Energy Surety Microgrids™ Supporting Renewable Technologies and Energy Assurance

Abbas Akhil and Mike Hightower

Sandia National Laboratories

aaakhil@sandia.gov **mmhight@sandia.gov**

(505) 844-7308 **(505) 844-5499**

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14. ABSTRACT
For the DoD, the success of military operations depends on the ability to maintain critical capabilities at fixed and forward bases, and to maintain tactical operations. Maintaining these critical functions and operations has become increasingly dependent on having secure and reliable supplies of energy. Traditionally, military bases often rely heavily on public utilities as the primary electricity, natural gas, and other energy need providers, and install back-up generation (typically diesel or natural gas) to supply peak or emergency energy supplies. In many cases, these generators are undersized, improperly located, and poorly maintained such that they cannot effectively meet critical mission energy needs for extended periods. Several groups, including Sandia National Laboratories, have been looking at approaches to integrate distributed energy generation, such as photovoltaic, wind, plug-in-hybrids, waste-toenergy systems, microturbines, and energy storage systems into one or more microgrids to improve base energy supply reliability and enhance critical mission assurance. This presentation will provide information on many common energy security and reliability pitfalls and concerns at military bases assessed by Sandia, and discuss considerations and analyses needed to integrate renewable distributed generation technologies into an energy surety microgrid and the associated energy security, reliability, benefits, and costs as well as environmental benefits.

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ENERGY SURETY MICROGRIDS – SUPPORTING RENEWABLE TECHNOLOGIES AND ENERGY ASSURANCE

MR. MIKE HIGHTOWER
Sandia National Laboratories
1515 Eubank SE
MS 1108
Albuquerque, NM 87123
(505) 844-5499
mmhight@sandia.gov

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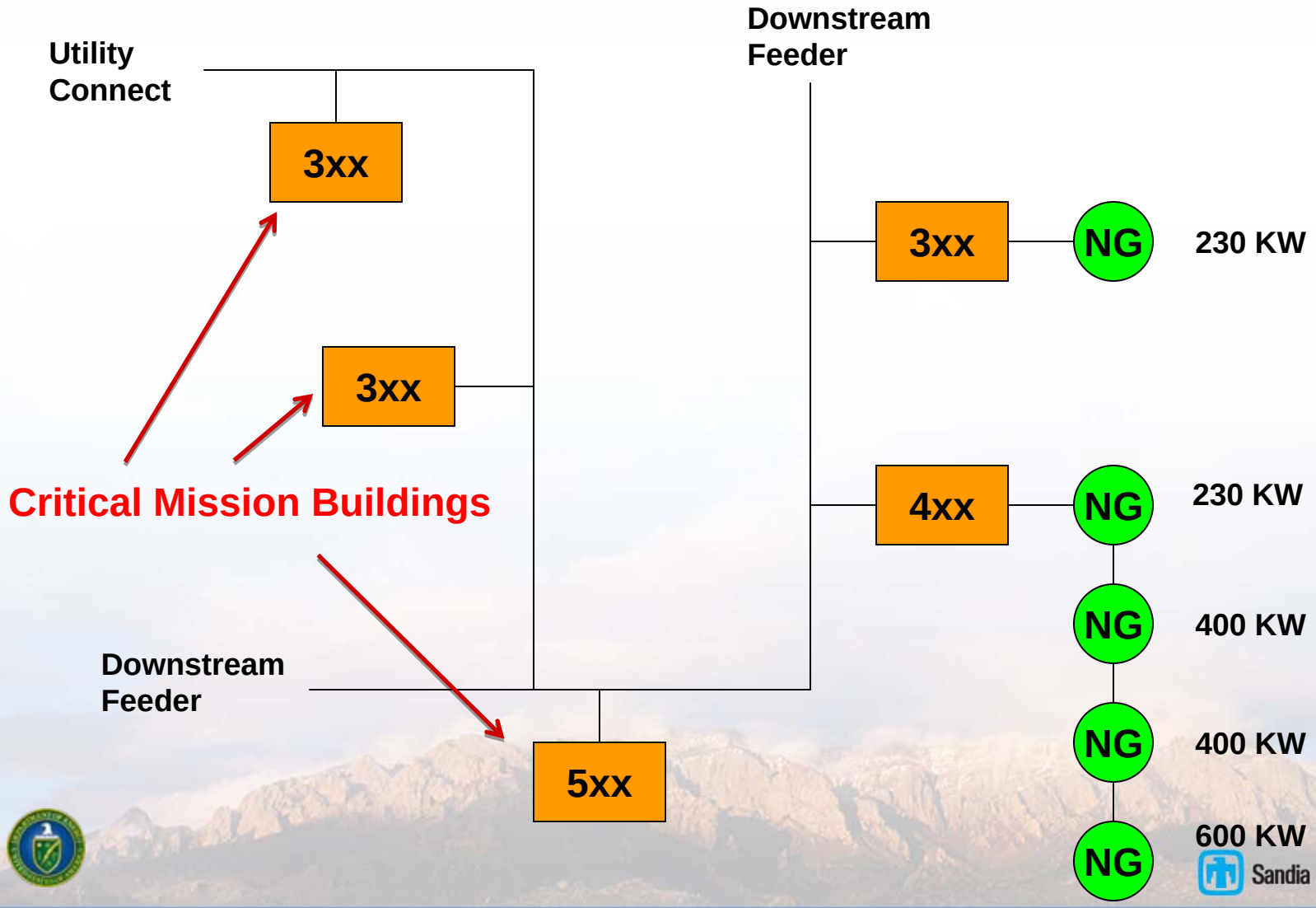
Common Military Base Electric Power Security and Reliability Issues

