U.S. DEPARTMENT OF ENERGY
Office of Electricity

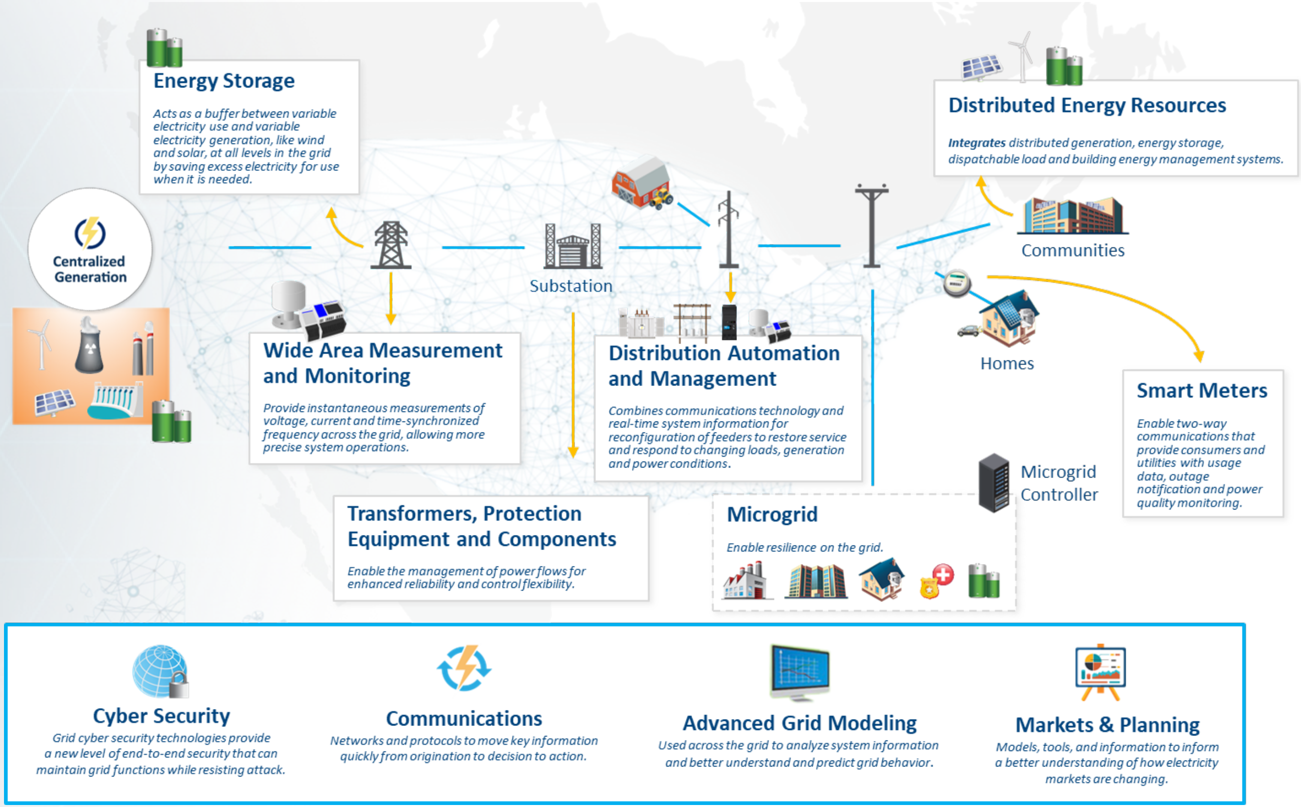
Promise of Integrated Distribution System Planning: *Unlocking the Power of Collaboration to Realize Our Energy Future*

