
Elements of a National Grid Resilience Architecture

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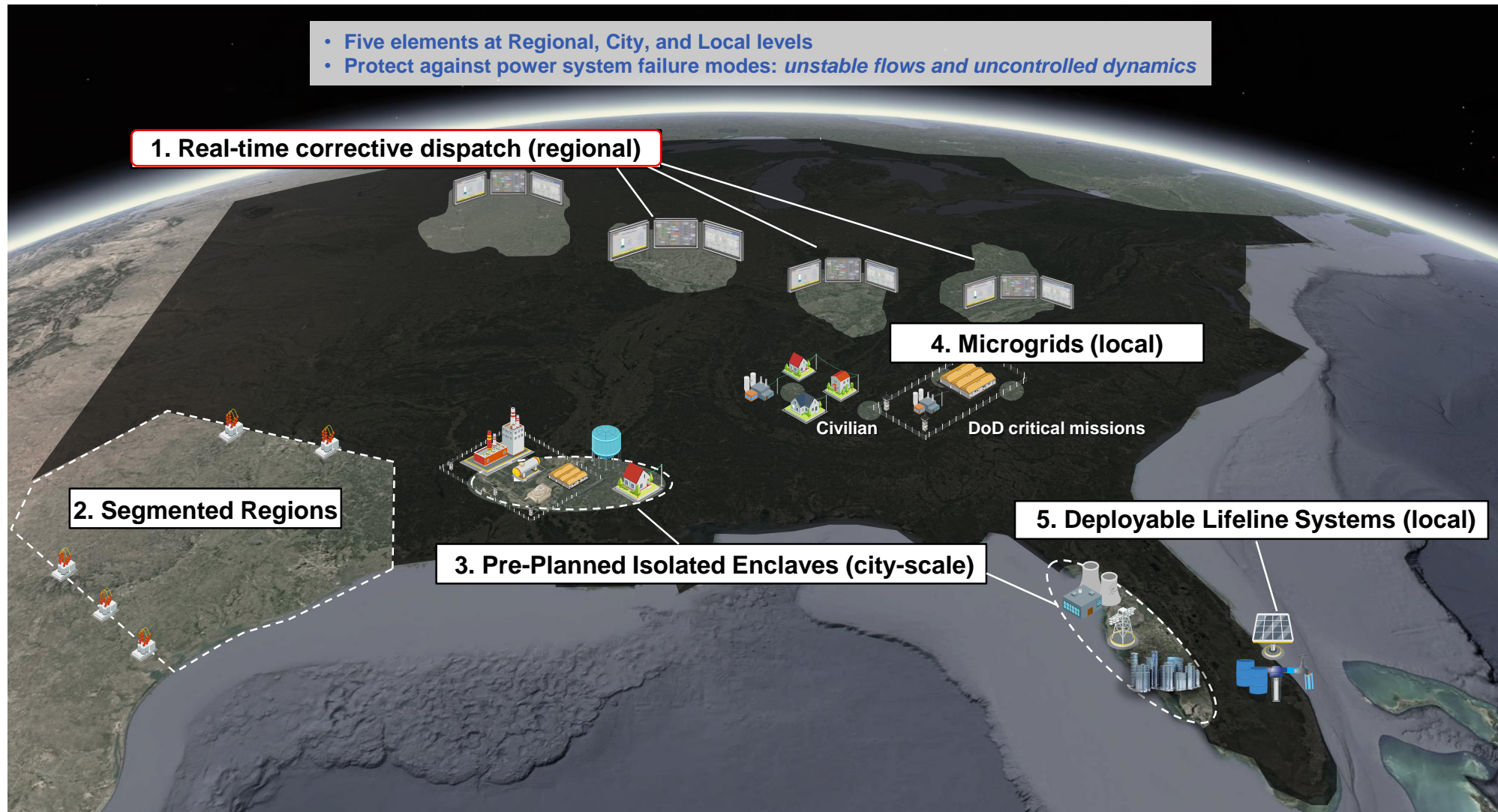
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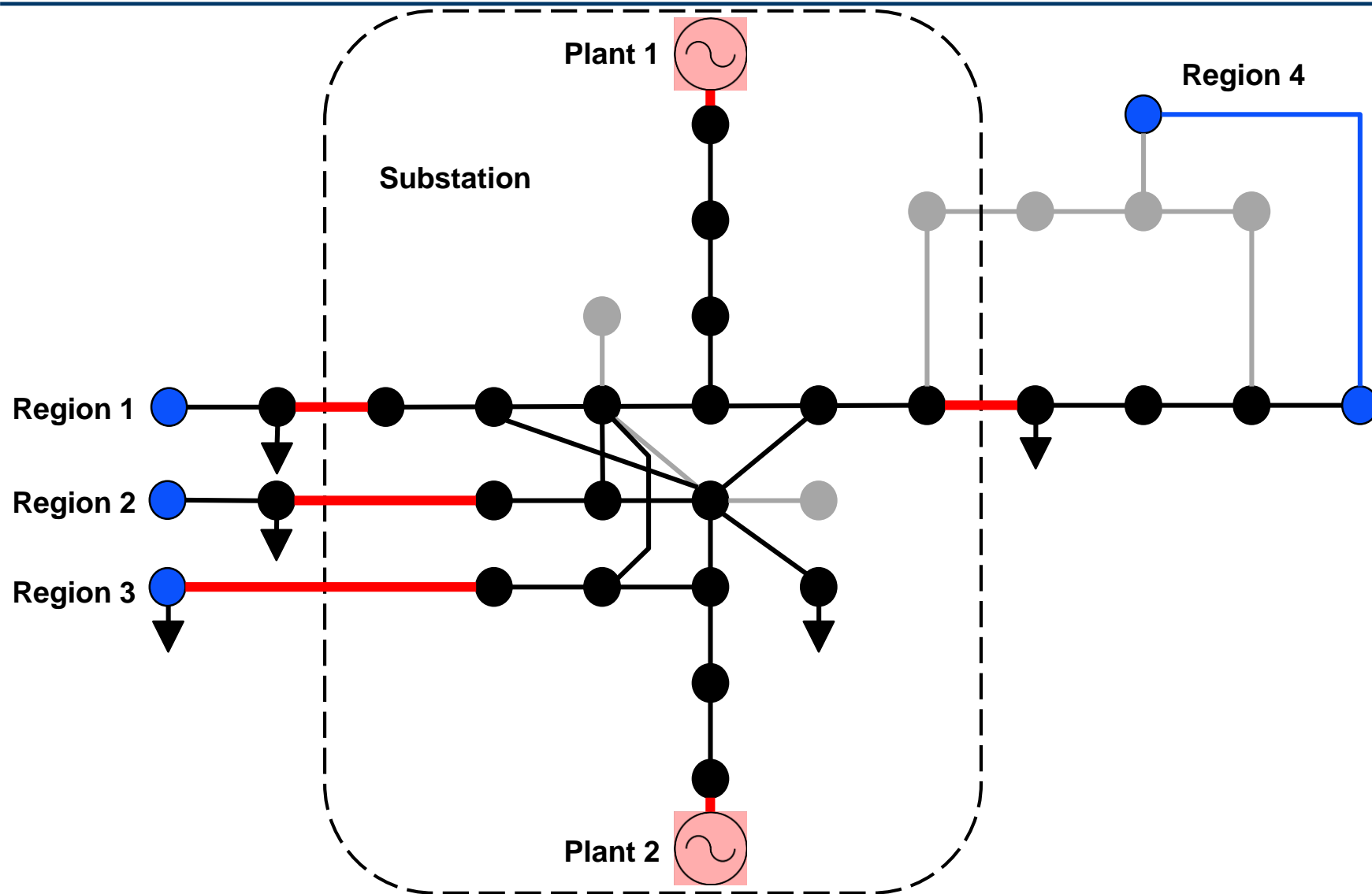


National Grid Resilience Architecture Vision





Anonymized Excerpt of ISO-NE System: Major Contingency



Major N-6 contingency event

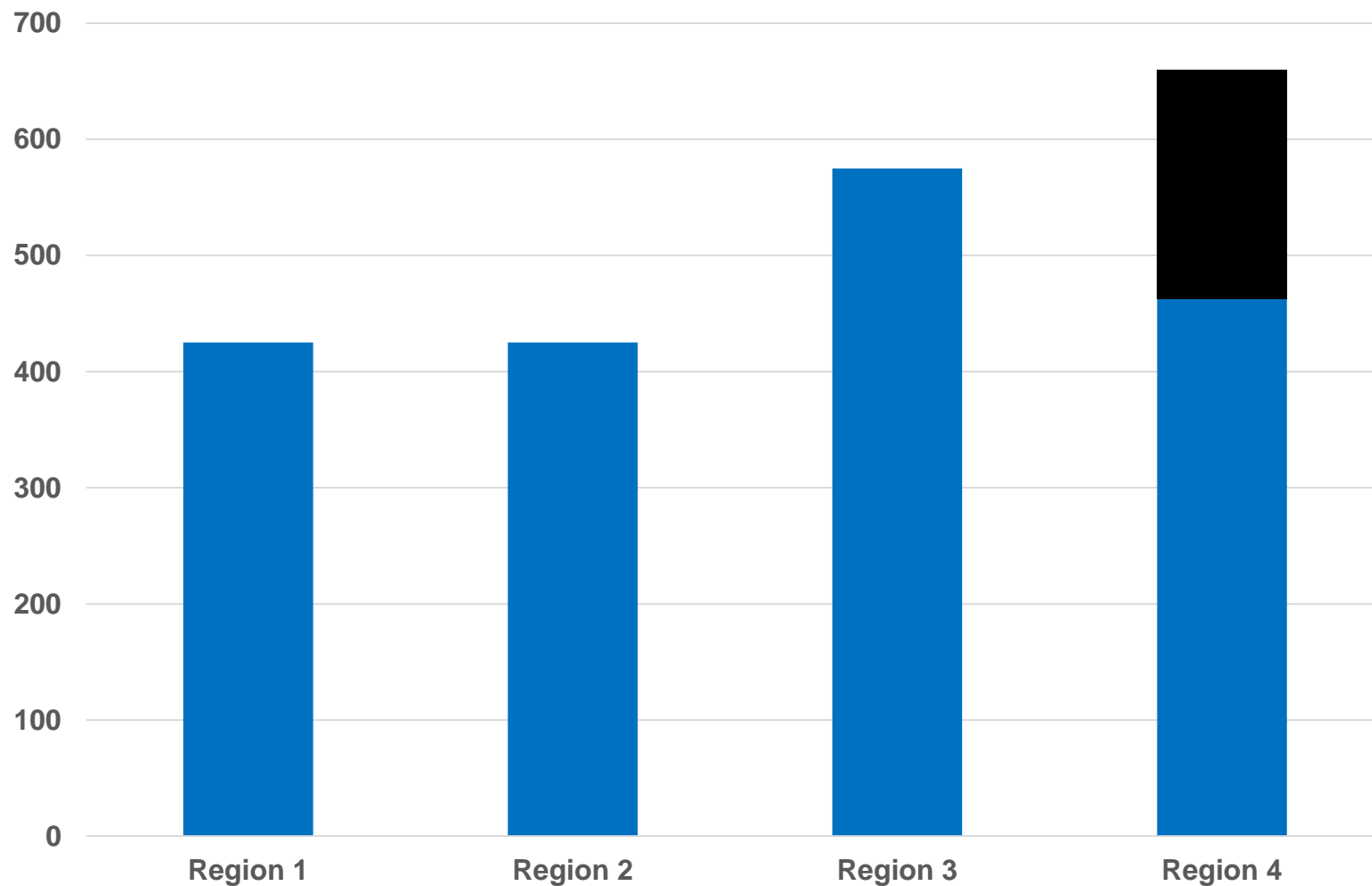
- 2.1 GW of generation lost
- Four major ties lost

Legend

- Faulted bus or generator
- Faulted breaker
- ⊗ Power generation plant
- Connection to rest of network
