Independent evaluation of proposed changes to Alberta's operating reserve market format and information release policies

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List of Acronyms

ADOE	Alberta Department of Energy ADOE
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AESO	Alberta Electric System Operator
AGC	Automatic Generation Control
AUC	Alberta Utilities Commission
BESS	Battery Energy Storage Systems
ETS	Energy Trading System
EUA	Electric Utilities Act
FCAS	Frequency Control Ancillary Services
FCC	Federal Communications Commission
FEOC	Fair, Efficient, and Openly Competitive
ISO	Independent System Operator
LEI	London Economics International LLC
LFS	Load Following Service
MPMA	Market Power Mitigation Advice
MSA	Market Surveillance Administrator
MW	Megawatts
NEM	Australian National Electricity Market
OR	Operating Reserves
PCS	Personal Communication Service
PJM	Pennsylvania-New Jersey-Maryland Interconnection
PPA	Power Purchase Arrangement
RR	Regulating reserves
RRO	Regulated Rate Option
SR	Spinning reserves
SUP	Supplementary reserves
TAC	TransAlta Corporation
TMR	Transmission must-run
WECC	Western Electricity Coordinating Council

1 Executive Summary

London Economics International LLC ("LEI") was retained by TransAlta Corporation ("TAC") to prepare an independent, expert evaluation of Alberta Electricity System Operator's ("AESO") proposed changes to the Operating Reserves ("OR") markets. AESO began an initiative in 2020 to review the OR market as part of its broader market power mitigation framework. AESO has stated that the current industry structure, although workably competitive, may not be conducive to attracting new market participants. After the first two stakeholder engagements, AESO has proposed to change the format of the procurement process from an open auction to a sealed bid format. In conjunction with the move to a sealed bid format for procurement of OR products, the AESO is also recommending that all offer data - which OR providers can see in real time - would be held back and released only after a 60-day period. LEI was asked to specifically focus on these two proposed changes. In light of AESO's initial concerns regarding efficiency, fidelity of the price signal and motivating new entrants, LEI believes that the proposed changes are not going to be beneficial to new entrants and therefore would not support improvements in dynamic efficiency.

1.1 Scope of LEI's engagement

LEI was asked to specifically focus on two issues: (i) the proposed changes to the format of OR procurement and (ii) associated changes to the information disclosure policies. LEI applied a methodological approach, which involved:

(a) investigation of the rationale for the changes being proposed through a review of the documentation issued by AESO in the stakeholder consultation process;

(b) examination of the applicable economic theory related to the core issues of auction format and information dissemination policies; and

(c) analysis of the advantages and disadvantages of the proposed changes through a pragmatic consideration of key features of Alberta's current energy and OR markets and insights from economic theory.

In preparing this independent evaluation, LEI deployed its in-depth knowledge and extensive experience in the Alberta electricity sector, as well as LEI's experience working on electricity issues – including energy and OR market design – in Alberta and in Canada, the U.S., and across other international jurisdictions. Appendix A provides a brief overview of LEI's experience in Alberta and market design expertise relevant for the preparation of this independent expert report.

1.2 Information reviewed and relied upon

LEI reviewed the Market Power Mitigation Advice ("MPMA") report, AESO's OR market initiative from sessions 1 and 2 of the stakeholder engagement, and the stakeholder comment matrices from sessions 1 and 2. Additional data was gathered directly from the AESO, and reports prepared by Alberta's Market Surveillance Administrator ("MSA"). LEI also studied historical trends in Alberta's OR market and current practices for trading OR. Finally, LEI also reviewed economic literature related to auction design with market participants of various sizes and levels

of sophistication, as well as information policies appropriate to support competition in auctions involving commodities.

LEI staff also relied upon industry knowledge acquired over their two-plus decades of experience working on various electricity sector issues in Alberta with a range of clients, as well as a principled understanding of the behavior of market participants in various auction settings.

1.3 Summary of findings

The AESO is recommending changing the procurement platform from sequential open auctions to a sealed-bid format. The AESO is also proposing to delay the disclosure of offer information for 60 days. AESO cites concerns around "latency" and anti-competitive behavior as the rationale for the change. The overarching objective, as the AESO noted at the start of the stakeholder consultations, is to reduce/remove barriers to entry, enhance the fidelity of the market price signal, and improve the long run efficiency of the OR market. **The changes being proposed by the AESO are not likely to achieve the AESO's own overarching objectives.**

Despite AESO's concerns about potential anti-competitive behavior, the OR market has been workably competitive and market outcomes have been shown to be disciplined by competition. Although hydroelectric resources have had a significant market share in the provision of OR in Alberta historically, this is neither unusual, nor an indication of market power. Hydroelectric resources with storage are naturally competitive suppliers of OR capacity, as they can shift their energy production to future periods. In other markets, such as California and Ontario, we also observe hydroelectric resources fulfill a large portion of the system operator's ancillary service needs. However, even with such a dominant position, hydroelectric resources face competition from existing resources and new entrants. In Alberta, the market share of offers cleared by hydroelectric resources in both the active spinning and active supplementary markets have decreased in recent years. This trend is not an anomaly or one unique to Alberta, rather, it is consistent with outcomes observed in other jurisdictions, with flexible load resources and battery energy storage systems ("BESS") joining the pool of conventional ancillary services providers.

Additionally, it is important to recognize that a proper market definition would find that OR markets and the energy market have a high level of substitutability. Market participants routinely choose whether to supply energy in lieu of OR and vice versa. Substitution-like decisions are routinely made by the buyer (for example, the AESO decides on how much OR product to purchase in order to accommodate its expectations for reliable operations of the energy market). As such, it is inappropriate to draw conclusions regarding the competitive nature of any single OR product auction. A proper competition analysis needs to reflect an accurate market definition and recognize that OR markets are not economically distinct from energy markets. Therefore, the competitive nature of the OR markets mirrors the competitive outcomes in the energy markets.

We observe through offered volumes that competition has intensified. Indeed, there are times when the net price of certain OR products has fallen to zero. Between 2016 and 2021, prices in the spinning and supplemental reserves market were competed down to $0/MWh for 11.2% and 54.4% of the trading periods, respectively. These outcomes are the direct result of new participants, such as load and BESS. According to the Market Surveillance Administrator ("MSA")'s quarterly reports, between 2020 and 2022 the share of supplemental dispatched OR volumes provided by load grew from approximately 20% to 57%, while BESS resources provided

15% of dispatched spinning reserves. **In light of these factors, the AESO's hypothetical concerns regarding inadequate competition in Alberta's OR market appear to be unsupported by the data.**

The AESO noted that only a certain set of resources provide OR and this observation raises potential concerns about barriers to new entry. It is well accepted that OR providers must meet certain technical requirements. However, these technical requirements have not resulted in a permanently limited pool of OR providers. As technology has evolved, AESO has been able to relax its technical rules regarding OR qualifications. And that has, in turn, spurred new entry (for example, demand-side resources have increased their activity in the supplemental OR market in recent years). LEI finds that there are no specific economic barriers to entry created by the auction format in Alberta's OR market. Rather, technical requirements for the provision of operating reserves, the small size of the Alberta energy market (which means there is a smaller pool of overall market participants), and the natural comparative advantage of certain resource types creates the impression of a highly concentrated market characterized by a limited pool of OR providers. A change in procurement format and information policies will not "correct" for these factors: a new entrant must still meet the technical requirements and will still have to make tradeoffs between the energy and OR markets. In fact, a move towards a sealed bid auction may make it more difficult for new entrants to gain timely information to make appropriate decisions which will, in turn, increase the perceived risk of participating in the OR markets as discussed in economic theory with respect to the "winner's curse" concept. The **AESO's proposed change to the procurement format and information policies may backfire – weakening the position of new entrants and smaller providers of OR.**

The AESO has observed that the majority of offers are submitted within seconds of the closing of each daily auction. They refer to this as a "latency issue." Although the use of the adjective ("latency") is descriptive of the phenomenon present in the OR auctions, LEI disagrees with the characterization of this phenomenon as an issue. There is a natural and competitive rationale for the latency – simply put, it allows market participants to combat inefficient price wars. On the other hand, the presence of latency in the offer strategy of providers does not invalidate the price discovery that the current open auction format affords all market participants. The sequential, open auction format used in the procurement of OR in Alberta today provides market participants with multiple opportunities for price discovery. The publication of real time offers supports price discovery for later auctions in the same day. For example, observed trends in offer prices in the regulating reserve market informs market participants for the next series of auctions (spinning and supplemental). The price discovery that occurs in the OR markets also supports the next day's OR procurement process and informs market participants about expectations in the energy market. Even though the identities of OR providers are not known at the time of the auctions, the detailed offer data can be useful to market participants studying trends over time. In addition, the pattern of offers in the active spinning reserve auction yields valuable information about market participants' views on scarcity in the real-time energy market. In the open auction format, market participants are also able to see AESO's bid, and that information contributes toward price discovery. **In summary, access to real-time information is a key factor in achieving efficient pricing outcomes, regardless of when the majority of offers are submitted.**

For auctions to be efficient in the short term and long term, information must be readily available to all market participants about market conditions and the economic valuation of the traded commodity. A sealed bid format with a lag in disclosure of offer data would immediately

undermine price discovery for all market participants. This may result in offers and market outcomes that are not as allocatively or productively efficient – for both the OR and energy market. For example, AESO may end up clearing OR offers that lead to a less efficient mix of resources committed to the OR market versus the energy market. A delay in publishing vital information that supports price discovery (for future periods, other OR and energy products) may create unintended negative consequences. If a good or service has a "common value," an open auction will aid in resolving the winner's curse problem and thus yield more efficient auction outcomes. OR products have common value properties, therefore lack of information in an asymmetric oligopoly setting may well raise the winner's curse problem predicted in economic and auction theory. Market participants facing a winner's curse paradigm will not be inclined to be as aggressive in their offer strategies for fear of underpricing and incurring an economic loss. This would lead to higher clearing prices in the OR market. In addition, economic theory predicts that the lack of transparency and timely information would bias the smaller, less sophisticated market participants, which could lead to market exit by this disadvantaged cohort over time. This is precisely the outcome that AESO should be looking to avoid. **The current open auction design and ability for all market participants to observe the full spectrum of OR offers motivates intense competition and efficient outcomes. Therefore, the current market design should be preserved.**

1.4 Structure of the report

In Section 2 of this report, we briefly summarize and describe the stakeholder engagement to date. LEI's review of the stakeholder engagement sessions provided a means for understanding AESO's objectives and the information that AESO relied on to arrive at its recommendation.

In Section 3, we highlight major factors that influence the outcomes of the OR market and provide additional details relevant to the current open auction format. Items discussed in this section provide insight/serve as a foundation in understanding the economic review.

In Section 4, we discuss the profile of OR providers in Alberta, and consider the characteristics of OR providers vis-a-vis market outcomes. We also consider if this structure precludes competitive market outcomes – one of the concerns raised by AESO.

In Section 5, we focus on the key lessons learned from economic theory related to auction design and information policies. We highlight potential issues that arise from a sealed-bid auction format as it relates to AESO's overarching objectives related to motivating new entrants and improving the efficiency of OR market outcomes.

Finally, in Section 6, LEI concludes with a summary of our key findings and the implications of those findings relative to AESO's recommendation for changing the format of procurement and information release policies.

2 Summary of AESO Stakeholder Engagement

Although the AESO and the MSA have concluded that the OR markets are functioning in a workably competitive manner, the AESO appears to still be concerned with competition and barriers to new entry. One of AESO's recommendations from the stakeholder engagement is to change the procurement platform from a series of sequential open auctions to a sealed-bid format. While some stakeholders have shown support for this initiative, the majority of stakeholders have raised concerns about the purpose of this modification and whether it will achieve AESO's broad objectives.

2.1 Motivation for stakeholder engagement

In the *Market Power Mitigation Advice* ("MPMA") report prepared by the AESO and provided to the Minister of Energy in November 2019, AESO concluded that competitive pressures in the OR markets were more limited as compared to the energy market. On that basis, AESO suggested increasing competition would help mitigate potential issues of market power.[1] With this objective in mind, AESO decided in 2021 to begin a review of the current OR market design and associated rules.

At the stakeholder engagement sessions in 2021 and early 2022, the AESO noted that "at the highest level, the [OR] market is functioning, but there are several design elements that are not performing in a way that promotes efficiency."[2] Efficiency is a well-defined concept in Alberta's electricity sector and part of the legislative mandate. The Electric Utilities Act ("EUA") specifies that all market participants have an obligation to act in a manner that supports fair, efficient, and openly competitive ("FEOC") market outcomes.[3] The EUA treats competition and efficiency as distinct, yet complementary, attributes for a successful market. Efficiency can be achieved if competition is present. In relation to the current OR markets, AESO has concluded that

> AESO defines efficiency based on two (time-dependent) metrics: **static (short-run) efficiency** and **dynamic (long-run) efficiency**.
>
> **Static efficiency**: refers to the economic performance of the market in real-time and focuses on the productive and allocative efficiency of the market. This means that output is being produced at the lowest cost and all gains from trade are exhausted.
>
> **Dynamic efficiency**: refers to the maximization of social welfare over time, which is achieved through timely changes in capital stock – retirements and new entry. Therefore, the major driver of dynamic efficiency is the free entry and exit of firms in the market. Hence, barriers to entry (and exit) should be minimized.[5]

[1] Specifically, the AESO concluded at that time that "there have been occasions where strategic behavior has occurred in the OR market resulting in price outcomes that were not consistent with a competitive market. These instances demonstrate that the opportunity for participants to exercise market power exists today" (MPMA. Page 9).

[2] AESO. *Operating Reserves Market Review – Session 1.* November 2021.

[3] Market Surveillance Administrator (MSA). *A Common Understanding: Fair, Efficient, and Openly Competitive.* p.3. November 4, 2005.

competition is present and adequate.[4] Nevertheless, LEI understands that the AESO is focused on identifying improvements in the current OR market design to motivate new market participants. Given that efficiency has a short-term and long-term dimension (as discussed in the textbox on the prior page),[5] AESO appears to be primarily worried about dynamic efficiency. On that basis, LEI recognizes that the broad objective of the ongoing OR market review initiative is to evaluate market design changes that may motivate additional new entry by removing barriers to entry (if there are any) and by improving the price signal so it can attract investment and diversify the current mix of OR providers.

2.2 Overview of stakeholder engagement

The stakeholder engagement process was designed to follow a phased approach. Phase I includes three sessions, as summarized in the figure below. This independent expert report is being prepared ahead of the third session in Phase I. LEI understands that a decision to move forward with Phase II, which would contain draft Independent System Operator ("ISO") rules and an application filing with the Alberta Utilities Commission ("AUC"), has not been made.

Figure 1. AESO Stakeholder Engagement Timeline

Source: AESO. *Operating Reserves Market Review Session* #2. April 7, 2022.

[4] AESO. *Operating Reserves Market Review – Session 1*. November 2021.

[5] AESO. *Market Power Mitigation Report*. p.25. November 2019.

