Building a Minnesota Conversation on

Grid Modernization

With a Focus on Distribution Systems

June 30, 2015

Outline of Presentation

- Evolving Electric Grid
- Grid Modernization
- Distribution
  - Distributed Energy Resources
  - Distribution Systems
  - Investments, Efficiency
- Summary
- MN PUC Initiative on Grid Modernization

Evolution of the Electric Grid

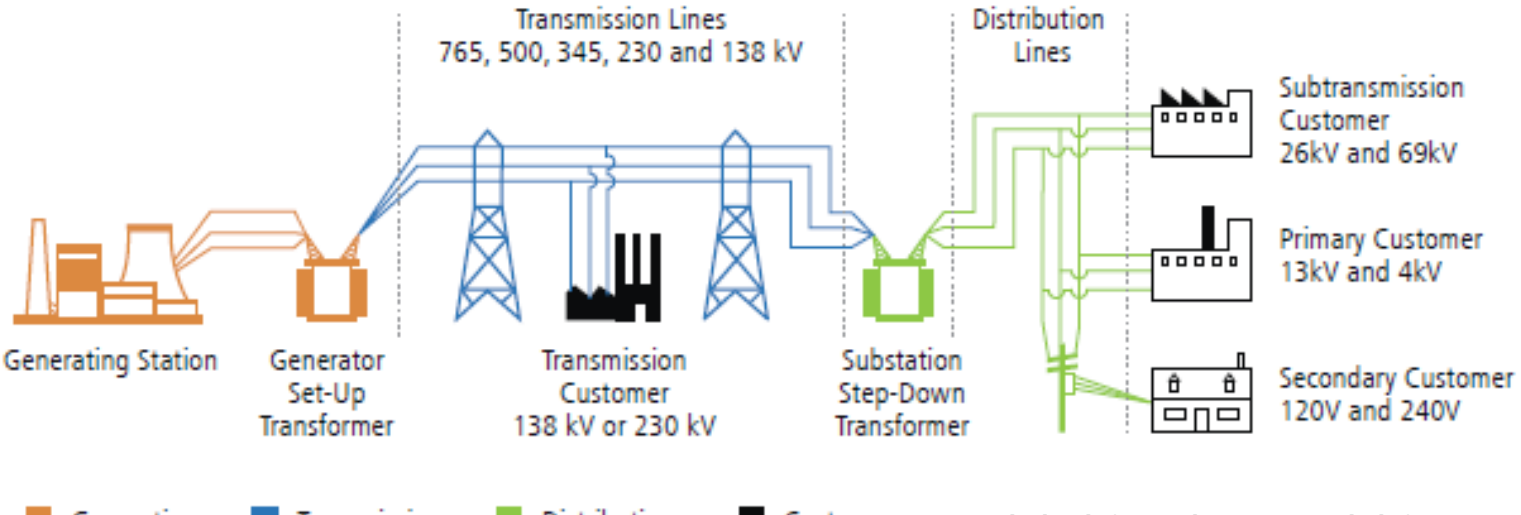
- Individual Grids (Local)
  - Developed in the late 1800s by early builders of small local grids.
- Interconnected Grids (Regional)
  - By the second half of the last century, power systems had developed to become larger and more complex; By the 1960s there were several large, interconnected, synchronized U.S. systems.

Drivers for further grid modernization include:

- ⇨ **Changing consumer demands**, increasingly engaged customers, declining sales
- ⇨ **Evolving public policy**, new environmental regulations, de-carbonization
- ⇨ **New distributed technologies**, both supply and demand side resources

- **Integrated Grid** (Enabling Customers: Local ←→ Regional)
  - Over the next two decades, the grid will evolve to meet the increasing demands;
  - Will require planning and operating to optimize and extract value throughout the electric grid.

Today's Electric Grid



Includes information & controls infrastructure to monitor and control the grid,

- **Reliable, affordable, & increasingly clean**
- **At a strategic inflection point** – a time of significant change
  - Changes underway include retirements of large centralized plants, deployment of distributed resources, severe weather and climate change, low load growth, growing jurisdictional interactions at Federal & state levels
- **Innovative technologies and services are being introduced** at an unprecedented rate – often increasing efficiency, reliability, and the role of customers; also increasing uncertainty

Source: U.S. DOE *Quadrennial Energy Review*. *April 2015*

Grid Modernization – U.S. DOE

The future grid provides a ***critical platform for U.S. prosperity, competiveness, and innovation*** in a global clean energy economy. It ***must deliver reliable, affordable, and clean electricity*** to consumers where they want it, when they want it, how they want it.

