DOD Energy Security and Microgrids

Presented to SAME Facility Asset Management Committee
Energy and Sustainability Committee

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What is a Microgrid?

- Isolatable Segment of Existing Distribution System
- Capable of Independent Operation from Remaining System
- Typically Involves Multiple Generation Assets and Multiple Loads

The U.S. Department of Energy’s official definition of a microgrid is “a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid [and can] connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.”
Common Features of Microgrids

- Seamless transition to/from Utility
- Integration of renewable assets to support loads without Utility presence
- High levels of automation
- Selection of loads served based on criticality
What Microgrids are Not

• Controls-only solutions
• Uninterruptible Power Sources (UPS)
• Sources of revenue (by themselves)
Common Microgrid Assets with Payback

- Distributed generation assets
- Combined Heat and Power (CHP)
- Renewable resources
- SCADA systems
Reasons for Microgrids

• Energy Security

• Energy Security

• Energy Security
DoD Drivers for Microgrids

- Military missions dependent on state-side installations for operations and logistics
- Increasingly fragile US power grid
- Increasing cyber threats
- Prolonged outage capabilities
- Reduce reliance on fossil fuels
SPIDERS Stakeholders

USPACOM, USNORTHCOM, DOE, DHS

5 DOE Nat’l Labs

USACE/ERDC-CERL, Philadelphia District, Omaha District

Military Services

Naval Facilities Engineering Command

Local Utility Companies

States of Hawaii & Colorado
SPIDERS JCTD Objectives

• Provide a cyber-secure Microgrid for enhanced Mission Assurance
  • Increase reliability of backup generation
  • Reduce fossil fuel consumption of generators
  • Integrate renewable generation in islanded mode
  • Provide a cyber-secure control system
SPIDERS Multiphase Approach

PEARL-HICKAM CIRCUIT LVL DEMO
- Solar (wind) Renewable
- Flow Battery Storage
- Energy Management Sys
- Cyber architecture
- SCADA evaluation at Sandia National Labs

FT CARSON MICRO-GRID
- Large Scale Renewables
- Vehicle-to-Grid
- Smart Micro-Grid
- Critical Assets
- Mission Assurance Demo
- COOP Exercise

CAMP SMITH ENERGY ISLAND
- Entire Installation
- Smart Micro-Grid
- Grid-tied & Islanded Operations
- High Penetration of Renewables
- Demand-Side Management
- Ancillary Services
- Makani Pahili Hurricane Exercise

TRANSITION
- Template for DoD-wide implementation
- New Uniform Facility Codes
- CONOPS
- TTPs
- Training Plans
- DSIA Certification
- Transition to Electric Utility Sector
- Transition Cyber-Security to Federal Sector and Utilities

STAIRWAY TO ENERGY SECURE INSTALLATIONS

RIGOROUS ASSESSMENT WITH RED TEAMING IN EACH PHASE
SPIDERS Considerations

Minimize Changes to Existing Infrastructure

• Maximize value through use of existing assets
• Utilize existing infrastructure to increase reliability and maintainability of systems

Minimize Disruption to Ongoing Operations

• Critical Missions can’t afford lengthy construction and testing outages
SPIDERS Approach

• Decouple generators from loads
• Integrate isolated controls systems via cyber-secure distributed controllers
• Ensure system can operate without renewable sources
Generator Optimization

Generator Fuel Consumption vs. Load

- 800kW
- 1600kW

- gal/hr
- kW

[Graph showing fuel consumption vs. load for 800kW and 1600kW generators.]
SPIDERS Value Proposition

Repurpose Existing Assets

- Reduced cost
- Utilize otherwise stranded assets
- Minimize downtime of existing facilities

Flexibility in Usage

- Fully functional fail-safe mode
- Satisfy life safety codes
- Facilitate improved testing and maintenance
SPIDERS Value Proposition

Cyber Secure Controls

• Dramatically increase situational awareness
• Isolated network with multiple enclaves
• Distributed controls philosophy

COTS-Based Solution

• Adaptable to each site’s unique requirements
• Facilitate maintenance consistency
SPIDERS Breaker
SPIDERS Phase I
Joint Base Pearl Harbor Hickam
Approach and Results
JBPHH Microgrid Overview

- Serves 400-700kW critical load (WWTP)
- Two electrically isolated generators and busses
- 150kW PV array
Generator Synchronization Path

1600 kW Generator Controller

800 kW Generator Controller

Mamala Substation Breaker
What has SPIDERS Phase I Demonstrated?

