FEDERAL UTILITY PARTNERSHIP WORKING GROUP SEMINAR

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SOUTHERN CALIFORNIA EDISON®

The Cost of Energy Security and Resilience

Mr. Michael Savena, NAVFAC HQ
Dr. Nicholas Judson, MIT Lincoln Laboratory
Mr. Alexander Pina, MIT Lincoln Laboratory

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Outline

- Department of the Navy efforts on energy resilience
  - 3-Pillars approach to holistic solutions (reliability, resiliency, and efficiency)
  - Benchmarking and assessing performance
  - DON challenges and opportunities
- MIT Lincoln Laboratory Energy Resilience Analysis (ERA) program overview and design principles
  - Global findings from site visits
  - General recommendations
  - Design principles
- ERA methodology
- ERA example output

Mission requirements drive solutions for resiliency. Develop a consistent lens to evaluate technology agnostic options.

DON Overview and Perspective on Resiliency

- **ASN (EI&E) – Energy Security Framework (ESF) Memo, 7 June 2017**
- **NAVFAC – P-602 (3-Pillars of Energy Security), 13 July 2017**
- **CNIC/NAVFAC completed ESAT data call 31 Oct 2017**
- **ESF Working Group evaluating COAs for establishing stakeholder review board for prioritization (EMIG) – FY20/21 Programs**

Focus has changed from energy conservation and renewables to:

Holistic and integrated Energy Security Framework (ESF)

- Benchmark installation energy security performance
- Assess installation performance against benchmarks
- Prioritize energy security improvements based on gap analysis

Benchmarking and Assessing Performance

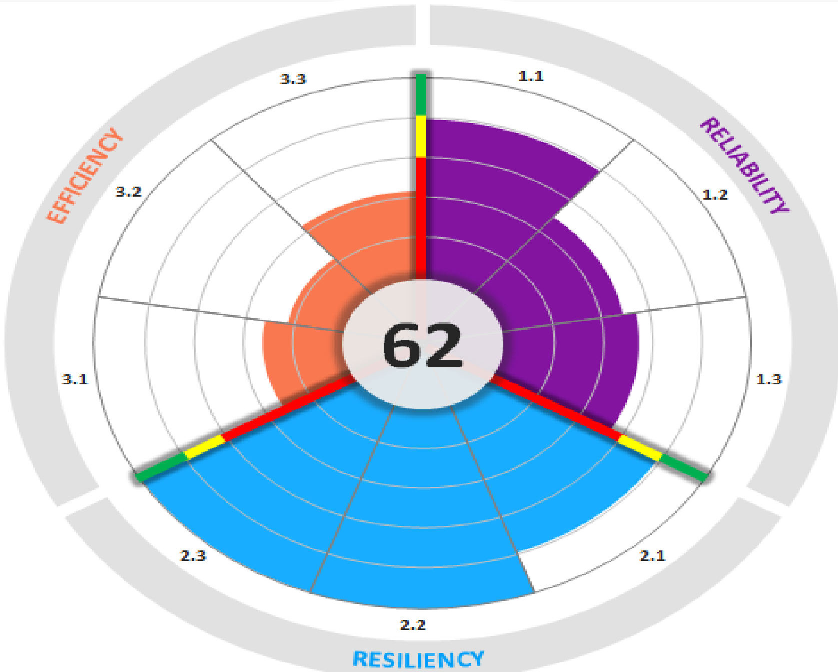
Energy Security Assessment Reputing Tool

IMPORT → DATA → SCORE → RECALCULATE → COMPARE

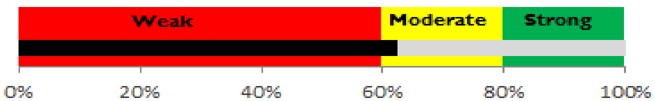
Select Installation: **NAVBASE GUAM**

Installation UIC:	CNIC Region
N61755	**CNR GUAM**
PWD or USMC Base	**Facility Engineering Command (FEC)**
PWD MARIANAS	**Marianas**

