SAND2015-6386C

Energy Surety and the Smart Grid: Approaches and Benefits with Microgrids

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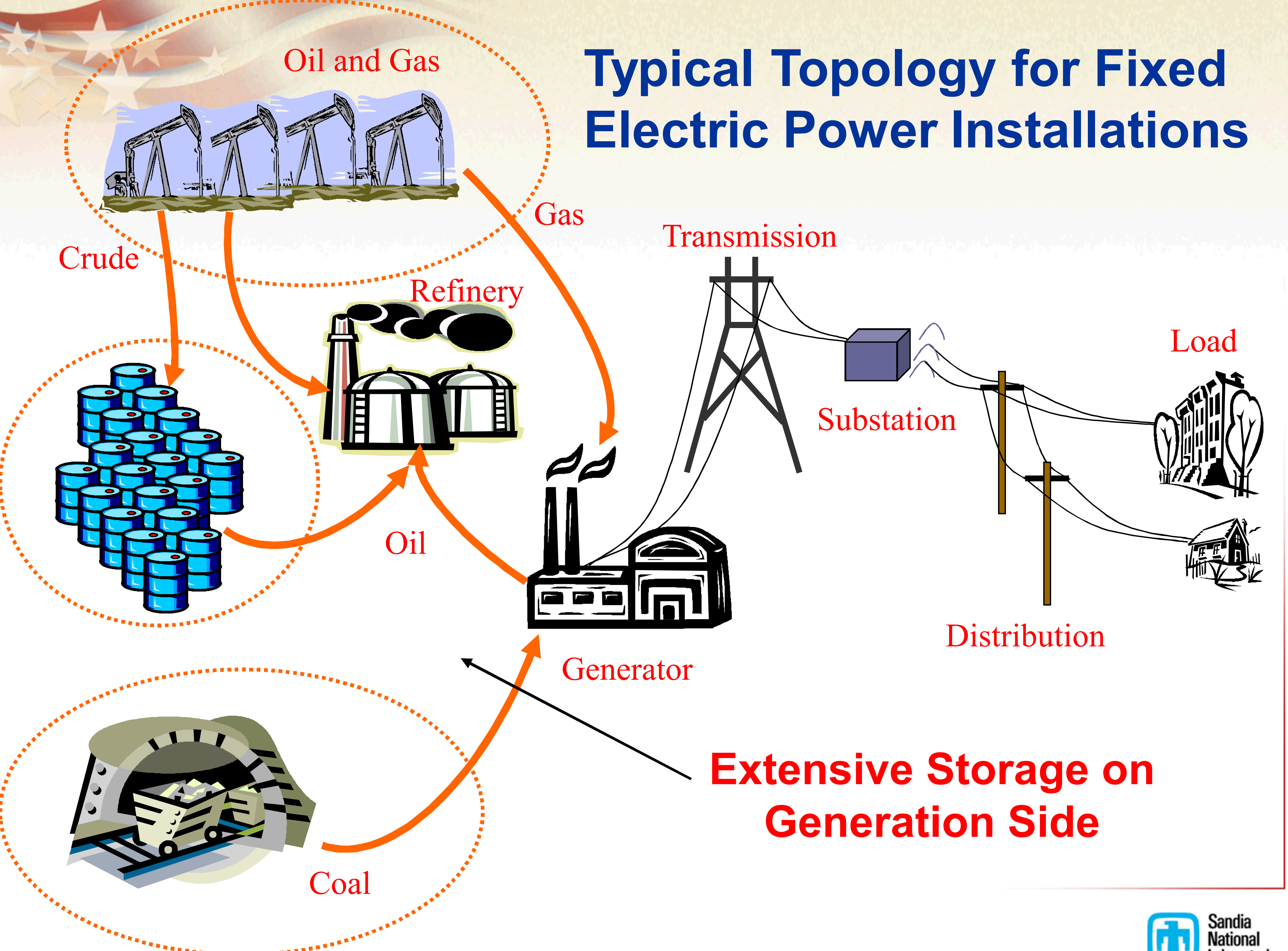
Presentation Overview

- **Common Energy Infrastructure Protection and Reliability Challenges**
  – Problems and issues with common approaches
- **Smart Grid Needs and Issues**
- **Energy Surety Concepts and Microgrids**
  – Matching system designs and operations to achieve energy safety, security, reliability, and cost-effectiveness
- **Advanced Microgrid Evaluation, Design, and Implementation Framework and Approach**

