



Deep decarbonization pathways for Brazil

A Low GHG Emissions Development Strategy leading to net zero carbon by 2050

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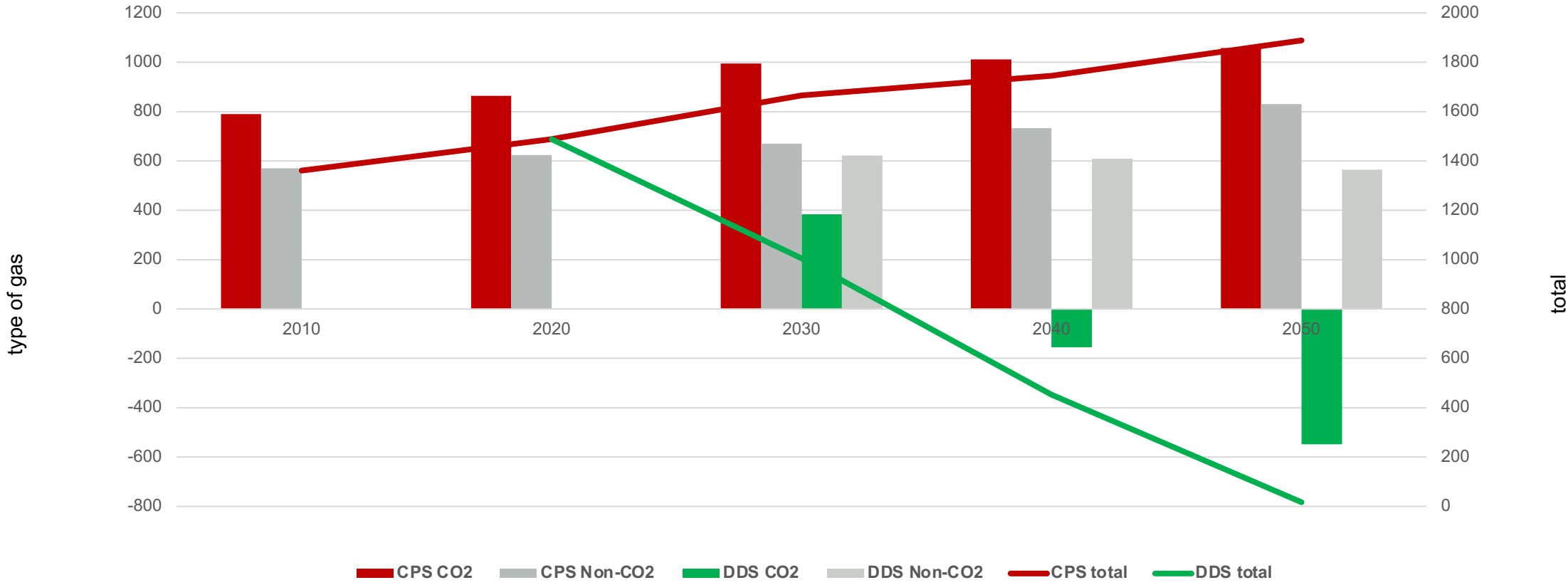
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- **Objective:** Contribution to new (more ambitious) Brazilian NDCs and to the preparation of a LTS (LEDS).
- **Background:** bottom-up sectorial modelling of emission scenarios from 1991 to 2011 (based upon energy scenarios since the 70's).
- New generation of IES Brasil studies (Economic and social implications of low-carbon scenarios in Brazil) = **DDPP1, IES Brasil 2030, DDPP2, IES Brasil 2050, Brasil Zero Carbon in 2060, ICAT, PMR Brasil, DDP-BIICS**, made possible by:
 - the development of a **CGE model** in 2011-2015, **IMACLIM-BR** (adapted from **CIRED's IMACLIM**) -> modelling framework integrating bottom-up sectorial models & a CGE model;
 - use a stakeholders' driven approach through the convening of a **Scenario Building Team** gathering experts from the government, business sector, NGOs, academy, trade unions, to select pertinent scenario assumptions, mitigation actions and costs, validate the results, identify decarbonization barriers and suggest instruments to overcome them.
- **DDP-BIICS:** Update of IES-Brasil 2050 after economic recession and COVID-19:
 - **CPS** – Current Policies Scenario including mitigation actions to meet NDC targets by 2025 (-37%) and get close to NDC target in 2030 (-43% of 2005 level) with no further ambition up to 2050;
 - **DDS** – Deep Decarbonization Scenario with additional actions getting to net zero GHG emissions by 2050 (negative CO₂ emissions in 2040), using available technologies only (no CCS, just EOR; increasing share of oil&gas production to exports, average oil price of 45 US\$/bbl in 2025-2050).

- Curbing down annual deforestation rates from 2020 to 2050 across all Brazilian biomes (and especially in the Amazon and “Cerrado” – the savannah plains in Central Brazil), and maintenance of low deforestation rates after 2050.
- The increase of protected areas (Conservation Units and Indigenous Lands), the restoration of native forest (private and public areas) and forestry are the main potential carbon sinks in Brazil. Along with reducing deforestation in DD Scenario, these Nature Based Solutions - NBS are responsible for most of the mitigation in the DDS, allowing to compensate for a substantial share of other sectors’ GHG emissions.
- Setting a price to most GHG emissions (scope as wide as possible); starting with a relatively low price and gradually increasing it at an anticipated pace; allowing the use of a limited amount of forest offsets in cap-and-trade systems applied to Industry; using a share of the carbon tax proceeds to incentive employment and compensate low-income households; enabling a border tax system to protect domestic industry competitiveness.
- Improvement of quality of life of the vast majority of the population thanks to the co-benefits of DDS: ecosystem services, lower air pollution in cities, better sanitation infrastructure, etc.

