



Energy Surety Microgrids™ for Critical Mission Assurance

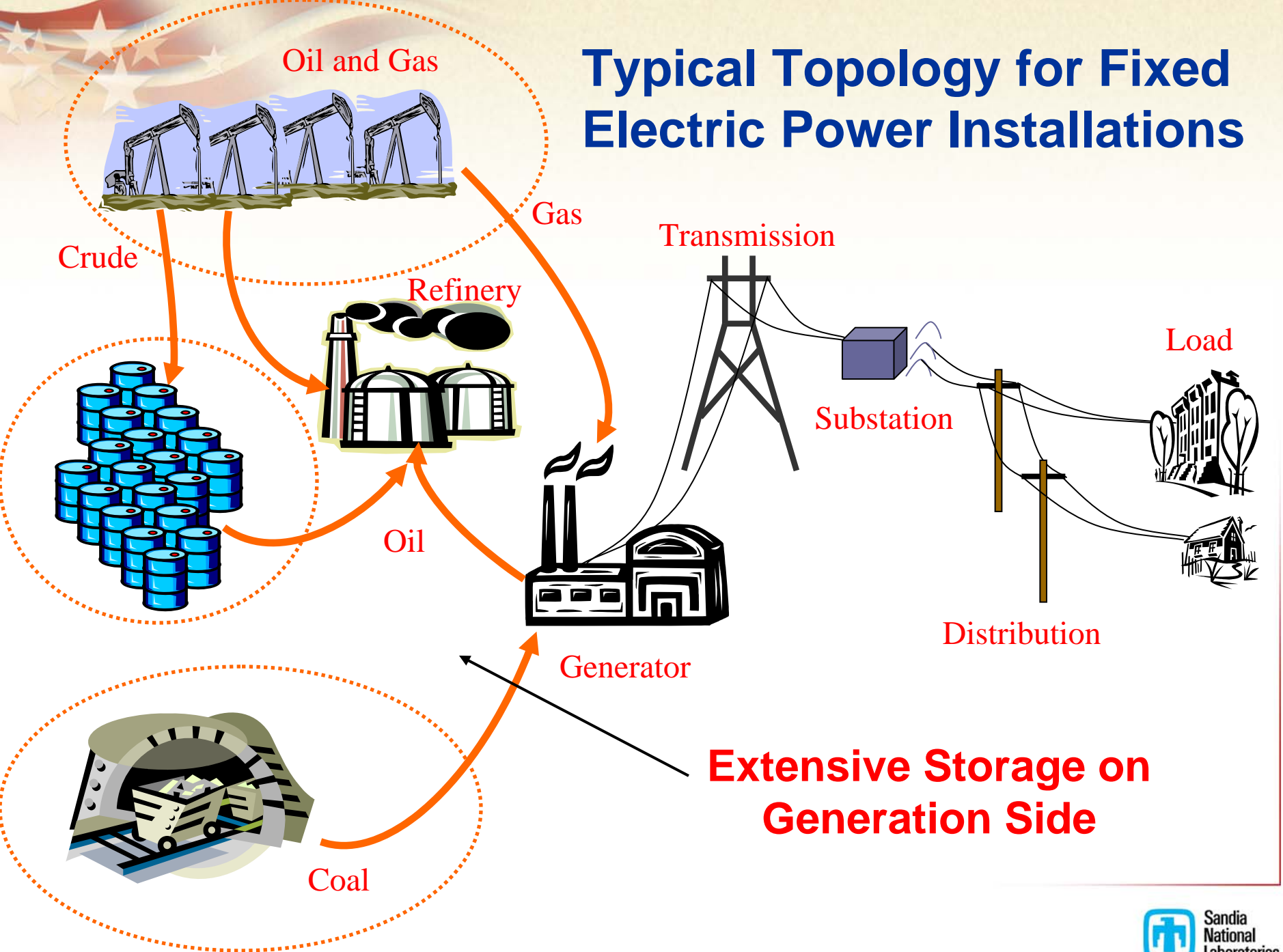
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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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Presentation Overview

- **DoD critical mission assurance – emerging energy security issues and requirements**
- **Military facility energy security considerations to support multiple tenants and their associated critical missions**
- **Application of Sandia risk-based Energy Surety Microgrid™ approach to:**
 - Identify base critical mission energy requirements
 - Cost-effectively integrate new renewable and distributed generation with existing base energy infrastructure
 - Improve base energy reliability, security, and safety

