Distribution System Planning & Non-Wires Solutions

Natalie Mims Frick, Berkeley Lab

Contributions by Lisa Schwartz, Berkeley Lab

NASEO-NARUC Grid-interactive Efficient Buildings Working Group
October 26, 2022

GRID MODERNIZATION LABORATORY CONSORTIUM
U.S. Department of Energy

Disclaimer

Copyright Notice

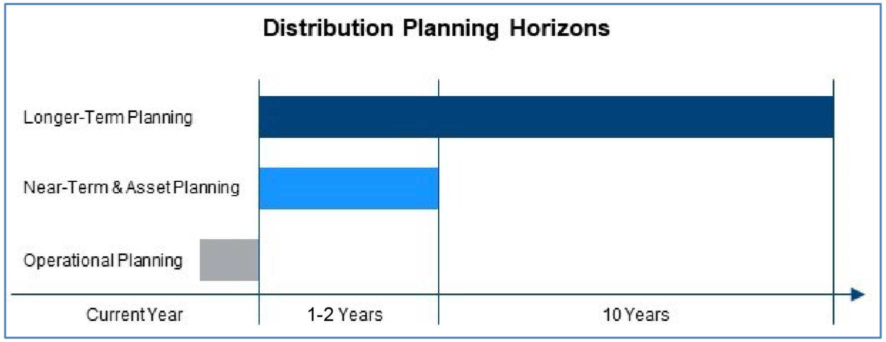
In this presentation

- Planning elements and state requirements
- Grid modernization and distribution planning
- Distributed energy resources (DERs) and distribution planning
    - Hosting capacity analysis
    - Interconnection
    - Non-wires solutions
    - DER tariffs
- Questions state energy offices and public utility commissions can ask

For more information on all of these topics, see the full version of this presentation [here](), and access the recording [here]().

Planning Elements and State Requirements

Electricity system planning



- Distribution planning - Assess needed physical and operational changes to the local grid

  Annual process, with 1–2 year planning horizon*

  - Identify and define distribution system needs
  - Identify and assess possible solutions
  - Select projects to meet system needs

  Longer-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 (IRP)* - Identify future investments to meet bulk power system reliability and public policy objectives at a reasonable cost

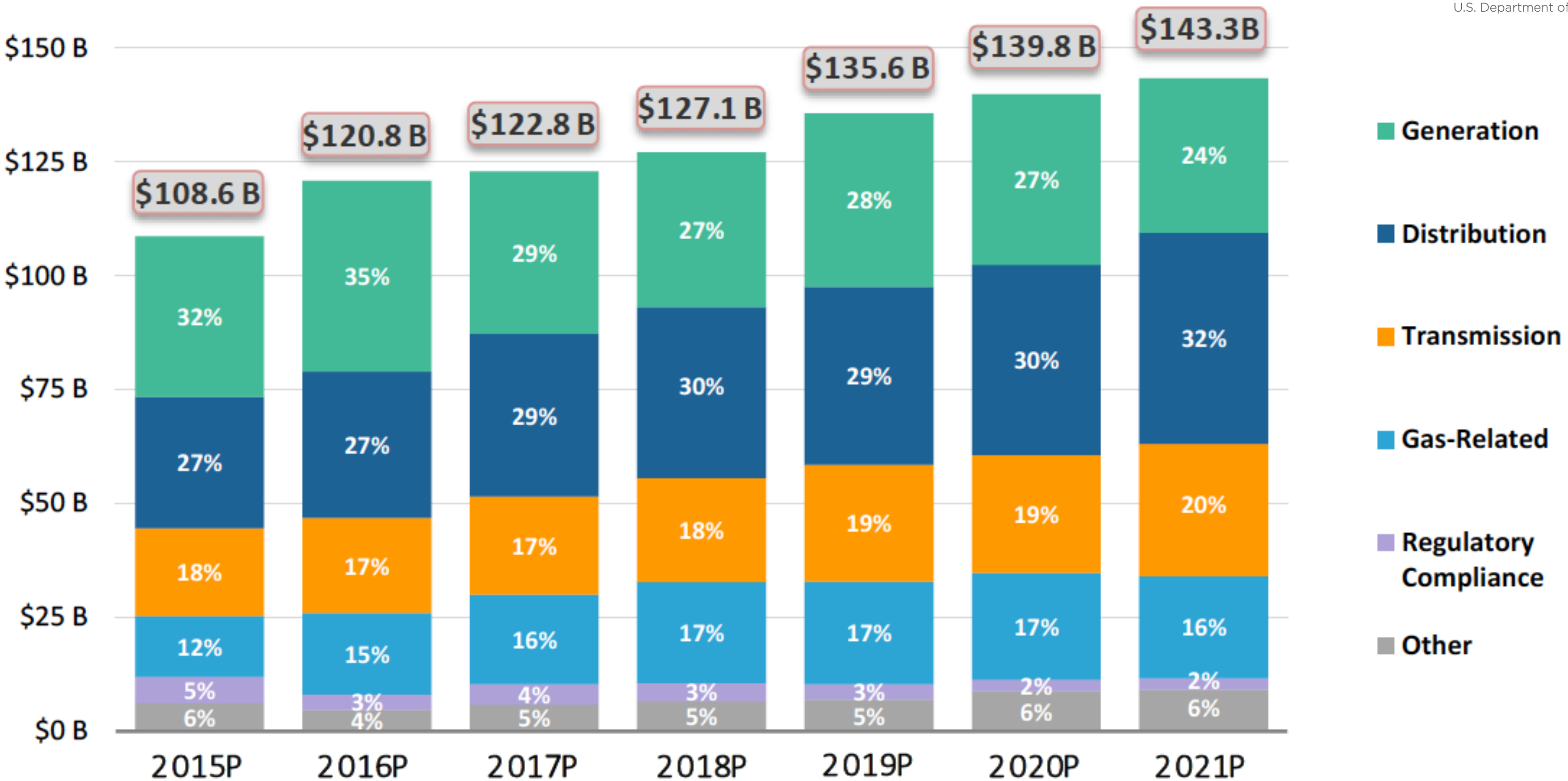
  Consider scenarios for loads and distributed resources; impacts on need and timing for utility investments

- Transmission planning – Identify future transmission expansion needs and options

Also: energy efficiency, demand-side management, electrification and climate plans

*Operational planning addresses immediate concerns (intraday through the current year).

One reason states are increasingly interested in distribution planning

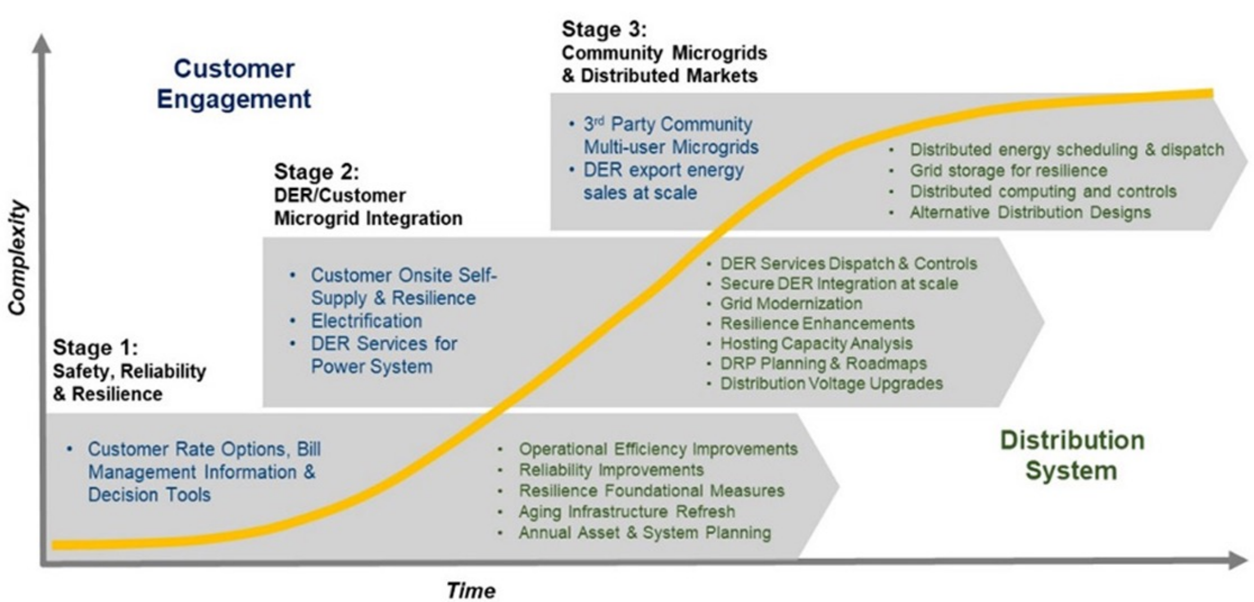


Distribution system investments account for the largest portion (32%) of capex for U.S. investor-owned utilities: $46.4B (projected) in 2021.

Source: [Edison Electric Institute]

Other potential benefits from improved distribution planning processes

- Makes transparent utility plans for distribution system investments holistically, before showing up individually in a rider request or rate case
- Provides opportunities for meaningful PUC and stakeholder engagement
  - Can improve outcomes — more data, community input, review
- Considers uncertainties under a range of possible futures
- Considers all solutions for least cost/risk
- Motivates utility to choose least cost/risk solutions
- Enables consumers and 3rd party providers to propose grid solutions and participate in providing grid services



Source: DOE 2021

States with distribution planning requirements

	California	Colorado	Delaware	District of Columbia	Florida	Hawaii	Illinois	Indiana	Maine	Maryland	Massachusetts	Michigan	Minnesota	Nevada	New Hampshire	New Jersey	New York	Ohio	Oregon	Pennsylvania	Rhode Island	Texas	Utah	Vermont	Virginia	Washington
Distribution system plan requirement	●	●	●	●		●	●	●	●	●	●	●	●	●	●		●		●		●			●	●	●
Grid modernization plan requirement	●					●					●		●				●	●								
Hosting capacity analysis/mapping requirement	●	●				●					●	●	●	●	●		●		●							
Non-wires alternatives / locational value requirements	●	●	●	●		●			●			●	●	●	●		●				●					
Storage Mandates or Targets	●						●		●		●			●		●	●		●						●	
Benefit-Cost Methodology / Guidance	●						●			●				●			●				●					
Storm hardening requirements					●					●															●	
Required reporting on poor-performing circuits and improvement plans		●	●		●		●			●	●		●			●	●	●	●	●	●	●	●	●		●

Berkeley Lab and Pacific Northwest National Laboratory

Distribution plans may be incorporated in integrated resource plans or integrated grid plans. Grid modernization plans may be filed in combination with distribution plans. This list is not all-inclusive.

Example state requirements*

- Distribution system plans

  California, Colorado, Delaware, DC, Hawaii, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, Nevada, New York, Oregon, Rhode Island, Vermont, Virginia, Washington

- Grid modernization plans

  California, Hawaii, Massachusetts Minnesota, New York, Ohio

  Utilities in other states have filed grid modernization plans absent requirements (e.g., GA, NC, SC, TX).

- Hosting capacity analysis/maps

  California, Colorado, Hawaii, Massachusetts, Michigan, Minnesota, Nevada, New Hampshire, New York, Oregon

- NWA/locational value

  CA, CO, DE, DC, HI, ME, MI, MN, NV, NH, NY, RI

- Benefit-cost handbook/guidance

  CA, DC (draft), IL, MD, NV, NY, RI, SC

- States using or considering adopting NSPM framework

  AR, CO, CT, DC, MD, MI, MN, MO, NH, NJ, RI, PA, WA

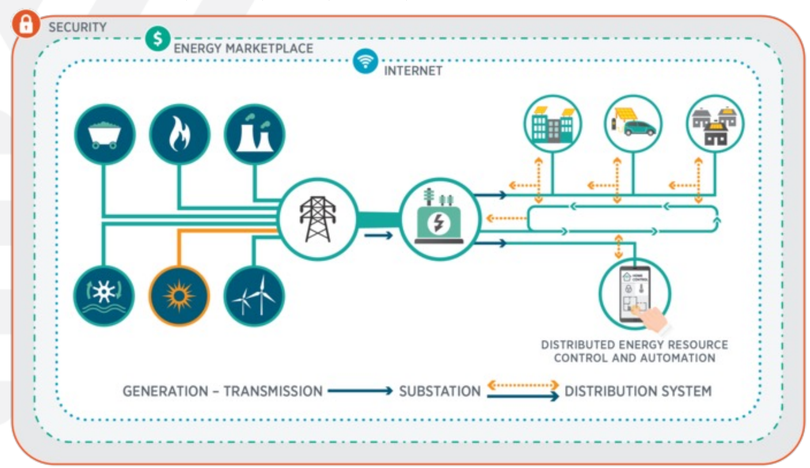
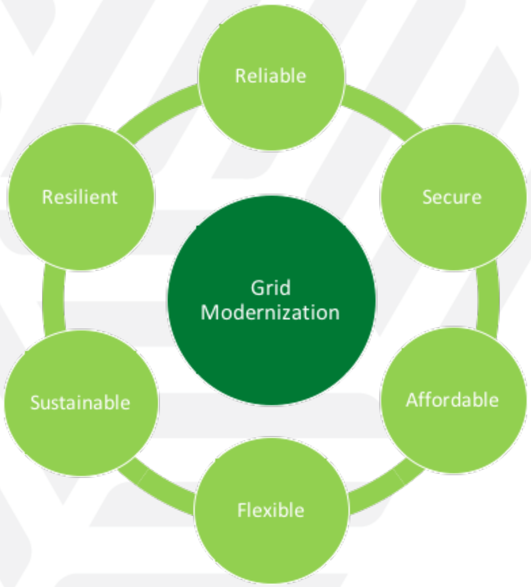


Figure: U.S. Department of Energy

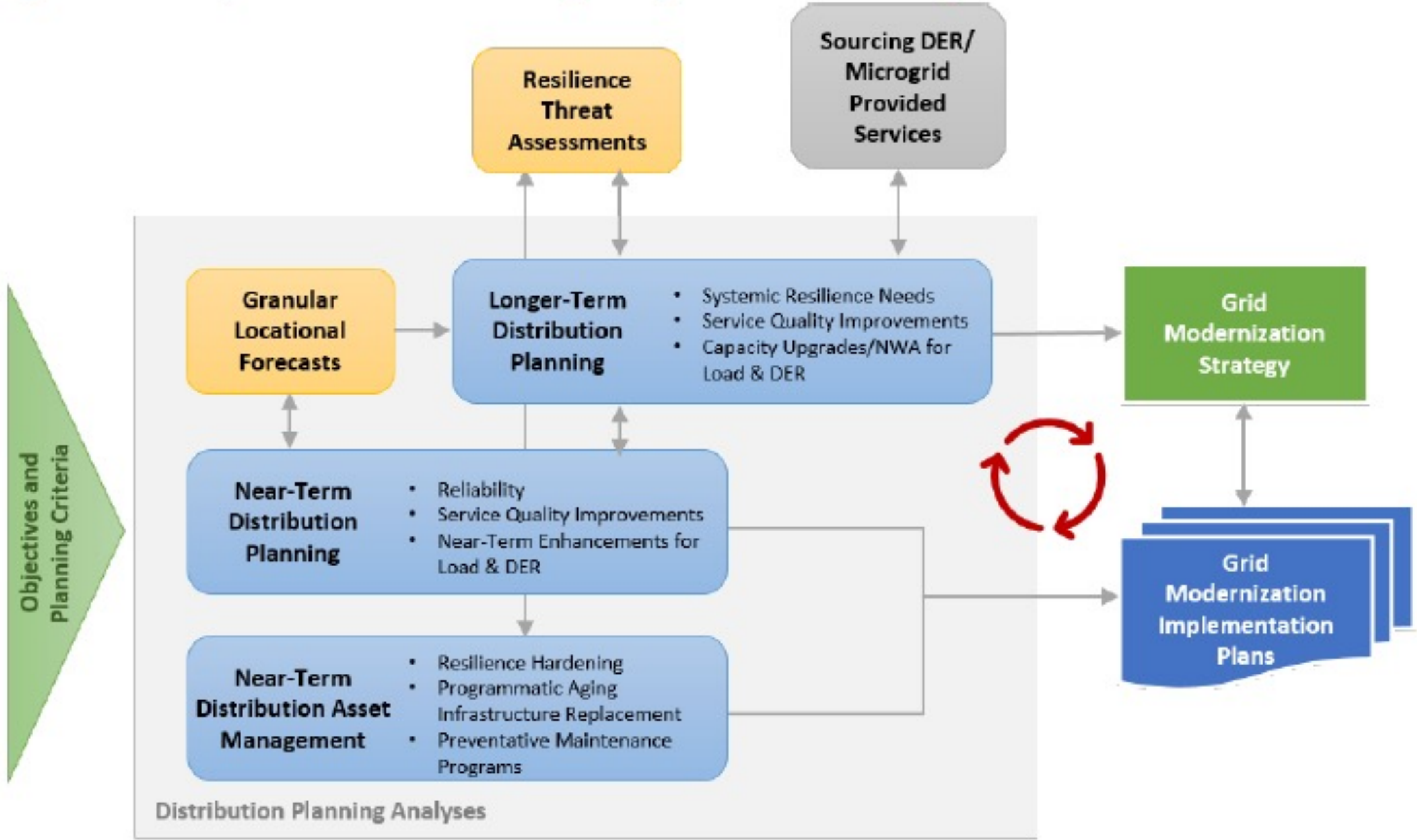
*This list is not all-inclusive.

Grid Modernization and Distribution Planning



Source: U.S. Department of Energy's *Grid Modernization Multi-Year Program Plan*

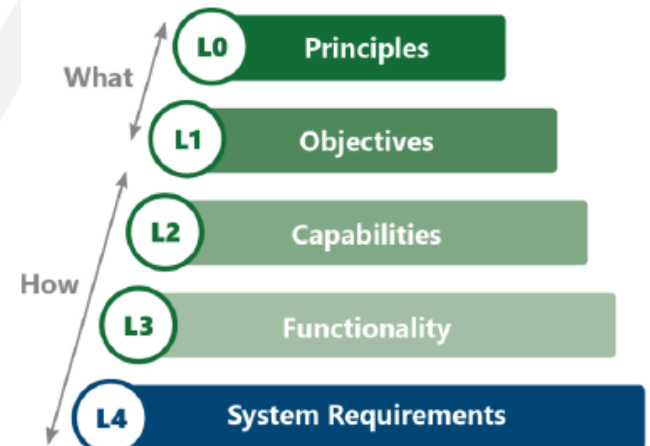
Relationship of grid modernization planning to integrated distribution planning



Source: DOE 2021

Start with principles and objectives instead of picking technologies

- Grid modernization planning starts with principles, objectives and capabilities needed. They determine functionality and system requirements.
- Holistic, long-term planning for grid modernization is needed to:
  - Support state goals, including reliability, resilience, affordability, clean energy resources, climate and electrification (e.g., AMI for time-varying rates that provide demand flexibility to integrate more wind and solar)
  - Address interdependent technologies and systems, including “platform” components (e.g., Advanced Distribution Management Systems, Geographic Information System, Outage Management System) needed to enable or support other grid modernization projects
  - Consider proactive grid upgrades to facilitate customer choice
- Other plans may feed into distribution plans:
  - Electrification plan informs grid needs for EV charging
  - Cybersecurity plan identifies resilience threats that distribution planning can consider
  - Demand-side management plan specifies capabilities that distribution technologies and systems should provide to achieve multi-year targets for demand response, energy efficiency and conservation



Source: DOE 2021

DERs and Distribution Planning

Proactive planning is more effective.

Tell customers where the grid needs help and what services the grid needs. Provide appropriate incentives.

- *Load and DER forecasting* helps resource planners avoid overbuilding and feeds into analysis of which feeders may be stressed by DER in the near-term.
- *Hosting capacity analysis* shows how much more DER can be managed on a given feeder easily and where interconnection costs will be low/high.
- Together, these processes identify feeders that are likely to see DER growth and can be considered for proactive upgrades.
- *Locational net benefits analysis* helps determine the benefits of specific services at a specific location to guide developers.
- Cost-effective *non-wires alternatives* are DERs that provide specific services at specific locations can defer some traditional infrastructure investments, leveraging customer and third-party capital investments. DERs like energy efficiency and demand response can make more hosting capacity available.
- These analyses can inform rates and tariffs.

Source: Adapted from Debbie Lew, Emerging distribution planning analyses, prepared for Berkeley Lab, 2020

What is hosting capacity?

- Amount of DERs that can be interconnected without adversely impacting power quality or reliability under existing control and protection systems and without infrastructure upgrades
- Analysis shared by utility typically in maps with supporting data
- Three main constraints: thermal, voltage/power quality, protection limits

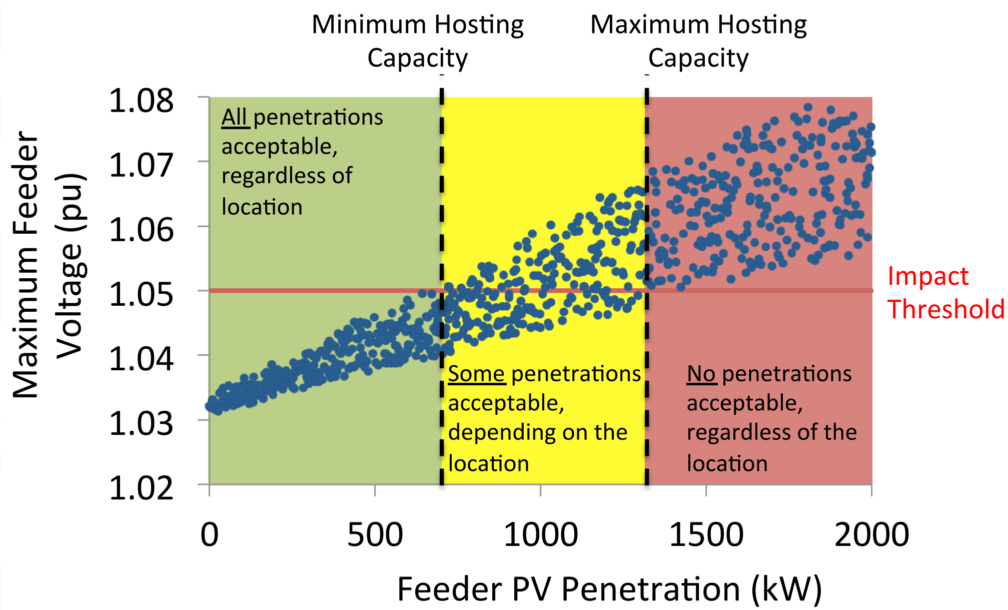


Figure adapted by Berkeley Lab from EPRI (2015), [*Distribution Feeder Hosting Capacity: What Matters When Planning for DER?*]

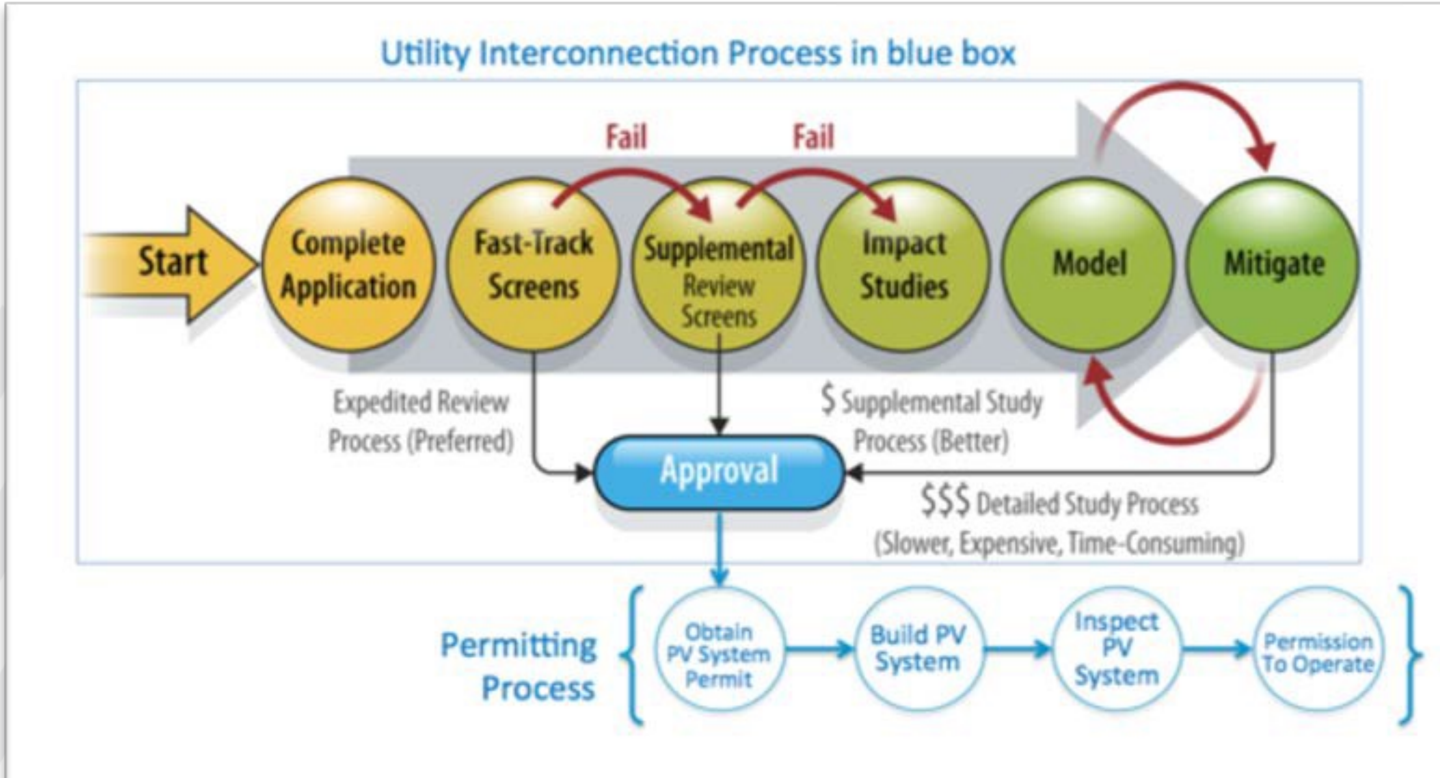
Hosting capacity use cases

	Use Case	Objective	Capability	Challenges
Hosting Capacity Analysis Use Cases	**Development Guide**	Support market-driven DER deployment	Identify areas with potentially lower interconnection costs	Security concerns; analysis/model refresh; data accuracy and availability
	Technical Screens	Improve the interconnection screening process	Augment or replace rules of thumb; determine need for detailed study	Data granularity; benchmarking and validation to detailed studies
	Distribution Planning Tool	Enable greater DER integration	Identify potential future constraints and proactive upgrades	Higher input data requirements; granular load and DER forecasts

Source: ICF International for DOE

Useful reference: IREC, *Key Decisions for Hosting Capacity Analysis*, 2021

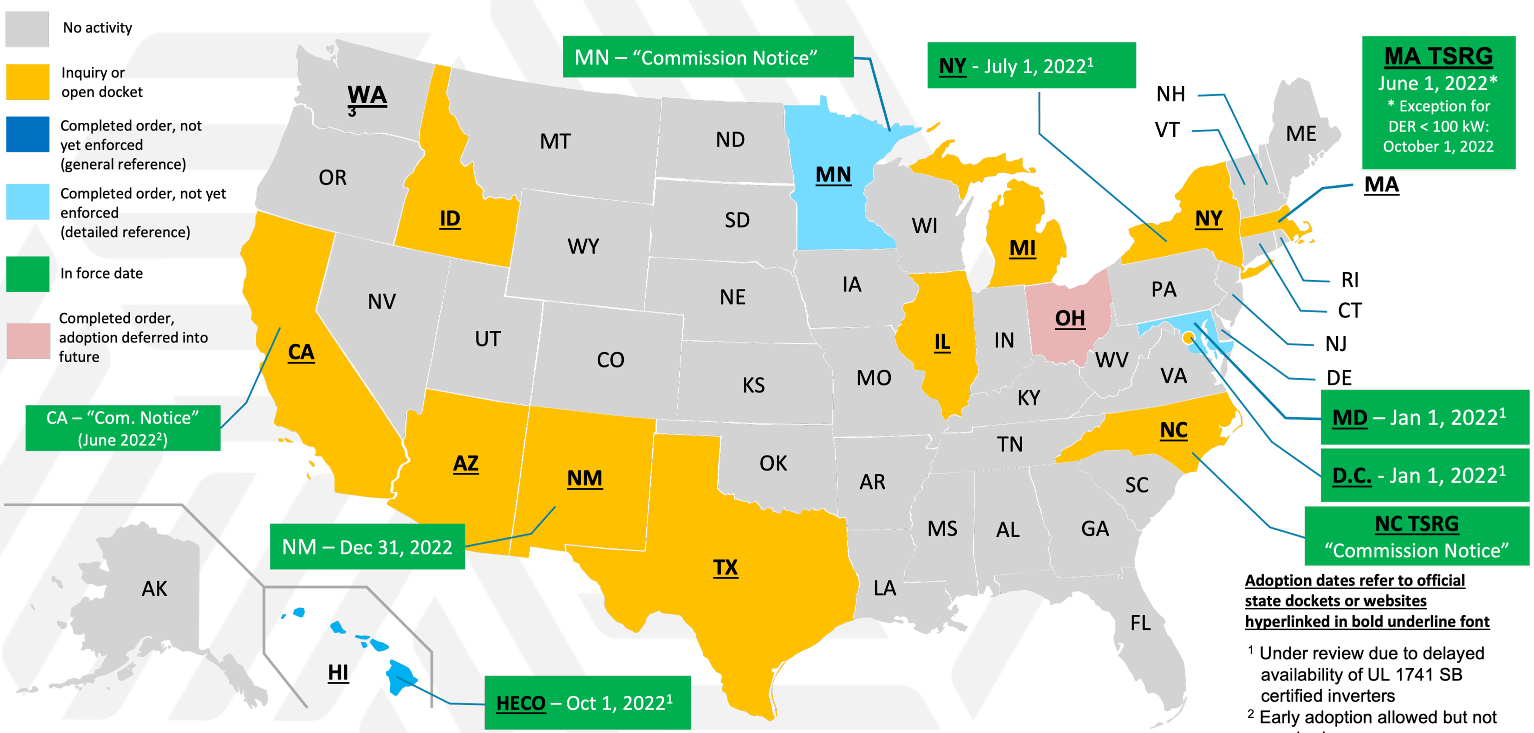
Interconnection process



Systems above a certain size may skip the Fast-Track Screens and go straight to detailed Impact Studies

Source: Horowitz et al., [An Overview of Distributed Energy Resource (DER) Interconnection: Current Practices and Emerging Solutions](), April 2019, National Renewable Energy Laboratory

U.S. states adopting IEEE Standard 1547-2018



Adoption dates refer to official state dockets or websites hyperlinked in bold underline font

[1] Under review due to delayed availability of UL 1741 SB certified inverters

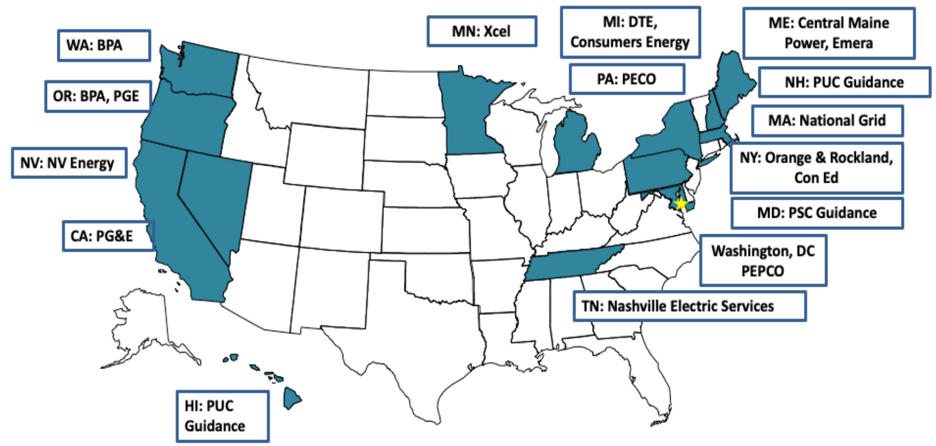
[2] Early adoption allowed but not required

[3] Reference to "latest" IEEE 1547

Source: EPRI, "[IEEE Std 1547™-2018: Status of Adoption across the U.S.]()," May 2022.
See Extra Slides for ISO/RTO adoption and state resources on interconnection.

What are non-wires alternatives?

- Options for meeting distribution system needs related to load growth, reliability and resilience.
  - Single large DER (e.g., battery) or portfolio of DERs that can meet the specified need
- Objectives: Provide load relief, address voltage issues, reduce interruptions, enhance resilience, or meet local generation needs
- Potential to reduce utility costs
  - Defer or avoid infrastructure upgrades
  - Implement solutions *incrementally,* offering a flexible approach to uncertainty in load growth and potentially avoiding large upfront costs for load that may not show up.



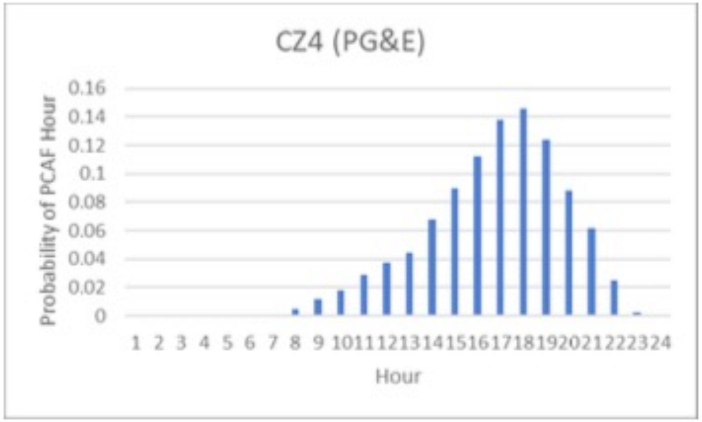
Case studies featured in Berkeley Lab report, *Locational Value of Distributed Energy Resources*

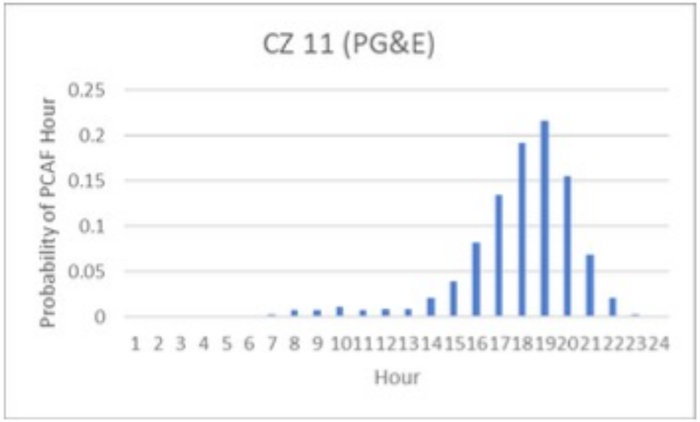
- Typically, the utility issues a competitive solicitation for NWA for specific distribution system needs and compares these bids to planned traditional grid investments to determine the lowest reasonable cost solution.
- Jurisdictions that require NWA consideration include CA, CO, DE, DC, HI, ME, MI, MN, NV, NH, NY and RI. Other states have related proceedings, pilots or studies underway.

Locational value of DERs

- In addition to analyzing DERs as alternatives to *specific projects*, utilities can conduct *systematic* studies of DER locational value to:
  - Better understand where to target DERs
  - Calibrate incentive levels
  - Reduce load growth for specific areas of the distribution system
  - Reduce the need for traditional distribution system upgrades.
- Locational net benefits analysis systematically analyzes costs and benefits of DERs to determine the net benefits DERs can provide for a given area of the distribution system.
- These studies can become a routine and transparent part of the utility's distribution planning process. Information also can be used for DER programs and rate designs.

Example PG&E peak capacity allocation factors distribution by hour for climate zone 4 and climate zone 11. Source [Avoided Cost Calculator](#) (2021)

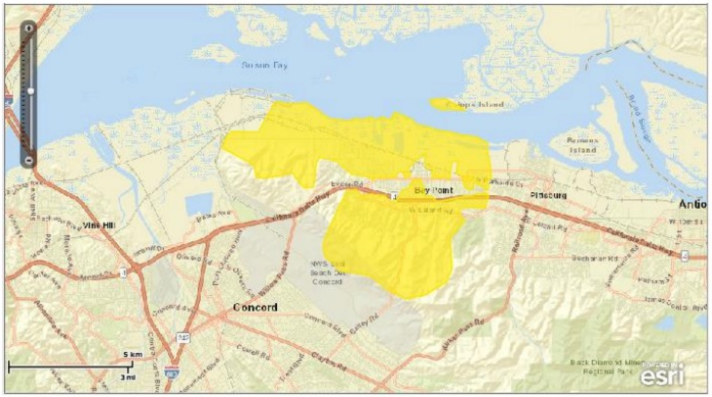




NWS procurement strategies in California

- Three procurement mechanisms identify opportunities to cost-effectively defer or avoid traditional utility investments to use DERs to mitigate forecasted deficiencies:
  1. Distribution Investment Deferral Framework (DIDF) - Annual Grid Needs Assessments and Distribution Deferral Opportunity Reports
     - Examples: SCE, PG&E, SDG&E
     - Following a Distribution Planning Advisory Group stakeholder process, the utilities issue their request for offers (RFO) for competitive annual solicitations for specific deferral projects.
  2. Partnership Pilot (2021) - Utilities prescreen aggregators to procure owned, behind-the-meter (BTM) aggregation improves and accelerates deferral implementation
  3. Standard Offer Contract Pilot - Utilities select offers for front-of-the-meter DERs through a simple auction

Willow Pass Substation Bank 3 Map



Source: PG&E presentation on 2021 RFO

2021 Distribution Deferral Status

- As of February 2021, the CPUC approved 16 MW of battery storage contracts for PG&E and 18.5 MW for SCE.
- PG&E and SCE released their 2021 DIDF RFO in January 2021.
  - Insufficient quantity of viable bids received to meet the full need for any deferral opportunities identified by PG&E or SCE.
- SDG&E, PG&E and SCE filed 2021 DIDF plans in August 2021.
  - SDG&E identified one project that is eligible for deferral and released its 2021 DIDF RFO in December 2021.
- CA investor-owned utilities continue to have challenges successfully implementing NWS.
- New procurement mechanisms — the Partnership Pilot and Standard Offer Contract — were designed to accelerate procurement timelines to enable successful deployment of NWS.

See Extra Slides for more information.

Partnership Pilot

- Customers participate in the pilot through a pre-screened aggregator.
- Pre-screened aggregators meet experience and financial viability criteria, and have demonstrated the capability to reliably dispatch DERs.
- The pilot is first-come, first-serve. It remains open until the subscription period closes or when the utility contracts 120% of identified need.
- When the utility receives offers that meet 90% of the capacity needed to defer the distribution project, the utility contracts with the aggregators.
- The pilot budget is capped at 85% of the estimated cost per kW of traditional investment.
- Annually, each utility must identify three projects to test the pilot.

Southern California Edison Partnership Pilot Project

Partnership Pilot Project Name: New Circuit at El Casco Substation

Project Cities May Include	Need Area	Tranche	Tranche Status	Tranche Procurement Goal (Capacity - MW)	Tranche Procurement Goal (Energy - MWh)	Subscription Period Launch Date	Subscription Period End Date	Operating Date	Deferral Value (Cost Cap-PV $)	Tariff Budget (Nominal $)	Deployment Budget	Reservation Budget	Performance Budget
Beaumont, Calimesa	Jonagold Circuit	1	Open	0.1	0.1	1/18/2022	12/1/2022	6/1/2024	$65,627	$12,130	$2,426	$3,639	$6,065
		2	Closed	0.3	0.6	~1/15/2023	12/1/2023	6/1/2025	$61,271	$80,056	$16,011	$24,017	$40,028
		3	Closed	0.4	0.7	~1/15/2024	12/1/2024	6/1/2026	$57,205	$102,738	$20,548	$30,822	$51,369
		4	Closed	0.4	0.6	~1/15/2025	12/1/2025	6/1/2027	$53,408	$96,868	$19,374	$29,060	$48,434
		5	Closed	0.3	0.5	~1/15/2026	12/1/2026	6/1/2028	$49,864	$88,795	$17,759	$26,639	$44,398
		6	Closed	0.3	0.3	~1/15/2027	12/1/2027	6/1/2029	$46,554	$58,605	$11,721	$17,581	$29,302
		7	Closed	0.3	0.4	~1/15/2028	12/1/2028	6/1/2030	$43,465	$85,954	$17,191	$25,786	$42,977
									Total Tariff Budget	$525,146			

Standard Offer Contract

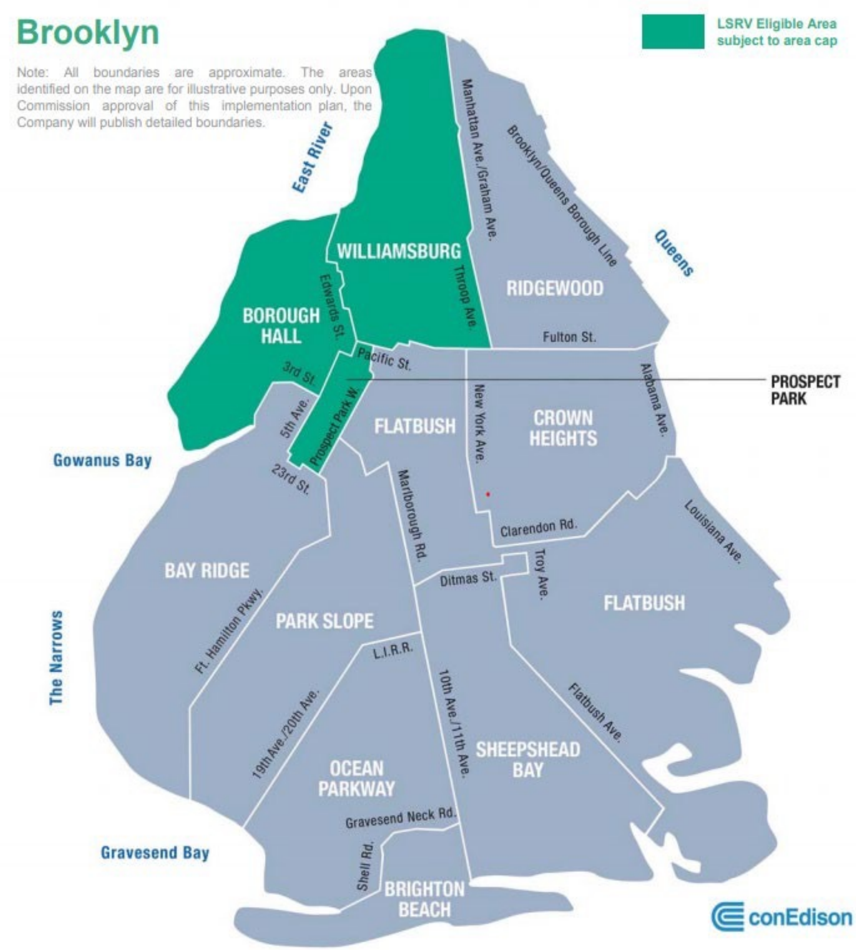
- Participants use a standard contract to offer front-of-the meter DERs to avoid or defer identified utility distribution investments.
  - Contract is based on Technology Neutral Pro Forma contract — for example, SDG&E's contract is here.
  - DERs can be dispatchable or non-dispatchable.
- Participants can submit partial or full offers, and the utility can combine offers together to create a solution. Offers include a $/kW-Month price.
- The offer price cap is the value of a one-year deferral of the planned distribution project, which the utilities publish. Once 90% of the capacity is filled the utilities start the contract process.
- Utilities are required to select one project annually to test the pilot.

Southern California Edison Standard Offer Contract Pilot Project

Project Description	Tier	Location(s) of Need	Distribution Service Required	Operating Date	Max 10-year Capacity Need (MW)	Max 10-year Duration (hr)	Standard Offer Contract Pilot Project Ranking
New Circuit at Eisenhower	Tier 1	Crossley 33kV	Capacity	6/1/2024	2.9	6	1
New Circuit at El Casco Substation	Tier 1	Jonagold 12kV	Capacity	6/1/2024	0.4	2	2
New Circuit at Elizabeth Lake	Tier 1	Guitar 16kV Oboe 16kV Trumpet 16kV	Capacity (UCT) FLAG	6/1/2024	9.0	11	3

DER tariffs

- DER payments based on Value of DER
  - New York [Value Stack tariff] compensates DER based on location, in addition to energy, capacity, environmental and demand reduction values
  - Locational specific relief value (LSRV) zones are identified by each utility
  - Response to event calls in LSRV zones results in additional DER compensation
  - [Net energy metering] still an option for onsite residential and commercial DG <750 kW



Source: Con Edison [LSRV Zone map]

Getting starting with an IDSP proceeding: What other states have done

- Develop staff report or white paper outlining DSP needs, goals, and vision
  Example: Oregon PUC Staff White Paper
- Issue surveys or targeted questions to utilities and stakeholders
  Example utility survey from Minnesota
  Utility survey, stakeholder survey and follow-up stakeholder questions used in Oregon
  Initial meetings or workshops
  - Review and discuss surveys and questions
  - Understand current processes, data, systems and filings
- Host targeted presentations or trainings for staff and stakeholders
  Examples: Colorado, Oregon, New Mexico
- Require utilities to develop a stakeholder engagement plan prior to technical planning
  Example: Joint Utilities of NY stakeholder plan and timeline, Oregon Community Engagement Plans
- Require utilities to develop initial distribution system plan to report on current system and processes. Example: New York April 20, 2016, order
  1. Develop plan and timeline for stakeholder engagement (May 5, 2016)
  2. File Initial DSIP addressing current planning, operations, and administration and identifying immediate changes to meet state energy goals (June 30, 2016)
  3. File Joint DSIP addressing tools, processes and protocols developed jointly or under shared standards (Nov. 1, 2016)

Questions state energy offices and public utility commissions can ask

- How are grid modernization strategies and distributed energy resources addressed in distribution system plans today? What improvements can be made to better plan for uncertainties and risks in the future?
- How do planned or proposed grid modernization investments contribute to achieving state energy goals (e.g., climate, equity, economic development, DER integration)?
- What steps can be taken today to plan for interoperability between DER owners, utilities and third-party aggregators?
- Are there opportunities to improve the diversity of participating stakeholders, increase data transparency, and clarify the role of stakeholder feedback in distribution system planning processes?
- When evaluating distribution system solutions, are all costs and benefits of the NWAs included in the analysis?
- What data access provisions are needed to provide consumers and third parties with useful customer and system level data?

Resources for more information

U.S. Department of Energy's (DOE) *Modern Distribution Grid*, Vol. IV, 2021

Berkeley Lab's integrated distribution system planning website: https://emp.lbl.gov/projects/integrated-distribution-system-planning

Berkeley Lab's research on time- and locational-sensitive value of DERs

A. Cooke, J. Homer, L. Schwartz, *Distribution System Planning – State Examples by Topic*, Pacific Northwest National Laboratory and Berkeley Lab, 2018

P. De Martini et al., *The Rising Value of Stakeholder Engagement in Today's High-Stakes Power Landscape*, ICF, 2016

P. De Martini et al., *Integrated Resilience Distribution Planning*, PNNL, 2022

T. Eckman, L. Schwartz and G. Leventis, *Determining Utility System Value of Demand Flexibility From Grid-interactive Efficient Buildings*, Berkeley Lab, 2020

C. Farley et al., *Advancing Equity in Utility Regulation*, Berkeley Lab, 2021

N. Frick, S. Price, L. Schwartz, N. Hanus and B. Shapiro, *Locational Value of Distributed Energy Resources*, Berkeley Lab, 2021

J. Homer, A. Cooke, L. Schwartz, G. Leventis, F. Flores-Espino and M. Coddington, *State Engagement in Electric Distribution Planning*, Pacific Northwest National Laboratory, Berkeley Lab and National Renewable Energy Laboratory, 2017

J.S. Homer, Y. Tang, J.D. Taft, D. Lew, D. Narang, M. Coddington, M. Ingram, A. Hoke, *Electric Distribution System Planning with DERs — Tools and Methods*, Pacific Northwest National Laboratory and National Renewable Energy Laboratory, 2020

ICF, *Integrated Distribution Planning: Utility Practices in Hosting Capacity Analysis and Locational Value Assessment*, 2018

J. McAdams, *Public Utility Commission Stakeholder Engagement: A Decision making Framework*, NARUC, 2021

Smart Electric Power Alliance, *Integrated Distribution Planning: A Framework for the Future*, 2020

N.L. Seidman, J. Shenot, J. Lazar, *Health Benefits by the Kilowatt-Hour: Using EPA Data to Analyze the Cost-Effectiveness of Efficiency and Renewables*, Regulatory Assistance Project, 2021

Y. Tang, J.S. Homer, T.E. McDermott, M. Coddington, B. Sigrin, B. Mather, *Summary of Electric Distribution System Analyses with a Focus on DERs*, Pacific Northwest National Laboratory and National Renewable Energy Laboratory, 2017

T. Woolf, B. Havumaki, D. Bhandari, M. Whited and L. Schwartz, *Benefit-Cost Analysis for Utility-Facing Grid Modernization Investments: Trends, Challenges and Considerations*, Berkeley Lab, 2021

Xcel Energy, *2022-2031 Integrated Distribution Plan*, 2021

Contact

Natalie Mims Frick
nfrick@lbl.gov
510-486-7584

Electricity Markets and Policy Department
Berkeley Lab
https://emp.lbl.gov/

Click here to stay up to date on our publications and webinars and follow us @BerkeleyLabEMP