# Stakeholder Comment Matrix – Jan. 3, 2023

## 2023 Long-Term Outlook | Scope & Input Assumptions Written Consultation

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| Comment period: | **Jan. 3, 2023 to Jan. 24, 2023** | Contact: | Ken Hogg |
| Comments from: | Alberta Renewable Energy Alliance | Email: | kshogg@shaw.ca |
| Date: | Jan. 24, 2023 | | |

## Updated Instructions

1. Please fill out the section above as indicated.
2. Please respond to the questions below and provide your specific comments. We welcome your expertise and input and should some of the questions not be applicable to your area of expertise please feel free to leave those responses blank.
3. **Please upload one completed comment matrix per organization**.
4. **To upload your completed comment matrix:**
   i. You will need to be registered and signed in on the AESO Engage platform
   ii. You will need to be on the Forecasting Insights page (www.aesoengage.aeso.ca/forecasting-insights), which can be found on the AESO website at www.aeso.ca and follow the path: AESO Engage (found on very top navigation bar) > Forecasting Insights > Stakeholder Feedback > Request for Feedback | Scope & Input Assumptions Jan.3-20, 2023
   iii. Please click on the "Complete Stakeholder Feedback" box to upload your completed comment matrix
5. **Stakeholder Feedback results will be published on AESO Engage, in their original state.**

## Introduction

To continue to support the AESO's mandate to provide for the safe, reliable, and economic operation of the Alberta electricity system while facilitating a fair, efficient, and openly competitive market for electricity the AESO is initiating the development of the 2023 Long-term Outlook (LTO) with an anticipated release date in the fall of 2023. This work will look to build on and integrate learnings from our 2022 *Net Zero Emissions Pathways* report as well as the *AESO 2021 Technology Forward Publication* and the AESO Technology Summit 2021 – Power Tomorrow.

The 2023 LTO is the AESO's forecast of Alberta load and generation requirements over the next 20 years and is used as one of many inputs to guide transmission system planning, resource adequacy assessments and market evaluations.


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This report is being developed during a period of global uncertainty, and the outlook will cover a significant period of transformation of Alberta's electricity industry. Changes in technology, government regulation and policy, economics and the way power is produced and consumed will significantly impact load growth and development of the resources to support and manage Alberta's power needs.

At its core, the 2023 LTO will be grounded in market fundamentals including demographics and employment, existing industrial energy needs, core economic sectors, utilization of existing resource mix and economic additions based on decarbonization-oriented policies. Additionally, further decarbonization of the supply mix, electrification of high-emitting sectors, and energy efficiency improvements will also be explored as part of the 2023 LTO scenarios. Carbon pricing and regulation, technological innovations, and new ways to generate, store and consume electricity as well as support from various levels of government around federal zero-emission vehicle credits and mandates, carbon capture, and other low emission technology tax treatment are anticipated to continue to grow and support the energy transition, which will drive additional emissions reductions economy wide.

## Request for Feedback

The AESO is seeking feedback from interested stakeholders on their perspectives as it relates to the proposed scope and input assumptions of the 2023 LTO. Please be as specific as possible with your responses. Thank you.

Stakeholder engagement, dialogue, and feedback will be key to framing the AESO's analysis and calibrating modeling parameters to ensure that the information provided to stakeholders via this analysis is valuable. The AESO would like to thank stakeholders in advance for their ideas, thoughts, and perspectives related to electric system transformation in Alberta.

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| ***1*** | ***2023 Long-Term Outlook Scope***<br>Alberta's Electricity industry continues to evolve due to the transition away from coal generation, stemming from carbon regulation and policy, lower emission natural gas generation, and proliferation of renewable generation, particularly wind and solar. The 2023 LTO will consider these factors along with anticipated impacts from carbon policy implementation, economic growth, load growth, energy efficiency, distributed energy resources, changes in electrical energy use patterns and proliferation of new types of uses (electrical vehicles (EV) for example), and the evolution of generation and emission reducing technologies. The 2023 LTO will provide the AESO and external stakeholders with valuable insights, information, and data to help inform decisions aligning with the AESO's *2022 Strategic Plan*.<br>The AESO intends to review load and generation scenarios that reflect current trends in decarbonization, with the intention of illustrating possible cases and scenarios. With respect to supply the AESO intends to review three scenarios as part of the LTO framework supply scenarios in greater quantitative detail to gain further insight on potential market and operational implications. These are:<br>• **Reference** – Pace of changes are incremental and aligned with current understanding of federal and provincial policy, economic expectations, and technology landscape.<br>    ○ Using historical trends and current economic outlooks for the energy sector to forecast future growth. As well account for trends in EV adoption, energy efficiency, distributed energy resources (DERs), building electrification, heavy industry, and flexible loads. | |