	Score	Weight
1. RELIABILITY		
1.1 Utility Grid Infrastructure	79	0.3
1.2 On-site Electric Infrastructure	50	0.3
1.3 Condition and Configuration	55	0.3
Reliability Score	**55**	**0.33**
2. RESILIENCY		
2.1 Backup Generation Capabilities	79	0.3
2.2 UPS Capabilities	100	0.3
2.3 Supported Missions Resiliency	100	0.3
Resiliency Score	**84**	**0.33**
3. EFFICIENCY		
3.1 Energy Efficiency	32	0.3
3.2 Electric Demand Management	23	0.3
3.2 ICS Inventory Sufficiency	44	0.3
Efficiency Score	**30**	**0.33**



INSTALLATION OVERALL ENERGY SECURITY & READINESS RATING



DON Challenges and Opportunities

DON Challenges:

1. Resiliency and Reliability – How to define and measure
2. Limited Budget for Facility/Utility Management
3. Existing infrastructure near end of useful life
4. Reliability and Resiliency represent potential cost increases
5. Cyber security and networking – Risk and cost increasing

DON Opportunities:

1. Tactical approach to resiliency
2. Leverage traditional 3rd party financing and SME
3. Incorporate alternative 3rd party financing and partnerships
4. Utilize ERCIP program for targeted resiliency investments

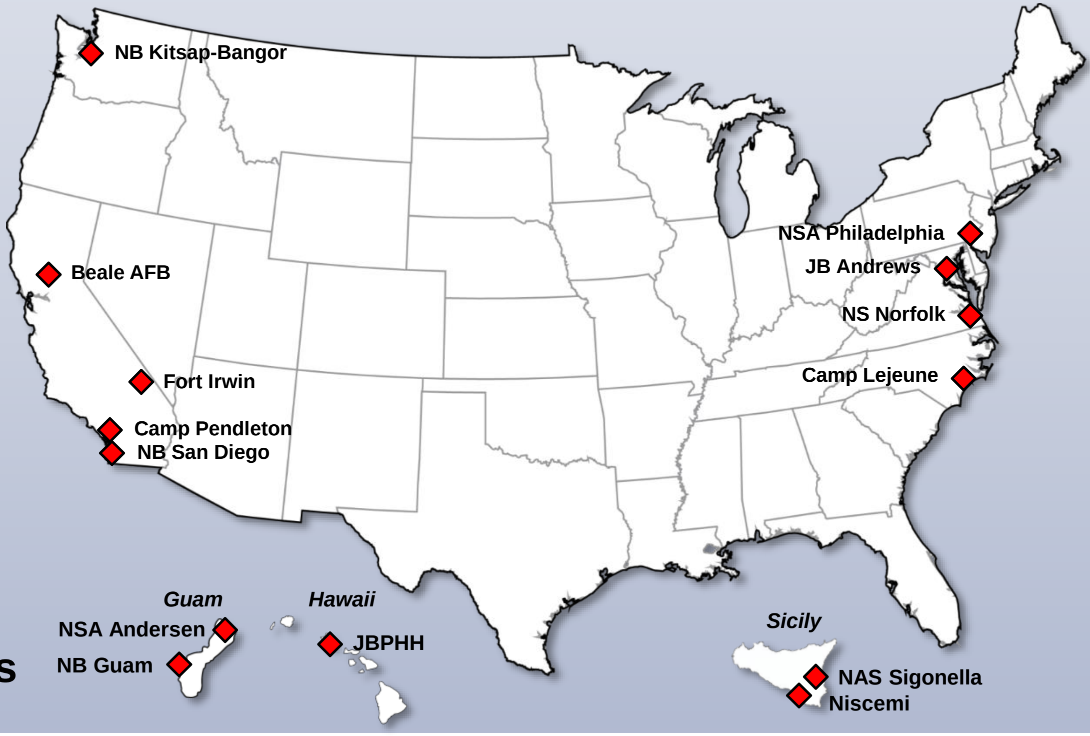
Bottom Line Up Front

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 financing 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 contractual 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

