SECURITY OF POWER SUPPLY IN NET ZERO SCENARIOS: AN UNCERTAINTY AWARENESS TECHNO ECONOMIC APPROACH

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Overview

Electricifcation of uses is a major lever to mitigate the climate change. (*World Energy Outlook 2023*, n.d.) Forecasts in the STEPS, APS NZE scenarios state that a more significant share of electricity generation comes from low-carbon sources (without considering nuclear). It increases from 39 % in 2023 to a range between 57 % and 71% by 2030, depending on the scenario. Aligned with the increase in the share of low-emission power sources, the share of electricity in final consumption also rises from 30% to more than 50% by 2050, depending on the scenario; this increases the electricity amount from low-emissions sources even more. These forecasts corroborate the new role granted to electricity and renewable power sources as a primary energy carrier and energy sources to reduce GHG emissions, respectively.

The reliability and robustness of the power system will undergo structural changes due to the phasing out of dispatchable fossi-fuel plants replaced by weather-dependant renewable energies. However current adequacy long-term planning based on GEP tend to overestimating of technologies' flexibility and the underestimation of intermittency renewable representation . Hence, overlooking power security in prospective models significantly affects strategic decisions and energy mix compositions [(Alimou et al., 2020; Loisel et al., 2022; Seck et al., 2020). Adressing this drawback this study used stochastic optimasition to proposed a robust adequacy planning in Europe for 2050 horizon

Methods

I propose to address this problem by the measurement of the uncertainty in energy planning and identify the determinants factors in order to propose a hedging strategy and evaluate the cost of the uncertainty.(Moret et al., 2020; Nadal et al., 2019; Perrier, 2017) address the uncertainty in parameters of energy models and the impacts on the outcomes. They highlight the incidence of considering uncertainty in strategic energy planning. This directly influences the composition of the cost-effective power mix. My proposal aims to identify that some technology choices in the mix reflect the uncertainty inherent in their assumptions on the modeling results (such as investment decisions, generation, and flows) more strongly than others do, thereby weakening power supply security and increasing the need for power system flexibility. To address my research question, I aim to assess the propagation of uncertainty arising from assumptions (usually related to parameters within the scenarios) in linear programming across the energy system (primary supply, final supply, or energy uses) within a unit commitment generation expansion-planning scheme. I intend to use stochastic optimisation to propose robust strategies considering a scheme linking between scheduling operations and strategic planning, for example, a soft link between an energy-planning model KiNESYS (TIMES – World Energy Investment model) and an operations model ESMOD (ANTARES RTE Europeen power unit commitment model) or another scheme, and economic investment analysis under uncertainty. My goal is to contribute to the literature by assessing the impact of uncertainty propagation across the energy system in strategic planning models while considering power supply security in Europe for the 2050 horizon.

In my view, ensuring the security of power supply involves dealing with uncertainty and the need to adjust supply to demand based on deviations from forecasts. Under this framework, combining the two approaches seems evident and valuable in addressing my main research concern: the security of the power supply in low-carbon systems. Therefore, I seek to explore the economic value of technologies in a decarbonization roadmap accounting for uncertainty propagation (Roald et al., 2023) and the power supply-demand equilibrium.

Results

Compliant with (Moret et al., 2020) taking into account uncertainty in energy planning impacts the pathways of decarbonisation. My preliminary results show the sensitivity of nuclear developpement when considering uncertainty in reaching the carbon targets and investment costs of nuclear energy. Other variables such as the availability of carbon storage or the climate year are relevant also in configuring an optimal pathway to reach the carbon neutrality considering the uncertainty. Following (Lynch, 2023; Lynch et al., 2022) the modelling of nuclear fleet flexibility should impact the neutral pathways. The preliminary outcomes of the unit commitment model show that uncertainty awareness might exacerbate this effect revealing an extra role of nuclear energy development to reach the carbon targets.

Conclusions

We confirm that uncertainty consideration impacts on the net zero pathways so, it also impacts on the strategies to reach the carbon neutrality. Some technologies such as nuclear might have an extra role in the net zero scenarios when taking into account uncertainty, the intermittence of renewable energy sources and the massive electrification. This aspect should take into account in the planning of the mix power in France and Europe.

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