Typical Topology for Fixed Electric Power Installations

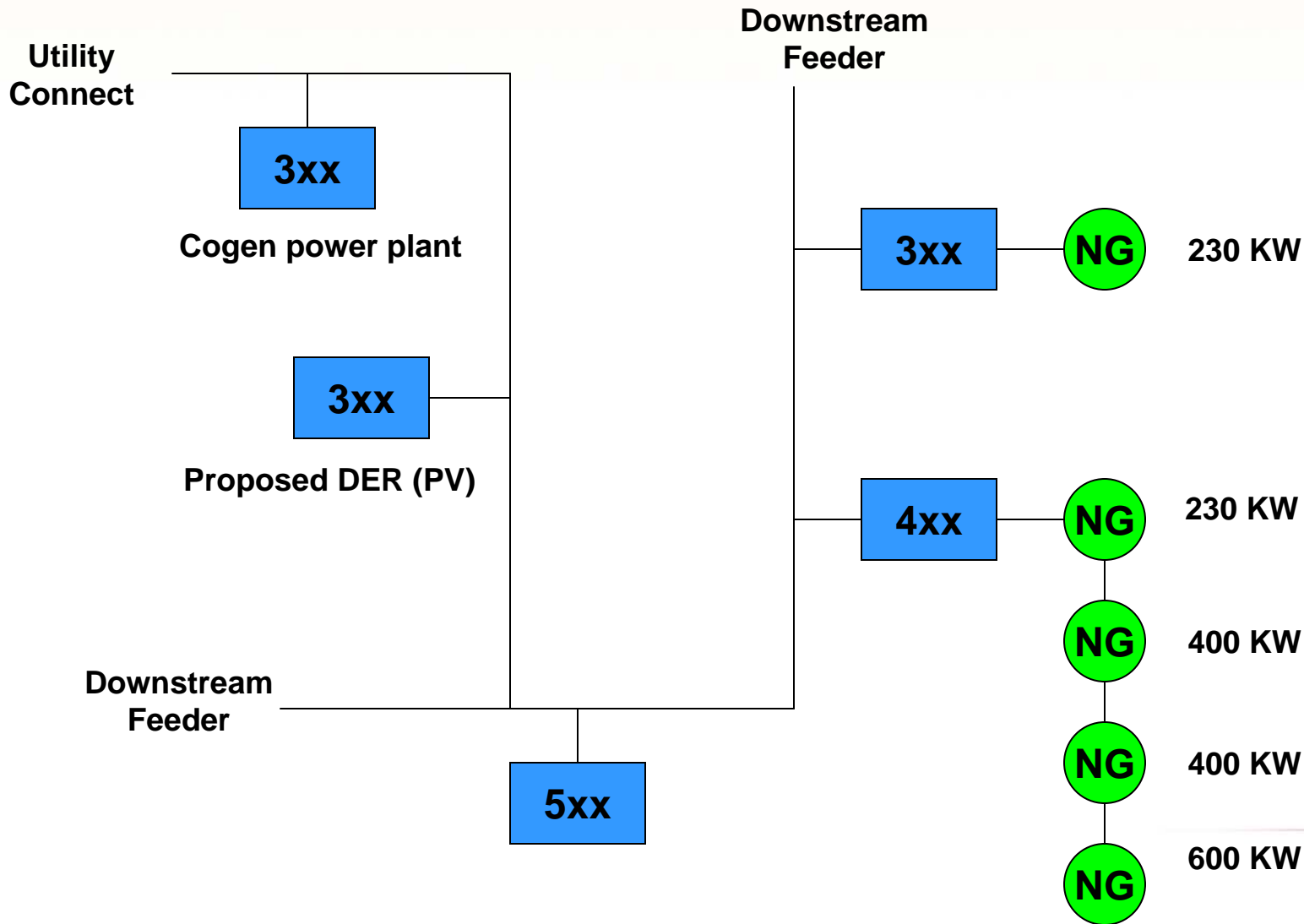


Common Military Base Electric Power Energy Security and Reliability Issues

- **Power outages occurring as many as 300 times per year at some bases**
- **Lack of critical mission understanding and energy needs**
 - Varying needs of base commander, tenant commanders, utility managers
- **Major substations outside base control**
 - Often a common point of failure for all feeders
- **Radial electric power feeder systems could provide redundancy but often are not interconnected**
 - Limited focus of grid improvements on critical mission needs
- **Over reliance on back up generation for outage support**
 - 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*

