

Integrated Distribution System Planning Overview

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DOE Clean Energy Innovator Fellows Training

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What is distribution system planning?

- Assesses needed physical and operational changes to the local grid
 - ▣ Annual planning for distribution system spending
 - ▣ Longer-term utility capital plan over 5–10 year planning horizon
 - With updated solutions and cost estimates every 1–3 years

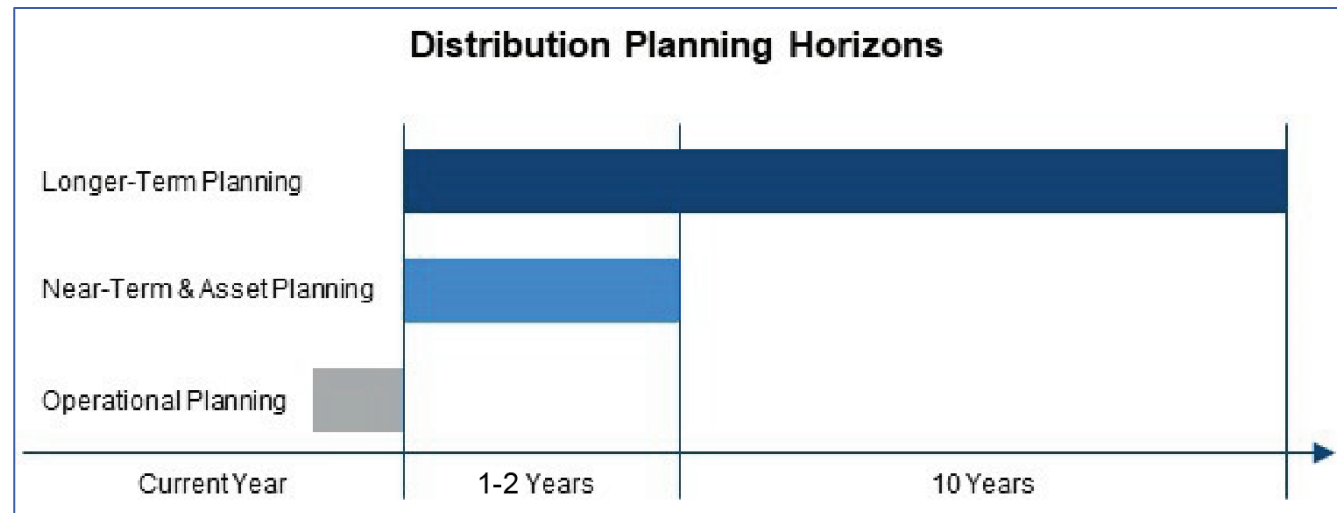


Figure: [DOE 2020](#)

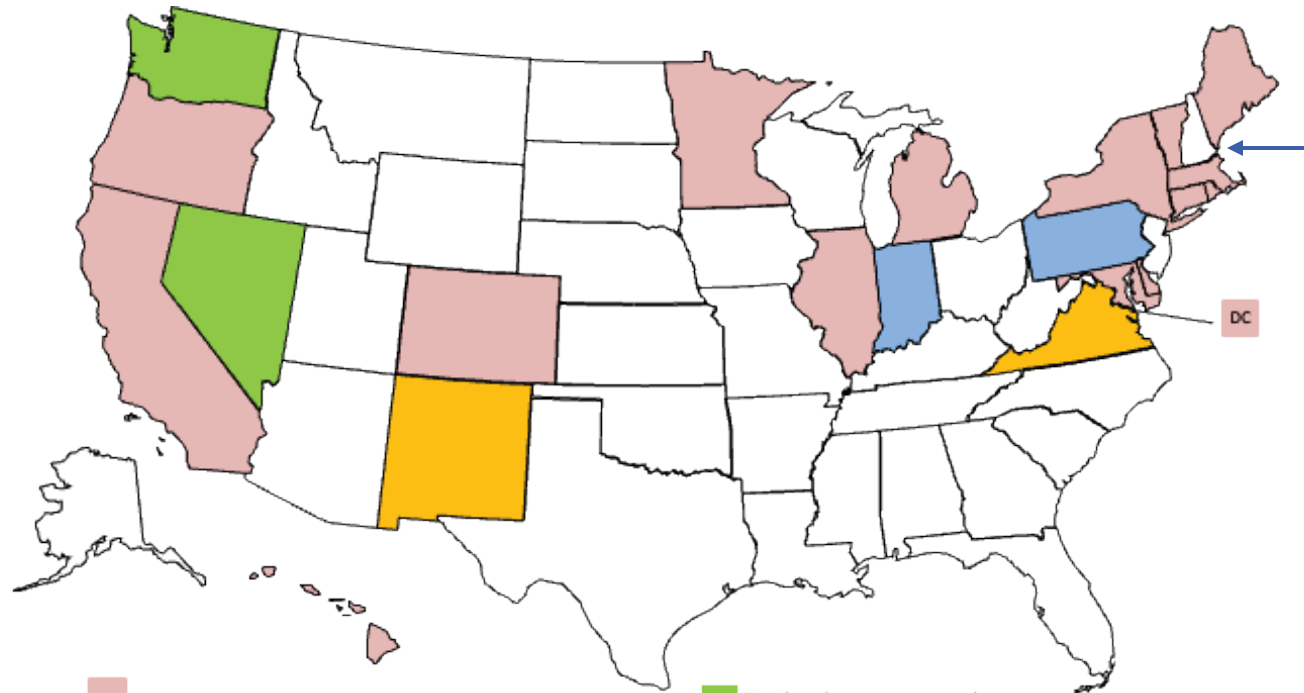


Poll

How many states require regulated utilities to file distribution system plans?



What states require regulated utilities to file distribution plans?



The NH Legislature enacted [HB 1431](#) in 2024 to require integrated distribution planning

- Distribution system plan or integrated grid plan
- Distributed energy resources plan
- Grid modernization plan*
- Transmission and distribution improvement plan**

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

Source: NASEO and Berkeley Lab (2023), [State Energy Offices' Engagement in Electric Distribution Planning to Meet State Policy Goals](#)



What types of distribution plans do utilities file? (1)

□ Distribution system improvement plans

Enables expedited cost recovery for certain system improvements

- [Indiana's Transmission, Distribution, and Storage System Improvement Charge](#) can include new or replacement transmission, distribution, or utility storage projects for safety, reliability, system modernization, or economic development.
- [Pennsylvania's Distribution System Improvement Charge](#) can be used to recover costs to repair, improve, or replace eligible distribution property.

