- IPCC Special Report 1.5°C (Rogelj et al., 2018):

  - Remaining carbon budgets depend on the climate target and the availability of NETs

- NETs are essential if we are to meet the Paris Agreement

3 GtCO$_2$/year $\rightarrow$ 29 GtCO$_2$/year
2. Opportunities for Brazil
NETs Opportunities for Brazil

Brazil has the largest potential for reforestation in the world

Brazil is a major producer and consumer of biomass and bioenergy

Brazil is a hotspot for NETs deployment
3. Brazilian NETs Portfolio
Brazilian NETs Portfolio

The diversification of NETs portfolios is of utmost importance for NETs development and for its deployment to provide effective results in what regards climate mitigation pathways

(Minx et al., 2018; Fuss et al., 2018; Nemet et al., 2018)
Brazilian NETs Portfolio

- Reforestation
- Integrated Crop- Livestock- Forestry
- Biochar
- BECCS
- Biochemicals
Reforestation
Reforestation

• One of the most well-known NETs option;

• Presents several positive externalities (e.g. biodiversity);

• However, positive externalities are not currently valued:
Reforestation

• Brazil has the **largest estimated potential** for reforestation in the world:
  • 25 GtCO$_2$ between 2020-2050 with a carbon cost of up to 20 US$/tCO$_2$ (Busch et al., 2019).

• However, this potential would only be possible through:
  • Large **investments**;
  • **Policies to control** some of the bottlenecks of reforestation in Brazil.

• Additionally, considerable effort should be employed to prevent land-grabbing and illegal occupation, which in turn lead to the high deforestation rates in Brazil.
ICLF Systems
Integrated Crop-Livestock-Forestry Systems
Integrated Crop-Livestock-Forestry (ICLF)

- **Integration** between different types of **productive systems** with high productivity, intercropping, succession and/or rotation;

- **Mutual benefit** between crops and creations and have great concern with the recovery of degraded areas;

- **Increased sustainability** aiming at symbiosis between farms and crops in order to improve the **physicochemical** structure of degraded soils, increasing local **biodiversity** and assisting in **carbon capture** by planting native and/or planted forests.
Integrated Crop-Livestock-Forestry (ICLF)

- **Integrated Crop-Forest (ICF) (a)**, which places agricultural production in the same area together with forestry of native or planted forests;

- **Integrated Livestock-Forest (ILF) (b)**, with the production of beef or dairy cattle in conjunction with forestry;

- **Integrated Crop-Livestock (ICL) (c)**, which seeks to consort in the same area the production of beef or dairy cattle along with rotational cultivation;

- **Integrated Crop-Livestock-Forestry (ICLF) (d)**, which is the complete ILPF system that seeks in the same area to place agricultural, silviculous and beef cattle or milk production.
Integrated Crop-Livestock-Forestry (ICLF)

- **Carbon sequestration** is currently in the range of 30 tonnes of CO$_2$eq per hectare year (ILPF);
- **High** theoretical potential;
- **Low** technical potential due to problems such as:
  - Productive system as the need for large quantities of **skilled labor**;
  - **High** level of initial **investment**, usually provided from bank loans;
  - Distrust on the part of growers, given the **initial difficulties** and **low short-term monetary returns**, many growers eventually give up on the system because they find it flawed.

Theoretic Potential ~ -8,052 MtCO$_2$eq/year
Biochar
Biochar

- **Application** of charred biomass as an amendment to the soil;

- **Carbon sequestration** method that provide many **co-benefits to the soil** (e.g.: carbon content, water and nutrient recycling, pH correction, cation exchange capacity);

- Brazil has the **largest production of charcoal** in the World, applied in pig iron production (21-30 Mt/yr of charcoal production between 2009 and 2018);

- First major discoveries of the benefits of biochar to the soil were made in the Brazilian territory ("**Terra Preta de Índio**" in the Amazon Basin)
Biochar

Case study: improvement of degraded pasturlands in Brazil with biochar from agricultural and forestry residues

- Degraded pastureland in Brazil: ~64 Mha
- Agricultural Residues:
  - Sugarcane (straw and bagasse)
  - Rice (straw and hulls)
  - Maize (straw)
  - Soybean (straw)
  - Wheat (straw)
- Forestry Residues
  - Eucalyptus
  - Pinus
  - Charcoal

Degraded pastureland in Brazil* (2017)

Biochar production potential

* UFG/LAPIG, 2019: https://pastagem.org/atlas/map
Biochar

Theoretic CO$_2$ sequestration potential

Low application rate (5 t/ha)

Average application rate (10 t/ha)

High application rate (15 t/ha)
BECCS
Bioenergy and Carbon Capture and Storage
BECCS

- In IAMs scenarios, most negative emissions are provided by BECCS

- BECCS include a variety of technologies, such as carbon capture in power generation, or in the production of biofuels

- Low-hanging fruit: CO$_2$ capture from the fermentation process in sugarcane distilleries (ethanol production)
BECCS

**BECCS Potentials (MtCO₂/yr)**

- **BECCS BTL Diesel**: 11 US$/tCO₂
- **BECCS BTL Biojet**: 80 US$/tCO₂
- **BECCS BTL Bunker**: 11 US$/tCO₂
- **BECCS Ethanol Fermentation**: 118 US$/tCO₂
- **BECCS Bagasse Cogeneration**: 118 US$/tCO₂
Biochemicals
Biochemicals

• Conversion of biomass into a chemical product can be a NET option;

• Opportunity for the Brazilian chemical industry which, along with the abundant sources of biomass (e.g. ethanol) in Brazil, can lead to higher competitiveness in carbon-constrained scenarios;

• Brazil already has a commercial plant with a capacity of producing 200 kt/y of bio-ethylene from ethanol;

• Based on the current annual ethylene production in Brazil, roughly 25% of all ethanol production would be required as feedstock.
Biochemicals

Bio-ethylene could make the Brazilian chemical industry more competitive. This would be achieved by applying the revenues from carbon credits associated with using ethanol and sugarcane bagasse as feedstock for bio-ethylene production. This could favor an industry under a severe crisis.

Three production routes were compared according to their estimated cost of production in Brazil under a simplified life cycle analysis.

This study assessed a best-case for bio-ethylene products’ final disposal, which means that the biogenic carbon captured in the sugarcane production is embodied into a long-lifetime product.
4. Estimated Potentials and Costs
NETs Estimated Potentials

NETs Estimated Potentials for Brazil (MtCO₂/yr)
NETs Estimated Potentials for Brazil (MtCO$_2$/yr)
Estimated Costs of NETs

Range of Estimated Costs (US$/tCO₂)
NETs Estimated Potentials

Marginal Abatement Curve

Reforestation
5. Final Remarks
• Brazil has a **significant** potential for NETs

• Current national potential of roughly **1,110 MtCO₂/yr** of negative emissions

• Economy sectors, such as agriculture and industry, could **benefit** from the employment of NETs

• Some options are expected to cost less than **50 US$/tCO₂**
• **However**, socioeconomic and environmental impacts have not been thoroughly assessed

• Future analysis should further investigate such **impacts**

• **Future work** should include all NETs options in IAMs developed for Brazil
Thank you.

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