Lack of Coherent Energy Security and Reliability Strategy

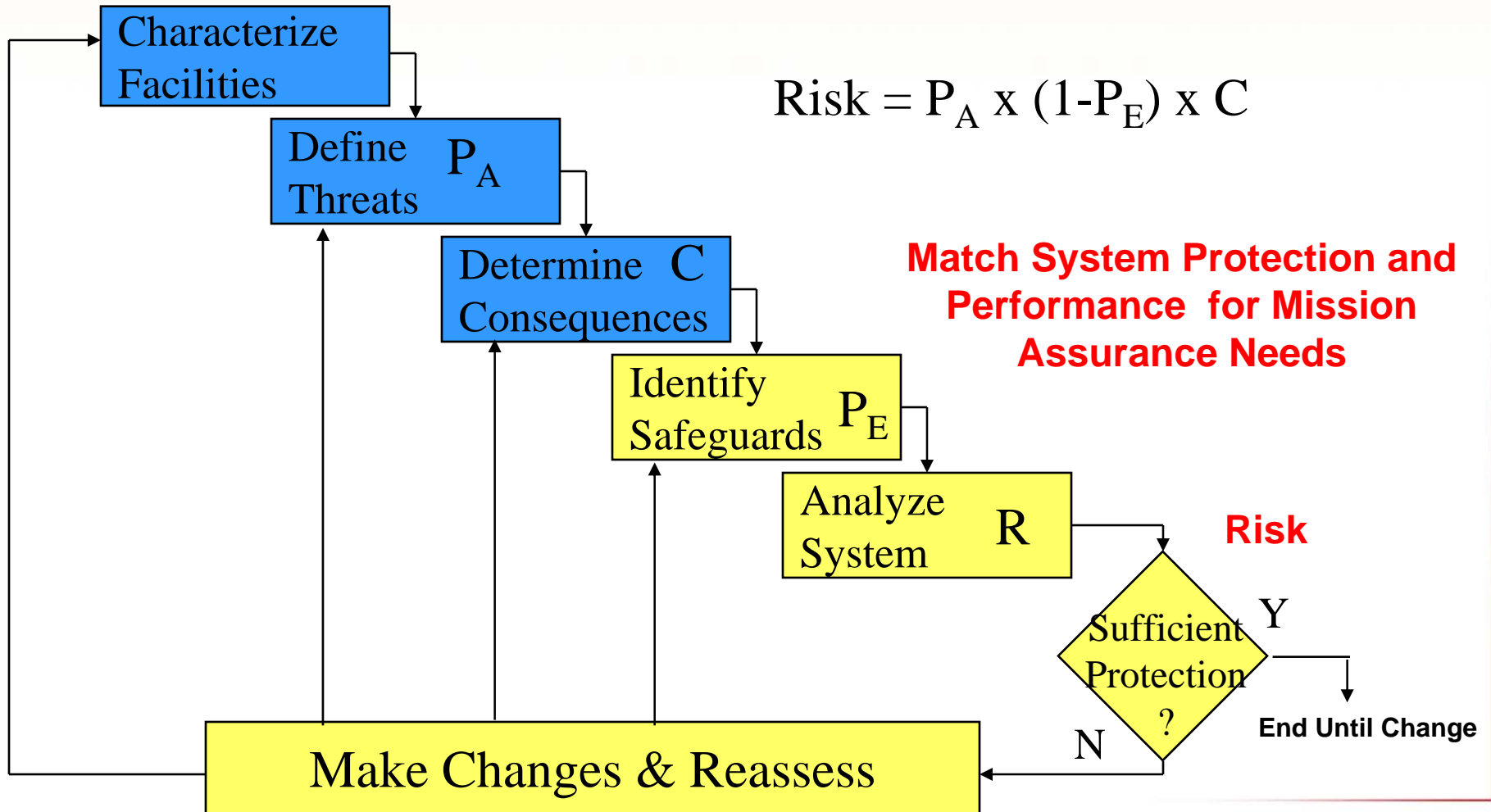
Common System Layout – Critical Buildings and Back-up Generation



