Long-Term Reliability Assessment 2020

Webinar

Tuesday, December 8, 2020 | 10:00 a.m. to 12:00 p.m.

MIDWEST RELIABILITY ORGANIZATION

380 St. Peter St, Suite 800
Saint Paul, MN 55102
651-855-1760
www.MRO.net

LOGISTICS

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Audio Conference information: +1-415-655-0002 US Toll Global call-in numbers

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Audio
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Questions
If you have questions for a speaker, please utilize WebEx's chat feature. Please submit all questions to the "Host & Presenter." If we are unable to get all questions asked/answered during the conference, a response will be provided after the conference either directly to the requestor or through another form of outreach.

Presentations
All presentations from today's conference are available in this packet. The individual presentations and recordings from today's conference will be made available in the near future.

Feedback
Your feedback is very important to us. Please utilize the link: https://www.surveymonkey.com/r/LTRA2020 also at the end of this packet, to provide your feedback.

AGENDA

Tuesday, December 8, 2020 | 10:00 a.m. to 12:00 p.m.

10:00 a.m.	**Welcome** *Moderator: Salva Andiappan, Principal Reliability Assessment Engineer*
10:05 a.m. – 10:25 a.m.	*Mark Olson, North American Electric Reliability Corporation*
10: 25 a.m. – 10:50 a.m.	*Suman Thapa, Saskatchewan Power*
10:50 a.m. – 11:15 a.m.	*Kelly Hunter, Manitoba Hydro*
11:15 a.m. – 11:35 a.m.	*Stuart Hansen, Midcontinent Independent System Operator*
11:35 a.m. – 12:00 p.m.	*Chris Haley, Southwest Power Pool*
12:00 p.m.	**Closing** *Moderator: Salva Andiappan, Principal Reliability Assessment Engineer*

SPEAKER BIOGRAPHIES

Salva Andiappan, Moderator

MRO Principal Reliability Assessment Engineer

Salva Andiappan is the Principal Reliability Assessment Engineer at Midwest Reliability Organization (MRO) with over 21 years of experience in transmission planning, power system modeling and reliability assessments. At MRO, Salva works in the Reliability Assessment and Performance Analysis (RAPA) program area and is involved in various committees and activities at MRO, NERC and ERAG. Prior to joining MRO in 2006, Salva spent 5 years with Midcontinent Independent System Operator (MISO), as a senior transmission planning and on-call operations engineer supporting MISO MTEP and conducting daily power flow and dynamic security analysis and developing operating guides. He was also on the August 4th 2003 Northeast Blackout technical team and system disturbance analyst. Salva also worked for Mid-Continent Area Power Pool (MAPP) as Engineer III where he was responsible for performing reliability assessments, power flow modeling and operating studies including inter-regional transfer capability studies for MAPP, MAIN and SPP regions.

Salva has a Bachelor of Science in Electrical Engineering from St. Cloud State University, Minnesota and Masters of Science in Electrical Engineering from University of North Dakota.

Contact Salva: salva.andiappan@mro.net

Mark Olson

Manager, Reliability Assessments, North American Electric Reliability Corporation (NERC)

Mark Olson joined NERC in October 2012 and has been involved with Reliability Assessments, Reliability Standards, and ERO Technical Committees. Before joining NERC, Mark was a career officer in the U.S. Navy where he served in positions related to the operations and management of surface ships and naval personnel. He has a master's degree in electrical engineering from the Naval Postgraduate School and a bachelor's degree from the U.S. Naval Academy. He holds a Professional Engineer license in the State of Georgia.

Contact Mark: Mark.Olson@nerc.net

Suman Thapa

Senior Engineer, Saskatchewan Power

Suman Thapa works as a Senior Engineer in SaskPower's System Planning and Asset Management department and has been with SaskPower for seven years. His work in SaskPower focuses on Transmission System Planning, Generation Interconnections and Interconnections with adjacent areas. Mr. Thapa's work also includes reliability assessments for several NERC reliability standards (TPL, PRC and MOD) that are adopted in Saskatchewan. He represents SaskPower in SaskPower-Manitoba Hydro Planning Committee and Canadian Utility Forum. He received the Ph.D. in Electrical Engineering from University of Saskatchewan and is a registered Professional Engineer in Saskatchewan.

Contact Suman: sthapa@saskpower.com

Kelly Hunter

Senior Engineer, Manitoba Hydro)

Kelly Hunter is a senior engineer with responsibilities for market and resource adequacy analysis with Manitoba Hydro's Resource Planning Department. Kelly has been with Manitoba Hydro over 30 years. The first decade of his career was spent in the mechanical design and construction areas working on the rehabilitation of hydro generation equipment and auxiliary systems. The second decade of his career was spent in Manitoba Hydro's Export Power Marketing Department, with responsibilities that included regulatory affairs, market modeling, risk analysis, credit oversight, wind integration studies and MISO market stakeholder relations. For the last 10 years, his responsibilities in Resource Planning have included long term price forecasting, market, reliability and risk modeling, provincial regulatory affairs, and overseeing Manitoba Hydro's submissions for NERC's Long Term Reliability Assessment.

Mr. Hunter graduated from the University of Manitoba with a Bachelor of Science in Mechanical Engineering in 1987. He later received his Master of Business Administration, also from the University of Manitoba, in 1995.

Contact Kelly: khunter@hydro.mb.ca

Stuart Hansen

Advisor II, Resource Adequacy Policy and Analytics, Midcontinent Independent System Operator (MISO)

Mr. Hansen has been with MISO since 2012, working in transmission planning doing resource forecasting and policy assessment until January 2019. He then moved to resource adequacy conducting the annual OMS-MISO survey used in the LTRA, interfacing with the NERC RAS and working on other resource accreditation issues. Prior to working at MISO Mr. Hansen was with the MN PUC for 3 years assisting the commission in technical issues, keeping up with industry advancements and MISO issues. He also worked for FERC in the Office of Electric Reliability evaluating NERC Reliability Standards for just over a year. Mr. Hansen began his career at the US Patent & Trademark Office examining power supply patent applications

Mr. Hansen graduated from the University of Minnesota with a Bachelor of Science in Electrical Engineering in 2006.

Contact Stuart: shansen@misoenergy.org

Chris Haley

Senior Planning Specialist Southwest Power Pool

Chris Haley is a Senior Planning Specialist in the Reliability Assurance department at Southwest Power Pool. Chris began employment with SPP in 2006, and since that time has been involved with NERC standards, NERC assessments, as well as FERC reporting and SSAE16 process related. Chris is currently the Subject Matter Expert for Resource Adequacy policy issues, Staff Secretary for the Supply Adequacy Working Group (SAWG) and is a member of the NERC Reliability Assessment Subcommittee.

Contact Chris: chaley@spp.org

PRESENTATIONS

All presentations for today's webinar are included in order of presentation. Some presentations may have changed slightly after the print deadline.

MIDWEST RELIABILITY ORGANIZATION

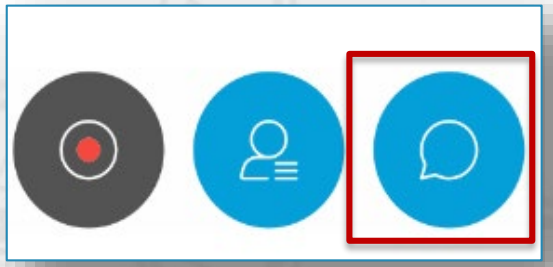
2020 Long-Term Reliability Assessment Overview

December 8, 2020

Mark Olson, North American Electric Reliability Corporation
Suman Thapa, Saskatchewan Power
Kelly Hunter, Manitoba Hydro
Stuart Hansen, Midcontinent Independent System Operator
Chris Haley, Southwest Power Pool

WebEx Chat Feature

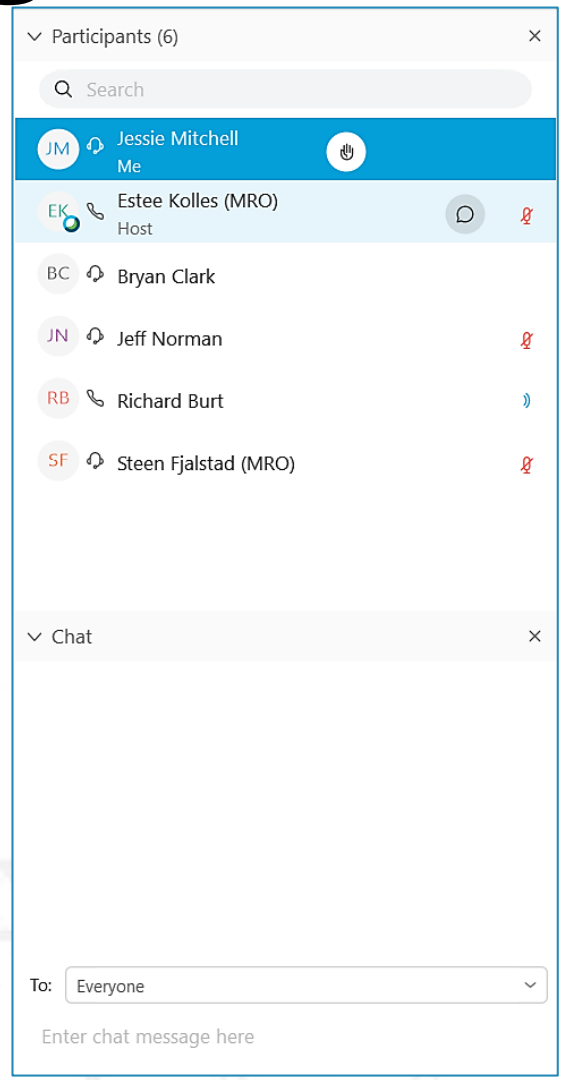
Open the Chat Feature:



The chat feature will appear to the right of the WebEx window.

Attendees should chat their questions to: “Dana Klem”.

Select Dana Klem by using the drop down arrow in the “To” field.



Long-Term Reliability Assessment (LTRA)

- **Coordination and Review:**
  - NERC
  - MRO Reliability Advisory Council (RAC)
- **High-level assessment of resource adequacy**
- **Demand growth, generation and transmission additions**
- **Emerging issues and trends**

MRO Assessment Areas

- Manitoba Hydro
- Midcontinent ISO
- Saskatchewan Power Corporation, and
- Southwest Power Pool

Assessment Area Summary

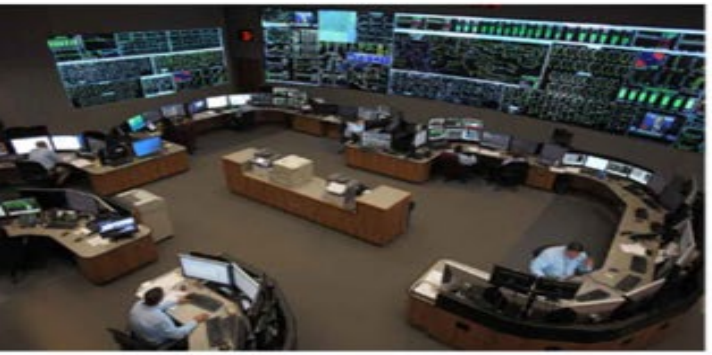
- Key takeaways
- Change since last year's assessment
- Reliability impact for the next 10 years
- Study process or methodology changes

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

2020 Long-Term Reliability Assessment

Mark Olson, Manager, Reliability Assessments
MRO LTRA Webinar
December 8, 2020

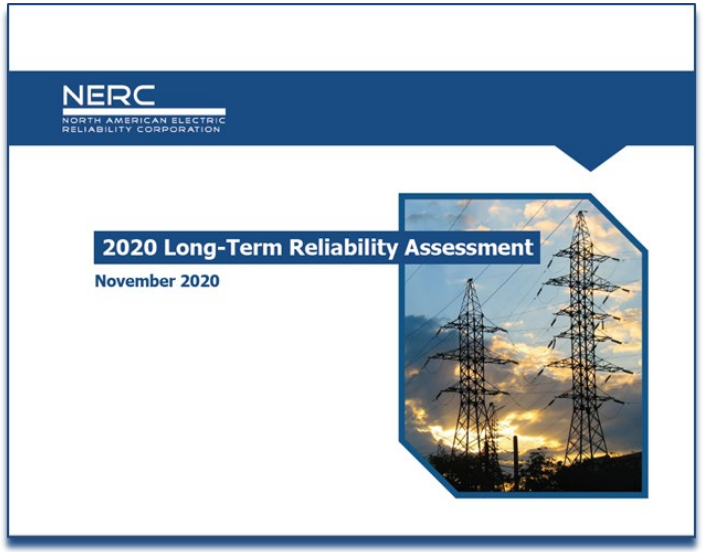
RELIABILITY | RESILIENCE | SECURITY




NERC Reliability Assessments

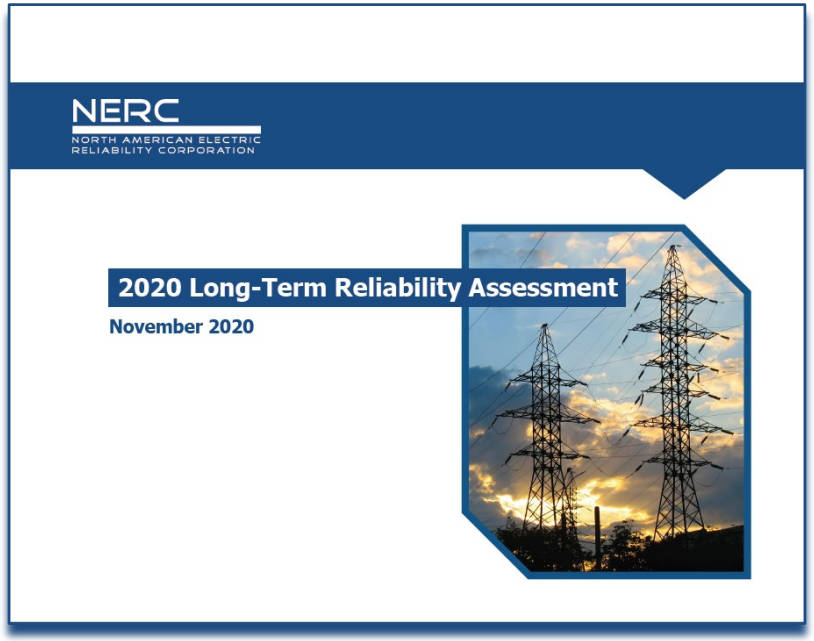
The Electric Reliability Organization shall conduct assessments of the adequacy of the Bulk-Power System in North America and report its findings to the Commission, the Secretary of Energy, each Regional Entity, and each Regional Advisory Body annually or more frequently if so ordered by the Commission.

-U.S. Federal Energy Regulatory Commission (FERC) Regulations



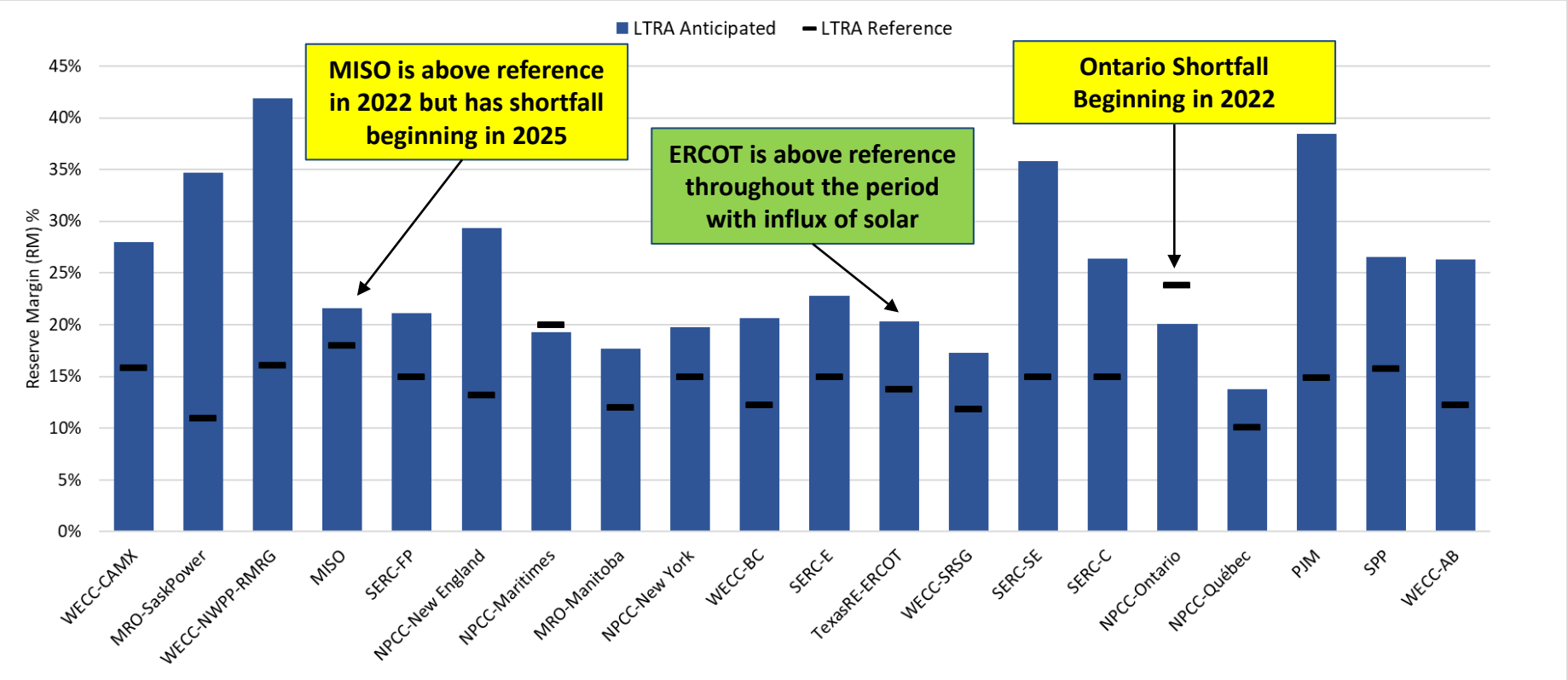
NERC Reliability Assessments

- Reliability
  - Resource Adequacy
  - Operating Reliability
- Transmission adequacy
- Demand and Generation forecasts
- Key issues - emerging trends
- 2020 LTRA findings cover five topics:
  - Planning Reserve Margins
  - Assessing Resource Adequacy across All Hours (Energy Assurance)
  - Changing Resource Mix
  - Distributed Energy Resource Impacts
  - Pandemic Impacts



Finding:
Planning Reserve Shortfalls in Few Areas

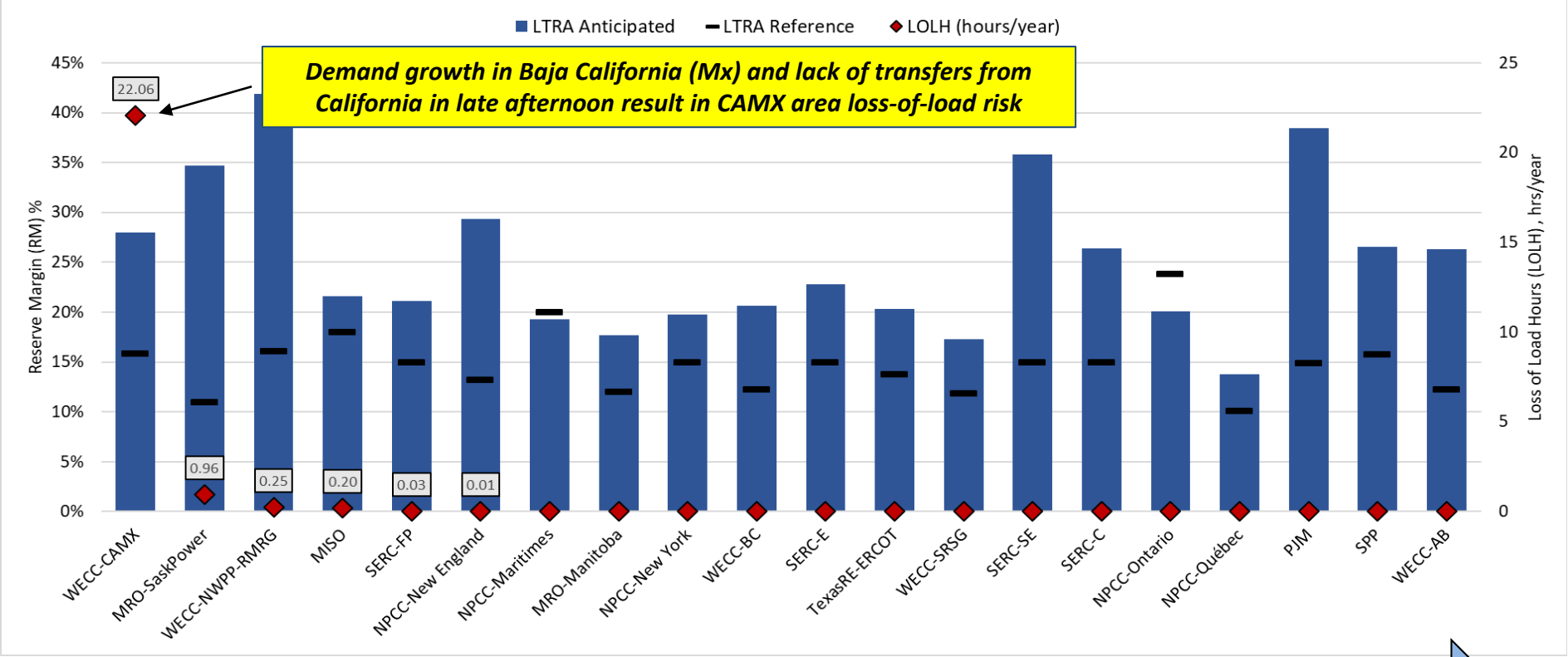
- Planned reserves fall below the Reference Margin Level in NPCC-Ontario and MISO during the first five years
  - Resource on-peak capacity is sufficient in all other areas



Anticipated Reserve Margins and Reference Margin Levels for 2022 Peak Season

Finding:
Probabilistic Assessment Highlights Risk Across All Hours

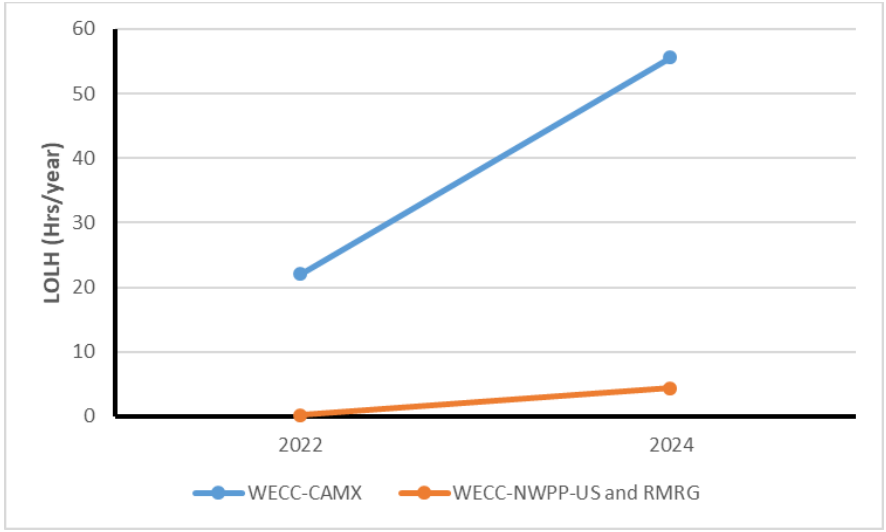
- Probabilistic evaluations of all demand hours identify resource adequacy risks at peak and off-peak



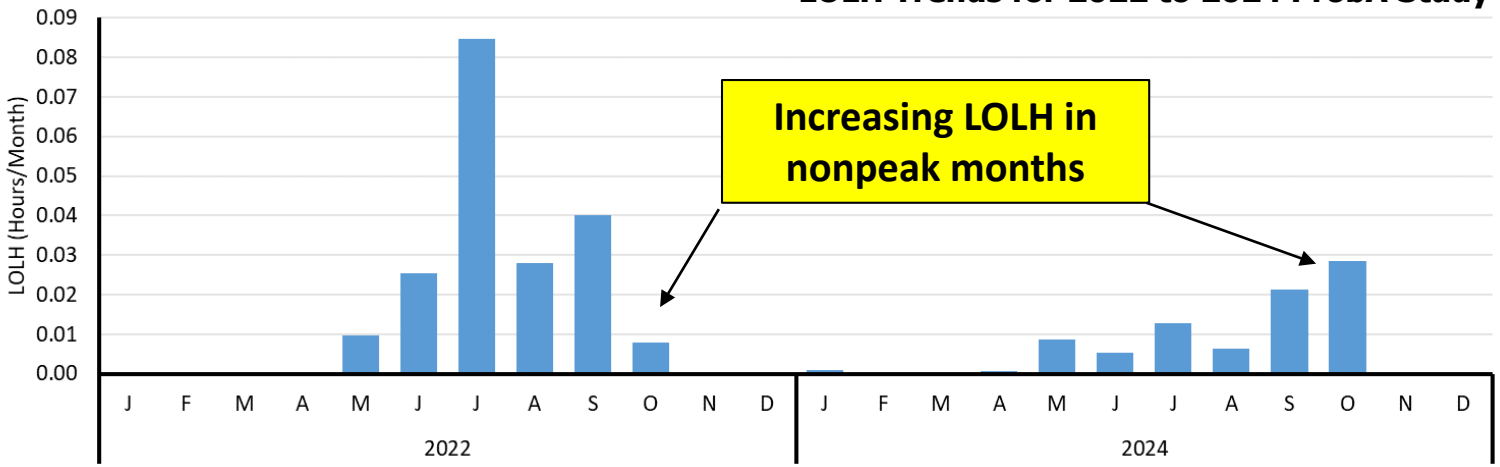
Reserve Margins and Loss-of-Load Hours (LOLH) for 2022 Peak Season

Finding:
Probabilistic Assessment Highlights Risk Across All Hours

- Indications of off-peak risk are emerging in other areas
  - LOLH and Expected Unserved Energy Trends
  - Reduced expected operating reserves during shoulder months or off-peak hours



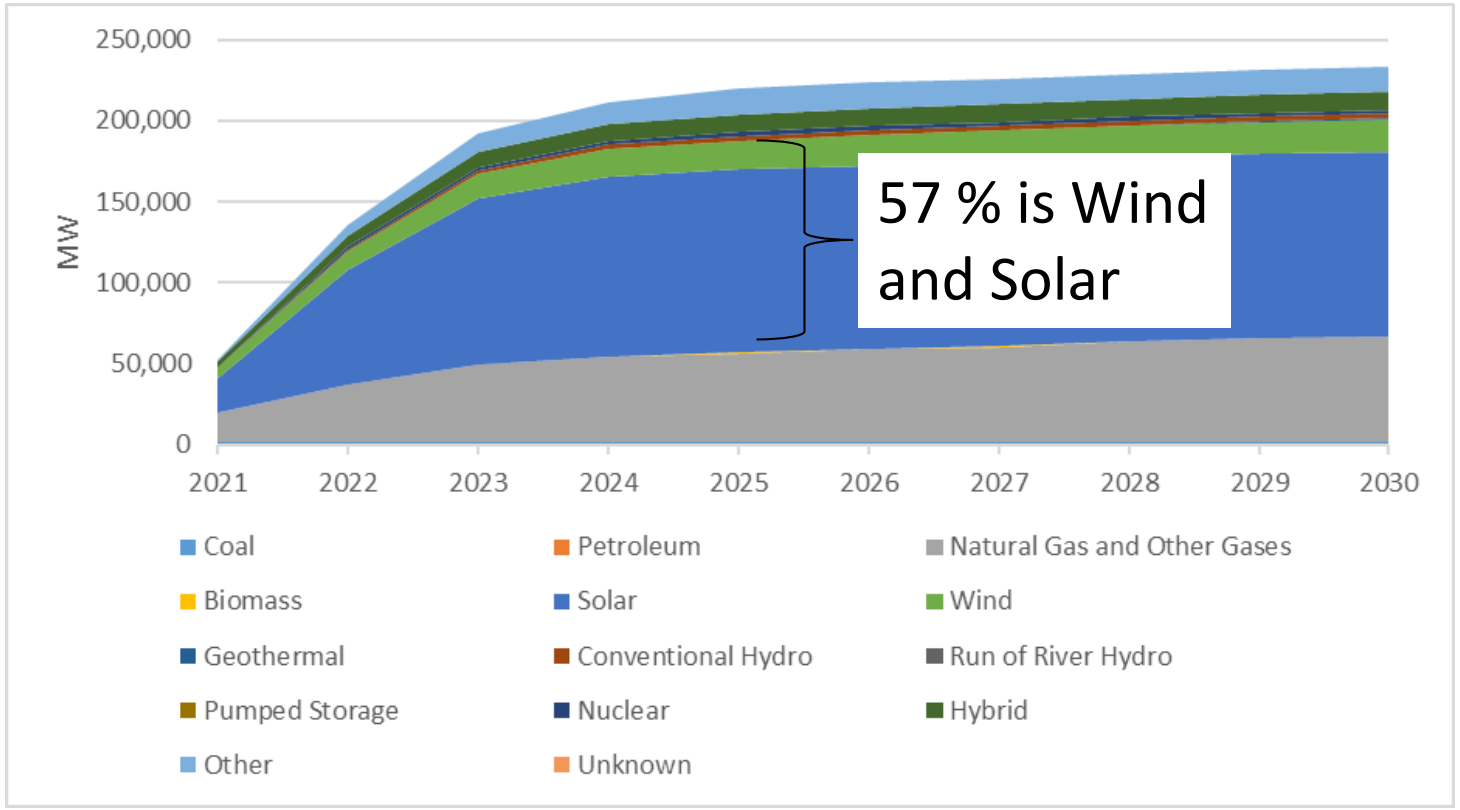
LOLH Trends for 2022 to 2024 ProbA Study Years



MISO Monthly LOLH for Study Years 2022 and 2024

Finding:
Variable Resources Growth Expected to Surpass All Other Future Generation

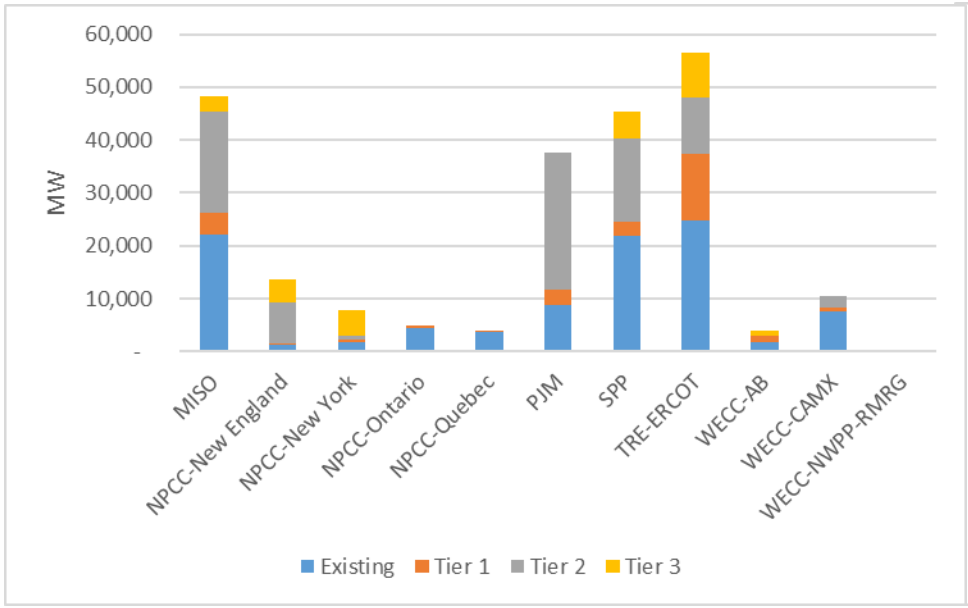
- Variable generation is surpassing natural gas-fired generation for future capacity additions to the grid



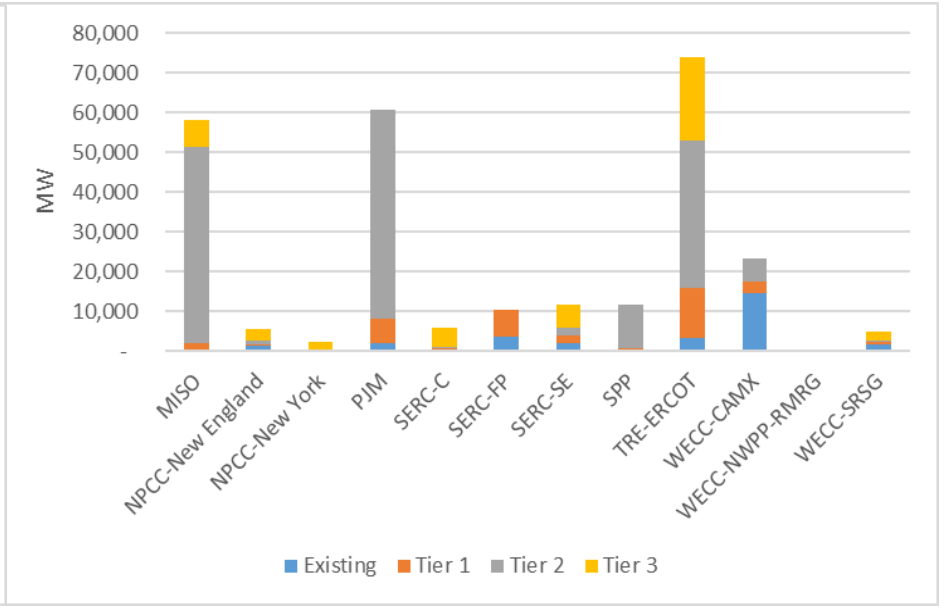
On-Peak Capacity of Generation Additions in Planning (Tiers 1 and 2) Through 2030

Finding:
Variable Resources are Overtaking Other New Generation

- Texas, PJM, and MISO have the most Solar and Wind Generation in planning over the 10-year assessment period



Wind

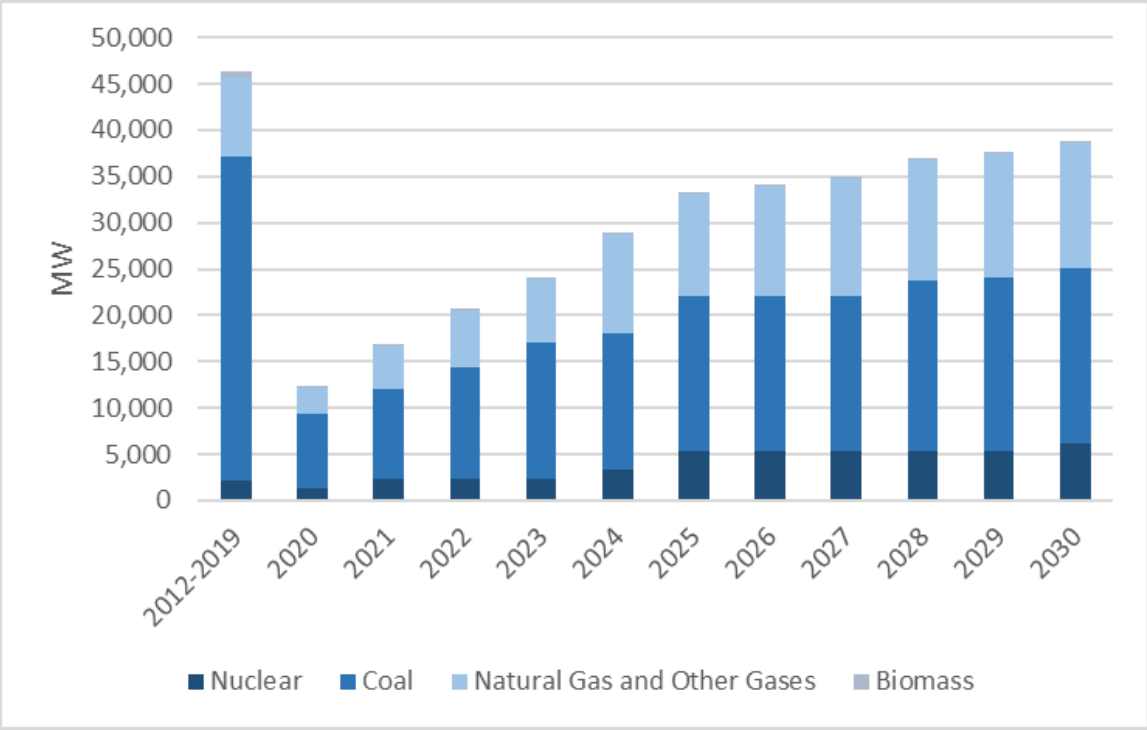


Solar

Existing and In-Planning Resources Through 2030 (Nameplate)

Generator Retirements

- Additional fossil-fueled generator retirements are anticipated as a result of economic uncertainty and policy goals
  - Projections below are for Confirmed Retirements ONLY



Capacity Retirements Since 2012 and Projected Cumulative Retirements Through 2030 (Confirmed)

Generator Retirements

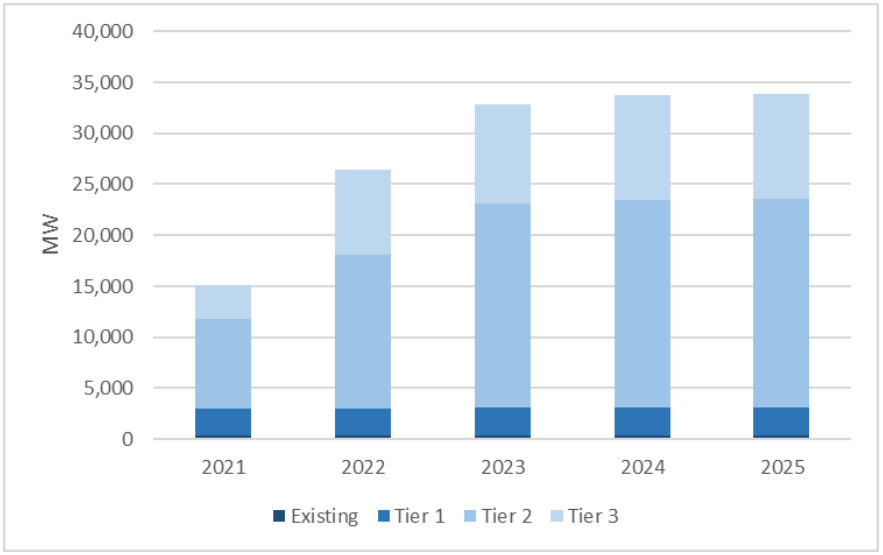
- Future resource retirements are challenging to predict, but are expected to be higher than what is committed

	2022 Capacity Projected in 2018		2022 Capacity Projected in 2020		2022 Capacity Based On 2018 Stress-Test	
Area	Coal (MW)	Nuclear (MW)	Coal (MW)	Nuclear (MW)	Coal (MW)	Nuclear (MW)
MISO	**57,792**	**11,955**	**51,948**	**12,169**	**40,454**	**6,575**
NPCC New England	**917**	**3,331**	**533**	**3,321**	**644**	**3,331**
NPCC New York	**1,011**	**3,364**	**-**	**3,343**	**707**	**3,334**
PJM	**54,432**	**28,620**	**52,405**	**32,626**	**38,103**	**15,602**
SERC-E	**17,384**	**8,653**	**15,552**	**12,104**	**12,169**	**4,759**
SERC-SE	**18,979**	**8,018**	**16,935**	**6,918**	**13,286**	**5,818**
SPP	**23,439**	**1,943**	**23,172**	**1,944**	**16,407**	**1,173**
TRE-ERCOT	**14,696**	**4,981**	**13,995**	**4,973**	**10,287**	**4,981**
WECC-SRSG	**8,964**	**3,937**	**5,616**	**2,856**	**6,275**	**2,624**

Projections of Year 2022 capacity made in 2018 and 2020. Projections on the left are based on LTRA data and confirmed retirements. Capacity on the right is a 2018 stress-test scenario (*NERC Generation Retirements Report*)

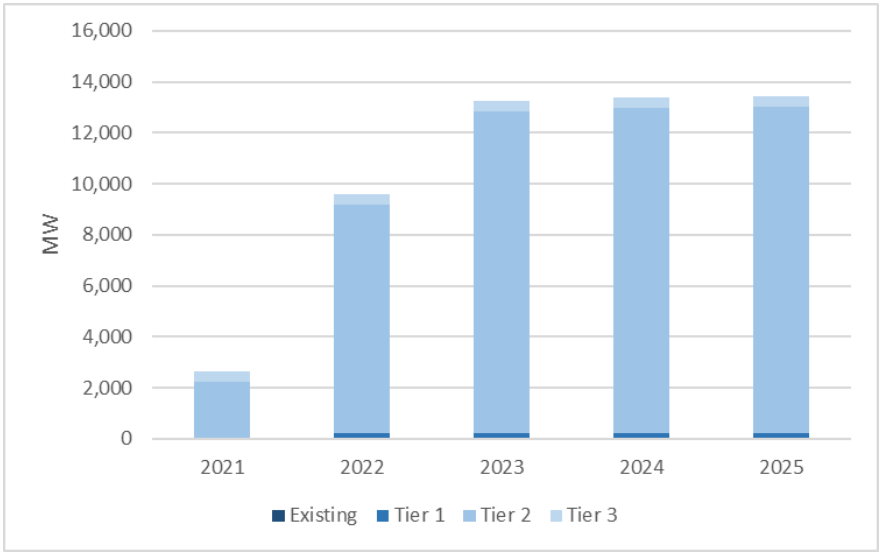
Battery Storage and Hybrid Generation

- Rapid growth and development over the next five years
  - Grid planners and operators need to address modeling, study, and operating issues in the near term for reliable integration



Battery Storage (Existing and Planning)

- **370 MW** Existing
- **23 GW** in Tier 1 and 2



Hybrid Generation (Existing and Planning)

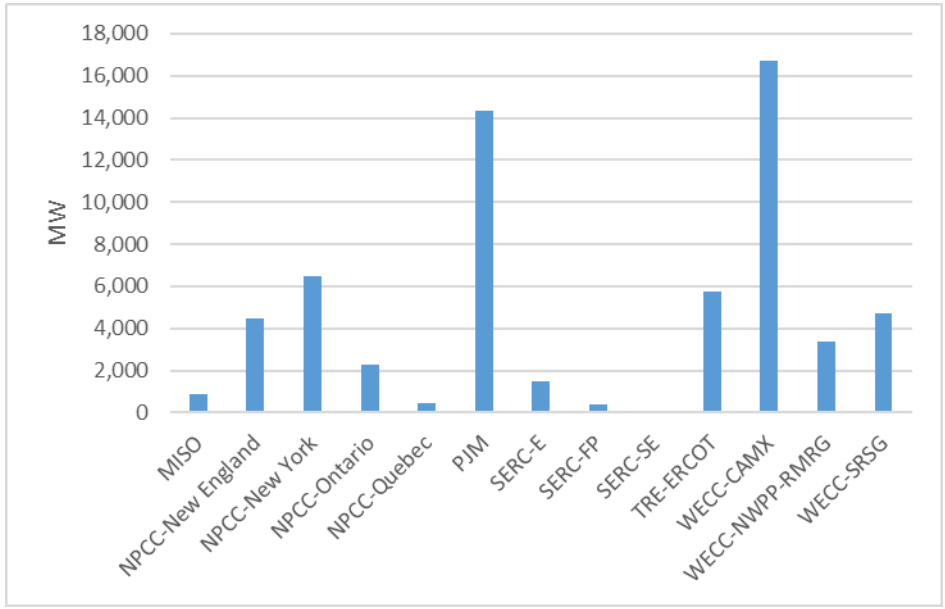
- **<100 MW** Existing
- **13 GW** in Tier 1 and 2

Battery Storage and Hybrid Generation

Battery Storage Capacity in MRO (Existing and In-Planning) Over the 10-year Horizon

Finding:
Distributed Energy Resource (DER) Growth

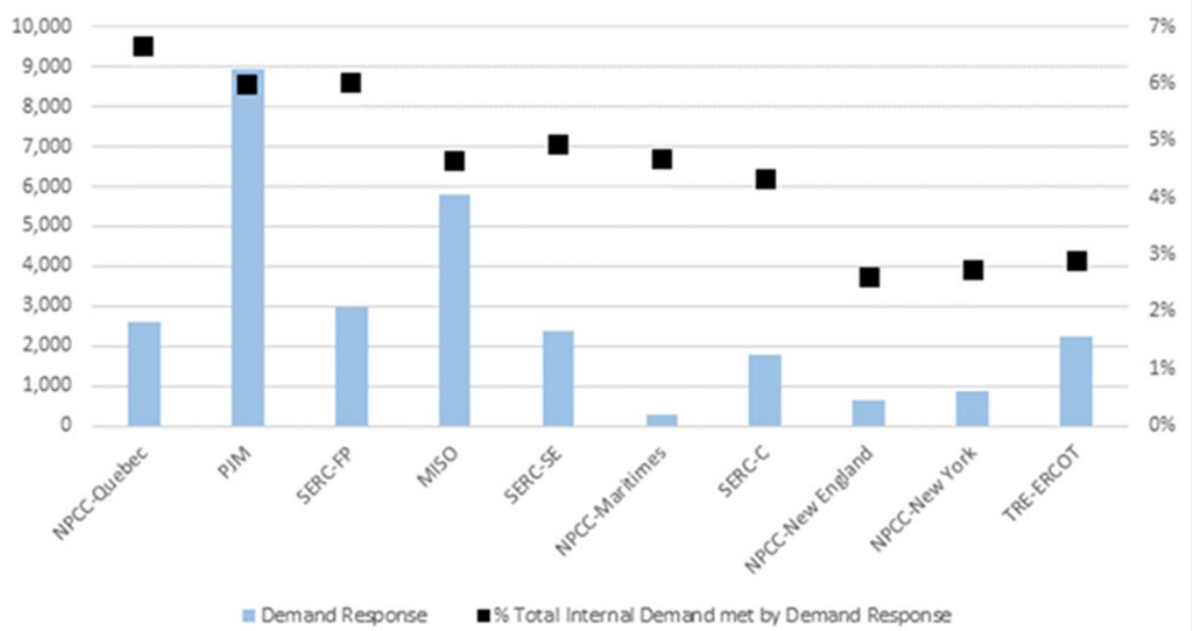
- NERC-wide solar DER are expected to nearly double over the next five years, and triple over the next ten years
- Texas, Ontario, and areas in the U.S. Northeast are approaching impactful levels of DER presently seen in the Western Interconnection



Projected Cumulative Distributed Solar PV Capacity by 2030

Finding: Pandemic Impact

- With the health crisis comes uncertainty in demand forecasts
  - Summer operating experience in many areas showed increased residential demand that can offset decreased commercial/industrial load
- Reduced industrial load can affect the availability of controllable demand response programs



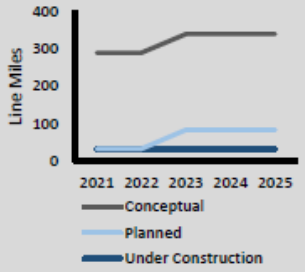
Projected 2021 Peak Season Demand Response – Assessment Areas with Highest DR Contribution to Meeting Total Peak Demand

Example Dashboard

Preliminary 2020

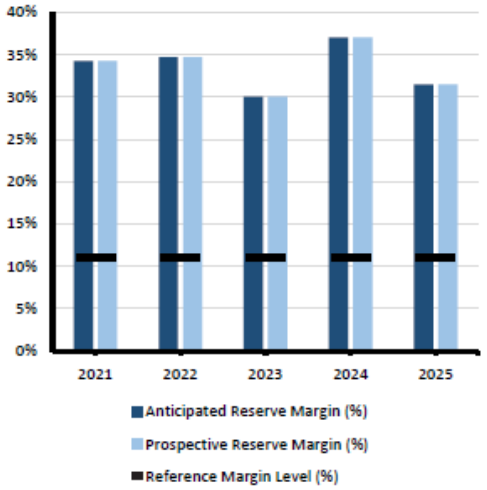
MRO-SaskPower

Saskatchewan is a province of Canada and comprises a geographic area of 651,900 square kilometers and approximately 1.12 million people. Peak demand is experienced in the winter. The Saskatchewan Power Corporation (SaskPower) is the Planning Authority and RC for the province of Saskatchewan and is the principal supplier of electricity in the province. SaskPower is a provincial Crown corporation and under provincial legislation is responsible for the reliability oversight of the Saskatchewan BES and its interconnections.

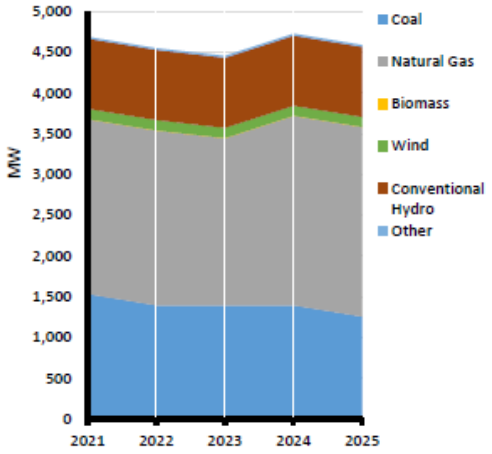


Projected Transmission Circuit Miles

Demand, Resources, and Reserve Margins (MW)										
Quantity	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total Internal Demand	3,576	3,597	3,631	3,648	3,682	3,704	3,686	3,689	3,707	3,728
Demand Response	60	60	60	60	60	60	60	60	60	60
Net Internal Demand	3,516	3,537	3,571	3,588	3,622	3,644	3,626	3,629	3,647	3,668
Additions: Tier 1	77	77	77	430	430	430	430	430	430	430
Additions: Tier 2	0	0	0	0	0	0	349	1,047	1,047	1,047
Additions: Tier 3	0	0	0	40	40	40	40	40	80	80
Net Firm Capacity Transfers	125	290	290	290	290	290	290	290	290	290
Existing-Certain and Net Firm Transfers	4,644	4,687	4,568	4,488	4,332	4,410	4,343	4,325	4,325	4,373
Anticipated Reserve Margin (%)	34.3%	34.7%	30.0%	37.0%	31.5%	32.8%	31.6%	31.0%	30.4%	30.9%
Prospective Reserve Margin (%)	34.3%	34.7%	30.0%	37.0%	31.5%	32.8%	41.2%	47.8%	36.6%	20.8%
Reference Margin Level (%)	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%



Planning Reserve Margins



Existing and Tier 1 Resources

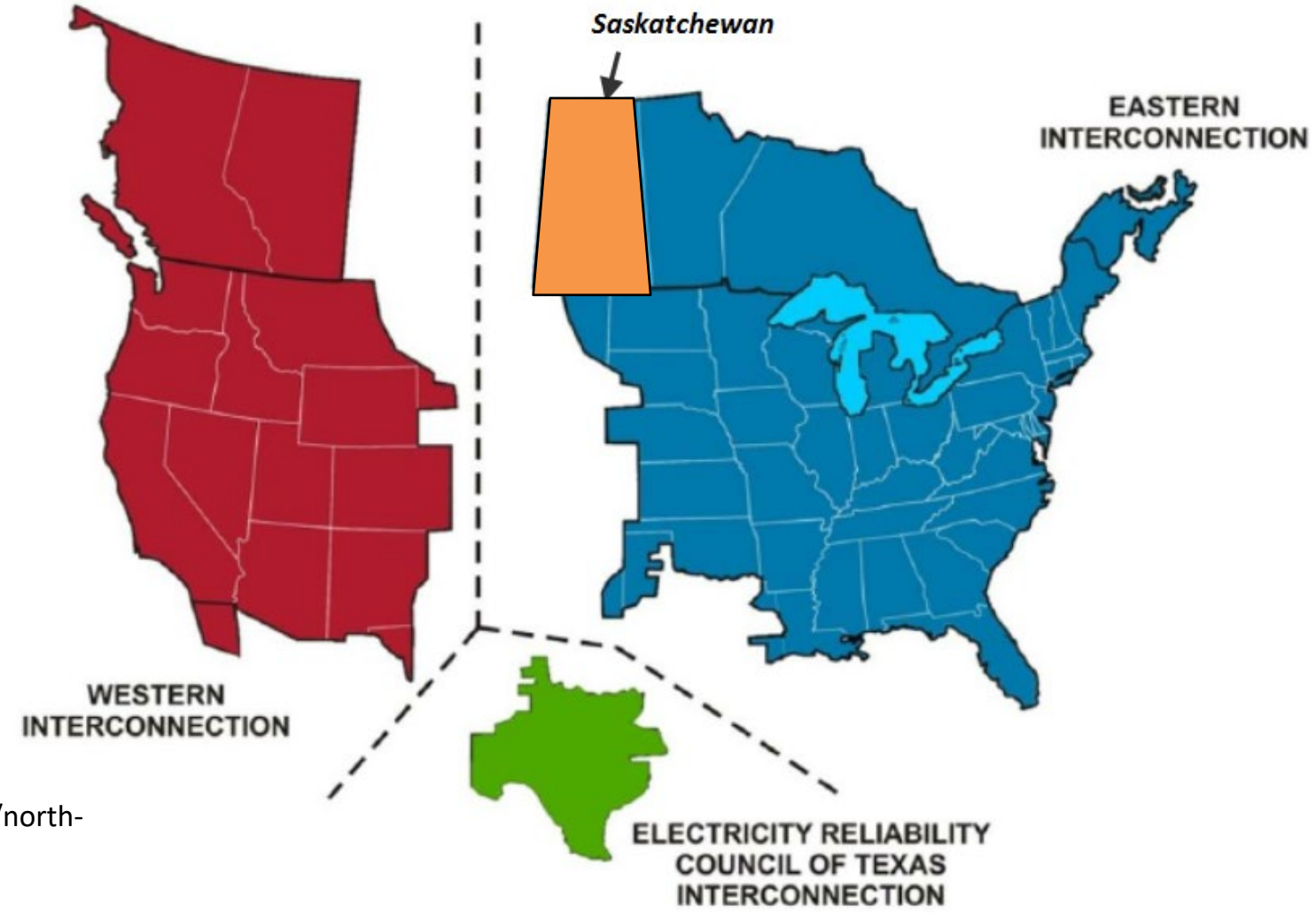
Questions and Answers

SASKATCHEWAN 2020 LTRA SUMMARY

Dec 08, 2020

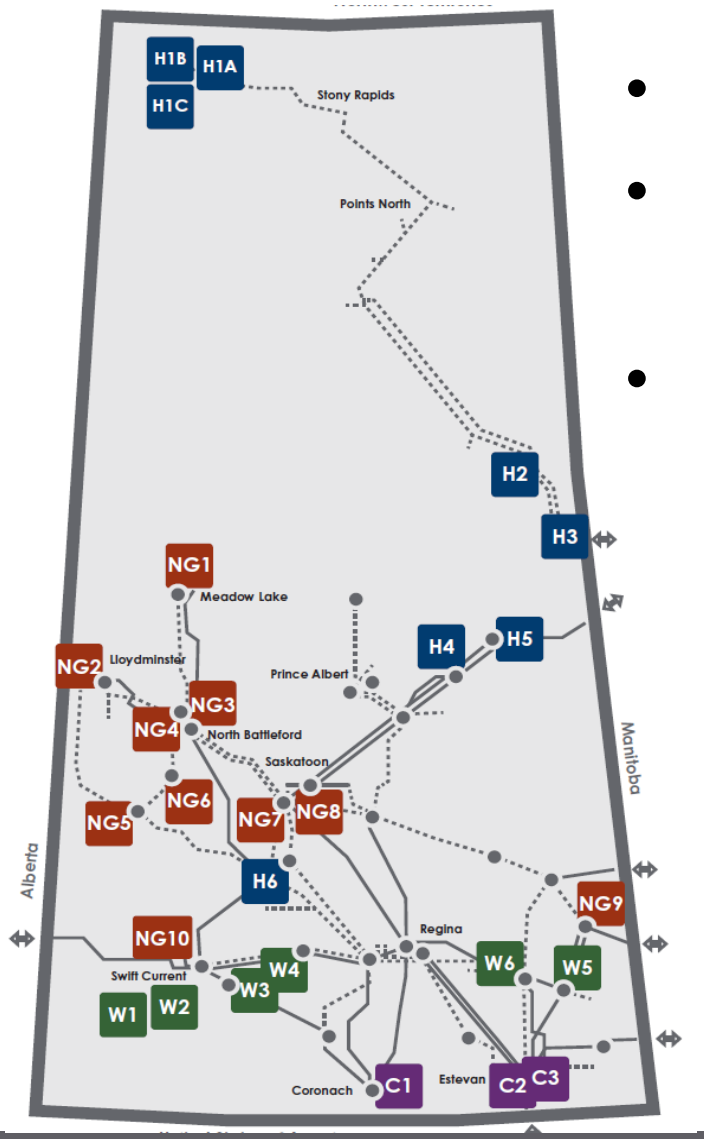
SaskPower
Powering the future®

Saskatchewan
Whereabouts in NERC Interconnections



Source: https://energy.gov/oe/downloads/north-american-electric-reliability-corporation-interconnections

Saskatchewan's Power Map



- 533,000 Customers
- 157,000 KM of Power Lines
- 3,792 MW Peak Load (2017)

8	3	10	6
Hydro Facilities	Coal Facilities	Natural Gas Facilities	Wind Facilities

MW					
Hydro	Coal	Natural Gas	Wind	Other small	Total
989	1530	2172	241	61	4993

Major Projects: Generation

- Chinook Power Station-353 MW CCGT (2019 December)
- Golden South - 200 MW Wind Facility (April, 2021)
- Blue Hill- 175 MW Wind Facility (October, 2021)

Major Projects: Transmission

- 230/138 kV transmission reinforcement between Swift Current and Regina (Completed in 2019)
- New 230 kV tie line with Manitoba (Mid 2021)- facilitates new long-term transfers
- New 230 kV phase shifting transformer (March 2021)

Assessment Process

Periodic Reliability Studies

- Transmission planning studies under TPL-001-4 every year
- Under frequency load shedding (UFLS) design assessment every five years and UFLS program data review every year
- Cascading studies (CIP-014) every two and half years
- Geomagnetically Induced Current (GIC) analysis (TPL-007) every year
- Planning studies required for Transmission Relay Loadibility (PRC-023) every year
- Planning studies required for Disturbance Monitoring and Reporting (PRC-002) every five years
- Review of Remedial Action Schemes (PRC-012/ PRC-014) every five years

Assessment Process

Periodic Reliability Studies (cont.)

- Generation and load interconnection studies (contingency power flow, stability analysis, voltage control and reactive power analysis, short circuit analysis & protection and control system analysis)
- Transmission service request studies
- NERC winter and summer reliability assessments

Resource Adequacy Assessments

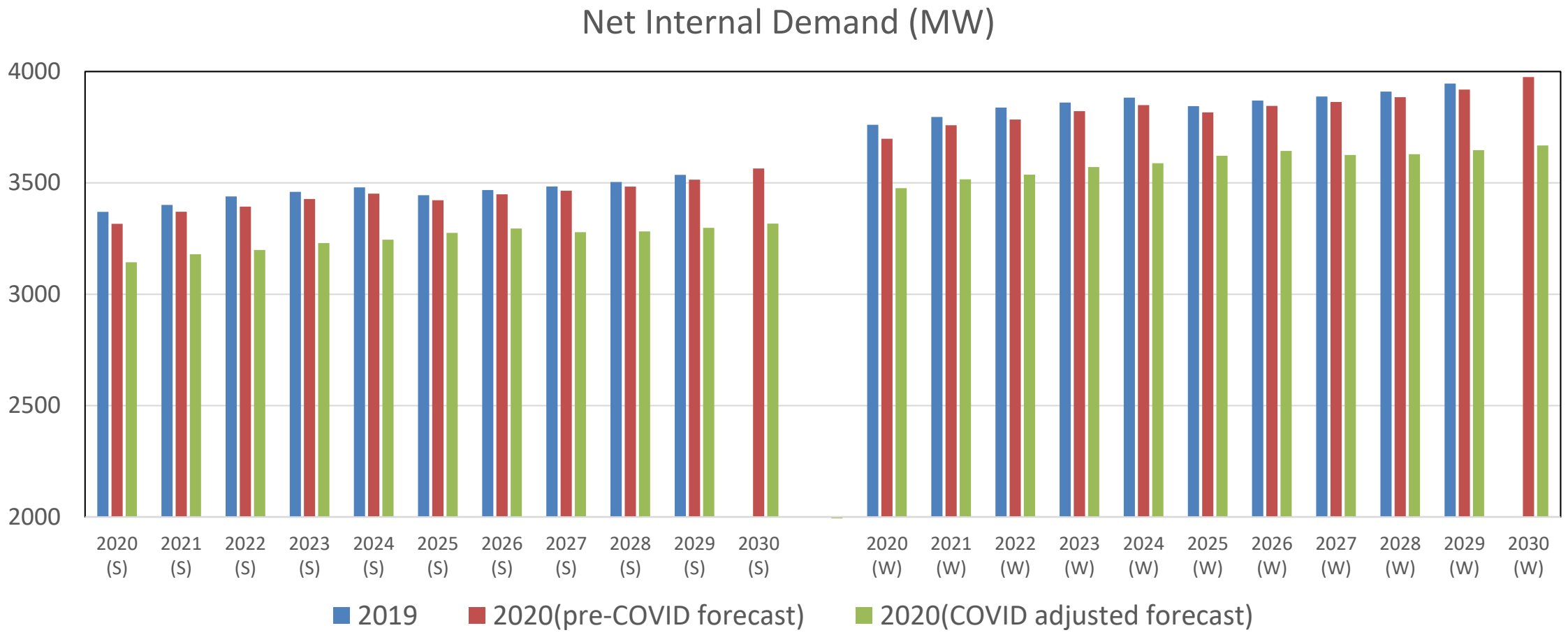
- Annual 10 year supply plan
  - Considers retirement of existing units, planned outages, degradation of unit performance between overhauls and regulatory requirements

Demand (Methods & Assumptions)

- Load forecast is based on SaskPower Economic Forecast, historical energy sales, and individual customer forecasts.
- Weather normalized daily peaks are computed on monthly and annual basis assuming average (normalized) daily weather conditions for the last 30 years.
- DSM/net-metering generation is considered as a reduction in both peak load and energy forecasts.

Demand (Summary)

Average annual growth ~0.5%



Generation (Methods & Assumptions)

- Saskatchewan has planned resources to meet its planning reserve requirements.
- Existing Certain units are expected to be available to meet peak demand, less the expected capacity not available due to seasonal derates or planned maintenance.
- Saskatchewan considers 10% of wind nameplate capacity in the Summer months, and 20% of wind nameplate capacity in Winter months.
- On-peak expected values for hydro assume nameplate net generation less expected seasonal derates due to water conditions.

Generation (Summary)

Planned new generation additions (2020-2030)

- Approximately up to 2400 MW projected to be added (including Tier 1, Tier 2 and Tier 3) throughout the assessment period
  - Tier 1 additions include 353 MW Natural gas, 385 MW wind and 10 MW PV power facilities, 290 MW of long term firm capacity imports.
  - Tier 2 additions include 1050 MW Natural gas and 10 MW PV power facilities
  - Tier 3 additions include 400 MW wind and 60 MW PV power facilities

Generation (Summary)

Projected Generation Retirements (2020-2030)

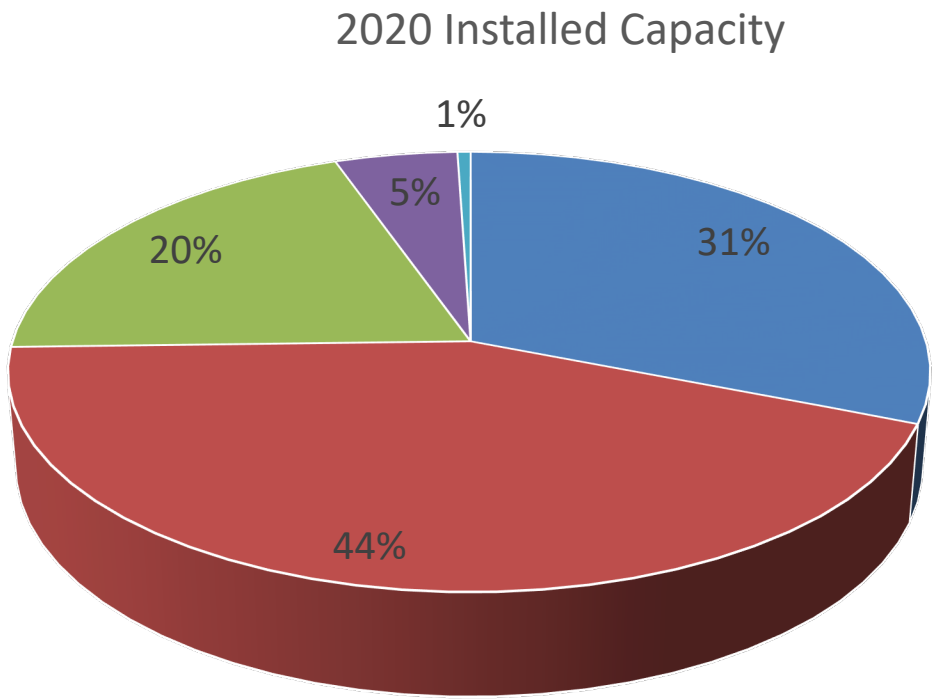
- Approximately 559 MW projected for retirement mainly driven by end of life.
  - 278 MW of Coal, 118 MW of Natural Gas, 95 MW of steam host, 21 MW of waste heat recovery, 22 MW of wind, 25 MW of firm import contract.
- Timing of retirements under consideration include 1200 MW of conventional coal and 222 MW of natural gas power facilities.

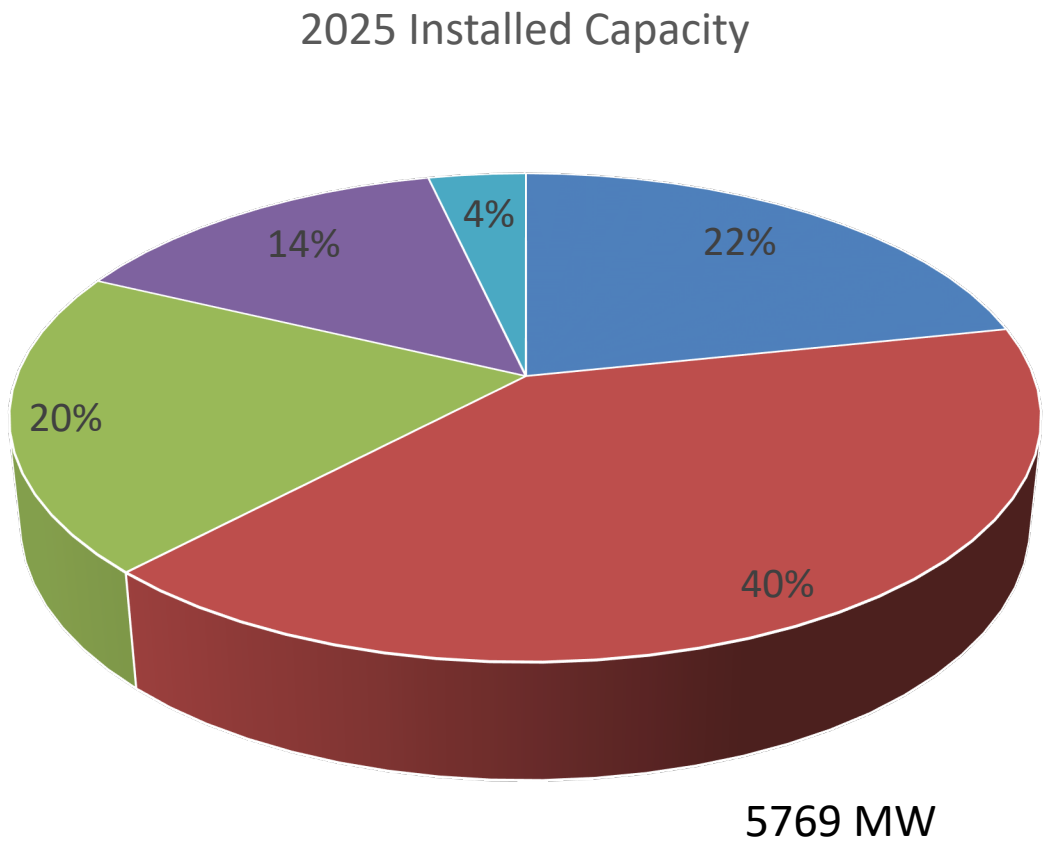
Capacity Transfers

- Transactions included in the assessment period aligns with the counterparty expectation of a firm contract.
  - Firm import contract in place for 25 MW import from Manitoba through the winter of 2021/2022.
  - Firm Import of 100 MW from Manitoba for the summer of 2020 until the end of the assessment period. Import is composed of long term and seasonal firm capacity before the new tie line is complete in 2021.
  - Firm additional import of 190 MW from Manitoba for the summer of 2022 until the end of the assessment period.

