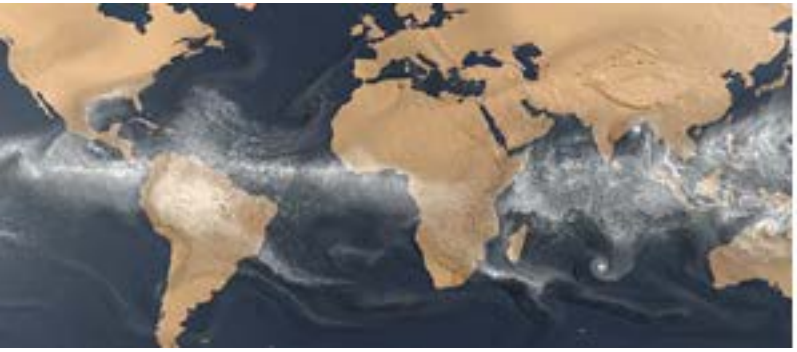
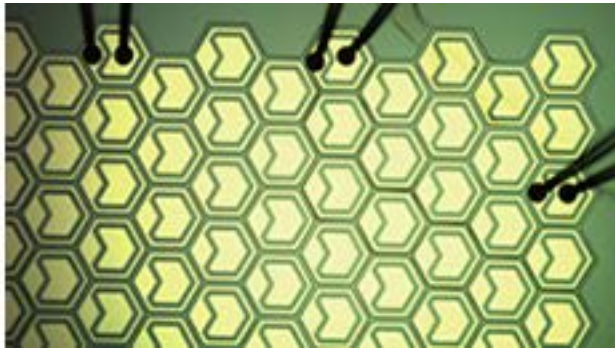
SAND2016-4407C

*Exceptional service in the national interest*

Sandia National Laboratories

energy.sandia.gov





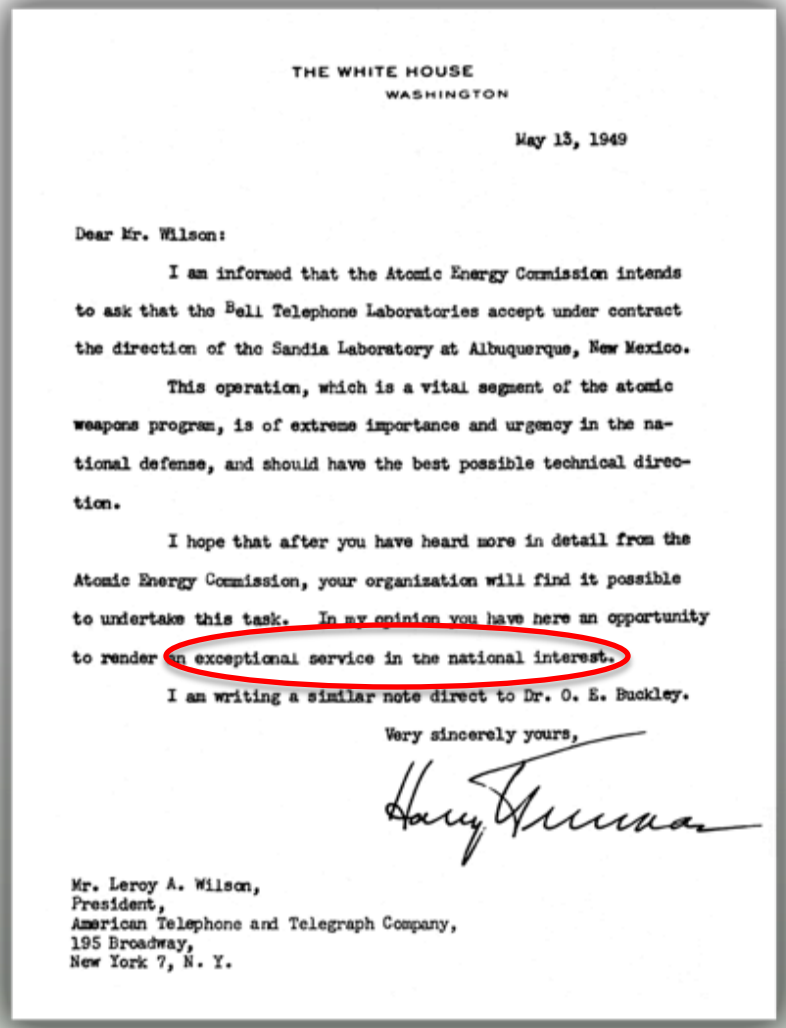
# Introduction to Sandia and Overview

Carol Adkins
Director, Energy Technologies & System Solutions Center
May 10, 2016

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND2016-0090 PE

# Sandia's History



THE WHITE HOUSE
WASHINGTON

May 13, 1949

Dear Mr. Wilson:

I am informed that the Atomic Energy Commission intends to ask that the Bell Telephone Laboratories accept under contract the direction of the Sandia Laboratory at Albuquerque, New Mexico.

This operation, which is a vital segment of the atomic weapons program, is of extreme importance and urgency in the national defense, and should have the best possible technical direction.

I hope that after you have heard more in detail from the Atomic Energy Commission, your organization will find it possible to undertake this task. In my opinion you have here an opportunity to render an exceptional service in the national interest.

I am writing a similar note direct to Dr. O. E. Buckley.

Very sincerely yours,

Harry Truman

Mr. Leroy A. Wilson,
President,
American Telephone and Telegraph Company,
195 Broadway,
New York 7, N. Y.



Sandia National Laboratories


# Sandia Addresses National Security Challenges

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| 1950s | 1960s | 1970s | 1980s | 1990s | 2000s | 2010s |
|---|---|---|---|---|---|---|
| Nuclear weapons | Development engineering | Multiprogram laboratory | Missile defense work | Post–Cold War transition | START<br>Post 9/11 | LEPs<br>Cyber, biosecurity proliferation |
| Production and manufacturing engineering | Vietnam conflict | Energy crisis | Cold War | Stockpile stewardship | National security | Evolving national security challenges |

# History of Sandia Energy Programs

**1970**

- Energy crisis of the 1970s spawned the beginning of significant energy work
- Strategic Petroleum Reserve
- Vertical-axis Wind Turbine

**1980**

- Combustion Research Facility (CRF) opens to researchers
- Solar Tower opens
- NRC cask certification studies & core melt studies
- Distributed Energy Technology Laboratory (DETL)

**1990**

- DOE's Tech Transfer Initiative established by Congress in 1991
- MELCOR code released

**2000**

- Energy Policy Act of 2005
- Power grid reliability study
- SunCatcher™ & Stirling Energy Systems

**2010**

- CRF & Cummins partnership
- Joint BioEnergy Institute
- Sunshine to Petrol Pilot Test
- Large-scale pool fire tests of liquefied natural gas (LNG) on water
- Climate study uncertainties to economies
- Consortium for Advanced Simulation of Light Water Reactors (CASL)
- Combustion Research Computation and Visualization (CRCV) opens

**2011**

- Water Power Program

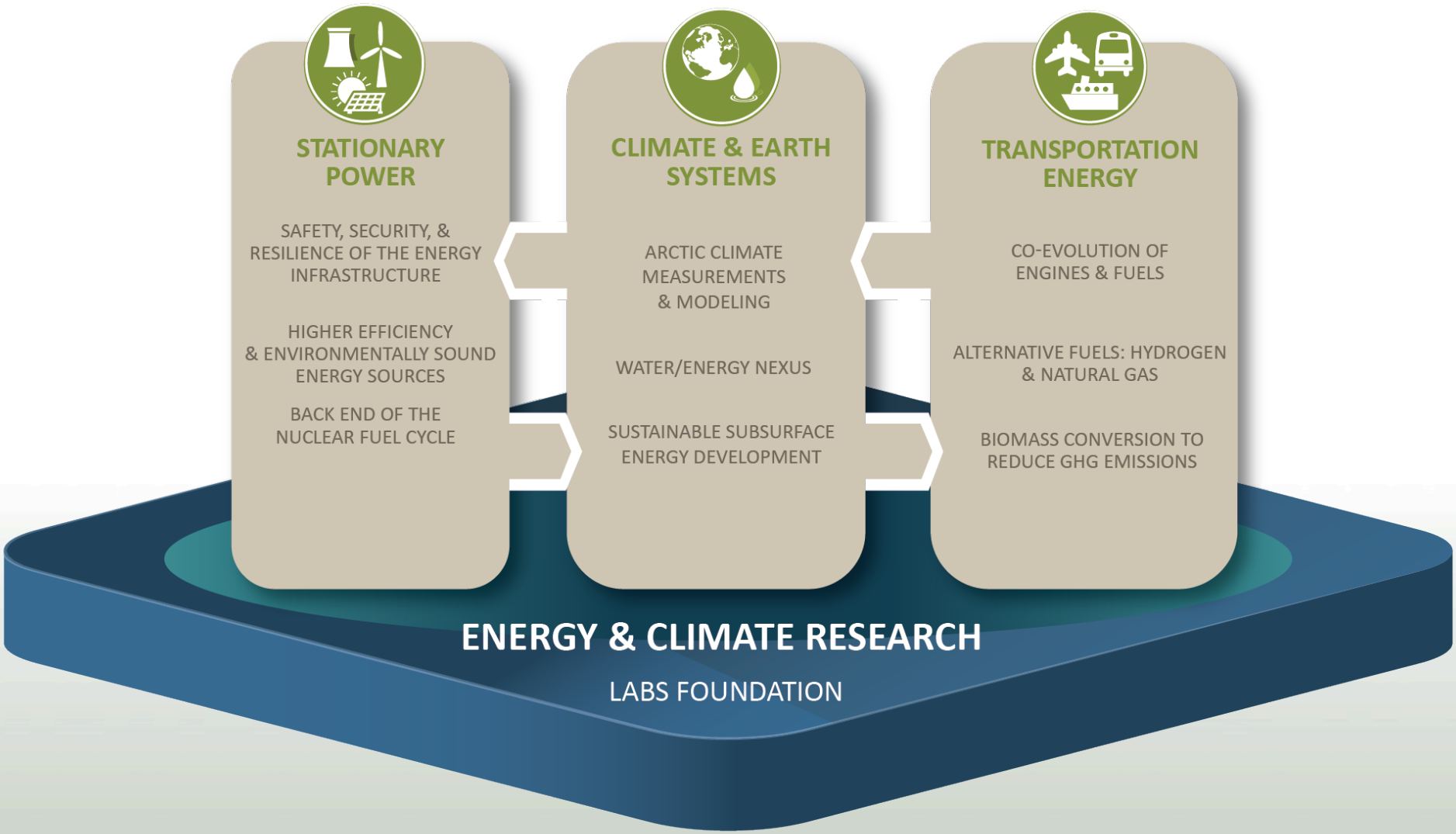
**2012**

- MEPV
- Criegee combustion intermediates
- PV Regional Test Centers (RTCs)
- Sandia Cooler
- CREW published
- Fukushima Recovery

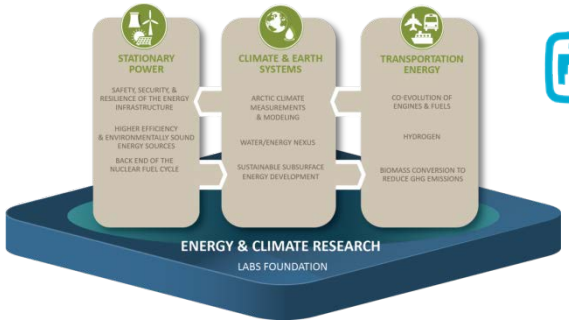
**2013**

- Solar Glare Analysis Tool (SGHAT)
- New diesel low-temp combustion model
- Biofuels: ionic liquid pretreatment
- Electricity Storage Handbook
- AMII increases US wind blade manufacturing

# Sandia's Energy Strategy



# Stationary Power




Sandia National Laboratories

## Safety, Security & Resilience of the Energy Infrastructure

Protect energy systems through R&D advances in cyber and physical security and resiliency

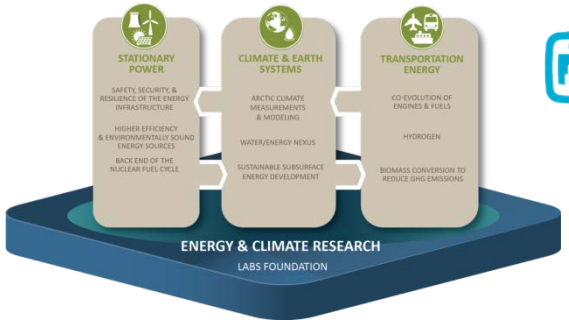

## Higher Efficiency & Environmentally Sound Energy Sources

Advance the next generation of energy technologies

## Back End of the Nuclear Fuel Cycle

Develop effective radioactive waste solutions across transportation, storage, and disposal

# Climate & Earth Systems

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## Arctic Climate Measurements & Modeling

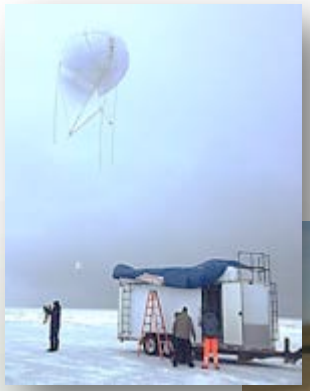
Measure and understand Arctic phenomena using Sandia's capabilities