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| ○ Based on current policies (*Technology Innovation and Emissions Reduction Regulation* (TIER), *Clean Electricity Regulations* (CER), etc.), technology costs and industry trends (e.g., Corporate Power Purchase Agreements (PPAs), Carbon Capture Utilization and Storage (CCUS), and Hydrogen). Near-term additions based on certainty criteria; long-term additions based on economics.<br>• **High Electrification** – With the anticipated decarbonization of the grid, the pace and scale of electrification is increased to take advantage of the potential to reduce emissions. The pace and scale of transportation electrification, building electrification, energy efficiency, and heavy industry are sped up to take advantage of a lower emission power grid.<br>• **Alternate Decarbonization** – Qualitatively and quantitatively explore the benefits and challenges of increased capacity of interties with neighboring jurisdictions. Anticipated technological costs and development timelines associated with CCUS and Hydrogen development are delayed, and performance is below expectations. Explore what alternate additional low emission technologies (i.e., additional wind, solar, storage, small modular reactors, hydro, etc.) are able to bridge the gap (sensitivities around additional cost declines, policy support). | |
| a) What is your view on the magnitude and structure with regards to interconnection with neighbouring jurisdictions that the AESO should explore? | The current intertie with BC must be upgraded.<br>A high voltage DC link with Manitoba should be more fully explored as was initiated in 2018.<br>Interties provide reliability to all interconnected parties; but it is complex and time consuming to control negotiations with neighbouring jurisdictions as opposed to more rapidly regulating provincial initiatives.<br>Distributed solar reduces the burden on grid interties, provides resiliency at the point of consumption, and acts as a proliferated source. Solar should be considered ahead of other solutions. |
| b) What is your view with regards to additional low emission technologies (i.e., wind, solar, storage, small modular reactors, hydro, etc.) around penetration levels, pace of adoption, opportunities, and challenges to implement/integrate within the Alberta electric system that the AESO should model? | As the world becomes more electrified in tandem with increased pressure to decarbonize grid generation, there will be amplified dependence on emission-free power.<br>Coal, gas, and oil will undergo punitive taxation, and will strand investments or operations that depend on them. Customers and companies will pay escalating costs related to externalities, such as environmental damage, climate disruption and health costs.<br>Deep penetration of distributed wind and solar (and potentially binary cycle geothermal) should be deployed rapidly across Alberta. Energy storage of surplus renewable generation must also be deployed to take advantage of times when that stored surplus can then be drawn |

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| | on to ensure continuous and reliable generation. The ability to store surplus renewable generation will mitigate the need to curtail such generation.<br><br>Model scenarios for small modular reactors. Conceivably, SMRs could significantly reduce the need for cogeneration in the oil sands.<br><br>The Contract for Differences (CFD) approach (whereby developers compete to establish the lowest cost for renewable generation) worked well when the Renewable Electricity Program (REP) was adopted in 2018.<br><br>For the record, the following information was obtained from the AESO website.<br><br>AESO, under the direction of the Alberta Government, guaranteed fixed price certainty for renewable generation of wind and solar.<br><br>Developers competed in an auction, with the lowest cost offers receiving contracts. The buyer (AESO) and seller (the renewable project developer) agreed on a price for the renewable electricity that was sold into Alberta's power pool. This payment mechanism was known as an Indexed REC (Renewable Energy Credit).<br><br>The winning bidder was paid a $/MWh payment as follows:<br><br>• The winning bidder bids a price that is, in essence, its lowest acceptable cost for the renewable project the bidder plans to advance. The competition puts downward pressure on the cost of renewable projects.<br><br>• The dollar value of support paid to the winning bidder for renewable attributes produced is calculated by subtracting the pool price from the bid price.<br><br>• It allows companies to competitively bid for the all-in price they need to develop a project. From the all-in price we (*AESO*) subtract the pool price and the difference is how much is paid in support. |

