

Alberta 2023 Emerging Reliability Risks

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Introduction

This report briefly presents the emerging challenges that the AIES is expected to face in 2023 and onward, in meeting its goal of a reliable electric system. The critical emerging risks listed in this report were identified based on input from several AESO subject matter experts on reliability and security.

It should be noted that this report was prepared to serve as an input to the AESO Risk-Based Compliance Monitoring Program. There are other risks the AESO and the industry would need to address or continue to focus on that are not listed here. In addition, as conditions within the AIES change, the risks and the priorities may also change.

Table 1 in the Appendix below lists the Alberta Reliability Standards (ARS) and requirements that the AESO has mapped to each of the emerging risks identified in this report, if applicable. The AESO monitors entity compliance with these ARS requirements in its execution of the Alberta Risk-Based Compliance Monitoring Program (ARCOMP). The AESO's identification of these risks and mapping to the applicable ARS requirements is the output of the System Level Risks process in the ARCOMP.

2023 Emerging Reliability Risks

The following four emerging risks are identified, as presented below, in order of criticality. In developing the list, three evaluation measures were used: 1) the risks as identified by NERC in its "2023 ERO Enterprise CMEP Implementation Plan" document; 2) the uniqueness of AIES and the ability for the AESO to contribute to mitigating the risks; and 3) the traditional risk approach based on probability and impact.

1. Change in Generation Mix
2. Cyberthreats
3. Extreme Natural Events
4. Remedial Action Schemes

Change in Generation Mix

It is well observed that renewable or other low-carbon sources have been assuming a rapidly increasing proportion of electricity production in Alberta in recent years. By 2022, inverter-based resources (IBRs) capacity had grown to 31% of Alberta's generation mix, up from 15% in 2018. This trend is expected to continue in 2023 and beyond. Meanwhile, gas and coal fired generation is dropping in Alberta's installed generation capacity at a fast pace.

The AESO is both the Balancing Authority (BA) and the Reliability Coordinator (RC) and, as such, is directly responsible for the reliable operation of AIES with high levels of IBR penetration. The "AESO 2023 Reliability Requirements Roadmap" identified three key areas of concern:

1. *Frequency Stability*

The ability of the electric system to maintain an acceptable frequency level and recover from imbalances caused by contingencies is heavily impacted by the composition of the generation fleet. An increase in the proportion of IBRs is generally associated with a reduction in frequency stability. The AIES's frequency response capability has been declining considerably due to changes in the generation mix impacting the inherent inertia and primary frequency response capabilities. Due to insufficient primary frequency response capabilities, UFLS was activated several times in 2020 and 2021. Existing frequency-related operational challenges mean that actions are required to reduce the frequency stability risk. The AESO's current highest priority is

to ensure the AIES has adequate frequency response capability notwithstanding high IBR penetration for real-time operation.

2. *System Strength*

High system strength entails a reduced vulnerability to severe voltage fluctuations and instability. An increase in IBR penetration is generally associated with a reduction in system strength. The displacement of key thermal plants and corresponding increase in IBRs has led to system strength shortfalls in parts of AIES. The declining trend in system strength brings about some reliability challenges and poses risks to the electric system.

3. *Flexibility Capability*

The ability of the electric system to adapt to changing conditions over various timescales while maintaining a balance between supply and demand will be impacted by the future generation mix. A natural property of IBR resources is their fuel volatility. The AIES will continue to experience sudden drops of large amounts of wind or solar generation due to weather conditions, requiring sufficient reserves with adequate ramping capability at the disposal of the system controllers.

Risks related to restoration activities must also be considered. The evolving generation mix has resulted in retirements of key thermal plants used in restoration activities, and the increased penetration of IBRs may drive remaining thermal plants to be offline at the time of a blackout. Furthermore, increasing penetration of distributed energy resources (DERs) results in complexities during load pickup during restoration by reducing the net demand.

IBR resources introduce another challenge related to modelling. There exist a variety of control techniques and logics, as the IBRs originate from a wide variety of manufacturers. As models become more complex, accuracy of the datasets and models is vital to technical studies on the system steady-state and dynamic behavior.

Cybersecurity

In North America, cyberattacks have caused loss of control or damage to communications and data for business operations. Cyberthreats in the AIES can result in partial or complete loss of the monitoring schemes, protection and control systems, and operational tools. Attacks can cause the loss of generation and load, and hinder the resilience and recovery systems under emergency conditions.

NERC and WECC have stated in their reliability risk reports that the number of malicious cyberattacks has been on a growing trend. Although most of the cyberattacks have been unsuccessful, the threat actors are becoming increasingly sophisticated and are capable of carrying out attacks on the grid at times selected for maximum disruption. Ransomware is a significant threat with the highest likelihood of success amongst all cybersecurity risks.

The greatest impact to the AIES would most likely come from a coordinated, wide-area cyberattack on multiple elements. Malicious actors must be prevented from gaining access to systems that are critical to the operation of the grid.

The pervasiveness, increasing risk and potential harm that can result from a cyberattack compel us to prioritize cybersecurity as a risk priority for the AIES. The AIES relies on healthy operation of the various computer tools and monitoring and control systems for a reliable grid. Moreover, the AIES has a number of Remedial Action Schemes (RAS) that use various devices, many of which are digital.

Extreme Natural Events

Extreme natural events appear to be more frequent, longer in duration, and more impactful in Alberta due to global changes in climate and weather patterns. Record-breaking hot and cold temperatures, prolonged heat waves and cold snaps, extended rainy and snowfall periods, and increasing intensity of wildfires change the way in which we plan and operate our system.

The greater difficulty in predicting future weather conditions makes the historical data related to loads and generation less reliable and informative. Without accurate forecasts of these critical parameters, it is increasingly difficult to develop long term plans to address future challenges.

For the foreseeable future, IBRs are expected to constitute greater portions of the generation fleet in the AIES. Extreme weather events will negatively impact not only the operation of the transmission (and distribution) facilities, but also the resource adequacy and availability. These IBRs include wind and solar generation, whose output is dependent on weather. It may also include resources like natural gas, which can be affected by fuel transportation issues caused by severe weather events. Ensuring that system controllers have the information they need (through accurate models, tools, and real-time data) to control and operate the AIES is increasingly challenging as the complexity and quantity of input variables increases.

The fact that some natural events can severely hinder the generation capability of certain IBRs is a paradigm shift from historical norms. For instance, a large solar farm may have to drastically reduce its output in response to gusty winds.

Remedial Action Schemes (RASs)

Currently over 60 remedial action schemes have been installed and armed in the AIES to respond to specifically defined operating conditions, generally with low probability of occurrence, to reduce or eliminate thermal overload, voltage, or transient instability issues.

As the RASs are becoming more complex in the triggering logic, with higher interdependency in arming and operation, their impact on the reliable operation of the AIES should be carefully examined. Risks could include:

- Some single contingencies can trigger multiple RAS, or could lead to a cascading effect which causes the sequential triggering of multiple RASs, potentially creating a larger level of unbalance in the system.
- Activation of a certain RAS could trip an asset to mitigate a specific violation but simultaneously could create or exacerbate a violation on some other elements.
- The same asset may be tripped by multiple RASs.
- The increase in generation tied to certain RASs could present the risk of violating the MSSC.

Appendix

Table 1: System Level Risks Mapped to Alberta Reliability Standards (ARS) Requirements

Emerging Risk	ARS Requirements
Change in Generation Mix	N/A
Cybersecurity	<ul style="list-style-type: none"> • CIP-003-AB-5 R2 • CIP-003-AB-8 R2 • CIP-005-AB-5 R2 • CIP-005-AB-7 R2 • CIP-005-AB-7 R3 • CIP-007-AB-5 R3 • CIP-008-AB-5 R1 • CIP-008-AB-5 R2 • CIP-008-AB-5 R3 • CIP-010-AB-1 R1 • CIP-010-AB-4 R1 • CIP-012-AB-1 R1 • CIP-013-AB-2 R1 • CIP-013-AB-2 R2 • CIP-014-AB-2 R4 • CIP-014-AB-2 R5
Extreme Natural Events	<ul style="list-style-type: none"> • EOP-005-AB-3 R1 • EOP-005-AB-3 R2 • EOP-005-AB-3 R3 • EOP-005-AB-3 R4 • EOP-005-AB-3 R5 • EOP-005-AB-3 R8 • EOP-005-AB-3 R9 • EOP-005-AB-3 R10 • EOP-005-AB-3 R12 • EOP-005-AB-3 R13 • EOP-005-AB-3 R14 • EOP-005-AB-3 R15 • EOP-005-AB-3 R16 • EOP-011-AB-1 R1 • EOP-011-AB-1 R4
Remedial Action Schemes	N/A