



**Office of Electricity
Delivery & Energy
Reliability**



Workshop and TRAC Program Overview

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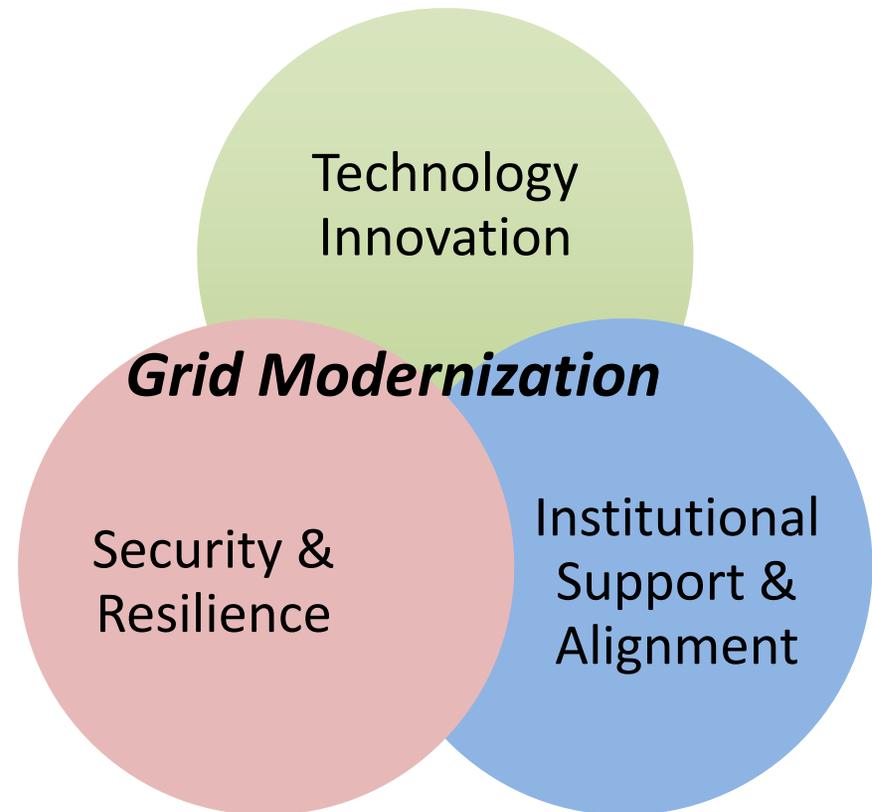
August 17-18, 2016



OE Mission

The Office of Electricity Delivery and Energy Reliability (OE) drives electric grid modernization and resiliency in the energy infrastructure.

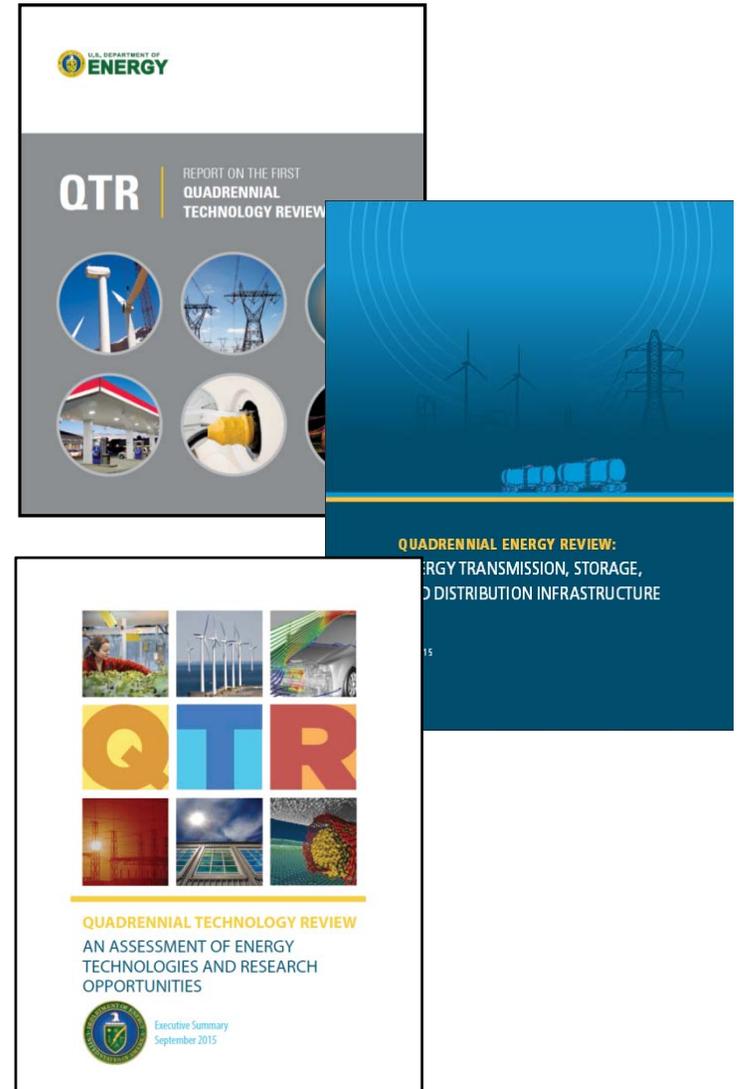
- OE leads the Department of Energy's efforts to ensure a resilient, reliable, and flexible electricity system.
- OE serves as the Energy Sector Specific lead for the Federal emergency response when activated by DHS/FEMA.





