# Discussion on Addressing the Transformational Challenges of the Electric Grid
## (Section 8008, “Pathways”)

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Electricity Advisory Committee Meeting

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# Section 8008 (H.R. 133, Energy Act of 2020)

## Section 8008 – Establishment of Voluntary Model Pathways

In consultation with a Steering Committee [EAC, plus FERC and national lab representation] initiate the development of model pathways for modernizing the electric grid through a collaborative, public-private effort that:

a) Produces illustrative policy pathways encompassing a diverse range of technologies that can be adapted for state and regional applications by regulators and policymakers
b) Facilitates the modernization of the electric grid and associated communications networks to achieve the objectives:
    1) Near-time situational awareness
    2) Advanced monitoring and control, and data visualization
    3) Enhanced certainty of policies for investment in the electric grid
    4) Increased innovation
    5) Greater consumer empowerment
    6) Enhanced reliability and resilience
    7) Improved integration of DER, interoperability, and predictive modeling/forecasting
    8) Diversification of generation resources
    9) Reduced cost of service to consumers
c) Ensures a reliable, resilient, affordable, safe, and secure electric grid
d) Acknowledges and accounts for different priorities, electric systems, and rate structures across States and regions

Includes providing technical assistance

H.R. 133 – Consolidated Appropriations Act of 2021 (contains the Energy Policy Act of 2020, Title VIII – Grid Modernization, Section 8008 begins on page 1405); download pdf at: https://www.congress.gov/bill/116th-congress/house-bill

# Steering Committee Membership and Process

**Andrew Barbeau**, The Accelerate Group
**Tom Bialek**, Toumetis
**Daniel Brooks**, Electric Power Research Institute
**Robert Cummings**, Red Yucca Power Consulting
**Andrew Fellon**, Alliance Advisory Services
**Flora Flygt**, American Transmission Company (Ret.)
**David Kathan**, Federal Energy Regulatory Commission
**Robert Jeffers**, Sandia National Laboratory
**Jessica Lau**, National Renewable Energy Laboratory
**Peter Larsen**, Lawrence Berkley National Laboratory
**Jessica O. Matthews**, Uncharted Power, Inc.
**Darlene Phillips**, PJM Interconnection LLC
**Wanda Reder**, Grid-X Partners, LLC
**Tom Weaver**, American Electric Power Company, Inc (Ret.)

**Facilitation and Support:**
Joe Paladino - DOE
Gil Bindewald - DOE
Matt Aronoff - DOE
Benjamin Stafford - ICF
Daniel Gray - ICF
Samir Succar - ICF