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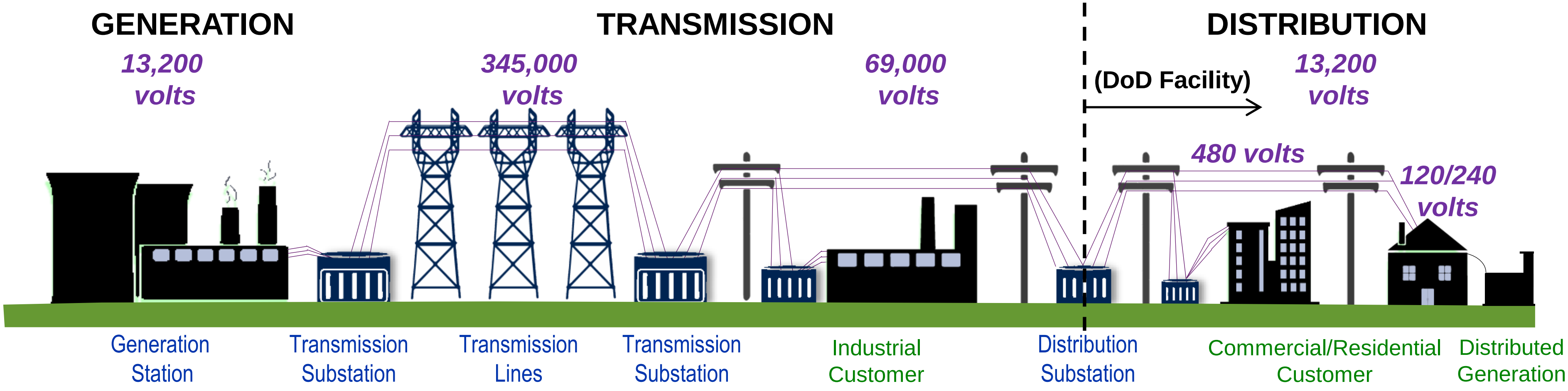
First Principles for Resilient Energy System Design

