# Integrated Distribution System Planning Overview

Integrated Distribution System Planning 2.0: Planning for Load Growth and Local Resources

Lisa Schwartz and Natalie Mims Frick

March 11, 2025

*This work was funded by the U.S. Department of Energy, Office of Electricity and Office of Energy Efficiency and Renewable Energy, under Contract No. DE-AC02-05CH11231.*

# Agenda

**Lisa**

- Introduction
  - What is the distribution system?
  - What is integrated distribution system planning?
  - Why is it important?
- Framework for integrated distribution system planning
- Integrating state policy objectives in planning guidance for utilities
- Data and analysis utilities can provide
- Economic evaluation of distribution modernization expenditures

**Natalie**

- Cost recovery for grid modernization investments
- Questions states can ask
- Actions states can take
- Resources for more information

**Q&A**

# Introduction

# Electricity systems

- Electricity systems were designed for power to flow from large generators to geographically distant loads.

- With distributed energy resources (DERs), the distribution system is evolving to accommodate bidirectional flow and enable control and automation of DERs, including solar, storage, microgrids, and grid-interactive demand response.

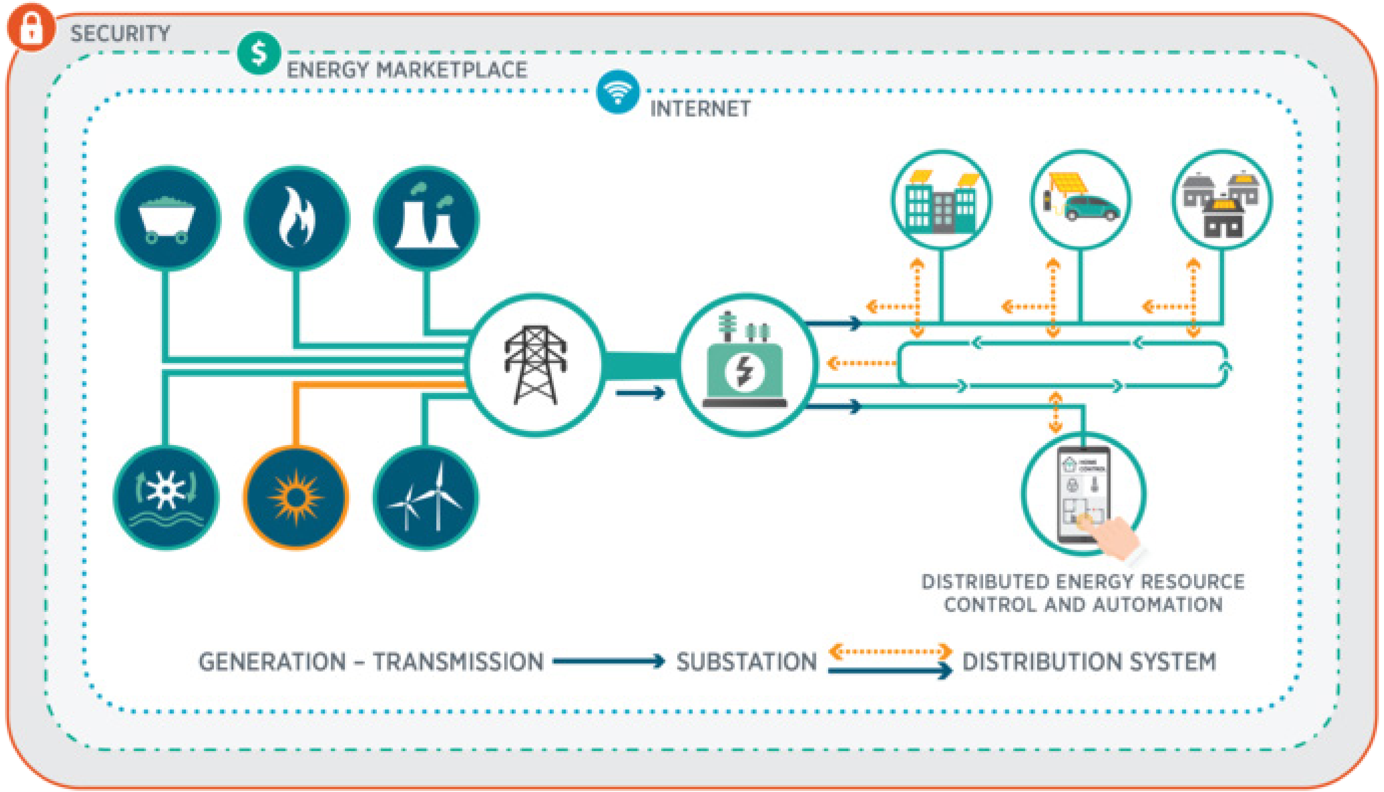



Figure source: DOE

# What is the distribution system?

- Portion of electric system composed of medium voltage lines, substations, feeders and related equipment
- Transports electricity to and from homes and businesses
- Connects to high-voltage transmission system that carries electricity long distances from large power plants
- Includes physical equipment as well as information, communications, and operations technologies

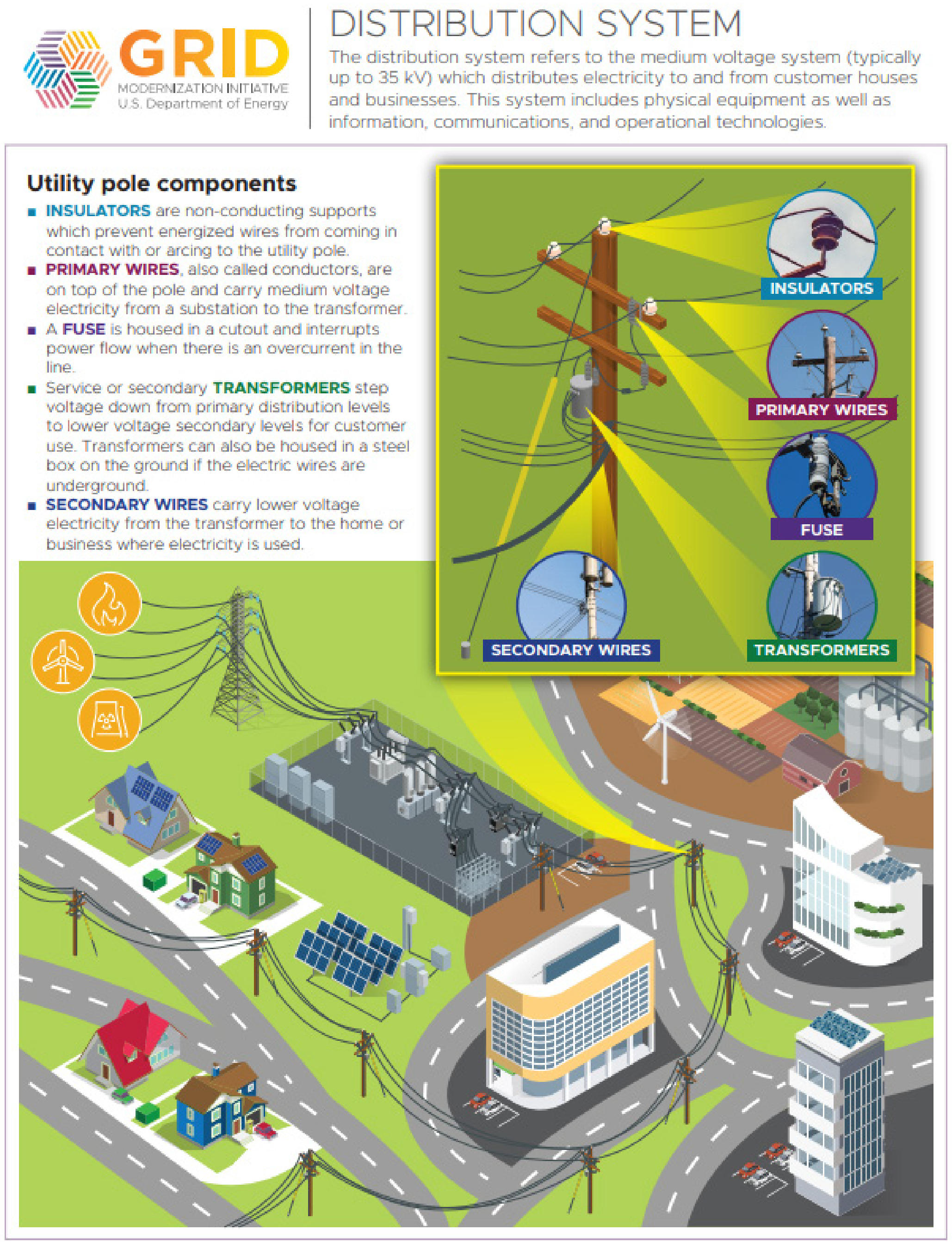



Figure: PNNL

GRID MODERNIZATION INITIATIVE
U.S. Department of Energy

# DISTRIBUTION SUBSTATION

A distribution substation is where high-voltage electricity from the transmission system or sub-transmission system is converted to lower-voltage electricity for the distribution system.

## Substation components

- **BUSWORK** consists of electrical conductors that interconnect electrical equipment.
- **CIRCUIT BREAKERS** protect a transformer from damage by interrupting the current when a fault in the line is detected.
- **VOLTAGE REGULATORS** adjust output voltage within a specified range regardless of changes in input voltage or load conditions.
- **STEP DOWN TRANSFORMERS** convert voltage from transmission or sub-transmission levels down to levels appropriate for local distribution.
- **CAPACITORS** maintain or increase voltage in power lines and improve efficiency of the system by compensating for inductive losses.

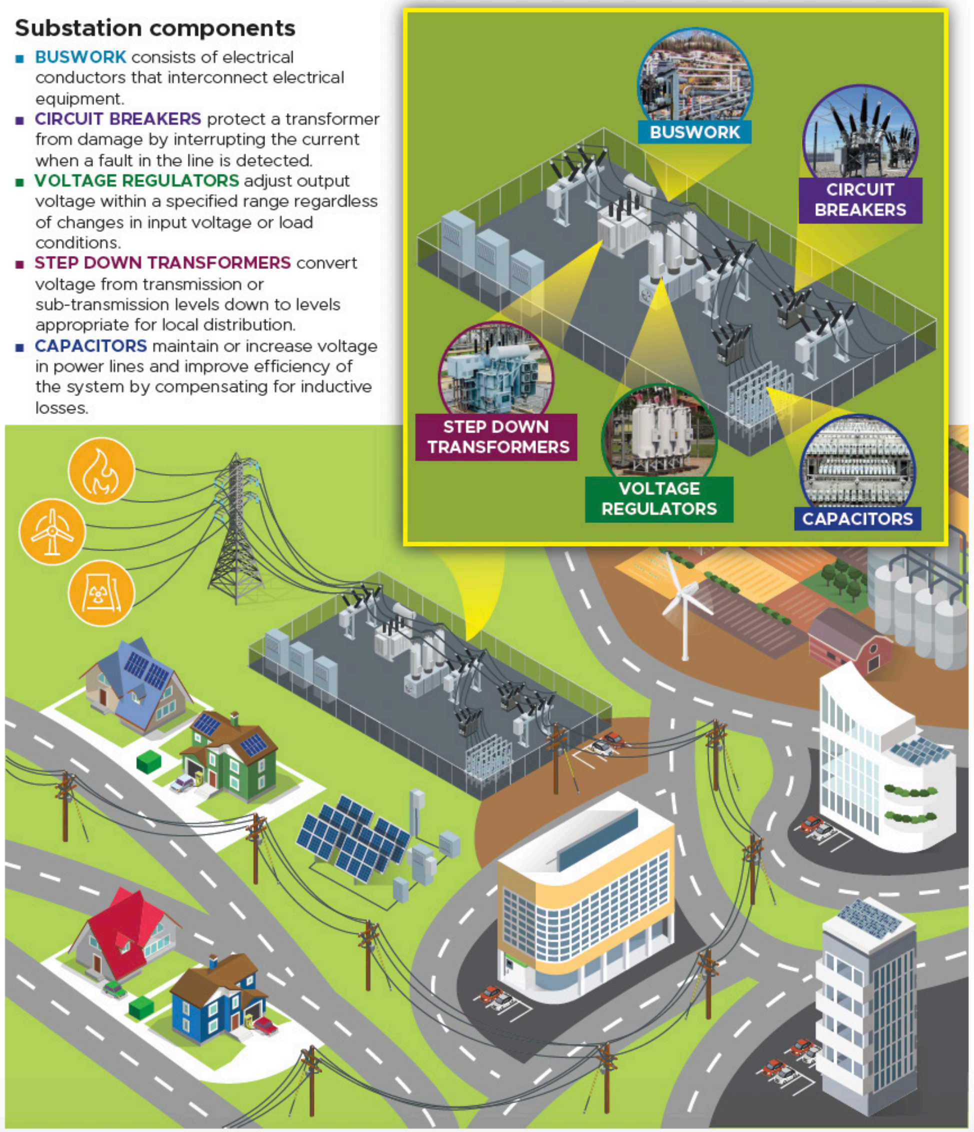



Figure: PNNL

# Electricity planning activities

- **Distribution planning** - Assess needed physical and operational changes to local grid
  - Annual distribution planning process
    - Identify and define distribution system needs
    - Identify and assess possible solutions
    - Select projects to meet system needs
  - Long-term utility capital plan
    - Includes solutions and cost estimates, typically over a 5- to 10-year period, updated every 1 to 3 years
- **Integrated resource planning** - Identify future investments to meet bulk power system reliability and other objectives at a reasonable cost
  - Can consider scenarios for loads and DERs and impacts on need for, and timing of, utility resource investments
  - *For states with vertically integrated utilities*
- **Transmission planning** – Identify future transmission expansion needs and options

