U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

U.S. DEPARTMENT OF ENERGY | OFFICE OF ELECTRICITY

HVDC Breaker Workshop

May 1, 2024

The TRAC Program and WETO Systems Integration Program

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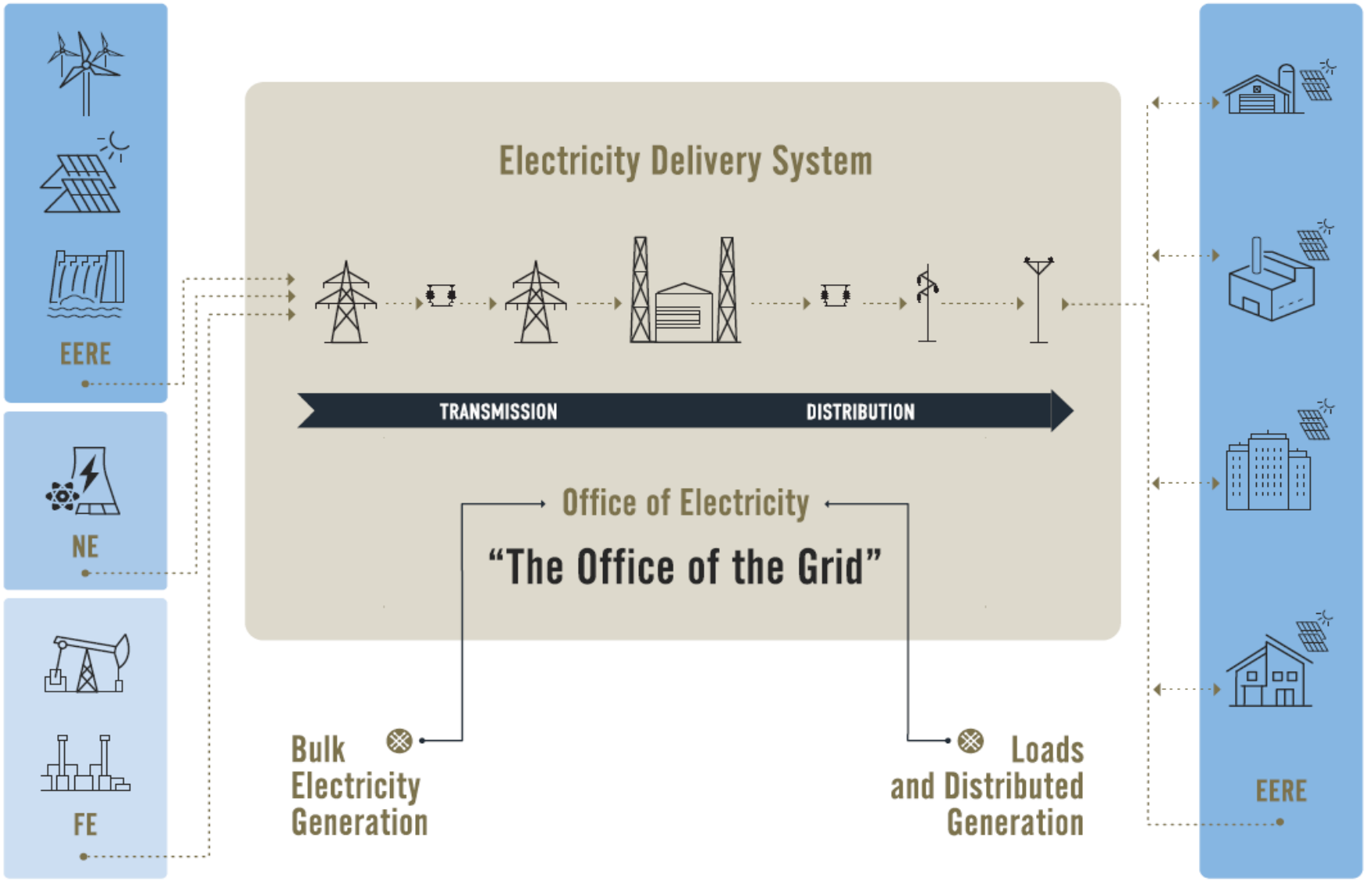
The Office of Electricity (OE)



