JCTD SPIDERS
Technical Overview Phases 1-3

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US Army Corps of Engineers®

ERDC
Engineer Research and Development Center

SPIDERS Partners

- OSD
- USPACOM, USNORTHCOM, DOE, and DHS
- USACE/ERDC-CERL
- Military Services
- 5 DOE National Laboratories
- US Army TARDEC
- Naval Facilities Engineering Command
- Local Utility Companies
- States of Hawaii and Colorado

The SPIDERS Multiphase Approach

STAIRWAY TO ENERGY SECURE INSTALLATIONS

Phase 1

PEARL-HICKAM CIRCUIT LVL DEMO

- Solar Renewables (8-9%)
- Two (2.4 MW) Generators
- Energy Management Sys
- Cyber architecture SCADA evaluation

Phase 2

FT CARSON MICRO-GRID

- Large Scale Renewables
- Vehicle-to-Grid
- Smart Micro-Grid
- Critical Assets
- Cyber Security Test (Lab and Live Grid)

Phase 3

CAMP SMITH ENERGY ISLAND

- Entire Installation Smart Micro-Grid
- Grid-tied & Islanded Operations
- Distributed Renewables
- Demand-Response of Economic Benefit
- Redundant Backup Power
- Clean, Dedicated Tier 4i Generation

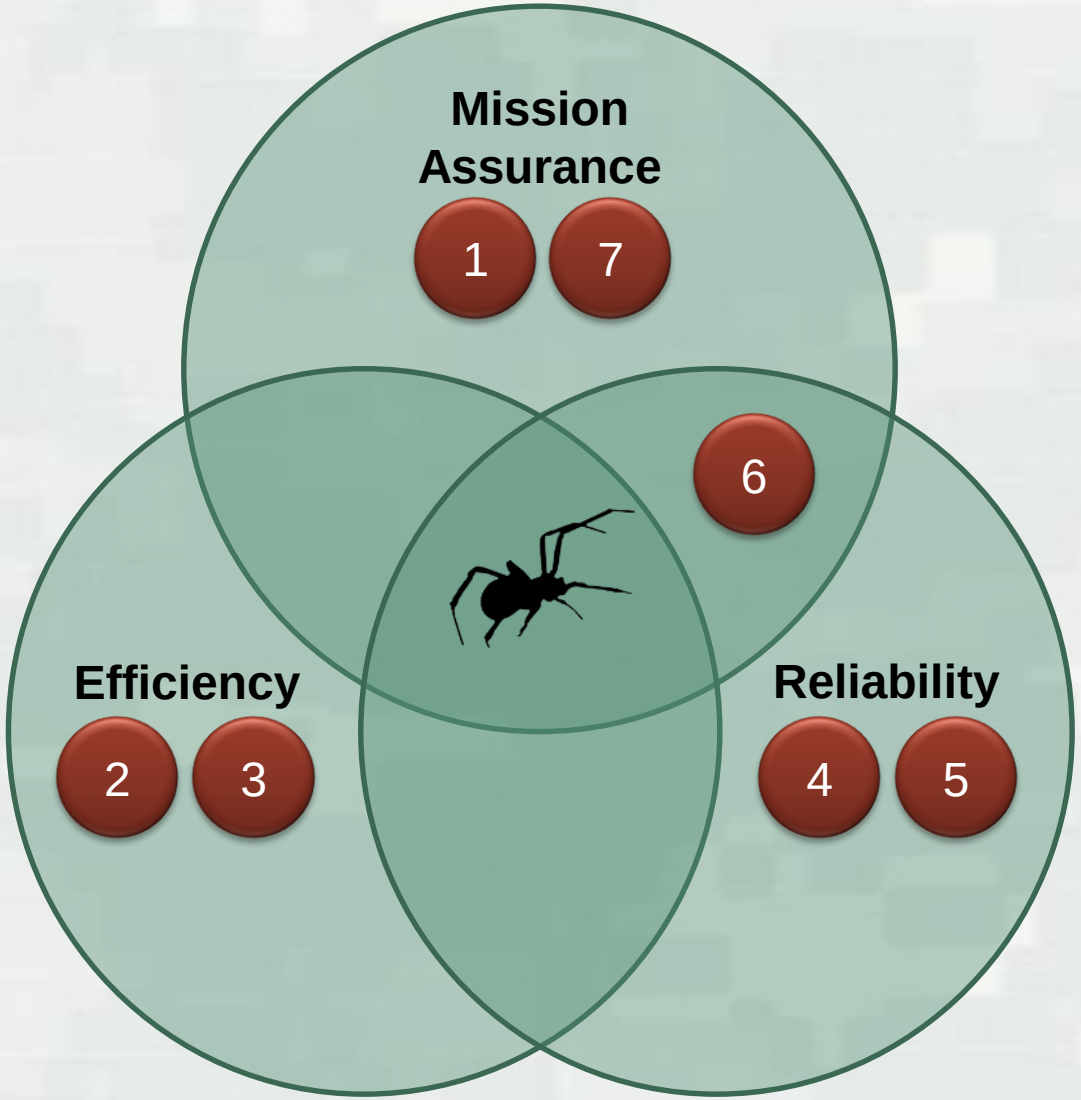
TRANSITION

- Template for DoD-wide implementation
- CONOPS
- TTPs
- Training Plans
- DOD Unified Facilities Criteria
- Transition to Industry
- Transition to Federal Sector and Utilities