2.2.1 Parties involved and positions taken in written comments

To date, the stakeholder engagement included 19 active participants in addition to the AESO, compromised of power producers,[6] trade associations,[7] and the MSA.[8] Stakeholders did not reach a consensus on the design changes proposed by AESO. Some participants agreed, some disagreed, and others maintained a partial stance on AESO's recommendations, depending on the specific proposed change. For example, the majority of stakeholders disagreed with AESO's recommendation to move to a sealed-bid approach, noting concerns ranging from reduced market transparency and increased risk, especially for new participants.[9] Notably, LEI identified in its review of the stakeholder consultation materials and comment matrices a recurrent theme about the lack of empirical evidence that demonstrated that the proposed changes would meet the intended objectives of the AESO.

2.2.2 Summary of first and second stakeholder engagement sessions

Session 1 introduced the OR market review initiative whose purpose is to improve efficiency through enhanced competition and price fidelity. AESO identified three focus areas (as seen in Figure 2 below). AESO also categorized areas of improvement to the current OR market design into two groups of design elements:

- Group 1 covered options that the AESO believes can be implemented fairly quickly, and
- Group 2 covered options that the AESO considered more complex and requiring more analysis.

The AESO then proceeded to use the MPMA report and basic economic principles and historical data analysis to identify options and draw conclusions regarding potential changes. Design elements for group 1 (equilibrium pricing and use of AESO bid price, standing offers, offer transparency, and minimum qualification/offer size) were discussed in detail in the first session while group 2 design elements (block procurement, contingency reserve procurement, and standby reserve pricing and procurement) were discussed in greater detail in session 2.

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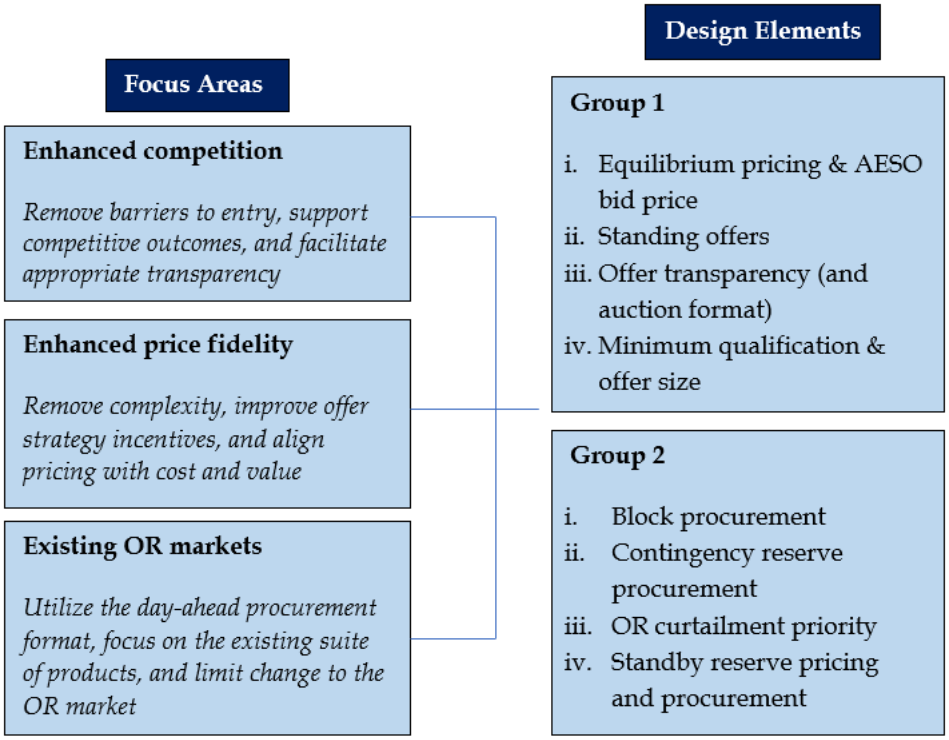
[6] In alphabetical order: BluEarth Renewables Inc., Campus Energy Partners, Capital Power Corporation, Enel North America, Enfinite Power, ENMAX, Greengate Power Corporation, Heartland Generation, Millar Western Forest Products Ltd., Suncor Energy, TransAlta Corporation, TransCanada Energy Ltd., URICA Asset Optimization Ltd., Versorium Energy Ltd., and Voltus Energy Canada.

[7] Canadian Renewable Energy Association ("CanREA"), Independent Power Producers Society of Alberta ("IPPSA"), and the Office of the Utilities Consumer Advocate ("UCA").

[8] Active participants, in this case, refer to stakeholders who submitted comments to the stakeholder comment matrix provided by AESO.

[9] AESO. *Stakeholders Comment Matrix – Sessions 1 and 2*. January 10 and May 16, 2022.

Figure 2. AESO's focus areas and design elements



Source: AESO. *Operating Reserves Market Review Session 1 and 2.*

Session 2 began with an overview of session 1, then proceeded to describe the stakeholder feedback that was received and how this feedback was considered by the AESO. As mentioned above, AESO also discussed its views and proposed alternatives to Group 2 design elements in the second stakeholder session.

Session 3, scheduled for late August 2022, is expected to include detailed recommendations for all design elements.[10]

2.2.3 Overview of the AESO's findings on the efficacy of the current OR market design

Based on the MPMA report and conclusions derived from historical data observations, the AESO identified several shortcomings in OR market participation:

- The AESO concluded that results from the "market liquidity study" indicated that concentration in the OR market was limited, especially in the active regulating reserves ("RR") market (see Figure 3). The AESO observed that average volume (megawatts ("MW")) offered for each product in excess of the traded volumes of active regulating reserves are much lower than the traded volumes in the active spinning reserves ("SR") and supplementary reserves ("SUP").

[10] AESO. *Operating Reserves Market Review – Session 2*. p.64. April 2022.

Figure 3. Average volume offered in excess of traded volumes (May 2019 to April 2020)

Product	On peak volume (MW)	Off peak volume (MW)
Active Regulating reserve	44MW (29%)	52MW (41%)
Active Spinning reserve	171MW (65%)	132MW (60%)
Active Supplementary reserve	227MW (86%)	238MW (108%)

*Percentages indicate average excess offers as a percentage of average procurement volume.
Source: AESO. Operating Reserves Market Review – Session 1. p.33. November 2021.

- The AESO relied on participant surveys which indicated that there were barriers to entry due to technical and operational restrictions stipulated in the ISO rules. Market participants cited the 5MW offer size threshold as a factor limiting wider participation. Some market participants also complained about their experience not clearing the OR auctions, i.e., their offers were priced out of the market.[11]

- Relative pricing in the OR market – specifically between active supplemental reserves and standby supplemental reserves – was another topic of discussion. The AESO observed some periods of anomalous outcomes, where price inversion occurred and products that have higher technical requirements were priced lower than products with lower technical requirements. The AESO notes that, while there may be instances where inverted price trends can be explained, it does not expect these trends to be a regular occurrence.[12]

- The AESO was also concerned with the timing of offer submission in the current OR auctions. Many offers were submitted in the last few seconds before the auction closed. The AESO referred to this phenomenon as latency. The AESO then theorized that the timing of offer submissions was undesirable, especially for smaller or newer market participants.

2.3 AESO's preliminary recommendations and initial takeaways from stakeholders

In response to the findings summarized above, the AESO concluded that total restructuring of the OR market is not required. Rather, the AESO recommended several modifications to the OR market design (see Figure 4 and Figure 5). At the request of TAC, this independent expert paper will focus on auction format and associated information dissemination policies (e.g., offer transparency).

[11] This observation reinforces that OR market price outcomes were extremely competitive.

[12] AESO. *Operating Reserves Market Review – Session 1.* p.35. November 2021.

Figure 4. Group 1 Design Elements

Group 1 Design Elements	
Equilibrium pricing and AESO bid price	• In active OR markets, the equilibrium price is determined by averaging the marginal offer and the AESO bid price • AESO's proposed alternative involves using the marginal offer price in place of the equilibrium pricing • AESO believes that this option of uniform pricing will increase competition, simplify the offer strategy, and improve price fidelity so that the price will be a better reflection of the market
Standing offers	• Currently, all participants are required to submit new offers to the Watt-Ex platform in the OR market • AESO believes that this may lead to a reduction in participation, especially for market participants whose assets rarely clear the market • Thus, AESO proposes standing offers to replace the current practice that requires daily offers to be submitted – as such, standing offers would be carried forward and automatically be included in future trading intervals
Offer transparency (auction format)	• Offers submitted to the Watt-Ex platform are currently visible to all market participants as soon as they are submitted and in addition, offer information disclosure outside the Watt-Ex platform is released after a 60-day lag • AESO believes that anti-competitive practices could occur if offer information is fully transparent; likewise, AESO believes that such practices contribute to offer strategy that results in delayed submission of offers (what AESO calls a "latency issue") • AESO suggests moving to a sealed-bid auction format which is less vulnerable to implicit coordination and price manipulation; AESO also recommends not releasing offer information until 60 days after the trading day
Minimum qualification/offer size	• The minimum qualification sizes for RR, SR, and SUP are 15 MW, 10MW, and 5MW respectively, while the minimum offer size for all operating reserves is currently 5MW • By reducing the minimum qualification and offer size, AESO believes that more resource types and sizes would be eligible to participate in the market • AESO believes that a uniform dispatch tolerance treatment across different asset types and sizes will simplify the requirements for market participants • AESO proposes a reduction of the minimum qualification and offer size to 1MW, as well as a uniform dispatch tolerance of 5% for all assets

Source: Compiled from AESO, *Operating Reserves Market Review – Session 1 & 2.*

Figure 5. Group 2 Design Elements

Group 2 Design Elements	
Block Procurement	• AESO procures reserves in four time blocks; additionally, active RR are purchased for super peak blocks, while other reserves are procured for on peak and off-peak blocks • Flexibility of hourly procurement may appeal to some technologies than the current block procurement approach • Consequently, AESO suggests moving to an hourly reserve procurement approach if there is interest from market participants to effect this change
Contingency reserve procurement	• Procurement in the OR market is carried out sequentially and the volumes qualified to provide SR can also provide SUP • AESO notes that when the price of SUP exceeds the price of SR, the AESO bears more costs in purchasing SUP, especially when SR might be available at a lower cost • Therefore, AESO suggests further consideration of two alternatives: firstly, AESO proposes that uncleared SR volumes get carried forward into the SUP procurement period, and secondly, AESO proposes moving to a simultaneous approach for procuring contingency reserves (SR and SUP)
OR curtailment priority	• Presently, energy is prioritized over ancillary services by the AESO when resolving transmission constraints • AESO proposes an assessment of this current practice to determine if changes are required, and proposes examining if an alternative curtailment priority would boost competition, efficiency, and/or cost • However, at the second session, AESO announced that it will not be pursuing any changes to these practices at this time
Standby reserves	• Reliability needs in Alberta cannot be met without the participation of standby reserves and as such, AESO proposes continuing the procurement of these reserves but with adjustments to the pricing and procurement mechanism • Currently, market participants submit a premium and an activation price to Watt-Ex, while AESO determines the percentage of activation • AESO explains that the process of determining prices is complex and the lack of an activation price index creates uncertainty and price risk • AESO's proposed alternatives include moving to either a single-part offer with only an activation price, or moving to a single-price offer with only a premium price

Source: Compiled from AESO, *Operating Reserves Market Review – Session 1 & 2.*

2.3.1 Issues raised with current OR market design by MSA

In the MPMA, questions about the competitive nature of the OR market (and energy market) were raised, especially in light of the expiration of the PPAs at the end of 2020. However, the MSA concluded through its ongoing monitoring and review that there has been no anticompetitive behavior in the OR markets that has the potential to affect overall market outcomes or breach the FEOC Regulations.

The MSA generally supported all of AESO's group 1 design elements but noted that the AESO should consider stakeholders' feedback regarding the minimum qualification and offer size before implementing a 5% directive tolerance band for smaller providers. Regarding the AESO's proposed change to offer transparency, the MSA notes that the AESO should apply the FEOC principles when drafting market rules covering offer transparency and that additional analysis should be conducted before implementation. Regarding the group 2 design elements, the MSA has not provided any additional information for or against each element at this time.[13]

2.3.2 Initial takeaways from stakeholders and AESO on design elements

Stakeholders generally expressed little interest in moving to the standing offer approach. Stakeholders believe that this approach would increase reliability risks in the OR market whereby offered volumes do not clear in the market. The AESO's draft recommendation is to not pursue this change at this time as it does not seem relevant to price fidelity and may not enhance participation in the market.

For other group 1 design elements, stakeholders' feedback was mixed. For instance, on the issue of removing the equilibrium pricing and replacing the AESO bid price with a publicly disclosed price cap, stakeholders generally believe that it will have a neutral to positive effect on the OR market and are interested in learning about the level of the price cap. The AESO has deferred the discussion of this issue to the third session.

The AESO's draft recommendation on offer transparency - moving to a sealed bid auction and to limiting publication of offers for 60 days – were more widely opposed. AESO has determined that a change to the auction format is warranted because of a concern about implicit coordination, in spite of no evidence of such market power exercise in the past. Based on the AESO's observations, many participants submit offers at the tail end of each procurement block (i.e., the "latency issue") which they believe could theoretically prevent competitive response from other market participants. In addition, the AESO is concerned that OR providers can learn from each other's behaviour, and in the presence of high concentration, this can lead to implicit coordination. Notably, these are hypothetical concerns as neither the AESO or the MSA provided evidence that competition has been prevented or that implicit coordination (or tacit collusion) has occurred and negatively impacted market outcomes in Alberta's OR markets.

The AESO believes the loss of offer transparency would not substantially harm the efficacy of market outcomes because price discovery – in the AESO's opinion - is limited due to the latency of offers. In other words, the AESO claims that the OR market effectively functions close to a sealed bid format. The AESO further states that that the daily operating reserve price report published through the Energy Trading System ("ETS") provides the price for each OR product, allowing market participants to know the daily market valuation for each product shortly after the auction occurs. The AESO's other justification for delaying offer disclosure is based on the belief that fully disclosed offer information may create an opportunity for anti-competitive practices. The AESO proposed that a sealed-bid auction may reduce the opportunity for learning

[13] AESO. *Stakeholders Comment Matrix – Sessions 1 and 2*. January 10 and May 16, 2022.

about competitors' offer strategies and implicit coordination. The AESO pointed to the alignment of OR offer disclosure with the current energy offer disclosure.[14]

Stakeholders like Campus Energy, Enfinite, ENMAX, Greengate, IPPSA, TAC, TransCanada, URICA, etc., are of the opinion that a sealed bid auction would decrease transparency and increase complexity. Many are not convinced of the AESO's concerns around latency. Moreover, these stakeholders question whether this change will lead to greater market efficiency.[15]

For **group 2** design elements, the AESO has decided not to pursue the OR curtailment priority following their assessment of current curtailment practices for OR and energy under the current ISO Rules. According to the AESO, potential benefits of such a change are small but the timeline for implementation will be relatively long.

The AESO does not believe that moving to an hourly reserve procurement is required to attain price fidelity and competition. However, if stakeholders show interest from a competition and entry standpoint, the AESO said it will undertake an analysis to see if the flexibility of hourly procurement will aid in reducing excess reserves. The AESO also noted that other potential options may exist if feedback from stakeholders indicates a preference for a particular duration of procurement.

