# Elements of a National Grid Resilience Architecture

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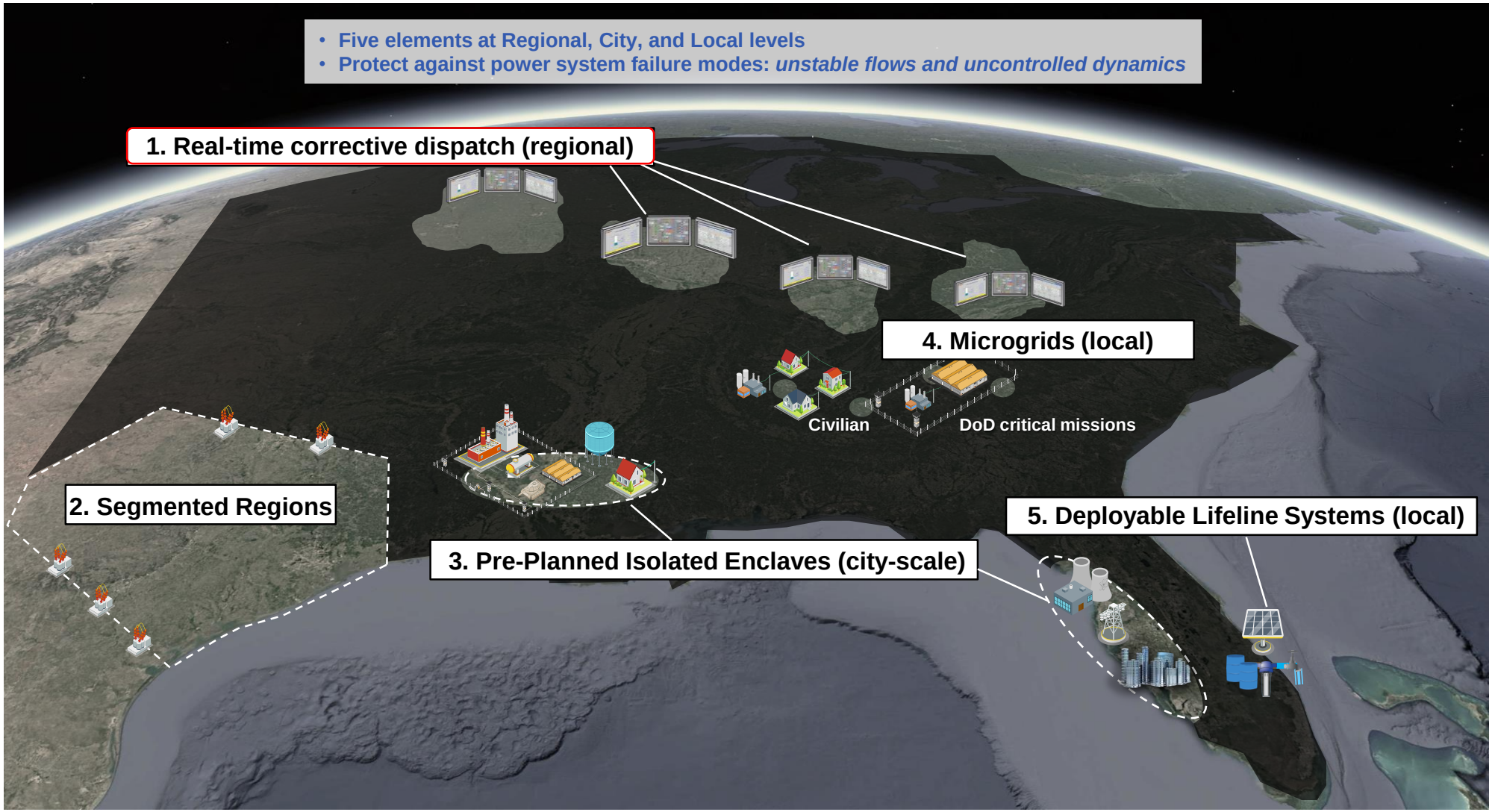
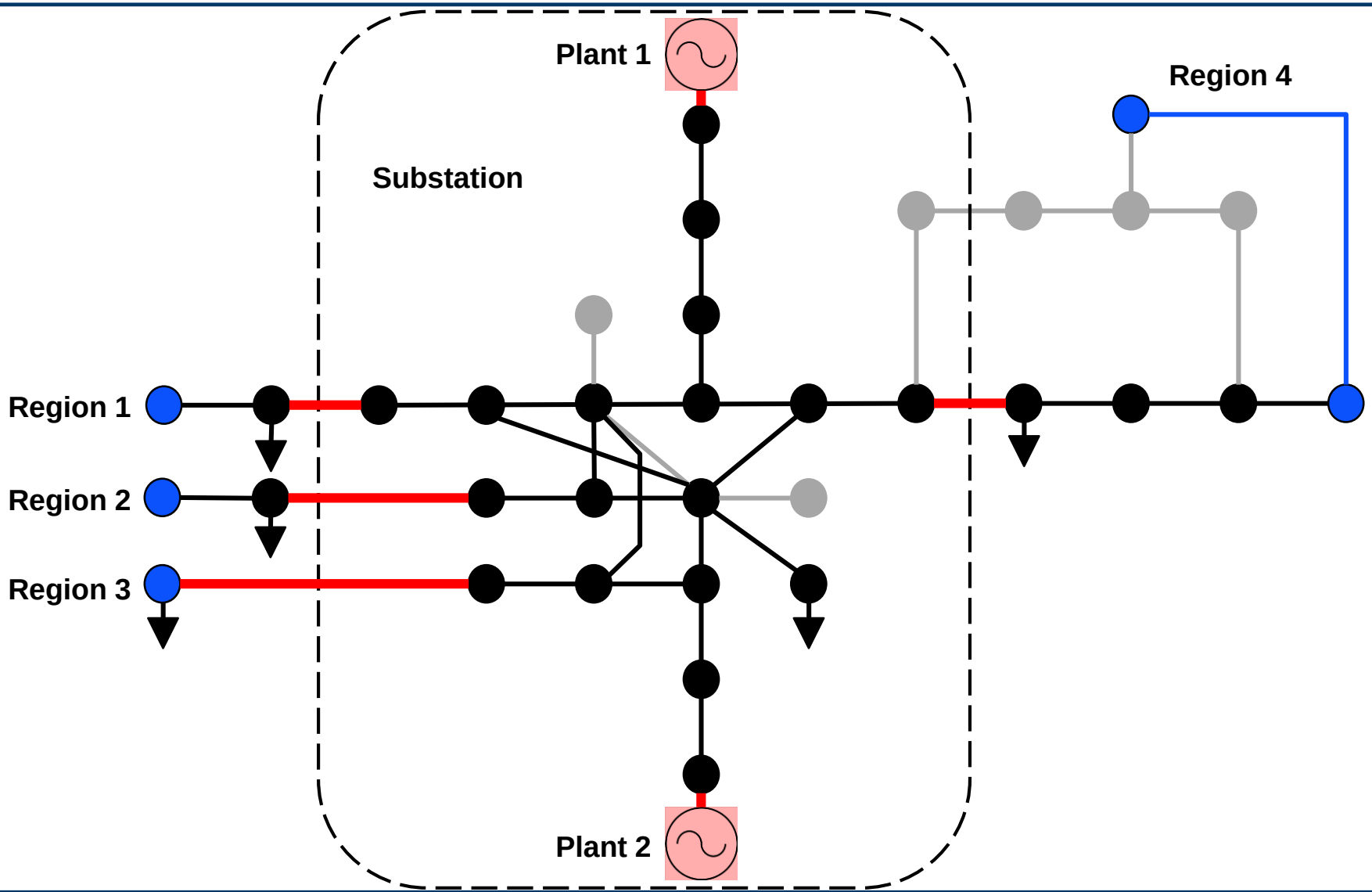
# National Grid Resilience Architecture Vision



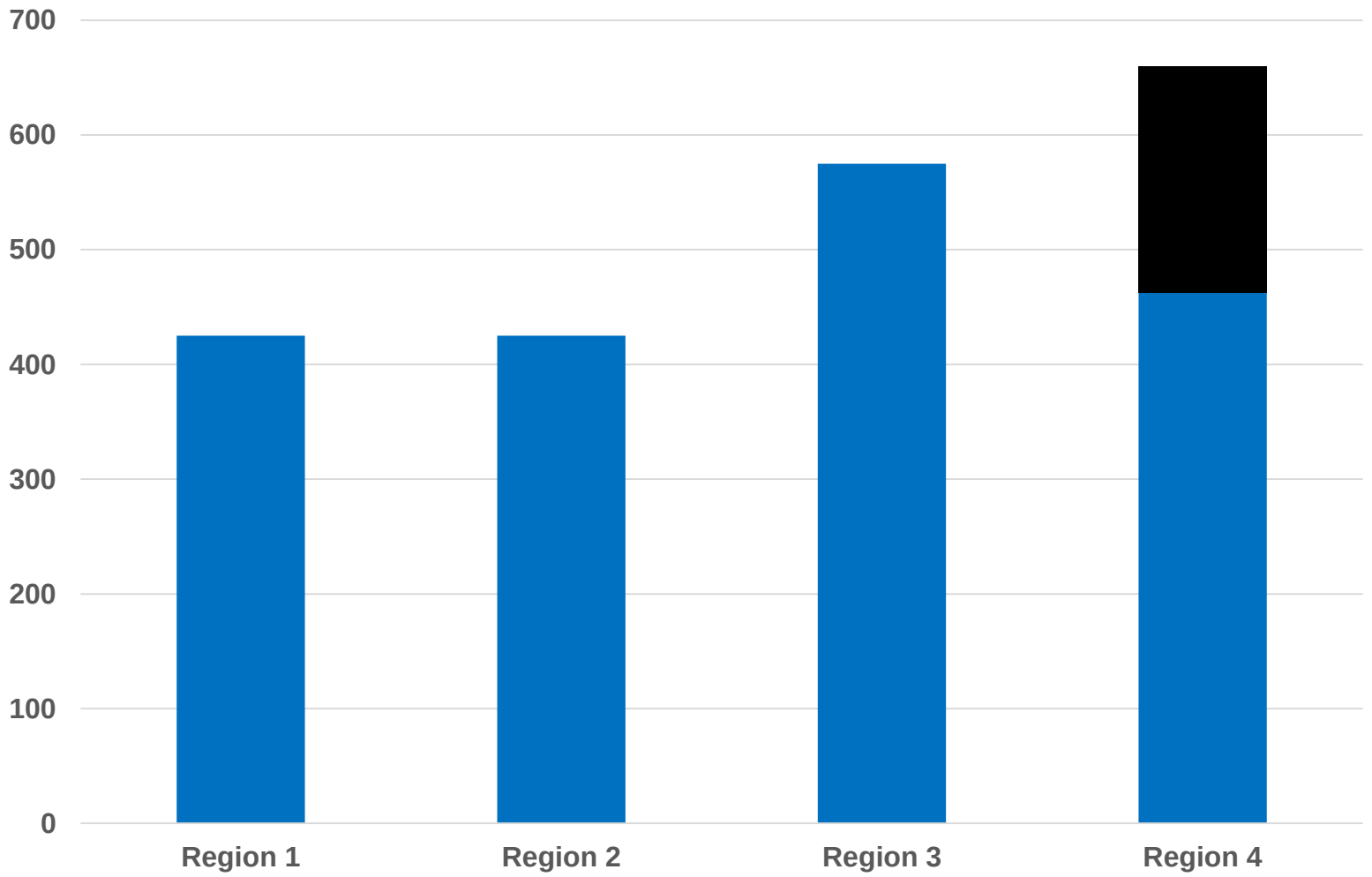
# Anonymized Excerpt of ISO-NE System: Major Contingency




**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

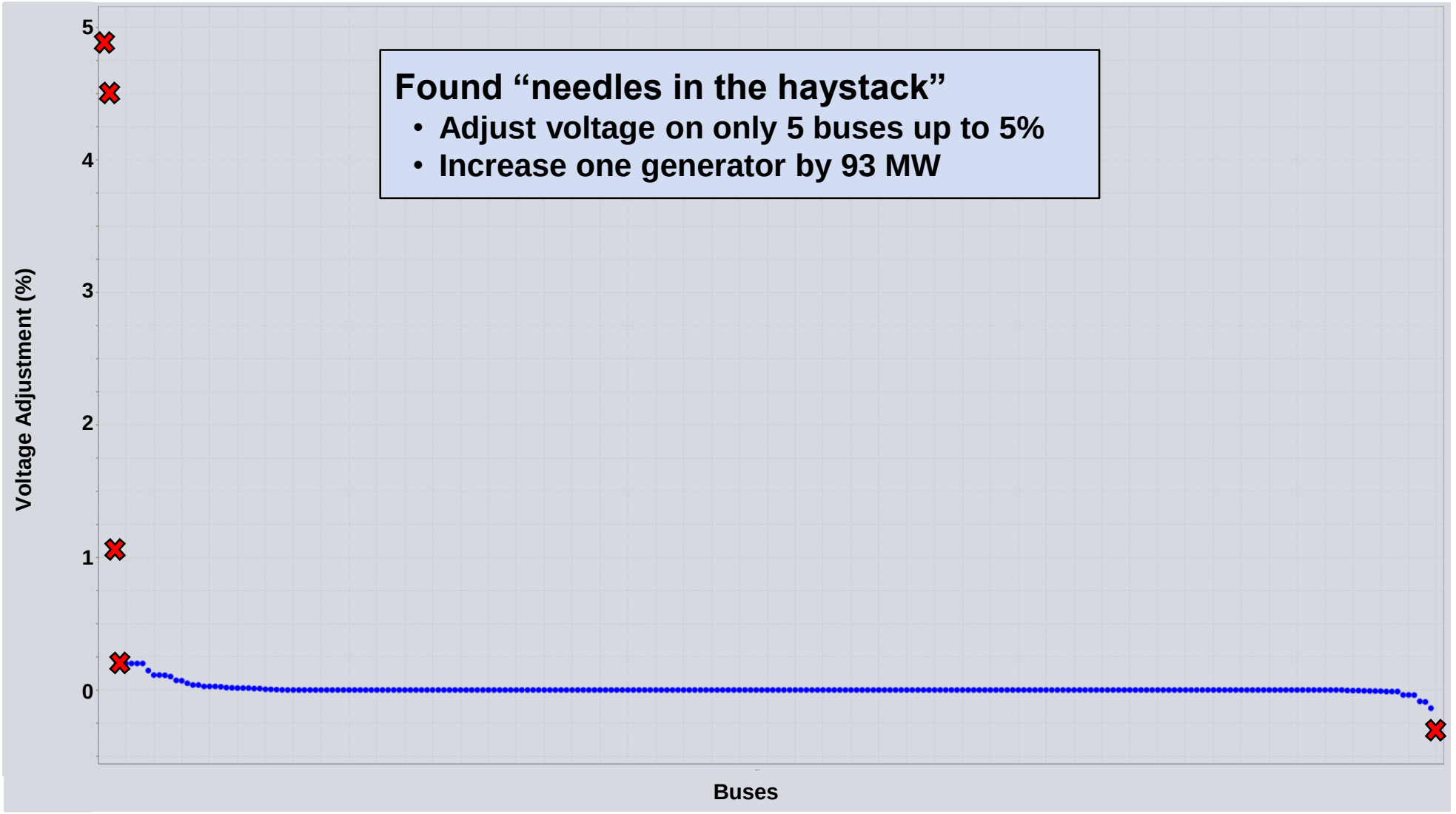
# Power Flow Optimization Results: Best Case Outage Scenario



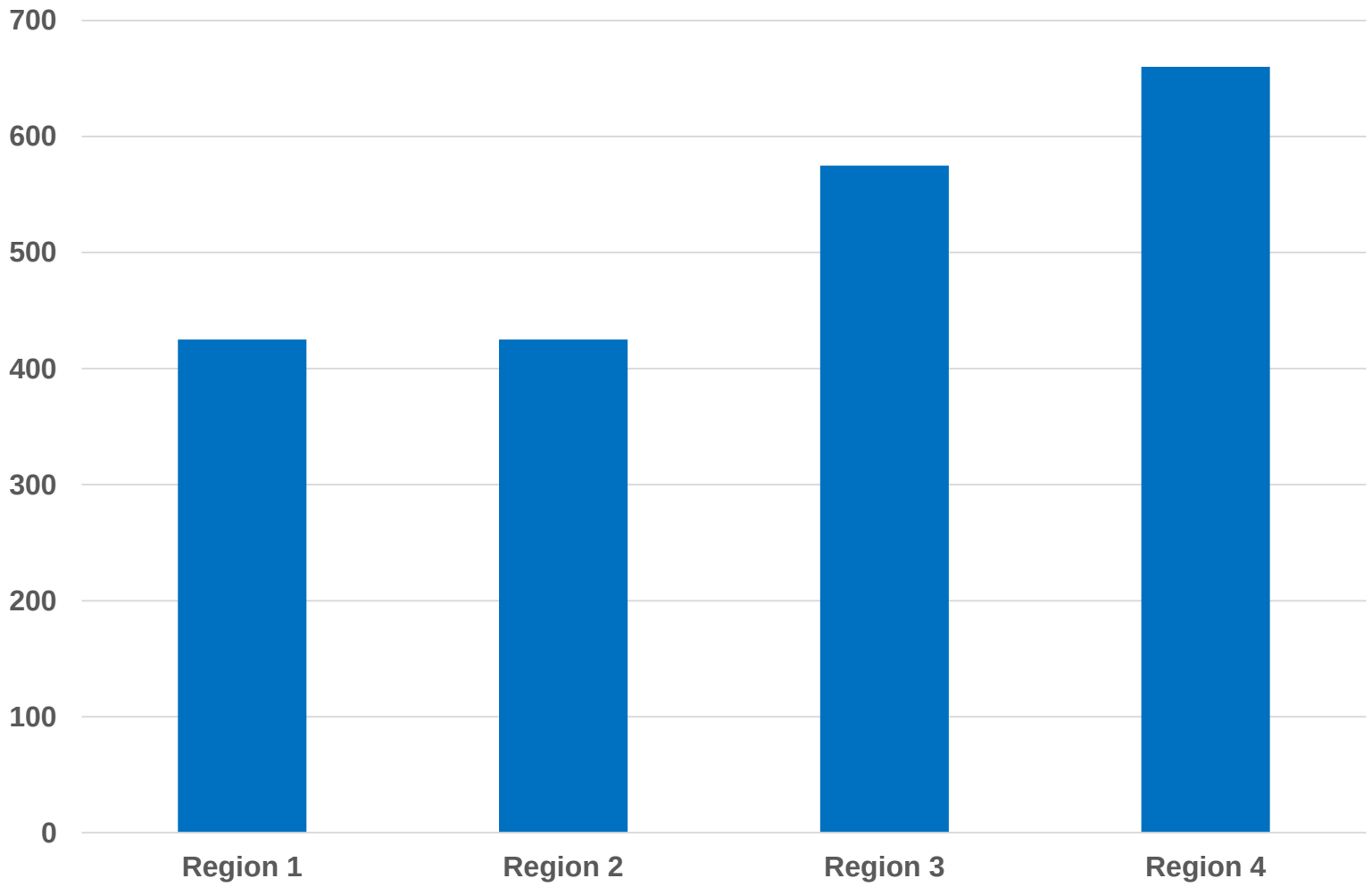

- **200 MW blackout**
- **Potential cascading outage**
  - **6 buses with voltage violations**

