Master's Thesis

Modelling Colombia's Energy System: The Role of Renewable Energy in Achieving Colombia's Emission Targets

Modellierung des kolumbianischen Energiesystems: Die Rolle Erneuerbarer Energien für das Erreichen von Kolumbiens Klimazielen

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Abstract

Colombia is facing the challenge of decreasing its reliance on hydropower and diversifying its energy mix to secure a reliable energy supply. Additionally, Colombia also needs to provide the country with affordable clean energy, leading to the intended 20% reduction of its greenhouse gas emissions and the achievement of set Intended National Determined Contribution targets by 2030. In order to determine the development of Colombia's energy system and to quantify if emission targets can still be met, this master's thesis applies the integrated assessment model MESSAGE and reproduces the Colombian energy system in a country-level version, namely MESSAGEix Colombia. Further, it evaluates most relevant scenarios in addressing the mentioned challenges and explores options for the least-cost decarbonization while satisfying projected demand until 2050.
Results propose that Colombia is most likely to fail set emission targets by more than 20%. Emission trajectories and thus demand significantly depends on the political incentive scheme. The suggested stand-alone carbon tax must be above 35 USD per ton of CO_2-equivalent to still be aligned with defined emission mitigation goals. Without carbon pricing, the end-use sectors heavily rely on fossil fuels. When imposing emission boundaries, natural gas power plants, including carbon capture and storage, become relevant, compete with zero-carbon renewables and replace coal and biomass usage. Renewables are identified as already cost-competitive and especially onshore and offshore wind potential is exploited. When the share of renewable energy increases, results indicate that the full load hours of gas power plants simultaneously decrease. This master's thesis suggest that set emission targets can still be achieved but only when the required measures will be implemented.