Applying the framework: A case study

South Australia Blackout, 2016

The South Australia blackout made headlines across the world, leaving many without power. On Wednesday 28 September 2016, tornadoes with wind speeds up to 260 km/h occurred in South Australia. Two tornadoes damaged three major transmission lines, wind farms ceased power generation and the Heywood interconnector was disconnected. South Australia could not operate in ‘islanded mode’ – the system managed by Australian Energy Market Operator collapsed within one second and the entire state of South Australia - 1.7m people - lost power. Twenty four hours later, power was restored to 90% of households, yet 70,000 people were still without electricity. 50 hours after the blackout the grid was back to normal.

Using the Energy Resilience Framework, we have mapped out the events, existing practices and recommendations in accordance with the official “Black System South Australia” report. In addition to the three dimensions and the official ‘Black System South Australia’ report, we have also mapped out the events, existing practices and recommendations in accordance with the framework:

**Strategic Vision**
- AEMO’s System Security framework to prevent a repeat of the 2016 incident
- Establishing a system in place to provide demand-side management to the system
- Establishing new options for procuring non-energy services

**Effective Regulation**
- Reviewing and updating technical standards for registered generation
- Multi-institutional regulatory initiatives
- Short-term focus areas
- Medium-term focus areas
- Rooftop PV regulation to maintain minimum level of system strength
- Robust energy market structure, in terms of having procedures for Electricity Market Supervision and Energy spot prices, were controlled in accordance with a pre-published “hurricane pricing schedule”
- Multiple-rule change proposals for standards

**Integrated Governance**
- Collaboration among AEMO, ARENA and ADFC (predictive coordination within the energy sector)
- COAG Independent Review into the Reliability and Security of the NEM, and ESCOSA to assess technical balance conditions for generation (Economies and Sustainability in the Interconnected Infrastructure sector)
- Collaboration and coordination among different organisations:
  - AEMO
  - TRAG
  - DSE
  - Generator

**Empowered and Engaged Customers**
- Further research is needed on the customers’ preparedness regarding possible interruption of electricity supply
- Further research is needed on how the customers responded to the interruption of electricity supply and what they were able to do to minimise impact
- Further research is needed on how the customers adapt or make their own arrangement to be more prepared for this type of event

**Sustainable Financial Systems**
- Existing procedure is available for Electricity Market Suspension
- Energy spot prices were determined in accordance with a pre-published “hurricane pricing schedule”
- Negative settlement management
- Further research is needed on whether any financial market responded to the event or any participants in any financial market e.g. stock exchange were affected by the black system
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- ADCC to review market processes and systems, and in collaboration with Registered Participants, to identify improvements and any associated NFR or procedural changes necessary to implement those improvements

**Whole System Thinking across Supply Chain**
- Wind farms failed to provide effective disaster response and recovery in the presence of the storms and tornadoes
- In addition to 456 MW of sustained reduction in wind generation, 42 MW of transient reduction was experienced due to natural wind losses through power outages
- Electricity network interconnection was not able to sustain the system after the reduction in wind generation, leading to system separation
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- The technical challenges of the changing generation mix must be managed with the support of efficient and effective regulatory and market mechanisms, to ensure the most cost-effective measures are used in the long-term interest of consumers

**Effective Disaster Response and Recovery**
- AEMO has clear restoration strategy in place, which sets out the roles and responsibilities of the different organisations involved, and details of AEMO’s restoration strategy used to restore the power system and load in South Australia
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**Effective Infrastructure Management**
- AEMO was unaware of protection settings for certain wind turbines
- TNSPs design standards and maintenance of their assets
-的能力，未能在复杂中找到连接点
- AEMO's System Security framework to prevent a repeat of the 2016 incident
- Establishing a system in place to provide demand-side management to the system
- Establishing new options for procuring non-energy services

**Adaptive and Integrated Planning**
- Strategic change in generation mix, i.e. high renewable and low conventional generation
- ULS scheme is in place to provide demand-side management to the system
- Establishing new options for procuring non-energy services
- Load shedding or generation response was not planned with a response time fast enough to prevent system separation
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- AEMO to develop detailed procedures on the disappearence and identification of any NFR changes so required to improve the process
- AEMO to investigate the possibility of implementing a better approach for ensuring the minimum stable load of generating units is taken into account in the dispatch process
- Increased modelling requirements
- Power system modeling and simulation studies

**Understanding Infrastructure Criticality**
- Classification assessment of credible power system contingencies based on weather conditions
- Lack of situational awareness in the control room
- Staff not trained to properly interpret weather information
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**Sustainable Solutions**
- Prevent the wind generation is 820MW (close to 30% of the generation mix at the time)
- At no wind and thermal successively ride through faults, until a pre-set limit which allows a maximum number of successful ride through events was reached or exceeded
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