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U.S. Department of Energy

Grid Modernization Initiative (GMI)

Integration of Renewable and Distributed Energy Resources (IRED) 2018

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U.S. DEPARTMENT OF ENERGY

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Five Key Trends Driving Grid Transformation

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- Changing mix of types and characteristics of electric generation (in particular, distributed and clean energy)
- Growing demands for a more resilient and reliable grid (especially due to weather impacts, and cyber and physical attacks)
- Growing supply- and demand-side opportunities for customers to participate in electricity markets
- Emergence of interconnected electricity information and control systems
- Aging electricity infrastructure

Creating a 21st Century Grid

Responding to the drivers of change

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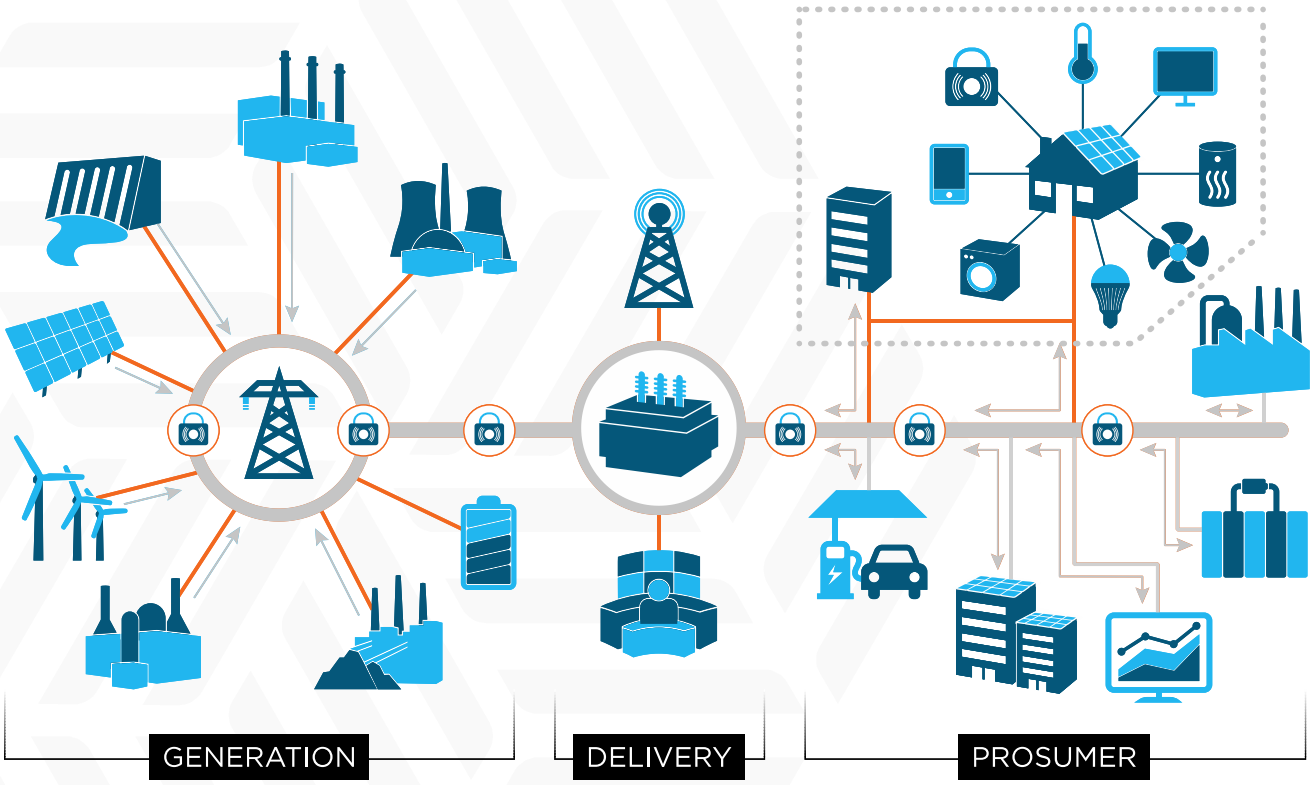

