THE INSURANCE VALUE OF RENEWABLE ENERGIES

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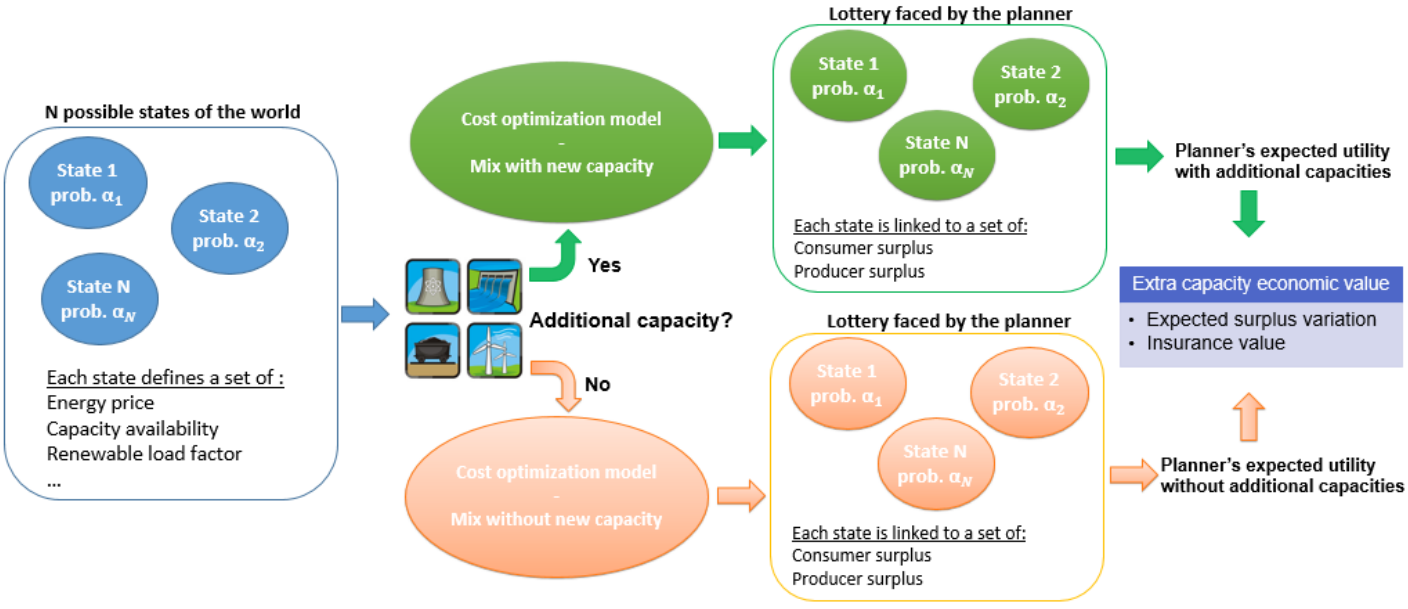
Overview

The 2022 gas crisis challenged the energy security of Europe. As a response, substantial investments occurred in the power system to strengthen its supply. However, governments still had to spend billions of euros in emergency packages to dampen inflation in the European electricity market. Moreover, some carbon-intensive technologies benefited from this period of high prices. Regarding energy transition and consumer protection concerns, public interventions in retrospect to the energy crisis led to mitigated results. In light of the recent events, this paper aims to investigate to which extent preemptive investments in additional power capacities effectively protect consumers against price risks and accelerate the energy transition. Much has been written on the stochastic capacity planning of the power system (de Maere d'Aertrycke *et al.*, 2017). However, a significant part of this literature focuses on the producer side and how uncertainty can reduce investments (Bichuch *et al.*, 2023). Less attention has been paid to the consumer's willingness to pay for additional risk coverage and how it might affect the optimal capacity mix (Fridgen *et al.*, 2020). This study proposes a new framework to evaluate the economic value of generating units in a context of uncertainty and analyses how consumers value protection against risks. This work emphasises on Variable Renewable Energies (VRE), namely solar and wind, to investigate if, in addition to their environmental benefits, they contribute to reduce supply risks despite their uncertain productions.