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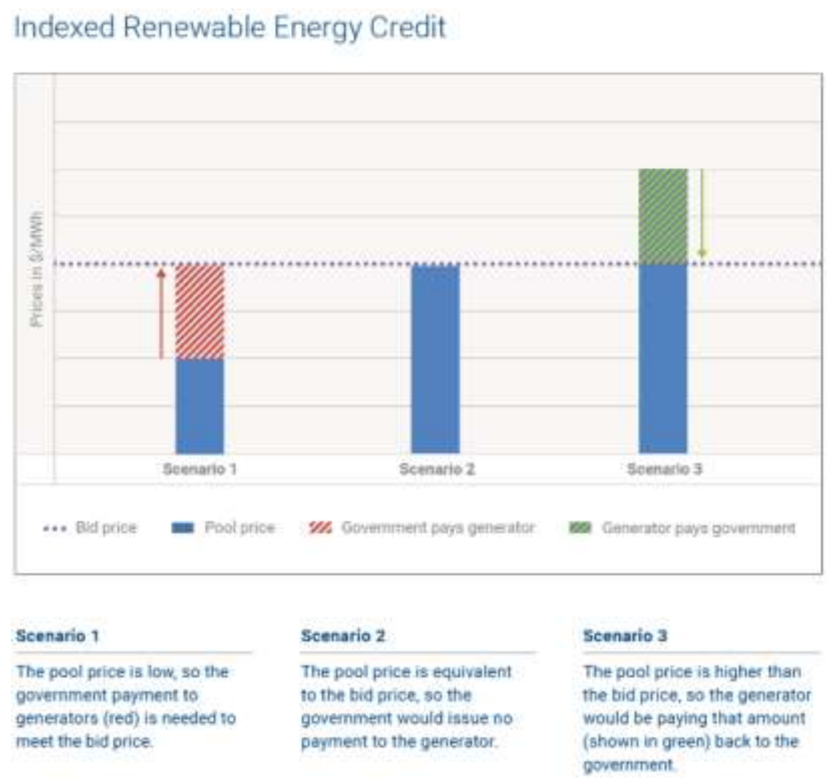
| | | AESO graphically displayed the arrangement as follows:<br><br>It is critical to note that the government retained control of the right to carbon offsets or emissions credits. In both situations, whether the pool price was above or below the bid price, all 'value' of offsets or credits accrued to the government. This obviated the need for the government to transfer or relinquish the economic value to project developers. |

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| | | Contract for Differences (CFD) mitigates risk for both the renewable energy project developer and the government. |
| | c) Is there any additional feedback that you would like to provide to the AESO with respect to the intended scenarios and analysis? | Under the Renewables scenario AESO forecasts for 2035 that cogeneration will generate 44,539,905 MWh, representing 44% of total generation. GHG emissions are forecast to be 431,863 tonnes CO2e. This yields an impossibly low cogen emission intensity of 0.0097 tnes CO2e / MWh. Compare this to Best in Class Combined Cycle Gas Turbine of 0.37 tnes CO2e / MWh. This underreporting of cogen emissions arises from the fact that AESO Notes: *"Emissions for cogeneration are restricted to those cogeneration assets that report their emissions using the NAICS code 221112."*<br><br>CAPP claims that cogeneration GHG emission intensity is 0.25 to 0.3 tonnes CO2e/MWh. (Source: Greenhouse Gas Emissions and Canada's Natural Gas and Oil Industry - pdf July 2021)<br><br>If unabated cogeneration is to be included in the generation mix, an emission intensity 0.25 to 0.3 tnes CO2 / MWh must be assumed. |
| ***2*** | ***Macroeconomic Context***<br>**a) Economic Outlook**<br>Recent economic outlooks suggest Alberta's economy will grow between 2.4 - 4.9 per cent in the near-term and then return to a long-term trend of around 1.5 per cent.[1] | From a macroeconomic viewpoint, decarbonization achieved via deep and rapid deployment of decentralized renewable generation coupled with energy storage and intertie upgrades will offer tens of thousands of good paying jobs throughout Alberta. |

