SPIDERS Industry Day
Implementation Considerations
Drivers for DoD Microgrids

• Military missions are growing more dependent on state-side installations for operations and logistics
• The US power grid is becoming increasingly fragile
• Threats of physical and cyber attacks on the grid are increasing
• Prolonged utility outages due to natural disasters are occurring more frequently
• Mandates to reduce reliance on fossil fuels
SPIDERS CONOPS

SPIDERS JCTD Objectives

• Provide a Cyber-secure microgrid for Enhanced Mission Assurance
  • Increase reliability of traditional backup generation
  • Reduce fossil fuel consumption of generators
  • Integrate renewable generation in islanded mode
• Implement a cyber-secure control system
SPIDERS CONOPS

Do No Harm!

• Maintain reliable legacy systems
  • Existing generation assets
  • Automatic Transfer Switches (ATS)
  • Existing distribution networks
• Avoid additional failure points
• Fail-safe modes should match existing conditions
SPIDERS CONOPS

Minimize Changes to Existing Infrastructure
• Maximize value through use of existing assets
• Utilize existing infrastructure to increase reliability and maintainability of systems
• Address existing deficiencies in power systems

Minimize Disruption to Ongoing Operations
• Critical Missions can’t afford lengthy construction and testing outages
• Seamless transition to/from utility power is crucial during testing and operation
SPIDERS CONOPS

Enhance Grid-tied Operations

• Improve generator testing capabilities through parallel operation with utility
  • Increase generator certainty
  • Reduce wet-stacking
• Support peak shaving opportunities
• Support grid services
SPIDERS Phase I
Joint Base Pearl Harbor Hickam
Technical Approach
Site Orientation

- Mamala Substation
- Renewable Island
- WWTP
JBPHH Microgrid Overview

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

1600 kW generator (400 kW load)

800 kW generator (100 kW load)

480V distribution

150 kW PV Array
SPIDERS Phase I System

Mamala Substation

Fort Kam 15kV Feeder

Renewable Island

1600kW Generator

Microgrid Control System

800kW Generator

Critical WWTP Loads

Seamans
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 (PRA Accreditation process)
Generator Synchronization Path

1600 kW Generator Controller

800 kW Generator Controller

Mamala Substation Breaker
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
Fort Carson Microgrid Overview

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

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

• Develop bi-directional PEV charging
  • Energy storage
  • Grid services
  • Power factor correction
Fort Carson Microgrid Overview

Specker Avenue

PV Array
Fort Carson Microgrid Overview
SPIDERS Microgrid
Planning & Design Considerations
Site Data Package Requirements

• Understand existing electrical topology
  • Substation/PCC Interface (breakers or switches)
  • Certainty of distribution configuration
  • Utility load management responsibilities
  • Grounding reference points

• Prioritization of Loads
  • Based on mission criticality of operation
  • Consider cost-benefits of adding critical loads, omitting non-critical loads
Site Data Package Requirements

• Understand load profiles
  • Peak and average loads
  • Availability of meter data
  • Ensure renewable output does not exceed load

• Control communications networks
  • Dedicated networks for cyber security
  • Ownership of data lines and pathways
  • Security and segmentation of data lines
Site Data Package Requirements

• Utility Operations Preferences
  • Utilization of visibility provided by microgrid control system
  • Automatic or manual initiation of microgrid modes
  • Pre-emptive islanding
  • Power reliability of control stations
  • Notifications to utility providers
Codes and Standards

- Unified Facility Criteria (UFC)
- Applicable Building Codes
- Site Specific Criteria
  - Installation standards
  - Corrosive environments
  - Temperature extremes
Changes to Codes and Standards

• For Buildings with 500kW and Larger Generators
  • Require Automatic Transfer Switches to have remote inputs to command switch to stay on emergency or normal source
  • Provide closed transition transfer switches
  • Require Generators to have load sharing capabilities
  • Require conduits for bypass breakers be installed to service transformer
  • Consider installing SPIDERS bypass breakers on generators
  • Consider standardizing on common generator size
Changes to Codes and Standards

• For Buildings with 100kW and Larger PV Arrays
  • Require reverse power monitoring of generator to shut down PV array
  • Require remote shutdown of PV array by microgrid controller
  • Require dedicated power meter on PV array to transmit output to microgrid controller
  • Consider VAR compensation
  • Consider connecting inverters directly to main switchboard
Interconnection Considerations

• Utility Requirements for UL-listing
  • Anti-islanding features of inverters
  • Lack of test standards for microgrid features (i.e. EVSE)

• 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
Interconnection Considerations

• Utility Requirements
  • Mixed resource microgrid can require multiple interconnect agreements
  • Work with utilities to widen operating frequencies and voltages for PV arrays
  • No clear requirements for bi-directional electric vehicle charging stations or batteries which operate at non-unity power factor
Interconnection Considerations

- Third-party Renewable PPA’s
  - 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
IA Considerations

• Determine control system Accreditation Authority
  • Certification of ICS not standard in the DOD

• Determine control system Ownership
  • Yet to be defined for Phase II
Questions?