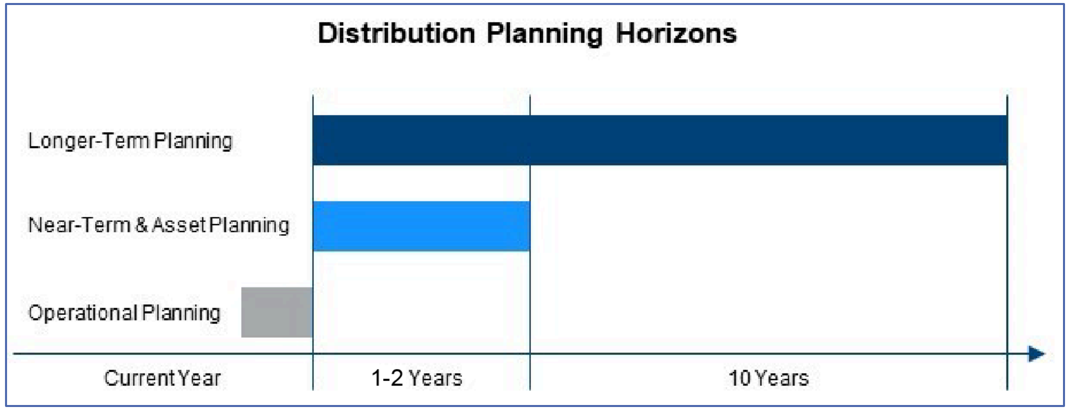
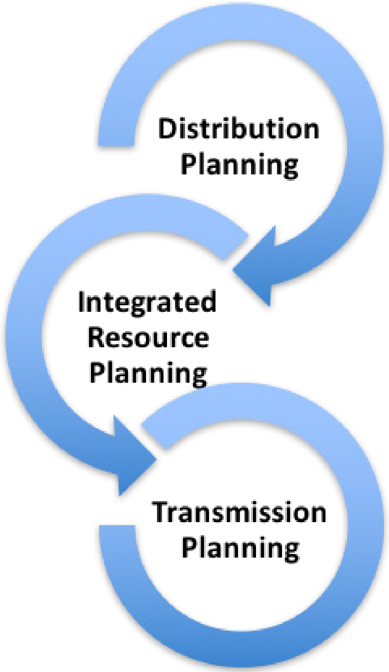
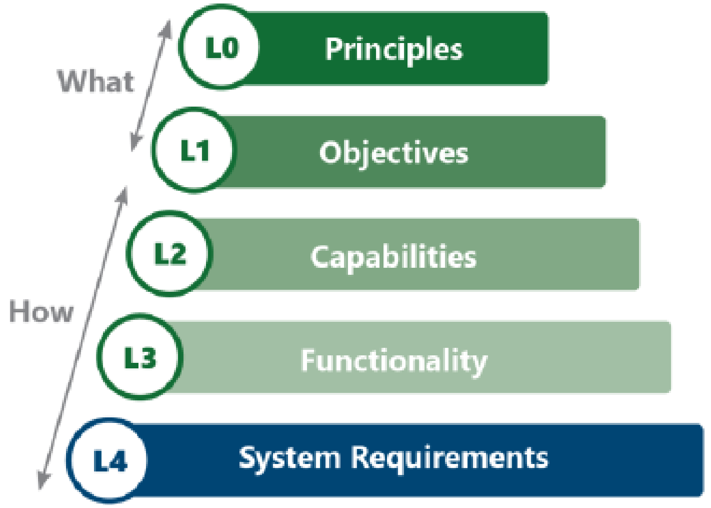



Figure: DOE 2020



# What is integrated distribution system planning?

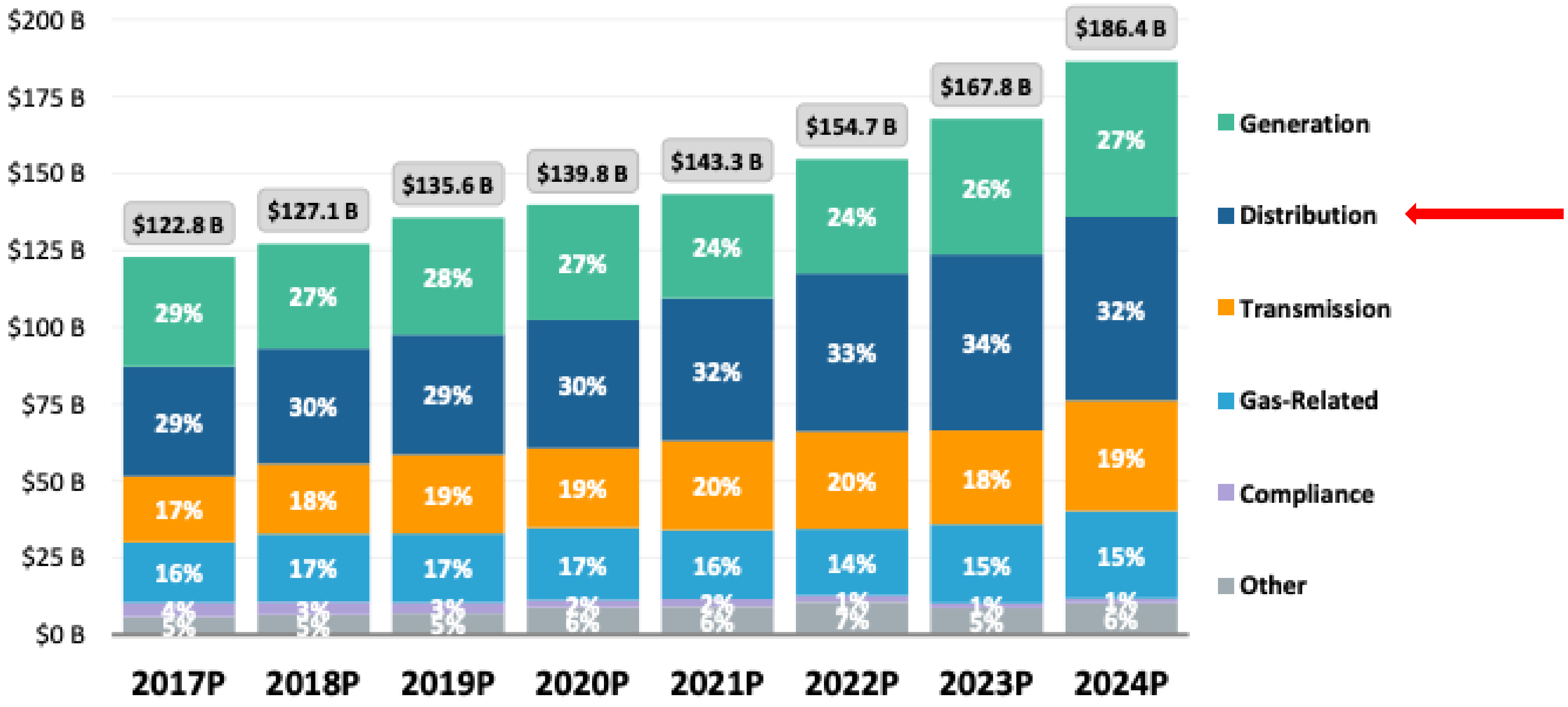
- A decision framework to enable formulation of long-term investment strategies for local grids, addressing state and local goals, objectives, and priorities, consumers' needs, and evolution at the grid edge
- State goals and objectives define **long-term, high-level outcomes** for grid planning.
- That determines **grid capabilities** needed, which in turn establish **distribution system functionality and system requirements**.
- Grid planning objectives
  - **Traditional regulatory aims** — safety, reliability and affordability
  - **Other objectives** include greater resilience to new threats, use local resources, reduce air pollution,* improve asset utilization, and better integration and utilization of DERs
- Grid planning objectives also reflect the importance of **transparency and stakeholder engagement**.
  - A **shared understanding across stakeholders of strategies** for addressing goals, objectives and priorities is essential.




Source: DOE 2020

*See Schwartz et al. 2025. Clean Air as a Bonus for Achieving Energy-Related State Goals: A Review of Policies and Programs in 15 States

# Why are states increasingly interested in distribution system planning?

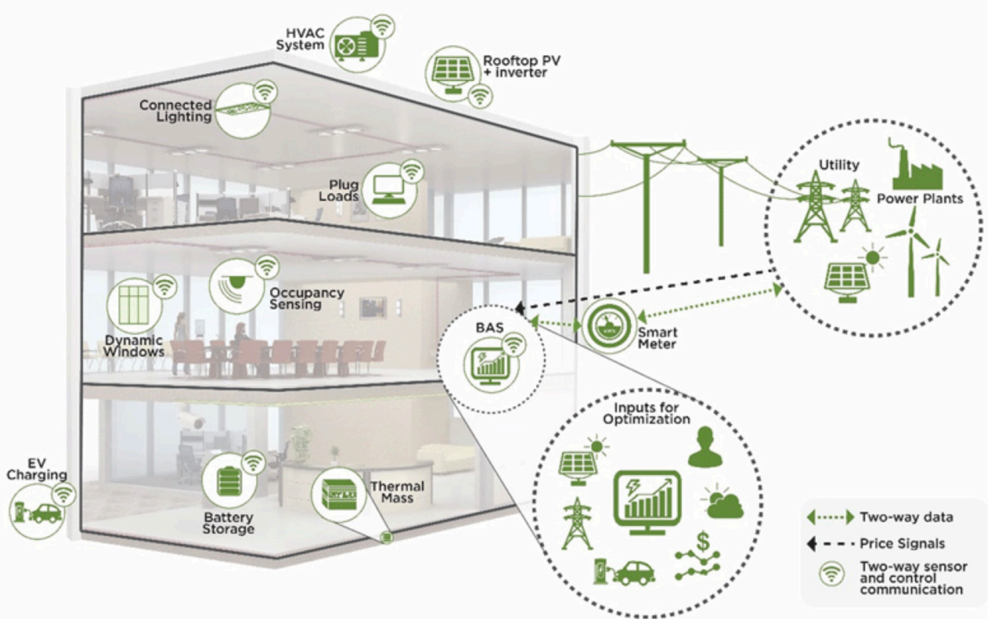



**Distribution system investments accounted for the largest portion of capex — 32% in 2024 (estimated $59.7B) — for U.S. investor-owned utilities.**

Source: EEI 2024

# What are the potential benefits from an improved planning process?

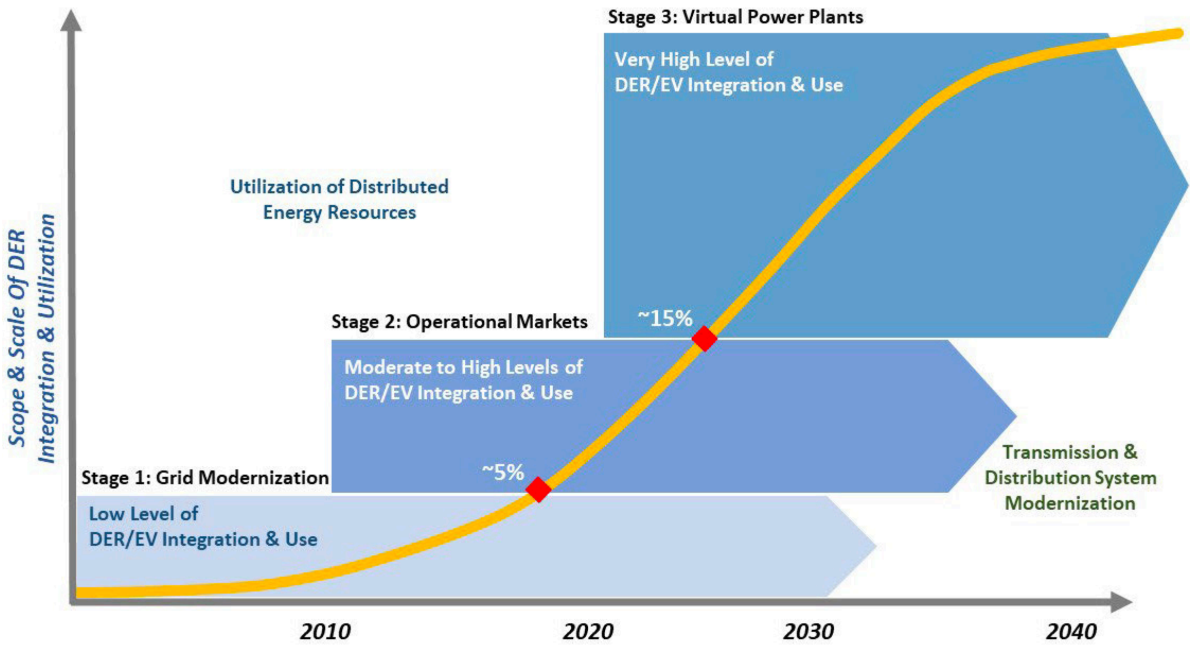
- Provide better **oversight** of utility expenditures
- Make **transparent** utility plans for distribution system investments in a **holistic** manner, before they show up individually in rate cases
- Enable opportunities for **meaningful engagement** with stakeholders and regulators to improve outcomes
- **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: Guidehouse Consulting*

# Example strategies for translating policy goals into planning guidance

- **Identify priorities**
  - Maine legislation – "…identify the priorities to be addressed in a filing by a covered utility regarding a grid plan that will assist in the cost-effective transition to a clean, affordable and reliable electric grid."
  - Public Utility Commission (PUC) priorities: (1) improve reliability and resilience while maintaining affordability and achieving climate goals, (2) improve data quality/integrity, (3) promote flexible management of consumers' resources and consumption
- **Gather baseline information on utility distribution systems and planning practices**
  - MN utilities, NJ utilities, OR utilities
- **Get input from experts and stakeholders**
  - Open an informational proceeding to gather input and increase understanding (CO, IL, ME, MA, MI, NM, OR)
  - Engage communities (CO, IL, NY, OR, WA)
- **Host work groups to refine requirements and address emerging issues (HI, ME, OR)**
- **Lay out the agency's vision for distribution planning (MN, NY, OR)**
- **Leverage the State Energy Office to convene a work group that makes recommendations to utilities on draft plans, before filing final plan with regulator (MA)**




