Energy Resilience Program and Assessment Tool
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DoD Acquisition & Sustainment

Energy Priorities

- **Mission**
  - Sustain warfighting readiness and lethality by providing all energy-related policy and governance for programs and activities that enable resilient, efficient, and cyber-secure energy for Joint forces, weapon systems, and installations

- **ODASD(Energy) priorities aligned to ASD(S) goals**
  - Enhance material readiness
  - Prepare the battlefield for 2025
  - Maintain safe places
  - Create and sustain resilient installations

- **Four primary focus areas**
  - Energy Resilience
  - Energy Risk
  - Energy Performance
  - Cyber Secure Facilities
Energy Resilience (ER) Program Timeline

2012 to 2014
- Shift from energy "security" to "resilience"
- Electric Power Working Group was established
- DoD Electric Power Resilience Memo released – first definition and requirements established

2015
- Broadened resilience initiative from "electric" to "energy"
- Study commissioned to investigate life cycle cost effective approaches for energy resilience with MIT-LI

2016
- DoD 470.11 updated to codify energy resilience definition and requirements
- Initiated first energy resilience assessments and MIT-LI developed Energy Resilience Assessment (ERA) Tool

2017
- Operation, maintenance, and testing guidance released
- RFI & RFO released to study defense energy resilience bank (DERB)
- First ECP guidance released to include energy resilience

2018
- Energy resilience included in installation energy plans and demand response guidance
- Policy issued to include energy resilience in ESPCs and USECs
- 1st black start exercise
- 2nd black start exercise

2019
- Energy resilience included in utility privatization guidance
- AEMRR guidance issued to include energy resilience metrics
- First ERCIP guidance to require the use of the ERA tool
- 3rd black start exercise

Key enablers to ER Program:
- DoDI 4170.11 Energy Resilience Policy
- Installation Energy Plans (IEPs)
- Black Start Exercises
- Alternative Finance

Energy resilience policies and capabilities align to national security and mission requirements
DoD Energy Resilience Assessment (ERA) tool allows sites to understand risks to critical systems and inform project development.

Tabletop exercises investigate responses and capabilities during an extended simulated outage.

Black start exercises provide awareness of actual system capabilities during a real outage.

>30 energy resilience base assessments and exercises completed
- ~1/5 of the Department’s electricity consumption
- > $450 million in electricity costs

Adverse weather events are damaging our electrical infrastructure.
Downstream effects may cause outages on DoD installations.
Real-world exercises ensure preparedness for an outage scenario.
How can we best arrange the electrical generation and storage systems on a military installations to provide “resilient” energy solutions at the lowest possible cost?

Two challenges for military installations:
- The periods of greatest need are often the periods of greatest risk
- The edge cases are paramount to any analysis

Requires analyzing the problem from a mission resilience perspective with a technology agnostic approach.
One Piece of The Mission Analysis Puzzle

Mission

Method 1
Installation X

Method 2
Installation Y

Method 3
Installation Z

Redundant methods of accomplishing a mission

Redundant installations that can perform that method
One Piece of The Mission Analysis Puzzle

Factors That Influence Energy Resilience

- Infrastructure Reliability
- Ability to repair and troubleshoot equipment
- Ability to move missions to another building
- Ability to reduce mission capabilities

... among many others
Energy Resilience Assessment (ERA) Tool

- **Mission**
  - **Method 1**
  - **Method 2**
  - **Method 3**

Redundant methods of accomplishing a mission

Redundant installations that can perform that method

- **Installation X**
- **Installation Y**
- **Installation Z**

**Stakeholders**
- Installation Commander
- Installation Energy Manager
- Mission A
- Mission B

**Energy Resilience Analysis Components**
- Power Distribution System
- Backup Power System
- Infrastructure Reliability
- Energy Costs
- Continuity of Operations Plan (COOP)
- Installation Energy Plan (IEP)
- …

At the installation level, the **ERA tool** is one method for assessing the appropriate infrastructure for energy resilience.
Purpose of the ERA Tool

- Provide comparison of lifecycle costs and mission resilience for a variety of energy generation and storage technology combinations

- Answer high level questions:
  - Does it make more sense to import or generate electricity?
  - Is centralized generation with a microgrid more effective than building level generation?
  - What solutions have the lowest lifecycle costs?
  - What technology combinations provide the best mission availability?

- Does not provide a full system design for the installation. Instead, provides simulated model results and recommendations for the types of architectures to cost-effectively pursue.
When Do You Use This Tool?

