



Cost-benefit analysis of net-zero emissions in the Brazilian power system



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Context

➤ COP21 - PARIS 2015



PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

➤ Nationally Determined Contribution (NDC)

- Reduction targets from the Brazilian NDC of 2015:
 - A 37% reduction by 2025 compared to 2005.
 - A 43% reduction by 2030 compared to 2005.

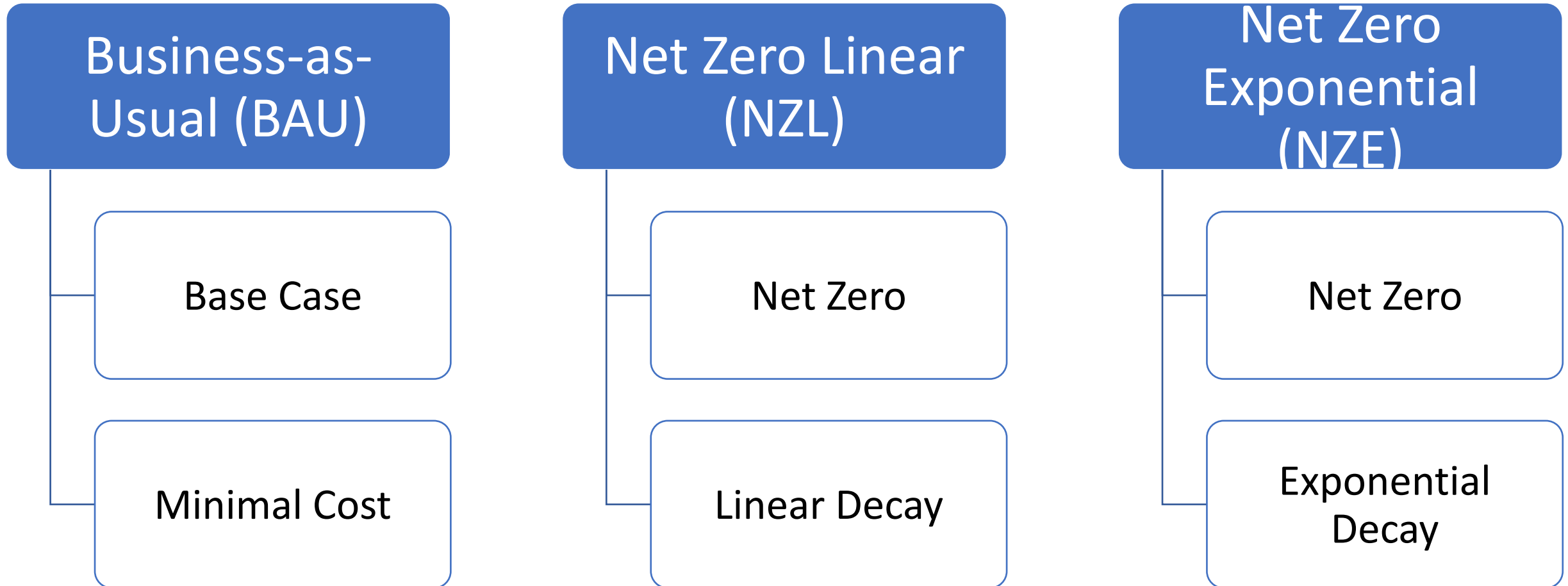
- Additional commitment in 2021:
 - A 50% reduction by 2030 compared to 2005.
 - Net Zero emissions by 2050

