Renewables for Resilience
Renewables for Resilience

Air Force Energy Assurance

Mr. R. Eric Yates, Director of Acquisition/Real Estate
Ms. Meredith Pringle, CTR Project Specialist
Air Force Office of Energy Assurance
August 16, 2017
The Air Force Established the Office of Energy Assurance

**MISSION:** Deliver creative installation energy resiliency solutions to meet 21st century threats.

**VISION:** The recognized leader for implementing innovative energy assurance solutions and providing the Air Force with mission-ready installations.

OEA drives energy assurance projects that power mission-critical installations with more resilient, cost-effective and cleaner energy through partnerships and third-party financing.
Energy is Mission Critical to Air Force Installations

AVIATION
5,191 Aircraft

INSTALLATIONS
10M Acres of Land

FACILITIES
626M Sq Ft of Buildings

RESOURCES
$8B, 2.1B Fuel, 63T BTUs
There are Various Threats to Air Force Installation Energy

**CYBER**
- Cyberattack cripples Ukrainian power grid
- Wake-up call for infrastructure operators around the world?

**NATURAL**
- Hurricane Matthew Batters Florida, Leaving Thousands Without Power

**PHYSICAL**

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**THREAT AMPLIFIERS**

- Aging Infrastructure
- Determined Adversaries
- Global Network
- Energy Approach
Renewables are Integral to Installation Energy Resilience

• Market-driven technology

• Continuous access to power during grid outage

• Synergistic effects:
  – Routine operations
  – Outage support

• Considerations:
  1. Market regulations
  2. Utility rates
  3. Land and geography

300KW/day waste-to-energy project demonstration at Joint Base Pearl Harbor-Hickam, Hawaii
Example: Global Hawk Mission at Beale Air Force Base

• Develop and deploy innovative energy resilience technologies and business models across the Air Force Enterprise

• Enable significant third-party investment in holistic, installation-level energy resiliency
### Example: Global Hawk Mission at Beale Air Force Base

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Challenge</th>
<th>Proposed Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>24/7 access to power on flight line</td>
<td>Sub-par and degrading infrastructure</td>
<td>0.5MW solar PV array for behind-the-meter generation + battery storage, microgrid controller, power and comms links</td>
</tr>
<tr>
<td></td>
<td>Connection to other mission critical buildings on base</td>
<td>Ability to connect to future RE projects</td>
</tr>
<tr>
<td>Onsite energy generation</td>
<td>Limited land availability due to environmental constraints and flight line requirements</td>
<td>Environmental assessment to inform project proposal</td>
</tr>
<tr>
<td>Economically feasible</td>
<td>Low cost of electricity vs. return on investment</td>
<td>Alternative CA state and federal financing mechanisms support renewable energy and battery storage</td>
</tr>
<tr>
<td></td>
<td>Traditional funding pathways aren’t economically attractive</td>
<td></td>
</tr>
</tbody>
</table>
Example: Global Hawk Mission at Beale Air Force Base

**Requirement:** *Global Hawk need for 24/7 access to reliable power*

- **Constraints**
  - Economic
  - Environmental
  - Infrastructure

- **Approach**
  - Mix of renewable energy (solar), storage, advanced controls
  - CEC grant and ERCIP

- **Lessons Learned**
  - Mission-focused energy assurance process
  - Identified gaps in requirements
  - Explore alternative financing mechanisms

- **Outcomes**
  - Saves energy
  - Delivers persistence
  - Preserves AF mission
Renewable energy increases energy resiliency by providing continuous access to power.

Key considerations include: mission requirements, market regulations, utility rates and land availability.

Larger economic considerations, such as return on investment, impact project feasibility.
  - Investigating alternative financing mechanisms is an often unexplored solution to this issue.
Shore Energy Resiliency

John Baxter
The Department of the Navy’s Resilient Energy Program Office
August 16, 2017
The Department of Defense “should explore alternate and renewable energy sources that are reliable, cost effective, and can relieve the dependence of deployed forces on vulnerable fuel supply chains. ...The purpose of such efforts should be to increase the readiness and reach of our forces.”