Source: Distribution System Evolution

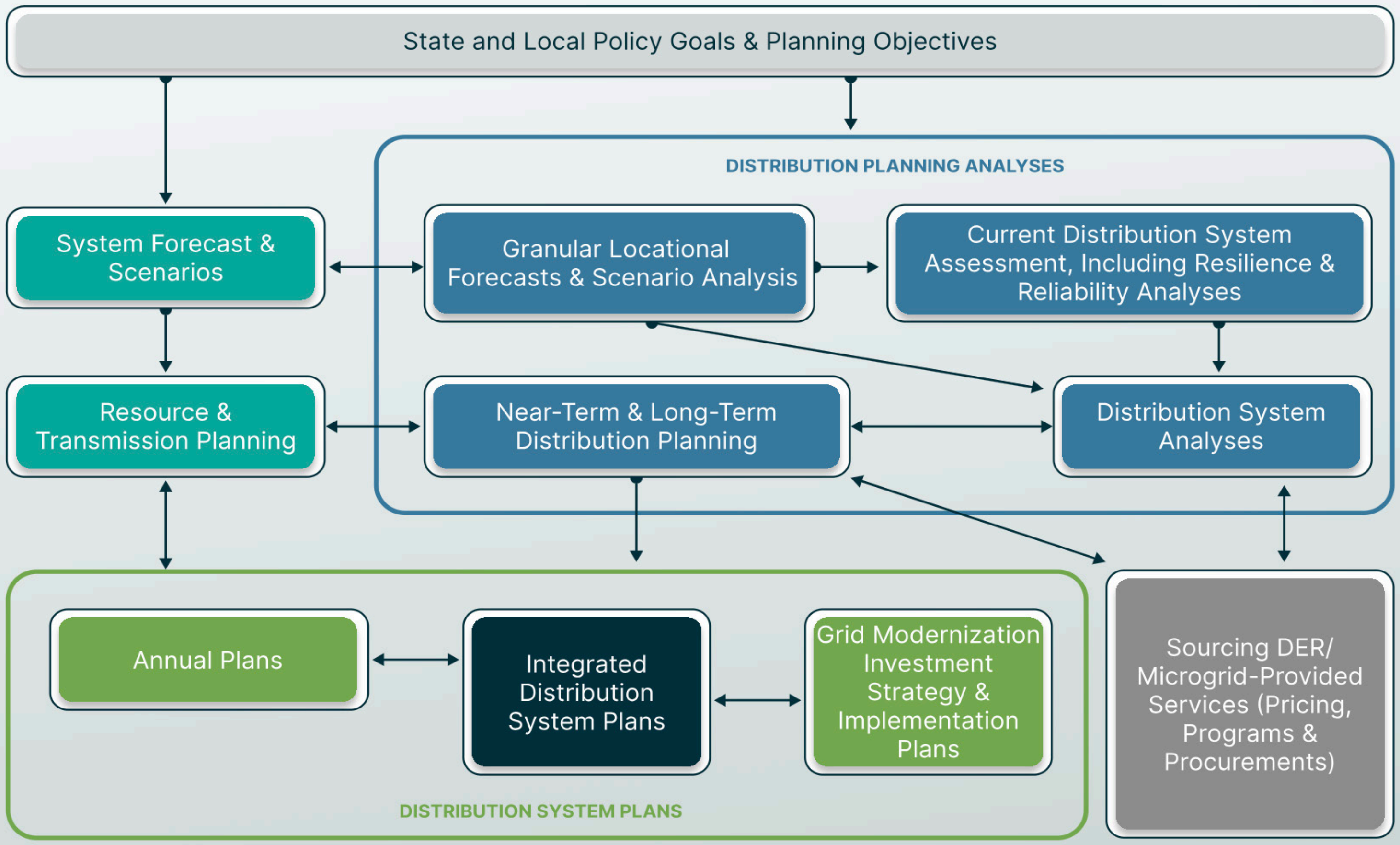
# Some indicators of success

- **Stakeholder input is reflected** in utility plans.
- Utilities consider **all potential solutions** to meet grid needs, using **robust and transparent analysis**.
- Filed distribution system plans provide a **roadmap for grid investments, systems, and processes designed to achieve state and utility goals and objectives**, with utility priorities and timelines.
- Filings are **well-organized and documented**, specify how they meet regulatory requirements, explain how they are **coordinated with other utility and state plans**, and provide **useful information** for regulators and stakeholders.
- **Regulators provide feedback** to utilities on filed plans.
- The planning process **facilitates cost recovery of prudent utility investments** in grid modernization and DER integration and utilization.
- Utility **cost recovery requests are clearly tied to achieving state goals and objectives** and utility grid priorities.
- Utilities **track and report on progress** for implementing plans.

*Source: Eversource*

# Framework for Integrated Distribution System Planning

# Interactive Decision Framework for Integrated Distribution System Planning




https://emp.lbl.gov/projects/integrated-distribution-system-planning

BERKELEY LAB

# What's included?

## Overview

- What is it?
- Why is it important?
- Key questions (Q&A)

## Roles and Responsibilities

## Best Practices

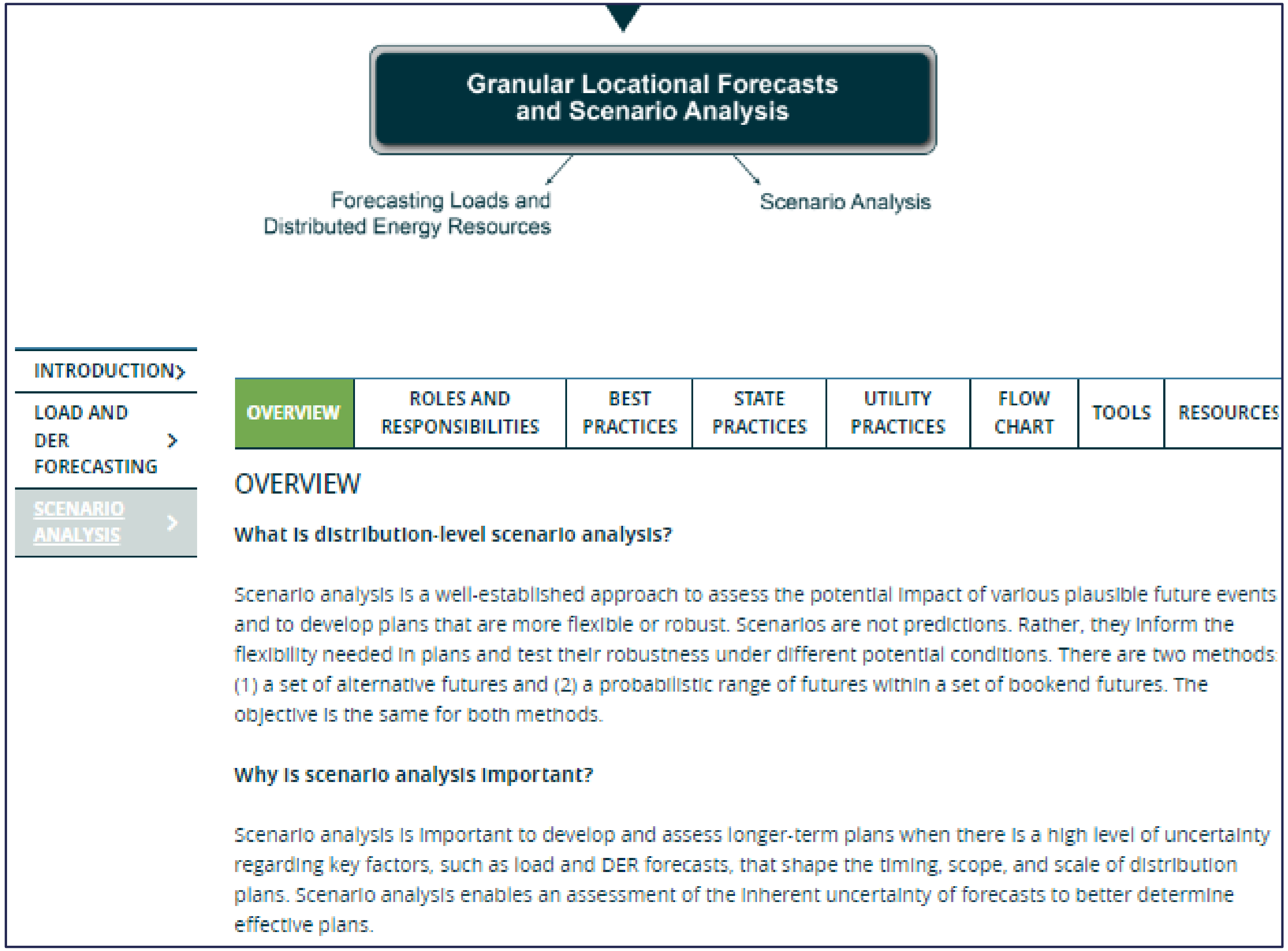
## State Practices

## Utility Practices

## Flow Chart (e.g., inputs/outputs)

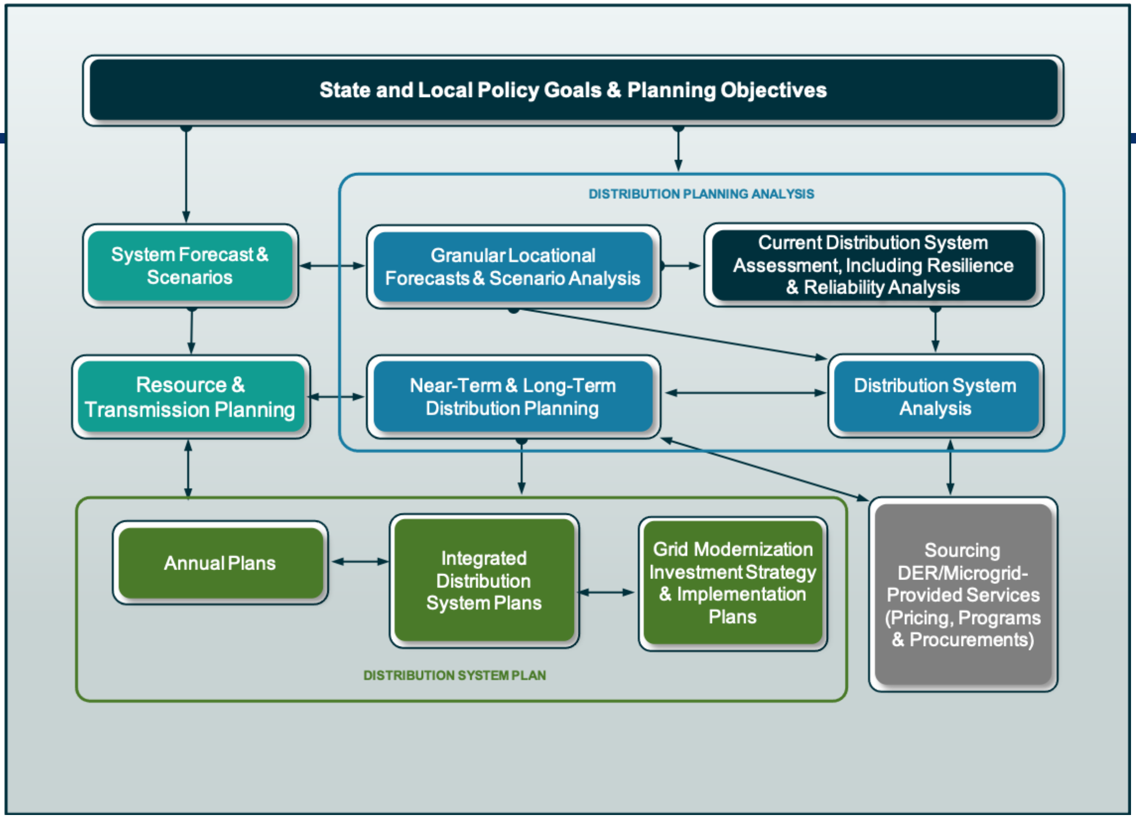
## Tools

## Annotated Resources List

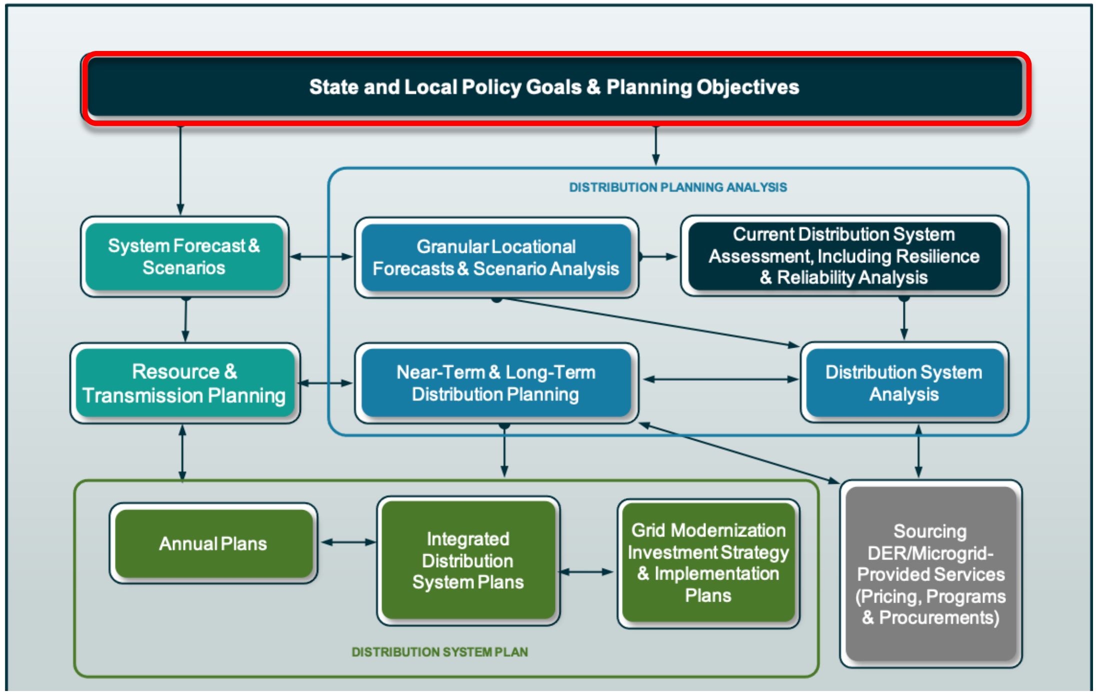


# Among the topics covered

- ☐ Stakeholder Engagement
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ Geotargeting Programs
- ☐ Procurements