- System Architecture
- Cyber Security

CYBER SECURITY BEST PRACTICES

RIGOROUS ASSESSMENT WITH RED TEAMING IN EACH PHASE

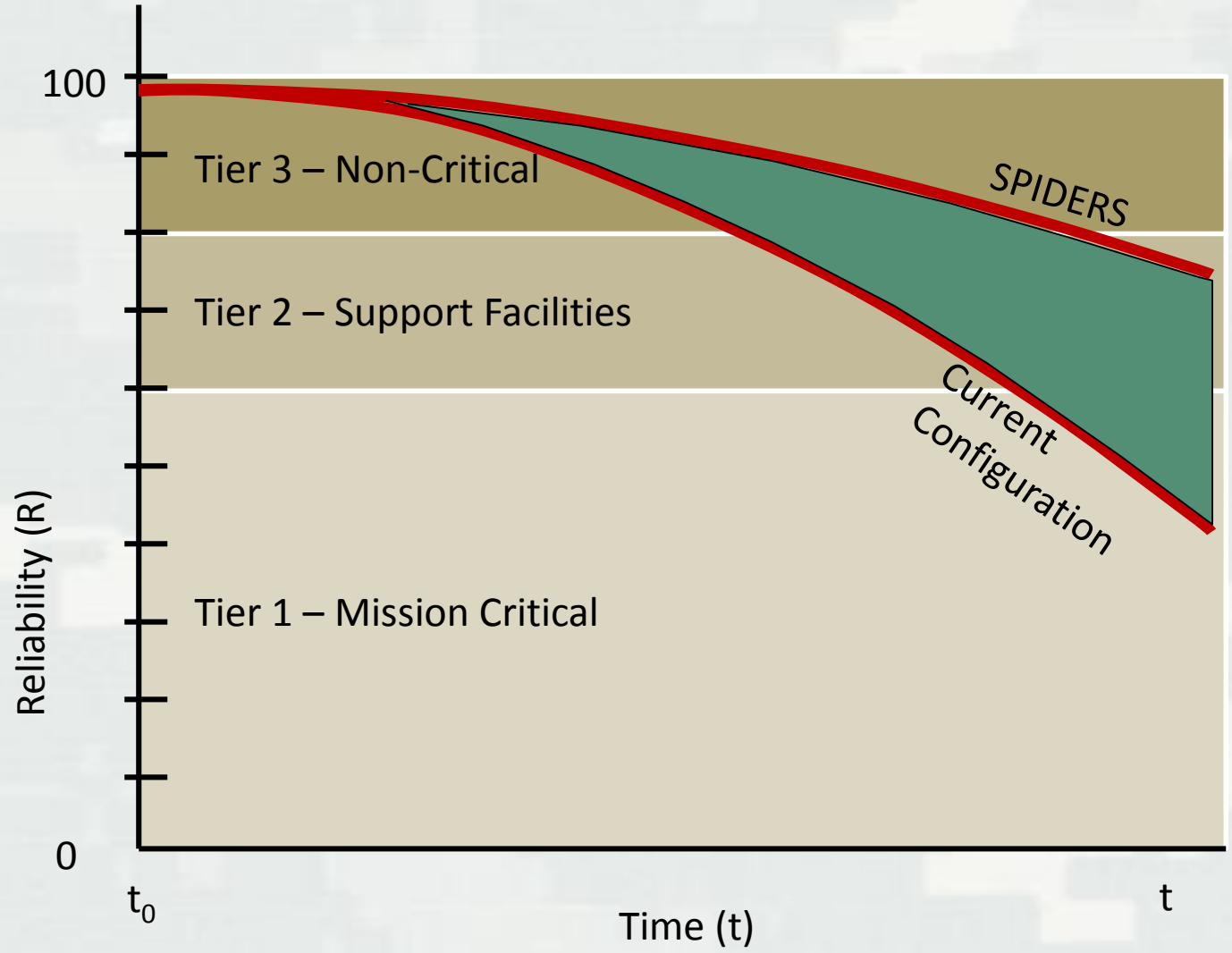
The SPIDERS Phase 2 and DOD Energy Security



