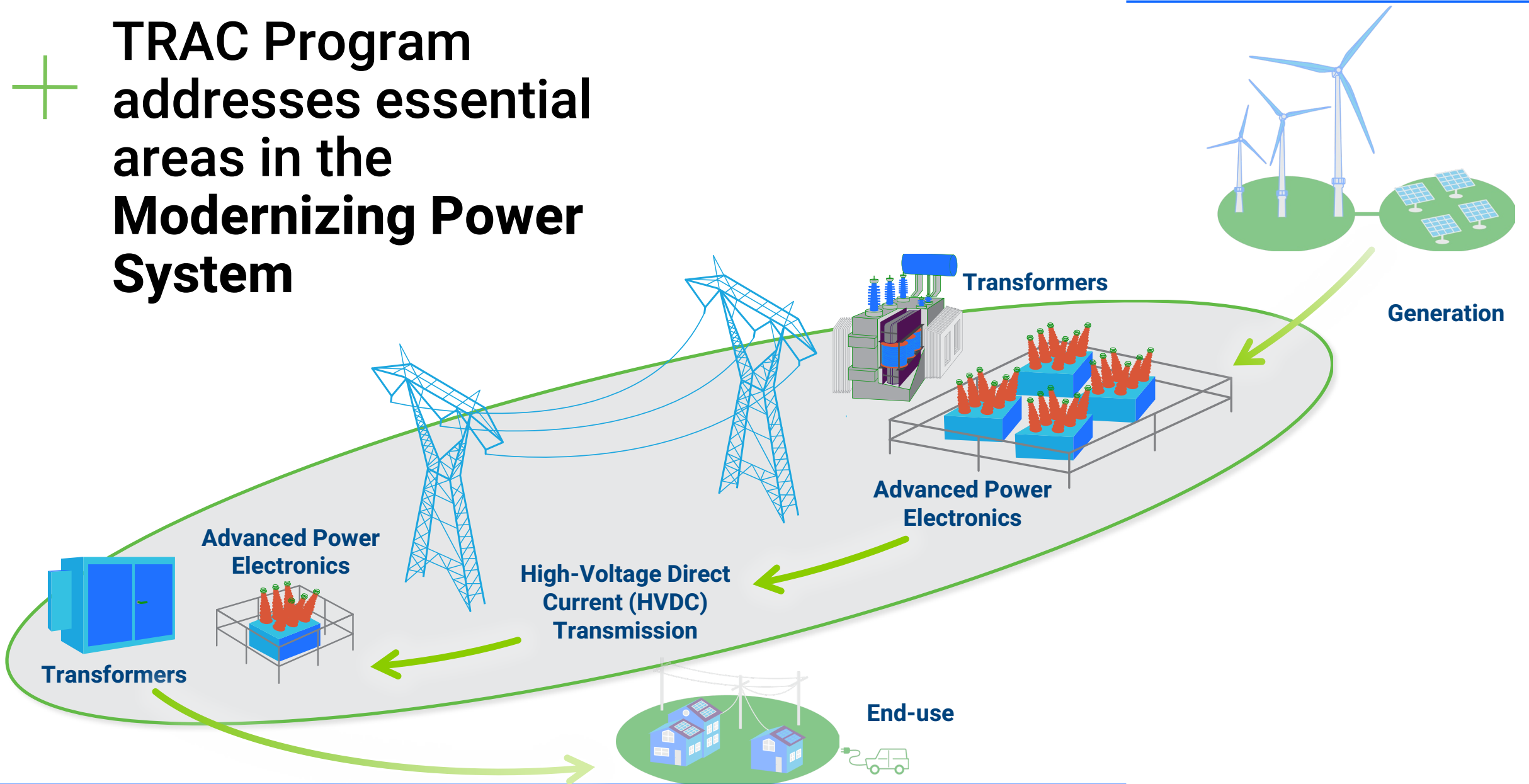


**Transformer Resilience and Advanced Components (TRAC) Program
Peer Review
&
Power Electronics Accelerator Consortium for Electrification (PACE)
Annual Meeting**

