Energy Surety Microgrids™ for Critical Mission Assurance to Support DOE and DoD Energy Initiatives

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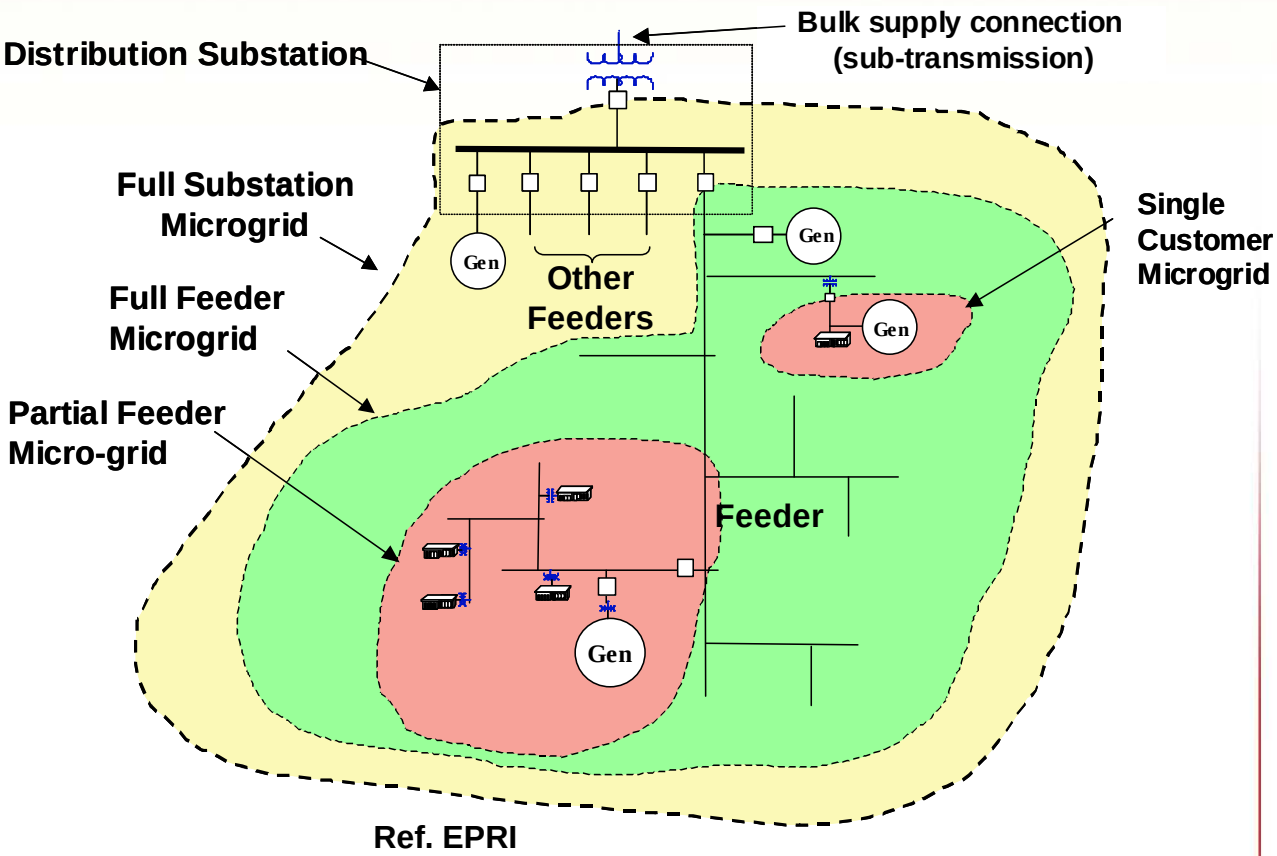
Use Renewable and Distributed Generation to Support DoD Microgrids and the Smart Grid

- 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

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Microgrid Definition 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

