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Levelized cost analysis of thermoelectric generation in Brazil: A comparative economic and policy study with environmental implications.

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ABSTRACT

A comprehensive economic comparison between the most commonly employed thermoelectric technologies in Brazil, such as natural gas, coal, biomass, and fuel oil is of great relevance for an assessment of the electricity mix status and potential. Multiple scenarios were evaluated through the application of a modified levelized cost of electricity (MLCOE), obtaining the overall thermoelectric generation cost in the country, given its specificities, the market, and other relevant issues. Moreover, the analysis of the produced data combined to an additional indicator, the levelized avoided cost of electricity (LACE), provides an extensive view of economic, environmental, and infrastructural aspects. The major modifications in the traditional LCOE methodology were the introduction of the cost of leakage in the natural gas production chain, the transmission costs, and the fuel prices analysis for the different technologies involved. Additionally, the recent discoveries of large gas reservoirs in the Brazilian ultra-deep waters, on the coast of Sao Paulo, the largest electricity market in South America, show a promising scenario, along with strategic investment and adequate policy, for a sustainable transition in the electricity mix of Brazil. This transition should occur through the use of natural gas-fired power stations, as part of strategic planning to avoid the shortage of electricity supply. In this context, results indicated that natural gas-fired generators are very competitive and efficient, in both economic and environmental aspects, when compared to other thermoelectric technologies, even when externalities such as leakage, transmission, and carbon costs were considered. In addition, this study concluded that the natural gas leakage has the same impact as the CO₂ emissions from combustion, when the percentage of leakage goes beyond 4.0% on a mass basis. Above this percentage, the impact of the CH₄ leakage begins to surpass that of CO₂, to a level in which natural gas becomes as greenhouse gas intensive as biomass.

Keywords: thermoelectric power, natural gas, levelized cost of electricity, levelized avoided cost of electricity, Brazil, methane leakage.

Nomenclature

| | | | |
|-------------|--|-------------|----------------------|
| Q_{MW} | quantity of electricity generated in MWh in the year t | C_{fuel} | cost of fuel |
| P_{MW} | constant price of electricity sold in the year t | C_{inv} | cost of investment |
| TR_t | total revenue in year t | C_{eqCO2} | cost of emissions |
| TC_t | total costs in year t | C_{trans} | cost of transmission |
| C_{op} | cost of operations & management | C_{leak} | cost of leakage |
| P_{fuelX} | price of fuel for a given scenario X | i | discount rate |

1. Introduction

The electricity sector of Brazil includes a large group of stakeholders who provide services through distinct electricity generation, transmission, and distribution for different classes of final customers (Table 1). It also includes several governmental agencies that regulate the sector. In 2015, there were 4,520 electric utilities

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