

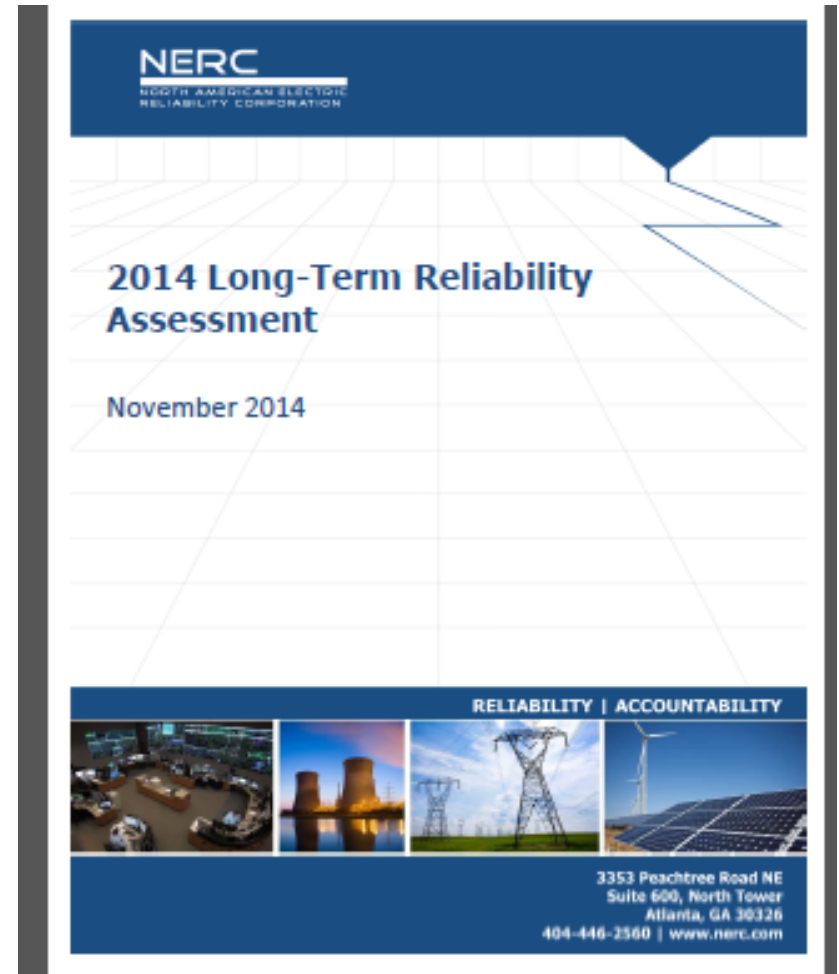
NERC Long-Term Reliability Assessment (LTRA)

Anna Lafoyiannis, Reliability Assessments

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Overview

- Description of LTRA
- 2014 Key Reliability Findings
 - Declining reserve margins
 - Environmental regulations create uncertainty
 - Need for new approaches to assessing reliability
- Other observations
 - Demand forecasting uncertainties
 - Aging infrastructure
- Conclusions



Description of LTRA

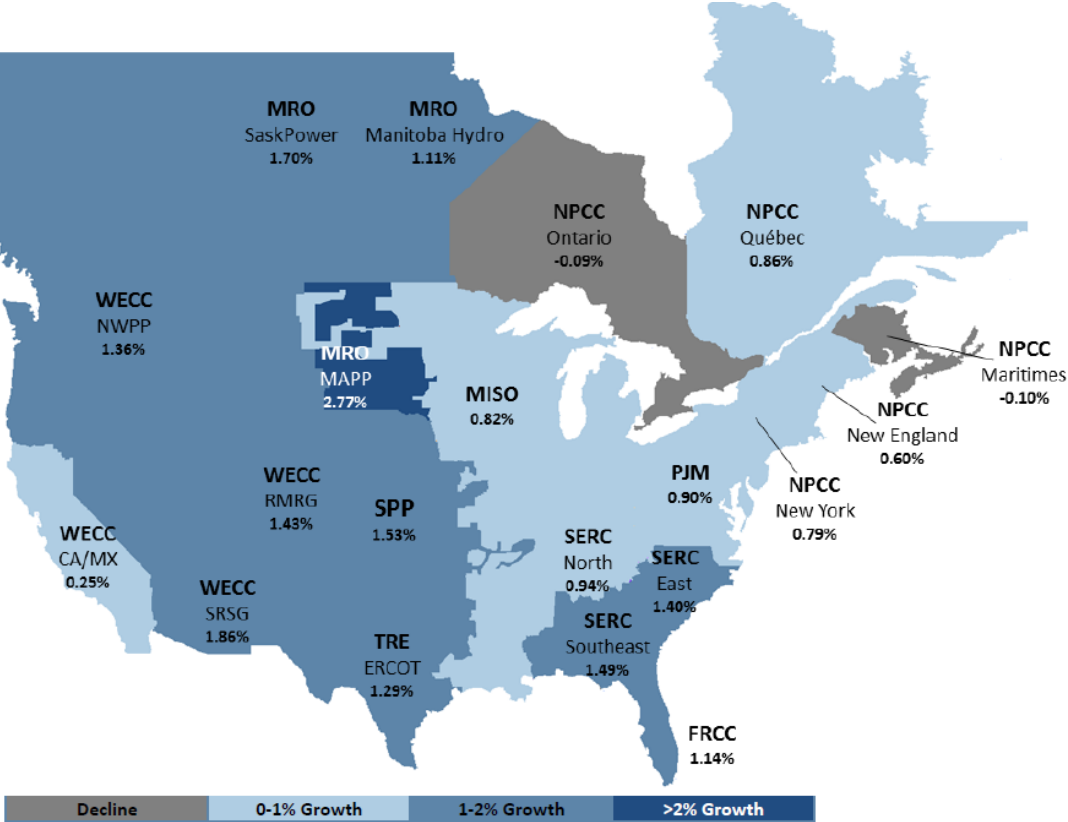
- Periodic assessment of the adequacy of generation, demand-side resources, and transmission systems necessary to meet system reliability needs over the next decade
- Issues that may impact the reliability of the North American grid
- Industry plans to maintain reliability during the next decade
 - Frequency: Annual
 - Horizon: Ten years
 - Area: NERC wide

2014 LTRA Key Findings

- Reserve Margins have been trending downward in some areas, despite low load growth
- Environmental regulations create uncertainty—need to identify and address potential reliability impacts
- Changing resource mix requires new approaches to assessing reliability

Reserve Margins:

Low Load Growth



10-Year Compound Annual Growth Rate
(Peak Season)

Current Trends:

- Economic factors
- Energy efficiency
- Conservation
- Distributed generation

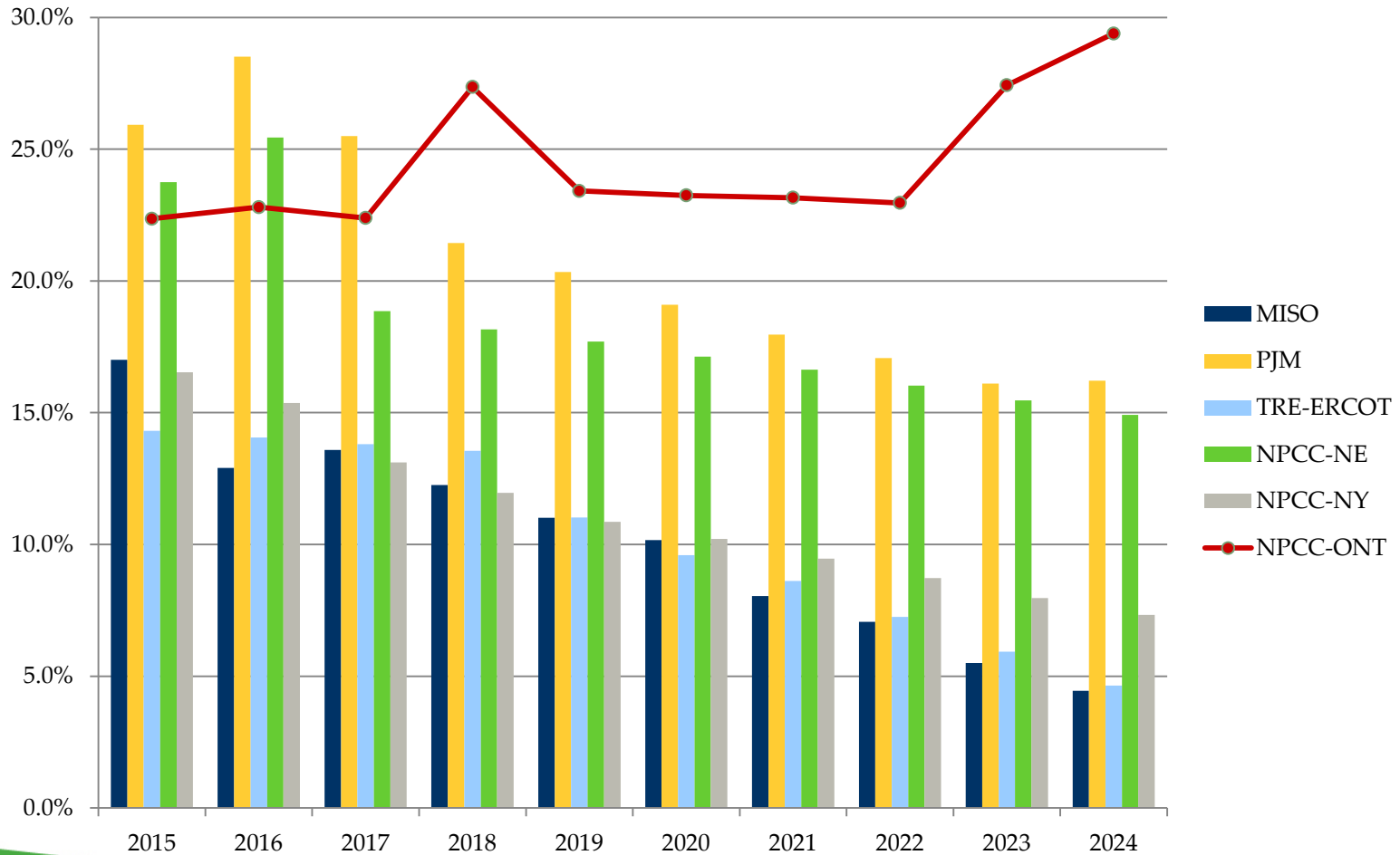
NERC Findings:

- Most areas show growth below 2%

Ontario Perspective:

- Low load partially driven by embedded generation, conservation & demand side management

Reserve Margins: Declining in Some Areas

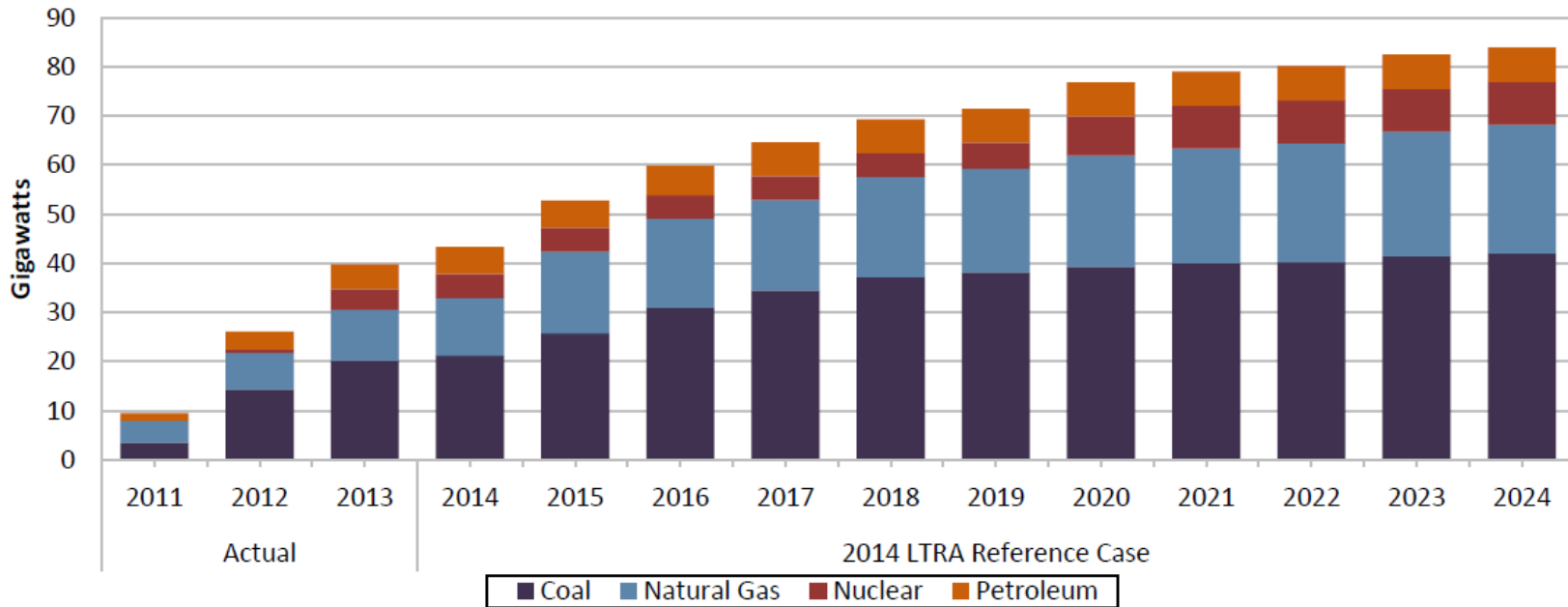


Environmental Regulations

- Current Trend:
 - Variety of new environmental regulations
- NERC Findings:
 - Regulations can drive changes to resource mix
 - Industry should study the reliability impacts of regulations
- Ontario's Perspective:
 - Major regulation was directive to shut down coal
 - Reliability studies and other preparations took place to ensure reliability was maintained throughout the transition

Changing Resource Mix:

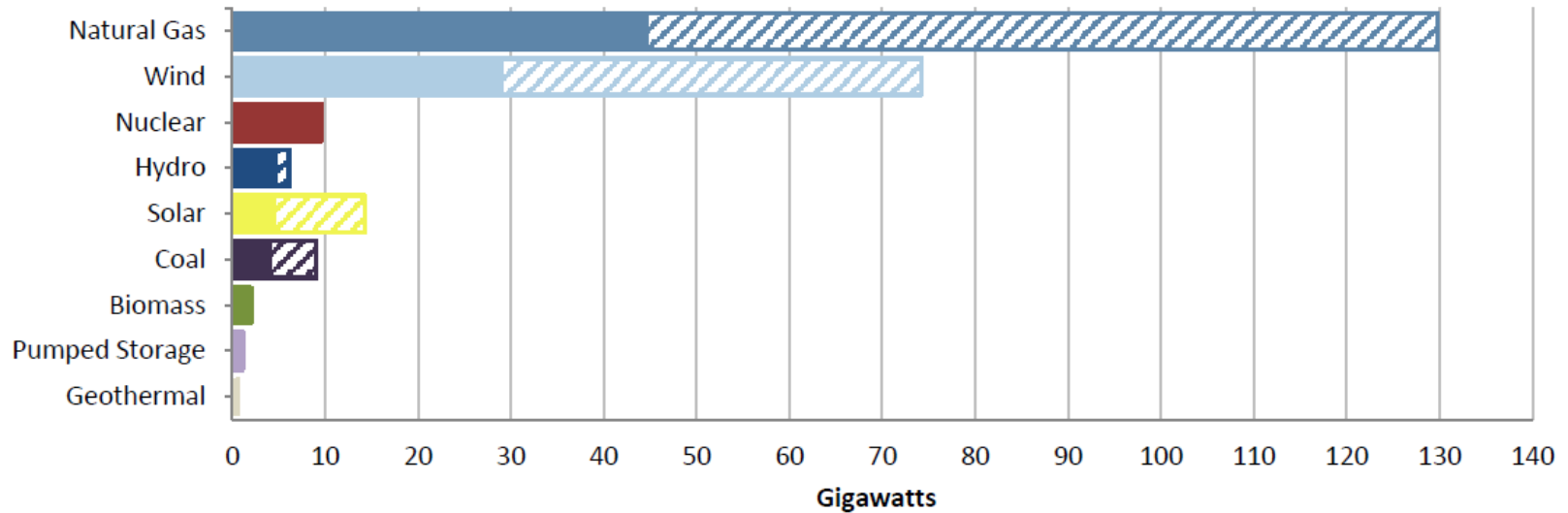
Expected Retirements



Cumulative Fossil-Fuel and Nuclear Retirements between 2011 and 2024

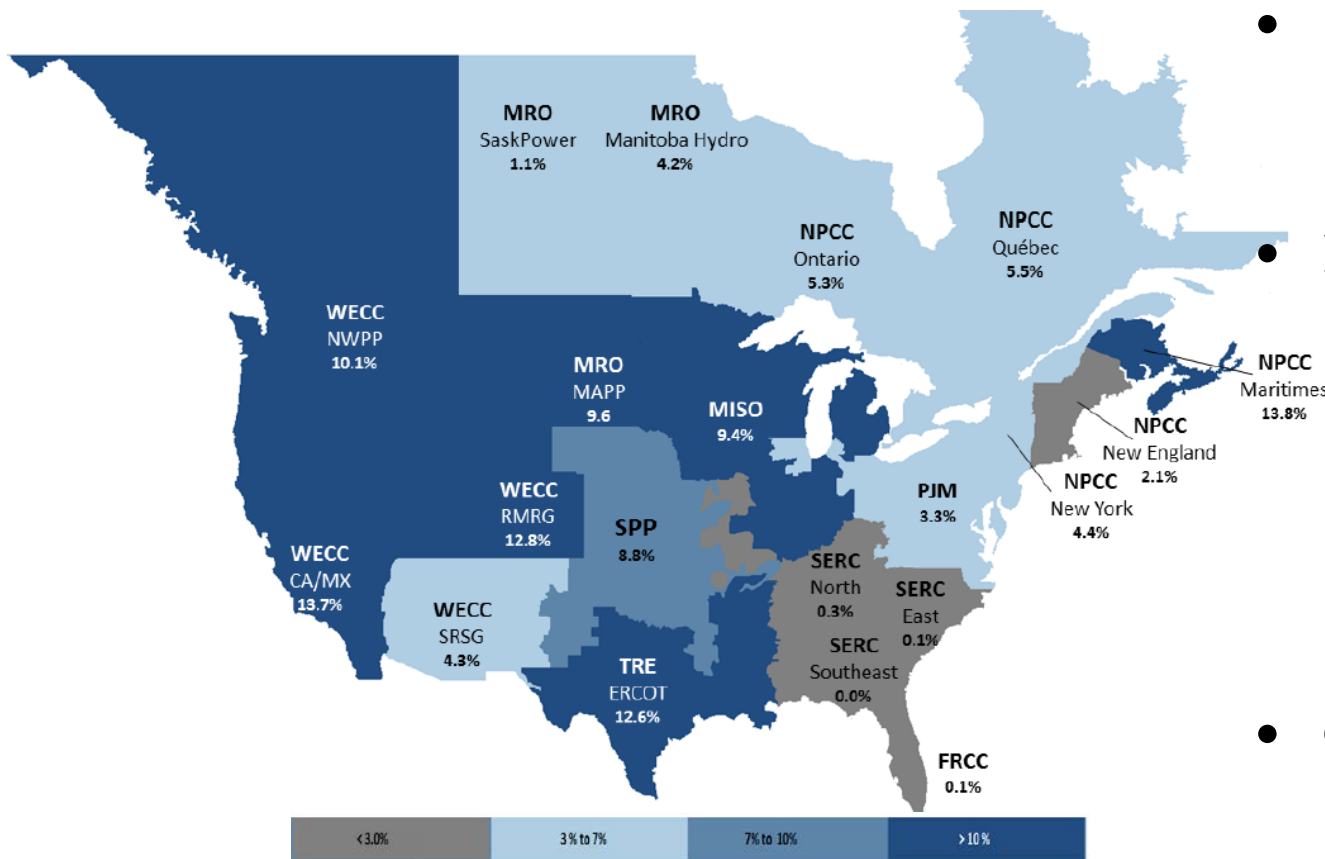
Changing Resource Mix:

Expected Additions



NERC Wide Additions between 2015-2024 by Fuel Type

Changing Resource Mix: Growth in Wind and Solar Generation



Existing Variable Energy Resources Penetration (Nameplate) as a Portion of the 2015 Generation Mix

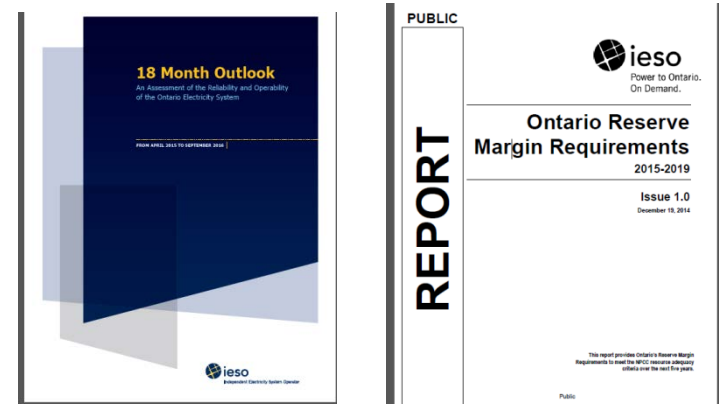
- Current Trend:
 - Policies encourage wind & solar
 - Decline in cost
- NERC Findings:
 - System Planners should account for:
 - On-peak availability
 - Ramping capability
 - Voltage & frequency support
 - Grid operators face challenges due to ramps in power output
- Ontario:
 - Renewable Integration Initiative
 - Performance Requirements

Changing Resource Mix:

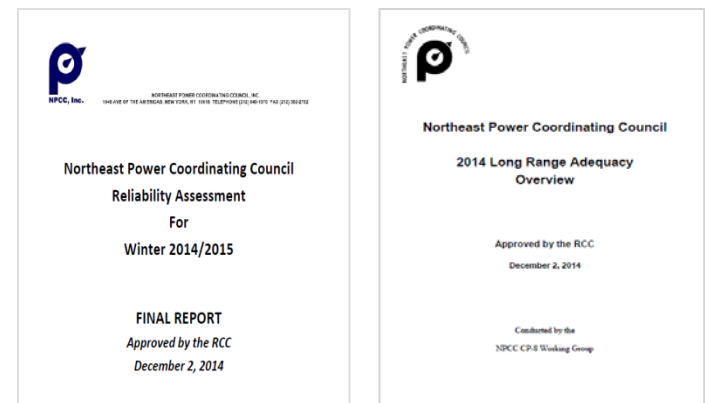
Drives Need for New Approaches for Assessing Reliability

- Traditional adequacy assessments focus on peak requirements
- Suggested enhancements:
 - probabilistic assessments
 - correlation between fuel availability & weather
 - reliability of variable generation during off-peak hours
 - stresses during shoulder periods
 - transmission adequacy assessments

Ontario Assessments



NPCC Assessments



Other Issues:

Demand Forecasting Uncertainties

- Traditional demand forecasting concerned with uncertainty of weather and economic drivers
- Future demand forecasting will be concerned with uncertainty from:
 - Conservation programs
 - Smart grid technologies
 - Embedded generation
 - Real time pricing
 - Electric vehicles

Other Issues:

Aging Infrastructure

- Causes:
 - Unavailability of spare parts
 - Obsolescence of older equipment
 - Outage scheduling restrictions
 - Integration of new technology
- NERC Finding:
 - Investment has increased, but varies widely across regions
- Ontario Perspective:
 - Hydro One plans to invest \$688M in next 3 years on transmission renewal
 - Long Term Energy Plan to coordinate generation renewal

Conclusions

- North America's grid is changing:
 - Some reserve margins are declining
 - New environmental regulations may drive retirements
 - Changing resource mix requires new approaches for managing reliability
 - Demand forecast uncertainty is more complex
 - Aging infrastructure requires investment
- Ontario is well equipped to address emerging reliability issues

References

- 2014 NERC LTRA is located at:
http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/2014LTRA_ERATTA.pdf