- **Power outages occurring as many as 300 times per year at some bases**
  - Low maintenance and understanding of back up generation
    - *Low probability of start when needed (60%)*
    - *Operations for extended periods limited,*
    - *Often over or under designed and support only one building*
- **Radial electric power feeder systems could provide redundancy but are often not interconnected**
- **Substations commonly outside base control and often a common point of failure for base feeders**
- **Lack of critical mission understanding and energy needs**
  - Varying drivers by base commander, tenant commanders, and utility managers

Lack of Strategic Energy Security and Reliability Approach

Example of Common Backup Generator Configurations



2010 QDR Provides Guidance on Domestic Facility Energy Security

- **Defines Energy Security**
  - "Energy security for the Department means having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs"
- **Directs facilities to:**
  - Address energy security while simultaneously enhancing mission assurance
  - Conduct a coordinated energy assessment to prioritize critical assets
  - Promote investments in energy efficiency
  - Ensure that critical assets are prepared for prolonged outages: natural disasters, accidents, attacks

Energy Assurance = Energy Reliability, Security, Sufficient

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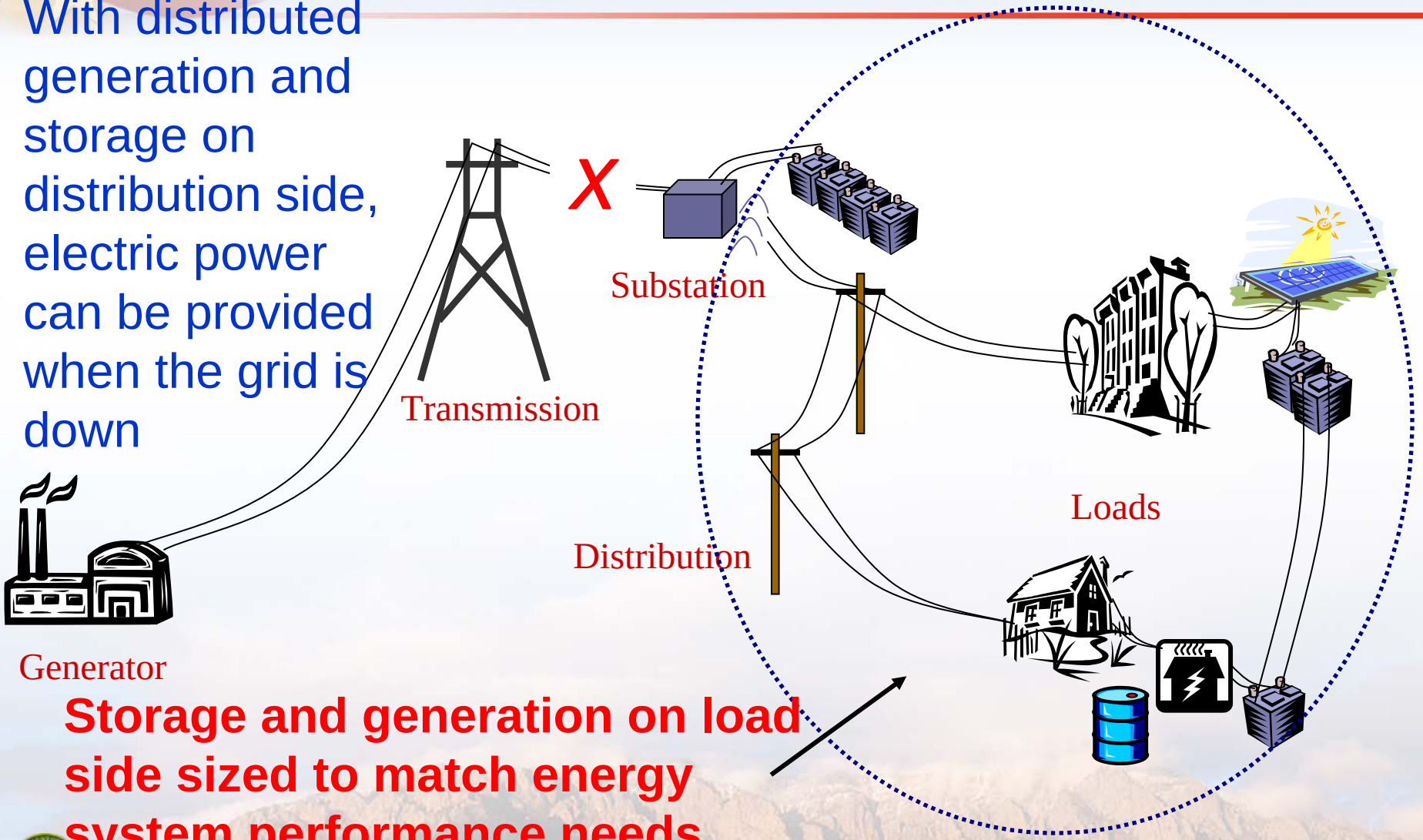
Energy Surety Microgrid™ Approach to Energy Assurance

With distributed generation and storage on distribution side, electric power can be provided when the grid is down



Storage and generation on load side sized to match energy system performance needs

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General Microgrid Characteristics and Benefits

Key Attributes (Defining Characteristics):