The AESO is proposing to modify contingency reserve procurement by specifically carrying forward offers that did not clear in the contingency spinning market to the contingency supplemental market.

Finally, according to the AESO, active reserves alone are not sufficient to achieve system reliability and competitive outcomes, so the AESO recommends procuring standby reserves with adjustments to the pricing and procurement procedures, including moving to a single part offer with only an activation price or single part offer with only a premium price.

[14] AESO. *Operating Reserves Market Review – Session 1*. p.56. November 2021.

[15] AESO. *Stakeholders Comment Matrix – Sessions 1 and 2*. January 10 and May 16, 2022.

3 Important factors for examining Alberta's current OR markets

The AESO has made recommendations to modify the Alberta OR procurement format and reduce offer transparency because of competition concerns, although OR market outcomes historically have been deemed to be workably competitive. The AESO has shared some basic statistics on offered capacity in the OR markets as an indication of its theoretical competition concerns. OR markets have requirements that naturally limit the pool of qualified resources – and this is not a unique aspect of the Alberta OR markets. It is not uncommon for an ISO to lean on specific types of resources to provide OR. Therefore, the high market share of hydroelectric generation in some of the OR products is simply evidence of the comparative advantage of hydroelectric resources in meeting the technical attributes requisite in the OR requirements. Indeed, as technology advances have permitted AESO to adjust qualifications, new resources have participated in the OR markets (for example, demand-side resources in the active supplemental market and battery energy storage systems in the spinning market). In addition, it is important to keep in mind that the OR markets are not distinct from the energy market – there is a level of interdependence and substitutability. Expected energy market outcomes influence behavior in the OR markets and offered capacity that is selected to provide active OR can be converted into energy at the AESO's direction. In addition, as OR markets occur day-ahead, information gleaned from the offers of OR providers can provide insight and price discovery for the real-time energy markets.

3.1 Available OR supply is naturally constrained by technical requirements; hydroelectric resources have a natural advantage

During the consultation, the AESO discussed the higher market concentration in some of the OR product markets as compared to the energy market. This is a natural outcome of the technical requirements associated with OR provision. For example, for the RR products, providers must have automatic generation control ("AGC") systems in place to permit the AESO to automatically increase and decrease energy production. Not all generators in the province have such equipment. RR providers must also be running in the energy market but still have some spare capacity (so they can regulate up and down); this requirement can disqualify (or disincentivize) some technologies from participating in the RR auctions, especially those that are not sure - on a day ahead basis – that they would be economic to dispatch in the energy market in all the hours within the RR block period. In addition, there are certain ramping requirements for the spinning reserve product: within ten minutes of receiving a directive from AESO, the asset must be able to provide real power and maintain a certain level of generation in the case of generators or reduce electricity consumption in the case of loads.[16] Once again, not all generators (or load) will be able to comply.

Hydroelectric resources are major providers of OR in Alberta because they are quick-responding and have the ability to modulate their marginal costs (opportunity costs).[17] A hydroelectric resource with storage is capable of quickly adjusting output in response to changing conditions on the grid to help keep the system balanced. Although hydroelectric assets may be energy constrained, they can move their energy to other periods, making it possible for them to offer OR

[16] AESO. *Information Document Contingency Reserve ID #2013-007R*. February 2018.

[17] AESO. *2015 Annual Market Statistics*. p.26. March 2016.

capacity at competitive prices, especially when they are storing energy for future use. In other markets where there are material amounts of hydroelectric resources with storage capacity, ISOs have favored such assets in providing various forms of OR. In the California ISO ("CAISO"), hydroelectric power plants are a major provider of ancillary services, especially in the spinning reserves market. Between 2019 and 2021, the share of hydroelectric resources in the spinning reserves market averaged between 49% (in 2019) to 67% (in 2021).[18] Similarly, in Ontario, the Independent Electricity System Operator ("IESO") procured more than 50% of the scheduled OR from hydroelectric resources in recent years, although such resources represented only a 25% market share in generating capacity terms.[19] Such market outcomes are consistent with least cost, competitive market outcomes. For a hydroelectric resource with storage capacity, OR sales complement the storage of energy (for future use).[20] This provides a comparative advantage to such resources relative to other technologies that have to be willing to forego energy production (and cannot "save" that energy for future use) when deciding to participate in the OR markets. MSA's Q4 2021 report indicates that the AESO frequently issues directives to dispatch contingency reserves to large resources (fuel types of over 50 MW, which turns out to be generally hydro resources). The MSA notes that the AESO's preference is due to the very responsive nature of larger assets – in other words, a technical attribute rather than the ownership status.[21]

3.2 Competition is not a "problem" in Alberta's OR markets

Neither the AESO nor the MSA have identified concrete market power abuses or uncompetitive market outcomes.[22] Nevertheless, AESO has argued that competition issues are a key driver behind their initial recommendations to change the format of the auction. In presenting its recommendations, the AESO has relied on conventional metrics of market power potential like market shares. As we explain further below, these metrics are not evidence of a competition problem – indeed, given the integrated nature of the energy and OR markets, these metrics may be yielding a false impression of market power potential.

In the regulating reserves market, the AESO also notes that more than half of the capacity cleared has historically been owned by a few market participants. For example, in 2019, before the expiration of the Power Purchase Arrangements ("PPAs"), AESO estimated that ATCO, ENMAX, TransAlta, and TransAlta Hydro were responsible for providing 1,968 MW out of a total volume

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[18] CAISO "2021 Annual Report on Market Issues and Performance. p.175. 27 July 2022. <https://www.caiso.com/Documents/Presentation-2021-Annual-Report-on-Market-Issues-and-Performance-Jul-29-2022.pdf>

[19] Ontario Energy Board. *Market Surveillance Panel Report 36*. p.92. March 2022. <https://www.oeb.ca/sites/default/files/msp-monitoring-report-202203.pdf>

[20] The AESO "recognizes the importance of water management to the operation of hydro assets and that opportunity cost is a critical element of determining when the available water is best used to produce energy." (AESO Consolidated Rationale. p. 119).

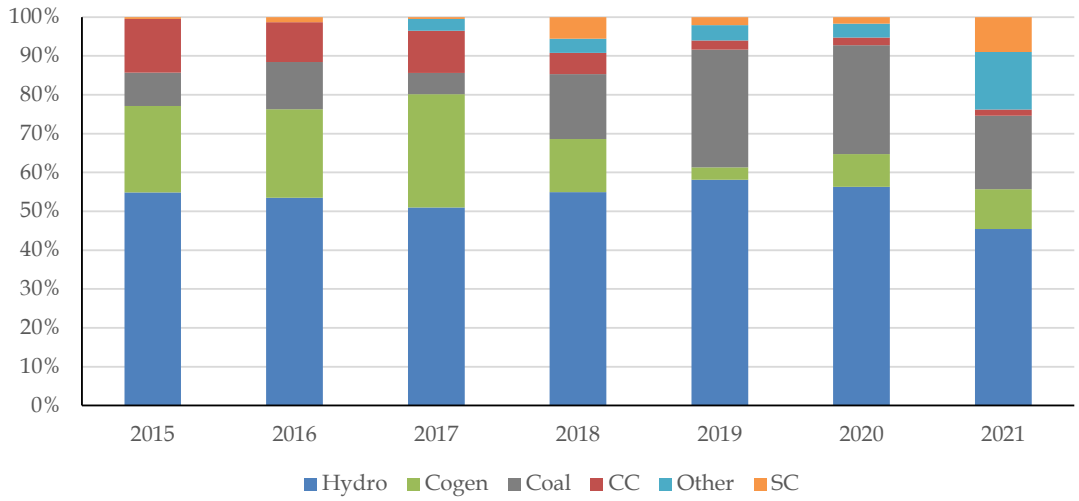
[21] MSA. *Quarterly Report for Q4 2021*. p.35. February 2022.

[22] AESO. *Operating Reserves Market Review – Session 1*. November 2021.

of 4,284 MW qualified capacity.[23,24] Market concentration pursuant to such metrics is expected to remain high now that the PPAs expired. However, based on analysis in the OR market review, pre and post PPA expiry, AESO maintains that PPA expiry has not affected market performance.[25,26]

Based on AESO's analysis of the OR market, (see Figure 6 and Figure 7), we observe that the market share of hydroelectric resources in the active spinning and supplemental reserves has gradually decreased over time, due to, increased participation of new assets/resources in the market.[27] Notably between 2015 and 2021, the market share of hydroelectric resources in terms of total cleared volumes in the active spinning reserves decreased from approximately 55% in 2015, to 45% by 2021. We observe a similar trend in the active supplemental reserves market in prior years. For example, the market share of cleared volumes by hydro resources decreased from approximately 37% in 2015 to 20% in 2020. In addition, we observe increased participation from other assets in this market, especially from load resources, which grew from approximately 20% to 40% in 2021. Although we do not believe that the AESO's market share metrics are a reliable indicator of competitive concerns, the trend over time is clearly indicating that there is an increasing amount of other (non -hydroelectric) capacity clearing in the OR auctions.

Figure 6. Market share of active spinning reserves by technology, 2015 - 2021



Sources: Based on data from the AESO's 2019 and 2021 Annual Market Statistics reports.

[23] Although TransAlta and TransAlta Hydro are the same company, the AESO made a distinction between the two technologies given the differences in incentives under the Hydro PPAs (which were in place until the end of 2020).

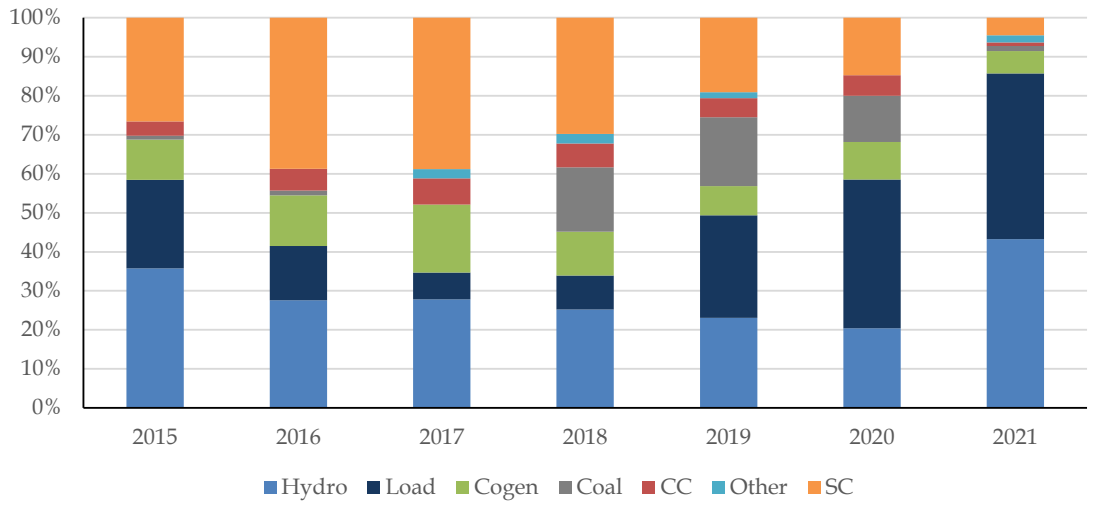
[24] AESO. *Market Power Mitigation Advice Report.* p.40. November 2019.

[25] AESO. *Market Power Mitigation Advice Report.* p.9. November 2019.

[26] AESO. Operating Reserves Market Review – Session 1. November 2021.

[27] Based on data from: AESO. *AESO 2021 Annual Market Statistics*. March 2022.

Figure 7. Market share of active supplemental reserves by technology, 2015-2021



Sources: Based on data from the AESO's 2019 and 2021 Annual Market Statistics reports.

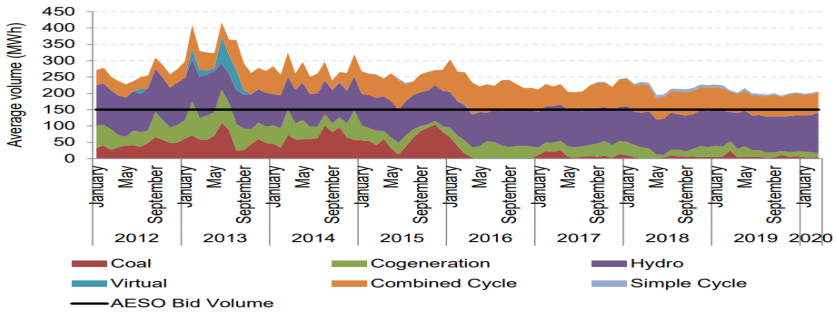
Market share metrics that focus only on capacity that cleared in each OR product auction may be misleading. Such metrics do not provide an accurate representation of industry structure since they do not reflect all offered capacity but only the segment that was selected. Moreover, market shares for each OR product on a standalone basis are not reflective of a properly defined economic market, as discussed further below. Data on offer volumes by fuel type from the MSA (see Figure 8, Figure 9, and Figure 10) indicates average hourly offered volumes in the market consistently exceed AESO's procurement targets across the active regulating, spinning, and supplementary reserves market. AESO's market share statistics exclude offers made and not selected, and therefore under-represents the total volume of resources competing in the OR auctions. The MSA's charts on total volumes of offers are a better indicator of the qualified and economically motivated pool of suppliers in the OR markets. For example, in contrast to the data in Figure 7, Figure 10 indicates that hydroelectric resources are less dominant in the supplemental OR market – in fact, as a technology class, hydroelectric resources have a smaller share of offered volumes relative to other resources like cogeneration and simple cycle.

Since AESO opened the OR market to load, participation of demand-side resources has increased and load resources represent a 42% market share of cleared volumes in the active supplemental reserve market in 2021 (refer to Figure 7).[28] In comparison to generators, load resources providing supplemental reserves have a lower opportunity cost from participating in the OR market, because the probability of being directed to provide energy (or in the case of load resources, to cut back on

[28] AESO. *Annual Market Statistics Report*. 2010 -2021.