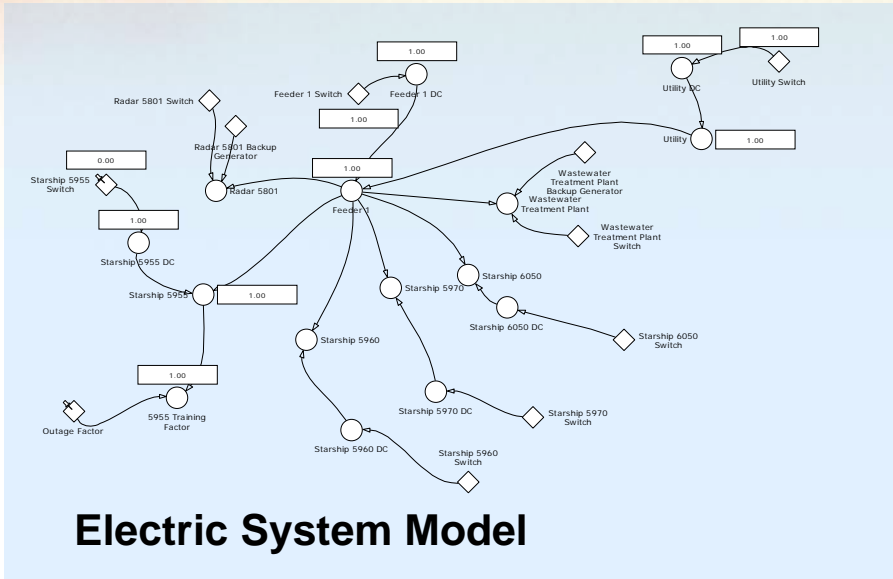
Changes Needed to Improve Energy Surety at DoD Installations

- **Identify energy needs for critical mission assurance**
 - Buildings and durations will vary over time
- **Aggregate energy system assets (current and new generation and storage upgrades) to meet critical mission energy performance needs**
 - Drives the location, size, and integration of resources
- **Develop an effective energy surety strategy**
 - Include both physical and cyber security, so upgrades improve energy security and reliability
- **For flexibility and performance assurance, design for “grid-tied” and “islanded” system operations**
 - Has cost and reliability benefits, but safety and cyber issues

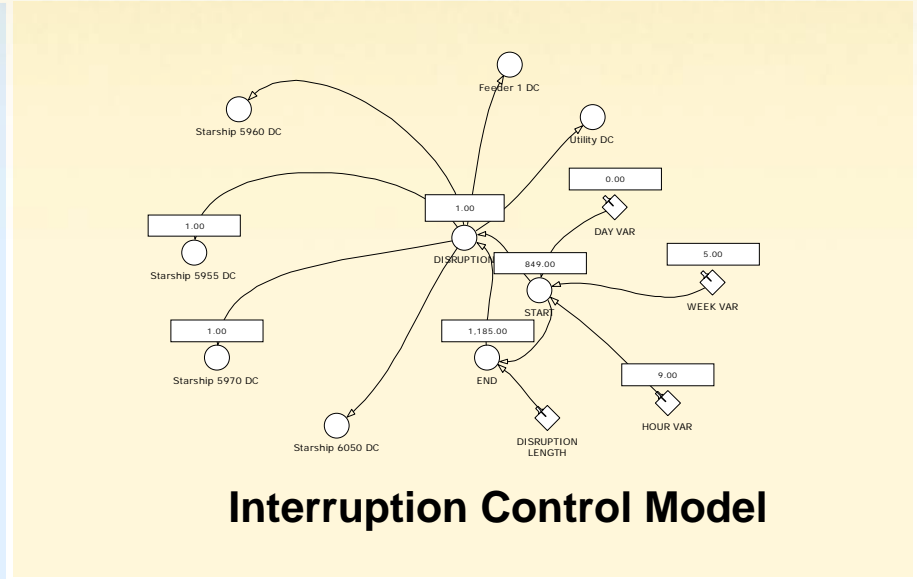
Risk-based Assessment Approach for Energy Systems



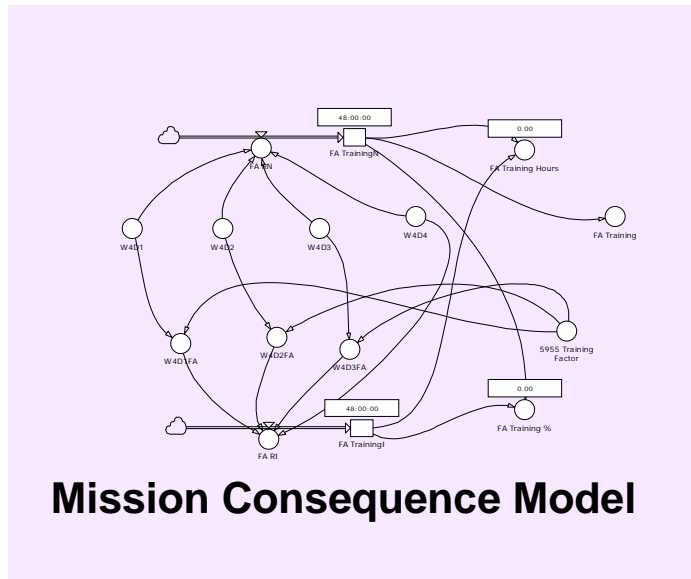
Consequence Modeling



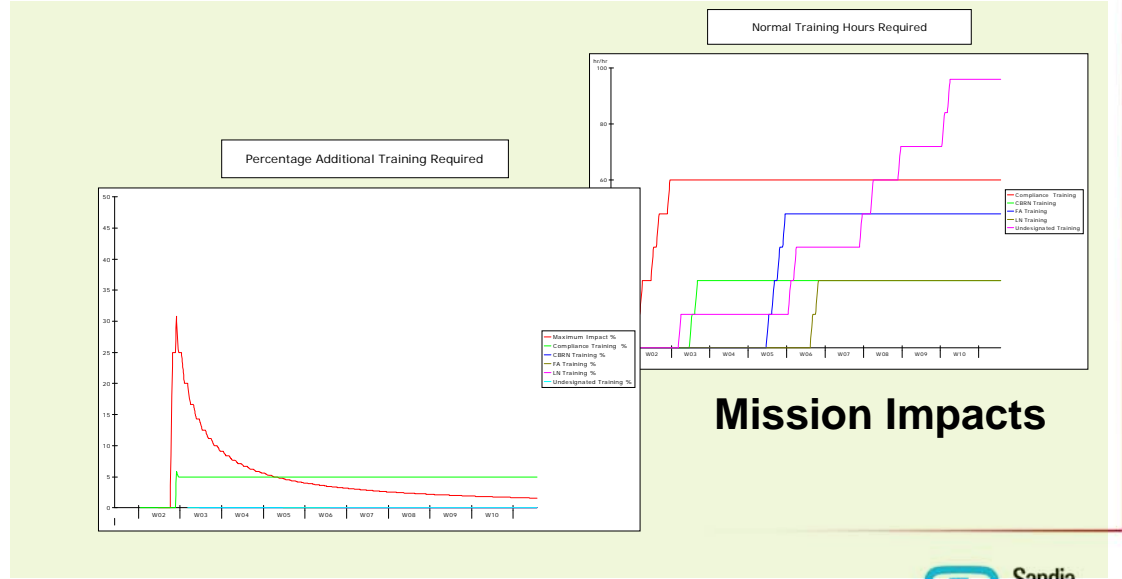
Electric System Model



Interruption Control Model



