

# 167ª DEFESA DE DISSERTAÇÃO EM ENGENHARIA INDUSTRIAL - MAEI

## PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA INDUSTRIAL - PEI



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**Título:** “Optimizing Microgrid Design and Operation in Brazil: A Decision-Making Framework for Residential Distributed Energy Systems”.

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#### Resumo:

Distributed Energy Systems (DES), also known as microgrids, from renewable energy sources were conceived as a way to reduce the emission of polluting gases into the atmosphere and have become a major incentive for self-producers of energy. Although Brazil has a large availability of natural resources, which creates a strong potential for the application of microgrids based on renewable energy sources such as solar, wind, and biomass, it is still little explored in relation to other countries. This study aims to bridge the gaps in the current literature regarding microgrid design by addressing the impact of energy demands in the sizing of a microgrid and climate on renewable resource efficiency. The study pioneers the application of biogas to all residential energy demands in a microgrid and offers a new approach to analyzing the effects of varying input variables over time in an on-grid microgrid. Therefore the study proposes a decision-making framework for designing and operating residential DES in Brazil, based on mixed-integer nonlinear programming (MINLP) models that take into account the particularities of the country, such as the availability of various renewable resources and the impact of COVID-19 on energy demand. The models optimize the cost of designing and operating a microgrid with integrated pipelines and consider the varying efficiency of different technologies over time, as well as different options for renewable incentive policies. Additionally, it proposes a systematic, cluster-based method to split the time horizon of the model, allowing for a more accurate representation of the dynamics of the input variables of the optimization problem such as energy demand, wind speed, and solar irradiation over time. The framework is tested on a case study of a residential DES of 5 and 10 houses in Salvador, Brazil, comparing pre- and post-COVID-19 scenarios. The results show that the use of distributed energy resources has turned out to be economically and environmentally advantageous compared to using only non-renewable resources. The study also demonstrates the economic viability of using biogas and the new energy trends emerging during the pandemic, and how this impacts the sizing of microgrids. By not considering time-dependent efficiency in the analysis, there may have been a positive impact on the economic gain of around 90% in relation to the baseline scenario, but it may also have contributed to the underestimation of power generation. Also, although the empirical method showed a greater reduction in environmental costs (60%), the clustering method had a greater reduction (80%) in total costs. This highlights the relevance of the innovative approaches utilized in the optimization problem for designing a microgrid.

**Palavras-chaves:** Distributed Energy Systems (DES); Microgrid; MINLP; Clustering.