Power System Transformation and Implications for Electricity Security

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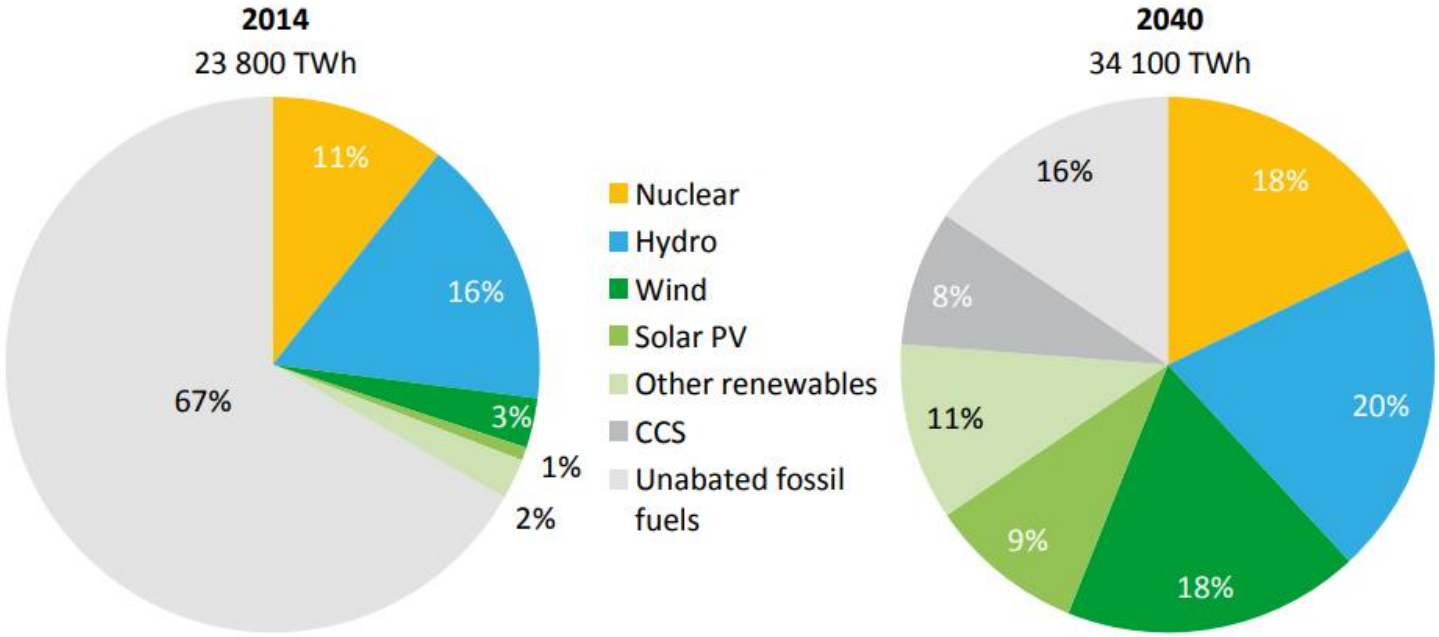
What do we mean by electricity security?

- Electricity is an increasingly important part of the overall energy system
  - Globally, its share of total final consumption is increasing:
    - Doubled from 9 to 18% since 1973
    - Expected to reach 23% by 2040
- Increased reliance on electricity means increasing focus on *electricity security*
- But, no single definition!
  - Resource adequacy:
    - Do we have enough capacity? Do we have the right kind of capacity?
  - Resilience:
    - How well can we withstand system shocks (fuel disruptions, extreme weather events, cybersecurity, etc.)?
- Increasingly, these definitions are interlinked

What do we mean by power system transformation?