- De-energized bus
- Energized bus
- Normally-open breaker
- Normally-closed breaker



Power Flow Optimization Results: Best Case Outage Scenario



- 200 MW blackout
- Potential cascading outage
 - 6 buses with voltage violations

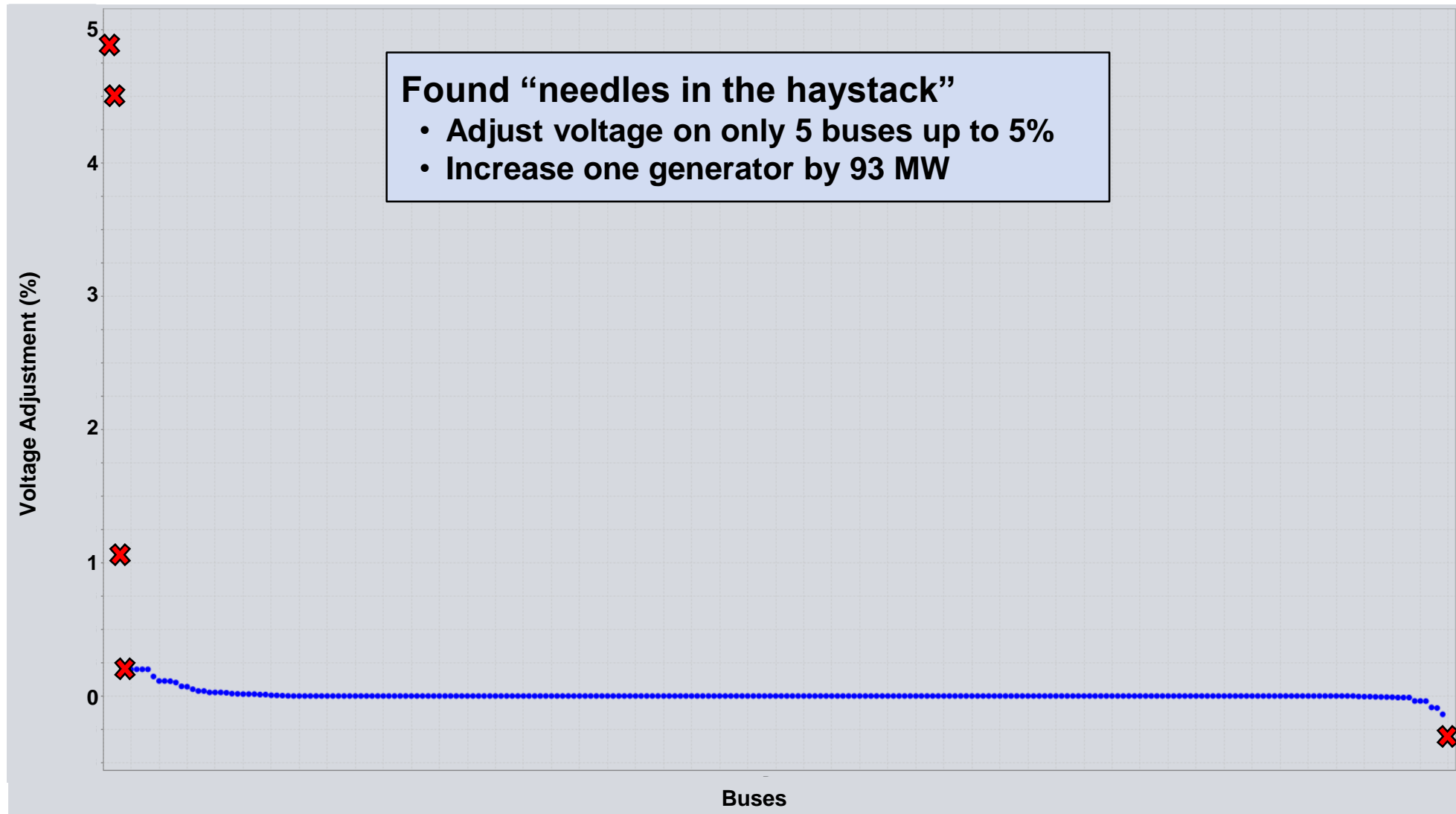
■ Best-case Unserved Load *Blackout* (MW)