Gil Bindewald

Principal Deputy Assistant Secretary,
Office of Electricity

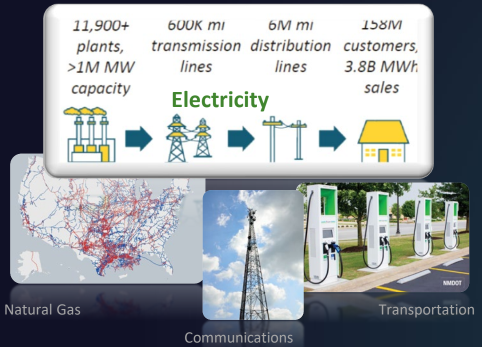
September 2024

The Grid: A Complex System of Systems

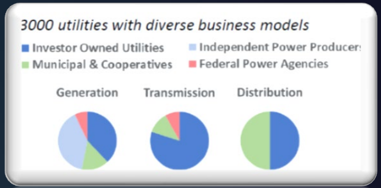


The Grid Reality

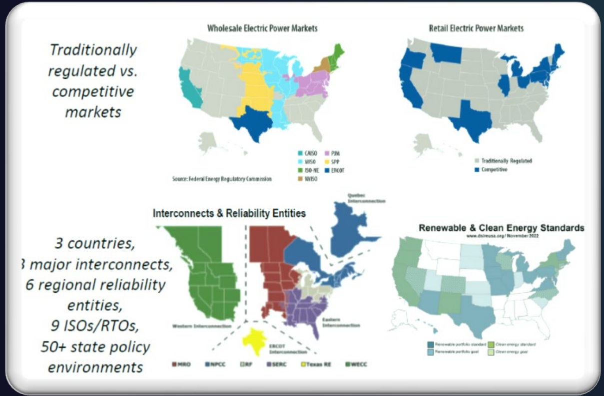
Infrastructure environment



Institutional environment



Regulatory, governance, and market environment



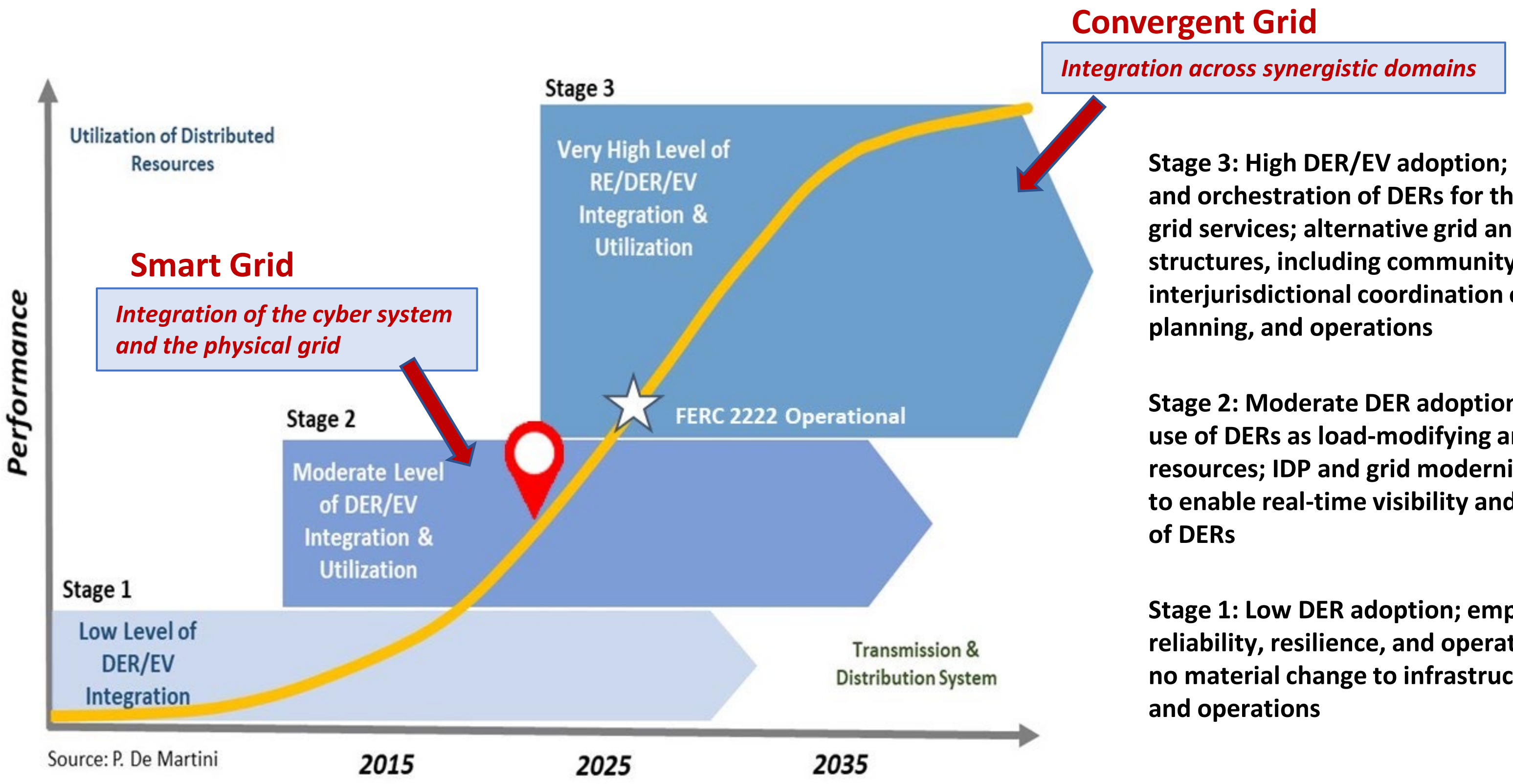
Threat environment

Role of customers

- Evolving convergence of utility, 3rd-party, and customer systems and priorities
- New, rapidly emerging types of participants offering grid services and technologies which need to coherently integrate with the legacy system

Distribution System Evolution & the Grid Edge

Increased use of distributed energy resources means additional complexity in grid planning and operations



