Policy Note

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"Risk analysis based on weather variables allows estimating the premium even if the insurance company lacks information about past RE projects with similar characteristics. The proposed methodology could be used to price the risk of a given VRE project when only weather series and technology features are available and, therefore, is of interest as well for banks and investors in the energy sector. This study illustrates the proposed technique with solar panels, where the modeling of solar radiation (i.e., its natural input for electricity generation) allows them to find an optimal way to measure the risk of generation, particularly associated with weather factors".

Pricing the risk due to weather conditions in small variable renewable energy projects

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To effectively mitigate the most adverse consequences of climate change, it is necessary to limit the increment in the global average temperature to 2 °C above the pre-industrial levels and ideally to 1.5 °C, as recently committed during the Glasgow's Conference of the Parties, COP26-2021. This will be possible only if a significant contribution of renewable energy (RE) generation to the total electricity generation mix is achieved. In particular, variable renewable electricity (VRE), which is electricity converted from stochastic energy flows (e.g., wind and solar), is expected to play a fundamental role in substituting generation from fossil fuels and decarbonizing the power sector. As the number of RE investments increases, so does the need to measure the associated risk from the perspective of different stakeholders throughout the planning, construction, and operational phases. Although RE technologies potentially have a lower risk profile than conventional energy sources because they are disconnected from fossil fuels' prices, they still face considerable technological, financial, and regulatory risks. Moreover, they are notably exposed to weather risk, i.e., generation may be lower than expected due to stochastic weather configurations.

Price risk, understood as high volatility in electricity prices, has been identified as one of the principal investment risks in VRE projects. That is why we propose how to carry out the process of ratemaking (insurance premium calculation) for a small VRE project based on weather variables which, to the best of our knowledge, has not been proposed before in the literature. Past studies have focused on risk hedging for large VRE projects that have access to instruments offered by the financial sector. Regarding weather hedging mechanisms, derivatives are the most studied case by the academic literature. Thus, small VRE projects, such as those pursued by prosumers, currently do not have options for hedging weather variations in their generation projects.

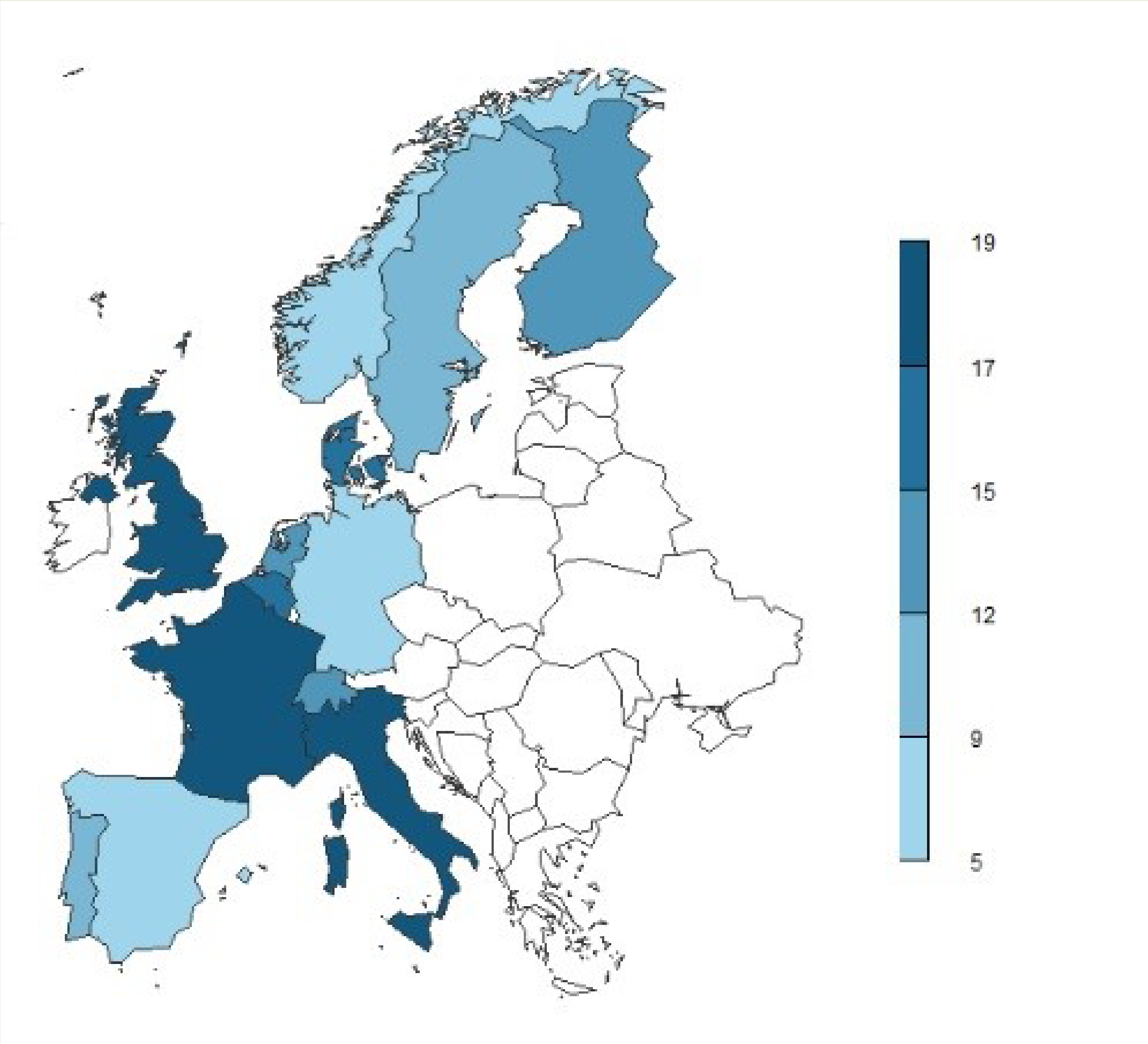
Is analysis based on weather variables allows estimating the premium even if the insurance company lacks information about past RE projects with similar characteristics. The proposed methodology could be used to price the risk of a given VRE project when only weather series and technology features are available and, therefore, is of interest as well for banks and investors in the energy sector. Moreover, our methodology and results are of general interest to small firms and neighborhoods that want to start generating their own electricity, but lack the means to conduct an accurate risk assessment of the generation risks they will face during the expected life of the VRE technology. In a broader sense, we contribute with new tools and results to the literature that analyzes the risk that firms and households will face during the energy transition due to the switch in energy generation from fossil fuels to renewable sources.

The generic insurance product that we analyze can be thought of as one that pays compensation whenever the electricity requirement of the project surpasses its own generation (or when the needs exceed a certain threshold that is beyond a certain tolerance level). In this case, the prosumer of electricity will need to connect to the grid to demand the excess of electricity and will likely face high electricity prices because low generation by renewables is positively related to spikes in electricity prices. This proposed product will stabilize the cash flow of the prosumer of electricity and will let her know in advance (from the project planning phase) when she can expect to recover the initial investment in the VRE technology.

We illustrate our proposed technique with solar panels, where the modeling of solar radiation (i.e., its natural input for electricity generation) allows us to find an optimal way to measure the risk of generation, particularly associated with weather factors. We use daily data of solar radiation recorded on the Earth's surface for 40 cities in 13 countries across Europe, with different latitudes and, therefore, exposed to idiosyncratic weather variations. We consider variables such as temperature, wind speed, and precipitation in our calculations. We also discuss how to extend the analysis to other technologies such as wind turbines in a straightforward fashion.

Based on quantile regression, we introduce the VaR of VaR (or VaR2) concept to the literature, which corresponds to the Value at Risk (VaR) of the Value at Risk. The VaR is a risk measure widely used in the financial industry, both by regulators and companies. In this study, first, we calculate an analog of financial VaR, but instead of estimating an expected financial loss, we estimate a very low quantile of the distribution of solar radiation. Once we estimate the daily VaR of the solar radiation, in the next step, we estimate a quantile of the VaR series, which will naturally refer to the worst scenarios among the worst scenarios. This is what we label as the VaR of the VaR or VaR2. Based on the latter statistic, we measure the expected value loss that is sought to be secured (associated with very extreme low-generation events), at any time horizon (i.e., one year), which, therefore, allows us to estimate the value of the annual premium and to set the insurance payment clauses.

The proposed methodology and our empirical results are of direct interest for insurance companies that are starting to explore the market for insurance products during the European energy transition that is currently in progress, but also for prosumers of electricity, because our results allow them to gauge the risk of generation due to weather conditions, of any project that relies on VRE technologies, especially solar panels. Our proposal contributes to the design of new products within the insurance industry, which will undoubtedly favor the mitigation of the risk associated with weather factors implicit in VRE projects. In this way, the materialization of more VRE projects is encouraged since better tools are provided to potential investors aiming to maintain risk under tolerable levels. Furthermore, the implementation of more private projects (or self-consumption by households or neighboring communities) for the generation of electricity through renewable energy sources has known significant positive impacts in terms of environmental and economic sustainability for the society as a whole.



The figure shows a heat map of the city premium averaged per country.
Note: the premiums of the United Kingdom's cities are transformed to euros using an exchange rate of 1.2 €/£.

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