

Driving With the "Check Engine" Light On - Alberta's Grid



We've all done it. You're driving along and the "check engine" light comes on. At first, there's some anxiety and your heart rate jumps a bit, but then you keep driving and there aren't any odd noises or smells and you calm down a bit and think "maybe its just a loose gas cap or something". You look at the owner's manual and it says that a yellow light means get it checked out soon and a red light means do something right now. But the light is yellow, so you keep driving and the longer nothing bad happens, the longer you keep driving, hoping that whatever's wrong is minor and you can take care of it the next time you get around to taking the car into the shop.

In my opinion, this is what we've been doing in Alberta with our power system for some time now. The [Alberta Electric System Operator \(AESO\)](#) has published reports warning of significant power system problems, so it's no secret that something's wrong, and we've been operating the power system with that "check engine" light on for a while now.

The Check Engine Light Turns Red

On January 13th, 2024, all Albertans saw that check engine light turn from yellow to red. The Alberta power system came [perilously close to a supply shortfall](#), which means that the demand for power very nearly exceeded the available power supply. We came within tens of MW of supply shortfall, which would have meant controlled (rolling) blackouts during -35 C ambient temperatures - not good.

This event was due to the declining level of dispatchable generation capacity and growing Alberta electricity demand, that is, decreasing resource adequacy. However, resource adequacy is only one of four power system problems we are facing in Alberta:

- Decreasing Resource Adequacy
- Frequency Stability challenges
- System Strength challenges
- Flexibility Capability challenges

I'll briefly discuss each of these.

Decreasing Resource Adequacy

Each year, the AESO publishes the [Annual Market Statistics Report](#), which provides detailed data on all aspects of Alberta's power system and market. The report provides the system reserve margin, which is the available dispatchable generation capacity in excess of system peak demand. Reserve margin excludes wind and solar and assumes seasonal hydro capacity, and is provided with and without intertie capacity.

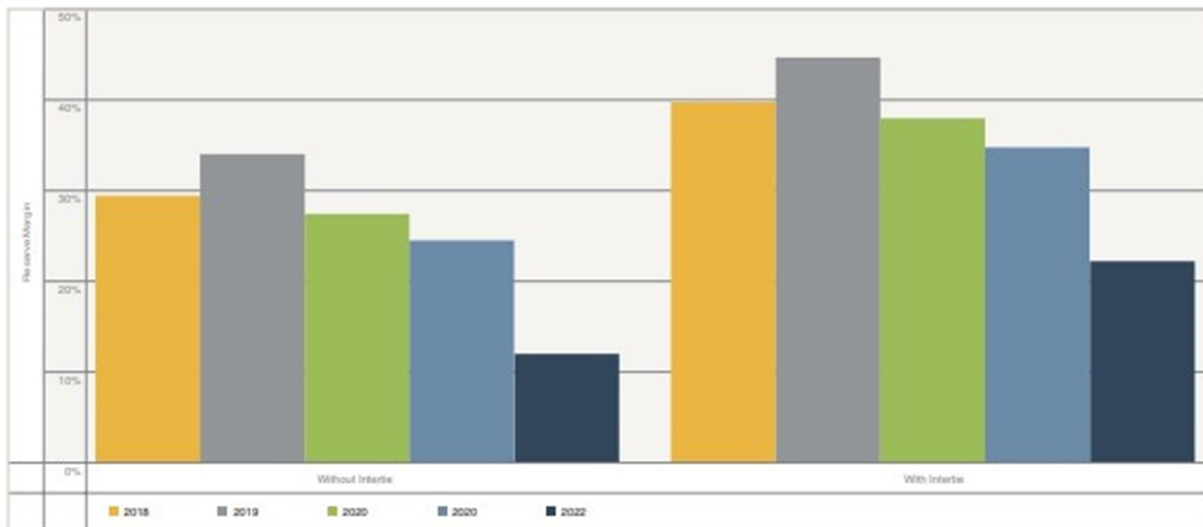
Reserve margin is an indicator of resource adequacy - the larger the reserve margin, the better the resource adequacy. In an energy-only market design like Alberta, we depend on private investment to ensure resource adequacy, and the AESO cannot "enforce" a specific reserve margin, it only monitors it as an indication of market health.

In Alberta, the reserve margin has been declining since 2019, and in 2022, the latest published report, the reserve margin was just 12% without interties.

You might be asking, so what should the reserve margin be? Well, it varies depending on the characteristics of each power system and typically involves the calculation of [loss of load expectation](#) (LOLE) and consideration of forced outage probabilities, but typical planning reserve margins are in the 20% range. For example, [New York ISO uses a 20% target reserve margin](#).

The figure below, from page 25 of the [2022 Market Statistics Report](#), tells the story.

FIGURE 22: Annual reserve margin



This means that at the end of 2022, Alberta had just over 1000 MW of dispatchable capacity in excess of peak demand. Therefore, if peak demand is higher than expected and/or some of that dispatchable capacity is unavailable due to forced outages or planned maintenance, then the system could come close to supply shortfall. In my opinion, this is an outcome of many years of federal government policy biased against private investment in dispatchable (i.e., emitting) generation, which has resulted in significant investment in renewable generation, but insufficient investment in dispatchable generation, which is what we need to maintain a healthy reserve margin and, therefore, to ensure resource adequacy.

The yellow check engine light is on.

Degrading System Operability

On March 10th, 2023, the Alberta Electric System Operator (AESO) published the [Reliability Requirements Roadmap](#) which provided a detailed summary of the power system operational impacts of increasing levels of variable renewable generation on the transmission system, distribution connected renewable resources, and changes to demand patterns due to increasing electrification. The report provided an excellent overview of the challenges facing Alberta's evolving power system due to the energy transition and highlighted the fact that *"While this shift creates investment opportunities and helps the province to progress towards a decarbonized electricity system and economy, it also presents significant operational challenges."*

The report clearly outlines three specific operational challenges the Alberta power system is facing:

Frequency Stability

This is the ability of the power system to maintain sufficient frequency and recover to normal operating frequency (60 Hz) following the sudden loss of a large supply source. The AESO considers Frequency Stability to be their highest priority, stating *"Existing frequency-related operational challenges mean that **immediate action is required** to reduce frequency stability risk. The need for mitigation will continue to grow over time as the generation fleet continues to transform."* Essentially, the AESO is saying that as more variable renewables are added to the system without the addition of dispatchable generation, the harder it will be to maintain adequate frequency control. Several actions are noted, including increasing arming levels of Fast Frequency Response (FFR) service and procuring more FFR services by 2025.

System Strength

This is the ability of the power system to maintain normal voltage at any given location despite system disturbances. The AESO sees **System Strength** as a localized challenge in specific areas of the system in the near term but increasing in significance if not addressed soon. Actions will include changes to renewables interconnection requirements and controls and possible market-based solutions.

Flexibility Capability

This is the ability of the power system to adapt to dynamic and changing conditions while maintaining the balance between supply and demand. This is manageable today but will become more challenging as more variable renewable generation is added. Potential solutions include increased levels of regulating reserves and incentives for flexible dispatchable generation.

Taken together, these three problems paint a picture of a power system that has become increasingly fragile, increasingly hard for the AESO to operate, and therefore increasingly unreliable. These are the operational outcomes of the policy environment I discussed above with respect to resource adequacy. Increasing levels of variable, inverter-based generation capacity relative to synchronous dispatchable generation capacity have resulted in a power system that is becoming increasingly operationally unreliable.

Again, the yellow check engine light on.

Time to Visit the Shop

The check engine light turned from yellow to red on January 13th when we came uncomfortably close to supply shortfall on one of the coldest days of the year. This event very publicly alerted everyone to that check engine light, and the time has come to visit the shop and do some repairs.

Luckily, we had a scheduled appointment because the Alberta government, the AESO, and the AUC already had initiatives underway to address these issues, so repairs are on the horizon.

The Alberta government is [reviewing the transmission policy](#) and market structure, the AESO's [Market Pathways](#) initiative is exploring market changes required to navigate the energy transition, and the [AUC is exploring the impacts to reliability of continued addition of renewables to the power system](#). In addition, the [Market Surveillance Administrator](#) is providing advice and input to the government. The government will take the findings, recommendations, and advice from the AESO, AUC, and MSA into account in developing electricity policy changes that are expected to be unveiled in early March 2024.

However, in the meantime, the power system will be in a perilous state until we can get some new dispatchable generation on the system, which is expected this spring with the addition of the [Cascade combined cycle plant](#) and the [Suncor cogen plant](#). These dispatchable and baseload capacity additions will help address our immediate resource adequacy issues and some of the operational challenges, but will not fix our longer term issues. The longer term issues will hopefully be addressed through the implementation of electricity policy reforms that the Alberta government will be releasing this year.

Until then, buckle up and try not to look at that check engine light.