- **Enables Grid Modernization (becomes Smart Grid Node)**
- **Enhances the integration of distributed and renewable energy sources**
- **Improves local energy flexibility, security, and reliability**
- **Supports improves Grid operations**

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Basis for Sandia Focused DoD Microgrid Efforts for DOE

- DoD often early adopters of innovative technologies
- New DoD guidance and focus on energy security and energy reliability for critical mission assurance
- Concept is to use DoD sites as testbeds for microgrid designs and collect operational cost and performance data
- Apply lessons learned from DoD microgrid applications to Smart Grid Node applications for domestic utility and grid upgrade applications

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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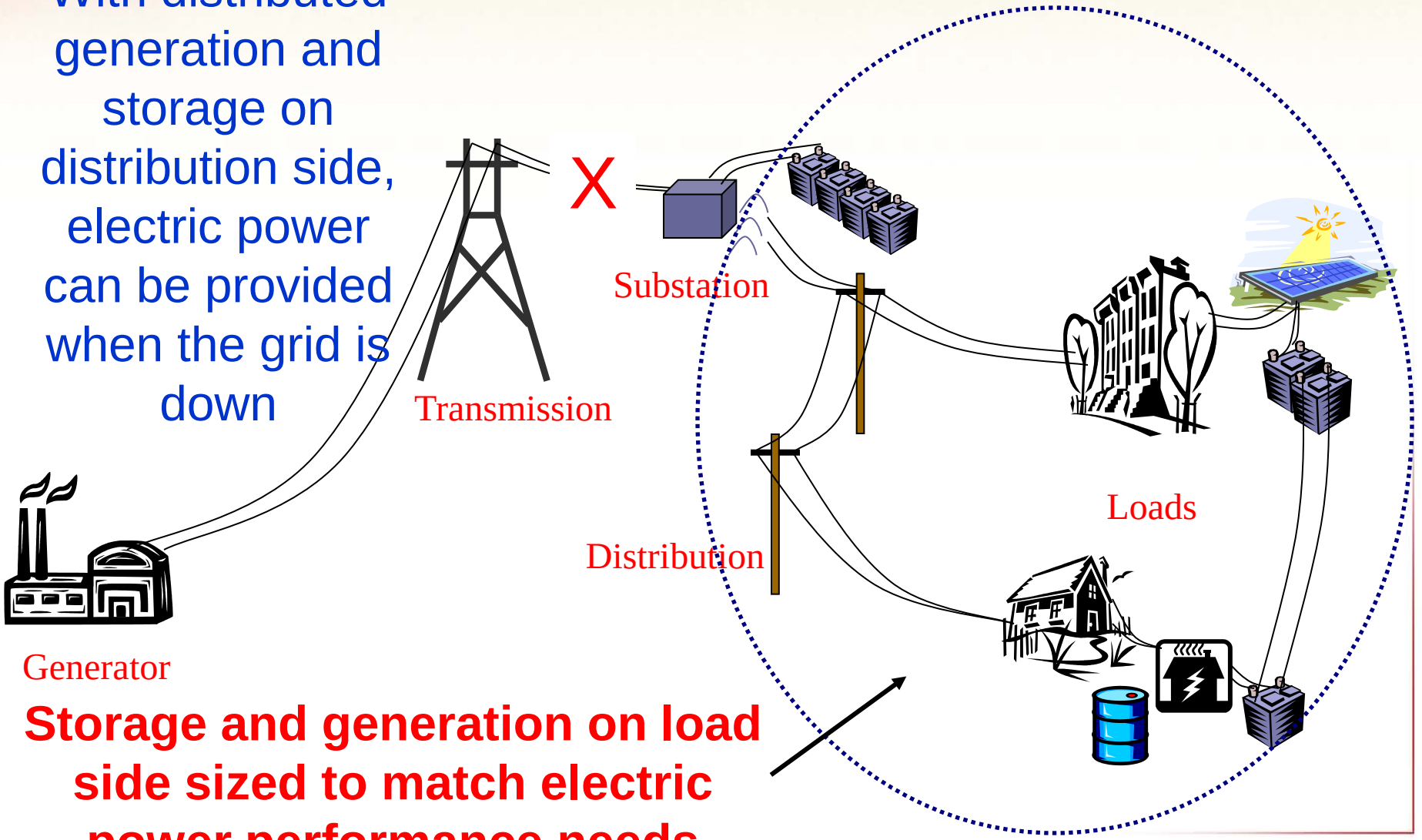
Energy Surety Microgrid™ Approach to Energy Assurance