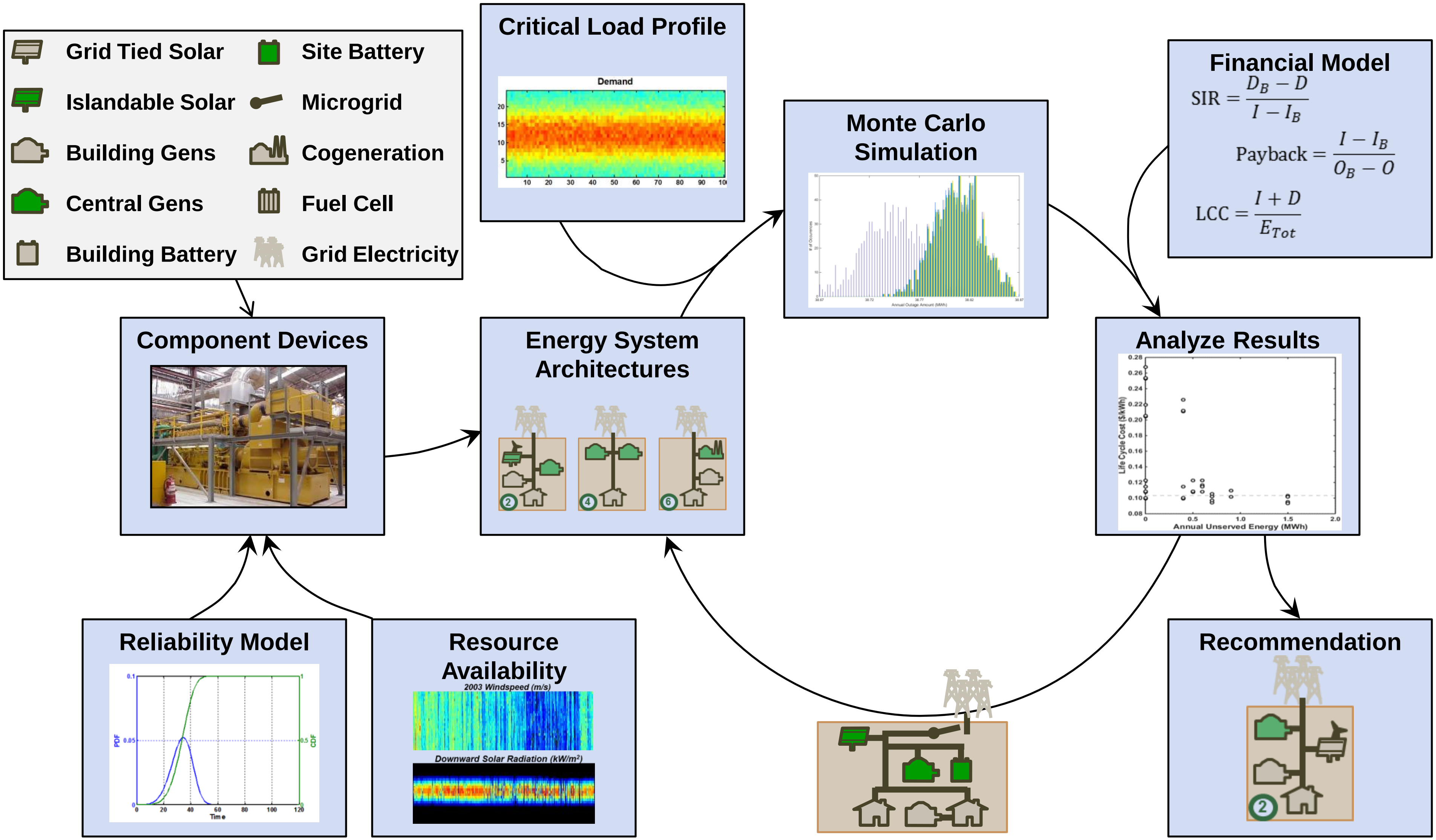
- **Mission requirements drive design**
  - **What is the cost if the mission cannot continue?**
  - **Include required interdependent infrastructure**
- **Flexible electric delivery system (redundancy where needed)**
- **Prioritize loads ruthlessly (allow for load shedding dependent on situation)**
- **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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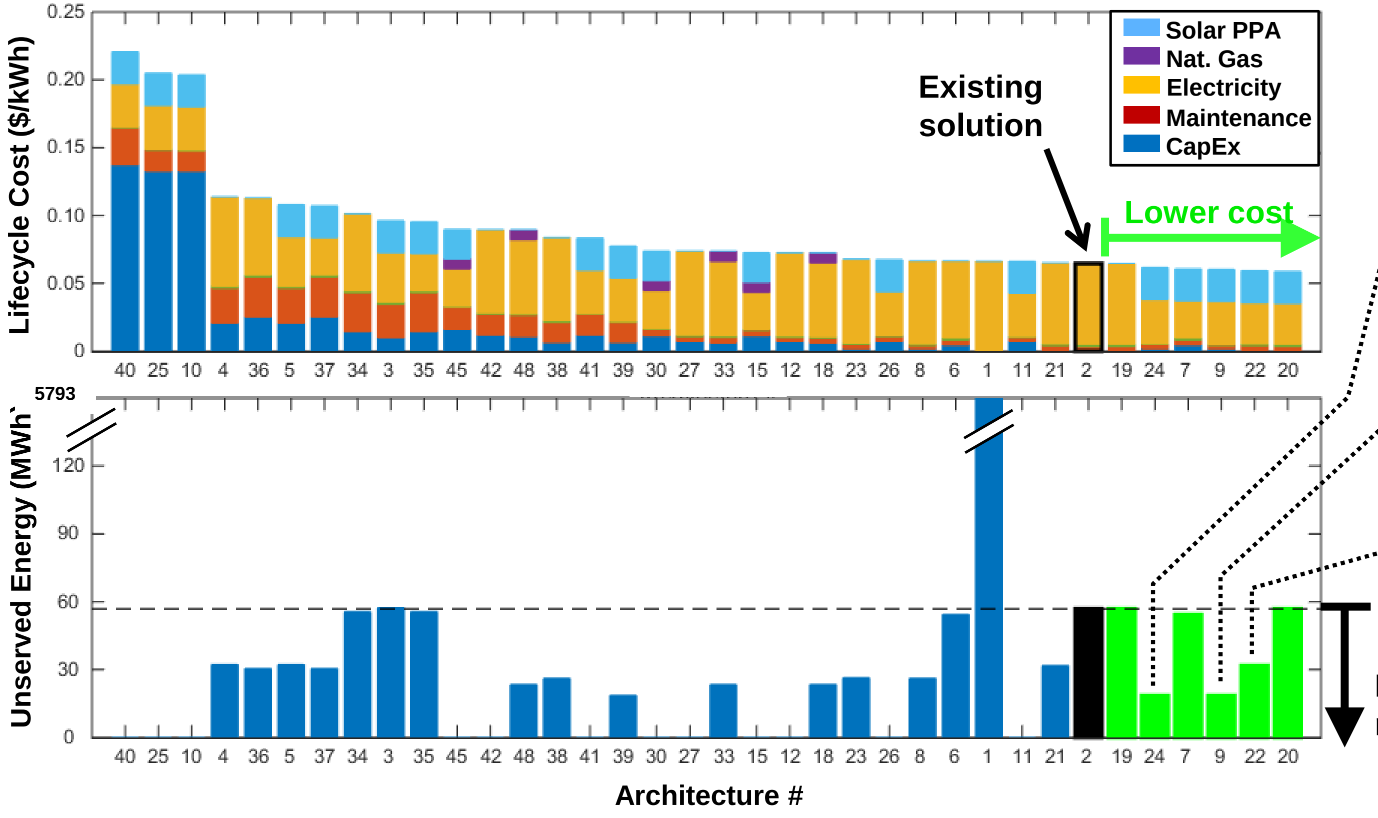
System Architecture Cost Breakdown vs. Historical Outages