Saskatchewan 2020 LTRA Highlights

Generation Mix





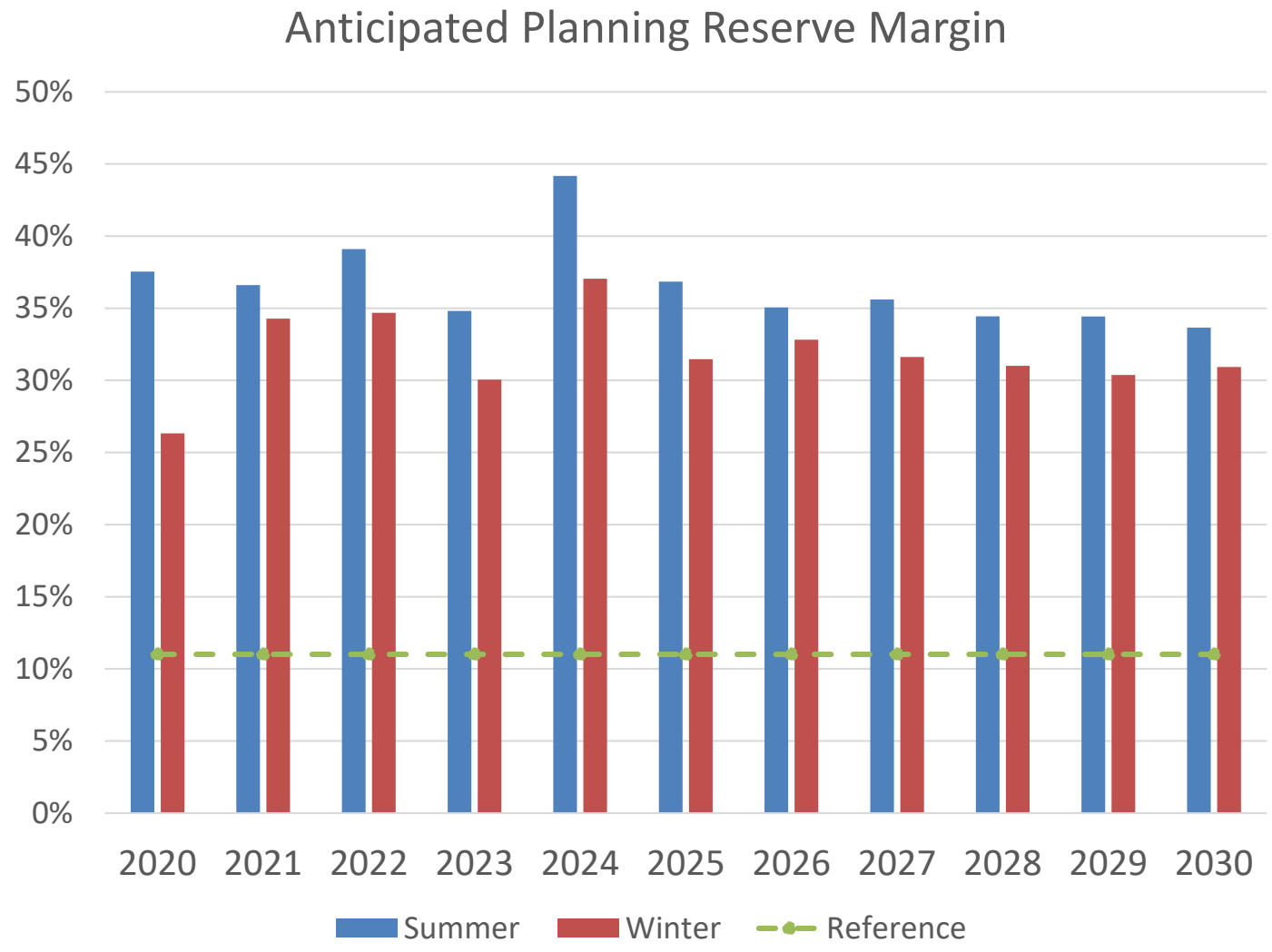
Coal Natural Gas Hydro Wind Other

2019 LTRA Comparison

LTRA Summary Line Item		2019 LTRA	2020 LTRA	% Change
Net internal Demand, 2021	MW	3796	3516	-7.4
Net internal Demand, 2025	MW	3845	3622	-5.8
Anticipated Resources, 2021	MW	4674	4721	1.0
Anticipated Resources, 2025	MW	4736	4762	0.6
Prospective Resources, 2021	MW	4674	4721	1.0
Prospective Resources, 2025	MW	4570	4762	4.2
Reference Margin Level	%	11	11	N/A
Anticipated RM, 2021	%	23	34	N/A
Anticipated RM, 2025	%	23	32	N/A

Planning Reserve Margins

- Reference Reserve Margin for Saskatchewan is 11%.
- Saskatchewan has planned for adequate resources to meet anticipated load and reserve requirement.
- Anticipated reserve margin ranges from 26% to 37%.



Planning Reserve Margins

- Reference Reserve Margin for Saskatchewan is 11%.
- Perspective reserve margin ranges from 20% to 48%.

Distributed Energy Resources

- BTM distributed generation ranges from 37 MW to 50 MW in the next five years.
- Potential for non-BTM distributed generation up to 105 MW in the next 5 years.
- No operational impact due to DERs yet but watching for future potential operational issues as the penetration becomes significant such as:
  - over-voltage during light loading
  - over-voltage during the operation of feeder protection
  - excessive voltage fluctuation in response to load and system changes

Demand Side Management

- Demand Response
  - 60 MW for load shedding with a 12 min event response time
  - Programs providing additional curtailable load with 2 hour event response time are not considered in reserve margin calculations.

Reliability Findings

- No changes to the assessment area footprint have occurred or are expected.
- Average demand growth has decreased compared to the previous assessment.
- Changes to the resource mix (additional wind, solar and reduced coal) is expected in Long Term Planning Horizon.
- With the planned facilities, reliability requirements are met in the assessment period.

Thank You!

Questions?

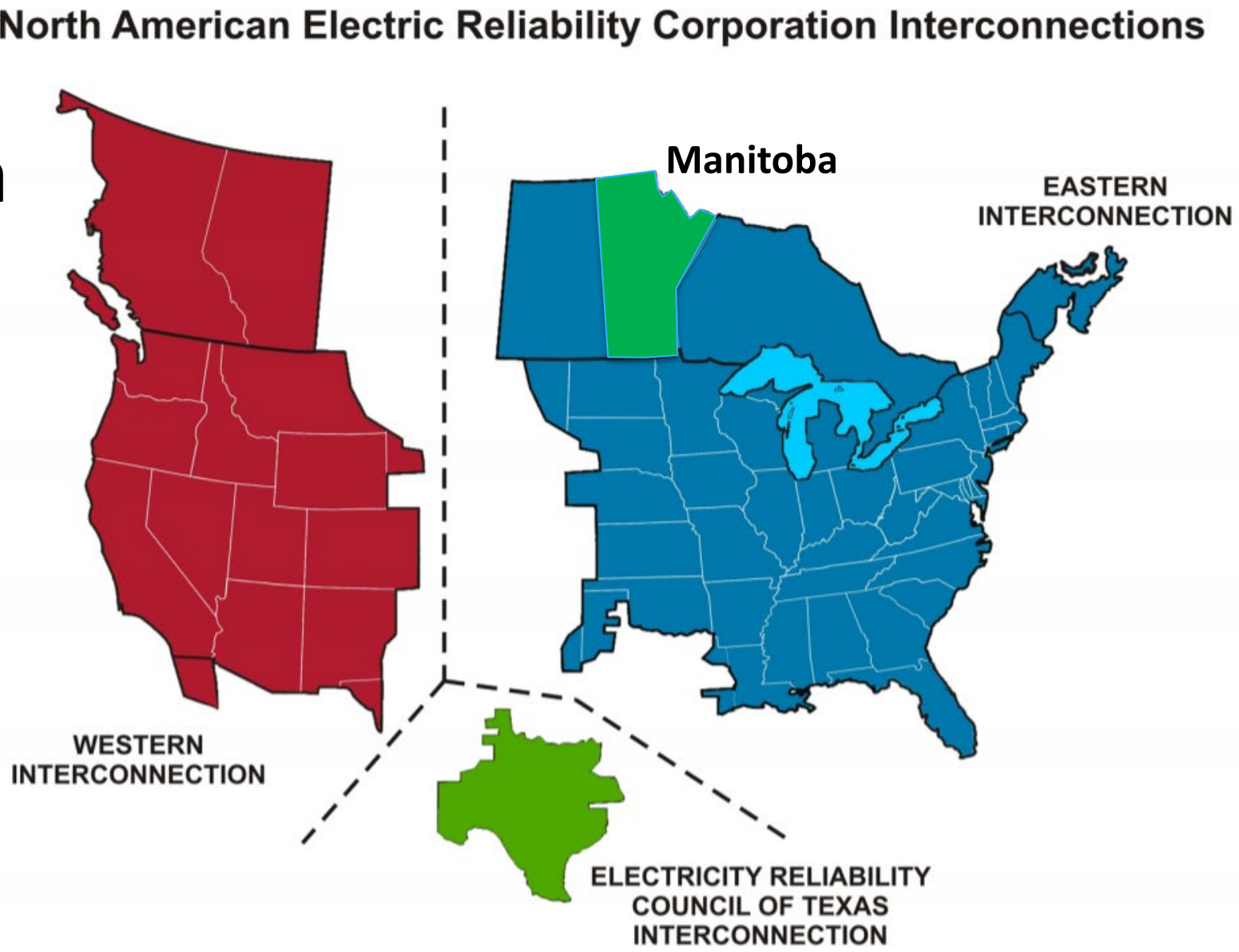
Manitoba Hydro's 2020 Long-Term Reliability Assessment

MRO Webinar

December 8, 2020

Assessment Area Overview - Manitoba

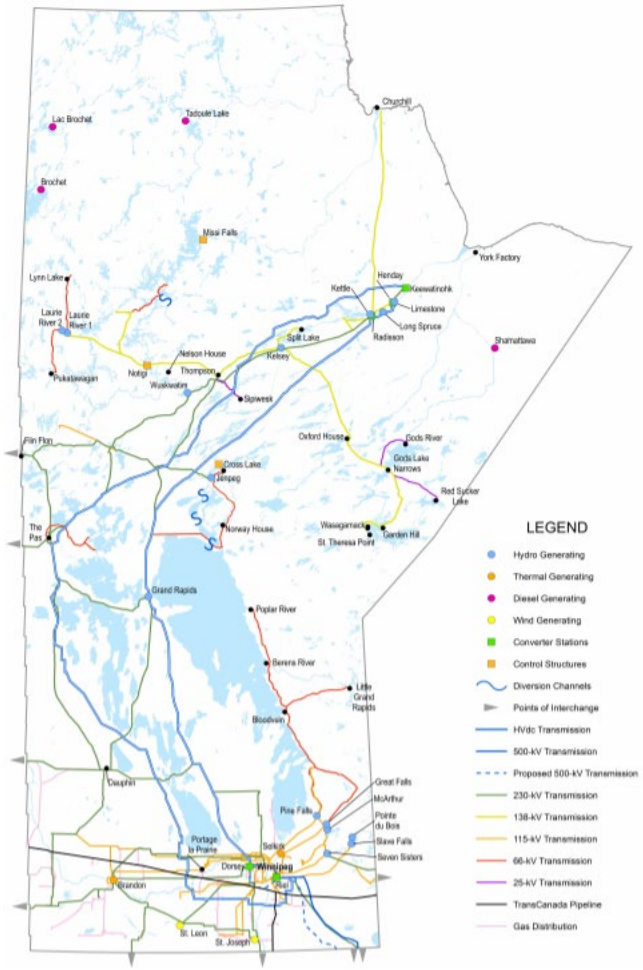
- 587,000 electric customers
- Existing generation capacity:
- 5928 MW Summer Season
- 6005 MW Winter Season
- All-time peak:
- 4910.5 MW on January 30, 2019
- Temperature: -39.8 °C



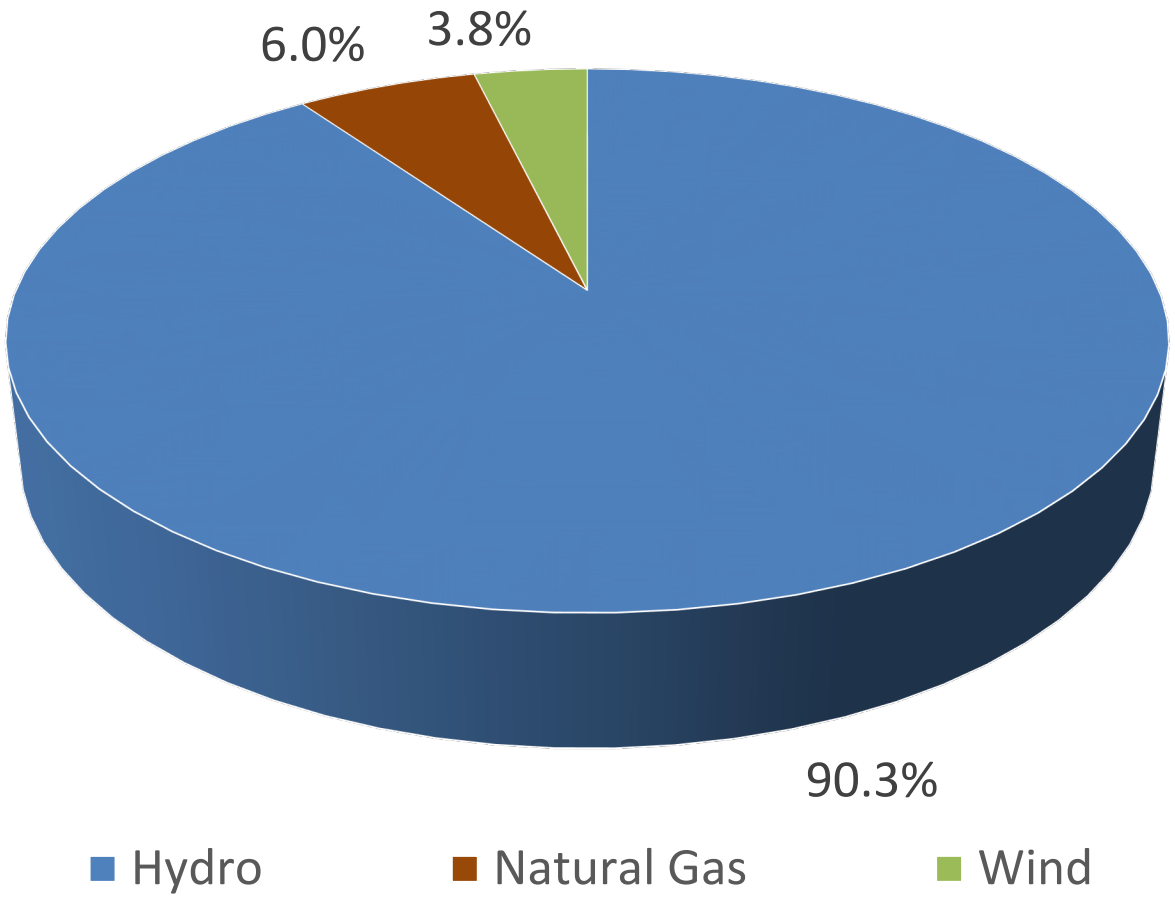
Manitoba Hydro

Assessment Area Overview: Manitoba

- Predominantly hydroelectric system
- Strongly winter peaking
- Manitoba Hydro is planning coordinator and balancing authority
- Coordinating member of MISO
- No change in footprint since last LTRA