□ Distributed energy resources (DERs) plan

Evaluates benefits and costs of DERs, considers ways to increase deployment of cost-effective DERs, and facilitates better integration of DERs in distribution planning

- Regulated utilities in Nevada must submit a [Distributed Resource Plan](#) to the Public Utilities Commission every three years as part of their integrated resource plan.
 - Evaluate locational benefits and costs of DERs, including distributed generation systems, energy efficiency, energy storage, electric vehicles (EVs), and demand response technologies
 - DER forecasting and hosting capacity analysis that inform grid needs assessment
 - Propose infrastructure upgrades and non-wires alternatives for identified grid constraints



What types of distribution plans do utilities file? (2)

□ **Grid modernization plan**

Reasoned strategy linking technology deployment roadmap to stated objectives

- Examples: CA, MA, MN, NM, RI, VA
- Plans may include a request for approval of grid modernization investments and programs, with expedited cost recovery.

□ **Integrated distribution system plan**

□ Systematic approach to satisfy customer service expectations and state objectives

- Includes grid mod strategy and DER planning
- May coordinate across planning domains (e.g., [HECO's 2023 Integrated Grid Plan](#), [Maine Integrated Grid Plan statute](#))

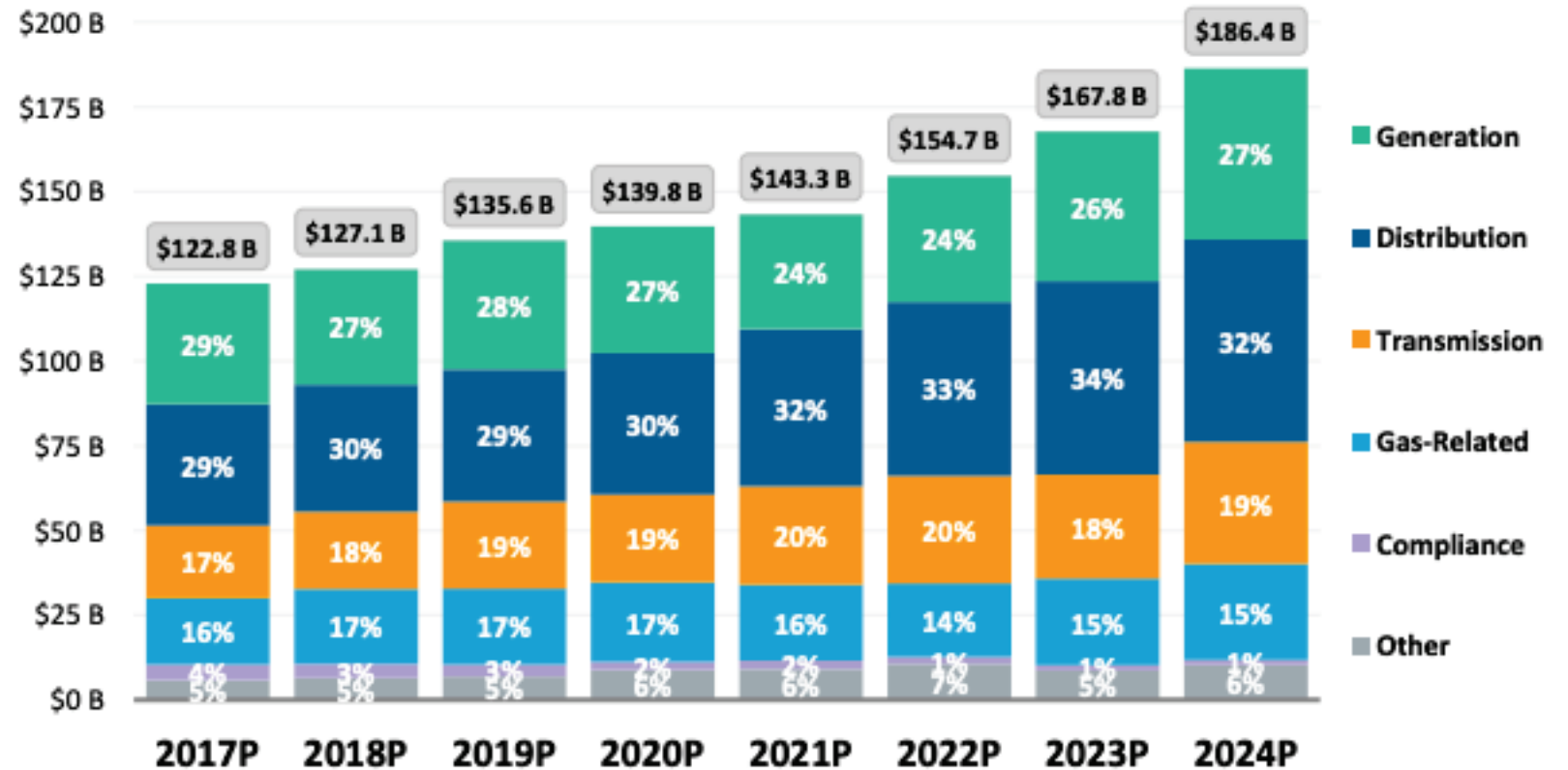


Source: EPRI



Why are states increasingly interested in distribution system planning?

Distribution system investments account for the largest portion of capex — 32% in 2024 (projected \$59.7B) — for U.S. investor-owned utilities.



Source: [EEI 2024](#)



What are the potential benefits from an improved planning process?