Stage 3: High DER/EV adoption; optimization and orchestration of DERs for the provision of grid services; alternative grid and ownership structures, including community microgrids; interjurisdictional coordination of markets, planning, and operations

Stage 2: Moderate DER adoption; emphasis on use of DERs as load-modifying and energy resources; IDP and grid modernization required to enable real-time visibility and operational use of DERs

Stage 1: Low DER adoption; emphasis on reliability, resilience, and operational efficiency; no material change to infrastructure, planning, and operations

Key Challenges

The ability to utilize DERs reliability, securely, and cost-effectively at scale will require advancing and standardizing practices and processes across the industry, as well as within and across jurisdictions

The ability to utilize DERs reliably, securely, and cost-effectively at a large scale

requires advancing and standardizing practices and processes for

- Developing holistic and future-looking grid investment strategies that conform to stakeholder objectives and priorities through integrated planning practices
- Establishing roles and responsibilities, including data exchange requirements, for coordinated operations among all participants in the management, oversight, and delivery of services from DERs
- Addressing technology development and implementation requirements needed to support increasing levels of complexity in grid structure and function
- Ensuring seamless and secure interoperability between devices and systems
- Guaranteeing fair compensation for all parties where DER services provide value

Integrated Distribution System Planning

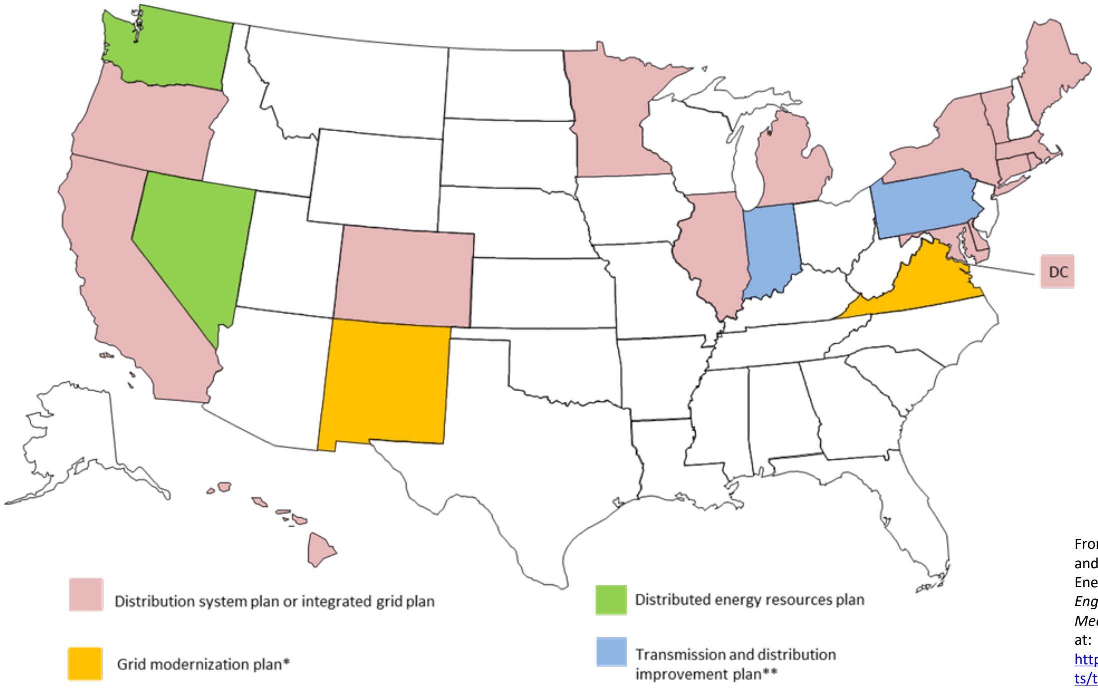
Distribution planning across the U.S. addresses 3 key overlapping areas of focus to meet customer needs

Key considerations:

- Convergence of state energy policy objectives and priorities with utility/3rd-party planning processes
- Integration of customer and 3rd-party systems with utility systems
- Coordination, control, and application of distributed energy resources (DERs)
- Improvement in reliability, resilience and operational efficiency, including asset management strategy
- The application of advanced sensing, communications, control, information management, and computing technologies to enable the above
- The application of grid architecture to ensure the building of a coherent system that is scalable
- Business process redesign to support effective planning, grid operations, and market operations

State Requirements for Filing Distribution System Plans

The practice of integrated distribution system planning is evolving and not universally or consistently applied across the U.S.