[1] https://www.conferenceboard.ca/e-library/abstract.aspx?did=11811

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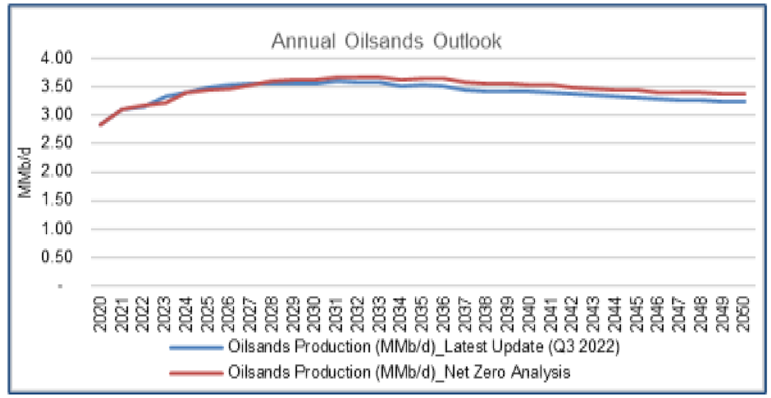
| • What is your view of the 5- to 20-year economic outlook of the province?<br>• How will decarbonization and electrification policies impact the Alberta macroeconomic landscape? | |
| **b) Oil Sands Outlook**<br>Oil sands production is a key driver of Alberta’s load growth. The latest IHS (S&P Global) outlook notes that Canadian oil sands output will rise to ~3.5 MMb/d by 2030, indicated by the blue line in Figure 1. In the AESO’s *Net-Zero Emissions Pathways* report, the AESO adopted an earlier version of this outlook, where it assumed oil sands production would rise up to 3.6 MMb/d by 2030 (as indicated by the red line in Figure 1). | **Figure 1: Oil Sands Outlook Assumptions**<br> |
| • What is your view of long-term oil sands output?<br>• What is your view on whether/how carbon policies will impact the sector and its load? | Current estimates are that producing a barrel of oil from the oil sands after extraction, production, transport, refining, and accounting for externalities, shifts the activity into a negative economic proposition. Low carbon policies will force the oil sands to become less viable. |
| **c) Natural Gas Outlook**<br>Current forward gas prices are in the $4.25/GJ range.<br>• Five years into the future, do you see gas prices remaining at this level, decreasing, or increasing beyond inflationary rates?<br>• What do you see as key drivers of gas prices going forward?<br>• If a natural gas price sensitivity is completed, what is an appropriate range to consider (i.e., +/- $1/GJ)? | If the war in Ukraine provides any precedent, the pricing of gas is highly sensitive to a volatile energy event and supply chain disruptions.<br>Considering methane’s magnified negative impact on the atmosphere (86 times that of Carbon Dioxide over a 20 year time frame), the use of gas as a bridge fuel will be temporary, as alternatives appear. |

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| ***3*** | ***Policy and Electricity Value Chain Impact***<br>a) What further changes do you expect to see in the *Technology Innovation and Emissions Reduction Regulation* (TIER) framework that will impact electricity supply and demand in Alberta in the medium and long term?<br>**Note:** For the purpose of modelling the 2023 LTO, the AESO intends to assume that the high-performance benchmarks for electricity and hydrogen tighten at 2 per cent per annum until 2030, per the amendments to the *TIER Regulation,* released Dec. 14, 2022[2]. The AESO intends to assume the 2 per cent tightening continues until 2034. Thereafter, the AESO intends to assume a high-performance benchmark for electricity that is commensurate with the emissions from a combined-cycle natural gas unit with 90 per cent post combustion carbon capture and sequestration. | Being the province with the highest carbon footprint, there will be mounting pressure on Alberta to lower significantly its emission intensity of generation.<br>A tightening of 2 per cent per annum will be too low to accomplish a zero carbon emission goal by 2035.<br>A tightening of 7% per cent per annum should be imposed to reduce annual emissions from all gas turbine generation from best in class 0.37 tnes CO2e/MWh to zero by 2035.<br>For example, the Federal Government in 2019 proposed a tightening or stringency on all new gas turbine generation at an annual rate of 10% such that gas turbine emissions would be reduced to zero tne CO2e/MWh by 2030. |
| | b) How should the AESO reflect the Federal *Clean Electricity Regulations* (CER) within its modelling assumptions to account for its impact on the electricity supply mix in Alberta? | The word ‘clean’ in Clean Electricity should be defined and regulated, given that the Lieutenant Governor of Alberta promulgated the word ‘clean’ as follows.<br>On March 31, 2017 Lieutenant Governor of Alberta, Lois Mitchell, signed Order in Council O.C. 120 / 2017 which recognized under SCHEDULE Clause G<br>• “***the Government of Alberta’s objectives of providing clean, affordable and reliable energy to Albertans.”***<br>The word ‘clean’ has been virtually ignored since that Order in Council was signed. The Government of Alberta is now<br>• ***“committed to maintaining a safe, reliable, and affordable electricity system for all Albertans by*** |

