Investment Planning to Enhance Resilience of Power Systems against Extreme Weather Events

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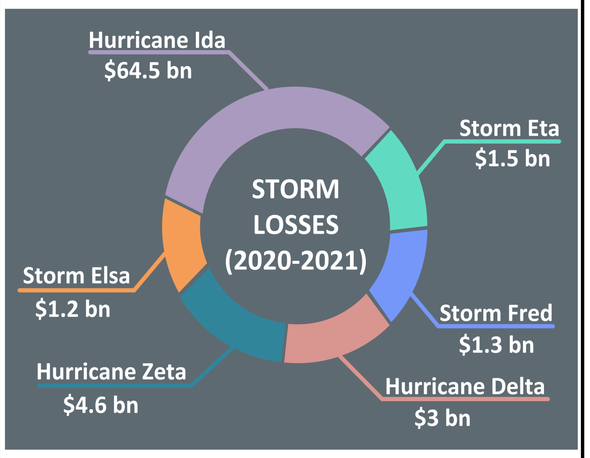
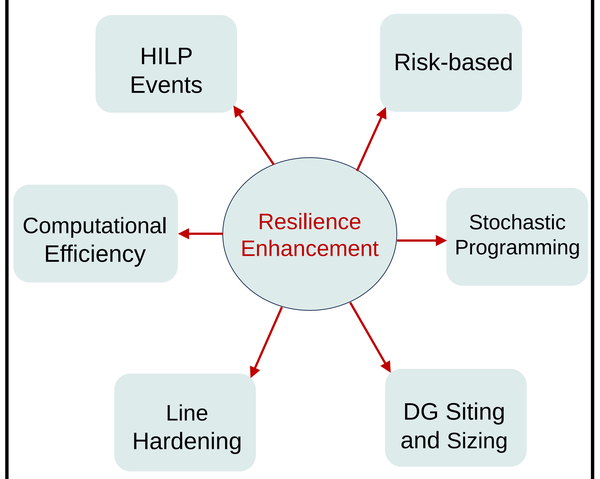
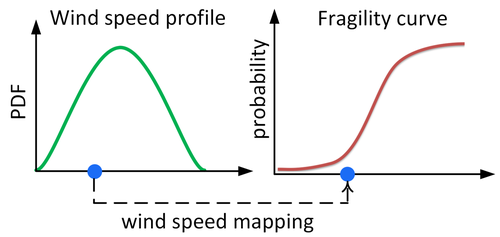
1. BACKGROUND AND MOTIVATION

- Almost $1.06 trillion economic loss due to weather-related events
- Major reason of socio-economic losses → high-impact low-probability events
- Annual average of disaster exceeding $1 billion
  - 8.1 events from 1980 to 2022
  - 18 events from 2018 to 2022
- 83% of major outages(2000-2021) were weather related
- Annual average power outages grew by 78% compared to last decades
- Traditional system planning methods do not incorporate the impact of high-impact low-probability events
- Risk-based planning framework to enhance the resilience of power systems is required



