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How and Where DERs Impact Transmission and Distribution and Who Is Doing What About It

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Presentation to the National Council on Electricity Policy

May 8, 2018

Agenda

- Basics
- Technology and operations
- Planning
- State-specific policy landscape considerations

Thanks to US DOE* and colleagues who provided insights

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*Both DOE Office of Electricity and Solar Energy Technologies Office

Electricity supply system

- Electricity supply system consists of:
  - Generating facilities that produce electricity
  - Transmission and distribution facilities that move energy from where produced to where used
  - Transmission and distribution systems are connected but they are distinct systems with unique:
    - structures
    - characteristics
    - functions
    - operating principles

Map of Transmission 115-kV

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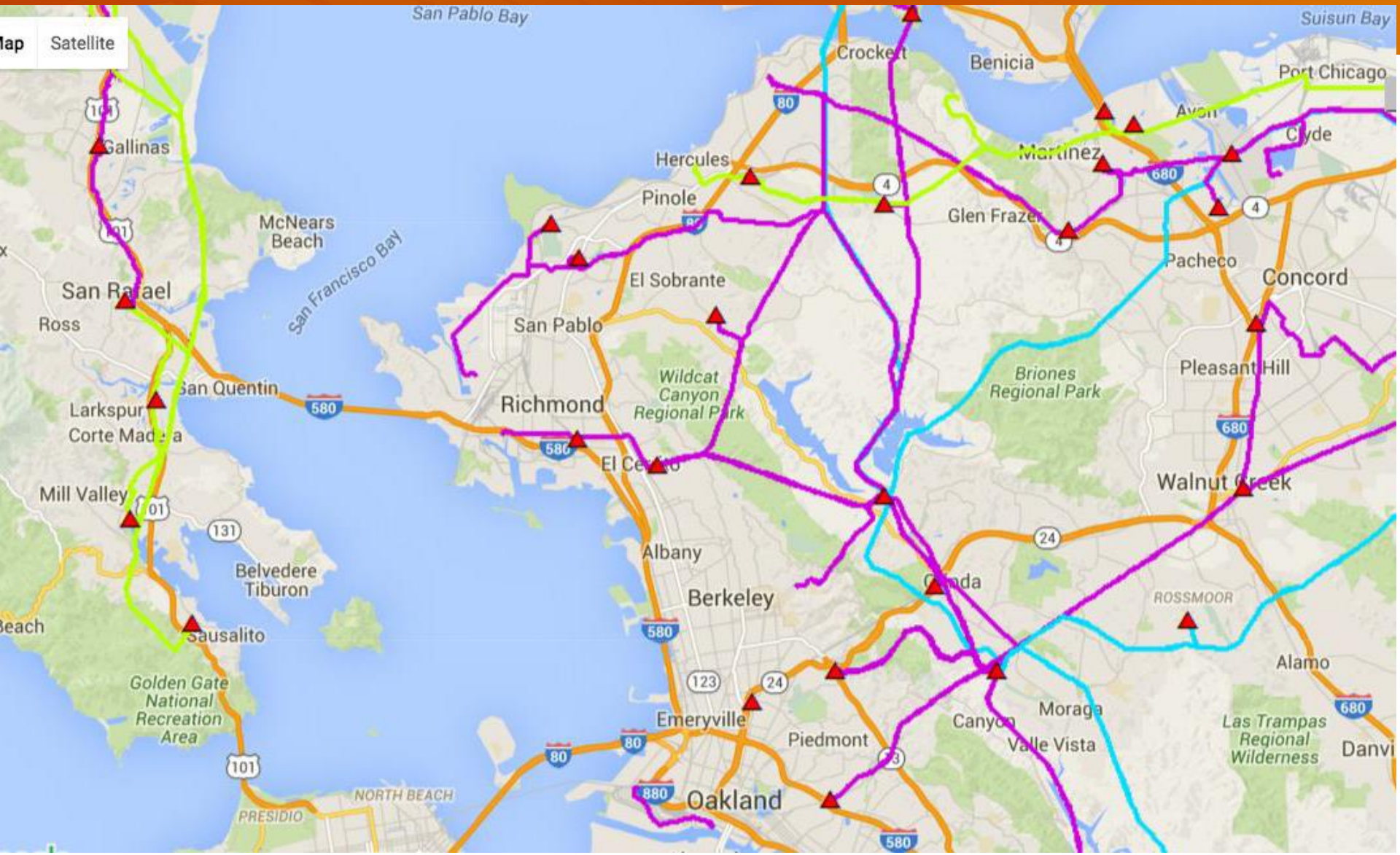
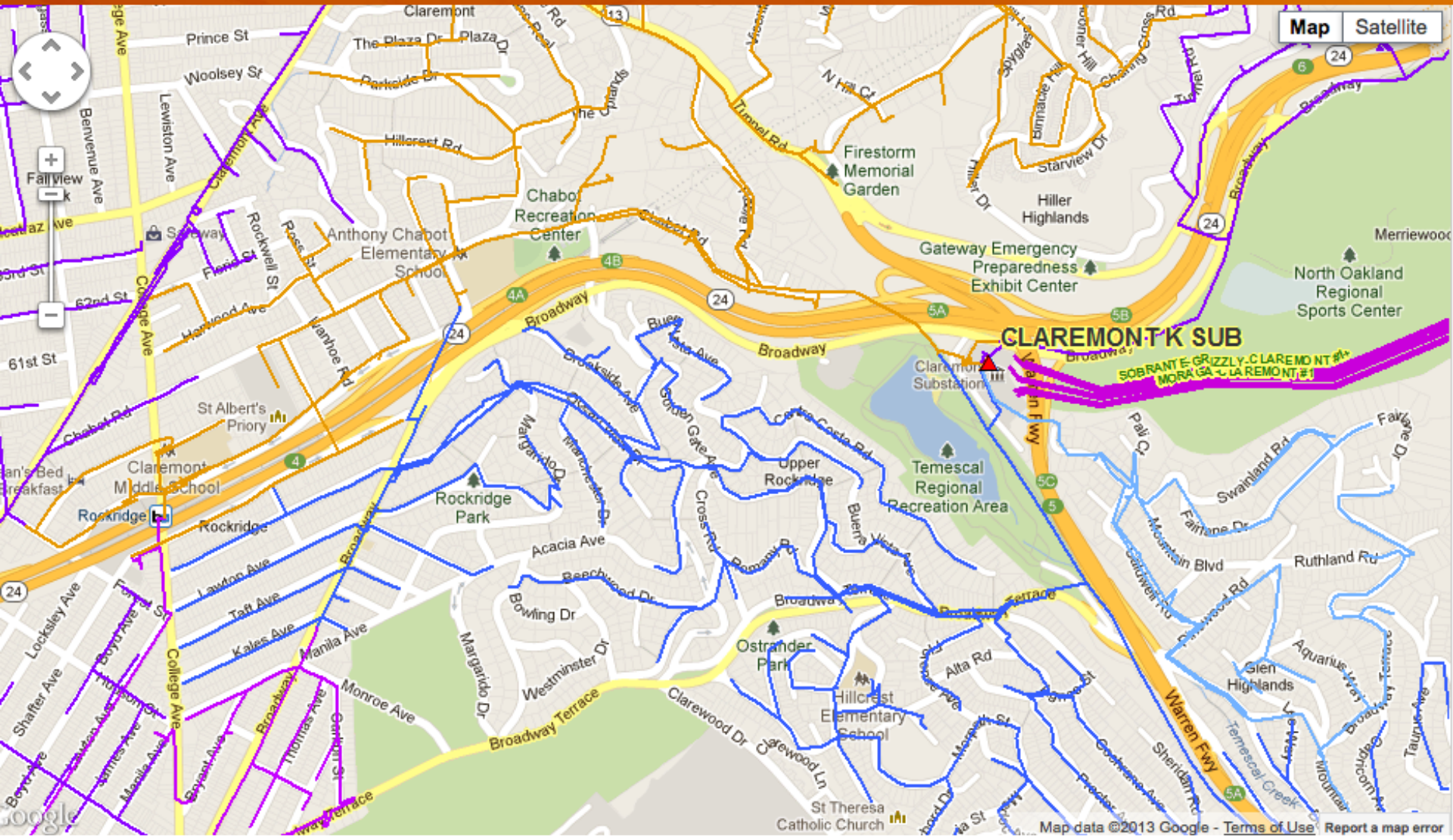