Installed Nameplate Capacity



Assessment Summary

- No significant methodology changes
- Anticipated Reserve Margin did not fall below the Reference Margin Level of 12% in any year during the assessment period
- 500 kV Dorsey (Winnipeg) to Iron Range (near Duluth, Minnesota) transmission line was placed into service June 1, 2020. Improves MH- MISO import/export, and adds resilience.
- Keeyask hydroelectric generating station
  - Dam complete, forebay level raised to operating level
  - Tier 1 capacity of 630 MW net addition, construction nearing completion, commissioning has begun

Manitoba Hydro

Assessment Process

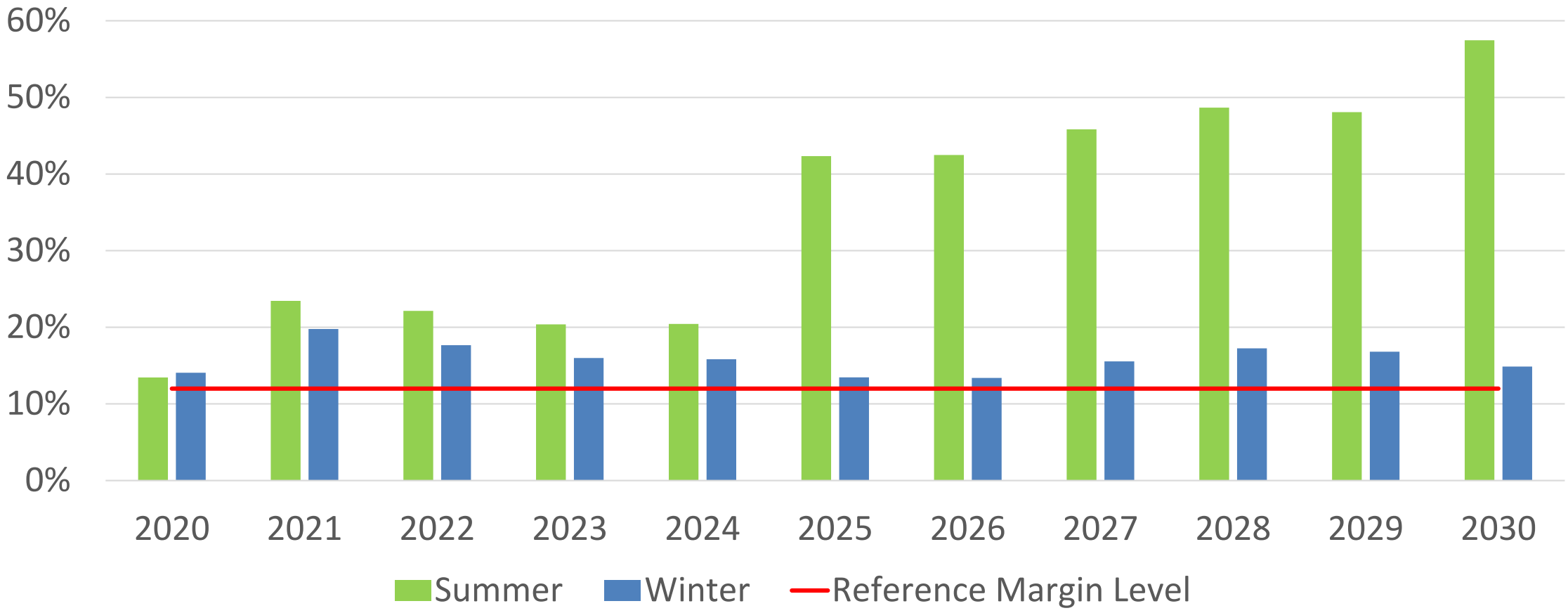
- Annual resource plan update with a supply and demand balance assessment to meet Manitoba Hydro's generation planning criteria for the long-term planning horizon
- Key inputs:
  - Electric Load Forecast
  - Demand Side Management Forecast
    (energy efficiency and conservation programs)
  - Resource capabilities

Planning Reserve Margin

- Predominately hydroelectric system
- Utilize 12% Reference Margin Level
  - Higher than 10% default for predominately hydro systems
- The Reference Margin Level is based on both system historical adequacy performance analysis and reference to probabilistic resource adequacy studies using the index of loss of load expectation (LOLE) and loss of energy expectation (LOEE)

Manitoba Hydro

Anticipated Reserve Margin



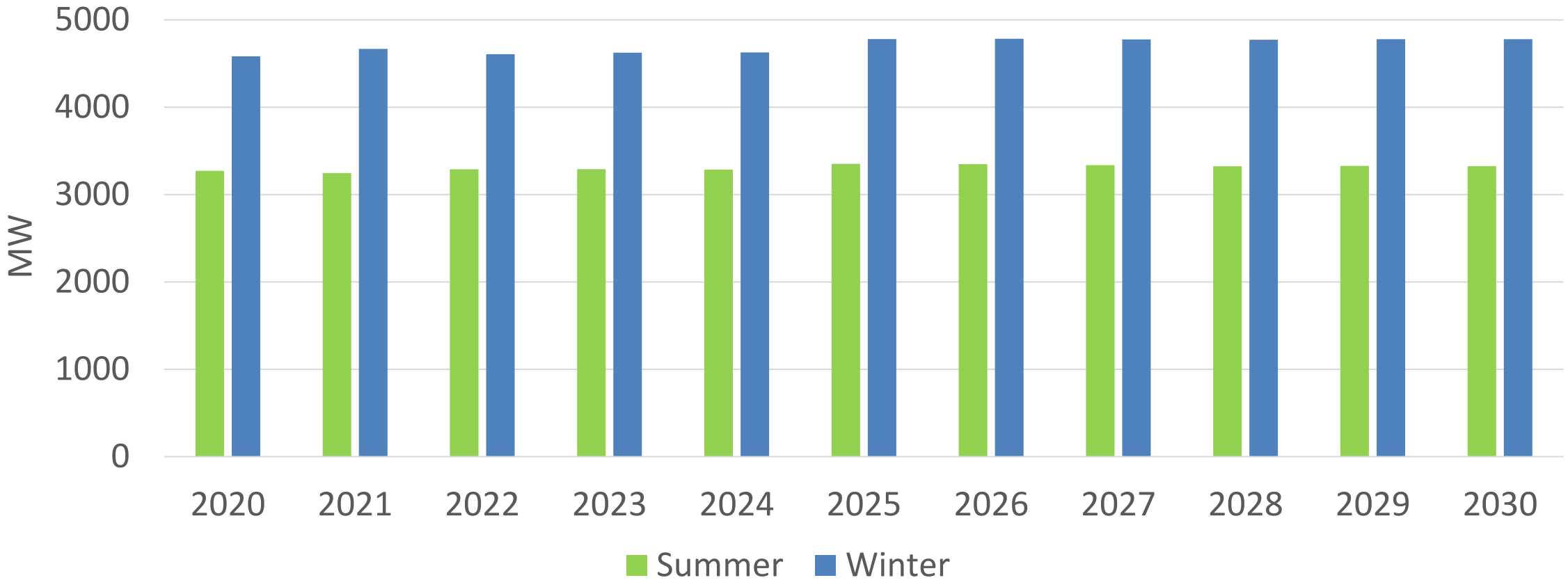
Demand

- Electric Load Forecast comprised of:
  - Residential
  - General Service Mass Market (Commercial)
  - Top Consumers
- Population and economy are main drivers
- Adjust historical load to remove weather effect
- Normal weather based on past 25 years of temperatures (50/50 forecast)
- Includes an estimate of electric vehicle demand

Energy Efficiency and Conservation (Demand Side Management or DSM)

- No Controllable and Dispatchable Demand Response
- Have indirectly controlled Curtailable Rate Program – incorporated into electric load forecast as reduction for a five-year planning period
- DSM Forecast contains significant energy efficiency and conservation programs
- Energy efficiency and conservation programming transitioned from Manitoba Hydro to a new Crown Corporation, Efficiency Manitoba, effective April 1, 2020.
- DSM measurement and verification activities, will be undertaken by an independent third-party evaluator that will be contracted by Efficiency Manitoba.

Net Peak Hour Demand Forecast



Manitoba System is Evolving Slowly

- No new wind generation since 2011
- Solar PV has less favorable economics further north and in meeting a winter peaking load
- Hydro plants last 100+ years
- Thermal is small portion of system, and declining

Distributed Energy Resources

- Distributed and behind the meter generation
  - ~35 MW DC of solar PV distributed energy resources in Manitoba as of March 2020
    - 16.7 MW DC residential, 18.3 MW DC commercial
    - Solar Energy Program (incentive) ended April 2018
  - Modest solar growth anticipated as incentives have ended
  - No impact on winter peak load

Manitoba Hydro

Inverter Based Resources

- Manitoba Hydro currently has the following inverter-based resources:
  - 138 MW wind (type 4) plus 35 MW DC DER solar PV
  - 4,184 MW of hydro (including Keeyask) connected via three HVDC bipoles (line commutated converters)
  - The total share of inverter-based resources to conventional resources is 66%
- Biggest challenge is ensuring an adequate short circuit ratio at the HVDC inverter bus
- This challenge is overcome via the installation of synchronous condensers:
  - Four 250 MVAr + three 300 MVAr + six 160 MVAr synchronous condensers
  - These devices are used to maintain a minimum short circuit ratio of 2.5 at each HVDC converter

Manitoba Hydro

Off-Peak Demand Periods

- Loss of load expectation studies indicate the risk of loss of load is concentrated in the peak and near peak (99 percentile load and greater) hours
- Predominately hydro system which is energy (fuel) limited
  - Have energy criterion in addition to a Planning Reserve Margin to ensure resource adequacy in the event of an extreme drought
  - Energy criterion requires adequate energy resources to supply the firm energy demand in the event that the lowest recorded coincident river flow conditions on the hydraulic flow record of over 100 years are repeated
- Have an internal monthly process resource adequacy which takes into account planned outages. If necessary, planned outages will be rescheduled in order to maintain 12% planning reserve on a season ahead basis.

Manitoba Hydro

Generation Additions/Retirements

- Existing generation ratings based on MISO Generation Verification Test Capacity (GVTC)
- Keeyask hydroelectric generating station
  - Dam complete, forebay level raised to operating level
  - Tier 1 capacity of 630 MW net addition, construction nearing completion
  - First 90 MW unit now in commissioning
  - Significant increase in supply for 2021 and beyond
- Unconfirmed Capacity Retirement
  - Selkirk (natural gas), 33 MW summer/118 MW winter
    - Driven by desire to reduce carbon emissions, high operating costs, additional supply being available from the Keeyask hydro station, and additional import capability with the Manitoba to Minnesota Transmission Project

Manitoba Hydro

Wind Capacity Accreditation

- For wind generation in the summer months, Manitoba Hydro assumes a capacity value of 16.6% percent, based on the Effective Load Carrying Capability (ELCC) analysis in MISO's Planning Year 2020-2021 Wind & Solar Capacity Credit report
- For wind generation in the winter months, Manitoba Hydro assumes a 20% capacity value, based on a peak period analysis of 2007-2015 data for the top 8 daily winter peak Manitoba load values per year using the 70th exceedance percentile of hourly production values

Solar Capacity Accreditation

- For solar photovoltaic, a peak period analysis of 2007-2015 data for top 8 daily winter peak Manitoba load values per year utilizing the 70th exceedance percentile of simulated hourly solar production values was conducted
- Manitoba Hydro assumes a capacity value of 35% summer and 0% winter for utility scale solar generation
- Solar has a very low capacity value during the winter because the Manitoba load typically peaks in January at or before sunrise or after sunset

Electricity Storage (ES) Impacts

- Manitoba Hydro currently has no energy storage resources
- None have been committed to in the next 10-year period
- Therefore, detailed studies for energy storage resources have not been undertaken to date
- The hydro generation resources, while not storing electricity directly, do store water in a reservoir for conversion to electricity, and have been in use for over 100 years

Capacity Transfers

- Includes all firm imports and exports
  - Higher level of capacity exports in summer when Manitoba peak load is lower
- All capacity transfers coordinated, reviewed, vetted by neighbouring Assessment Areas
  - SaskPower
  - MISO

Manitoba Hydro

Transmission

- Major transmission projects:
  - Manitoba (Winnipeg) to Minnesota (Duluth) 500 kV interconnection in-service June 2020
  - Manitoba (Birtle) to Saskatchewan (Tantallon) 230 kV interconnection is expected to be in-service in 2021

Transmission

- Conduct extreme event studies
  - Natural gas capacity about 7% of total generation
  - Loss of major transmission corridors – Bipole III helps mitigate risk
  - Cascading outages not expected based on extreme events studied
- No changes to UFLS protection due to resource mix changes
  - Resource mix is not changing very fast

Manitoba Hydro

Extreme Events – October 2019 Storm

- Experienced a significant storm event in October 2019
- Roughly 1000 kilometers (~620 miles) of distribution lines were impacted; 60% were repaired in 10 days
- Five out of ten available 230 kV transmission lines were out of service during the storm as well as a few 115 kV lines
- Some of the lessons learned from this event:
  - Increase visibility of the distribution network as lack of monitoring makes it difficult to assess storm damage in a timely manner
  - Review distribution and transmission line design standards. The current design standards are based on expected ice load in each local geographic area. Changing climate patterns and reduced risk tolerance could lead to more stringent design standards to aid in resiliency.

Manitoba Hydro

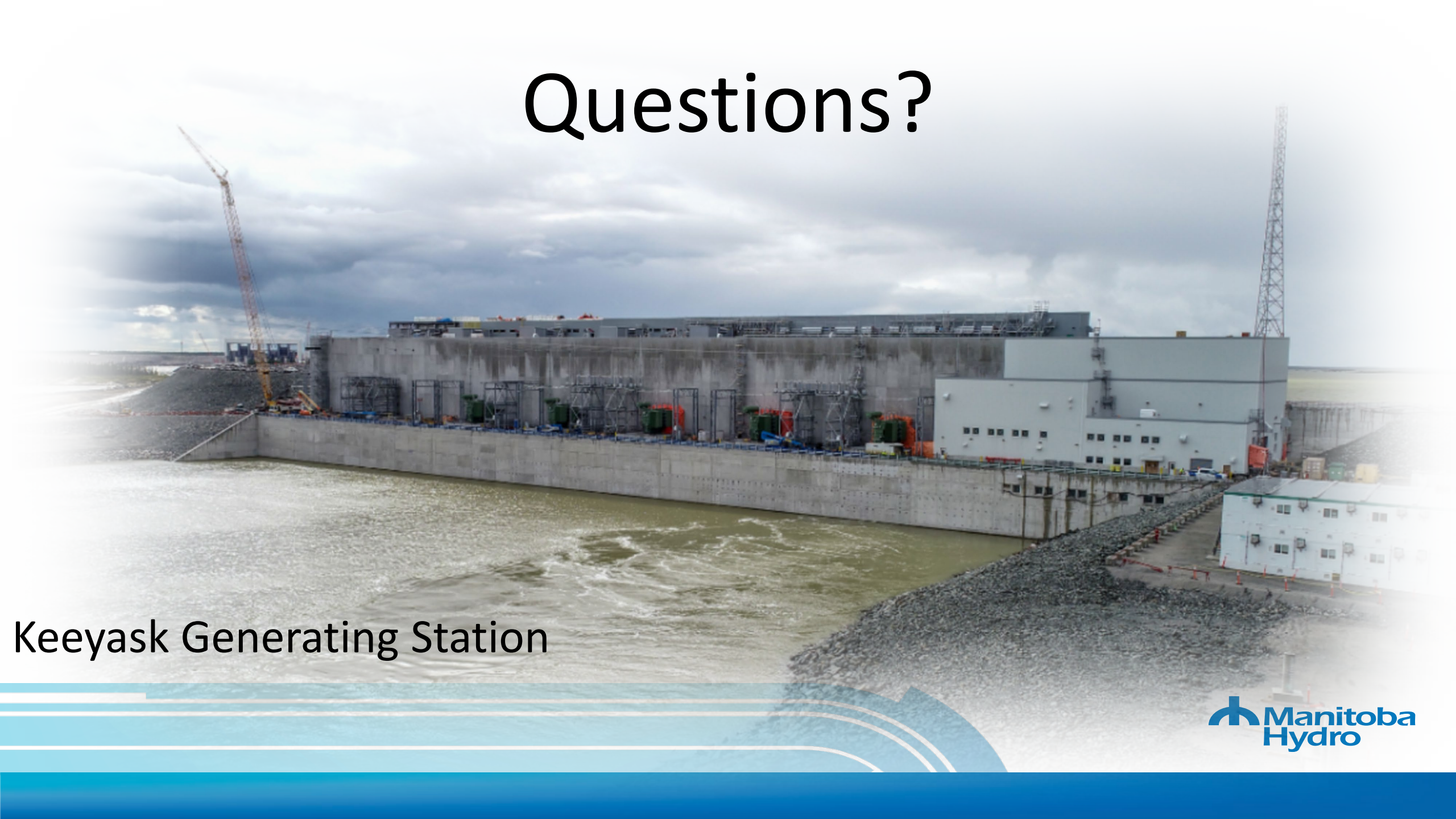
Extreme Events – October 2019 Storm

Reliability Issues Being Monitored

- Extreme weather
  - Ice storms
  - Extreme winter weather for winter peaking system
    - Polar vortex type temperatures are not unusual
    - Generators designed for low temperature operation
- Severe drought
  - Energy planning criterion assumes worst drought on record of greater than 100 years
- Impact of a common corridor outage of HVDC bipoles
  - Loss of two bipoles which could result in losing the supply from three generating stations in northern Manitoba
  - Bipole III, in-service July 2018, substantially mitigates the common corridor outage issue

Manitoba Hydro

Questions?