Andre Pereira

6/27/23

+ TRAC Program
addresses essential
areas in the
**Modernizing Power
System**



TRAC Program Strategy Enabling Research to Application

Component Design
and Development

R&D Applications

- Advanced Power Electronics
- High Voltage Direct Current (HVDC)
- Advanced Transformers
- Grid Enhancing Technologies (GETs)
- Switchgear, Breakers, & Protection Equipment

Market and Systems
Analysis

R&D Applications

- HVDC
- SSPS
- Transformers
- GETs
- Conductors

Advanced Materials

R&D Applications

- Semiconductor Devices
- Dielectric Insulators
- Passives: Magnetics & Capacitors
- Cables & Conductors

TRAC Portfolio

TRAC Technology Areas		
Component Design and Development	Market and System Analysis	Advanced Materials
<ul style="list-style-type: none"> + Advanced Low voltage & Medium voltage DC/DC Intelligent Power Stage (IPS) + Modular Solid-State Switch (MS3) + High Voltage, High Power WBG Module Development + SSPS 1.0 Hardware Prototype Development + LPT FOA GA Tech + LPT FOA University of Texas Austin + LPT FOA Nextwatt 	<ul style="list-style-type: none"> + SuperFACTS + Multiport HUB: GMLC + SSPS Hardware in the loop (HIL) validation + SSPS 1.0 node Use case Validation with Smart Universal Power Electronics Regulators (SUPERs) + Solid State Power Substation (SSPS) 1.0 Controller + SSPS Field Demonstration + Scalable Hybrid Large-Scale dc-ac Grid Analysis Methods + MVDC Use Case + Transmission Optimization with Grid Enhancing Technologies (TOGETs) 	<ul style="list-style-type: none"> + Optical Fiber Sensors for Acetylene Detection + Al/Ca Composite Conductor + Soft Magnetics for Power Conversion Applications

27 Projects: 19 presentations , 9 Posters

What is PACE?

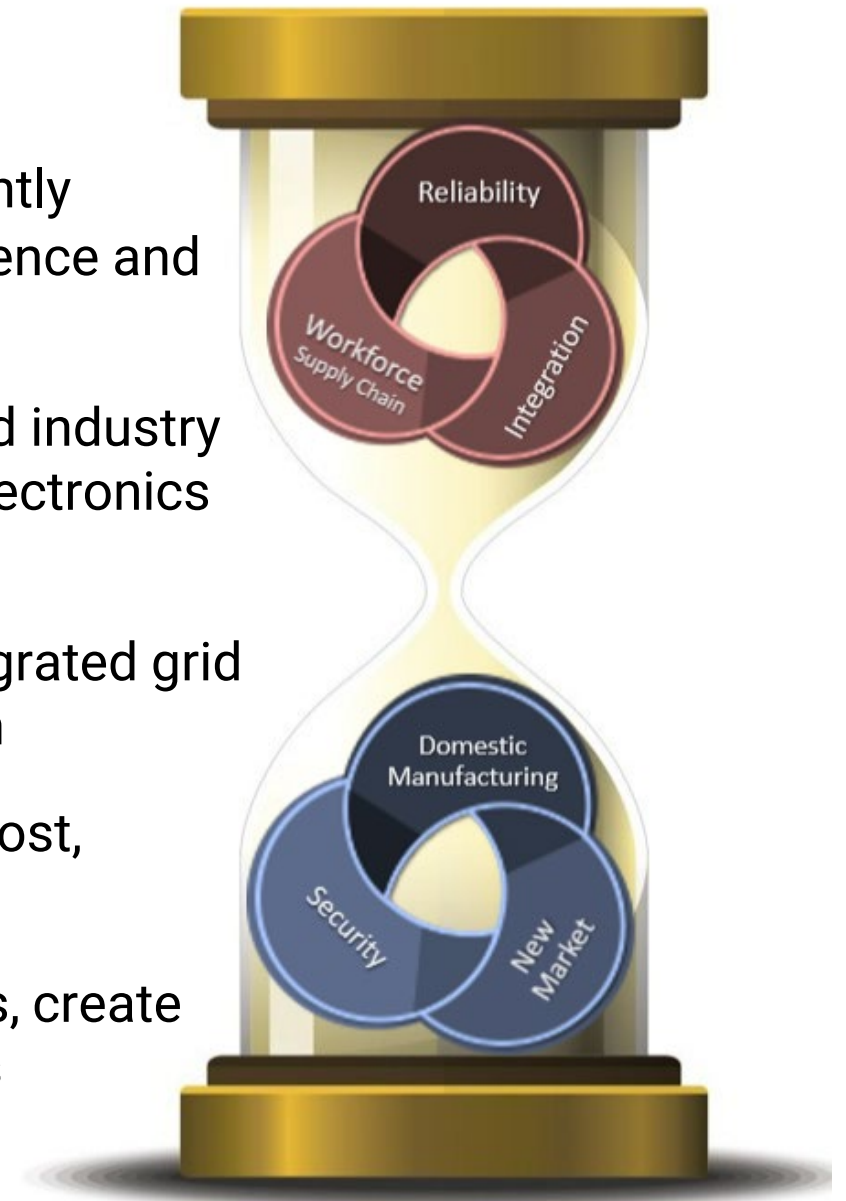
PACE is a U.S. Department of Energy cross-cut initiative, currently supported by the DOE Office of Electricity's Transformer Resilience and Advanced Components (TRAC) program.

