Curtailment Mitigation in Wind Power Integration via Coordinated Reactive Power Control with FACTS and Wind Farms

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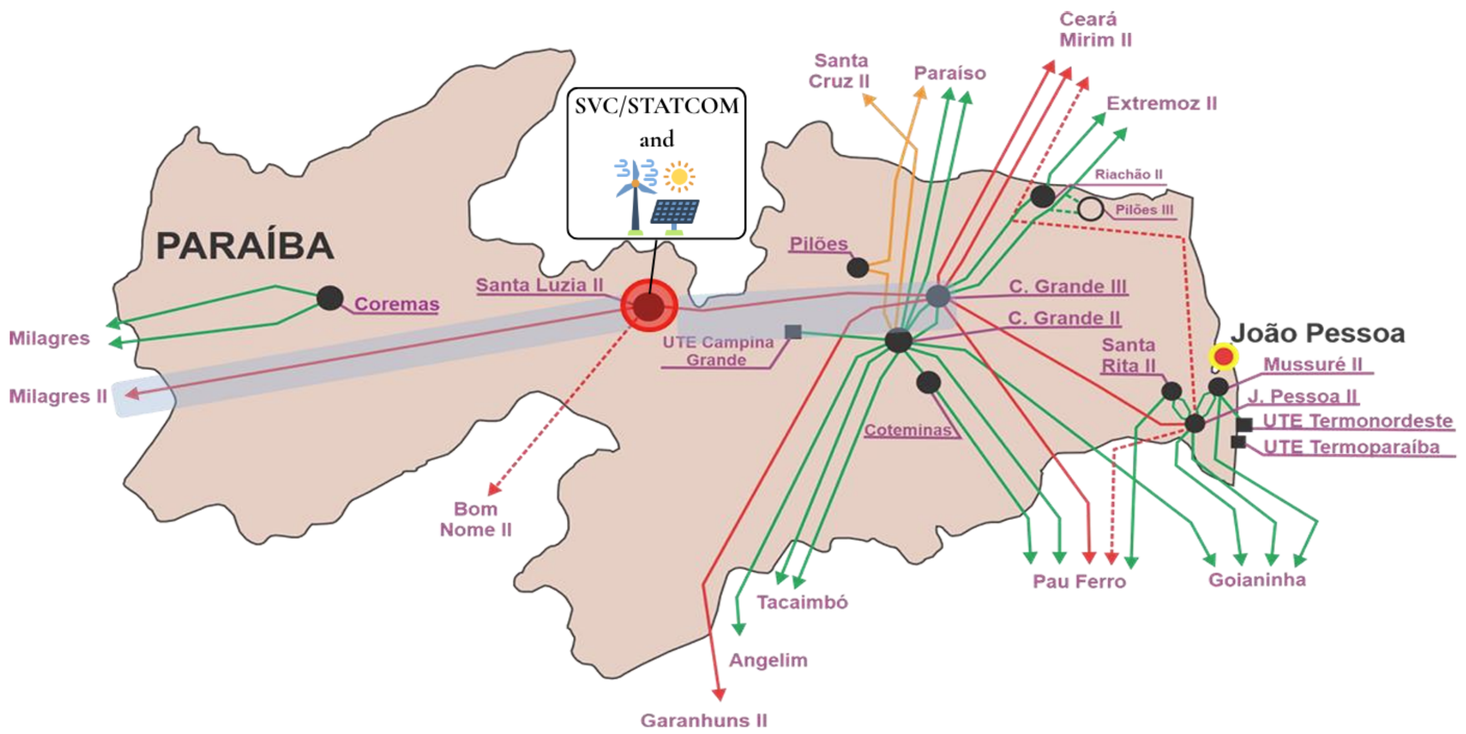
Introduction

- High penetration of wind power in the Brazilian Northeast has increased voltage stability challenges.
- Radial 500 kV corridors with limited reactive support are prone to curtailment under contingencies.
- Curtailment preserves security but causes renewable energy waste and economic losses.
- Low reactive power availability and LVRT-triggered disconnections are key operational risks.

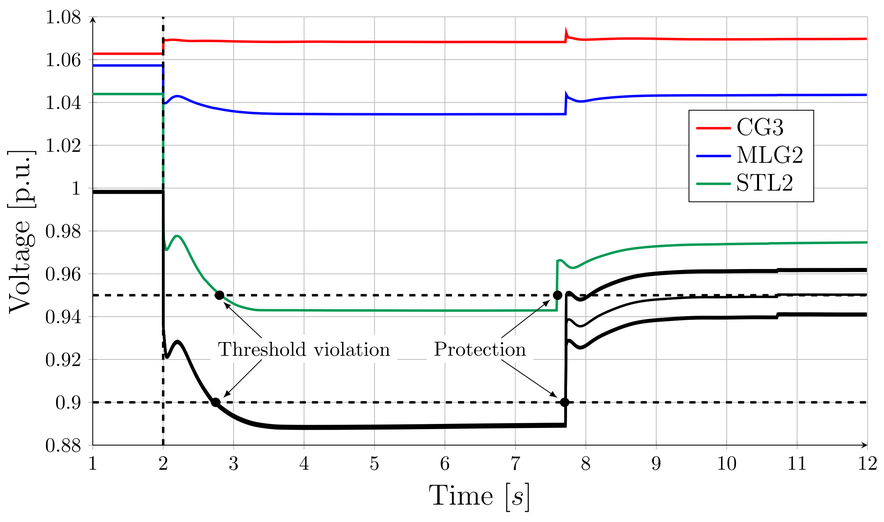
The objectives and contributions of this paper are:

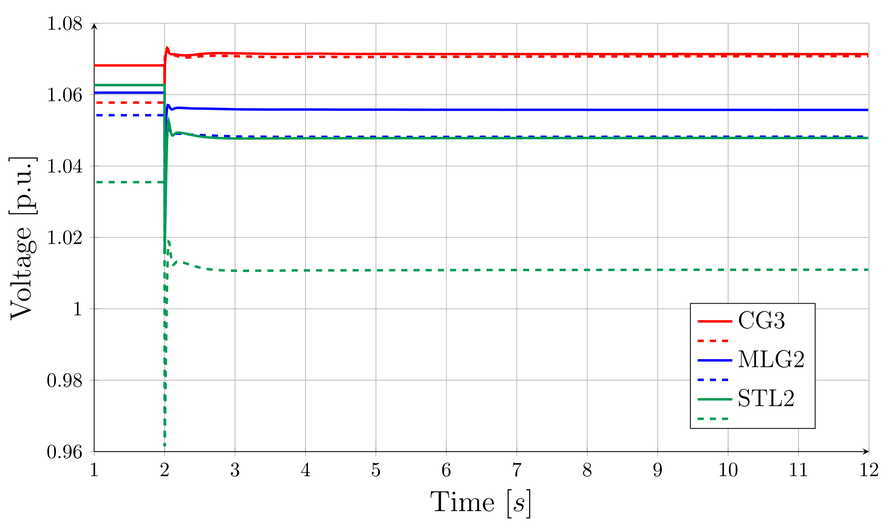
- Compare curtailment mitigation strategies based on reactive power support.
- Evaluate coordinated inverter-based control from wind farms versus STATCOM support.
- Assess voltage stability, renewable disconnections, and post-contingency recovery.
- Support operational planning and incentive mechanisms for ancillary services.

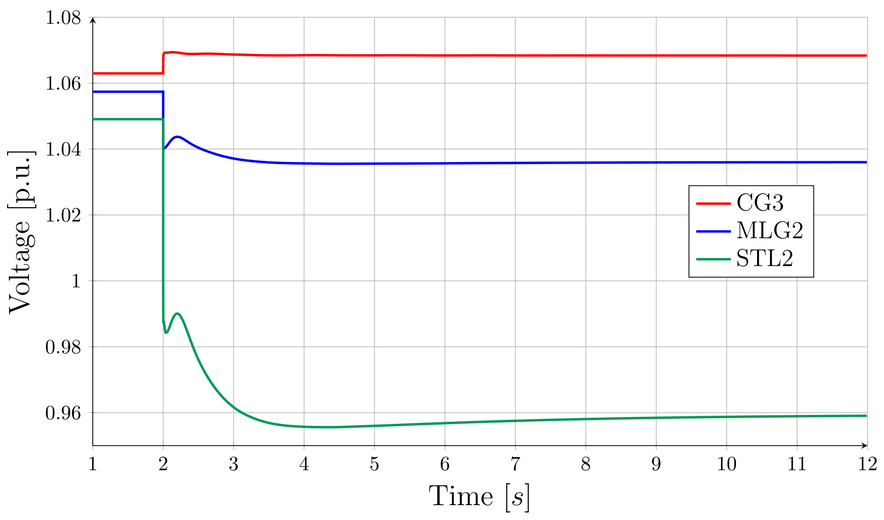
System Topology

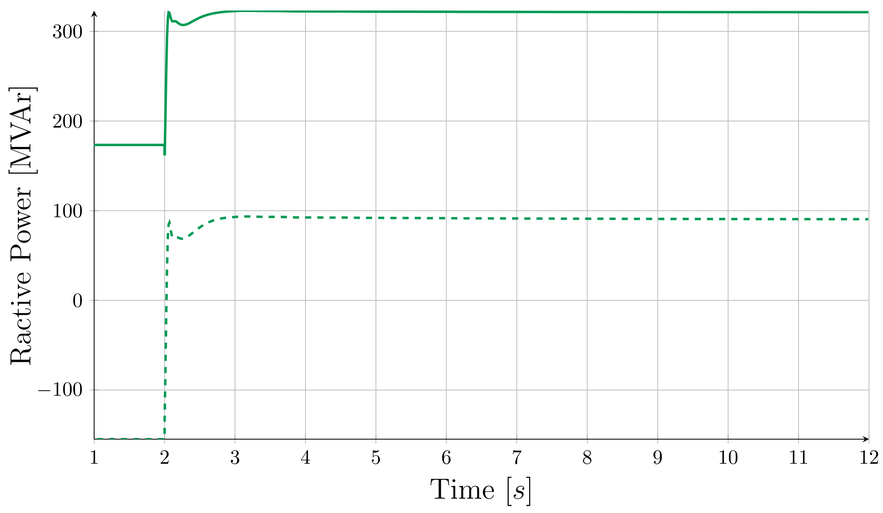


Key Results









Case Study

- Permanent outage of a 500 kV transmission line in a radial corridor.
- Coordinated wind farm control injects 6–8 MVAr, avoiding LVRT activation.
- SVC/STATCOM maintains voltages above emergency limits for different reference settings.

Conclusions and Implications

- Coordinated wind farm reactive control and STATCOMs both mitigate curtailment effectively.
- SVC/STATCOM offer superior dynamic performance but involve high costs and long deployment times.
- Wind-based coordinated control is cost-effective and scalable using existing infrastructure.
- Hybrid solutions may offer the best trade-off between performance and feasibility.
- Results support regulatory frameworks enabling renewables to provide ancillary services.

Sponsors

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