GHG and CO₂ Emissions in Brazil, 2010-2050, CPS & DDS (in MtCO₂eq)

GHG Emissions, CO₂ and non-CO₂ (Mt CO₂eq)



Main synergies and trade-offs with country non-climate objectives

| Scenario | 2015 | 2020 | CPS (2030) | CPS (2050) | DDS (2030) | DDS (2050) |
|---|-------|-------|---------------|---------------|---------------|---------------|
| Population | 203 | 212 | 225 | 233 | 225 | 233 |
| GDP (Billion 2015 USD) | 1,896 | 1,852 | 2,385 | 3,547 | 2,391 | 3,552 |
| GDP variation in relation to CPS | - | - | - | - | 0.3% | 0.1% |
| GDP per capita (Thousand 2015 USD) | 9.32 | 8.75 | 10.60 | 15.23 | 10.63 | 15.25 |
| Trade Balance (% of GDP) | -0.4% | -1.0% | -0.4% | -0.2% | -0.5% | -0.9% |
| Unemployment rate (%) | 9.5% | 7.6% | 6.9% | 7.4% | 6.8% | 7.2% |
| Price index in relation to CPS (CPS=1) | - | - | - | - | 1.01 | 1.04 |
| Disposable income_HH1 (2015=1) (poorest 20% of households) | 1.00 | 1.05 | 1.44 | 2.40 | 1.45 | 2.45 |
| Disposable income_HH2 (2015=1) (40% of households) | 1.00 | 1.04 | 1.37 | 2.15 | 1.38 | 2.17 |
| Disposable income_HH3 (2015=1) (30% of households) | 1.00 | 1.01 | 1.29 | 1.92 | 1.30 | 1.93 |
| Disposable income_HH4 (2015=1) (richest 10% of households) | 1.00 | 0.98 | 1.23 | 1.80 | 1.23 | 1.80 |

Priority short-term policies and actions

- Resuming policies successfully adopted in the recent past (2004-2012) to sharply reduce annual deforestation rates: both command-and-control and economic instruments.
- Developing smart financial mechanisms to foster the funding of investments in mitigation actions, and mainly in forest cover restoration and low-carbon infrastructure.
- Carbon Pricing: provide a long-term, stable signal to induce economic agents to choose low-carbon technologies through a well-structured cap-and-trade scheme for Industry and a carbon tax on other sectors. A significant share of avoided emissions can be obtained at negative or very low costs.
- Relying in the AFOLU sector to reduce and capture the largest share of emissions in the first half of the century to get close to net-zero target by 2050 helps to reduce overall costs for Brazil and provides sufficient time for disruptive technologies to be economically viable.
- Substantial support of Annex I countries to foster financial flows targeted at mitigation actions in non-Annex I countries, including both the climate finance tools within UNFCCC (GCF, SDM) and international financial initiatives to channel private capital to low-carbon investments: key enabler of de-risking low carbon projects

Investments patterns for DDS pathways

➤ A significant share of avoided emissions can be obtained at negative or very low costs. Costs for a given mitigation option may vary throughout the three decades due to increasing economies of scale and variations in cost assumptions (e.g., decreasing costs for electric vehicles and renewable electricity).

Additional mitigation investment in DDS compared to CPS, per economic sector, per decade

| Sectoral investment (USD billion) | 2021-2030 | 2031-2040 | 2041-2050 |
|--------------------------------------|--------------|--------------|---------------|
| AFOLU | 4.22 | 14.22 | 35.64 |
| Transport | 16.53 | 37.62 | 52.93 |
| Industry | 2.39 | 7.88 | 14.63 |
| Energy Supply | 0.45 | 1.47 | 4.37 |
| Waste | - | 28.09 | 39.70 |
| TOTAL | 23.60 | 89.28 | 147.26 |

Key Findings, Reflections, improvements and challenges

- **Key Findings**

- DDS is just one among many pathways for Brazil to reach climate neutrality by 2050.
 - Underlying assumption: use of available technologies only; huge mitigation potential at low costs in Brazil even before the deployment of technological “*breakthroughs*”.
 - Sharp reduction of annual deforestation rate and native vegetation restoration in public and private areas have a significant abatement potential and lower costs than mitigation actions in other sectors.
 - A pathway towards net-zero GHG emissions in 2050 can be reached with a carbon price of 25, 45 and 65 USD/t CO₂eq, respectively, in each decade.
 - DDS allows to reach carbon neutrality while keeping slightly better economic and social development results than in CPS (smart recycling of carbon pricing revenues).
- From forecasting to **backcasting**: milestones for **MRV** -> embedding climate change in routine management.
 - **Modelling**: co-benefits (SDGs), climate finance (capital costs), employment & labor market.
 - **Challenges**: Zero deforestation; International oil prices; Political acceptability.