APPENDIX
Methodology

The analysis and findings presented in this report are based on a modelled scenario constructed from publicly available data on electricity generation profiles, load profiles, and power purchase agreement (PPA) pricing.

This document provides a detailed explanation of the analysis methodology, including the key data sources, parameters, and necessary assumptions.

If you have any questions regarding our approach, please reach out to info@businessrenewables.ca.

Contents

1. Analytical Framework

Baseline Case and Procurement Scenarios

To evaluate the cost and hourly matching implications of different renewable energy procurement strategies, this analysis is anchored in a representative commercial or industrial facility whose annual electricity demand can be met by a 100 MW solar PPA. In other words, its average demand over the year matches the average generation from a 100 MW solar facility – about 22 MW or 192 GWh in total. This baseline was selected because solar is currently the lowest-cost option for an annually matched PPA in Alberta, Canada, and offers a predictable generation profile over the span of days and weeks and has a substantially higher volume of shovel-ready projects than wind energy.[1]

From this baseline, three additional procurement options were layered in for all types of facilities to assess their respective contributions to hourly matching performance and overall buyer cost:

- A 50 MW wind PPA was added to the solar baseline to provide generation, which complements the solar well. For example, wind is available during overnight hours and in the winter, where solar output is unavailable or substantially reduced. Wind, as the second lowest-cost option, extends clean energy coverage into periods when the solar facility is not operating. This option allowed the facility to reach around 85% hourly matching for a year.
- A combination of battery storage and demand response was then assessed to achieve nearly 100% hourly matching. The battery was modelled as a four-hour duration facility with various scenarios for size, and demand response assumed to load shift within the same day at a maximum of 5 MW.
- Other permutations were also tested to understand the trend of cost impacts as facilities may meet other proportions of hourly matching. For example, a smaller 10 MW wind PPA with and without a 50 MW battery storage facility attached to achieve ~55 and 80% hourly matching.

Sizing Rationale for Storage

The battery storage component was sized to achieve at least 95% hourly matching. Small fluctuations in generation and load data across facilities and over time can substantially increase the energy capacity required to meet residual demand, resulting in inflated cost outcomes that may not reflect typical market conditions. Instead, demand response was expected to meet energy needs for facilities during these fluctuations.

To estimate the cost effects of perfect 100% matching, we analyzed cost trends from just annual matching through various permutations of wind and storage PPAs added relative to the percentage of hours for which the load is satisfied by clean energy.

[1] Business Renewables Centre, *Renewables in Review 2025* (2026), 9-10. https://businessrenewables.ca/resource/brc-canada-renewables-review-2025

Cost Calculation

The total calculated cost of the PPA for buyers incorporates two additional factors beyond the contracted PPA price:

- The cost of residual emissions covered by Alberta's industrial carbon pricing system is set at a credit price of $30/t$CO_2$e, which is approximately the value of offsets and emissions performance credits in 2025 and 2026.
- Revenue earned from generating carbon credits for electricity generation more than hourly load needs — that is, when clean energy generation exceeds the facility's consumption during a given hour.
- Although the Federal-Alberta energy MOU may increase the floor price of credits, it is not certain at the time of writing how proposed changes will affect the credit market in the long run. For example, there is a chance that oversupply will persist, with only some credits purchased while others remain in the market. While credit prices initially rose to $40/t$CO_2$e following the MOU Implementation Agreement, at the time of publication prices are again near $30/t$CO_2$e.[2]

2. Key Data and Assumptions

PPA Pricing

PPA cost estimates for solar and wind were sourced from publicly available data across Alberta, Canada, and North America. Battery storage costs were derived from published cost data, including data from European markets. The figures below represent the buyer-side cost of each technology under current market conditions and serve as the basis for all cost modelling in this report. While these prices are anchored in current vPPA pricing trends, the analysis focuses on the relative change in total cost to the buyer rather than on a specific dollar increase in spend. This is intentional and reflects fluctuations in power and PPA pricing over time.

Table 1: Buyer-Side Cost of Solar, Wind, and Battery PPAs

Technology	Cost of PPA ($/MWh)
Solar	$75
Wind	$80
Battery storage (incremental adder)	+$26

[2] Access from ICE NGX, "Introducing Alberta TIER Futures on ICE NGX." https://www.ice.com/events/webinar/introducing-alberta-tier-futures-on-ice-ngx

Electricity Load Profiles

Hourly electricity load profiles are a central input to this analysis because hourly matching cannot be assessed without detailed, time-resolved data on when facilities consume electricity. Load profiles were drawn from two published academic datasets:

- Bellinguer et al. (2023) provided representative hourly load data for 18 sectors over one calendar year. The dataset was compiled from real-world consumption data shared by the French Distribution System Operator, covering 55,730 facilities across 424 sub-sectors. Machine learning methods were used to cluster these sub-sectors into 19 sectors with similar load profiles. This dataset was selected because it is among the first to provide commercial and industrial electricity loads at high temporal and sectoral resolution.
- Valdes and Ramirez Camargo (2021) provided synthetic hourly demand profiles for food and paper industrial facilities, based on two years of data collected in Chile.