Grid Modernization Initiative (GMI)

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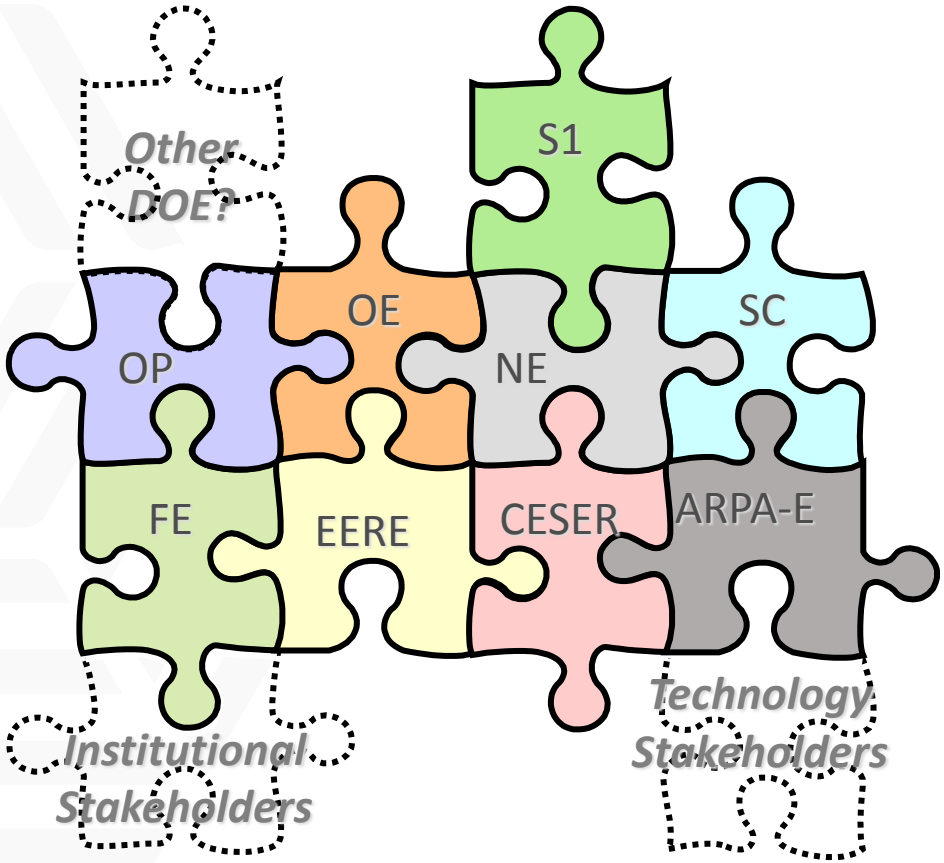
An aggressive and urgent five-year grid modernization strategy for the U.S. Department of Energy (DOE) that:

- **Aligns existing base activities across DOE offices**
- **Defines a vision for the modern grid through an integrated Multi-Year Program Plan (MYPP)**
- **Establishes new activities to fill major gaps in the existing base**
- **Leverages strategic partnerships through a laboratory consortium with core scientific abilities and regional outreach**



Create a Five Year Plan: Grid Modernization Multi-Year Program Plan (MYPP)

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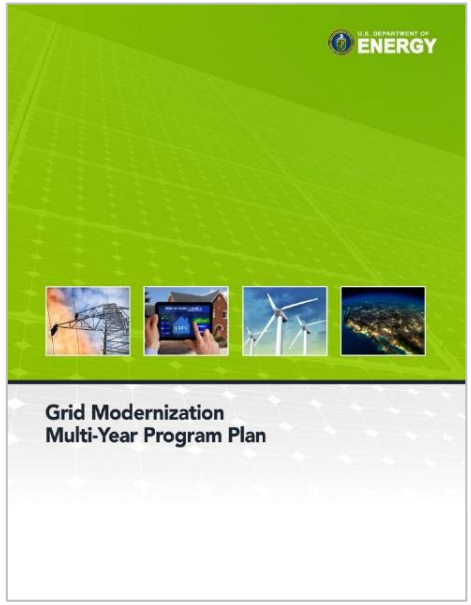
- Design and Planning Tools
- System Operations, Power Flow, and Control
- Sensing and Measurements
- Devices and Integrated Systems
- Security and Resilience
- Institutional Support