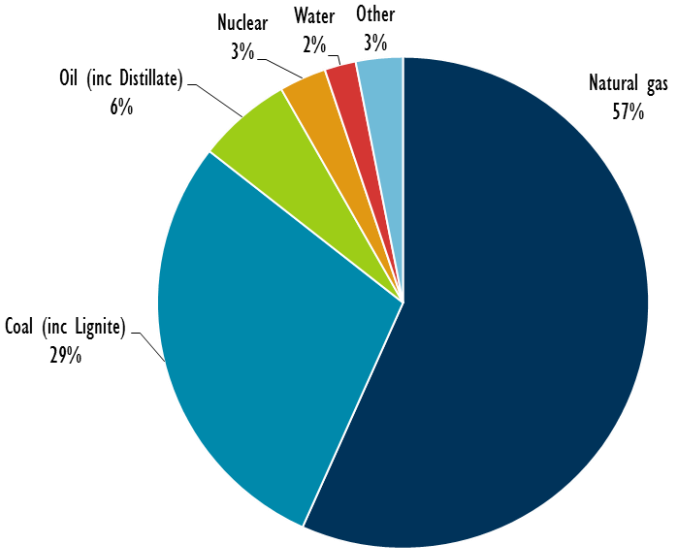
Evolution of the global power mix under the 450 ppm scenario, World Energy Outlook 2016



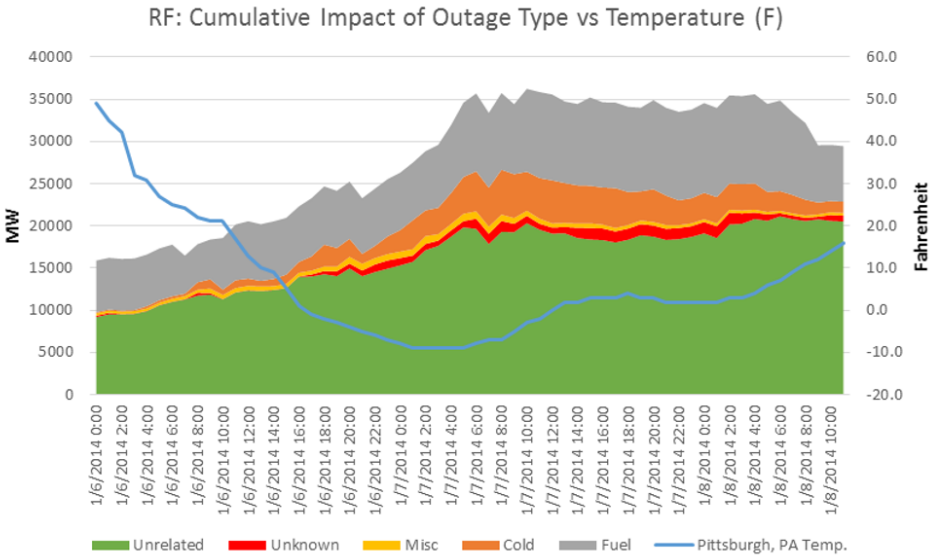
Under a 2 degree scenario, wind and solar increase from 4% to 27% of the generation mix, and economies become increasingly reliant on electricity. Power systems must evolve accordingly.

The “right” generation mix: how secure are “traditional” resources?

Forced outages by fuel type during the “Polar Vortex” Eastern US and Texas



Polar Vortex outage type versus temperature ReliabilityFirst (PJM)

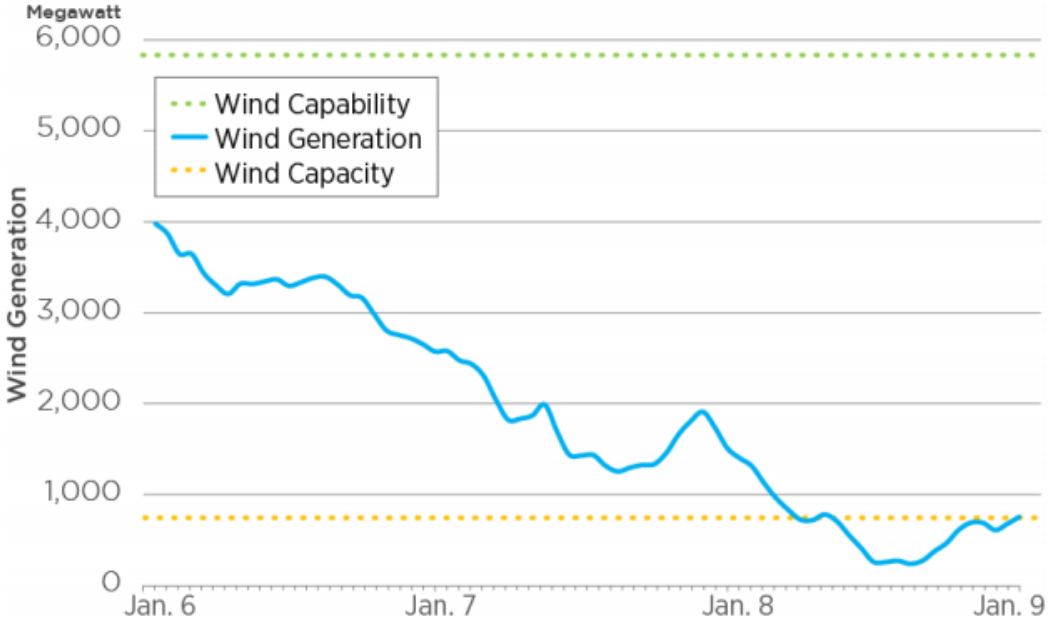


Source: NERC

During the 2014 US Polar Vortex, NG plants made up more than half of all forced outages, followed by coal plants. In regions most directly impacted, lack of fuel was a disproportionate cause of outages.

The role of renewables: wind to the rescue?

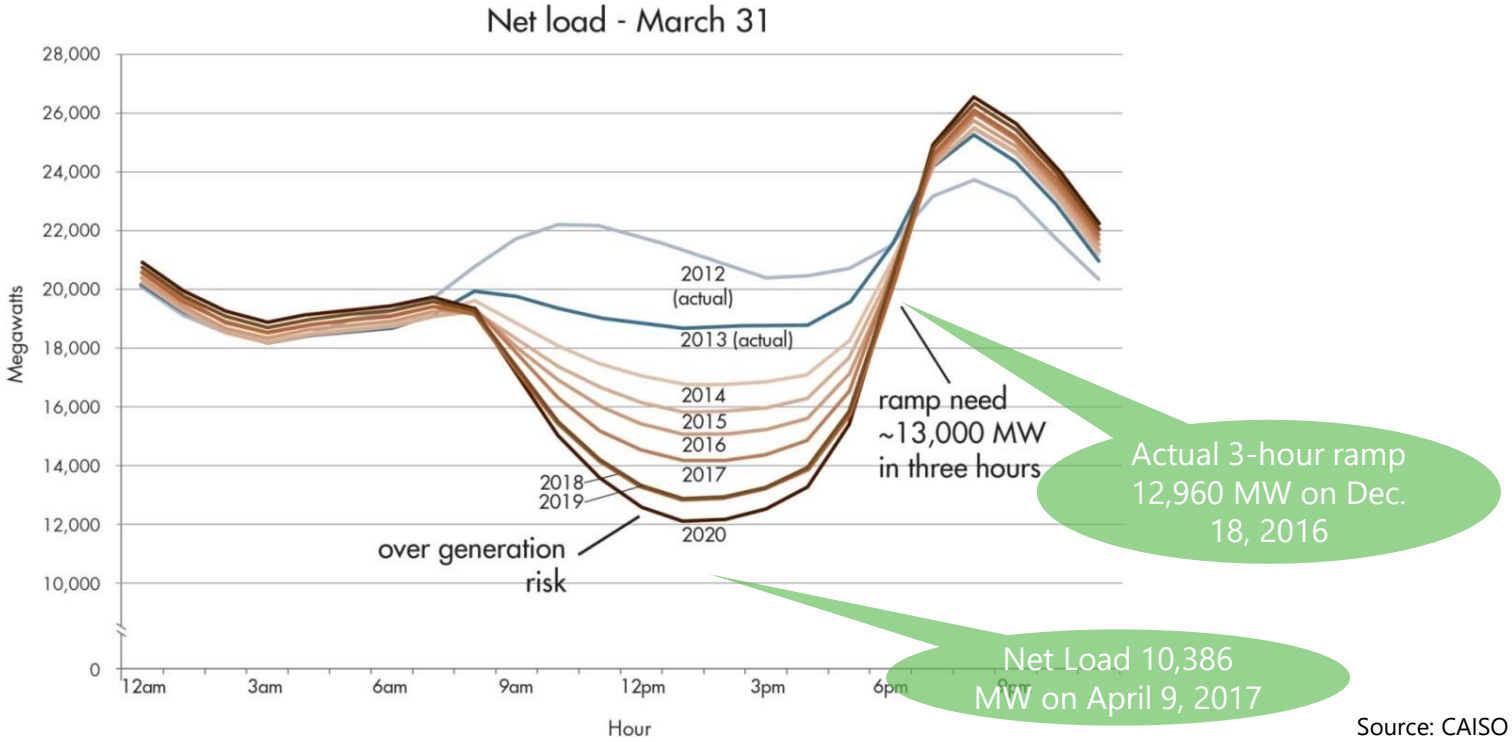
Wind generation in PJM during the Polar Vortex



Source: PJM

Wind generation rose as much as 4,000 MW above their rated capacity during the polar vortex period, having "a positive impact on supply and [contributing] to PJM's ability to maintain reliability."

The role of renewables: impact of behind-the-meter generation

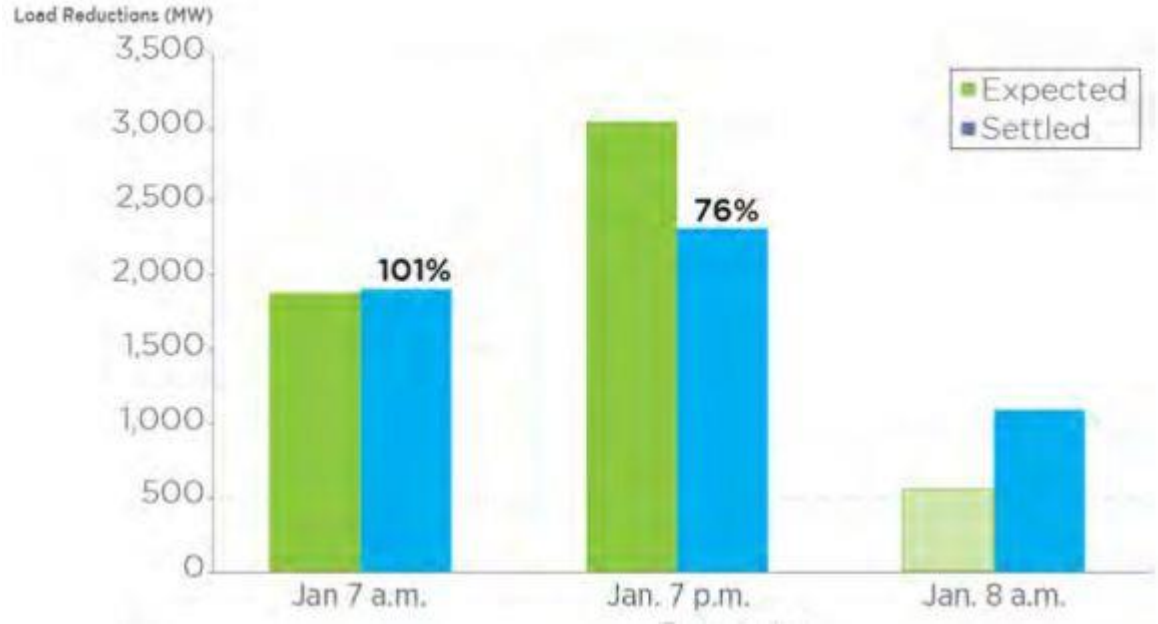


Source: CAISO

Historically, meeting resource adequacy meant targeting the right level of capacity to meet peak load needs. Increasingly, the need for *flexibility* is as or even more important.

The role of the consumer: demand response to the rescue?

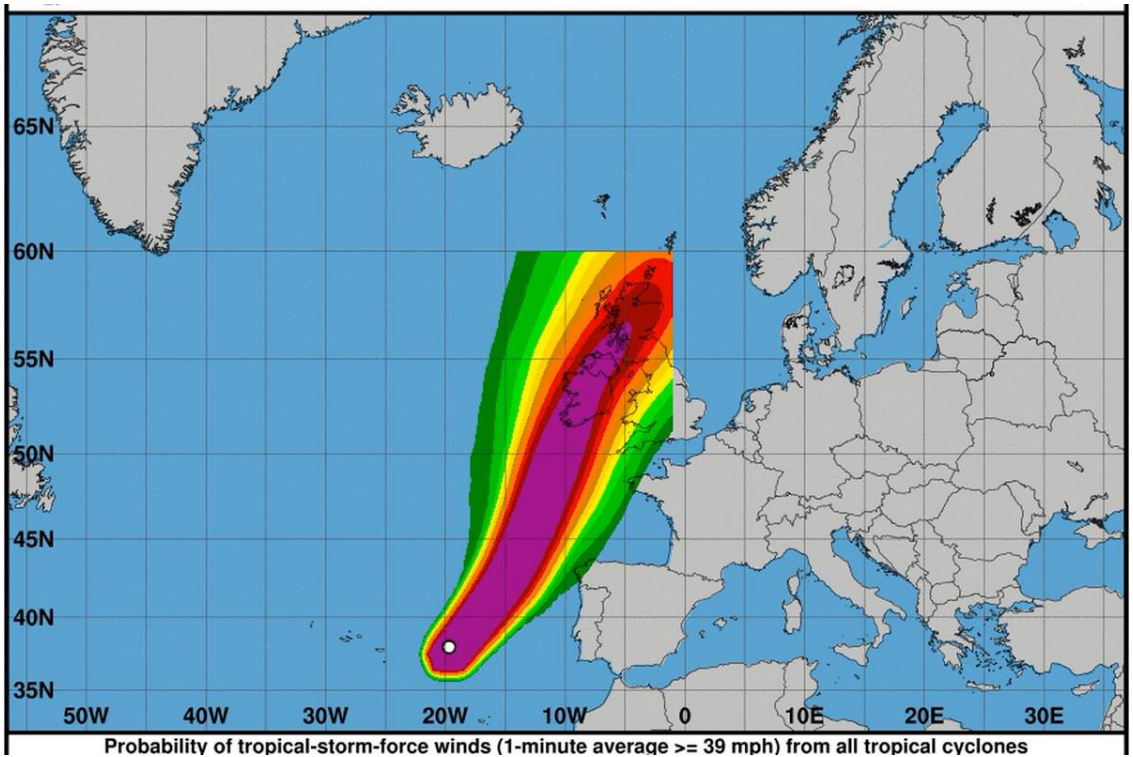
Demand response performance in PJM during the polar vortex



