



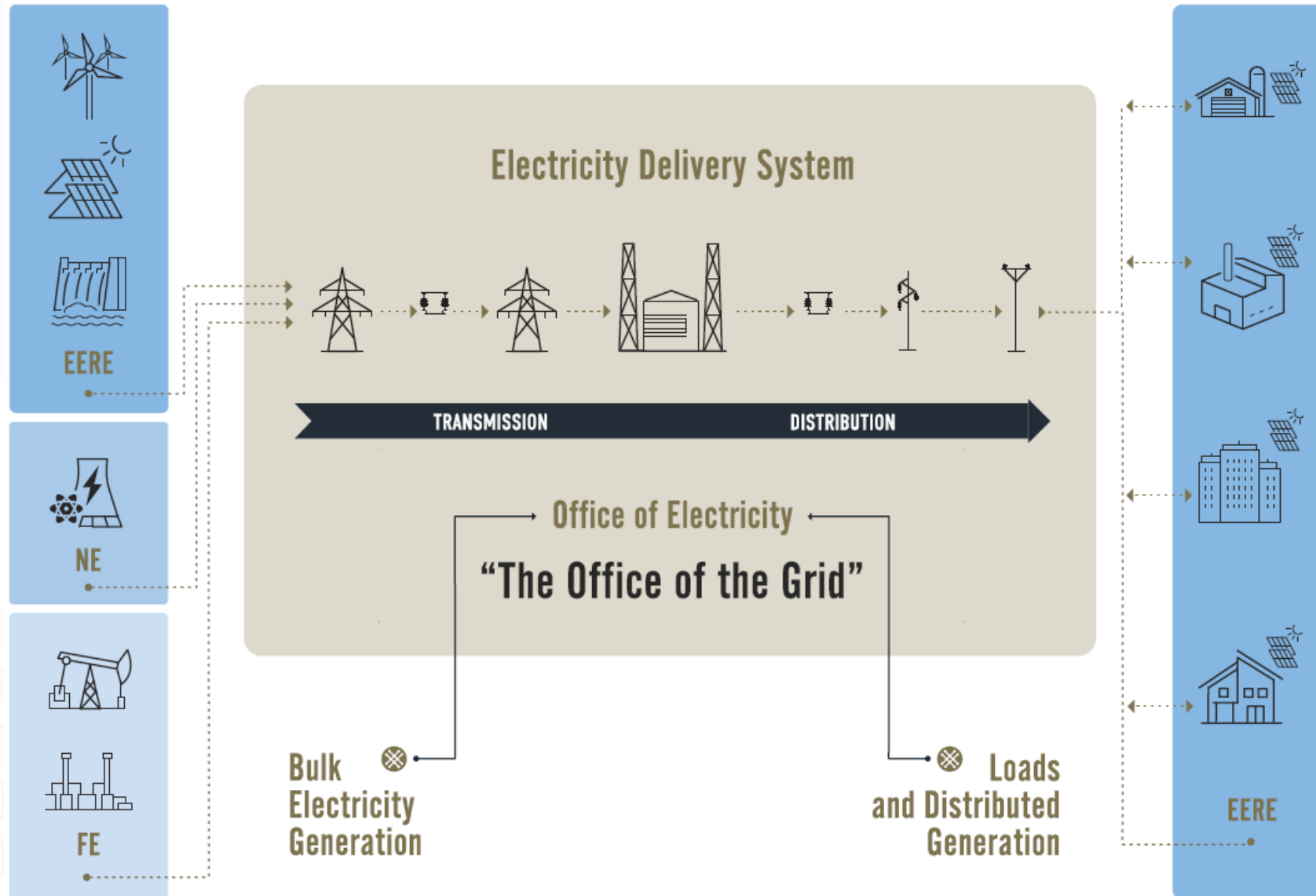
U.S. DEPARTMENT OF  
**ENERGY**  
OFFICE OF  
**ELECTRICITY**

# Decarbonized Grid Evolution

**Michael Pesin**

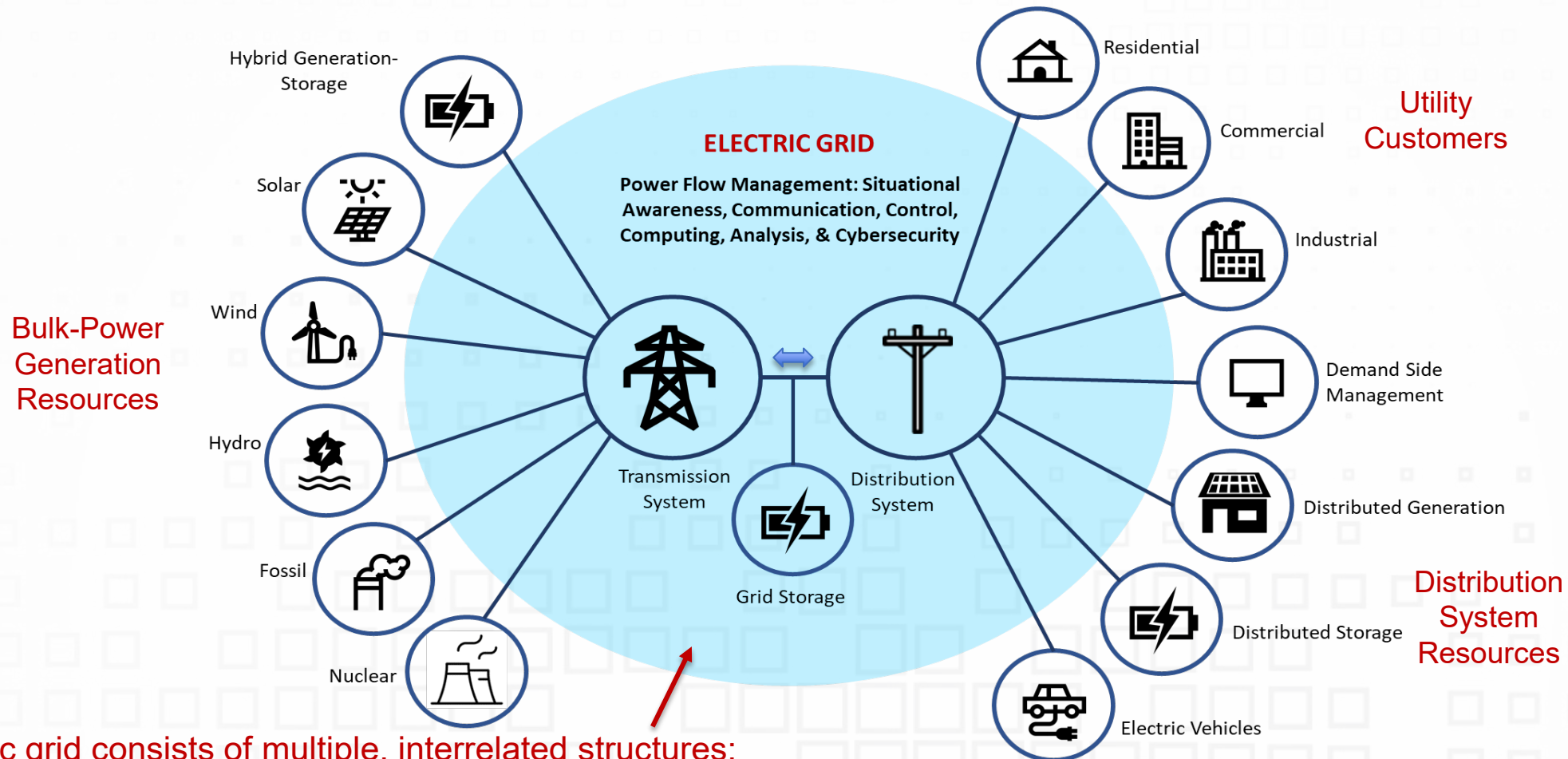
Deputy Assistant Secretary, Advanced Grid Research and Development  
Office of Electricity

# The Office of the Grid



# Electric Power System – Planning, Operations, Markets

The electric power system is undergoing a dramatic structural transformation. The electric grid, a vast complex machine, will require significant re-engineering.



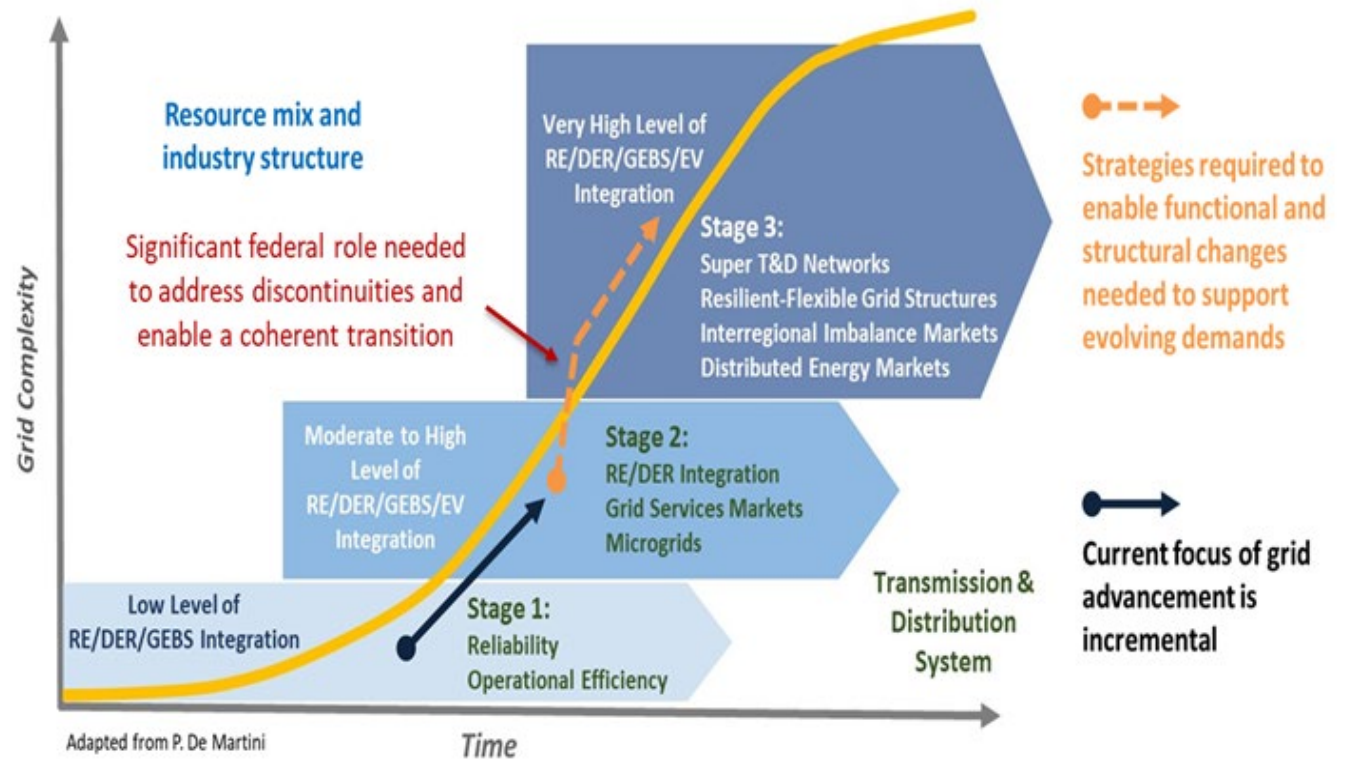
The electric grid consists of multiple, interrelated structures: the physical, cyber, market, industry, and regulatory structures

# Problem Statement

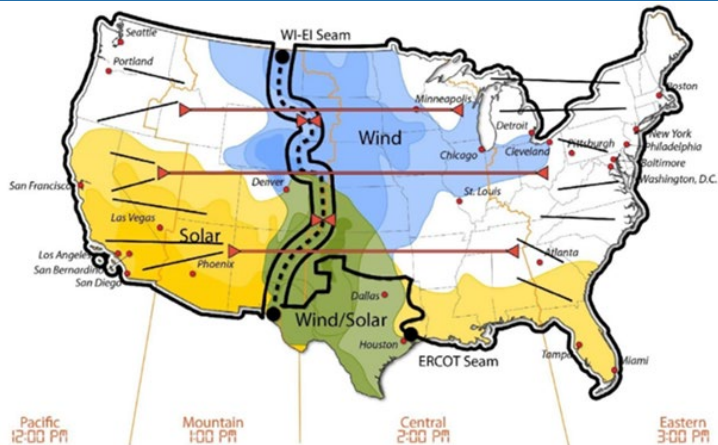
## Our ability to transform the electric grid to meet resilience, decarbonization, and equity goals will require a coordinated strategy that does not exist today

- Technological breakthroughs plus advances in system designs\* are needed to enable envisioned future requirements.
- There is no central authority for exerting a consistent path for advancing the electricity delivery system, as current planning approaches are fragmented.
- Staged, “least-regrets” strategies for applying advanced grid capabilities/designs for incorporation into investment decisions made by regulators, utilities, and technology developers are needed, but do not exist.
- Formal approaches for incorporating resilience, decarbonization, and equity into utility planning processes do not exist.
- Leadership is needed to set guidelines for planning, market designs, and operational coordination within and across regions of the country and jurisdictions.

\* For example, significant gaps remain in our understanding of how to model, simulate, and control systems with millions of intelligent fast-responding inverters



# Grid Trajectory Considerations



Loose Coupling  
Agile/Flexible

Large-Scale  
Generation, High-  
Voltage AC/DC Grids  
+ Storage

Variable, Integrative,  
and Flexible Grid  
across TD&C

## Next-Generation Electricity Network

- Control of flexible generation and load
- Energy storage
- Synthetic inertia
- Multi-directional power flow
- Varied/variable grid configuration

Capital Intensive  
Economies of scale

Capital Diffuse  
Network economies

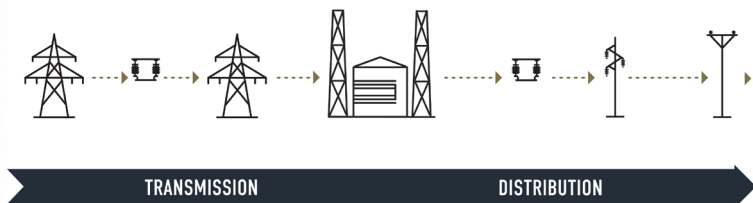
Strengthening the seam between the Eastern and Western Interconnections to encourage efficient development and utilization of U.S. energy resources.

Current Grid

High DER + Complex  
Industry Structure

Microgrids are a key part of the future Electric Delivery System, enabling more decentralization and DER integration

- Current DER wave: PV, smart buildings
- Next DER wave: energy storage, EVs, IoT



Tight Coupling  
Rigid/Brittle

# Transmission Innovation R&D Overview



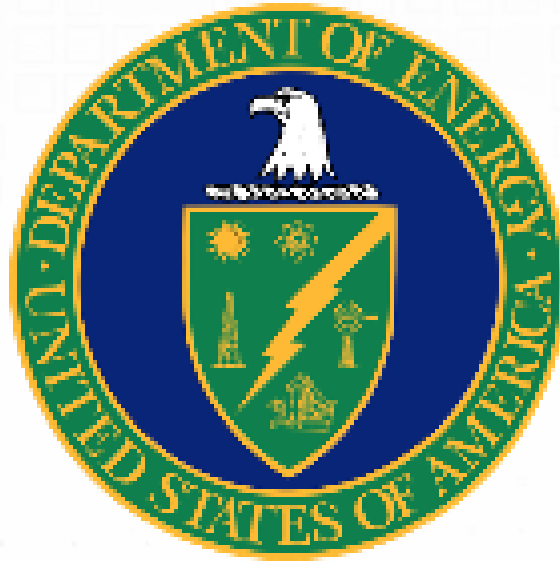
Grid Operations

Distribution Integrated with  
Transmission Operations

Automatic Control Systems

Hardware and Components

Economic Analysis and  
Planning Tools



# Thank You

Michael Pesin - Deputy Assistant Secretary  
U.S. Department of Energy, Office of Electricity,  
Advanced Grid Research & Development