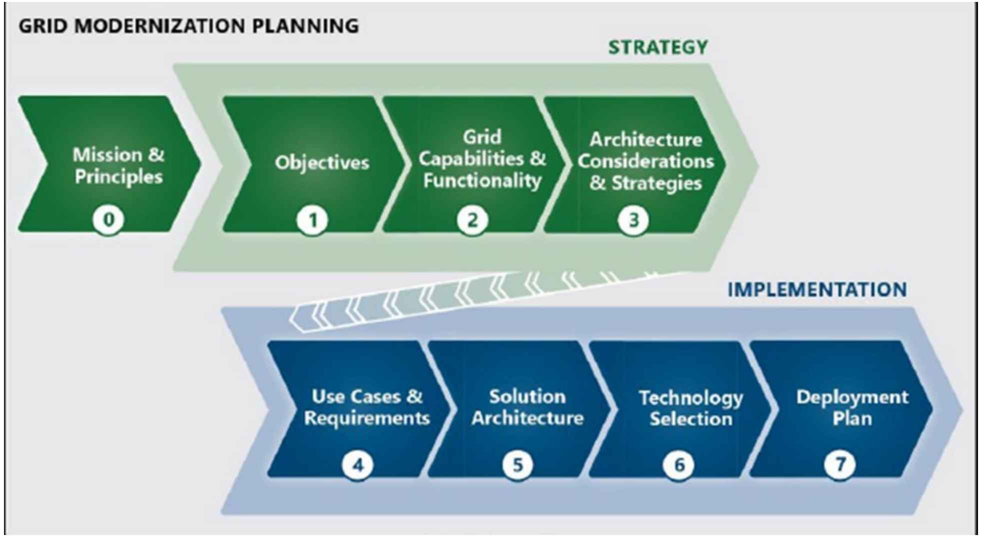
*Some states that require distribution system plans also require grid modernization plans (e.g., Minnesota and California).
**Indiana also includes storage.

From: S. Murphy, L. Schwartz, C. Reed, M. Gold, and K. Verclas. National Association of State Energy Officials. *State Energy Offices' Engagement in Electric Distribution Planning to Meet State Policy Goals*. 2023. Available online at: https://www.naseo.org/Data/Sites/1/documents/tk-news/naseo_electric-distribution-planning-final.pdf.

Grid Modernization Strategy & Implementation Planning

Resist the temptation to start with technology choices --- Community/state policy objectives, metrics, and priorities, combined with customer demand and DER/EV forecasts, are key inputs into the formulation of grid modernization strategies. These strategies should holistically address both functional and structural capabilities needed over time. Such strategies can then inform decisions on the selection and staged deployment of technology.

"To the man who only has a hammer, everything he encounters begins to look like a nail."
— Abraham Maslow



Source: *Modern Distribution Grid Guidebook, Strategy & Implementation Planning Guidebook*, Version 1.0 Final Draft, DOE Office of Electricity, June 2020; [Modern-Distribution-Grid_Volume_IV_v1_0_draft.pdf (pnnl.gov)]

Objectives and Priorities Guide Planning

A well-designed integrated system planning process provides a framework for translating policy objectives, metrics, and priorities into holistic infrastructure investment strategies

Metrics and analytical methods are well-established and applied

- Reliability
- Efficiency
- Decarbonization

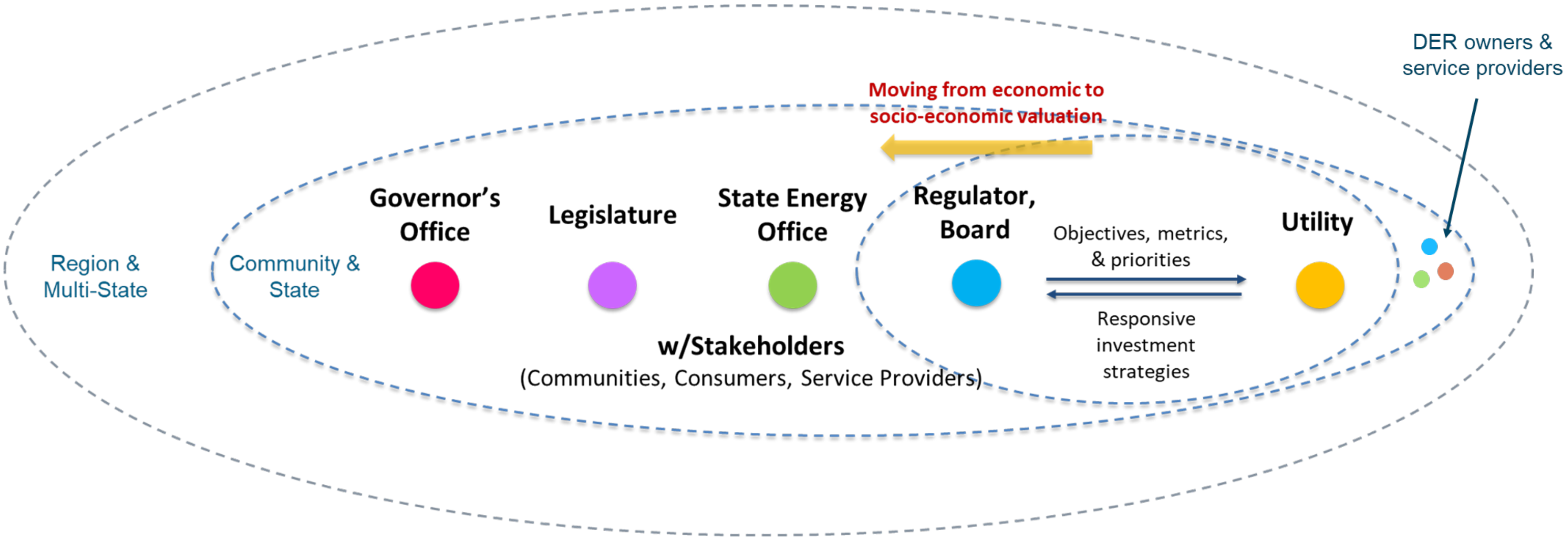
Metrics and analytical methods are not well-established and evolving