[2] https://kings-printer.alberta.ca/documents/Orders/Orders_in_Council/2022/2022_403.html

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| | | ***focusing our attention on energy costs to mitigate the impacts on consumers, including industry and individuals."***<br><br>What is 'clean' energy?<br><br>Canada exhibits a 'low carbon' electricity grid due to the utilization of low emission power generated via hydro 62%, nuclear 16% and renewables such as wind and solar 6%. The most recent April, 2022 Canadian National Inventory Report (NIR) for year 2020 documented that Canada rates well with a GHG emissions intensity of 120 kg CO2e / MWh.<br><br>But Alberta's power grid is not clean. Canada's 2022 NIR for year 2020 documented that Alberta's power grid emissions were 590 kg CO2e /MWh. Alberta's electricity emissions were 53% of Canada's total GHG emissions; coal units in Alberta emitted 63% of GHG emissions in Alberta in 2020. It should be acknowledged that in the interim between 2020 and currently, coal generation has been reduced significantly.<br><br>'Clean' electricity should be defined as zero kg CO2e/MWh. The 2022 NIR documented that Prince Edward Island generated clean electricity in 2020 of 0.0 kg CO2e/MWh from 660 GWh of renewables generation.<br><br>As documented in NIR 2022, hydro dominant Manitoba and Quebec had grid emission intensities of 1.1 and 1.5 kg CO2 / MWh respectfully. These intensities should be acknowledged as virtually clean.<br><br>To summarize, Alberta should adopt a Clean Electricity Regulation which requires an annual reduction in electricity emissions that will result in a GHG grid emission intensity of 0.0 tnes CO2e/MWh by 2035. |

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| | c) With regards to the recently announced Investment Tax Credits (ITC) impacting carbon capture technologies, clean energy technologies, and clean hydrogen technologies:<br>• Given limited detail on the structure of the ITC, do you have potential insights to the mechanics of the credit?<br>• Do you foresee that these investment tax credits will be pivotal in their capacity to change the electricity generation landscape in Alberta?<br>• Which technologies do you expect will benefit the most from these incentives? Which technologies do you expect will face challenges? | As discussed in b) 'clean' must be defined in clean energy technologies and clean hydrogen technologies. Renewable generation supported with energy storage of surplus renewable energy can be considered clean as can electrolytic hydrogen from renewable energy. Blue hydrogen from the methane is less 'clean' given the unabated leakage of methane. As well, the uncaptured 10% to 15% of carbon emissions from CCS of gas turbine generation cannot be considered 'clean'.<br>Investment Tax Credits, if applied equitably to all emission reduction technologies will incentivize proven and rapidly deployable low carbon generation.<br>CCUS on gas powered generation will face operational and economic challenges. |
| | d) Are there any other related policy or regulatory considerations that you would like to provide feedback on? | Alberta should restrict trading in carbon credits and offsets exclusively to projects planned, engineered and implemented in Alberta to mitigate against carbon 'leakage'. |
| ***4*** | ***Electrification and Electricity Demand Drivers in Alberta***<br>**a) Energy efficiency**<br>• What is your view on the potential penetration, impact and/or pace of greater energy efficiency across sectors (residential, commercial, and/or industrial)? What would trigger more energy efficiency or conservation efforts? | The impending rapid and substantial increase of electrified transportation will trigger the need for energy efficiency and conservation in conjunction with the requirement for increased capacity build-out to residential, commercial and industrial sites.<br>This need will bring with it an opportunity to modernize the grid. One example would be to take advantage of 'roving' storage in the form of EV vehicles in addition to residential solar coupled with storage.<br>DSM (Demand Side Management) and TOD (Time of Day) billing should be promoted by the Alberta government to incentivize consumers to optimize their energy use. Consumers can reduce |

