Sandia National Laboratories

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DOE Grid Modernization Initiative and Sandia National Lab's engagement with EPSCoR

PRESENTED BY

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ENERGY   NNSA
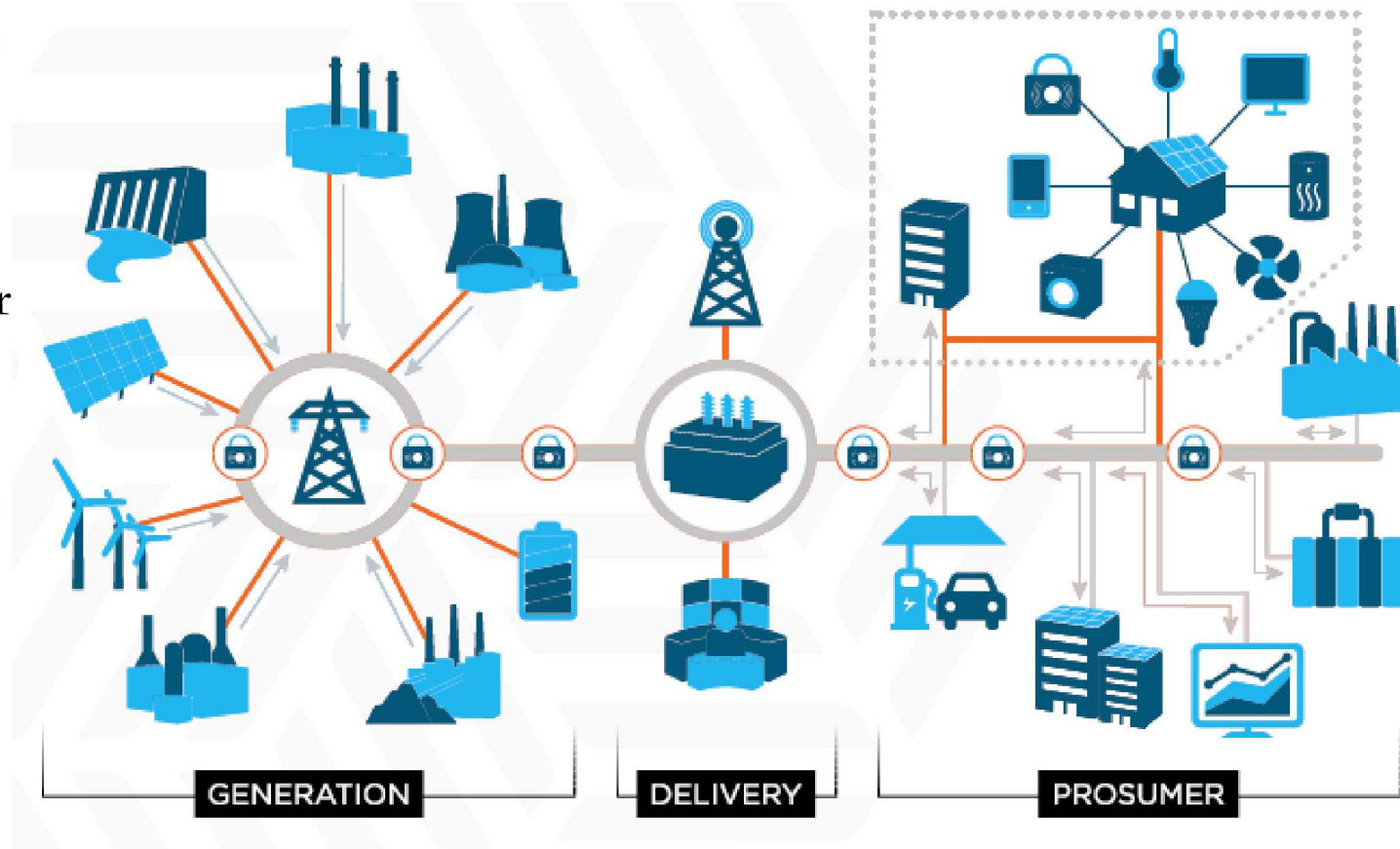
Creating a 21ˢᵗ Century Grid: Responding to the Drivers of Change

- Changing mix of types and characteristics of electric generation (in particular, distributed and clean energy)

- Growing demands for a more resilient and reliable grid (especially due to weather impacts, and cyber and physical attacks)

- Growing supply- and demand-side opportunities for customers to participate in electricity markets

