Energy Resilience Analysis

Dr. Nicholas Judson

Energy Planning for Resilient Military Installations Workshop

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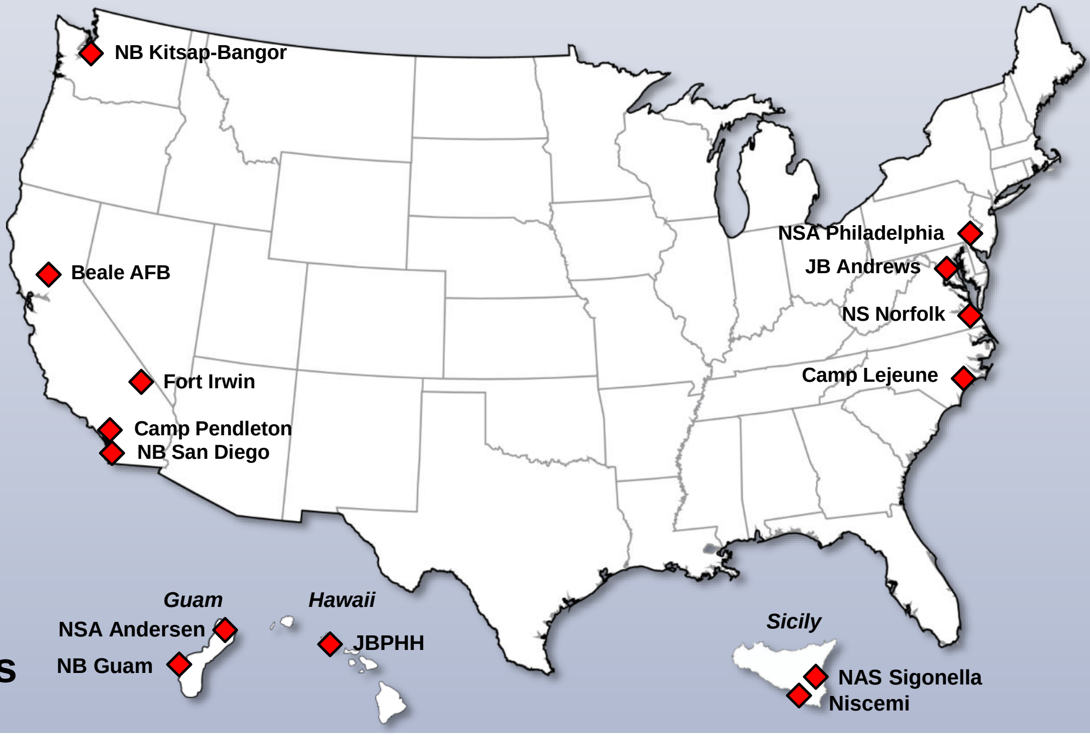
Bottom Line Up Front

Using mission requirements as the lens through which to evaluate options makes us technology agnostic and capabilities focused. Cost & performance can often be improved over existing approach.

- Energy projects need to be approached from a mission resiliency point of view
  - Resilience: the ability to change the operational approach based on the current status of systems or threat
- Location-specific viewpoint
  - Are there site-specific constraints on technology acceptance?
    - RE constraints; Air quality constraints; land use; utility service
  - Resupply of components is time-consuming
    - Use consistent components and control systems to streamline operations
- Scenarios through which to view the installation energy posture
  - Seismic or weather threats: long duration outage
  - Human-induced threat: resupply or site-specific concerns

DoD Energy Resilience Conditions

- **Current energy security solutions at DoD installations typically consists of backup diesel generators at the point of load**
  - **Large numbers of generators, difficult to refuel and maintain**
  - **Maintenance staffs are undermanned**
- **Many installations have large diesel reserves to fuel trucks and other equipment**
- **Levels of interdependency with the surrounding community vary considerably**
  - **Installations in heavily populated regions are likely more reliant on off base services (water, wastewater, etc.)**
  - **Isolated installations will be more self sufficient, but will still have some dependencies**



Global Findings from Site Visits

- **Mission knowledge of backup power capabilities varies widely**
  - **Some missions test generation realistically and frequently**
    - **SWFPAC; NCTS**
  - **Some missions have no visibility into the risk posture that their generation systems present**
- **Mission owners are not well connected to utility system operators**
  - **Critical missions may have the resources to fix problems as they see them – limited discussion with PWD/ CES/ DPW**
- **Mission requirements for energy not well defined or communicated to PWD/ CES/ DPW**
- **Prioritization across the site often not clear (and changes depending on scenario)**
- **Mission loads not known: generators often oversized**
- **Focus on new technology without knowing basic requirements**

General Recommendations

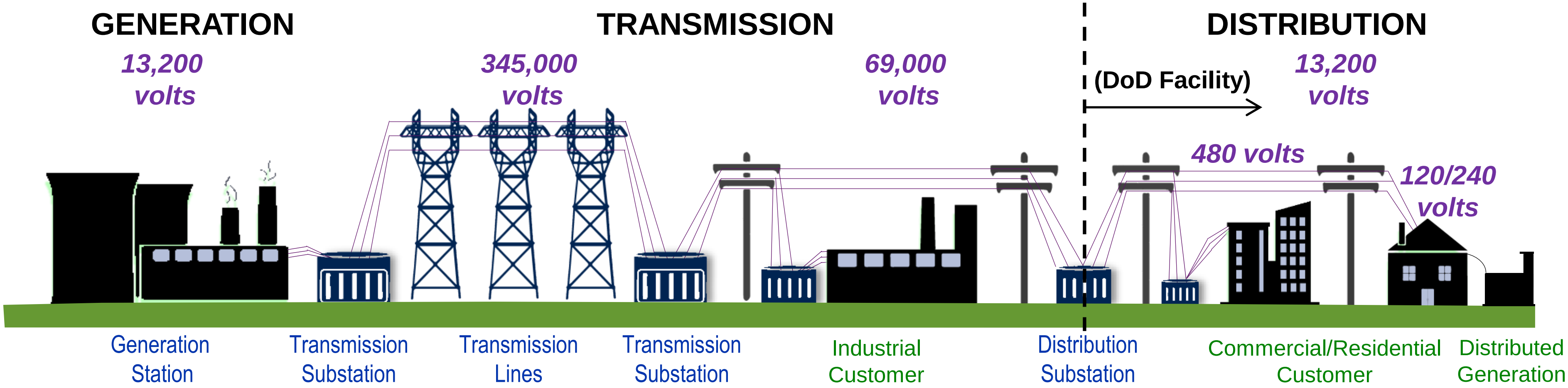
- **Consolidated generation at the substation / critical feeder level improves resiliency**
  - **Large emergency diesel generators or natural gas cogeneration with dual fuel capability**
  - **Requires a reliable distribution system on the installation**
  - **Reduces the maintenance burden on base personnel: more likely to work during an outage; large installations can have 100s of generators**
- **Solar PV through 3rd party financed PPAs can often provide electricity to the installation at below market rates**
  - **For islanded operation the appropriate inverter functionality will need to be included in the PPA agreement**
  - **Potential to offset a modest amount of diesel needed during grid outages**
- **Power systems that enable a more flexible allocation of power on the installation can also improve resiliency**
  - **Upgraded distribution system including additional switching capability**
  - **Installation wide communication and control of the energy system**

Requirements driven designs and realistic testing can show capabilities gaps in the existing approach

First Principles for Resilient Energy System Design

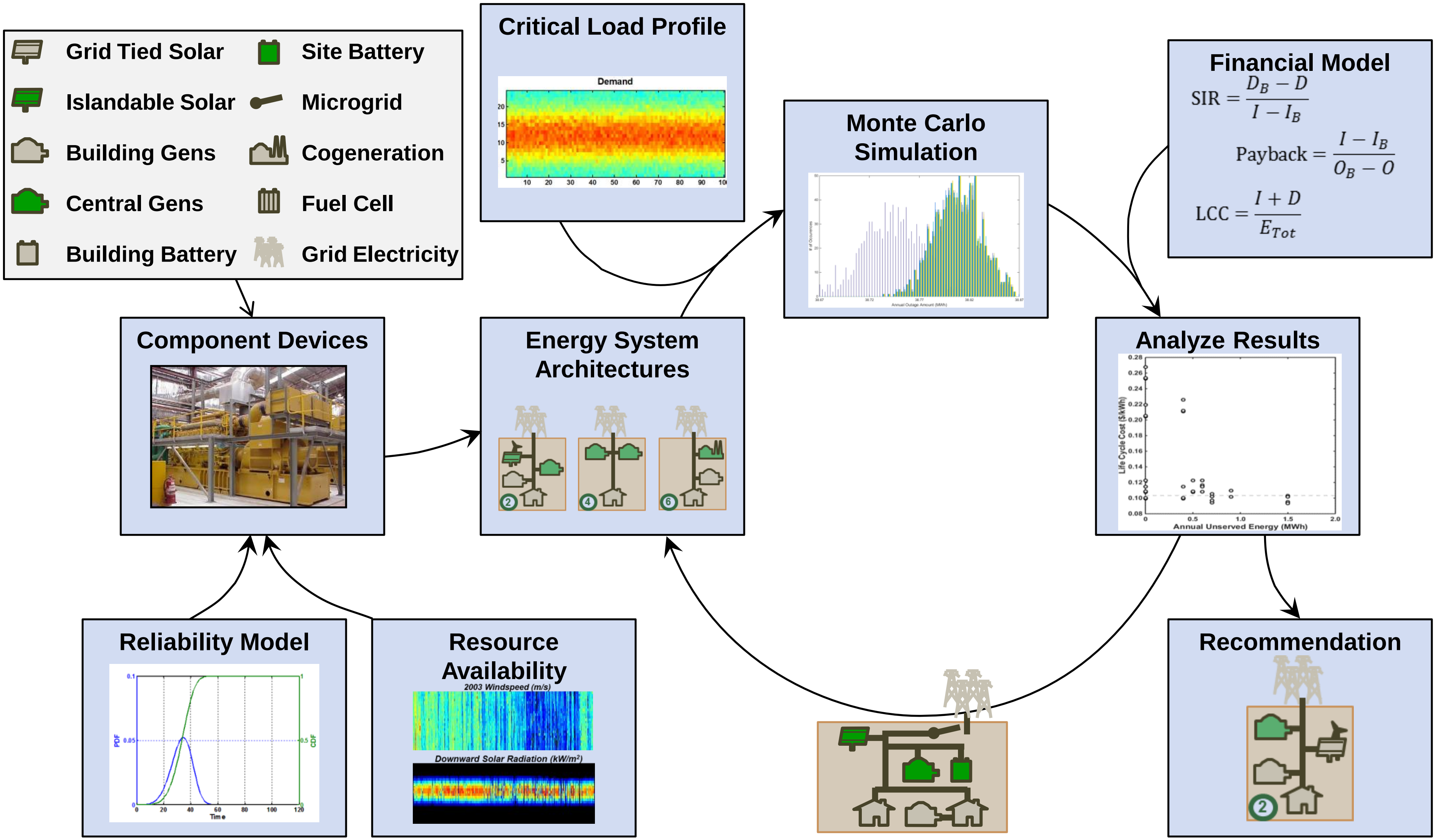
- Mission requirements drive design
  - What is the cost if the mission cannot continue?
  - Include required interdependent infrastructure
- Flexible electric delivery system (redundancy where needed)
- Prioritize loads ruthlessly (allow for load shedding dependent on situation)
- Aggregate generation assets and loads prudently
  - Unreliable electric distribution systems force each critical load to have its own generation or storage system
- Design assets for dual use during both blue and black sky events
  - CHP, if an option, is both prime generation and more efficient
  - Islandable solar allows operation during grid outages
- Test assets realistically

Energy Resiliency for DoD Installations



- **Resiliency is the ability of a system to resist, absorb, and recover from the effects of a hazard in a timely and efficient manner**
- **Focus of this effort is the resiliency of critical loads on DoD installations to a significant outage in the bulk power grid**
  - **Focus is primarily "inside the fence line" – the power distribution system**
  - **Includes interdependent infrastructure (water, comms, etc.,) required to maintain mission performance**
- **Analysis of options to increase performance and decrease costs**

Analysis Methodology



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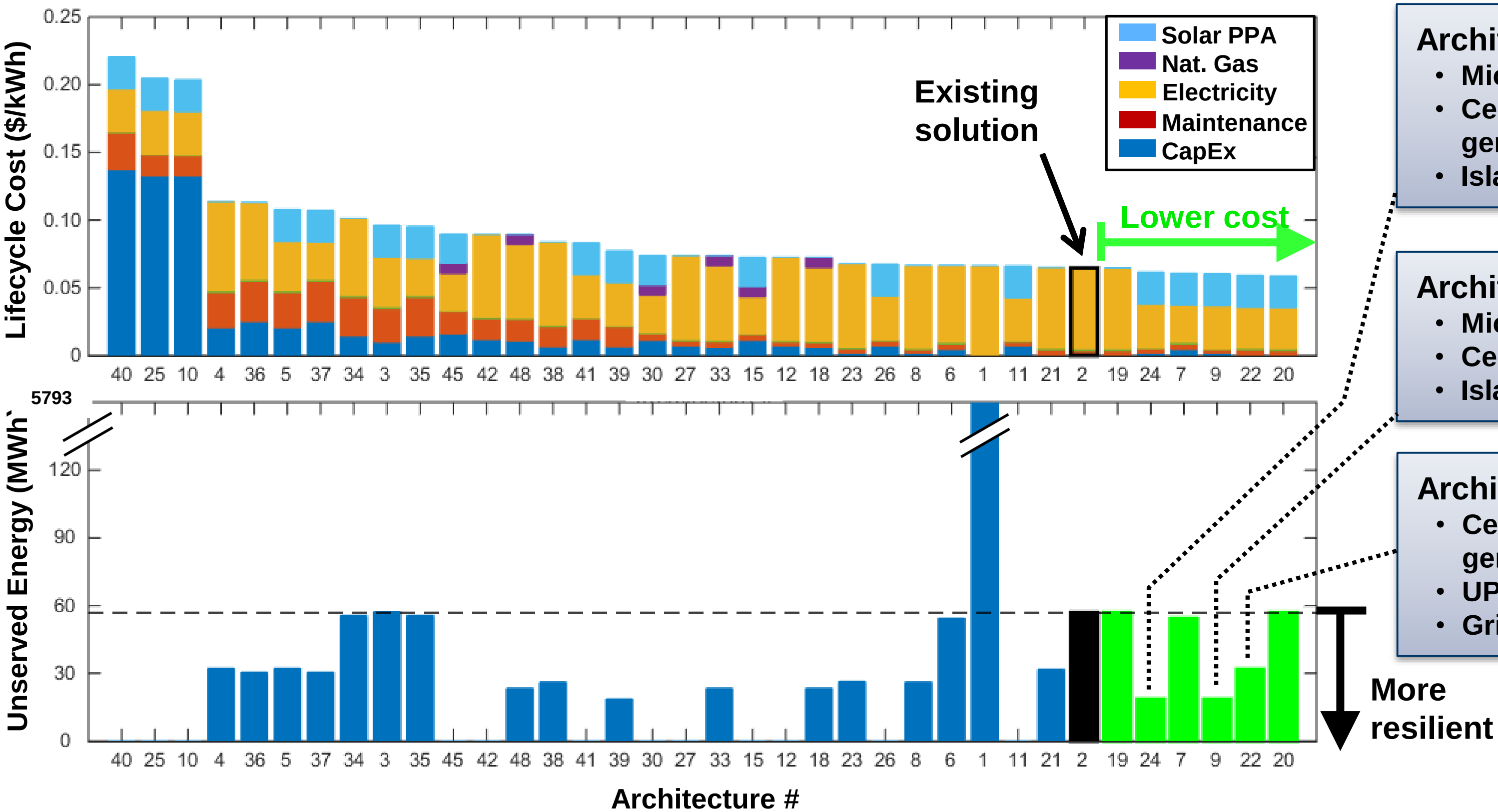
System Architecture Cost Breakdown vs. Historical Outages



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

Higher cost options typically include batteries and/ or fuel cells

Lower cost options include generators, microgrids, and/ or solar

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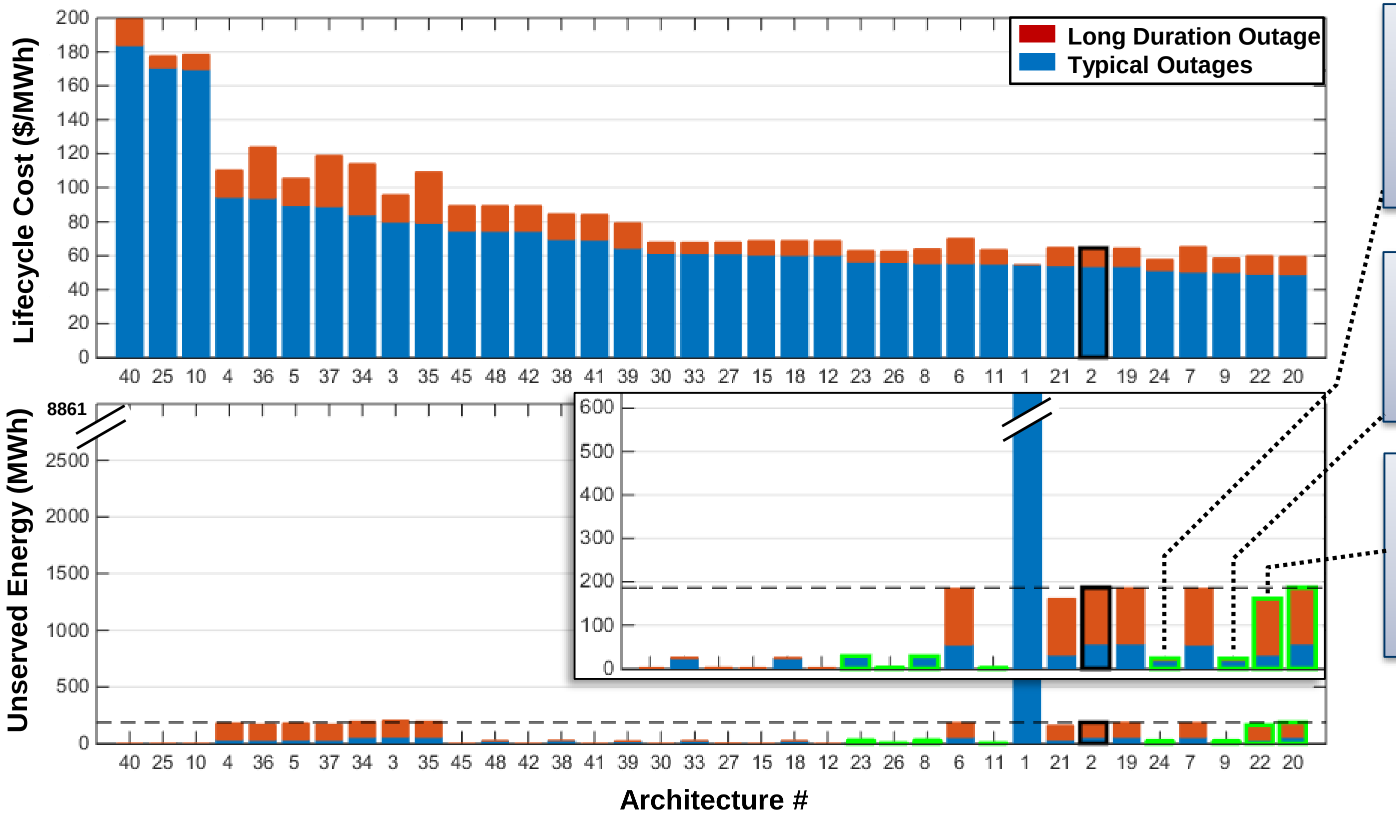
Architectures vs. 2 Wk. Utility Outage

2 Wk. Fuel Reserves, No Offsite Maintenance



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Example Site-wide Recommendations

Issue	Potential effect	Recommendation
Lack of operational testing with multiple small generators	Backup power may not function during a contingency event	Perform live load testing of generators monthly to verify functionality
Unknown cause of power quality seen at multiple locations	Building and boat damage reduces mission capability and increases costs	Perform power quality analysis on incoming lines from utility to determine the cause of power quality issues
Submarine susceptibility to poor shore power quality	Mission failure	Determine if similar power quality problems are experienced by submarines located elsewhere
Critical missions without backup power	Failure of alarms and security systems on critical components during power outages	Install backup power systems on alarms
AMI meters not used to their full capability	Data logging and protection settings are underused	Modify BOS contract to enable power quality analytics and protection functions in installed AMI meters and relays
Shared HMI workstations between utility and DoD	Mission failure from cyber-hack on utility and resulting control of DoD circuits	Continue to work with utility to reduce and eliminate cyber security related concerns
Dedicated building generators only serve the building loads	Excess generation capacity cannot serve additional loads as needed during events	Acquire mission-based backup generators with ability to connect to the base electrical distribution system
Increased maintenance and operations cost from multiple small generators and switchgear from different vendors	Backup power may not function during a contingency event; resupply from mainland is a significant delay	Standardize component and generator procurement to ensure interoperability of components

Summary

- Defense installations currently have a grid resiliency approach: backup generation at the point of load
  - For large installations this can mean 100s of diesel generators
  - This solution has a cost and reliability that can be compared to alternatives
- Larger systems that service critical sections of the installation can be more effective
  - Easier to maintain, more reliable generation sources
  - Additional flexibility to route power during grid outages
- Requirements driven designs and realistic testing can show capabilities gaps in the existing approach
- The Department of Defense can be important early adopter and demonstration platform for solutions for the domestic grid that increase mission effectiveness and resilience