Generation Profiles

Generation profiles were based on actual performance data from 2024,[3] drawn from the existing fleet of wind and solar projects operating in Alberta. This grounds the modelled output in real-world conditions specific to the province, including its resource variability and seasonal patterns. The generation profile of wind and solar facilities will differ in other regions in Canada, such as Ontario, and between years.

3. Sector Coverage

This methodology was applied across 19 industry sectors, with midstream and downstream oil and gas activities — such as compression, upgrading, and refining — excluded from the analysis. The sectors covered are:

- Manufacturing (including chemicals, but not oil and gas)
- Large paper manufacturing
- Small paper manufacturing
- Trades (non-food)
- Trades (food)
- Education
- Offices
- Crop farming and transportation
- Livestock farming

[3] Alberta Electric System Operator, 2024 Historical Generation Data, https://www.aeso.ca/market/market-and-system-reporting/data-requests/historical-generation-data/

- Water supply and telecommunications (including oil and gas extraction, but not upgrading)
- Food processing
- Restaurants
- Food industry
- Energy supply and rental activities (electricity generation and general real estate)
- Hotels
- Bakeries
- Property management
- Hospital activities
- Construction

This breadth of sector coverage reflects the diversity of commercial and industrial electricity users across Alberta's economy. Each sector has a distinct hourly load profile, so the cost and matching implications of a given PPA structure can vary significantly by facility type. However, the lack of oil and gas facilities and of data centres are important omission to highlight, given the concentration of O&G activities in Alberta and emerging interest in developing data centres.

4. Limitations

As with any modelling exercise of this nature, a number of limitations apply. These should be considered when interpreting the findings and cost estimates presented in this report.

Load Profile Representativeness

The electricity load datasets used in this analysis are approximations derived from non-Alberta sources and may not fully reflect the demand patterns of facilities operating in this province. Notable differences may exist — for example, Alberta facilities may exhibit lower summer air-conditioning demand relative to the French dataset on which the Bellinguer et al. profiles are based, and higher winter demand due to space heating. Users of this analysis should interpret sector-level results with this geographic mismatch in mind.

Oil Sands and Heavy Industrial Facilities

The load datasets exclude midstream and downstream oil and gas facilities, such as upgraders and refineries. While oil extraction is represented, some of Alberta's oil sands in-situ facilities may have substantially higher electricity loads and materially different consumption profiles than those captured in the modelled sectors. Additionally, many of these facilities comply with emissions accounting regulations set by Alberta's industrial carbon pricing system rather than the GHG Protocol's guidance. Further analysis is required to determine the magnitude of the impact on this sector.

PPA Pricing and Market Evolution

Actual PPA costs may have shifted since the data underlying this analysis was compiled, particularly given ongoing changes to Alberta's electricity market structure. However, the direction and magnitude of cost changes associated with moving from annual to hourly matching — and with adding wind and storage to a solar-only position — are expected to remain directionally consistent under Alberta's evolving market design. The analysis is intended to illustrate relative cost impacts rather than serve as a precise pricing reference.

Data Sources

1 Solar and wind PPA cost data from:
BRC-Canada and Marathon Capital webinar for participants (2023) https://businessrenewables.ca/resource/webinar-key-drivers-canadian-renewable-energy-market-ppas,
Canadian Renewable Energy Association and Dunsky Energy + Climate, *Market Outlook 2025* (2025), 5. https://renewablesassociation.ca/wp-content/uploads/2025/09/CanadianREmarketoutlook2025-ExecutiveSummary.pdf, and
LevelTen's 2025 Q3 Price Index (2025), https://www.leveltenenergy.com/post/levelten-energy-north-america-ppa-price-index-q3-2025.

2 Battery storage costs aggregated from:
Mark Bolinger et al., Hybrid Power Plants; Status of Operating and Proposed Plants (Lawrence Berkeley National Laboratory, 2023), https://escholarship.org/content/qt65f1013r/qt65f1013r.pdf,
EPRI Quick Insights: Declining PPA Prices for Renewables Plus Storage Plants (2019), https://restservice.epri.com/publicdownload/000000003002014791/0/Product, an
Luca Pedretti LinkedIn post (Pexapark data from Europe), https://www.linkedin.com/posts/luca-pedretti-746ba218_ppa-activity-7318698217762611200-JoYi/.

3 Kevin Bellinguer et al., "ELMAS: a one-year dataset of hourly electrical load profiles from 424 French industrial and tertiary sectors," Scientific Data 10 (2023). https://doi.org/10.1038/s41597-023-02542-z

4 Javier Valdes and Luis Ramirez Camargo, "Synthetic hourly electricity load data for the paper and food industries," Data in Brief 35 (2021). https://doi.org/10.1016/j.dib.2021.106903