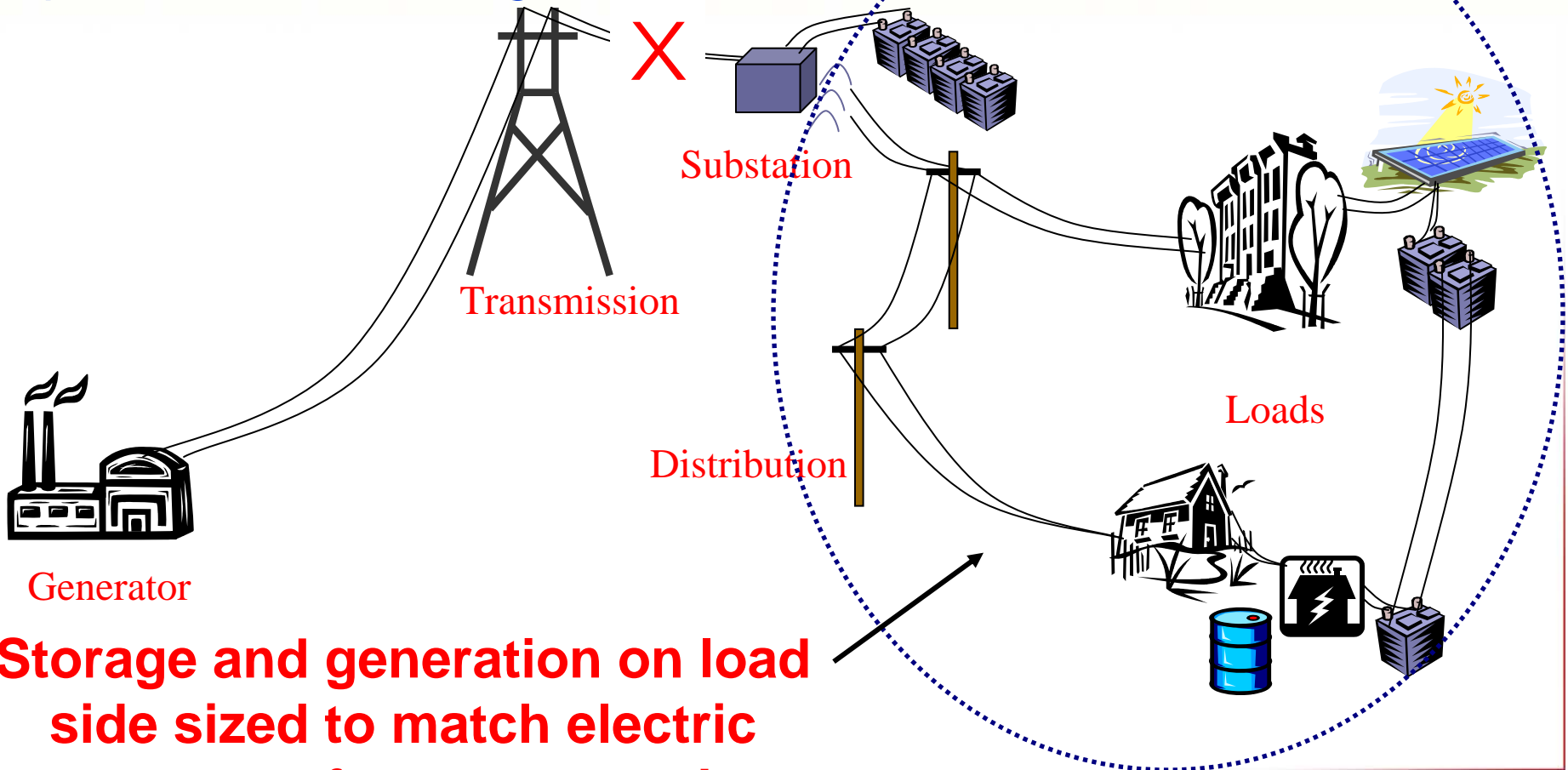
Mission Consequence Model



Mission Impacts

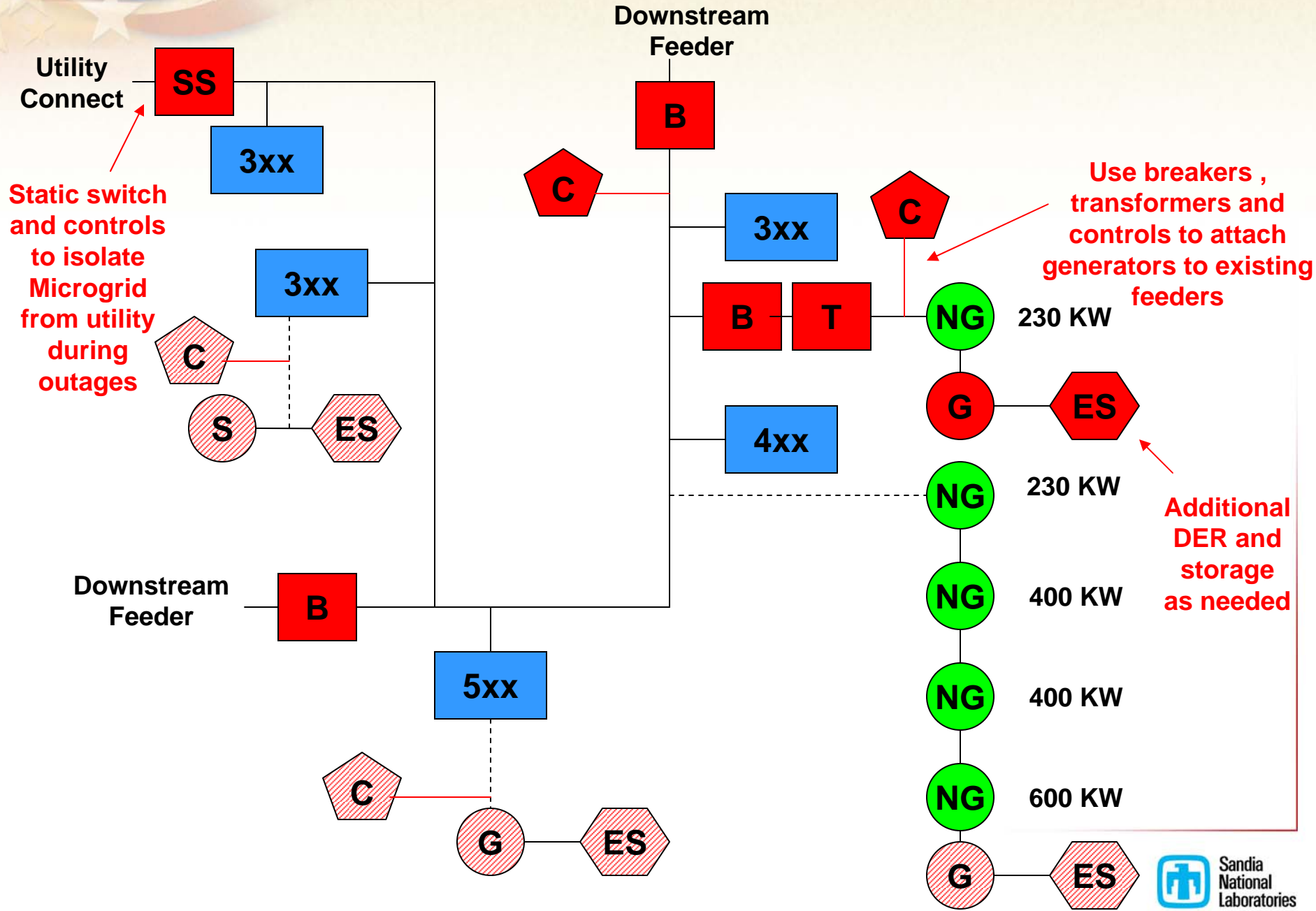
Energy Surety Microgrid™

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



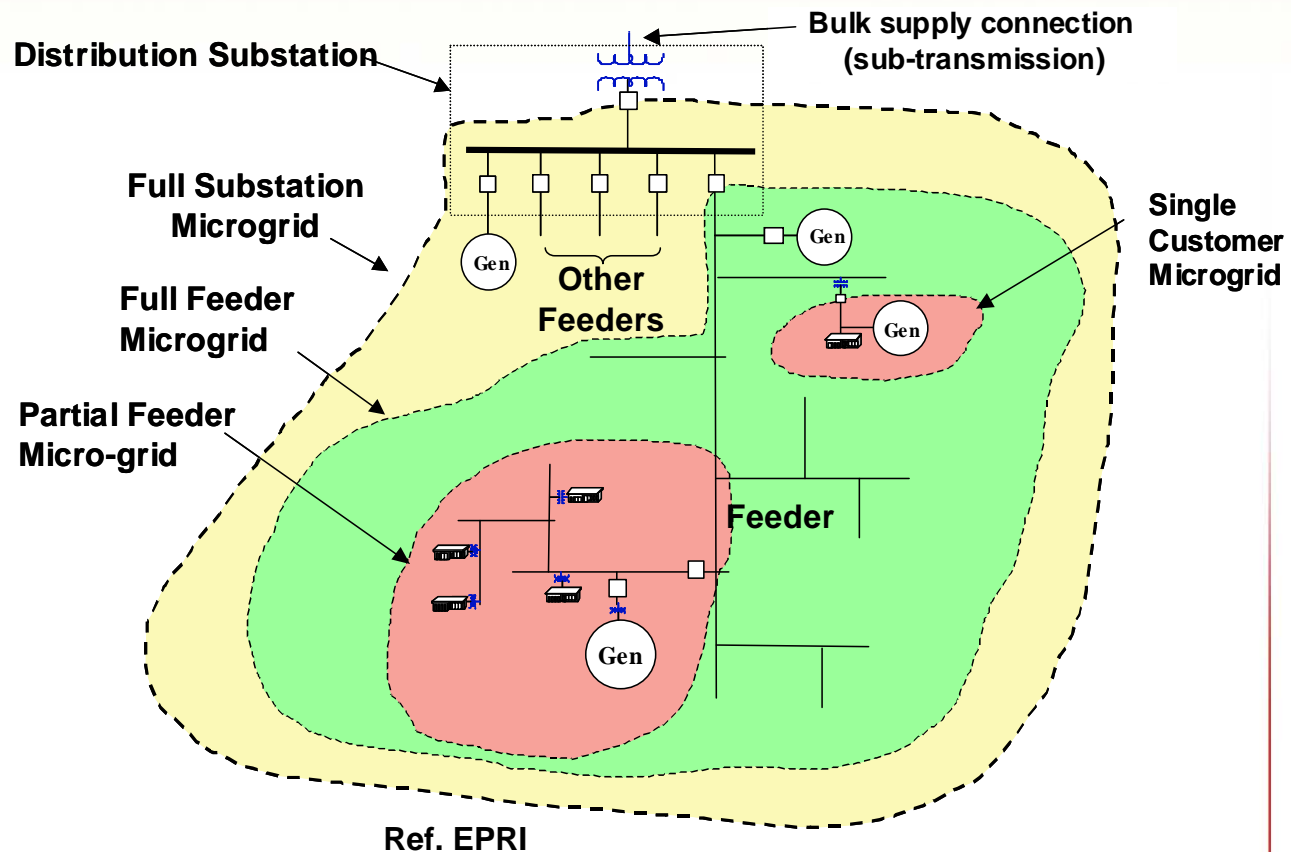
Storage and generation on load side sized to match electric power performance needs