- Secretary of Defense
James Mattis
DoD/DON Shore Energy Consumption

- 211,095 B BTUs of installation energy consumed by DoD in FY15
- 30% of total DoD energy consumption attributable to installations
- 5% of DoD FY15 Installation Energy Consumption
- 29% of DoD’s installation energy consumption attributable to DON

DON	Air Force	Army
29% 36% 30%

Defense Agencies

Energy Exchange: Connect • Collaborate • Conserve
Where We’ve Been: History of the Shore Energy Mission

The Resilient Energy Program Office “shall execute energy resilience, alternative energy, and renewable energy projects.”

-SECNAV Instruction 4101.3A – January 2017

Dec 2015

- Renewable 1GW

Mar 2016

- Resilience Microgrid

Dec 2016

- Culture Integration

2017

- 3rd Party Finance Scale
Where We’re Going: Three Pillars of Energy Security

Energy Security

Reliability
The percentage of time energy delivery systems (utilities) can serve customers at acceptable regulatory standards.

Resiliency
The ability of a system to anticipate, resist, absorb, respond, adapt, and recover from a disturbance.

Efficiency
The use of the minimal energy required to achieve the desired level of service.
Holistic Energy Security Approach

- Critical assets powered by dedicated base energy sources
- Islanding microgrid capabilities
- Potential community microgriding capabilities
- Long-term PPAs can provide cost stability for the DON and help to incentivize the diversification of regional energy sources
- ESPCs will make buildings more efficient and produce long-term cost savings
Deploying new renewable energy generation will enhance the DON’s energy security posture:

- Long-term contracts for RE at a set price provides cost-stability
- Power diversification to increase the availability of local energy sources
- Locating facilities on-base to provide physical security
- Collaborating with local communities to provide regional resilience
Funding Resiliency

- Third-party Financing (the 1 GW Models)

  **Model 1**
  Off-base Generation for On-base Consumption (Acquisition: USC/PPA)

  **Model 2**
  On-base Generation for Off-base Consumption (Real Estate: Outgrant)

  **Model 3**
  On-base Generation for On-base Consumption (Acquisition: PPA)
  + Existing Renewable Energy

- Energy Savings Performance Contracts (ESPCs)

- Utility Energy Savings Contracts (UESCs)
Solar and Battery Storage at NB Ventura County

7 MW solar hybrid battery energy storage system (BESS)

• Cutting edge battery system
  – Extremely high energy density
  – Long life-span
  – 100% recyclability
  – Long and short term generation asset

• The project will provide both the DON and Ventura County community with energy resiliency and storage reliability

• The system can cover over 65% of the base’s peak loads for hours at a time
Ongoing Efficiency Projects (ESPCs)

Naval Amphibious Base (NAB) Coronado:
- Began as a MCON project: ~$91M
- Capital Investment: $70M
- Annual Estimated Cost Savings: $5M
- Total Energy Savings: 321,115 (MMBTU/yr)

Naval Station Guantanamo Bay:
- Fence-to-fence analysis of needs
- Maximizing cost savings
- Reducing petroleum reliance via smart grid, distributed energy (batteries, PV, combined heat and power plant, HVAC upgrades)

Marine Corps Logistics Base Albany:
- Net zero installation (Electricity) through biomass steam turbine generator
- Capital Investment: $47M
- Annual Estimated Cost Savings: $5M
- Total Energy Savings: 157,000 (MMBTU/yr)
- Excess sales of electricity to Georgia Power
UESC Example: Naval Support Activity Annapolis, MD

$7.7M Water Conservation Project (Completed in 2015)

• Water plant upgrades included centrifuges and gravity settlers
• Projected $860K annual savings
• Reduces operational costs through an improved sludge removal process, recapturing of filter backwash, reduced energy consumption, and reduced chemical treatment
• Reduces environmental impact associated with run-off discharged into the Chesapeake Bay
UESC Example Continued

Reduces groundwater production requirement up to 40% (135 million gallons per year)
Renewables for Resilience