- ❑ Better oversee utility expenditures
- ❑ Make transparent utility plans for distribution system investments in a holistic manner, before showing up individually in rate cases
- ❑ Provide opportunities for meaningful engagement with stakeholders and (for regulated utilities) regulators to improve outcomes
- ❑ Consider uncertainties under a range of possible futures (scenarios)
- ❑ Consider all solutions for least cost/risk (including DERs)
- ❑ Enable consumers and third-party providers to propose grid solutions and participate in providing grid services (e.g., grid-interactive efficient buildings)

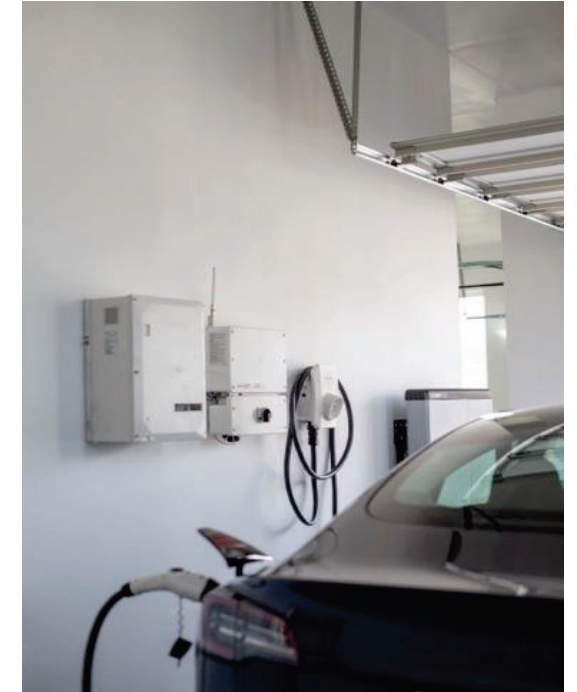


Source: Con Edison



What is integrated distribution system planning?

- States set goals, objectives, and priorities that define **long-term, high-level outcomes** for grid planning.
- Integrated distribution system planning provides a **decision framework to enable the formulation of long-term grid investment strategies** that address state and local policy goals, objectives, and priorities, consumers' needs, and evolution at the grid edge.
- **Shared understanding among stakeholders of strategies** for addressing goals, objectives and priorities in grid planning is essential.
 - Goals for grid planning include **traditional regulatory aims** (e.g., safety, reliability, and affordability) **and newer policy goals** (e.g., transportation electrification, more renewable resources, and emissions reductions) and related outcomes such as greater asset utilization and improved integration and utilization DERs.
 - Grid planning objectives also reflect the importance of **transparency and stakeholder engagement**.



Source: Sunrun



Why states establish distribution planning goals and objectives

- Planning starts with planning goals/ principles and objectives.
- That determines grid capabilities needed, which in turn establish distribution system functionality and system requirements.
- Holistic long-term planning supports state goals and objectives.
- States can set long-term, high-level outcomes for grid planning and steps to achieve them.

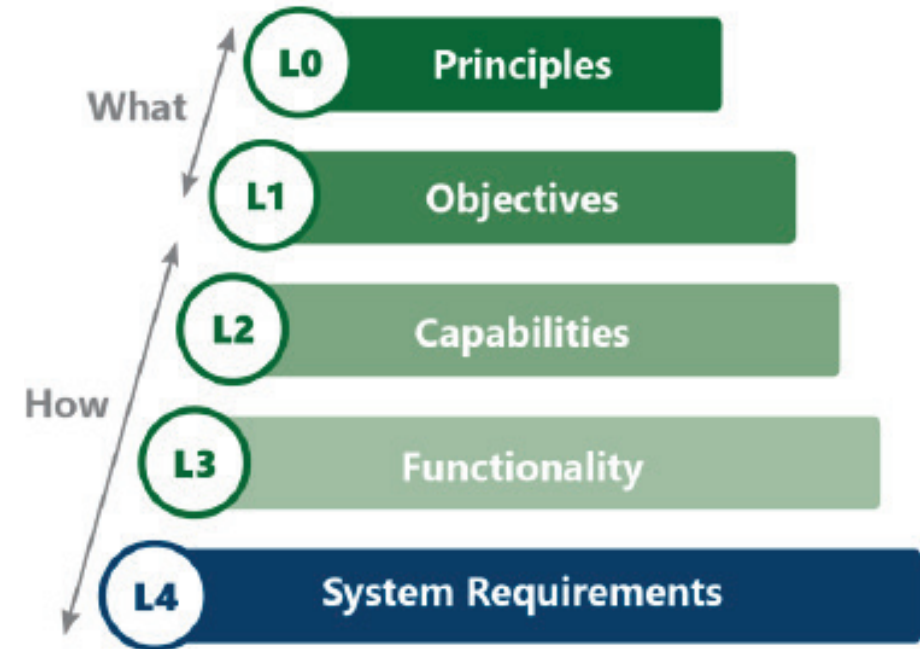


Figure: [DOE 2020](#)



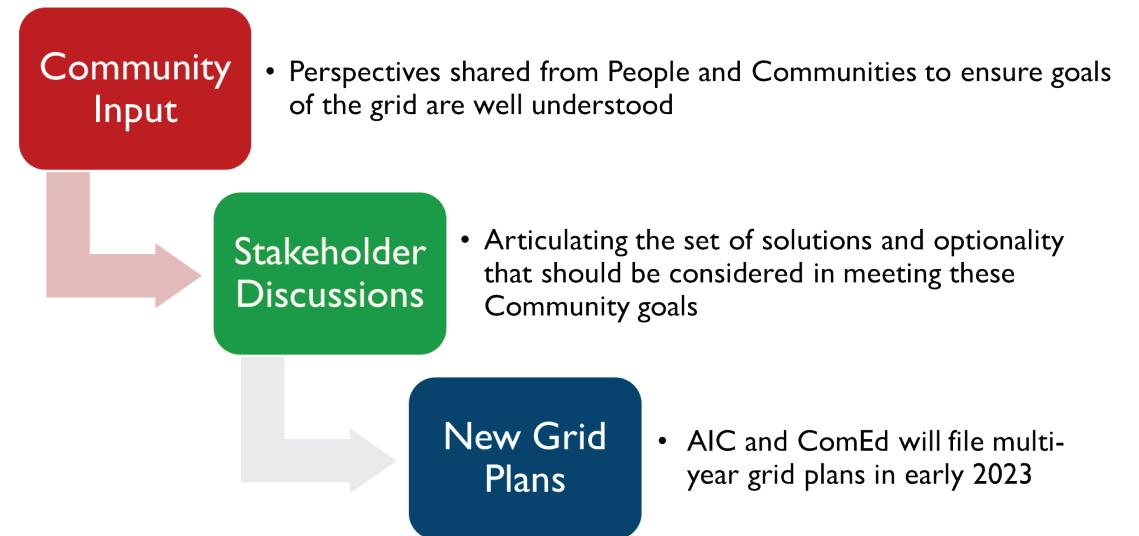
Stakeholder engagement in distribution planning