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 electric power performance needs

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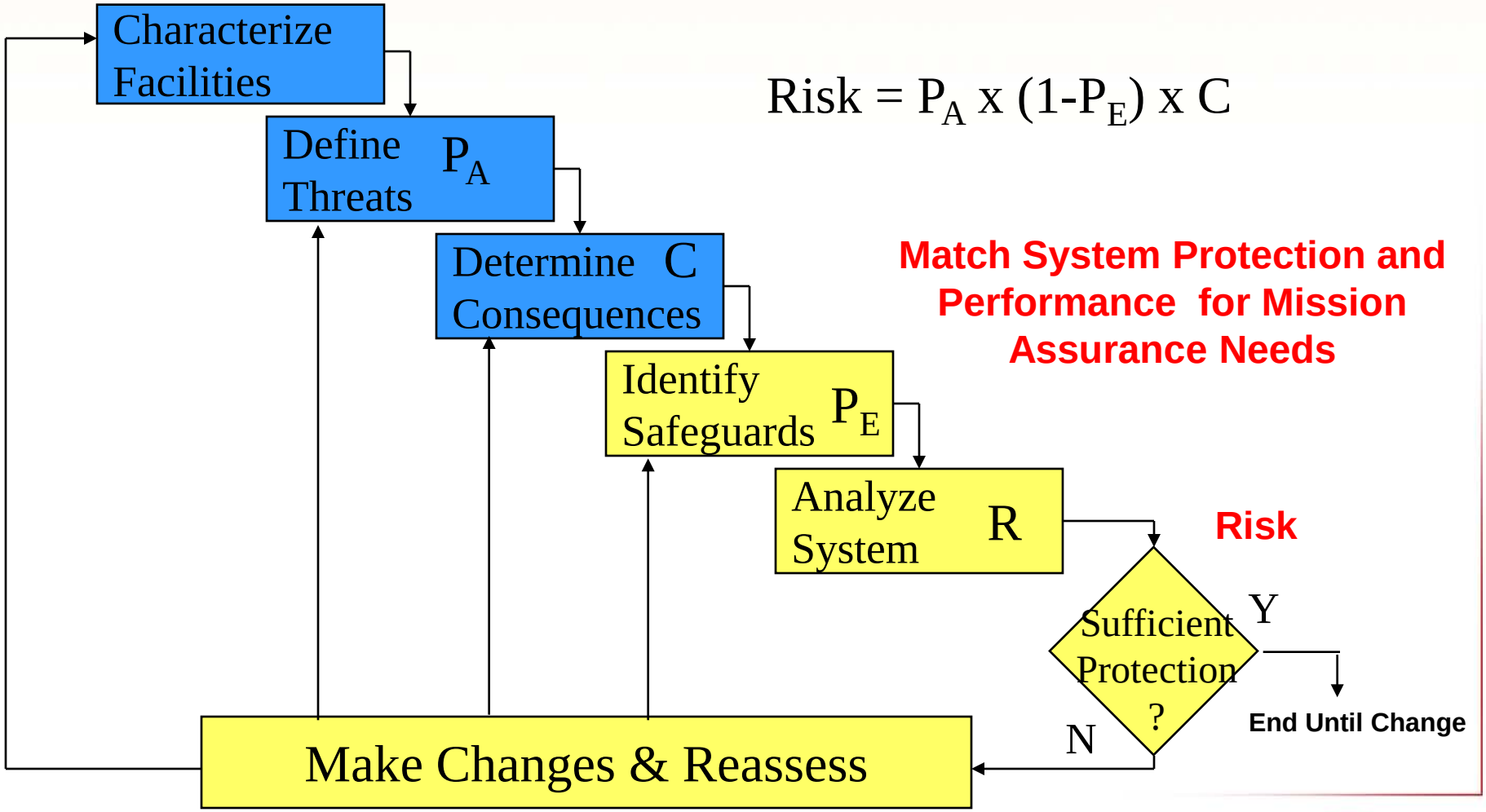
Sandia ESM uses Risk-based Assessment Method for Energy System Assurance



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

Match System Protection and Performance for Mission Assurance Needs

Risk

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Energy Infrastructure Security and Protection Concerns and Challenges

Front

No systematic security approach

Back

Major energy assets outside base control

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Common Military Base Electric Power Energy 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 can support only one building*
- **Radial electric power feeder systems could provide redundancy but are often not interconnected**
  - Poor understanding of base energy grid
- **Base substations outside base control**
  - Often a common point of failure for all base feeders
- **Lack of critical mission understanding and energy needs**
  - Varying drivers by base commander, tenant commanders, utility managers

Lack of Coherent Energy Security and Reliability Strategy

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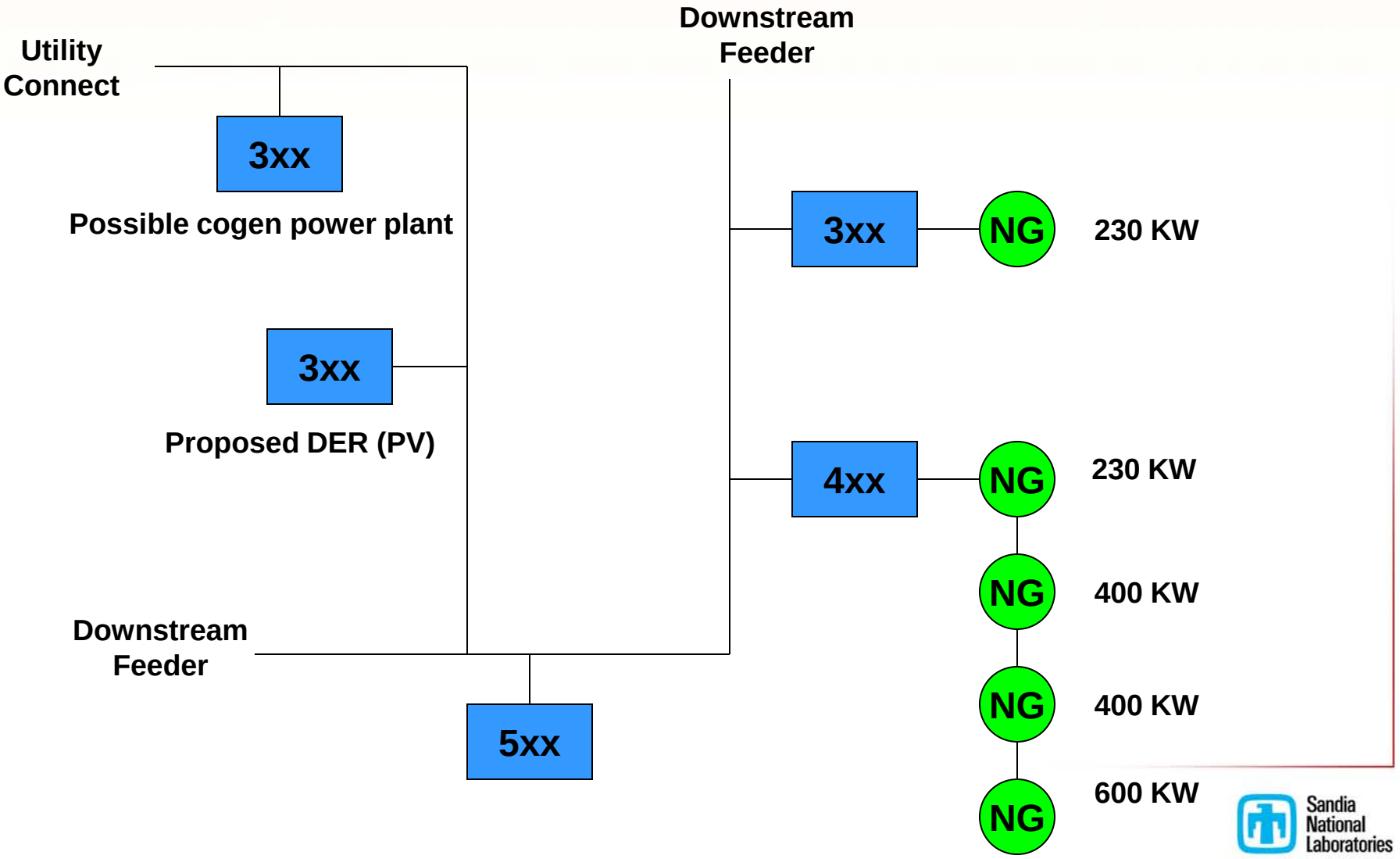
Example of Common Backup Generator Configurations - Over and Under-designed Uses



