

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Assessment of the North American Bulk Power System

A Reliability Perspective on Future Needs and Challenges

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RELIABILITY | ACCOUNTABILITY



To ensure the reliability of the North American bulk power system

- Develop and enforce reliability standards
- Assess current and future reliability
- Analyze system events and recommend improved practices
- Encourage active participation by all stakeholders
- Accountable as ERO to regulators in the United States (FERC) and Canada (NEB and provincial governments)



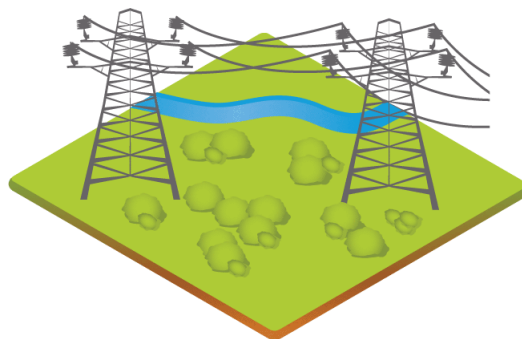


Generation

Over 5,000 plants
Over 20,000 EGUs

65% of average customer
monthly bill

Employs approximately
120,000 people

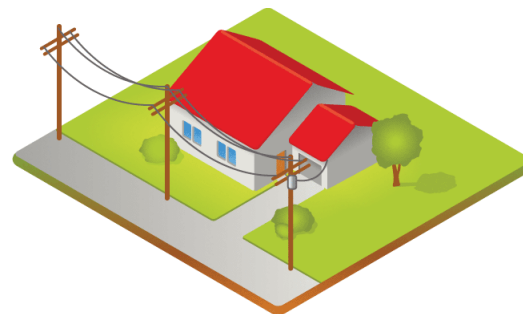


Transmission

Over 460,000 miles
>100kV

5% of average customer
monthly bill

Employs approximately
15,000 people

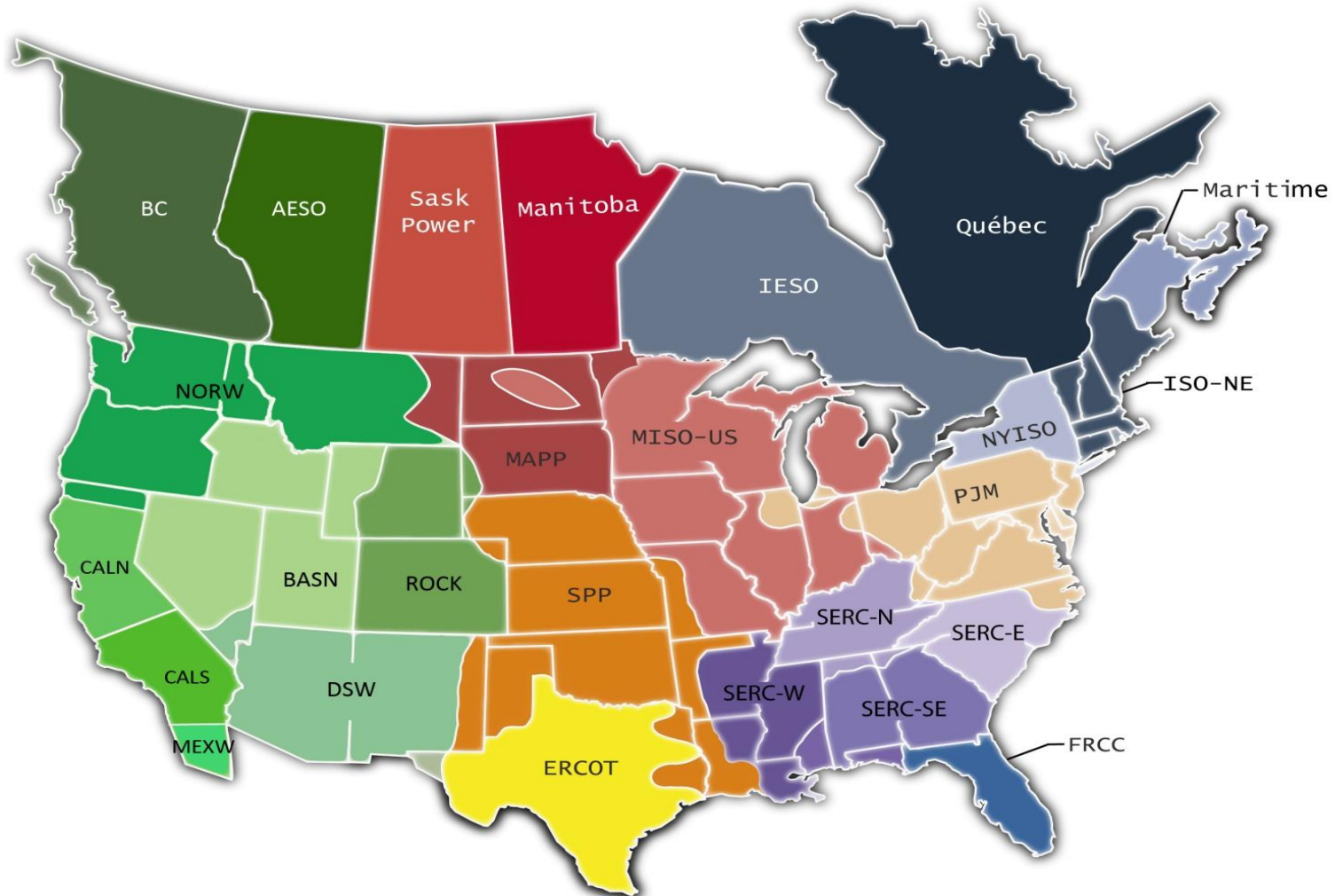


Distribution

Over 1,000,000 miles

30% of average customer
monthly bill

Employs approximately
400,000 people

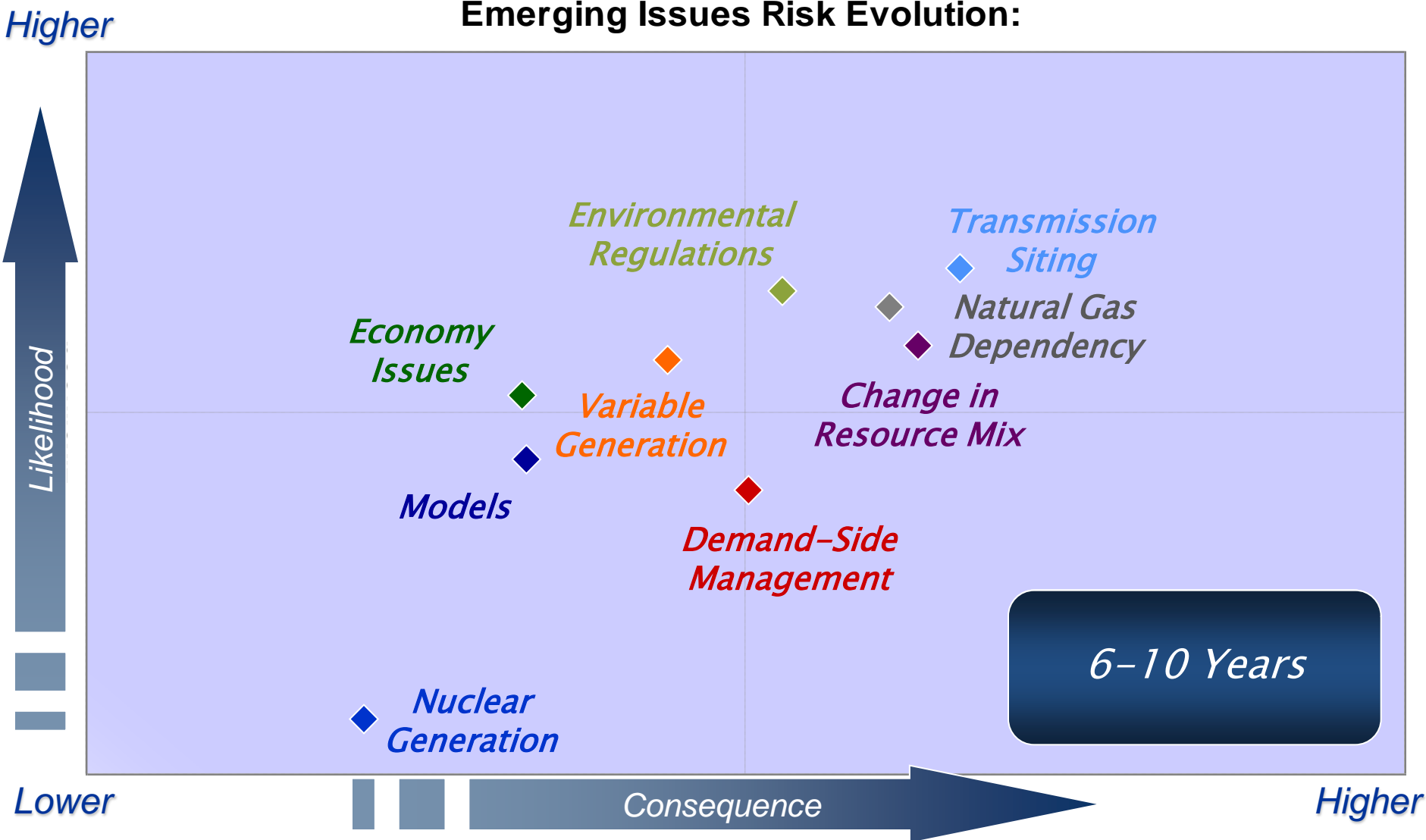


- Peak demand forecasts
- Resource adequacy
- Transmission adequacy
- Key issues - emerging trends
 - Technical challenges
 - Evolving market practices
 - System elements/dynamics
 - Potential legislation/regulation
- Regional self-assessment
- Ad-hoc special Assessments



Risk Assessment for Emerging & Standing Issues

Emerging Issues Risk Evolution:



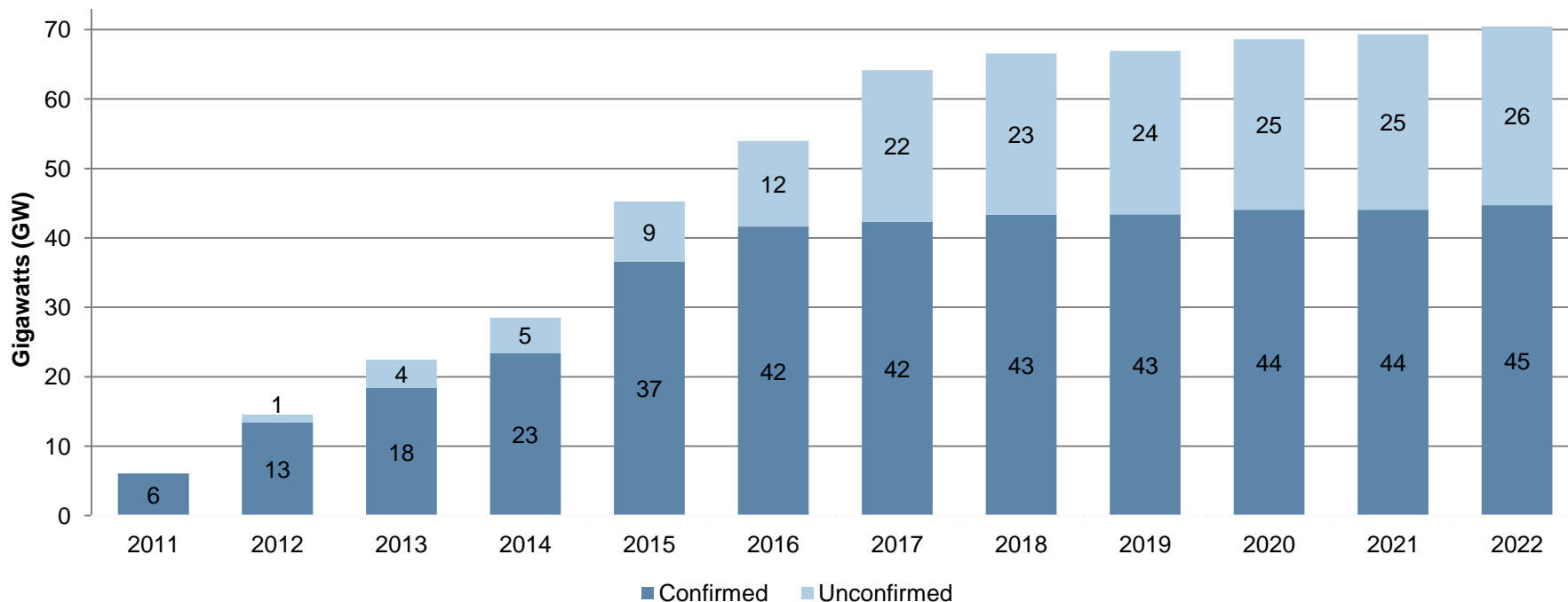
- Significant Loss of Fossil-Fired Generation Capacity
 - ~70 GW of confirmed retirements/derates (2012-2023)
- Increases in Variable Generation
 - ~20 GW of on-peak capacity (2023); wind and solar
- ERCOT (Texas) below Target Reserve Margin throughout
- Demand-Side Management to offset 80 GW of 2023 peak demand
 - Penetration levels highest in PJM and MISO, ~12% of peak demand
- Nuclear Generation Retirements
- Increasing Dependency on Gas-fired Generation
 - 70-100 GW to be added; Total of nearly 500 GW by 2023

- Common-mode failures and contingencies (beyond N-1)
 - Increasing variable generation and system dynamics
 - Interruption of gas deliver / catastrophic failure of pipeline transportation (*force majeure* curtailments)
- Transmission limit representations
- Fundamental changes in generation characteristics
- Stakeholder consensus for Reserve Margin targets
 - Paradigm shift recognizing limitations and potentially misleading deterministic planning targets
 - Potential increases in energy-limited systems
- Consistent definitions of reliability planning criteria:
 - Loss-of-Load and “1 in 10”

