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National Association of Regulatory Utility Commissioners

National Council on Electricity Policy

Compendium of Resources for State Electricity Policy Officials: Evolving Transmission & Distribution Intersections

NATIONAL COUNCIL ON ELECTRICITY POLICY

Resources Identified at NCEP Annual Meeting and Workshop, May 8-9, 2018

As investment in customer-sited energy technologies, products, and activities is growing, energy decision makers at local, state, and regional levels are foreseeing that their decisions will affect how the grid operates at customer locations, across the distribution system, and into the transmission system. These technologies and decisions have effects along the full spectrum of planning, operations, and markets of both the transmission and distribution grid. However, the intersection points of these systems are not fully understood, as technologies and processes are evolving all the time.

NCEP hosted a well-attended annual meeting and workshop in May 2018 to explore the evolution and effect of distributed energy resources (DERs) on the transmission and distribution systems in the context of planning, operations, and markets at the state level. State electricity decision makers discussed DERs such as energy efficiency, distributed generation [e.g., solar photovoltaic (PV) systems], energy storage, demand response, electric vehicles, and more.

During the workshop, participants offered examples of projects and decisions from across the country that help illustrate how the interactions between transmission and distribution might evolve. Participants also provided helpful resources and references, and facilitators documented questions and research that still need to be addressed. These valuable insights can help guide state decision-makers and provide a research agenda for the broader energy community.

Topics addressed included:

- Transmission planning that incorporates non-wires solutions
- Distribution-level grid services that also support the transmission and bulk power systems
- Valuating the grid: how benefits are allocated and how services are measured
- Support for, and recognition of, customer needs and expectations
- Reliability and resiliency on the transmission and distribution systems

This compendium of resources documents all of the examples of projects and policies, resources and references, and lingering questions and research needs that participants articulated at the May 2018 NCEP Annual Meeting and Workshop. Readers will find brief bullets and hyperlinks to the source materials. Inclusion in this compendium should not be construed as an endorsement of the source or of the contents therein by NCEP. All referenced materials are included in this document.

In late 2018, NCEP will publish a "State of Transmission & Distribution System Intersections" paper on these topics, which will provide additional context, synthesize lessons learned, and match state electricity policymaker questions with resources while refining the list of needed research.

To submit a request to include an additional resource, please send the name of the resource, publishing date, hyperlink, and where it belongs in the compendium to resources@naruc.org.

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Planning for a More Integrated Grid

Careful planning of new transmission and distribution infrastructure is critical for the successful integration of distributed energy resources (DERs). Several pilot projects and policy approaches have been used to support planning of Transmission and Distribution (T&D) infrastructure in light of increasing penetration of DERs.

Planning: Example Approaches, Policies, and Pilot Projects

1. Planning Approaches

- Non-Wires Alternatives (NWA) suitability criteria
  - > For insight into how suitability criteria fit into the planning process for NWA, see ICF blogpost outlining key issues in certain states.
  - > New York. Distribution System Planning Engagement Group, Summary of Stakeholder Engagement Group Meetings on NWA Suitability, July 2016
  - > Rhode Island. Acadia Center's Distribution System Planning Engagement Group, NWA Suitability Criteria, June 2016
- New York Independent System Operator (ISO) – NYISO DER Roadmap, January 2017
  - > Roadmap includes general policy advice to consider energy efficiency (EE) measures before sizing and installing any DERs
- California ISO 2017-18 Transmission Plan. Oakland project to eliminate gas peaking power plants in a constrained area without building transmission (p. 128)
  - > See also *PV Magazine* article analyzing the project
- Xcel Energy Colorado's Grid Modernization project "Advanced Grid Intelligence and Security" (AGIS). Application and filing documentation, and the *Denver Post's* June 2017 article about potential pitfalls