□ Benefits

- Improve quality of proceedings and outcomes
- Develop solutions with broad support
- Build trust among parties

□ Requirements

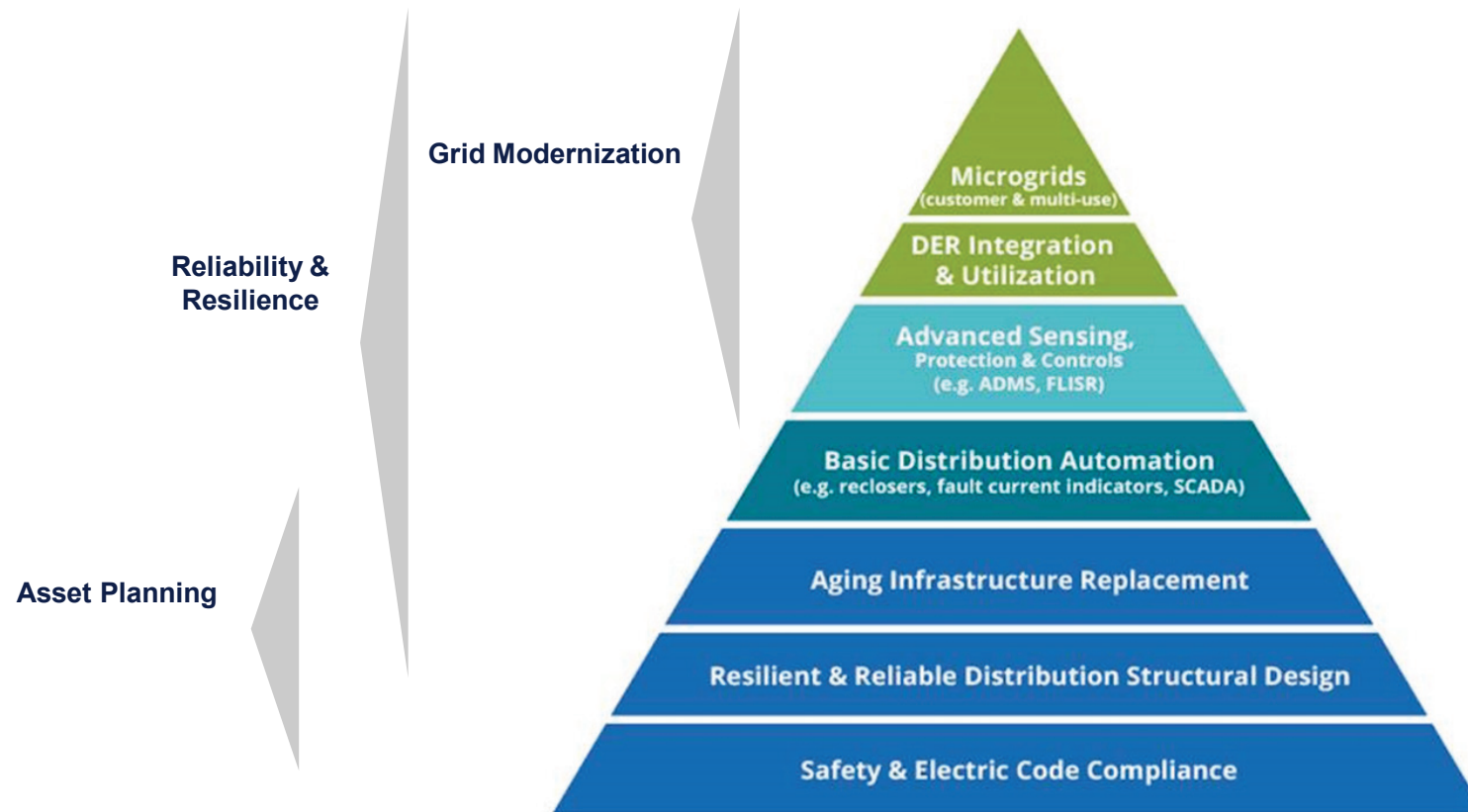
- *Before plan is filed:* Can include significant input through working groups (e.g., CA, DC, HI, MI, NY) and stakeholder meetings (e.g., IL)
- *After plan is filed:* Stakeholders file comments on plan, utility considers/addresses comments, and utility provides periodic plan updates



Source: [Multi-Year Integrated Grid Plan Workshop Facilitator's Report: *Synthesizing the Input Collected through 15 Workshops*](#)

Distribution system investment categories

Grid modernization layers on top of and integrates with foundational grid infrastructure.

