U.S. DEPARTMENT OF ENERGY
Office of Electricity

Integrated Distribution System Planning

Status, Challenges, and Approaches

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US Department of Energy

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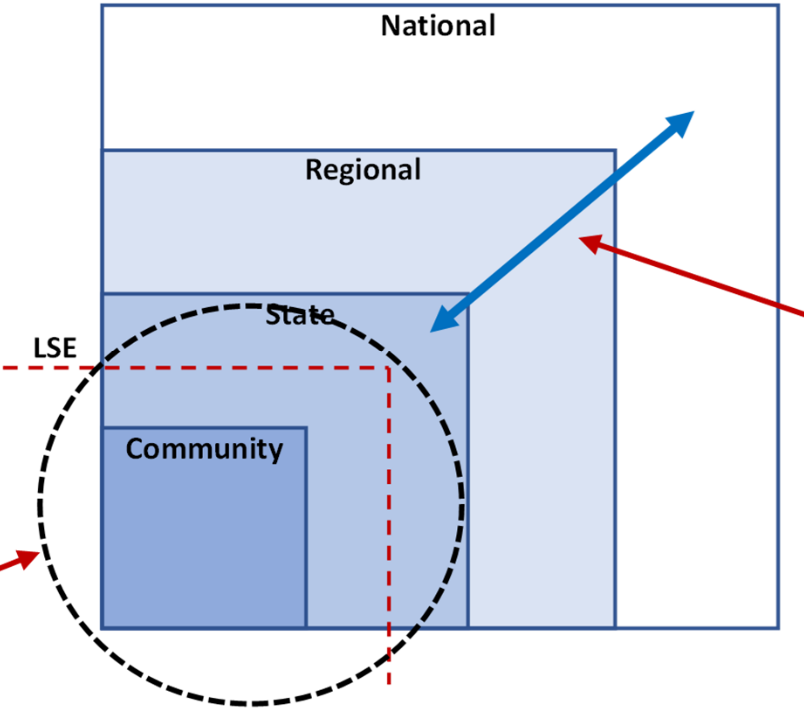
Scale of Integrated Planning

Address state/community objectives through an IDSP process and align with regional planning efforts



Alignment of community and state strategies with regional, multi-state strategies

IDPs align community and state policy goals into multi-year investment strategies

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
- 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

IDP Maturity

Twenty-two States have IDP processes underway at various levels of maturity and complexity

California AB327 (2013)
Hawaii Docket 2014-0192 (2014)
Minnesota Docket CI-15-556 (2015)
New York REV Proceeding 14-M-0101 (2015)

- Effective integration/utilization of DERs
  - Reduce interconnection queues/costs
  - Interconnection standards (inverter functions)
  - Hosting capacity analysis
  - Locational benefits assessment
  - NWAs
- Load and DER forecasting
- Customer empowerment (AMI focus)
- Grid reliability, resilience, & flexibility
- Grid modernization strategy (pace & valuation)
- Strategy for capital investments (5-10 yr horizon)

Increased level of complexity →

Today (2023)