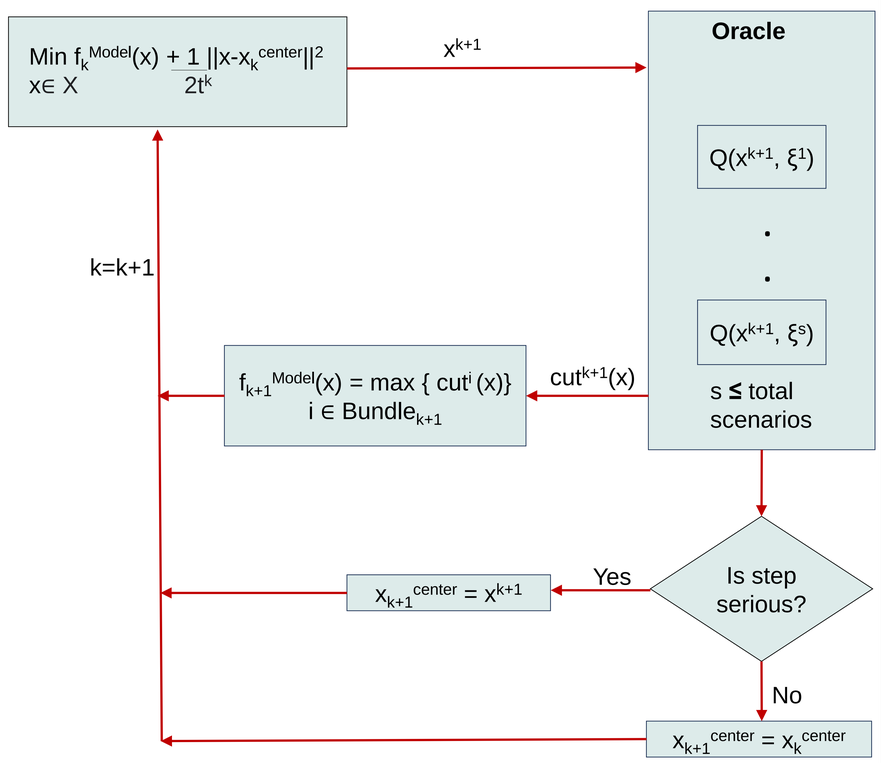


2. IMPACT MODELING



- An event is characterized by:
  - Intensity of event (wind speed here)
  - Probability of its occurrence
- Wind speed is mapped to component level fragility curve which then gives system level impact using Monte Carlo Simulation

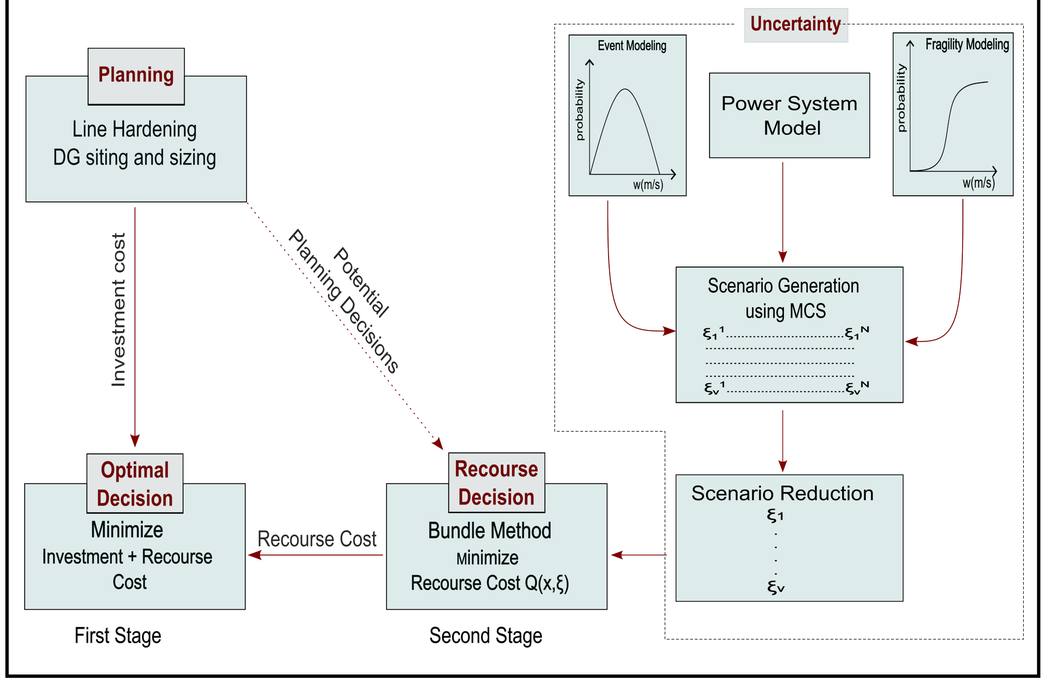
3. DECOMPOSITION METHOD



Inexact Bundle Method

- $f_k^{Model}(x)$ is the approximated model of objective function given by linearizations
- Bundle should contain at least two linearizations at all iterations
- Step will be serious if current solution(x^{k+1}) has lower objective value than that of stability center(x_k^{center})

4. METHODOLOGY



5. EXPECTED RESULT

- Selective line hardening and DG placement under limited budget reduces the load loss in the system during uncertain HILP event.

6. CONCLUSION AND FUTURE WORK

- Risk-averse two stage stochastic programming is proposed to enhance power system resilience
- Efficient decomposition method will be implemented to approximate expected function
- Systematic scenario reduction technique will be implemented

REFERENCES

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3. W. Oliveira, C. Sagastizábal, and S. Scheimberg, “Inexact bundle methods for two-stage stochastic programming,” SIAM Journal on Optimization, vol. 21, no. 2, pp. 517–544, 2011