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| | their electricity bills by adjusting the timing and amount of electricity use.<br>Rebates and low interest loans for energy efficiency measures have proven to be effective.<br>Stacked assistance from Federal, Provincial and Municipal entities (e.g. carbon tax refunds tied to home renovations) will encourage customers to invest in energy efficiency and conservation measures. |
| **b) Distributed Energy Resources (DERs)**<br>• What is your view on how current policies and capital costs will impact DERs (e.g., gas-fired generation, solar, wind, small-scale energy storage systems, demand-side management technologies, load aggregator technologies, micro-grids, etc.) going forward? | Contract for Difference programs for large scale GW grid generation has been proven successful in Alberta.<br>At the residential or ICI (Industrial, Commercial, Institutional) scale, rebates or low interest loans will incent investment at kW and MW small scales.<br>DSR (Distributed Storage Resources) down to the household/EV battery level will cause a sea change in how power will be reliably provided and guaranteed for all customers. |
| **c) Transportation Sector**<br>• What is your view on the potential penetration and pace of electrification of the transportation sector (e.g., passenger vehicles and light-duty trucks, commercial fleets, heavy-duty trucks, rail, other)?<br>• How effective do you expect the policy and financing programs announced in the federal 2030 emissions reduction plan will be in incenting electrification of different vehicle classes? | There will be deep and rapid penetration of batteries for electric passenger vehicles, light-duty trucks and commercial fleets. Heavy-duty trucks and rail may be fueled with green hydrogen.<br>North America will mirror what is happening in the EU where light duty cars and trucks will rely on advancing battery technologies. |
| **d) Buildings**<br>• What is your view on the potential penetration and pace of electrification of space heating/cooling and/or water heating? | There is a vast current stock of buildings that are heated with natural gas that is combusted at high efficiencies approaching 98%. The pace to convert to alternative heating with electricity such as air or ground source heat pumps will be protracted.<br>Transitional retrofitting of gas hot water and space heating may be an option in the short term. For example, gas hot water could be |

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| | • What is your view on increased adoption and energy consumption of air conditioning in the province? | switched to heating with electricity. Space heating could be supplemented with single room customer controlled electric heat. Both measures should not be disruptive within current building stock.<br><br>Electricity for air conditioning should be provided by decentralized roof top photovoltaic energy. Heat stress is caused by hot sunny weather – ergo sunny weather will yield concurrent photovoltaic electricity from abundant solar energy. |
| | **e) Industrial Sectors**<br>• Deployment of carbon capture, utilization and storage (CCUS) and hydrogen production (especially if based on electrolysis) could increase industrial load. What is your view on the expected increase in load (either served on-site or from the grid) from these industrial processes?<br>• What is your view on load growth and the impact of net-zero targets on other industries, sectors or technologies (e.g., cryptocurrency mining, data centers, petrochemical facilities, cement, steel, others)? | Electrolytic hydrogen produced with high carbon emitting grid electricity defeats the purpose of using hydrogen as a low carbon energy carrier. Rather, electrolytic hydrogen can be produced from surplus renewable energy and stored for extended periods and used to abate various carbon heavy industrial processes. |
| ***5*** | ***Generation Technologies***<br>a) What generation technologies do you perceive as being the most economic electricity supply options in Alberta? | Wind and solar generation, coupled with energy storage for reliability will be the most economic supply options. Geothermal power should be assessed and pilot projects developed, especially in Alberta which has abundant drilling expertise. |
| | b) Which generation technologies do you expect to become competitive in the long-term outlook? | Wind and solar are now competitive with gas power generation.<br><br>Technologies to store wind and solar energy are necessary to ensure that reliable power is provided continuously. |
| | c) What technologies do you expect will receive advantages or hinderances due to the implementation of government policies? | CapEx and O&M costs for wind and solar comprise known low dollar values which thereby have an advantage over unknown costs for CCUS. CCUS projects are extensive and complex and inherently costly. |

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| | | SMR projects will be hindered with large upfront costs and intense public resistance to nuclear energy technology, despite the fact that GHG emissions from nuclear generation is very low. |

**6** ***2023 LTO Future Generation Technology Costs***

The following table contains anticipated generation technologies and operational specifications pertaining to potential future generation developments. The data herein has been primarily derived from three sources:

1. The US Energy Information Administration's *Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies*[3], for nuclear and gas-fired generation
2. Pacific Northwest National Laboratory's *2022 Grid Energy Storage Cost and Performance Assessment*[4], for pumped hydro and compressed air energy storage
3. A third-party consultant report prepared for the AESO for wind generation, solar generation, and battery energy storage

Certain other technology cost and characteristics were derived from recent regional developments such as recent estimates of hydroelectric development.