■ Post-outage Load Rebalanced (MW)



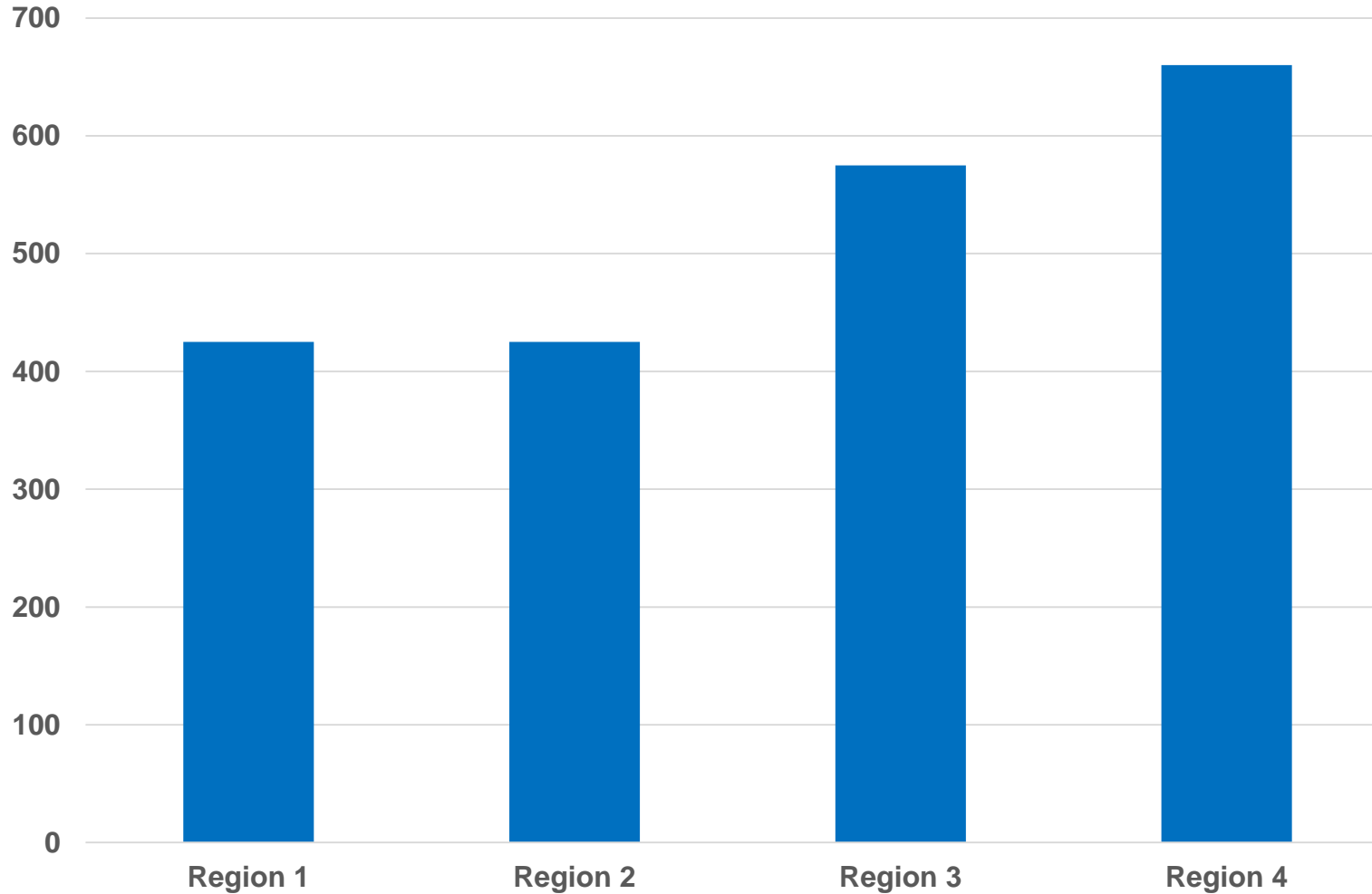
RARES Optimization Algorithm Results

Voltage Adjustment Guidance to Operators