USAG-Dugway

Sean Svendsen, CTR Resource Efficiency Manager

August 16, 2017
Lessons Learned on the Use of Renewables for Energy Assurance and Resilience

Mike Hightower
Sandia National Labs - University of New Mexico
August 16, 2017
Challenges of using renewables to support energy resilience

- Utility concerns over safety and intermittency management issues
- Lack of understanding of price advantages during extended outages
- Inability to partition, balance, or manage energy output - design and regulatory priorities
- Therefore renewable systems often not designed nor operated to integrate with distribution system, site loads, etc.
- Concern about cost/need of energy storage for power quality and response and overall impact on system cost-effectiveness

These challenges have hindered renewable energy use for resiliency
Emerging Operational Approaches Enable Improved Distributed and Renewables Integration to Meet New Energy Goals

Emerging Energy Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Safe for end user</td>
</tr>
<tr>
<td>Security</td>
<td>Protection of energy generation and resources</td>
</tr>
<tr>
<td>Reliability</td>
<td>High energy availability and quality</td>
</tr>
<tr>
<td>Sustainable</td>
<td>Long-term minimal use of resources</td>
</tr>
<tr>
<td>Cost effective</td>
<td>Provided at affordable cost</td>
</tr>
<tr>
<td>Resilient</td>
<td>Withstand and recover rapidly from changing conditions</td>
</tr>
</tbody>
</table>
Integration of Microgrids and Renewables for Energy Resilience

- With Point of Common Connection (PCC) renewables can stay online during a power outage
- Renewables can be easily integrated with other distributed generation resources to address intermittency and cost when islanded
- Large-scale renewables can be partitioned to better integrate into a distribution system during an outage
  - Up to 40-50% penetration without degradation of power quality
  - If integrated at substations can provide energy resilience to wide areas
- Ability to operate grid-tied, allows distributed generation the opportunity to provide high-value ancillary services to the utility as needed

<table>
<thead>
<tr>
<th>Line Voltage</th>
<th>Nominal Line Length</th>
<th>Nominal Line Load</th>
<th>Operating Line Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>480 v</td>
<td>480 yds</td>
<td>300 kW</td>
<td>250 kW</td>
</tr>
<tr>
<td>4 kV</td>
<td>4000 yds</td>
<td>1 MW</td>
<td>750 kW</td>
</tr>
<tr>
<td>13.5 kV</td>
<td>2.5 mi</td>
<td>10 MW</td>
<td>7 MW</td>
</tr>
<tr>
<td>34 kV</td>
<td>7 mi</td>
<td>35 MW</td>
<td>22 MW</td>
</tr>
<tr>
<td>46 kV</td>
<td>9 mi</td>
<td>50 MW</td>
<td>40 MW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ancillary Service</th>
<th>Value of Service ($ per kWhr)</th>
<th>Required Response (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Regulation</td>
<td>High</td>
<td>1</td>
</tr>
<tr>
<td>Spinning Reserve</td>
<td>Medium</td>
<td>1-10</td>
</tr>
<tr>
<td>Auto Response</td>
<td>Medium</td>
<td>10-20</td>
</tr>
<tr>
<td>Manual Response</td>
<td>Low</td>
<td>30-60</td>
</tr>
<tr>
<td>Non-spinning Reserve</td>
<td>Very Low</td>
<td>10</td>
</tr>
<tr>
<td>Replacement Reserve</td>
<td>Very Low</td>
<td>30</td>
</tr>
</tbody>
</table>
Example Microgrid Operations and Use for Energy Security, Reliability and Resiliency