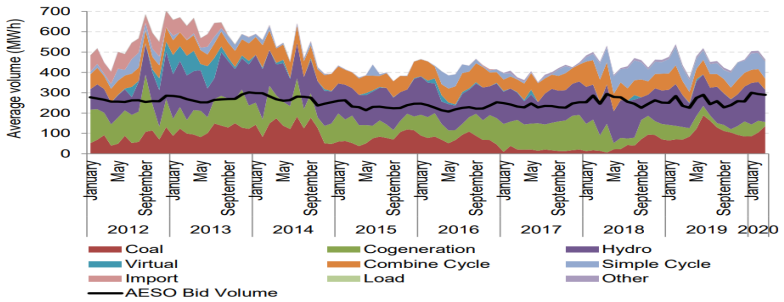
energy consumption) is very low (the directive rate has been less than 1% for active supplemental reserves according to the MSA's Q4 2021 report).[29]

Figure 8. Offer volume by fuel type for on-peak regulating reserve



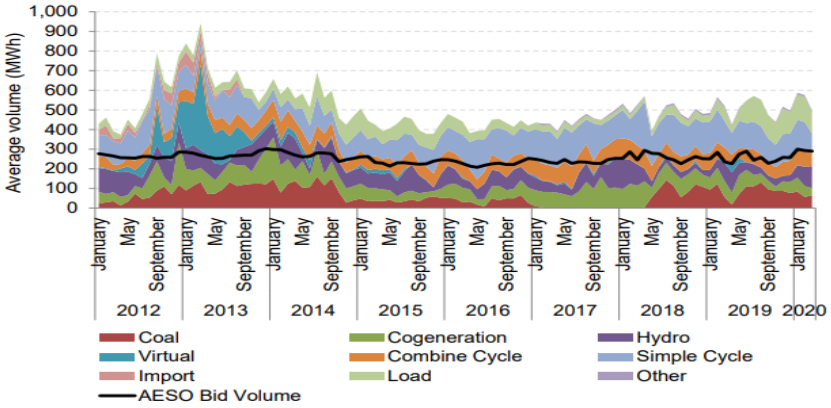
Source: MSA. *Quarterly Report for Q1 2020*, p.17. May 14, 2020.
<https://www.albertamsa.ca/assets/Documents/Quarterly-Report-for-Q1-2020.pdf>

Figure 9. Offer volume by fuel type for on-peak spinning reserve



Source: MSA. *Quarterly Report for Q1 2020*, p.18. May 14, 2020.
<https://www.albertamsa.ca/assets/Documents/Quarterly-Report-for-Q1-2020.pdf>

Figure 10. Offer volume by fuel type for on-peak supplemental reserve



Source: MSA. *Quarterly Report for Q1 2020*, p.18. May 14, 2020.
https://www.albertamsa.ca/assets/Documents/Quarterly-Report-for-Q1-2020.pdf

[29] MSA. *Quarterly Report for Q4 2021*. p.34. February 2022.

In addition, given the inherent substitutability between different OR products and between OR products and energy, OR markets should not be evaluated as distinct markets from each other and the broader energy markets.[30] Focusing on each individual OR product implies a narrow market definition and therefore predisposes any such analysis to mistakenly conclude that the market is concentrated, and suppliers possess market power potential. A more relevant market share statistic is that of the broader energy market. Over the 2015 to 2021 timeframe, hydroelectric resources supplied 3% of the energy in the wholesale market relative to its installed capacity share of 5% (as of 2021).[31] Moreover, there are legislative limits in place on offer control in the energy market – no generation owner can have economic offer control over more than 30% of the operating capacity in the Province.[32] No generator has breached this limit since it was instituted, even after the PPAs expired at the end of 2020. This is relevant given that AESO has acknowledged that the issue of implicit coordination - which is the primary issue noted in justification of the revised offer disclosure policies - only arises under certain conditions.[33]

Trends in market outcomes are another indicator of satisfactory competition. The MSA explains in its recent quarterly report that there has been a reduction in index prices (indexed to the hourly pool price) in the OR market due to an increased level of competition in the supplemental market by new market entrants. A significant decline of index prices from negative $55/MWh to negative $130/MW was recorded between Q1 2021 and Q1 2022. Total and average OR costs have also decreased between Q1 2021 and Q1 2022, with the greatest change in the supplemental market which fell from $52.11/MWh to $23.84/MWh. Amongst other factors (lower pool prices and import volumes), the MSA credits the decline in OR market prices to high levels of competition/participation.[34]

The relatively smaller pool of OR providers than energy market suppliers is not a unique feature of Alberta. For instance, in the Australian National Electricity Market ("NEM"), the ancillary services market has historically been dominated by only a few players. However, the Australian Energy Regulator ("AER") reports that the ancillary services market is more competitive than it was five years ago, as new entry from demand response aggregators and BESS have increased

[30] This would be inconsistent with proper market definition. Energy and OR are essentially substitutes from the system operator's perspective once OR resources are activated and are also substitutes from the perspective of providers (suppliers) s they must forego selling energy from the same megawatt that was committed in the active OR markets. The AESO has also recognized in prior market design initiatives that OR product markets are part of the broader energy market framework in Alberta (AESO. *Application For Approval of The First Set of ISO Rules to Establish and Operate the Capacity Market*. June 21, 2019. p.296).

[31] AESO. *2021 Annual Market Statistics.* March 2022.

[32] Alberta Utilities Commission Act. *Fair, Efficient, and Open Competition Regulation*. Subsection 5. p.9. October 30, 2019.

[33] Competition Bureau of Canada. *Enforcement Guidelines – Merger Enforcement Guidelines*. October 6, 2011. Part 6, p.24-27.<https://competitionbureau.gc.ca/eic/site/cb-bc.nsf/vwapj/cb-meg-2011-e.pdf/$file/cb-meg-2011-e.pdf>

[34] MSA. *Quarterly Report for Q1 2022*. p.32. May 13, 2022.

the number of players in the frequency control ancillary services ("FCAS")[35] market and reduced market concentration. These new entrants now represent up to 17% of effectively available capacity and are gradually displacing incumbent market participants like hydroelectric resources.[36] As of Quarter 1 2022, battery storage has displaced hydro and black coal to become the asset with the largest market share in Australia's FCAS by volume.[37] Although hydroelectric resources experienced an average growth of about 100 MW in FCAS enablement volumes (contingency lower reserves) between Q1 2021 and Q1 2022, BESS have experienced growth twice this size (over 200 MW in total, cutting across the regulation, contingency lower, and contingency higher reserve products), indicating that the presence of incumbent players in the market does not deter new entry or affect the level of competition in the market.[38] Notably, the AER highlights that offers in the FCAS are largely dependent on the dynamics in the energy market and that benefits from new entry may not be realized immediately. Rather, the AER expects that increased participation and competition will emerge over time.[39]

Similarly, in the Pennsylvania-New Jersey-Maryland Interconnection ("PJM"), the independent market monitor has routinely found that certain system-wide ancillary services have a highly concentrated supply, but that has not prevented competitive market outcomes With a Herfindahl-Hirschman Index ("HHI") of 3460, PJM's tier 2 synchronized reserve market (which is equivalent to Alberta's spinning reserves market) is characterized as a market with high levels of supplier concentration. However, participant behavior in the market is disciplined by various rules and as such, the independent market monitor in PJM has not indicated any concern with the market outcomes.[40] In another example, ISO New England has reported "modest structural market power" in its Forward Reserve Market over recent years, based on the size of the largest supplier and the need for some portion of that supplier's offered volume to meet the ten-minute non-spinning and thirty-minute operating reserve requirements.[41] However, ISO-NE has also concluded that "clearing prices and payments have been comparatively low… and stable" and there are no remarkable differences between prices in " auctions with and without structural market power", suggesting that market concentration is not a concern.

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[35] The FCAS are categorized generally into 2 groups: regulation and contingency reserves, similar to the roles of regulating and contingency reserves in Alberta. In total, the Australian Energy Market Operator ("AEMO") dispatches services in 8 FCAS markets to maintain system frequency at close to 50 Hz as follows: raise and lower regulation services, raise and lower 6-second contingency, raise and lower 60-second contingency, and raise and lower 5-minute contingency.

[36] AER. Wholesale electricity market performance report 2020. p.85-95. December 2020

[37] Battery storage now controls 31% of the market, while hydroelectric and black coal resources each control 21%.

[38] Australian Energy Market Operator ("AEMO"). *Quarterly Energy Dynamics Q1 2022*. p.33. April 2022

[39] AER. Wholesale electricity market performance report 2020. p.90. December 2020

[40] PJM. 2021 State of the Market Report. Section 10 (Ancillary services), p.3. March 10, 2022

- [41] ISO-NE Internal Market Monitor. 2021 Annual Markets Report. p.227. May 26, 2022.

3.3 New entry has occurred in the past under the current design

Due to the relatively small market size (AESO is typically procuring a few hundred megawatts of each OR product in the active markets in contrast to the energy market, where minimum load is around 8,000 MW) and the need to consider more lucrative arbitrage opportunities in the energy market, the OR markets on their own are unlikely to motivate new investment.[42] However, when energy profits are low, more suppliers shift their focus on how to make a profit in the OR market.

In the MSA's Q1 2016 report, the net revenue analysis indicates that during periods of low pool prices, participants were better off participating in the OR markets, specifically in the regulating super peak and spinning reserves markets, than in the energy market. Between Q1 2015 and Q1 2016, participants in the energy market went from making a revenue of $2,000/MWh to a negative return of -$10,000/MWh. While profits generally fell, participants providing regulating super peak reserves were still able to make a positive return ($1,000/MWh) in Q1 2016.[43]

Consistent with our findings in the AEMO's FCAS market, technological developments are increasing the pool of eligible resources and driving competition in Alberta's OR markets. Battery Energy Storage Systems ("BESS") are one of such assets that have growth potential vis-a-vis the OR, as noted by the MSA.[44] The first BESS participating in Alberta's OR market came online at the end of 2020, and between Q4 2020 and Q1 2022, the MSA notes that BESS were responsible for 15% of dispatched spinning reserves, despite making up only 0.4% of installed capacity (as of August 2022).[45][46] Per the AESO 2022 Long Term Adequacy report, approximately four times the current size of BESS (50 MW), is currently under construction or has received approval from the AUC, while an additional 5,340 MW of new BESS has been announced. In the long run, AESO anticipates a total of 5,600 MW, which will be just over 100 times the current size of operational BESS.[47] The introduction of BESS to the OR markets a few years ago and prospects for development highlight that new resources can and do participate in the OR markets, when they can be technically compliant and profitable.

3.4 Current open auction process provides valuable price discovery

Generators that qualify for and choose to participate in one of the active OR markets will submit a price and quantity offer, for a specified time block (peak and/or off-peak) on a day-ahead basis through the Watt-Ex exchange platform. Participants submit their price offers as a discount or

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[42] AESO. 2021 Long-term Outlook. *Reference Case Hourly Alberta Internal Load, 2021-2035 [Microsoft Excel Spreadsheet]*. August 11, 2021. <https://www.aeso.ca/assets/2021-Long-term-Outlook-data-file-updated-Aug-11.xlsx>

[43] MSA. *Q1/2016 Quarterly Report*. p.14-15. April 29, 2016.

[44] MSA. *Quarterly Report for Q4 2020*. p.46. February 12, 2021.

[45] AESO. "Current Supply Demand Report – Generation". ETS. Accessed August 29, 2022

[46] MSA. *Quarterly Report for Q1 2022*. p.35. May 13, 2022.

[47] AESO. *Long-Term Adequacy Report*. p.18. August 2022.

premium to the pool price. Considering that these reserves are procured one day in advance, the timing can be referred to as "day minus one" or "D-1".[48]

Watt-Ex sets the daily schedule for offer submission in the OR market and these submissions occur between 09:00am and 10:10am. Procurement on the Watt-Ex closes sequentially for each reserve product, with the active reserve market closing first (as seen in Figure 11 below), then the standby reserve market. By sequentially closing the market, if a participant fails to sell all their OR-qualified capacity in the first auction (for regulating reserve) they still have an opportunity to sell any remaining capacity in the other OR product auctions (i.e., spinning, or supplemental reserves). Information on market clearing is provided immediately to all market participants on the Watt-Ex platform for the OR markets. This sequential nature of the procurement process allows for price discovery in between products, while the day-ahead timeframe promotes price discovery for the real-time energy market and the next day's OR markets.

Figure 11. Timing of Operating Reserve Procurement

9:00am	All Markets Open
9:10am	Active Regulating On/Off Peak Close
9:20am	Active Regulating Super Peak Close
9:30am	Active Spinning Close
9:40am	Active Supplemental Close
9:50am	Standby Regulating Close
10:00am	Standby Spinning Close
10:10am	Standby Supplemental Close

Source: ASEO. Information Document Operating Reserve ID #2013-005R. June 19, 2020.

3.4.1 Information released by AESO

The AESO sets the amount of OR it needs to procure based on its requirement to balance supply and demand within the AESO's balancing authority area and Western Electricity Coordinating Council ("WECC") requirements. For example, for purposes of contingency reserves, the AESO relies on the single largest contingency (or 3% of the hourly integrated amount of load and supply, if that is larger).[49,50] Based on these requirements, at least half of contingency reserves must be spinning reserves (with supplemental reserves, therefore consisting of up to but no more than 50% of contingency reserves). As the AESO takes into account expected market conditions on a day ahead basis (or longer, if the OR auctions are for a weekend/holiday period[51]), the total quantity of OR that AESO seeks to purchase can change – especially for spinning and supplemental reserves. OR providers are informed of the AESO's bid quantity once the auction

[48] AESO. *Ancillary Services Participant Manual – Edition 3*. p.25-27. January 2012.

[49] For specific details see: AESO. *Alberta Reliability Standard: Contingency Reserve - BAL-002-WECC-AB1-2*. Effective July 26, 2015.

[50] AESO. *Alberta Reliability Standard Contingency Reserve BAL-002-WECC-AB1-2*. Effective July 26, 2015.

[51] Procurement only occurs during the weekdays; hence, all weekend trading must take place on Friday. In addition, procurements also occur on the last business day before a holiday.

starts. The publication of the AESO's bid quantity (and price) are the first opportunity for market participants to collect information for purposes of price discovery.

3.4.2 Clearing process

For each market, at the 10-minute mark, the AESO sorts through all offers received from lowest to highest and procures enough to meet its bid volume. The highest-priced offer from participants that clears the process sets the marginal offer price in the active OR markets, which the AESO uses to establish the "equilibrium price" – the average of the marginal offer price and the AESO's bid ceiling price which is known and disclosed to market participants. Participants that clear in the active OR market receive the same "equilibrium price" plus the pool price (which is set in the real-time energy market), with the floor of this combined price set at $0/MWh (e.g., if equilibrium price plus pool price is less than $0/MWh, then the price OR providers receive is $0/MWh). This is referred to as the "clearing price" for the active OR market, which is akin to a capacity payment (i.e., payment for reserving capacity), and all participants that clear get the same price.[52] It is notable that between 2016 and 2021, prices in the spinning and supplemental reserves market were competed down to $0/MWh for 11.2% and 54.4% of the trading periods, respectively.[53] This type of price outcome is one indication of strong competition.

3.4.3 Offer process

Before each OR auction, Alberta market participants have access to information available on the Watt-Ex platform which provides data on all OR products in the ancillary market, and in addition, have access to other trading platforms that provide energy forwards and gas forwards. Market participants also have access to market information published by the AESO on the ETS website such as supply and demand forecasts, outage reports, 7-days hourly available capability reports, etc. These various information sources enable market participants to estimate a pool price forecast and anticipate their opportunity costs from participating in the OR market, including their potential foregone energy profits. In addition, as gas is traded day ahead, a generator may be able to lock in gas prices for the next day and therefore have an anticipated marginal cost, which can also influence their offer strategy in the OR market.

