

MULTICRITERIA GENERATION AND TRANSMISSION EXPANSION PLANNING IN PARAGUAY

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ABSTRACT

The purpose of this research is to develop a methodology using welfare economics expanded with multi attribute decision making for portfolio selection of renewable sources in Paraguay's regulated hydroelectric market. This approach considers expansion planning of the Paraguayan Interconnected System (SIN), including generation, transmission, and 2016 Paraguay's Energy Policy. This optimization of the generation expansion problem involves a study period from 2017-2040 with a 9.84% per year increase demand rate. First, it includes modeling the SIN using Stochastic Dynamic Dual Programming (SDDP), a probabilistic hydrothermal operation cost optimizer. Base on this Base Case, generation expansion is needed after 2026. Using the Optimization Expansion-Operation Module (OPTGEN-SDDP) software to solve the Expansion Case Optimization, after 2029 the transmission system cannot sustain the demand increase. By 2040, the new installed capacity needed is 26,900 MW. Also by 2040, there is a need for 13,571 MVA transmission expansion to connect mostly South systems to the Metro system. At 2014 prices, the transmission expansion would be at a cost of \$ 7.4 million per MVA of installed capacity (3% of new generation total cost). Finally, a simple mix-integer linear optimization formulation is implemented outside the OPTGEN-SDDP Module. The multicriteria expansion problem is analyzed using a utility function to consider socio-economical, technology and environmental criteria of Energy Policy interest. The result is then incorporated back to the OPTGEN-SDDP Module. Analyzing a sustainability index for each case, in all cases the Net Importer index has a decreasing trend in the period of study. Furthermore, due to transmission constraints, the Reliability index cannot be improved without transmission expansion in any study case. The resultant generation portfolio in both expansion problems includes 26% Solar Generation, and is in line with Paraguay's Energy Policy of diversification of the energy matrix.

Defining "viable energy source" as an existing resource, cost effectively, and inside energy policy considerations, small hydro and solar generation sources are a viable alternative to build an electricity generation portfolio mix for the Paraguayan Electricity market. That is concluded using a welfare economics optimization, but also by extending the OPTGEN-SDDP module applying a multi attribute decision making approach.

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