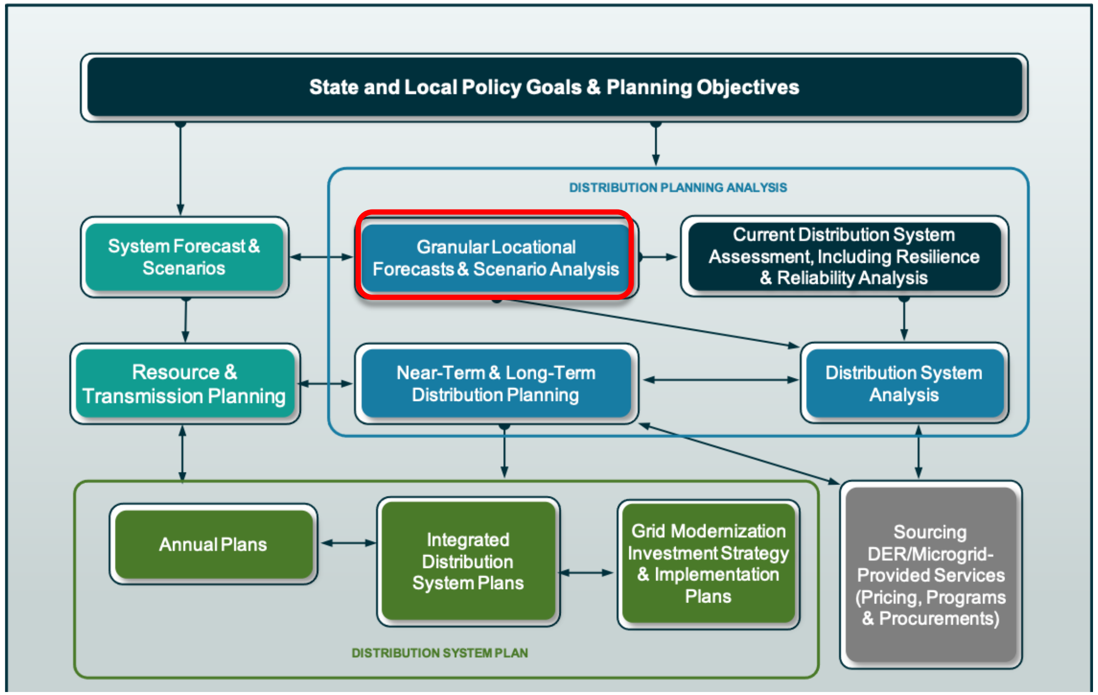
- ☐ **Stakeholder Engagement**
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ Geotargeting Programs
- ☐ Procurements




**State and local policy goals and planning objectives** are key IDSP inputs. Planning objectives and priorities originate from these goals, as well as input from communities and stakeholders.

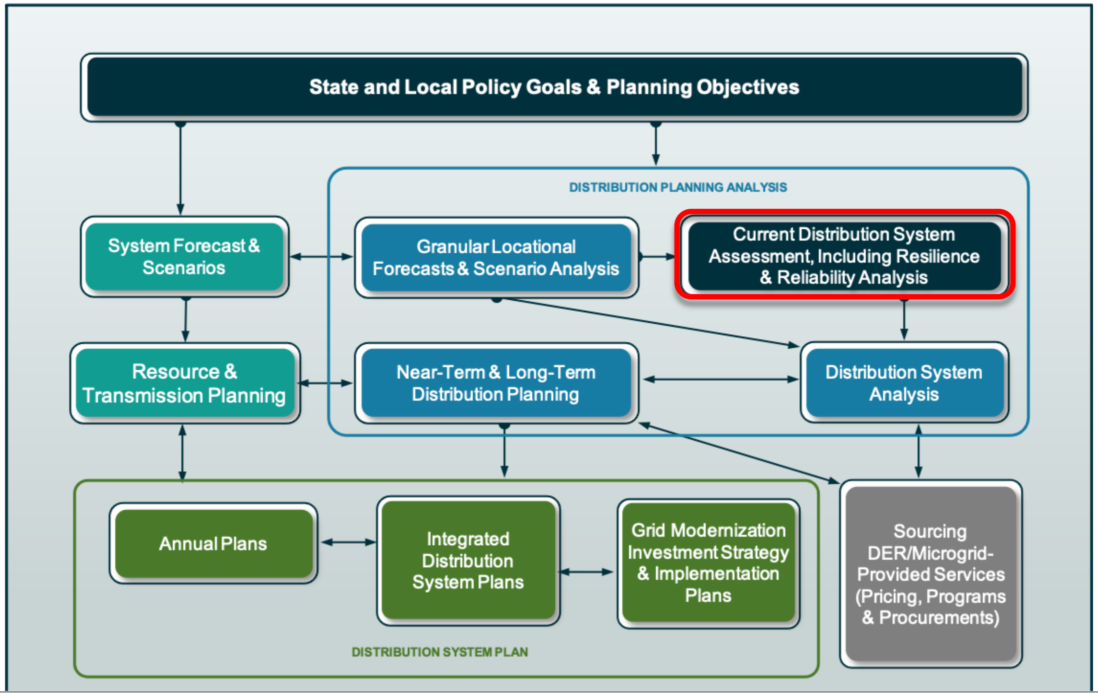
- **Stakeholder engagement** involves participation by a wide variety of interested or concerned parties to provide feedback on planning objectives, inputs, methods, scenarios, and priority investments.

- ☐ Stakeholder Engagement
- ☐ **Forecasting Loads and DERs**
- ☐ **Scenario Analysis**
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ Geotargeting Programs
- ☐ Procurements




- **Granular locational forecasts** are projections of loads and DERs at the distribution substation and feeder levels that provide locational and temporal information to inform the type and timing of distribution system investments needed. The forecasting process considers potential changes to loads due to load modifiers such as various types of DERs.
- **Scenario analysis** assesses the potential impact of various plausible future events to inform the flexibility needed in grid plans and test their robustness under different potential conditions.

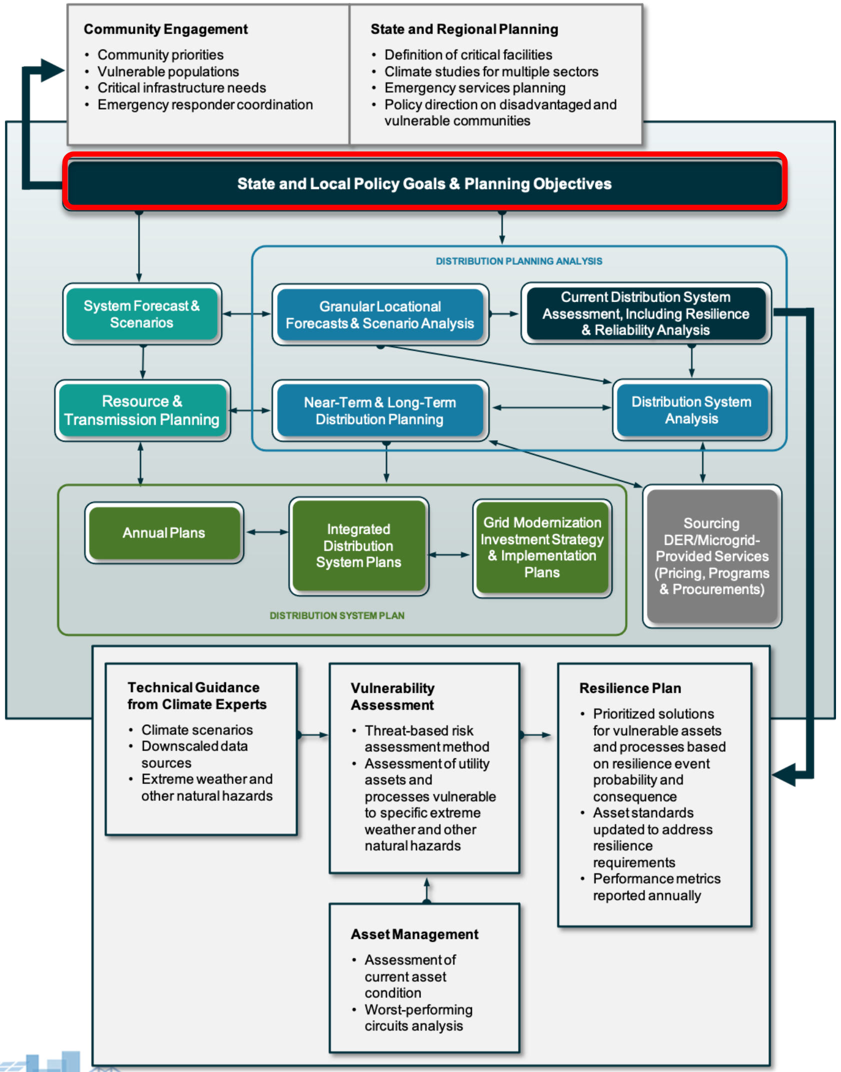
- ☐ Stakeholder Engagement
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ **Threat-Based Risk Assessment**
- ☐ **Worst-Performing Circuits Analysis**
- ☐ **Asset Management Strategy**
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ Geotargeting Programs
- ☐ Procurements




**Current distribution system assessment** evaluates asset condition and operational performance with respect to planning criteria and service standards, *including for reliability and resilience*.

- **Threat-based risk assessment** identifies specific threats to assets and processes and categorizes vulnerability levels based on consequences (e.g., customer interruptions, grid damage).
- **Worst-performing circuits analysis** examines outage data to develop a list of circuits with the worst reliability performance and assess potential root causes to develop a remediation plan to reduce the duration and/or frequency of interruptions.
- **Asset management strategy** is the process of managing physical infrastructure for delivering electric service, including a systematic analysis of the condition and performance of physical grid assets.

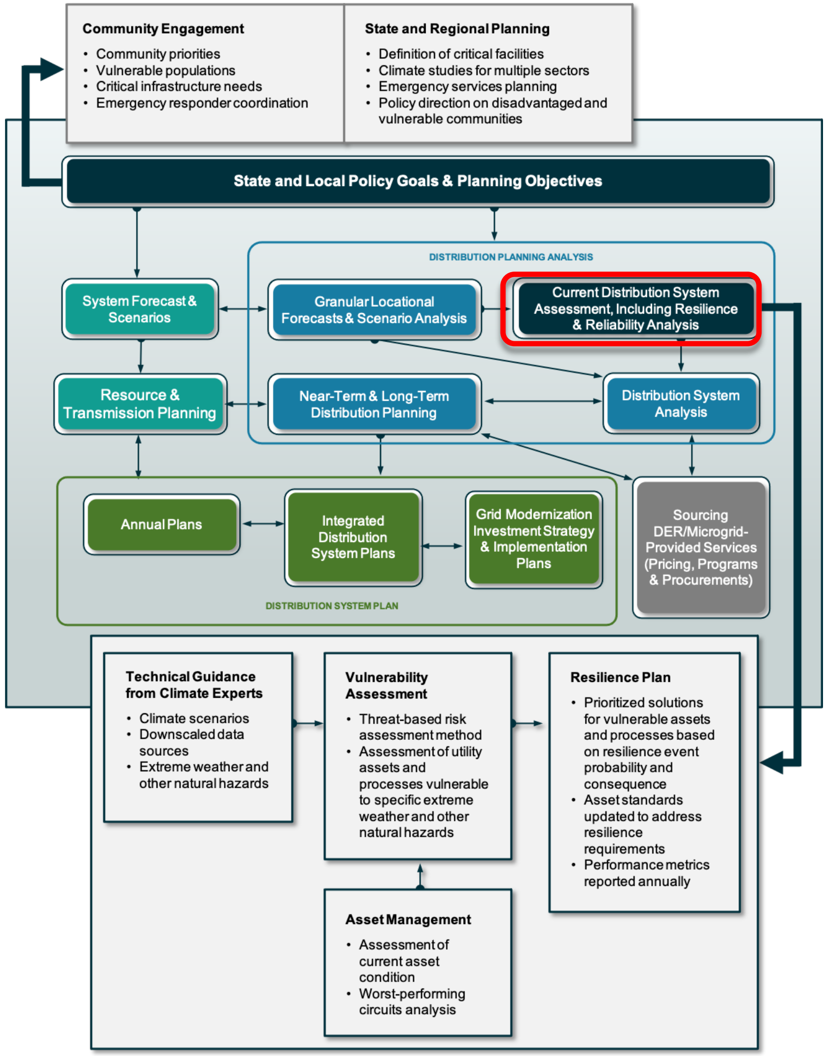
# Integrating resilience planning and distribution planning (1)

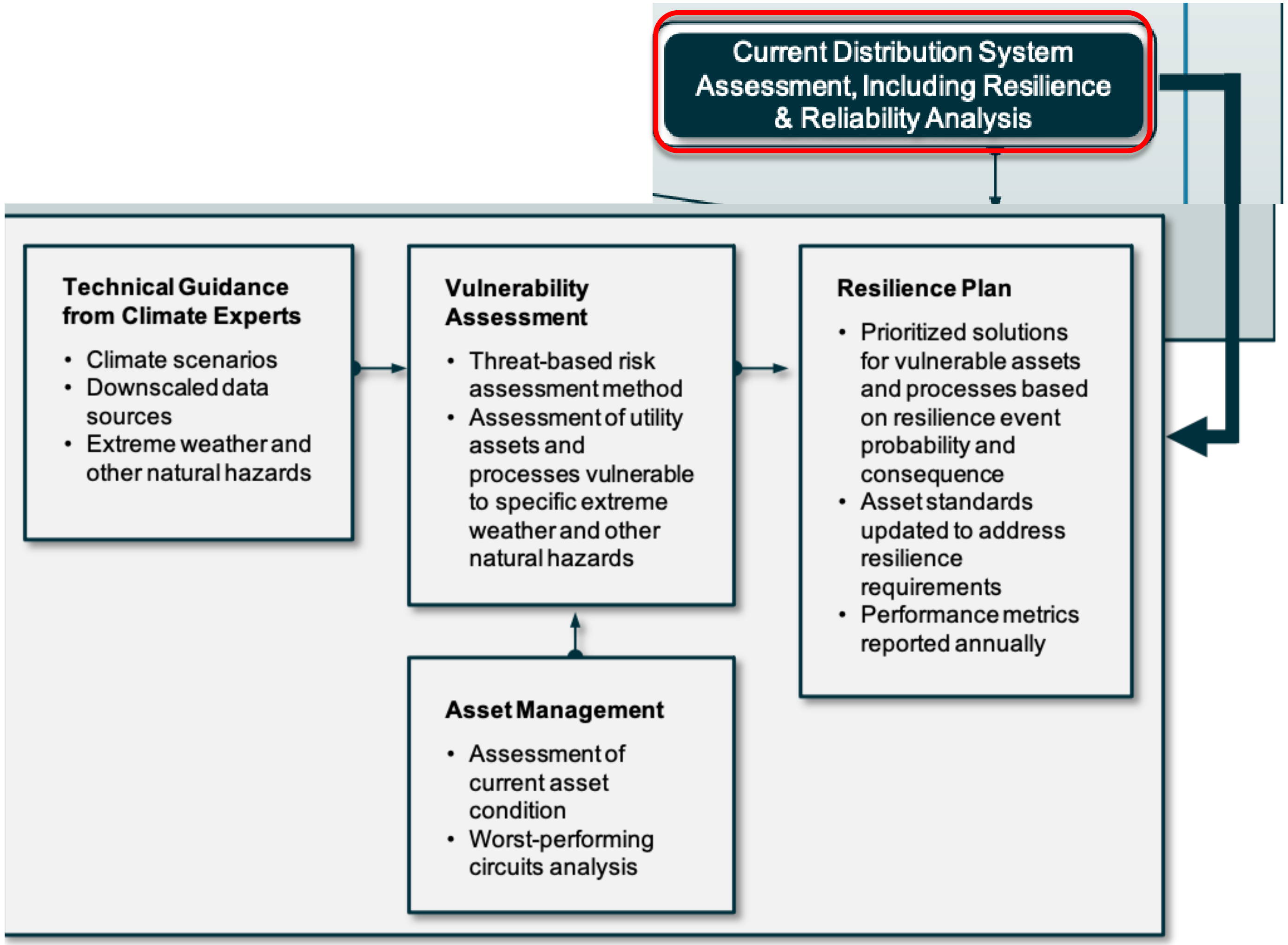




Source: Berkeley Lab, *Grid Resilience Planning: State Requirements, Utility Practices, and Utility Plan Template*