115 kV Transmission network

Distribution substations

Map of Distribution Systems



Interface between Transmission and Distribution

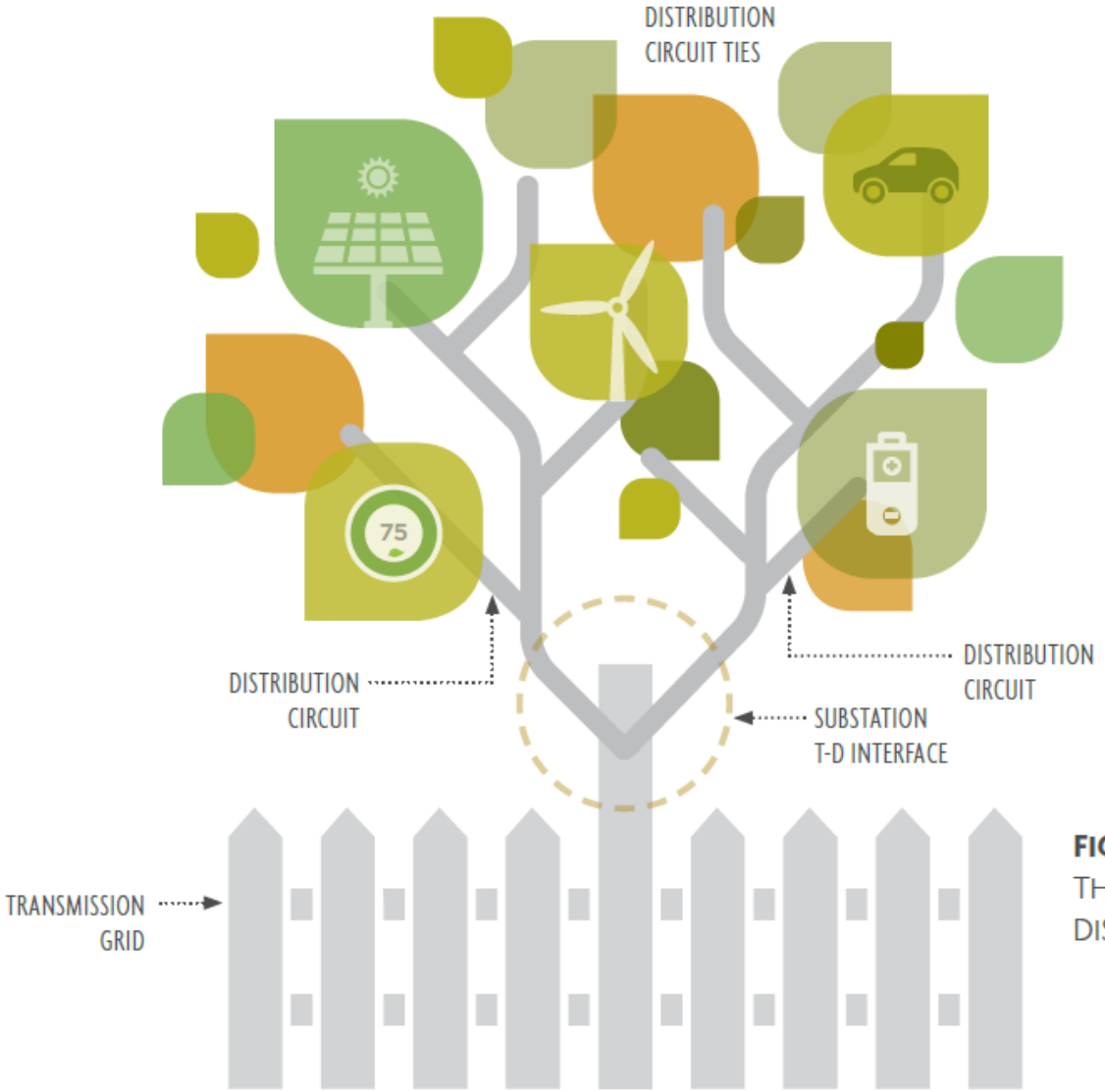


FIGURE 1. STRUCTURE OF THE TRANSMISSION AND DISTRIBUTION SYSTEMS

Source: More Than Smart http://gridworks.org/wp-content/uploads/2017/06/MTS_CoordinationTransmissionReport.pdf

Interface between transmission and distribution (T&D) systems

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- Traditionally
  - Very hierarchical – transmission system drove economics and energy
  - All power was produced on the transmission system
  - Distribution system took what it was given from the transmission system
  - The interface between T&D systems was static
  - Transmission operators managed transmission with their models
  - Distribution operators managed distribution with their models
- With increased Distributed Energy Resources (DERs)
  - The interface between T&D is more complex and dynamic
  - Under certain conditions, power can flow from distribution system to transmission system
  - Software, tools and communications have to evolve
  - Transition from transmission-to-distribution hierarchy to more co-equal - tougher modeling problem!