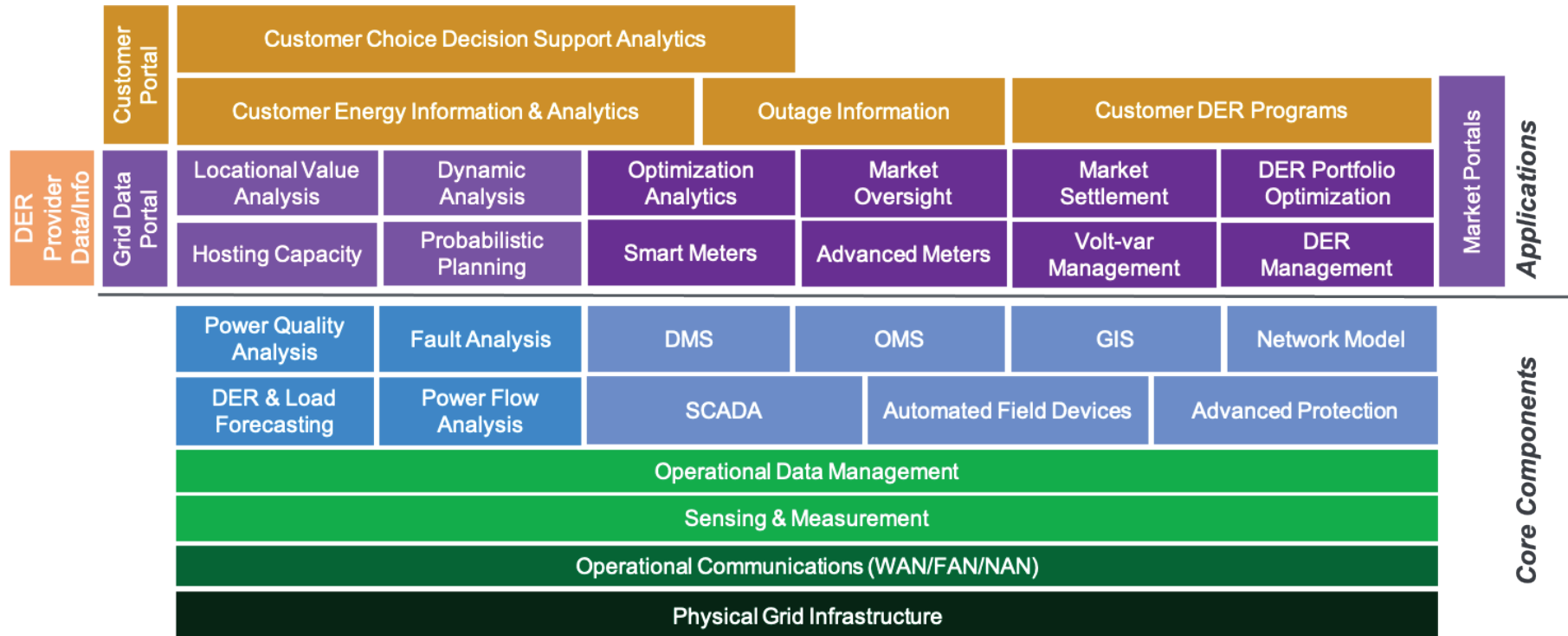


Source: De Martini

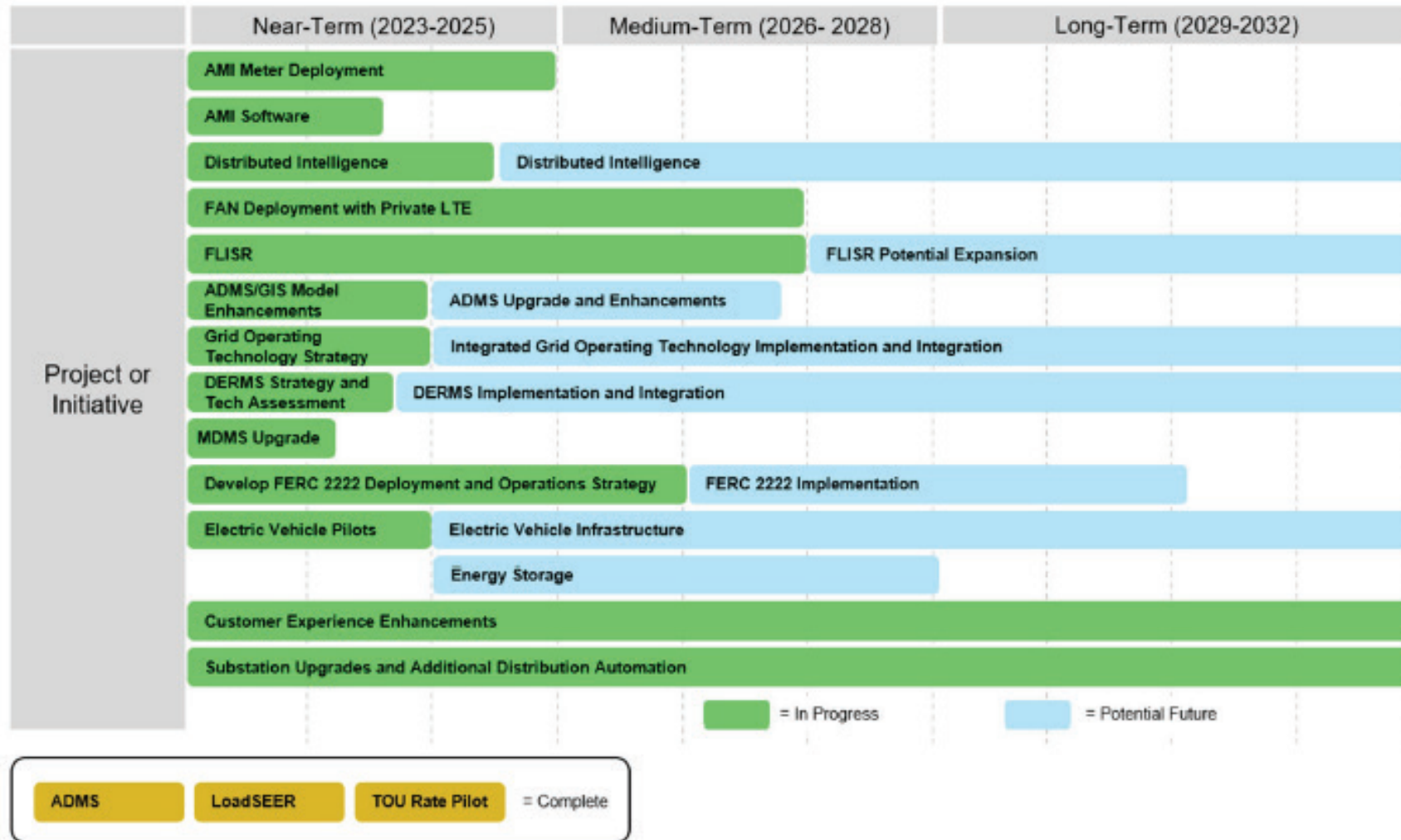


Foundational and interdependent technologies and systems

- **Core components** — e.g., Advanced Distribution Management System, Geographic Information System, Outage Management System
- **Applications** to support other grid modernization projects — e.g., smart meters, DER management



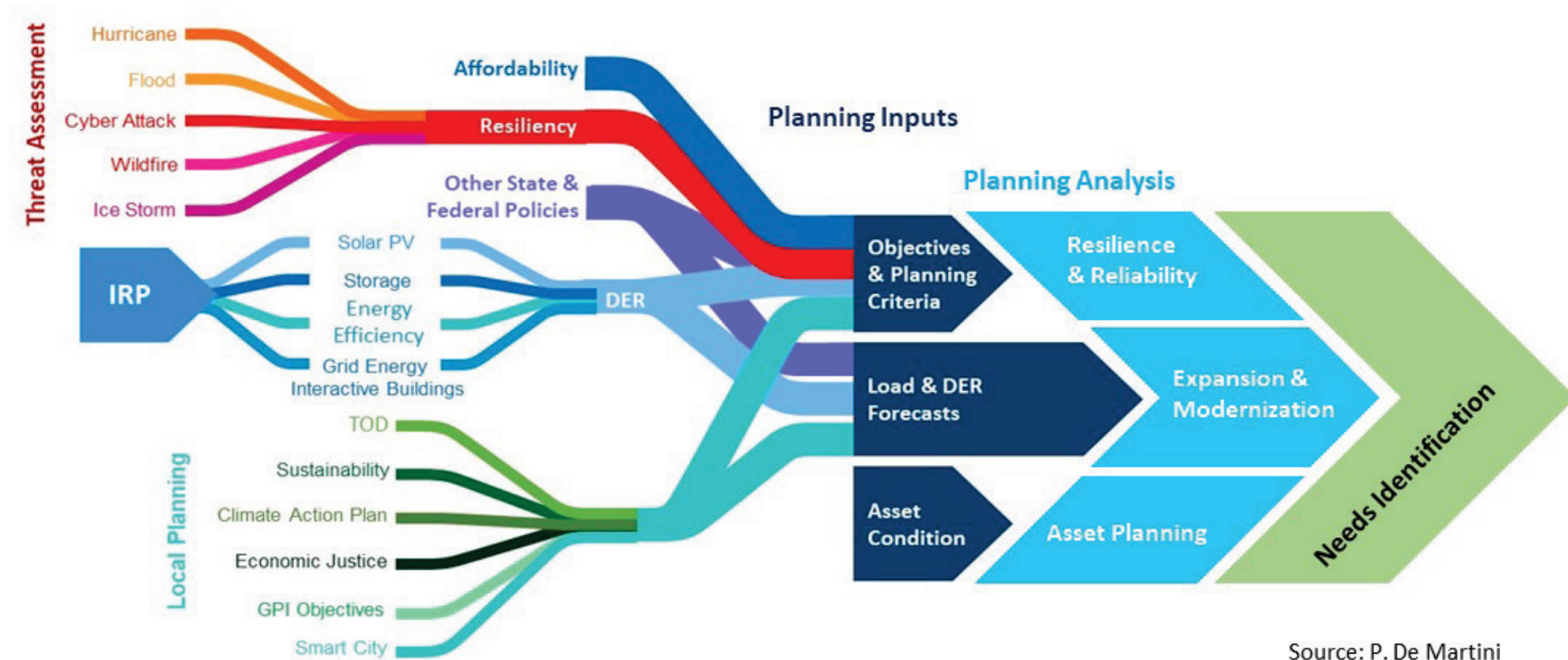
Example technology roadmap



Source: [xcel Energy \(2023\)](#)

How is distribution planning changing?

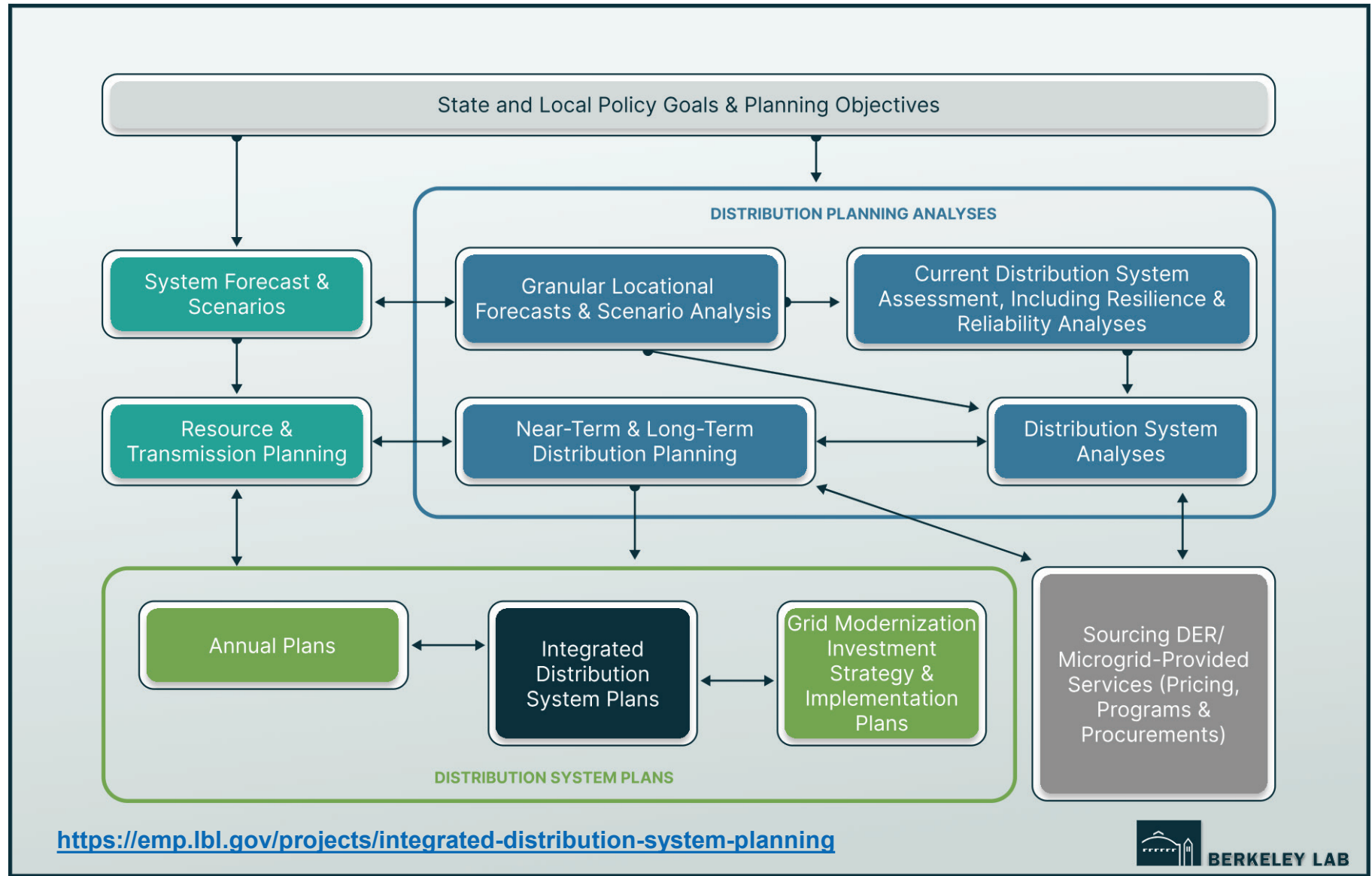
Distribution planning is increasingly dependent on resilience planning, bulk power system planning, local planning, and using DERs.