Research Questions

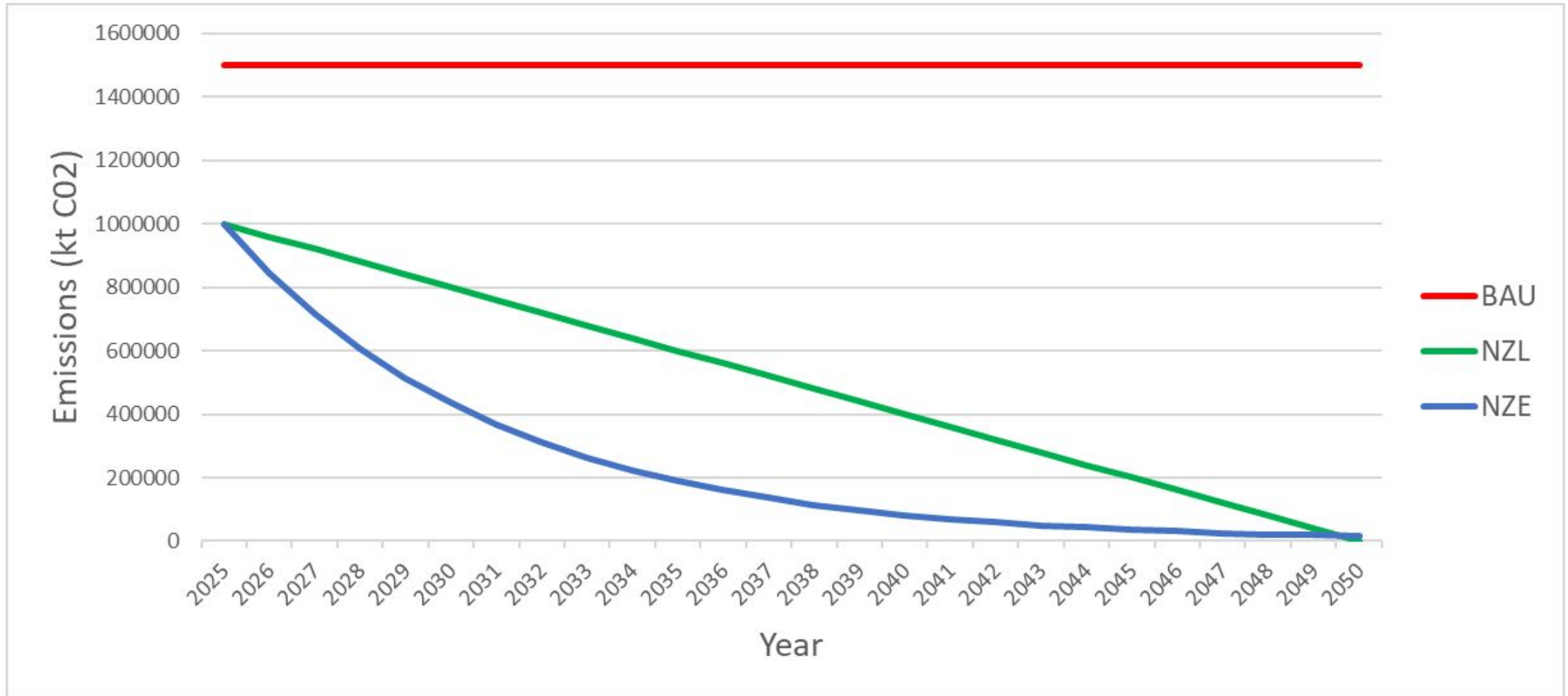
- 1) How does the Net Zero scenario influence Brazil's energy matrix?**
- 2) What are the benefits of a Net Zero scenario?**
- 3) Which Net Zero scenario is more cost-effective, and which one has the lowest cumulative emissions at the end of the planning?**

Scenarios

OSeMOSYS used to evaluate the following scenarios:

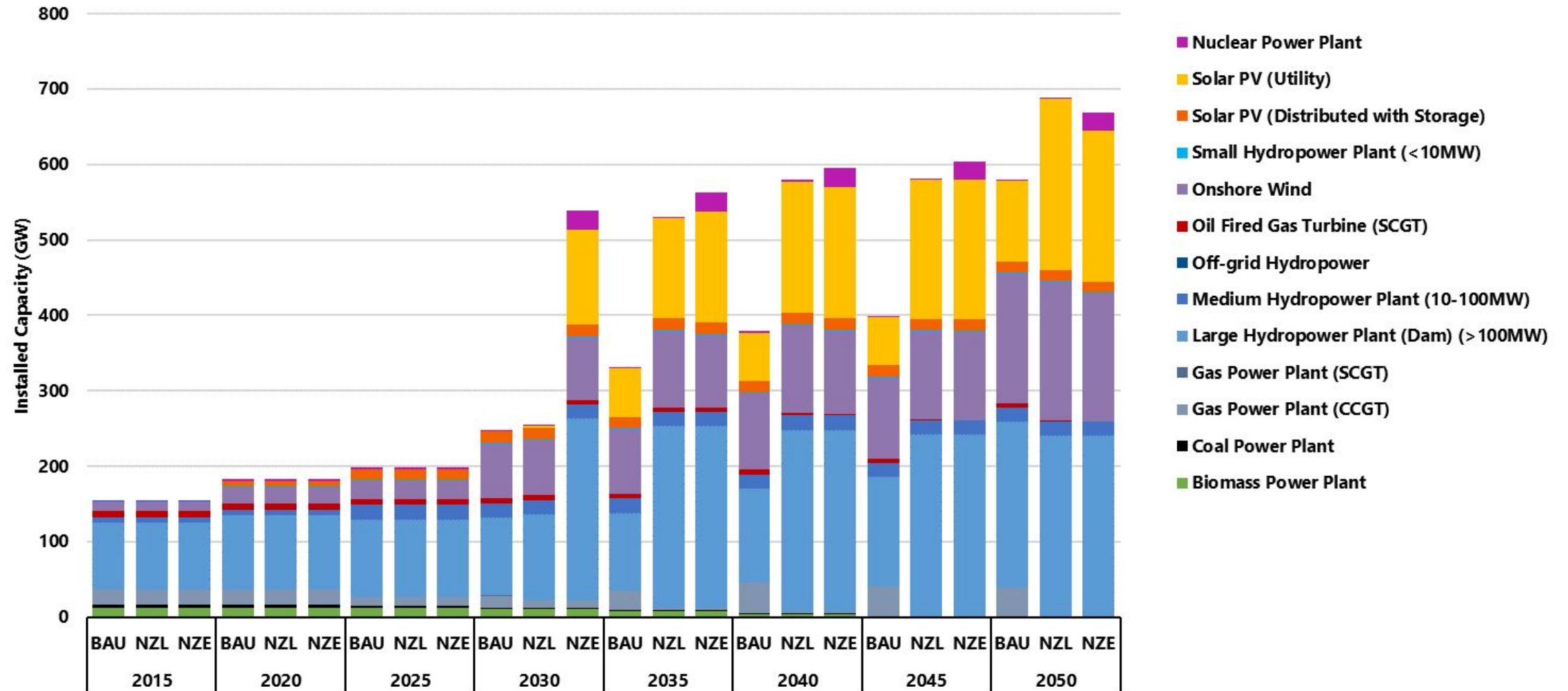


Annual Emissions Limit



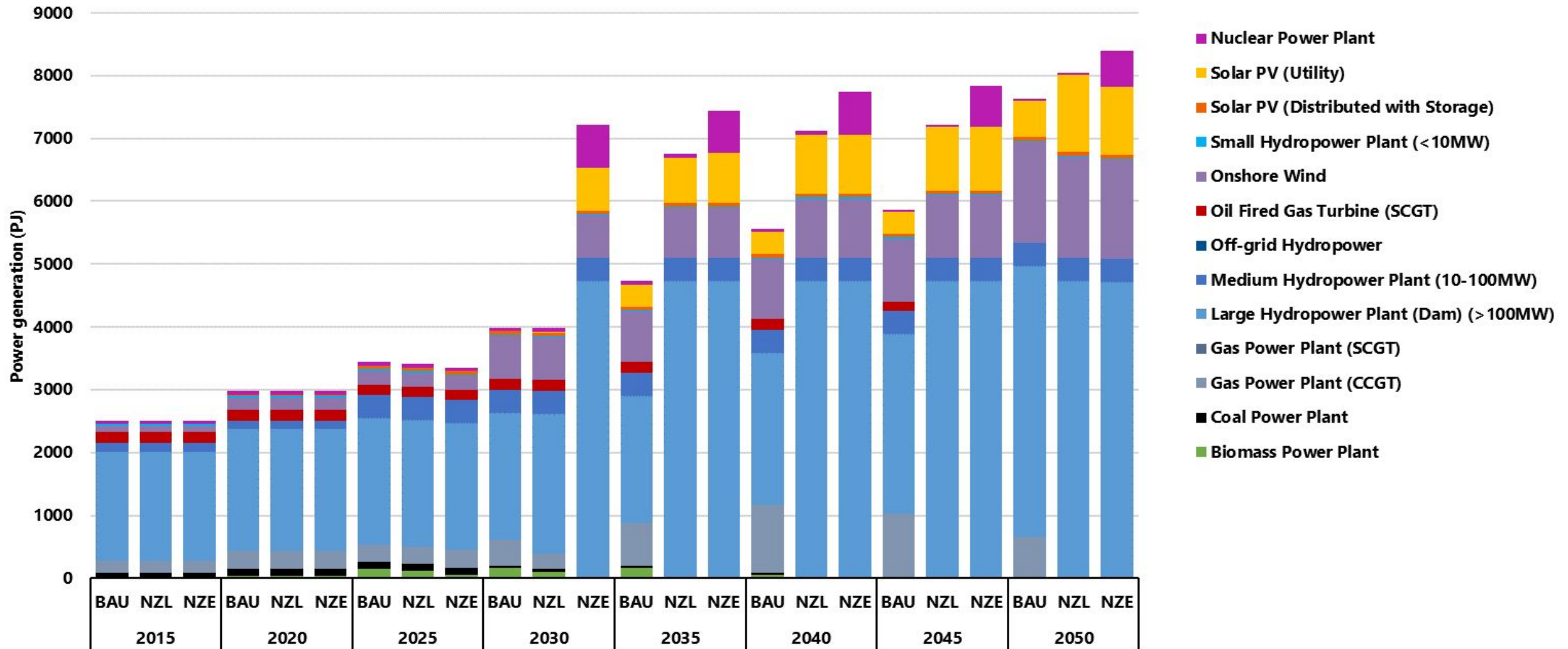
Source: Authors

Installed Capacity | Brazil



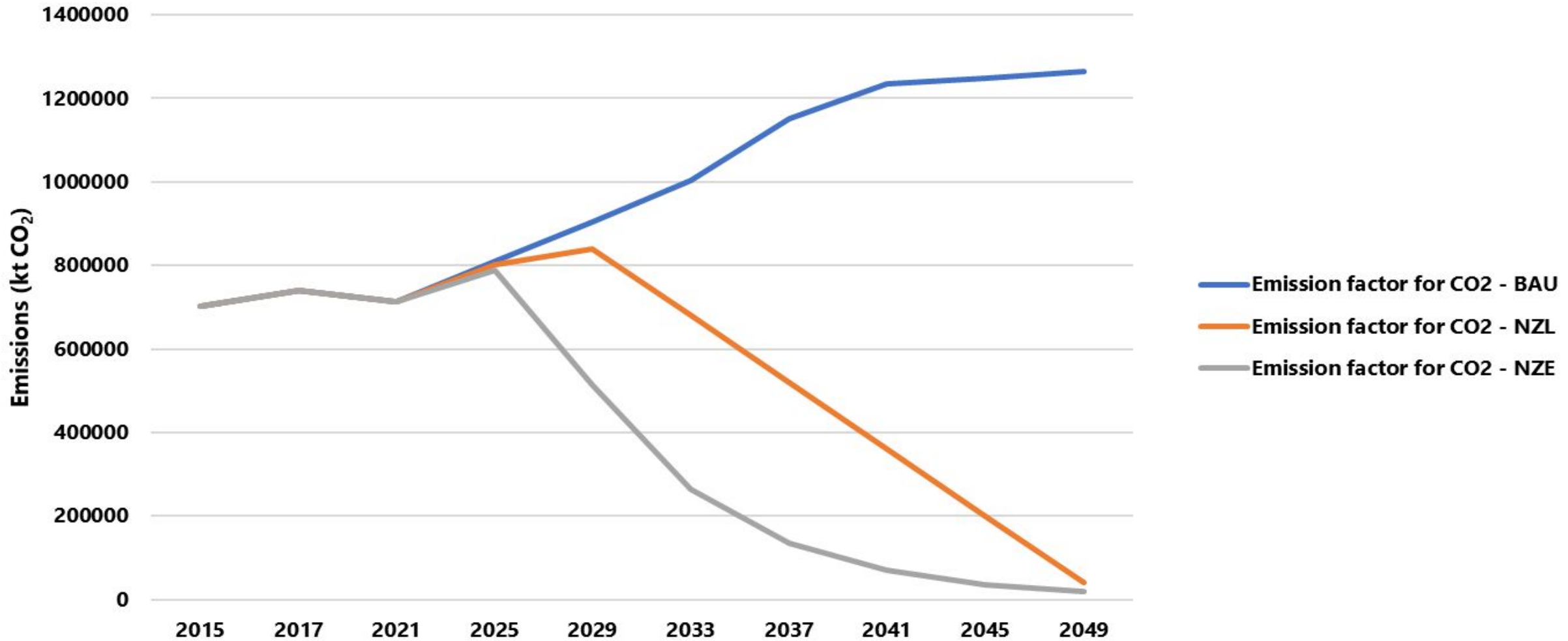
