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Assessment of Tall Onshore Wind Benefits When Integrating with Other Renewables in the US Southeast

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BACKGROUND

- To increase the extent of renewable energy penetration, an increase in solar PV and the addition of offshore wind in the US Southeast are being called for development.

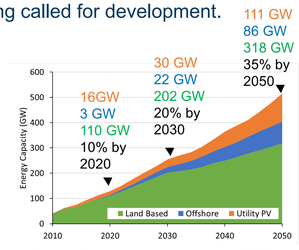

Fig.1 US Energy capacity projections (US DOE.gov)

- Onshore wind was not an option in the US Southeast due to the low wind speed at the typical hub height of 80 to 100 m.
- With the new wind tower technologies (e.g., Hexcrete) that can support wind turbines up to the hub height of 160 m, the onshore wind is achievable today at an expected LCOE of $45/MWh, which is anticipated to reduce further by 2035.
- Integration of energy storage in power production can be complemented with relatively more cost-effective onshore wind power.
- By using measured wind speed from multiple sites in the Southeastern states, the onshore wind energy is found to be attractive to increase the renewable energy penetration while helping to minimize the storage need.
- This study will promote the build-out of an integrated renewable energy system with onshore wind farms, helping to achieve the renewable energy goals of the US Southeast and the nation faster.

OBJECTIVE

- Assess the net AEP and capacity factor from 80 – 160m for chosen sites in the Southeast region.
- Estimate and compare the energy storage demand for the Southeast region with and without integrating tall onshore wind energy.

DATA DESCRIPTION

- Historical power generation data for the Southeast states
- Wind resource measurements at 4 chosen sites in the Southeast states
  - Multiple year-long datasets at 10-minute intervals

RESULTS FOR THE CAROLINAS REGION

Current power generation mix in the Carolinas

- >70% of the total power generation in the region is from non-renewable sources (i.e., coal, natural gas, nuclear etc.).
- The electricity demand peaks during the day; stored energy can be used to optimize the total power generation.

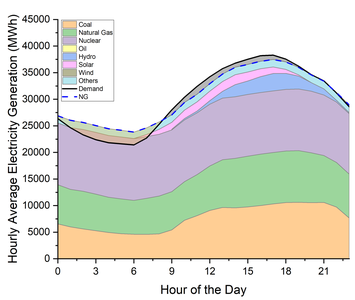

Fig.2 Hourly average electricity generation for all energy sources today in Carolinas (EIA.gov)

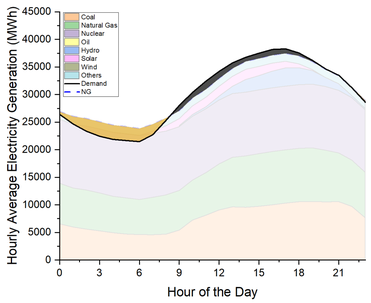

Fig.3 Hourly variations of energy storage demand today in Carolinas (EIA.gov)

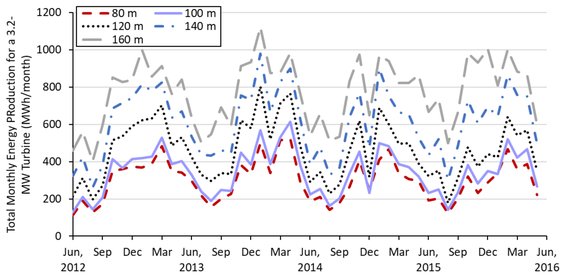

Fig.4 Total monthly energy production for a 3.2 MW turbine at different hub heights for a site in the Carolinas region

Wind energy production estimates for the Carolinas region

- Using low specific power wind turbines, the wind energy production is expected to increase significantly.
- With hub heights increased to 140 m or higher, a capacity factor of 40% is achievable.

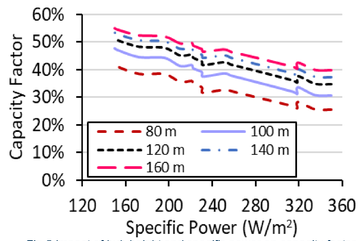

Fig.5 Impact of hub height and specific power on capacity factor

Design power generation mix for tall onshore wind energy

- Use an average hub height of 140 m and add 0.5 GW onshore wind capacity
- Reduce the coal power production in the total power generation mix
- Reduce the needed storage by more than 50% compared to that with solar energy alone, leading to a reduction of about 6 GW

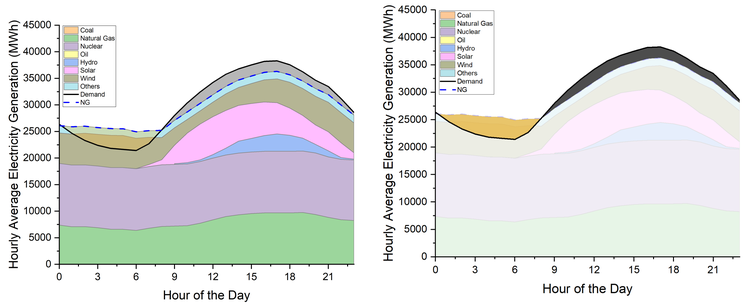

Fig.6 Hourly variations of energy storage demand for minimizing the coal power production in Carolinas

CONCLUSIONS

- Using solar PV energy alone to generate renewable energy for the US Southeast region is not efficient.
- Using tall onshore wind towers with hub heights of 140m or higher, a favorable capacity factor of 40% is achievable in the US Southeast.
- An initial target capacity of 0.5 GW for onshore wind will optimally reduce the coal power production, minimize the storage demand and increase the renewable penetration in the US Southeast.

ACKNOWLEDGEMENTS

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