Keeyask Generating Station

Manitoba Hydro

2020 MISO LTRA

MRO RAC

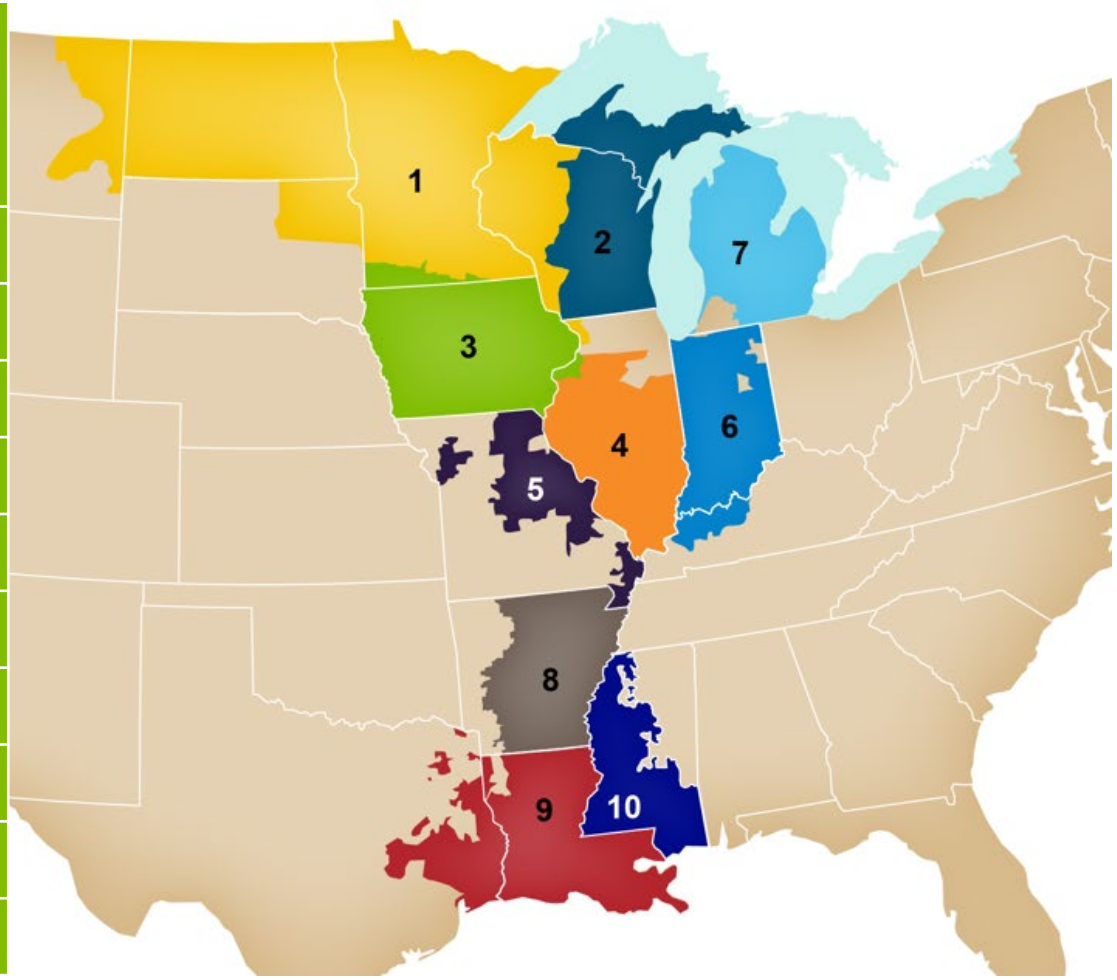
December 08, 2020

Key Takeaways

- Outlook narrowed from last cycle
  - Adequate anticipated resources through 2023
- Changing fleet trends continue to drive Resource Adequacy (RA) risks
  - The Resource Availability and Need (RAN) effort aims to address RA construct and accreditation changes needed to ensure reliability

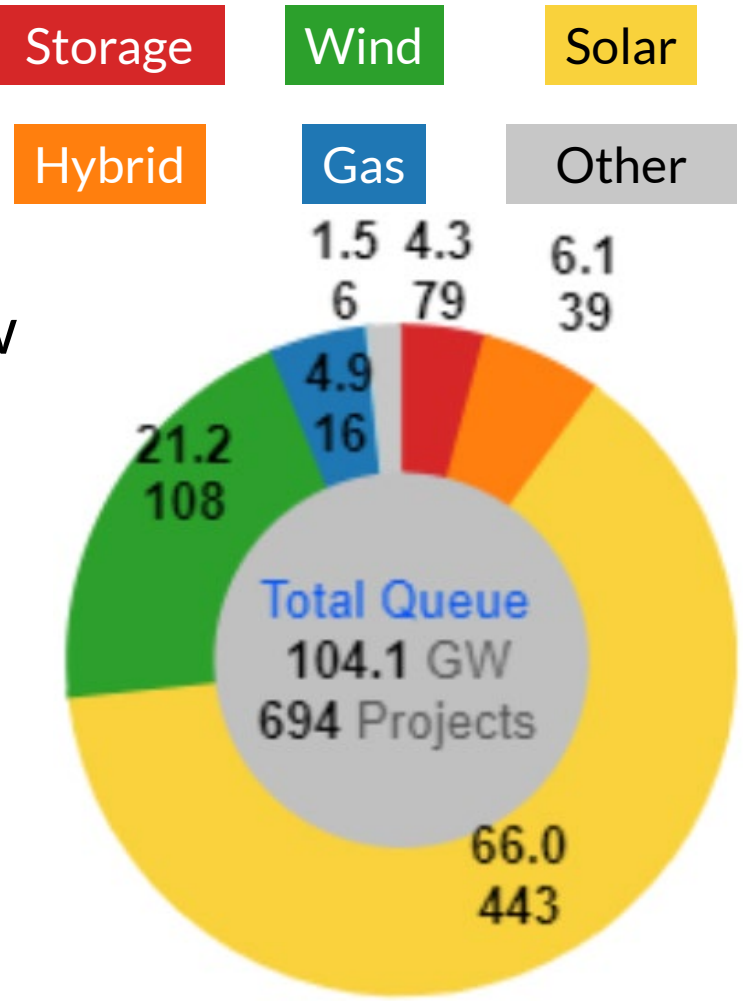
MISO Local Resource Zones

Local Resource Zone	Local Balancing Authorities
1	DPC, GRE, MDU, MP, NSP, OTP, SMP
2	ALTE, MGE, MIUP, UPPC, WEC, WPS
3	ALTW, MEC, MPW
4	AMIL, CWLP, SIPC
5	AMMO, CWLD
6	BREC, CIN, HE, IPL, NIPSCO, SIGE
7	CONS, DECO
8	EAI
9	CLEC, EES, LAFA, LAGN, LEPA
10	EMBA, SME

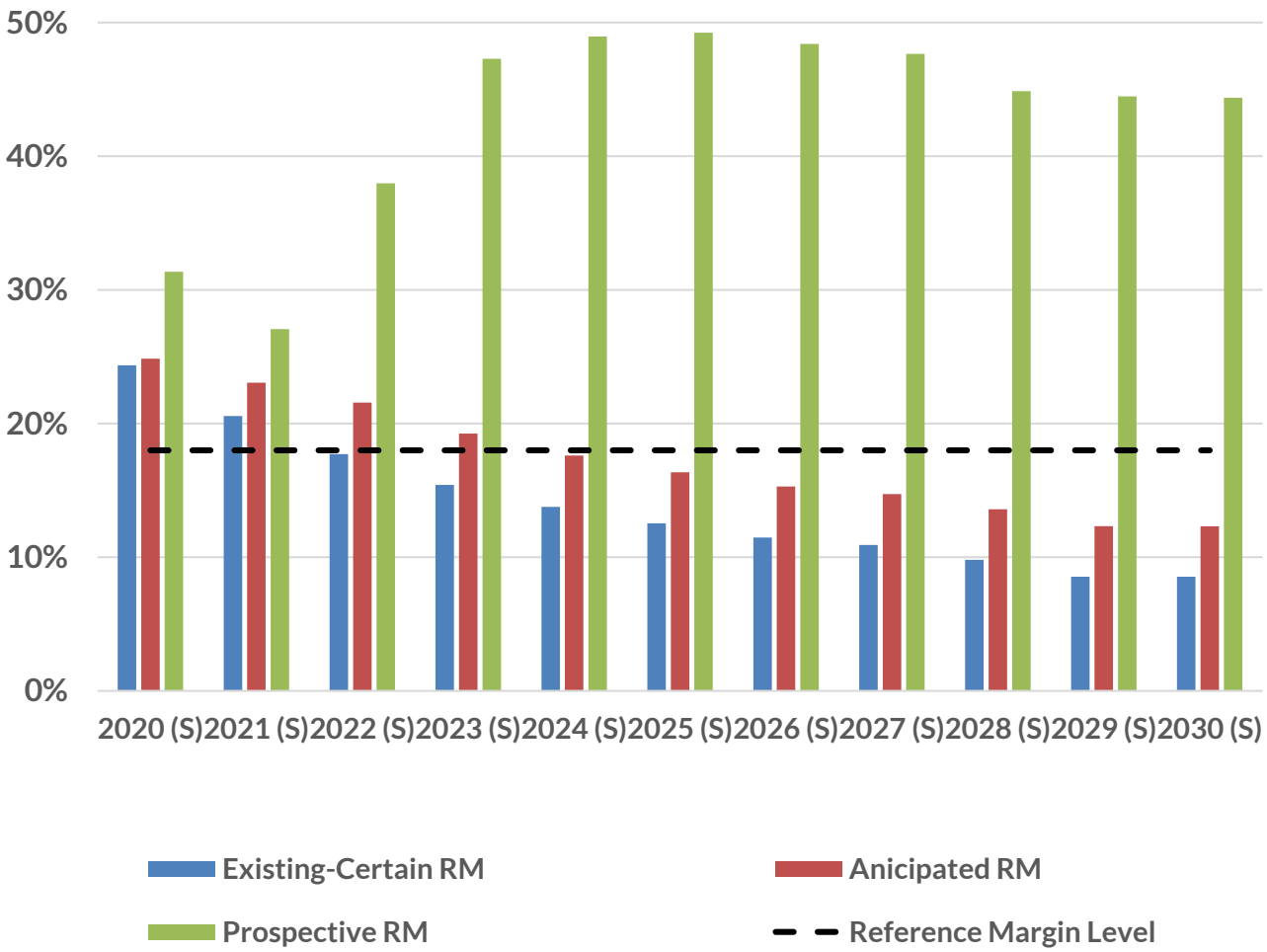


LTRA Changes Since 2019

- No major LTRA changes to data, study processes or study methodology.
- Projects in the MISO queue measure over **100 GWs** of new generation requesting interconnection service.
- Near-future resource plans will get MISO closer to the PRMR, presenting operating challenges, but new unit additions may prevent overall capacity deficiencies.



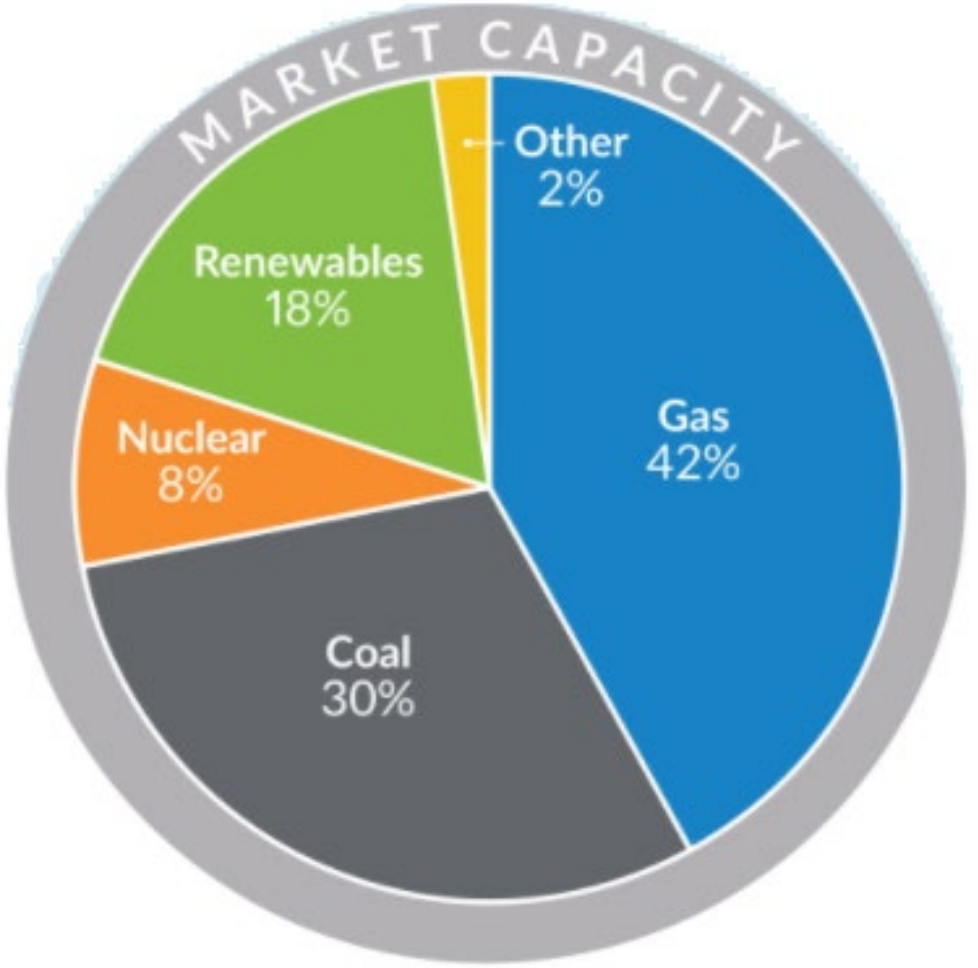
Future reserves are uncertain



- MISO's Planning Reserve Margin exceeds the 18% requirement through 2023.
- MISO projects that each zone within the footprint will have sufficient resources to meet their Local Clearing Requirements.
- LTRA results are a point in time forecast. Figures will change as future capacity plans are solidified.

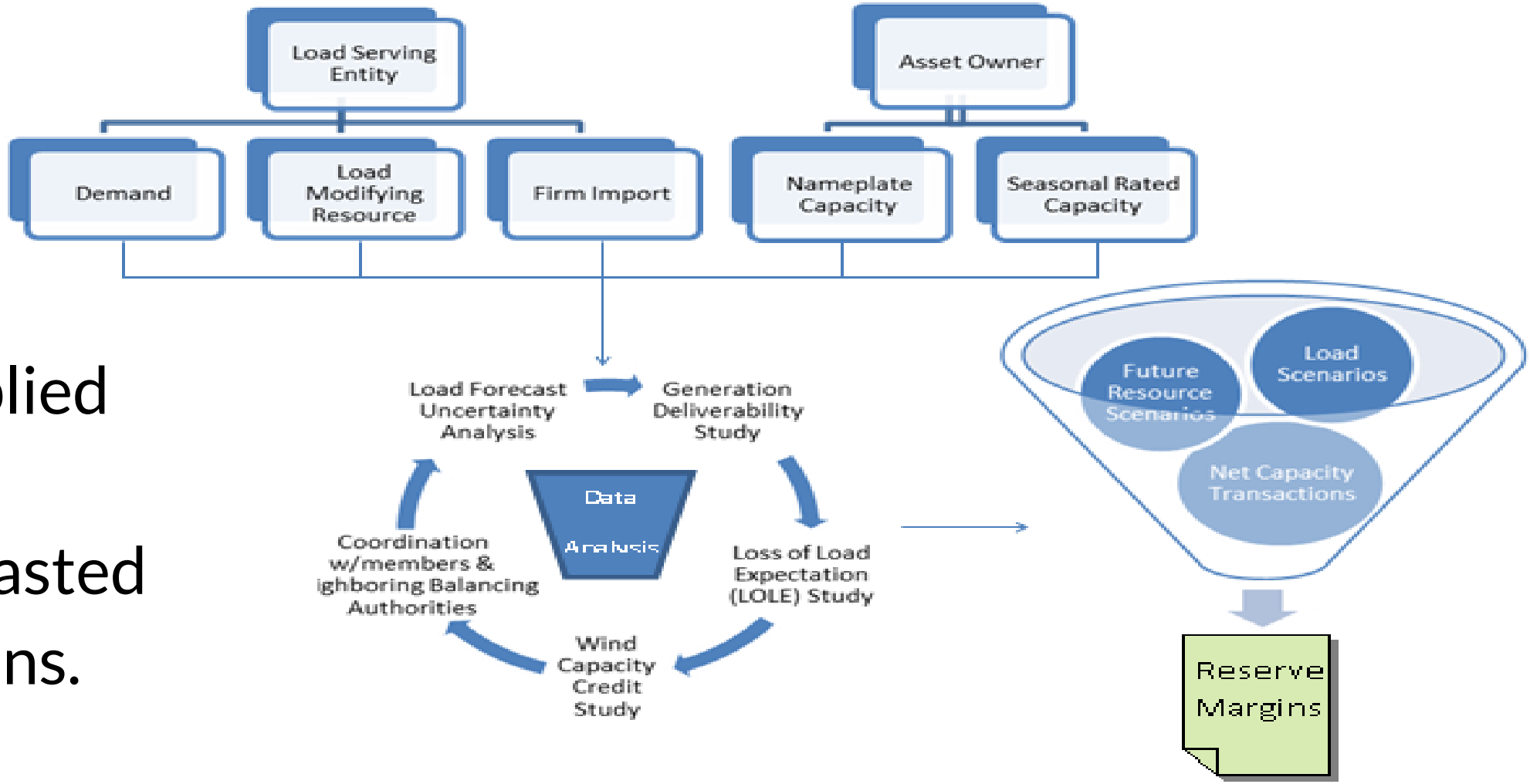
Drivers for Changes in Capacity Position

- Reserve requirements increased from 16.8% to 18% on an ICAP basis
- Peak load forecast decreased 300 MW,
- 5-year growth-rate rose 0.2% to 0.3%
- Possible retirements of 17 – 24 GW over coming decade
- Coming replacements are not firm, but working though the interconnection queue



Assessment Process

Member supplied data used to analyze forecasted reserve margins.