Source: PJM

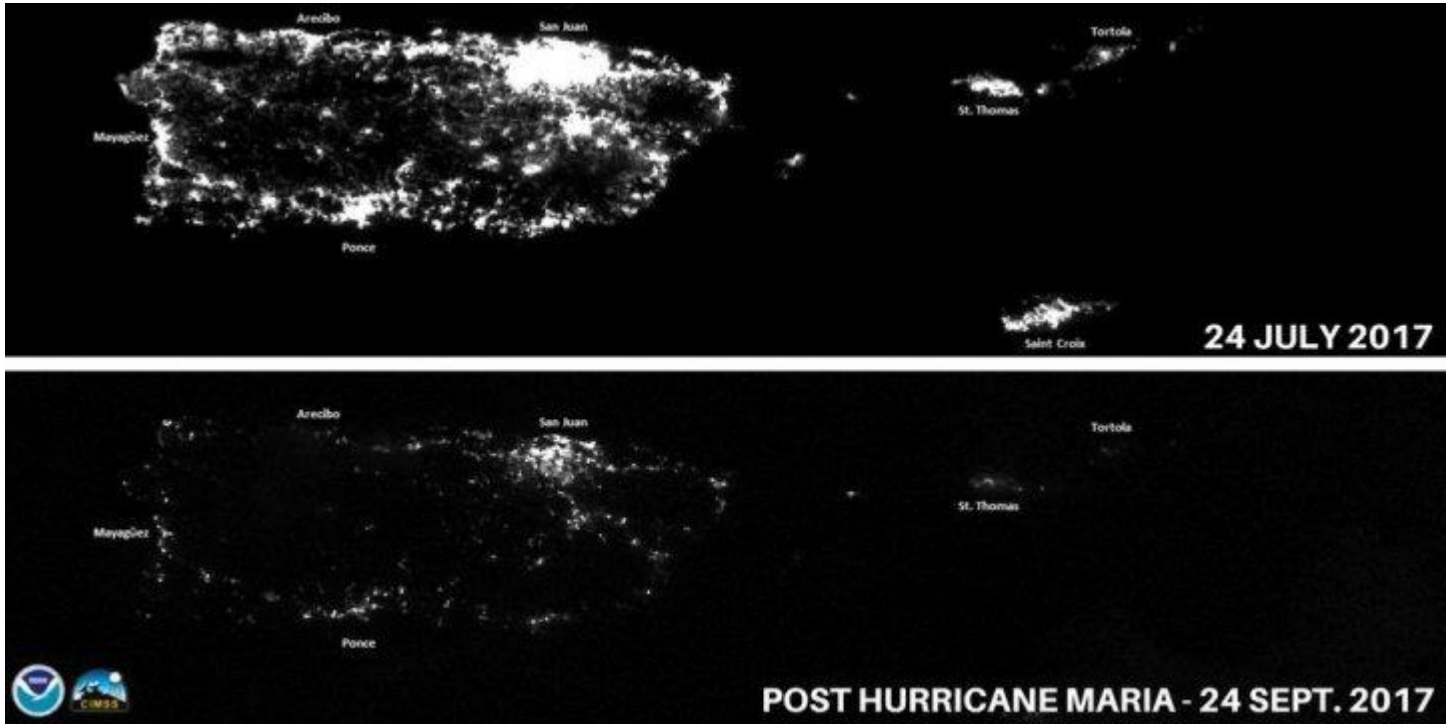
Demand response was able to provide more than 2,000 MW of load reductions during the Polar Vortex, despite the fact that providers had no obligation to respond during the winter period.

Resilience: learning to expect the unexpected



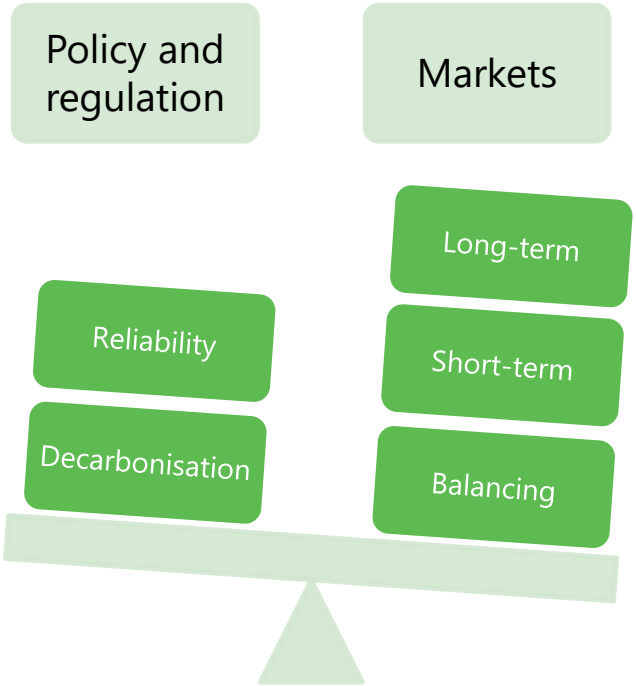
On October 15, Hurricane Ophelia travelled farther east than any Cat 3 hurricane in history. Thinking about the future of electricity security means doing more than just extrapolating from the past.

Resilience: the limits of supply- and demand-side solutions



Diverse supply and flexible demand are of limited use if they aren't supported by a modern grid.

Security: what roles for market and regulatory mechanisms?



A comprehensive market framework needs to effectively balance policy maker goals, regulatory oversight, and the efficiency of competitive markets.

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