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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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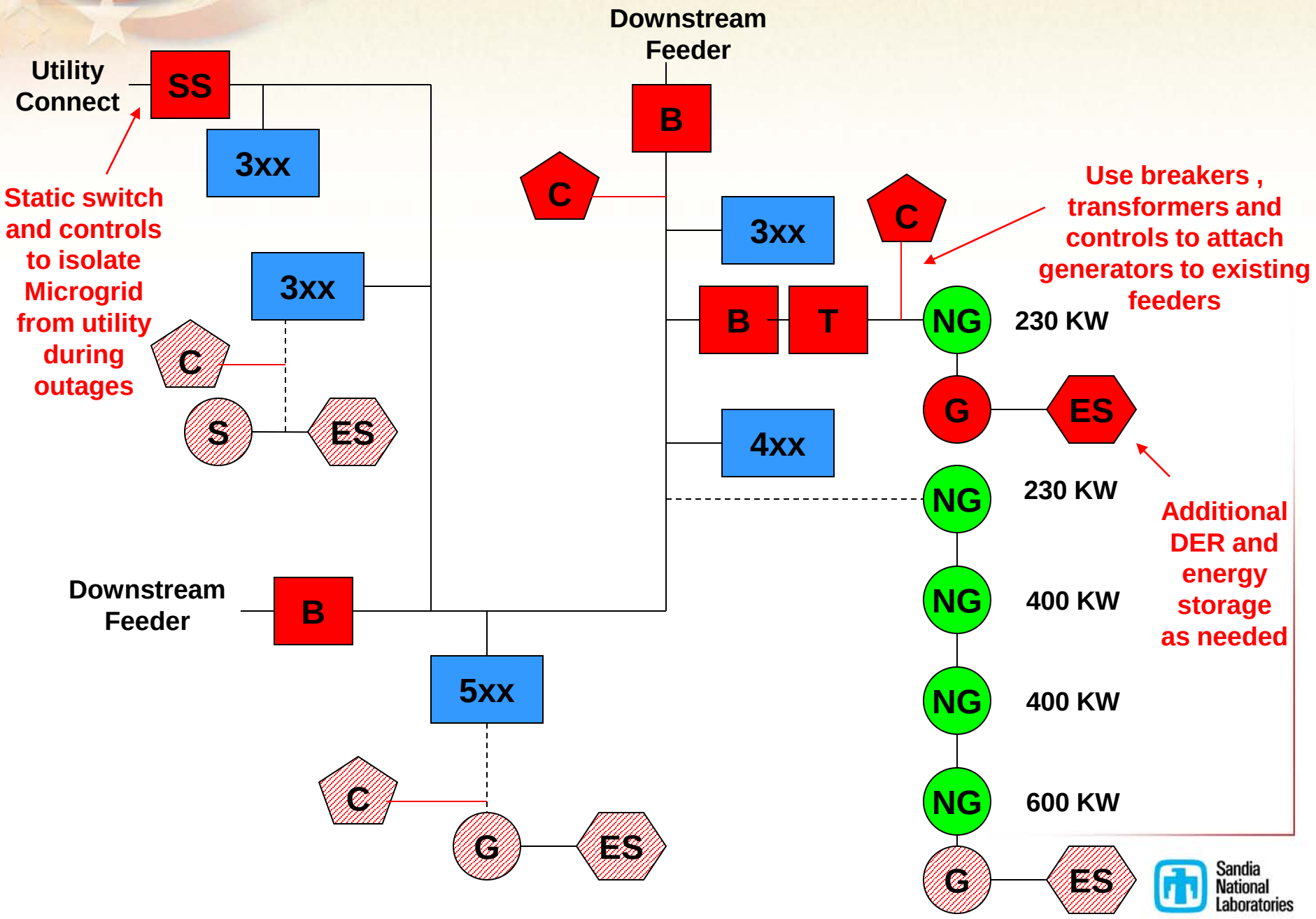
Example Microgrid Design for Energy Assurance