Source: Authors

Power Generation | Brazil



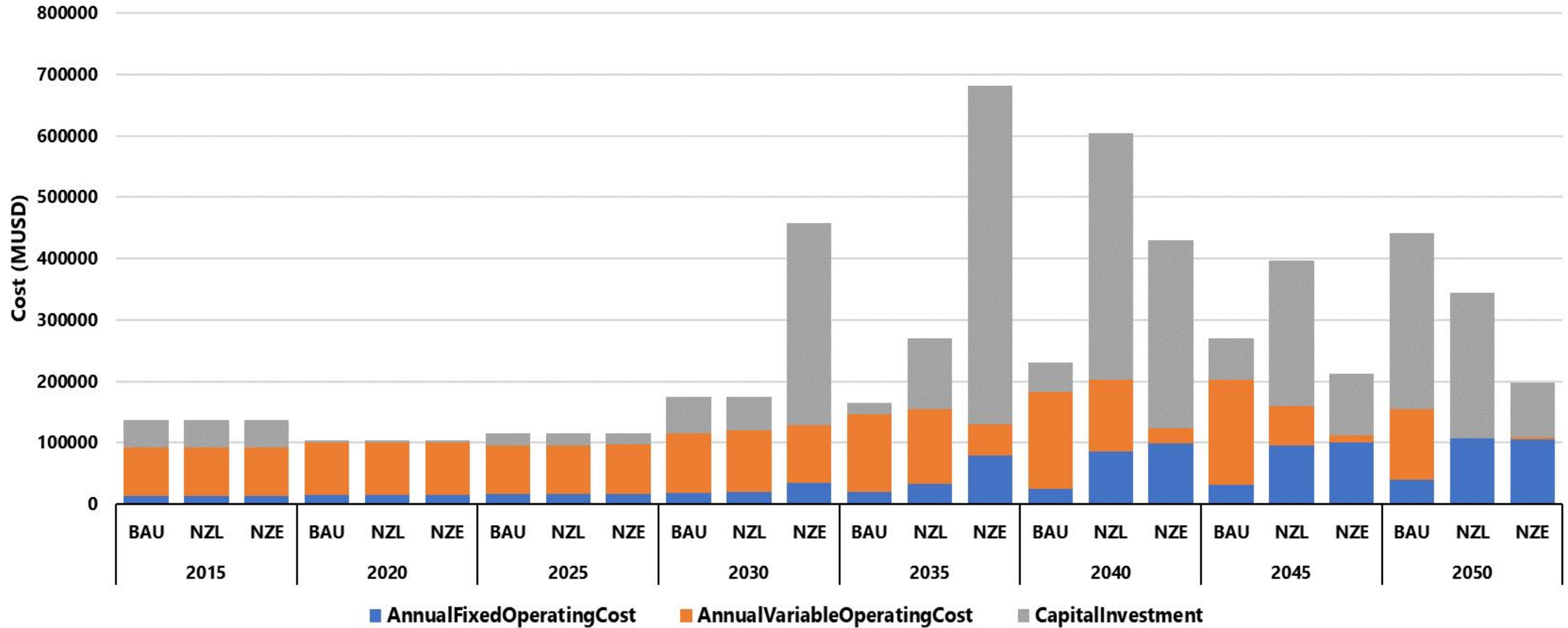
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Annual Emissions | Brazil