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

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

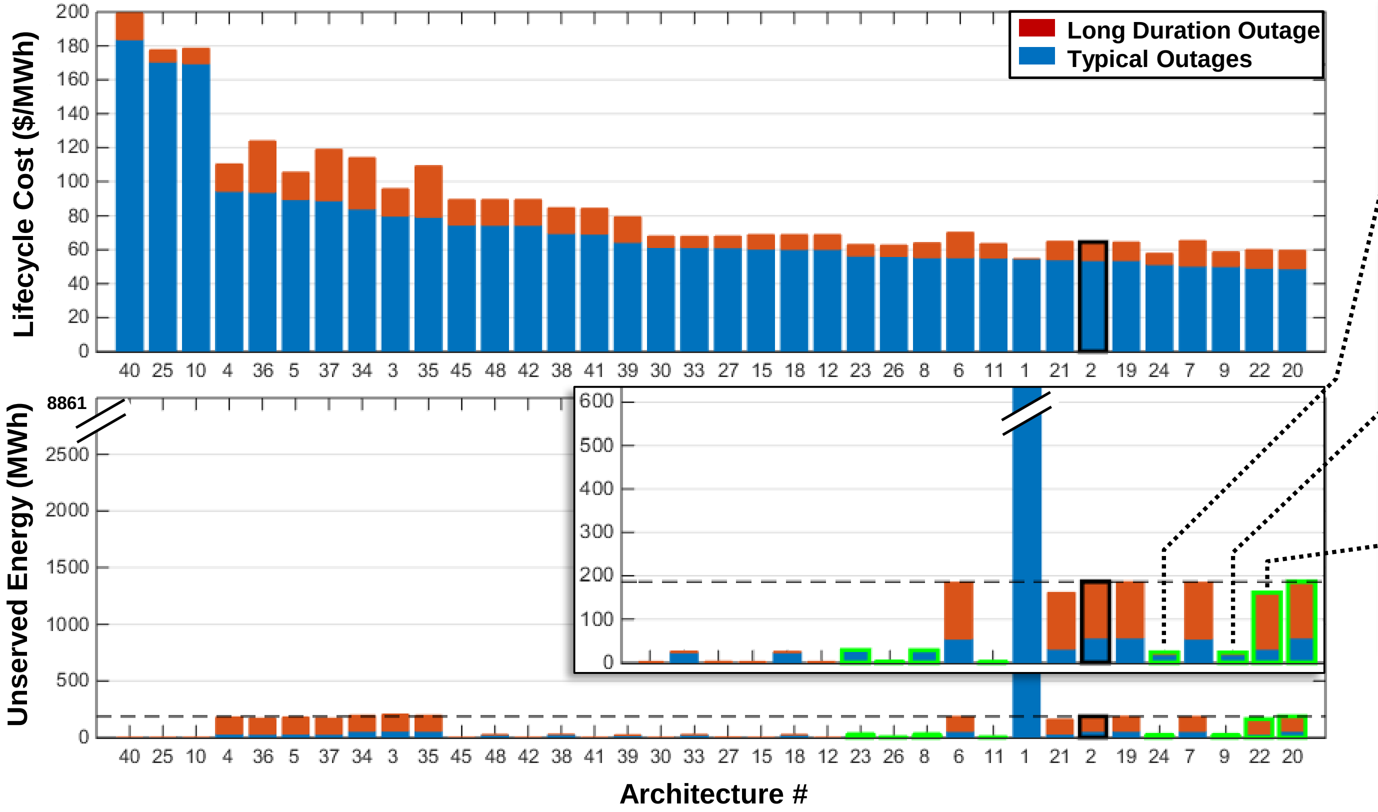
Architecture #22 assets:
- Central & building generators
- UPS
- Grid-tied solar