EAC

**Guidance to DOE on how to address the problem:**

- What to address and with whom

# Analytical Approach

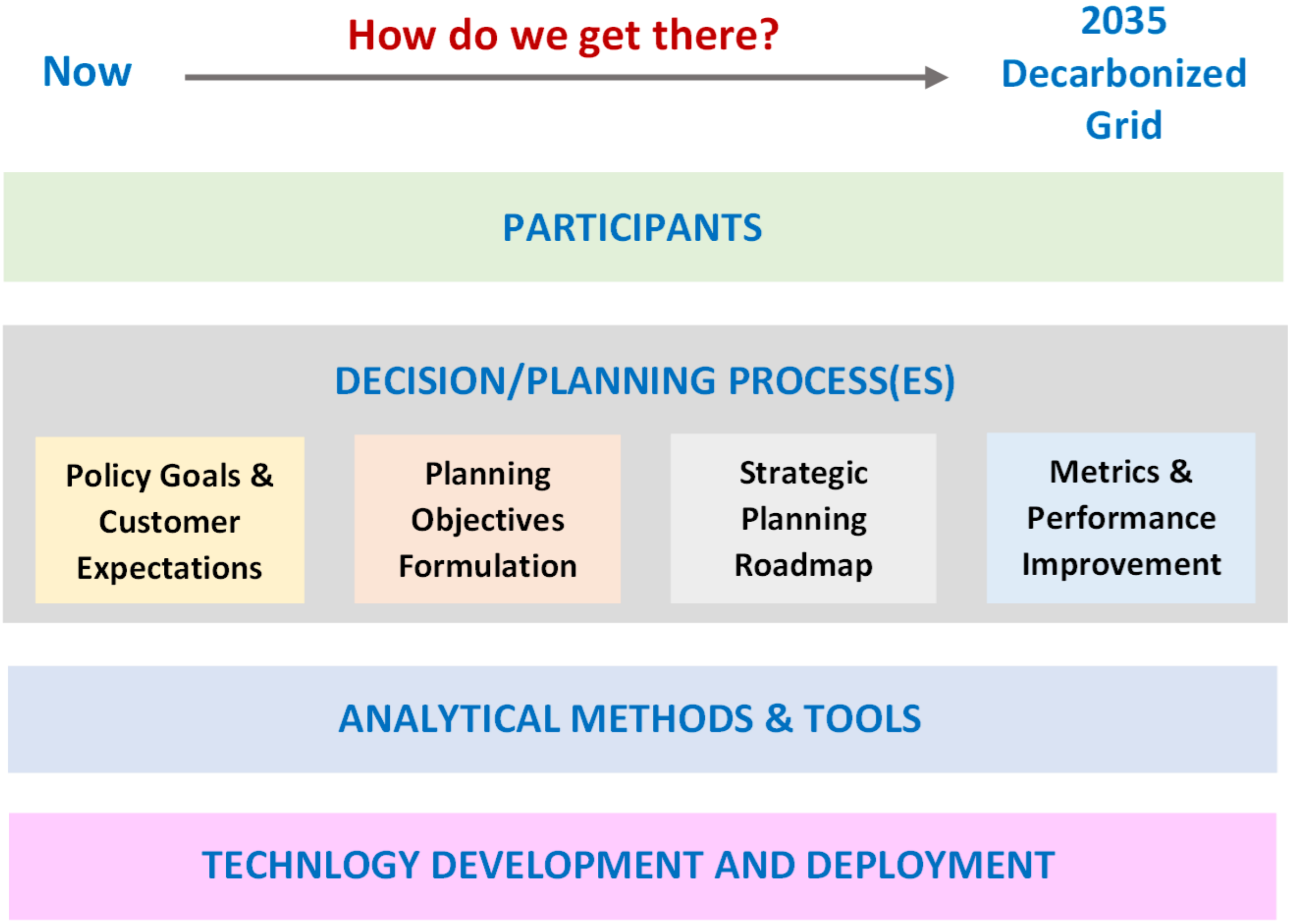
**August 2021 - Present**

Facilitated discussion of six scenarios:

1. A robust transmission system
2. A plug-and-play distribution system
3. The coordination of planning, operations, and market design/operations across the transmission, distribution, and behind-the-meter domains
4. Incorporation of flexibility into grid operations and design
5. Incorporation of resilience into grid operations and design
6. Mechanisms that accelerate the adoption of advanced technological capabilities

Within each Scenario:

- Who would need to be involved within decision processes associated with each scenario?
- What decision processes exist or need to be developed to address the key challenges associated with each scenario?
- What are the analytical requirements needed to support decision-making?
- What technologies and system capabilities are needed to enable the scenarios?



# Scenario 1 – A Robust Transmission System

**A robust transmission system that supports:**

a) Efficient use of remote renewable energy
b) Electrification
c) Efficient movement of power (e.g., along high-voltage backbones)
d) Application of alternative configurations, e.g., microgrids
e) Utilization of DERs and energy storage

**Sample Key Challenges:**

- Current planning processes are not well-coordinated across jurisdictions and/or regions. The critical federal role in promoting integrated multi-level planning remains unclear.
- Many of the needed modeling and simulation tools for examining and comparing system options do not exist, plus analytical platforms for transmission and distribution operate on different platforms, making the exchange and analysis of information difficult.
- We need regulatory certainty (e.g., siting transmission lines). Who is responsible for providing it, and what form does it take?

