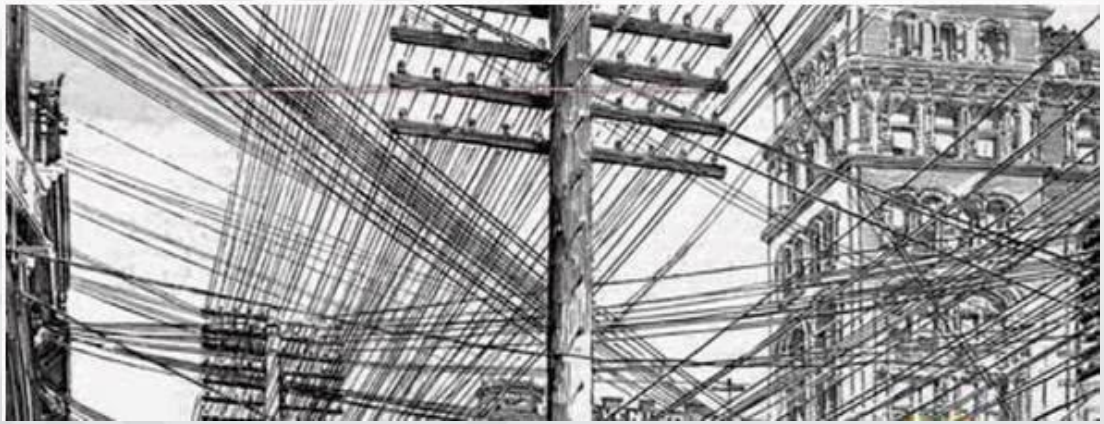


PUC Distribution Planning Practices

Lisa Schwartz, Lawrence Berkeley National Laboratory
Juliet Homer, Pacific Northwest National Laboratory

Distribution Systems and Planning Training
for New England Conference of Public Utility Commissioners, Sept. 27-29, 2017

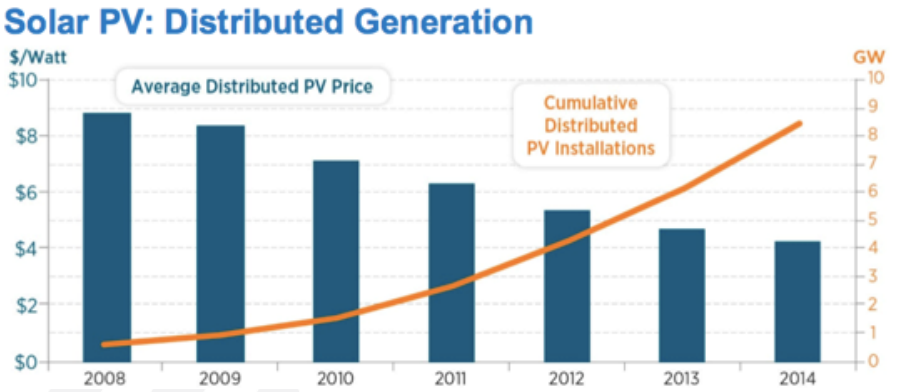
In this presentation

- Increasing state engagement in distribution planning
  - Drivers
  - Benefits
  - Considerations for establishing a regulatory process
  - Variety of approaches
  - Possible places to start
- Survey of states *outside* New England
  - States with advanced distribution system planning practices
  - More state approaches to distribution system planning
- Some takeaways
- Additional slides (beyond what we cover today)
  - Principles for grid modernization (MN PUC)
  - Electric grid planning activities
  - Integrated planning considerations
  - Resources for more information - technical assistance for states and publications

Increasing state engagement in distribution planning

State drivers for improved distribution planning

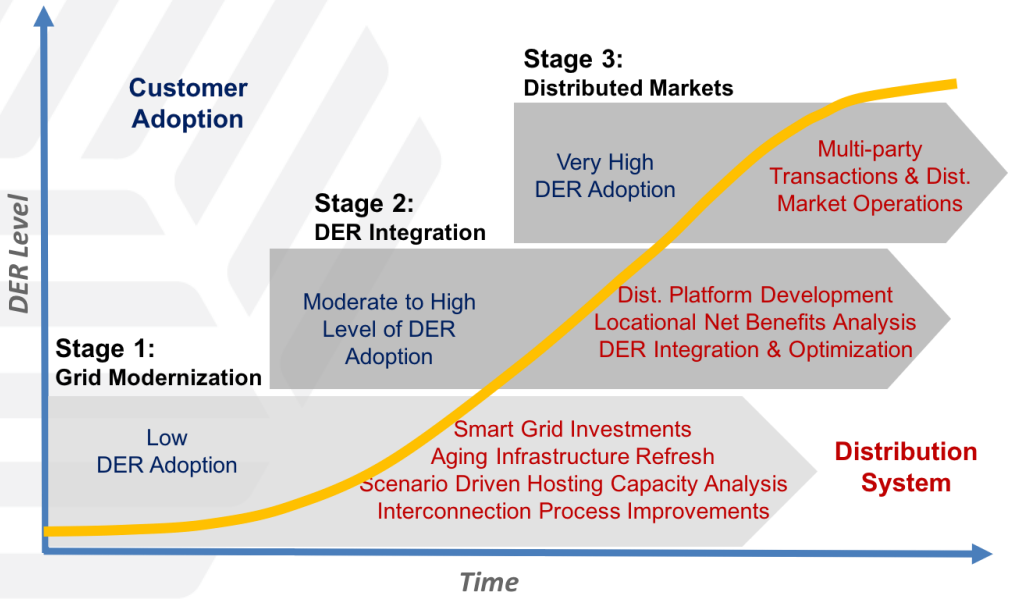
- More distributed energy resources (DERs) due to:
  - Cost reductions
  - Public policies
  - Third-party providers
  - Consumer interest in control over energy costs and sources
- Resiliency and reliability
- More data and better tools to analyze data
- Aging grid infrastructure and proposals for grid investments
- Need for greater grid flexibility with high levels of wind and solar
- Interest in distribution efficiency improvements
  - Conservation Voltage Reduction and Volt/VAR Optimization
- Pilots demonstrating cases where alternatives to traditional distribution solutions provide net benefits to customers



DOE, Revolution Now

State benefits from improved distribution planning

- Makes transparent utility distribution system investments before showing up individually in rider or rate case
- Provides opportunities for meaningful PUC and stakeholder engagement
  - Can improve outcomes
- 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 third parties to propose grid solutions and participate in providing grid services



Graph from DeMartini and Kristov, for Berkeley Lab (see "Publications")

Some considerations for establishing a regulatory process for distribution planning

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- Statutory requirements, regulatory precedents
- Priorities, phasing, related proceedings
- What's worked elsewhere, tailored to your state
- Recognize differences across utilities
- Regulatory clarity with flexibility built-in
- Quick wins, early benefits for consumers
- Long-term, cohesive view to achieve goals
- Pilots vs. full-scale approaches (including economy of scale, rate impacts)
- Utility distribution investments are large
  - $32B nationally among Edison Electric Institute members in 2016

States are advancing distribution system planning in a variety of ways.

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- Requirements for utilities to file distribution system/grid modernization plans with stakeholder engagement (e.g., NY, CA, MA)
- Ad hoc directive to file a distribution system plan (e.g., MI, MD)
- Requirements to conduct hosting capacity analysis (e.g., MN, CA, NY)
- Consideration of cost-effective non-wires alternatives (e.g., NY, CA)
- Locational net benefits analysis for DERs (e.g., NY, CA)
- Investigations into DER procurement strategies (e.g., HI, NY, CA)
- Requirements for utilities to report regularly on poor-performing circuits and propose investments (e.g., PA)
- Storm hardening and undergrounding requirements (e.g., FL)
- Reliability codes and annual compliance reports (e.g., OH, IL)
- Smart grid reporting (e.g., OR, WA)

Possible places to start

- *Take early integration steps* - Consistency in inputs (e.g., assumptions, forecasts), scenarios and modeling methods — updated in time — across distribution planning, transmission planning and integrated resource planning (IRP, in vertically integrated states)
- *Account for all resources* – Consider energy efficiency, demand response (including direct load control, smart thermostats and time-varying pricing), distributed generation and energy storage, alongside traditional distribution solutions
- *Specify DER attributes* – In order to meet identified needs
- *Test new sourcing and pricing methods* – e.g., competitive solicitations, tariffs, programs
- *Analyze multiple possible futures* – e.g., loads, DERs, markets

Possible places to start - 2

- *Phase in hosting capacity analysis* – To facilitate distributed generation integration and indicate better or more difficult locations
- *Pilot evaluation of locational impacts* – Identify where DERs might offer greatest benefits
- *Plan integration of utility systems in advance* – Specify how any proposed investments (e.g., advanced metering infrastructure, automated distribution management systems) will be used with other systems, in distribution planning and for the benefit of consumers.
- *Education and training* – You are doing that right now!

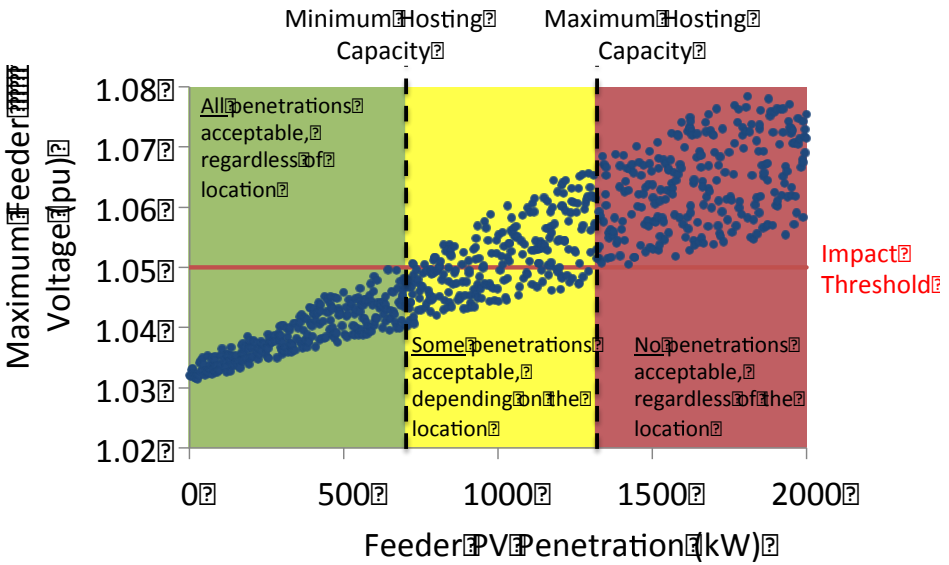

Figure adapted by Berkeley Lab from EPRI (2015), *Distribution Feeder Hosting Capacity: What Matters When Planning for DER?*

Survey of states *outside* New England

States advancing distribution planning

- **New York** – Reforming the Energy Vision
  - Utilities filing Distribution System Implementation Plans with stakeholder engagement
  - Expansion of non-wires alternatives (NWAs)
    - Brooklyn and Queens Demand Management project ($200M) enabled $1.2B deferral of traditional network upgrades (41 MW customer-side, 11 MW utility-side)
    - Focusing on NWA suitability criteria - Utilities incorporating NWA criteria into transmission and distribution capital planning – Must routinely identify projects that are candidates for NWA solutions (load relief, reliability, etc.) and post to websites with information including timing
    - Issue requests for proposals for NWAs

States advancing distribution planning - 2

NY, cont.

- Value Stack tariff
  - Demand relief values being calculated and location-specific relief value zones identified
  - Payments to be made to DER projects based on energy, capacity, environmental, demand reduction and locational system relief value
  - Future:
    - Hosting capacity maps for all circuits ≥12 kV by 10/1/17
    - Updated marginal cost of service studies
    - Interconnection portal online for developers
    - Two energy storage projects per utility required by end of 2018

States advancing distribution planning - 3

► California

- AB 327 and PUC order on distribution planning
- Distribution Resource Plans
  - *Locational Net Benefits Analysis* - Specify net benefits DERs can provide at any given location, using E3's Distributed Resource Avoided Cost Calculator as framework for system-level values and PUC-required, location-specific methods for avoided T&D costs
  - *Integration Capacity Analysis* – "Streamlined" hosting capacity analysis to identify how much generation can be installed on a line section w/o distribution upgrades. 9 functional requirements for demos
  - DER Adoption and Distribution Load Forecasting methodology
  - Grid Modernization Investment Guidance (staff whitepaper)
  - Distribution Investment Deferral to establish annual process for third party-owned DERs to defer or avoid traditional capital investments in distribution systems
- Demo projects: Integrated capacity analysis, locational benefits (2), distribution operations with high DERs and microgrids

States advancing distribution planning - 4

CA, cont.

- Utility incentive mechanism pilot for DERs – Utilities earn 4% on customer or third-party DER projects that cost-effectively defer distribution system investments; Pilot - one to four projects each IOU
  - Also addresses cost effectiveness framework
- Integrated Resource Planning rulemaking to set GHG targets for load serving entities; CPUC staff to do initial modeling
- SCE Grid Modernization Plan – As part of 2018 rate case SCE proposed $1.9 billion to modernize grid for DERs; Commission decision Jan 2018
- Report on improving T&D coordination for high DERs from More Than Smart, CAISO, PG&E, SCE, SDG&E
- Energy storage mandate (AB 2514) - target of 1,350 MW of energy storage by 2020

States advancing distribution planning - 5

► Hawaii

- Clean Energy Initiative
  - 100% RPS by 2045
  - Reducing electricity consumption by 4,300 GWh by 2030, enough electricity to power every home for more than two years
- High penetration levels of distributed solar PV and isolated island grids
- Investigations into DERs including procurement
  - No more net metering – three new tariff options:
    - Customer self-supply
    - Customer grid-supply (Smart Export tariff)
    - Time-of-use tariff
- HPUC rejected piecemeal investment proposals and required HECO to file a comprehensive Grid Modernization Plan
- Demand response tariffs in process that will provide capacity, fast frequency response, regulating reserves and replacement reserves
- PUC inclinations on future of utilities
- Study on alternative utility and regulatory models underway. Contractor selected by HI Energy Office; report due December 2018

States advancing distribution planning - 6

- **DC** – Modernizing the Energy Delivery System, staff report issued in Jan 2017 included two draft NOPRs for Commission to consider
- **WA** – Rulemaking considering resource planning changes: consideration of DERs including energy storage; distribution system modeling; RFP, avoided costs; smart grid reporting (with sunset of current reporting requirements)
- **OR** – Utilities must submit smart grid implementation plans biennially and annually report on projected construction budgets for T&D projects >$10 million; staff proposed Commission open investigation to adopt process for distribution system planning (5- to 10-year planning horizon)

States advancing distribution planning - 7

► Minnesota

- Biennial Distribution Grid Modernization Reports (Minn. Stat. §216B.2425)
  - ◆ Utility identifies projects it considers necessary to modernize its T&D systems
  - ◆ May ask Commission to certify grid modernization projects as priority projects, a requirement for utility to recover costs through a rider (outside of a general rate case)
  - ◆ Distribution study to identify interconnection points for small-scale distributed generation (DG) and distribution system upgrades to support continued DG development; no formal Commission action required
- Xcel Energy filed 1st Biennial Distribution Grid Modernization Report in 2015 (Docket No. E-002/M-15-962)
  - Commission order certified an advanced distribution management system (ADMS) and required initial hosting capacity analysis by 12/1/16 — analysis of each feeder for DG ≤1 MW and potential distribution upgrades necessary to support expected DG (based on utility's IRP filings and Community Solar Gardens process)
  - Staff issued briefing papers on 1st hosting capacity analysis filed by Xcel Energy
  - Commission decision requires hosting capacity analyses Nov. 1 each year and provides guidance for next analysis: reliable estimates and maps of available hosting capacity at feeder level; details to inform distribution planning and upgrades needed for efficient DG integration; detailed information on data, modeling assumptions and methodologies

States advancing distribution planning - 8

MN, cont.

- PUC initiated inquiry in May 2015 on Electric Utility Grid Modernization with a focus on distribution planning (Docket No. CI-15-556)
  - Series of stakeholder meetings that continued through fall 2016
  - DOE sponsored a consultant report on integrated distribution system planning for MN
  - Questionnaire on utility planning practices with stakeholder comments and responses
    - How do Minnesota utilities currently plan their distribution systems?
    - What is the status of each utility's current plan?
    - Are there ways to improve or augment utility planning processes?
- Staff Report on Grid Modernization (March 2016)
  - Tees up 3 questions
    - Are we planning for and investing in the distribution system we will need in the future?
    - Are planning processes aligned to ensure future reliability, efficient use of resources, maximize customer benefits and successful implementation of public policy?
    - What commission actions would support improved alignment of planning and investment?
  - Proposes principles for grid modernization (see "Additional slides")

More state approaches to distribution planning

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- **Colorado**
  - PUC approved an unopposed settlement agreement on Xcel Energy's grid modernization proposal, including Advanced Metering Infrastructure (AMI), Integrated Volt-VAr Optimization Infrastructure and associated components of an advanced communications network, including a Field Area Network and Home Area Network

- **Pennsylvania**
  - Utilities can propose a Distribution System Improvement Charge to recover reasonable and prudent costs to repair, improve or replace certain eligible distribution property by filing Long Term Infrastructure Improvement Plans
    - e.g., see FirstEnergy LTIIP
  - Distribution reliability code directs PSC to regulate distribution inspection & maintenance plans, requires utilities to report quarterly on worst-performing circuits and make annual compliance filings (see 2016 PA reliability report)

More state approaches to distribution planning - 2

GRID MODERNIZATION LABORATORY CONSORTIUM
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- **Illinois**
  - Utilities file annual reliability reports, ICC assesses utility report ≤3 years
  - Energy Infrastructure Modernization Act authorized investment plans for grid hardening and smart meters
    - Utilities file annual Grid Modernization Action Plans with formula rates for ICC approval — e.g., see ICC order on 2016 Ameren plan
  - ICC kicked off NextGrid initiative in March 2017, a consumer-focused study on topics such as leveraging Illinois' restructured energy market, investment in smart grid technology, and recent law expanding renewables and efficiency
    - ICC resolution invited stakeholders to comment on an independent facilitator and topics to be considered as part of the initiative
    - Series of workshops to kick off 18-month process
- **Indiana**
  - In February 2017, Southern Indiana Gas & Electric filed a $500 million, 7-yr T&D modernization plan including AMI, distribution automation, and advanced distribution management system (ADMS)

More state approaches to distribution planning - 3

GRID MODERNIZATION LABORATORY CONSORTIUM
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- **Maryland**
  - Distribution planning is one of six topics* addressed in PC 44 - Transforming Maryland's Electric Grid proceeding.
    - RFP for consultant to study benefits & costs of distributed solar in IOUs' service areas
  - Orders in Case No. 9406 (BGE rate case) and Case No. 9418 (Pepco rate case) require a five-year distribution investment plan within 12 months
    - BGE distribution investment plan filed; Pepco plan forthcoming
- **Michigan**
  - PSC ordered utilities (Consumers Energy - Case No. U-17990 and DTE Electric - Case No. U-18014) to file draft 5-yr distribution investment & maintenance plans "to increase visibility into the needs of maintaining the state's system and to obtain a more thorough understanding of anticipated needs, priorities, and spending."
  - DTE Electric and Consumers Energy filed plans; comments were due 9/6/17
  - Utilities to address "electric distribution system conditions, including equipment age and useful life; system goals and related reliability metrics; local system load forecasts; and maintenance and upgrade plans"

*Other topics: rate design, EVs, competitive markets/customer choice, interconnection process and energy storage

More state approaches to distribution planning - 4

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- **Ohio**
  - PUCO's PowerForward initiative is reviewing technological and regulatory innovation that could enhance the consumer electricity experience.
    - Workshops with industry experts "to chart a path forward for future grid modernization projects, innovative regulations and forward-thinking policies"
  - Duke's electric security plan includes a rider for "new offerings designed to advance programs, services, and initiatives reflective of … PowerForward"
  - AEP's amended electric security plan includes installation of EV charging stations, microgrids and smart lighting controls
  - FirstEnergy – PUCO approved Distribution Modernization Rider (3/31/16; $132.5M/yr for 3 yr); Grid Modernization Business Plan filed 2/29/16 includes 3 scenarios with full deployment of AMI and ADMS, plus Distribution Automation and Integrated Volt/VAR Control to varying degrees
  - Distribution system reliability code, distribution circuit performance codes and annual reliability compliance filings

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Conclusion

Some takeaways

- Most states have not yet begun to directly engage in longer-term (5- to 10-year) utility distribution system planning. And states further down the path are still early in the process.
  - Approaches range from a cohesive set of requirements to an order in a utility rate case
- Some PUC distribution planning processes are tied to greater utility assurance of cost recovery for distribution investments that are included in approved plans.
- Beyond universal interest in affordability and reliability, common state drivers for a state distribution system planning process include improving system efficiency, enabling greater consumer engagement, and integrating DERs.
- Common *emerging* distribution system planning elements include DER forecasting, DER locational value, hosting capacity analysis, and engaging stakeholders (including third-party service providers) to help identify solutions.
- Some states are taking steps toward: 1) including non-wires alternatives in distribution planning and competitive procurements to meet certain grid needs and 2) modifying utilities' annual capital planning process to account for DER options.
- Integration of distribution planning with demand-side management planning, integrated resource planning and transmission planning is nascent.

Additional slides

Minnesota staff – Principles for grid modernization

- Maintain and enhance the safety, security, reliability, and resilience of the electricity grid, at fair and reasonable costs, consistent with the state's energy policies
- Enable greater customer engagement, empowerment, and options for energy services
- Move toward the creation of efficient, cost-effective, accessible grid platforms for new products, new services, and opportunities for adoption of new distributed technologies
- Ensure optimized utilization of electricity grid assets and resources to minimize total system costs
- Facilitate comprehensive, coordinated, transparent, integrated distribution system planning

Staff Report on Grid Modernization, March 2016

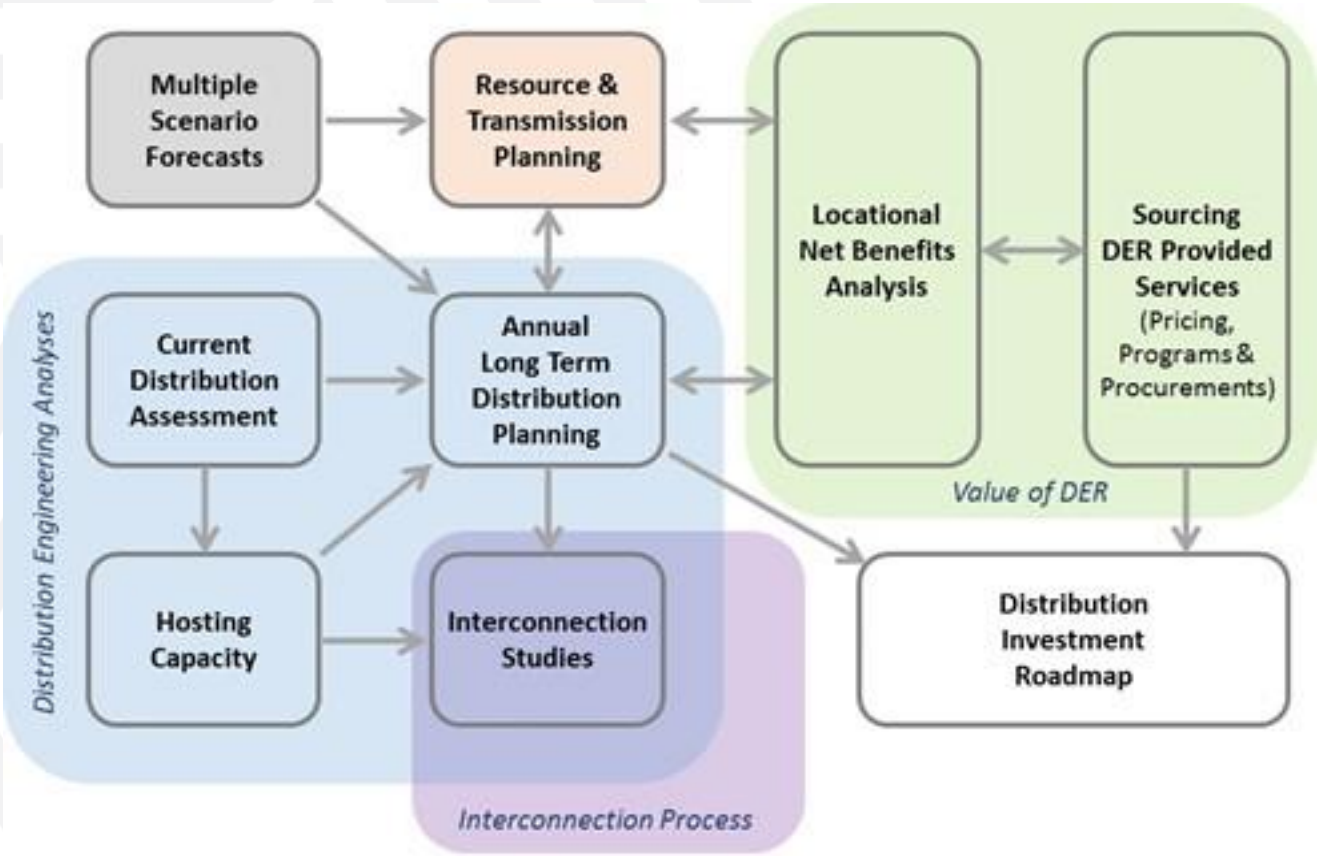
Electric grid planning activities

- *Distribution planning* is focused on assessing needed physical and operational changes to local grid.
  - Can support DER growth and net benefits for all
- *Integrated resource planning* (in vertically integrated states) is focused on identifying future investments to meet bulk power system reliability and public policy objectives at a reasonable cost.
  - Can consider scenarios for DERs and impacts on need for, and timing, of utility investments
- *Transmission planning* is focused on identifying future transmission expansion needs and options for meeting those needs.
  - Can begin anticipating operational challenges at transmission-distribution interface* and solutions

**Boundary between wholesale & retail markets; between meshed high-voltage network & radial, lower-voltage feeders; and between federal & state regulatory jurisdiction*

Integrated planning considerations

Integrated planning and analysis within and across the transmission, distribution and customer/3rd party domains



From *Integrated Distribution Planning* (see "Publications")

Resources for more information

Technical assistance for states

- DOE's Solar Energy Technologies Office, in partnership with Berkeley Lab, Pacific Northwest National Laboratory and National Renewable Energy Laboratory, recently launched a three-year analytical support program for PUCs on topics related to distribution utility planning and regulatory, policy, programmatic and technology assessments of DERs. Applications for year 1 selected this month (September 2017); the next round of support will begin in about a year.
- Berkeley Lab's Electricity Markets and Policy Group provides independent and unbiased technical assistance to state utility regulatory commissions, state energy offices, tribes and regional entities in these areas:
  - Energy efficiency (e.g., financing, EM&V, utility programs, behavior-based approaches, cost-effectiveness, administrative options, program planning and design, cost recovery)
  - Renewable energy resources
  - Demand response (e.g., time-varying pricing), smart grid and grid modernization
  - Utility regulation and business models (e.g., financial impacts to utility and utility customers)
  - Transmission and reliability, resource planning

Publications for more information

- U.S. Department of Energy's (DOE) Modern Distribution Grid initiative and report (www.doe-dspx.org)
  - Volume I: Customer and State Policy Driven Functionality
  - Volume II: Advanced Technology Market Assessment
  - Volume III: Decision Guide
- *Integrated Distribution Planning*, by Paul De Martini, ICF, for the Minnesota Public Utilities Commission, August 2016
- *Summary of Electric Distribution System Analyses with a Focus on DERs*, by Y. Tang, J.S. Homer, T.E. McDermott, M. Coddington, B. Sigrin, B. Mather, Pacific Northwest National Laboratory and National Renewable Energy Laboratory, April 2017
- JS Homer, Lisa Schwartz, AL Cooke, Greg Leventis and Francisco Flores-Espino, *State Engagement in Electric Distribution Planning* (forthcoming), Pacific Northwest National Laboratory, Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory
- Berkeley Lab's Future Electric Utility Regulation report series — in particular:
  - *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*, by Paul De Martini (Cal Tech) and Lorenzo Kristov (CAISO)
  - *The Future of Electricity Resource Planning*, by Fredrich Kahrl (E3), Andrew Mills (Berkeley Lab), Luke Lavin, Nancy Ryan and Arne Olsen (E3)
  - *Value-Added Electricity Services: New Roles for Utilities and Third-Party Providers* (forthcoming), by Jonathan Blansfied and Lisa Wood, Institute for Electric Innovation; Ryan Katofsky, Benjamin Stafford and Danny Waggoner, Advanced Energy Economy; and National Association of State Utility Consumer Advocates

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