- Stable operation of the Microgrid with PV and diesel power sources in parallel
- High penetration of renewable sources in a microgrid (up to 90% PV penetration)
- Transmission of generator load sharing control signals over long distances
- Creation of a secure control network for a Microgrid per DIACAP Guidelines
What has SPIDERS Phase I Demonstrated?

• Fail-safe control that reverts to traditional backup power modes
• Enhanced generator testing: ability to test generators at any load without interrupting WWTP
• 30% reduction in diesel fuel consumption when in SPIDERS power mode
Performance Data
Typical Microgrid Power and Fuel Consumption

Fuel savings due to generator optimization

Fuel savings due to PV integration
SPIDERS Phase II
Fort Carson, CO
Technical Approach
Fort Carson Microgrid Overview

• Serves Tier 1, 2 & 3 building loads (2,000 kW)

• Integrates existing generation assets
  • Three, large diesel generators
  • 2MW PV Array

• Develop bi-directional PEV charging
  • Energy storage
  • Grid services
  • Power factor correction
Microgrid Power Sources

- 1250kW Diesel Generator
- 1000kW Diesel Generator
- 900kW Diesel Generator
- 2MW PV Array
- Five, 60kW Bi-Directional Electric Vehicles (600kWh combined capacity)
Microgrid Loads

**Tier 1**
- 4th ID HQ
- NEC Data Center
- NEC
- Network Control Center

**Tier 2**
- Battalion Headquarters
- Community Service Center

**Tier 3**
- Grant Library
Normal Operation
Microgrid Forms
Microgrid Fully Formed
Microgrid Differences
Fort Carson EVSE

- Develop bi-directional PEV charging
  - Energy storage
  - Grid services
  - Power factor correction
Camp Smith Microgrid Overview

- Serves Entire Camp (4,500 kW)
  - Approximately 35, 15kV Distribution Breakers
  - Load Shedding at 15kV and 480V Levels

- Integrates existing generation assets
  - Two, large diesel generators (2MW total)
  - Multiple PV Arrays (1MW total)

- Tier 4I On Site Generation
  - 4.5MW Capacity
  - Utility Demand Response
  - Battery System for Blinkless Transfer
Camp Smith Microgrid Overview
Microgrid Considerations for DOD Initiatives
Renewables Interface

• System Stability
  
  • UL Listing of typical grid-tied equipment requires voltage and frequency stability for operation
  
  • Increased use of PV (unity power factor output) reduces power factor from utility, potentially increasing utility rates from penalties
  
  • Variability of many renewable types requires spinning reserve in the system to compensate for sharp drops in renewable output

C.13. Grid Isolation Technology
[NOTICE TO DRAFTER: Insert this section if applicable - Grid isolation technology is required as defined in the Contract so that a continuously operated plant will self-isolate and remain functional upon external grid power failure in accordance with IEEE 1547 (Standard for Interconnecting Distributed Resources with Electric Power Systems) and UL 1741 (Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources). The grid isolation effort may be included as an optional price in the Contract.]

C.14. Existing On-Site Generation Assets
Modifications to the Installation’s electrical system beyond the Point of Connection to the Government’s electrical system is required by the Contractor to provide proper circuit coordination, system isolation, and protection with consideration of fault current contribution from the Project. The cost of modifications shall be borne by the Contractor. Electric Utility regulations must be adhered to at all times, in particular when operating on circuits with automatic standby power unit(s).]
Renewables Interface

• PPA Considerations
  • Large renewable assets should be available for backup power use
  • PPA contracts should allow for microgrid control interface to system
  • PV array design should allow for segmentation of output into manageable “blocks” (250kW inverters rather than 1MW blocks)
  • PPA/EUL access agreements should consider future microgrid construction/access
  • DOD must define ICS IA “ownership”
  • PV should be distributed throughout system
Army Standardization

• UFCs for Microgrid Compatibility
  • New generator installations should consider “SPIDERS” breakers
  • ATS should be closed transition type
  • Sectionalizing switches should be capable of adding automation
  • High speed breakers should be provided at potential microgrid tie points
Thank You