Minor Adjustments Prevent a Blackout

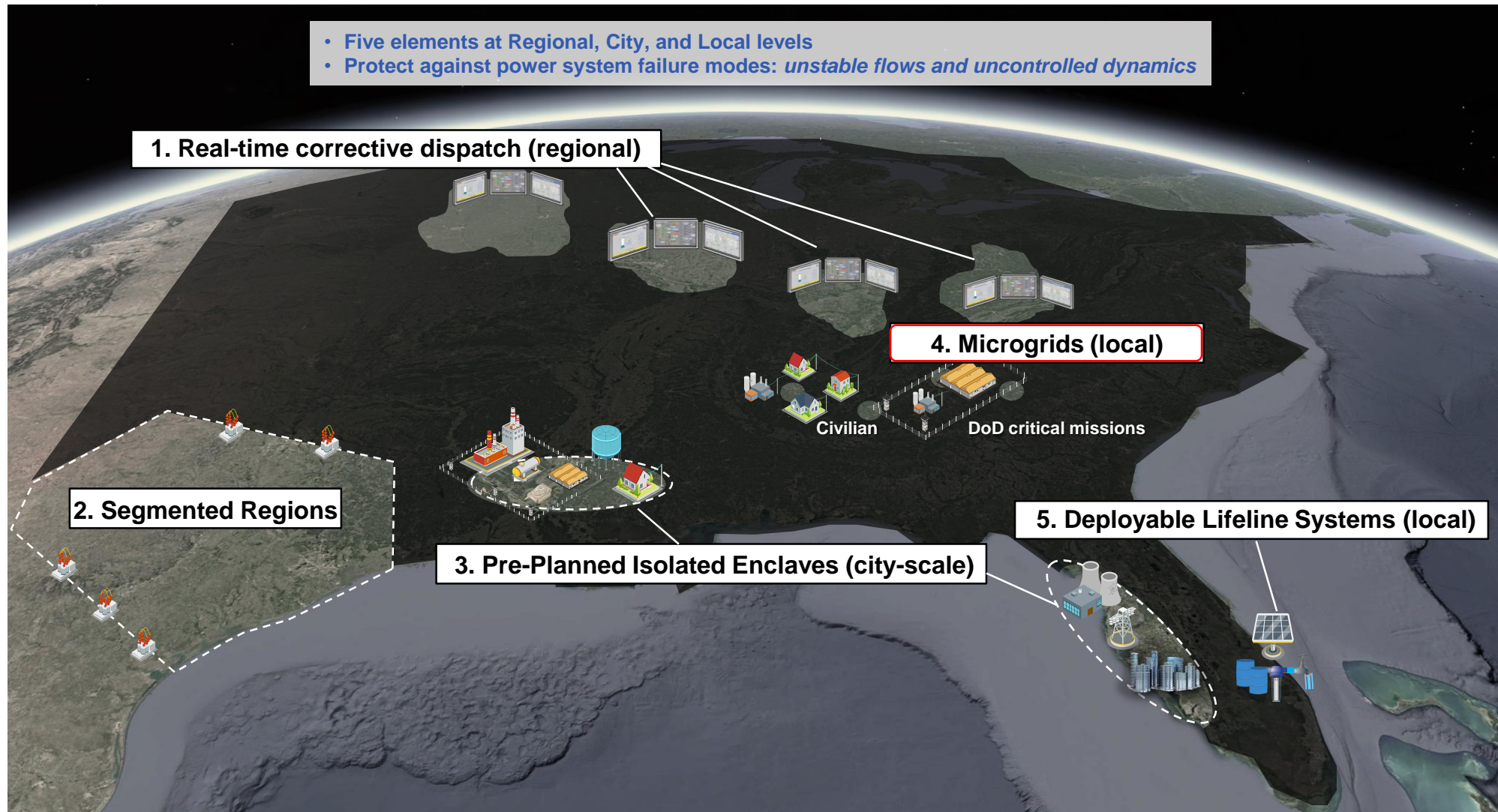


- **MIT-LL's RARES results solved on the ISO-NE power flow software**

■ Rebalanced Load with RARES Adjustments (MW)