PACE is a coalition of partner research institutions, utilities, and industry manufacturers working to take innovative research in power electronics to grid-level pilot demonstration.

Vision: Accelerate the development and demonstration of integrated grid systems with power electronics technologies for electrification

Focus: Solve power electronics and grid hardware barriers of cost, integration, and reliability

Impact: Increase in adoption of power electronics technologies, create domestic manufacturing, and enable new market opportunities



Increasing role and Opportunities for power electronics

+ **Interfacing**

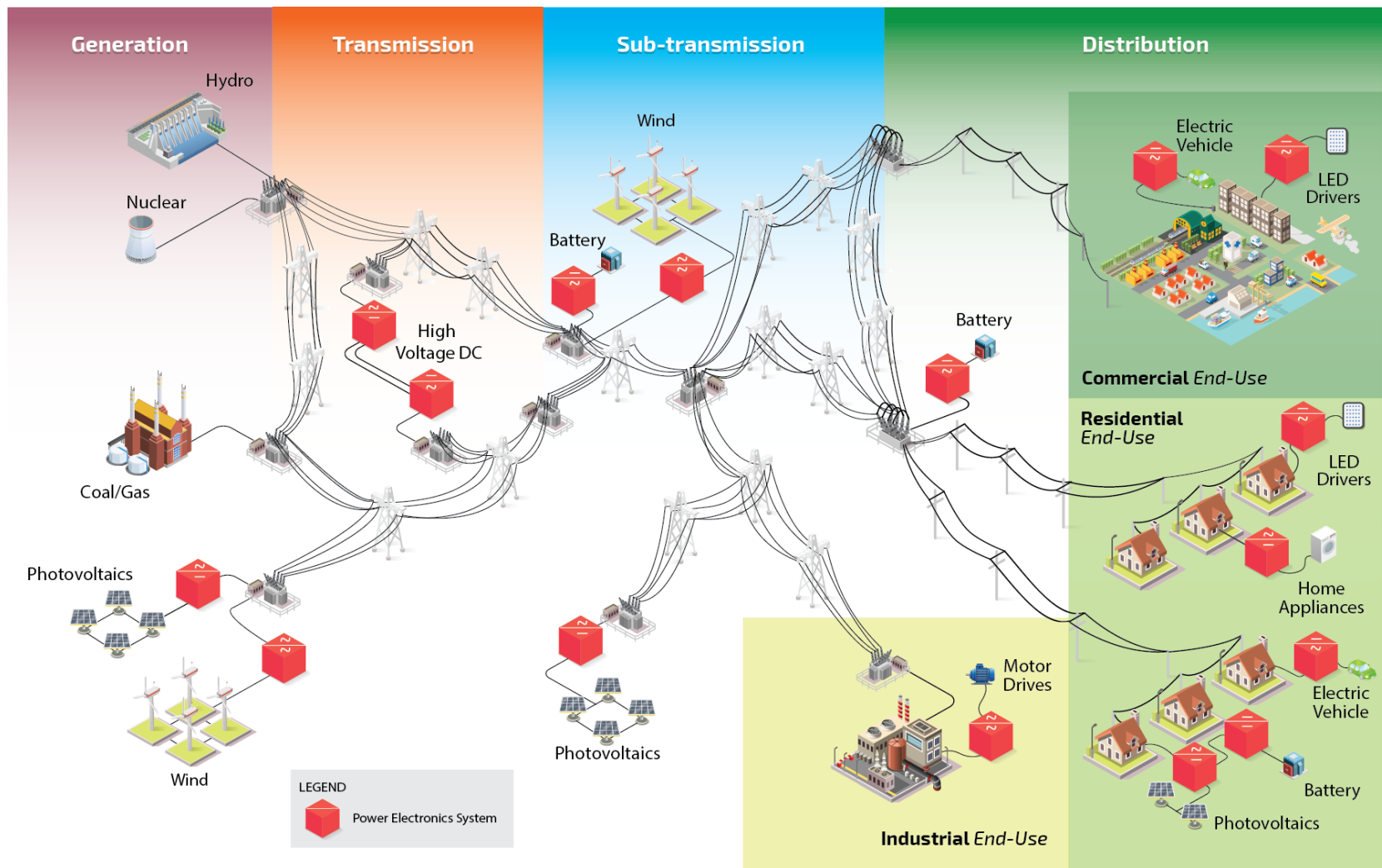
Power conditioning and grid integration: DER and energy storage

+ **Delivery**

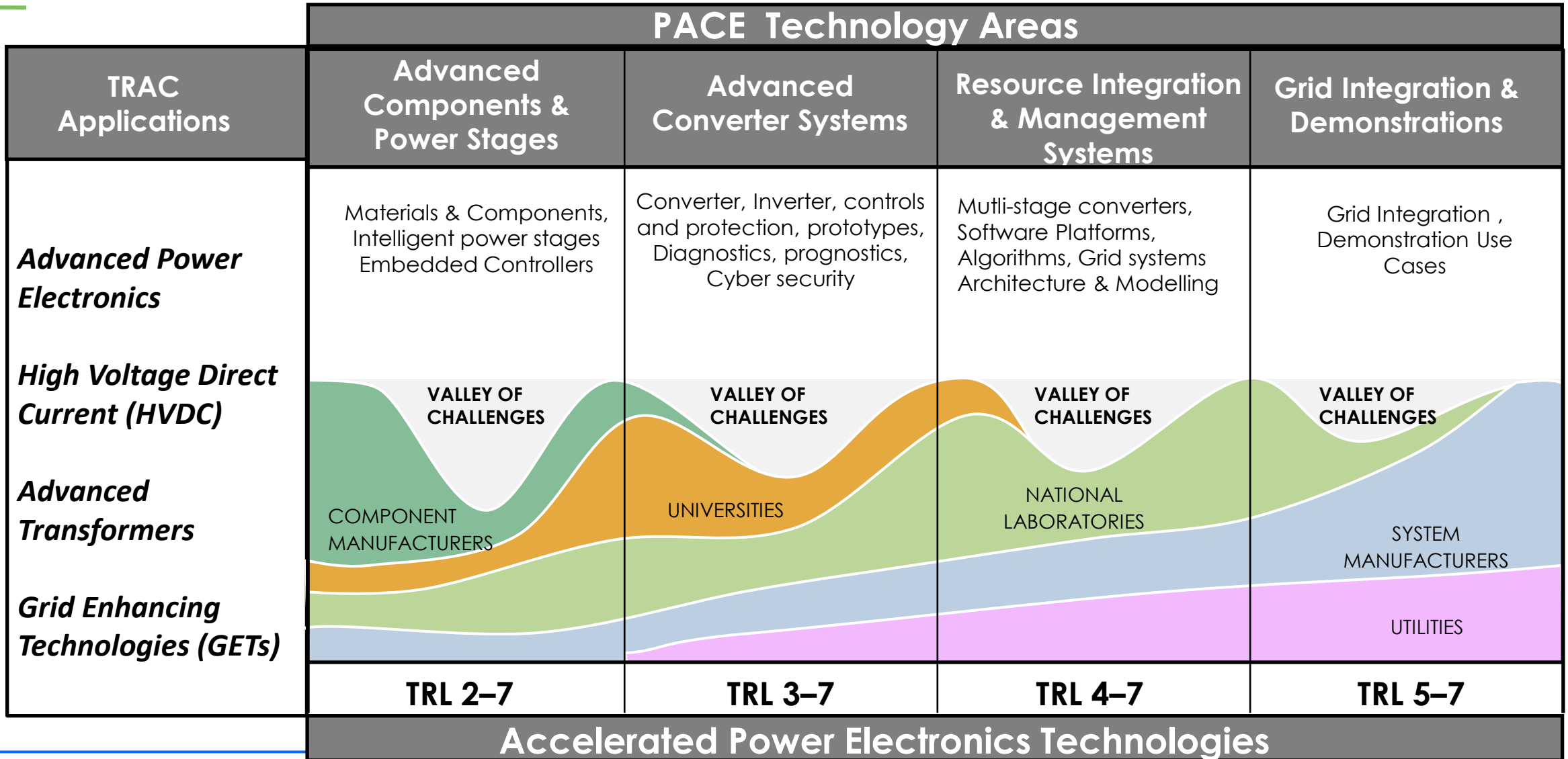
Long distance power transfer: Off-shore wind, utility-scale solar

+ **Management and conversion**

Megawatt-scale charging infrastructure, industrial processes and equipment



PACE Framework and Collaboration

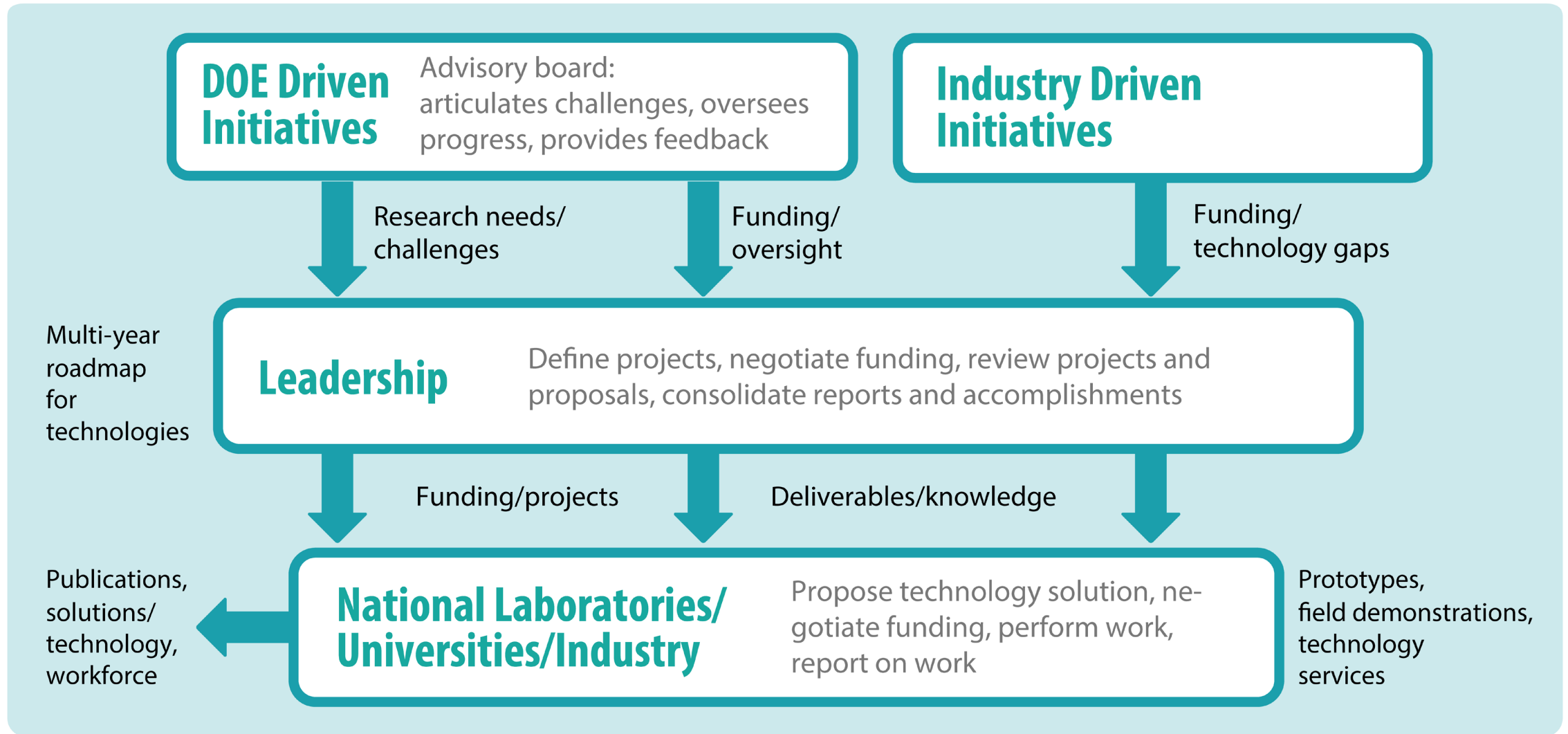


TRAC Portfolio and PACE



PACE Technology Areas			
Advanced Components & Power Stages	Advanced Converter Systems	Resource Integration & Management Systems	Grid Integration & Demonstrations
Materials & Components, Intelligent power stages Embedded Controllers	Converter, Inverter, controls and protection, prototypes, Diagnostics, prognostics, Cyber security	Multi-stage converters, Software Platforms, Algorithms, Grid systems Architecture & Modelling	Grid Integration , Demonstration Use Cases
<ul style="list-style-type: none"> + Advanced Low voltage & Medium voltage DC/DC Intelligent Power Stage (IPS) + Modular Solid-State Switch (MS3) + High Voltage, High Power WBG Module Development + Optical Fiber Sensors for Acetylene Detection + Al/Ca Composite Conductor + Soft Magnetics for Power Conversion Applications 	<ul style="list-style-type: none"> + SSPS 1.0 Hardware Prototype Development + SuperFACTS + LPT FOA GA Tech + LPT FOA University of Texas Austin + LPT FOA Nextwatt 	<ul style="list-style-type: none"> + Multiport HUB: GMLC + SSPS Hardware in the loop (HIL) validation + SSPS 1.0 node Use case Validation with Smart Universal Power Electronics Regulators (SUPERs) + Solid State Power Substation (SSPS) 1.0 Controller 	<ul style="list-style-type: none"> + SSPS Field Demonstration + Scalable Hybrid Large-Scale dc-ac Grid Analysis Methods + MVDC Use Case + Transmission Optimization with Grid Enhancing Technologies (TOGETs)

PACE Execution Framework



PACE Engagement & Funding Opportunities: DOE Initiatives



DOE TRAC Initiatives: Transformers

Funding Opportunity Announcement (FOA): FY18 \$7.5M FOA focused on the development of LPT prototypes that are more flexible and adaptable

