DDP BRAZIL

DEEP DECARBONIZATION OF POWER GENERATION IN BRAZIL

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SUMMARY

The power generation in Brazil represented about 25% of the emissions of the energy supply sector in 2020, about 22MtCO_2eq. The energy supply sector integrates the emissions from oil & gas activities. As production costs remained low and competitive globally, production increased substantially and was progressively directed towards exports. GHG emissions from the energy supply are mainly due to the consumption of fossil fuels and fugitive emissions in refineries, oil & gas production platforms and pipelines. Along with thermopower generation, emissions can achieve heights in dry periods, as in the recent drought from 2015 to 2021.

Historically, power generation in Brazil relies on renewable sources. The installed capacity of the SIN (national grid) is mainly composed of hydropower plants distributed in different country regions. Wind farms have been growing in recent years, mainly in the Northeast and South

DDP

The DDP is an initiative of the Institute for Sustainable Development and International Relations (IDDRI). It aims to demonstrate how countries can transform their economies by 2050 to achieve global net zero emissions and national development priorities, consistently with the Paris Agreement. Analyses are carried out at the national scale, by national research teams. National research teams openly share their methods, modelling tools, data and the results of their analyses to share knowledge between partners in a collaborative manner and to facilitate engagement with sectoral experts and decision-makers.

About this project

The ACT-DDP research project is an international pilot project, which aims at accelerating the implementation of national and sectoral deep decarbonisation through a better dialogue between private companies and governments and for a mutual enrichment of their low-carbon strategies. Through the synergy between two pioneer initiatives, the Assessing low Carbon Transition (ACT) initiative and the Deep Decarbonization Pathways initiative (DDP), the project partners built and tested methodologies and tools for developing national and sectoral deep decarbonisation pathways compatible with the Paris Agreement and assessing company strategies with them.

This project is supported by the Fonds Français pour l'Environnement Mondial (FFEM) and by in-country French representatives such as the local French Development Agencies (AFD) and French embassies.

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regions. Thermopower plants, generally located close to the main consumption sites (southeast and south of Brazil), play an important strategic role as they contribute to the security of supply. The transmission systems integrate the different power generation sources and make it possible to supply the consumer market. Therefore, the power mix was already a very low carbon mix at 36 kgCO_2eq/MWh in 2020.

After the strong decline of the economy during the period 2015 to 2020, due to a political and economic crisis followed by the COVID-19 pandemic, the Brazilian economy has resumed growing in 2021 and the electricity consumption. It is noteworthy that almost 100% of households already have access to electricity supply. The study simulates two economy-wide GHG emission scenarios for Brazil up to 2050: the current policies scenario (CPS) and the deep decarbonization scenario (DDS) (See the paper "Deep decarbonisation in Brazil"). Both scenarios reduce the emissions of the sector and the carbon content of the power generation to 14 and 2 kgCO_2eq/MWh, respectively, in the CPS and DDS (See **Figure 2**).

POWER CONSUMPTION

Electricity consumption grows faster than overall energy consumption, from 546 TWh in 2019 up to 928-972 TWh in 2050, but end-use efficiency gains allow for a lower growth in DDS. Electricity demand is 5% lower in DDS than in CPS, mainly thanks to a higher energy efficiency in the industry sector.

POWER GENERATION

Both scenarios are based on already available technologies, and no carbon capture and storage system is envisaged. **Table 1** represents the main technological features of CPS and DDS.

Renewable energies such as hydro, wind energy and photovoltaics are the main sources to expand their installed capacity and power generation (See **Figure 4**, **Table 2**). After 2040 when the Brazilian hydropower potential will be almost fully explored, biomass will replace its role and complement wind and solar contributions. Offshore wind starts to be used by 2040 only thanks due to high initial costs. Moreover, old thermopower plants are decommissioned and replaced by renewable power plants (wind, solar photovoltaic and biomass) due to their lower costs in both scenarios.

Regarding natural gas, it still plays an important role in CPS in dispatchable power generation for grid stability. While in DDS, the development of large intermittent renewable capacities is made possible by increasingly

Figure 1. GHG Emissions

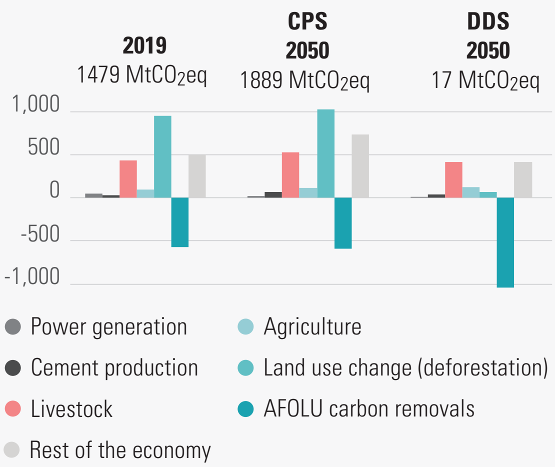
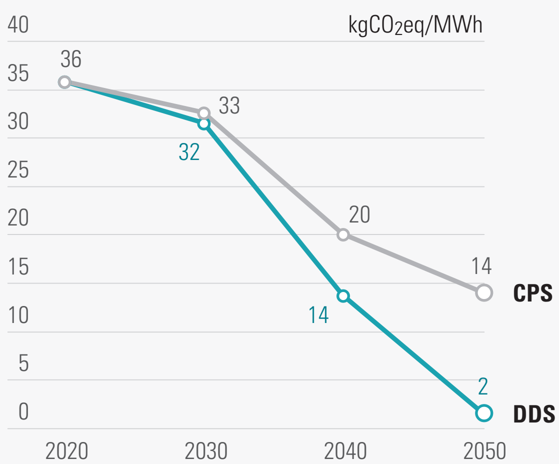