- The tool is required for OSD’s Energy Resilience Conservation Investment Program (ERCIP) as an initial planning tool before project scoping (e.g., before a 1391)
- Could be part of an Installation Energy Plan (IEP)
- Could be part of an educational course on the costs and benefits of different types of technologies

ERCIP Process

<table>
<thead>
<tr>
<th>Initial Data Analysis</th>
<th>Project Discussion</th>
<th>Prepare 1391 (Initial project proposal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• ERA Tool</td>
<td>• Synthesis of ERA tool outputs, IEP, COOP, master planning documents, preliminary designs</td>
<td>• Initial project scope</td>
</tr>
<tr>
<td>• IEP</td>
<td>• Does the proposed project make sense holistically?</td>
<td>• LCCA for selected project</td>
</tr>
<tr>
<td>• System Analysis</td>
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<td>• Project narrative</td>
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<tr>
<td>• Preliminary design</td>
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</tbody>
</table>
How Does The Tool Work?
How Does The Tool Work?

Possible Architecture Combinations

Architecture Option 1:
Utility feed + grid-tied solar

Architecture Option 2:
Utility feed + building level generators

Architecture Option 3:
Utility feed + centralized generators + microgrid

Architecture Option 4:
Utility feed + centralized generators + microgrid + fuel cells
e tc…

Site access: https://osdera.ll.mit.edu (CAC-enabled)
How Does The Tool Work?

- Installation name and location
- Fuel and electricity costs
- Number of feeders and substations
- Historical utility and distribution system outages
- Critical electrical and thermal load
How Does The Tool Work?

- Simulates failures and repairs of each generation and storage asset (e.g., each generator)
- Considers failures in utility service and distribution system
- Simulation of normal operation with sporadic utility and distribution system failures
- Simulation of black-sky, multi-day outage event, with option for suspending fuel delivery and equipment repairs
How Does The Tool Work?

Each technology combination

Mission Downtime

Lifecycle Cost
Example of an Installation Assessment

Far enough apart that centralization of generation across the entire installation is not possible

- Housing: 0.5 MW
- Critical Mission: 3 MW
- Main campus: 8 MW

~ 12 MW total load
Example of an Installation Assessment

- 0.5 MW is a small load that can be handled adequately with a couple building level generators
- Not a critical mission function that requires high availability

~ 12 MW total load

Housing 0.5 MW

Critical Mission 3 MW

Main campus 8 MW
Example of an Installation Assessment

- The critical mission already had centralized generation with recently updated infrastructure. Not a candidate for detailed assessment.
Example of an Installation Assessment

- The main campus, with a load of 8 MW, was a good candidate for a more detailed assessment.
- How does the cost and resilience of the existing power system compare to other possible technology options?
Planning for Day-to-Day Operations

Users are provided with:
- 10 year lifecycle cost, broken out by funding mechanism
- 10 year unserved load, mission downtime, or site-wide availability
- Color coded to drive discussion towards what is important to you (e.g., CapEx versus operational costs)

Technology combinations
Planning for Day-to-Day Operations

- The existing option includes centralized and building level generation.
- On average, over a 10 year period, approximately 10 MWh of lost load, equivalent to 2 hours of downtime.
- There are options that are cheaper and better performing.

Existing Architecture
- Central backup generators
- Building backup generators
Planning for Day-to-Day Operations

- Alternative options with potentially better performance at lower cost
- Centralization and consolidation of generation assets could provide lower unserved load at a reduced cost
- Centralized UPS can help to bridge generator startups
- Six hour storage battery doesn’t cost out

Architecture #83 assets:
- Microgrid
- Central backup generators
- Battery system
- Islandable solar PV

Architecture #79 assets:
- Microgrid
- Central backup generators
- UPS system
- Islandable solar PV

Architecture #71 assets:
- Microgrid
- Central backup generators
- Islandable solar PV
Planning For An Edge Case

Installation concern: 14 day outage with 100,000 gallons of on-site diesel storage without fuel redelivery

Factors to consider during a multiday outage

- Length of simulation
- Fuel availability
- Repair technician availability
- Changes to mission requirements
- Targeted attacks on specific equipment

ERA Tool Focus

Black sky scenario
Day-to-day operations
Planning For An Edge Case

14 day outage with 14 days of on-site diesel storage

- When the fuel shortage issue is fixed, the existing solution suffers from high fuel costs and poor performance due to an over-resilience on diesel generators without redundancy.
Holistic Energy Resilience Assessment

Mission

- Method 1
- Method 2
- Method 3

- Installation X
- Installation Y
- Installation Z

Redundant methods of accomplishing a mission

Redundant installations that can perform that method

- Is there sufficient fuel storage for a multi-day outage?
- What is the relative reliability of the distribution system and utility service?
- Is producing electricity on-site more cost effective than importing it?
- What technologies make sense from a cost and reliability perspective?

One piece of analysis for a larger discussion of whether centralization of generation and alternative generation technologies make sense for an installation.
Questions?

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