Source: Authors

Annual Costs | Brazil



Source: Authors

Conclusions and Policy Insights

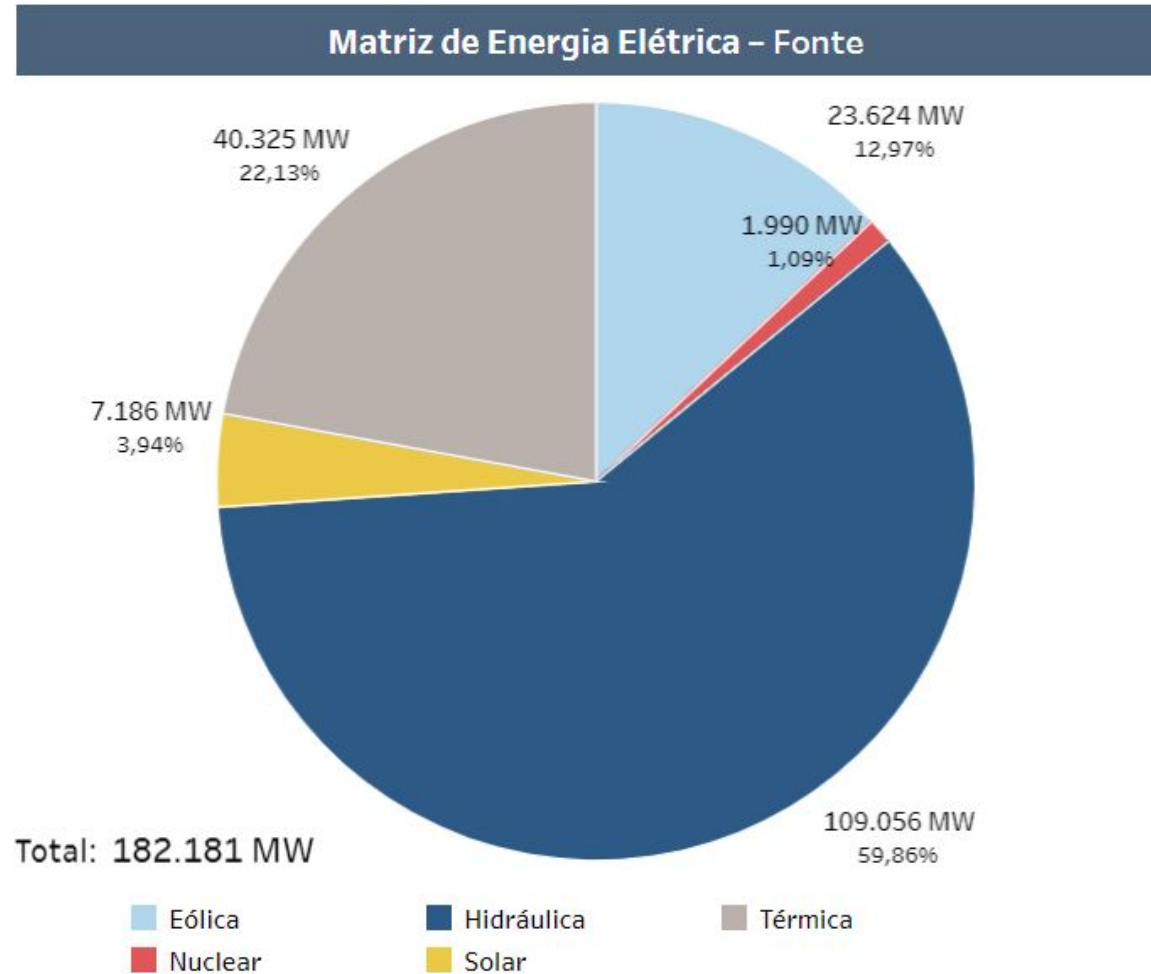
- Net Zero policies encourage the increase of renewable generation in the Brazilian matrix, such as solar and wind.
- Both Net Zero policies have proven effective in reducing CO2 emissions.
- The implementation of Net Zero policies requires a significant annual increase in investment.
- In the long term, Net Zero scenarios have lower annual costs than the base case.
- The linear emissions limitation policy has proven to be more economical than the exponential one.
- The exponential emissions limitation policy is the one that generates the lowest amount of CO2 emissions.

