Powering Energy Security: Unleashing Renewables for Resilience in a World of Uncertainty

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Extended abstract:

Overview:

In the context of geopolitical conflicts, the energy systems of affected countries can be subject to numerous destabilizations. Disruptions in the import and export of energy commodities, caused by economic sanctions in the concerned countries, can have severe economic consequences and jeopardize the energy security of importing countries. More broadly, these events can also lead to destabilizations and price fluctuations on the energy markets and those that are strongly interconnected to them. Consequently, the energy security of the concerned countries, as well as that of countries reliant on their electricity supply, is often compromised. These conditions may affect consumption patterns, underscoring the need to explore how consumers are impacted and can adjust to these disruptions, potentially reshaping their energy practices in response to ongoing uncertainties and instabilities.

Faced with these challenges, this article explores the relationship between renewable energy deployment and energy security in the context of geopolitical disruption. Our research then examines how the integration of renewable energies could modulate the economic consequences of these disruptions in terms of electricity prices. The aim is to assess whether these technologies can effectively strengthen the resilience and recovery of electricity prices and ensure improved continuity of electricity supply.

Method:

This article investigates the determinants of electricity prices in a context of great instability, illustrated in our case by the Russia-Ukraine war. European countries have different electricity production mixes, which can have various effects on their spot electricity prices. In addition to the commodity price increases potentially caused by shocks, an additional carbon cost for the electricity sector may be generated due to disruptions, forcing reliance on fossil fuels.

To focus on the effects of different production sources on electricity prices, an empirical study is conducted to compare these dynamics in France and Germany. The study period runs from 2016 to 2024, using price and production time series. Multiple linear regression models are used to assess the relationships between electricity price, gas price, and generation mix. A breakpoint test is applied to determine a structural change in the electricity price time series at the time of the energy crisis of 2022 to compare these dynamics before and after the crisis. In order to study the effects of increased reliance on fossil-fired power plants during periods of stress, we also investigate the interactions between electricity prices and carbon prices. To assess it, we use contagion and transmission model. This study enables us to estimate the additional carbon cost induced by geopolitical instability and disruptions.

This modeling enables us to track how geopolitical shocks spread through energy systems and markets and to examine the resulting dynamics. The primary objective is to investigate the link between renewable energy deployment and energy security in affected countries. This method is then intended to be applied to other crisis and uncertainty events, with different timeframes (such as extreme weather events), in order to assess the dynamics of electricity prices.

Results and conclusion:

This study contributes to the understanding of electricity price dynamics in markets undergoing shocks and uncertainty. The results demonstrate the role of gas prices as a key driver of electricity price volatility in both countries. They highlight the increasing effect of fossil generation on electricity prices, the stabilizing effect of nuclear power, and the downward effect of renewables over the period studied. They also show the dynamics and interactions between carbon, electricity and gas prices in a context of high geopolitical instability. Ultimately, this research allows us to outline potential resilience strategies based on our findings, contributing to a deeper understanding of effective responses to these global challenges. It confronts two different decarbonization trajectories and their potential resilience in a world of growing instability and uncertainty.

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