Typical Topology for Fixed Electric Power Installations



Extensive Storage on Generation Side

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Energy System Reliability and Vulnerability Issues

- Southwest Army base served by two feeders
- May 2002 forest fire takes out both feeders
- Base down for 16 hours
  - Est. cost $3M
  - Loss of mission capability

- Southwest semiconductor plant served by two feeders
- Forest fire takes out both feeders
- Chip fab shuts down for 3 months
  - High-value customers cancel orders due to delay
  - Economic loss forces plant to shut down permanently

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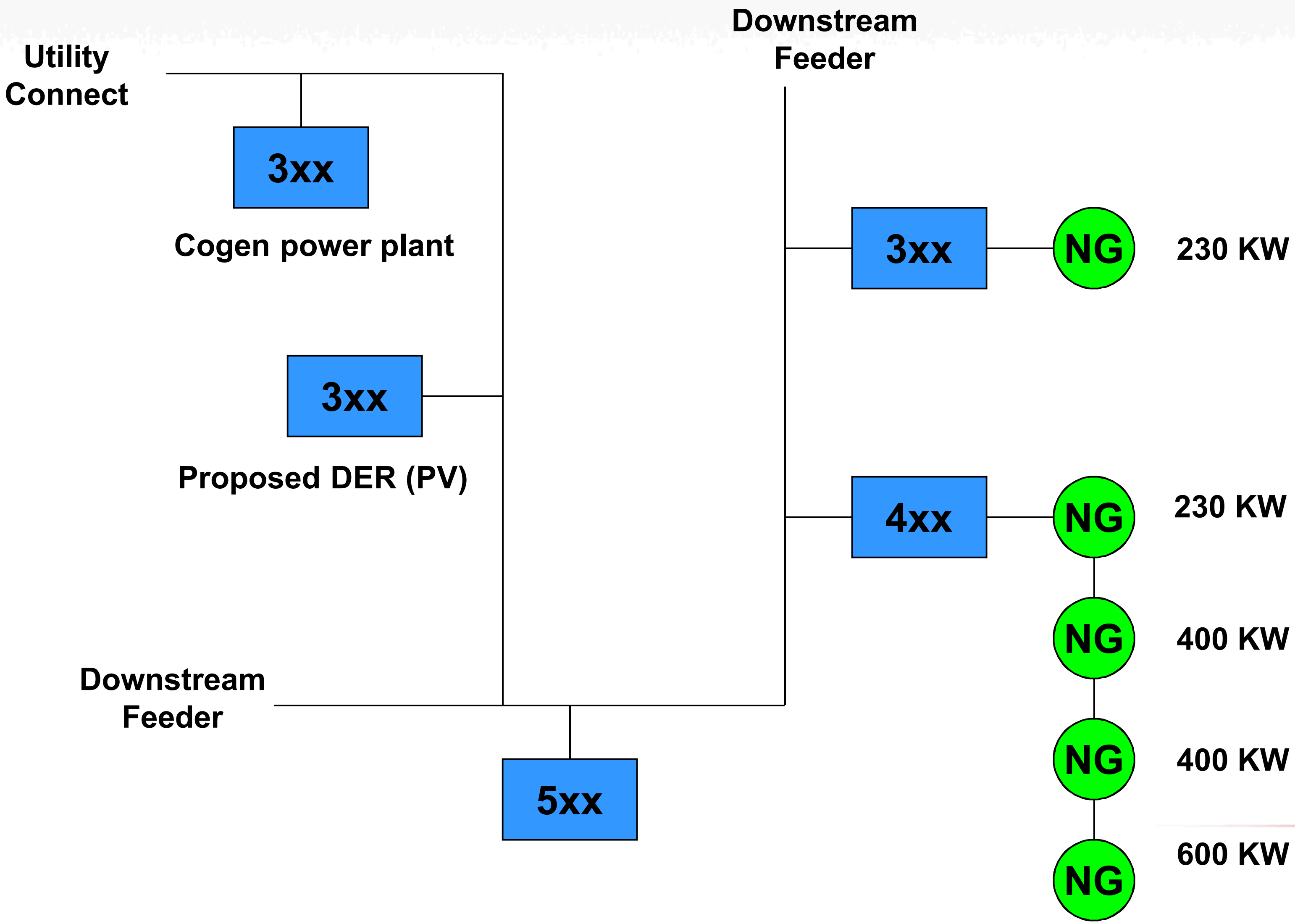
Common Backup Generation Connection for Critical Buildings



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Common Electric Power Security and Reliability Concerns

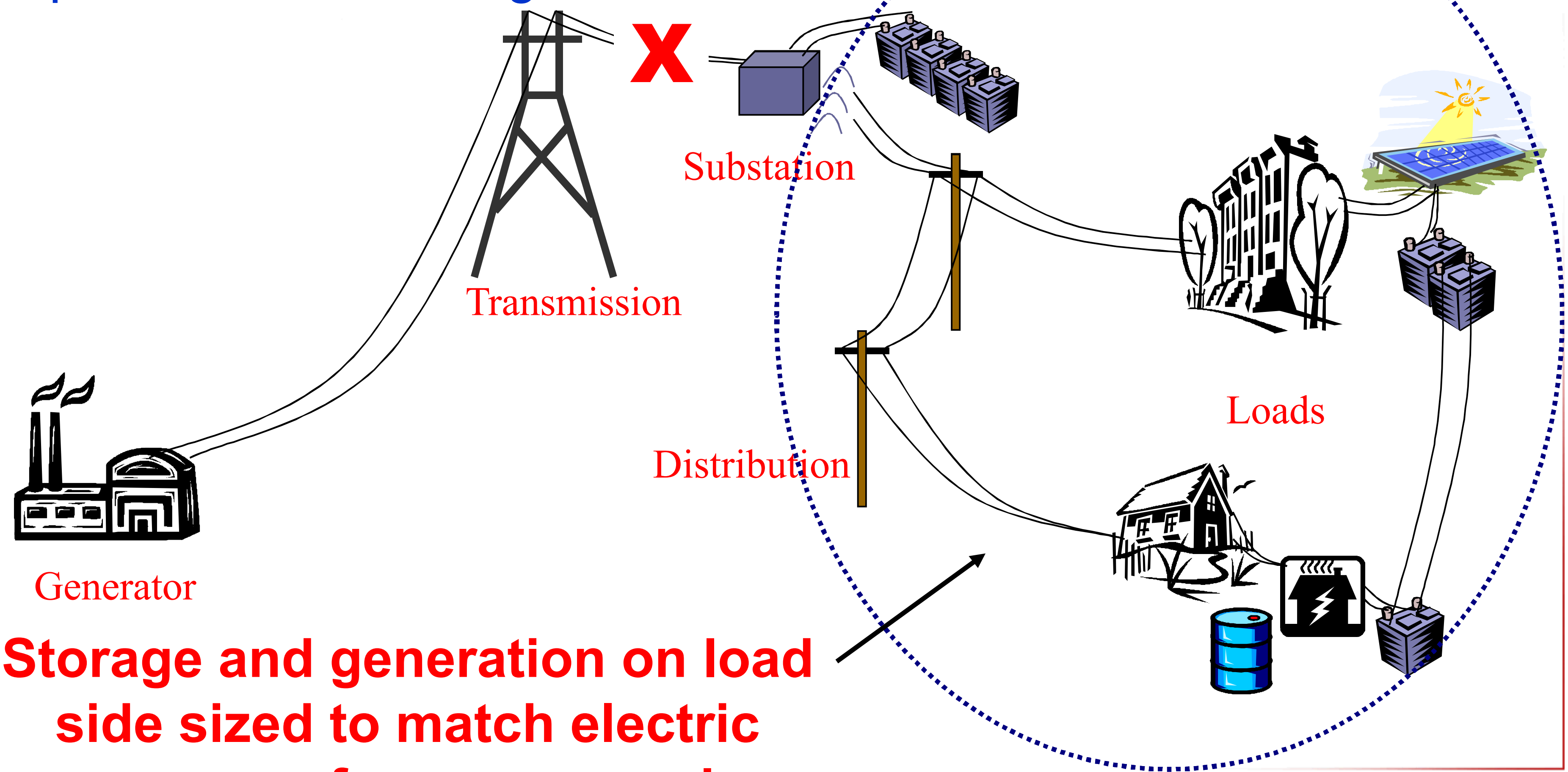
- **Current practice of providing power security often relies on back-up generators**
  - *Frequently over-sized and under-maintained*
  - *Low probability of start when needed*
  - *Dedicated to one building or facility – does not share power with other facilities*
  - *Operations for extended periods often problematic*
- **Supply redundancy from multiple feeders often not effective**
  - *Diminished effectiveness of renewable energy resources*
- **Stating 9's of reliability – does not factor in the erosion of critical energy needs for extended outages**

Enabling the 21st Century Grid with Enhanced Reliability and Security

- **Major Issues and Challenges**
  - Future electric grid incorporating extensive distributed generation will require more complex system control and integration to ensure energy safety, security, and reliability including:
    - Real-time or near real-time assessment, control, and optimization of extensive distributed generation resources while maintaining power quantity and quality
    - Significantly improved control system cyber security
    - Improved intermediate and large-scale energy storage technologies to maintain renewable energy delivery reliability
    - Bidirectional power flow requires new advanced safety standards for distributed generation connection and operation in grid-tied and islanded modes
    - System control and hardware design and operational standards scalable for micro, intermediate, and utility-scale grid applications
    - Extensive testing and monitoring of control and operations approaches to verify cost and performance to reduce operational and safety risks to utilities and the public

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 <u>performance</u> needs

Advanced Microgrids – Smart Grid Building Blocks

STANDARD MICROGRID	• Operates where there is no large grid or operates generally islanded from the larger grid • Often used with a central power plant or CCHP plant to balance power supplies and demand locally • Minimal grid interaction or support
ADVANCED MICROGRID	• Can integrate distributed generation and manage and control power demand and distributed resource allocation • Can operate islanded or grid-tied • Allow optimum use of energy resources during both power outages and for grid support
SMART GRID NODE	• Same functional capabilities as an advanced microgrid • Control capabilities to federate with other microgrids, if needed • Grid-tied operations are coordinated through the grid operator to support grid operations and performance

Advanced microgrids are the building blocks for Smart Grid Nodes, which in turn is one of the major power utility building blocks for the Smart Grid

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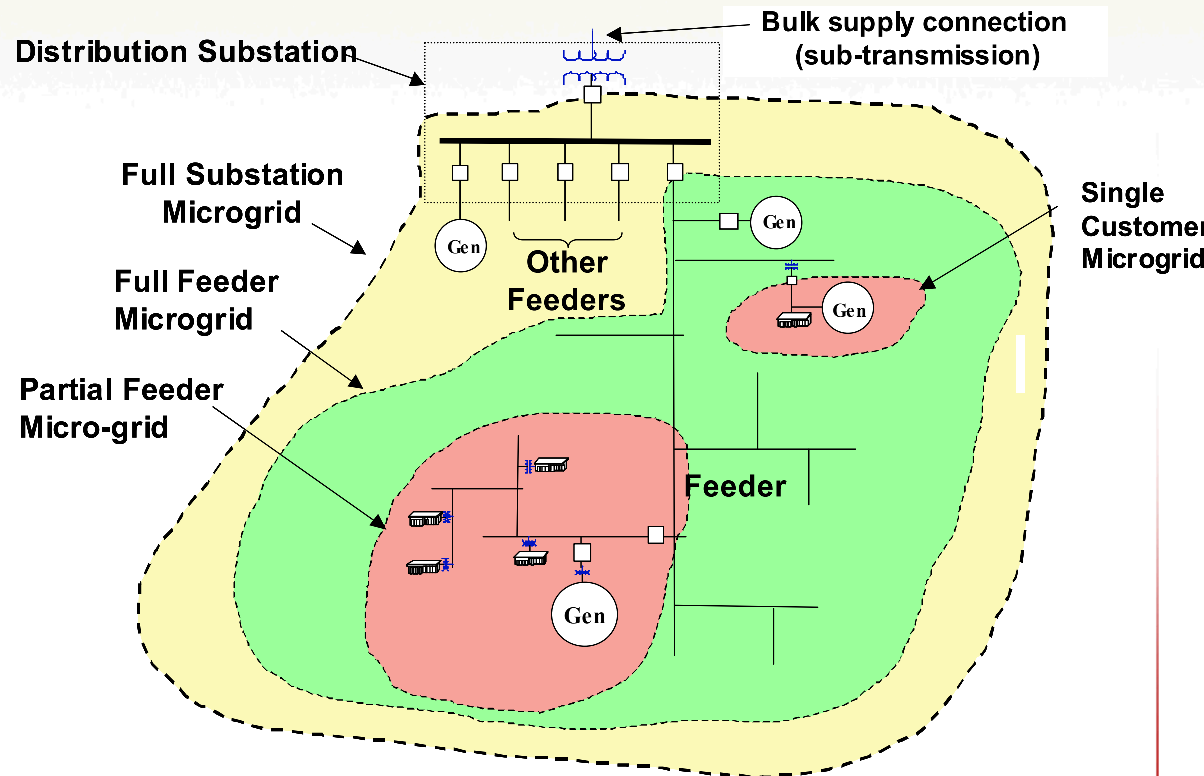
Advanced Microgrids – Smart Grid Building Blocks that Enhance Energy Assurance

- **Designed to operate ‘grid tied’ and ‘islanded’ through Point of Common Coupling (PCC)**
- **Supports enhanced**
  - Use of distributed energy and storage technologies
  - System resiliency
  - System reliability
  - System security and safety
  - Utility ancillary and demand/response benefits
- **Scalable implementation and aggregation of Smart Grid, automation, and energy technologies**



Nanogrid	Less than 10-kW, single-phase, residential
Advanced Microgrid	From 1 to 10MW, three phase
Smart Grid Node	Greater than 5 MW up to 20MW

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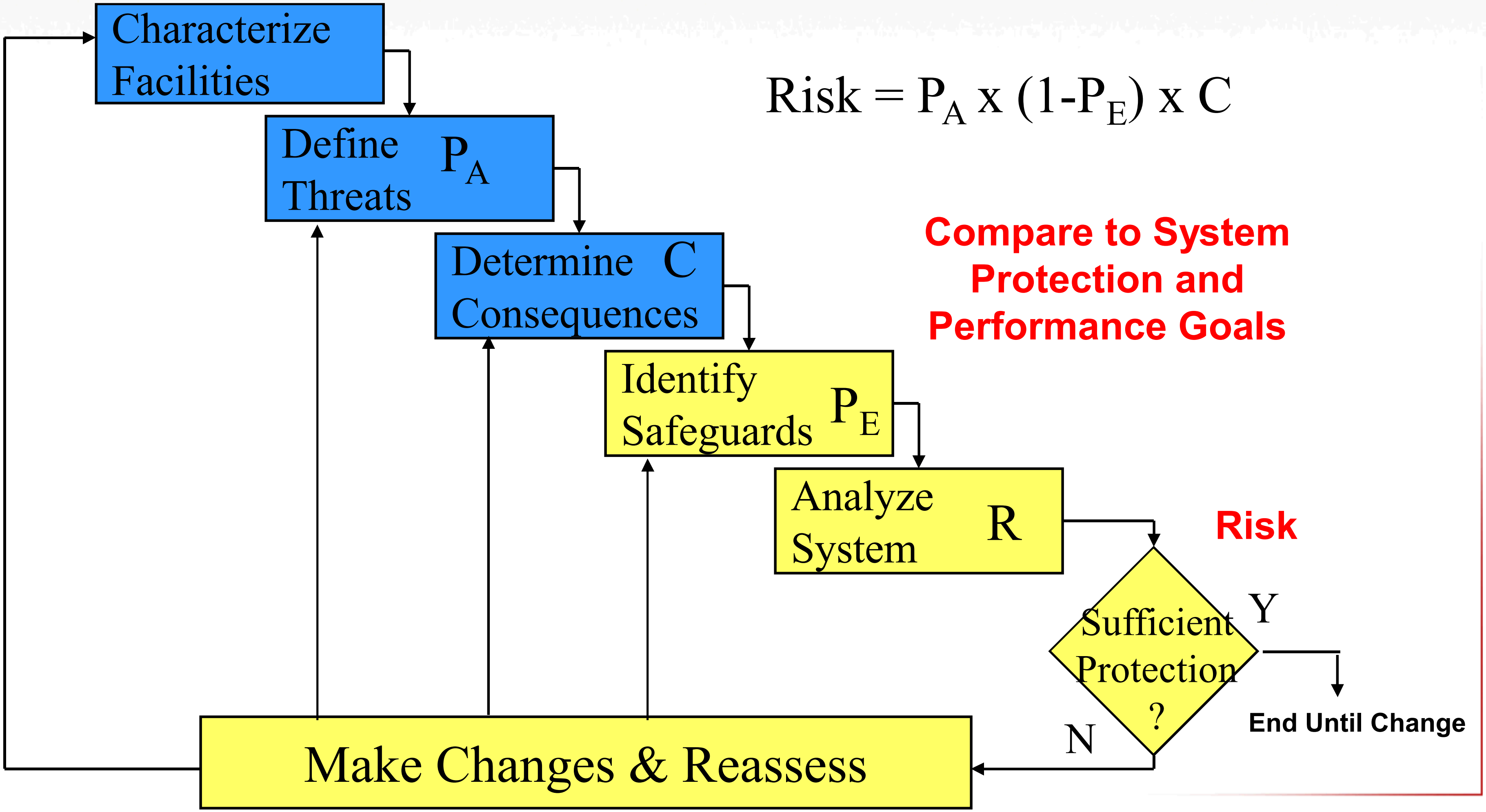
Energy Surety Concept
Improving Energy Safety, Security, Reliability

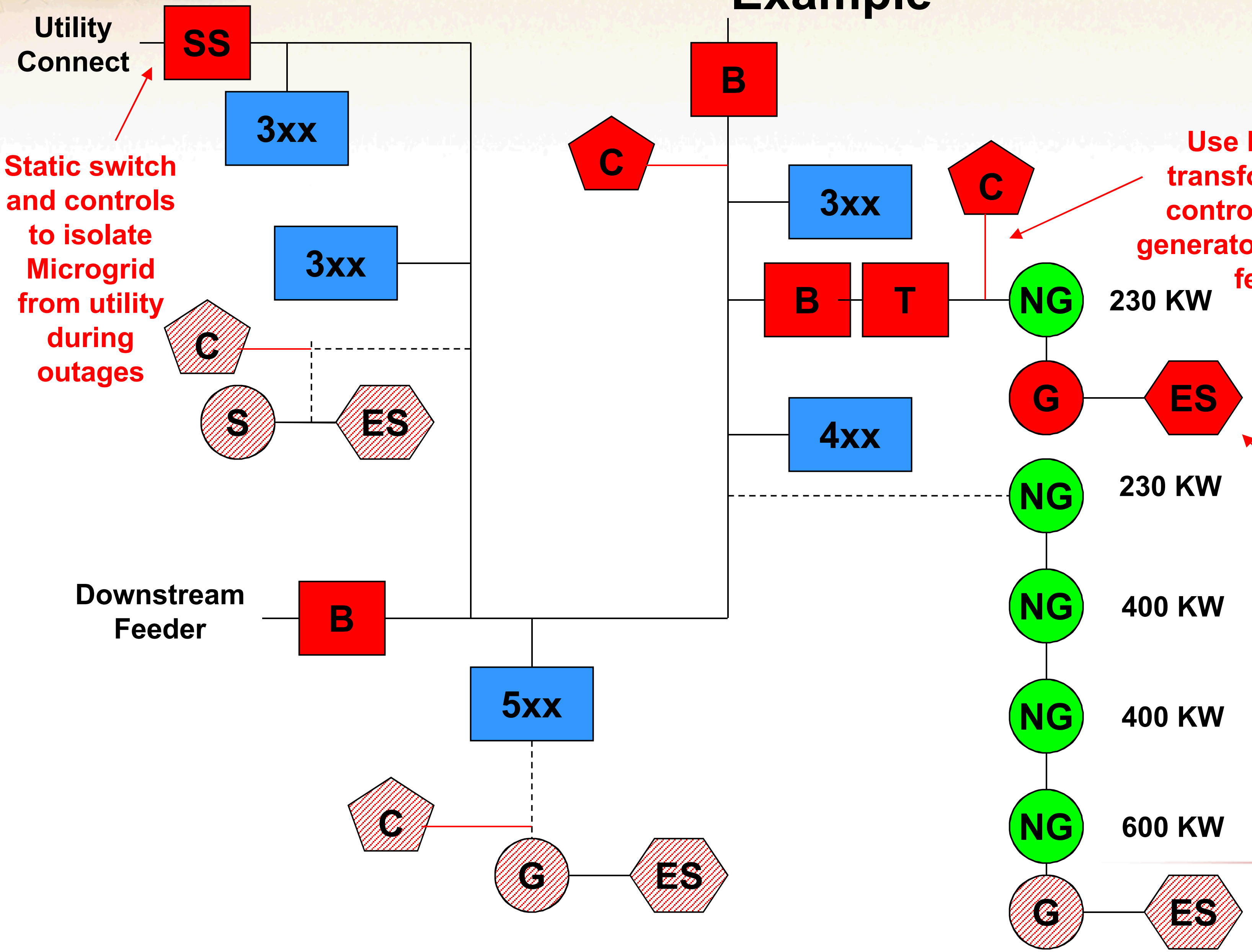
Energy Surety Elements	
Safety	Safely supplies energy to end user
Security	Maintains power in a malevolent environment
Reliability	Maintains power when and where needed
Sustainability	It can be maintained for mission duration
Cost Effectiveness	Produces energy at lowest predictable cost
Resiliency	Ability to provide adequate service and recover after extreme events

Distributed Infrastructures (like the Energy Infrastructure) are Hard to Protect

Risk-based Assessment Approach for Energy Systems



Energy Surety Microgrid Assessment Example



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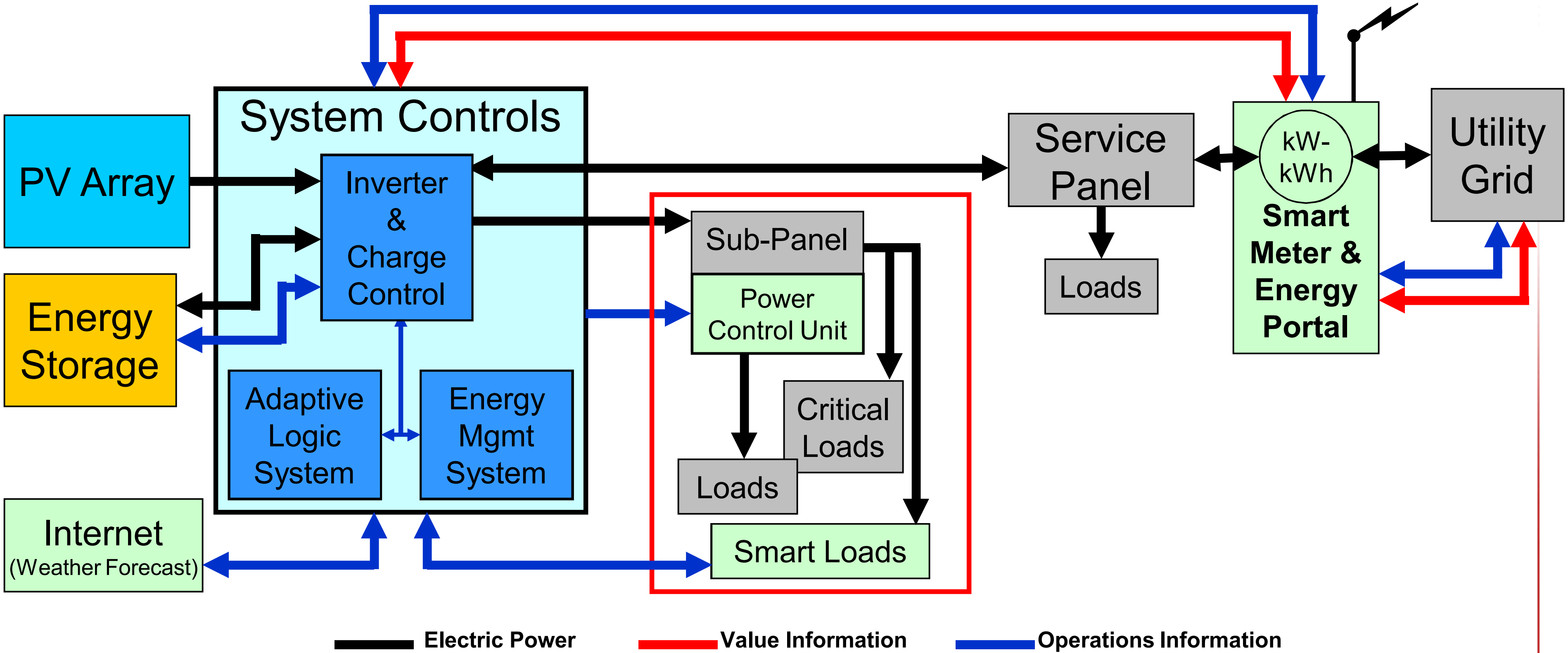
Complexity of Advanced Microgrids with Intelligence and Control

Advanced Distribution Infrastructure Operations will Require Cyber Security and Smart Controls



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Energy Surety Microgrid Summary