2. Policy Approaches

- Maryland's approach to time-varying rates includes default application of peak-time rebate. Maryland Public Service Commission (PSC) approval, May 2018
- Electric Reliability Council of Texas' (ERCOT) approach to market settlement on an hourly, customer-specific basis down to the residential class. ERCOT Concept Paper on Distributed Energy Resources in the ERCOT Region, August 2015
- Hawaii, Rhode Island, and Minnesota are leading on performance-based regulation (PBR) – See Forbes, America's Utility Of The Future Forms Around Performance-Based Regulation, May 2018. Other states are also exploring PBR, including N.Y., Pa., Mass., and R.I.
- Using seasonal capacity markets and smart meters as a means for residential air-conditioning load control

3. Pilot Projects

- Xcel (Minnesota) Time-of-Use (TOU) Pilot:
  - > Xcel's filing with Minnesota Public Utility Commission, November 2017
  - > *Star Tribune*, outlining the project and its impacts after its approval, May 2018
  - > *Utility Dive's* insights on this rate design, December 2017
- Brooklyn-Queens Demand Management Project. ConEd, Implementation and Outreach Plan, January 2018
- Great River Energy (MN cooperative utility) utility-controlled water heater demand response pilot. Great River Energy, 2018-2032 Integrated Resource Plan, April 2017
- Applied Integrated Grid Planning (IGP) in Hawaii. Hawaiian Electric Company filing of Integrated Grid Planning in 2017;, Planning Hawaii's Grid For Future Generations, March 2018
- San Diego Gas and Electric (SDGE) Borrego Springs Project using microgrids instead of new transmission. SDGE, http://newsroom.sdge.com/reliable/borrego-springs%E2%80%99-claim-energy-fame-microgrid-enhances-reliability, January 2018 and Microgrids at Berkeley Lab

Planning Resources and References

1. Regional Transmission Organizations (RTOs) and Multi-State Resources

- California ISO (CAISO) Model for DER Aggregation
  - > Distributed Energy Resource Provider (DERP) program approved by the Federal Energy Regulatory Commission (FERC) in 2016
  - > CAISO comments to FERC Storage/DER notice of proposed rulemaking (NOPR) filed February 2017
- Organization of MISO States (OMS). OMS Approach on Distributed Energy Resources, June 2017
- NYISO. NYISO DER study, August 2014

2. U.S. Department of Energy (DOE) National Labs

- DOE Next Generation Distribution Grid (DSPx) Project. Pacific Northwest National Laboratory (PNNL) Grid Architecture: visibility, measurement, metering strategies
  - > Modern Distribution Grid, Volume I: Customer and State Policy Driven Functionality, March 2017
  - > Summary of Electric Distribution System Analyses with a Focus on DERs, April 2017
  - > Tutorial and Advanced Concepts for Architecture of Electric Power Grids, 2018
- Lawrence Berkeley National Laboratory (Berkeley Lab or LBNL). Distribution Systems in a High Distributed Energy Resources Future, October 2015
- PNNL and Berkeley Lab Distribution Systems and DERs Research. Distribution System Planning – State Examples by Topic – PNNL-27366,, May 2018
- Sandia National Labs Fact Sheet, The Grid Analysis and Design for Energy Infrastructure Resilience in New Orleans, June 2017

3. Non-Governmental Organization (NGO) Papers

- GridLab, Integrated Distribution Planning: A Path Forward, 2018
- Center for Renewables Integration, Alternative Transmission Solutions: A Roadmap to the CAISO Transmission Planning Process, March 2018
- Quantifying DERs for Air Quality Attainment – American Council for an Energy Efficient Economy (ACEEE), Obtaining Credit for Energy Efficiency Policies and Programs in a State Implementation Plan, 2013

4. Related NCEP Workshop Presentations (May 2018)

- The Grid Revolution Underway: National Perspectives
  - > Juliet Homer, Pacific Northwest National Laboratory, How and Where Distributed Energy Resources Impact Transmission and Distribution and Who Is Doing What About It
  - > David Kathan, FERC, Commission Actions on the Participation of Storage and Distributed Energy Resources in Organized Wholesale Electricity Markets
  - > Larry Mansueti, DOE, Office of Electricity Delivery and Energy Reliability, DOE Initiatives on the Intersections of the Transmission and Distribution Grids
- Planning for Distribution-Level Services that Support the Transmission System
  - > Steve Rourke, Independent System Operator New England (ISO-NE), How Distributed Energy Resources Are Impacting the New England Power System
- Regional Transmission Planning that Incorporates Non-Wires Solutions on the Distribution System
  - > Honorable Bruce Williamson, Maine Public Utility Commission, Non-Wires Alternatives at Boothbay Harbor
  - > Ryan Fedie, Bonneville Power Authority (BPA), Deferring Transmission System Expansion

Lingering Questions and Research Needs for Planning

1. Foundational Questions

- How will the policies and approaches differ in RTO/ISO versus non-RTO/non-ISO markets?
- How much should utilities spend on grid improvements versus better management?
- What is the role of utilities in the penetration and operation of DERs compared to third parties?

2. Coordination Questions

- What exactly are we talking about for DER planning: Is it looking for areas that need utility-owned solutions, like NWA, or to understand how DERs (behind the meter) operate on the grid?
- Are DER plans designed to identify where DER (behind-the-meter) solutions are needed? And if so, how do you convince consumers to install and operate what the utility needs?
- How do investor-owned utilities (IOUs) effectively incorporate transmission and distribution planning in their integrated resource plans (IRPs) in light of rapidly increasing DERs? What are reasonable benchmark scenarios for DER forecasts?
  - > Included in IRPs

- What are municipalities doing (municipally owned cooperatives) and rural electric cooperatives to coordinate distribution system planning, IRPs, and transmission planning to optimize DERs and other investments?
  - > For example, in Washington, the Washington State Legislature regulates 61 utilities, including IOUs and cooperatives.
- How can coordination frameworks between transmission system operators (TSOs) and distribution system operators (DSOs) be improved?
- How can states create processes to enable local (city-level) planning to reduce carbon emissions, electricity use, and better interface with utility and joint planning?
- Are there safe places for jurisdictional lines or do we need to open the Federal Power Act for potential amendments?

3. Impact Questions

- With so much new technology on the electric system, who is ultimately held responsible for a major system problem (e.g., when a major outage occurs)?
- How can we quantify the multiple benefits and costs of DERs?
- How are the benefits for consumers identified and secured?
  - > What if the benefits do not materialize for all customers and all classes of customers?
- As DERs increase, is there concern about voltage control/system stability as thermal resources are reduced?
- What is the value of resilience and what does it mean?
- How can price-responsive demand be better reflected in forecasting and operations?
- What are the utility planning effects of customer voluntary actions to reduce usage and greenhouse gases (e.g., net-zero energy buildings and architecture 2030 districts)?
- What does transactional power do to rate design?
- What is the overall impact of plug-in and hybrid electric vehicles (EVs) on the system? (e.g., When and where do customers charge their vehicles? How does lack of information affect planning? At what speed and when should states push DERs? Where is the return and what level is the return?)

Evolving Grid Operations

Transmission and distribution grid operations are critical to the safety, reliability, and efficiency of electricity delivery. In a growing DER environment, distribution operators and RTOs do not have consistent visibility and situational awareness of the location, status, and output of DERs. In the future, T&D operators will need to establish and/or improve coordination and communication with each other in new ways to maintain reliable operation of their respective systems, and with the electric system as a whole.

Operations: Example Policies and Pilot Projects

1. Enhanced Visibility and Coordination

- Interconnection and smart Inverters
  - > Smart Inverter Standards. Smart Energy Consumer Collaborative explanation of standards, October 2015
  - > California Rule 21 on smart inverters. California Public Utility Commission's Smart Inverter Working Group (2015-2017)
  - > IEEE 1547 interconnection standard (updated 2018), which will require state public utility commission actions to adopt and enable new capabilities for smart inverters. IEEE 1547 Standard and Conformity Assessment, April 2015
  - > ISO New England and New England states' agreement on enhanced interconnection standards for solar PV. This approach is under discussion with PJM Interconnection, Minnesota, and the Electric Power Research Institute (EPRI). ISO-NE, Earth Day 2018: Setting regional solar and wind power records in New England, April 2018
  - > Update of federal Small Generator Interconnection Standards, 2016
- Large Customer Detection
  - > NV Energy and Casinos. Many casinos have cancelled their accounts with NV Energy and opted for the open market. *Nevada Independent*, Station Casinos, Biofuels Company Apply to Leave NV Energy, June 2018
  - > Microsoft and Puget Sound Energy. Washington Utilities and Transportation Commission (WUTC) allowed Microsoft to largely enter the wholesale market to meet its sustainability goals. *Geekwire*, Microsoft and Puget Sound Energy get OK for clean-energy deal to help power software giant's campus, July 2017; WUTC, State regulators green light Microsoft-PSE renewable energy contract, July 2017
- Operational Efficiencies
  - > Water/wastewater treatment and distribution consumes a large amount of energy. See the Minnesota Division of Energy Resources' competitive grant project on best practices for energy efficiency at wastewater treatment plants with potential for distributed generation.

2. Resilience

- CenterPoint Energy (Tex.) affected by Hurricane Ike in 2008 and Hurricane Harvey in 2017 had fast recovery due to extensive use of advanced metering infrastructure (AMI) to identify outage locations - CenterPoint Energy, Texas Strong: Hurricane Harvey Response and Restoration, February 2018
- Work with communities to identify critical use facilities is important for prioritization. For example, see Better Buildings' Combined Heat and Power for Resiliency, 2018
- Florida Power & Light (FPL) monthly hurricane training. How We Prepare and First responders, along with state and national stakeholders, join FPL for its annual storm drill, May 2018
- DOE's US Energy Sector Vulnerabilities and Resilience Solutions Reports, 2018

Operations Resources and References

1. DER Operations References

- More Than Smart and CAISO, Coordination of Transmission and Distribution Operations in a High Distributed Energy Resource Electric Grid, June 2017
- FERC Staff Report, DER Technical Considerations for the Bulk Power System February 2018, Docket AD18.10.000
- CPUC's Smart Inverter Working Group

2. Transmission Operations

- Smart Grid.gov Cost and Benefits of Conservation Voltage Reduction (CVR) Warrants Careful Examination, May 2014
- Dynamic line rating systems to maximize utilization of existing transmission. Idaho National Lab (INL), Helping Operators Implement Line Rating, 2018

3. Resilience

- ACEEE Report on Combined Heat and Power (CHP) and Resilience – proposes a metric to value the resiliency attributes of DERs. Valuing Distributed Energy Resources: Combined Heat and Power and the Modern Grid, April 2018
- Electric Infrastructure Security (EIS) Council handbooks are a good resource for studying interdependencies
- Value of Service Reliability – Willingness to Pay. Joe Eto, Berkeley Lab, How to Estimate the Value of Service Reliability Improvements
- North American Electric Reliability Corporation (NERC) and FERC – Arizona-Southern California Outages on September 8, 2011: Causes and Recommendations, April 2012
- Federal Emergency Management Agency (FEMA)
- National Emergency Management Association (NEMA)
- National Hurricane Center in Miami
- Louisiana Governor's Office of Homeland Security
- Book by Ted Lewis *Critical Infrastructure Protection in Homeland Security* (2006)
- NERC, Grid Security Exercise (GridEx) IV Lessons Learned (cyber and physical attacks), March 2018