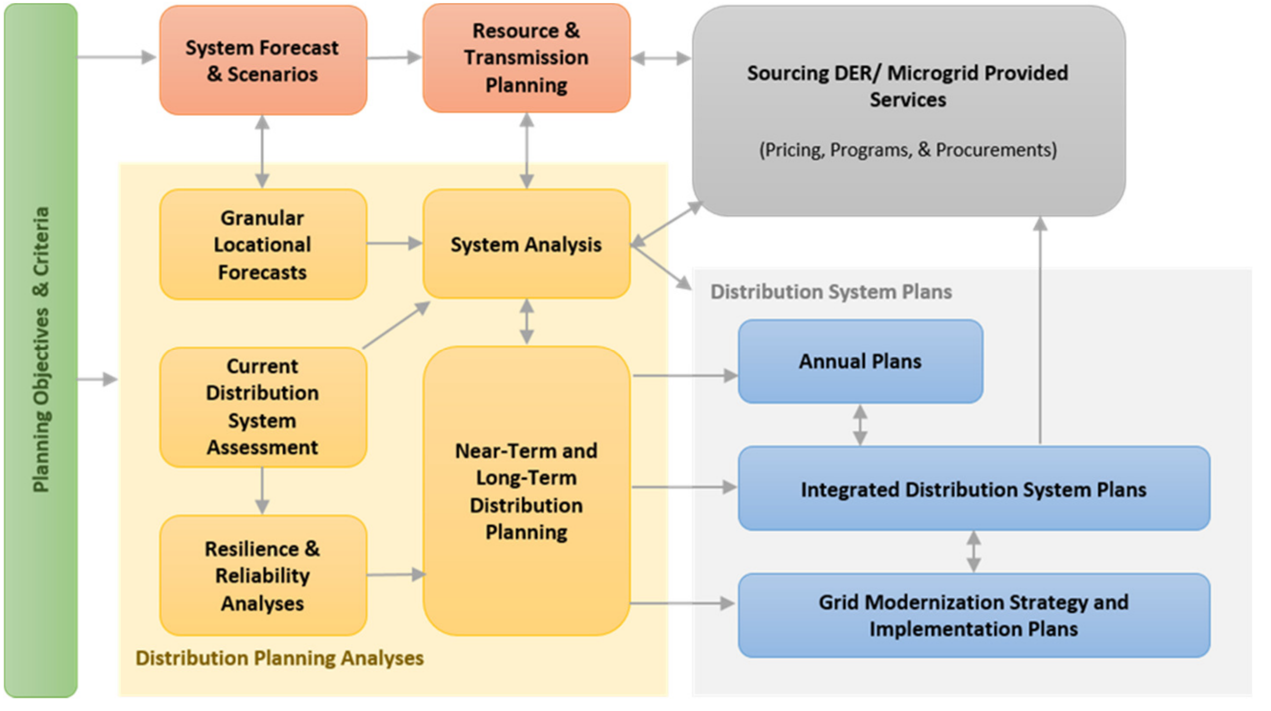
- Effective use of DERs in T&D markets (FERC 2222)
- DERs to enable load flexibility & resilience
- Forecasting load, DER adoption, & climate parameters
  - Electrification
  - Impact of climate on assets
- Community engagement
- Benefits to vulnerable/disadvantaged populations
- Prioritization of investments across multiple objectives
- Cost-effectiveness of proposed investments
- IDP/IRP synchronization

References:
- State Engagement in Electric Distribution System Planning, December 2017, PNNL-27066, State_Engagement_in_Electric_Distribution_System_Planning_PNNL_27066.pdf
- Distribution System Planning – State Examples by Topic, May 2018, PNNL- 27366, DSP_State_Examples-PNNL-27366.pdf

Objectives-Based Planning

Creating a shared understanding among stakeholders of strategies for incorporating objectives and priorities into current planning practices is essential. Without clear objectives, it becomes difficult to assess whether resulting plans are responsive and if key stakeholders will accept them.

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



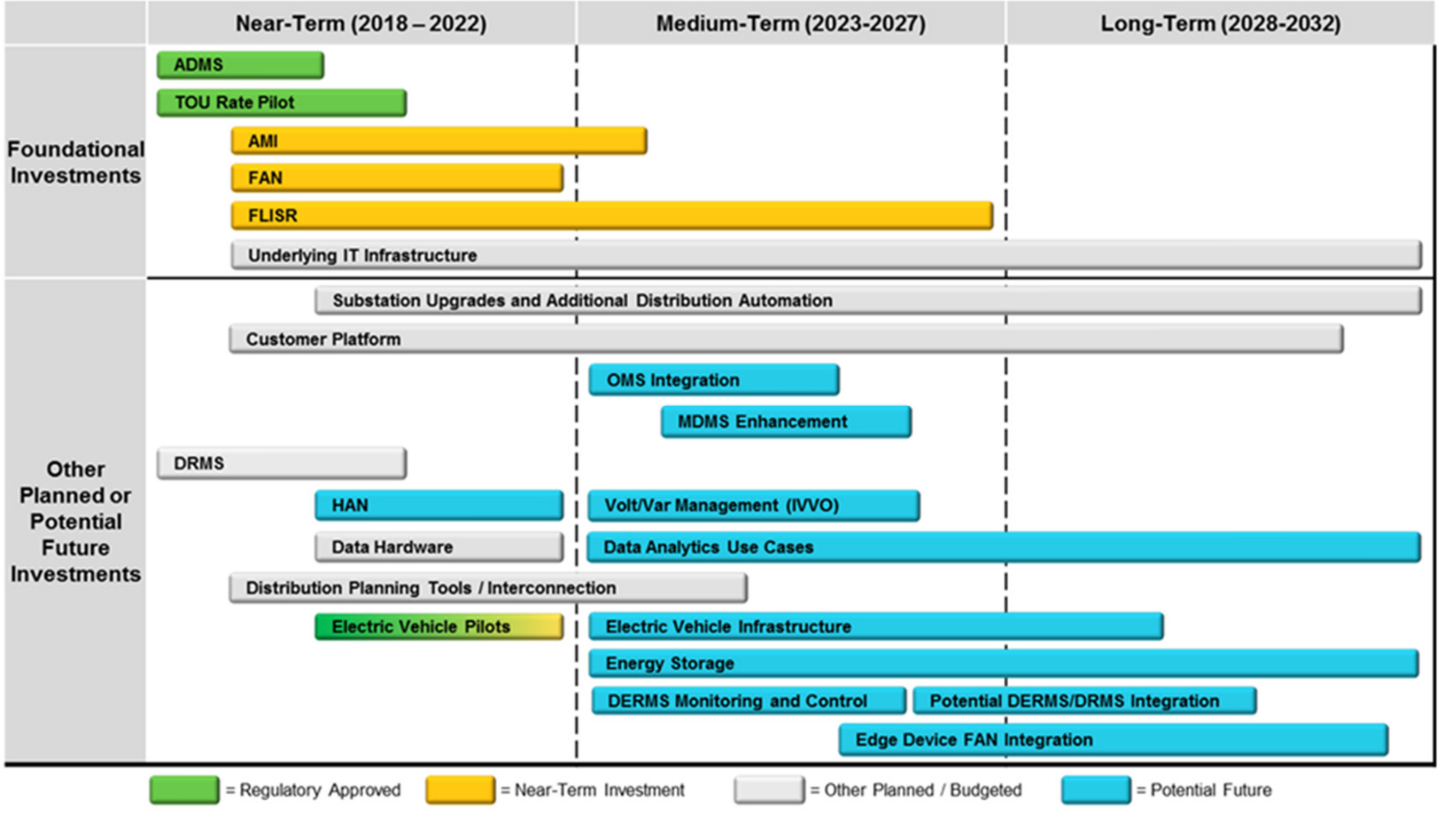
Regulators* review and approve plan with input from stakeholders