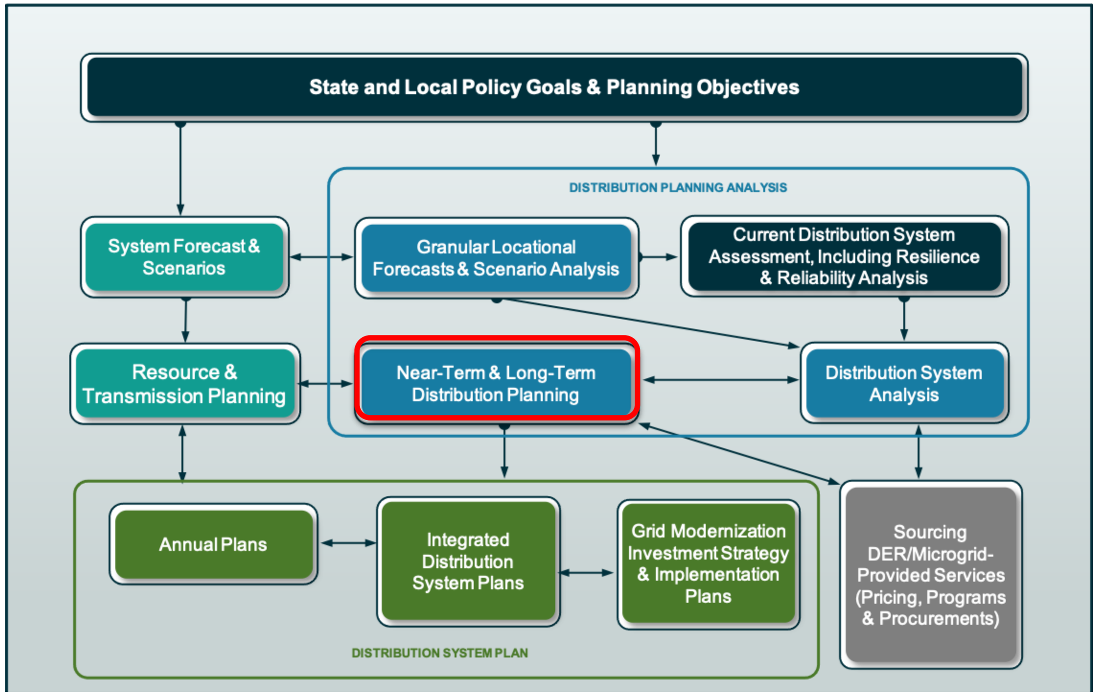
# Integrating resilience planning and distribution planning (2)




Source: Berkeley Lab, *Grid Resilience Planning: State Requirements, Utility Practices, and Utility Plan Template*

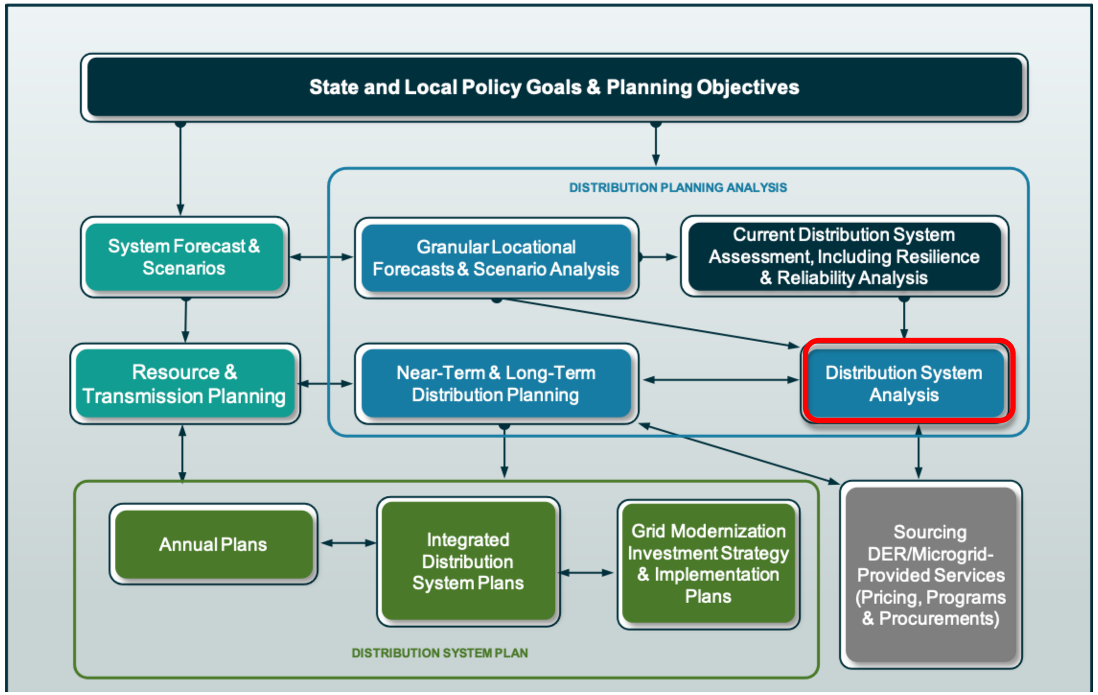
- ☐ Stakeholder Engagement
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ **Cost-Effectiveness Framework for Investments**
- ☐ **Multi-Objective Decision-making**
- ☐ **Coordinated Planning**
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ Geotargeting Programs
- ☐ Procurements




**Long-term plans** establish the utility's strategy for capital investments and other expenditures to address identified grid needs, typically over a 10-year period. **Near-term plans** identify expenditures with greater specificity over the next 3–5 years.

- **Cost-effectiveness evaluation** assesses benefits and costs of grid investments and qualitative factors to determine an optimal course of action to meet identified grid needs.
- **Multi-objective decision-making** is a set of methods to prioritize expenditures that provide the greatest value for meeting state goals, customer needs, regulatory requirements, and utility criteria.
- **Coordinated planning** harmonizes outputs from traditionally siloed planning processes (e.g., transmission and distribution planning) by enhancing consistency in assumptions and methods. **Integrated planning** unifies processes to streamline analyses, mitigate misalignment, and increase resource efficiency.

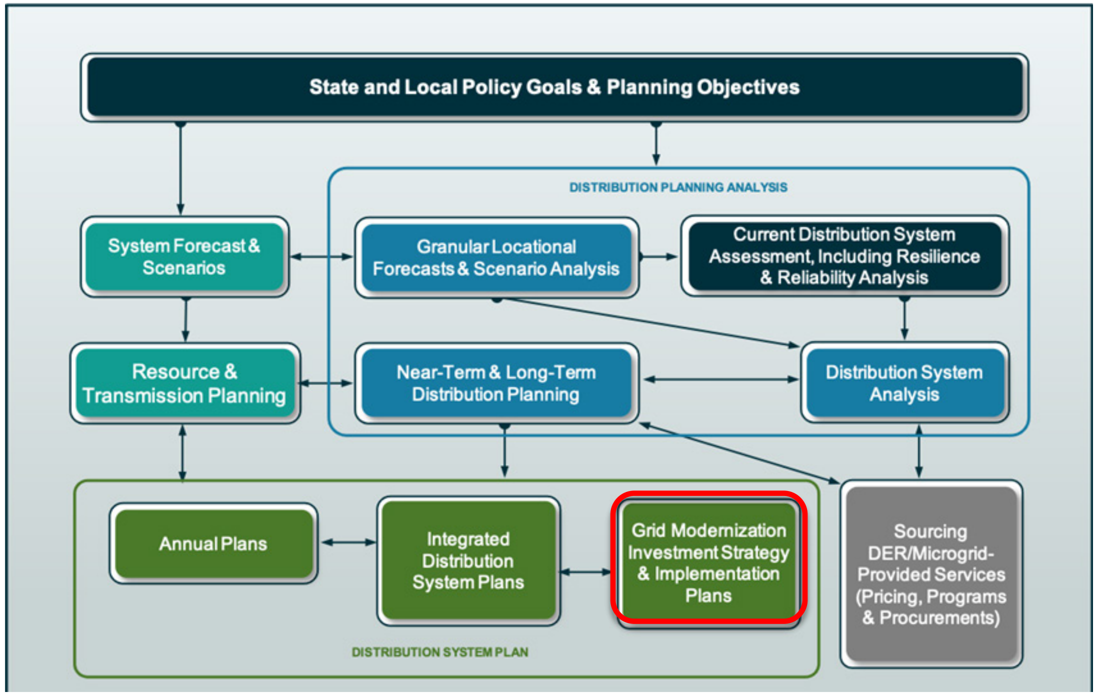
- ☐ Stakeholder Engagement
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ **Hosting Capacity Analysis**
- ☐ **Value of DERs**
- ☐ **Interconnection**
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ Geotargeting Programs
- ☐ Procurements




**Distribution system analyses** include engineering, economic, and other technical studies necessary for an effective planning process for local grids.

- **Hosting capacity analysis** identifies the amount of DERs that can be interconnected without adversely impacting power quality or reliability under existing control and protection systems and without infrastructure upgrades.
- **Value of DERs** derives from their capability to provide load relief, reduce power interruptions, address voltage issues, enhance resilience, or meet local energy needs. The potential value depends on capability to provide needed grid services at specific locations and times.
- **Interconnection** is the result of adding a DER to a distribution system. The term may refer to the technical, procedural, and legal requirements of the interconnection process or the physical location at which the DER provides certain electrical and interoperability capabilities.

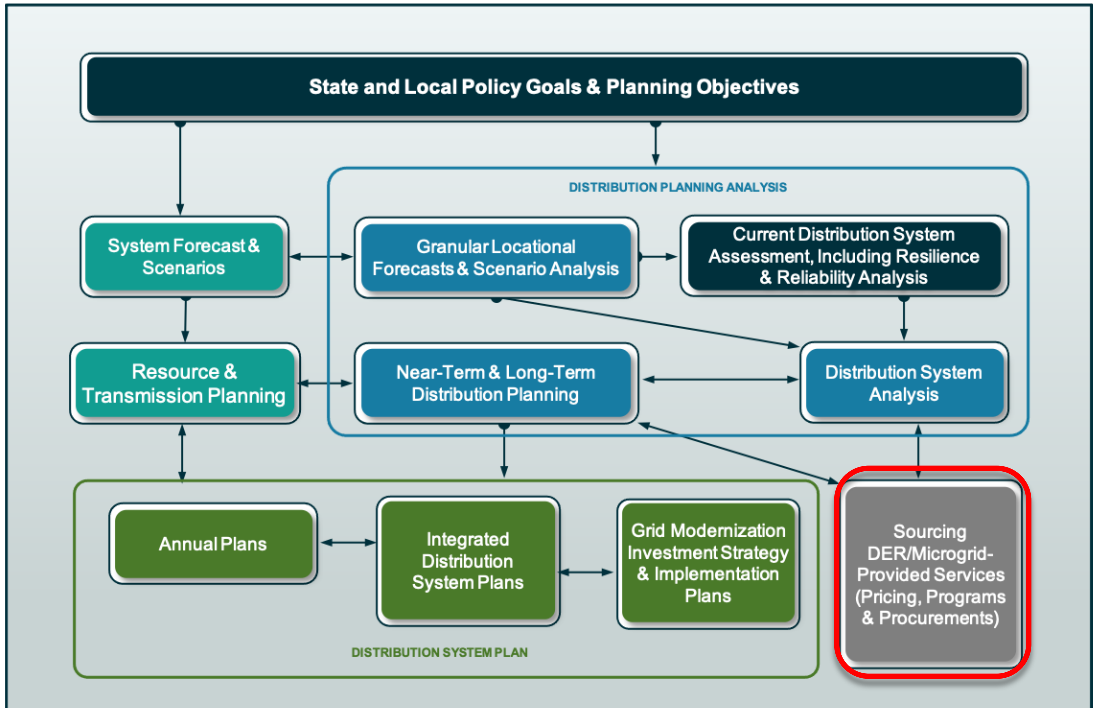
- ☐ Stakeholder Engagement
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ **Distribution Investment Strategy**
- ☐ **Functional Requirements Analysis**
- ☐ Geotargeting Programs
- ☐ Procurements




**Grid modernization strategy & implementation plans** establish a technology roadmap for capital investments, programs, and other expenditures. Grid modernization plans are informed by the IDSP and, ideally, are filed together.

