Optimizing the insertion of renewables in the Colombian power sector

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Overview

Colombia is rich in natural resources and greatly focuses on the exploitation of water for hydroelectricity purposes. About 65% percent of its power capacity comes from large hydropower facilities, while the remaining 35% from fossil-based technologies. Alternative cleaner energy sources, such as solar and wind power, have been largely neglected despite: a) its abundance, b) the complementarities between hydro, solar and wind power, and c) the cost competitiveness of renewable technologies. The current limited mix of energy sources creates considerable weaknesses for the system, particularly when facing extreme dry weather conditions, such as El Niño event. In the past, El Niño have exposed the truly consequences of a system heavily dependent on hydropower, i.e. loss of power supply, high energy production costs, and loss of overall competitiveness for the country. Nonetheless, it is expected that the participation of hydroelectricity will increase in the near future.

Methodology

This paper proposes a stochastic lineal programming model to optimize the insertion of renewable energy systems (RES) into the Colombian electricity sector. The model considers cost-based generation competition between traditional energy technologies and alternative RES, solar and wind power. This work evaluates the financial, environmental, and technical implications of different combinations of technologies. Various scenarios regarding the future evolution of costs of the technologies are considered in order to conduct sensitivity analysis of the solutions – to assess the extent of the participation of the RES in the Colombian power sector.

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Results

Optimization results indicate that, even in the worst-case scenario, where costs remain constant, the Colombian power sector should diversify its portfolio of technologies and invest strongly in solar and wind power technologies.

Conclusions

The diversification through RES will contribute to make the system less vulnerable to extreme weather conditions, reduce the overall system costs, cut CO_2 emissions, and decrease the chances of having national blackout events in the future. In contrast, the business as usual scenario indicates that the system will turn more costly and less reliable.

***Keywords*—** Energy policy and planning, stochastic programming, water management, sustainable development.