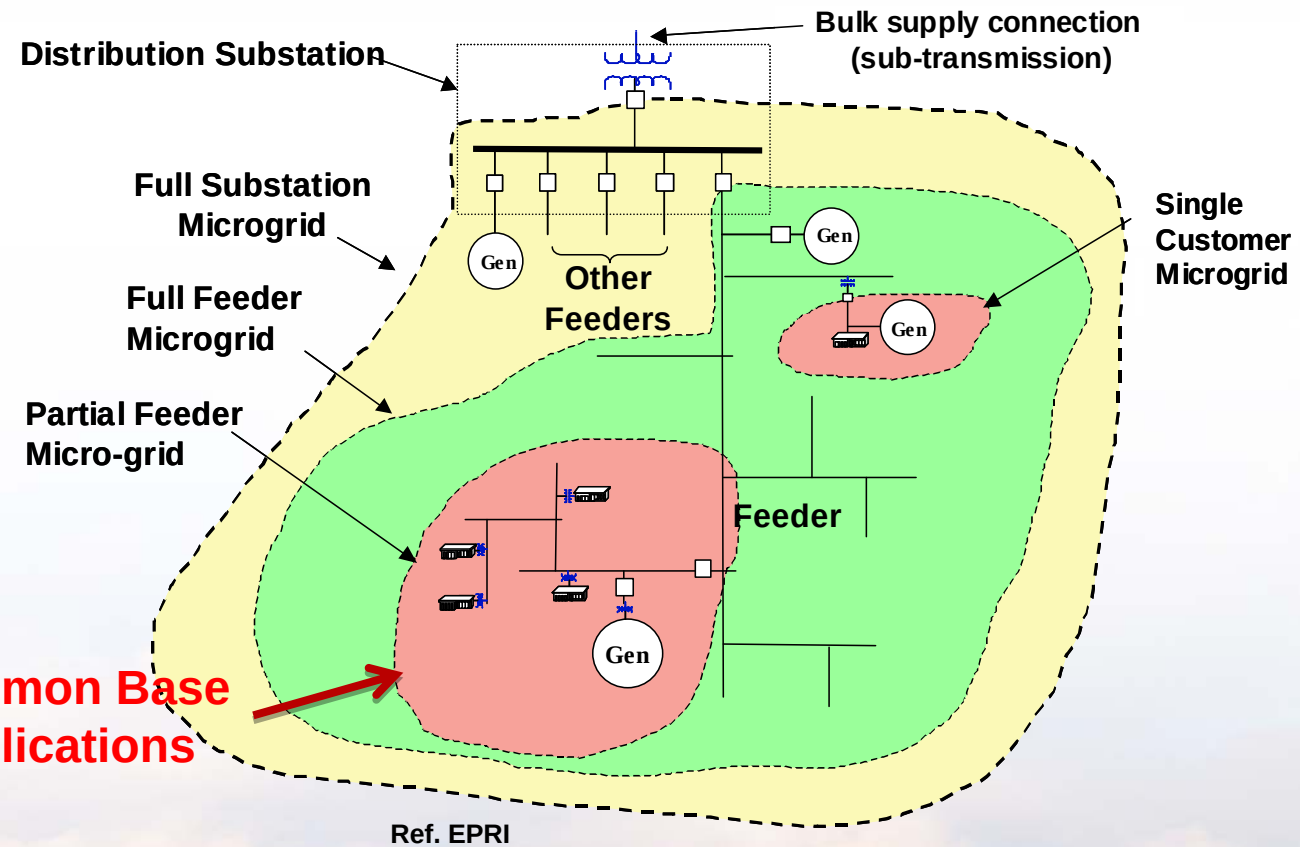
- Grouping of interconnected loads and distributed energy resources
- Can operate in both island mode or grid-connected
- Acts as a single controllable entity to the grid

Key Benefits (Military and Civilian)

- Enables faster Grid modernization
- Enhances use of distributed and renewable energy resources
- Improves local energy flexibility, security, and reliability
- Supports improved Grid management and operation

Renewable and Distributed Generation to Support Microgrids

- Small combustion and µ-turbines
- Fuel cells
- IC engines
- Small hydro and wind
- Solar electric and solar thermal
- Energy storage (batteries, flywheels,…)
- Plug in hybrid vehicles
- Small nuclear power



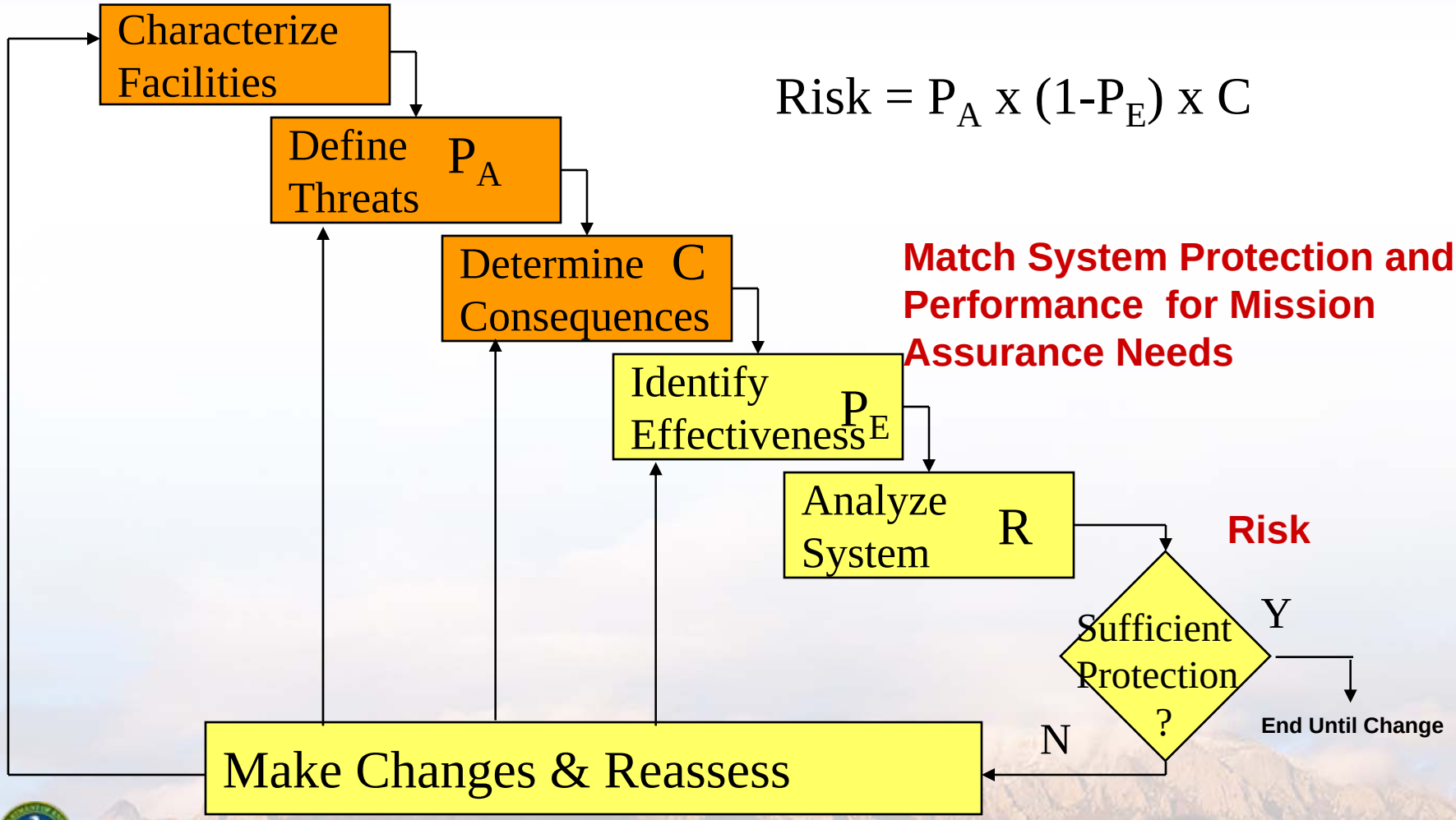
Ref. EPRI

Residential	Less than 10-kW, single-phase
Small Commercial	From 10-kW to 50-kW, typically three phase
Commercial	Greater than 50-kW up to 10MW

Sandia's Energy Surety Microgrid™ (ESM™)

- **Internally funded and developed as part of critical energy infrastructure protection and renewable energy research programs**
- **Integrates and controls dispersed loads and sources to operate in both islanded and grid-tied configurations**
- **Key features of ESM™**
  - Improved energy assurance (safety, security, reliability)
  - Facilitates integration of renewable resources and DG
  - Offers opportunities for CHP/Tri-power – greater fuel and energy efficiency
  - Reliability stated in terms of mission impact
    - Rather than in 9's of reliability