- The **distribution investment strategy and implementation plan** provides the utility's roadmap for meeting multiple planning objectives in an affordable way over the planning horizon. It demonstrates how the utility translates planning objectives into expenditure decisions and describes near-term needs in the context of long-term goals.
- **Functional requirements analysis** is a business process that identifies potential changes to utility organizational activities involving people, processes, and technologies to address specific grid needs.

- ☐ Stakeholder Engagement
- ☐ Forecasting Loads and DERs
- ☐ Scenario Analysis
- ☐ Threat-Based Risk Assessment
- ☐ Worst-Performing Circuits Analysis
- ☐ Asset Management Strategy
- ☐ Cost-Effectiveness Framework for Investments
- ☐ Multi-Objective Decision-making
- ☐ Coordinated Planning
- ☐ Hosting Capacity Analysis
- ☐ Value of DERs
- ☐ Interconnection
- ☐ Distribution Investment Strategy
- ☐ Functional Requirements Analysis
- ☐ **Geotargeting Programs**
- ☐ **Procurements**



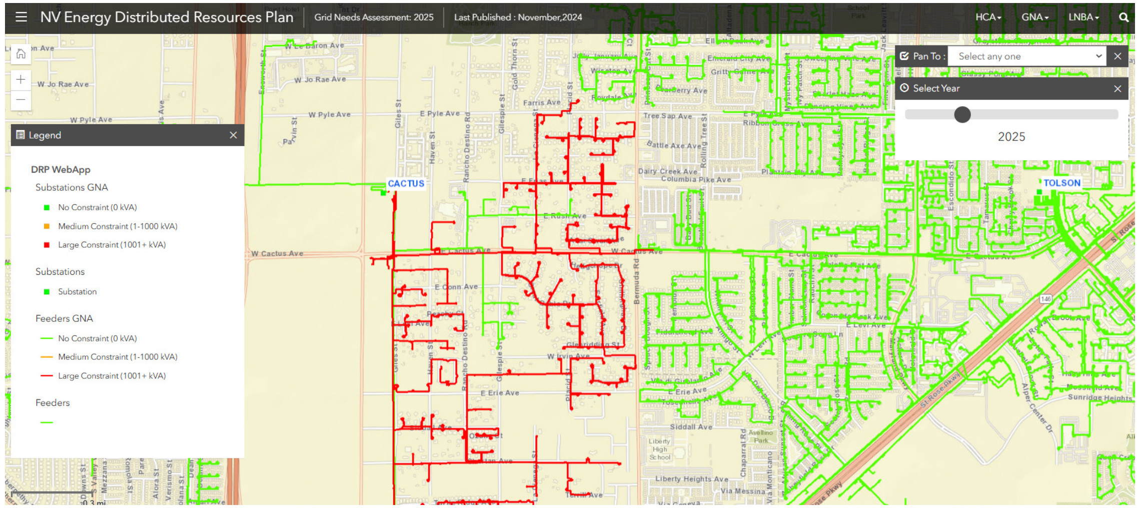

**Sourcing DER/microgrid-provided services** includes programs, procurements, and pricing to meet some distribution system needs with DERs.

- **Geotargeting programs** includes focusing incentives by grid location or providing higher incentives to address a specific locational grid need through DERs.
- **Procurements** are solicitations for non-wires alternatives to defer traditional distribution system investments, such as feeder and substation upgrades, by acquiring DERs to provide specific grid needs — e.g., to provide load relief, reduce power interruptions, or improve resilience.
- ***Pricing** includes designing new or adapting existing tariffs for utility customers to include location- and time-sensitive distribution system benefits of DERs. See Carvallo and Schwartz 2023.*

# Data and analysis that utilities can provide

# Bridging the Gap Between Utilities, State Agencies and Stakeholders

- Utilities conduct extensive analysis to develop distribution system plans. But regulators, state energy offices, and stakeholders often do not know:
  - What data are available
  - How the utility uses the data in planning
  - How the data and analysis affect utility decisions
- New Berkeley Lab report aims to increase understanding
  - Types of data, metrics, and analyses that utilities can provide state agencies and stakeholders
  - Impacts on planning and decision-making
- Interviewed representatives of electric utilities, public utility commissions (PUCs), and state energy offices
- Reviewed utility distribution system plans filed with PUCs

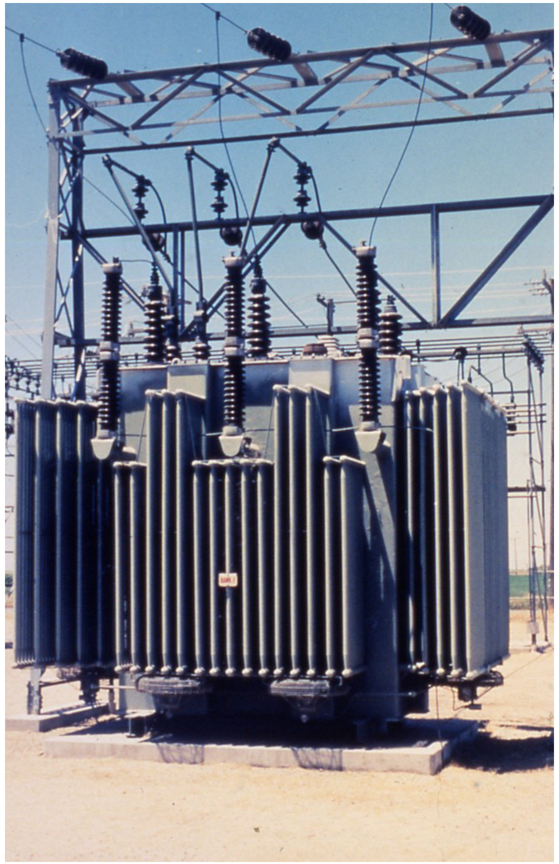



Source: NV Energy, 2024, Distributed Resources Plan Portal

Murphy, S., L. Schwartz, G. Pereira, and C. Davis. 2025. *Bridging the Gap on Data and Analysis for Distribution System Planning: Information That Utilities Can Provide Regulators, State Energy Offices and Other Stakeholders*

# 11 data categories included in report

1. **Forecasting loads and DERs**
2. **Scenario analysis**
3. **Worst-performing circuits**
4. **Asset management strategy**
5. **Hosting capacity analysis**
6. **Value of DERs**
7. **Grid needs assessment**
8. **Cost-effectiveness framework for investments**
9. **Distribution system investment strategy and implementation**
10. **Geotargeted programs**
11. **Non-wires alternatives procurements**



*Source: EPRI*

- Excel-based **collection tool** that states and stakeholders can adapt to their needs
- **Interactive Decision Framework** for Integrated Distribution System Planning includes several additional topics.

# Example: Worst-performing circuits

Utilities analyze the duration, frequency, and number of customer service interruptions to identify circuits (feeders) with the worst reliability.

| Data category | Types of data reported | Impact of data on planning |
|---|---|---|
| Identification of worst-performing circuits | Metrics, methods, and criteria for selecting worst-performing circuits | Focuses efforts on circuits with the poorest performance and resulting local grid conditions |
| Worst-performing circuit characteristics | Circuit technical details, customer counts and classes, reliability performance, event and maintenance history | Provides historical and operational context for understanding circuit reliability |
| Remediation plans | Criteria for developing a remediation plan and planned remediation actions | Specifies how utilities plan to respond to known drivers of poor reliability performance |

# Example: Hosting capacity analysis

Utilities determine the amount of DERs that can interconnect at a specific point on the grid without infrastructure upgrades or adversely impacting power quality or reliability under existing control and protection systems.

| Data category | Type of data reported | Impact of data on planning |
|---|---|---|
| Analytical framework | Criteria for updating hosting capacity analysis and key methodological decisions | Provides transparency and enables regulators to validate utility decisions and propose alternatives |
| Distribution system infrastructure attributes | Locational, technical, and operational information on substations and feeders | Informs siting of DERs and loads absent power flow simulations |
| Load characteristics | Peak and minimum demand | Informs siting of DERs and loads |
| DER capacity | Installed and queued DER capacity | |
| Hosting capacity estimates | Generation, load, and storage hosting capacity | Informs siting, sizing, and operations of DERs and EV charging stations |
| Mitigation analysis | Options and costs for mitigating constraints | Provides transparency, enables validation of utility analyses, and provides insight into utility investment decisions and potential alternatives |

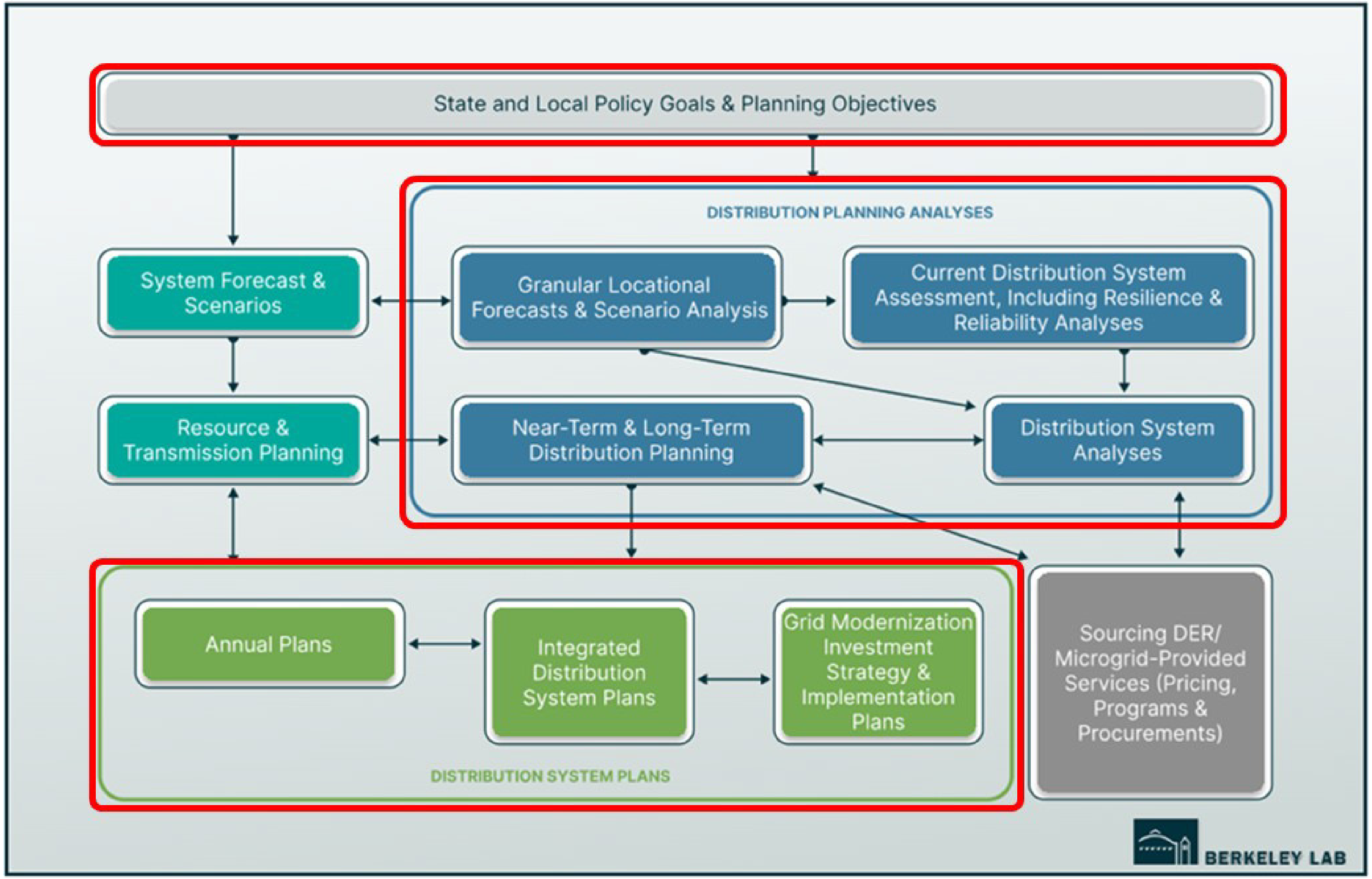
# Economic evaluation of distribution modernization expenditures

# Connections between distribution planning and economic evaluation of grid modernization expenditures

Cost-effectiveness evaluation of distribution modernization expenditures is integral to the distribution planning process.

