FEDERAL UTILITY PARTNERSHIP WORKING GROUP SEMINAR
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Ontario, California

Hosted by:

FEMP
Federal Energy Management Program

SOUTHERN CALIFORNIA EDISON
The Cost of Energy Security and Resilience

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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 Reporting Tool

Select Installation:

- NAVBASE GUAM
  - CNIC Region: CNR GUAM
  - Facility Engineering Command (FEC): Marianas

<table>
<thead>
<tr>
<th>Component</th>
<th>Score</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Utility Grid Infrastructure</td>
<td>79</td>
<td>0.3</td>
</tr>
<tr>
<td>1.2 On-site Electric Infrastructure</td>
<td>50</td>
<td>0.3</td>
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<tr>
<td>1.3 Condition and Configuration</td>
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<td>0.3</td>
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<tr>
<td>Reliability Score</td>
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<td>0.33</td>
</tr>
<tr>
<td>2.1 Backup Generation Capabilities</td>
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<tr>
<td>2.2 UPS Capabilities</td>
<td>100</td>
<td>0.3</td>
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<tr>
<td>2.3 Supported Missions Resiliency</td>
<td>100</td>
<td>0.3</td>
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<tr>
<td>Resiliency Score</td>
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<tr>
<td>3.1 Energy Efficiency</td>
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<td>0.3</td>
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<tr>
<td>3.2 Electric Demand Management</td>
<td>23</td>
<td>0.3</td>
</tr>
<tr>
<td>3.3 ICS Inventory Sufficiency</td>
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<td>0.3</td>
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<tr>
<td>Efficiency Score</td>
<td>35</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Installation Overall Energy Security & Readiness Rating

- Weak
- Moderate
- Strong

Federal Utility Partnership Working Group
November 15-16, 2017 Ontario, CA
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
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 consist 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
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

- Critical Load Profile
- Component Devices
- Energy System Architectures
- Reliability Model
- Resource Availability
- Financial Model
- Analyze Results
- Recommendation

- Grid Tied Solar
- Islandable Solar
- Building Gens
- Central Gens
- Building Battery
- Site Battery
- Microgrid
- Cogeneration
- Fuel Cell
- Grid Electricity

- SIR = \( \frac{D_B - D}{I - I_B} \)
- Payback = \( \frac{I - I_B}{O_B - O} \)
- LCC = \( \frac{I + D}{E_{Tot}} \)
System Architecture Cost Breakdown vs. Historical Outages

- **Architecture #22 assets:**
  - Microgrid
  - Central & building generators
  - Islandable solar

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

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

For **Higher cost options**, typically include batteries and/or fuel cells.

For **Lower cost options**, include generators, microgrids, and/or solar.

**Unserved Energy (MWh):**
- Higher cost options
- Lower cost options

**Lifecycle Cost ($/kWh):**
- Solar PPA
- Nat. Gas
- Electricity
- Maintenance
- CapEx

**Notes:**
- Solar PPA: Solar Purchase Power Agreement
- Nat. Gas: Natural Gas
- Electricity: Electricity
- Maintenance: Maintenance
- CapEx: Capital Expenditure

- **Lower cost**
- **More resilient**
Architectures vs. 2 Wk. Utility Outage
2 Wk. Fuel Reserves, No Offsite Maintenance

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

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

Architecture #22 assets:
- Central & building generators
- UPS
- Grid-tied solar
<table>
<thead>
<tr>
<th>Issue</th>
<th>Observation</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of operational testing with multiple small generators</td>
<td>Backup power may not function during a contingency event</td>
<td>Perform live load testing of generators monthly to verify functionality</td>
</tr>
<tr>
<td>Unknown cause of power quality seen at multiple locations</td>
<td>Building and boat damage reduces mission capability and increases costs</td>
<td>Perform power quality analysis on incoming lines from utility to determine the cause of power quality issues</td>
</tr>
<tr>
<td>Submarine susceptibility to poor shore power quality</td>
<td>Mission failure</td>
<td>Determine if similar power quality problems are experienced by submarines located elsewhere</td>
</tr>
<tr>
<td>Critical missions without backup power</td>
<td>Failure of alarms and security systems on critical components during power outages</td>
<td>Install backup power systems on alarms</td>
</tr>
<tr>
<td>AMI meters not used to their full capability</td>
<td>Data logging and protection settings are underused</td>
<td>Modify BOS contract to enable power quality analytics and protection functions in installed AMI meters and relays</td>
</tr>
<tr>
<td>Shared HMI workstations between utility and DoD</td>
<td>Mission failure from cyber-hack on utility and resulting control of DoD circuits</td>
<td>Continue to work with utility to reduce and eliminate cyber security related concerns</td>
</tr>
<tr>
<td>Dedicated building generators only serve the building loads</td>
<td>Excess generation capacity cannot serve additional loads as needed during events</td>
<td>Acquire mission-based backup generators with ability to connect to the base electrical distribution system</td>
</tr>
<tr>
<td>Increased maintenance and operations cost from multiple small generators and switchgear from different vendors</td>
<td>Backup power may not function during a contingency event; resupply from mainland is a significant delay</td>
<td>Standardize component and generator procurement to ensure interoperability of components</td>
</tr>
</tbody>
</table>
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 an important early adopter and demonstration platform for solutions for the domestic grid that increase mission effectiveness and resilience
Questions????

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# 3-Pillars of Energy Security

## Recommended Levels of Service

<table>
<thead>
<tr>
<th>Installation Type</th>
<th>SAIDI (Avg. outage duration per yr. in minutes)</th>
<th>SAIFI (Avg. interruption frequency per year)</th>
<th>Availability (% of time utility is operable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naval Shipyards</td>
<td>60</td>
<td>1</td>
<td>99.9886%</td>
</tr>
<tr>
<td>Other Installations</td>
<td>120</td>
<td>2</td>
<td>99.9772%</td>
</tr>
</tbody>
</table>

## Efficiency

**Parameter**
- **SECNAV Energy and Water Program Review**
  - 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

## 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