- Cost-Effectiveness
- Resilience
- Equity

Balancing and prioritization of objectives → Assessment of technological options and infrastructure deployment strategy

Broad Spectrum of Stakeholders

Integrated planning processes and supporting analytical tools are needed to address disparate objectives and priorities, as well as complexity and uncertainty, across multiple jurisdictions

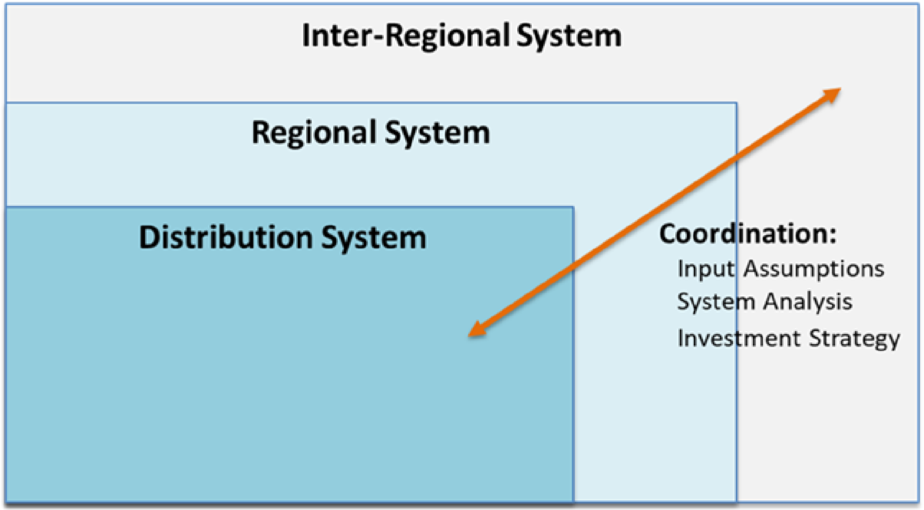


Coordination Across Multiple Jurisdictions

Advancements in decision practices and processes are needed for addressing technological and institutional challenges to enable the formulation of holistic, cost-effective, and forward-looking grid investment strategies

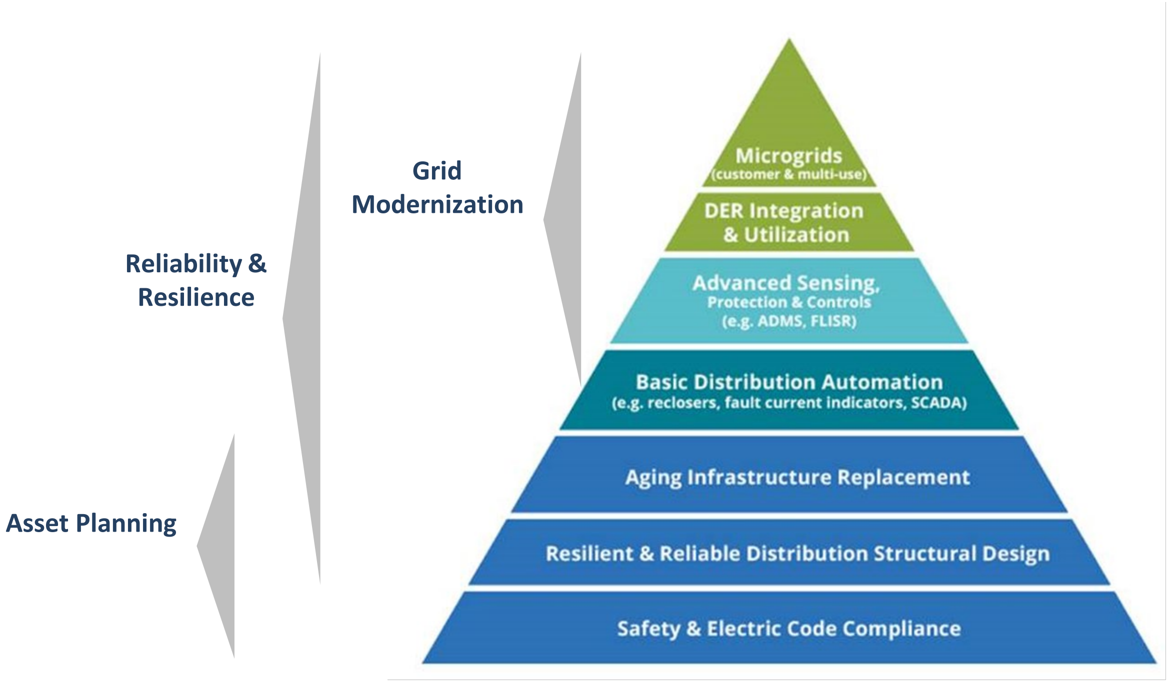
We are moving towards a regional, multi-state planning paradigm:

- DERs are becoming part of the resource mix
- Reliance on DERs may become more pronounced to satisfy load growth requirements (electrification) given transmission system constraints
- Strategic deployment of energy storage should be considered to address flexibility requirements.
- Resilience planning will require a combination of community, state, and regional investments, with comprehensive assessments of resource adequacy.
- Understanding interdependencies between the electricity and natural gas infrastructures and communications



Importance of Foundational Investments

Grid modernization technologies **layer on top of & integrate with** foundational physical grid infrastructure. Foundational investments are required to ensure reliability and resilience while enabling more advanced grid operations.

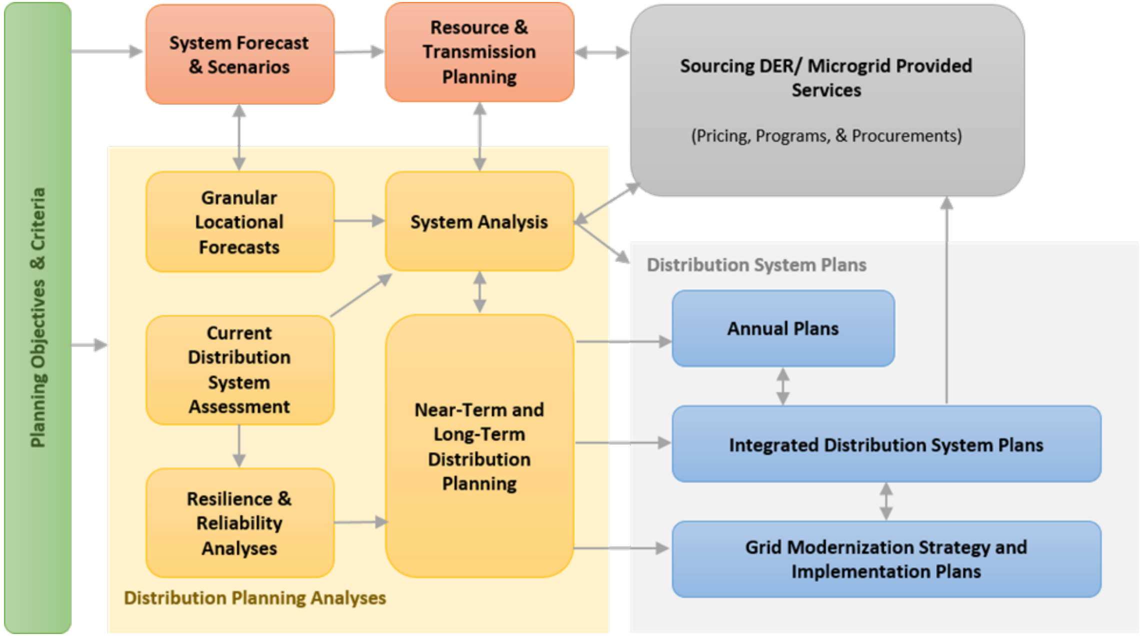


Source: De Martini

Components of Integrated Distribution System Planning

IDSP processes provide a platform for translating community/state objectives and priorities into holistic grid investment strategies with participation of key stakeholders

Planning objectives, metrics, and priorities are derived from state & community policies and customer needs



Regulators* review and approve plan with input from stakeholders

*The term "regulators" includes the approving boards of cooperative and municipal utilities

From Modern Distribution Grid Guidebook, DSPx Volume 4, June 2020, [PNNL: Grid Architecture - Modern Distribution Grid Project]

