AESO Reliability Requirements Roadmap
CanREA Summit

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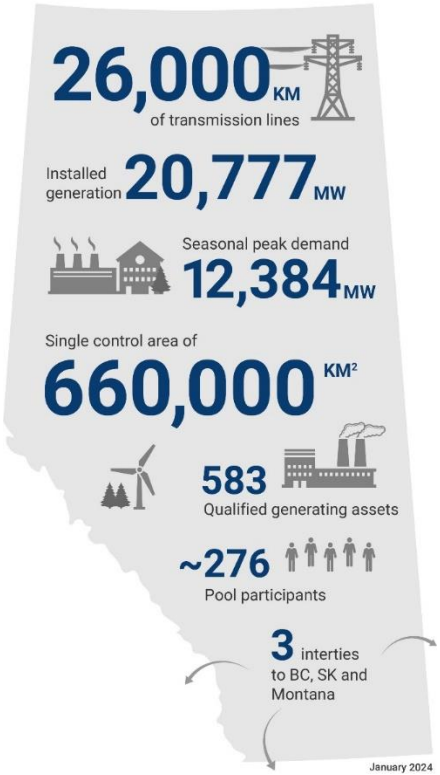
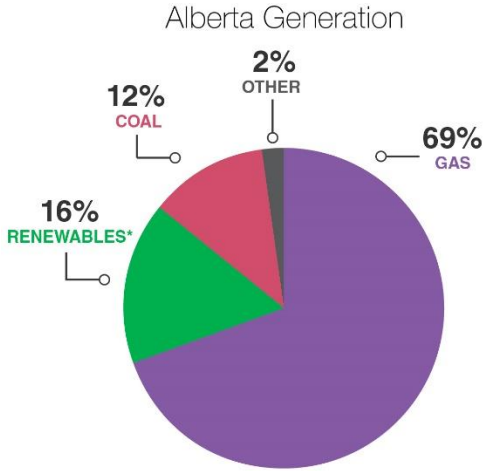
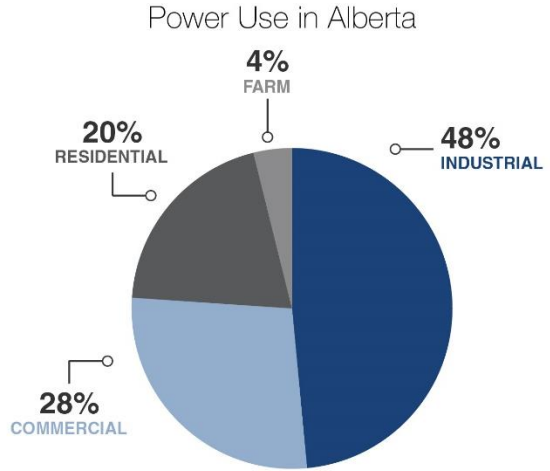
Alberta System Overview





Source: AESO Annual Market Statistics Datafile (data as of Dec 31, 2023)
*Renewables include wind, solar and hydro.