PRM – Methods and Assumptions

- Per Module E-1 of the MISO Tariff, MISO annually performs a probabilistic analysis using the Loss of Load Expectation (LOLE) study to determine the appropriate Planning Reserve Margin (PRM).
- MISO calculates the PRM such that the LOLE for the next planning year is one day in 10 years, or 0.1 days per year.
- PRM increased from 2019 LTRA – 16.8% to 18% in 2020 LTRA.
  - Changes in load shape
  - Changes in Generation Verification Test Capacity (GVTC)
  - Changes to Retirements & Suspensions & New Resources

Demand – Load Forecasts

- MISO does not forecast load
- Members supply load projections per the RA Requirements section (Module E-1) of the MISO Tariff.
- Forecast changes driven by
  - changing economic outlooks and
  - possible DER and LMR treatment

Forecast relatively stable

- Peak forecast down only 300 MW or 0.2%
- 5-year growth rate up from 0.2% to 0.3%

Demand-Side Management – Controllable and Dispatchable Demand

- MISO separates DR resources into two categories;
  - Direct Control Load Management
  - Interruptible Load
- MISO has roughly 6.2 GW of Direct Control and Interruptible Load
- MISO has roughly 4.8 GW of Behind-the-Meter Generation

Demand-Side Management - Energy Efficiency and Conservation

- Energy Efficiency is not explicitly forecasted at MISO
- MISO requires new energy efficiency programs to register as an explicit program for three years
  - After that programs can become part of the forecast
- 2020 MISO has registered EE programs for roughly 582 MWs.

Distributed Energy Resources

- Currently MISO does not collect distributed generation information
- Need to be registered within the MISO Resource Adequacy construct to receive Capacity Credit
- Load forecasts received are not granular enough to discern any DER within them
- MISO State regulators conduct an annual survey on DERs
  - Roughly 850 MWs of BTM solar reported

Questions?

SPP 2020 LTRA UPDATE

CHRIS HALEY, SPP STAFF

OUTLINE

- Highlights
- Assessment Process
- Planning Reserve Margin
- Capacity and Demand
- Reliability Issues

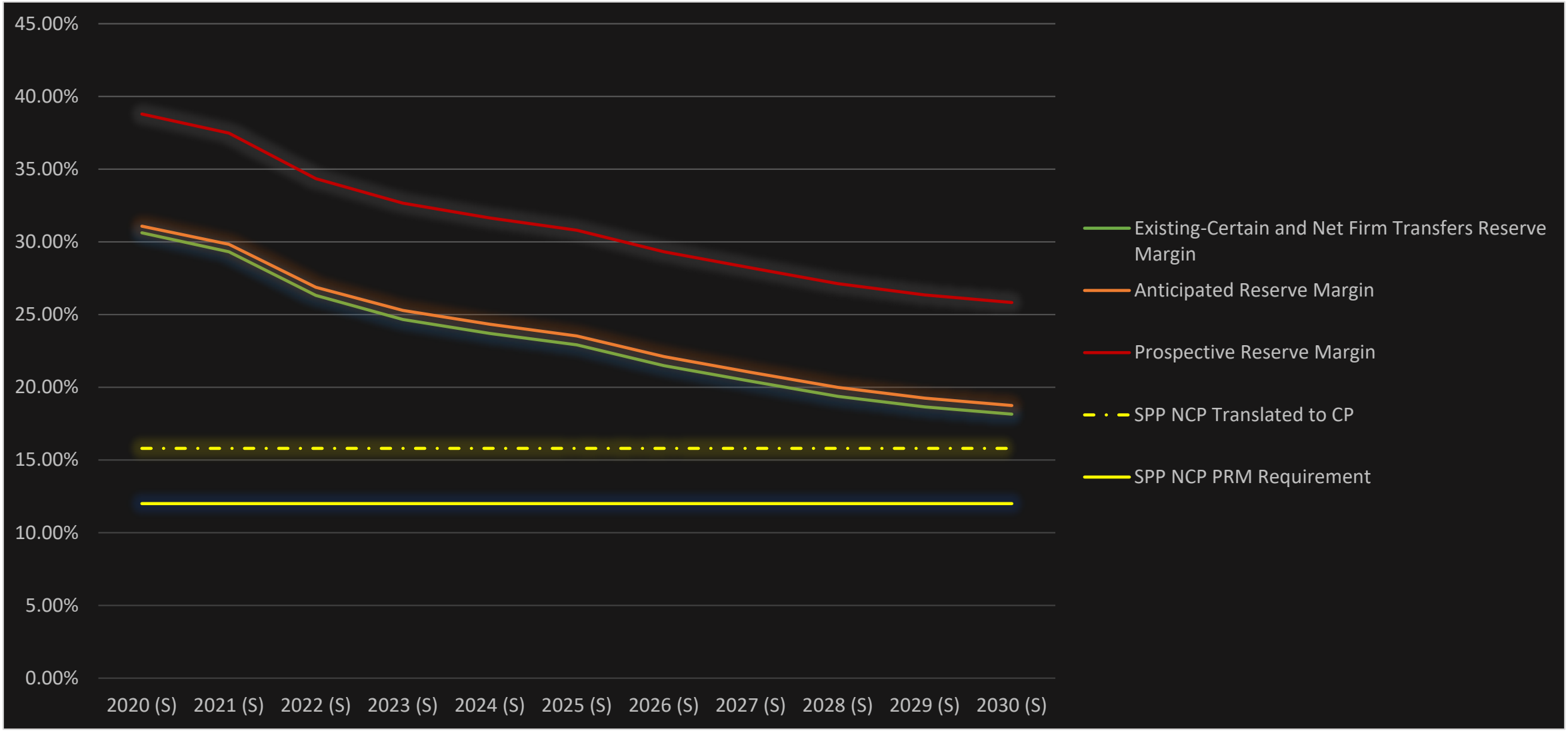
HIGHLIGHTS

- SPP projects to maintain more than enough capacity to meeting the planning reserve requirement during the assessment time frame
- SPP continues to see significant increase in wind penetration and along with setting new wind records
  - November 23rd saw a wind peak of 19,176MW
- SPP and ERCOT continues to communicate and maintain a coordination plan
  - The coordination plan addresses operational issues for coordination of the DC ties between the Texas Interconnection and Eastern Interconnection and switchable generation resources (SWGRs).
  - SPP has priority to recall the capacity of any SWGRs that have been committed to satisfy the resource adequacy requirements contained in Attachment AA of the SPP Open Access Transmission Tariff

ASSESSMENT PROCESS

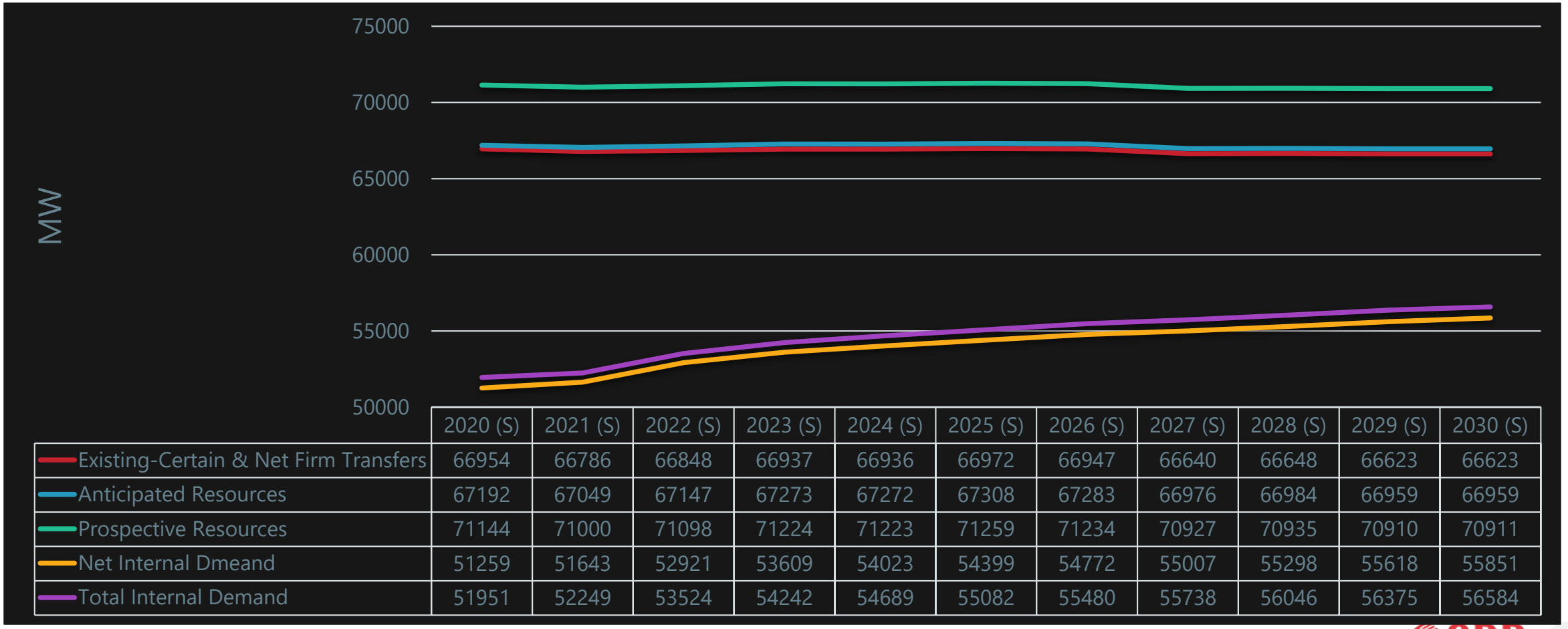
- Created with data/information submitted by SPP members
- SPP staff validates and cross-checks data to verify consistency
- SPP staff and stakeholders have the opportunity to provide input
- Attachment AA requires a Load Responsible Entity (LRE) to maintain adequate capacity to meet the upcoming Summer Season Resource Adequacy Requirement (RAR)
  - The RAR includes the capacity to cover load plus planning reserves

PLANNING RESERVE MARGIN



DEMAND AND CAPACITY

- SPP Assessment Area is a summer peaking region
- Peak Demand is an aggregated non-coincident number based on member-submitted data
- Demand is based on 50/50 forecast
- Net Peak Demand reflects the reduction of available Controllable and Dispatchable Demand Response



	2020 (S)	2021 (S)	2022 (S)	2023 (S)	2024 (S)	2025 (S)	2026 (S)	2027 (S)	2028 (S)	2029 (S)	2030 (S)
Existing-Certain & Net Firm Transfers	66954	66786	66848	66937	66936	66972	66947	66640	66648	66623	66623
Anticipated Resources	67192	67049	67147	67273	67272	67308	67283	66976	66984	66959	66959
Prospective Resources	71144	71000	71098	71224	71223	71259	71234	70927	70935	70910	70911
Net Internal Dmeand	51259	51643	52921	53609	54023	54399	54772	55007	55298	55618	55851
Total Internal Demand	51951	52249	53524	54242	54689	55082	55480	55738	56046	56375	56584

RELIABILITY ISSUES

- Not anticipating unique emerging reliability issues over the assessment timeframe
- Do not expect adverse reliability impacts resulting from fuel supply or transportation constraints during the assessment timeframe
  - SPP staff continues to monitor this area to ensure that there are no issues
- Do not expect any reliability concerns, at this time, due to extreme weather events
  - SPP performs a biennial LOLE study to determine the reserve margin based on the Loss of Load Expectation (LOLE) standard of one occurrence in ten years
  - Study recognizes, among other factors, load forecast uncertainty, generator availability and transmission constraints
  - Weather assumptions and load forecast includes a probability of extreme weather in its distribution
  - SPP Resource Adequacy, Operations, and Market staff frequently meet to discuss the coordination of efforts to ensure that planning understands the real time issues and needs and how to best access those scenarios in the planning processes

2019 LOLE STUDY OVERVIEW

CHRIS HALEY, SPP STAFF

OUTLINE

- Study Highlights
- Results Overview

STUDY HIGHLIGHTS

STUDY OVERVIEW

- Loss of Load Expectation (LOLE) probabilistic study performed every two years
  - Goal is to determine the adequate amount of planning reserves needed to maintain a reliability metric of one day (or less) in ten years
  - Evaluates each hour of the year (8,760 hours)
  - Uses sequential Monte-Carlo simulations (multiple iterations)
- An LOLE analysis is typically performed to determine the amount of capacity needed to meet the desired reliability target
- For the 2019 LOLE Study, new modifications were incorporated to the modeling assumptions and study process
- Analyzed years 2021 and 2024

KEY STUDY DIFFERENCES

	2017 Study	2019 Study
Software	GridView/SERVM	SERVM
Zonal Representation	LBA's (16)	LOLE Zones (6)
Transmission Modeling	Nodal	Pipe/Bubble
Historical Wind, Solar, & Load Profiles	One Year (2014)	Seven Years (2012-2018)
Unit Commitment	Commit-All	Economic
Unit Parameter Modeling	Not Modeled	Modeled
Forced Outage Rates	EFOR-d (No Derates)2012-2016	EFOR (With Derates)2012-2016
Value of Wind in PRM Calculation	Workbook accredited values	Methodology similar to ELCC

FUEL SUMMARY

Accredited Capacity by Fuel Type	2021 Study Year (MW)	2024 Study Year (MW)
Demand Response-Available	823	823
Coal Capacity	22,973	22,731
Gas Capacity	30,612	29,810
Hydro and Pumped Storage Capacity	3,090	3,090
Nuclear Capacity	1,958	1,958
Wind Capacity	5,761	6,250
Solar Capacity	201	201
Petroleum Capacity	2,341	2,341
Biomass	89	89
External Net Transactions	1,479	1,550
Total Capacity	69,327	68,843

- ~1,100MW Retired Units between years 2021 & 2024
- ~100MW Increase of External Net Transactions
- Included new generation submitted by members
  - Staff did not make assumptions based on the GI queue

RESULTS OVERVIEW

RESULTS SUMMARY

Result Summary Table				
Planning Year	**2021**	**2024**	2021(Sensitivity)	2021(Sensitivity)
Commit Method	**Economic**	**Economic**	Commit All	Economic
Scaling Method to derive 0.1 d/yr LOLE	**Load Scale**	**Load Scale**	Load Scale	Gen Scale
Capacity (MW)	**69,331**	**68,843**	68,776	60,475
Wind at 0.1 Days/year (MW)	**5,761**	**6,250**	5,198	5,437
Demand at 0.1 Days/year (MW)	**62,043**	**61,109**	62,698	54,275
PRM at 0.1 Days/year	**11.75%**	**12.65%**	9.69%	11.42%

KEY TAKEAWAYS

- Results confirm the current PRM requirement of 12% is adequate for maintaining system reliability at one day in ten years for 2020 and 2021
- The margin between SPP's 12% PRM requirement and the PRM at the reliability metric of one day in ten years has decreased in comparison to the 2017 LOLE Study results
- Reserve margin needs for 2021 and 2024 do not consider replacing retired resources
- Study results indicate an increase to the current PRM requirement of 12% may be needed by 2024
- SAWG does not recommend a change in the Planning Reserve Margin based on the 2019 LOLE study results

QUESTIONS?

CLOSING

Thank you all for attending this event!

Your feedback is very important to us. Please provide your feedback using the link: https://www.surveymonkey.com/r/LTRA2020 or QR Code below: