Assessing the Impacts of Dark Doldrums Events on Electric System Resource Portfolios

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KEY INSIGHTS

- Future system risks coincident with dark doldrum events are highest during morning or evening hours on days with low wind and relatively high demand, particularly during extended wind droughts lasting multiple days.
- For two case study regions in the Western United States, representative of different high-renewable systems, extreme doldrum events lasting over seven days were identified.
- This work explored various definitions of "doldrums" conditions to identify "extreme" historical years for planning model inputs while also demonstrating the benefit of a long historical record that captures sufficient variability of doldrum risks.
- Use of appropriate time sampling methods to capture extreme events in capacity expansion models enables future portfolios to consider dark doldrums risks.

Research Overview

Extended periods of dark doldrums, when the wind is not blowing and the sun not shining, may pose risks on high renewable energy systems. Better understanding these risks and integrating them into long-term resource planning models is important for a successful energy transition.

This research analyzes an extended history of weather data to provide insight on the likelihood and characteristics of dark doldrums risks for electric system planners. It also develops and tests planning methods to identify future low-carbon resource portfolios that consider dark doldrums risks.

The work includes 1) an exploratory analysis to identify dark doldrums characteristics in historical weather data and 2) electric system planning model runs conducted on two case study regions, to demonstrate methods for incorporating dark doldrums events and their impacts in electric system resource portfolio planning.

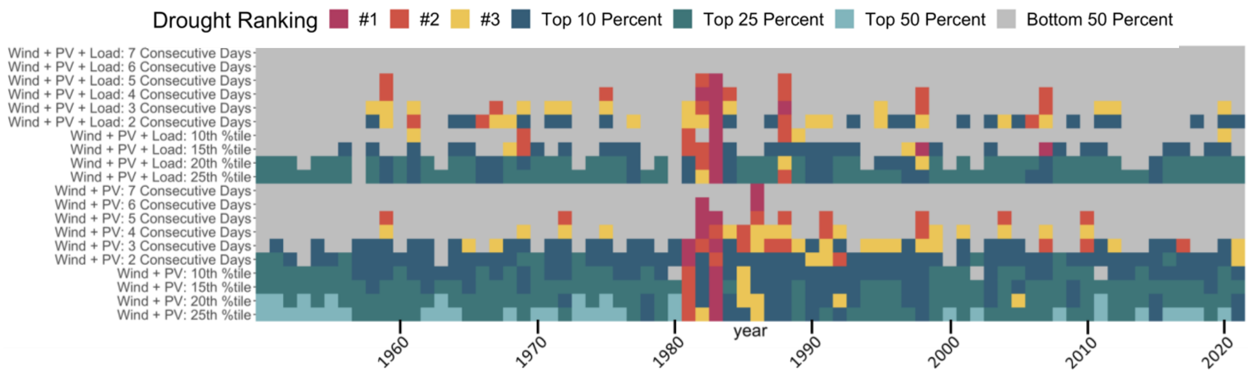

Figure 1: Visualizing occurrences of dark doldrums events across multiple definitions to identify extreme years.

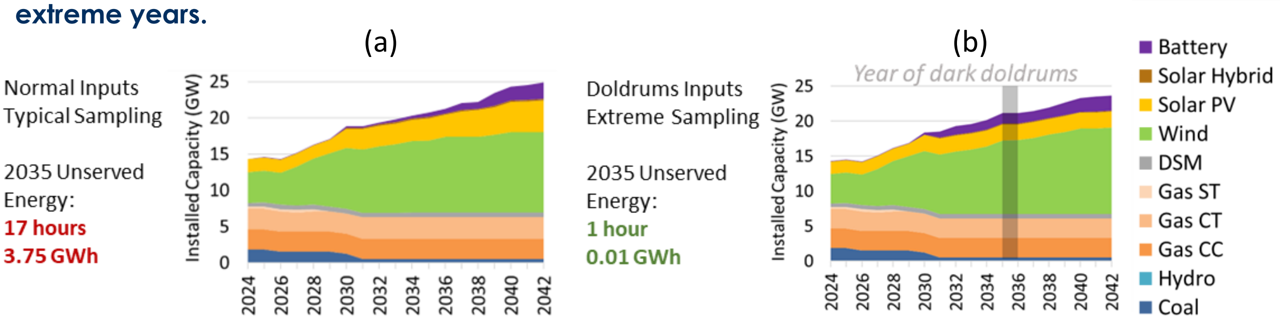

Figure 2: Capacity expansion and future unserved energy results from models that, (a) assume normal inputs, and (b) incorporate doldrums inputs and extreme event sampling techniques.

Summary of Findings

The exploratory analysis analyzed dark doldrums events considering relative levels of wind, solar, and load across a long weather history for the case study regions. Figure 1 displays historical years by their relative severity of doldrums events across multiple different definitions along the y-axis. This displays which years experienced high numbers of doldrums events (e.g., 1983 in Figure 1) compared to other more typical years. Model inputs for severe doldrums years are developed from these data.

Figure 2 compares model results from two scenarios in the research:

Panel (a) shows a capacity expansion buildout without considering doldrums inputs. It results in significant future unserved energy when stressed with doldrums inputs. Panel (b) shifts the time distribution of resources built in response to the specified doldrums year.

This research demonstrates the importance of analyzing long histories of weather to identify extreme dark doldrums events that could impact a company's system and the benefits of pairing this data with models that directly incorporate dark doldrums risks into investment planning decisions.

This research highlight is based on EPRI Report "Assessing the Impacts of Dark Doldrums Events on Electricity Resource Portfolios," Product ID 3002029146

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