DER Interconnection Cohort Meeting 4: Managing Interconnection Costs Part II: Distribution System Planning and Capacity Expansion Modeling

July 29, 2026

Objectives

Cohort objectives

- Support an interested group of utility regulatory commissions to better understand DER interconnection practices and advance solutions
- Provide participants with practical information and actionable templates, frameworks, and model language for jurisdictions to adapt for their specific circumstances
- Support peer-sharing and continuous learning

Today's objectives

- Provide information on how DSP (including capacity expansion modeling) can support efficient interconnection
- Example practices for coordinating interconnection and DSP
- Concrete actions participants can take to start or improve coordination of DSP with interconnection-related upgrades

Agenda

- Welcome
  - Brief overview of i2X initiative and cohort plan
  - Participant introductions & check-in question
- Presentation from Guillermo Pereira (LBNL) on Coordinating Distribution System Planning and Interconnection: State and Utility Practices
- Presentation from Miguel Heleno (LBNL) on Modeling DER Integration
- Break-out room discussion
- Closing and next steps

Review of i2X Initiative and Cohort Plan

i2X Mission and Key Elements

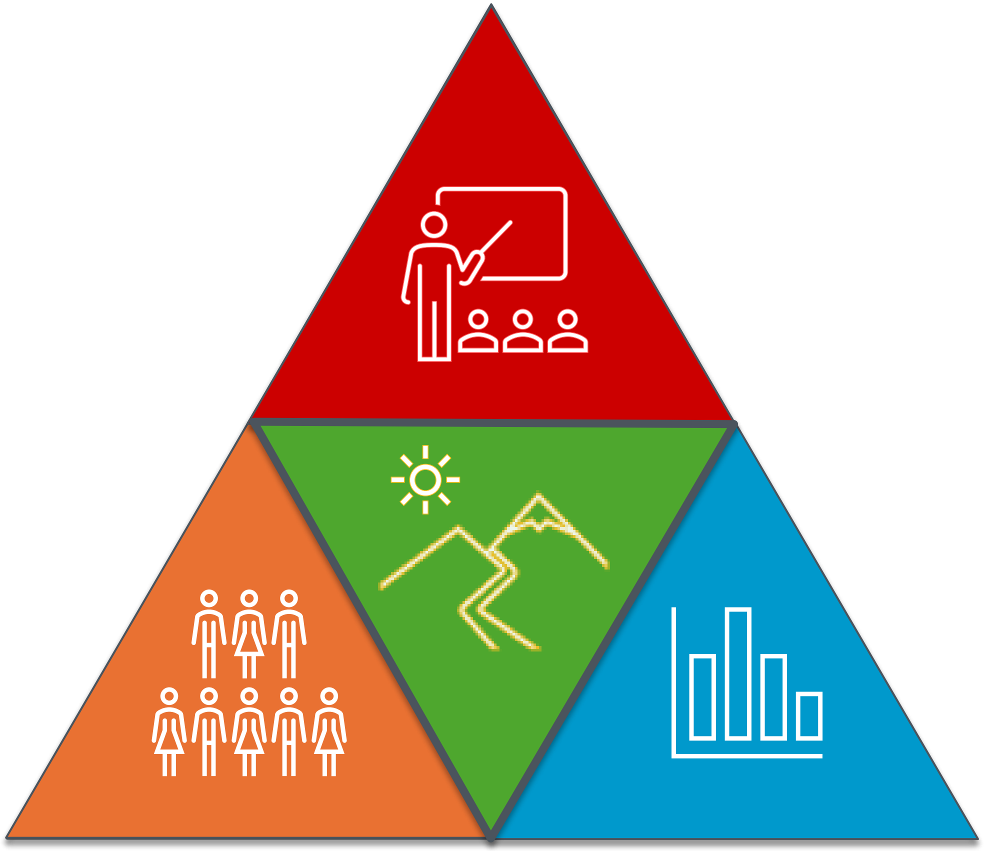
To enable **simple**, **fast**, and **affordable** interconnection while enhancing the **reliability** and **security** of our electric grid.

Strategic Roadmaps

Stakeholder Engagement

Data & Analytics

Research & Innovation



U.S. Department of Energy's DER Interconnection Solutions

Goal 1: Increase data access, transparency, and security for interconnection
- Data sharing guidelines
- Strategic use of automation
- Broaden use of hosting capacity analysis

Goal 2: Improve interconnection process and timeline
- Queue management
- Inclusive and fair processes
- Workforce development

Goal 3: Promote economic efficiency in interconnection
- Cost allocation
- Coordination between interconnection and grid planning
- Interconnection studies

Goal 4: Maintain a reliable, resilient, and secure grid
- Interconnection models and tools
- Interconnection standards

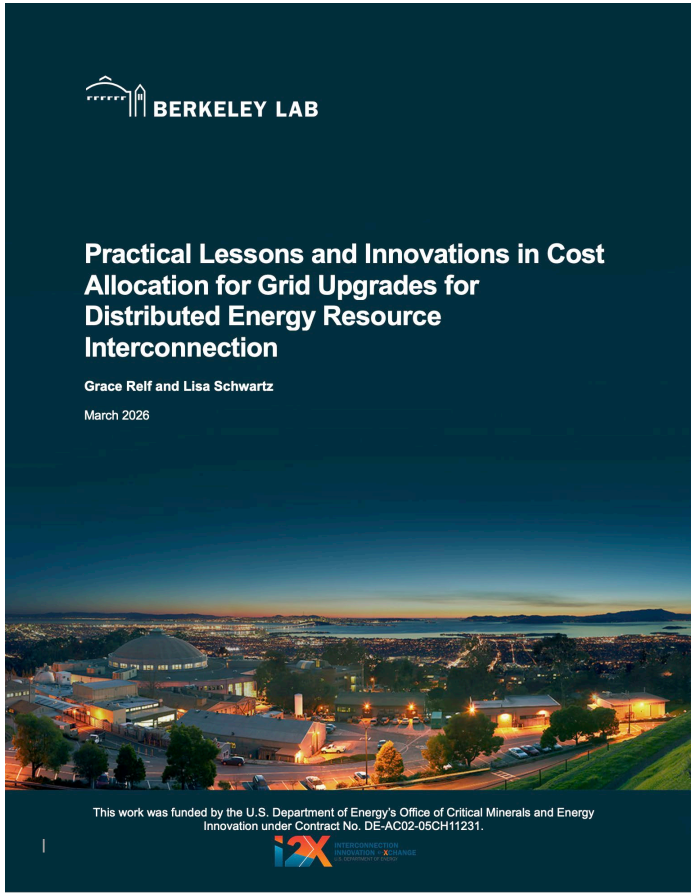
Measurable Success Targets for 2030

	Target	System Size*	2030 Target Value
Timing	(1) Median time from DER interconnection request to agreement§	< 50 kW	Within 1 day†
		50 kW–5 MW	< 75 days
		≥ 5 MW	< 140 days
Access	(2) Completion rate from entering the queue to execution of interconnection agreement	< 50 kW	> 99%
		50 kW–5 MW	> 90%
		≥ 5 MW	> 85%
Data	(3) Availability of public state-level interconnection queue data	All	50 states, Washington, D.C., and territories have public, detailed, and current queue data
Reliability	(4) No BPS disturbance events exacerbated by inaccurate DER modeling	All	0
Resilience	(5) Lower Customer Average Interruption Duration Index (CAIDI)‡	All	25% improvement (e.g., from 4 to 3 hours per occurrence)

* System size thresholds will vary across utilities and jurisdictions.
§ For systems that do not trigger system upgrades.
† Defined as 1 business day.
‡ CAIDI with loss of load removed but major event days included.

Berkeley Lab Resources

- Berkeley Lab is conducting research and developing tools on a variety of DER interconnection topics.
- Forthcoming technical documents
  - Cost allocation for grid upgrades
  - Automating DER interconnection processes
  - DER interconnection queues, timelines, and costs
- Additional resources
  - Forthcoming online DER interconnection cost and timeline data dashboard
  - Forthcoming cost allocation toolkit with model documents, checklists, and calculator
  - Educational trainings and webinars (including slides and recordings)
  - Technical assistance for states



Find out more: https://emp.lbl.gov/interconnection-innovation-e-xchange

Cohort Plan

- Meetings are monthly through September, from 3 – 4:30 pm ET.
- Topics to address key participant needs are:
  - **May 27th:** Interconnection Queues, Timelines, and Costs - Data Transparency
  - **June 23rd:** Managing Interconnection Costs Part 1 - Cost Allocation
  - **Today (July 29th):** Managing Interconnection Costs Part 2 - Distribution System Planning (DSP) and Capacity Expansion Modeling
  - **August 26th:** Interconnection Technical Standards, Studies, and Commission Processes for Improving DER Interconnection
  - **September 23rd:** Peer and Expert Coaching on Participant Questions, Follow-Ups from Past Meetings, and Additional Topics
- Commissioners and state agency staff can find past meeting materials and register for future meetings at: https://www.naruc.org/core-sectors/energy-resources-and-the-environment/der-integration-compensation/distributed-energy-projects-interconnection-cohort/

Participant Expectations and Introductions

- **Expectations**
  - Engage actively by attending as many meetings as possible and participating generously in conversations.
  - Create a collaborative space by sharing openly and respecting others' contributions.
- **Introductions**
  - Please say your name, agency, role, and a brief response to the check-in question**:**

Do you have any DERs at your home (e.g., smart thermostat, solar, storage, EV charger)? If so, did any of them require interconnection, and what did that involve?

Presentations from Guillermo Pereira & Miguel Heleno

Energy Markets & Planning
BERKELEY LAB

Coordinating Distribution System Planning and Interconnection
State and Utility Practices

Guillermo Pereira, Ph.D.

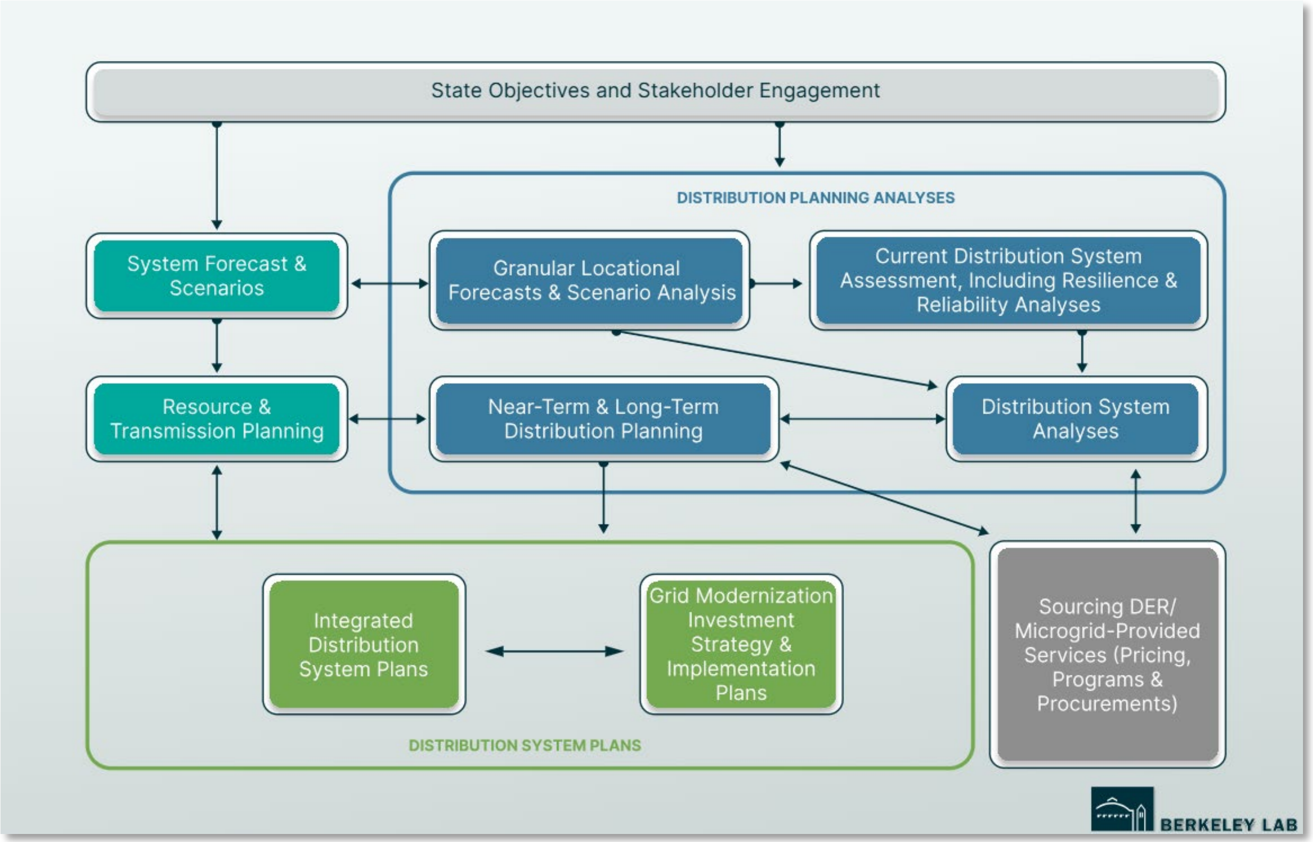
Distributed Energy Projects Interconnection Cohort Series Webinar #3: Managing Interconnection Costs Part 2 - Distribution System Planning and Capacity Expansion Modeling

July 29, 2026

This work was funded by the U.S. Department of Energy Office of Critical Minerals and Energy Innovation, under Contract No. DE-AC02-05CH11231.

Distribution System Planning (1)

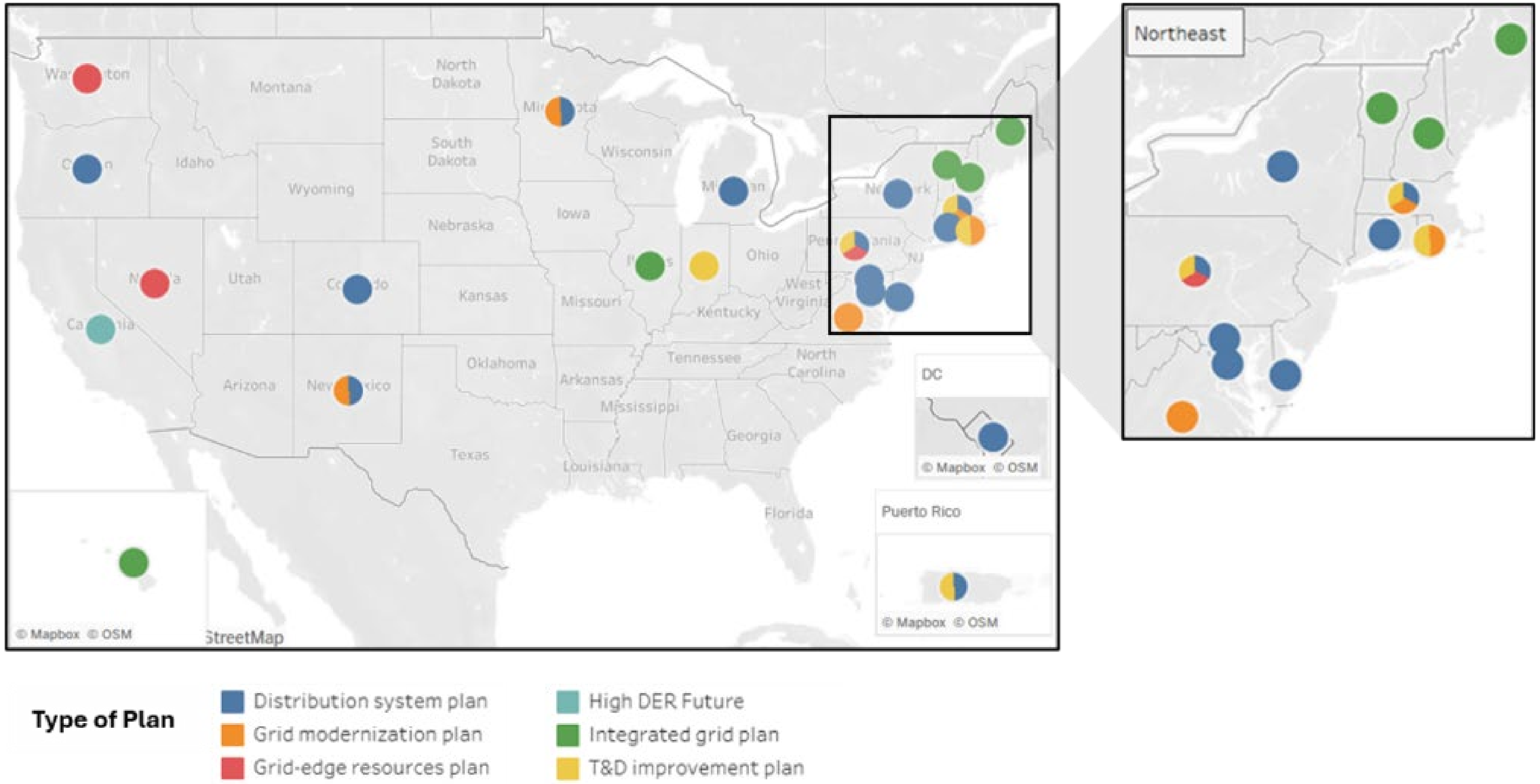
- Electric utilities conduct distribution system planning to assess and identify physical and operational changes needed to deliver safe and reliable electricity service
- Distribution system plans describe near- and long-term strategies, investments, and other expenditures to meet distribution system needs cost-effectively



Source: Lawrence Berkeley National Laboratory, Interactive Decision Framework for Integrated Distribution System Planning

Distribution System Planning (2)

- As of May 2026, distribution system planning requirements are in place in 22 states, Puerto Rico, and the District of Columbia
- In these jurisdictions, regulated utilities file a distribution system plan with the Public Utility Commission



Source: [Lawrence Berkeley National Laboratory, 2026, State Electric Distribution System Planning Practices]

Coordinating Distribution System Planning and Interconnection

Distribution system planning and interconnection coordination enables robust planning outcomes and effective interconnection processes

Coordination reduces information asymmetries between processes, enabling planning and interconnection decisions to leverage relevant information

Coordination enables utilities, regulators, and other stakeholders to

- Understand the scale and characteristics of the existing portfolio of grid-edge resources (GERs)* connected to the distribution system
- Assess future interconnection needs through forecasting and scenario analysis
- Evaluate available hosting capacity to inform the decisions of customers seeking interconnection
- Determine near-term grid needs to meet expected interconnection requests and inform capital planning
- Implement alternatives to meet growing demand and reduce infrastructure needs, such as through flexible interconnections

** Also known as distributed energy resources (DERs)*

Energy Markets & Planning
BERKELEY LAB

State and Utility Practices

State and Utility Practices

Existing state requirements and utility filings illustrate coordination between distribution system planning and interconnection in practice for a range of topics:

- Characterize existing portfolio of interconnected resources
- Describe resources in the interconnection queue
- Evaluate hosting capacity analysis and publish data for customers seeking interconnection
- Describe interconnection requirements
- Identify interconnection study tools
- Evaluate risks and mitigating measures
- Assess near-term grid needs to enable interconnections
- Describe interconnection alternatives
- Establish data sharing protocols
- Evaluate interconnection impacts
- Leverage stakeholder engagement

Characterize Existing Portfolio of Interconnected Resources (1)

State Practice

- In Maine, integrated grid planning requirements establish the information utilities must provide on GER deployment

“Current DER deployment by type, size, and geographic dispersion“

“Total number of projects and nameplate rating (kilowatt (kW), include kilowatt-hour (kWh) for storage) of DER interconnected to the system in each of the last 5 years, broken down by DER technology type (e.g., solar, combined solar/storage, storage, etc.).”

Source: Maine PUC, 2024, Docket No. 2022-00322, Grid Content Outline

Utility Practice

- Central Maine Power, in its 2024 Integrated Grid Plan, provides information on
  - GER deployment
  - Relationship with peak demand
  - Foundational investments needed in communication and GER management technologies to better integrate and optimize resources

Characterize Existing Portfolio of Interconnected Resources (2)

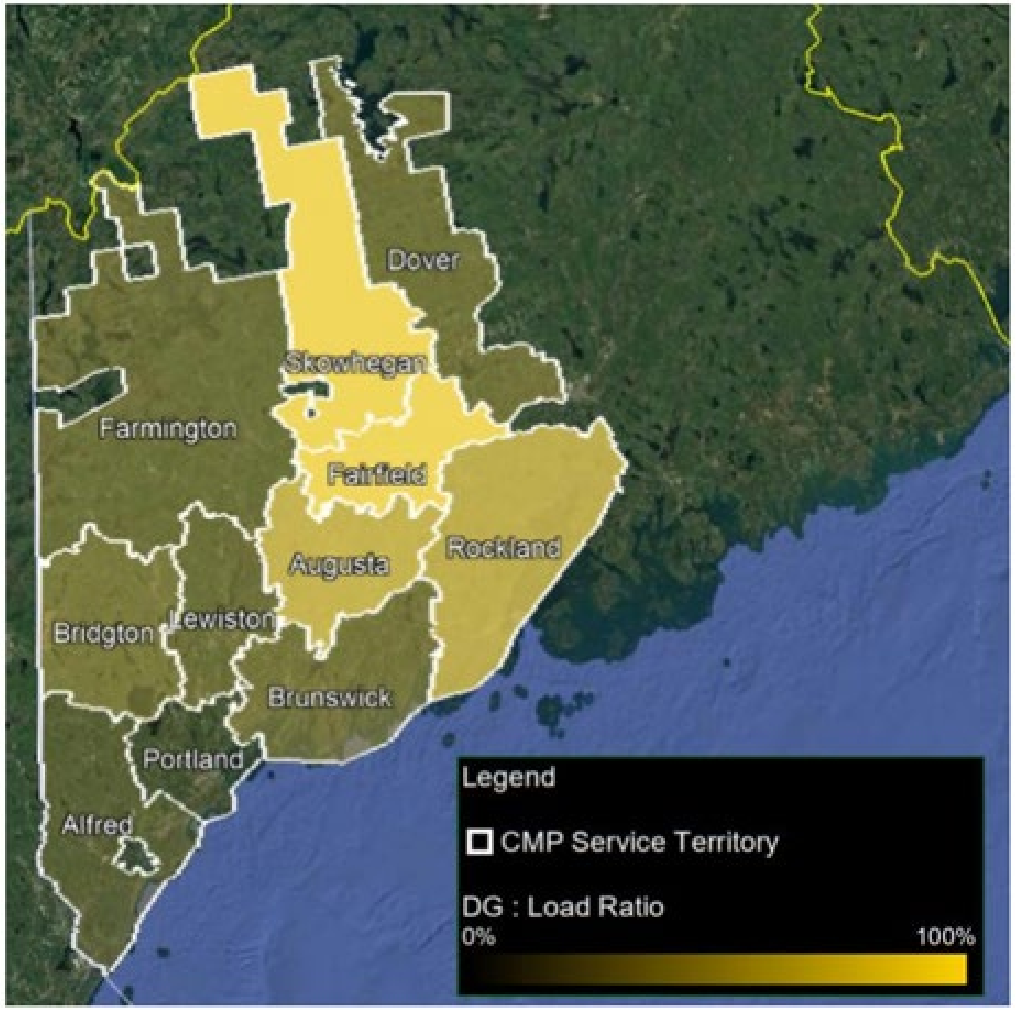
Existing GER deployment, by technology type

Technology	Capacity Connected (MW)
Solar PV	938.5
Combined Solar + Storage	41.72
Standalone Storage	5.50
Hydro	5.68
Wind	5.14
Other	5.09
Total	**1,001.7**

Existing GER deployment, by project size (number of projects)

Technology	<250 kW	250-500 kW	500-1000 kW	1000-2000 kW	2000-5000 kW	>5000 kW	Grand Total
Solar	16361	35	70	29	136	5	16636
Combined Solar/Storage	120	0	0	1	9	0	130
Standalone Storage	0	1	0	0	1	0	2
Hydroelectric	7	2	1	0	1	0	11
Wind	175	0	0	0	1	0	176
Other	48	1	1	0	1	0	51
Grand Total	**16711**	**39**	**72**	**30**	**149**	**5**	**17006**

GER to load ratio, per service division



Source: Central Maine Power, 2024, Integrated Grid Plan

Describe Resources in The Interconnection Queue

State Practice

- In New Mexico, the distribution system plan filing requirements establish the information utilities must submit related to the interconnection queue

"Status of current interconnection queues, including data describing time from application to interconnection, and interconnection cost on a feeder-by-feeder basis."

Source: [New Mexico PRC, 2026, Docket No. 22-00089-UT, Order Terminating Rulemaking and Requiring Distribution System Plans]

Utility Practice

- In Minnesota, Xcel Energy, in its [2025 Integrated Distribution Plan], provides information on the capacity and number of projects in its interconnection queue
  - Xcel Energy also provides monthly GER queue information to support customers seeking interconnection, including active projects by feeder

	Completed Projects		Queued Projects	
	MW/AC	# of Projects	MW/AC	# of Projects
Small Scale Solar PV				
Rooftop Solar	264	16,475	1,262	4,926
RDF Projects	35	25	1	1
Wind	22	79	3	7
Storage/Batteries[6]	5	430	13	175
	Completed Projects		Queued Projects	
	MW/AC	# of Projects	MW/AC	# of Projects
Large Scale Solar PV				
Community Solar	936	998	254	263
Grid Scale (Aurora)	100	16	0	0

Source: [Xcel Energy, 2025, Integrated Distribution Plan]

Evaluate Hosting Capacity Analysis and Publish Data For Customers Seeking Interconnection (1)

State Practice

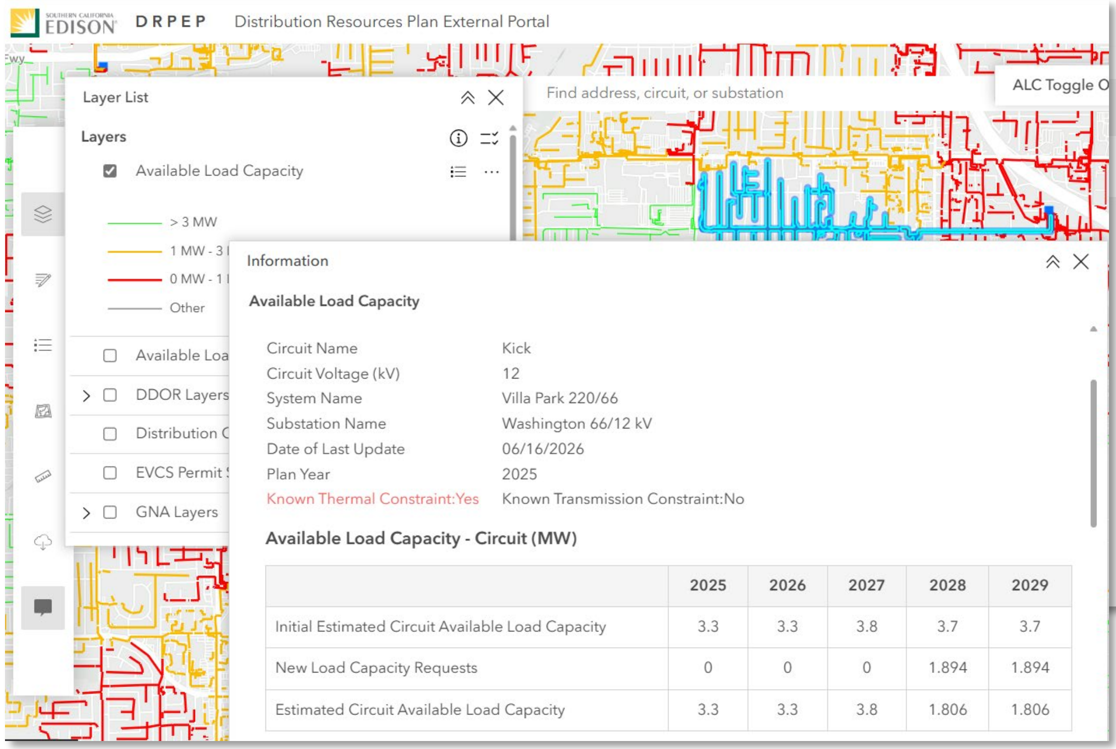
- In California, Decision 24-10-030, in the High DER proceeding, describes the interaction between planning, hosting capacity analysis (i.e., integration capacity analysis), and resource interconnection processes
  - Hosting capacity analysis supports two use cases
    - Online maps and streamline interconnection processes for customers seeking interconnection
    - Distribution planning
  - The order establishes utility requirements to revise and evaluate hosting capacity analysis practices, including
    - Revising hosting capacity maps to provide information and enable customers to develop limited generation profiles *"[…] the downloaded file should mirror the structure of that which [Utilities] propose for the customers to submit in their interconnection applications"*
    - *"modify their ICA methodologies to incorporate Limited Generation Profile data submitted with interconnection applications when estimating interconnection capacity instead of using standard generation profiles."* to improve accuracy for interconnecting customers
    - Submit a biannual report that *"describes all known issues related to ICA accuracy and missing or erroneous ICA values, […]. Further, the Commission directs quarterly public workshops focused on ICA problems, including but not limited to inaccuracies."*
    - *"[…] develop reporting aimed at understanding the frequency of zero-load ICA values […]"* as well as information on all annual refinements implemented
    - Incorporate load hosting capacity analysis data into energization process (PG&E) and describe the technical reasons to not incorporate this data and actions needed to remove those barriers (SDG&E and SCE)

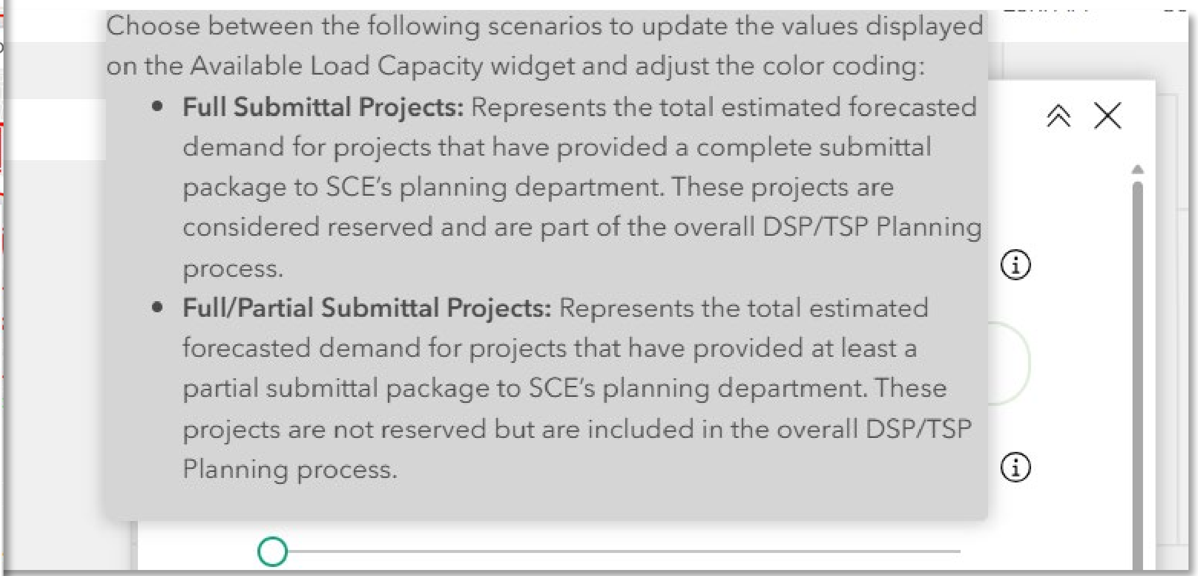
Source: CPUC, 2024, Decision 24-10-030, October 17, 2024

Evaluate Hosting Capacity Analysis and Publish Data For Customers Seeking Interconnection (2)

Utility Practice

- SCE's Distribution Resources Plan External Portal provides information to support interconnecting customers
  - Map tool displaying available load and generation capacity





Source: SCE Distribution Resources Plan External Portal

Describe Interconnection Requirements

State Practice

- In Michigan, distribution system plan requirements recommend

“The utility shall detail its efforts to address ongoing and upcoming distribution technologies and improvements to create a modern grid, including how each of the following topics is included or considered within the action plan:

i. Interconnection Processes, including for customer-owned and third-party-owned Distributed Energy Resources (DERs) […]”

Source: MPSC, 2025, Case No. U-20147, Order July 10, 2025

Utility Practice

- Upper Michigan Energy Resources Corporation, in its 2026 Distribution System Plan, provides information on:
  - Applicable state interconnection rules (Michigan Interconnection and Distributed Generation Standards, R 460.901-460.1026)
  - Existing review tracks for interconnection requests (i.e., non-export track review, fast track review, and study track review)
  - Existing tariffs available for customers seeking interconnection

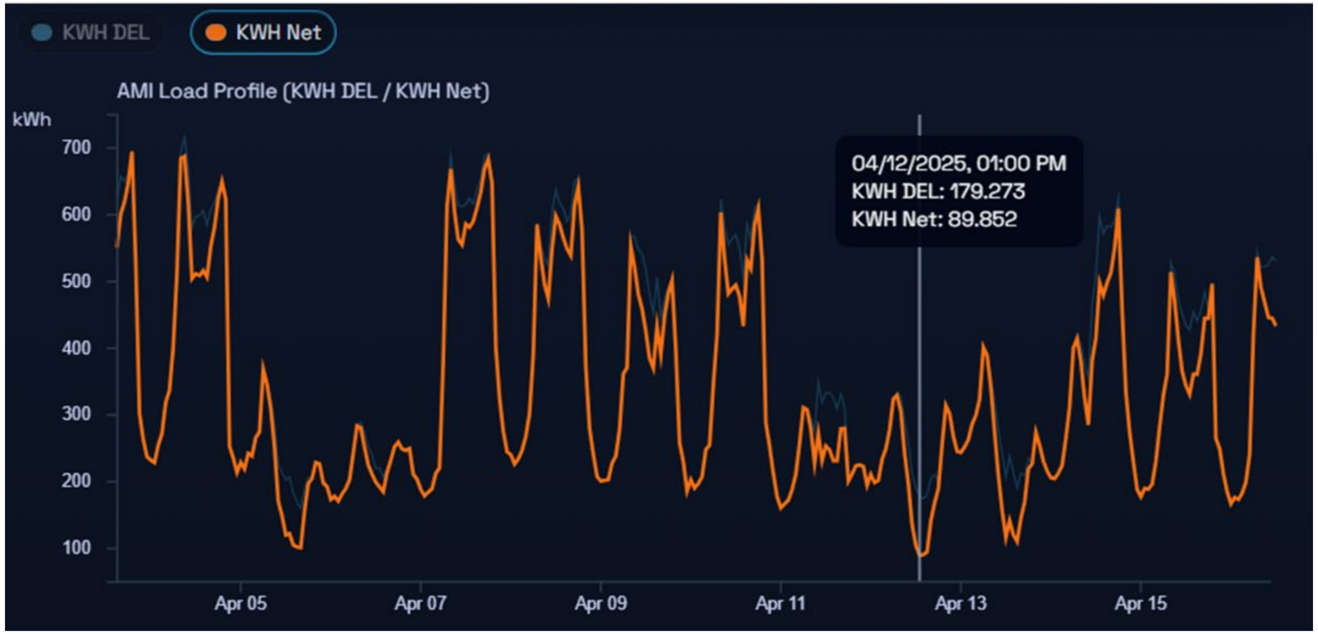
Source: Upper Michigan Energy Resources Corporation, 2026, Distribution System Plan

Identify Interconnection Study Tools

Utility Practice

- PacifiCorp, in its 2026 Distribution System Plan, describes the characteristics of an in-house tool, "Long-Range AMI [AMI Advanced Metering Infrastructure] Profile Aggregation Tool," developed to support interconnection studies in areas without telemetry
  - In parts of the distribution system where reclosers are not covered by supervisory control and data acquisition systems (SCADA), planners rely on AMI data to estimate minimum asset loading
  - The tool provides system, substation, feeder, and segment-level load shapes by phase and customer class
  - Minimum asset loading helps assess if proposed interconnections exceed available capacity

Example Load Profile



Source: PacifiCorp, 2026, Oregon Distribution System Plan Report

Evaluate Risks and Mitigating Measures (1)

State Practice

- In New York, 2023 staff guidance for distributed system implementation plans recommends utilities provide information on risks for a range of topics, including GER interconnection

“Identify and characterize any potential risk(s) and/or actual issue(s) that could affect timely implementation and describe the measures taken, or to be taken, to mitigate the risk(s) and/or resolve the issue(s).”

Source: NY DPS, 2023, Proposed Commission Guidance for the Electric Utilities’ DSIP Update Filings

Utility Practice

- National Grid, in its 2025 Distributed System Implementation Plan, identified risks and mitigating measures related to
  - Delays in resource interconnection and system upgrade costs
  - Increased transparency in cost estimates and actual interconnection costs
  - Lack of deployment of GER applications with microgrid technology

Source: National Grid, 2025, Distributed System Integration Plan

Evaluate Risks and Mitigating Measures (2)

Risk*	***Mitigation***
Longer interconnection times and higher upgrade costs will delay DER interconnections.	*The Company will champion policies and methods to facilitate more interconnections such as self build solutions, flexible interconnection pilots, and Cost-Sharing 2.0. Decreasing process cycle time has been a key internal initiative for National Grid. […]*
Interconnection applicants and industry have been seeking additional transparency in cost estimates and actual costs incurred to interconnect DER.	*National Grid has implemented a process to update cost estimates on an annual basis. The Company is leading efforts within ITGW and IPWG to coordinate and update cost matrices for the Joint Utilities and identify NY-SIR revisions needed to support further transparency.*
There is a lack of implementation for DER applications combined with microgrid interconnection devices (MID), such as V2G and V2H applications, due to technical and technology limitations, as well as the inability to meet utility interconnection compliance requirements.	*National Grid is working closely with other utilities, regulatory bodies, manufacturers, and other stakeholders to ensure that DER with MID (V2G/V2H) systems meet essential safety requirements. […]*

Acronyms: DER: *Distributed Energy Resources;* ***IPWG:*** *Interconnection Policy Working Group;* ***ITWG:*** *Interconnection Technical Working Group;* ***NY-SIR:*** *New York Standardized Interconnection Requirements;* ***V2G:*** *Vehicle-to-Grid;* ***V2H:*** *Vehicle-to-Home;* ***CRD:*** *Certification Requirements Decision;* ***MM:*** *Multimode;* ***NRTL:*** *Nationally Recognized Testing Laboratory.*

**Sample of risks and mitigation measures included National Grid's 2025 Distributed System Implementation Plan; for full details, consult the source document.*

Source: Adapted from National Grid, 2025, Distributed System Integration Plan

Assess Near-term Grid Needs to Enable Interconnections

State Practice

- In Connecticut, the Public Utilities Regulatory Authority proposed a final decision in its proceeding on integrated distribution system planning, establishing the details utilities may include for any proposed GER capacity upgrades
- Utilities may include a *GER interconnection* subsection in their plan filings, within the *grid needs assessment* section
- The proposed GER interconnection section will include
  - Narrative of how identified grid needs and proposed solutions deliver a forward-looking strategy for GER interconnection in capacity-constrained locations
  - Information on the alternative solutions considered
  - Costs and benefits of the solution selected

"[…] inclusion of proposed DER capacity upgrades, or any other proposed solution in the IDSP for that matter, does not constitute pre-approval by the Authority of the solution or its related costs."

Source: CT PURA, 2025, Docket No. 21-05-15RE03, Proposed Final Decision, August 8, 2025

Additional Practices

Describe interconnection alternatives, such as flexible interconnections

- Central Maine Power, 2024 Integrated Grid Plan
- Xcel Energy (Minnesota), 2025 Integrated Distribution Plan

Establish data sharing protocols

- New York DPS, 2023 Staff Guidance for Distributed System Implementation Plans

Evaluation of interconnection impacts

- Washington Administrative Code 480-108-120 Cumulative Effects of Interconnections

Leverage stakeholder engagement

- Central Maine Power, 2024 Integrated Grid Plan

Summary

Distribution system planning and interconnection processes benefit from robust coordination

Interconnection information can inform near-term investment needs and long-term distribution system strategy

Planning processes can contribute to developing system capabilities and identifying grid needs to enable timely and cost-effective GER interconnection

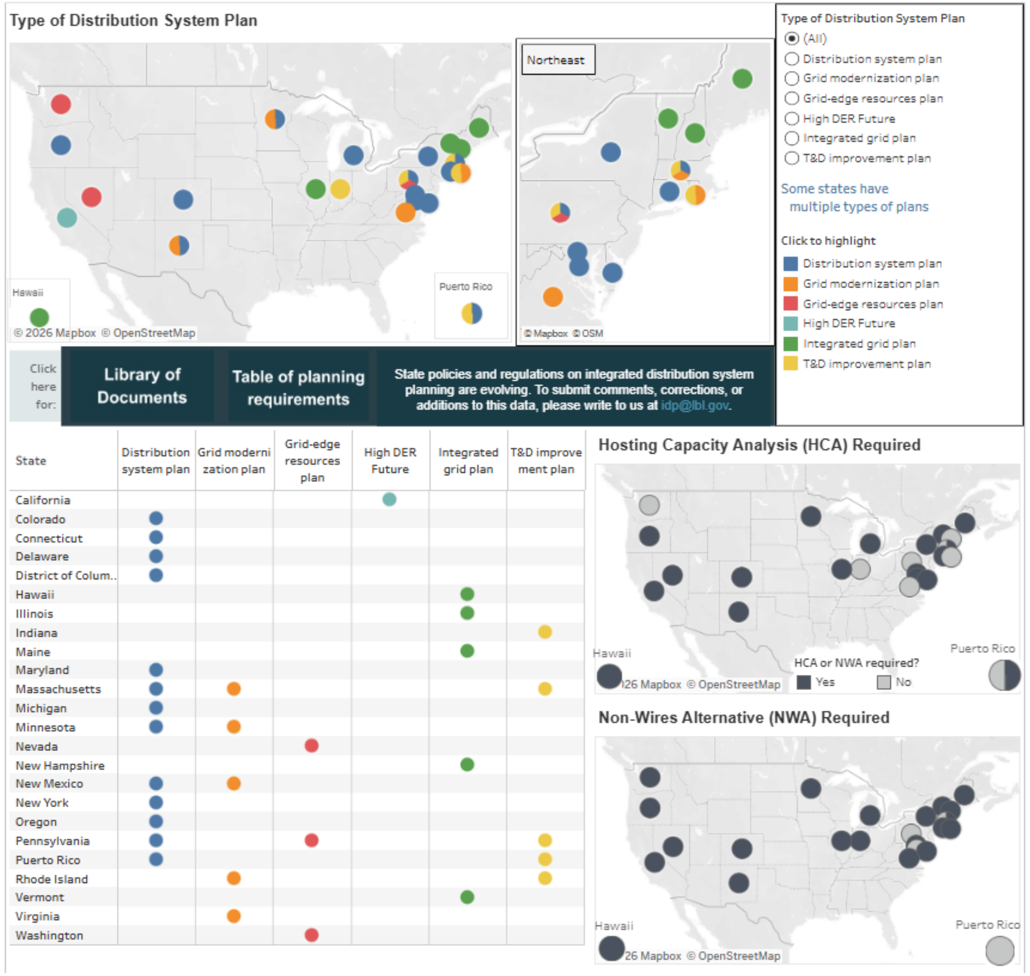
Robust coordination enables regulators and other stakeholders to assess planning and interconnection practices

Energy Markets & Planning
BERKELEY LAB

LBNL Resources

State Electric Distribution System Planning Practices: Data Visualization & Online Catalog

- Dataviz, online catalog, individual state summaries, and document library provide information on legislative and regulatory requirements for electric companies to file some type of distribution system plan in 22 states, Puerto Rico, and DC. Updated in May 2026.
- Data visualization provides **an interactive interface** to identify state-by-state requirements for:
  - Types of distribution plans filed
  - Non-wires alternatives/hosting capacity analyses
- Detailed information by state:
  - Legislative and regulatory requirements, proceedings, and orders
  - Filed utility plans and type of regulatory action taken
  - State planning goals and objectives
  - Term of action plan
  - Stakeholder engagement
  - Substantive elements, including large loads, **interconnection**, scenario analysis, and affordability



https://emp.lbl.gov/state-electric-distribution-system-planning-practices

Distribution System Plan Template and Guide for Electric Utilities for Adaptation by States and Utilities

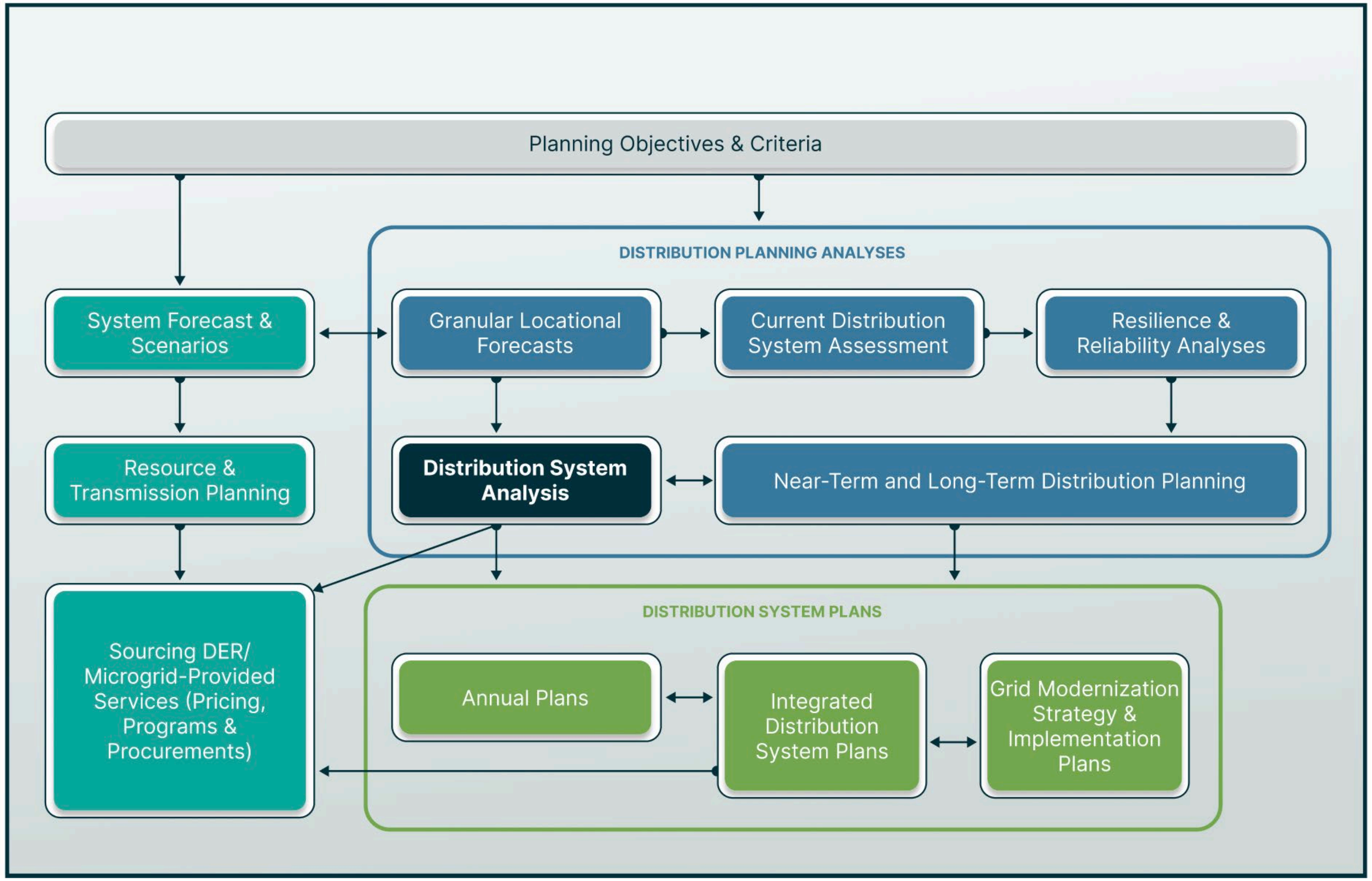
- Template and companion guide for structuring distribution system plans.
- The template covers 10 key sections in utility distribution system plans and underlying topics
  Executive Summary
  - Planning Objectives
  - **Current Distribution System (includes interconnection details)**
  - Planning Approach
  - Asset Management, Reliability and Resilience
  - O&M Expenses
  - Capacity Expansion Planning
  - Solution Identification
  - Cost-effectiveness
  - Implementation

https://eta.lbl.gov/publications/distribution-system-plan-template

Interactive IDSP Framework (1)

Topics included

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

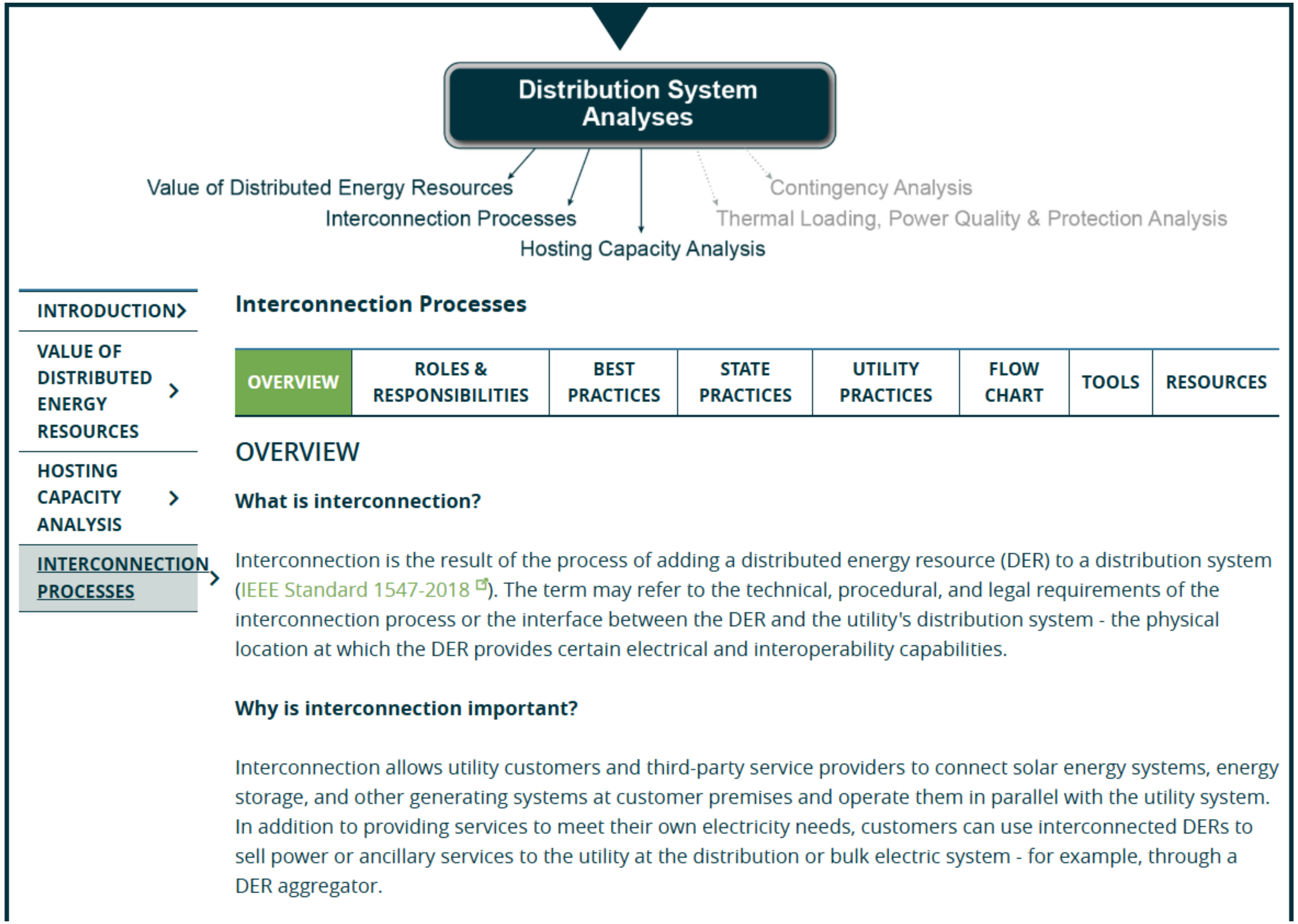


https://emp.lbl.gov/projects/integrated-distribution-system-planning

Interactive IDSP Framework (2)

What's included for each topic?

- 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



Contacts

Guillermo Pereira: GPereira@lbl.gov

For more information

Download publications: https://emp.lbl.gov/publications

Sign up for our email list: https://emp.lbl.gov/mailing-list

Follow us on social media: @BerkeleyLabEMP and @BerkeleyLabEMP.bsky.social

Acknowledgements

This work was funded by the U.S. Department of Energy Office of Critical Minerals and Energy Innovation, under Contract No. DE-AC02-05CH11231.

The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, or The Regents of the University of California.

Distributed Energy Integration via Least-cost Grid Expansion Modeling

Miguel Heleno

Distributed Energy Projects Interconnection Cohort Series Webinar #3: Managing Interconnection Costs

Part 2 - Distribution System Planning and Capacity Expansion Modeling

July 29, 2026

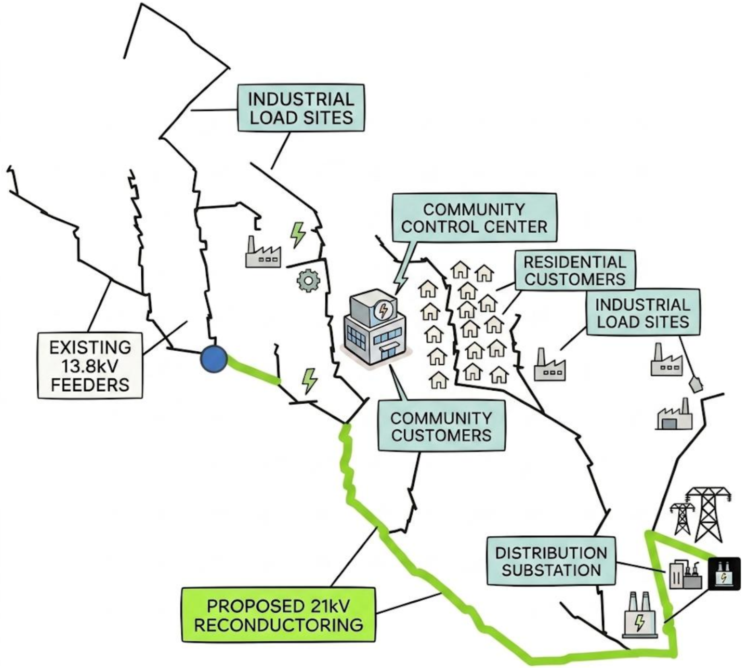
Energy Technologies Area
BERKELEY LAB

LODGE: Least-Cost Optimal Distribution Expansion

- The Least-cost Optimal Distribution Grid Expansion (LODGE) model provides **the optimal portfolio of distribution system upgrades** to interconnect distributed energy resources (DERs) and enable electrification.

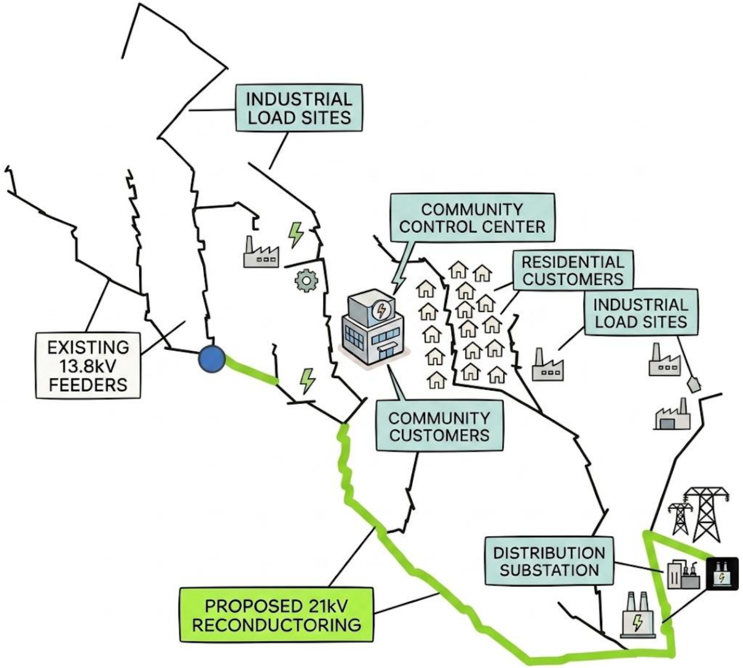
- Available investments include **voltage regulators, feeder reconductoring, transformers upgrades and non-wire alternatives (NWA)**, such as strategic siting of **distributed generation**.

- LODGE can be used to assess grid infrastructure costs and explore solutions for distribution planning and DER interconnection and valuation.



LODGE: Least-Cost Optimal Distribution Expansion

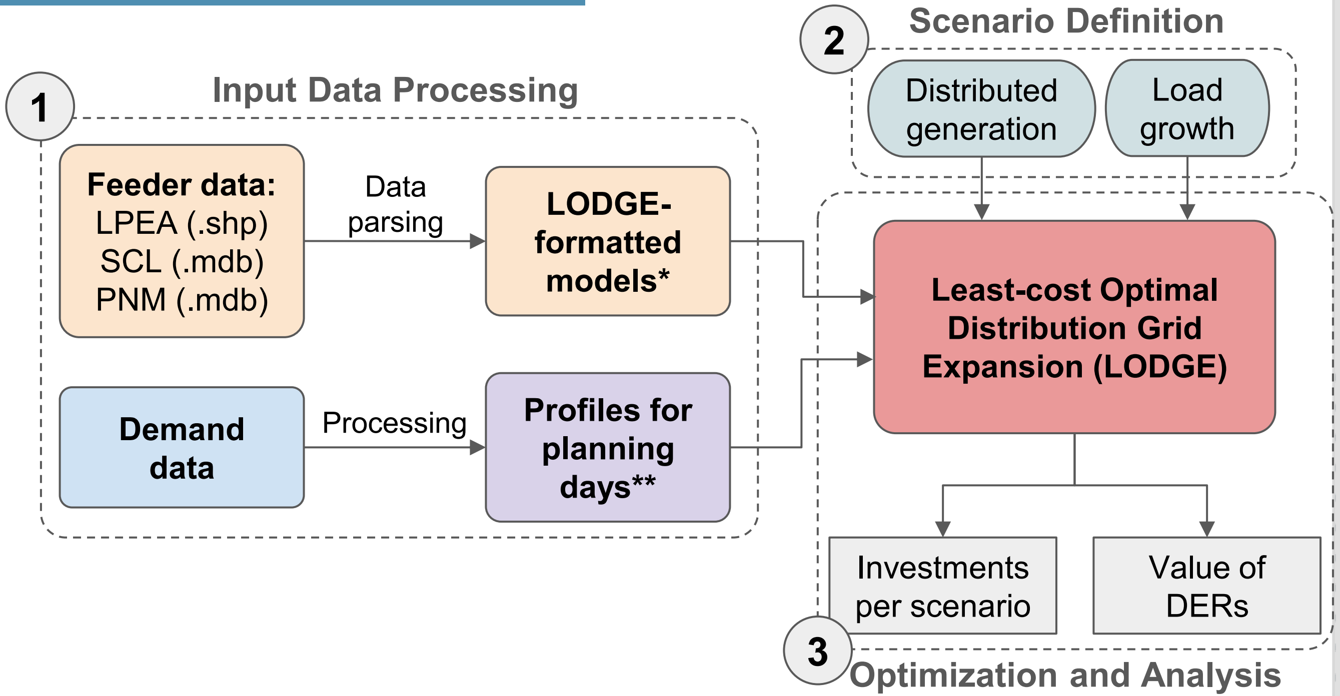
	Current Distribution planning approaches	LODGE model
Grid Needs Assessment	Via power flow tools	Offers multi-period power flow
Economic solution	Based on empirical assessment	Based on optimization methods
Interconnection Scenarios	Manual	Automated and scalable
DER valuation	Manual. Requires separate tools and processes.	Obtained within the same distribution planning analysis.



Implementation

For each pilot, the workflow considered:

1) **Feeder reconstruction and input data wrangling** into a LODGE-compatible format
2) Definition of community resources and load growth scenarios based on utility requirements
3) Investment optimization with LODGE and cost analysis from adoption



AMI: Advanced Metering Infrastructure
*feeder models for SCL and PNM, substation models for LPEA
**maximum net load, minimum daytime load, average load

Seattle City Light Pilot

Objective: Identify 10 feeders to install up to total 4 MW of community scale (CS) projects

Approach:

1) Generate up to 4 MW of capacity generation projects across all feeders in SCL territory;

2) Use the LBNL LODGE model to quantify least-cost grid upgrades and deferrals;

3) Assess the ability of distributed generation projects to meet demand, particularly in the winter.

Top 10 - 4000 kW of distributed generation

A **score is used to rank** feeders based on their interconnection cost:

- Feeders enabling **line investment deferrals** (e.g., F011) are given top priority for deployment, as they lead to the lowest cost per kW deployed

- The remaining feeders in the ranking are prioritized based on the **least expected transformer investment**
  - Service transformer capacity limits are calculated based on 8760 non-coincident peak.

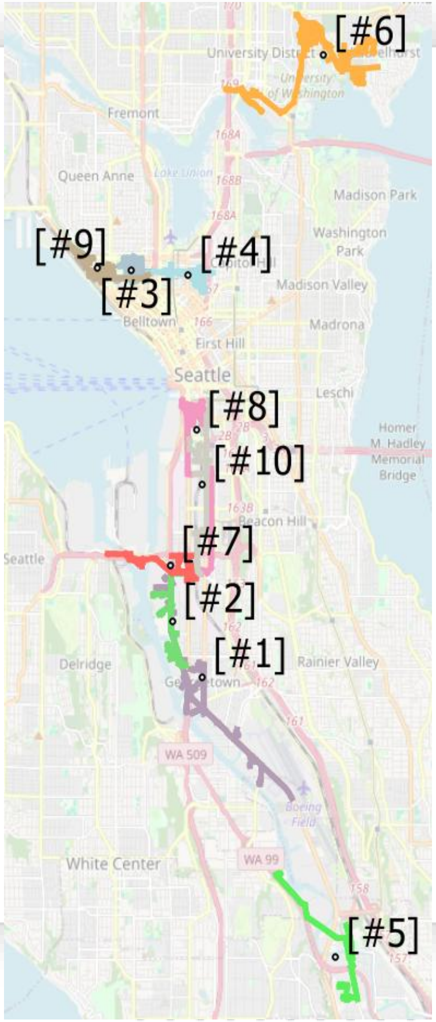
Feeder	Maximum load (MW)*	Additional line investment ($/year)**	Additional transformer investment ($/year)	Score	Peak reduction (%)	Ratio of CS used to cover feeder load
F011	23.23	-13,439.05	16,939.31	0.88	2.04	1.00
F001	6.46	0.00	9,472.55	2.37	4.01	0.99
F003	10.08	0.00	10,080.41	2.52	0.00	1.00
F007	7.82	0.00	10,140.15	2.54	0.00	1.00
F013	11.41	0.00	10,761.56	2.69	4.97	1.00
F004	11.76	0.00	10,935.89	2.73	2.75	0.98
F002	4.15	0.00	11,176.45	2.79	18.24	0.82
F014	6.87	0.00	11,232.99	2.81	0.00	0.88
F005	5.23	0.00	11,716.50	2.93	0.00	0.96
F006	2.26	0.00	11,802.86	2.95	7.59	0.42

**Load before PV deployment [technology scenario of interest to the SCL]*
***Negative values denote deferrals*

Top Ranked Feeder Location

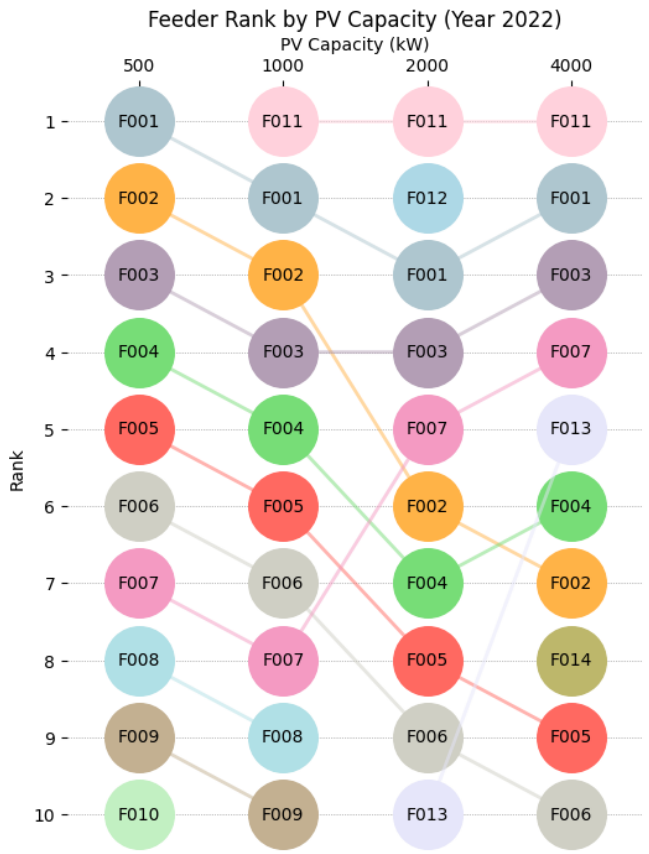
Installations up to 4000 kW are preferred in feeders with large transformers, which have larger capacity and are less likely to require upgrades (locations shown in Fig.)

Feeders within the top 10 are mainly located in central areas with **high-density corridors** where existing infrastructure supports PV integration.



Top 10 feeder – locational impact

- A comparison of feeder prioritization based on the target distributed generation per feeder is shown in the figure.
- Feeder rankings shift dynamically based on DER capacity, with some feeders being better ranked for lower PV deployment:
  - *Feeder F002 (orange):*
    - Contains a large, overloaded transformer; PV installation helps alleviate this overload (up to 1000 kW)
    - For PV above 2000 kW, there is a saturation of multiple individual transformers for, leading to a cost increase (rank decrease).
  - *Feeder F011 (pink)*
    - Deferrals of line investments for PV capacity of 1000 kW (or above)

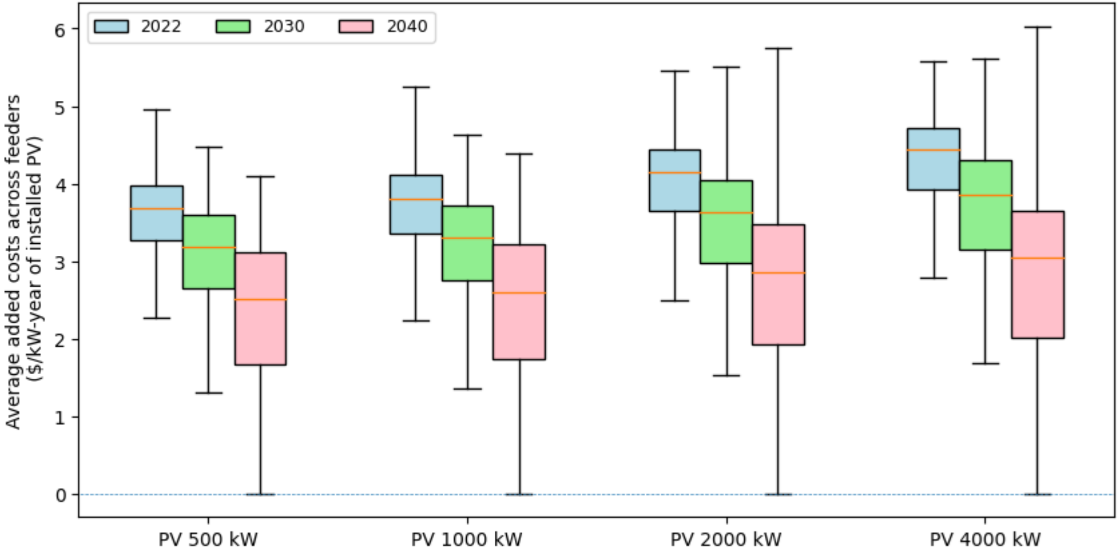


Combined Effect: generation and load growth

The unit cost of DER interconnection ($/kW) decreases when IRP projections for load growth are considered.

Load is expected to increase by 8% in 2030 and 27% by 2040. This leads to an average reduction of interconnection costs per kW of 13% and 31%, respectively.

This reinforce the benefit of assessing interconnection costs in the context of integrated and proactive planning.



Potential to Meet New Winter Load

$$Ratio = \frac{SolarGen(PVcap, winter)}{Demand_{winter}^{target\_year} - Demand_{winter}^{base\_year}}$$

With a 4000-kW PV adoption, the median percentage of new winter load to be supplied with PV is **47% for 2030** and **16% for 2040**

Feeders with smaller base loads can fully meet their increased demand with solar energy, provided batteries are used to distribute the energy throughout the day

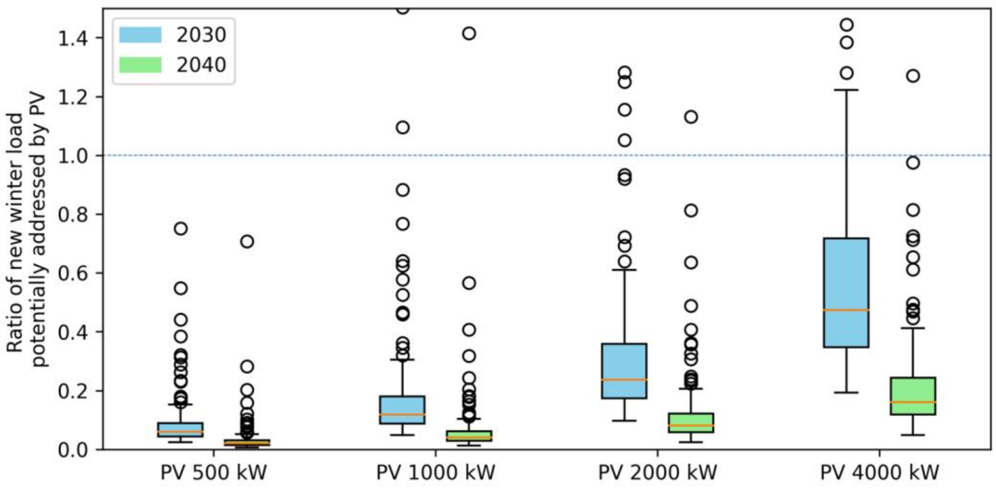


Fig. Distribution of the ratio of winter load per feeder covered by a 4000 kW PV deployment at each feeder. Values above 1 indicate generation exceeding load

PNM New Mexico Pilot

Objective: Identify locations for large 8MW community scale (CS) projects and least-cost strategies to integrate them.

Approach:

1) Generate deployment scenarios of CS projects in a set of 58 feeders selected by PNM;

2) Explore alternatives to maximize distributed generation strategic siting and battery storage;

3) Analyze impacts on distribution system planning and the value of DERs.

Distribution costs/deferrals

Median added costs remain below $6.78/kW of installed CS project when those projects are installed at an intermediate location.

The number of feeders with added costs increases with more distributed generation; most added costs occur **when capacity grows from 2500 kW to 4000 kW**, and reduces the value per kW installed in the large penetration scenario.

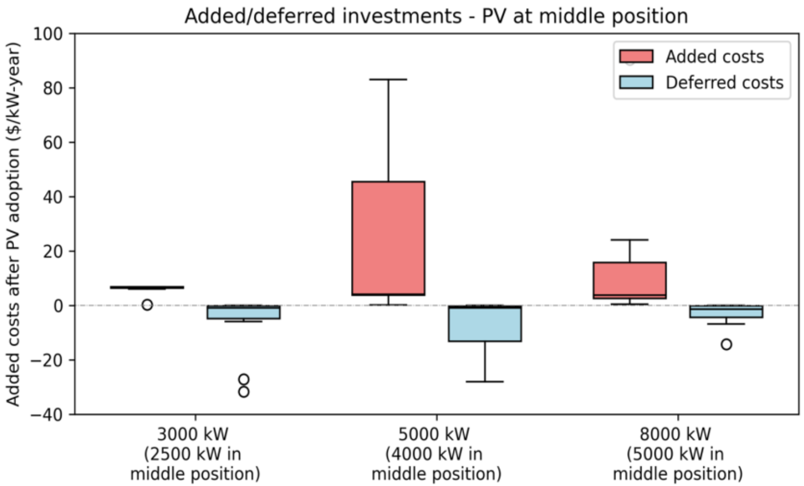


Fig. Distribution of added and deferred costs in different scenarios of CS deployment.

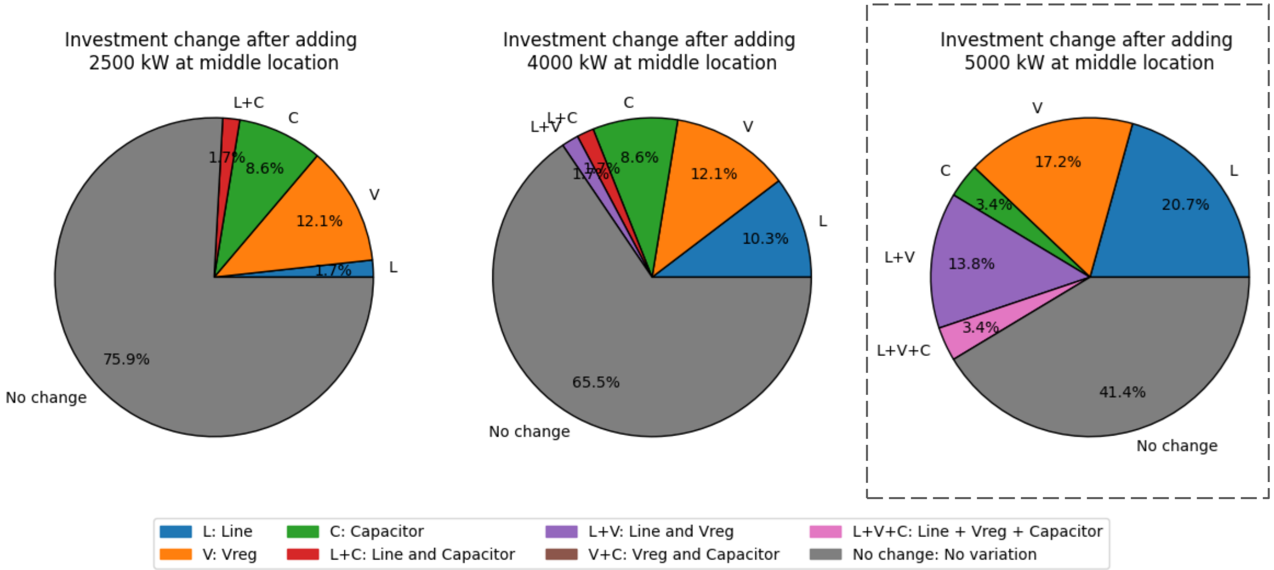
Table. Number of feeders with added/reduced/no investment changes compared to the base case

	Community generation capacity level		
Investment impact	**3000 kW PV**	**5000 kW PV**	**8000 kW PV**
Increased inv.	10	17	31
No change	31	27	17
Deferred inv.	17	14	10

Investment Change with generation capacity

Up to 4000 kW, 65% of the feeders do not require upgrades, indicating a safe spot for medium-scale PV interconnection.

Larger deployment significantly increases the number of feeder that require investments requiring multi-asset reinforcements



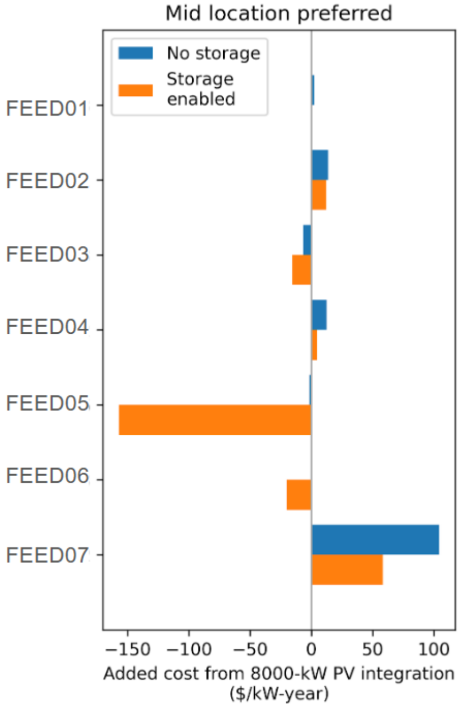
Reducing Line overloading

Positive values indicate added costs. Negative values correspond to deferred investments

Battery storage (sized between 29 kW and 1899 kW) **defers line reconductoring expenditure** by shifting available energy to high demand hours.

While most feeders see a moderate cost reduction, FEED05 shows a massive benefit, with **deferred investment savings exceeding $150/kW-year**.

Even in feeders where costs remain positive (like FEED07), enabling storage drastically lowers the price of PV integration compared to the no-storage baseline.



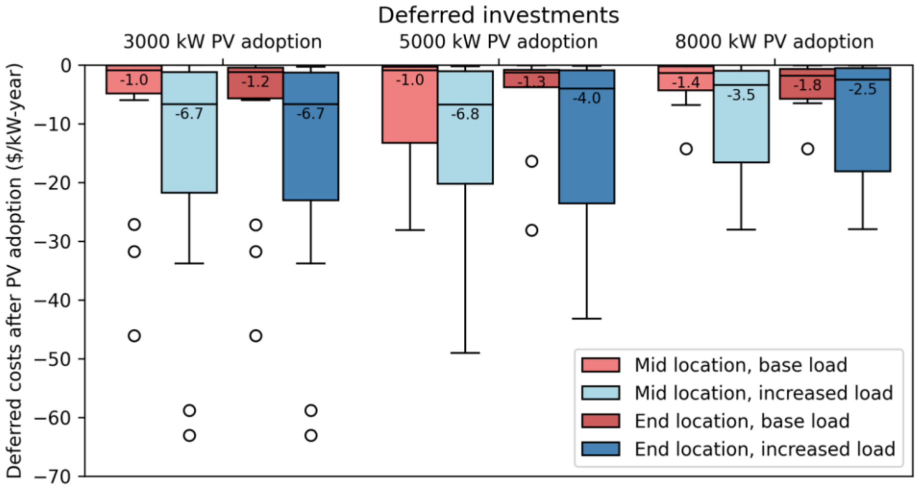
Feeder	Storage size (kW)*
FEED01	50
FEED02	85
FEED03	214
FEED04	90
FEED05	1899
FEED06	29
FEED07	260

*assuming 2-hour battery for the shown sizes

Combined generation and load growth

Distributed generation produces significant deferrals, particularly for the 3000–5000 kW level installed at the middle location

Deferrals become more pronounced under increased load, showing that CS has potential to avoid future grid upgrades.



Takeaways

Integration costs of community scale (CS) resources vary significantly across distribution feeders, depending on the size and location of solar assets.

Opportunities to **decrease (or even defer) costs** arise from pairing CS with storage and from proactively accounting for load growth in integration studies.

Advanced distribution modeling techniques are required to capture DER value and interconnection cost of distribution planning.

Thanks!

Questions?

LODGE Pilots in numbers

562,518
consumers

292
feeders

3,838
LODGE runs

Team
Miguel Heleno
Luis Rodriguez-Garcia
Alan Valenzuela
Jason MacDonald
Greg Leventis

Break-out discussion

- **For the next ~15 minutes, please join your assigned break out room and discuss:**

1. *How do you handle reviews of utility modeling that is included in different filings? What resources do you have? Staff experts? Consultants? Lab TA?*
2. *What do you think are the biggest sources of uncertainty in distribution system modeling?*
3. *Magic wand: What resource or requirement or agreement would you want to improve the quality of distribution system planning and modeling and help achieve your state's objectives for the distribution system?*
4. *Extra question: In what contexts do the utilities you regulate do capacity expansion modeling? Rate cases? DSP? IRP?*

Next Steps

- Find all meeting materials at: https://www.naruc.org/core-sectors/energy-resources-and-the-environment/der-integration-compensation/distributed-energy-projects-interconnection-cohort/
- **Register for the August 26th meeting (Distributed Energy Projects Interconnection Cohort Series Webinar #4: DER Interconnection Model Guidelines and Flexible Interconnection) at:** https://naruc-org.zoom.us/meeting/register/r_L4FLMtTcm6BL-GoJW1Dg?_x_zm_rtaid=OnQTH0pMT8CR2ZnAtx56oA.1782927097437.08b2382c50a46711a857def1d68c4201&_x_zm_rhtaid=868#/registration

Thank you!

Contacts

Sydney Forrester: spforrester@lbl.gov, 510-486-4123

Jeff Loiter: jloiter@naruc.org, 202-656-2128

For more information

Download our publications: https://emp.lbl.gov/publications

Sign up for our email list: https://emp.lbl.gov/mailing-list

Follow us on social media: @BerkeleyLabEMP.bsky.social and @BerkeleyLabEMP

Acknowledgements

This work was funded by the Interconnection Innovation e-Xchange (i2X), a U.S. Department of Energy initiative supported by the Office of Critical Minerals and Energy Innovation, under Contract No. DE-AC02-05CH11231.

Disclaimer

Copyright Notice