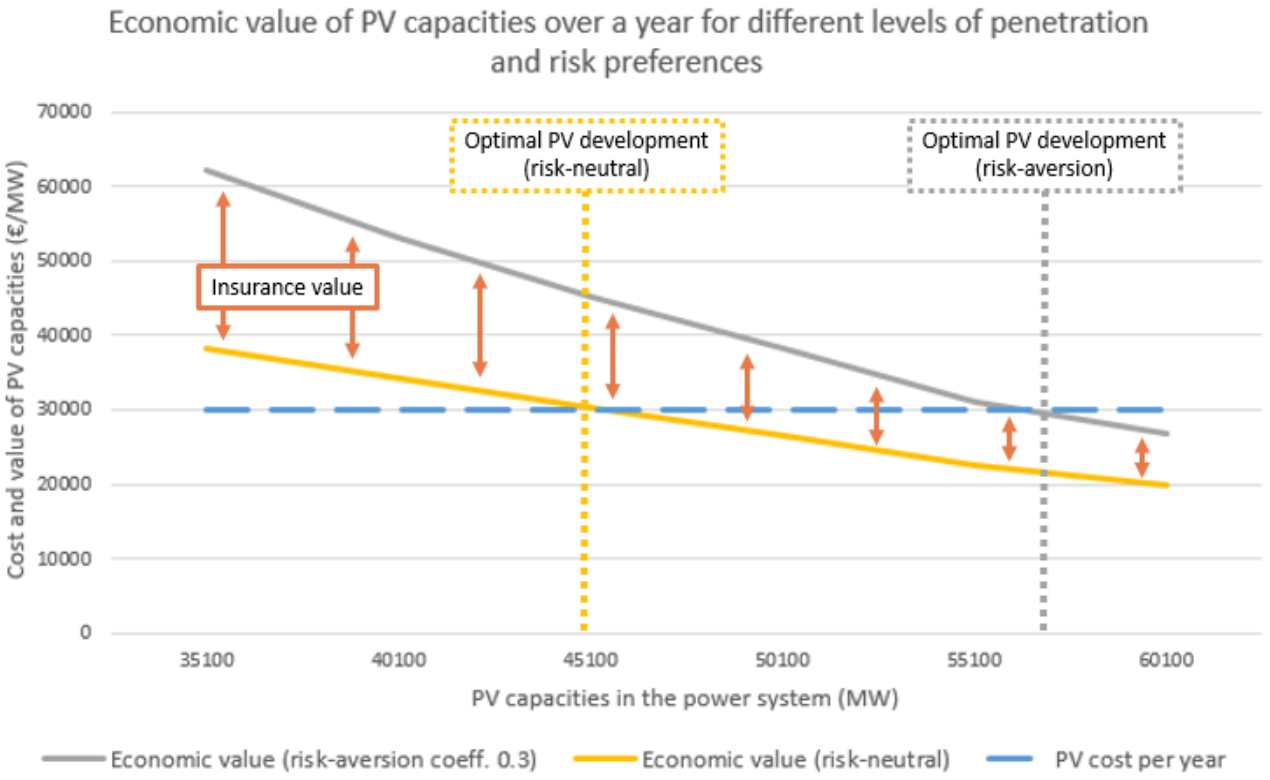
Methods

We define multiple states of the world with a fixed probability of occurrence and link them to a set of inputs for the power system (demand, load factors, energy prices, etc.). In each case, the electricity market sets consumer and producer surpluses over a year. To represent collective choices, we consider a risk-averse planner concerned about social surplus. This planner is rational and looks to maximize its expected utility (Hammond, 1982). Under those assumptions, we show that the socially optimal willingness to pay of consumers for an additional capacity is an addition of two components. One translates the variation in expected surplus, while the other translates the insurance value of the capacity, i.e., the variation of the risk premium associated with the lottery on the states of the world (Baumgärtner and Strunz, 2014). Then, we perform numerical estimations to test this theoretical framework using a cost optimization model to simulate the French power system in 2030. Multiple states of the world are considered in order to emulate the uncertainty relative to VRE intermittency and gas price shocks, which allows us to compute the insurance value of VRE. Finally, we implement different VRE penetration rates to determine the optimal capacity mix while considering insurance value. An overview of the method is given in the following graph.



Results

Considering the possibility of a gas shock similar to the one that occurred in Europe in 2022, the insurance value of VRE is positive, increasing their economic value relative to gas-fired power plants despite their intermittency. In such circumstances, solar and wind energy acts overall as an insurance against uncertain events, and consumers are willing to pay for it, justifying ex-ante additional support for VRE. As displayed in the following graph, considering the insurance value leads to a modification of the socially optimal capacity mix with a higher penetration of VRE.



Conclusion

In this work, we propose a new method to identify how much consumers are willing to pay for extra risk coverage in the electricity market and evaluate if VRE can be used to manage uncertainty. Our main conclusion is that solar and wind energies are effective tools for the power system to protect consumers against gas price risks, despite their intermittency. However, the current design of electricity markets in Europe better captures the daily, monthly, or yearly uncertainty related to VRE than the uncertainty of low-probability and high-impact events such as gas supply shocks. Higher penetration of VRE is associated with a higher expected variance of spot prices (Huisman *et al.*, 2021). Therefore, there is a gap between market outcomes and the socially optimal situation. In addition to the environmental benefit, this work suggests that there can be a new incentive for public intervention to support VRE development.

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