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Stochastic Approach for Technical-Economic Viability Analysis of Electricity Generation Projects with Natural Gas Pressure Reduction Turbines

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Abstract : Nowadays, society is working toward reducing energy losses and greenhouse gas emissions, as well as seeking clean energy sources, as a result of the constant increase in energy demand and emissions. Energy loss occurs in the gas pressure reduction stations at the delivery points in natural gas distribution systems (city gates). Installing pressure reduction turbines (PRT) parallel to the static reduction valves at the city gates enhances the energy efficiency of the system by recovering the enthalpy of the pressurized natural gas, obtaining in the pressure-lowering process shaft work and generating electrical power. Currently, the Brazilian natural gas transportation network has 9,409 km in extension, while the system has 16 national and 3 international natural gas processing plants, including more than 143 delivery points to final consumers. Thus, the potential of installing PRT in Brazil is 66 MW of power, which could yearly avoid the emission of 235,800 tons of CO2 and generate 333 GWh/year of electricity. On the other hand, an economic viability analysis of these energy efficiency projects is commonly carried out based on estimates of the project's cash flow obtained from several variables forecast. Usually, the cash flow analysis is performed using representative values of these variables, obtaining a deterministic set of financial indicators associated with the project. However, in most cases, these variables cannot be predicted with sufficient accuracy, resulting in the need to consider, to a greater or lesser degree, the risk associated with the calculated financial return. This paper presents an approach applied to the technical-economic viability analysis of PRTs projects that explicitly considers the uncertainties associated with the input parameters for the financial model, such as gas pressure at the delivery point, amount of energy generated by TRP, the future price of energy, among others, using sensitivity analysis techniques, scenario analysis, and Monte Carlo methods. In the latter case, estimates of several financial risk indicators, as well as their empirical probability distributions, can be obtained. This is a methodology for the financial risk analysis of PRT projects. The results of this paper allow a more accurate assessment of the potential PRT project's financial feasibility in Brazil. This methodology will be tested at the Cuiabá thermoelectric plant, located in the state of Mato Grosso, Brazil, and can be applied to study the potential in other countries.

Keywords : pressure reduction turbine, natural gas pressure drop station, energy efficiency, electricity generation, monte carlo methods
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