Sandia ESM™ uses Risk-based Method for Energy System Assurance Design



$$Risk = P_A \times (1-P_E) \times C$$

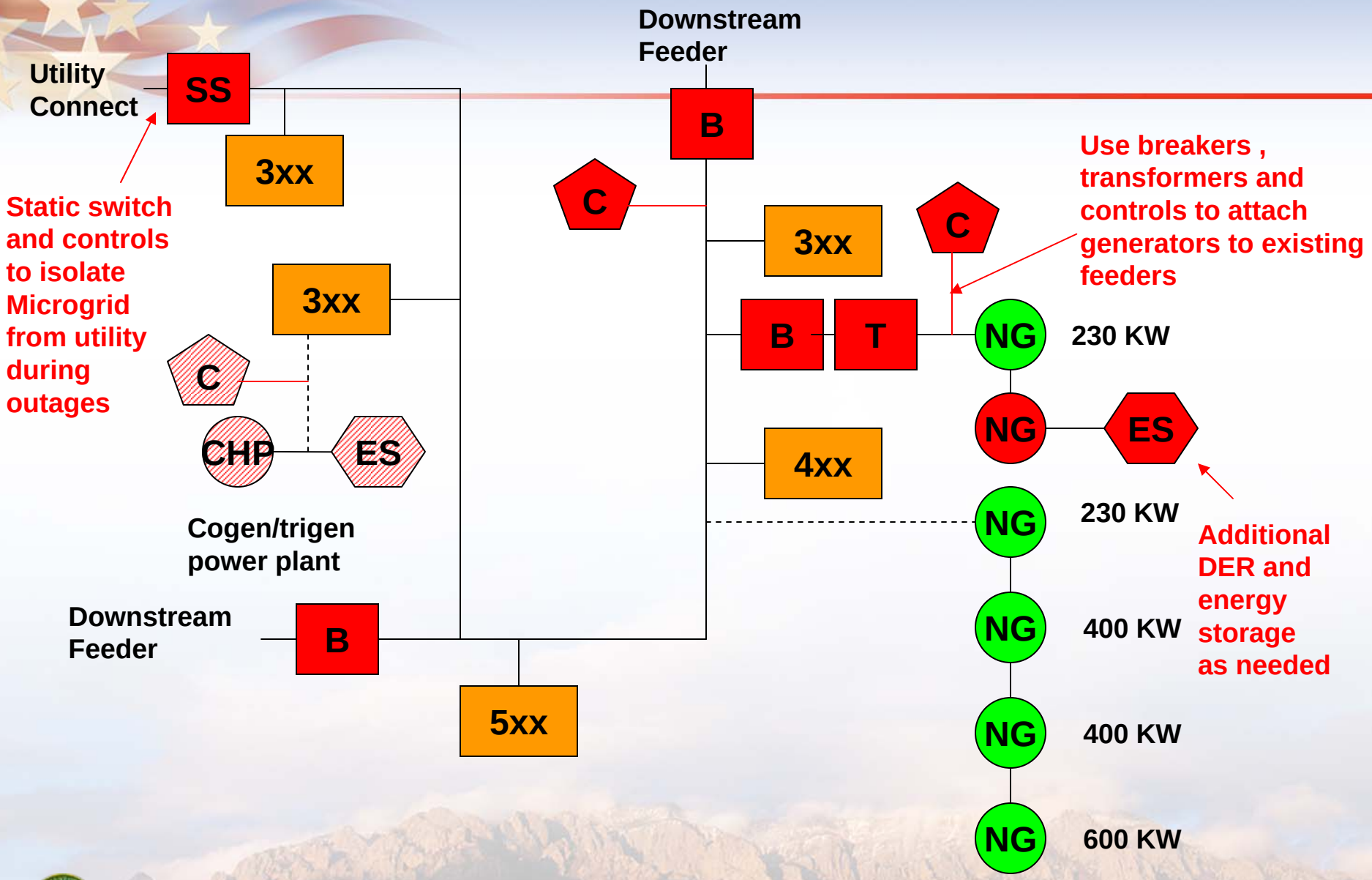
Match System Protection and Performance for Mission Assurance Needs