Figure 2. Carbon content of generation



using hydropower generation and batteries to ensure grid operation flexibility.
Losses incurred during energy transport activities (transmission losses) remained almost constant, at around 15%, in both scenarios.

Table 3. Transmission losses

Losses	2010	2020	2030	2040	2050
CPS (%)	16%	17%	15%	15%	15%
DDS (%)	16%	17%	15%	15%	15%

Table 1. Main technological features of CPS and DDS

	CPS	DDS
Nuclear	Angra III reactor (1405 MW) : 2026; Angra I (640 MW) reaches the end of lifetime in the period	
Fossil thermopower plants (TPP)	TPP Diesel and Fuel Oil: total decommissioning in 2045	
	TPP Natural Gas: expansion during the study horizon	TPP NG: no expansion beyond what was already contracted through New Energy Auctions, as of today
Renewables	Equal expansion constraints in both Scenarios	
New technologies	-	Offshore wind from 2040 onwards, reaching 3GW in 2050

Table 2. Power generation

Source	Data	CPS (TWh)				DDS (TWh)			
	2015	2020	2030	2040	2050	2020	2030	2040	2050
Coal	19	14	14	7	0	14	14	7	0
Oil products and other non renewable	25	0	2	2	3	0	0	0	0
Natural gas	79	24	31	28	33	24	30	15	0
Nuclear	15	14	27	22	21	14	25	23	20
Hydro	360	441	548	630	628	441	538	621	629
Wind	22	64	92	128	193	64	92	132	197
Solar	0	9	25	47	126	9	25	48	129
Biomass	47	45	53	85	112	45	49	68	94
TOTAL	567	612	793	950	1117	612	774	915	1068

Figure 3. Electricity demand

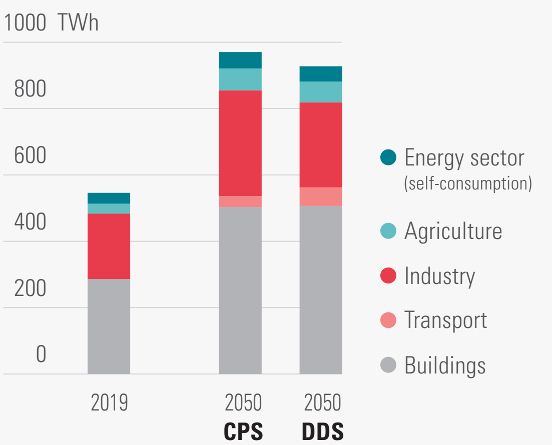
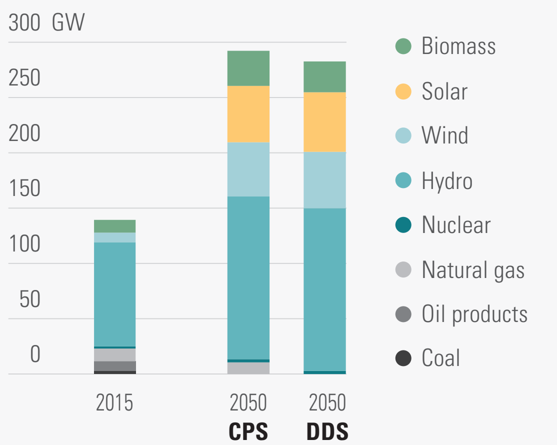


Figure 4. Installed capacity



OPPORTUNITIES TO DECARBONIZE EVEN FURTHER THE POWER SECTOR

- Strengthen the Northeast-Southeast transmission link to support the flow of solar and wind energy to the Southeast region
- Advanced specific regulation of offshore wind energy
- Establish minimum performance standards for photovoltaic energy, including improvements in connection to distribution networks.
- Encourage hydropower repowering measures.
- Valuing the socio-environmental and economic attributes of the hydro-powerplants
- Advance the technical, economic, and environmental feasibility studies and tap the potential fr deployment of reversible hydropower plants or water pumps.
- Ensure the purchase of excess energy from biomass-fired power plants
- Invest in R, D & I of new technologies (Hydrogen, Smart grids, others)
- Ensure the payment for ancillary services (storage using reversible hydropower, batteries and other technologies)