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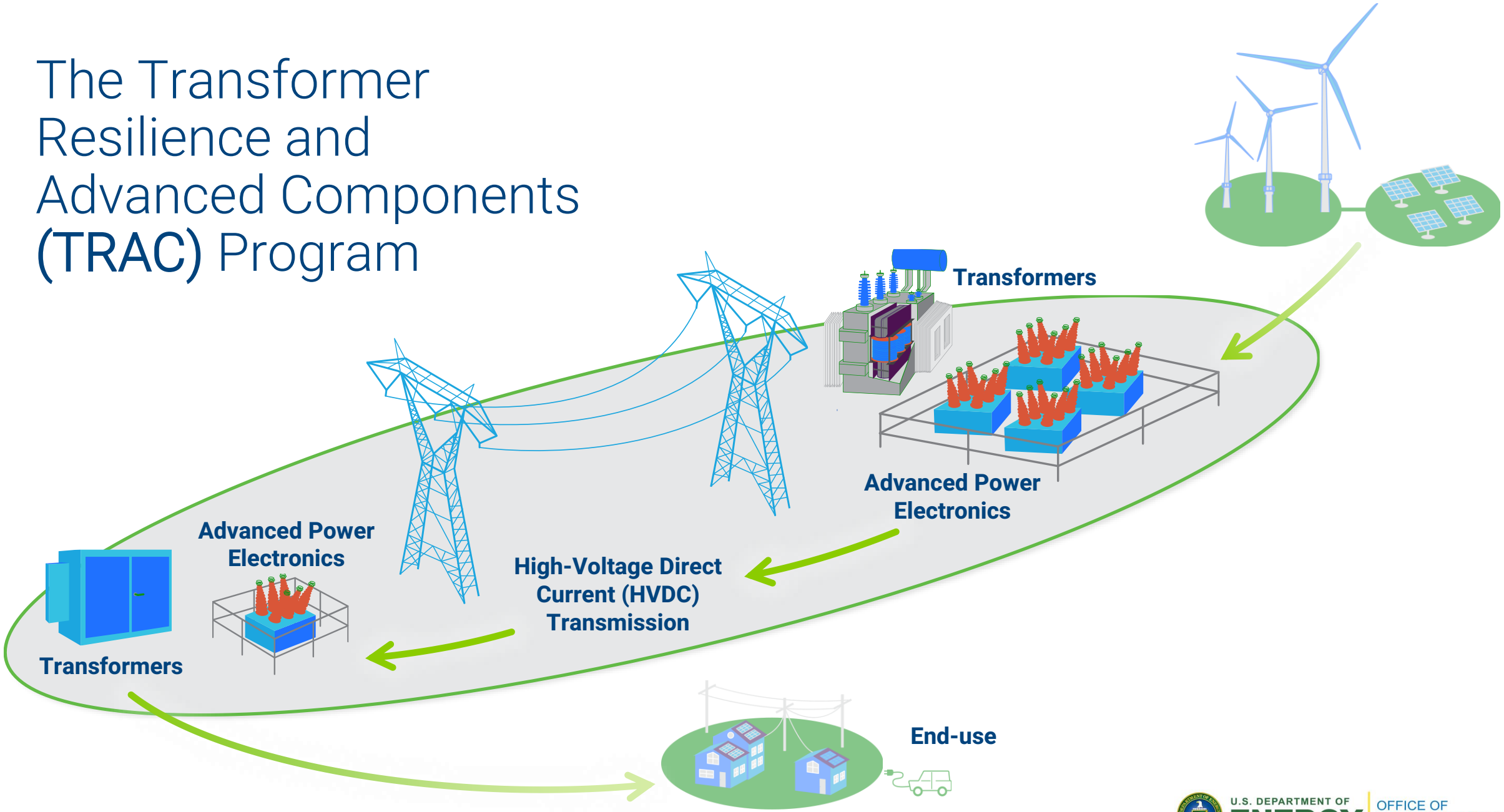
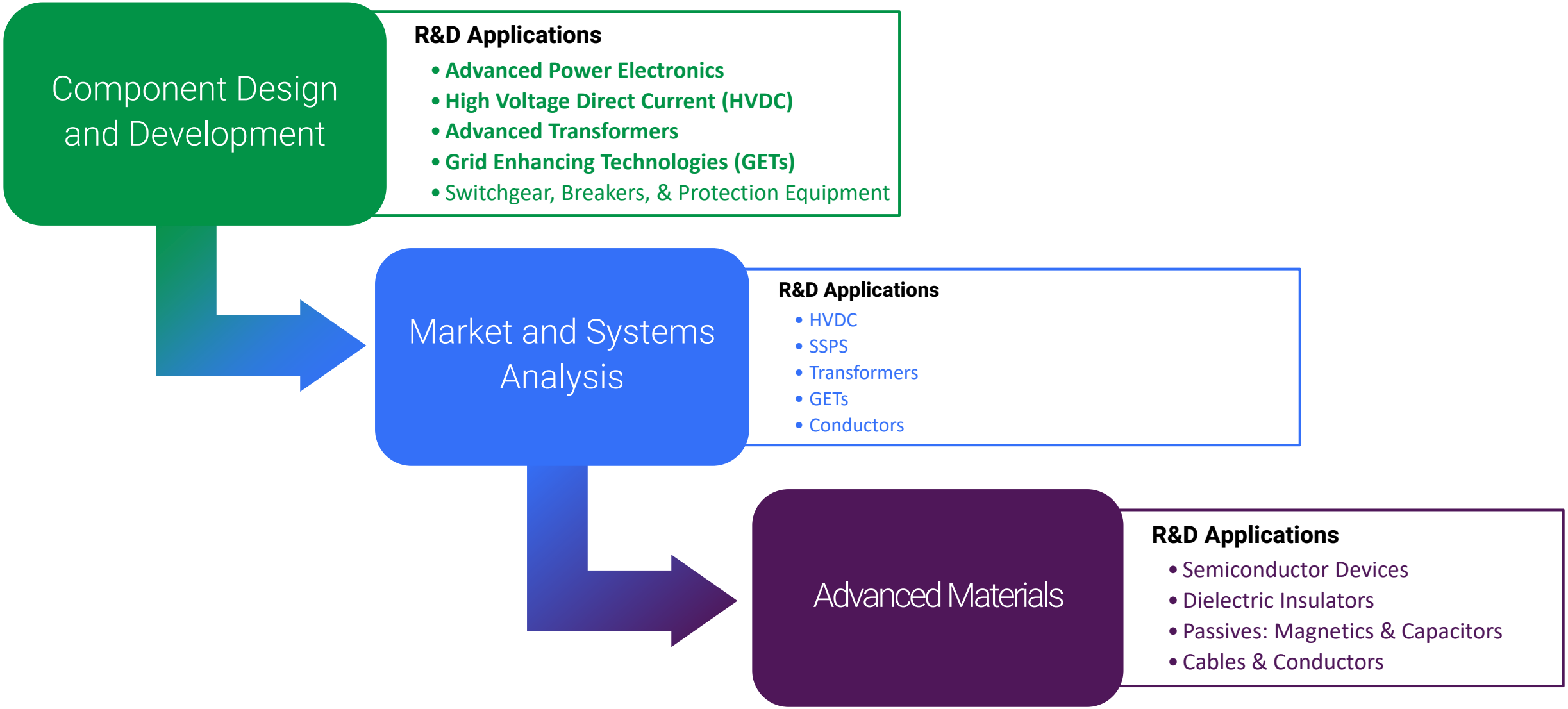
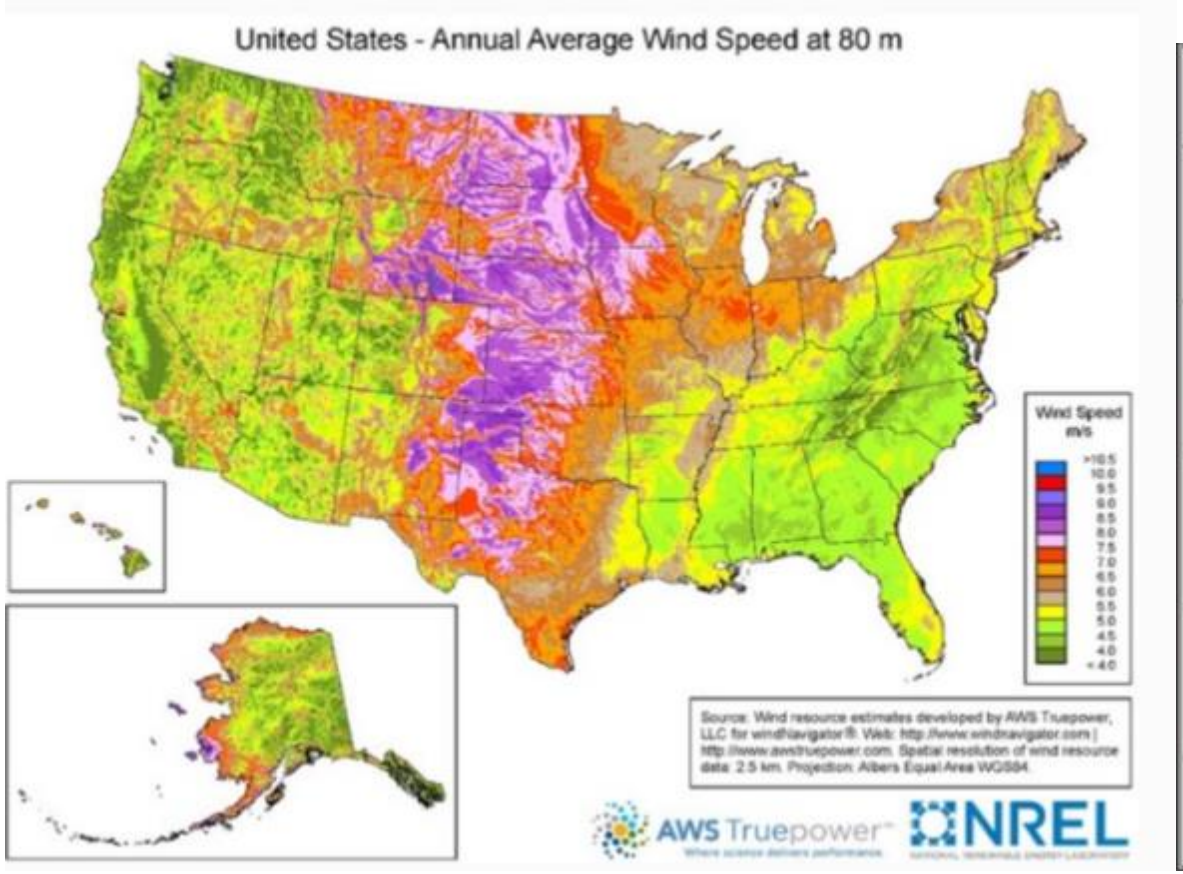
The Transformer Resilience and Advanced Components (TRAC) Program

