Resilience of offshore wind technologies under extreme weather events in New Jersey and the PJM interconnection

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Background

New Jersey (NJ) is not spared from hurricane impacts despite being well north of the tropical belt. Considering the Executive Orders mandating zero emissions by 2035 and 11 gigawatts of offshore wind by 2040, this research focuses on:

- Testing the resilience of the electricity grid and the durability of offshore wind technologies
- Understanding the trade-offs between cost and resilience for future grid planning
- Impact of high penetrations of offshore wind on electricity supply during hurricanes

Methods

My research encompasses a three-pronged approach and primarily used, GenX, a capacity-expansion modelling tool.

1. Capacity Expansion to find the cost-optimal grid configuration for the 2040 grid, and alternative grid configurations within a reasonable cost increase (~5%)
2. An extreme weather model to simulate generator failure using fragility curves, and wind field data from the PepC model
3. Economic Dispatch Model to find the impact on non-served energy due to the weather event

Preliminary Findings

1. Grid vulnerability increases during high demand periods (e.g. extreme heat/cold)
2. Fossil fuel generators compensate load during loss of offshore wind
3. Transmission line availability/redundancy decreases non-served energy costs

Next Steps

1. Refine weather model failure times to generation type
2. Consider alternative grid configurations and their response under extreme weather
3. Run Monte Carlo Simulations to encompass a wide range of storms and grid outcomes

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Results

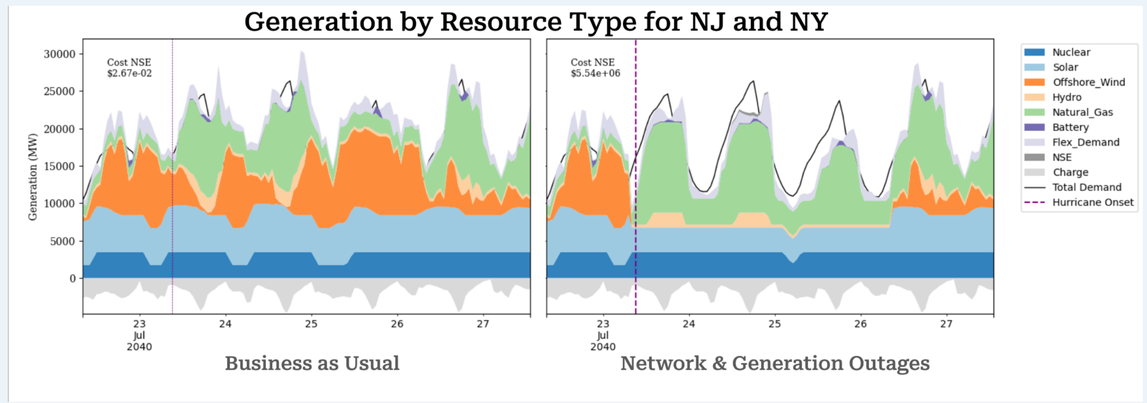

Figure 1: Figure showing extreme weather simulation. Hurricane impact occurred on July 23rd affecting generators and transmission lines in NY and NJ. There is no offshore wind generation. Transmission failures & high demand cause high costs associated with non-served energy (~$6 million vs. $0 in BAU case)

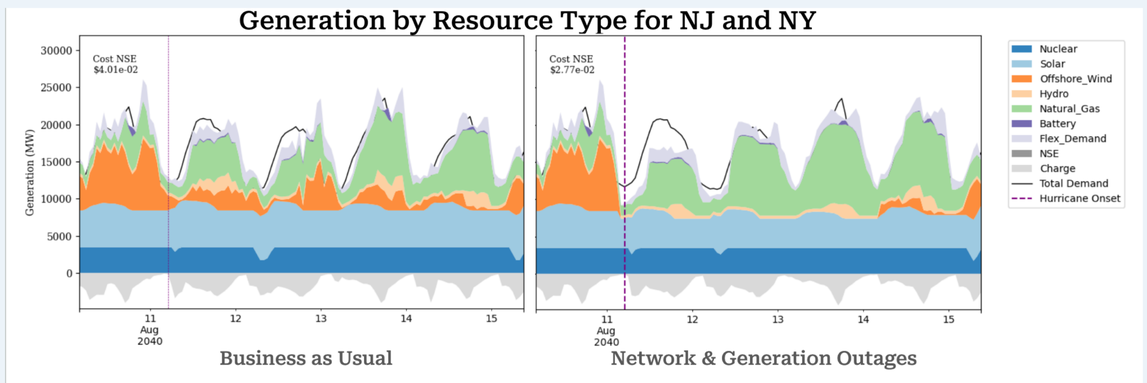

Figure 2: Figure showing another extreme weather simulation on August 11th. Offshore wind is also heavily impacted. Due to pre-existing low available of wind power and lower demand at this time of year, the extreme hazard impacts are less. This is signified by the low cost of non-served energy with network and generation outages.