In all cases, the dollar values have been escalated to represent 2022 dollars and converted to Canadian currency, where applicable. The costs represented in the table below do not include adjustments for grants, tax credits, or other incentives.

| Generation Type | Plant Capacity, MW | Capital Cost (2022), $/kW | Fixed O&M Costs, $/kW-yr | Variable O&M Costs, $/MWh | Heat Rate (HHV) or Efficiency, GJ/MWh or % |
|---|---|---|---|---|---|
| Advanced Nuclear Fission Reactor | 2,156 | 8,653 | 174.23 | 3.39 | 11.19 GJ/MWh |
| Small Modular Reactor – Nuclear Fission | 600 | 8,867 | 136.07 | 4.30 | 10.60 GJ/MWh |
| Hydroelectric | 1,100 | 14,545 | 42.77 | - | - |
| Battery Energy Storage | 50 (200MWh) | 2,104 | 57.28 | - | 83% round trip efficiency |

[3] https://www.eia.gov/analysis/studies/powerplants/capitalcost/

[4] https://www.pnnl.gov/sites/defa ult/files/media/file/ESGC%20Cost%20Performance%20Report%202022%20PNNL-33283.pdf

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| Pumped Hydro Energy Storage | 100 (1,000MWh) | 3,543 | 38.05 | - | 80% round trip efficiency |
| Compressed Air Energy Storage | 100 (1,000MW) | 1,648 | 21.76 | - | 52% round trip efficiency |
| Wind Generation | 100 | 1,563 | 107.32 | - | - |
| Solar Photovoltaic Generation | 50 | 1,687 | 27.05 | - | - |
| Combined-Cycle Natural Gas | 418 | 1,553 | 20.20 | 3.65 | 6.79 |
| Combined-Cycle Natural Gas with CCUS | 377 | 3,554 | 39.53 | 8.36 | 7.52 |
| Hydrogen-Fired Combined Cycle | 418 | 1,553 | 20.20 | 3.65 | 6.79 |
| Simple-Cycle Natural Gas – Aeroderivative | 105 | 1,683 | 23.35 | 6.73 | 9.63 |
| Simple-Cycle Natural Gas – Frame | 233 | 1,021 | 10.03 | 6.45 | 10.45 |
| Hydrogen-Fired Simple-Cycle – Aeroderivative | 105 | 1,683 | 23.35 | 6.73 | 9.63 |
| Hydrogen-Fired Simple-Cycle – Frame | 233 | 1,021 | 10.03 | 6.45 | 10.45 |

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| a) Do you believe that these are representative of the costs associated with potential future Alberta generation technologies? How do you expect the cost of these technologies to change by 2030? | The cost of carbon emissions must be included for all generation technologies in order to truly represent total cost of generation. For gas power generation, there should be acknowledgement of the cost of unabated methane leakage.<br><br>If carbon costs ratchet up to $150 / tonne CO2e by 2030 and continue to rise beyond that to 2035 when net zero goals are to be achieved, the costs to abate carbon emissions from hydrocarbon fueled power will be exorbitant. |
| b) What is your expectation of the retrofit costs to existing thermal generators to enable CCUS or hydrogen-fired generation? | Retrofit costs for thermal generation to enable zero carbon generation will be far higher than costs for wind, solar (possibly geothermal) coupled with reliable energy storage. Generation fired on electrolytic hydrogen from surplus renewable generation will likely be more cost effective that CCUS. |

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| | c) Please share any additional views on technologies and specifications that are not included within the table (please include the cost and operational characteristics applicable to the generation technology in the format of the provided table). | Specifications for binary cycle geothermal power generation should be added to the table. Information from experts in this emerging technology should be sought and published by AESO. |
| ***7*** | ***2023 LTO Materials and Data***<br>Previous Long-term Outlooks have provided a range of material and formats for general usage. This includes a detailed report, graphics and detailed appendices, stakeholder presentations and webinars, highlights providing a high-level overview of the report providing key insights, as well as a comprehensive data visualization tools with charts and data that can be downloaded[5].<br>The AESO would like to better understand how stakeholders utilize and consume the LTO information and data. Please provide any additional comments or insights around items that are valued and should continue as well as input on what else can be included, removed, enhanced, or altered for the 2023 LTO and future iterations. | Efforts by AESO to seek and publicly make available frequent and regular feedback from all stakeholders on Long-term Outlooks are commendable. |
| ***8*** | ***Other***<br>Please provide any additional information that you would like to share, which may contribute to the 2023 LTO analysis development. | Thank you for the opportunity to provide input to AESO's decision making process. |

[5] https://www.aeso.ca/grid/grid planning/forecasting/