**Considerations:**

Facilitate holistic, higher-level planning capabilities at a regional, bulk power system and/or national level(s) that examine and assess scenarios and options to inform state and regional planners.

# Scenario 2 – A Plug-and-Play Distribution System

## A plug-and-play distribution system that supports:

a) The utilization of all forms of DERs and energy storage
b) Evolving business, industry, and market structures
c) Convergence with transportation and building infrastructures
d) Electrification

## Sample Key Challenges:

- Methods and tools for modeling DER system behavior and impacts, including control schemes for orchestrating myriad inverter-based resources, remain nascent.
- Distribution-level grid interoperability will become critical for attracting innovation and growth. Two aspects of interoperability require consideration: 1) communication of data across systems and 2) plug-and-play integration of physical components.
- There is a discrepancy between what utilities say grid investment roadmaps will cost to implement compared to what regulators believe it will cost.

## Considerations:

Apply a system engineering capability and implement integrated distribution planning processes with supporting technical assistance that provide a shared understanding of strategies for building out distribution systems to meet demands.

# Scenario 3 – Coordination of planning, operations, and market design

## Coordination of planning, operations, and market design/operations across the T/D/BTM domains:

a) How does the evolution of markets, consumer preferences, and technological options affect changes at the grid edge and how do they impact grid operations?
b) How do we accommodate the different business models and what conditions are required for them to be sustainable for market participants?
c) How do we determine system criteria that drive the need for grid services, including from DERs?

## Sample Key Challenges:

- Coordination of planning, grid operations, and market design/operations across the transmission, distribution, and behind-the-meter domains is needed, but nascent. There are no operational coordination frameworks in place to effectively utilize services from DERs across the system.
- Operational continuity under normal and contingency situations will be necessary. There is a need to find a level of consensus on control architectures.
- Utilities are seeing FERC Order 2222 requirements as a reason to pursue DSO, but there is no ISO/RTO or FERC authority to impose any such model on distribution utilities.
- Methods for determining resource adequacy that can factor in the contribution of DERs are nascent, but evolving.

## Considerations:

Develop and vet operational coordination framework guidelines that take into account the roles and responsibilities of all participants and system requirements under all situations.

# Scenario 4 – Incorporation of flexibility into grid operations and design

## Incorporation of flexibility into grid operations and design through application of:

a) Energy storage, flexible generation, and flexible demand
b) Advanced control and computing technology for real-time operations
c) Modeling and simulation tools for planning and design purposes

## Sample Key Challenges:

- Authority to require/ensure flexibility is dispersed and/or undefined. The characteristic of flexibility may be implied in existing regulations, but not explicitly defined and/or required.
- The development of flexibility requirements and their incorporation into implementable solutions and infrastructure investment strategies requires more study. Planning is one potentially appropriate venue for flexibility analysis, however, new analytical approaches, including modeling and simulation tools, need to be developed.
- The pricing and incentives for flexibility products is nascent or undefined. How do markets price and incentivize flexibility?
- How do we address policy and technological uncertainty?

## Considerations:

Undertake a flexibility gap analysis to identify current practices and future needs. Understanding to what extent flexibility concerns are already embedded in current markets and operations is critical. In parallel, build a common language to inform regulators, as there is a need for a regulatory “business case” for multi-value assets, including flexibility value.

