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Scalable Microgrids that Efficiently Utilize Renewable Energy Resources

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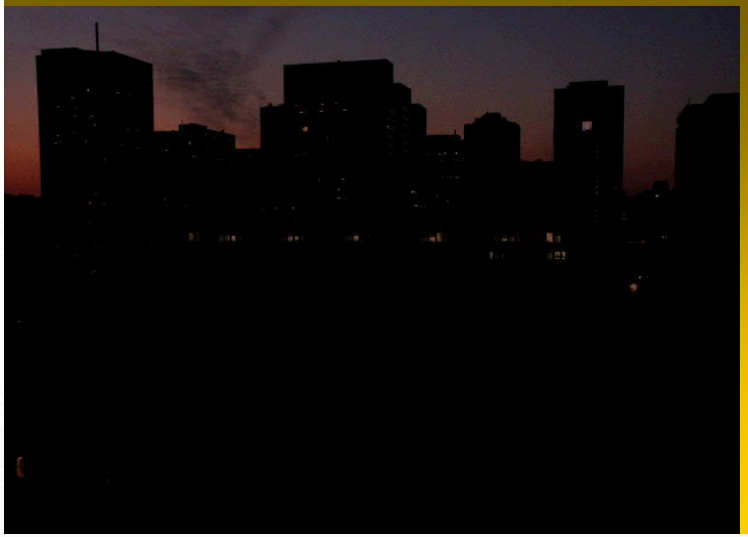
Chief Technology Officer

…Exceptional service in the national interest

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Key Technical Challenge: Provide Energy When the Grid is Down

- **The U.S. electrical grid is increasingly vulnerable to outages**
- **Energy reliability and vulnerability issues can and do lead to the loss of:**
  - mission capability
  - an estimated $49 billion per year in the U.S.
- **Optimizing renewables is increasingly important**



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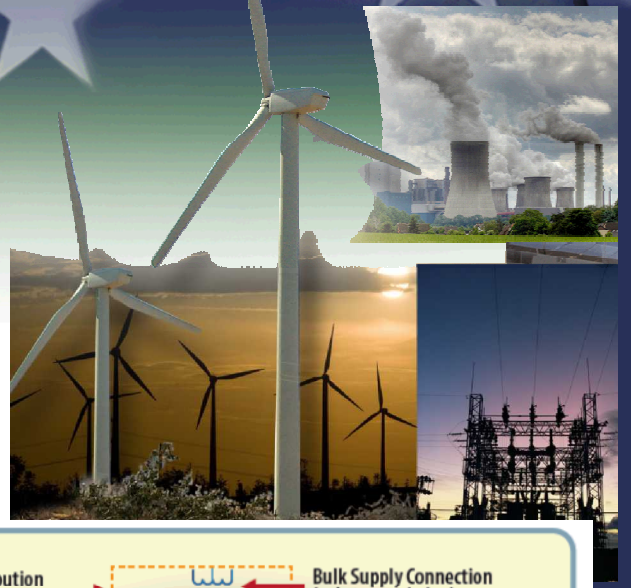
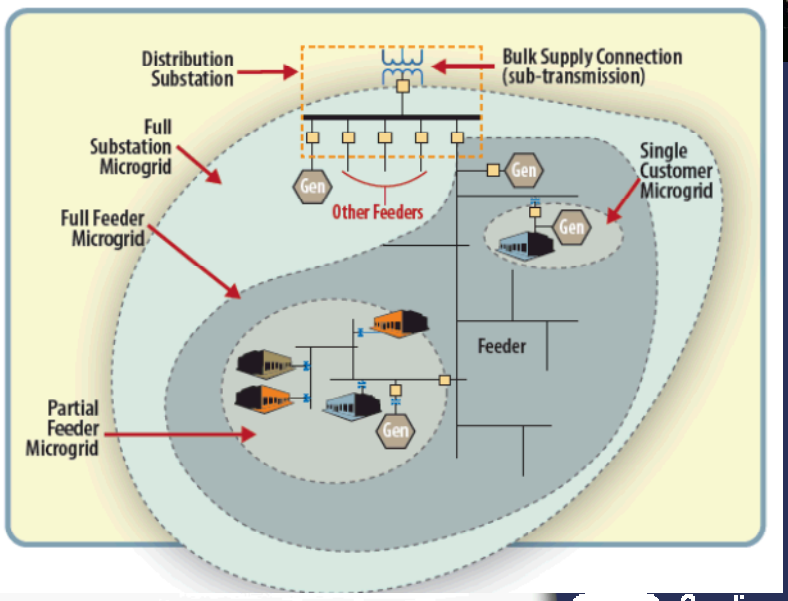
Current Research to Address This Challenge



Scalable, Secure Microgrids

- Will be self-sufficient and can "island" rapidly in the event of an outage
- Will be scalable for small, large, and regional scale energy infrastructure security and reliability applications
- Can provide a pathway for more effective use of high penetration renewable energy (up to 100%) through optimized storage and information flow
- Will incorporate advanced cyber security concepts



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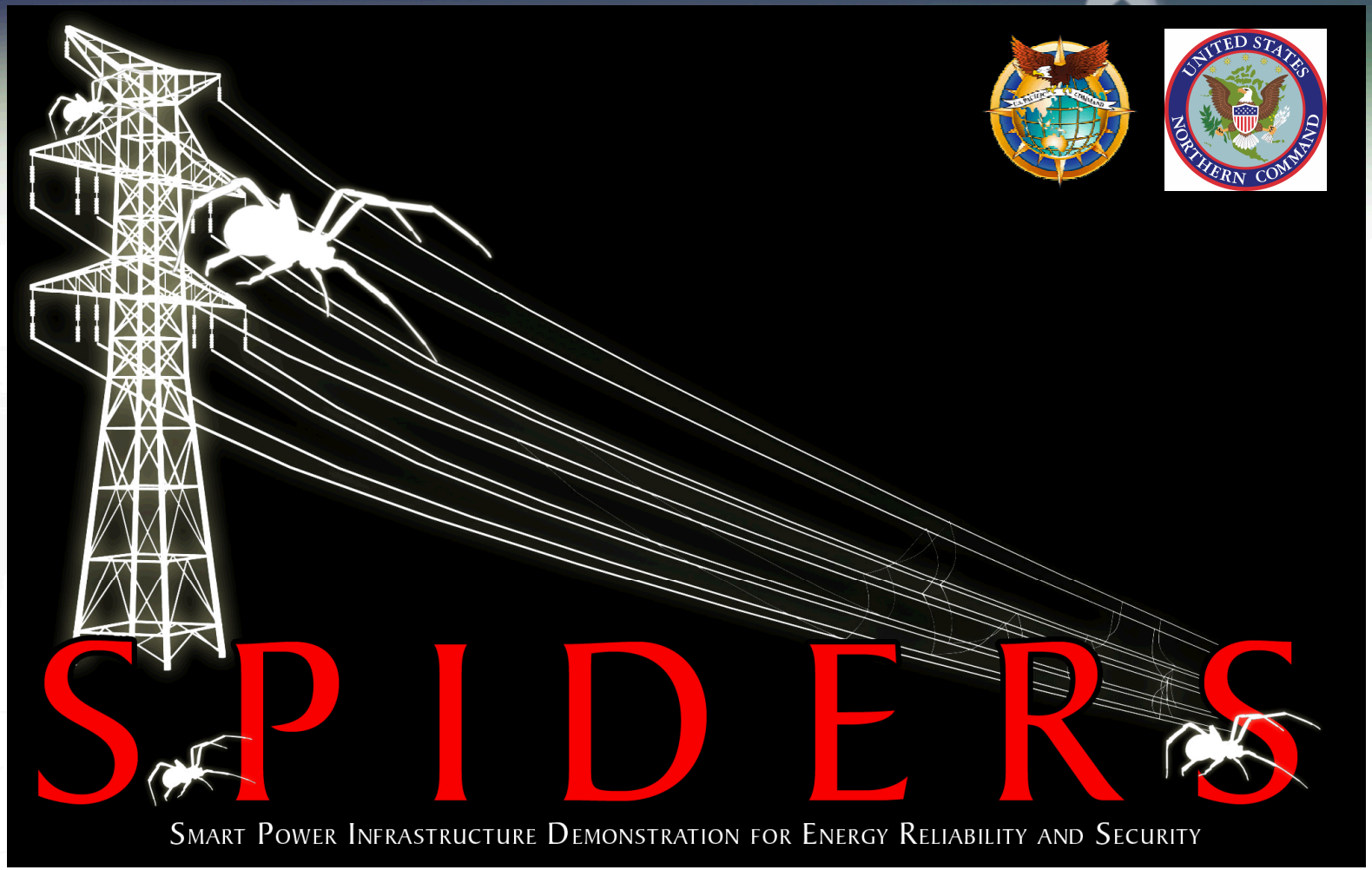
Microgrid Development is Underway for the Military



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NREL
OAK RIDGE National Laboratory
INL

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What Is SPIDERS?

Reduce the "unacceptably high risk"* of mission impact from an extended electric grid outage by developing the capability to maintain energy delivery for mission assurance

- ***Demonstrate:***
  - *Cyber-security of electric grid*
  - *Smart Grid technologies & applications*
  - *Secure microgrid generation & distribution*
  - *Integration of distributed & intermittent renewable sources*
  - *Demand-side management*
  - *Redundant back-up power systems*
- **Results in:**
  - Technically sound, commercially viable secure microgrid demonstration with mixed generation including renewables
  - First complete DoD installation with a secure, smart microgrid capable of islanding
  - Template for mission critical asset energy security for an entire installation and transition to commercial use

**From Defense Science Board Task Force on DoD Energy Security, Feb 2008*

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SPIDERS Participants

- USPACOM, USNORTHCOM DOE, and DHS
- DOE - 5 Nat'l Labs
- DOEP&P Power Surety Task Force
- Military Services
- Naval Facilities Engineering Cmd
- Local Utility Companies
- States of Hawaii & Colorado

Pacific Northwest NATIONAL LABORATORY

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NREL

OAK RIDGE National Laboratory

INL

U.S. AIR FORCE

U.S. ARMY

NAVFAC

Hawaiian Electric Company

Colorado Springs Utilities
It's how we're all connected

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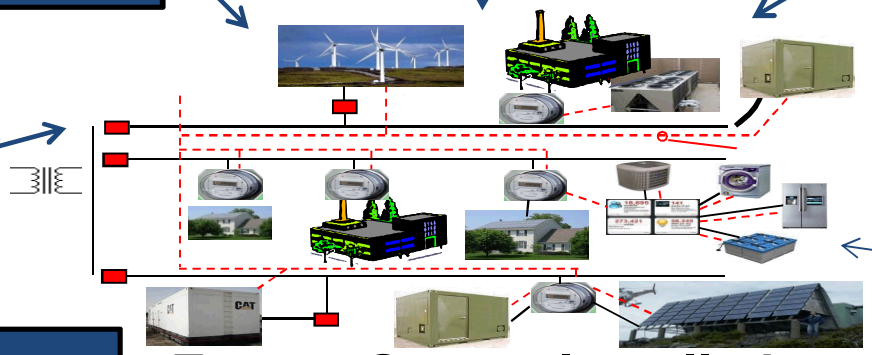
SPIDERS
Secure Microgrid Technologies

Microgrid (SNL)
- Advanced Metering Infrastructure
- Substation & Distribution Automation
- Two-Way Communications & Control
- Adaptive Relaying

Cyber Security (INL)
- Virtual Secure Enclave
- Live Action Network
- Secure Distributed Monitors
- Situational Awareness

Dynamic Control
(SNL, ORNL)
- Load Control Systems
- Islanding Control System
- Energy Management System
- Seamless Grid Synchronization

Assistant Technical Manager and Engineering Lead (SNL)



Energy Secure Installation

Assistant Transition Manager (PNNL)

Demand Side Management
(NREL, ORNL)
- Energy Efficiency Technologies
- Dynamic Voltage Regulators
- Smart Sockets
- Automated Load Shedding

Operational Test Agency (PNNL)

Energy Storage (NREL)
- Vehicle-to-Grid
- Hydrogen
- Batteries

Renewable Integration
(NREL)
- Photovoltaic
- Wind
- Fuel Cells
- Biofuel

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Energy Security Program

Energy Security Roles

$250M DOE Energy Research Program

Support DoD on energy system, physical, and cyber security

System integrator for the DOE/NNSA

DoD Installation Security Projects

Energy Security Focus

Operational Energy Systems

- **Electric Power Assurance**
  - **Microgrid, renewables, nuclear, storage, control systems, cyber**
- **Transportation Energy Assurance**
  - **Combustion research, renewable fuels**

Climate Change Science

- **Operational Impacts**
- **Assessments**

Nuclear Design & Fuel Cycle

Combustion Research Facility

Distributed Energy Technology Laboratory

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Related R&D at Sandia

- **Solar Glitter – glitter-sized photovoltaic cells**
- **Sunshine-to-Petrol – a process for the direct thermochemical conversion of CO_2 and H_2O to CO and H_2**
- **Improved Rechargeable Batteries – high capacity cathode materials capable of high energy densities, while offering significant safety and reliability advantages**

Solar Glitter

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