Modelling of Resilient Electricity Generation after Cascading Collapse

New England Case Study

Presentation of the Foundation for Resilient Societies

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All data and conclusions are preliminary pending review with ISO-New England
Executive Summary

- New England has minimal energy production and storage; region is dependent on imports
- We modelled cyber/physical attack scenario
  - Loss of gas compressor stations and SCADA control
  - Cascading collapse of Northeast electric grid
- Key findings:
  - With careful use of gas line pack, coal and petroleum stored on-site, and dual fuel plants, rolling blackouts can be largely avoided for several weeks
  - But without coal and nuclear plants, model projects persistent blackouts
  - Retirements of oil-fired plants also risk blackouts
New England Grid as Case Study in Limited Energy Storage
Electricity Flows into New England

- **New York: 1-9**
  - AC ties

- **Hydro-Quebec: 10-11**
  - Highgate HVDC
  - Phase II HVDC

- **New Brunswick: 12-13**
  - AC ties
Modelling of Resilient Electricity Generation and Demand
Cascading Collapse Scenario
Commencing on January 1st

- Combined cyber/physical attack at 6pm load peak
  - Loss of compressors for Northeast natural gas pipelines
  - Cascading collapse of ISO-New England grid
- All energy import into New England stops
- All nuclear power plants trip and SCRAM
- Resupply of oil-fired plants is difficult or impossible
- New England must rely almost entirely on its own stored energy sources for two weeks
  - Hydro-Quebec HVDC imports resume after restart
Methodology

- Use ISO-NE load profile from January 1-15, 2018
- Renewable generation from same time period
  - Wind, solar, landfill gas, wood, municipal waste, etc.
- Develop baseline profiles of resources over time
  - Natural gas, oil-fired, coal, nuclear, hydro, imports, DR
- Heat rates and BTU content of fuel from EIA for fossil fuel generators
- Matched EIA Form 860 for fossil fuel ramp rates
- Modelled start time and ramp for nuclear plants
- Model electricity generated at unit level
- Model fuel consumed at plant level
ISO-New England Generation Fuel Mix
Scenario Start at 18:00 Hours on January 1st
August 14, 2003 Nuclear Plant Trips

Percent of Overall Power Capacity

Days Since Cascading Collapse

August 14, 2003 Nuclear Plant Trips
Key Assumptions

- Gas pipeline line pack is near daily maximum
  - 34% of line pack available for electricity generation
- All oil tanks at generation plants are full
- Dual-fuel plants run exclusively on oil
- Mystic Generating Station is fully operational
- Distrigas LNG tanks full; 80% of re-gas for Mystic
- River flow for hydroelectric plants near maximum
- No electricity imports except HVDC hydropower
- No transmission constraints
- Nuclear plants receive NRC approval to operate
New England Natural Gas Consumption
January 2018

Source: EIA Natural Gas Consumption by End Use
Estimation of Fuel Tank Capacities

Source: Google Earth, Resilient Societies analysis
New England Energy Scenarios
Gas-Fired Generation Profile

Megawatts

Hours After Cascading Collapse
New England Energy Scenario After Cyber/Physical Attack During January with 2018 Generation Fleet
New England Energy Scenario After Cyber/Physical Attack
During January with All Coal and Nuclear Plants Retired

- Hydro River Flow
- Coal-Fired
- Demand Response
- Hydro Imports
- Nuclear
- Oil-Fired Baseload
- Renewables
- Gas-Fired
- Oil-Fired Peakers
- Peaking Hydro Discharge
- Peaking Hydro Charge
- Load Shed
New England Energy Scenario After Cyber/Physical Attack During January with ISO-NE “At Risk” Plants Retired
Summary Conclusions

- With current generation fleet, rolling blackouts after cyber/physical attack could be limited and manageable.
- If generation capacity with fuel stored on-site retires, load sheds could be one-third to one-half of peak demand.
  - Repeated challenges with cold-load pickup over many days.
  - Too large a shortfall for effective demand response.
- More generation capacity with zero or limited on-site energy storage will not protect against rolling blackouts.
  - Natural gas generators dependent on non-firm contracts.
  - Dual-fuel plants with only a few days of energy storage.
  - Renewables inherently limited by wind and daylight hours.
- Risk of major societal disruptions without on-site energy.
  - Hard to discriminate between critical and non-critical loads.
  - Blackouts for hospitals, fire stations, police, jails, pharmacies, etc.
For More Information

- To get a copy of our presentation, please send an email to: info@resilientsocieties.org

- Foundation for Resilient Societies is an IRS-approved 501(c)(3) charitable organization with the mission of critical infrastructure protection. Learn more by visiting www.resilientsocieties.org

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