# Scenario 5 – Incorporation of resilience into grid operations and design

**Incorporation of resilience into grid operations and design through application of:**

a) Energy storage, flexible operations, and alternative grid designs
b) Planning approaches incorporating risk management methods that span community, state, and regional jurisdictions

## Sample Key Challenges:

- Formal methods that incorporate resilience into integrated planning processes are developing, but not institutionalized in a way that permits the formulation of investment strategies that are balanced with myriad objectives.
- Coordination is required across jurisdictions (e.g., community, city, state, multi-state, and federal) to set objectives and determine resilience strategies that mitigate the impact of threats. Such coordination exists in regards to bolstering emergency preparedness, but not for implementing advanced grid designs and functional capabilities.
- Cyber security continues to be a broad concern, in addition to supply chain risks.

## Considerations:

Establish formal methods for incorporating resilience into integrated planning processes that can balance priorities across several objectives beginning at the community/state level and expanding into the multi-state level.

# Scenario 6 – Accelerate adoption of advanced technological capabilities

**Mechanisms for accelerating the adoption of advanced technological capabilities:**

a) How do we inform state policy-makers and regulators of beneficial advancements in technology so that they can develop with utilities rational infrastructure investment roadmaps?
b) How do we improve the efficiency of technology adoption by utilities?

**Sample Key Challenges:**

- Regulators and IOUs do not have a shared understanding of requirements and steps needed for grid modernization and infrastructure investments impeding our ability to achieve decarbonization and resilience goals.
- Interoperability remains a challenge across the industry and jurisdictions. Regulatory adoption of interoperability standards is inconsistent. Jurisdictional differences drive varied deployments, which ultimately may lead to inconsistent market development.
- Bridging the "valley of death" between grid technology R&D and its adoption by utilities requires integrated system demonstrations which are underfunded.

**Considerations:**

- Establish formal methods for incorporating resilience into integrated planning processes that can balance priorities across several objectives beginning at the community/state level and expanding into the multi-state level.
- Continue the work of the Smart Grid Interoperability Panel (circa 2010-2015) with federal support and incentives for coordinated industry leadership to address interoperability issues.

# Cross-Cutting Issues

- Workforce preparedness – training and development is needed for regulatory agencies, institutions.
- Cross-jurisdictional communication is essential for planning, operations, and market design.
- Integrated planning is an opportunity as policy, technology, and markets quickly evolve.
- Interoperability standards remain underdeveloped across and within grid domains.
- Institutional organizational development and technical assistance is needed.
- Equity must be at the forefront of energy transition across domains.

# Next Steps

- Steering Group identifies strategies to address key challenges
- EAC makes recommendations to DOE
- Establish stakeholder engagement strategies
- Develop model Voluntary Policy Pathways
  - Determine roles and responsibilities across stakeholders, including DOE

# Appendix – Scenario Descriptions

# Scenario 1

**A robust transmission system that supports:**

- Efficient use of remote renewable energy
- Electrification
- Efficient movement of power (e.g., along high-voltage backbones)
- Application of alternative configurations, e.g., microgrids
- Utilization of DERs and energy storage

For example, what are the pathways for addressing institutional and technological challenges associated with the following questions:

- Do we need to institute multi-state solutions?  How do we do that?
- How do we optimize the topology of the electric grid to enable the efficient transfer of power from remote renewable resources, e.g. from offshore wind locations, to population centers?
- How do we support the electrification of transportation and buildings?
- How do we consider and implement the application of high-voltage AC and/or DC backbones to address regional and interregional (seams) requirements?
- How do we account for resource adequacy given a changing resource mix?
- How do we improve system resilience and flexibility, for example through the application of microgrids and energy storage systems?
- How do we address loss of system inertia as we increase reliance on inverter-based resources?
- How do we balance grid-control solutions versus market-based solutions?
- What observability, control, and coordination strategies do we need to integrate DERs into transmission system operations?
- How do we address cost recovery?