Risk

Design Approach for Military Applications

- **Utilize existing backup generation where possible to reduce system costs (new generation and storage), and provide microgrid with a well-behaved operational performance backbone**
- **Include new generation/energy sources as needed for creating a microgrid interconnecting mission critical facilities and support functions**
- **Include cyber-secure, semi-autonomous, command/control of microgrid loads and generation for operational flexibility and cost savings opportunities**
  - Peak shaving, emergency operations, and utility grid support

Example Microgrid Design for Energy Assurance

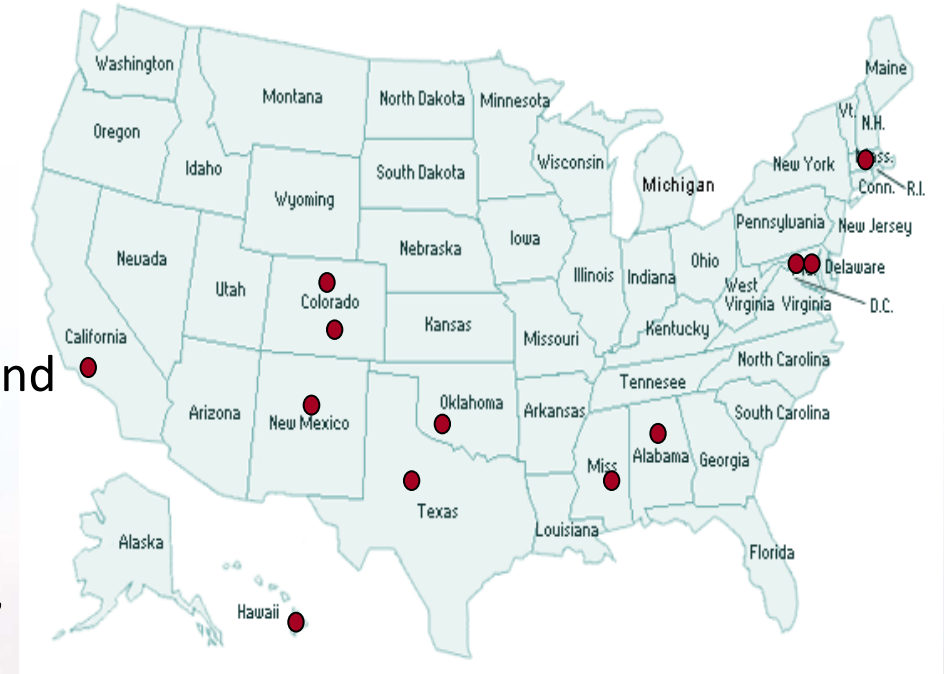


Benefits of Energy Surety Microgrid Design Approach

- **Provides tools and approach to:**
  - Identify and quantify critical mission energy needs and create an effective energy assurance strategy
    - Focus upgrades and configuration changes to improve overall system performance, reliability, and mission assurance
  - Matches energy system assets (generation and storage) to meet critical mission energy performance needs
    - Supports the location, sizing, and integration of distributed and renewable energy resources for more efficient operation
    - Can more easily quantify cost/benefits of energy reliability and security
  - Energy security focus and “grid-tied” and “islanded” operational capability encourages renewable use
    - Enhances opportunities for demand management and changes in time-of-day operations, promotes CHP and Trigen integration, allows higher penetration of renewables

Current Sandia Military Microgrid Conceptual Design Efforts

- **Army**
  - Ft Sill, Ft. Bliss, Ft. Belvoir, 99th Air Guard (Ft. Devens), Ft. Carson
- **Navy/Marines**
  - Indian Head, Camp Smith
  - PACCOM/NORTHCOM JCTD
- **Air Force**
  - Maxwell, Kirtland, Vandenberg, and Schreiver
- **FY 11 project interest**
  - Philadelphia Navy Yard, Aberdeen, Travis AFB, Cannon AFB, West Point, NAVFAC (Norfolk)



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