Progress

- New co-simulation models are being developed at laboratories and research organizations
  - DOE making significant progress with HELICS (Hierarchical Engine for Large-scale Infrastructure Co-simulation)
  - Probably ~ five years to commercial availability
- Smart inverters (which can be connected to solar and storage systems) can help avoid some of the bigger problems
  - IEEE 1547 new standards can be adopted by states
- Energy storage can also help as can increased sensors sprinkled out on the distribution system
  - “Widgets and the system” - Technology by itself isn’t the answer – must be systematically integrated into the system
- T&D and DER market coordination steps are being recommended:
  - More Than Smart/CAISO/PG&E/SCE/SDG&E developed good paper on this: http://morethansmart.org/wp-content/uploads/2017/06/MTS_CoordinationTransmissionReport.pdf

Should you be worried?

- Each state is in a different place
- California and Hawaii are closer to this being a real issue
- Key factor is penetration of DER relative to load
- Good to be thinking and planning ahead
- Enhanced and integrated distribution system planning is a way some states are starting to address these issues

Electricity Planning

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- Utilities have been doing Integrated Resource Planning for years
  - Whole system electricity demand is projected over planning horizon
  - Generation and demand side management options are evaluated for meeting whole system demand
- Transmission planning often performed as a companion side analysis in Integrated Resource Planning
- Utilities have always engaged in distribution system planning to address local load growth and assess needed physical and operational changes to local grids to maintain safe, reliable and affordable service
  - Typically short planning horizons and minimal involvement of regulators
  - Distribution system planning is not included in Integrated Resource Planning
- Drivers for enhanced distribution system planning include integrating higher levels of distributed energy resources (DER), replacing aging infrastructure and modernizing grids, allowing for greater customer choice and improved efficiency

Challenges to traditional planning

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- To understand the impacts (benefits and costs) of distributed energy resources (DER), need to better understand the conditions, needs and opportunities at the distribution system level
  - Question: What's the "value" of rooftop solar?
  - Answer: It depends
- Great variability on the distribution system
  - One area could greatly benefit from new rooftop solar, whereas in another area increased customer solar would cause problems
- There's far less visibility on distribution system than transmission system
- Many more assets and moving parts on the distribution system
- Customers make their own choices about installing distributed generation
- Utility often doesn't know, much less control, everything about customer generation

How are states approaching advanced integrated distribution planning?

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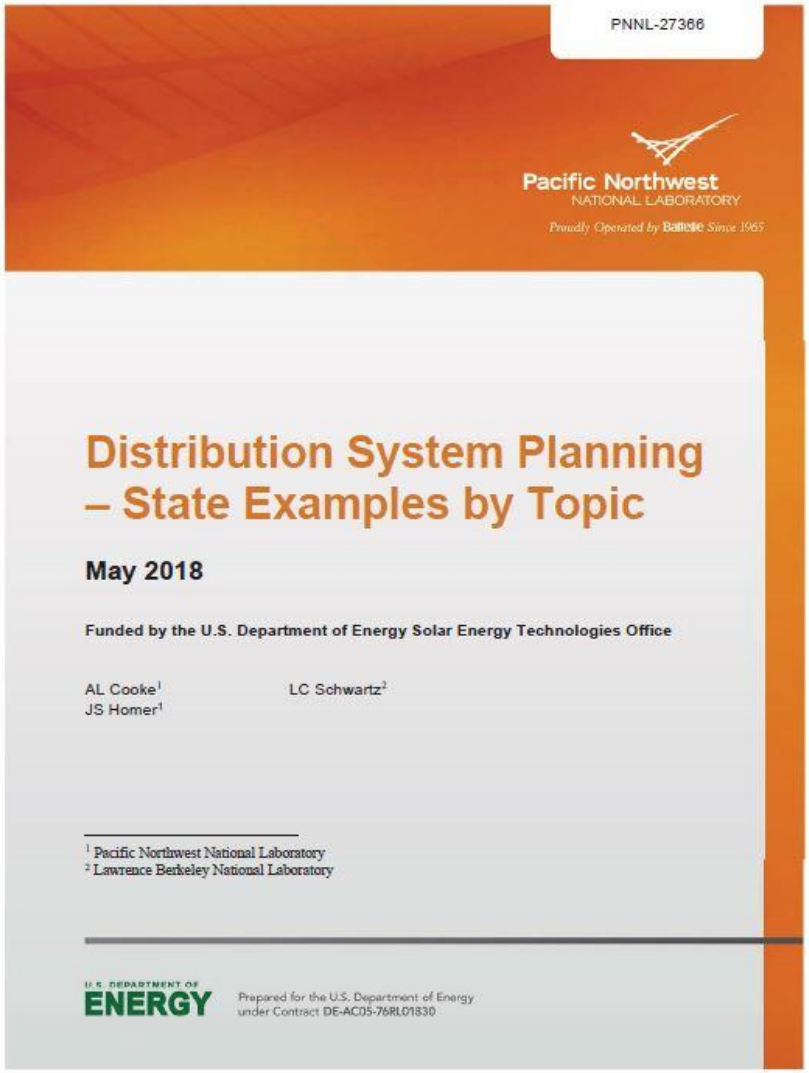
- Advanced distribution planning efforts across the country (NY, CA, MN) are still nascent, but early indications point to convergence around the following common themes:

- Detailed projections of load and DERs
- Understanding the capacity of distribution circuits to safely and reliably "host" DER (hosting capacity)
- More transparent distribution system investment plans
- Locational value of DER
- Non-wires alternatives (NWA) to traditional investments
- Increasing visibility into distribution system
- Accurately representing distribution system in models that can be used for planning and operations
- Extensive stakeholder engagement

States are advancing distribution system planning in a variety of ways

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

New Report and Upcoming Webinar



- Report summarizes state activities in distribution planning by category
- **Free Webinar Monday, May 14, 2018 at 11:00 a.m. Pacific**
- Link to new report:
  - https://epe.pnnl.gov/pdfs/DSP_State_Examples-PNNL-27366.pdf
- To register for the webinar:
  - https://register.gotowebinar.com/register/7938657961300006658

Policy-making Landscape Considerations

- Consider the relationships and roles of different state and local entities in policy-making
- Where are the intersection points or “handshakes” and can they be strengthened?
- Who is taking what into consideration and who is ultimately being impacted?

Energy is more than just energy

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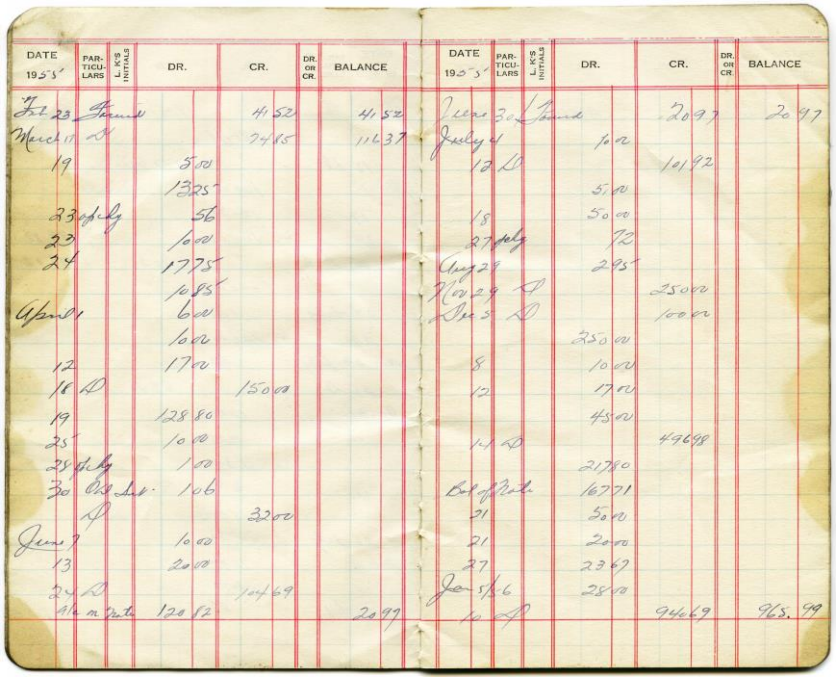
- Services utilities must provide:
  - Day to day energy
  - Energy at peak demand
  - Voltage control
  - Frequency regulation
  - Ancillary services
  - Standby generation in case something unexpected happens
- Externalities associated with energy decision-making
  - Emissions and solid waste
  - Water
  - Health
  - Economic impacts
  - Jobs
- It is hard to sort out the ledgers



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