DOE Quadrennial Reviews

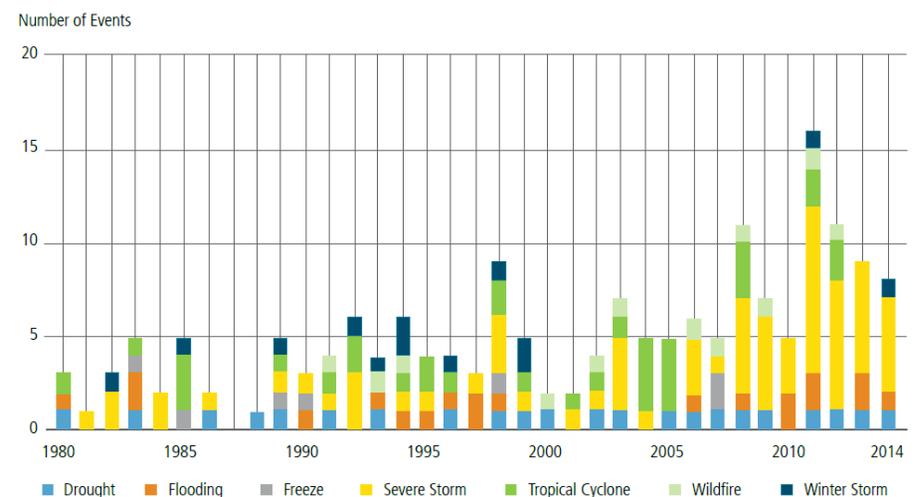
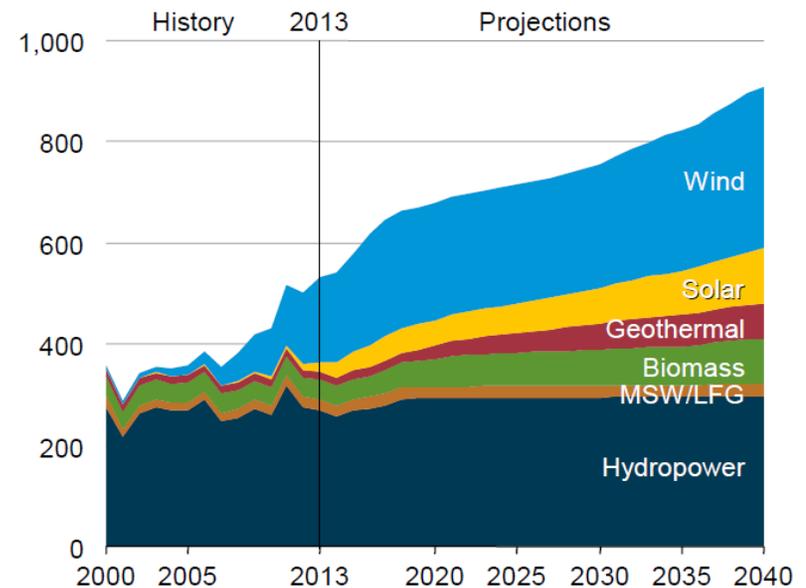
- The President’s Council of Advisors on Science and Technology (PCAST) recommended an integrated federal energy policy (11/2010)
- The Quadrennial Energy Review (QER) was called for by the President on January 9, 2014
 - **Volume 1 released on April 21, 2015**
 - **Focused on energy infrastructure (TS&D)**
 - **Volume 2 focuses on end-to-end electricity**
- A review of DOE’s work on energy technology innovation—the Quadrennial Technology Review (QTR)—is a parallel effort.
 - **First QTR published in September 2011**
 - **2015 QTR released in September 2015**





Power System Trends

- Changing Generation Mix
 - More variable renewables and natural gas installations
 - Coal and nuclear retirements
- Evolving Customer
 - More DER, efficiency, and EVs
 - More connectivity and engagement (prosumer)
- Increasing Risks
 - More frequent and severe extreme weather events
 - Cyber and physical attacks
 - Aging infrastructure
 - Complexity and interdependency



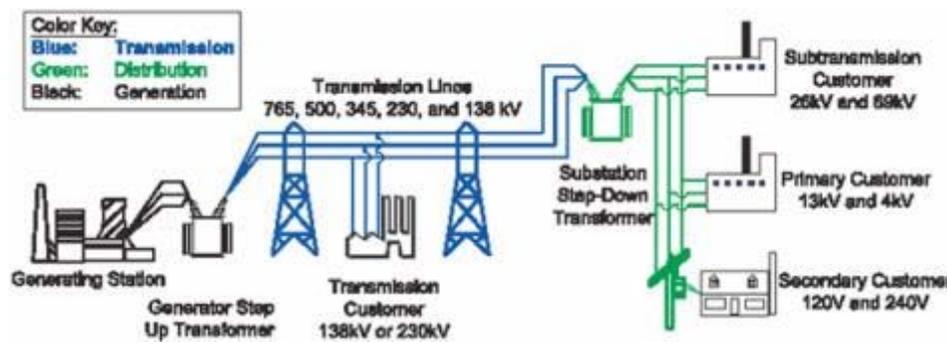
Costly weather-related disasters have been increasing in frequency over the past decade.



Transforming the Grid

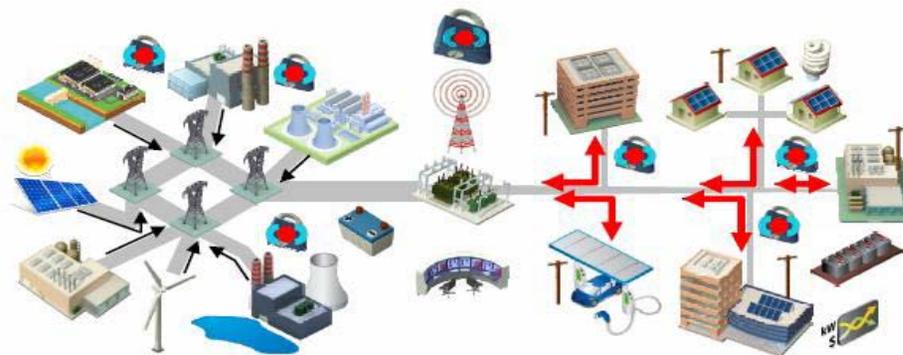
Current System

- Monolithic
- Centralized generation
- Decisions driven by cost
- Catastrophic events
- Limited energy choices
- Vulnerable to new threats



Future Paradigm

- Modular and Agile
- Centralized and distributed generation
- Decisions driven by cost and environmental sustainability
- Contained events
- Personalized energy options
- Inherently secure to all threats

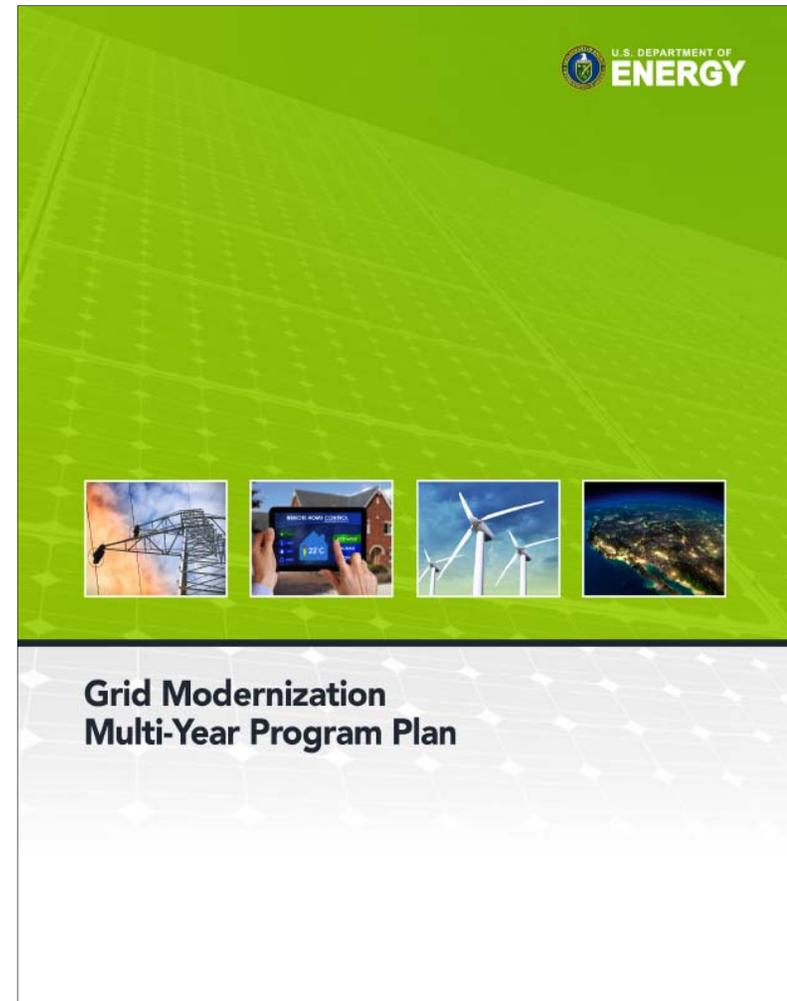




Grid Modernization Initiative

The vision of DOE's Grid Modernization Initiative (GMI) is:

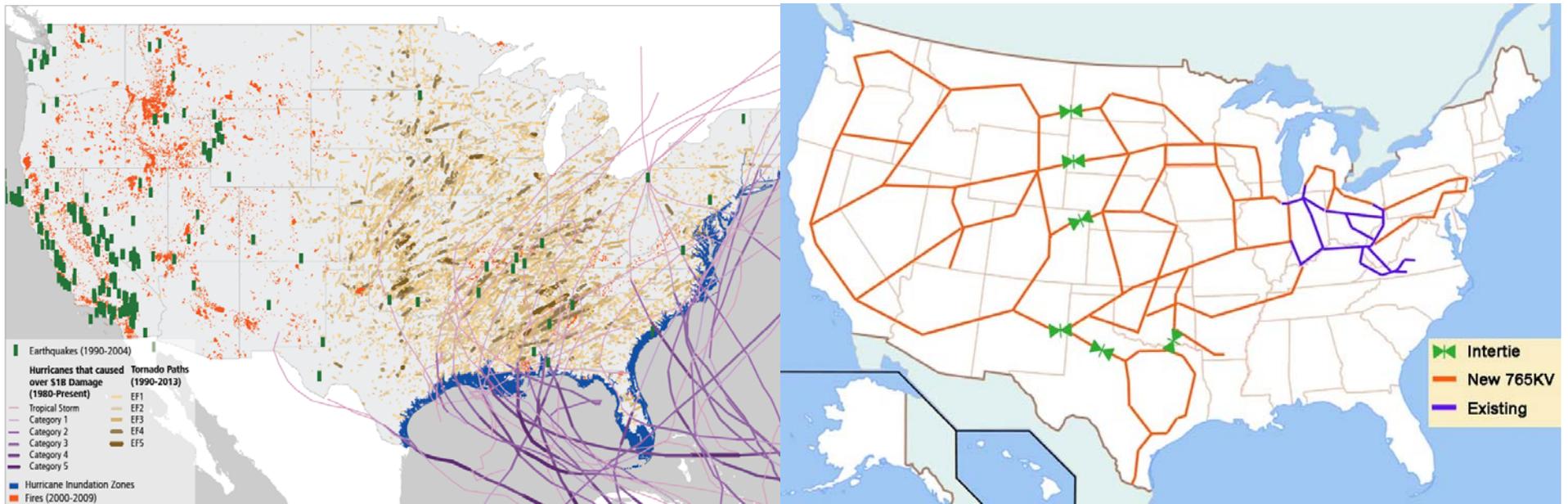
- A future grid that will solve the challenges of seamlessly integrating conventional and renewable sources, storage, and central and distributed generation.
- The future grid as a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy.
- A future grid that will deliver **resilient, reliable, flexible, secure, sustainable,** and **affordable** electricity to consumers where they want it, when they want it, how they want it.





TRAC Program

- Transformer Resilience Advanced Components
 - Ensure the resilience of aging assets and identify new requirements for future grid components (**Near-Term Focus**)
 - Accelerate the development, demonstration, and deployment of next-generation components (**Long-Term Focus**)

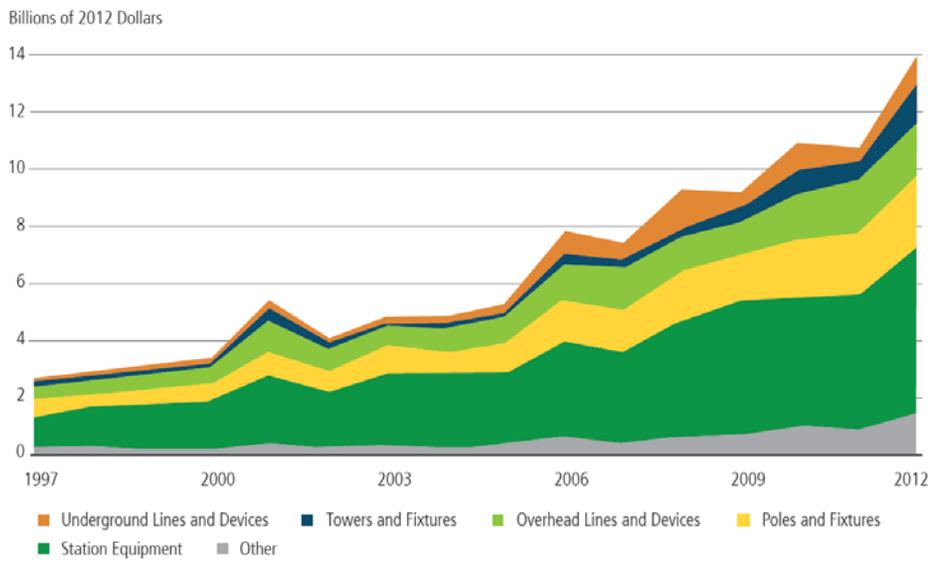




Program Motivation

- Much of grid modernization to date focused on applying advanced digital ICT to improve the system's performance (i.e., the "smart grid")
- Advances in grid hardware are needed to achieve the full value of grid modernization by providing new capabilities required
- The timing is ripe to deploy next-generation hardware and avoid "lock-in" with outdated technologies that are long-lived and expensive

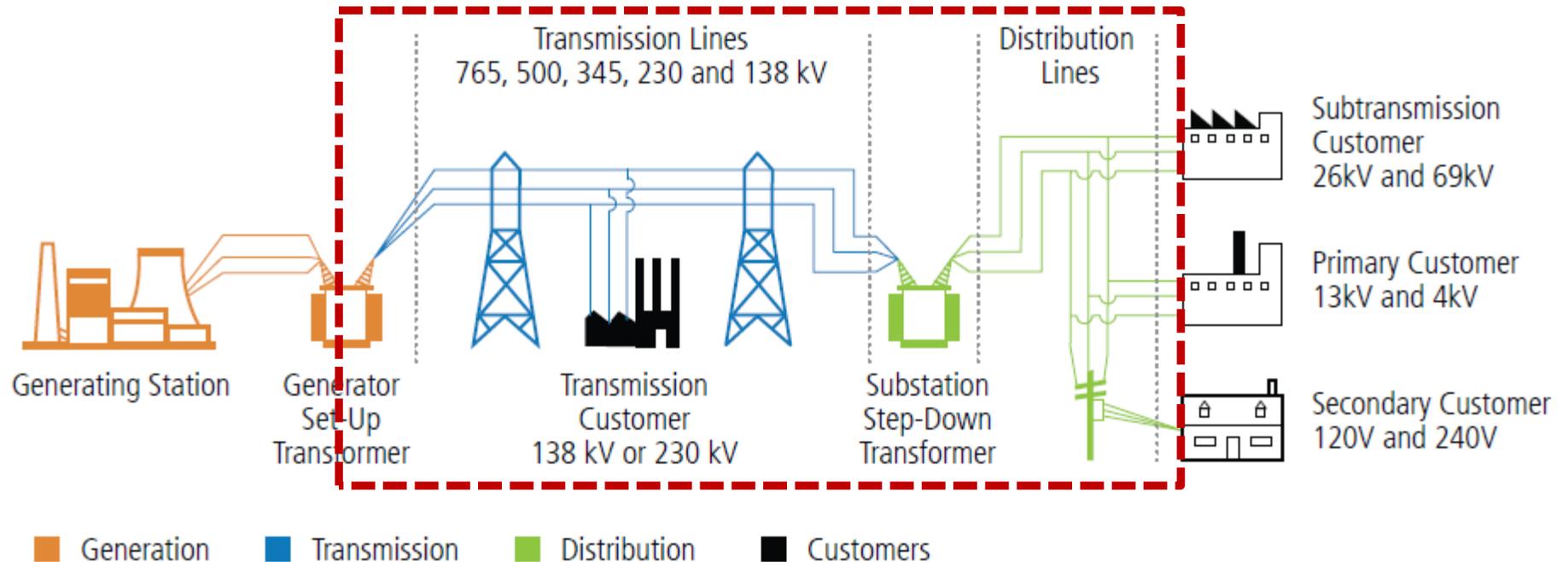
Figure SPM-5. Investment in Transmission Infrastructure by Investor-Owned Utilities, 1997–2012





Program Scope

Figure 3-1. The Electric Grid¹



- Transmission and distribution components, the hardware responsible for carrying and controlling electric power, are the primary focus.
- Generators (e.g., inverters), loads, SCADA systems, communication systems, and energy storage are **not included**; however, their evolution and impact on T&D components is considered.

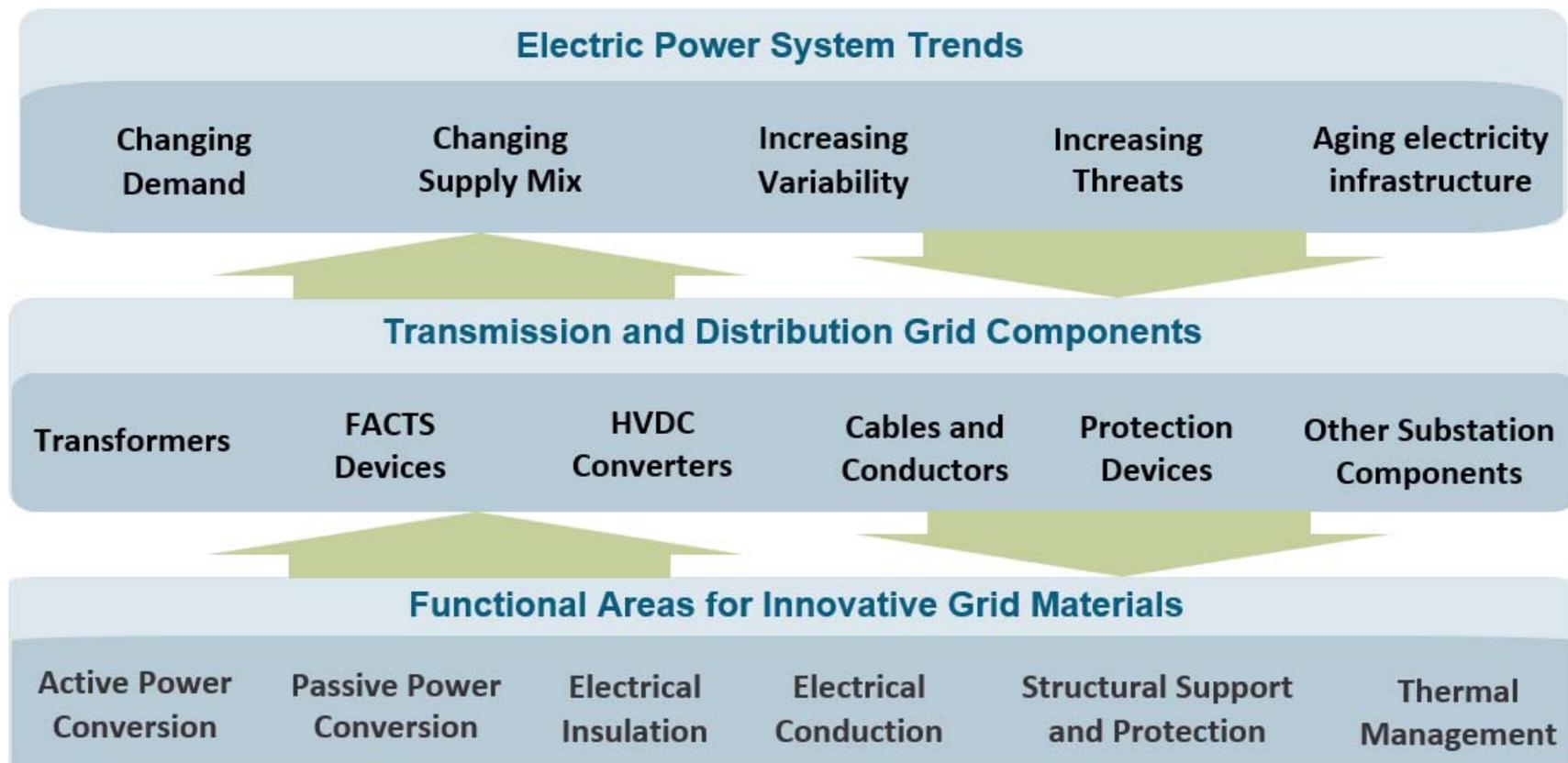


Program Portfolio

- **Component Monitoring, Modeling, and Testing**
 - Improve the monitoring capabilities and modeling of grid components to improve asset management, enhance system operation and resilience, and identify new component requirements
- **Market and System Impact Analysis**
 - Conduct system modeling and techno-economic analyses to improve the understanding of the barriers, cost, benefits, and impacts of deploying next-generation components
- **Applied Materials Research and Innovation**
 - Conduct R&D to accelerate fundamental materials innovations into products that can be utilized in current and future grid components
- **Component Design and Development**
 - Conduct RD&D of next-generation grid components including design, prototyping, system-scale up, and field demonstration



Materials Innovation Workshop



- Nanocomposite soft magnetics; super-hydrophobic materials and coatings
- Metal hydride alloys; heat-pipes with decoupled electrical and thermal properties
- Room temperature superconductors; ballistic carbon nanotube and graphene
- Self-healing ceramics and polymers; structural composites



FY 2016 TRAC Activities

- **GMD and EMP Testing:** Conduct multi-physics modeling and small-scale testing of transformers to improve understanding of failure mechanisms when exposed to GMD/EMP.
- **HVDC Control Analysis:** Explore scenarios and use cases involving HVDC system control strategies that provide artificial inertia to the grid while simultaneously optimizing power flows.
- **Next Generation Transformers – Flexible Designs:** Funding Opportunity Announcement focused on the design of flexible and adaptable LPTs that can be readily used in different substations. The objective is to stimulate innovative designs to promote greater standardization and interchangeability.
 - \$1.5 M FOA issued; 5-7 awards expected
 - Released June 8, 2016
 - Closed July 26, 2016



Workshop Objective & Agenda

- To identify gaps in the landscape of grid T&D components, highlight opportunities for R&D, and outline goals and priorities.
- Inform the development of TRAC’s multi-year program plan.

TIME	DAY1 - ACTIVITIES
9:10 am	Plenary Presentations
10:55 am	Overview of the City of Pittsburgh Microgrid Initiative – Ben Morris
11:15 am	Overview of Grid Components Landscape – Dominic Lee
11:45 am	Lunch
1:15 pm	Breakout Session 1 – Transmission Components R&D Gaps
3:15 pm	Breakout Session 2 – Distribution Components R&D Gaps
5:15 pm	Report Out
TIME	DAY2 - ACTIVITIES
8:30 am	Breakout Session 3 – T&D Priorities and Goals
10:15 am	Crosscutting Discussion
11:15 am	Optional Tour



Plenary Panelists

- **Steve Griffith**, Industry Director (NEMA)
- **Jeff Hildreth**, Electrical Engineer (BPA)
- **Steve Whisenant**, Lead Engineer (Duke Energy)
- **Dale Player**, Manager – Asset Performance (ComEd)
- **Lilian Bruce**, Director – Strategic Planning (EPB)
- **Joe Schatz**, Manager – T&D Research (Southern Co.)
- **Kevin Berent**, Senior Program Manager (EPRI)