SPIDERS Objectives and Capabilities

1. Improve reliability for mission-critical loads.
2. Reduce reliance on fuel by using renewable energy sources during grid outages.
3. Increase efficiency of generators through coordinated operation.
4. Reduce operational risk for energy systems through strong cyber security.
5. Enable full-load generator testing.
6. Provide N+1 backup power redundancy.
7. Allow critical mission buildings to receive backup power from multiple generators.

Notional Power Reliability



The SPIDERS Multiphase Approach

- Two generators (2.4 MVA)
- 150 kW solar array
- Single Distribution Feeder
- Accredited System Security
- Critical Facility Support

- Three generators (3.5 MVA)
- 1 MW solar array
- Three Distribution Feeders
- Functional Enclave Security
- 5 Bi-directionally Charging Electric Vehicles
- Critical Facility Support

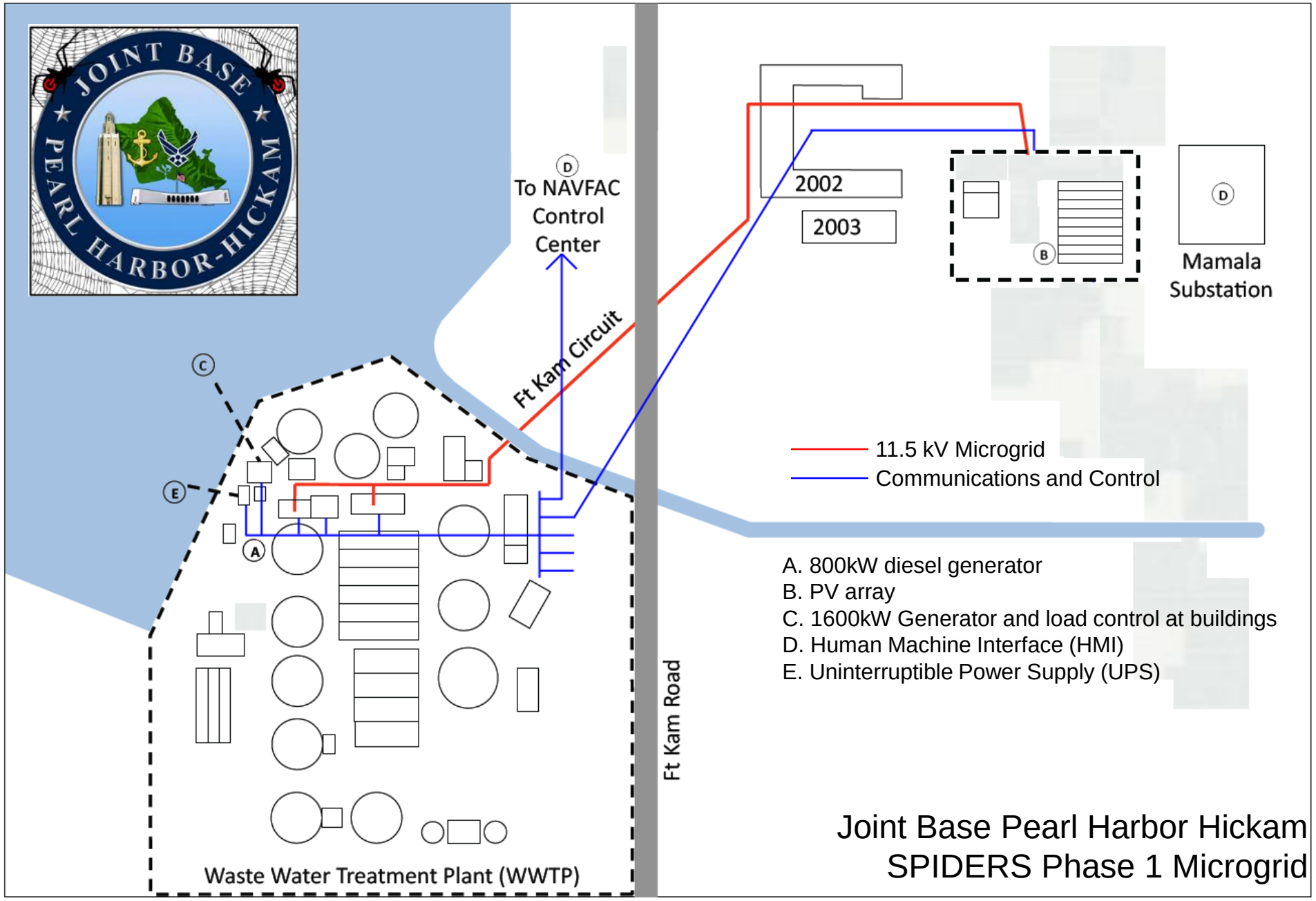
- Six generators (5 MVA)
- Three sub-microgrids
- Whole installation Support
- Strong Security Posture with external connections
- Tier 4i generators support daily peak-shaving operation
- Participating in utility programs to generate ROI
- Critical Facility Support

SPIDERS Design Methodology

- Minimize changes to existing infrastructure and maximize use of existing assets
- Avoid unnecessary complexity and failure points
- Minimize disruptions to critical installation operations during construction and testing
- Provide “N+1” generation redundancy for critical operations
- **Do No Harm**: Built in fail safe modes revert to traditional (facility-dedicated) back up power operations

JCTD SPIDERS Timeline

	Jan 2015 — SPIDERS Transition
The SPIDERS Transition Team will lead efforts to develop UFCs and UFGSs to share lessons learned.	**Dec 2015** — Camp Smith Operational Demonstration
	30 April 2015 — Camp Smith Construction Complete
Laboratory and live grid red team experiments will vette the Phase 3 security posture.	**15 Jul 2015** — Camp Smith Authority to Operate
	9 Dec 2013 — Camp Smith 60% Design Review
	21 Oct 2013 — Fort Carson Oper. Demonstration
Systems integrator and two RIF contractors will develop a 100% design for bid-build MILCON award.	**26 Sep 2013** — Camp Smith Contracting Finalized
EVs and EVSEs at Fort Carson provide power to the grid and inject VARs.	**25 July 2013** — EVSEs perform V2G and VAR support
	15 Apr 2013 — Initial Cyber Security Experiment
NWO/CERL team successfully award a contract with CLINs for both RDT&E and MILCON work.	**21 Jan 2013** — JBPHH Operational Demonstration
ERDC-CERL partners with USACE MDC to award the first SPIDERS contract.	**Aug 2011-Jun 2012** — SPIDERS Phases 1&2 Contracting
	17 Jun 2011 — SPIDERS receives first funding


JOINT BASE
PEARL HARBOR-HICKAM
D
To NAVFAC
Control
Center
2002
2003
B
D
Mamala
Substation
Ft Kam Circuit
C
E
A
11.5 kV Microgrid
Communications and Control
A. 800kW diesel generator
B. PV array
C. 1600kW Generator and load control at buildings
D. Human Machine Interface (HMI)
E. Uninterruptible Power Supply (UPS)
Ft Kam Road
Waste Water Treatment Plant (WWTP)
Joint Base Pearl Harbor Hickam
SPIDERS Phase 1 Microgrid

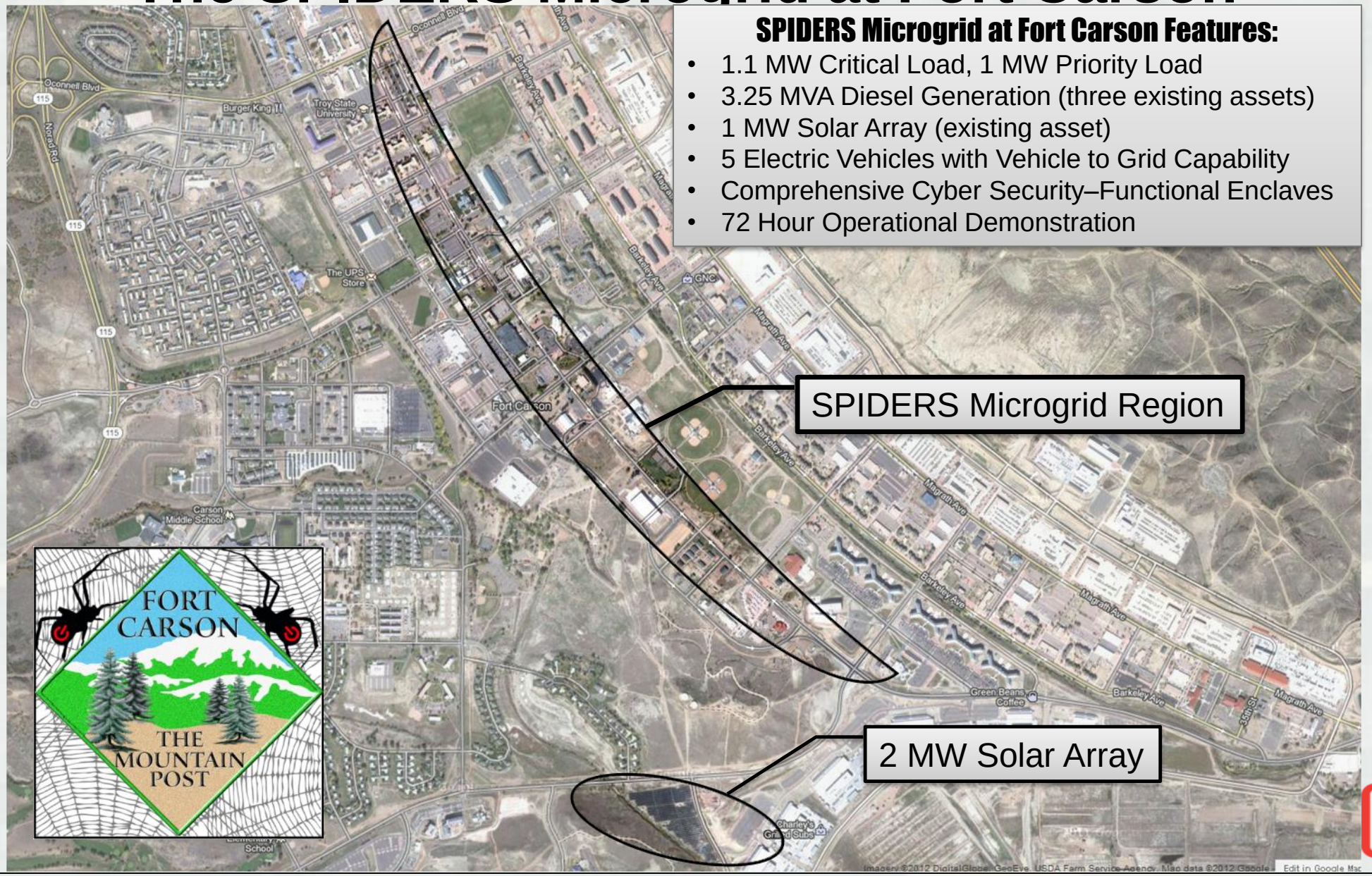
The SPIDERS Microgrid at JB Pearl Harbor Hickam

- Microgrid Resources:
  - 2.4 MW Diesel Generation
  - 150 kW Solar Array
  - UPS for uninterruptible load
  - Black Start Capable

- Phase 1 System Capabilities:

  - Nearly 30% fuel savings.
  - Remote HMI Station provides control room awareness.
  - Solar array integration provides test for large scale integration at Fort Carson.
    - **Penetration level reached 90%**
  - Exported about 1MW when grid tied.
  - Enables plant operation with a single generator.

The SPIDERS Microgrid at Fort Carson



The SPIDERS Microgrid at Fort Carson

- 1 MW solar connected, 500 kW functional for OD
  - No modifications to PV inverters
  - Proof-of-concept at JBPHH with 150kW PV array
  - Maximum output prediction and metering manage PV integration.

- 5 Electric Vehicles with V2G Capability

  - Provide some stabilization to microgrid
  - Developmental converter/aggregator interfaces with microgrid control system
  - Intended to provide demand response, peak shaving, and ancillary services in a wholesale market
  - Active VAR injection from charging stations promises rapid payback.

Phase 2 Demonstrations

- Completed successfully with all microgrid resources online.
  - 1 MW of solar connected, 500 kW functional during Operational Demonstration
  - 4 electric vehicles connected: 1 Boulder EV, 3 Smith EVs
  - 5 EVSEs providing VAR injection (voltage support)

- Generator maintenance conducted during microgrid operation revealed important operational process lessons.

- SPIDERS Phase 2 follow up activities:
  - TARDEC led grid services demonstration with electric vehicles
  - Cyber security Red Team exercise.





SPIDERS Phase 2 Challenges

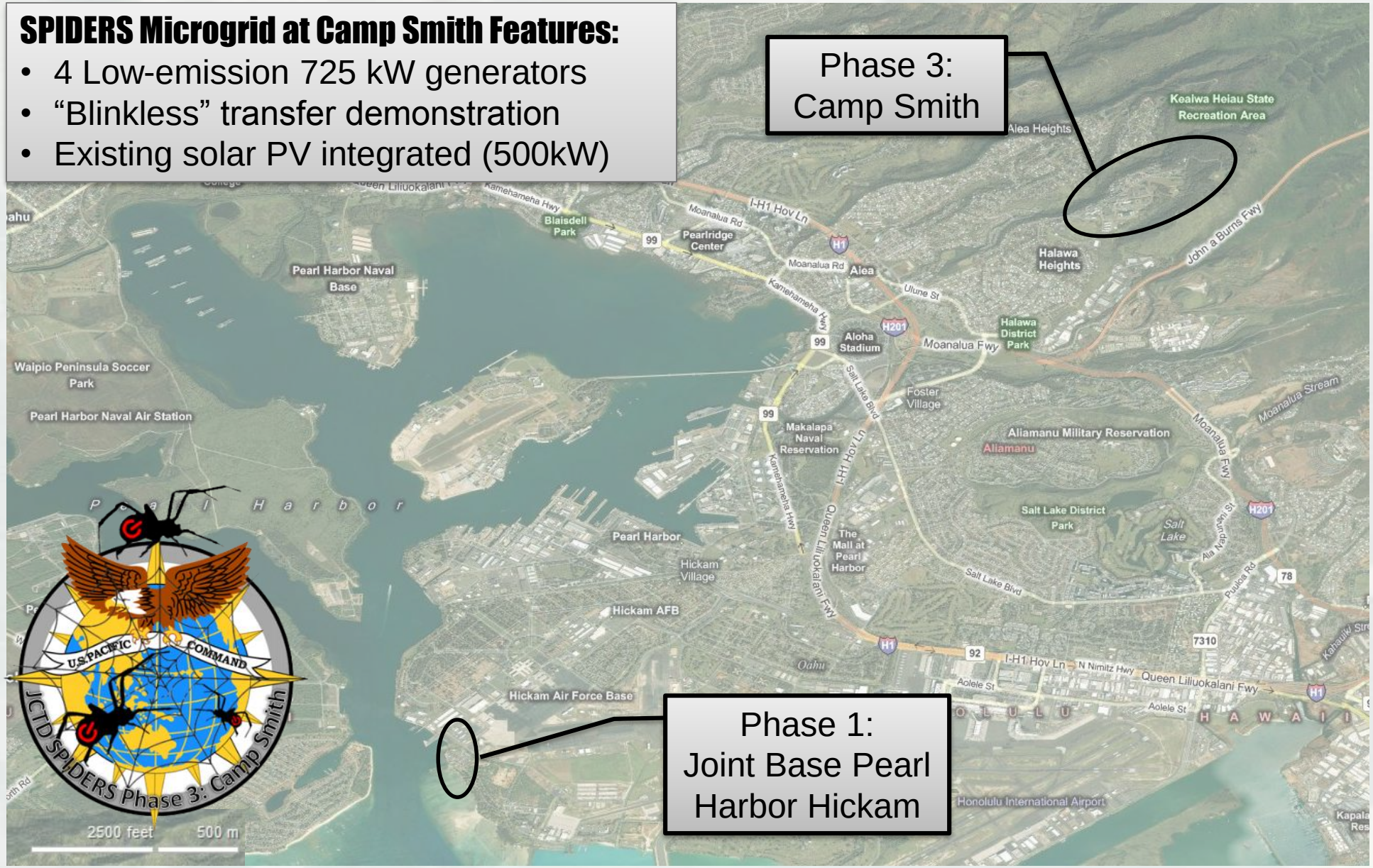
- Fires, Floods, and Furloughs
  - Waldo Canyon, Black Forrest
  - 9 September 2013 Flooding
  - Federal Furloughs and Shutdown
- Existing Infrastructure:
  - Designing around existing distribution
  - “Cherry picking” loads
  - Minimum impact mentality
  - Practical research projects

- Control System Maintenance and Sustainment
  - No ICS system owner (Army)
  - Long term security relies on good maintenance
  - SPIDERS IATT expires in 6 months.
- Integrating 3rd Party-Owned Assets
  - Consideration in design phase (segments, fiber)
  - Provisions in PPA for microgrid integration
  - SPIDERS integration could have higher utilization