Benefits of Energy Surety Microgrid Design Approach

- **Provides tools and approach to:**
  - Identify critical mission energy needs and identify an effective energy assurance strategy
    - Upgrades configured to improve system performance, reliability, and cost-effectiveness while enhancing mission assurance
  - Match 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 to reduce capital and operational costs
  - Provides “grid-tied” and “islanded” operations for improved cost
    - Enhances benefit/cost of system changes by supporting demand management, changes in time-of-day operations to reduce demand or energy charges, reduced power-outage costs, and energy security and reliability cost/benefit evaluations

Sandia Microgrid RDDTE

- **Microgrid system design and operations research and testing required**
  - Load management and control strategies
  - Generation resource management for individual performance and power quality optimization
  - Control system cyber security
  - Safety requirements and systems to support grid-tied and islanded operations
- **Distributed generation and energy storage integration evaluation and modeling to identify critical mission energy security requirements**

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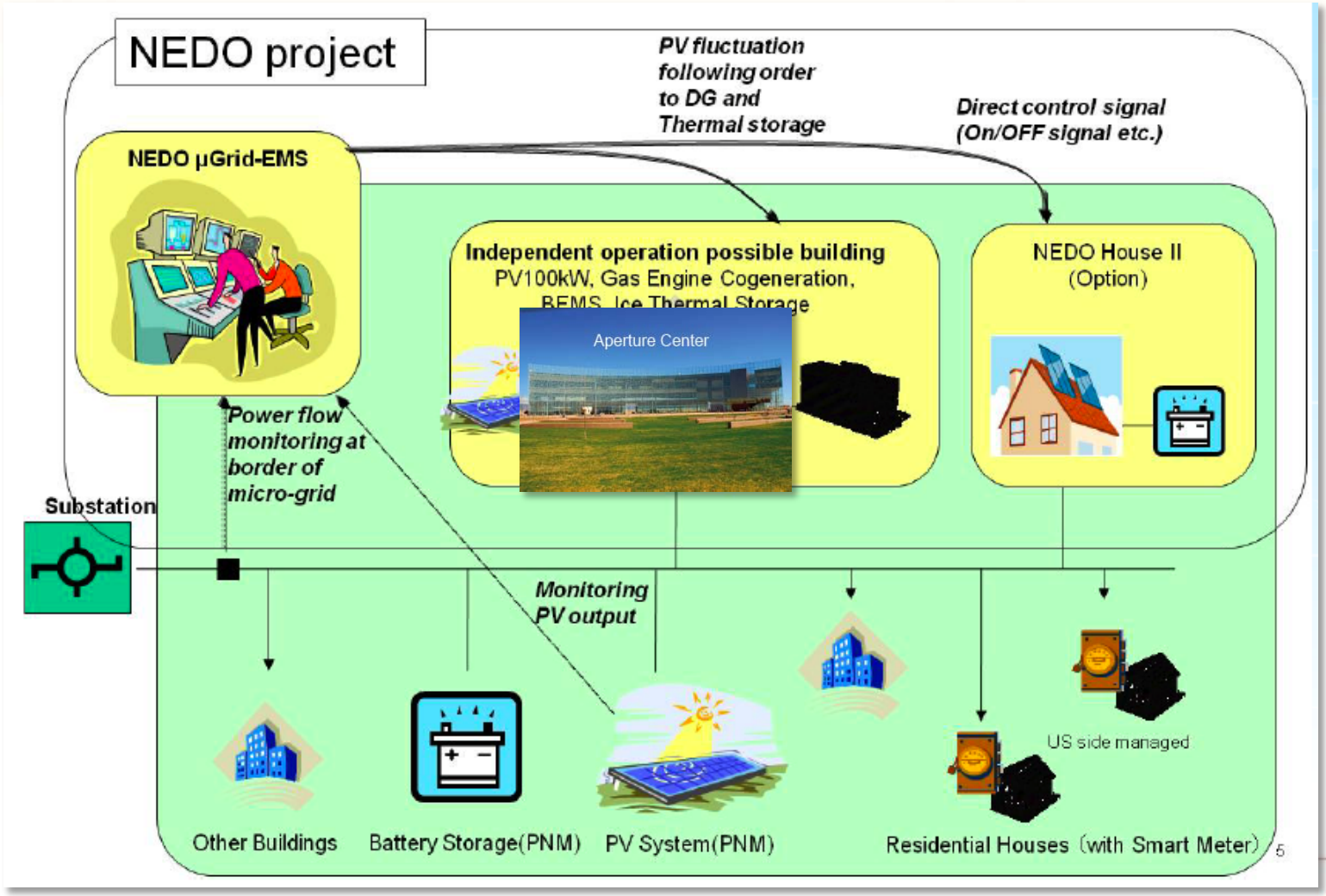
Sandia is Part of an International Team Demonstrating the Use of Microgrids with Renewables in NM



NEDO

PNM

Mesa del Sol

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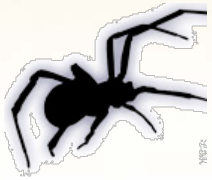
Smart Power Infrastructure Demonstration for Energy Reliability and Security JCTD



CIRCUIT LEVEL DEMONSTRATION

- Renewables
- Storage
- Energy Management

FT CARSON MICRO-GRID

- Large Scale Renewables
- Vehicle-to-Grid
- Smart Micro-Grid
- Critical Assets
- CONUS Homeland Defense Demo
- COOP Exercise

CAMP SMITH ENERGY ISLAND

- Entire Installation Smart Micro-Grid
- Islanded Installation
- High Penetration of Renewables
- Demand-Side Management
- Redundant Backup Power
- Makana Pahili Hurricane Exercise

TRANSITION

- Template for DoD-wide implementation
- CONOPS
- TTPs
- Training Plans
- DoD Adds Specs to GSA Schedule
- Transition to Commercial Sector
- Transition Cyber-Security to Federal Sector and Utilities

VIRTUAL SECURE ENCLAVE CYBER-SECURITY

- Use of Sandia developed Energy Surety Microgrid conceptual designs at Ft. Carson and Camp Smith
- Sandia designated Deputy Technical Manager to OSD Power Surety Task Force

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