# Scenario 2

**A plug-and-play distribution system that supports:**

a. The utilization of all forms of DERs and energy storage
b. Evolving business, industry, and market structures
c. Convergence with transportation and building infrastructures
d. Electrification

**For example, what are the pathways for addressing institutional and technological challenges associated with the following questions:**

- How do we incorporate resilience, equity, and decarbonization policy goals into implementable solutions and infrastructure investment strategies? How do we prioritize between complementary and competing objectives with limited resources?
- How do we ensure interoperability between devices and systems?
- How do we manage DERs and how do we control and utilize inverter-based resources to support grid operations? And wholesale markets?
- How do we formulate grid modernization strategies with the appropriate functional and structural characteristics to address evolution at the grid edge, including convergence of the grid with the transportation, buildings, and telecommunications, infrastructures?
- How do we improve system resilience and flexibility?
- How do we coordinate distribution and behind-the-meter assets, and how do they coordinate with transmission system operations?
- How do we assign value to DERs?
- How do we enable customer choice and equity?

# Scenario 3

**Coordination of planning, operations, and market design/operations across the transmission, distribution, and behind-the-meter domains.**

**For example, what are the pathways for addressing institutional and technological challenges associated with the following questions:**

- How does the evolution of markets, consumer preferences, and technological options affect changes at the grid edge and how do they impact grid operations?
- How do we accommodate the different business models and what conditions are required for them to be sustainable for market participants?
- How do we determine system criteria that drive the need for grid services, including from DERs?
- How do we determine control strategies (e.g., though prices, direct control, and autonomous control) that that will shape T/D/BTM coordination requirements, keeping in mind we need to maintain a reliable and resilient system?
- How do we address temporal and spatial (architecture) issues, e.g., tier-bypassing, conflicting control signals, and laminar coordination to permit co-optimization of local and system interests?
- How do we address lack of homogeneity in the US RTO/ISO markets or related state policies/regulation?
- How do we address interoperability given edge device manufacturers' proprietary strategies for their products/systems?
- How do we reach a “level of consensus” by which the DER community determines how to work with utilities?
- How do we develop practical approaches for implementing coordination frameworks that address: a) the roles and responsibilities of all participants (including grid codes), b) data and information flow requirements, and c) observability, communication, computing, and control requirements?

# Scenario 4

**Incorporation of flexibility into grid operations and design through application of:**

- Energy storage, flexible generation, and flexible demand
- Advanced control and computing technology for real-time operations
- Modeling and simulation tools for planning and design purposes

**For example, what are the pathways for addressing institutional and technological challenges associated with the following questions:**

- How do we institute a flexibility metric?
- What are the techniques used for improving flexibility (e.g., through the application of flexible generation, flexible demand, discrete or networked energy storage devices, and advanced control systems) and how do we institute them?
- How do we develop flexibility requirements and incorporate them into implementable solutions and infrastructure investment strategies? How do we address flexibility requirements as we scale from community-based domains to multi-state domains?
- How do we address policy and technologic uncertainty?

# Scenario 5

- **Incorporation of resilience into grid operations and design through application of:**
- Energy storage, flexible operations, and alternative grid designs
- Planning approaches incorporating risk management methods that span community, state, and regional jurisdictions

**For example, what are the pathways for addressing institutional and technological challenges associated with the following questions:**

- What are the techniques used for improving resilience, e.g., through the application of alternative grid configurations, such as microgrids, and adaptive control mechanisms?
- How do we incorporate resilience, goals into implementable solutions and infrastructure investment strategies? How do we address resilience needs as we scale from community-based domains to multi-state domains?
- How do we address infrastructure interdependencies?
- How do we address policy and technologic uncertainty?
- How do we address cybersecurity?
- How do we address supply chain risks?
- How do we address workforce issues?
- What are the cost-recovery requirements?

# Scenario 6

**Mechanisms that accelerate the adoption of advanced technological capabilities**

**For example, what are the pathways for addressing institutional and technological challenges associated with the following questions:**

- How do we inform state policy-makers and regulators of beneficial advancements in technology so that they can develop with utilities rational infrastructure investment roadmaps?
- How do we improve the efficiency of technology adoption by utilities?