Grid modernization is needed to:

- Achieve Public Policy Goals
  - Maintain access to reliable, affordable electricity;
  - Reduce environmental impacts;
- Sustain Economic Growth and Innovation
  - Encourage new technologies, products, services, & business models
- Mitigate Risks and Secure the Grid
  - Keep the lights on & protect against threats (extreme weather, cyber threats, physical attacks, aging infrastructure)

Source: U.S. DOE *Grid Modernization Initiative*. IEEE ISGT Feb 2015

Grid Modernization – MN e21

Customer demands, adaptation to new technology, increased attention to system resilience, and public policy requirements are driving the need for a modern grid that will support new ways in which electric energy will be generated, delivered, and used.

Planning for a Modern & Efficient Grid

Proactive planning for an intelligent, flexible, efficient, open, and secure distribution system over the next several decades that can handle new distributed energy technologies and the complexity of many actors on the system.

Desired outcomes include:

A cleaner, more flexible grid that is reliable, resilient, and secure and enables customers to manage and potentially reduce their energy costs.

Source: e21 Initiative. *Phase I Report: Charting a Path to a 21st Century Energy System in Minnesota.* December 2014.

Distributed Energy Resources

Supply and demand side resources that can be used throughout an electric distribution system to meet energy and reliability needs of customers; can be installed on either the customer or the utility side of the electric meter

- Include ***Efficiency*** (End use efficiency), ***Distributed Generation*** (Solar PV, Combined heat and power, Small wind), ***Distributed Flexibility and Storage*** (Demand response, Electric vehicles, Thermal storage, Battery storage), and ***Distributed intelligence*** (Information and control technologies that support system integration)

Future Electric Grid

Tomorrow's grid will:

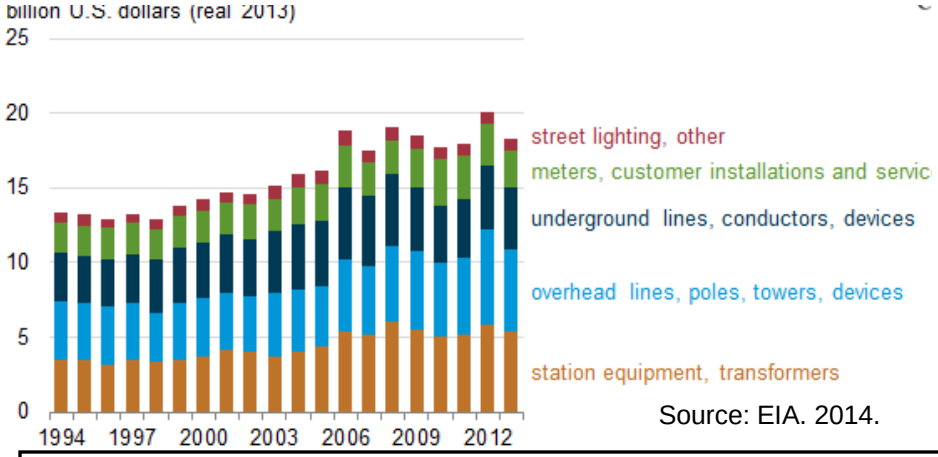
- Be more distributed, flexible, intelligent, real-time controlled, autonomous, open *and* secure;
- Be cleaner and reliable;
- Operate resiliently against attack and natural disaster.

Tomorrow's distribution systems will:

- Enable a high level of integrated Distributed Resources, both supply and demand side, with active participation by consumers;
- Manage two way flows of electricity;
- Provide for seamless integration and interoperability of varied systems and components;
- Implement modern distribution management systems (DMS) including advanced control and communications;
- Be planned in coordination with resource and transmission planning; could incorporate stakeholder informed planning scenarios.

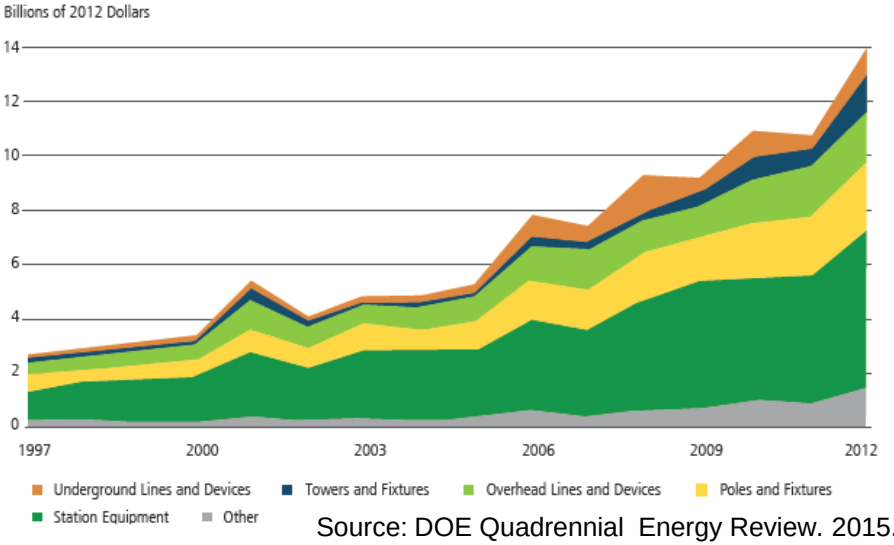
Grid Investments

U.S. Distribution System Investments



Source: EIA. 2014.

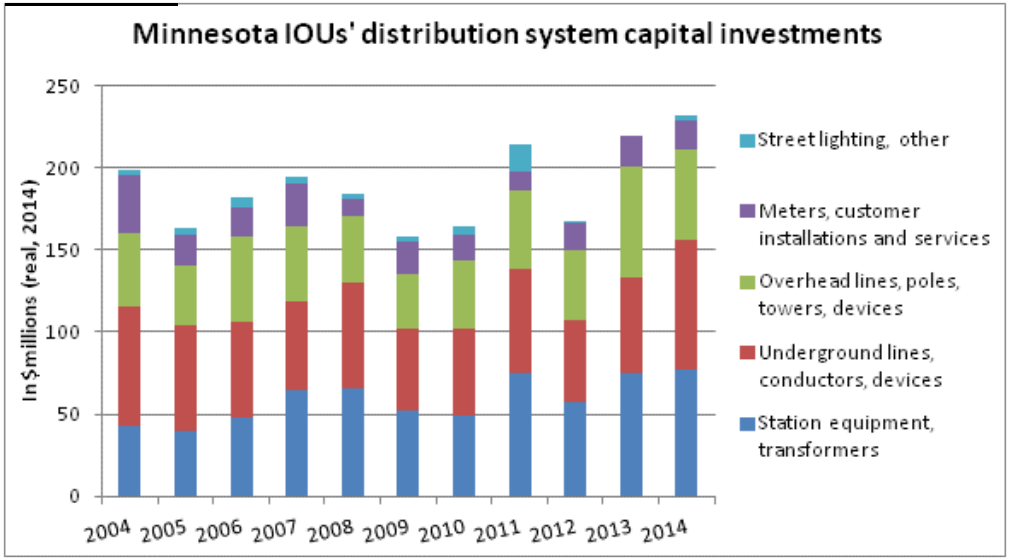
U.S. Transmission Investments (IOUs)

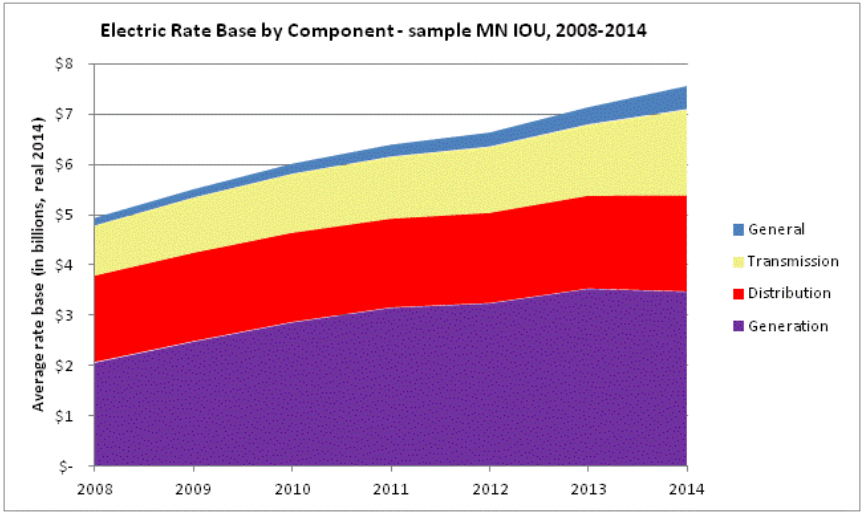


Source: DOE Quadrennial Energy Review. 2015.

Unprecedented opportunity to invest in the 21st century grid

Minnesota

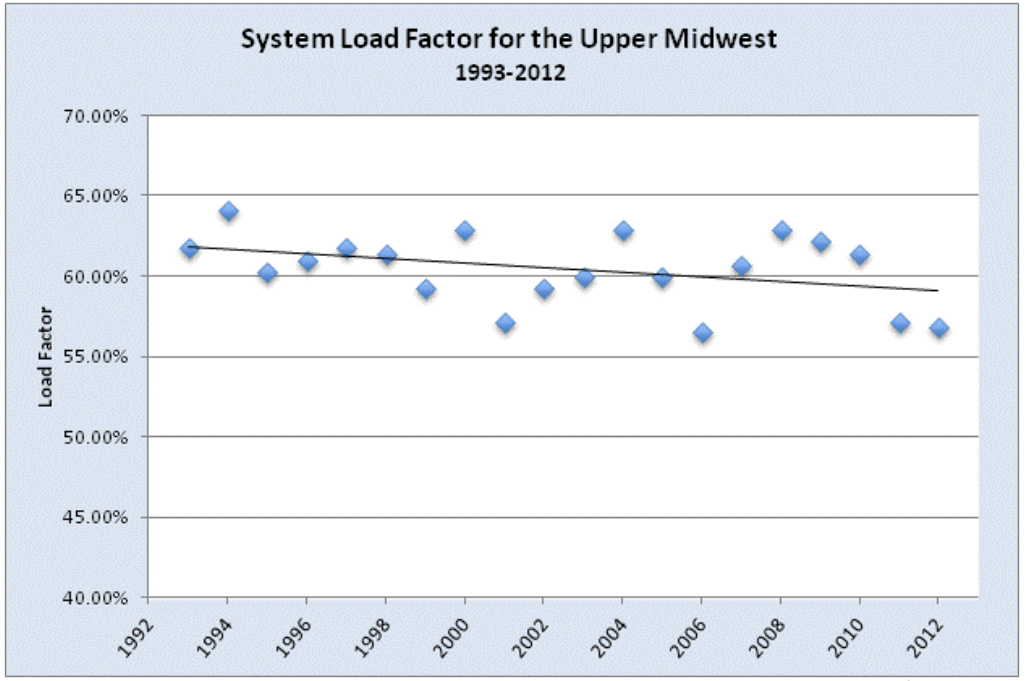




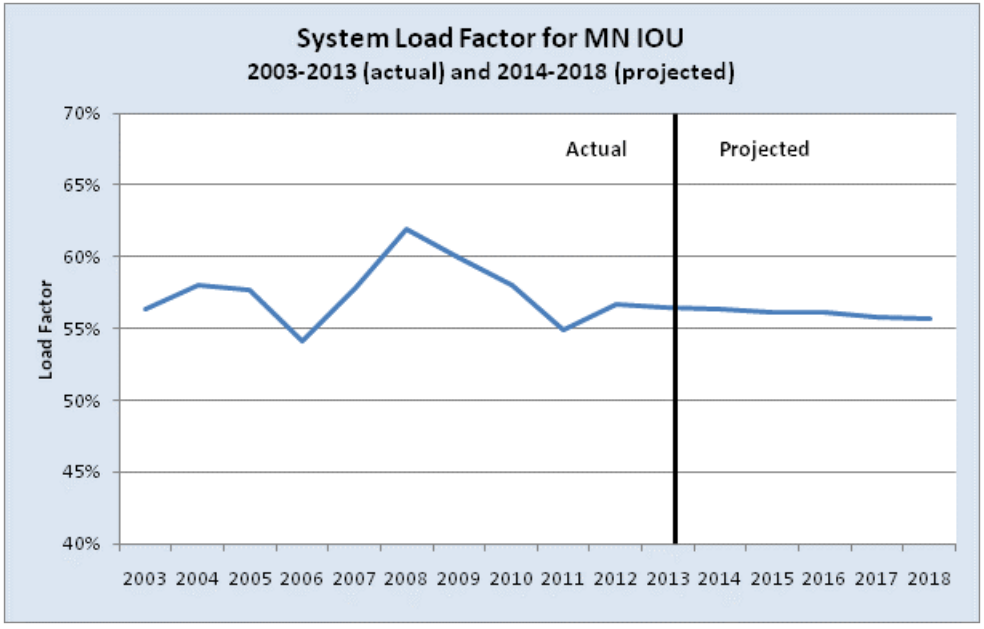
Source: MN PUC Filings

Grid Efficiency

- System Load Factor is a measure of the average utilization levels of grid investments (generators, transmission, distribution)



Source: EIA – MISO region



Source: MN PUC Filings – sample MN IOU

- Opportunity to reduce system costs by better utilizing existing system assets

Summary

- Today's interconnected power grid is reliable, affordable, increasingly clean;
- The grid is at a strategic inflection point, a time of significant change;
- Changing customer demands, new technologies, and evolving public policy will drive increased deployment of distributed resources;
- Tomorrow's integrated electric grid will be more distributed and flexible; will optimize and extract value through the grid; will operate resiliently against natural disaster and attacks; will be cleaner, reliable, and affordable;
- Development of tomorrow's grid is already underway; there is an unprecedented opportunity to invest in a 21st century grid;
- Updates to distribution planning process will be needed to support a reliable, efficient, robust grid in a changing (and uncertain) future; should be coordinated with resource and transmission planning; could incorporate stakeholder informed planning scenarios.

MN PUC – Distribution Grid Modernization

The Minnesota PUC's grid modernization initiative will be designed to address the following key questions:

1. Are we planning for and investing in the distribution system that we will need in the future?
2. Are the planning processes aligned to ensure future reliability, efficient use of resources, maximize customer benefits, and successful implementation of public policy?
3. What commission actions would support improved alignment of planning for and investment in the distribution system?

Source: PUC Planning Meeting presentation, Commissioner Nancy Lange. May 12, 2015.

MN PUC – Distribution Grid Modernization

On May 12, 2015, the Minnesota Public Utilities Commission initiated an inquiry into Electric Utility Grid Modernization with a focus on Distribution Planning (**Docket No. CI-15-556**).

The first phase of this initiative will commence with a series of three meetings to facilitate a dialogue on Minnesota's electric distribution systems.

- The **September 25th** meeting will focus on Minnesota's electric utility distribution systems, with a discussion of the design, operations, performance, capability, and planning processes for existing distribution systems;
- The **October 30th** meeting will examine national distribution grid modernization work and emerging best practices;
- The **November 20th** meeting will consider stakeholder perspectives, giving interested parties an opportunity to provide feedback on current distribution planning processes and to suggest next steps the Commission could take to improve distribution planning in the future.

These day-long meetings are open to all interested stakeholders.

PUC Contact: Andrew Twite, Andrew.Twite@state.mn.us

Source: PUC Docket Number CI-15-556.

Some Additional Resources

CPUC. Ruling on Guidance for Public Utilities - Distribution Resources Plan (14-08-013). February 6, 2015. http://www.cpuc.ca.gov/PUC/energy/drp/

De Martini (Caltech), Kristov (CAISO). *21st Century Electric Distribution System Operations.* May 2014 http://smart.caltech.edu/papers/21stCElectricSystemOperations050714.pdf

EPRI. *The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources.* February 2014. http://integratedgrid.epri.com/

EPRI (Smith, Rylander, Rogers, Dugan). *It's All in the Plans, Maximizing the Benefits and Minimizing the Impacts of Distributed Energy Resources in an Integrated Grid.* IEEE Power and Energy Magazine, March 2015.

Feldman. *A Huge Distribution Opportunity.* Electricity Policy Journal February 2015.

Fox-Penner, Peter. *Smart Power: Climate Change, the Smart Grid, and the Future of Electric Utilities.* Island Press. 2010 & 2014.

Greentech Leadership Group. *More Than Smart: A Framework to Make the Distribution Grid More Open, Efficient, and Resilient.* August 2014. http://greentechleadership.org/mtsworkinggroup/

Gridwise Alliance. *The Future of the Grid: Evolving to Meet America's Needs.* December 2014. http://www.gridwise.org/

IREC. *Integrated Distribution Planning Concept Paper.* May 2013. http://www.irecusa.org/2013/06/integrated-distribution-planning-a-path-to-sustaining-growth/

MA DPU. Grid Modernization (DPU 12-76-B). http://www.mass.gov/eea/energy-utilities-clean-tech/electric-power/grid-mod/grid-modernization.html

MIT. *The Future of the Electric Grid, An Interdisciplinary Study.* December 2011. http://mitei.mit.edu/publications/reports-studies/future-electric-grid

NGA. *Governor's Guide to Modernizing the Electric Power Grid.* March 2014. http://www.nga.org/files/live/sites/NGA/files/pdf/2014/1403GovernorsGuideModernizingElectricPowerGrid.pdf

NY PSC. Order Adopting Regulatory Policy Framework and Implementation Plan. NY REV 14-M-010. February 26, 2015. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b0B599D87-445B-4197-9815-24C27623A6A0%7d

US DOE. *Quadrennial Energy Review: Energy Transmission, Storage, and Distribution Infrastructure.* April 2015. http://energy.gov/epsa/quadrennial-energy-review-qer