



How we Drive Grid Innovation with Targeted R&D

Office of Electricity

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U.S. DEPARTMENT OF

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Executive Order on Tackling the Climate Crisis at Home and Abroad. (January 27, 2021)

Sec. 205(i):

A carbon pollution-free electricity sector no
later than 2035

Key Trends Driving Electricity System Transformation

Current structural transformation will require re-engineering of the electric grid and advancement of institutional decision processes

A changing mix of characteristics and types of electricity generation with T&D integration

Customers and merchants providing grid services and participating in electricity markets

Demand for a more resilient grid and alternative configurations

Growing need to enhance grid flexibility

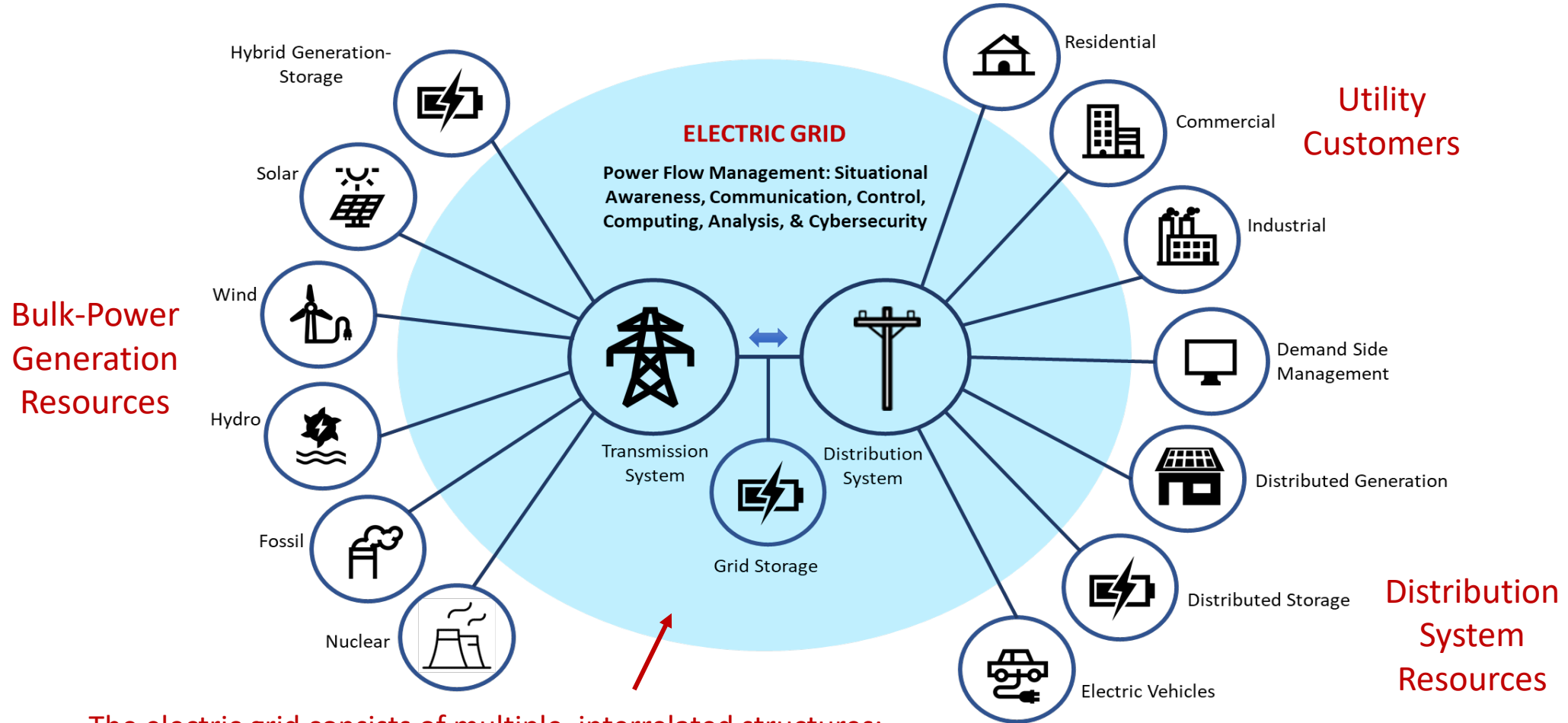
Use of digital and communications technologies for grid operations

Electrification of transportation and buildings, and convergence with grid operations



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



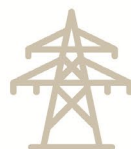
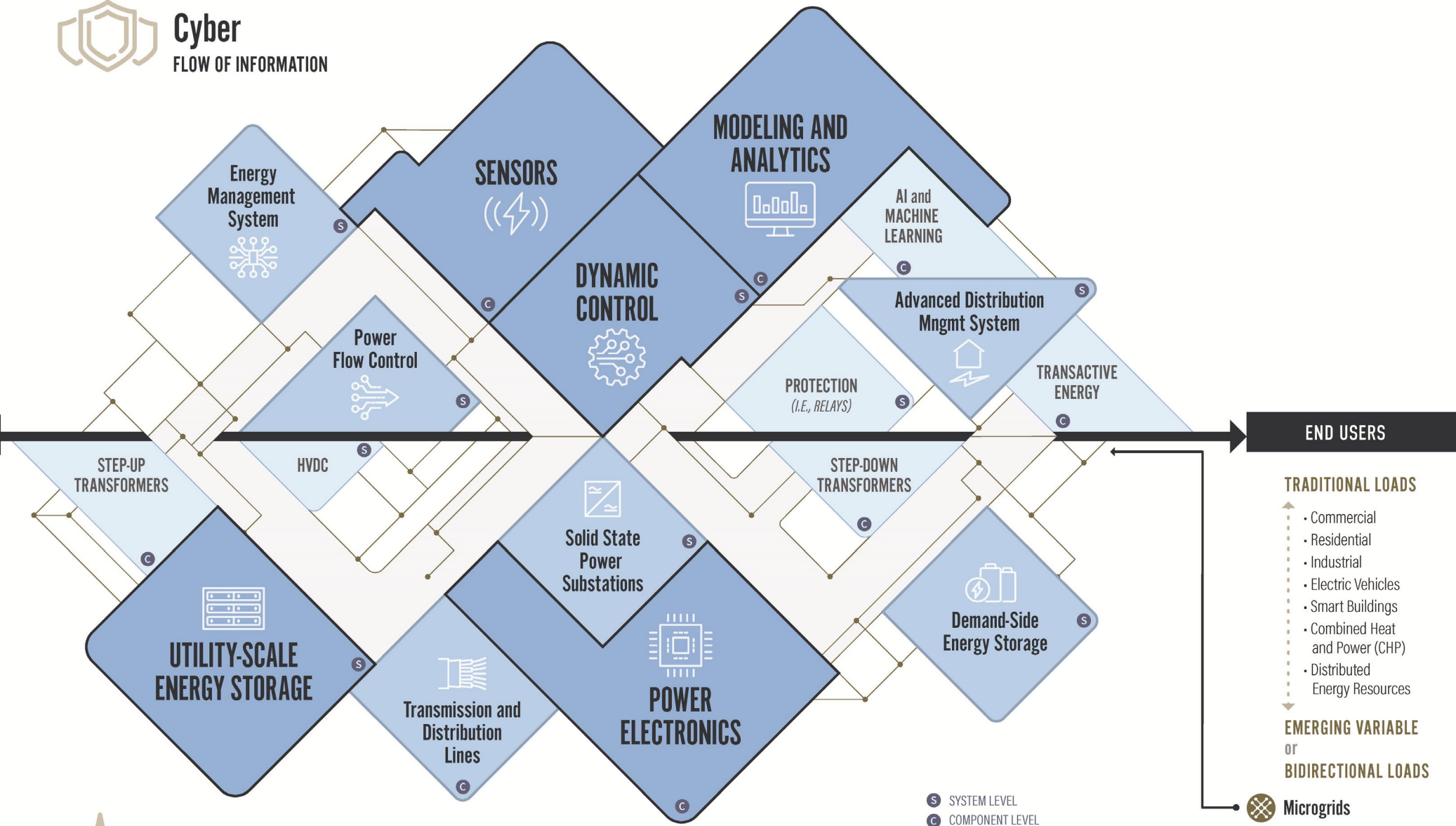
Cyber
FLOW OF INFORMATION

SYNCHRONOUS

- Coal
- Nuclear
- Natural Gas
- Hydropower
- Biomass
- Geothermal
- Solar
- Wind

ASYNCHRONOUS

BULK GENERATION



Physical
FLOW OF POWER



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Dramatic Structural Transformation Taking Place

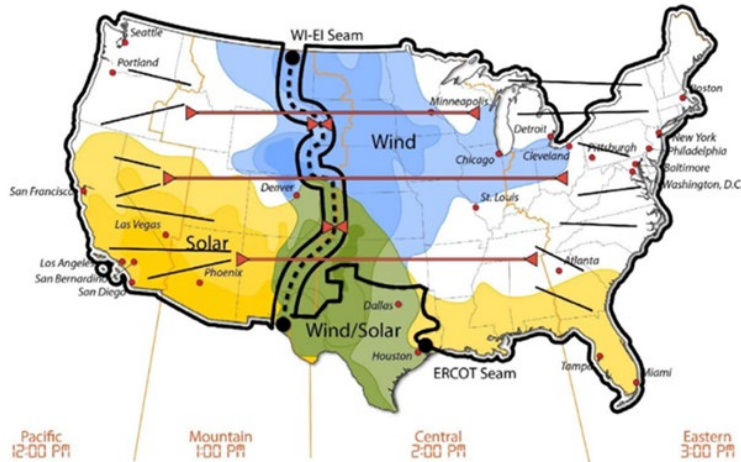
We are facing a step-change in the production, delivery, and interactive use of electricity which will radically affect the design and operation of the electric grid



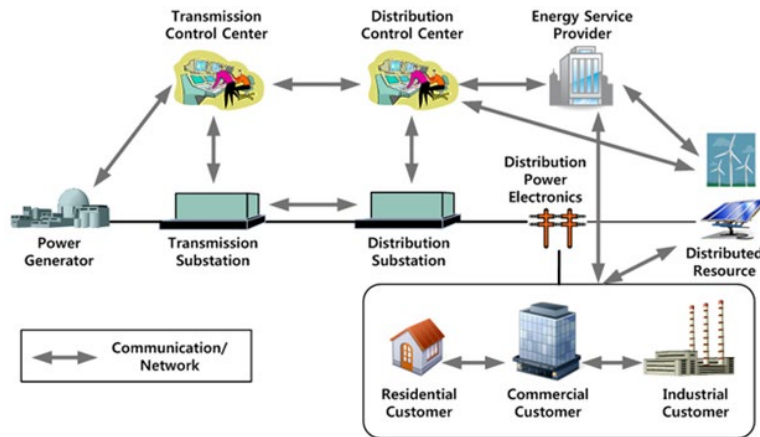
- **Interregional transmission** – more effective utilization of generation resources made possible through the integration of the nation’s three interconnections (e.g., high-voltage backbone and interties)
- **Regional transmission** – becoming a generation tie for large-scale solar/wind generation to distant load centers while enabling energy imbalance markets and utilizing resources located within distribution systems
- **Local & metro transmission** – transitioning from one-way energy delivery systems to becoming generation gathering networks for solar, wind, and storage farms and for enabling electrification
- **Distribution** – increasingly required to manage myriad generation and load-modifying resources, accommodate customer/merchant-owned systems (incl microgrids), and deliver energy services into wholesale markets

A future grid will need to handle the bi-directional flow of electricity, apply alternative grid configurations, and coordinate planning and operations across multiple participants and jurisdictions

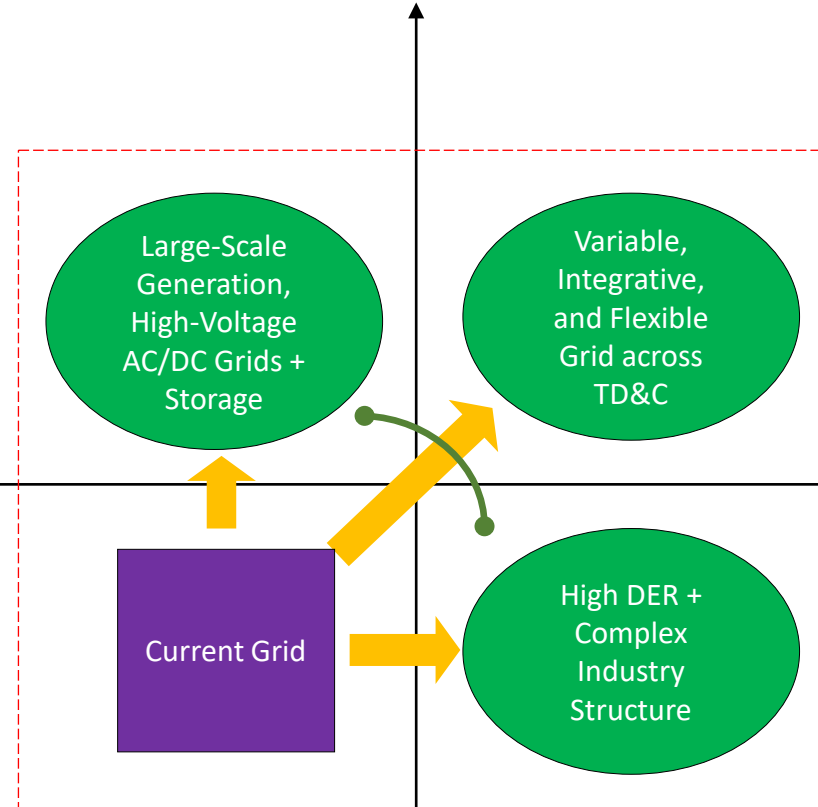
Grid Trajectory Considerations



Capital Intensive
Economies of scale



Loose Coupling
Agile/Flexible

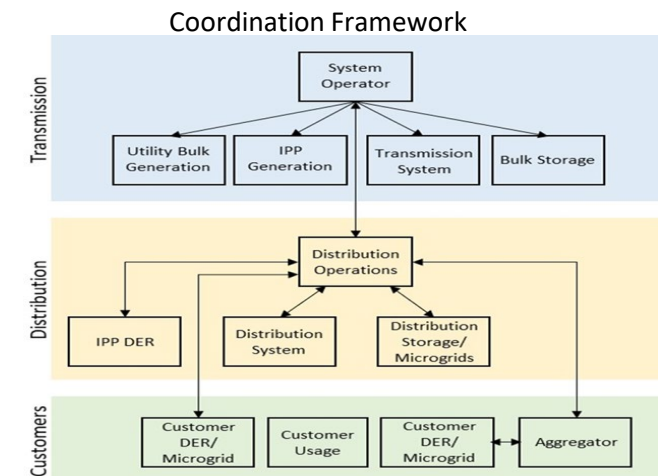


Tight Coupling
Rigid/Brittle

Next-Generation Electricity Network

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

Capital Diffuse
Network economies





Questions?

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