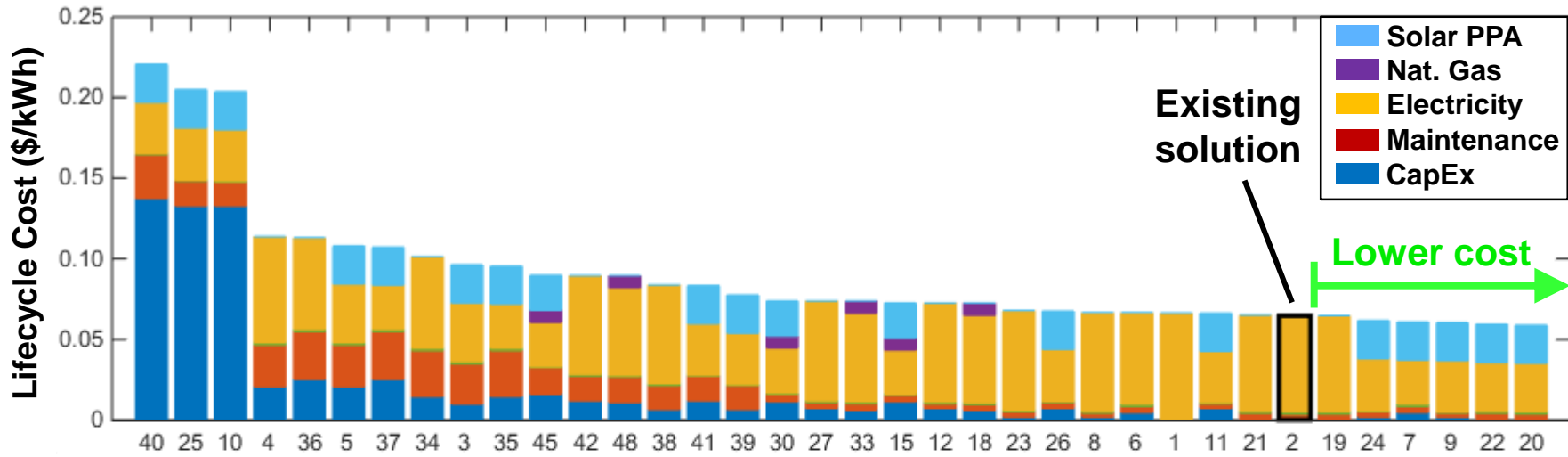


National Grid Resilience Architecture Vision





Typical Outage Events – 90 MW Site Using Available Fuel Reserves



Architecture #24 assets:

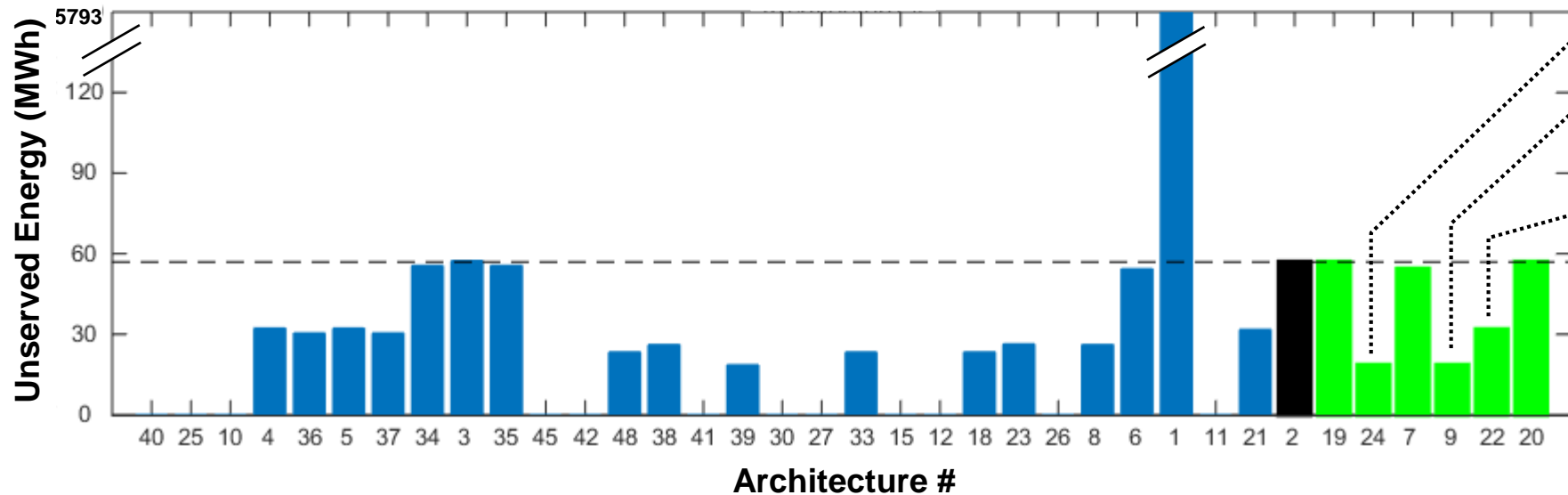
- Microgrid
- Central & building generators
- Islandable solar