# 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**

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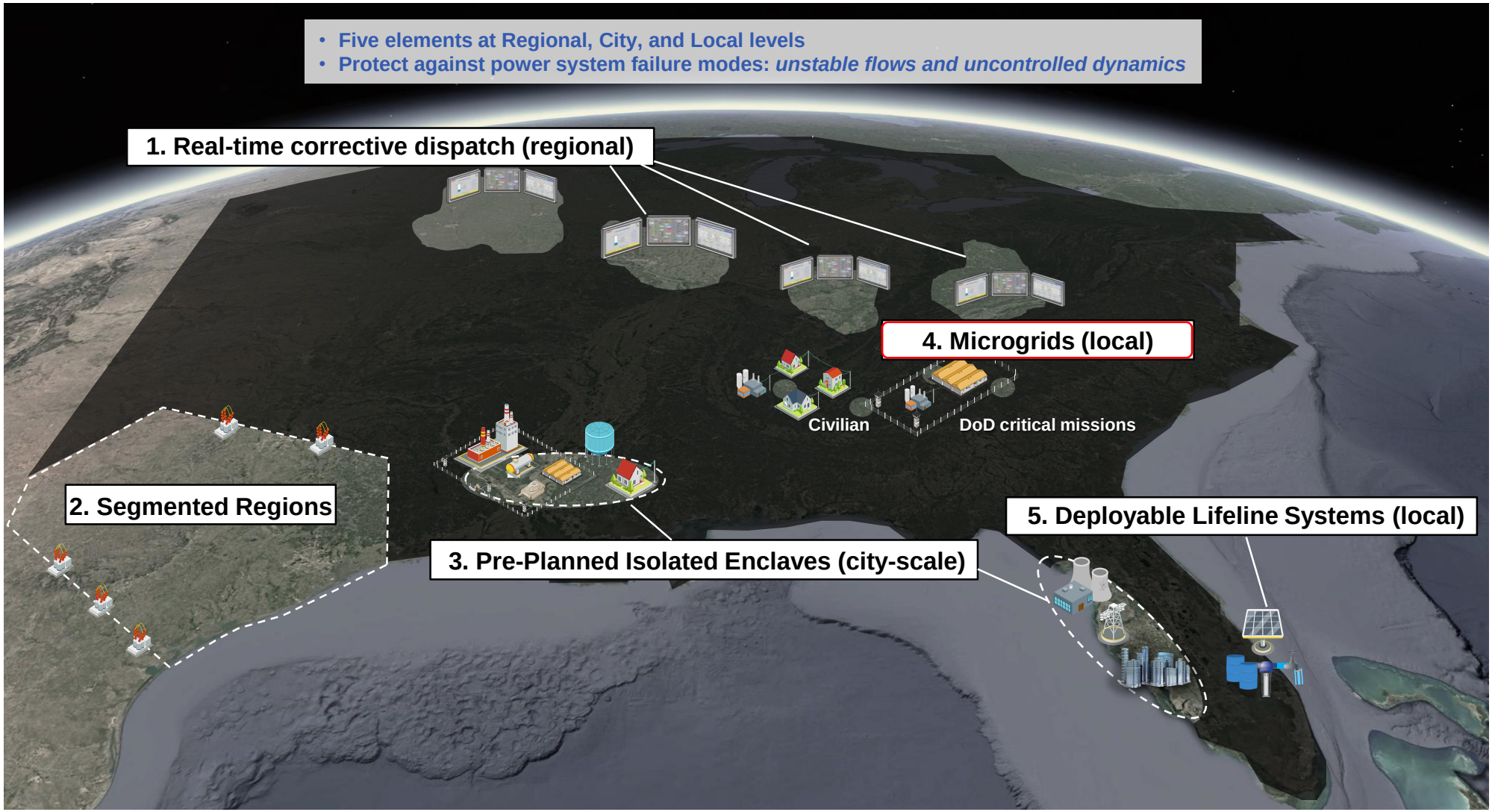
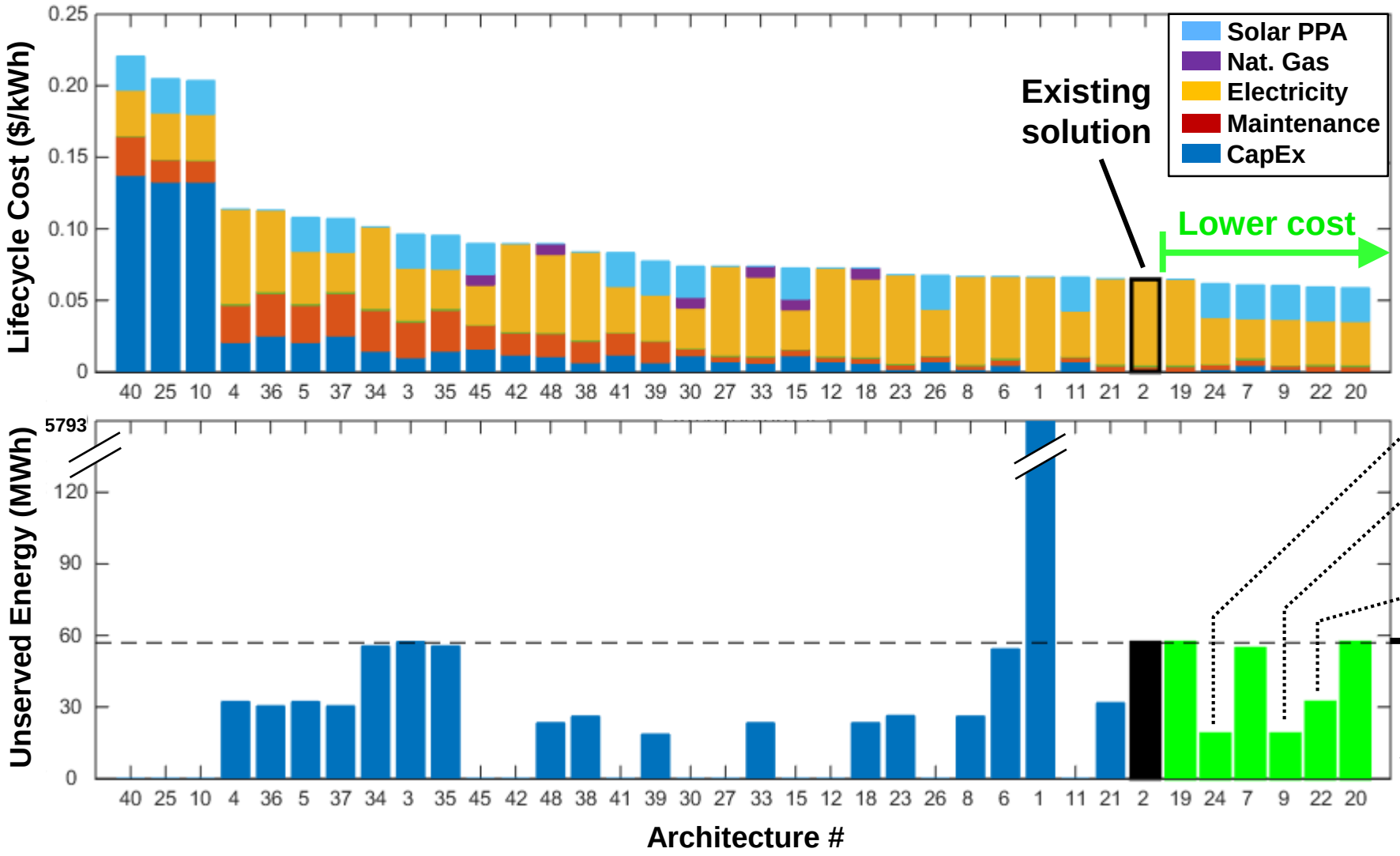


# Typical Outage Events – 90 MW Site

## Using Available Fuel Reserves




**Architecture #24 assets:**
- Microgrid
- Central & building generators
- Islandable solar

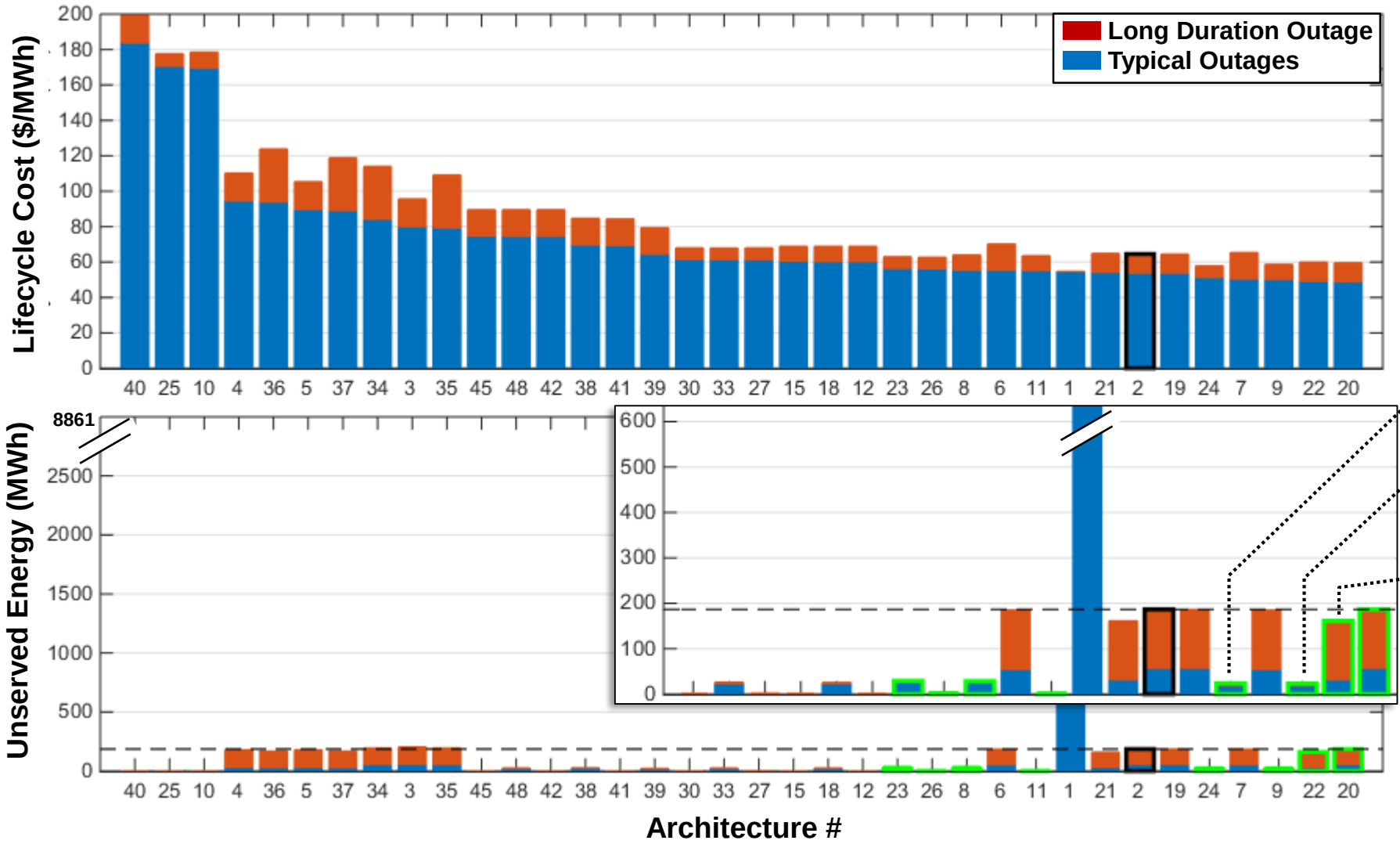
**Architecture #9 assets:**
- Microgrid
- Central generators
- Islandable solar