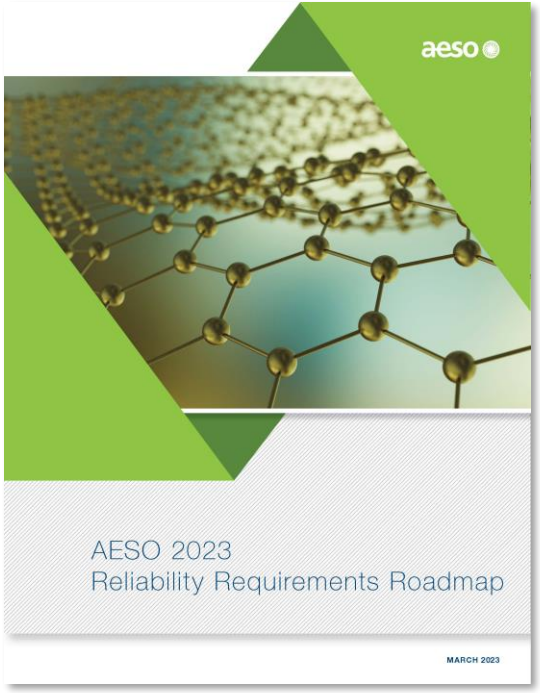


Source: Monthly Sales History 2022 (www.auc.ab.ca/annual-electricity data/

Reliability Requirements Roadmap

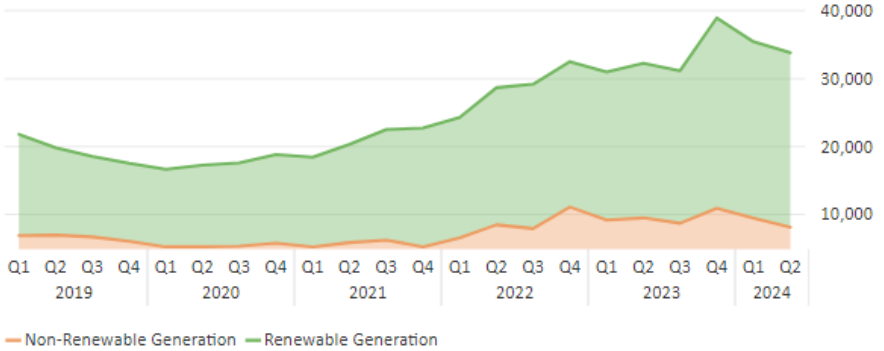
Purpose of the Roadmap

- Identifies reliability requirements to support the current and future supply transformation
  - Includes options and action plans to ensure the safe, reliable, and economic operation of the Alberta Interconnected Electric System (AIES)
- Explains the operational challenges that a transforming grid brings
- Presents the key findings of detailed technical analysis exploring these challenges
  - Based on models informed by operational experience and realistic supply scenarios
  - Current or expected impacts and degree of urgency
- Presents options for mitigation and prioritized action plans

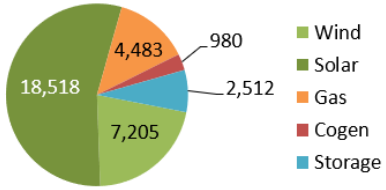


~ 34,000 MW Generation in the Connection Process (as of May 1st, 2024)

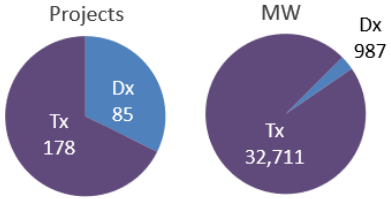
Generation MW in the Project List



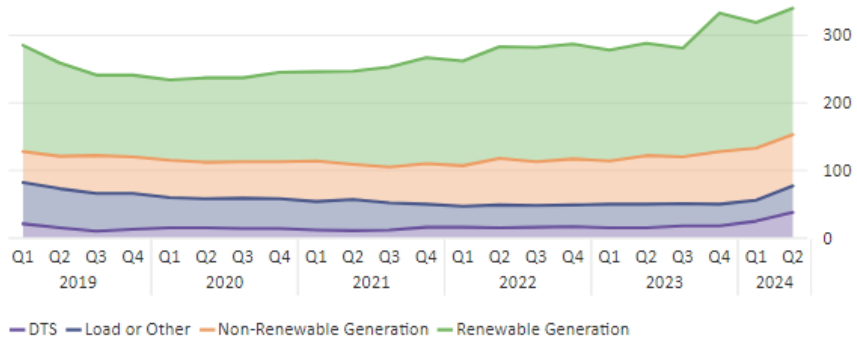
Generation MW by Type



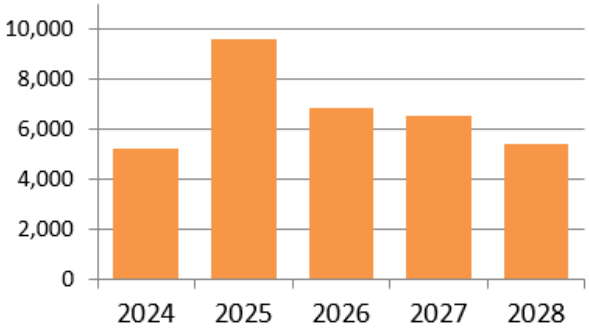
Generation by Connection



Projects in the Project List



Generation MW by ISD



System Reliability

- The AESO has been working to more comprehensively understand system reliability challenges resulting from the rapid re-composition of Alberta's generator fleet
- These challenges are occurring because:
  - Synchronous generators (such as coal-fired generators) are being retired or re-powered
  - Variable wind and solar generators are being added to the system
  - Variable, inverter-based resources (including wind, solar, and energy storage) have different characteristics from synchronous generators
- Reliability challenges have already started to emerge

Reliability Roadmap Overview

- To better understand reliability challenges that have emerged and those likely to emerge through time, the AESO performed several technical studies, which:
  - Incorporated observed operational data from recent events
  - Enhanced and extended prior analyses
  - Employed scenario-based projections for a decarbonized grid
  - Identified current challenges and those anticipated within the next ten years
- The Reliability Roadmap focuses on reliability challenges in three key areas:
  - Frequency stability
  - System strength
  - Flexibility capability