References

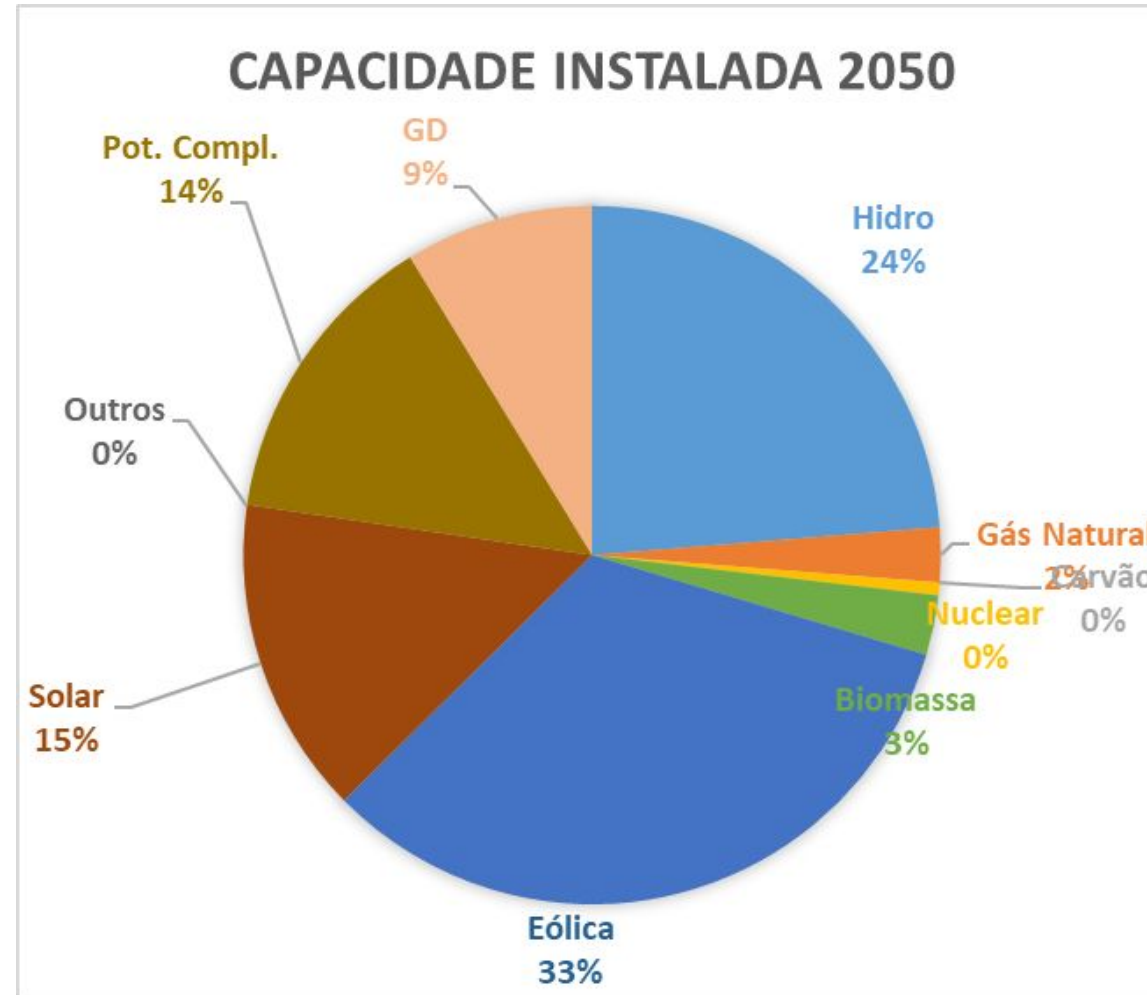
- [1] Borba, Bruno, et al. "Integrated Long-Term Expansion Planning and Short-Term Operation Assessment for Decarbonisation Pathways in Brazil Considering Utility-Scale Storage." (2023).
- [2] Plazas-Niño, Fernando, et al. "Informing Sustainable Energy Policy in Developing Countries: An Assessment of Decarbonization Pathways in Colombia Using Open Energy System Optimization Modelling." (2023).
- [3] Sobre o SIN: o sistema em números, Operador do Sistema Nacional ONS, Brazilian government, accessed 10 August 2023, <<https://www.ons.org.br/paginas/sobre-o-sin/o-sistema-em-numeros>>.
- [4] Plano Nacional de Energia - 2050, Empresa de Pesquisa Energética EPE, Brazilian government, accessed 10 August 2023, <<https://www.epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/Plano-Nacional-de-Energia-2050>>.
- [5] Neutralidade de carbono até 2050: Cenários para uma transição eficiente no Brasil, Centro Brasileiro de Relações Internacionais CEBRI, Brazilian government, accessed 10 August 2023, <<https://www.cebri.org/br/doc/309/neutralidade-de-carbono-ate-2050-cenarios-para-uma-transicao-eficiente-no-brasil>>.
- [6] Wang, Pei, et al. "Estimates of the social cost of carbon: A review based on meta-analysis." Journal of cleaner production 209 (2019): 1494-1507.