**Architecture #22 assets:**
- Central & building generators
- UPS
- Grid-tied solar

More resilient

# 14-day Outage – 90 MW Site

## 14-day Fuel Reserves, No Offsite Maintenance

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**The correct systems could make sites resilient to long-duration outages**

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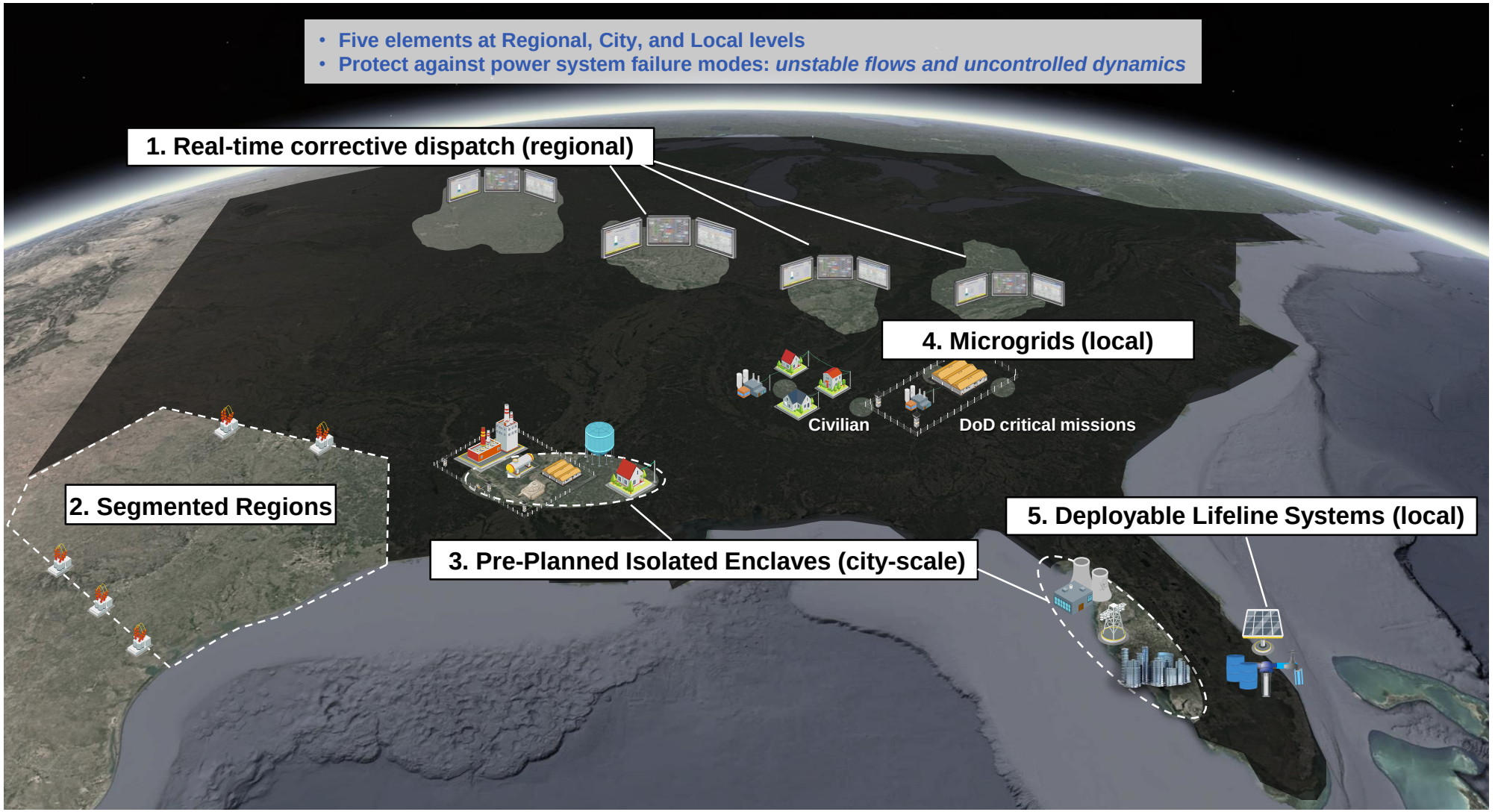

# Internet Connectivity as a Proxy for Power Status

## Hurricane Irma: Florida