<table>
<thead>
<tr>
<th>MICROGRID</th>
<th>CIRCA</th>
<th>POINT OF COMMON COUPLING</th>
<th>INTERCONNECTED GENERATION AND LOAD</th>
<th>DISCONNECT/RECONNECT sec</th>
<th>POWER RELIABILITY</th>
<th>POWER SECURITY</th>
<th>ANCILLARY BENEFITS USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ft. Greely</td>
<td>1960</td>
<td>Substation</td>
<td>8MW 3MW</td>
<td>Man, &lt;60 sec</td>
<td>x</td>
<td>x</td>
<td>x x</td>
</tr>
<tr>
<td>Ft. Detrick</td>
<td>1985</td>
<td>Feeder</td>
<td>4MW 2MW</td>
<td>Man, &lt;60 sec</td>
<td>x</td>
<td>x</td>
<td>x -</td>
</tr>
<tr>
<td>Ft. Greely</td>
<td>2005</td>
<td>Feeder</td>
<td>10MW 3MW</td>
<td>Man, &lt;60 sec</td>
<td>x</td>
<td>x</td>
<td>- -</td>
</tr>
<tr>
<td>Ft. Bragg1</td>
<td>2005</td>
<td>Feeder</td>
<td>5MW 3MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>x -</td>
</tr>
<tr>
<td>Ft. Bliss</td>
<td>2012</td>
<td>Feeder</td>
<td>1.5MW 1MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>x - 25%</td>
</tr>
<tr>
<td>Ft. Detrick</td>
<td>2012</td>
<td>Feeder</td>
<td>4MW 2MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>- -</td>
</tr>
<tr>
<td>Ft. Carson</td>
<td>2013</td>
<td>Feeder</td>
<td>3MW 1.5MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>- - 30%</td>
</tr>
<tr>
<td>Ft. Bragg2</td>
<td>2015</td>
<td>Feeder</td>
<td>5MW 3MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>x -</td>
</tr>
<tr>
<td>Ft. Detrick2</td>
<td>2016</td>
<td>Feeder</td>
<td>20MW 15MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>x - 40%</td>
</tr>
<tr>
<td>Tinker AFB</td>
<td>2000</td>
<td>Substation</td>
<td>80MW 15MW</td>
<td>Man, &lt;90 sec</td>
<td>x</td>
<td>x</td>
<td>- x -</td>
</tr>
<tr>
<td>Pearl/Hickam</td>
<td>2013</td>
<td>Feeder</td>
<td>1.2MW 1MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>x - 20%</td>
</tr>
<tr>
<td>29 Palms</td>
<td>2014</td>
<td>Feeder</td>
<td>8 MW 5 MW</td>
<td>Auto, &lt;10 sec</td>
<td>x</td>
<td>x</td>
<td>- - 20%</td>
</tr>
</tbody>
</table>

Similar microgrid designs for communities in VT, MA, NJ, LA, and VA for critical infrastructure and critical services resiliency
• **No major technical implementation and operational challenges identified**
  
  – No safety issues observed in transitioning between grid-tied and islanded modes
  
  – All control systems support ~10-60 sec. transition to islanded operations, critical circuits on UPS systems, all controls meet cyber security requirements
  
  – Advanced microgrids and distributed and renewable energy resources can effectively support local energy and community resilience and support critical services
  
  – Renewable energy systems greater than 1 MW partitioned to support feeders or connected to substations, were more easily integrated and utilized

Energy resiliency has matured significantly in past decade
Many critical services and infrastructures are reliant on energy
  - water, waste water, telecom, emergency services, etc.
Local microgrids can integrate multiple critical services and distributed and renewable energy resources to create resilient community nodes
Resilient node concept applicable to community, military, and important industrial/commercial applications

New Orleans Resilient Nodes

NYC After Tropical Storm Sandy
Recommendation for Accelerating Renewables Integration for Enhanced Energy Resiliency

• Education:
  – Energy managers on advanced microgrid opportunities, requirements, implementation, operational strategies and costs
  – Renewable energy developers to address designs to address multiple policy drivers including energy cost, sustainability, security, and resiliency
• Develop guidance on integrating regulatory and policy requirements for energy security, sustainability, and resiliency into efficient and cost effective energy systems
• Provide training in sizing and integrating distributed and renewable generation for cost effective energy security and resiliency benefits
  – Training is needed for renewable energy providers and microgrid designers on integrating renewables and storage to optimize cost/performance for security and resiliency benefits

These efforts will increase the understanding of microgrid capabilities and benefits to support and accelerate renewables implementation, utilization, and integration for resiliency