Once the auction starts, participants are able to see the offer prices and the corresponding volumes of other market participants as the auction proceeds sequentially from the active regulating reserves products (peak, off-peak, super-peak) to active spinning reserves (peak, off-peak) and then active supplementary reserves (peak, off-peak). Each auction lasts 10 minutes. However, five minutes before each auction closes (also known as the secondary bidding window), participants' offers are locked, and thereafter for the remaining five minutes, participants are unable to retract or make upward revisions to their offers but can submit additional offer quantities or reduce their price. Because the majority of market participants wait until the last minute to submit their offers, the influence of other market bidders is limited in the very first auction session. However, due to the sequential nature of the auctions, market

[52] ASEO. *Information Document Operating Reserve ID #2013-005R*. June 19, 2020.

[53] Based on LEI analysis of prices in the OR market from 2016-2021

participants can glean additional information to resolve uncertainty about expected market conditions and the remaining supply for other OR products.

Price discovery is occurring for the next day's OR market and also the energy market. Transparency of the OR offer stack can also provide valuable information to market participants for the next day's OR markets. OR providers may be able to improve the acceptability of their offers the next day by studying the offer patterns of past (recent) days with similar supply-demand conditions. The level of information currently collected by OR market participants is different from the daily operating reserve price report published through the AESO's publicly available market reports. The active spinning OR market provides valuable information to market participants about tomorrow's real-time energy market. Unlike the regulating reserves market which has technical requirements and is somewhat skewed towards large OR providers (and involves high directive rates), the offer curve in the spinning market provides a market view of how pool prices could potentially settle the next day. For example, if the spinning market offers are clustered around deeper discounts to pool prices, that points to the likelihood of higher volatility or the likelihood that other participants expect tomorrow's market may settle at higher pool prices.

The price discovery process under the current open auction format also supports the procurement of sufficient OR to meet AESO's needs, which improves system reliability. Specifically, the open auction format allows market participants observe if there is under procurement in the market. So, if other market participants do not submit additional offers, participants become aware of the opportunity and can decide to offer more volumes in the market to meet the AESO's bid to ensure there are no instances of under-supply, especially for weekend trading sessions and long weekend packages that can last from three to six days.[54]

3.4.4 Price discovery is valuable for offsetting various uncertainties faced by OR market participants

Trading in the OR market comes with a high level of uncertainty due to various factors. Pool prices are not known. There is a risk, if pool prices fall below expectations, that OR providers get paid zero. As such, market participants have to develop pool price forecasts and marginal cost estimates to make sure that they minimize the risks of uneconomic commitments. OR auctions are held only on weekdays, causing a significant level of trading/forecasting risk for market participants because they must trade a day (or even multiple days) in advance of real-time energy markets (in the case of weekends, public holidays, and USA/Canadian statutory holidays, it can be up to six days). Another uncertainty for OR providers is with respect to clearing the auction. The market also has a mix of suppliers with various technologies, costs, and commercial objectives. For instance, hydro resources will be focused on managing their hydrology and stored water reservoirs, other market participants may be managing their retail load obligations for their generation fleet, while load-based suppliers in the supplemental market may be managing the

[54] For instance, if holidays (e.g., Christmas and Boxing Day) fall on a Monday and Tuesday, the last business day before the holiday is Friday, and as such, all trading must occur on Friday. Therefore, AESO would have to procure reserves for Saturday, Sunday, Monday, Tuesday, and Wednesday – Wednesday because reserves are procured one day in advance. The same applies if the holidays fall on Friday and Monday; in this case, the last business day becomes Thursday.

economics of participating in the OR market and the requirements of their industrial process. In the current open auction setting, OR providers can monitor the offers of their competitors. And based on the offered quantities and price, they can adjust their offers to improve the probability of clearing.

Moving to a sealed bid format and delaying the release of offer data for 60-days would cause even larger disparities in market information between larger, more sophisticated market participants and those market participants with smaller resource portfolios (and new entrants). In Section 5, we discuss the implications of such information asymmetries, especially in the context of procurement auctions for a commodity with common value traits and a mix of suppliers (of different sizes and sophistications). Economic theory tells us that information asymmetries can lead to increased risk for some market participants, expanding the winner's curse problem and discouraging market participation by those that face the higher risk. Such a situation would be in conflict with the AESO's stated objectives to encourage new entrants and new suppliers.

4 Implications from economic theory about the industry structure in Alberta's OR markets

Alberta's OR markets appear to have features typical of an oligopolistic market with a few dominant (large) providers and a number of smaller providers. The larger OR providers, as discussed in Section 3, are a result of historical legacies of asset ownership and natural comparative advantages of certain technologies vis-à-vis the technical requirements for OR products. While an oligopolistic market structure can theoretically lead to prices higher than competitive levels, it can also yield competitive outcomes. Considerations around the economic theory of the "dominant firm and competitive fringe" are especially appropriate for consideration of the Alberta OR markets given similarities in the industry structure and historical experience. Provided new entry is possible, this economic theory suggests market outcomes will converge to competitive levels. Historical market outcomes confirm the applicability of the dominant firm and competitive fringe economic theory. This also means that the AESO's use of the concentrated nature of OR market is not a relevant concern for ensuring competitive outcomes in the long run.

4.1 Implications of an oligopoly industry structure

The MSA noted in the State of Market Report from 2012, "the Alberta market is an oligopoly and there is nothing exceptional or unusual in this finding; the same could be said for many different product markets in Canada and around the world". Oligopolies exist in various forms, and at a broad level, can be classified as symmetric or asymmetric. An oligopoly is considered to be symmetric when all firms in the market are (nearly) the same size. In the absence of such a condition, we have an asymmetric oligopoly, in which there may be one or more dominant firms co-existing with many other smaller firms (known as the "competitive fringe").[55] Dominant firms typically control a substantial portion of the market and hold a market share that is significantly higher than their next rival. "Competitive fringes" refers to other small competitors or market participants, and may also include new entrants to the market, who are responsible for the rest of the market's supply.[56]

According to economic theory, dominant firms exist for several reasons, including a first-mover advantage, economies of scale, brand equity, and innovation.[57] In the case of Alberta, dominant suppliers exist due to legacy considerations and economies of scale (that have led to construction of fairly large power plants relative to the size of the Alberta energy market). The major

[55] "Glossary of Industrial Organisation Economics and Competition Law - OECD." OECD. 3 Jan. 2002. <https://stats.oecd.org/glossary/detail.asp?ID=3270>

[56] Gerasymenko, Anzhelika. "Barriers to Competitive Fringe Expansion as a Seed of Market Power." ECONOMIC ANNALS, vol. 57, no. 195, 2012. p.103–114. <https://doi.org/10.2298/eka1295103g>

[57] Gerasymenko, Anzhelika. "Barriers to Competitive Fringe Expansion as a Seed of Market Power." ECONOMIC ANNALS, vol. 57, no. 195, 2012. p.103–114. <https://doi.org/10.2298/eka1295103g>

generation owners (TAC, ENMAX, ATCO[58], and Capital Power) in the market today were established before the deregulation of Alberta's electricity market, built under a cost-of-service monopoly regime. These larger generators also had the advantage of being incumbents in both the energy and OR markets – analogous to a first mover advantage.

Another reason an oligopolistic structure exists in the OR markets is due to the technical and operational requirements of operating reserves. Not all energy providers are qualified to participate in the OR markets. For instance, referring to the data in Figure 3, we observe that the pool of qualified suppliers is naturally smaller for regulating reserves than for contingency reserves. For example, regulating reserve providers are required to have AGC systems installed in place to permit the AESO to automatically increase and decrease energy production. In summary, based on the data for Alberta's OR market, we see that the active OR market fits the structure of an asymmetric oligopoly.

With this type of market structure, it is easy to see why the AESO has theorized that there may be a competition problem and has made recommendations in the context of potential competition problems. However, there is no evidence of such problems in Alberta. OR prices have been competitive, as verified by the MSA. Moreover, the industry structure has not precluded new entry (as evidenced by the successful entry of demand-side resources once market rules accommodated their participation). If we dig further into the possibilities around an asymmetric oligopolistic structure, it becomes clear that the industry structure can lead to efficient and competitive outcomes.

4.2 Pricing outcomes under an asymmetric oligopoly with dominant firms and competitive fringe

Unlike monopolies, dominant firms in an asymmetric oligopolistic structure do not have sole control over pricing and supply outcomes.[59] To maximize profit, the dominant firms must apply some restraint in setting prices and must take into consideration the supply decisions of the competitive fringe. The dominant firms can accept the market position of the fringe firms and

[58] On May 27, 2019, Canadian Utilities Limited announced the sale of certain ATCO Power Canada Ltd, assets to Heartland Generation Ltd. The sale was finalized, and Heartland Generation Ltd. gained offer control of ATCO's former assets, with a total 11.3% offer control.

[59] In a monopoly, firms can determine either the price sold, or the quantity produced in the market because they are the sole producer/supplier of the good. However, the prices monopolies set are constrained by demand, which in this case is the same as the market demand. Hence, monopolies set the price to be greater than the marginal revenue and marginal cost of the good, up until the level consumers will be induced to pay.

therefore price according to residual demand net of supply by the competitive fringe, or the dominant firms can practice limit pricing.[60,61,62]

The limit pricing approach involves dominant firms setting lower prices below the level that induces a supply response from the competitive fringe firms. There are two types of limit pricing: static and dynamic limit pricing.

In the static limit pricing approach, the dominant firm lowers price up to the level that restricts all competitive fringe firms from entering the market. If the dominant firm chooses this approach, its current economic profits fall to zero because the dominant firm will now fulfill the entire market demand, but at a lower price.[63] In Alberta's OR market, we know that this situation of static limit pricing does not apply as the pricing strategies of the larger OR providers have not precluded new entry. Some of the incumbent suppliers are in fact price takers and smaller competitive suppliers have had a strong influence on market outcomes. Indeed, over time the Alberta OR markets have experienced providers going in and out of the OR markets, as dictated by opportunities for energy market sales. For example, when energy prices are low (due to oversupply), market participation in OR markets pick up. On the other hand, as energy market conditions tighten and lucrative energy market opportunities increase in frequency, participation rates in OR markets fall.

With the dynamic limit pricing approach, dominant firms take the other competitors as a "given" in the market and gradually begin to adjust (lower) their prices in the market. The competitive fringe are rational firms (i.e., they aim to maximize profit); hence, if the rate of return in the market is perceived to be lucrative, that will then motivate new competitors to come into the market. As the competitive fringe grows in size, prices fall until they reach an equilibrium that should equate with short run marginal costs of the price setter from among the competitive fringes. So, the equilibrium in that situation results in comparable outcomes to a perfectly competitive market.[64,65] This form of competition among providers is consistent with what we observe in Alberta OR markets.

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[60] Haworth, Barry. "Strategic Entry Barriers: The Dominant Firm and Limit Pricing." University of Louisville. June 2022. <https://econpage.com/301/handouts/DomFirm/domfirm.html>

[61] The competitive fringe will supply to the market at the point where the marginal cost of production is equal to their marginal revenue, which is consistent with the behaviour of firms in perfect competition. This results in a residual demand curve for the dominant firms considering that part of the market's demand can be met by the competitive fringe.

[62] White, Lawrence J. "Monopoly and Dominant Firms: Antitrust Economics and Policy Approaches." September 2013. NYU Working Paper No. 2451/31979. <https://ssrn.com/abstract=2321110>

[63] Cherry, Robert. "The Dominant Firm Model Revisited." *Review of Industrial Organization* 16.1 (2000): 89–95.<http://www.jstor.org/stable/41798905>

[64] Carlton, Dennis, and Jeffrey Perloff. "Dynamic Limit Pricing." Pearson Education, 2000. <https://wps.pearsoned.com/aw_carltonper_modernio_4/21/5566/1424991.cw/content/index.html>

[65] If a firm (firm X) sets prices above marginal cost and another firm (firm Y) sets price just below firm X's price but above the marginal cost, firm Y gains the entire market demand (in this case, up to their maximum capacity). Firm X can respond to this pricing behaviour by setting price just below firm Y's price. As the process of

4.3 Survey of empirical and theoretical papers related to asymmetric oligopoly

A number of empirical studies have been conducted over the years to determine if the theory around the dominant firm-competitive fringe economic model holds in real markets. As summarized in the textbox on the next page, a common observation from these studies is that an asymmetric oligopoly is quite common, and dominant firms and competitive fringe can co-exist. Furthermore, several empirical studies find that the presence of competitive fringe and possibility of new entry helps maintain an equilibrium in prices that is aligned with competition.

Empirical studies related to the economic theory of the dominant firms and competitive fringe

- In a study of the telecommunications market in the United States by Shepherd and Graniere (1990), Shepherd explains that effective competition still exists in an oligopolistic market, and collusion can be avoided provided none of the largest five firms in the market individually holds over 40% of the entire market share and there is relatively free entry of firms into the market. These prerequisites for competition are consistent with the Alberta's OR markets.[66]

- Likewise, Gabszewicz and Shitovitz (1992) note that in a market where a continuum of traders is observed, the influence of a single market participant is negligible and thus, market decisions will approximate perfect competition. Competitive outcomes arise because the combined set of smaller firms (eventually) nullifies the impact of the large firms. There are analogous dynamics in Alberta, where we see larger OR providers make "baseload" offers early in the auction window and act as price takers. Moreover, as a fungible commodity, the AESO tends to be indifferent to who the provider of OR is so long as the resources meet the technical requirements.

- Kokovin et al. (2017) consider the interaction of dominant and competitive fringe firms that produce different varieties of the same differentiated product in the market. They observe that there is a dilution of market power because aggregate output in the market is dependent on the total number of firms in the market and not just the output decisions of the dominant firms. Competition between the dominant firm and competitive fringe occurs in the market through a process of price adjustment and continues until a profit-maximizing outcome is achieved, which in turn converges to a competitive equilibrium. This is also consistent with the OR market, especially under the current open auction process hosted on the Watt-Ex platform and given the iterative nature of the OR markets.

- Modeling a framework of mixed competition between small and large firms, Gonharenko et al. (2018), concluded that in a mixed competition of dominant firms and competitive fringe, both firm types are active participants in determining the overall market outcome.

undercutting price continues in the market, price falls to the point where it is equal to marginal cost. This is known as the Bertrand paradox because firms in this market are not expected to set price equal to the marginal cost, but above the marginal cost so as to make economic profits. Based on this pricing mechanism, the process of dynamic limit pricing is akin to the outcome of a Bertrand paradox.

[66] As of 2022, the AESO estimated that the largest five firms in Alberta's OR market control a significant share of the market: approximately 86% of the RR, 76% of the spinning product, and 55% of the supplemental reserves product. However, no single firm controls more than 40% of any OR product market. However, as we discussed in Section 3.1, these market shares may not capture the full extent of qualified offers (as AESO appears to have focused on cleared volumes in its analysis) and the market shares are not consistent with a proper economic market definition. So, it is difficult to draw any theoretically rigorous conclusions about these concentration and market share ratios. Notably, FEOC Regulations also prevent individual firms from controlling more than 30% of the broader energy market.

5 Key principles from economic theory on auction format and information dissemination policies to support competition

Auction theory establishes several conditions that, if met, indicate that the price arrived at through the auction process is efficient and an accurate assessment of the market value of the product being transacted. The primary condition is that the auction is competitive. Famed economist Paul Klemperer recently summed it up best when he wrote: "[w]hat really matters in auction design are the same issues that any industry regulator would recognize as key concerns: discouraging collusive, entry-deterring and predatory behavior." [67] ***Access to information is considered to be a key ingredient for maintaining and motivating competition and thereby efficient outcomes. Access to market information, especially for a good or service that is impacted by common value traits, is critical to competition in an auction setting. Market information replaces private information that can be biased and incomplete (in other words, market information reduces the need to rely on "private valuations"). Market information also resolves uncertainties, and in so doing motivates more aggressive competition. The AESO's recommendation to hide market information from market participants through a sealed bid process and delay in offer disclosure is not consistent with relevant economic theory. As such, we believe that the proposed modification on offer transparency will actually hinder competition and potentially cause some smaller providers of OR to exit the market.***

5.1 Types of auction mechanisms

Auctions have been used to sell goods and services since the times of the ancient Greeks and Romans. But only recently, since the pioneering work of Vickrey,[68] have economists seriously examined what does and does not make auctions successful, and how to structure the rules in an auction process to yield a competitive market price and meet the buyer's objectives (in the context of a procurement auction) of buying the goods or services at the lowest cost. Over the last two decades, the literature on auctions has proliferated to consider many variations on auctions with different clearing mechanisms. For the purposes of this independent expert paper, we will focus on a comparison of an "open auction" with a "sealed-bid" process.

Pricing outcomes of auctions not only depend on the type of auction, but also on the valuation of the good or service and participants' perception of risk. If a good or service has a "common value," an open auction will aid in resolving the winner's curse and thus yield more efficient auction outcomes that better reflect market participants' more refined future expectations than a sealed-bid process. This occurs due to benefit of information disclosed in an open auction. If participants have access to the same information, during an auction, they have the ability to update their valuation and bid more aggressively alongside their competitors. Market participants will compete and drive prices down until they reach their reservation price. On the other hand, in a sealed bid process, participants may bid below their valuation for the item in an attempt to reduce their risk of winner's curse. If a participant bids at or above their value, their payment equals or exceeds their value if they win the auction, and therefore expected profit will

[67] Klemperer, Paul. "What Really Matters in Auction Design." *Journal of Economic Perspectives* (2002): 169-189.

[68] See, for example: Vickrey, W. *Counterspeculation, Auctions, and Competitive Sealed Tenders*. *Journal of Finance* 16 (1961): 8-37.

be zero or negative (e.g., an economic loss occurs). Market participants are aware of this risk and therefore become less aggressive in their bidding.

Open auction

An open auction is a process in which one or more providers compete to sell a good or service to a buyer, there are several suppliers and when they make offers to sell, other suppliers can see the offer price and quantity. The open auction allows for suppliers to change their mind (to some degree and subject to auction rules) about their offer price and/or offer quantity. The basic operation of the auction is that the auction closes after a specified period of time (or when no supplier wishes to change his/her offer).

Sealed-bid process

A sealed-bid process differs from an open auction in that there is no iteration and no publication of offers made prior to the process being completed. Rather, qualified suppliers simply submit their (binding) offer without knowing what other suppliers may have submitted. Winners are chosen based on the best offer(s) received. The sealed-bid auction has several important characteristics but the most important is the lack of transparency on offers being made, thus making it difficult to determine how other parties are participating and what they will offer.[69] That said, it is a common approach used in procurements of goods and services.

Factoring in risk aversion, sealed-bid processes cause bidders to raise their valuation more than ascending and second price sealed-bid auctions. Participants in the first price sealed-bid auctions can only submit offers once, while participants in open auctions – like the AESO's OR markets – can submit and modify their offer subject to certain time limits and other ISO Rules. Hence, in order to reduce the risk of losing out on the auction (and not clearing), OR providers may reduce their price (increase the discount to pool price) as compared to their original valuation. Participants adjust their valuation with the new market information they gather can influence market outcomes in the near future and in the longer term.[70,71]

A combination of these different auction mechanisms will yield different outcomes as will be elaborated in sections below. An efficient procurement process has a number of desirable characteristics: it allocates transactions to the lowest-cost suppliers, it provides buyers (in the case of OR markets, the AESO) with the lowest possible equilibrium price, and the prices themselves account for all the information available in the market. Thus, the ability of an auction to incorporate all the available information has serious implications for the efficiency of the outcome and attainable competitive equilibrium. While a sealed bid process can also ensure efficiency, lack of information can lead to risk aversion which will inevitably drive down competition in the

[69]GSMA. *Auction Best Practice*. September 2021. <https://www.gsma.com/spectrum/wp-content/uploads/2021/09/Auction-Best-Practice.pdf>

[70]Econport. *Types of Auctions*. <http://www.econport.org/content/handbook/auctions/commntypes.html>

[71] Fine, L.R. Econlib. *Auctions*. <https://www.econlib.org/library/Enc/Auctions.html>

market. In auction theory, auction mechanisms and equilibrium outcomes are distinguished by the type of information that participants have access to on the value of the product being transacted: public information and private information. Public information is available to all parties and private information is available to only a limited number of parties or one single party. For a good or service with common value traits, a level playing field with respect to public information is more important to competitive outcomes than refinement of private information, as we discuss further in Section 5.2 below.[72] In fact, reliance on private information – which becomes necessary in a sealed bid format – can chill market participation and drive some participants away.

5.2 Common and private value and implications for auction design

The extent to which the various auction formats summarized above maximize revenue and otherwise achieve efficient outcomes has been extensively analyzed. The performance of different auction formats is in large part dependent on the nature of the goods being sold.

In the economic literature, a careful distinction is drawn between two forms of goods or services that can be the subject of an auction. *Common value auctions* refer to those transactions in which each potential purchaser would place the same value on the goods if they held the same information. *Private value auctions*, on the other hand, are those where different buyers would value the goods differently, even if they face common information.[73]

5.2.1 Private Value Auctions

The distinction between various auction processes is very important. Under a private value auction, the economic literature indicates that the sum of producer and consumer surplus[74] is the same under an open auction or under a sealed bid, provided that certain conditions are satisfied.[75] These conditions include, for example, that demand is inelastic and that there is no collusion between bidders. Thus, in practice, the choice of private value mechanism depends precisely on the extent to which these conditions are violated in reality.

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[72] Milgrom, P. *Putting Auction Theory to Work*. Cambridge: Cambridge University Press. 2004. p.1-24. <http://doi.org/10.1017/CBO9780511813825.003>

[73] Boatwright, Peter, et al. "Common Value vs. Private Value Categories in Online Auctions: A Distinction without a Difference?" *Decision Analysis* vol. 7, no. 1 (2010): 86–98. <https://doi.org/10.1287/deca.1090.0150>

[74] Consumer surplus refers to a consumer's net gain (excess benefit) from the purchase of a good. It is, therefore, equal to the difference between the consumer's willingness to pay and the actual amount paid (market price). Producer surplus on the other hand refers to the net gain to a seller/producer from selling/producing a good. It is equal to the difference between the market price and the producer's least cost (willingness to sell/produce). Source: Wells, Robin, and Krugman,Paul. "Consumer and Producer Surplus." Microeconomics. United States, Worth Publishers, 2014.

[75] This relates to an economic theory of auctions termed the Revenue Equivalence Theory (see Riley, John G., and Samuelson, William F. "Optimal Auctions." *American Economic Review* 71 (1981). p.381-92). The theory sets out the conditions under which different auction mechanisms deliver the same outcome and provides a framework for ranking auction mechanisms when those conditions are not satisfied.

In a private value auction, bidders can be considered either 'weak' or 'strong'. Weak bidders have low private values, strong bidders have high private values. Typically, new entrants are weak, and incumbents are strong. All participants know that a well-designed ascending auction will deliver the product to the strongest bidders, and that weak bidders will not be successful. Accordingly, weak bidders simply refuse to participate because they are destined to lose, and therefore avoid wasted auction transaction costs. [76]

As a result, participation may be limited. Several mechanisms have been developed to overcome this consequence, for example:

- explicit allocation of some of the assets to specific classes of participants, where there are sound grounds for differentiation of weak and strong bidders (for example, by reserving an asset for new entrants); and

- adoption of a sealed-bid auction which gives weak bidders a better chance of winning (at the expense of some productive inefficiency, in that a weak bidder winning implies that one of the losers values the asset more highly).[77] But the benefits of greater participation will very often outweigh anticipated productive efficiency losses.

5.2.2 Common Value Auctions

A different problem arises for the buyer and seller in common value auctions. Recall that in private value auctions the task is to place the assets into the hands of those that value them the most because they can use the asset most effectively. This is not so in the common value auctions because, by definition, all bidders will use the asset in an identical fashion: there will be no difference in usage efficiency.

Rather, the differences in the valuations of the assets are derived from differences in information about the precise value of the asset. Many factors go into that value including, for example in the current context, expectations of future pool prices and possibility that OR providers will be directed to provide energy, all of which bidders cannot control.[78] These conditions where bidders have different private information ("signals") about a product that has a common (single market) value gives rise to the winner's curse (see textbox below). The AESO OR market, despite the differences in providers and their generation technologies, probably has a higher proportion of common value than private value given the presence of a single equilibrium price and the index

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[76] This is best exemplified in spectrum auctions where the spectrum is likely to be used for mobile telephony. The private value of the spectrum to the new entrant relates strictly to the number of subscribers that the entrant can win with access to the spectrum. The value to the incumbent is the same *plus* the prospective loss of profits that occur if it were to lose the spectrum to a new entrant (i.e., see competitive erosion of its current rents). Hence the incumbent has a higher private value and is a stronger bidder.

[77] The process as a whole is transparent, and at the conclusion of each round, results are posted disclosing the identities of the bidders, their bids, the "standing high bid" and its corresponding bidder. Additional bidding rounds occur until such time as no new bid is received which is higher than the standing high bid of the previous round.

[78] One might argue that bidders could control fuel prices. But when one notes that fuel prices are set through liquid primary fuel prices, even this is uncertain.

to the broader pool price. As such, a sealed bid process (where there are asymmetries of information) is an inferior option for promoting competition and motivating new entry.

The Winner's Curse Problem

The winner's curse was first described in the context of auctions for oil exploration licenses.[79] It was noted that bidders that were successful invariably underperformed vis-à-vis their expectations (in the sense of earning lower than expected returns). This was ascribed to the winner's curse which, simply put, states that the winner of a common value auction in which bids reflect unbiased[80] valuations will be the bidder that most over-estimates that value. That is, the winner will habitually expect greater returns than other bidders and will invariably be disappointed once realized returns are not as expected.

The problem of the winner's curse for the auctioneer is that, in the absence of a mechanism for resolving it, market participants may not offer as low a price for the product if they fear that the winner's curse is large, and they lack an accurate valuation of the product. This results in higher clearing prices than what would have occurred if winner's curse was mitigated. It is important to note that, relationship to number of participants is not relevant to OR markets. But if there is a general expected winner's curse, there is more uncertainty about common value.[81] Open auctions provide a means of resolving the winner's curse. The information revealed indicates (to all other bidders) how competitors value the asset. In effect, bidders reveal all relevant information as to the asset value in their bids, so all bidders are fully informed. Since the risk of over-optimistic valuation springs from different information and since bidders are fully informed through the auction process, it follows that bidders can set bids without facing a significant winner's curse. All other things being equal, this will improve auction outcomes. Therefore, for a procurement process such as the one encapsulated in the Alberta OR markets, that will mean a lower clearing price. It then follows that in a sealed-bid auction, where information about other bidders' offers is restricted, some bidders will perceive a higher risk of the winner's curse.[82]

5.3 One-time auction versus repeated auction

It is useful to also consider what economic theory says about repeated auctions. The OR markets are essentially repeated auctions – each day, market participants make offers to supply OR capacity for the next day. The incentives around bidding and the value of information are quite different between an auction that occurs only one time versus an auction that is repeated over

[79] Capen, Clapp and Campbell. "Competitive bidding in high-risk situations." *Journal of Petroleum Technology* (1971).

[80] By which we mean the bidder simply bids up to their own valuation without reference to any other bids.

[81] Casari, Marco, and Timothy N. Cason. "Common Value Auctions with Voluntary and Qualified Entry", Revue économique, vol. 67, no. 5, 2016, p. 953-976.

[82] Levin, Dan, and Kagel, John H. "The Winner's Curse and Public Information in Common Value Auctions." Common Value Auctions and the Winner's Curse. Ukraine, Princeton University Press, 2021. p. 107–119.

and over again. In a one-time auction, participants in a sealed-bid process or open auction are generally equally likely to bid close to their respective valuations. If we assume the good or service being auctioned has private value components, dominant firms may be able to benefit more, to the detriment of the smaller players because of their influence over the market outcomes. Likewise, if we assume common value properties for the good or service being sold/bought, dominant players will largely benefit due to information asymmetry (they may have better strategies or access to additional information that are sufficient for them to win the one-time auction). Generally, when there are dominant and smaller participants in auction, a single round auction design will favor the dominant participants.[83]

In repeated auctions, there is an opportunity for price discovery in an open auction which can level the playing field in markets where dominant firms and competitive fringe co-exist. Through repeated rounds, participants are able to observe the valuation of others and can improve their valuation in subsequent rounds so as to reduce the winner's curse.[84] Likewise, in a sealed-bid process that is reoccurring, ex-post information will assist participants in updating their valuations, but this is conditional on how fast the information is released. A delay in the release of information will raise the winner's curse problem and reduce the aggressiveness of smaller participants (the competitive fringe), who may feel outmaneuvered and less knowledgeable than the dominant firm counterparts.

Economists have noted that in a repeated auction setting, an open auction generally yields better outcomes even in an asymmetric oligopolistic setting. Smaller players have the opportunity to observe and learn from previous rounds which will enable them to bid more effectively, resulting in efficiency improvements. This is analogous to the "information effect" that is commonly observed in multi-round auctions – as price discovery occurs, this tends to move bid prices closer to the efficient valuation. [85]

5.4 Information policies and auction design

The extent of information publication depends upon the specific auction. It can extend to detailed information about each bid and each bidder for every round, or it can be limited to simply the new winning price at each round. The choice of information disclosure has to strike a balance between efficient dissemination of information that resolves uncertainties and improves competition versus minimizing the risk of collusion and uncompetitive behavior.

As discussed above in Section 5.2, OR as a commodity likely has more common value elements than private value, since the market value of active OR products – once it is set – is the same for all providers. Recall that in the OR market, there are various market participants, with various technologies, costs, and commercial objectives. There are also sophisticated (large incumbents –

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[83] Organization for Economic Co-Operation and Development (OECD). *Competition in Bidding Markets 2006*. June 4, 2007. p.47-50. <https://www.oecd.org/competition/abuse/38773965.pdf>

[84] Nedelec, Thomas, et al. "Learning in repeated auctions." *Foundations and Trends® in Machine Learning* 15.3 (2022): 176-334.

[85] Mezzetti, C., Pekeč, A. S., & Tsetlin, I. "Sequential vs. single-round uniform-price auctions." *Games and Economic Behavior*, 62.2 (2008): 591–609. doi: 10.1016/j.geb.2007.05.002.

dominant firms) and less sophisticated (smaller providers and new entrants) providers, active in the OR market, and some bidders have more than one asset participating in the OR market. These factors, coupled with the level of uncertainty that generally exists in the electricity market, it is easy to see how the issue of information asymmetry can arise to be a core issue. Each market participant will have different information signals going into the auction and this could reduce the efficiency of the auction for both the participants and auctioneer, in this case, Watt-Ex, on behalf of the AESO.

The dissemination of information helps refine the participants' views on the value of the product being sold/bought and is generally considered to be efficiency-enhancing because it reduces private values and uncertainties, and in so doing motivates more aggressive competition. The risk-reduction benefits of additional information can also expand the horizon of bidders (statically, by lowering the threshold cost of participation, and dynamically, through incentives for new entrants).[86] It is therefore important to not prevent or artificially limit price discovery and information dissemination. In the absence of valuation-enhancing information (such as public value information) and with procurement of a product that has majority of common-value traits, the issue of a winner's curse arises. A sealed bid format will therefore be prone to the negative effects of winner's curse – undermining the AESO's overarching objectives.

5.5 Activity Rules

Activity rules are a key element of auction design because they help in increasing the pace of an auction. They can restrain strategic bidding delays by requiring a specific cadence in bidders' activities making auctions more efficient. According to economists Lawrence Ausubel and Oleg Baranov, "the specification of the "right" activity rule is a nontrivial and important problem in auction design".[87] Therefore, determining the right activity rule based on the market's unique characteristics may be both complex and essential.

Alberta's OR markets already include some basic activity rules to match the duration and sequential nature of trading in the OR market. In the first 5 minutes of the auction, there is flexibility in trading - an OR provider can drop offers into the market, make adjustments (in price and quantity, in both directions) or remove prior offers entirely. After the 5-minute mark, the auction locks – participants who have offered into the market cannot remove their offers. However, they can make upward revisions to the volume initially offered or make negative revisions to their offer price (e.g., provide a more competitive offer price). New offers can be placed – both from market participants with locked offers and from new market participants who have not placed any offers – and they can do this in the remaining 5 minutes of the auction. Once the 10-minute mark of the trading session elapses, the auction closes and cleared bids are identified.

[86] Vasserman, S. and Watt, M. "Risk Aversion and Auction Design: Theoretical and Empirical Evidence." *International Journal of Industrial Organization* 79 (2021). <https://doi.org/10.1016/j.ijindorg.2021.102758>

[87] Ausubel, L. and Baranov, O. *Revealed Preference and Activity Rules in Dynamic Auctions*. January 2020. <https://doi.org/10.1111/iere.12431>

5.5.1 Types of Activity Rules

The Federal Communications Commission ("FCC") spectrum auctions, which began development in 1993, consisted of a simultaneous ascending auction originally designed by Vickrey (1976) and later developed for use in the US spectrum auctions.[88] The distinguishing factor in the type of auction used was that it facilitated an open auction approach for many licenses covering discreet geographical locations to be sold simultaneously.

There are several reasons that the spectrum auctions were successful under this model. First, the auctions were intentionally designed with the goal of facilitating efficient combinations of licenses into optimal bundles, an important consideration since there are substantial geographical scale economies in mobile telephony. Second, while the auction clearly had a private value component, there was also common value related to the expected revenue per customer within each license zone: the auction provided vital information to the bidders on the value of the licenses and the associated costs, and general information on the market penetration and value that bidders expect to obtain.[89]

Early spectrum auctions were not without problems. One observation around issues was the cadence in offers each round. Bidders delayed revealing their valuations until the very last minute, for fear that their offer would be bested by a competitor.[90] Therefore a delayed, last minute offer is not a feature unique to the OR market, but a frequent and expected outcome with timed auctions.

Milgrom-Wilson activity rule

One of the most popular activity rules that can be implemented to address latency in an auction setting is the Milgrom-Wilson activity rule. By tying the eligibility of future rounds/auctions to a bidder's activity level in the current round, the Milgrom-Wilson activity rule prevents market participants from holding out until the last few seconds of the game. For instance, using this activity rule/auction design in their broadband Personal Communication Service ("PCS") auction, the FCC was able to achieve active participation throughout the duration of the auction. Since then, several versions of this activity rule have successfully been implemented in various markets around the world.[91]

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[88] The simultaneous ascending auction was developed by McAfee, Milgrom, and Wilson for the FCC spectrum auctions.

[89] FCC. *THE FCC REPORT TO CONGRESS ON SPECTRUM AUCTIONS*. WT Docket No. 97-150. October 9, 1997. <https://www.fcc.gov/sites/default/files/wireless/auctions/data/papersAndStudies/fc970353.pdf>

[90] Barbaro, Salvatore, and Bernd Bracht. "Shilling, Squeezing, Sniping. A Further Explanation for Late Bidding in Online Second-Price Auctions." *Journal of Behavioral and Experimental Finance* 31 (Sept. 2021). <https://doi.org/10.1016/j.jbef.2021.100553>

[91] Milgrom, P. *Putting Auction Theory to Work*. Cambridge: Cambridge University Press, 2003. p.6. <http://doi.org/10.1017/CBO9780511813825.003>

Robert Wilson also proposed various activity rules for wholesale energy market, when he was advising on the formation of the California Power Exchange ("PX") in the late 1990s, some of which we discuss below.

The Opening Rule: This activity rule has two parts; the first rule notes that new offers can only be made in the first round of an iterative auction. In subsequent rounds, revisions to offers can be submitted. The second rule states that the controller of the auction, in this case, PX, can estimate the seed price for the first round. Here, seed price refers to predictions about the final clearing price. What this activity rule provides is the ability for the maximum supply of each participant in the market to be revealed early in the auction. Since the opportunity for price discovery significantly increases, we can assume this will result in auctions getting to an equilibrium more quickly.
The Closing Rule: Markets using this activity rule close simultaneously after iterative rounds where no participation (no revisions to offers are made) is recorded. According to Wilson, there is little efficiency lost with this approach because progress in the market has generally slowed down. Because a convergence of prices in the market is expected, it is assumed that any additional benefits from offers that could have been made would be close to other prices that were successfully submitted in the market and thus will not have significant influence on final offers and prices in the market.[92]
The Random Close Activity Rule: Like the name implies, this type of activity rule involves closing auctions at random time intervals. This activity rule has become one of the most important design rules in dealing with latency. This activity rule is currently being implemented by many exchanges, such as: the Australian Securities Exchange ("ASX"), London Stock Exchange ("LSE"), National Stock Exchange of India ("NSE"), Korea Stock Exchange ("KRX"), and Hong Kong Stock Exchange ("HKEX"). This activity rule can take on various formats; auctions could end at some random point in time or at different random points of time (in a multi-round auction). These activity rules can be "orderly random" and "conditional random." The ASX for example, uses an orderly random approach meaning that, auctions close in a certain order (in this case, stocks are divided into five groups and close in an alphabetical order). With the conditional random approach, certain conditions are implemented by the auctioneer and made known to all participants. For instance, a random-end auction is initiated if prices fluctuate by more than 5% in the normal opening or closing time of an auction in the KRX.[93] Use of activity rules can successfully improve competition and increase market efficiency while maintaining an open auction format.[94,95,96]

[92] Wilson, R. "*Activity Rules for an Iterated Double Auction*. 2002". Game Theory and Business Applications. *International Series in Operations Research & Management Science* 35. Springer, Boston, MA. <https://doi.org/10.1007/0-306-47568-5_12>

[93] Lin, Yiping and Michayluk, David and Zou, Mi. *Can Random Auction Ending Curb Market Manipulation?* June 15, 2019. <https://ssrn.com/abstract=3404507>

[94] Cramton, Peter, et al. "Using Spectrum Auctions to Enhance Competition in Wireless Services." The Journal of Law & Economics, vol. 54, no. 4, 2011, pp. S167–88. JSTOR, https://doi.org/10.1086/661939. Accessed 30 Aug. 2022.

[95] Cramton Peter. "Ascending Auctions," European Economic Review 42:3-5 (1998) 745-756.

[96] Ockenfels, Axel, and Alvin E. Roth. "Ending Rules in Internet Auctions: Design and behavior". The Handbook of Market Design. (Oxford, 2013; online edn, Oxford Academic, 23 Jan. 2014). https://doi.org/10.1093/acprof:oso/9780199570515.003.0014 Accessed August 30, 2022

6 Concluding remarks

In order to improve efficiency in the OR market, the AESO is proposing to move to a sealed-bid auction format while releasing offer information only after a 60-day lag. These modifications to auction format and information dissemination are targeted to address the AESO's concerns around latency in offers and possibility (based on its interpretation of theory and current industry structure) for anti-competitive behavior. The AESO explains that its concerns rest on the possibility that participants can learn from each other's behavior and in a concentrated market, that can presumably lead to implicit coordination. A sealed-bid process would preclude market participants from seeing any offer information from competitors. And while the sealed-bid format may reduce the opportunity for real-time price discovery, AESO claims that price discovery at present is of limited benefit.

LEI finds that AESO's concern for anti-competitive behavior rests on a shaky foundation, theoretically and empirically. Indeed, in recent years, the OR markets in Alberta have been characterized as competitive by the MSA, and market prices are subject to such strong competitive pressures. The strong competition, in combination with the indexing to Pool Prices, can result in a zero payment to cleared OR resources – such that AESO is getting OR capacity for nothing - a bargain for Alberta electric consumers! For example, in 2021, the active supplemental reserve market had over 50% of the trading periods with a zero net price to providers, after settlement against pool price.

The AESO has not provided any concrete evidence of uncompetitive behavior or economic barriers to entry. In the OR stakeholder session 1, AESO provided some figures on the concentration ratio of qualified OR capacity by the top 4 and top 5 market participants, as a means to indicate market concentration. However, as established in Section 3.2, this is a flawed metric to measure market power/concentration because the OR market is not economically distinct from the energy market. Therefore, focusing on only OR product predisposes any such analysis to mistakenly conclude that the market is concentrated, and suppliers possess market power potential. A more accurate measure of concentration would be the market share statistic of the broader energy market. For instance, while hydro has been observed to be a key role player in the OR markets, with an average market share of 50% in the active spinning reserves market, hydro resources supplied 3% of the energy in the wholesale market relative to its installed capacity share of 5% over the same 2015 to 2021 period.

By focusing on only market share of cleared volumes and not offered reserves, AESO overstates the concentration of the competitive pool of supply in the market. Relative to the average market share of hydro (approximately 31%) in the supplemental reserves by cleared volumes, data on offered volumes indicate that simple cycle and cogeneration resources offer more volumes into the market (i.e., they have a higher market share than hydro assets). Moreover, one key factor AESO omits in its assessment of market concentration, is the technical nature of providing OR services – this is the real constraint and the reason why not all energy providers can offer OR. Regardless of the different ancillary services across all jurisdictions, all electricity markets have specific technical requirements and thus, it is not uncommon for an ISO to lean towards an asset to provide these reserves. In CAISO for instance, the installed capacity of large hydro is 1.3% and

in terms of renewables, small hydro accounts for 1.2% of total renewable installed capacity.[97] However, the share of hydro in terms of procured spinning reserves between 2019 and 2021, has increased from 40% to over 60% respectively. Likewise in Ontario, the share of average hourly OR scheduled by resource type indicates that the market is very concentrated with hydro accounting for 53% of this share, relative to its installed capacity (transmission connected) of 23% in the broader energy market.[98] In PJM, the market for synchronized reserves are also concentrated, whereby combined cycle accounts for 42.7% of tier 1 synchronized reserve by resource and fuel type and combustion turbine natural gas accounts for 35.9% of tier 2 synchronized reserve by resource and fuel type, the largest share in the market.[99] Other markets in the US have similarly high participation rates from key resources and relatively high levels of concentration but it does not mean that those markets are uncompetitive. In fact, in Alberta, there has been entry in the OR market. The MSA's quarterly reports between 2020 and 2022 indicate that there has been increasing participation of load and battery energy storage systems. Between 2020 and 2022, the market share of supplemental dispatched OR volumes provided by load has increased from approximately 20% to 57%, while BESS (a new entrant to the market) currently provides 15% of dispatched spinning reserves.[100] These observations suggest strong competition and dynamic efficiency in the current OR market design.

The price discovery process under the current OR design is more nuanced than that portrayed by AESO at the prior stakeholder engagement sessions. Based on our review of the actual market trading environment, LEI finds that there is substantial price discovery occurring that benefits downstream OR auctions (on the same day), benefits future OR auctions (on the next day), and to the real-time energy market (on the next day).

Moreover, LEI is worried that AESO's proposed solution to limit anticompetitive behavior and solve the observed latency "problem" is likely to have unintended consequences that weaken the incentives and increase the risks for new entrants and smaller OR providers. The cadence in offers is not a competitive flaw, but rather a defensive tactic in a very competitive market where participants are concerned about being undercut and losing out on their OR sales opportunity. There are however modifications that can be made to the existing activity rules that may adjust the cadence of offers. Changes to the activity rules is a better option, with fewer downside risks as compared to the more extreme move to a sealed-bid format.

Economic theory shows that an open auction is better for accommodating and stimulating activity from smaller firms, including new entrants, because it gives them an opportunity to gather more information and resolve uncertainties they have about the value of the good or service being auctioned. There is a lot of uncertainty for OR market participants in Alberta. In addition, we need to keep in mind that the OR products are a form of product that has common value

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[97] CAISO. *Current Supply Outlook*. Web. Accessed August 30, 2022. <https://www.caiso.com/todaysoutlook/Pages/supply.html#section-current>

[98] IESO. Ontario's Electricity Grid. Web. Accessed August 30, 2022. <https://www.ieso.ca/en/Learn/Ontario-Electricity-Grid/Supply-Mix-and-Generation>

[99] PJM. 2021 State of the Market Report. Section 10 (Ancillary services), p.17,22. March 10, 2022

[100] MSA. *Quarterly Report for Q1 2022*. p.35. May 13, 2022.

properties. Therefore, access to timely offer information is crucial for market participants. Theory suggests that information dissemination enhances competition (smaller market participants can be more aggressive in their bidding) and motivates new entry under the conditions that align with Alberta's OR markets. LEI recommends that the AESO reconsider changing the format of the active OR auctions and restricting release of offer data. The AESO's proposed changes are unnecessary as the current design appears to be achieving the AESO's objective of dynamic efficiency.

7 Appendix A: Overview of LEI's qualifications

LEI is a global economic, financial, and strategic advisory professional services firm specializing in energy and infrastructure. The firm combines a detailed understanding of specific network and commodity industries, such as electricity generation, transmission, and distribution, with a suite of proprietary quantitative models to produce reliable and comprehensible results. LEI's areas of expertise are briefly described in Figure 12.

Figure 12. LEI's areas of expertise

The firm has its roots in advising on the initial round of privatization of electricity, gas, and water companies in the UK. Since then, LEI has advised private sector clients, market institutions, and governments on tariff design, privatization, asset valuation, deregulation, market power, and strategy development in virtually all deregulated markets worldwide, including Canada, the United States, Europe, Asia, Latin America, Africa, and the Middle East. LEI is active across the power sector value chain and has a comprehensive understanding of the issues faced by investors, utilities, and regulators.

7.1 Alberta market experience

LEI has considerable experience advising governments, arms-length government agencies, and private companies on a range of issues related to the Alberta electricity sector. The following are a sample of these engagements.

Expert analysis in support of a dispute regarding the valuation of a peaking generator: LEI was retained as independent energy market expert to provide testimony in a litigated proceeding in Alberta, Canada. LEI prepared a report to specifically describe the economic operations of a flexible RICE generation unit, and discuss all the revenue levels that could be optimized, based on the unit's physical attributes

relative to the market and its connection at the distribution system level. LEI also carried out extensive research on the operations of independent power producer in the AESO-operated energy and ancillary services markets, and how that compared and contrasts with financial hedging.

Transmission tariff design: LEI has extensive experience analyzing transmission rate designs and developing new transmission tariffs using well-established techniques for cost-of-service ratemaking, including empirically supported analysis of the cost of capital and efficient cost allocation. LEI staff have also supported numerous clients in matters related to performance-based ratemaking and incentive design. In North America and abroad, LEI has provided advisory and expert services on the theoretical and practical requirements of performance-based ratemaking and performed extensive empirical analyses necessary to support performance-based ratemaking schemes. LEI has also applied concepts of demand elasticity and customer-oriented market analysis to consider rate impacts for transmission companies and regulators.

Long term energy and capacity market forecasting: LEI was engaged by an infrastructure investment fund to provide consulting and advisory services in support of due diligence efforts on a potential wind portfolio acquisition in ISO-NE and California. The scope of the due diligence effort includes reviewing data room materials, critically reviewing a market report prepared by the sell-side consultant, preparing independent long-term 20-year energy and capacity price forecast for the target assets under two different scenarios, one reflecting a base case scenario with nation-wide carbon tax implemented by 2028, and another reflecting decarbonization goal achieved through non-carbon tax policies.

Analysis of non-market RRO design: LEI prepared a research workpaper to explore strategic options for a major Canadian IPP's generation fleet in response to potential reliability issues faced in Alberta's electricity system as a result of rising levels of renewables in the generation mix and the increased interest from AESO to create a new category of ancillary services (Fast Frequency Response). LEI's paper examined technological considerations in solving the issue of falling inertia, based on real world experience of other markets, including the UK, Ireland, Australia and the California ISO. LEI further discussed what drives policymakers and market designers to tackle the issue of frequency response – whether it was driven by changes in the generation mix, changes in demand, or transmission system configuration. The paper also investigated how current technologies help solve the perceived problem(s) and considered the type of market mechanisms regulators and ISOs have proposed to tackle the problem(s). LEI also discussed the pros/cons of non-market mechanisms that system operators can implement to counter concerns of frequency loss events and system reliability.

Policy design: LEI's regulatory economics practice examines the universe of economic and financial issues facing regulators, market institutions, regulated companies, and consumers. LEI staff have frequently provided advisory services related to economic policies, designing transmission rates and cost recovery, cost allocation, planning, and designing and implementing competitive solicitations involving new infrastructure. Whether advising on regulatory strategy for a wires company, tariff design, or implementation of market reforms for a regulator, LEI's ability to balance the needs of various stakeholder groups ensures durable, long-term, and cost-effective solutions to difficult regulatory conundrums.

Valuing transmission assets: LEI creates meaningful simulations of transmission investment impacts using proprietary tools such as Valuation of Transmission Augmentation Links ("ViTAL"), a modeling framework specifically designed for regulators and transmission system

owners and operators. Other tools employed in LEI's cost-benefit analysis work include POOLMod, a network simulation model used to forecast the impact of new transmission infrastructure on electricity prices and quantify benefits of new transmission capacity. In addition, LEI provides advice and analysis related to the valuation of congestion contracts across North America using real options coupled with POOLMod. Finally, LEI has performed several economic development studies to investigate the positive externalities of infrastructure investment on local and regional economies, including estimation and measurement of labor sector (employment) benefits, environmental policy compliance (decarbonization), tax revenue implications, and more generally, the longer-term value-added contributions to the economy from the impact that new infrastructure has on lower overall costs of electricity.

Procurement process and contract design: LEI applies fundamental economic principles and an exhaustive knowledge of electricity markets to help governments, regulators, and private companies create effective, rational, and transparent procurement processes, including competitive solicitations for transmission capacity, and independent management of open seasons and open solicitations. LEI's support for procurement processes includes proposing selection criteria, drafting contracts, publicizing the procurement, communicating with stakeholders, monitoring the opening and examination of bids, and creating an analytic and modeling framework to evaluate bids.

Expert testimony on capacity market design: LEI supported a power generator in Alberta through the AUC process to review provisional market rules for the new capacity market. Work entailed analysis of specific policy topics (such as economic withholding), drafting of expert testimony, review of other participant submissions, testimony, etc.

Facilitating an open solicitation process for a merchant transmission project: LEI was selected by a transmission developer to serve as an Independent Examiner for a proposed merchant transmission project open solicitation process. LEI designed a novel process to not only solicit transmission customers, but match suppliers, buyers, and marketers to help reduce the market risk of shippers signing up for long term transmission agreements. LEI's scope of work included designing the solicitation process, meeting with FERC staff in advance of the project's application for negotiated rate authority, preparing all solicitation documents, coordinating the marketing campaign with an outside firm, conducting information sessions, matching suppliers/buyers/marketers, allocating transmission capacity, and submitting a report to FERC demonstrating the results of the process as part of the developers' Section 205 filing.

Comprehensive review of Alberta's electricity market: For the Alberta Provincial Government, LEI performed a comprehensive review of the province's electricity market, which included analysis of the roles of the Power Pool, the Transmission Administrator, the Market Surveillance Administrator, the Balancing Pool, and the System Controller. LEI performed extensive stakeholder consultation and prepared an analysis of how these roles are performed in ten competitive wholesale markets worldwide. LEI then created a series of models for the evolution of all of the entities studied and the industry as a whole. Based on further stakeholder and government input, these models were distilled into final recommendations regarding how the industry components should be structured in the future.

Study to further deregulate Alberta's retail electricity market: LEI supported the Alberta Department of Energy ("ADOE") in an attempt to select the most appropriate way to further

deregulate its retail market. LEI's team analyzed the economic impact of five different options being considered by ADOE on customer bills by using historical data as well as developing a cost benefit analysis model that looked at both quantitative and qualitative issues that were prioritized by the ADOE. LEI provided a ranking of options and recommendations as to which would best meet ADOE needs.

Estimate impact of Alberta power price changes for a litigation: LEI was retained by a Canadian industrial conglomerate to estimate damages incurred because of power price changes during the life of a five-year swap agreement, which obligated the client to pay a fixed price in exchange for a floating-rate payment based on an hourly average pool price. LEI first investigated whether a material change in the determination of market-clearing prices in the Power Pool of Alberta had occurred on a specific date in 2001 and then estimated the magnitude of the price shift attributable to the change in the Clover Bar's pricing strategy over the term of the swap agreement and the amount of the resulting damages.

Develop plans for an energy-only market to an energy and capacity market transition: LEI supported a large generator in Alberta to develop plans to transition from an energy-only market to an energy and capacity market. Work included detailed analysis on revenues, reliability, and costs to consumers under different market designs, including various permutations of capacity markets; quantitative analysis of what a transition to a day ahead market might entail and the economic implications of co-optimizing energy and operating reserves, as well as adding a fast ramp product; a series of issue papers on technical topics related to capacity market design such as pros and cons of auction clearing mechanisms, the Cost of New Entry in Alberta, market power mitigation options, implications for Alberta's ancillary services market, and a qualitative assessment of transitioning to a day ahead market.

7.2 Auction design and information policies

Analysis of transmission rights and auction mechanism: LEI was engaged by PJM to research, summarize, and analyze any other existing or previously conceived mechanisms that could be utilized to address the problem that required adoption of Financial Transmission Rights ("FTRs") /Auction Revenue Rights ("ARRs") as identified by LEI in its report entitled "Review of PJM's ARR/FTRs." The analysis of these mechanisms included a discussion of the pros and cons of each mechanism from the perspective of load who is most concerned with receiving optimal value from the system for which it funds.

Develop asset strategies for auctions: LEI was retained by an Independent Power Producer to prepare a workshop on asset strategies for New England's proposed Competitive Auctions for Sponsored Resources ("CASPR"). This included an overview of the Forward Capacity Auction, the auction mechanics of CASPR, as well as a review of the necessary documentation required to prepare a de-list bid.

Auction Design Review for UK Department of Energy and Climate Change: A market regulator was interested in whether US power markets evaluate generation bids based on criteria other than the price bid, specifically, if the length of contract had a role in the auctions. LEI reviewed capacity market rules for PJM, ISO-New England and the New York ISO. We examined whether and for how long a "lock-in" option for the first-year capacity price is offered to new generation assets bidding into the auctions. LEI also reviewed international spectrum auctions, North

American gas transmission open season rules, and international auctions for toll roads to examine whether and how duration or length of contract is incorporated into bidding.

Evaluation of auction mechanism: ENMAX retained LEI to act as an independent expert on matters related to the auction that they proposed to hold in early 2014. LEI provided an independent evaluation of the proposed auction, including evaluation of the both the product being auctioned and the auction mechanism and key parameters. The product as proposed to be auctioned was referred to as the Load Following Service ("LFS") product and was meant to represent the "shape risk" in the RRO service. LEI's evaluation considered whether the product and auction mechanism would result in an efficient, competitive and fair outcome for the Alberta market, RRO providers, potential suppliers of the auctioned product, and customers of the RRO service.

Oversee Transitional Standard Offer (TSO) auction: LEI was hired by the State of Connecticut's Department of Public Utility Control (DPUC) to oversee the Transitional Standard Offer (TSO) auction by Connecticut Light and Power (CL&P) for its 2005 and 2006 load (more than 5,000 MW peak demand). The scope of the project included approving the RFP and communication protocol, participating in all bidder calls and negotiations, analyzing the New England market and developing scenarios for likely bids, and verifying CL&P's decision-making process for selecting winning bids. LEI also provided testimony to the DPUC based on its assessment of the auction process and its accordance with DPUC principles of competition.

Develop holding restrictions for PPA auctions: LEI leveraged its proprietary model of strategic behavior in electricity markets, known as CUSTOMBid to analyze the Alberta market. As a result of our analysis, a series of holding restrictions were developed which allowed for sale of capacity into the market without increasing the potential for strategic bidding.

Advice on the selection of sale process for strip contracts: LEI was retained by the AESO, to advise on a sealed-bid option (i.e., a bank mediated private sale) or some type of open auction process for strip contracts. LEI provided a detailed report, setting out the advantages and disadvantages to either approach. LEI focused on, reviewing the theoretical arguments and relevant case studies and examined the practical aspects (within the context of the Alberta market) of various auction styles and their implication on the sales process.

Study of renewable energy development and auction mechanisms: LEI acted as a subcontractor to a US energy efficiency consulting group in providing analysis of various restructuring issues pertaining to the distribution of funds intended to foster the development of renewable energy resources. LEI's analysis included the design of incentive schemes to produce the optimal amount of entry by renewable energy developers and examining different auction mechanisms.

7.3 OR market advisory

Empirical analysis of proposed market design: LEI conducted an empirical analysis of two proposed New England wholesale electricity market design changes, including long term modeling of the New England energy and capacity markets, and provided tabular summaries of simulated market outcomes and financial data. Specifically, LEI (i) created, built, and simulated the proposed market design changes, (ii) analyzed resulting market impacts, and (iii) provided observations to the Client. The first proposed market design change is the Competitive Auctions with State Policy Resources (CASPR) proposal. The CASPR proposal involves adding a second

or "substitution" auction to the current Forward Capacity Market (FCM) framework. LEI examined the fundamentals for this substitution auction and integrate it within Contractor's overall FCM model. LEI evaluated the financial incentives for incumbent (existing) resources to remain in operation versus the financial incentive to retire (and therefore the bidding strategy of these resources). LEI considered critically the tradeoffs that existing generators will be making in the face of the substitution auction, including the opportunity/risk of continuing to operate versus the opportunity/risk of submitting a retirement bid and participating in the substitution auction. The second proposed market design change is the Forward Clean Energy Market (FCEM) proposal. The FCEM proposal is a market-based solution to the selection and procurement of clean energy supply. LEI built a model that simulates the supply and demand fundamentals of the proposed FCEM and integrate the results of the FCEM with its energy market model and FCM model. LEI used a bottom-up approach and build a detailed FCEM model based on aggregated supply of "clean energy" from all eligible resource types and aggregated demand based on each New England state's clean energy requirements.

Energy and capacity price forecast: LEI was retained by Cube Hydro to prepare a 20-year energy and capacity price forecast for PJM. This is related to Cube Hydro's potential target of a portfolio of hydro assets in SERC which looks to sell into PJM West. LEI delivered price forecast of PJM West to Cube Hydro by updating gas prices, calibrating retirement and new entry based on the recent results from the capacity market auctions, and adjusting import/export flows.

Theoretical and empirical analysis of competition concepts related to ancillary services in Alberta: LEI developed a briefing paper that outlined the concept of market definition and applied it to the facts at issue in the case of the Alberta power market. The paper identified whether ancillary service products, including the super-peak regulating service, will be a stand-alone market for competition analysis. LEI also developed a briefing paper on Canadian and international cases of predatory pricing to determine economic techniques used to test claims of predatory pricing, particularly focusing on electricity markets.

Devise holding restrictions for Alberta's ancillary services market: LEI was engaged by Alberta's Balancing Pool to devise relevant holding restrictions for the Canadian province's ancillary services market. LEI's work included a survey of generators capable of providing ancillary services, technical and rules-based restrictions on the provision of these services, as well as stipulations regarding ESBI's procurement policies. LEI's report focused on regulating and operating reserves, and assessed the mechanisms associated with the other ancillary services required in Alberta. This included transmission must-run ("TMR") status, black start, reactive power and voltage control.

Analysis of various OR markets: On behalf of a UK nuclear power producer, LEI provided an analysis of the operating reserve market projected to be operational at market opening and interpreted the market rules and compared potential dynamics with operating ancillary service markets in New York and PJM. LEI also forecasted operating reserve prices for 15 years.

Analysis of offer strategy between energy and ancillary services markets: For a developer in Alberta, LEI was engaged to assist the client in optimizing its offer strategy, for a potential pumped hydro storage project in Alberta. Using LEI's proprietary simulation software, POOLMod and ConjectureMod, LEI provided a pool price and operating reserve price forecast for 2023-2042, and a financial model of the gross profit margin. Additionally, LEI studied the

economies of scale and scope of the project, by testing various pumping capabilities and storage sizes for the project.

Advise on capacity market design: LEI advised the California Energy Commission and other stakeholders on the design and development of a web-based software system supporting the trading of an electricity capacity product tracked by state regulators in connection with resource adequacy requirements. LEI analyzed similar systems in other jurisdictions, defined potential core functionalities of the California system – including, for example, posting of bids and offers. The engagement also required LEI to track titles, examine bilateral and/or multi-lateral trades and compliance reporting. LEI conducted a survey of industry participants to identify required and desired system capabilities.

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