*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]

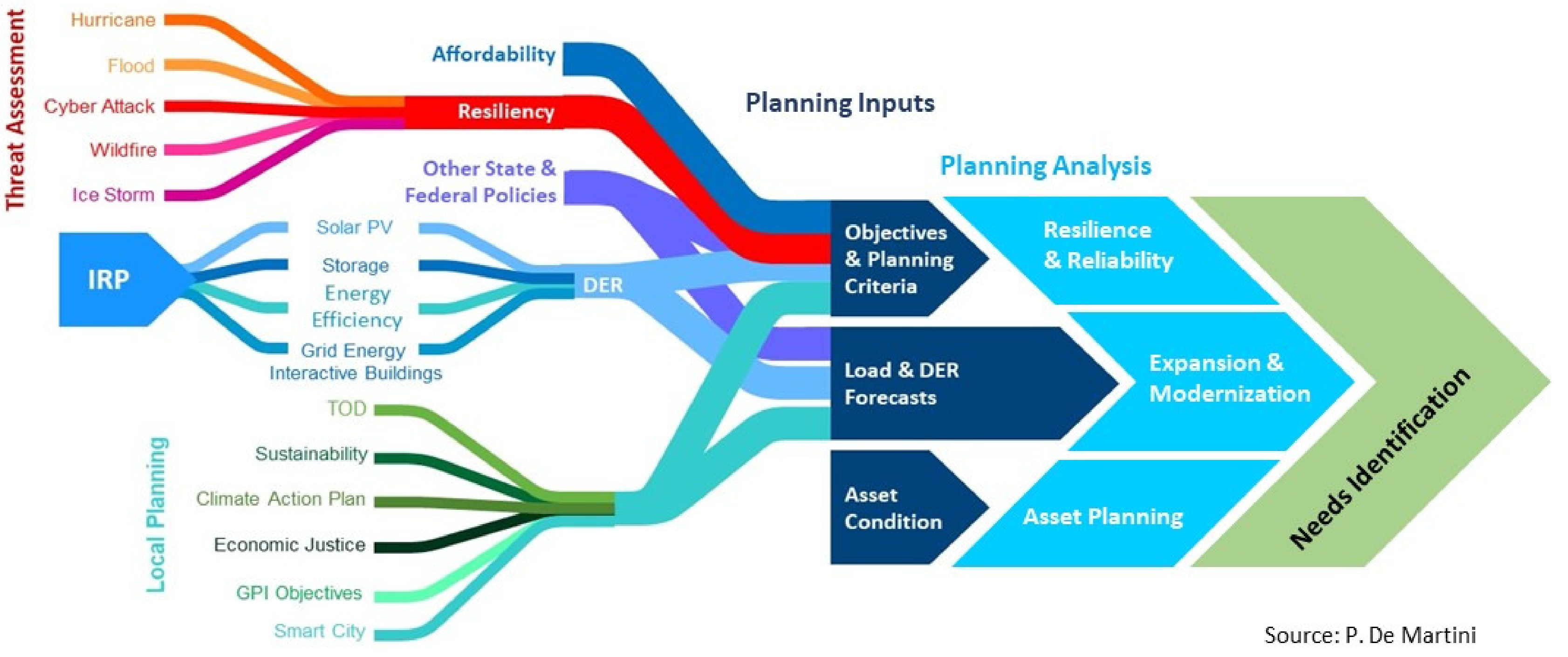
Xcel Energy 15-Year Grid Mod Roadmap (2019)

Xcel Energy's roadmap reflects a staged and proportional technology deployment strategy based on need



Emerging Distribution System Planning Inputs

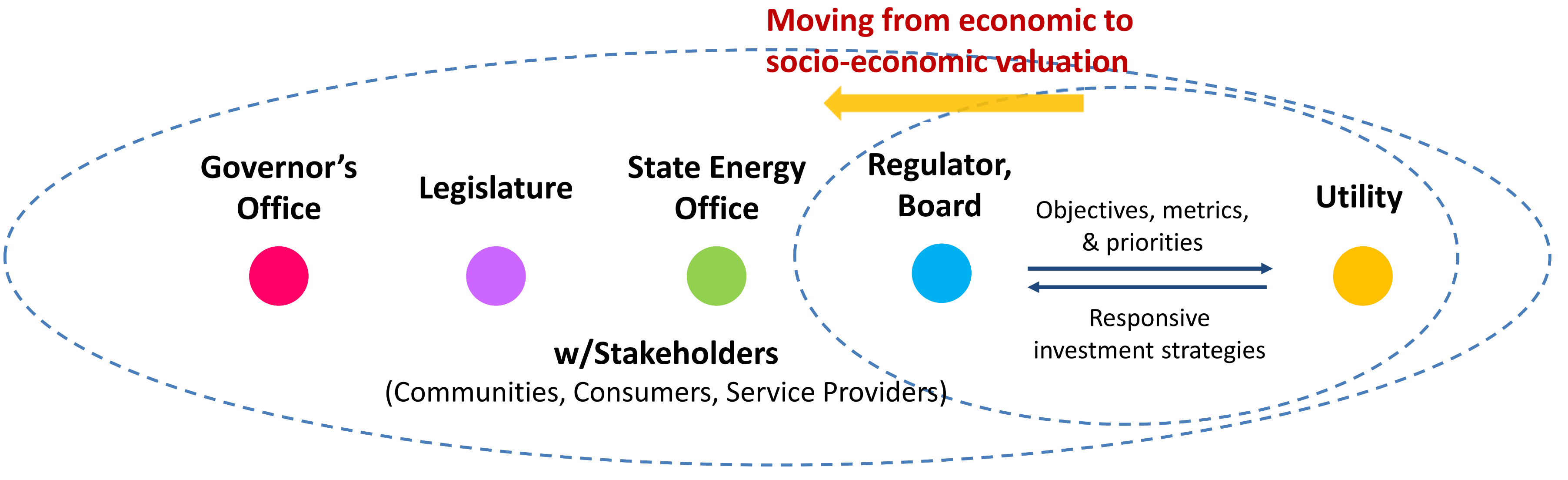
Distribution planning increasingly dependent upon IRP/bulk power planning, local sustainability & resilience plans, and use of DER



Source: P. De Martini

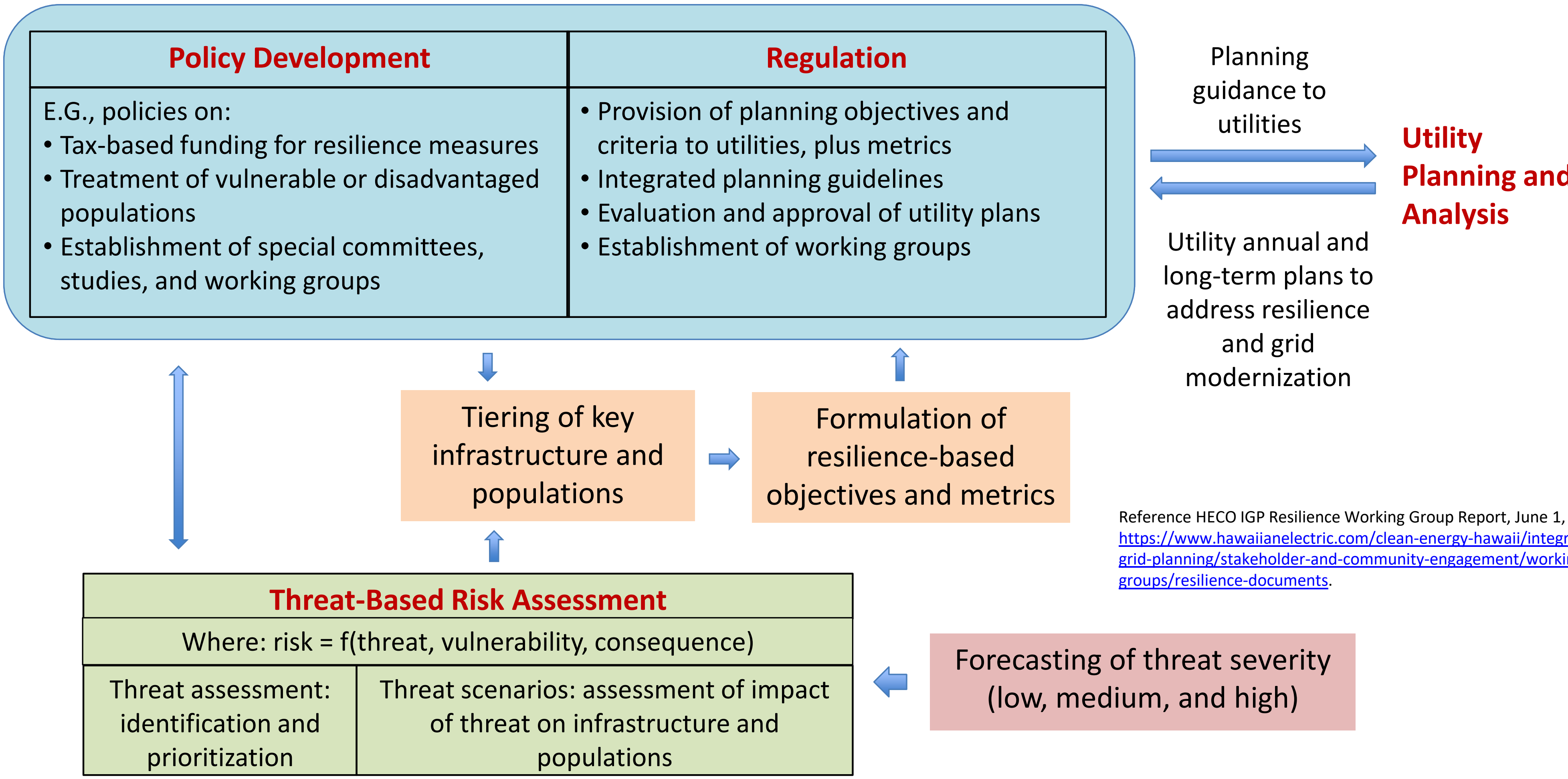
Formulation of Objectives and Priorities

Collaborative efforts are required to enable the formulation of equitable strategies for transitioning to a decarbonized and resilient electricity delivery system



Based on research conducted by the North Carolina Clean Energy Technology Center, there were 498 grid modernization-related policy and deployment actions in 48 states in Q3 2021, but regulators approved only $904.4 million (6.2%) of the $14.7 billion in proposed utility investments. Some $12.7 billion was held for closer scrutiny, with $1.1 billion rejected. See: https://www.utilitydive.com/news/duke-sce-other-grid-mod-proposals-confronted-big-cost-questions-in-2021-a/610977/.

Considering Equity and Resilience



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.

Use of DERs to Provide Load Flexibility

One of the key functionalities that the industry sees as important to a transition to a modern grid is flexible management of consumers' resources and energy consumption as a resource to operate the power system

The Brattle Group forecasts that national benefits of load flexibility could exceed $15 billion/year by 2030 and Brattle identified the potential for nearly 200 GW, equal to 20% of peak, of cost-effective load flexibility potential in U.S. by 2030 providing national benefits exceeding $15 billion/yr.*

This will require:

- That flexible load/DER management programs operate on shorter time cycles as well as operate more frequently to manage a significantly more dynamic grid (mix of pricing and automated responses) and
- A significant change in how consumers are asked to contribute and their considerations for being willing and able to participate.

*R. Hledik, A. Faruqui, T. Lee and J. Higham, The National Potential for Load Flexibility, Brattle, 2019; [The National Potential for Load Flexibility: Value and Market Potential Through 2030 (brattle.com)]

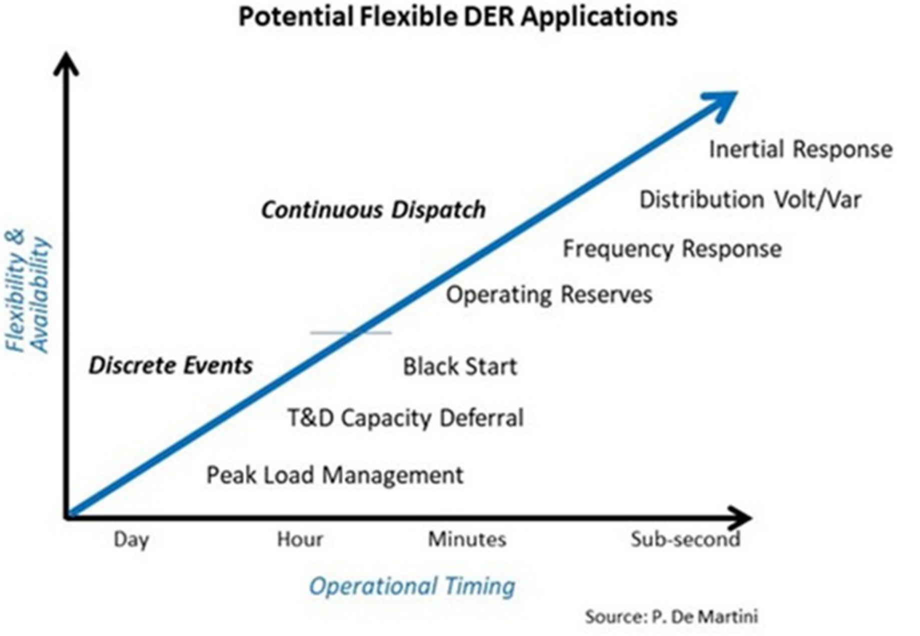


Figure from Consumer Resource Automation, by Andrew and Paul De Martini, in draft

Challenges Facing Regulators

Regulators are asking for processes that can result in rational, yet holistic grid investment strategies

ANSWER CHOICES		RESPONSES	
Forecasting		82.61%	19
Evaluating cost-effectiveness of grid modernization investments		78.26%	18
Non-wires alternatives (programs, pricing and procurements)		73.91%	17
Resilience		65.22%	15
Reviewing utility distribution system plans		60.87%	14
Reliability		60.87%	14
Approaches for developing guidelines or requirements for utility filings		56.52%	13
Cost recovery for distribution system investments, including for grid modernization		56.52%	13
Equity		52.17%	12
Data access		52.17%	12
Hosting capacity analysis		52.17%	12
Risk analysis		43.48%	10
Stakeholder engagement		30.43%	7
Other topics – please describe	Responses	13.04%	3
Total Respondents: 23			

From recent survey conducted by by Lisa Schwartz, LBNL

IDSP Program Strategy

We need to address technological and institutional issues to formulate rational and forward-looking investment strategies

Advancing best practices for formulating grid investment strategies that serve communities, states, and their affected publics

System Planning

Integrated Distribution System Planning (IDSP)

Industry Group

Informs

System Design

Operational Coordination across T-D-BTM Domains

Industry Group

Distribution System Architecture

Staged strategies for advancing grid structure and function to meet current drivers and uncertainties

<u>Partners</u>:

Internal – Joint OE/EERE (e.g., Grid Solutions Program) for DER integration and GDO for resilience planning

External – NARUC, NASEO, NGA, NCSL, NRECA, APPA, RAP, ESIG, EPRI DER

Approach

Development and application of best and emerging methods and practices to address key issues

Early Co-Creation
(focused exchange btw SMEs and early adopters)

- Method Development (SMEs)
- Sharing & Vetting
- Stakeholder Input (Early Adopters)

General Application of Best and Emerging Methods & Practices
(focused exchange through cohorts and pilot projects)

- State Policymakers & Regulators
- Utilities
- Regional Planners

Outcome

Continuous Improvement

Guidelines on Best and Emerging Methods & Practices, e.g., Decision Process Frameworks and Supporting Analytics

Mechanisms

- Workshops/Practicums
- Working Groups & Discussion Platforms
- Training
- Resource Library

IDSP Guidelines

Deliver state-of-the-art guidelines for IDSP through stakeholder-vetted processes

IDSP Guidance:

- Staged strategies for addressing grid-edge evolution
- Incorporation of resilience and equity into planning processes
- Stakeholder engagement practices
- Cost-effectiveness framework
- IDSP/IGP integration

Industry Working Groups with SMEs, utilities, regulators
(Includes EPRI and NRECA)

Activities:

Gap Analysis & Roadmap
- PUC Approval vs Utility Plans
- State DSP Policies & Practices
- Study on IDP Challenges

Direct TA
- NJ – establish state IDSP (Master Energy Plan)
- ME – determine priorities for their 10-yr IDSP
- MD – determine goal/metrics for their IDSP
- SC – grid resilience metrics (with GDO)
- CT – requested IDSP workshop

Capturing Best Practices
- Electrification Impacts on Planning
- Resilience and Equity Planning
- Multi-objective Decision Analysis
- Cost-effectiveness Methodology

IDSP Training Workshops & Webinars
- Continue regional IDSP Training
- Provide monthly webinars

with the National Associations, RAP, EPRI, and ESIG in partnership with other DOE Offices (EERE & GDO))

Grid Service Mechanisms for DER

It is important to distinguish compensation methods from operating mechanisms when considering operational coordination across the T, D, and BTM domains

Example Only (In Development)	BA Interchange	Bulk System	Bulk -> Dist	Dist -> Bulk	Distribution	Edge - Dist	Microgrid	Edge
Grid Products & Services								
Energy Supply	Price	Phys/Price	Price	Price	Phy/Price	Phy/Price	Phy/Price	Price
Energy Transport	Price	Price	Price	Price	Price	Price	Price	x
Operating Reserves	x	Phys/Price	x	Phys	Price	Phys	x	x
Frequency Regulation	x	Phys/Auto	x	x	?	x	Phys/Price	Phys/Price
Volt/Var Regulation	x	Phys/Auto	x	Phys	Phys/Auto	Phys/Auto	Phys/Auto	Auto
Capacity Deferral	x	Phys/Price	x	Phys	Phys	Phys	x	x
Black Start	x	Phys/Auto	x	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto
Resilience	x	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto	Phys/Auto

Legend	
Price	Price Formation
Phys	Physical Control
Auto	Parametric Autonomous
x	Not Applicable
(green)	Mature Service in Wide Use
(yellow)	In Limited Use/Demonstration
(red)	Service under Research

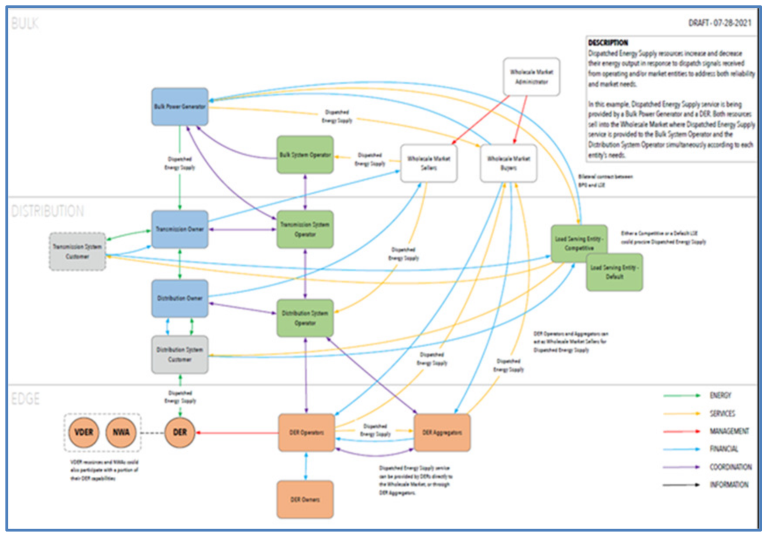
Coordination Framework Methodology

Given differing operating mechanisms and time cycles, each grid service will need to be evaluated individually and in aggregate to resolve the coordination structure.

Approach:

- Develop coordination structures for each discrete service associated with each operating mechanism
- Identify actors, information, and timing requirements
- Evaluate the resulting "stack" of structures to resolve any conflicts
- Develop and vet methodology to guide structural and design considerations and enable implementation
- Develop and vet grid codes

Energy Supply Service



Generic Grid Code

- Regulatory/ Policy Codes
  - Governance and Oversight
  - Information Sharing
- Process Codes
  - Service Agreements
  - Interconnection Agreements
  - Utility Workflows
- Technical Codes
  - Grid Engineering
  - Grid Connection of DERs
  - Operations
  - Information Sharing

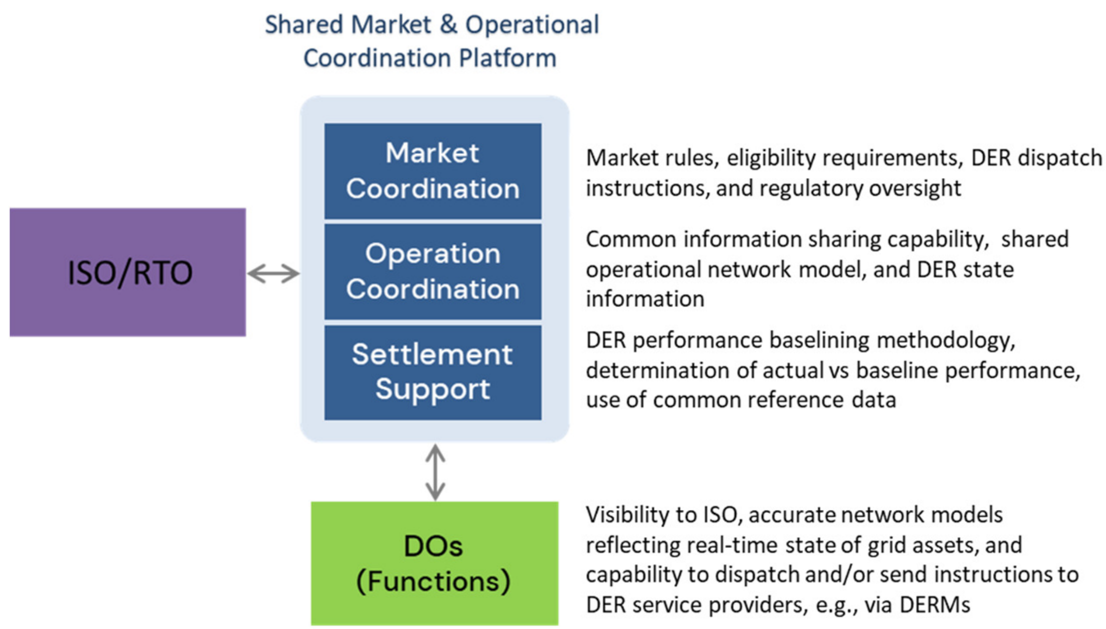
Architectural Platform for Operational Coordination

Utilization of DERs across the power system requires coordinated planning and operations across jurisdictions

Enabling the application of grid services from DERs will require:

- Deploying capabilities to provide real-time visibility and dispatching of grid assets while maintaining grid reliability under all conditions in support of coordinated operations amongst all participants
- Developing distribution system designs and modeling capabilities that lead to technology deployment strategies enabling the use of myriad DERs, including microgrids, VPPs, and electric vehicle infrastructure
- Determining interoperability requirements so that disparate assets and systems can seamlessly share data and interoperate, and
- Formulating planning guidelines so that regulators and utilities can formulate holistic grid investment strategies that incorporate DERs.

Platform architecture required to support operations across the transmission, distribution, and BTM domains



Distribution System Architecture

Provide regulators and utilities an approach to systematically transform today's distribution system to support the decarbonized, resilient, and participatory objectives of the future grid

Support industry move from architecture concepts to application

Grid Architecture Principles & Structures — Leverage grid architecture principles and structures

↓

Distribution System Functional Architecture — Define roles & responsibilities, system requirements, information flows

↓

Macro Use Case Scenario Reference Designs — Apply architecture to address fundamental future grid operational needs in example dist. system context

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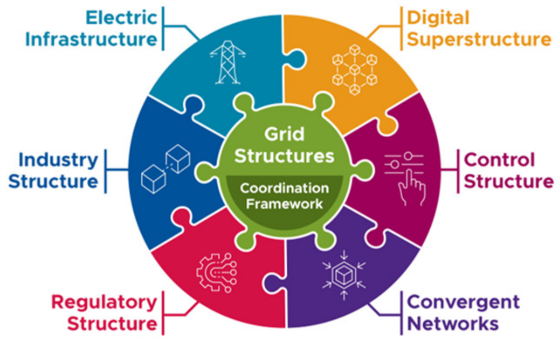
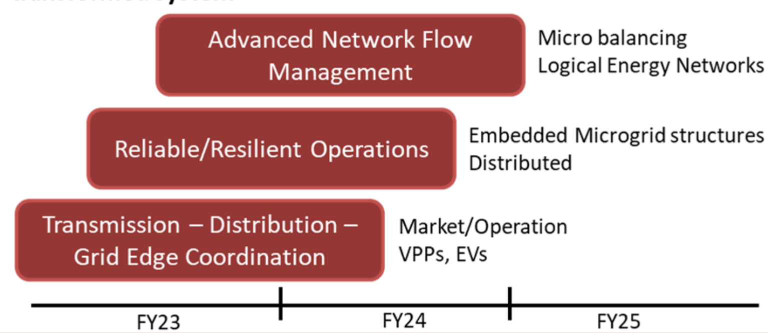
Distribution Transformation Implementation Guides — Chart a course for regulators and utilities to navigate toward the transformed distribution system

A holistic grid architecture approach



Macro use case scenarios provide building blocks toward transformed system



Thank You