Simulating Impacts of Extreme Events on Grids with High Penetrations of Wind Power Resources

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Introduction

As extreme weather events become more frequent and intense, the demand for connecting grid operation and infrastructure planning with extreme event models will increase as well. We present a methodology for creating damage contingencies and scenarios for electric transmission grids during a hurricane strike. Using WIND Toolkit meteorological data in conjunction with fragility curves for various electric grid elements, we generate stochastic damage scenarios that can be used for short- and long-term planning problems, e.g., emergency asset management. Included is an example case study: Hurricane Dolly damaging a synthetic 2000-bus test system during its landing in Southern Texas.

Scenario: Hurricane Dolly

Our working example includes the path of the Hurricane Dolly over a week in July of 2008 and synthetic TAMU 2000-bus grid (Figure 1 & 2). NREL’s WIND Toolkit data (Figure 3) is mostly over continental United States, and it contains only the last 2 days of Hurricane Dolly. However, that is what we are interested in most: landing and overland period. Most of the damages occur within the first 8 hours of landing.

Fragility curves: idea via wind plant example

Wind turbine

Mean | Std | Max | Min
---- |---- |---- |----
53.4 | 6.5 | 95 | 34

Figure 4: Realization when max number of branches were damaged. Damaged lines (red lines) and damaged poles (black dots).

Applications

Economic dispatch over 2 days

Ripple-type voltage control

Figure 5: