SPIDERS
Energy Security JCTD Proposal

Dr. George Ka'iliwai
**USPACOM J8, Director of
Resources and Assessment**

Mr. Wade Jost
**OSD Power Surety Task Force
The RedGate Group**

This brief is:
UNCLASSIFIED

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The Situation

Defense Science Board

- "Critical national security and homeland defense missions are at an unacceptably high risk of extended outage from failure of the electric grid." The Defense Science Board Task Force on DoD Energy Security, July 2008

The Situation

CNA
ANALYSIS & SOLUTIONS

- "There have been numerous attacks on the operating systems of major critical infrastructure facilities, including power grids, around the world in recent years: Chinese and Russian spies have "penetrated the U.S. electrical grid" and left behind dormant but malicious software."

- "Aurora threat revealed the possibility that sophisticated hackers could seriously damage the grid by destroying mechanisms downstream from the initial point of attack."

- "DoD should pioneer the adoption of smart-grid technologies on its installations. These technologies would help the installations better manage their energy demand, increase efficiency, enable more effective use of renewable sources, and provide resilience against electrical disruptions."

Powering America's Defense, Energy and the Risks to National Security, by the Center for Naval Analyses Military Advisory Board, May 2009
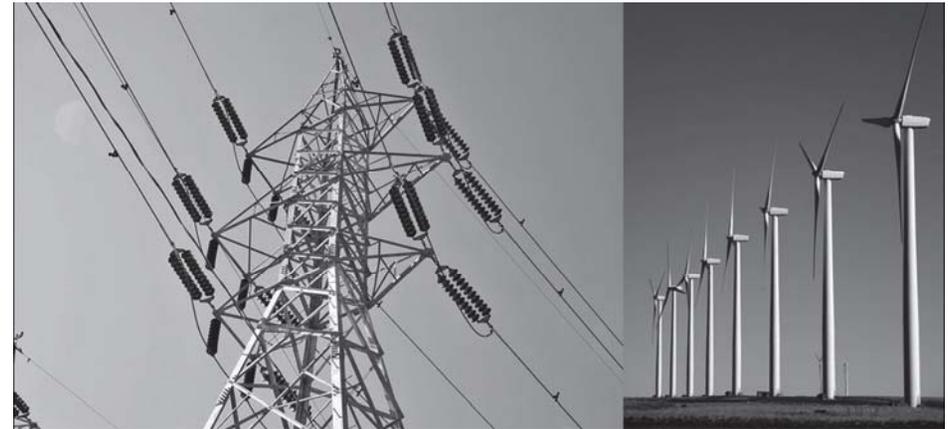
SPIDERS JCTD Proposal

- **SPIDERS – Smart Power Infrastructure Demonstration for Energy Reliability and Security**

- **Joint Capability Technology Demonstration (JCTD) on Energy Security**

  - **Will look at**
    1. **Cyber defense**
    2. **Smart microgrid**
    3. **On Camp Smith, Hawaii**

  - **Partners**
    - **OSD Power Surety Task Force**
    - **DOE (5 labs)**
    - **Military Services**
    - **U.S. Pacific Command**
    - **Defense Energy Support Center**
    - **Hawaiian Electric Company**
    - **State of Hawaii**

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SPIDERS – Smart Power Infrastructure for Energy Reliability and Security

As of Nov 09

SPIDERS

Coalition / Joint / Interagency Operational Problem

The ability of today's warfighter to command, control, deploy, and sustain forces is adversely impacted by a fragile, aging, and fossil fuel dependent electricity grid, posing a significant threat to national security.

– Inability to protect task critical assets from loss of power due to cyber attack

– Inability to integrate renewable and other distributed generation electricity to power task critical assets in times of emergency

– Inability to sustain critical operations during prolonged power outages

– Inability to manage installation electrical power and consumption efficiently, to reduce petroleum demand, carbon "bootprint," and cost
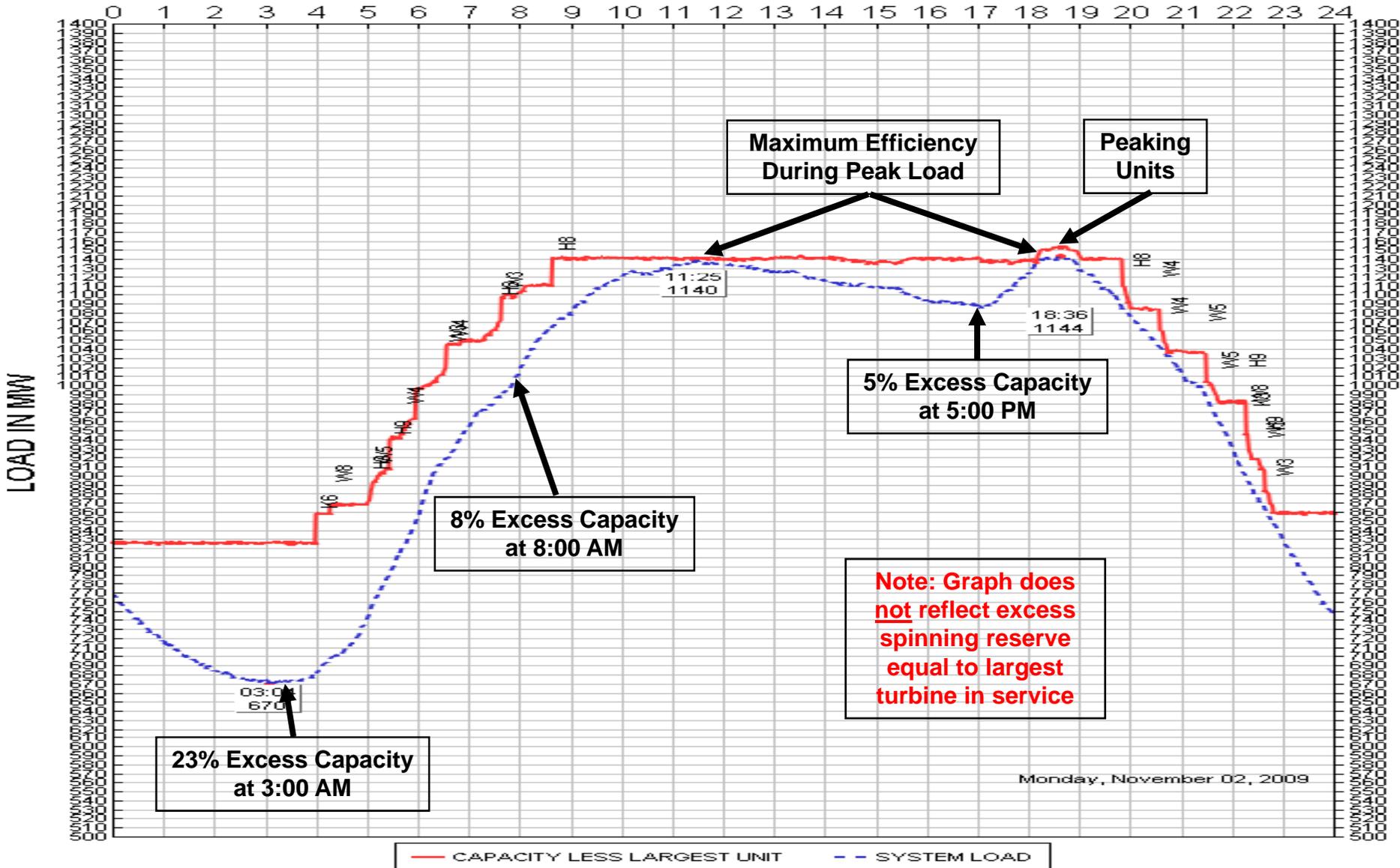
> The modern military needs to evolve its power infrastructure. New threats demand new defenses

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HECO Typical Daily System Load vs Capacity

SYSTEM LOAD

LOAD IN MW

Maximum Efficiency During Peak Load

Peaking Units

11:25 1140

18:36 1144

5% Excess Capacity at 5:00 PM

8% Excess Capacity at 8:00 AM

Note: Graph does not reflect excess spinning reserve equal to largest turbine in service

03:0 670

23% Excess Capacity at 3:00 AM

Monday, November 02, 2009

—— CAPACITY LESS LARGEST UNIT   – – SYSTEM LOAD

SPIDERS Desired Capabilities by 2013

- **Provide cyber defense of a smart grid network**
  - **Establish a strategy of defense-in-depth using virtual secure enclaves and a sensor architecture**
  - **Institute strong authentication and role-based access controls**
- **Intelligent and secure electric grid providing efficient and reliable 24/7/365 power to military task critical assets ensuring uninterrupted nat'l defense**
  - **Allow power to be used with maximum efficiency**
    - **Institute energy demand management systems**
    - **Maximize asset utilization**
  - **Make the DoD demonstration grid both fault and attack tolerant with rapid recovery after natural disaster or deliberate attack**
    - **Enable islanding, protection of power supply & task critical assets**
  - **Allow all sources of power to provide electricity to the grid**
  - **Enable the high penetration, stability and security of renewable energy production**
    - **Dynamic/adaptive protective relaying scheme**
- **CONOP and TTP**
  - **Coordination and demonstration with utilities, military installations/organizations and others**
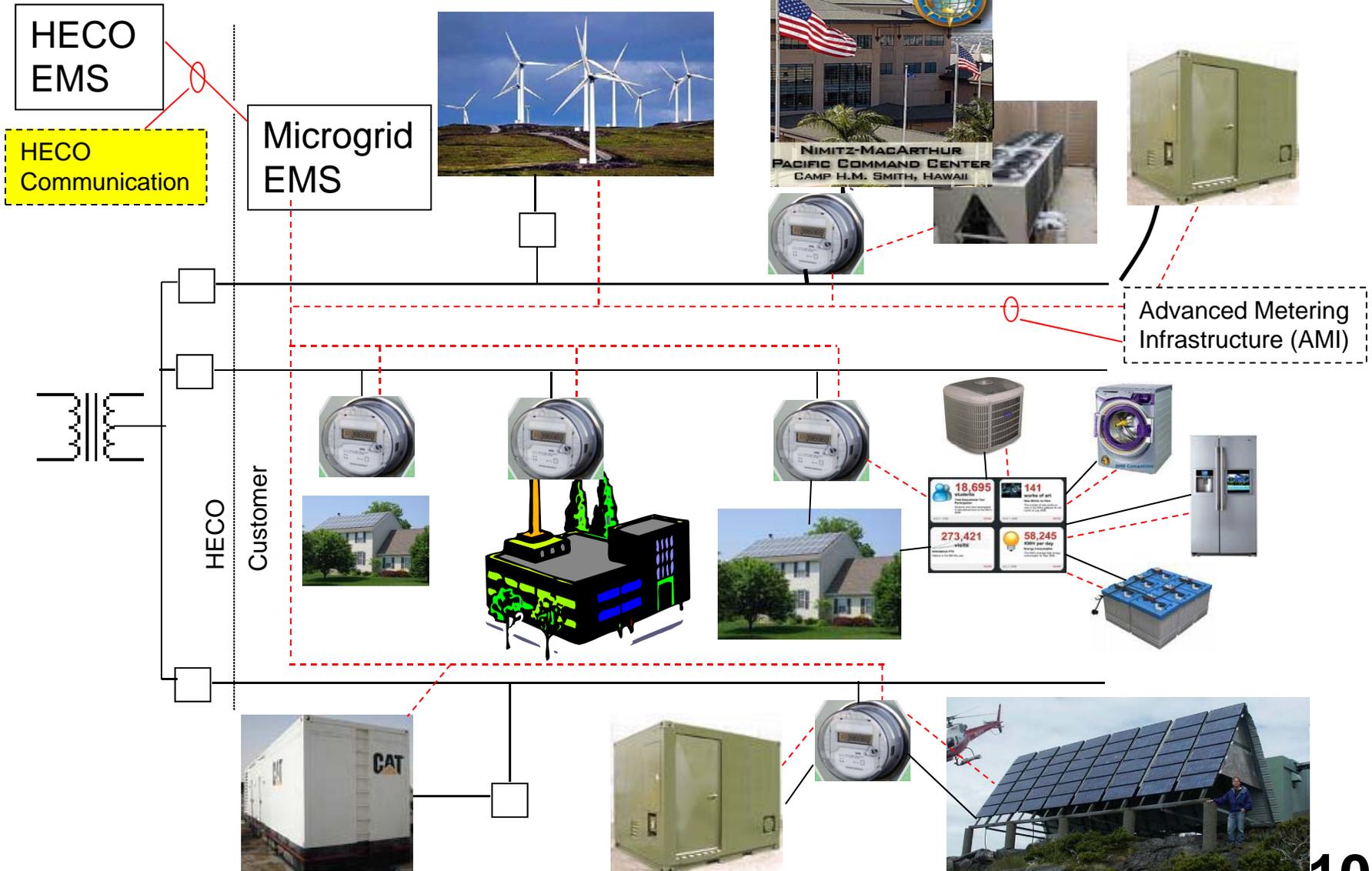
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SPIDERS Smart Grid Definition

An electric power system infrastructure that is:

- **Information rich**
  - **Automated**
  - **Interoperable**
  - **Energy is generated, distribute and consumed more efficiently and cost effectively**
- **Resilient and reliable**
  - **Attack and fault tolerant**
  - **Secure**
  - **Self healing**
  - **Capable of operating in parallel with or independent from the commercial grid**
- **Consumer participatory**
  - **Responds to market variations, loads and generation capability**
- **Able to integrate conventional, renewable, stored energy sources and other new technologies**

SPIDERS Operational View – 1 (OV-1)

HECO EMS

HECO Communication

Microgrid EMS

Advanced Metering Infrastructure (AMI)

HECO

Customer

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SPIDERS Overall Demonstration Strategy

Two complementary technologies will be developed independently initially until a live smart microgrid can be created at Camp Smith, HI

Smart Microgrid Project Strategy

Year 0 – Pre-JCTD smart microgrid conceptual design, Sandia & Oak Ridge Nat'l Labs

Year 1 – Smart microgrid acquisition

Year 2 – Installation and system integration, including cyber defense

Year 3 – Evaluation and transition

Grid

VSE
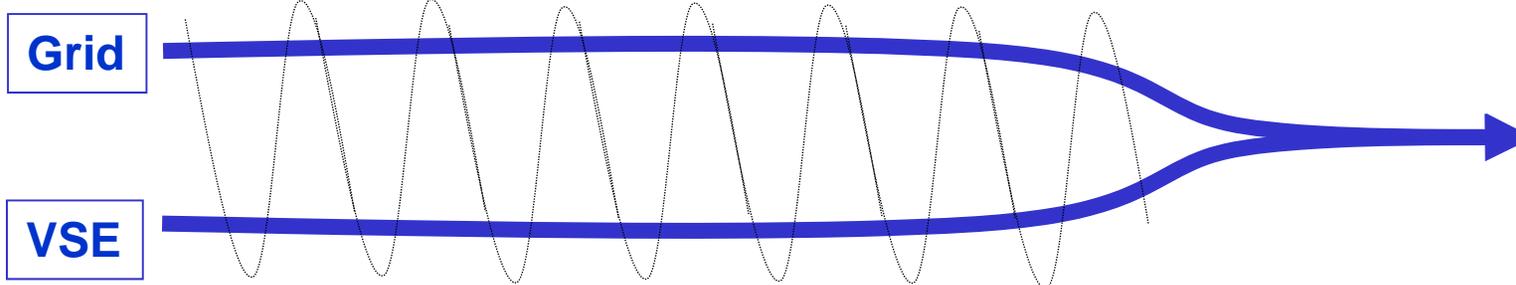
Parallel Virtual Secure Enclave (VSE) Cyber Experimentation Strategy

Year 0 – Pre-JCTD SCADA defense experiment at Idaho National Lab, National SCADA Test Bed

Year 1 – Follow-on SCADA defense experiment at INL

Year 2 – SCADA defense of Camp Smith smart microgrid

Year 3 – Evaluation and transition

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SPIDERS Core Technologies

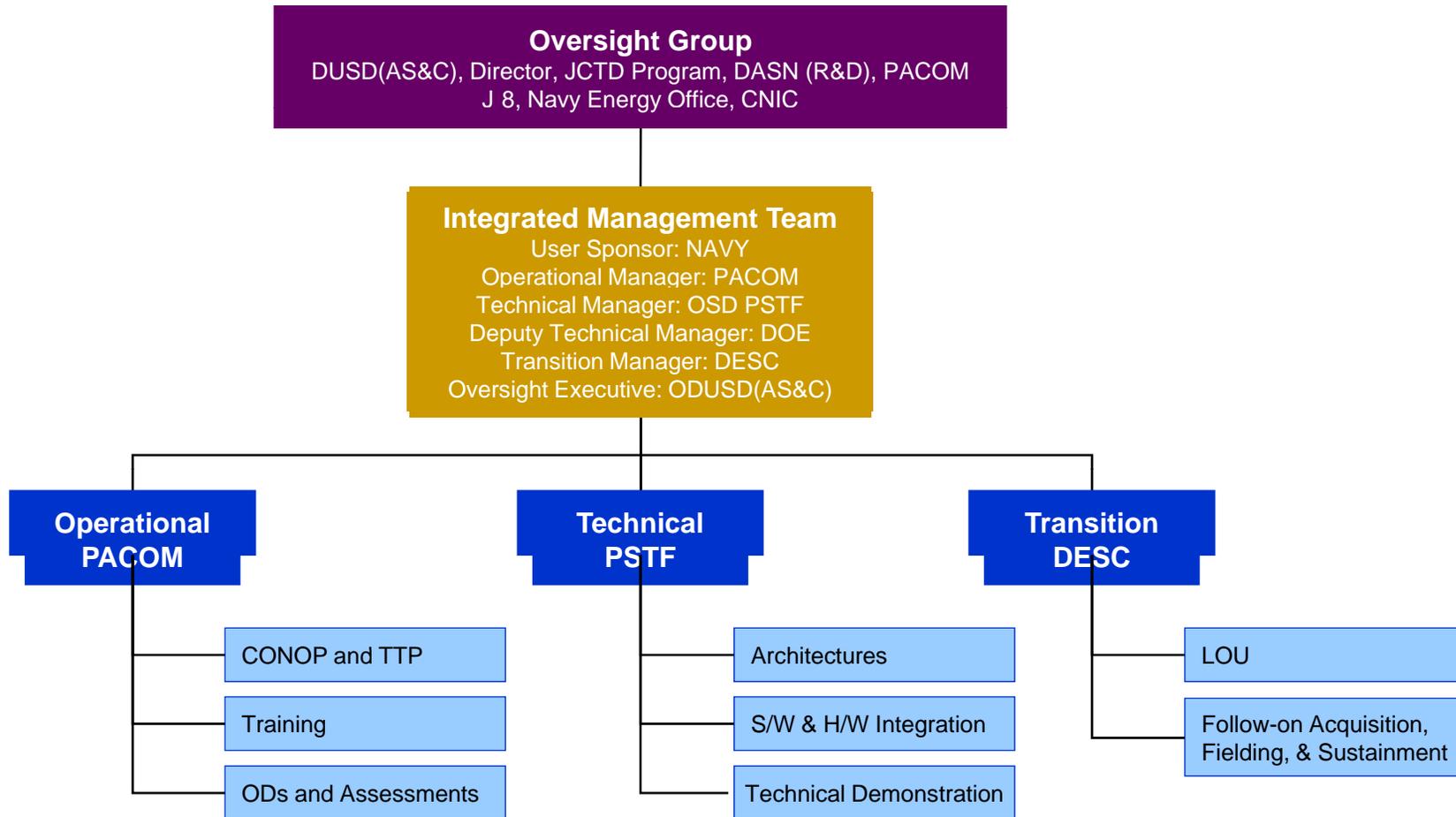| TRL	Today	FY13
Cyber Defense		
• Virtual Secure Enclave (pri 3, JT&E, CANDID JCTD)	7	9
• Live Action Network Management Tool (pri 3, same)	8	9
• Secure Distributed Monitors (pri 3)	4	6
• Cyber Security Situational Awareness (pri 3)	4	6
Energy Management Control and Operations		
• Energy Management Customer Interface (pri 2)	6	8
• Seamless grid synchronization (pri 3)	5	7
• Advanced Metering Infrastructure (pri 1)	9	9
• Microgrid Energy Mgt System (pri 2 HECO prop)	5	8
• Operator Interface (pri 3)	8	9
• Adaptive Relaying Design and Installation (pri 3)	4	7
• Substation (HECO prop) & Distribution Automation	8	9
Renewable Energy Microgrid Integration		
• Integration of Solar Photovoltaics (pri 2, NAVFAC RFP)	5	7
• Integration of Wind Turbines (pri 2)	5	7
• Integration of Black Start Generator (pri 2)	5	7
• Integration of Energy Storage (pri 2)	6	8

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SPIDERS Interoperability and Integration

Interoperability and integration with Hawaiian Electric Company (HECO) systems will be critically important to the success of SPIDERS JCTD

- VSE strategy included by Hawaiian Electric Company (HECO) in smart grid grant proposal to DOE
  - Developed by USPACOM J81 Joint Innovation and Experimentation Division in same office as SPIDERS Operational Manager

- Will ensure smart microgrid components (meters, energy management system, etc.) are compatible with HECO systems
  - Industry standards under development
  - HECO partnering with General Electric in DOE grant proposal
  - Will use HECO recommended functional requirements within government contracting process

- Will comply with Federal Energy Regulatory Commission (FERC) and North American Electric Reliability Corporation (NERC) standards whenever possible
  - Cyber defense protocols under development by FERC
  - FERC/NERC jurisdiction only applies to continental U.S.

SPIDERS Organizational Wiring Diagram (Draft)

Oversight Group
DUSD(AS&C), Director, JCTD Program, DASN (R&D), PACOM
J 8, Navy Energy Office, CNIC

Integrated Management Team
User Sponsor: NAVY
Operational Manager: PACOM
Technical Manager: OSD PSTF
Deputy Technical Manager: DOE
Transition Manager: DESC
Oversight Executive: ODUSD(AS&C)

Operational PACOM
- CONOP and TTP
- Training
- ODs and Assessments

Technical PSTF
- Architectures
- S/W & H/W Integration
- Technical Demonstration

Transition DESC
- LOU
- Follow-on Acquisition, Fielding, & Sustainment

Supporting narrative descriptions for each management area provided in Proposal Paper

SPIDERS Phases

Phase 1

- **Secure AMI**

Phase 2

- **Secure smart microgrid using current supply and generation capability**
- **Open architecture allowing 33% renewable on-site generation (currently equal to critical load)**

Phase 3

- **Integrate renewables into microgrid**
- **Simulate demand mgt and grid synch**

Phase 4, Post-JCTD

- **Demand mgt and seamless grid synchronization**

Phase 5, Post-JCTD

- **Demonstrate ability to export excess emergency power to local grid**

SPIDERS Schedule FY11, 12, 13

Acquisition
- FY11Q2 Smart Grid (SG)
- FY11Q4 Cyber Security (CS)

Tech Demo
- FY11Q4 SG Tech Demo at Sandia National Lab (SNL)?
- FY12Q1 Evaluate SG Tech Demo
- FY12Q1 CS Tech Demo at SNL
- FY12Q2 Evaluate CS Tech Demo

Installation
- FY11Q2 – FY12Q2 Install SG modules (ie renewables, relays, etc)
- FY12Q2 SG Limited Objective Experiment (LOE)
- FY12Q3 Evaluate SG LOE
- FY12Q3 CS Limited Objective Experiment (LOE)
- FY12Q4 Evaluate SG LOE

Integration
- FY12Q4 Integration of SG and CS
- FY13Q2 Final Operational Utility Assessment (OUA)

Evaluation and Transition
- FY13Q3 Evaluate SG and CS as a system
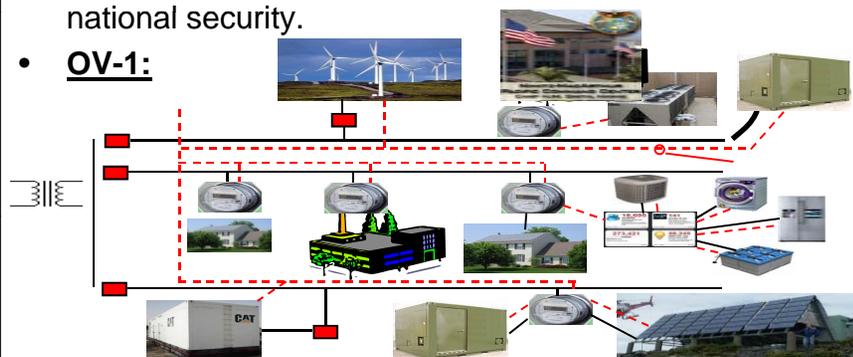- FY13Q4+ Transition to DOD and industry

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Quad Chart:
SPIDERS JCTD FY11-13

As of Nov 09

- **Operational Problem:** The ability of today's warfighter to command, control, deploy, and sustain forces is adversely impacted by a fragile, aging, and fossil fuel dependent electricity grid, posing a significant threat to national security.

- **OV-1:**

Operational Capabilities:

- **Combined resilient, fault and attack tolerant smart grid hardware & software consisting of:**
    - **Cyber security and smart grid equipment, renewable and conventional distributed generation, emergency generators, energy storage, intrusion detection, rapid forensic**

Technology:

TRL		Today	
Cyber Defense		4-8	6-9
Energy Mgt Control & Ops	4-9	FY13	7-9
Integration of Renewables		5-6	7-8

Participants:
- **User Sponsor: U.S. Pacific Command**
- **Lead Agency: U.S. Navy**
- **OM: PACOM**
- **TM: OSD Power Surety Task Force**
- **Asst TM: DOE**
- **XM: DESC**

Schedule:
- **Acquisition FY11Q2 - 11Q4**
- **Tech Demo FY11Q4 - 12Q2**
- **Installation FY11Q2 - 12Q4**
- **Integration FY12Q4 - 13Q2**
- **Eval & Transition FY13Q3 - 13Q4**

Transition:
- **TBD**

Funding:
- **U.S. Navy - ARRA-funded PV project + $2M PV array at Camp Smith funded by PPA**
- **DOE FEMP - $347K with Sandia National Lab and Oak Ridge National Lab**
- **HECO/GE/Forest City smart grid grant with DOE pending approval**

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