Architecture #9 assets:

- Microgrid
- Central generators
- Islandable solar

Architecture #22 assets:

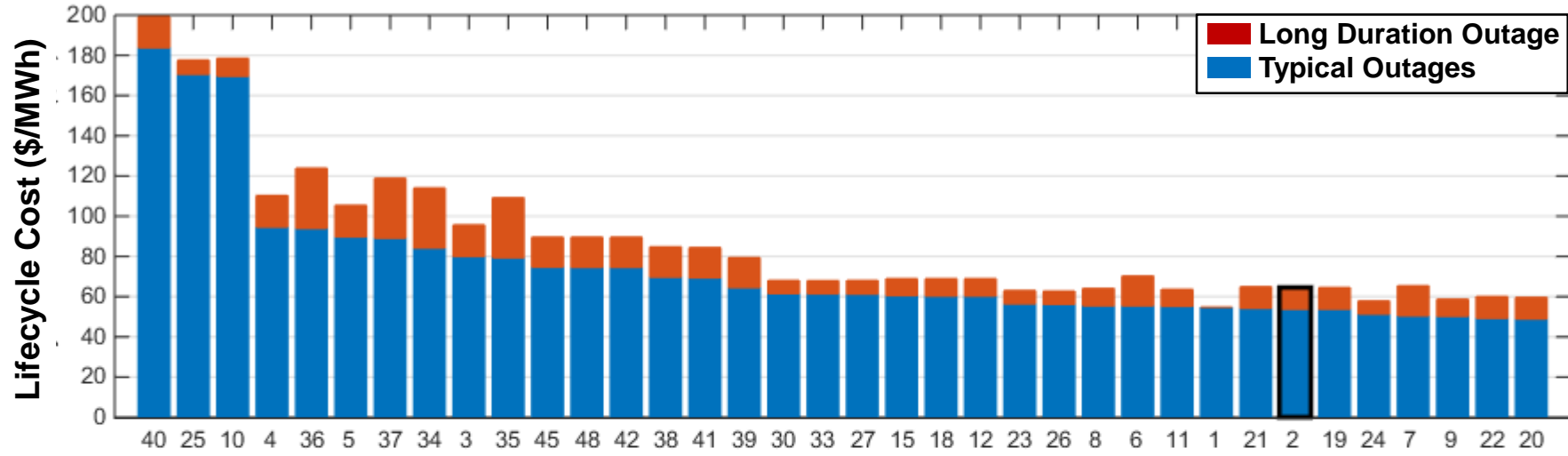
- Central & building generators
- UPS
- Grid-tied solar





14-day Outage – 90 MW Site

14-day Fuel Reserves, No Offsite Maintenance



Architecture #24 assets:

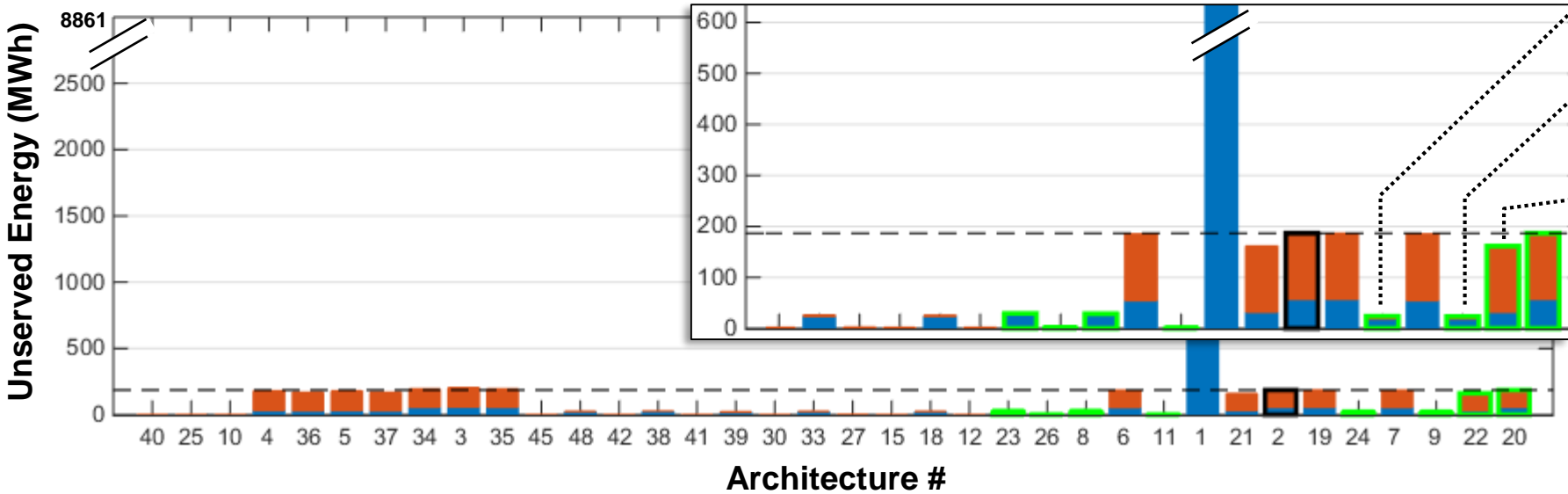
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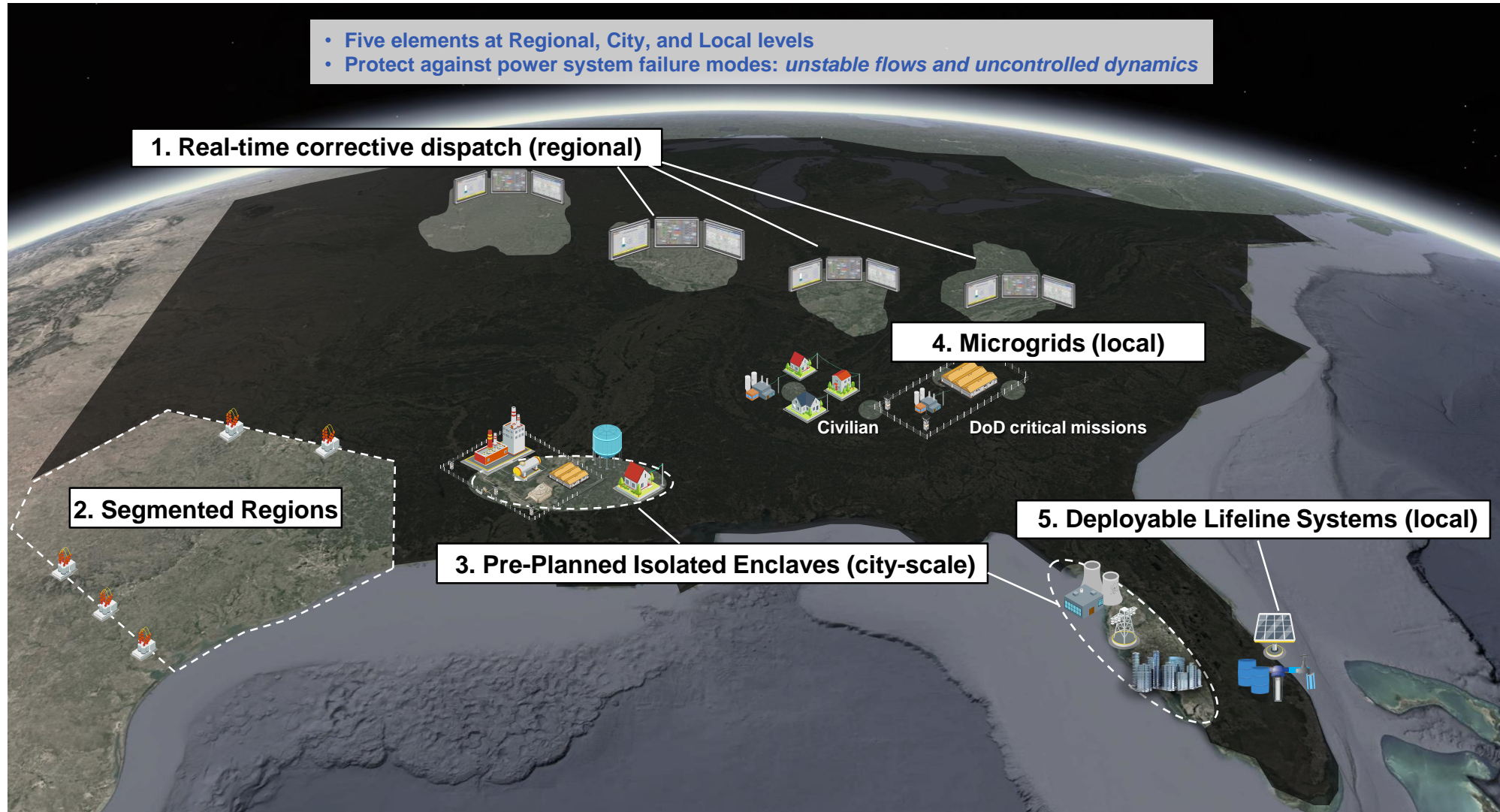
- Central & building generators
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The correct systems could make sites resilient to long-duration outages



National Grid Resilience Architecture Vision





Internet Connectivity as a Proxy for Power Status

Hurricane Irma: Florida