Higher cost options typically include batteries and/ or fuel cells

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

Architectures vs. 2 Wk. Utility Outage

2 Wk. Fuel Reserves, No Offsite Maintenance



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Example Site-wide Recommendations

Issue	Observation	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

Cost-Benefit Tradeoffs

- **Existing backup systems show your willingness to pay for energy resilience**
- **Cost of grid electricity vs. net cost of other generation assets**
  - **Net cost of generation assets = Capital Expense + Operations + Maintenance + Testing – ancillary services revenue**
- **Existing electrical outages seen (both utility and installation/ campus caused) vs. impact to mission**
- **Electrical outages to plan for**
  - **Long duration outages**
  - **Outage scenarios**
- **Cost of mission downtime**
  - **Lost revenue (eg. Navy working capital fund)**
  - **Cost to have backup vs. cost to duplicate assets elsewhere vs. cost to relocate mission**

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**

Questions????

Michael Savena, NAVFAC HQ, Public Works, Utility Management

- **Michael.savena@navy.mil**

Nicholas Judson, Assistant Group Leader, Energy Systems, MIT Lincoln Laboratory

- **judson@LL.mit.edu**

Alex Pina, Associate Technical Staff, Energy Systems, MIT Lincoln Laboratory

- **Alexander.Pina@LL.mit.edu**

Backup

3-Pillars of Energy Security

Reliability

Recommended Levels of Service			
Installation Type	SAIDI (Avg. outage duration per yr. in minutes)	SAIFI (Avg. interruption frequency per year)	Availability (% of time utility is operable)
Naval Shipyards	60	1	99.9886%
Other Installations	120	2	99.9772%

Efficiency

Parameter	Navy Benchmarks	USMC Benchmarks
SECNAV Energy and Water Program Review	• BLUE Management Award (criteria provided in App. B)	• BLUE Management Award (criteria provided in App. B)
AMI, SCADA, or DDC of electrical, water, and steam systems	• Mission Dependency Index (MDI)>85 and/or • Covered FACILITIES with > 75% energy use	• MDI>85 and/or • Covered FACILITIES with > 75% energy use

Resiliency

Backup Power Requirements	
Backup / Emergency Generation	Multiple UFCs (20) establish requirements for backup generation / emergency generation and/or UPS (for specified equipment).
Fuel Supply	UFC 3-540-01 requires seven days of on-site fuel storage or 24 hours of on-site fuel storage with a refueling plan

Brief Technology Overview

- **Diesel generators**
  - **Require maintenance, testing, and appropriate loading**
  - **Air Force methodology for testing generators is worth following**
  - **Long maintenance and testing tail to ensure operation**
- **Microgrids: generation, controls, and islanded operation**
  - **Make sense when installed to meet mission requirements**
  - **Commercialization is not mature; Caveat emptor**
- **Renewable energy (wind and solar)**
  - **Extend fuel supplies in long-duration outages**
  - **Can not be relied on for planning for short duration events**
- **Energy storage**
  - **Can increase grid reliability, smooth power fluctuations**
  - **Batteries allow load shifting, but increase total energy used on site**

Data Required for Analysis

• List of all buildings on the installation
• List of critical facilities and their tenants
• Building map with distribution system
• Electrical single line diagram
• Generator list with location, capacity, and fuel
• Critical facility electrical load data (1-3 years)
• Critical facility electrical bills (1-3 years)
• Electrical outage data (3-5 years)
• Natural gas billing data (1-3 years)
• Master planning document