Integrated Distribution System Planning

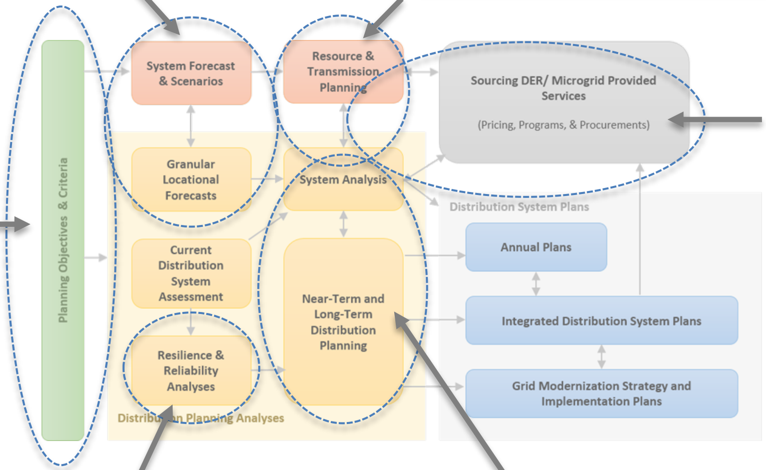
System and more granular forecasts of load, DER adoption, and electrification serve as key inputs

Coupling key assumptions and analytical findings (with co-optimization) between distribution and regional planning efforts

Translation of community and state policies, mandates, priorities, and metrics into IDSP planning guidance, for example, in the following areas:

- Reliability
- Resilience
- Equity
- Environmental
- Efficiency
- Affordability
- Economic development

This might include extensive stakeholder engagement, as well as threat-based risk assessments of the energy/electricity system.



Approaches for integrating and utilizing DERs for utility customers, as well as for serving operations and markets at both the distribution and bulk-power-system levels. This includes determining how to utilize DERs to optimize distribution system operations, as well as determining appropriate valuation and compensation mechanisms to incent the application of DERs where/when needed temporally and spatially

Determining reliability and resilience needs/priorities and informing the asset management strategy. Inputs derived from risk assessments, including climate forecasting, and stakeholder priorities

System engineering that determines a 10-year grid investment strategy which addresses policies, priorities, and forecasts; applies prioritization to establish top projects given constraints; and incorporates RD&D planning

Considering Equity and Resilience

Policy Development

E.G., policies on:
- Tax-based funding for resilience measures
- Treatment of vulnerable or disadvantaged populations
- Establishment of special committees, studies, and working groups

Regulation

- Provision of planning objectives and criteria to utilities, plus metrics
- Integrated planning guidelines
- Evaluation and approval of utility plans
- Establishment of working groups

Planning guidance to utilities

Utility Planning and Analysis

Utility annual and long-term plans to address resilience and grid modernization

Tiering of key infrastructure and populations

Formulation of resilience-based objectives and metrics

Threat-Based Risk Assessment

Where: risk = f(threat, vulnerability, consequence)

Threat assessment: identification and prioritization	Threat scenarios: assessment of impact of threat on infrastructure and populations

Forecasting of threat severity (low, medium, and high)

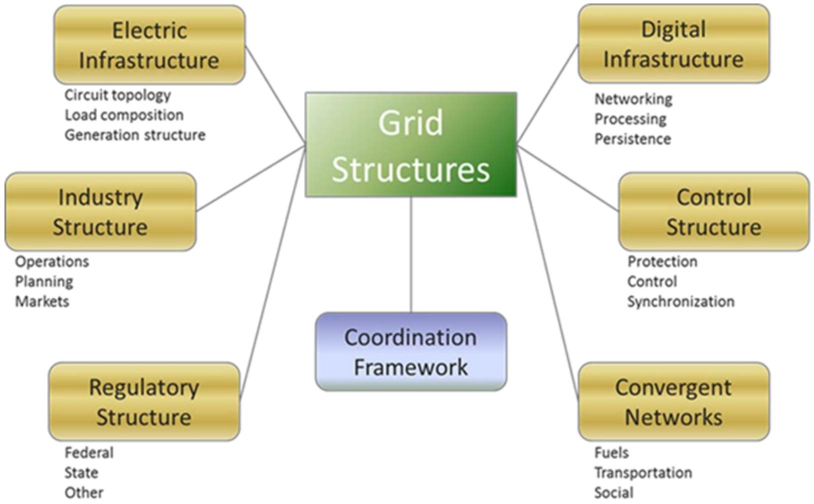
Reference HECO IGP Resilience Working Group Report, June 1, 2020: https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-and-community-engagement/working-groups/resilience-documents.