- Emergence of interconnected electricity information and control systems

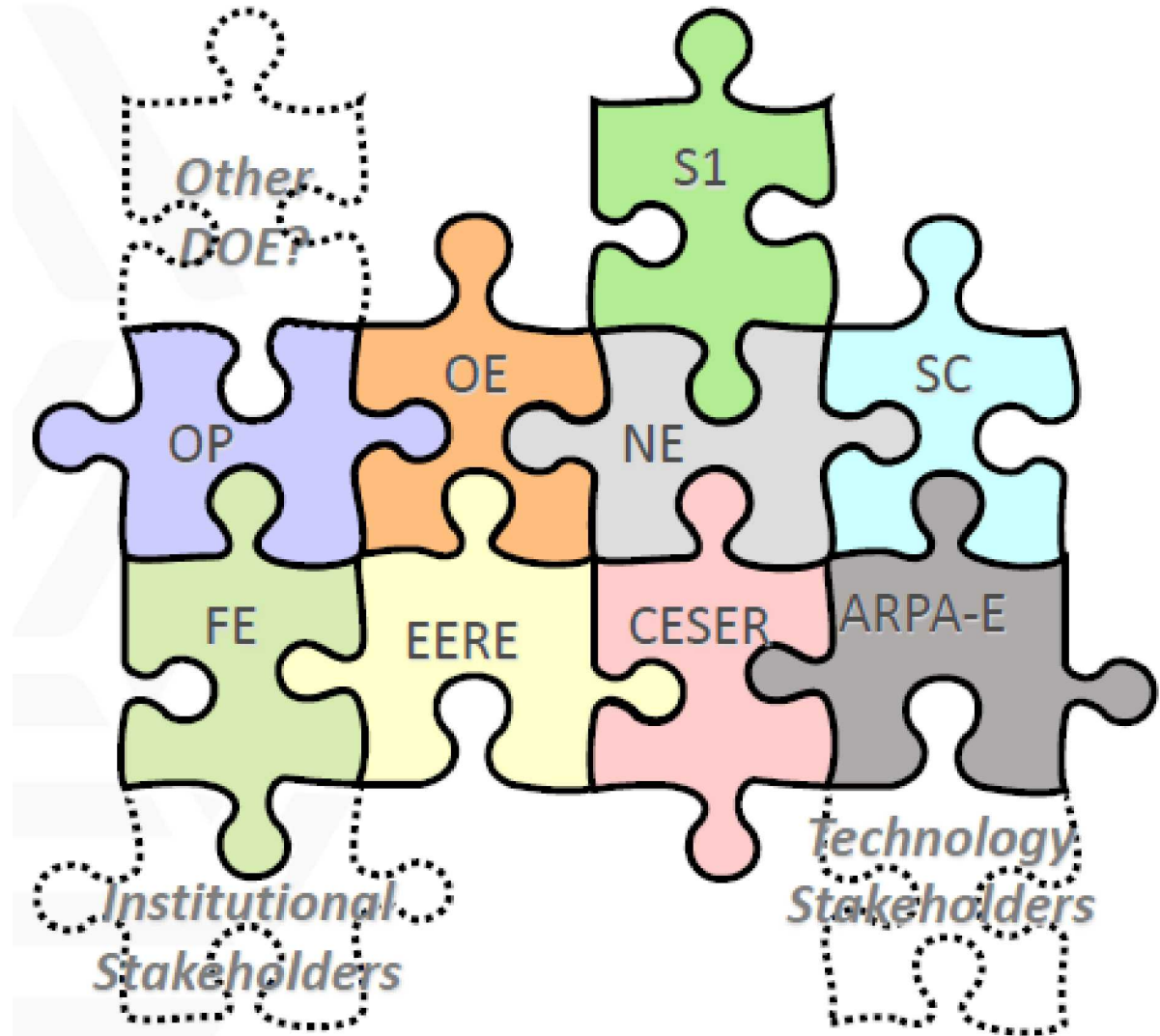- Aging electricity infrastructure

DOE Grid Modernization Initiative

An aggressive and urgent five-year grid modernization strategy for the U.S. Department of Energy (DOE) that:

◦ Aligns existing base activities across DOE offices

◦ Defines a vision for the modern grid through an integrated Multi-Year Program Plan (MYPP)

◦ Establishes new activities to fill major gaps in the existing base

◦ Leverages strategic partnerships through a laboratory consortium with core scientific abilities and regional outreach
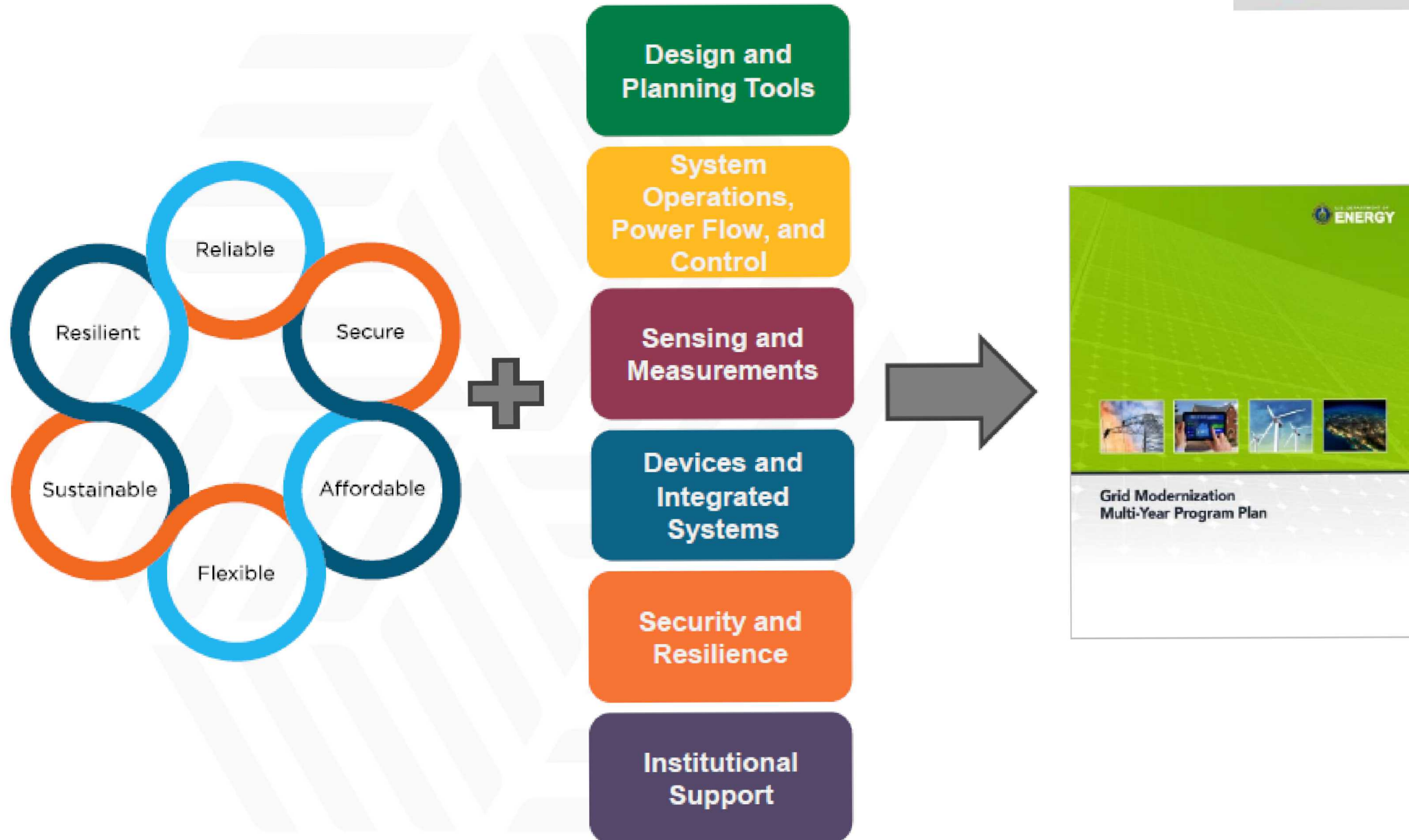
More information:
https://energy.gov/gmi

Grid Modernization 5-Year Program Plan

Grid Modernization Laboratory Consortium (GMLC)

Move from a collection of DOE and lab projects to a DOE-lab consortium model that integrates and coordinates laboratory expertise and facilities to best advance DOE grid modernization goals

GMLC RD&D Project Portfolio

2016 GMLC Lab Call

- Up to $220M, 88 projects
- 13 National Labs and 150+ partners
- Foundational and office-specific specific projects

2017 Resilient Distribution Systems

- Up to $32M, 14 Regional Partnerships
- Field validation of novel technologies under high penetration of and integration of multiple DER technologies.
- Built-in cybersecurity and interoperability