4. Related NCEP Workshop Presentations (May 2018)

- Evolving Transmission & Distribution System Operations: Examples of Enhanced Visibility, Coordination, and Communications
  - > Matthew Tisdale, Gridworks, Coordination of Transmission And Distribution Operations In A High Distributed Energy Resource Electric Grid
  - > Samantha Ruiz, Hawaii Public Service Commission, Evolving Transmission and Distribution System Operations: A Hawai'i Snapshot
- Enhancing Transmission and Distribution System Interface for Resilience Benefits
  - > Mary-Anna Holden, New Jersey Board of Public Utilities, Presentation on Resiliency and Transmission Reliability Issues
  - > Tom Walker, New Jersey Board of Public Utilities, Transmission and Distribution Interface for Resilience
  - > Jeff Bladen, Midcontinent Independent System Operator (MISO), Presentation on MISO's Efforts on Resiliency

Lingering Questions and Research Needs about Operations

1. Data for Operators

- How will the vast amounts of data (real-time and after-the-fact) from DERs be collected and transmitted to support:
  - > Real-time operations;
  - > Operations forecasting; and
  - > Wholesale market performance assessments and settlement?

2. Reliability and Resilience

- What do customers want more: reliability or resilience? Is it more important to have fewer outages or shorter outages?
- Common framework needed for how to value reliability and resilience of DERs
- Research is needed for customer "willingness to pay" for reliability improvements
- How do you enable a safe way to let a rooftop solar building operate when there's a power outage? (For example, "islanding" is not allowed in Nevada; customers have been upset that they lost power in an outage even though they have solar on their roofs.)
- What is the value of demand-side management (DSM) in terms of reliability and resilience?

The Potential for Markets

Increased adoption of a range of DER technologies has the potential to change or activate markets within both the transmission and distribution systems. Key to exploring this potential is understanding the benefits and services DERs provide; how utilities, distribution grid operators, and transmission operators value those services; and ultimately working out how and who will transact for these services.

Markets: Example Projects and Policies

1. DER Projects and Analyses

- California's Locational Net Benefits Analysis (LNBA), resulting from years of service and locational value.
  - > CPUC establishing filing, May 2016
  - > Working Group Reports
- CAISO Energy Storage and Distributed Energy Resources (ESDER): Three-phase plan initiative. Status of phases and other CAISO ESDER documentation
- CAISO Distributed Energy Resource Provider (DERP) allows for aggregation of DERs to participate in the market. CAISO DERP webpage
- Sacramento Municipal Utility District (SMUD) Smart Sacramento DOE OE0000214 Project - Visualization of smart grid using situational intelligence software. SMUD Visualizes Smart Grid With Space-Time Insight's Situational Intelligence Software, June 2013
- SMUD customer resistance to smart metering and TOU charges resulted in SMUD including an opt-out clause, but related fees to switch back to analog meters resulted in a dismissed lawsuit in 2016. *Sacramento Bee*, "Judge dismisses lawsuit by man who says SMUD smart meters are health hazard," October 2016
- Connexus Energy (Minnesota) and Dakota Electric Solar PV plus storage projects promising 10 MW PV/15-20 MWh storage
  - > Energy News, Minnesota co-op plans state's biggest energy storage project, July 2017
  - > Solar Industry, Minnesota Co-op Issues Solar and Storage RFP, January 2018
- Puget Sound Energy advanced metering infrastructure (AMI) and time of use (TOU) rates. *Utility Dive*, "As grid modernization accelerates, which states are in the lead, and why?," December 2017

2. Policies

- Hawaii SB2939. Distributed Utility Compensation Reform
- *Utility Dive*, "Have California's efforts to value distributed resources hit a roadblock?," March 2017

Market Resources and References

1. Valuing DERs

- Analysis Group, The Value of "DER to "D": The Role of Distributed Energy Resources in Supporting Local Electric Distribution System Reliability, March 2016
- FERC Annual Demand Response (DR) Reports. Docket No, AD18-10-000, February 2018
- Georgia Public Service Commission, Georgia Renewable Cost Framework, December 2016
- NERC DER Analysis. Distributed Energy Resources: Connection Modeling and Reliability Considerations, February 2017
- Gridworks: Sustaining Solar Beyond NEM
- Lawrence Berkeley National Laboratory's Demand Response Advanced Controls

2. Markets for DERs

- Demand Response (DR) Potential Study (Lawrence Berkeley National Lab): Charting California's Demand Response Future, March 2017
- Northwest Conservation Council, Demand Response Advisory Committee
- PricewaterhouseCoopers, The road ahead: Gaining momentum from energy transformation

3. Rate Design

- Gridworks: Sustaining Solar Beyond NEM
- Industry Examples of time of use (TOU) rates. Rocky Mountain Institute (RMI) A Review of Alternative Rate Designs
- RMI - The Economics of Demand Flexibility
- Watch for upcoming Rocky Mountain Institute (RMI) reports on strategic electrification of heating loads and economics of clean energy portfolios (avoiding peaking needs)
- SMUD electrification of electric vehicles (EVs)
  - > See SMUD, 2017 Electric Vehicle Strategy, October 2017
  - > SMUD encouraging EV-owning customers to switch to TOU rates

4. Related NCEP Workshop Presentations (May 2018)

- DER Investments that Are Providing Services to the Transmission & Distribution System
  - > Leia Guccione, Rocky Mountain Institute (RMI), Grid Service Requirements on A Changing Grid
  - > Tom Stanton, National Regulatory Research Institute (NRRI), Weaving the DER Pieces Together in the "Land of Steady Habits"
- The Value of Distributed Energy Resources to the Grid
  - > Kelly Stroup, PJM Interconnection, Distributed Energy Resources in PJM Market Integration Considerations
  - > Lise Trudeau, Minnesota Department of Commerce, "The Value of Solar"
- Tracking Results and Quantifying DER Impacts on the Transmission and Distribution Systems
  - > Rich Hydzik, Avista on behalf of NERC's Essential Reliability Services Working Group and DER Task Force, "DER Connection Modeling and Reliability Considerations"
  - > Grace Relf, ACEEE, "What We Can Learn from Experiences with Energy Efficiency in Regional Markets"

Lingering Questions and Research Needs about Markets

1. Data Needs

- Are DER + EE active or passive?
  - > Do we need to control them or just respond to them?
- What incentives are offered to customers to operate their behind-the-meter DERs in a way that benefits the grid/provides an NWA solution?
- How do you include behind-the-meter DERs in load forecasting? What reliability can you give to behind-the-meter DERs for resource planning?
- How do DERs provide flexibility? What amount of impact do they have?
  - > Load response to price changes
  - > Some studies identify the potential for shifting load with TOU rates, but need to know how much flexibility exists
- What data show that targeted DSM/DR will occur and when and where is it needed to avoid redundant investments?
  - > Need to build confidence for PUCs
- Better information is needed on the EE supply curve for use in IRPs and distribution planning
  - > Bonneville is a resource for 20-year supply curves for both EE and DR.
  - > EPRI has a load shapes database.
  - > Northwest Energy Efficiency Alliance (NEEA) is working on a six-year study and data collection effort to update load shapes.

- Need accurate, robust modeling of performance of storage to learn more about cost-effectiveness and readiness to serve.
- Are there metrics that can be applied systematically across the board to track the services that DERs are providing (or could provide) to the T&D grids? If so, what are they?
- What are the economic impacts of DERs on utilities' service territories?
  - > Often seen as a loss of sale, but there may be relevant economic growth opportunities in the value chain.

2. Other DER Questions

- How do DERs support resiliency on both the T&D systems? Are some more effective than others?
- What are considered appropriate DERs? Would diesel, as stated by PJM, be appropriate because it is a "dirty" fuel?
- Where is EE applied as a first initiative before other DERs are added?
  - > New Jersey is a prime example of this policy
- Utility customer bases are changing the future; how should they respond? (For example, voluntary actions of customers can reduce greenhouse gas emissions, such as Net Zero commitments, 100 percent renewable energy cities, and the 2030 reduction standards)
- What to do when the solution to a reliability issue is located in a different state?
- Can success stories such as the NW Conservation Council be replicated elsewhere?
- When and where will customers charge EVs?
- How do we get utilities more interested in EVs, as they relate to load growth, for example?