- **Energy Surety Microgrids are an example of energy risk management - matching energy supply reliability and security within a community energy assurance context**
- **Consequence analysis and assessment can illustrate the effect of energy improvements on critical mission capability**
  - Different from stating 9's of reliability – which does not factor in the erosion of critical energy needs for extended outages
- **Supports energy assurance for extended operations as needed during either loss of utility power or as a stand alone small distributed energy grid**
- **Advanced microgrids permit integration of renewables into power supply infrastructure for 'islanded' and 'grid-tied' operations to increase electric power system safety and reliability to meet community critical energy needs**

MicrogridTest and Validation

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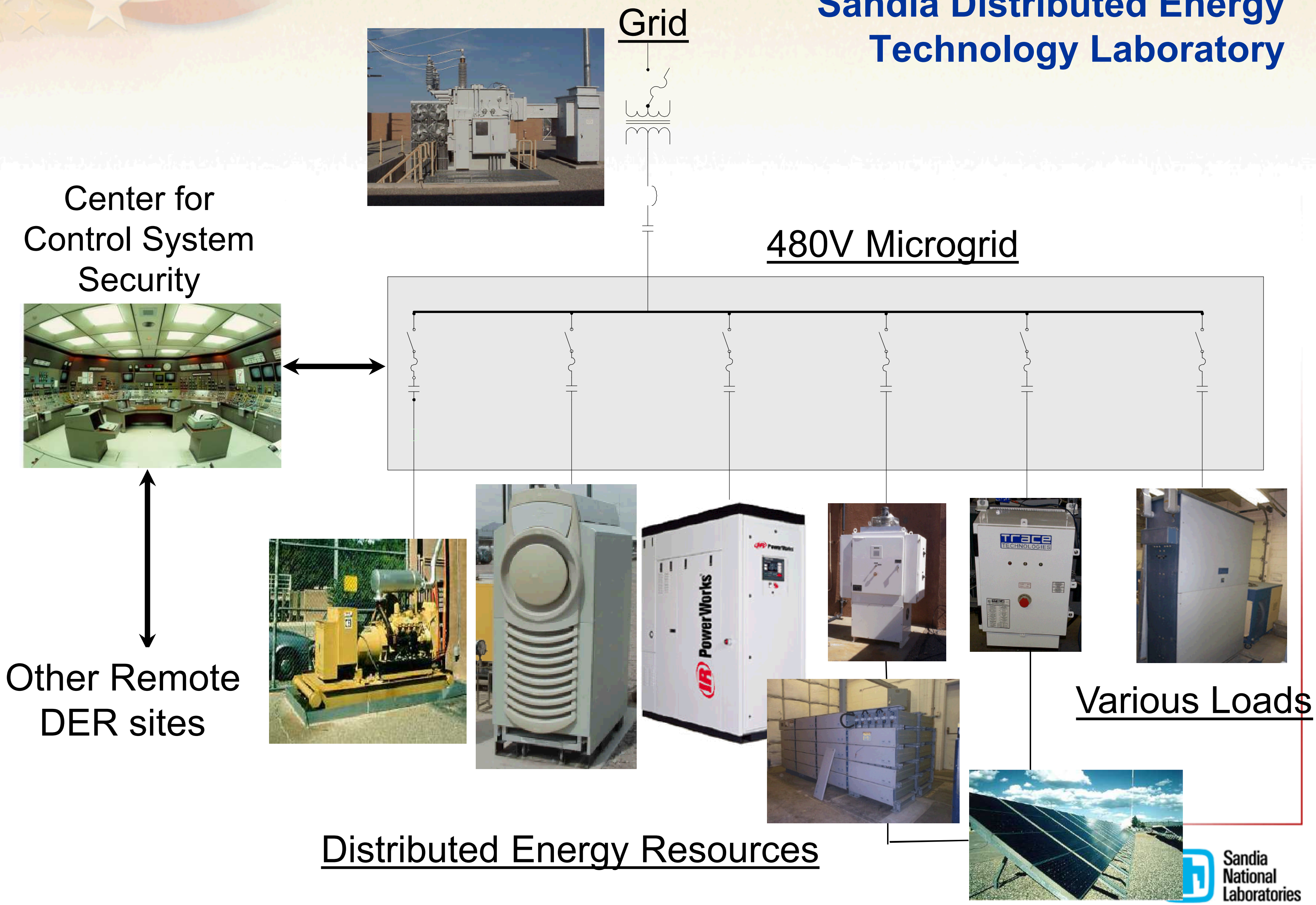

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