Thank You!

Electric Power Matrix 2022 - National Energy Balance 2022 by ONS



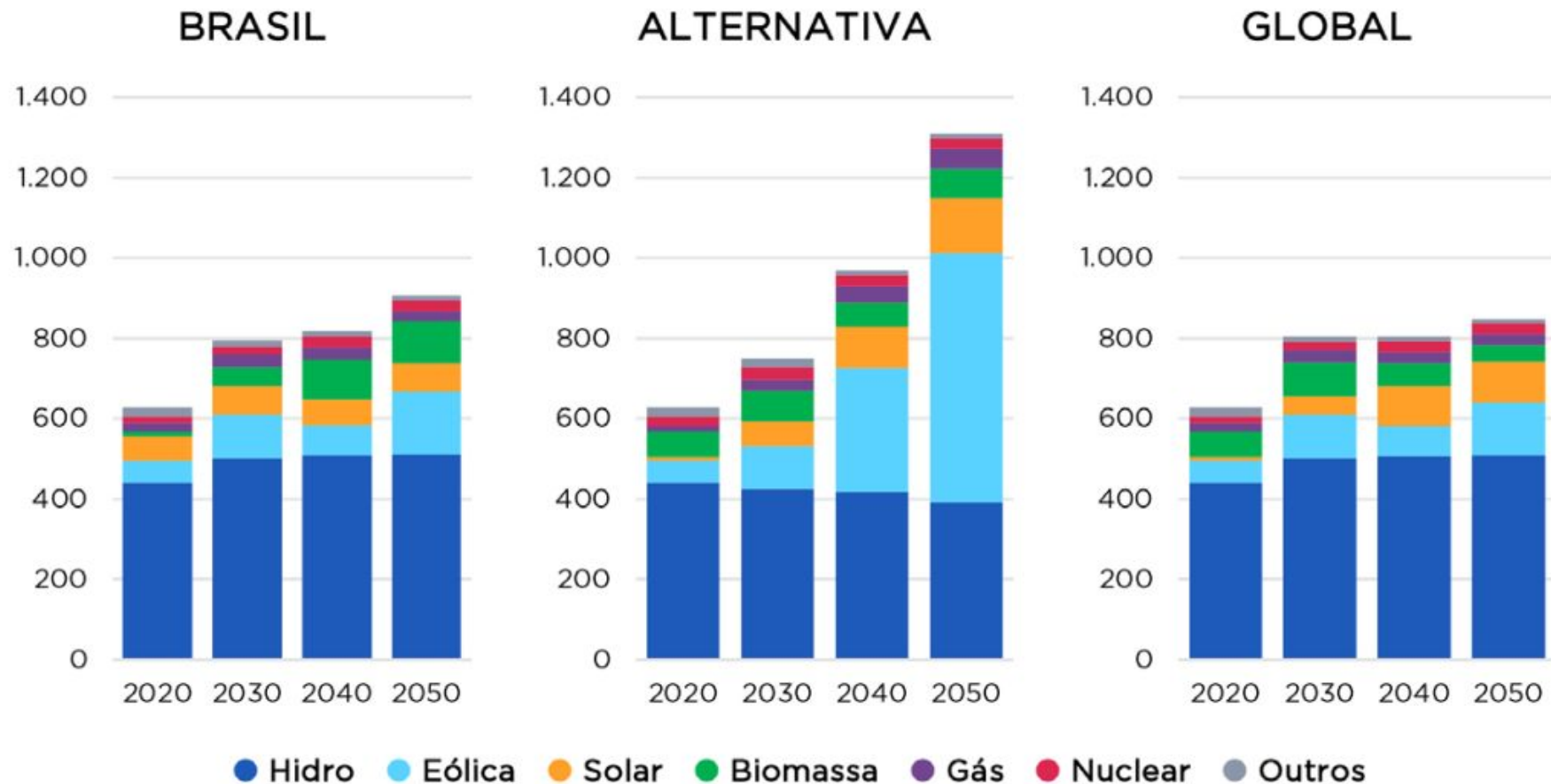
Electric grid expansion based on non-GHG emitting technologies - National Energy Plan 2050 by EPE