Source: P. De Martini

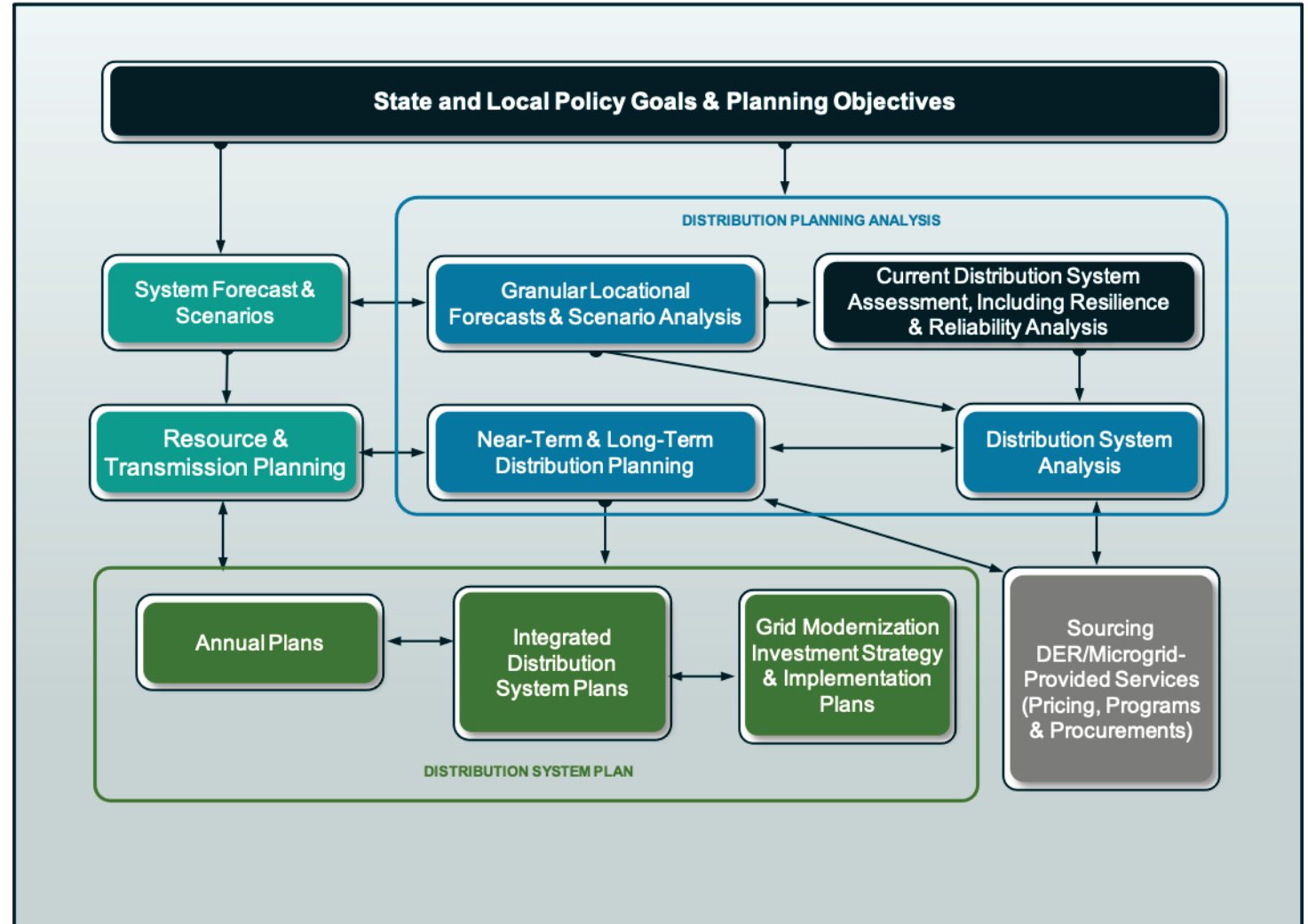


New Interactive Decision Framework for Integrated Distribution System Planning



What topics are covered?

1. Stakeholder Engagement
2. Equity Considerations
3. Forecasting Loads and DERs
4. Scenario Analysis
5. Threat-Based Risk Assessment
6. Worst-Performing Circuits Analysis
7. Asset Management Strategy
8. Cost-Effectiveness Framework for Investments
9. Multi-Objective Decision-making
10. Coordinated Planning
11. Hosting Capacity Analysis
12. Value of DERs
13. Interconnection
14. Distribution Investment Strategy
15. Functional Requirements Analysis
16. Geotargeting Programs
17. Procurements



What's included?

- Overview
 - ▣ What is it?
 - ▣ Why is it important?
 - ▣ Key questions (Q&A)
- Roles and Responsibilities
- Best Practices
- State Practices
- Utility Practices
- Flow Chart (e.g., inputs/outputs)
- Tools
- Annotated Resources List

Granular Locational Forecasts and Scenario Analysis

Forecasting Loads and Distributed Energy Resources Scenario Analysis

OVERVIEW	ROLES AND RESPONSIBILITIES	BEST PRACTICES	STATE PRACTICES	UTILITY PRACTICES	FLOW CHART	TOOLS	RESOURCES
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OVERVIEW

What is distribution-level scenario analysis?

Scenario analysis is a well-established approach to assess the potential impact of various plausible future events and to develop plans that are more flexible or robust. Scenarios are not predictions. Rather, they inform the flexibility needed in plans and test their robustness under different potential conditions. There are two methods (1) a set of alternative futures and (2) a probabilistic range of futures within a set of bookend futures. The objective is the same for both methods.

Why is scenario analysis important?

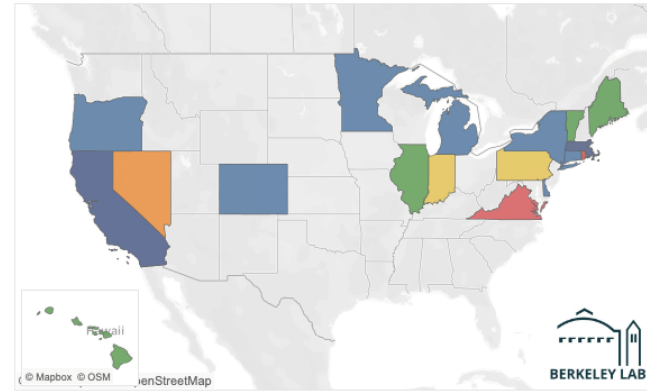
Scenario analysis is important to develop and assess longer-term plans when there is a high level of uncertainty regarding key factors, such as load and DER forecasts, that shape the timing, scope, and scale of distribution plans. Scenario analysis enables an assessment of the inherent uncertainty of forecasts to better determine effective plans.



State distribution planning requirements

- Online catalog and data visualization
 - ▣ Update in early 2025
- Forthcoming companion report

Map: Type of Plan



Choose map

Type of Plan

Hosting Capacity Analysis (HCA) Required

Non-Wires Alternative (NWA) Required

Frequency of filing (years)*

1 5

3 20

Planning horizon (years)*

* Could be a range of years. Check the "Detailed Table" tab for more details.

State policies and regulations on integrated distribution system planning are evolving. To submit comments, corrections, or additions to this data, please write to us at:

mdp@lbl.gov

[For details on state policies and regulations, click here.](#)

State	Distributed energy resources plan	Distribution system plan	Grid modernization plan	High DER Future	Integrated grid plan	T&D improvement plan	NWA	HCA
California		•	•	•			•	•
Colorado		•					•	•
Connecticut		•					•	•
Delaware		•					•	•
District of Columbia		•					•	•
Hawaii					•		•	•
Illinois					•		•	•
Indiana						•		
Maine					•		•	•
Maryland		•					•	•
Massachusetts		•	•			•	•	•
Michigan		•					•	•
Minnesota		•					•	•
Nevada	•						•	•
New Mexico			•				•	•
New York		•					•	•
Oregon		•					•	•
Pennsylvania						•		
Rhode Island			•		•	•	•	•
Vermont					•		•	•
Virginia			•				•	•
Washington	•						•	•

From the Berkeley Lab report *State Requirements for Electric Distribution System Planning*. For more research on Integrated Distribution System Planning visit <https://emp.lbl.gov/integrated-distribution-system-planning>



Forthcoming Resources

- Distribution planning data, metrics and analyses that states can ask for
- Resilience planning data, metrics and analyses states can ask for
- Cost-effectiveness evaluation for grid modernization investments
- Cost recovery challenges for grid modernization investments
- Interactive resource for best practices for grid codes



More resources

Berkeley Lab's Integrated Distribution System Planning [website](#)

U.S. Department of Energy's [Distribution Grid Transformation website](#) and [Modern Distribution Grid](#) guidebooks

S. Murphy, L. Schwartz, C. Reed, M. Gold, and K. Verclas, [State Energy Offices' Engagement in Electric Distribution Planning to Meet State Policy Goals](#), National Association of State Energy Officials, 2023

J. Carvallo and L. Schwartz, [The use of price-based demand response as a resource in electricity system planning](#), Berkeley Lab, 2023

J. Keen, E. Pohl, N. Mims Frick, J.P. Carvallo and L. Schwartz, [Duke Energy's Integrated System and Operations Planning: A comparative analysis of integrated planning practices](#), Grid Modernization Laboratory Consortium, 2023

Berkeley Lab, Pacific Northwest National Lab and NARUC, [Peer-Sharing Webinars](#) for Public Utility Commissions on Integrated Distribution System Planning, 2023

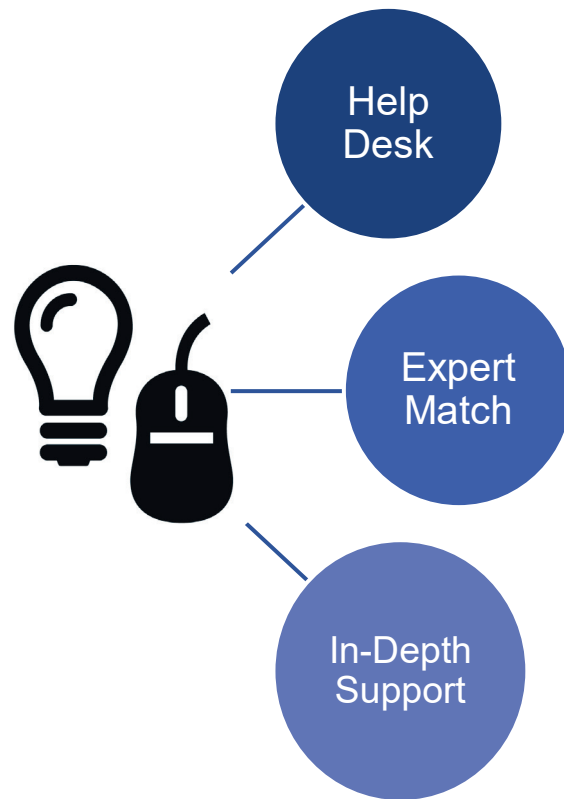
[Grid Resilience Plans: State Requirements, Utility Practices, and Utility Plan Template](#), 2024

[Locational Value of Distributed Energy Resources](#), Berkeley Lab, 2021



Direct state technical assistance from National Labs

- **Distribution system planning and grid resilience planning:** Contact Lisa Schwartz: lschwartz@lbl.gov
- **Other electricity topics:** [Resources and Assistance for State Energy Offices and Regulators program](#)



- Online intake form with rolling Lab screening
- Connect to PM within 2 business day to clarify request
- Connect to SME within 5 business days
- Up 4 person-hours of support

- Online intake form with rolling review by Labs
- Connect to PM within 2 business day to clarify request
- Connect to SME within 5 business days
- Up to 80 person-hours of support

- Detailed application form
- Planned 9-month work cycle by Labs & DOE
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