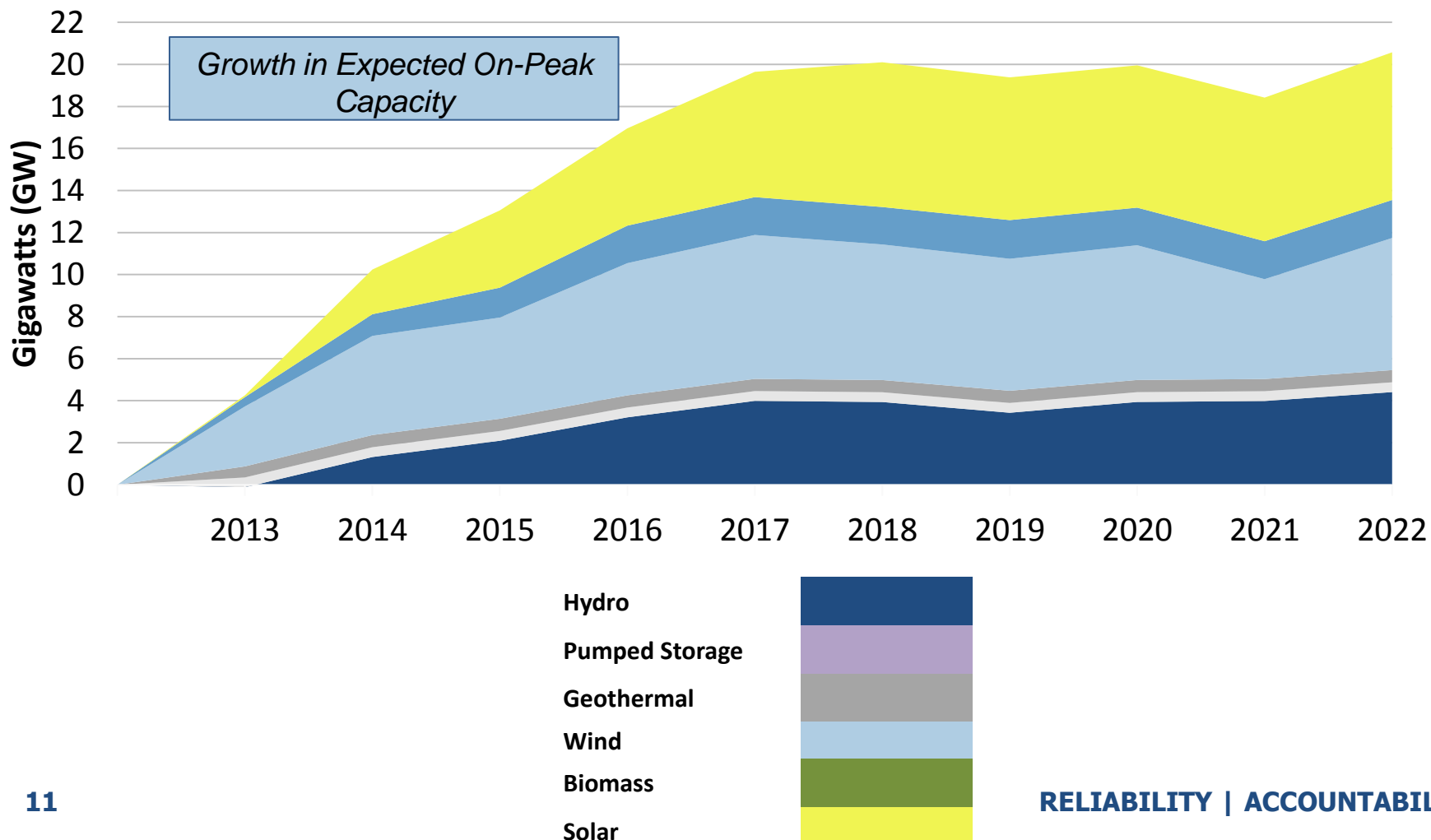
- Generation & Transmission Reliability Planning Models Task Force (GTRPMTF) was organized in January 2009 to develop composite G&T modeling methodology for assessing resource adequacy
- Successful execution of a long-term probabilistic-based reliability assessment is a significant step forward in determining future reliability of the bulk power system in North America
 - Provide a common set of probabilistic reliability indices
 - Recommend probabilistic-based work products
 - Completed the very first continent-wide probabilistic assessment (2013)

Significant Fossil-Fired Generator Retirements Over Next Five Years

- Cumulative retirements between 2012 and 2022
- Slightly larger impacts than our 2011 generator retirement study

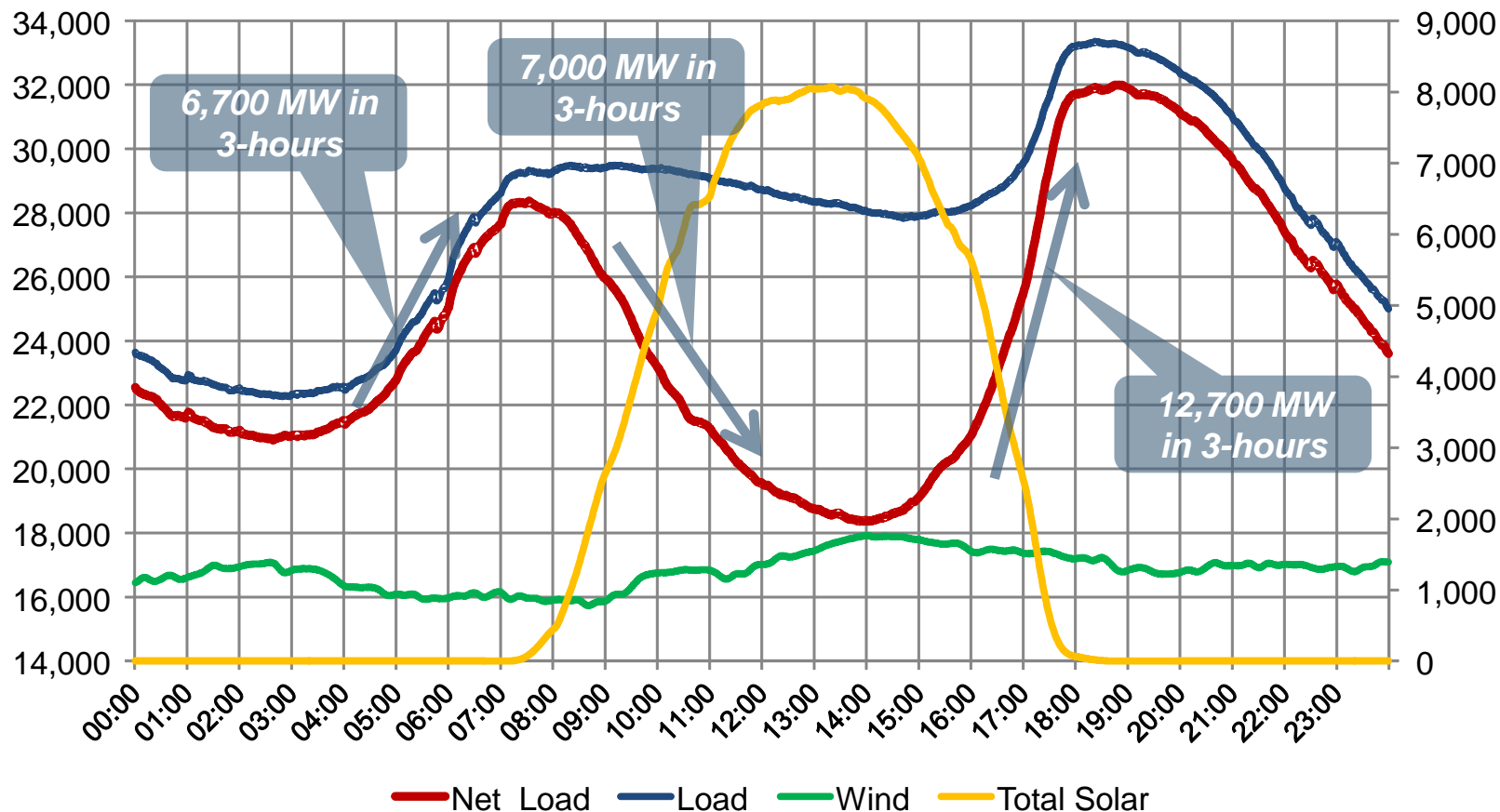


New Renewable/Variable Resources Introduce New System Planning and Operational Challenges



The Need For Flexibility: A Future, Not a Scenario

**Load, Wind & Solar Profiles --- Base Scenario
January 2020**



Accommodating High-Levels of Variable Generation

Reliably integrating these resources into the bulk power system will require significant changes to traditional methods used for system planning and operation

Forecasting

- Variable Fuels Must Be Used When Available
- Forecast is only information; operator must make informed decisions
- “It’s the ramps, not the ripples”
- Methods for calculating expected on-peak capacity

Flexibility

- More Ancillary Services
- Larger Balancing Authorities
- Flexible Resources
 - Storage
 - PHEV
 - Leverage fuel diversity of other variable resources
- Distribution; Ride-through Capability

Transmission

- Interconnect variable energy resources in remote areas
- Construct/site/permit transmission to deliver power across long distances

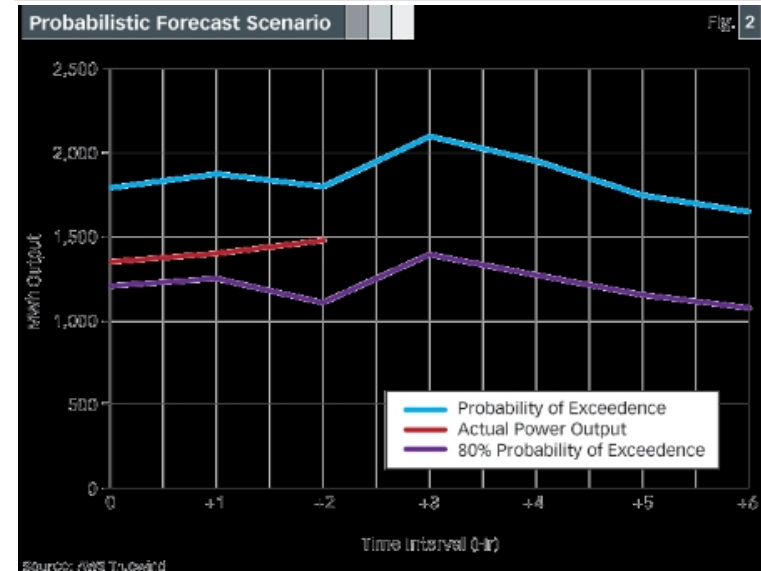
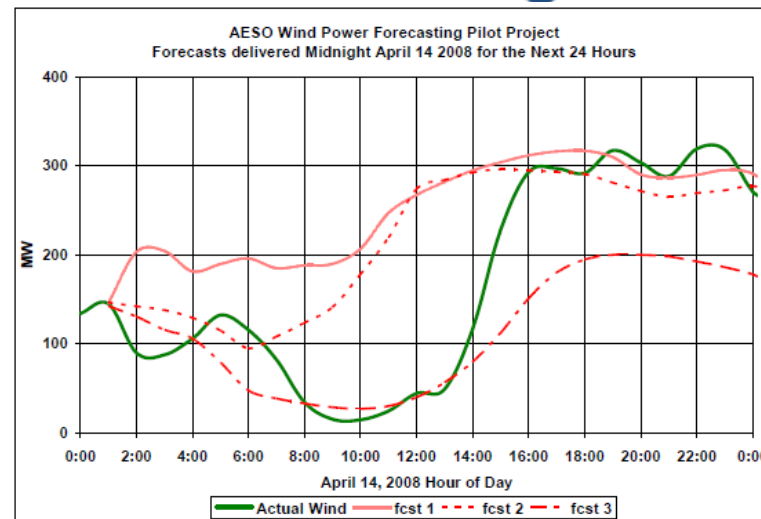
Improved measurement forecasting of variable generation output is needed

- **Challenge**

A forecast is only information

Operators need tools to react to forecast

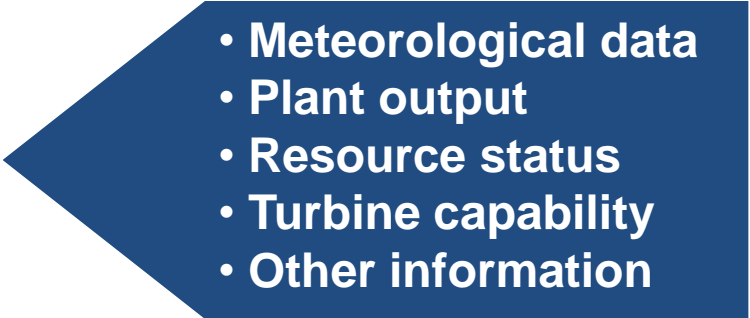
Sufficient lead-time needed for preventive and corrective actions



- **Additional flexible resources**, such as demand response, plug-in hybrid electric vehicles, and energy storage may help balance steep “ramps”
- Deploying **complementary types of variable generation** (e.g. wind and solar) **leveraging fuel diversity** over large geographic regions, and **advanced control technologies** show promise in managing unique operating characteristics
- Greater **access to larger pools of generation and demand** may facilitate the large-scale integration of variable resources
- Increased reliance on **gas generation**



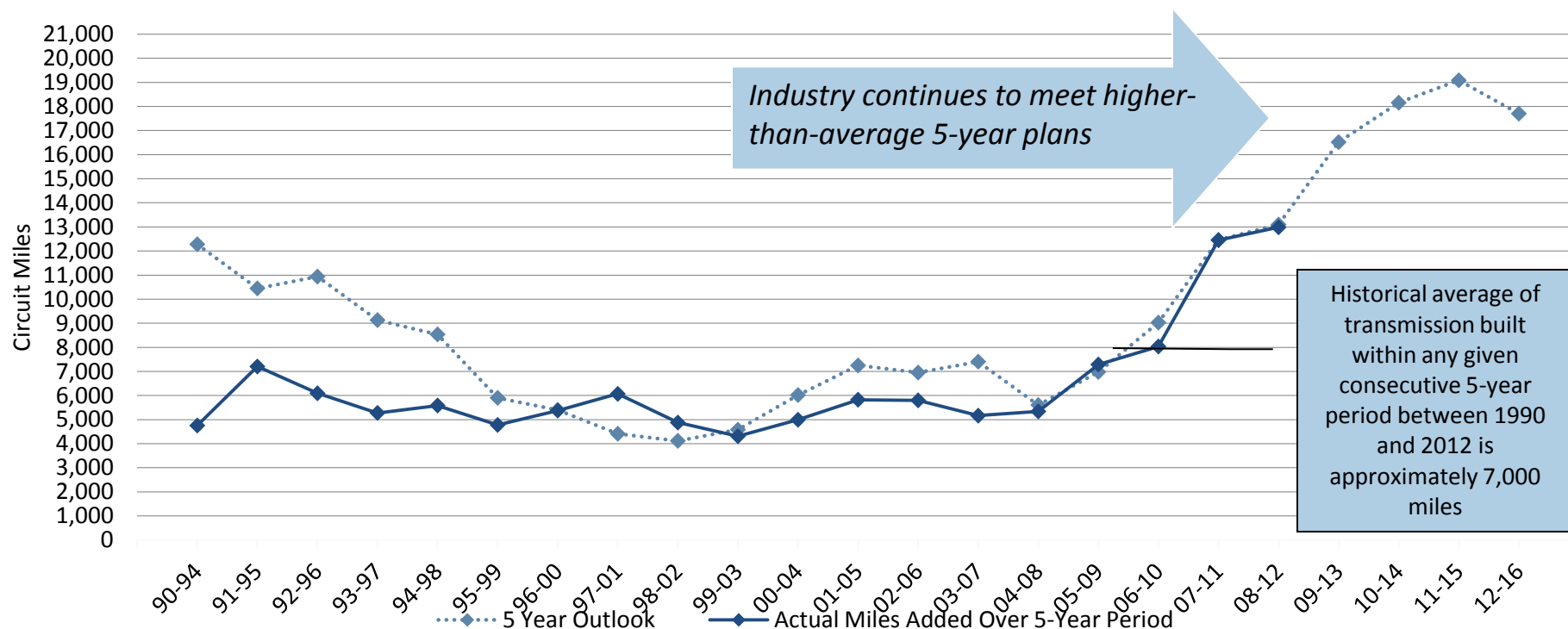
- Four characteristics of conventional generation that VERs should also provide:
 - Capability to provide reactive power support;
 - Capability to increase or reduce energy output automatically, in response to system frequency;
 - Ability to limit power production as needed for the promotion of reliability; and
 - Capability to provide inertial response.

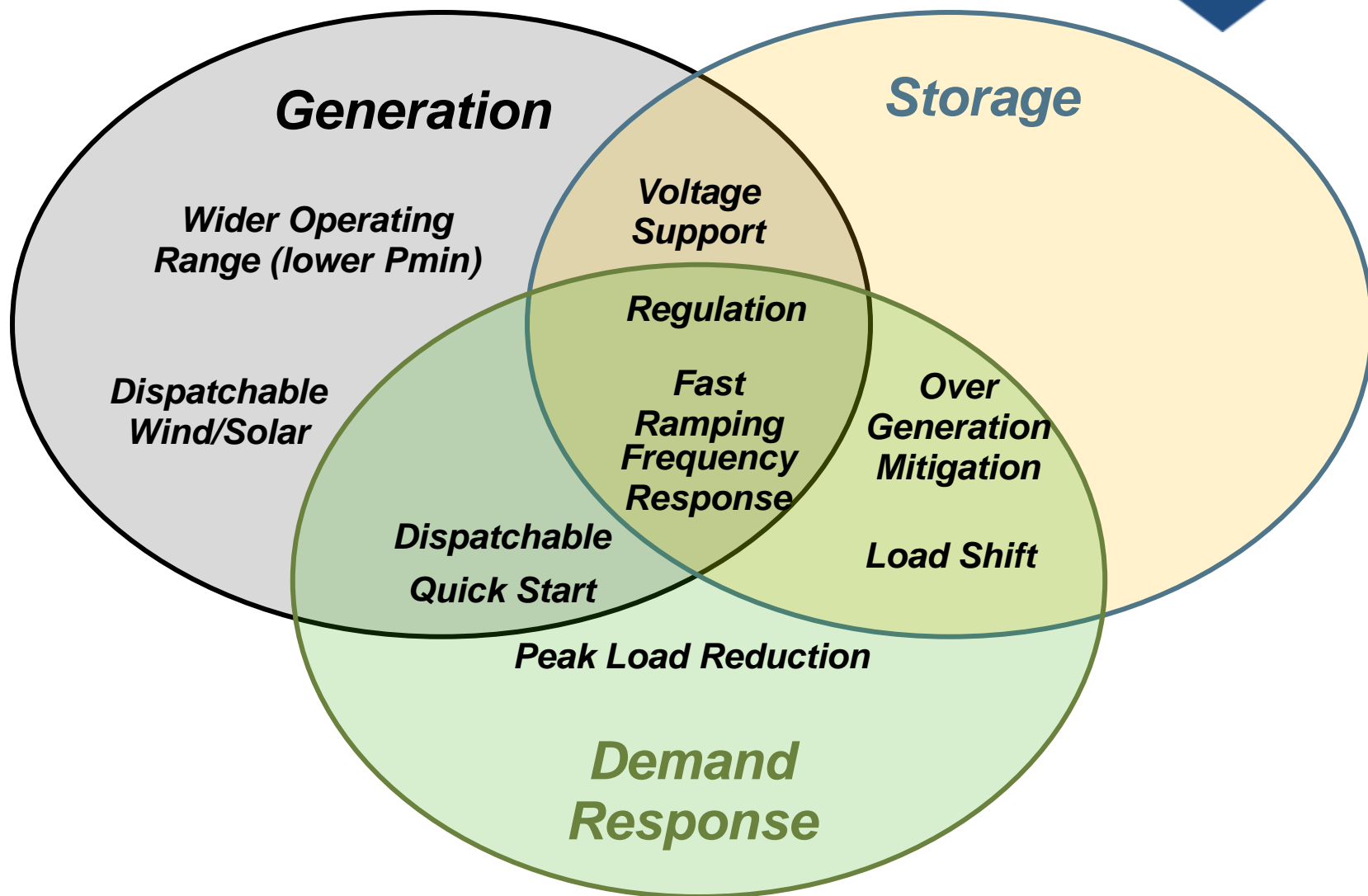
- Interconnection Standards
 - Low-voltage ride through (disturbances)
 - Protection and Relay
 - Active/Reactive Power Control
 - Communication
 - Telemetry
 - Control
 - Data and Information
 - Standard non-proprietary models
 - Forecasting and availability
- 
- Meteorological data
 - Plant output
 - Resource status
 - Turbine capability
 - Other information

Market Enhancements – California ISO

- Active flexible capacity procurement
- Dynamic transfers
- Lower bid floor to incentivize economic curtailment
- Pay-for-performance regulation
- FERC 764, intra-hour scheduling
- Proposed enhancements to the California Public Utilities Commission's (CPUC) resource adequacy program
- Energy Imbalance Market (Regional Coordination)
- Dispatchable VERs

Overall Growth of Transmission Infrastructure Responding to Increased Plans to Integrate and Deliver New Resources







Questions and Answers

- **NERC Reports on Accommodating High Levels of Variable Generation:**
 - [DRAFT Joint NERC-CAISO Special Reliability Assessment: Maintaining Bulk Power System Reliability While Integrating Variable Energy Resources to Meet Renewable Portfolio Standards](#)
 - [Interconnection Requirements for Variable Generation, NERC, September 2012](#)
 - [Potential Bulk System Reliability Impacts of Distributed Resources](#)
 - [Methods to Model and Calculate Capacity Contributions of Variable Generation for Resource Adequacy Planning](#)
 - [Ancillary Service and Balancing Authority Area Solutions to Integrate Variable Generation](#)
 - [Operating Practices, Procedures, and Tools](#)
 - [Potential Reliability Impacts of Emerging Flexible Resources](#)
 - [Variable Generation Power Forecasting for Operations](#)
 - [Standard Models for Variable Generation](#)
 - [Flexibility Requirements and Potential Metrics for Variable Generation](#)
- **NERC Reports on Accommodating and Increased Dependency on Natural Gas**
 - [Primer \(Phase I\)](#)
 - [Vulnerability Assessment \(Phase II\)](#)
- **NERC Reliability Assessments (Long-Term and Seasonal)**
 - <http://www.nerc.com/pa/RAPA/ra/Pages/default.aspx>