Planning activities circled in **red** involve cost-effectiveness process steps:

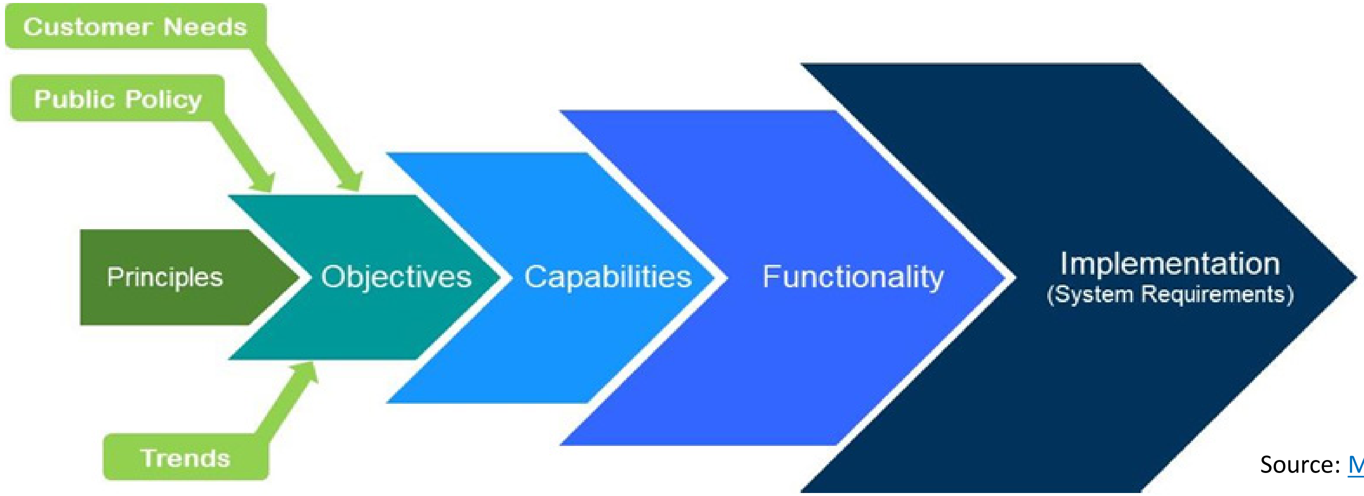
- State and Local Objectives
- Distribution Planning Analyses
- Distribution System Plans




De Martini, P., L. Schwartz, J. Ball. 2025. *Economic Evaluation of Modernization Expenditures for Electric Utility Distribution Systems: A Guide for Utility Regulators*. Berkeley Lab

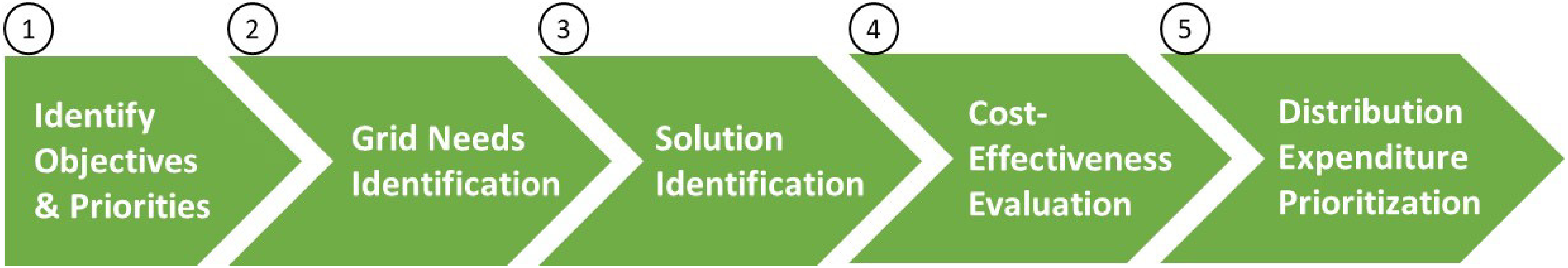
# Three core principles

1. **Create transparency and consistency in assessment methods to ensure cost-effectiveness evaluation of alternatives clearly shows the relationship between proposed solutions, identified grid needs, and related objectives.**
   - Clarity and consistency in underlying assumptions, parameters and values
2. **Use credible, methodologically sound data from independent or balanced sources that reflect a time frame relevant to the analysis.**
3. **Conduct a holistic analysis that includes all supporting analyses of grid needs and identifies monetary and non-monetary benefits and costs.**




Source: Modern Distribution Grid, Volume I (2019)

# Multi-objective decision-making process



# 1. Identify objectives and priorities

## Establish objectives, metrics and priorities through a stakeholder-engaged process

### Example Utility Grid Planning Objectives & Metrics

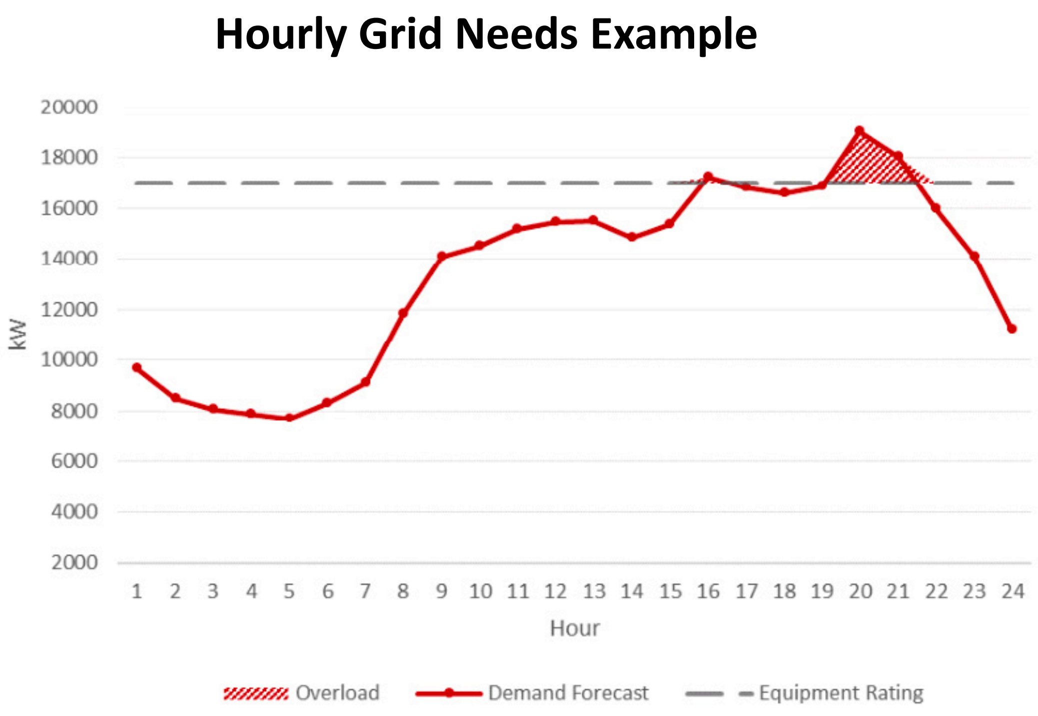
**Customer Affordability**

| | Reduce Wildfire Risk | Increase Grid Capacity | Improve Asset Health | Improve Reliability | Increase Resilience |
|---|---|---|---|---|---|
| **Description** | Reducing wildfire risk and preventative outage impacts to customers and communities | Expand grid capacity to remedy overloading and facilitate electrification | Address underlying asset health (e.g., age) issues that lead to failure | Reducing frequency and duration of outages | Aim to build a more resilient to anticipated impacts of climate change and other natural disasters |
| **Metrics** | Wildfire Multi-factor Risk Score<br><br>PSPS related CMI | Number and MW of substations & feeders overloaded | Risk-weighted share of unhealthy assets<br><br>Percentage of assets past expected life and at risk of failure | SAIDI & SAIFI w/o Major Events<br><br>CEMI | Percentage of spend in areas at risk of climate and other natural hazards (e.g., earthquakes)<br><br>Number of identified grid vulnerabilities addressed |

Source: P. De Martini

# 2. Identify grid needs

- **Clearly describe grid needs in terms of objectives and metrics**
- ***Grid needs assessment* is the distribution system analysis output that identifies specific grid deficiencies**
  - Describes each grid need, with engineering characteristics or functional requirements and timing
  - Starting point for developing solutions to address each need

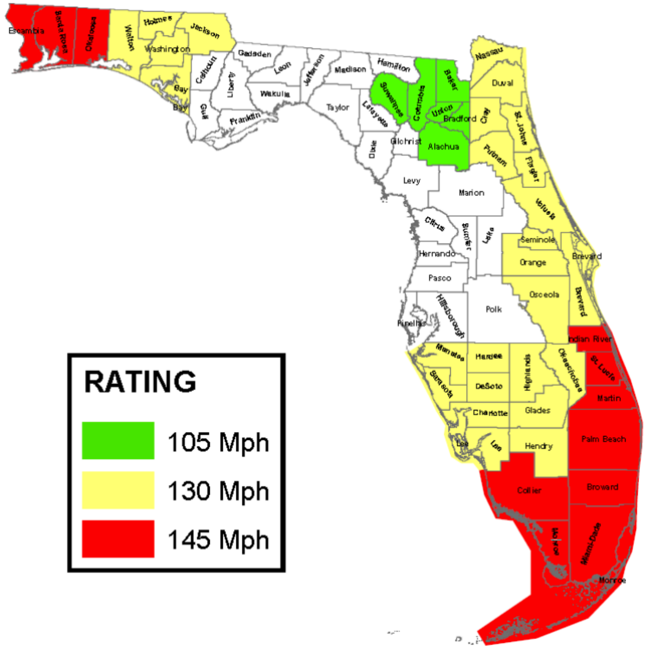



Source: [HECO]

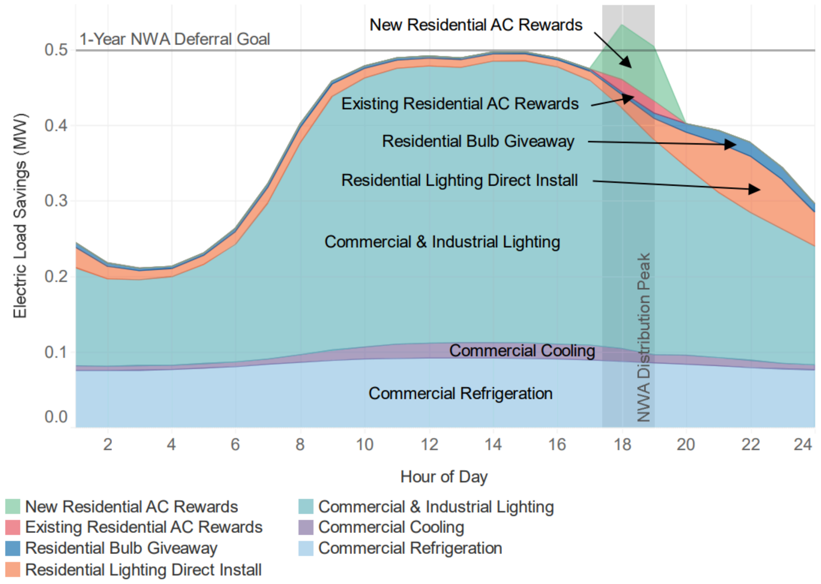
# 3. Identify potential solutions

- **System improvements (*incremental cost*), such as resilience investments, programmatic asset replacement, infrastructure upgrades, and grid technology investments**
- **Operational changes (*no incremental cost*), such as system reconfiguration and new design standards**
- **Non-wires alternatives, such as time-varying rates (*low incremental cost where smart meters are installed*), geotargeted demand-side management programs (*no or low incremental cost*), and procurements for third-party DER services (*incremental cost*)**

*Source: EPRI*

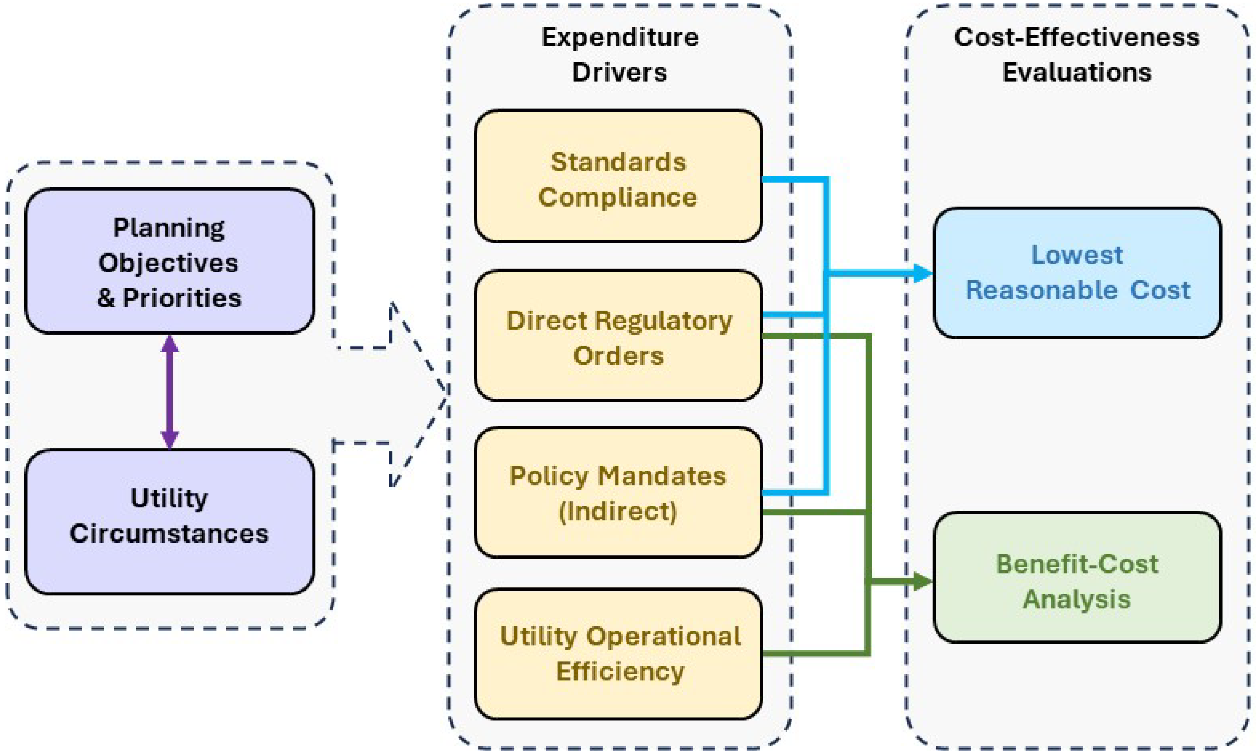



*Source: Florida Power & Light*




*Source: CEE*

# 4. Screen for cost-effectiveness




**Lowest Reasonable Cost** – is a quantitatively focused method based on engineering or technology architectural analysis, or both to discern the necessity and cost of a solution based on compliance with statutory requirements and explicit or implicit regulatory requirements identified in the distribution planning process.

**Benefit-Cost Analysis** is a quantitatively focused method based on monetizing the benefits and costs of distribution modernization expenditures over a defined time period. It is best used when the dollar value of the benefits of a distribution modernization solution is discrete, assignable, and quantitatively measurable.