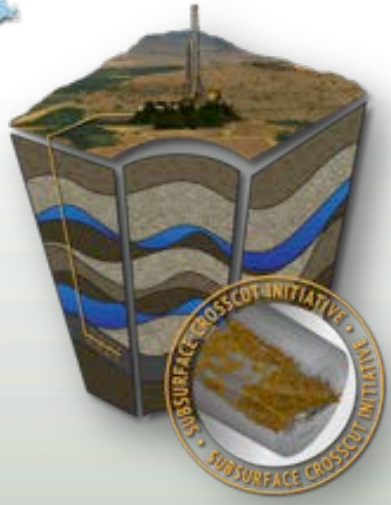
## Water/Energy Nexus

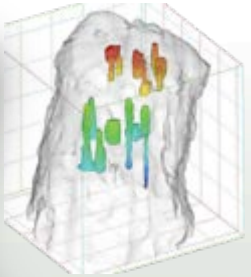
Develop unique solutions for water-energy challenges in the Southwest and Southern Rocky Mountains

## Sustainable Subsurface Energy Development

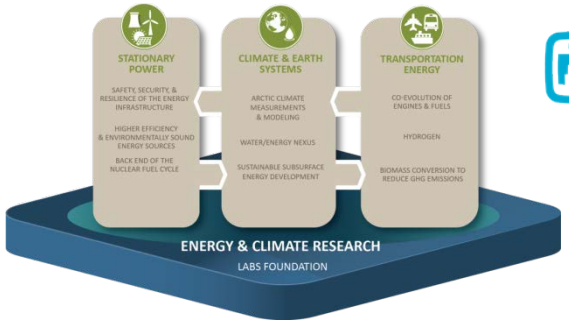
Solve subsurface energy challenges by collaborating with other labs to connect geoscience and engineering





# Transportation Energy

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## Co-evolution of Engines & Fuels

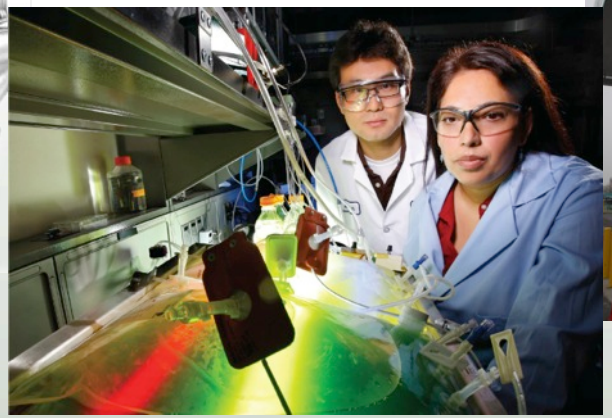
Support the development and deployment of new fuels and engines to reduce GHG emissions

## Biomass Conversion to Reduce GHG Emissions

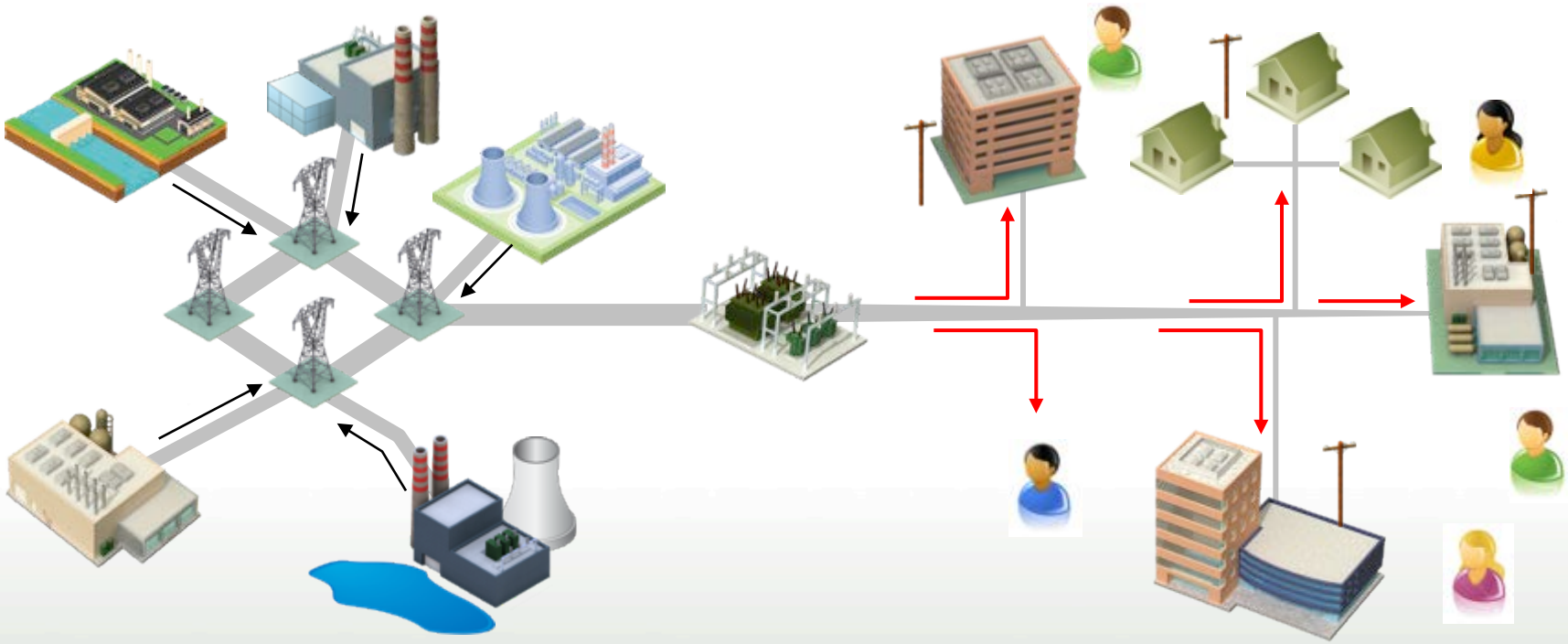
Improve the economics of biomass conversion to produce renewable biofuels and other products to reduce GHG emissions

## Alternative Fuels: Hydrogen and Natural Gas

Leverage SNL's expertise to develop hydrogen-fuel approaches and improve efficiency of natural gas engines



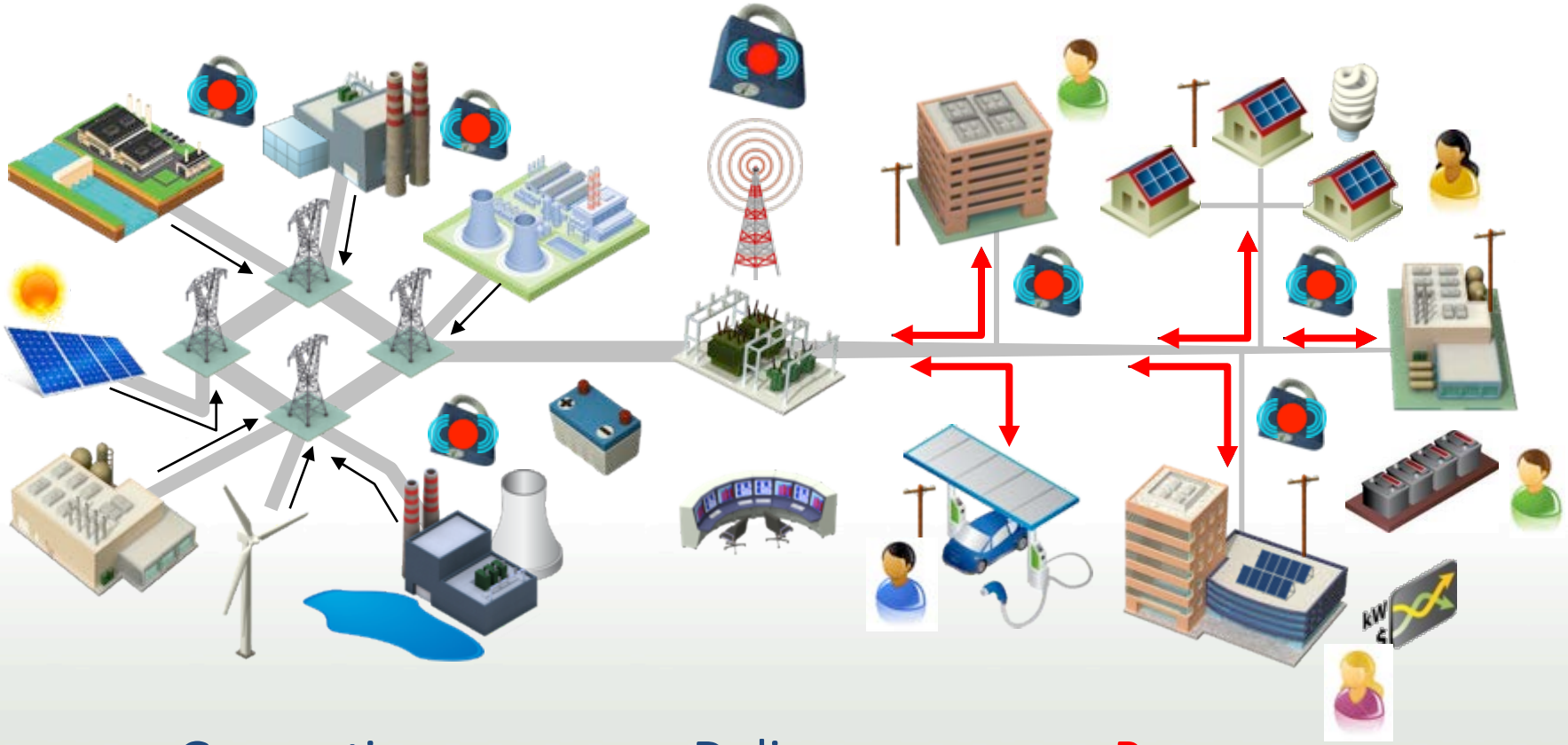
# The Grid of the Past



Generation Delivery Customer

**Source: EPRI, 2009**

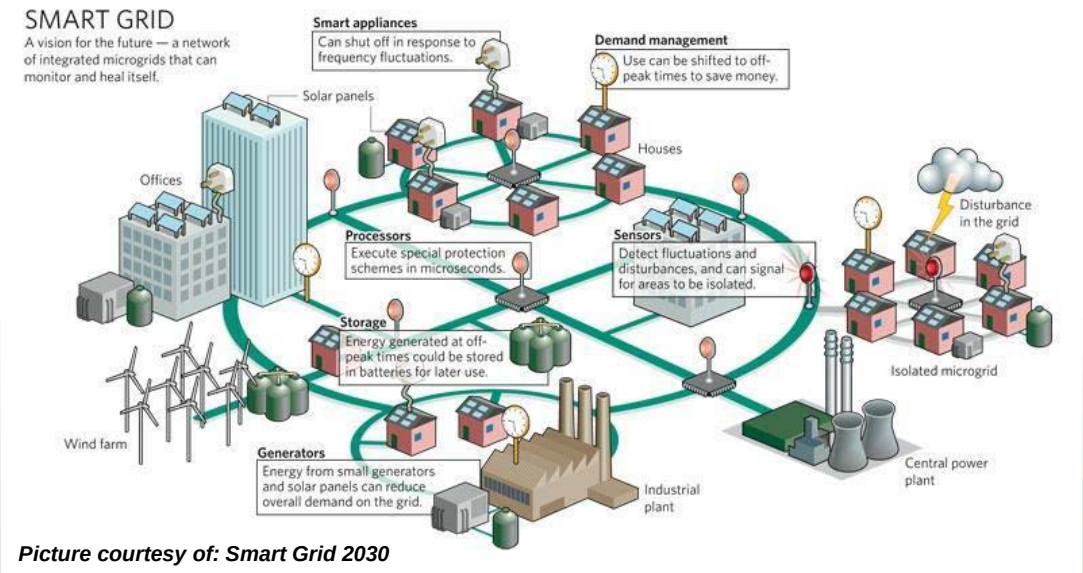
# The Grid of the Future




**Source: EPRI, 2009**

# Sandia's Grid Modernization Vision

A world of interdependent and variable distributed systems that are optimized at multiple scales – including transmission – to maximize local resources in providing secure, resilient, and clean energy to all users at all times.

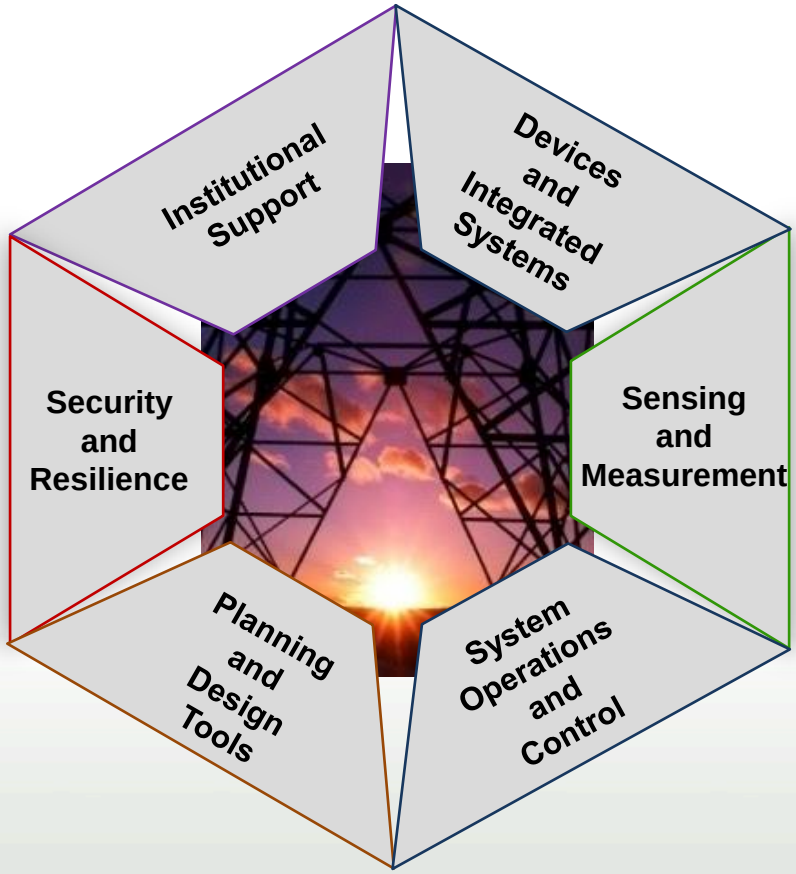


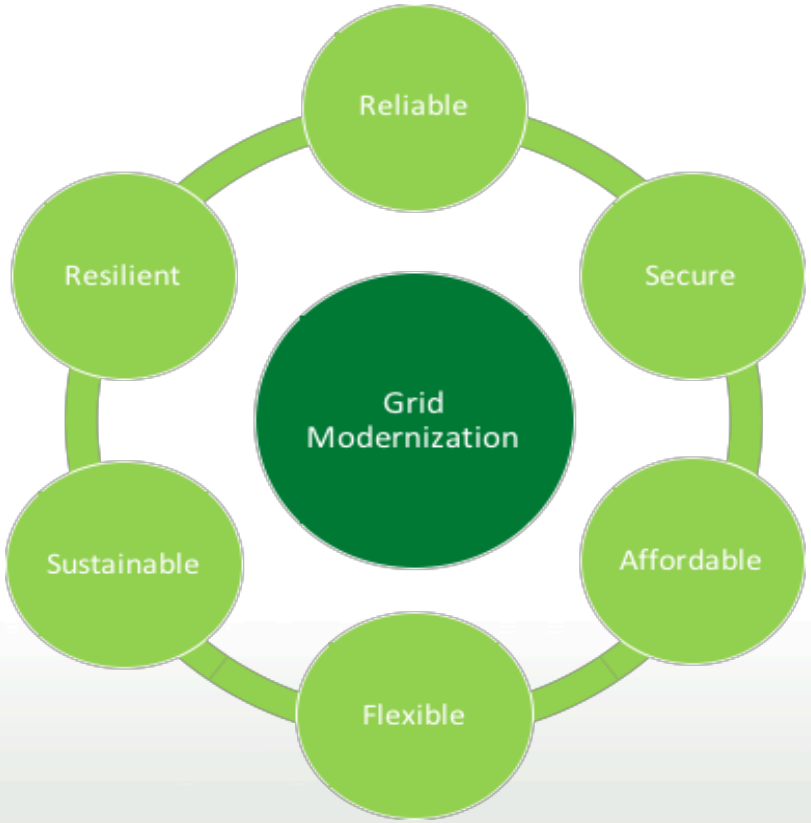

***Picture courtesy of: Smart Grid 2030***

*Our capabilities support this vision:*

- DER and renewable energy integration
- Power electronics and controls
- Secure and scalable microgrids
- Advanced grid analytics/complex systems
- Infrastructure interdependencies
- Cyber and physical security
- Embedded sensors, information processing, and secure manufacturing
- Energy storage systems

# DOE's Grid Modernization Lab Consortium …



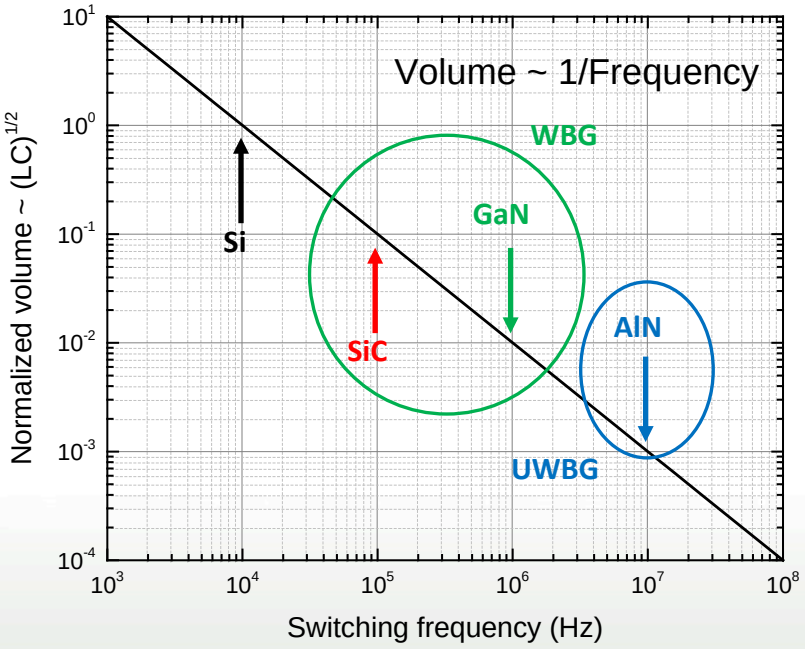

**Contributing to all 6 GMLC core teams**
**Leading 6 new projects**
**Supporting 29 projects total**

**Leading the application of resilience metrics**

*http://energy.gov/doe-grid-modernization-laboratory-consortium-gmlc-awards*

# Power Electronics for the Future … Dramatic Reduction in Power Converter Volume with Increasing Bandgap


SiC is 10% the volume and weight of Si for equivalent capability (10 kV, 100 A)




***UWBG power electronics may result in another order-of-magnitude SWaP improvement compared to WBG devices***

# A New Class of Power Electronics, Based on Materials and Device Science Foundations

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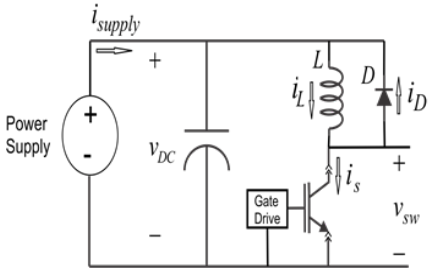
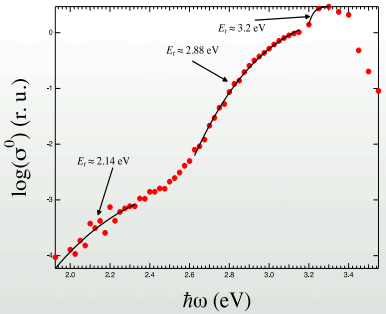
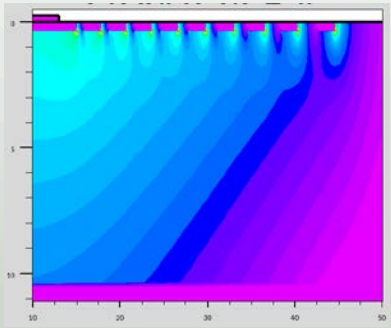


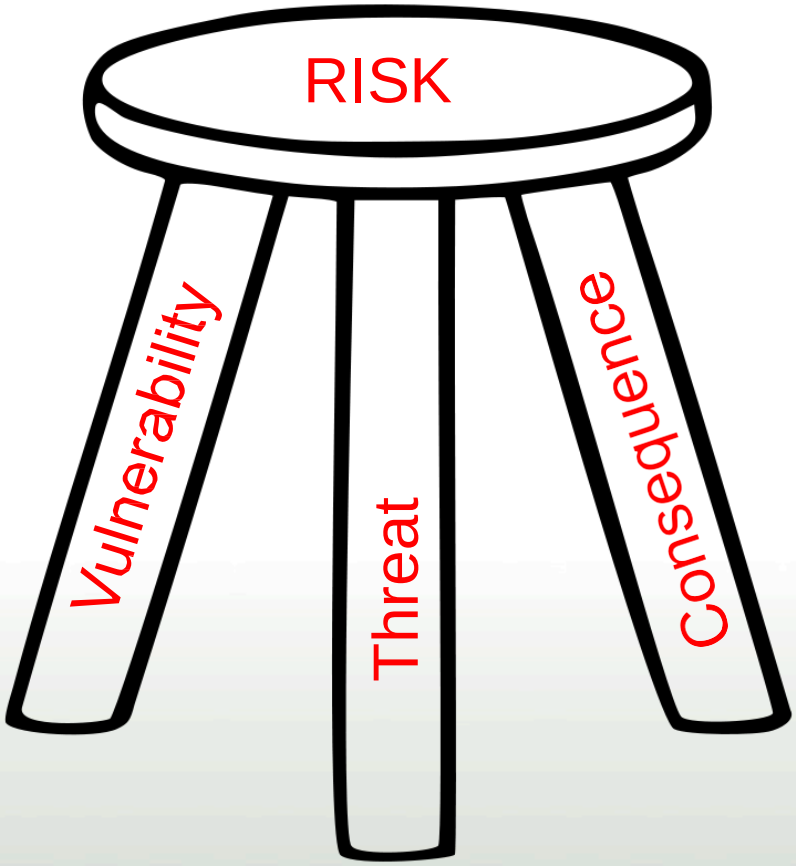









# Resilience: A Risk-Based Approach




Probability of Consequences =

f(vulnerability, threat)

# Resilience versus Reliability

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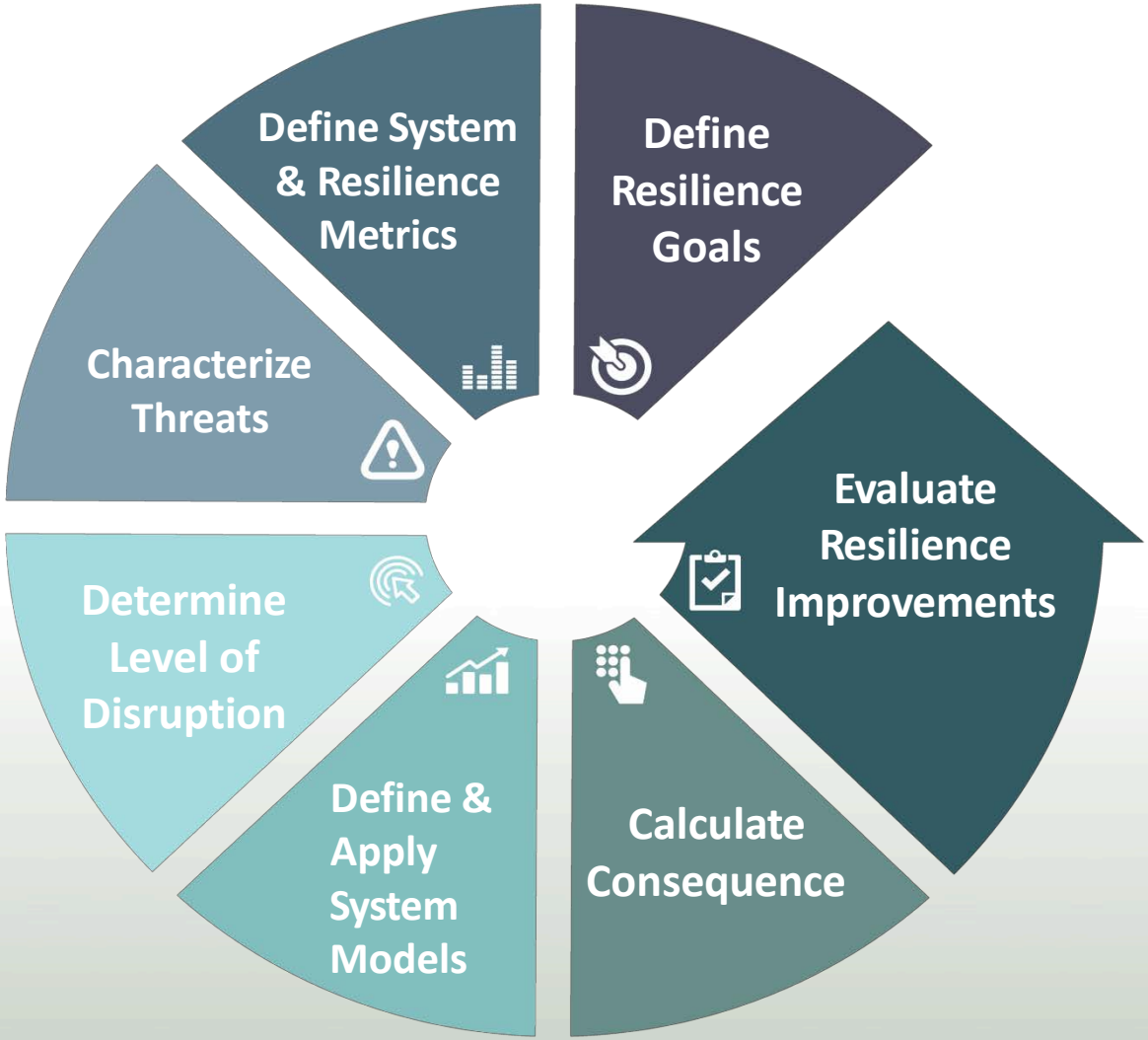
## *Differentiating reliability and resilience is important*

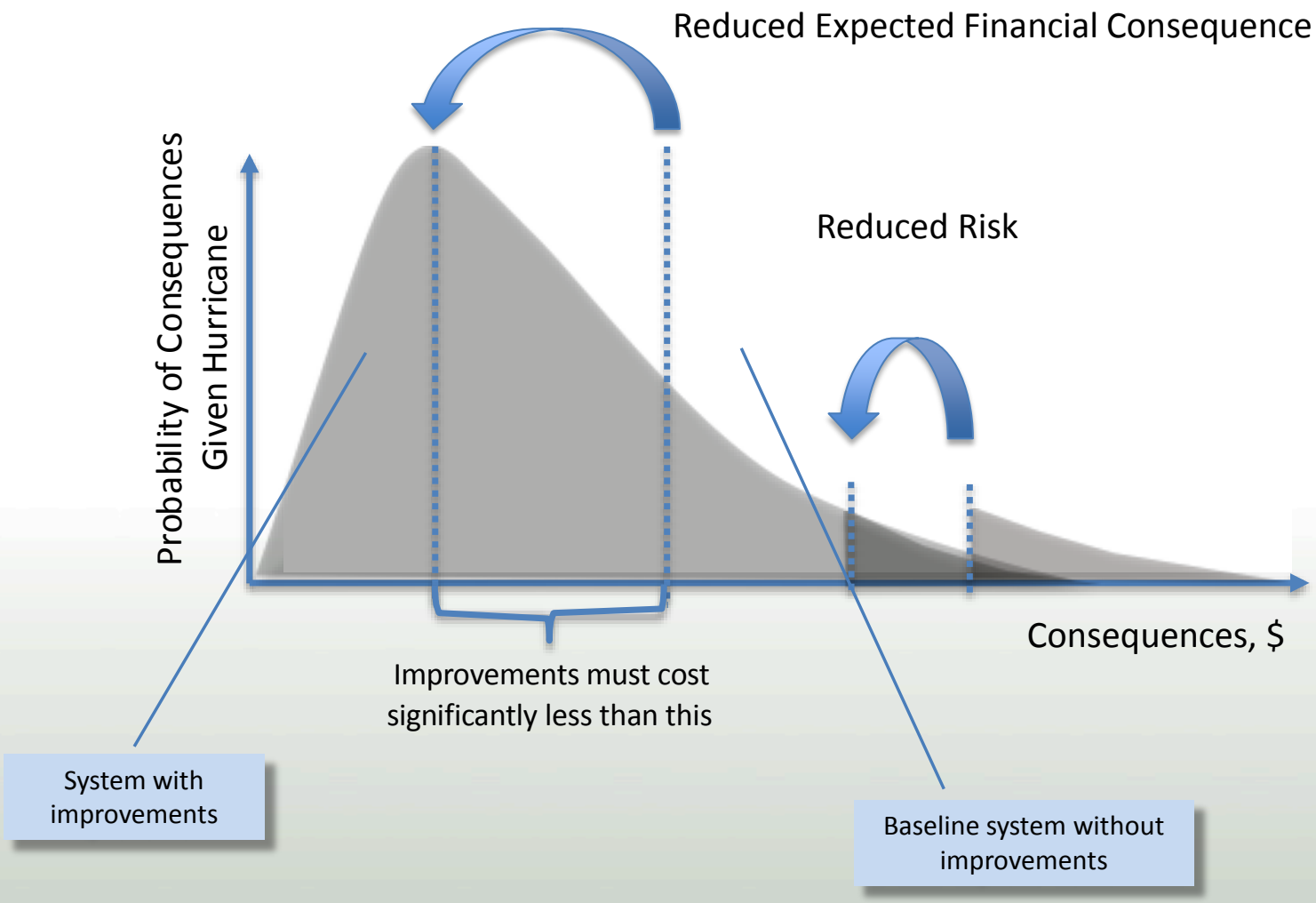
- Reliability is compulsory
- Reliability is related to rate recovery
- Adoption of resilience metrics will be easier if reliability definitions remain as-is

| Reliability | Resilience |
|---|---|
| High Probability, Low Consequence (SAIDI/SAIFI exclude storm data) | Low Probability, High Consequence |
| Not risk based | Risk Based, includes:<br>Threat (you are resilient to something)<br>System Vulnerability (~reliability)<br>Consequence (beyond the system) |
| Operationally, You are reliable, or you are not [0 1]. Confidence is unspecified | Resilience is a continuum, confidence is specified |
| Focus is on the measuring impact to the system | Focus is on measuring impact to humans |

# Resilience Analysis Process (RAP)



# Evaluating Resilience Improvements



# Application of Sandia Resilience Methods to the City of Norfolk, VA

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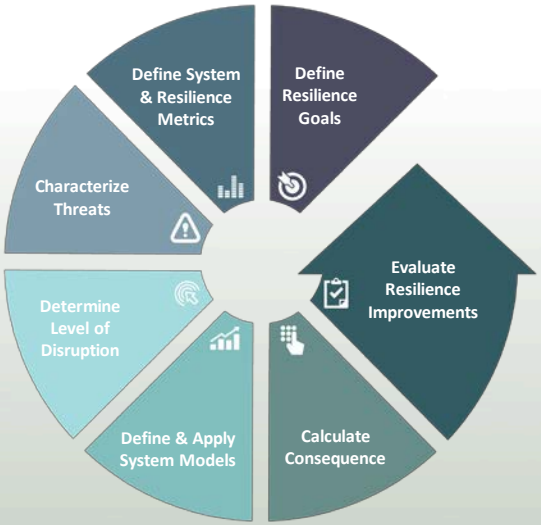
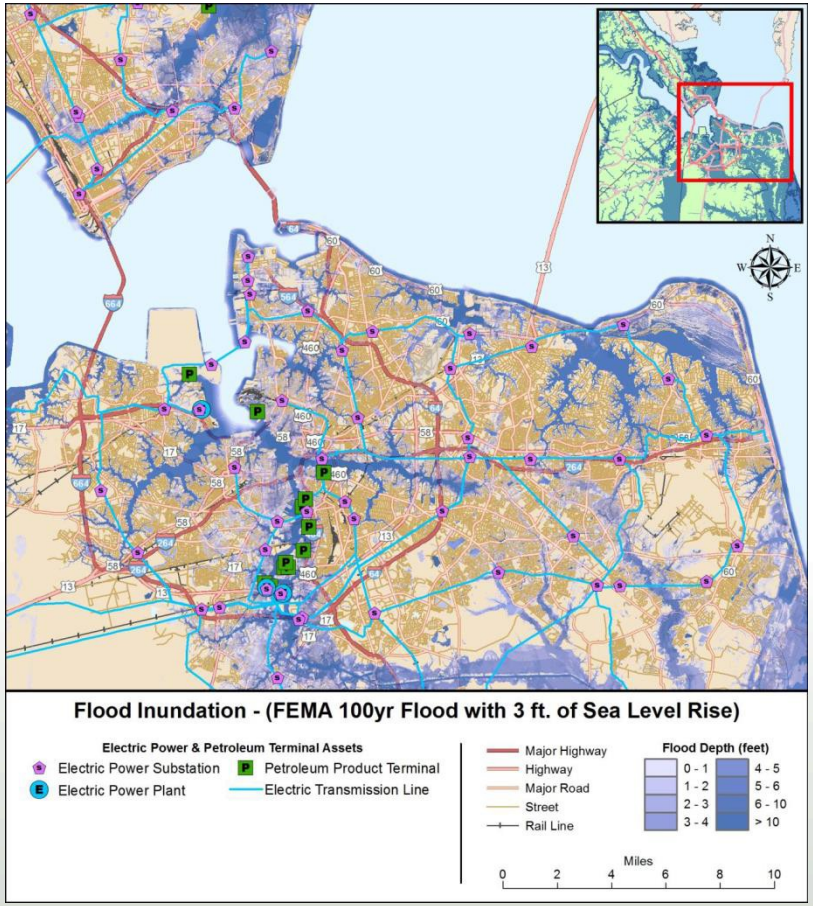
- Design Basis Threat (DBT): 100 Year Flood +0ft, +1.5ft, +3ft
- Scope: power, fuel, communications and transportation systems
- Applied analysis principles to identify and compare resilience enhancement options



# Examples of Sandia's impact

*Core, dynamic, and rapid response*

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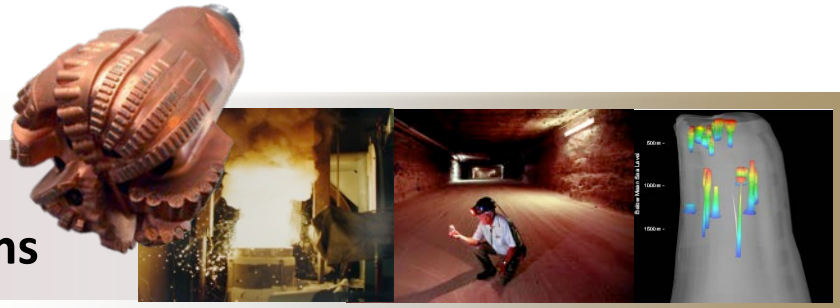
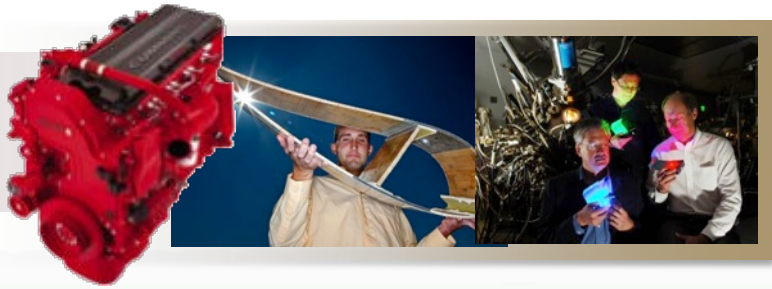


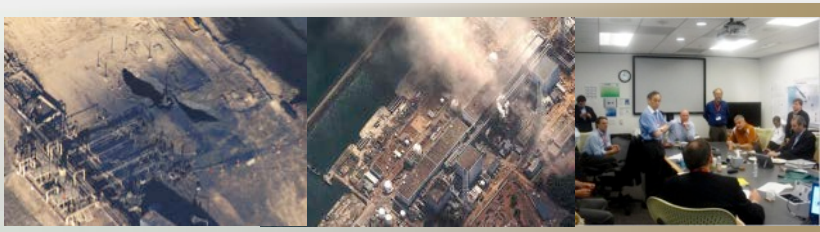
**Core: Long term research that solves the nation's immense problems**

- Drilling technologies, nuclear reactor safety, nuclear waste disposal, and Strategic Petroleum Reserve



**Dynamic: Addressing current national Needs on a 5-10 year timeframe**

- Efficient engines, wind energy, and solid-state lighting



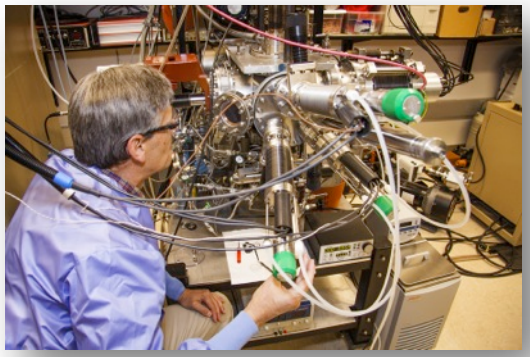
**Rapid Response: Quick mobilization of expertise for urgent national needs**

- Aliso Canyon, Fukushima, and Deepwater Horizon

# Partnerships

Sandia National Laboratories

***"… because the DOE neither manufactures nor sells commercial-scale energy technologies, our work must be relevant to the private sector, which is the agent of deployment." – DOE QTR***

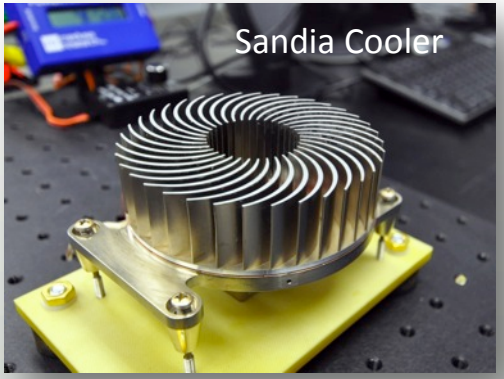


Joint Center for Energy Storage Research (JCESR) public private partnership

Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) multi-agency project being conducted under a MOU between the DOE and DoD

Scaled Wind Farm Technology (SWiFT) Facility


Hydrogen Fueling Infrastructure Research and Station Technology (H2FIRST)




United Technologies Research Center

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