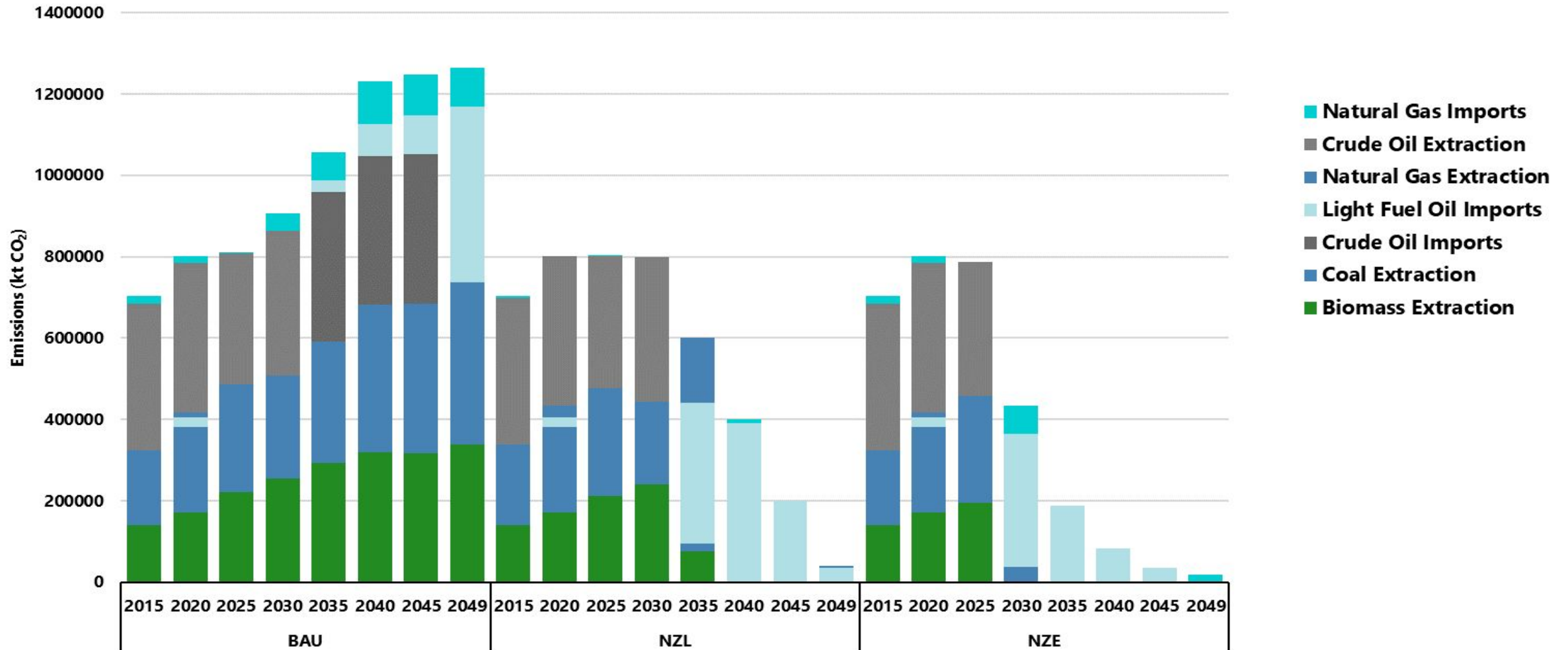
Carbon neutrality by 2050: Scenarios for an efficient transition in Brazil

GRÁFICO 11

GERAÇÃO DE ELETRICIDADE POR FONTE E CENÁRIO (TWH/ANO)



Annual Emissions by Source | Brazil



Source: Authors

Total cost

Scenario	Total Cost (\$)	Relative BAU (%)
BAU	1,268,620	+0.00
NZL	1,664,203	+31.18
NZE	2,162,336	+70.45

- The socioeconomic assessment considers capital cost, operational cost, carbon taxes, and externality costs [2].
- The results obtained in this study do not include carbon taxes and external costs.
- A BAU scenario will result in high externality cost (linked to health and global warming effects). In this scenario, the costs of the Net Zero scenarios become more affordable.

Total cost - 54.70\$/tCO2 [6]

Scenario	Total Emission (kt CO2)	Total Cost (Bi \$)	Relative BAU (%)
BAU	34,778,509	190.139	+0.00
NZL	20,089,135	109.803	-42.24
NZE	13,676,036	74.700	-60.68

Net-Zero Strategies

Emission Control Measures:

- (a) Implementing emissions penalties.
- (b) Adjusting emission cost parameters – increase.
- (c) Limiting annual emissions.

Prioritizing High-Variability Renewables (Solar and Wind):

- (a) Emphasizing the expansion of high-variability renewables (solar and wind).
- (b) Tweaking the cost parameters of these technologies – decrease.
- (c) Establishing an annual percentage target for the utilization of high-variability renewable sources.