Redesigning the Electric Grid

Grid architecture is primarily about structure and ensuring coherence while addressing functional requirements needed over time

Key Architectural Principles:

- *Coordination* is the process that causes or enables a set of decentralized elements to cooperate to solve a common problem
- *Scalability* is the ability of a system to accommodate an expanding number of endpoints or participants without having to undertake major rework
- *Layering* is applying fundamental or commonly-needed capabilities and services to a variable set of uses or applications through well-defined interoperable interfaces (leads to the concept of *platform*)
- *Buffering* is the ability to make the system resilient to a variety of perturbations
- *Convergence* is the process by which disparate infrastructures are coupled operationally



Source: *Grid Architecture 2*, JD Taft, Pacific Northwest National Laboratory, PNL-24044, January 2016; [Grid Architecture 2 (pnnl.gov)]

Distribution Grid Codes for Operational Coordination

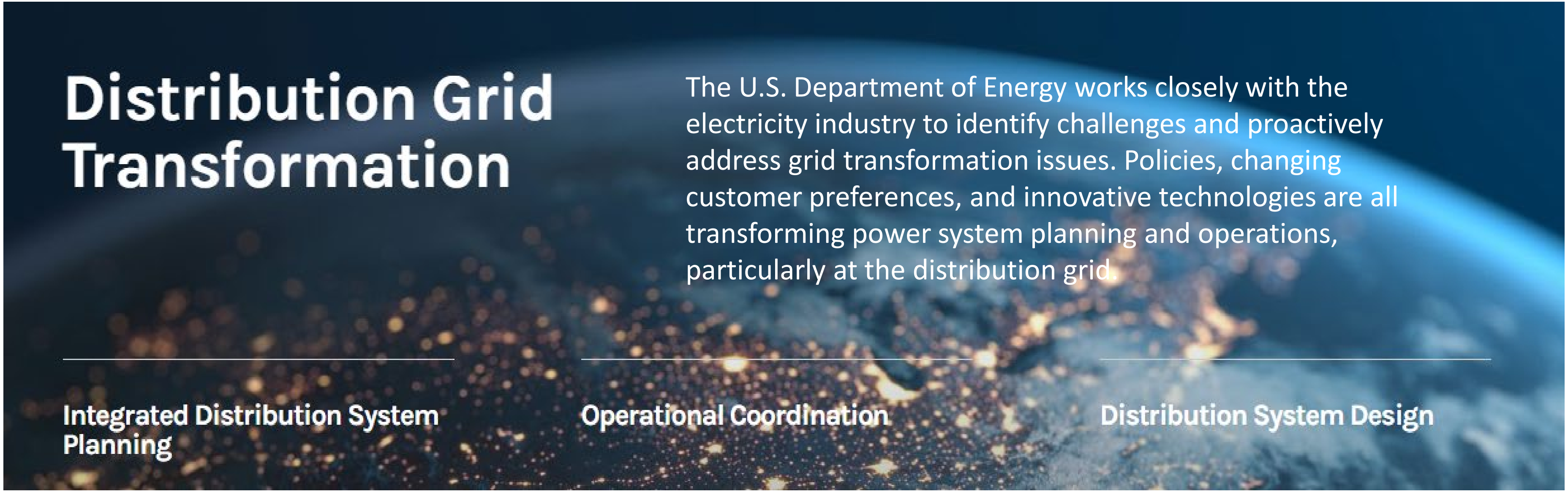
Code Families	Code Elements
Grid Engineering	Hosting Capacity Analysis Short and Long – Term DER Forecasting Locational Value Analysis Electrification
DER & Microgrid Integration	Inverter Based Resources Microgrids Monitoring and Control of DERs DER Interconnection Procedures Community Based Renewable Energy Microgrid Interconnection Procedures
Virtual Power Plants and Microgrid Services	Retail Energy and Distribution Grid Services Distribution Resilience Service DER Aggregation DER Aggregator Wholesale Market Services
DER & Microgrid Operations	Monitoring and Control of DERs Distributed Resource Management - Utility Distributed Resource Management – Aggregator Operating Agreements Common Information Sharing Model/ Framework/ Capability between System Operators, Utilities, Market Participants Utility Operational Technology (ADMS/ DERMS/ SCADA) Registration of DERs and DER Aggregations for Market Services Market Participation Rules Validation for DER Aggregations Net Load Baselining and Performance Analytics for DERs and DER Aggregations
Information Sharing and Security	Customer Data Access and Privacy Distribution System Data Information Sharing – Aggregators Cybersecurity
Governance and Oversight	Distribution Open Access DER Aggregator Oversight DER/ Microgrid Value Determination and Cost Allocation Governance and Oversight of Wholesale Market Participating DER (for e.g., through FERC Order 2222)

Grid codes refer to the collection of institutional and business processes, and technical standards to safely and effectively integrate and utilize distributed energy resources and aggregations within the electric distribution system.

Why is the adoption of standardized grid codes required?

- Federal clean energy policy goals and objectives.
- Integration and utilization of DER to meet peak demand and DER penetration goals.
- Uniform processes and techniques to enable the penetration and adoption of DERs at scale.

Additional Resources



This framework helps decisionmakers to develop holistic grid investment strategies that address community and state policies and increasing complexity at the grid edge

The integration and utilization of distributed energy resources owned by multiple entities requires standard processes for coordinating grid operations

Determining future distribution system designs will require a holistic understanding of needed functional and structural requirements.

https://www.energy.gov/distribution-grid