Integrate Technical Thrusts in the Grid Modernization MYPP

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Design and Planning Tools	• Create grid planning tools that integrate transmission and distribution and system dynamics over a variety of time and spatial scales
System Operations, Power Flow, and Control	• Design and implement a new grid architecture that coordinates and controls millions of devices and integrates with energy management systems
Sensing and Measurements	• Incorporate information and communications technologies and advance low-cost sensors, analytics, and visualizations that enable 100% observability
Devices and Integrated Systems	• Develop new devices to increase grid services and utilization and validate high levels of distributed energy resources at multiple scales
Security and Resilience	• Develop resilient and advanced security (cyber and physical) solutions and real-time incident response capabilities for emerging technologies and systems
Institutional Support	• Provide tools and data that enable more informed decisions and reduce risks on key issues that influence the future of the electric grid/power sector

Coordinate the National Laboratories: Grid Modernization Laboratory Consortium (GMLC)

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Move from a collection of DOE and lab projects to a DOE-lab consortium model that integrates and coordinates laboratory expertise and facilities to best advance DOE grid modernization goals

Efficiency ▪ Synergy ▪ Collaboration ▪ Acceleration

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Grid Modernization Lab Call 2016

Working across the country

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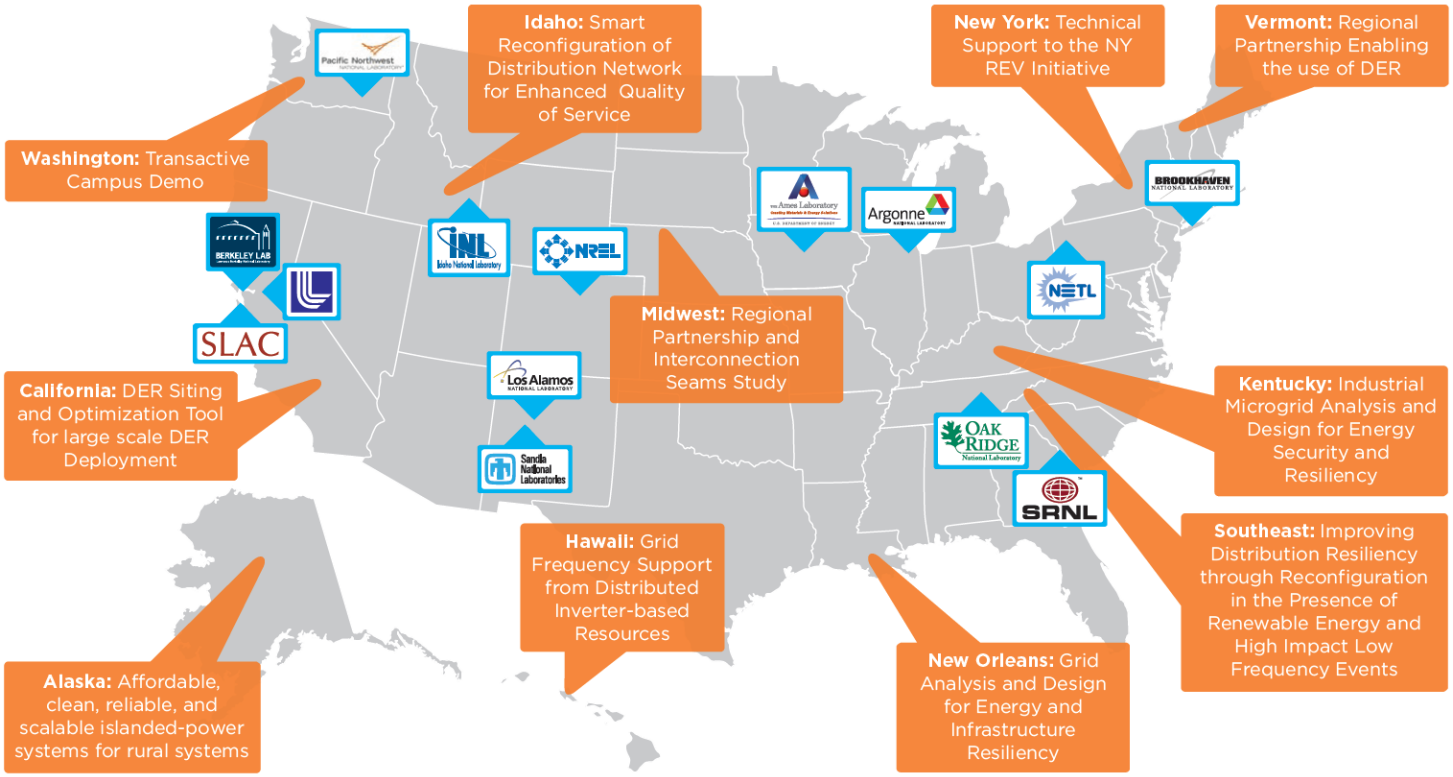

- Up to $220M
- 13 national laboratories
- 88 projects
- 150+ partners

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Involve a Diverse Group of Stakeholders

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Design and Planning Tools

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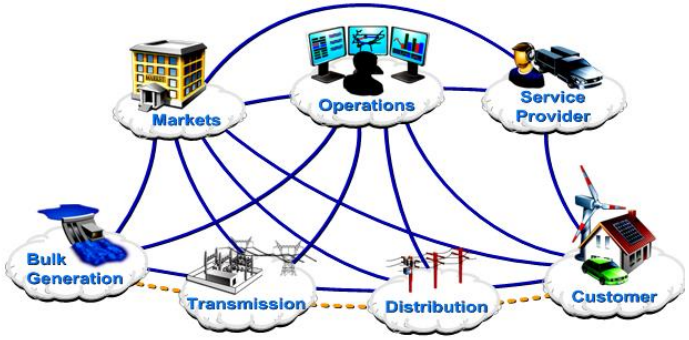
Objective: Drive development of next-generation tools that address evolving grid needs

Expected Outcomes

- A software framework to couple grid transmission, distribution, and communications models to understand cross-domain effects
- The incorporation of uncertainty and system dynamics into planning tools to accurately model renewables, extreme events, etc.
- Computational tools, methods, and libraries that enable a 1,000x improvement in performance



Simulating Interactions across Domains

Computational Speedup

System Operations, Power Flow, and Control

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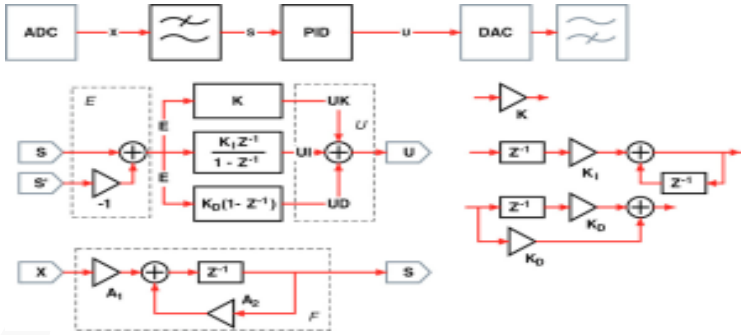
Objective: Develop advanced control technologies to enhance reliability and resilience, increase asset utilization, and enable greater flexibility of transmission and distribution systems

Expected Outcomes

- By 2020, deliver an architecture, framework, and algorithms for controlling a clean, resilient, and secure power grid
  - Leveraging advanced concepts, high performance computing, and more real-time data than existing control paradigms
  - Involving distributed energy resources as additional control elements
- Develop software platforms for decision support, predictive operations, and real-time adaptive control
- Deploy—through demonstration projects—new classes of power flow control device hardware and concepts
- Advance fundamental knowledge for new control paradigms (e.g., robustness uncompromised by uncertainty)



Conventional Controls

Distributed Controls

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Sensing and Measurements

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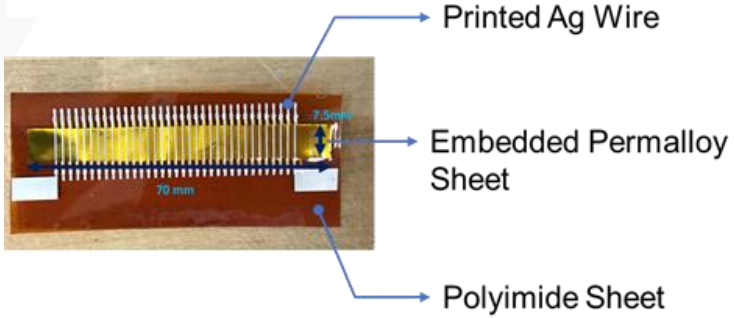
Objective: Develop low cost, advanced sensor and deployment strategies to provide complete grid system visibility for system resilience and predictive control

Expected Outcomes

- Advance and integrate novel, low-cost sensors to provide system visibility
- Develop next-generation, low-cost sensors that are accurate through disturbances to enable closed-loop controls and improved system resilience
- Develop real-time data management and data exchange frameworks that enable analytics to improve prediction and reduce uncertainty



Devices and Integrated Systems

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Objective: Develop and update interconnection and interoperability methods, protocols, standards & test procedures

Focus Areas

- Work across DOE Program offices to develop technologies that provide a **range of grid services**
- Develop and **update interconnection and interoperability methods**, protocols, standards & test procedures
- Conduct technology and **integrated system testing and validation**

Expected Outcomes

- Develop new grid interfaces to **increase ability of new technology to provide grid services** for reliability, resilience and increase utilization of infrastructure
- Coordinate and support the development of interconnection and interoperability standards and test procedures for provision of grid services **across all element of the grid**
- Validate secure and reliability grid operation with **all forms of energy** at multiple scales (microgrids to transmission systems)

Institutional Support

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Objective: Support and manage institutional change in a period of rapid (and potentially disruptive) technological innovation

Expected Outcomes

- Address high-priority grid modernization challenges and needs identified by electric power industry stakeholders, with particular emphasis on state policymakers and regional planning organizations
- Convene key grid stakeholders as an honest-broker for collaborative dialogues on grid modernization
- Create an overarching suite of grid-related "institutional" analysis, workshops, and dialogues to highlight challenges and explore options for transforming the grid, focusing on key policy questions related to new technologies, regulatory practices, and market designs

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Security and Resilience

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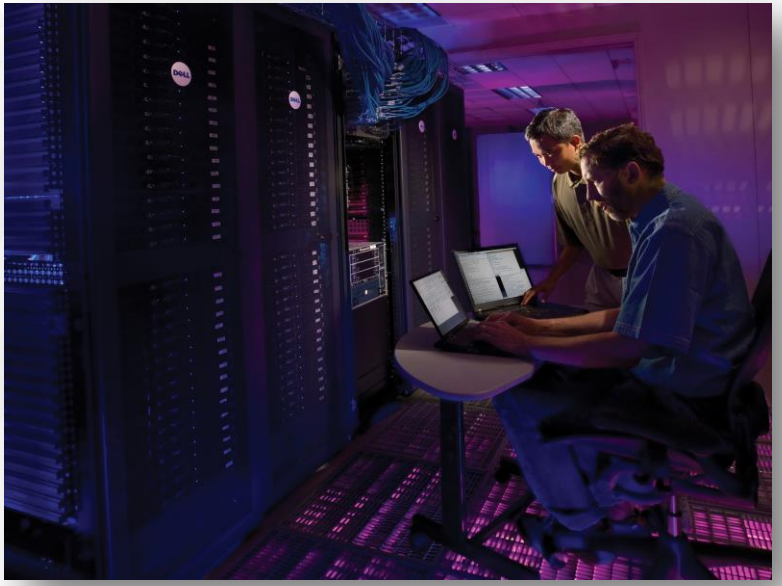
Objective: Provide a pathway to comprehensive multi-scale security and resilience for the nation's power grid

Expected Outcomes

- Holistic grid security and resilience—from devices, to microgrids, to systems
- Inherent security designed into components and systems, not security as an afterthought
- Security and resilience addressed throughout system lifecycle and covering the spectrum of legacy and emerging technologies



Resilient Distribution Systems

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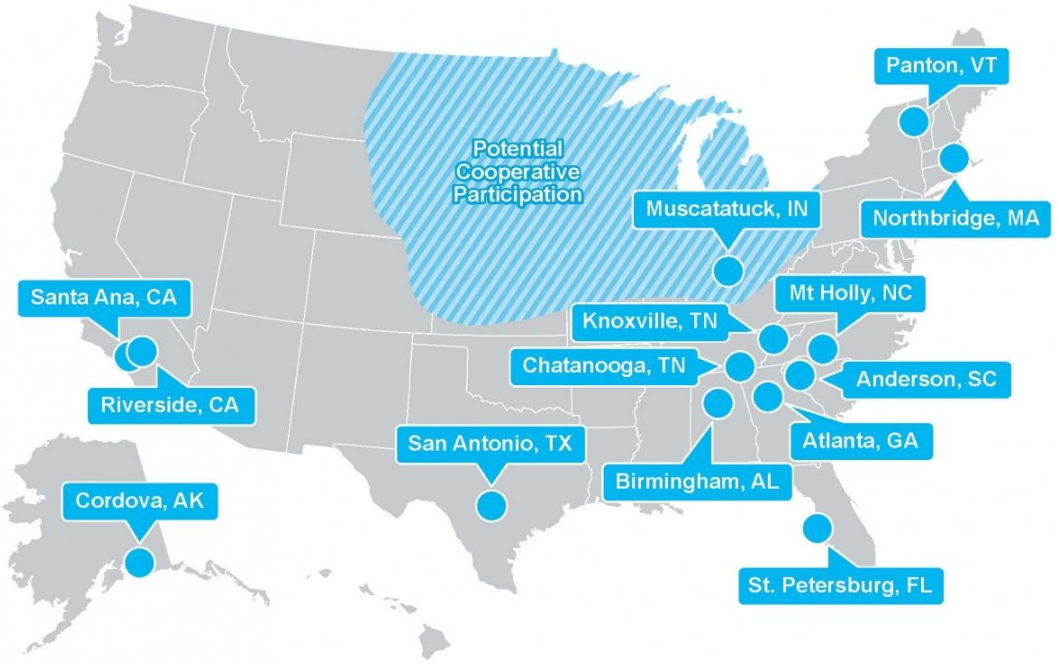
- Seeks to develop innovative approaches to enhance the resilience of distribution systems, including microgrids, with high penetration of clean distributed energy resources (DERs).
- Focuses on field validations, including control/coordination strategies, real-time system monitoring, robust communications infrastructure, grid planning and analytical platforms, and integration of multiple DER technologies.
- Addresses cybersecurity needs in grid technologies from the earliest stages to survive a cyber incident.
- Builds upon previous GMLC work

- **Period of Performance –** FY18/19/20
- **Total Funding –** $32M



Map of Research Locations for Selected Projects

Beyond the Levelized Cost of Energy (LCOE)

LCOE is not a bad metric…but an incomplete one

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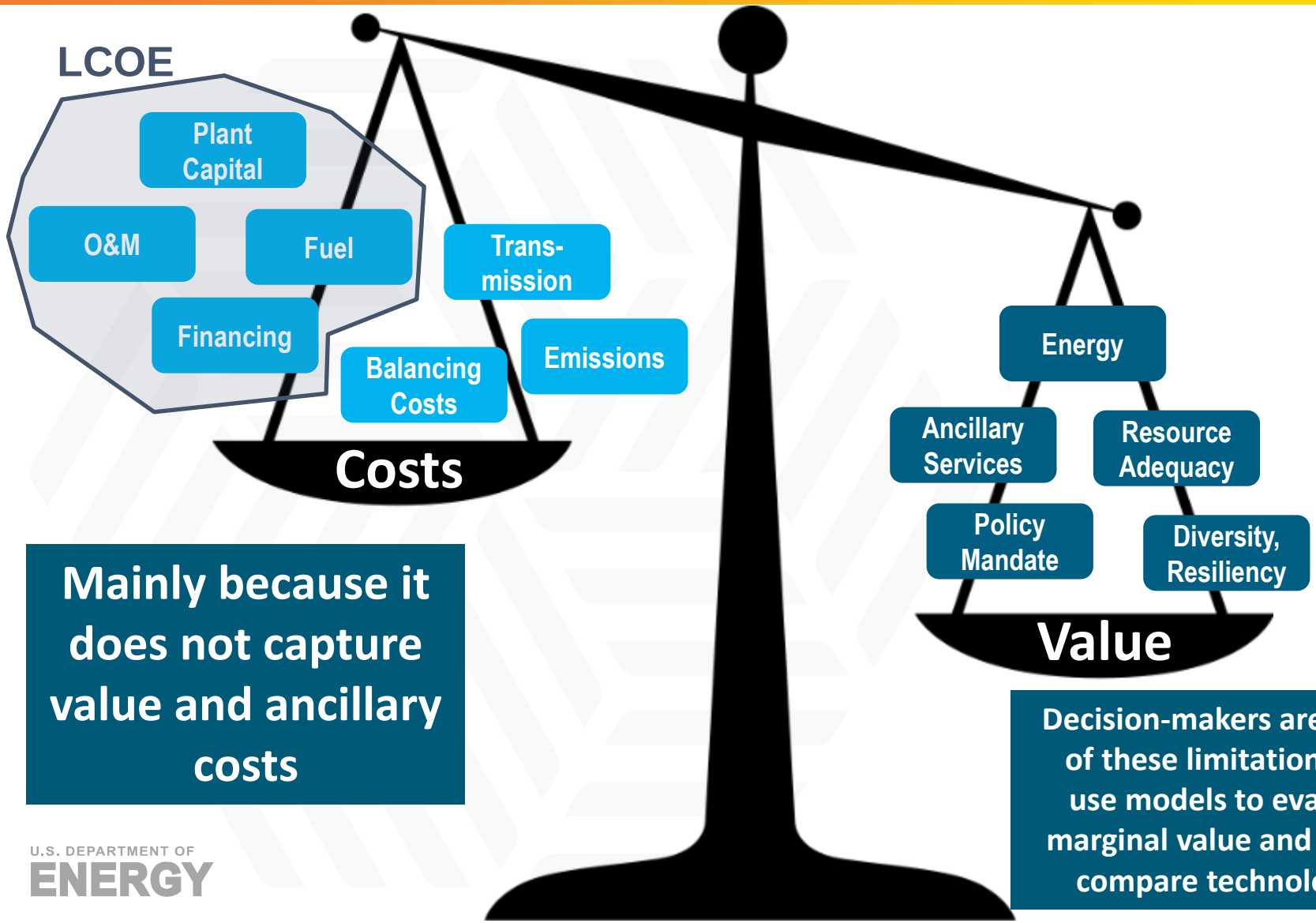

Mainly because it does not capture value and ancillary costs

Decision-makers are aware of these limitations and use models to evaluate marginal value and cost to compare technologies

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Thank You

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Contact us at gmi@hq.doe.gov
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