Frequency Stability | *Challenges*

Overview

- **Frequency stability** is the ability of the system to maintain an acceptable frequency and recover sufficiently quickly after contingencies

Urgency | **HIGH**

- Ensuring the system can maintain frequency stability is AESO's highest priority
- Immediate action is required to mitigate the risk of frequency instability
- The need for mitigation will continue to grow with ongoing generation fleet transformation

Key Findings

- Urgent need to mitigate risk of under-frequency load shed (UFLS) activation due to supply loss contingencies
- Elevated UFLS activation risk when the AIES is islanded
- Lack of primary frequency response is the main factor driving mitigation needs
- System inertia is a secondary factor

Frequency Stability | *Action Plan*

Priority | **Critical (0-6 months)**

- Adjust Load Shed Service for imports (LSSi)/Fast Frequency Response (FFR) arming requirements to lower current UFLS risk
- Explore immediate procurement of FFR services for islanded operation
- Develop procurement for FFR services to be operational in January 2025 or earlier

Priority | **High (1 year)**

- Continue to assess long-term solutions to address frequency stability, balancing mitigation costs with benefits, in collaboration with stakeholders

System Strength | *Challenges*

Overview

- **System strength** is the ability of the system to maintain normal voltage when disturbances occur

Urgency | **Medium**

- Challenges are currently confined to a small number of local areas
- Progressively more generators will be affected over the next decade

Key Findings

- Challenges occur where there is a high concentration of wind and solar inverter-based resources (IBRs) with relatively few synchronous generators
- Weak areas are generally concentrated in southern Alberta
- Relative system strength will decline as the prevalence of grid-following IBRs increases

System Strength | *Action Plan*

Priority | **High (1 - 2 years)**

- Improve the AESO's modeling capability, requiring electromagnetic transient (EMT) models from facility owners
- Work with industry to adjust or enhance IBR controls in affected areas and ensure reliable performance is verified in simulations
- Enhance the connection process for IBR facilities so system strength concerns are detected and mitigated early
- Evaluate potential longer-term solutions including market-based solutions, new technology, and infrastructure; including feasibility, cost, market, operations, and regulatory considerations
- Implement real-time stability assessment for operational readiness

Priority | **Medium**

- Review existing IBR performance requirements to identify gaps vs. best practices, determine appropriate actions and implement changes

Priority | **Long Term**

- Develop performance requirements that leverage new inverter technology capabilities (such as grid-forming inverters)

Flexibility Capability | *Challenges*

Overview

- **System flexibility capability** refers broadly to the electric system's ability to adapt to dynamic and changing conditions while maintaining supply/demand balance

Urgency | **Medium**

- Meeting performance obligations in this area will gradually become more difficult
- In the near term, balancing challenges are generally manageable using regulating reserve, forecasting, and energy market dispatch

Key Findings

- System flexibility becomes more challenging as variable generation increases
- Increased net demand variability will lead to increases in the frequency, speed, and magnitude of ramping, eventually requiring mitigation

Flexibility Capability | *Action Plan*

Priority | **High (1 - 2 years)**

- Investigate opportunities to improve short-term forecasts and provide more detailed adequacy assessments
- Investigate and progress market changes to improve flexibility or increase commitment certainty, in coordination with other market design changes
- Improve dispatch simulation software and models

Priority | **Medium (1 – 2 years)**

- Periodically reassess regulating reserve volumes to manage increasing net demand variability
- Investigate rule-based changes, such as time, to respond to dispatches/directives, more granular ramp rate submissions with tighter tolerances, or regulating reserve technical requirements
- Investigate process-based changes to improve flexibility, such as automated dispatch

Updates Since R3 Publication

Work in Progress and Future Considerations

Frequency

- In May 2024, obtained approval of ISO rules enabling technology-neutral FFR
- Procured technology-neutral discrete FFR to support intertie operation
- Procurement in progress for technology-neutral FFR for islanded operation
- Currently investigating proportional FFR and the potential to allow overlap of FFR with other services

System Strength

- In February 2024, developed interconnection requirements for inverter-based resources that will enhance reliability in weak system conditions
- Currently working with project owners to apply the requirements to their facilities

Flexibility

- Monitoring balancing performance and boosting regulating reserve as needed
- Developing a new Fast Regulating Reserve ancillary service
  - Motivated by growth in non-dispatched renewables that was faster than anticipated
  - Needed to manage reliability risks arising from fast down-ramps or supply loss
  - Design goals include accommodating energy-limited and cycling-limited assets

Thank You