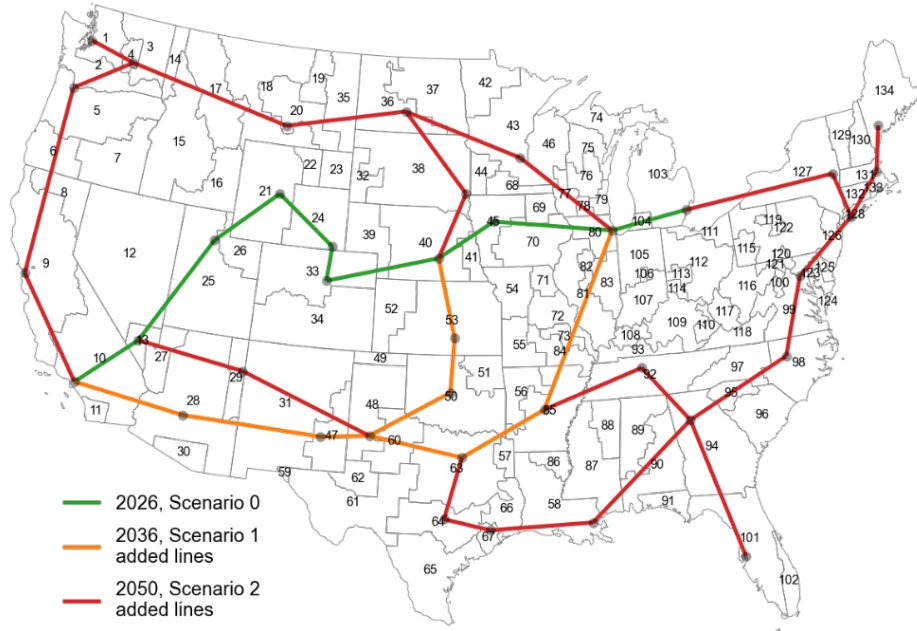
RFI Issued – April 2023: A Request for Information (RFI) for Innovative Advanced Transformers to obtain public input regarding a potential future Funding Opportunity Announcement seeking the research, development, and demonstration of innovative advanced transformers that can be readily utilized across a range of distribution to transmission scale applications

OE Transformer Technologies Workshop – May 2023: The goal of the workshop was to identify research, development, and demonstration (RD&D) opportunities for both distribution and power transformers



DOE TRAC Initiatives: HVDC

National Labs R&D, Annual Operating Funds



Models and methods for HVDC Technologies 2016-2019

Scalable Hybrid Large-Scale dc-ac Grid Analysis Methods: 2021-2024

Activities

- + **HVDC Workshop (2022 : TRAC+WETO)**
 - + ORNL,PNNL,NREL,EPRI
- + **HVDC Technology Roadmap**
 - + ORNL,PNNL,NREL,EPRI
 - + Anticipated Release December 2023
- + **HVDC Prize Competition**
 - + Winner Announcement – August 26th
- + **HVDC Moonshot (TRAC+WETO)**
 - + Focus : HVDC Stations, HVDC Systems
 - + ORNL,PNNL,NREL,EPRI
 - + Currently working on drafting metrics
 - + Cost: BOS \$/MVA
 - + System reliability
 - + System Ratings
 - + Standardization

DOE TRAC Initiatives: Advanced Power Electronics and SSPS

Solid State Power Substation Technology Roadmap

*U.S. DOE Office of Electricity
Transformer Resilience and Advanced Components (TRAC) Program
June 2020*



Workshop 2018

Roadmap 2020

National Labs R&D, Annual Operating Funds

SSPS 1.0 Architecture Development-
2020-2021

SSPS 1.0 Hardware Prototype
Development – 2021-2023

Total. no. of publications ~ 20

Total. No. of. Patents – 5

DOE Initiatives: GMLC

PACE Lab Call: Medium Voltage subsystem development

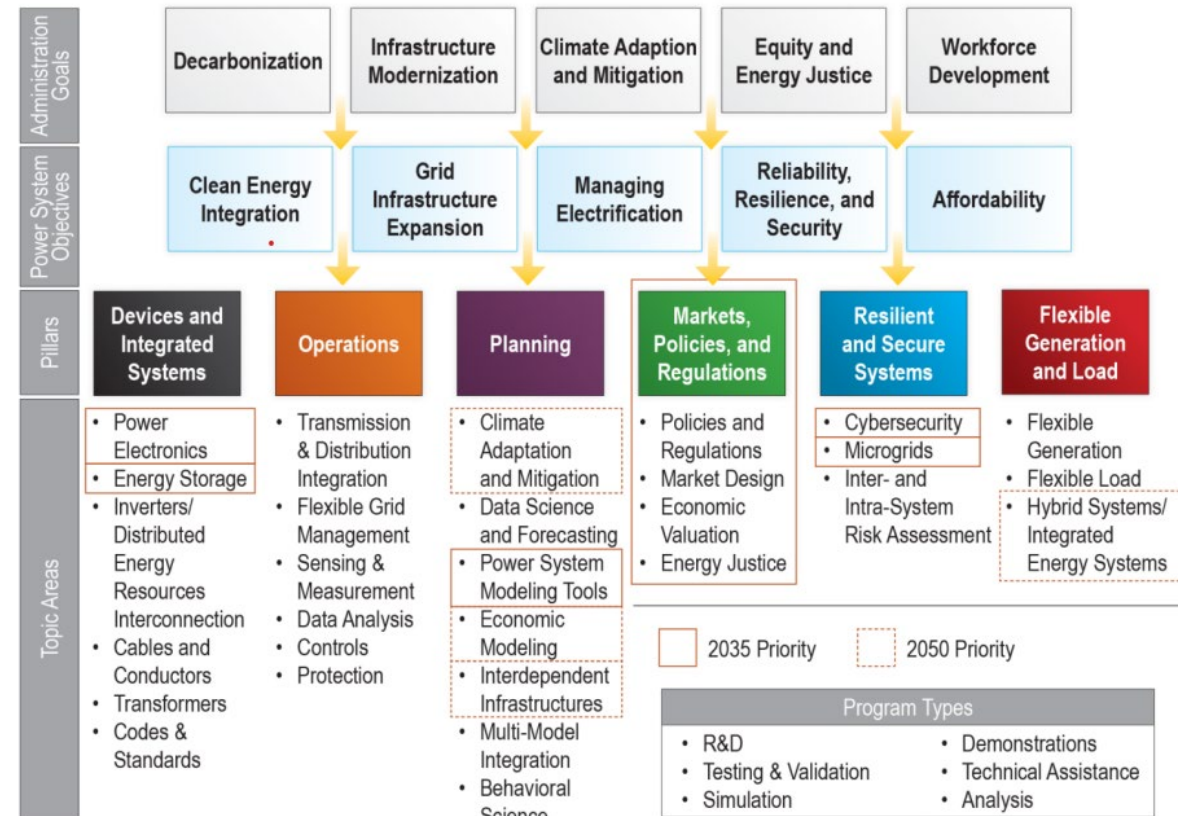
Supporting Offices: EERE, OE

Funding: \$13.75 M

The focus is on addressing gaps in 'smart' medium-voltage (MV, 4.16kV-34.5kV) electrical interfaces critical to a modernized grid through development of a medium voltage power and control electronics sub-system approach that is modular, scalable, and cost effective.

National Labs R&D

Partners: Industry and Academia



+ DOE Initiatives: GETs

- + **GETs FOA: Increasing Utilization and Reliability of Electric Infrastructure with Grid-enhancing technologies (GETs) (Feb 2023)**

Supporting Offices: EERE, OE. **Funding: \$6.5 M**

The FOA aims to fill gaps in information on the real-world benefits and usage of GETs through at-scale field demonstrations. The FOA is focused on Power Flow Controllers (PFCs) and Dynamic Line Rating (DLR)

- + **Grid-Enhancing Technologies: A Case Study in Ratepayer Impact (March 2022)**
- + **Transmission Optimization with Grid Enhancing Technologies (TOGETs) Project**
- + **Advanced Transmission Technologies Report (December 2020)**



TRAC's Success is founded in its diverse, strategic Domestic Partnerships



TRAC support maintains US competitiveness in the science and technology – fundamental to this sector through funds to national labs, universities and industry partners.



Questions?

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+ Why a Consortium?

Benefits to DOE

- + Provides single point of contact for all aspects of the technical focus
- + Provides one stream of accountability
- + Provides streamlined reporting

Benefits to Utilities/Vendors/Labs/Universities

- + Single blended funding stream
- + Less administrative burden, more focus on delivery
- + Reduced need to interact with DOE by individual project owners
- + Results are owned and shared among consortium
- + Risk is reduced through extensive collaborations.

Andre Pereira

Program Manager

Office of Electricity



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