Example Microgrid Options for Critical Buildings



DoD Needs Often Require a Range of Microgrid Sizes and Operations

- 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



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

Typical Microgrid Design and Implementation Considerations

- **Large facilities looking at 1-5 microgrid(s) with existing and new generation to meet critical mission assurance needs for various durations**
- **Requires energy system upgrades to implement the microgrid, but often with minimal rerouting of existing distribution feeders**
- **Energy security and reliability can be quantified, especially with consequence modeling,**
 - Supports return on investment decisions
 - Identifies best distributed energy approach and location
- **Many bases considering a “critical campus” for future expansion**

Current Sandia Military Microgrid Conceptual Design Efforts

- **Army**
 - Ft Sill, Ft. Bliss, Ft. Belvoir, 99th Army 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, Travis AFB, Cannon AFB, NAVFAC (Norfolk)



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

Sandia Microgrid RDDTE Focus

- **Microgrid system design and operations research and testing**
 - 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 support varying system energy reliability and safety needs**
- **Operation and aggregation of microgrids to behave as Smart Grid Nodes**

Sandia Distributed Energy and Microgrid Technology Lab

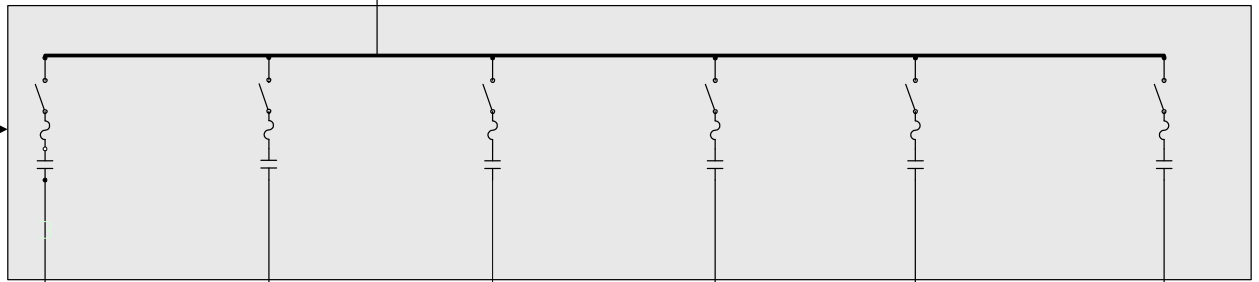
Center for Control System Security



Grid



480V Microgrid



Other Remote DER sites



Various Loads



Distributed Energy Resources

