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Géremi Gilson Dranka, Paula Ferreira

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# Planning for a renewable future in the Brazilian power system

*Gérémi Gilson Dranka<sup>a,b</sup>, Paula Ferreira<sup>c</sup>*

<sup>a</sup> ALGORITMI Research Center, University of Minho, Guimarães, Portugal, [geremidranka@gmail.com](mailto:geremidranka@gmail.com)

<sup>b</sup> Department of Electrical Engineering, Federal University of Technology (UTFPR), Paraná, Pato Branco, Brazil

<sup>c</sup> ALGORITMI Research Center University of Minho, Guimarães, Portugal, [paulaf@dps.uminho.pt](mailto:paulaf@dps.uminho.pt)

## Abstract:

The Brazilian electricity system is an important example of a large country relying on a high renewable energy matrix with a major focus on hydropower, which has historically allowed for low carbon electricity production. However, the increase in the demand and climate change impacts on the availability of these renewable resources represent important challenges for long-term power planning. The contribution of this paper is twofold: Firstly, a first attempt to use the EnergyPLAN model for the analysis of the Brazilian electricity sector and in particular to study future scenarios is presented. Secondly, the possibility of achieving a 100% RES system is also addressed. The 100% RES scenario is found to be theoretically possible but a substantial increase in the overall installed capacity would be required, to support the grid mainly during the spring and summer season. The results underline the importance of seasonal complementarity of hydro and wind power and reveal how an increase in RES would add exportation potential, reducing also the Brazilian external energy dependency. The study identifies risk factors for these high RES scenarios and outlines several avenues for future research to address cost, environmental and technical uncertainties of the system.

## Keywords:

Brazilian Electricity Sector, Energy System Analysis, EnergyPLAN, Renewable Energy.

## 1. Introduction

The share of Renewable Energy Sources (RES) has increased substantially in the energy mix of developed and emerging countries as is the case of Brazil. This trend is expected to continue in the future, primarily aiming for the reduction of Greenhouse gas (GHG) emissions and mitigation of climate impacts [1]. The growth of energy consumption is also a common characteristic of most developing nations, including Brazil. Therefore, the prospects for achieving a sustainable energy system have been considered widely in literature and each year new studies are being published addressing different perspectives such as technological development, climate change and demand projections. RES to power is seen as a fundamental strategy to reach these sustainability goals, notwithstanding, there are several technical and economic challenges to be surpassed in order to achieve a high share of RES integration [1].

The proper construction of future scenarios for the electricity sector is fundamental to subsidize the government decision-making process. On the other side, the risks and uncertainties had increased in short, medium and mainly in the long-term [2]. Specifically, for the long-term generation expansion planning, the challenges are even greater primarily due to the characteristics inherent to the sector in which such decisions need to be made in advance. Energy planning is considered a complex issue that involves many factors and there can be no one size fits all solution, given the different challenges facing each country. This energy planning exercise will then result in a large discrepancy of scenarios, which depend on factors as cultural, economic and political ones, among others [3]. Regardless of this diversity of options and difficulties, scenario planning is fundamental for both policy making and the development of business strategies, mainly those relating to investments.

There are several challenges in the scenario's construction, especially for long-term planning. One of the main difficulties is to predict the behaviour over time of energy technologies that currently may not be feasible on a large scale or are not yet available. The definition of consistent hypotheses and the proper problem delimitation are also essential to achieve real and relevant scenarios.

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