DOE National Laboratories

Sandia Grid Modernization Timeline

Distributed Energy Technology Laboratory (DETL) opens
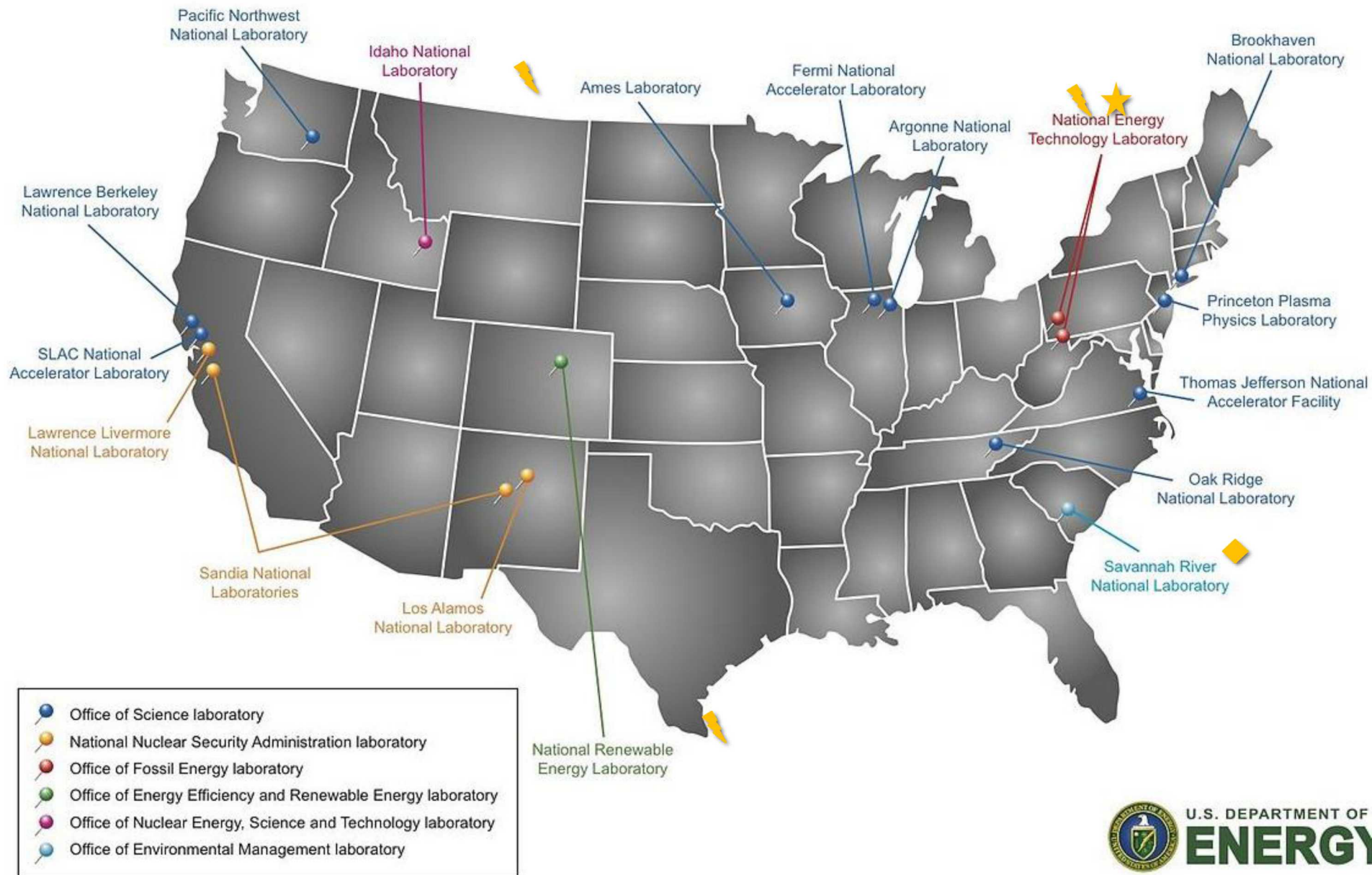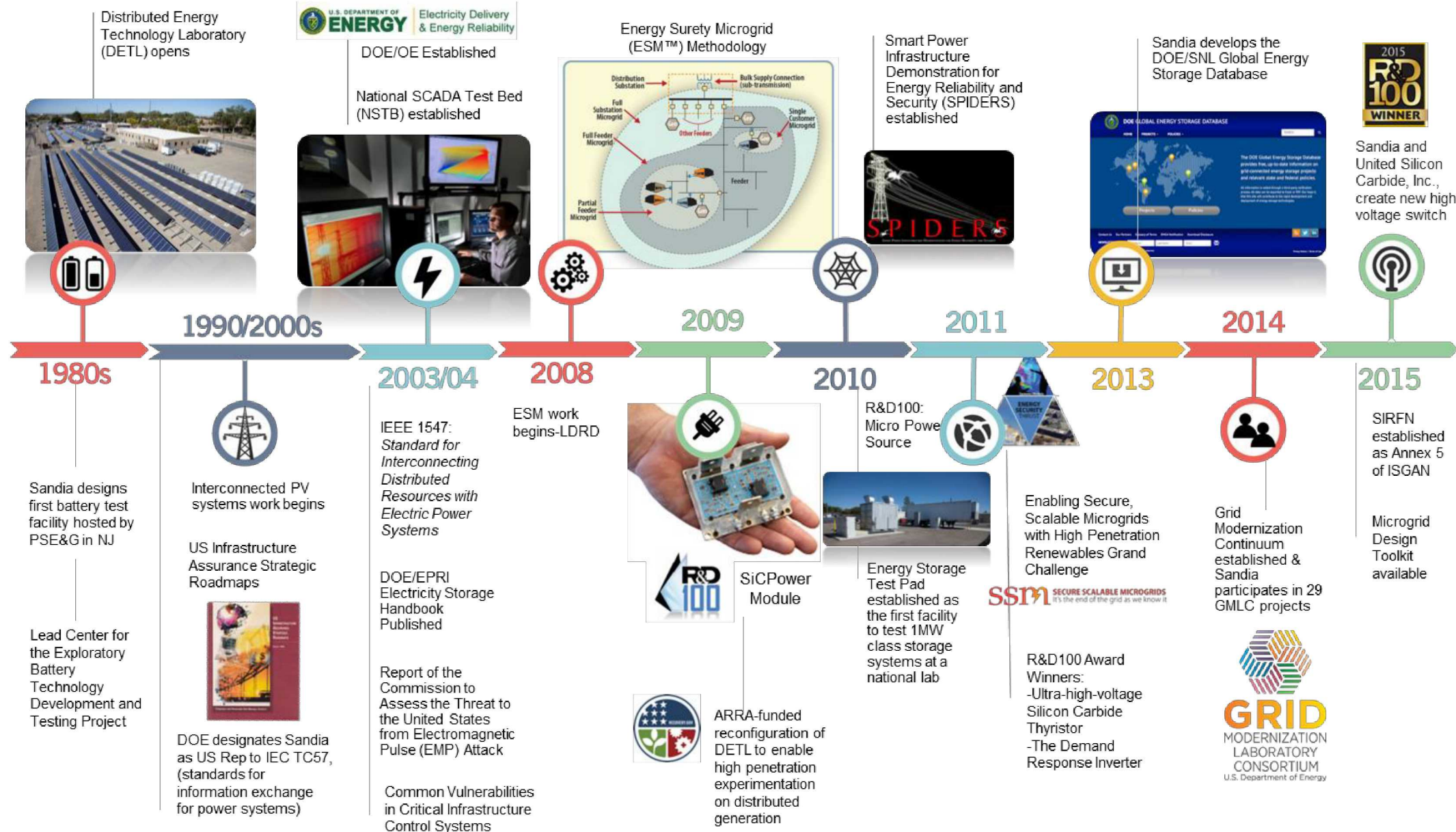
DOE/OE Established

National SCADA Test Bed (NSTB) established

Energy Surety Microgrid (ESM™) Methodology

Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) established

Sandia develops the DOE/SNL Global Energy Storage Database

Sandia and United Silicon Carbide, Inc., create new high voltage switch

1980s · **1990/2000s** · **2003/04** · **2008** · **2009** · **2010** · **2011** · **2013** · **2014** · **2015**

Sandia designs first battery test facility hosted by PSE&G in NJ

Lead Center for the Exploratory Battery Technology Development and Testing Project

Interconnected PV systems work begins

US Infrastructure Assurance Strategic Roadmaps

DOE designates Sandia as US Rep to IEC TC57, (standards for information exchange for power systems)

IEEE 1547: *Standard for Interconnecting Distributed Resources with Electric Power Systems*

DOE/EPRI Electricity Storage Handbook Published

Report of the Commission to Assess the Threat to the United States from Electromagnetic Pulse (EMP) Attack

Common Vulnerabilities in Critical Infrastructure Control Systems

ESM work begins-LDRD

SiCPower Module

ARRA-funded reconfiguration of DETL to enable high penetration experimentation on distributed generation

R&D100: Micro Power Source

Energy Storage Test Pad established as the first facility to test 1MW class storage systems at a national lab

Enabling Secure, Scalable Microgrids with High Penetration Renewables Grand Challenge

SECURE SCALABLE MICROGRIDS It's the end of the grid as we know it

R&D100 Award Winners:
-Ultra-high-voltage Silicon Carbide Thyristor
-The Demand Response Inverter

Grid Modernization Continuum established & Sandia participates in 29 GMLC projects

GRID MODERNIZATION LABORATORY CONSORTIUM U.S. Department of Energy

SIRFN established as Annex 5 of ISGAN

Microgrid Design Toolkit available

Energy-Related Research Platform

Distributed Energy Technologies Laboratory (DETL)

Supervisory Control & Data Acquisition (SCADA) Test Bed

Combustion Research Facility (CRF)

Control and Optimization of Networked Energy Technologies (CONET) Lab

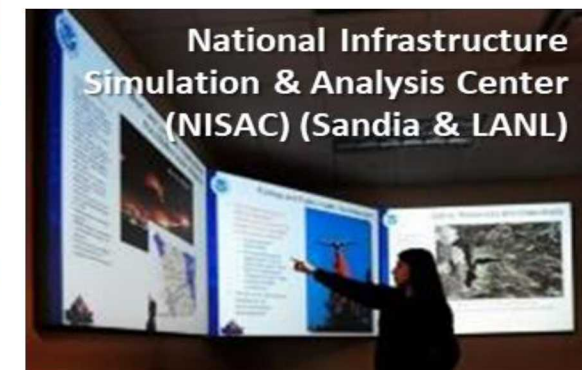Battery Abuse Testing Laboratory (BATLab)

National Solar Thermal Test Facility

Scaled Wind Farm Technology (SWiFT) Facility

Photovoltaic Systems Engineering Laboratory (PSEL)

Center for Integrated Nanotechnologies (CINT) (Sandia and LANL)

National Infrastructure Simulation & Analysis Center (NISAC) (Sandia & LANL)

Distributed Energy Technologies Laboratory (DETL) Energy Storage Test Pad (ESTP)

ESTP

DETL

- Flexible, reconfigurable, high-density, p/c-HIL
- Specializes on DER systems integration: inverters, energy storage, gensets, microgrids, controllers
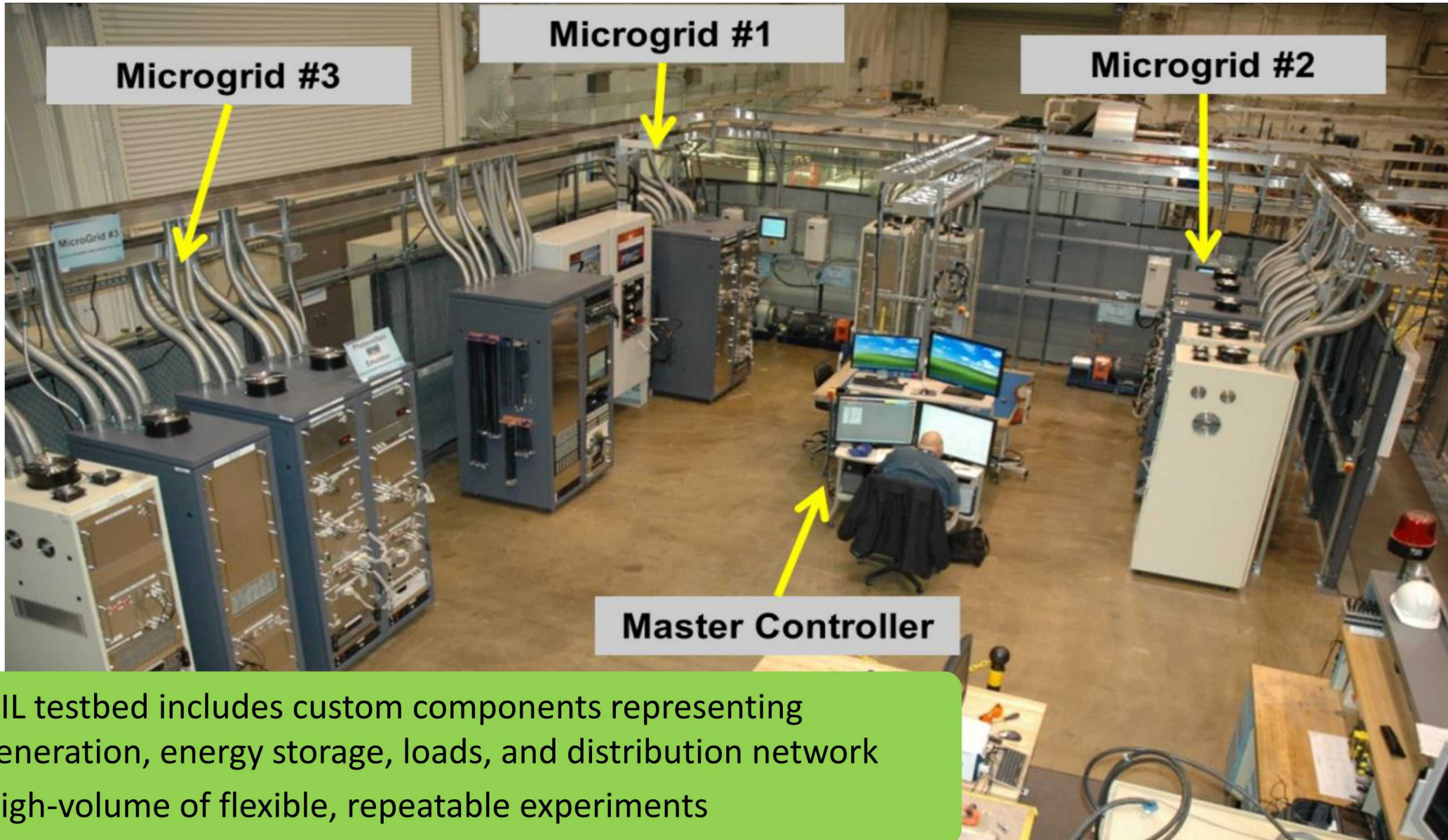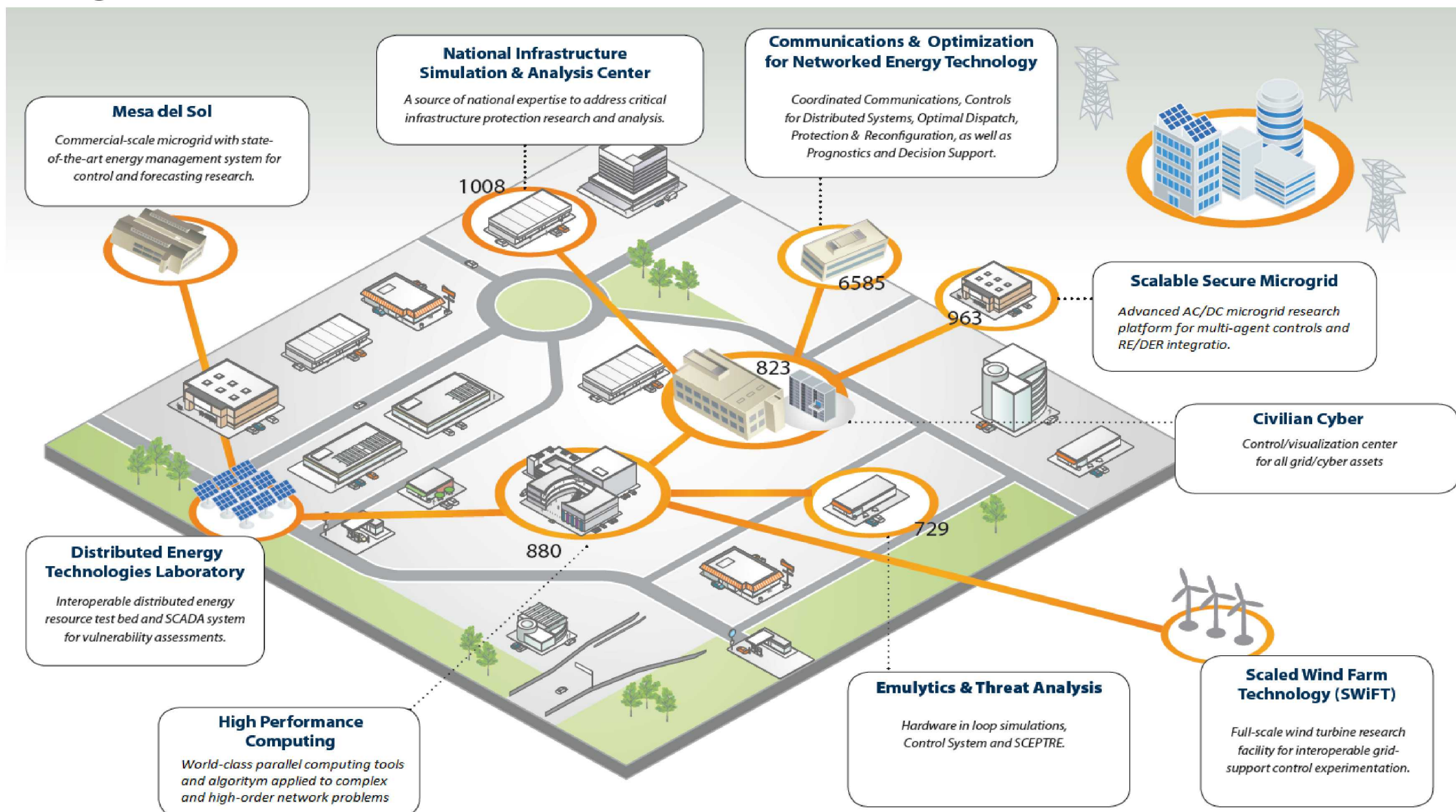- Efficiency, reliability, safety, interoperability, cyber-security, standards conformance

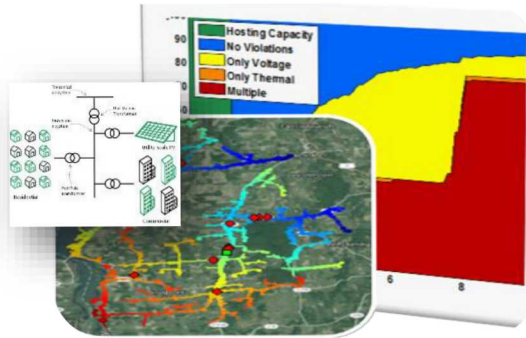# Secure Scalable Microgrid (SSM) Testbed

- HIL testbed includes custom components representing generation, energy storage, loads, and distribution network
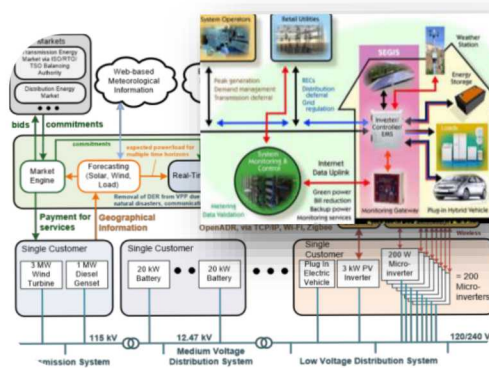- High-volume of flexible, repeatable experiments

Integrated Grid R&D Platform

Mesa del Sol

Commercial-scale microgrid with state-of-the-art energy management system for control and forecasting research.

National Infrastructure Simulation & Analysis Center

A source of national expertise to address critical infrastructure protection research and analysis.

Communications & Optimization for Networked Energy Technology

Coordinated Communications, Controls for Distributed Systems, Optimal Dispatch, Protection & Reconfiguration, as well as Prognostics and Decision Support.

Scalable Secure Microgrid

Advanced AC/DC microgrid research platform for multi-agent controls and RE/DER integratio.

Civilian Cyber

Control/visualization center for all grid/cyber assets

Distributed Energy Technologies Laboratory

Interoperable distributed energy resource test bed and SCADA system for vulnerability assessments.

High Performance Computing

World-class parallel computing tools and algoritym applied to complex and high-order network problems

Emulytics & Threat Analysis

Hardware in loop simulations, Control System and SCEPTRE.

Scaled Wind Farm Technology (SWiFT)

Full-scale wind turbine research facility for interoperable grid-support control experimentation.

1008

6585

963

823

880

729

Sandia Renewable and Distributed Systems Integration R&D

T&D Modeling, Simulation and Analysis

Real-time Controls and Operational Optimization

DER technology Development and Validation

Communications, Networking & Cybersecurity

Power Electronics Devices and Systems

Safety, Reliability & Resilience

Provide national leadership in science and engineering by establishing enduring partnerships with a focused set of universities.

Sandia Campus Executive (CE) and Academic Alliance (AA) Programs

CE and AA focus areas are well aligned with EPSCoR program

University	Area of Focus	POC
NMSU(CE)	**Power systems**; water purification; signal processing	Campus Exec: Jaime Moya Deputy: Rita Gonzalez
New Mexico Tech (CE)	Energetic materials; **cybersecurity**; bioengineering	Campus Exec: Ron Baker
UNM (AA)	Bioscience for national security; energy (materials/water, etc.); high energy density science; **high performance/quantum/cyber computing**; nano/micro; nuclear engineering	Campus Exec: Carol Adkins Tech. Deputy: Diane Peebles Business Deputy: Isaac Romero

More Information:
https://university.sandia.gov

Lab Directed Research and Development (LDRD)

Advancing the frontiers of knowledge in areas relevant to Sandia missions

Developing innovative solutions and novel tools

Attracting, developing, and retaining a world-class technical workforce

FY 2017 LDRD Program Statistics

$154.7M
Total Program Cost

$343K
Median Project Size

344
Total LDRD Projects

165
New Projects in 2017

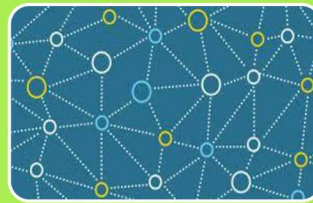| Investment Areas	
Research Foundations	Bioscience
	Computation and Informational Sciences
	Engineering Sciences
	Geoscience
	Material Science
	Nanodevices and Microsystems
	Radiation effects and High Energy Density Sciences
	New ideas
Mission Foundations	Defense Systems and Assessments
	Climate and Energy
	Global Security
	Nuclear Weapons
Grand Challenges	
Exploratory Express	

Pathways for Sandia Involvement in EPSCoR

Proposed EPSCoR-Related LDRD Topics

1. Internships, postdocs, adjunct faculty, advisory boards

2. Leverage Campus Executive and Academic Alliance programs

3. Collaborative research projects

4. Aligned LDRD projects (Proposed)

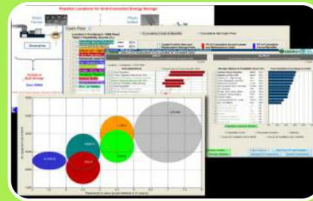5. Strategic partnering on new funding opportunities (e.g., GMLC)

Resilient Architecture
- Microgrids and enabling technologies
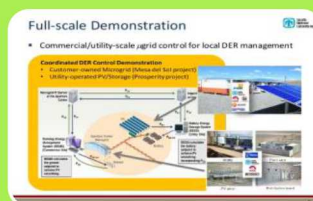- Controls, protection, optimization, mod/sim

Resilient Networking
- Cyber-secure comm. and control systems
- Data encoding and compression, access controls, intrusion detection

Decision Support
- Autonomous control systems
- Data extraction and machine learning

Deployment
- Demonstrations at MdS and SWTDI

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