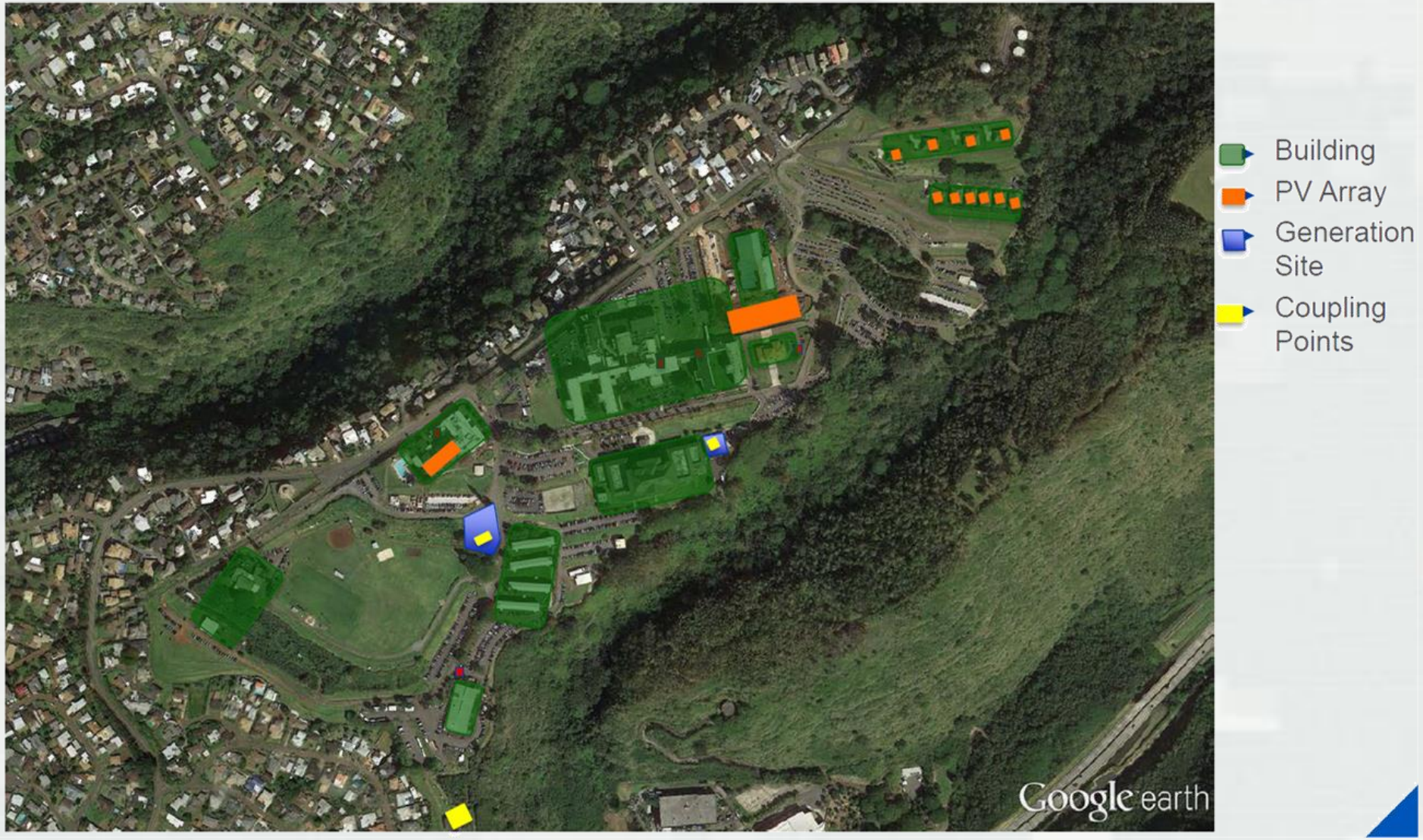
SPIDERS Microgrids On Oahu

SPIDERS Microgrid at Camp Smith Features:

- 4 Low-emission 725 kW generators
- “Blinkless” transfer demonstration
- Existing solar PV integrated (500kW)



SPIDERS Phase 3 Microgrid



The SPIDERS Microgrid at Camp Smith

- SPIDERS Camp Smith represents many firsts:
  - First DoD ***Installation Scale*** Microgrid
  - First OSD/COCOM sponsored Microgrid
  - First DoD Microgrid with ***EPA Tier 4I*** Generation
  - First Microgrid with ***Blinkless*** Energy Storage
  - First ***fully DoD IA accredited*** Microgrid with rigorous USPACOM cyber experimentation
  - First installation JCTD to ***combine R&D and MILCON*** Investments
  - First DoD Microgrid with ***aggressive demand response*** to defer utility costs and support HECO

Balancing Capabilities and Risk

- Introducing new vulnerabilities could eliminate the benefits of the microgrid.

- Strong security posture is required to realize the benefits of microgrid technology.
  - ► Must be maintained to remain strong.

- SPIDERS offers a demonstrated solution, but clear policy is needed for wider implementation.

Microgrid	Traditional Backup
Network Vulnerabilities	No Network
Advanced Control System	Limited Control
Renewables Integration	Aging Delivery System
Improved Efficiency/Emissions	Poor Efficiency/Emissions
Higher Availability/Reliability	No Backup Redundancy

Thank you!

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