Integrating the Grid

Minnesota Progress and Challenges

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Minnesota Public Utilities Commission

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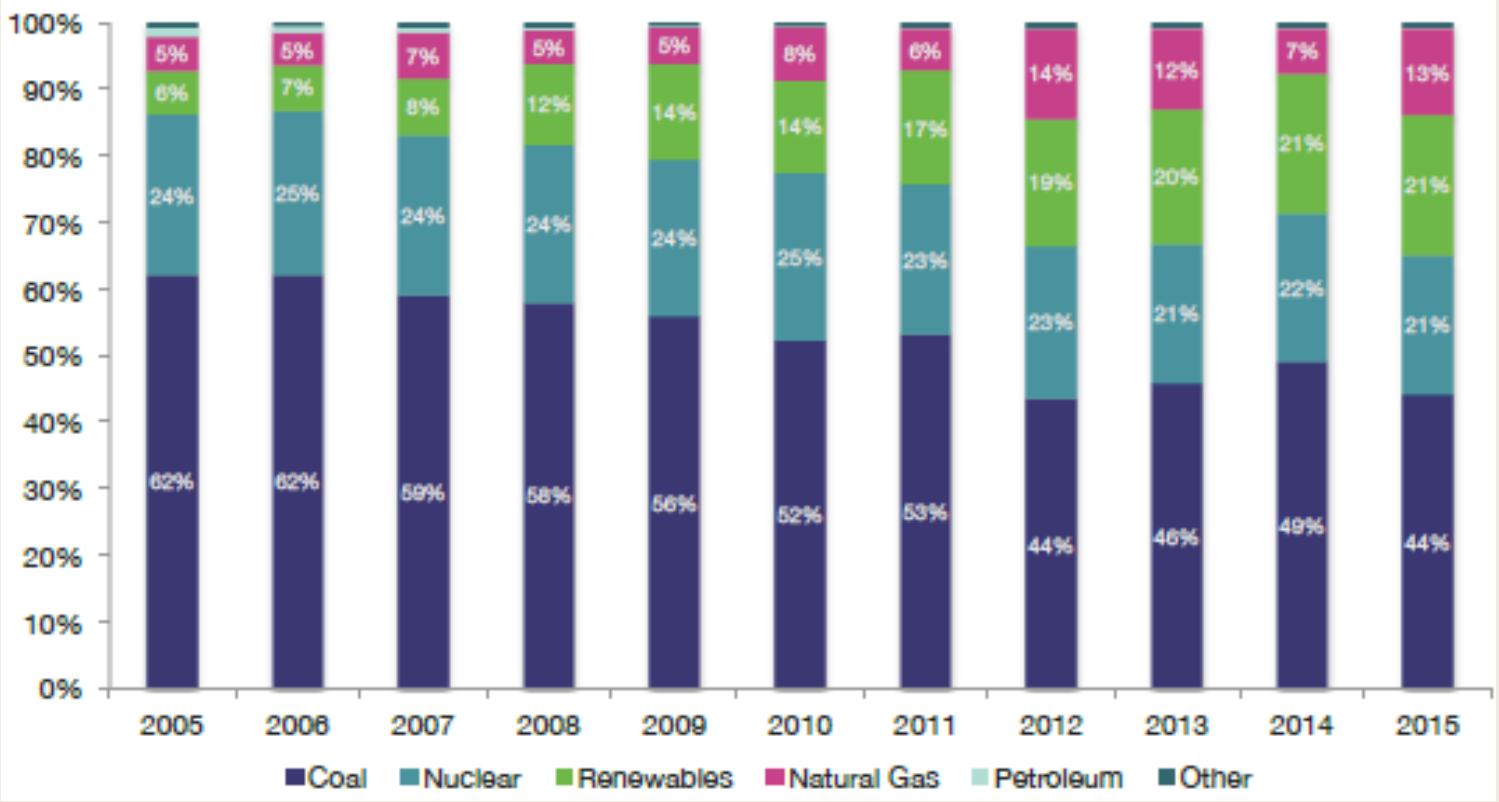
Overview of Presentation

- Background
- Planning – Resources, Transmission
- Grid Integration of Renewables
- Integrated Distribution Planning
- Future Developments

Minnesota Electricity Generation



Source: U.S. Energy Information Administration

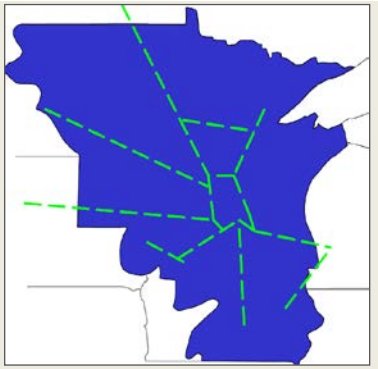
Resource Plans

Minnesota Integrated Resource Plans

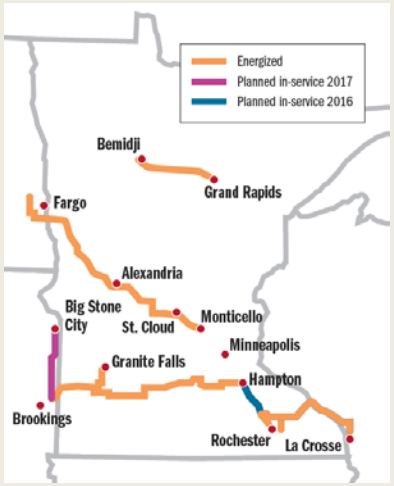
- Mix of supply and demand side resource options that a utility could use to meet the service needs of its customers
  - Filed every 2 - 4 years by all major generator owning utilities;
  - Detailed analysis performed for a minimum 15-year time horizon;
  - Minimize costs; Comply with state policies and Commission Orders.
- Commission must consider:
  - Reliability;
  - Customer rates and bills;
  - Socioeconomic and environmental impacts;
  - Financial, social, and technological factors affecting utility operations; and
  - Risk management.
- Determine the size, type and timing of any resource additions

Transmission Plans

Minnesota: CapX2020 Transmission Initiative



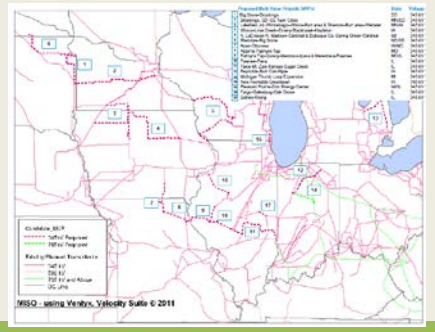
- Eleven MN Electric Utilities
  - **Scenario planning; Collaborative process**



- Transmission expansion
  - 600 miles of double-circuit capable 345 kV transmission; $2 billion investment
  - **Foundation for future development; Capacity to meet renewable energy development**
  - 10+ year timeline

Regional: MISO Transmission Planning

- **Annual MISO transmission expansion plan**
- Multi-Value Portfolio (approved MISO in 2011)
  - 17 lines, 10 states, $5 billion investment
  - Multi-values; Supports state RESs
  - 10+ years timeline



Wind Integration into the Midwest Regional Grid

Work on grid integration of large amounts of wind generation in Minnesota and the upper Midwest began in the early 2000s:

- **Initial work focused on *interconnection***
- **Minnesota utilities & MISO developed regional transmission plans**

Higher penetrations of variable renewables required a forward looking systems approach and regional consensus on planning scenarios.

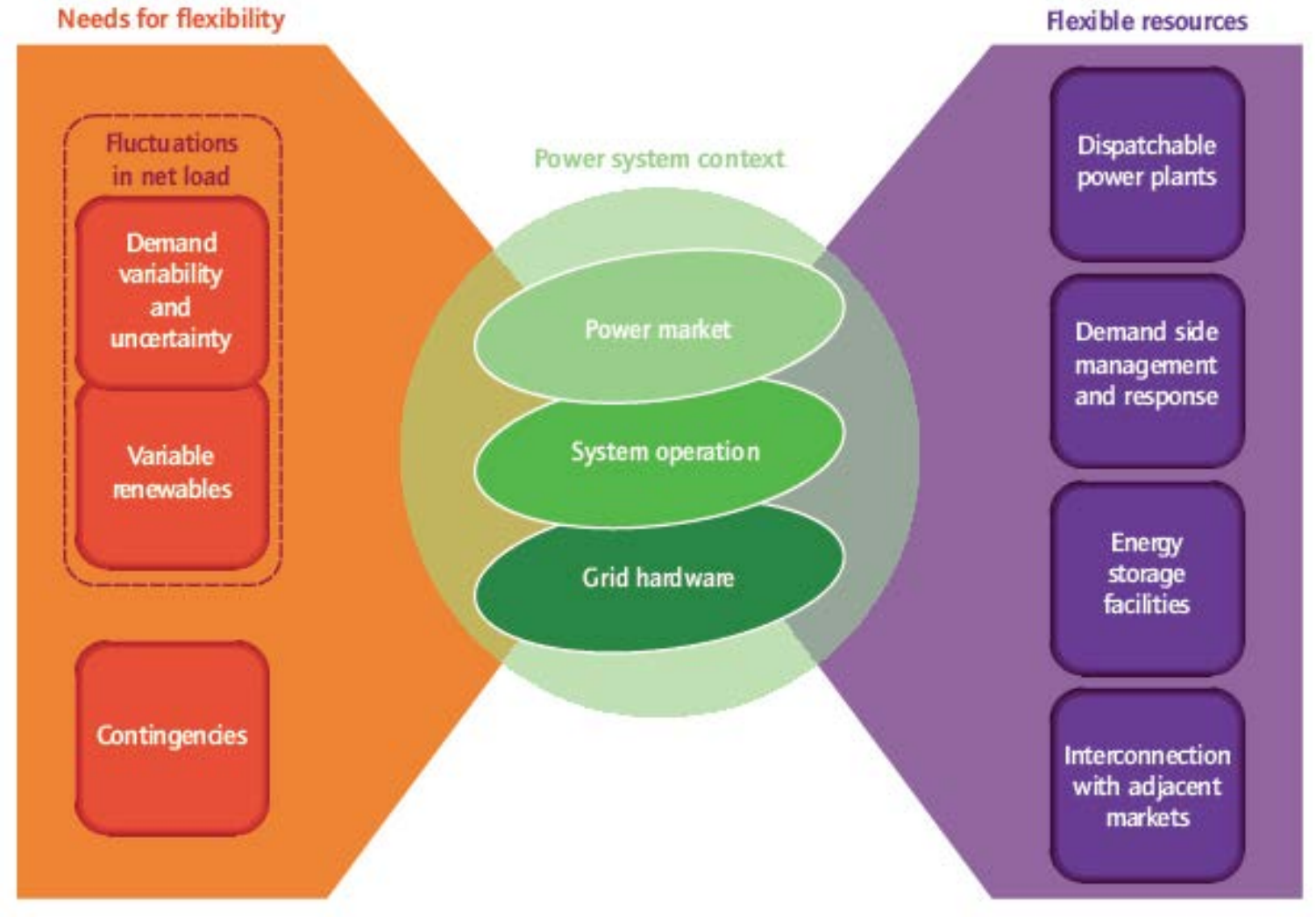
- **Several Minnesota *grid integration* studies facilitated significant learning** on all sides of the challenge (2004, 2006, 2009, 2014)

Today, the regional grid is planned and operated differently;
new approaches/tools; improved market rules; and,
wind generators are able to and are required to perform much better.

Minnesota Renewable Energy Integration and Transmission Study (MRITS 2014)

- **Reliability Study**
  - Completed by Minnesota Utilities and Transmission Companies; in coordination with MISO
  - Independent technical review
- **Increase Minnesota wind and solar generation**
  - 40% and 50% of annual electric energy
- **Three core and interrelated analyses:**
  - Developed a conceptual transmission plan;
  - Evaluated hour by hour operational performance of the power system for full year; and
  - Evaluated transient stability and system strength.

Grid Balancing and Flexibility



Source: *Harnessing Variable Renewables. IEA.*

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.

Includes:

- ***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)

Valuing DER on the Grid

Minnesota Value of Solar Methodology

Value of distributed solar – *to the utility, its customers, and society*

Includes the value of avoided energy and its delivery, generation capacity, transmission capacity, location-specific distribution capacity, and environmental value

- **Expressed in a present value, $ per kWh, for a 25-year levelized stream**
- **Separates customer electricity usage and production**

  Customers are billed for all electricity usage under their existing applicable tariff and are *credited* for all solar energy production under the VOS rate.

- **Implementation**

  Investor Owned Utilities may apply to the MN PUC for a VOS tariff, in lieu of Net Metering, for solar PV;

  Xcel is required to purchase energy generated by solar gardens at the value-of-solar rate.

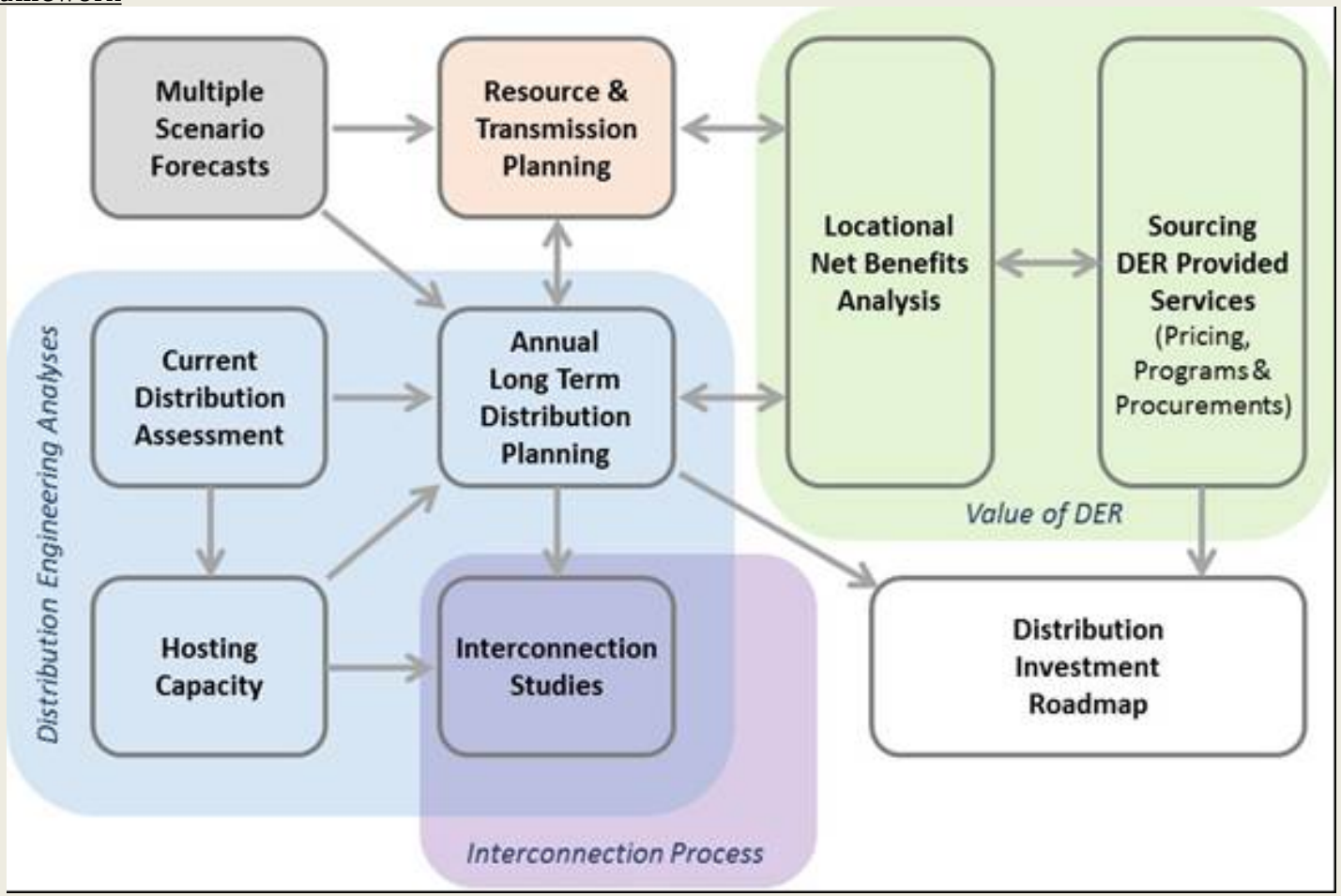
Minnesota Grid Modernization
Focus on Distribution Planning

Principles:

- 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**.

Integrated Distribution Planning

Proposed framework



Source: De Martini - ICF, *Integrated Distribution Planning*, August 2016. Prepared for the Minnesota PUC.

Evolving Electric Grid

- **Minnesota's electric grid is reliable, affordable, increasingly clean**;
- **The grid is at a time of significant change,** drivers include:
  - **Evolving public policy**, new environmental regulations, de-carbonization;
  - **Changing consumer demands**, increasingly engaged customers;
  - **New distributed technologies**, both supply and demand side resources;
- **Tomorrow's *integrated* grid will *optimize and extract value throughout the system***
  - will be **more distributed and flexible**;
  - will **operate resiliently** against natural disaster and attacks;
  - will be **cleaner, reliable, and affordable**;
- The **regional transmission grid and markets will continue to be vital**;

  The local electric distribution systems will need updated planning to support a reliable, efficient, robust grid in a changing (and uncertain) future.

Thank you!

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