

Clustering electricity market dynamics with hidden Markov models

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This study presents the generalized normal distribution hidden Markov model (GND-HMM) with both unconstrained and constrained parameters. Specifically, the parameters are constrained to be equal across the k -th state-dependent distributions. The model is applied to daily electricity price returns in the northern Italian (day ahead) market to identify periods of turmoil between 2020 and 2023. The GND-HMM successfully identifies electricity market regimes and important aggregate events like the Covid-19 pandemic and the Russia-Ukraine conflict. Another target of this study is to investigate the relationship between the detected turmoil periods and the time series of CO_2 emissions in the northern Italian electricity market. Periods of high volatility in the electricity market often lead to changes in marginal electricity generation. For instance, during times of high demand or supply disruptions, there may be increased reliance on power plants that emit higher levels of CO_2 compared to cleaner sources like natural gas or renewables.

Keywords: hidden Markov models, generalized normal distribution, electricity prices, CO_2 emissions.

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