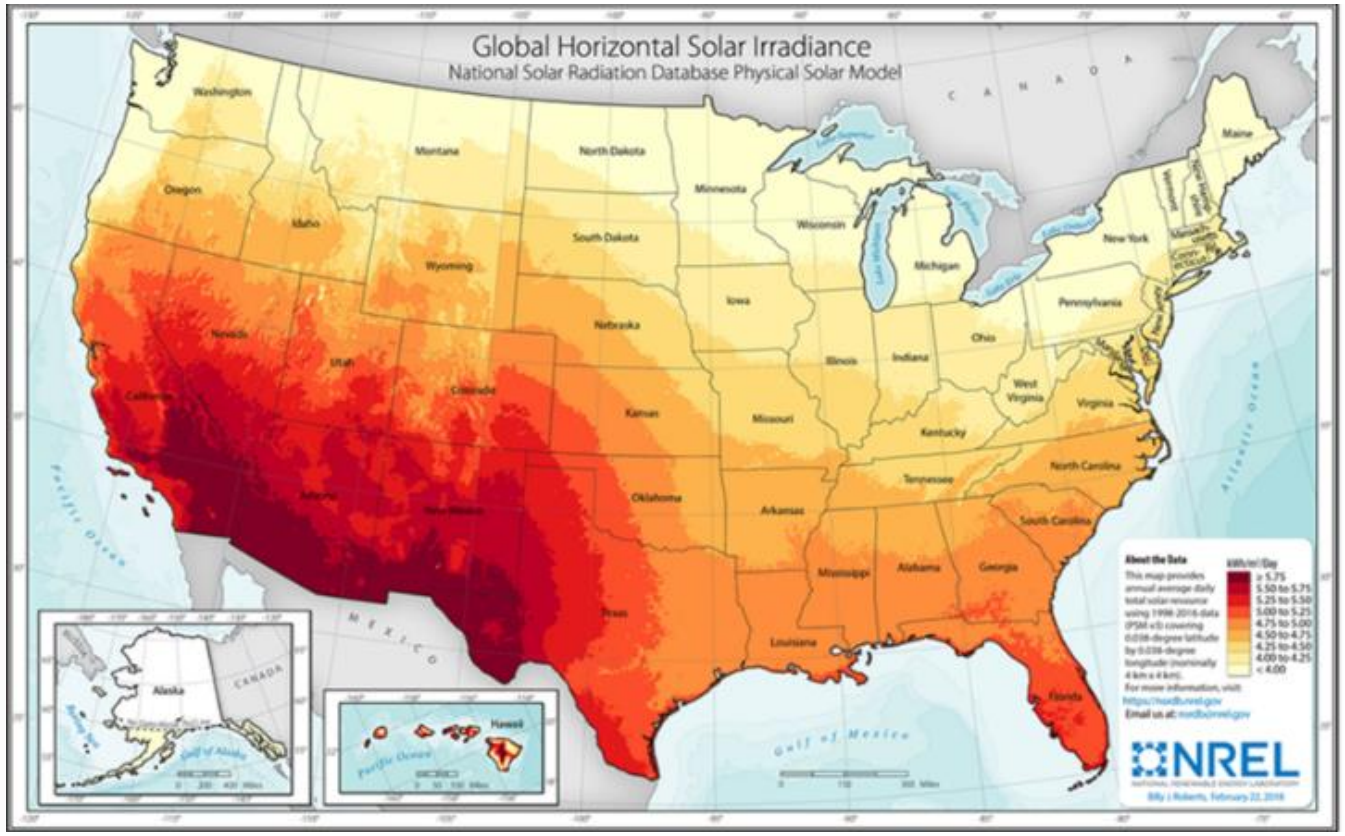


TRAC Program Strategy Enabling Research to Application



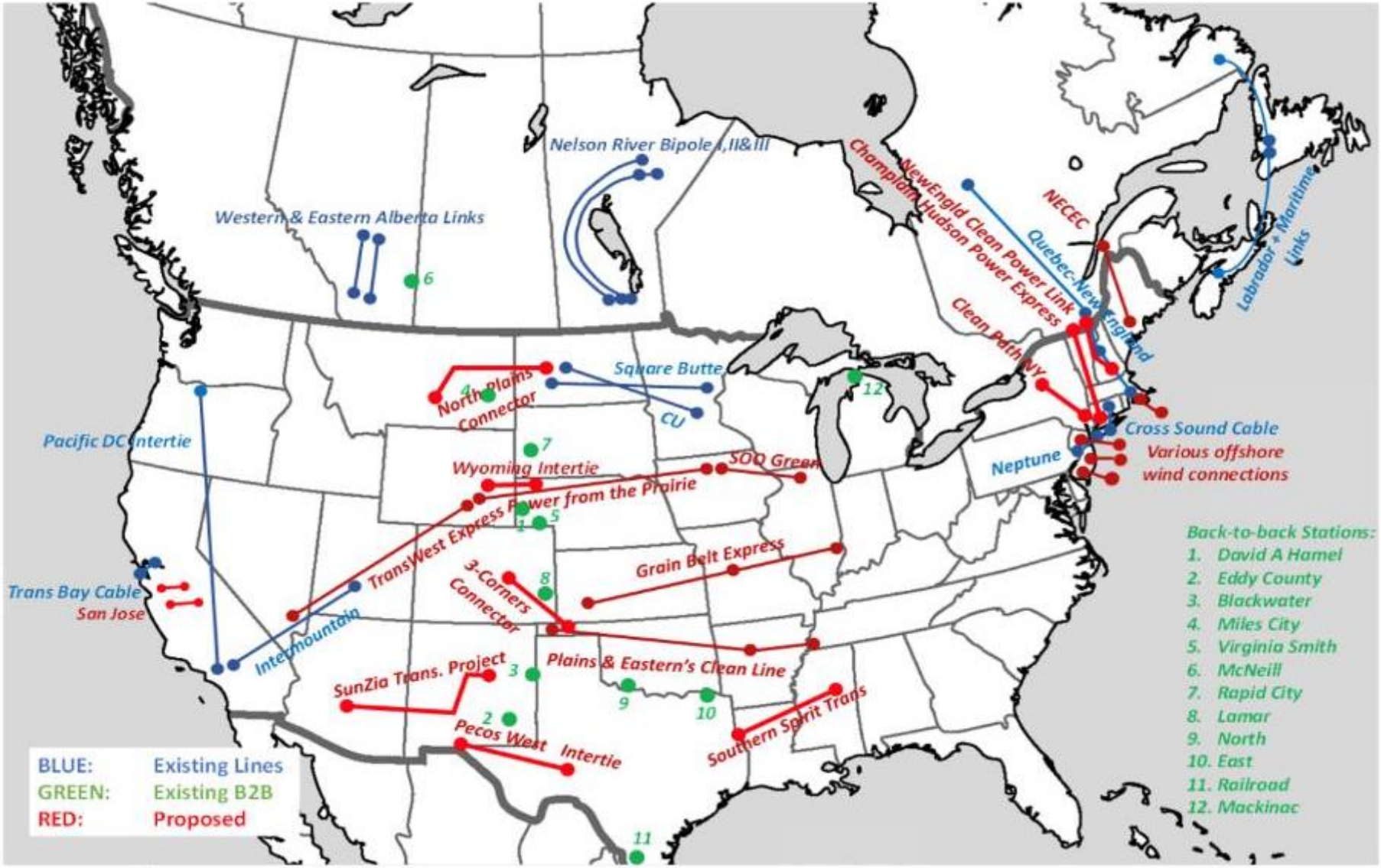
High Potential Areas for Wind and Solar Generation





Source: NREL

HVDC Projects (existing and planned)



Source: *Jim McCalley, Iowa State University*

WETO Systems Integration

Key Research Areas

Grid Planning and Access – ***Understanding transmission needs and how best to utilize what we have***
Interconnection process, transmission planning and siting analysis, optimal utilization of transmission capacity, data/modeling/tools

Reliable and Resilient Grid Operation – ***Wind being good stewards of the grid, keeping grid reliable and resilient***
Wind control for grid services, grid monitoring and control, grid protection, grid stability

Wind Hybrid Systems – ***increasing wind dispatchability and enabling wind for boarder decarbonized economy***
Assess, design, control, and configure wind hybrid systems for grid and for decarbonized industry

Wind Cybersecurity – ***Addressing wind specific cybersecurity needs***
Resilient wind plants that detect and defend cyber-attacks

Enabling Technologies – ***Improving performance and reducing cost for wind integration components***
HVDC systems, offshore power cable and substation, wind converter, and testing capabilities,

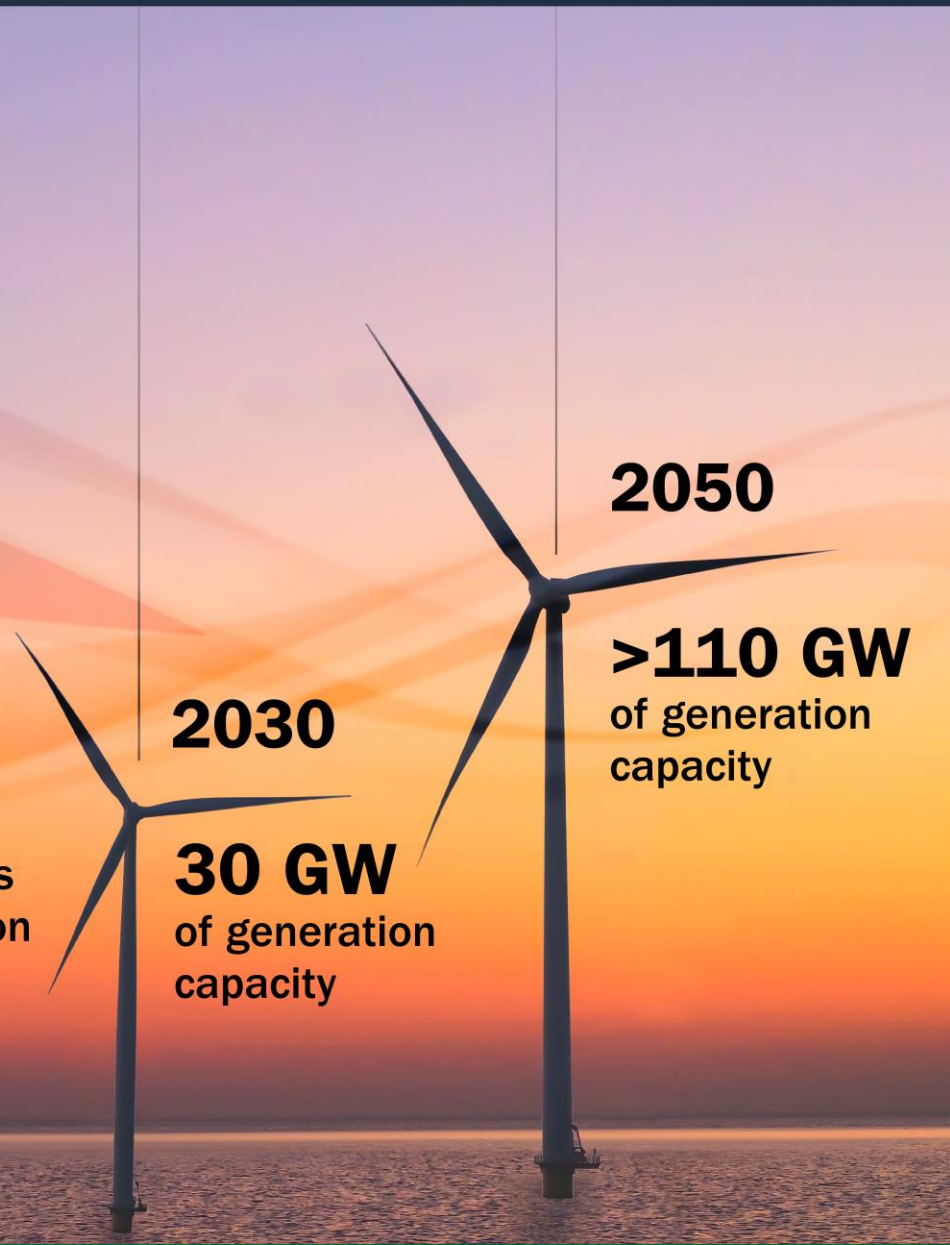
Offshore Wind Energy Strategic Initiatives

NOW
Lower costs, develop supply chain, and inform deployment of fixed-bottom offshore wind

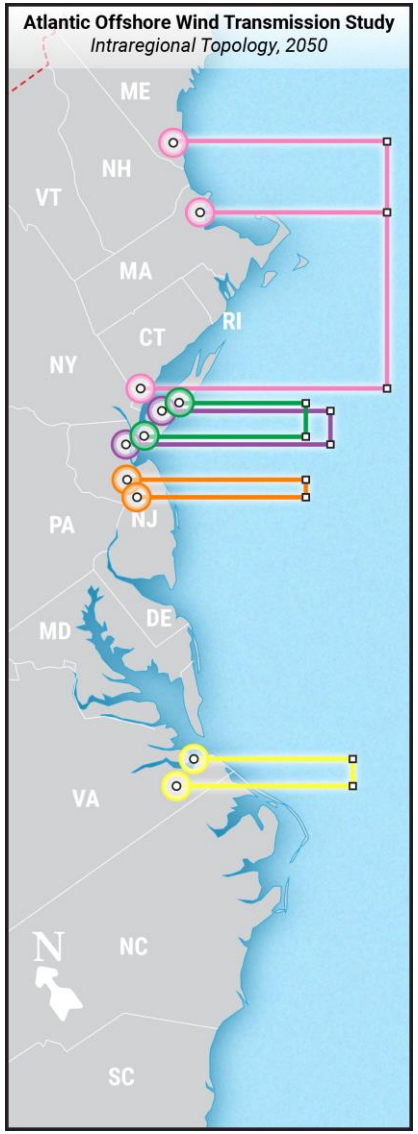
FORWARD
Establish U.S. leadership in floating offshore wind design, manufacturing, and informed deployment

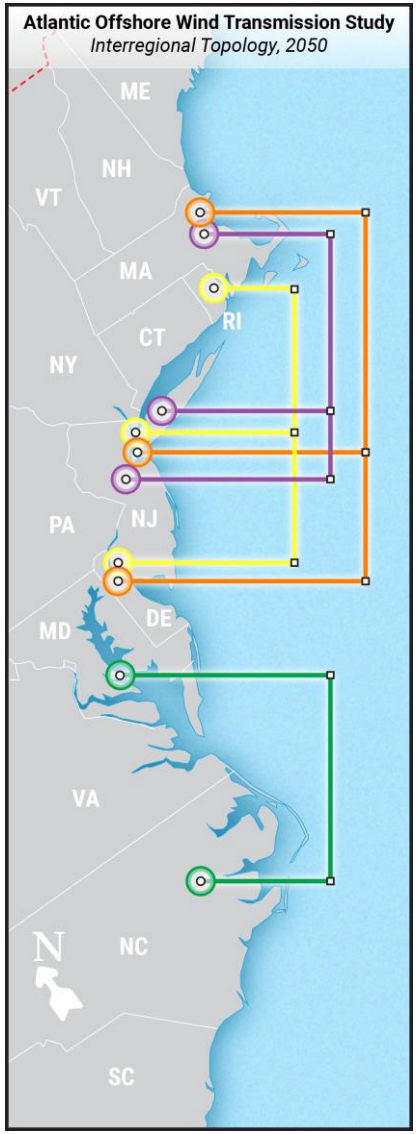
CONNECT
Enable reliable and resilient transmission solutions for large-scale offshore wind deployment

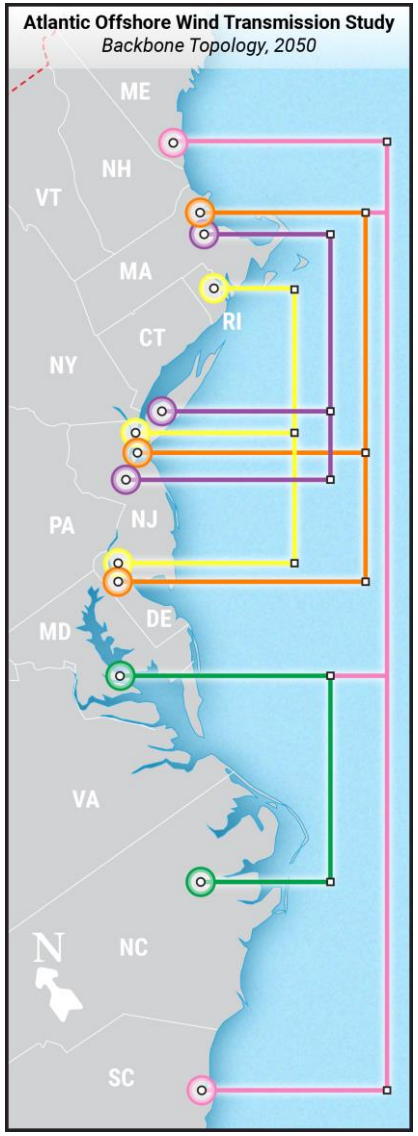
TRANSFORM
Expand offshore wind co-generation technologies for widespread electrification and decarbonization



Atlantic Offshore Wind Transmission Study: Topology Options







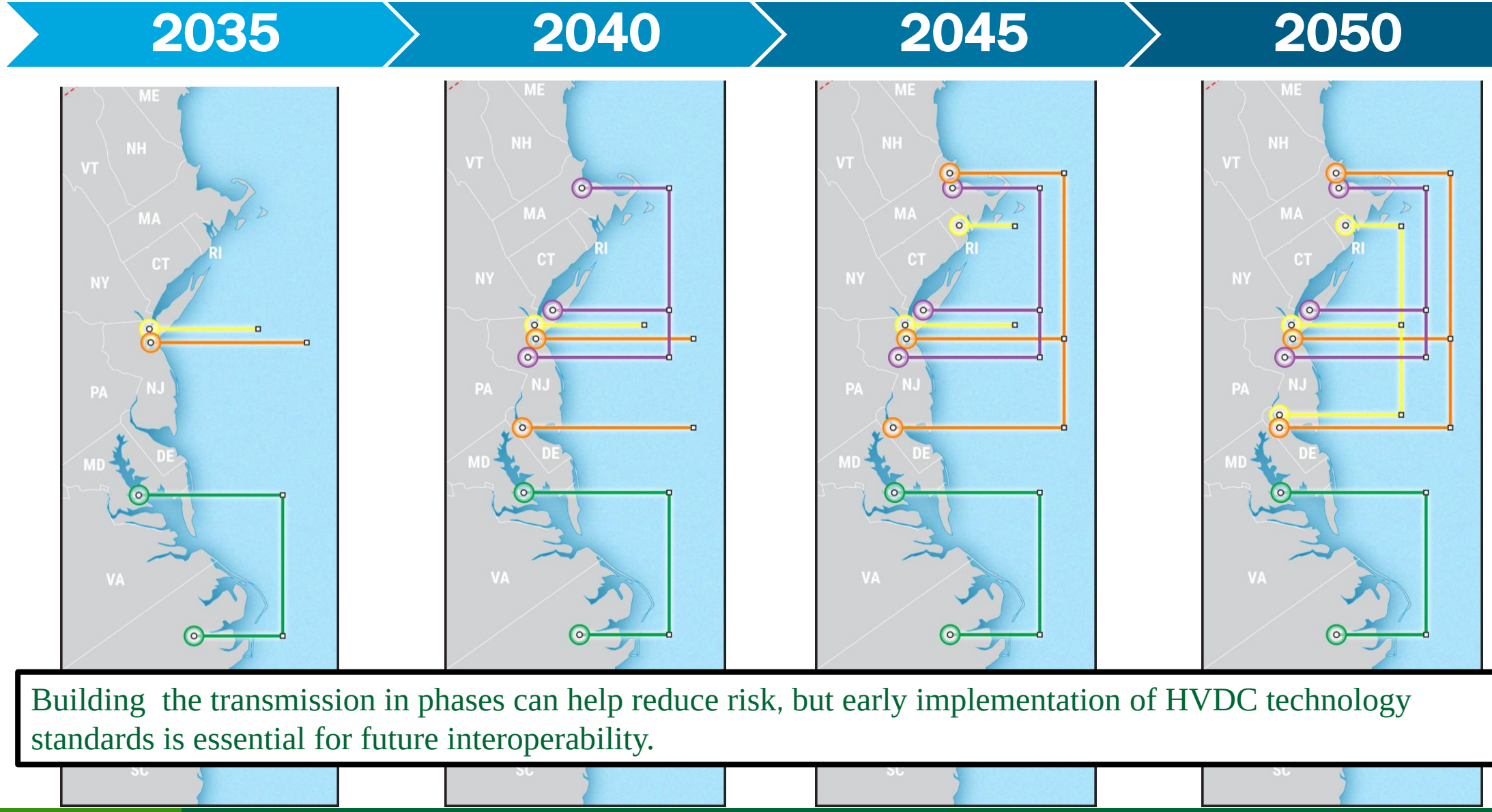
Benefits of offshore transmission networking outweigh the costs, often by a ratio of 2:1 or more. Offshore networks with Interregional interlinks provide the highest value.

- Offshore wind investment in HVDC converter stations, interconnection, and platforms can be leveraged by interlinking between platforms.
- Inter- and intra- strategies can be mixed.
- Majority of interregional costs are cables.

Net value (2050 benefits minus annual costs) and benefit to cost ratios:

Scenario	Net Annual Value ($M)	Benefit Cost Ratio
Intraregional	330	2.3
Interregional	1560	2.9
Inter-Intra	1760	2.6
Backbone	2470	2.7

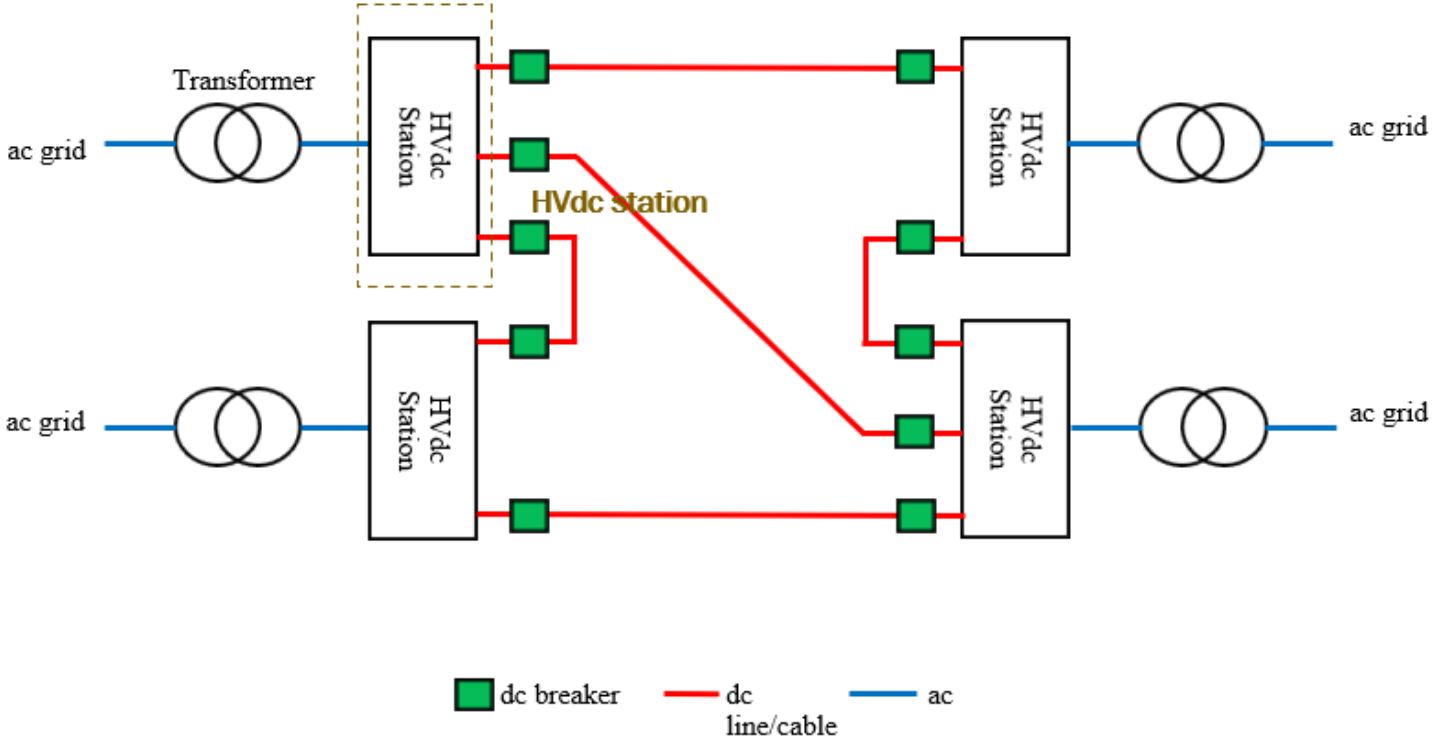
Transition from Radial 2030 to Interregional 2050



Building the transmission in phases can help reduce risk, but early implementation of HVDC technology standards is essential for future interoperability.

Joint OE-WETO HVDC Workshop Series

- May 2022 – Research Needs for HVDC
- May 2023 – HVDC Converter
- May 2024 – HVDC Breaker

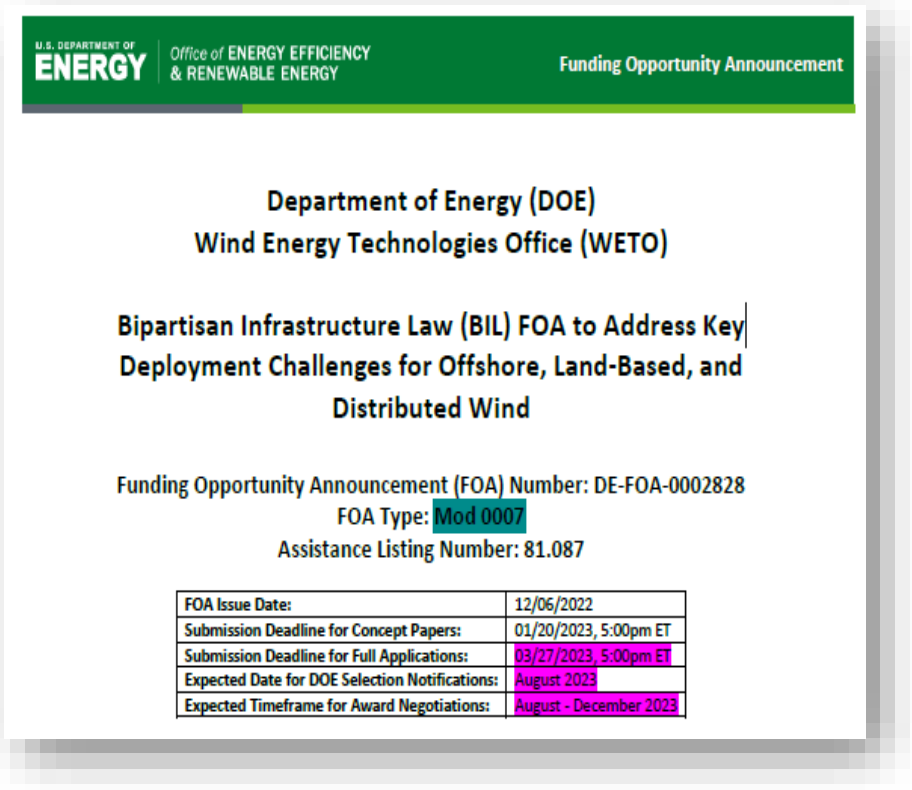


Source: World's first unmanned HVDC offshore platform installed at world's largest offshore wind farm | SSE Renewables

Source: ABB Power Grids Hybrid HVDC Breaker - A Breakthrough Towards HVDC Grid Realization.pdf

HVDC Standards and Curriculum FOA

DE-FOA-0002828: Bipartisan Infrastructure Law (BIL) Funding Opportunity Announcement (FOA) to Address Key Deployment Challenges for Offshore, Land-based, and Distributed Wind



U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY — Funding Opportunity Announcement

Department of Energy (DOE)
Wind Energy Technologies Office (WETO)

Bipartisan Infrastructure Law (BIL) FOA to Address Key Deployment Challenges for Offshore, Land-Based, and Distributed Wind

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002828
FOA Type: Mod 0007
Assistance Listing Number: 81.087

FOA Issue Date:	12/06/2022
Submission Deadline for Concept Papers:	01/20/2023, 5:00pm ET
Submission Deadline for Full Applications:	03/27/2023, 5:00pm ET
Expected Date for DOE Selection Notifications:	August 2023
Expected Timeframe for Award Negotiations:	August - December 2023

Topic Area 1: **High Voltage Direct Current (HVDC) for Offshore Wind**

- Subtopic Area 1: HVDC standards and benchmark system development
- Multi-terminal HVDC controls and functional requirements
- HVDC curriculum development for education and workforce training

DNV

IOWA STATE UNIVERSITY

OAK RIDGE National Laboratory

HVDC CORE Initiative & IDEAL-HVDC FOA

HVDC CORE Initiatives

- Congress directed the creation of this initiative in Fiscal Year 2023 Appropriations
- Supports R&D to reduce costs of HVDC technology and long-distance transmission 35% by 2035 (35 by 35)
- Target metrics were established to meet this goal:
  - HVDC substation to $210 MW/kV
  - HVDC system with overhead lines to $1000 MW/mi
  - HVDC system with cables to $4000 MW/mi

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U.S. Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE) and Office of Electricity (OE)

Innovative DEsigns for high-performAnce Low-cost HVDC Converters (IDEAL HVDC)

Funding Opportunity Announcement (FOA) Number: DE-FOA-0003141
FOA Type: Initial
Assistance Listing Number: 81.087

FOA Issue Date:	9/27/2023 - 5:00 p.m. ET
Submission Deadline for Concept Papers:	11/14/2023 - 5:00 p.m. ET
Submission Deadline for Full Applications:	2/5/2024 - 5:00 p.m. ET
Expected Submission Deadline for Replies to Reviewer Comments:	3/19/2024 - 5:00 p.m. ET
Expected Date for EERE Selection Notifications:	June 2024
Expected Timeframe for Award Negotiations:	September 2024

CORE Initiative Metrics

Silicon Carbide (SiC) Packaging Prize

This $2.25 million prize—launched by the U.S. Department of Energy's (DOE's) Office of Electricity—invites competitors to propose, design, build, and test state-of-the-art packaging prototypes that move the industry beyond its current state. This prize establishes a final goal of developing 10-kV, 2,000-A rated SiC power modules that expand the state of the art in semiconductor packaging.

Phase & Prize Details

Phase 1 – Design Study (8 months) *NOW OPEN | SUBMISSIONS DUE AUG. 30*
Prizes: Up to 10 winners of $50,000 each

Phase 2 – Initial Demonstration (14 months) *OPENS NOV. 2024*
Prizes: Up to 4 winners of $250,000 each

Phase 3 – Final Demonstration (14 months) *OPENS FEB. 2026*
Prizes: Up to 1 winner of $750,000

Learn More

- Follow the prize on HeroX: https://www.herox.com/SiCPackagingPrize
- Register for an Informational Webinar on March 20: https://nrel.zoomgov.com/webinar/register/WN_Gpqs82HYQG-LpLt4wJBRQg

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