# 5. Prioritize investments based on multiple objectives

- **Use multi-objective decision analysis to prioritize grid modernization and all other distribution expenditures to optimize value toward meeting state goals, customer needs, regulatory requirements and other criteria**
- **Identify which solutions materially address the most or highest priority objectives for a given net cost**
- **Goal: A prioritized portfolio of distribution expenditures for a given revenue requirement**
  - ***Customer affordability*** *is the global objective, setting the financial constraint for optimizing expenditures to achieve other objectives*
- **Assess each proposed expenditure quantitatively, qualitatively, or both against each objective and metric**
  - Score each proposed solution based on its contribution to addressing each objective, then apply a weighting factor that reflects the objective's priority ranking (PGE example below). Finally, rank each possible solution using its final score and cost.
- **Use a *value-spend efficiency approach* for objectives that do not have a clearly defined methodology for determining the contribution of a grid solution to the desired outcome (illustrative example below)**

| | Score | Weighting | SAM score (avg) | |
|---|---|---|---|---|
| Reliability | 4 | 27% | 1.08 | 3.2 |
| Risk | 4 | 27% | 1.08 | |
| Financial | 4 | 27% | 1.08 | |
| | | | Portfolio score (avg) | |
| Safety | 0 | 4% | 0 | 0.2 |
| Compliance | 0 | 4% | 0 | |
| Environmental | 0 | 4% | 0 | |
| Operational | 1 | 4% | .04 | |
| Customer | 1 | 4% | .16 | |
| Final prioritization score; Optimizes on value | | | Total value **3.4** | |

Source: [Portland General Electric's 2022 Distribution System Plan]

| Specific Projects | Planning Objectives Ranked (1-5): Safety (5) | Service Compliance (5) | Reliability (3) | Resilience (4) | Electrification (3) | DG/DS Integration (3) | Equity (4) | Score | Cost ($mm) | Spend Efficiency (S/C) |
|---|---|---|---|---|---|---|---|---|---|---|
| Tree Trimming[1] | 5/25 | | 5/15 | 5/20 | 1/3 | | 2/8 | 71 | $3.0 | 23.7 |
| Undergrounding[2] | 5/15 | | 3/9 | 4/16 | 1/3 | 3/9 | 2/8 | 60 | $10.0 | 6.0 |
| Pole/Tower Hardening | 2/10 | 2/10 | 3/9 | 4/12 | | | 1/4 | 45 | $10.0 | 4.5 |
| 4kV Voltage Conversions | 4/20 | 4/20 | 2/6 | 3/12 | 3/9 | 3/9 | 3/12 | 88 | $25.0 | 3.5 |
| Substation Breaker Replacement[2] | 5/25 | 5/25 | 3/9 | | 1/3 | 1/3 | | 65 | $5.0 | 13 |
| ADMS | | 3/15 | 3/9 | 3/12 | 2/6 | 3/9 | 1/4 | 54 | $5.0 | 10.8 |
| Field Automation[2,3] | 3/15 | 3/15 | 3/9 | 3/12 | | 1/3 | 2/8 | 62 | $3.0 | 20.7 |

1. Improved reliability & resilience supports greater consumer reliance on electrification
2. If the program involves using larger conductor or higher capacity equipment
3. Improved reliability and resilience of grid improve the availability for DER to provide bulk power & grid services

*Source: P. De Martini*

# Cost recovery for grid modernization investments

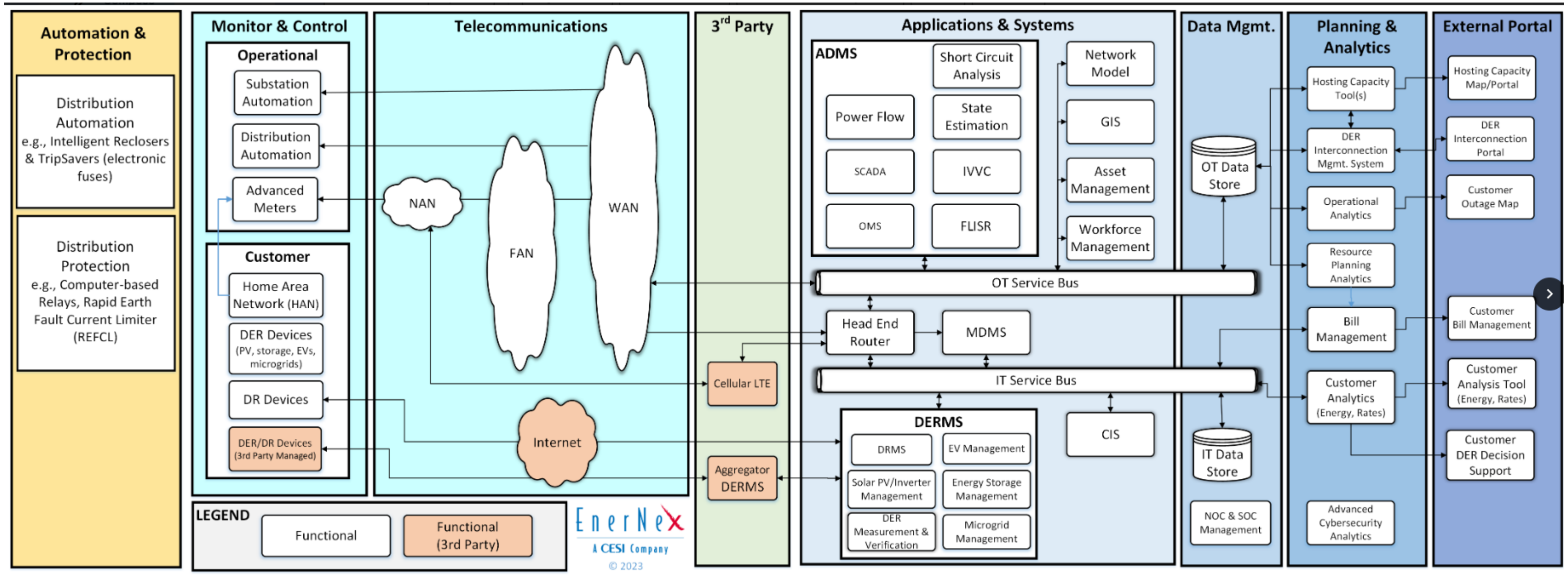
# Cost recovery for grid modernization investments

A forthcoming Berkeley Lab report will explore example cases illustrating the rationale and outcomes of regulatory decisions for proposed utility investments in grid modernization.

Generally, commissions supported proposals with:

- **Clear linkages** between grid modernization investment proposals, state policies and other electricity planning processes (e.g., distribution system planning)
- **Robust cost-effectiveness analysis**
- Strong analysis of **alternative investment options**
- **Prioritized investments** during the planning period

## Example Grid Modernization IT/OT Topology



# Linkages between utility cost recovery requests, planning & state objectives

- Investment in PG&E's advanced distribution management (ADMS) system was approved because "ADMS is a **key component of its grid modernization effort** and a reduced [financial] forecast could delay the functionality" which could **impede a high DER future**.

- The New York PSC approved Orange & Rockland's ADMS investment. O&R's justification in part stated that it "is a **fundamental component to enabling the DSP and supporting the achievement of the CLCPA's** goals. All planned advanced applications will enhance the visibility, monitoring, and control that the Company has across the system."

# Robust cost-effectiveness analysis (1)

The North Carolina Commission approved grid investments that Duke Energy Carolinas proposed. Project summaries included:

- Project purpose
- Explanation of need for proposed expenditure
- Timeline for construction*
- Estimated in-service date*
- Program description
- Illustrative figures
- Project costs
- Grid capabilities enabled
- Policy considerations
- **Benefit-cost analysis**
  - **Costs, benefits, net value (absolute $)**
  - **Benefit-cost ratio**
- **Benefit category and description of benefits**

*Referencing another document

Minnesota PUC approved Xcel Energy's Fault Location, Isolation, and Service Restoration (FLISR) investment. The Department of Commerce staff and Administrative Law Judge supported the Company's benefit-cost analysis.

"Xcel's cost-benefit analysis **was reasonable because it relied on sound assumptions and methodologies**. The [Commerce] Department agreed with Xcel's analysis that the proposed FLISR program is likely to produce net benefits and therefore recommended that the Commission approve recovery of the requested FLISR expense."

# Robust cost-effectiveness analysis (2)

In Illinois, the PUC rejected the utilities' Multi-Year Integrated Grid Plans. Among the technologies the Attorney General (AG) commented on was Commonwealth Edison's proposed Intelligent Substations.

"The AG demonstrates that there are **several flaws in the Company's proposed Intelligent Substations project**… Given these increasing costs, as well as historical data which could be analyzed to determine the cost-effectiveness of such investments, the AG argues that **ComEd should have been able to provide a robust business case to support the program**… The AG explains that when **asked for a benefit-cost analysis,** or the underlying customer and reliability data for the substations in question that would allow stakeholders to conduct their own benefit-cost analysis, **the Company refused to provide such data** on the grounds that "the Intelligent Substation program is not primarily or directly prioritized to respond to outages in the context of short term reliability impacts, but rather to advance resiliency in prevention of, and impact reduction of, future events and outages."

# Strong analysis of alternatives

**Few of the filings Berkeley Lab reviewed included (or were required to include) robust analysis of alternatives to the proposed utility investments.**

For example, Commonwealth Edison's initial multi-year integrated grid plan filing was rejected, in part due to lack of consideration of alternatives. "The AG has identified several concerns with the REACTS/ PERFORM [Renewable Energy Advanced Control and Telemetry Systems (REACTS) /Platform Enablement Reinforcement Measures PERFORM)] proposal: **(1) ComEd did not meaningfully seek and consider alternatives to a capital-intensive, utility-built communications project**; (2) ComEd's financial analysis supporting the project has serious flaws; (3) ComEd's record building communications infrastructure should give the Commission pause; and (4) ComEd has not demonstrated a need for the capabilities to the extent that would justify an advanced communications project. As a result of these flaws, the AG recommends that the Commission defer approval of the REACTS/PERFORM program until a more thorough examination of the plan can take place."

# Prioritized investments

**Lack of prioritization and consideration for the timing of investments were justifications for deferring approval of investments or rejecting investments.**


The Georgia PSC instructed Georgia Power to report back to the PSC in 2025 on the utility's need for further system modifications. The PSC found "the level of distributed energy resources needed to justify such a system is high, **and will not be reached by the time the proposed DERMS** [DER management system] **is fully depreciated in 2030**, let alone by the end of the upcoming rate planning period in 2025."

In Maryland, Baltimore Gas and Electric testified in its Multi-Year Rate Plan that it "always has more work than it can perform so that priority is often a matter of timing." In response, "The Commission noted that **BGE has *also* proposed more work than ratepayers should reasonably pay for**, and that part of the Commission's job is to balance the needs of BGE's distribution system, including reliability, resiliency, safety, and environmental goals, with the needs of ratepayers that include affordability."

# Questions States Can Ask

- If utilities are not filing distribution plans in your state, why not?
- How are DERs considered in distribution planning — e.g., in the utility's forecasting, grid modernization strategy, technology roadmap, geotargeted demand-side management programs, and procurement of non-wires alternatives?
- How is electricity load growth for transportation and buildings considered in distribution planning?
- Are State Energy Offices, PUCs and utilities working together to maximize benefits of distribution system investments?
- Are the utility's proposed grid modernization investments achievable in the planning period, and are they appropriately prioritized when considering all other cost recovery requests?
- Did the utility analyze alternatives to proposed investments and provide clear supporting information?

# Actions States Can Take

- Establish clear goals, objectives and priorities for distribution system planning
- Request baseline data from utilities to understand the current state of distribution systems and distribution planning practices
- Open an informational proceeding to educate stakeholders on distribution planning
- Provide guidance to utilities on filing distribution plans for regulatory and stakeholder review
- Ask utilities to document data inputs and outputs, metrics, and analytical methods that support distribution plans
- Provide guidance to utilities on using multi-objective decision analysis to prioritize grid modernization and all other distribution expenditures to optimize value
- Consider developing a standard template for presenting information on costs and benefits of proposed grid modernization technologies
- Provide guidance to utilities to include grid modernization proposals in distribution plan filings

# Resources for more information

- Berkeley Lab's Integrated Distribution System Planning website, including slides and recordings for previous trainings
- Online catalog of state distribution planning requirements (to be updated by April)
- U.S. Department of Energy (DOE) Distribution Grid Transformation website and *Modern Distribution Grid* guidebooks
- Schwartz, L., N. Mims Frick, S. Murphy, G. Pereira, G. Relf, J. Shipley, J. Schellenberg and A. Fernandez. 2024. *State Requirements for Electric Distribution System Planning*. Berkeley Lab
- De Martini, P., L. Schwartz, J. Ball. 2025. *Economic Evaluation of Modernization Expenditures for Electric Utility Distribution Systems: A Guide for Utility Regulators*. Berkeley Lab
- Murphy, S., L. Schwartz, G. Pereira, and C. Davis. 2025. *Bridging the Gap on Data and Analysis for Distribution System Planning: Information That Utilities Can Provide Regulators, State Energy Offices and Other Stakeholders*. Berkeley Lab
- Collins, M., M. Whiting, J. Schellenberg and L. Schwartz. 2025. *Bridging the Gap on Data, Metrics, and Analyses for Grid Resilience to Weather Events: Information that utilities can provide regulators, state energy offices, and other stakeholders*. Berkeley Lab
- Schellenberg, J., and L. Schwartz. 2024. *Grid Resilience Plans: State Requirements, Utility Practices, and Utility Plan Template*. Berkeley Lab
- S. Murphy, L. Schwartz, C. Reed, M. Gold and K. Verclas. 2023. *State Energy Offices' Engagement in Electric Distribution Planning to Meet State Policy Goals*. National Association of State Energy Officials
- J. Schellenberg and L. Schwartz. 2024. *Grid Resilience Planning: State Requirements, Utility Practices, and Utility Plan Template*. Berkeley Lab
- J. Carvallo and L. Schwartz. 2023. *The use of price-based demand response as a resource in electricity system planning*. Berkeley Lab
- B. Biewald, D. Glick, S. Kwok, J.P. Carvallo and L. Schwartz. 2024. *Best Practices in Integrated Resource Planning: A guide for planners developing the electricity resource mix of the future*. Synapse Energy Economics and Berkeley Lab
- J. Keen, E. Pohl, N. Mims Frick, J.P. Carvallo and L. Schwartz. 2023. *Duke Energy's Integrated System and Operations Planning: A comparative analysis of integrated planning practices*, Grid Modernization Laboratory Consortium

## Contacts

Lisa Schwartz: lcschwartz@lbl.gov
Natalie Mims Frick: nfrick@lbl.gov

## For more information

***Download*** publications from Energy Markets & Policy: https://emp.lbl.gov/publications
***Sign up*** for our email list: https://emp.lbl.gov/mailing-list
***Follow*** Energy Markets & Policy on Bluesky: @BerkeleyLabEMP.bsky.social

## Acknowledgements

This work was funded by the U.S. Department of Energy, Office of Electricity and Office of Energy Efficiency and Renewable Energy, under Contract No. DE-AC02-05CH11231.

## Disclaimer



## Copyright Notice