

Outlook for Alberta's Electricity Market Focusing on PPAs



June 16, 2020



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BRC Webinar Series

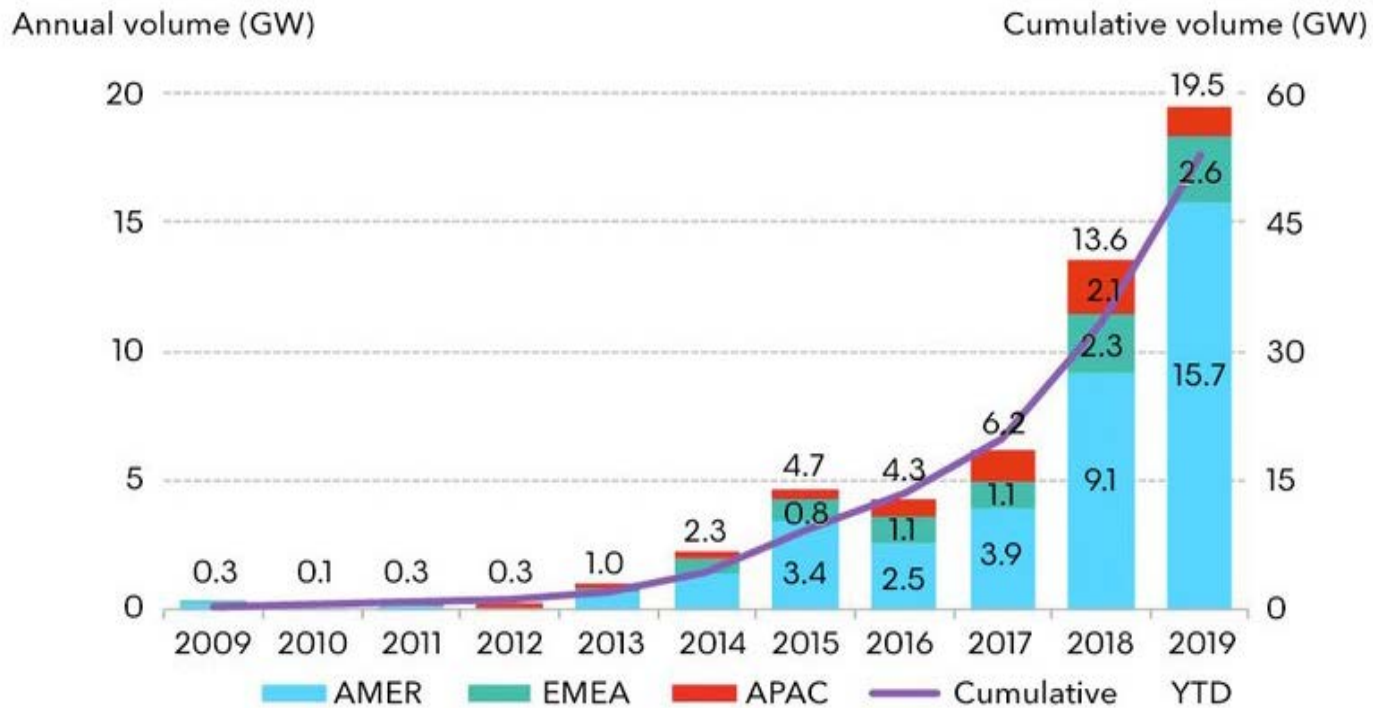
Topics

1. Corporate PPAs and Potential in Canada
2. Alberta Electricity Market Demand and Supply Outlook
3. Alberta Wholesale Energy Price Forecast and Main Drivers
4. Considerations for Prospective Suppliers and Buyers of Corporate PPAs
5. Future Key Canadian Markets for Corporate PPAs

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1. Corporate PPAs and Potential in Canada

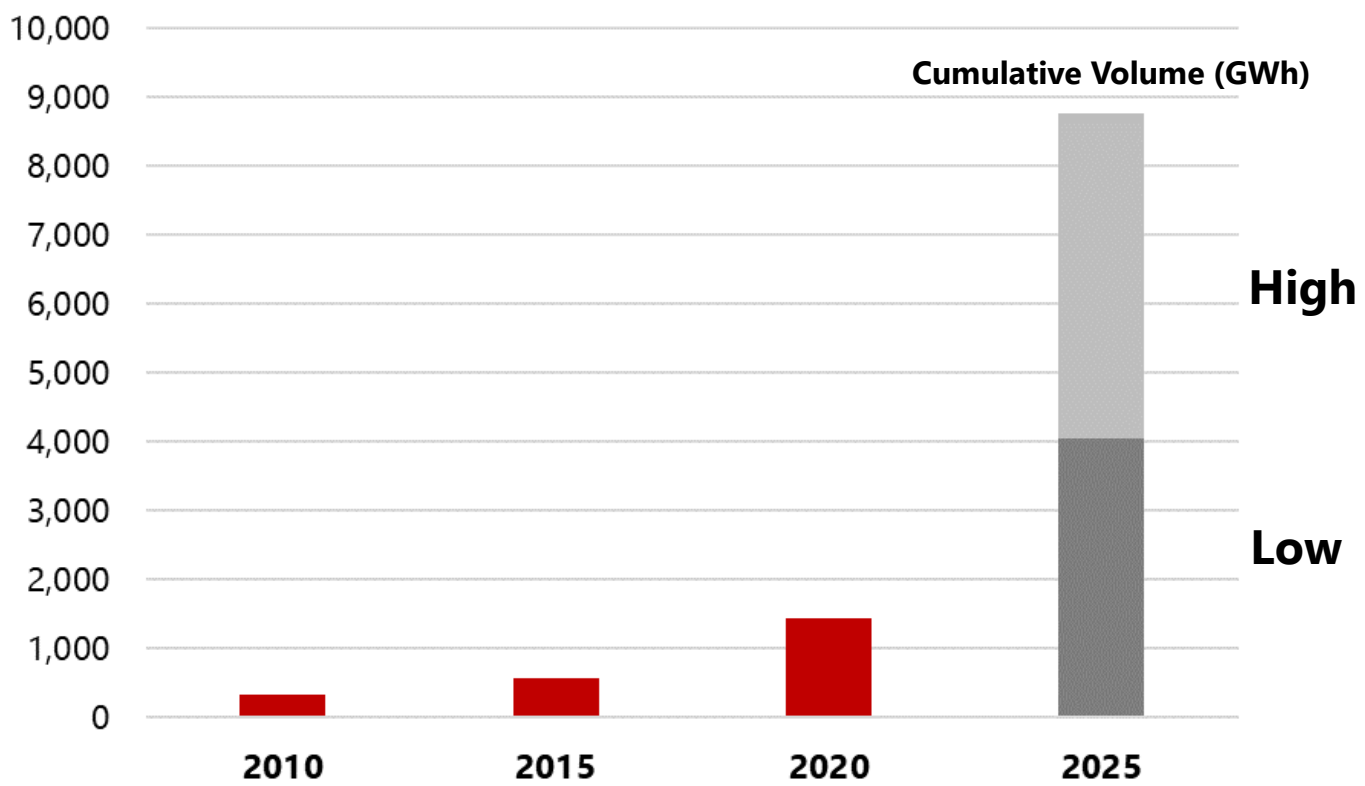
Corporate PPAs - Globally



Source: BloombergNEF. Note: Data are through 2019, reported in MW DC capacity. Onsite PPAs are not included. Australia sleeved PPAs are not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. These figures are subject to change and may be updated as more information is made available.

- Corporate PPAs increasing exponentially due to: rising fixed electricity costs; technological advances and declining production costs; specific buyer goals and objectives (e.g., RE-100, ESG, etc.)

Potential for Corporate PPAs – Canada



- From forthcoming Power Advisory report for Natural Resources Canada (NRCAN), corporate PPAs have potential near-term exponential growth in Canada – led by Alberta



2. Alberta Electricity Market Demand and Supply Outlook

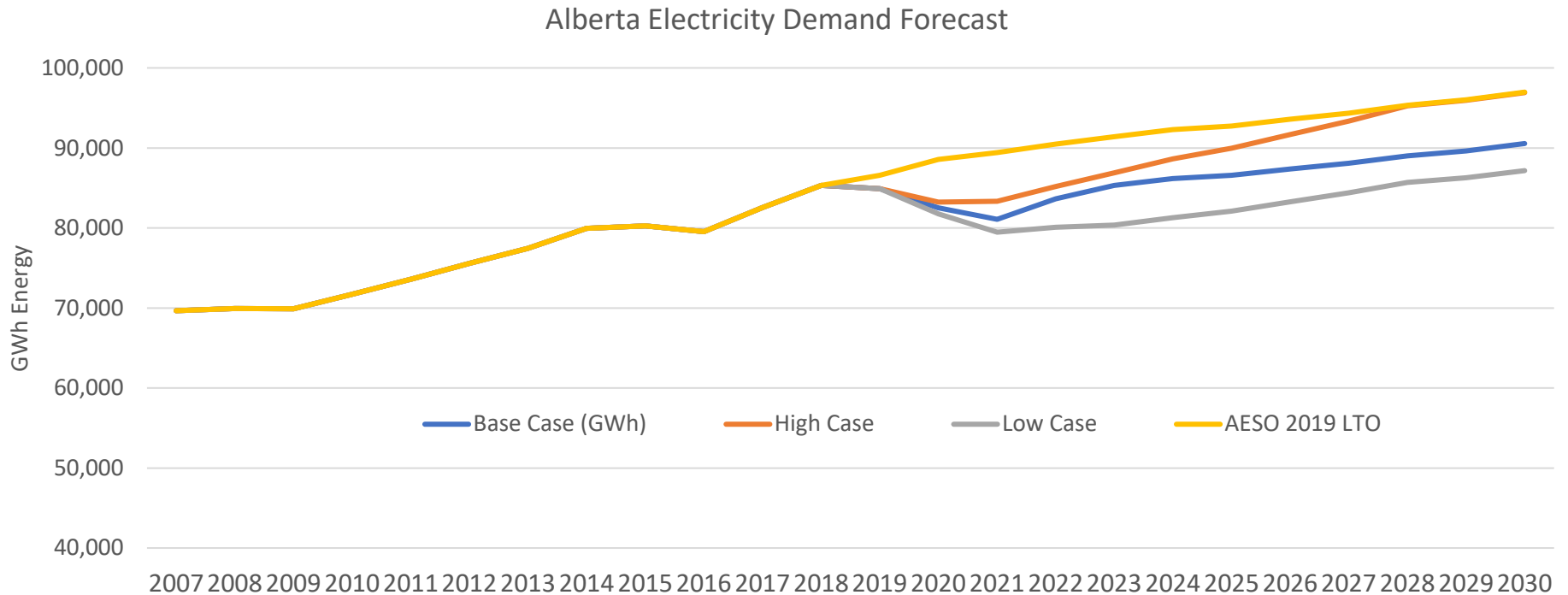
Key Drivers – Future Alberta Electricity Market and Outlook for Renewable Generation with Implication for Corporate PPAs

- Demand growth – was 2018 peak or future growth?
 - Impacts of COVID-19, lower oil prices?
- Carbon policy – \$50/tonne carbon tax (2022), post 2022 carbon prices?
 - Carbon prices and policies impact on renewables?
- Coal-to-gas generation conversions
 - Carbon price drivers now, but future impacts of demand growth and supply competition?
- Generation development projects
 - ~800 MW under construction, which other projects will and will not proceed?
- Technological changes
 - Wind, solar, storage cost declines projected to continue

COVID-19 and Oil Price Impacts on Alberta Electricity Demand

- Near-term economic downturn, reduced oil production
 - ~8% to 12% Alberta GDP reduction
 - Oil production decline ~20% to 25%
- AESO demand forecast
 - ~650 MW to 900 MW demand reduction due to economic downturn, reduced oil production
- Therefore, COVID-19 impacts on Alberta economy and electricity market likely reduces peak winter demand (2020/21) ~650 MW to 900 MW or ~4,500 GWh to 6,500 GWh (assuming 83% load factor)
 - Demand could be lower if economic downturn and oil production are worse than forecast

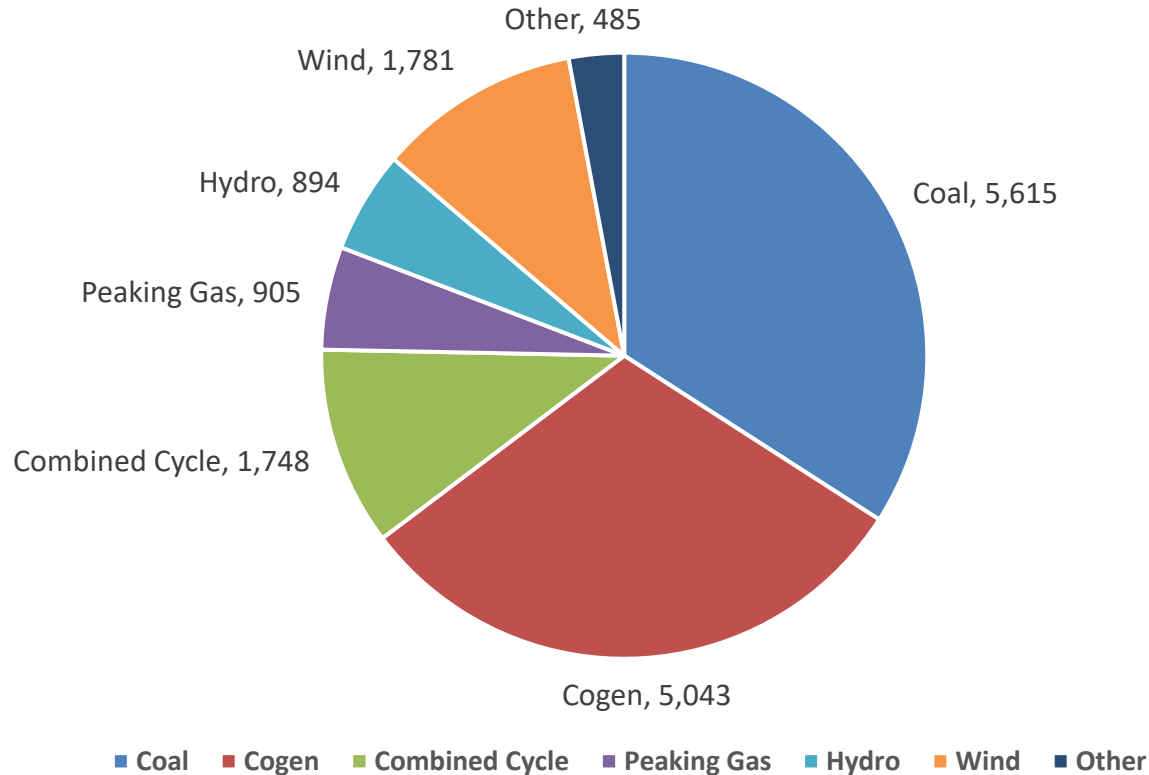
Alberta Electricity Demand Forecasts



- Negative demand growth forecast (2020)
- 10,000 GWh potential demand range (2030)
- Key impacts of higher/lower demand growth
 - Coal-to-gas conversions vs retirements
 - Energy price sensitivity due to generation additions

Alberta Electricity Generation Supply Mix

Alberta Installed Generation Capacity



- 16,532 MW – total installed generation capacity (2019)
 - Roughly 800 MW coal-fired generation mothballed
 - Another 831 MW under construction, majority in-service in 2020

Changes to Alberta Electricity Generation Supply Mix – Post 2020

- 372 MW gas-fired generation under construction
 - 202 MW 'peaking' gas-fired generation
 - Remainder cogeneration
- 249 MW solar generation under construction
- 10 MW energy storage under construction
- 200 MW wind generation under construction

Key Coal-to-Gas Conversions – Implications for Future Supply

- Maxim HR Milner coal-fired generation retired Q2/20, replaced with 208 MW 'peaking' gas-fired generation
- TransAlta/Heartland Sheerness #1, #2 and Capital Power Genesee #1, #2, #3
 - Dual fuel capability (2021), mostly natural gas fueled (based on carbon prices)
- TransAlta conversion of Sundance 6 currently underway
 - Sundance 3 and 4 only converted with supporting market conditions
 - Keephills 1 planned to re-power (post 2024)

Increasing Alberta Wind Generation Supply

Developer	Project	REP Round	Capacity
EDP Renewables	Sharp Hills	1	248
Enel	Riverview	1	115
Enel	Castle Rock Phase 2	1	31
Capital Power	Whitla	1	202
EDF	Cypress	2	202
Potentia	Stirling	2	113
Capstone	Buffalo Atlee 1	2	17
Capstone	Buffalo Atlee 2	2	14
Capstone	Buffalo Atlee 3	2	17
TransAlta	Windrise	3	207
Potentia	Jenner	3	122
Potentia	Jenner 2	3	71
Total			1,359

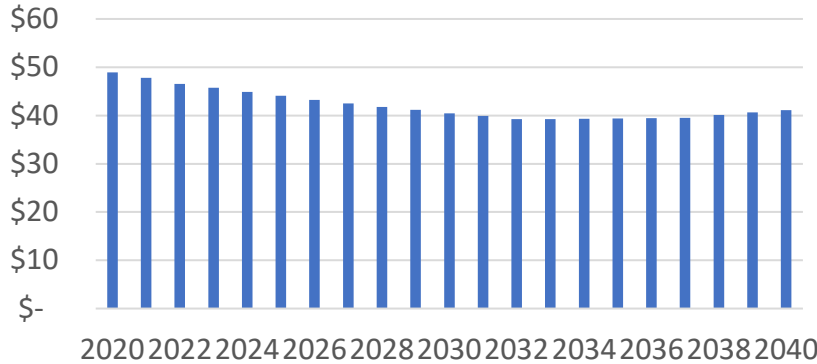
- 3 projects (AESO REP) in-service
 - Riverview – 115 MW
 - Castle Rock Phase 2 – 31 MW
 - Whitla – 202 MW
- Remainder in-service 2021-2022
- Alberta government cancelled REP contracting (2019)

Projected Changes to Alberta Generation Supply Mix

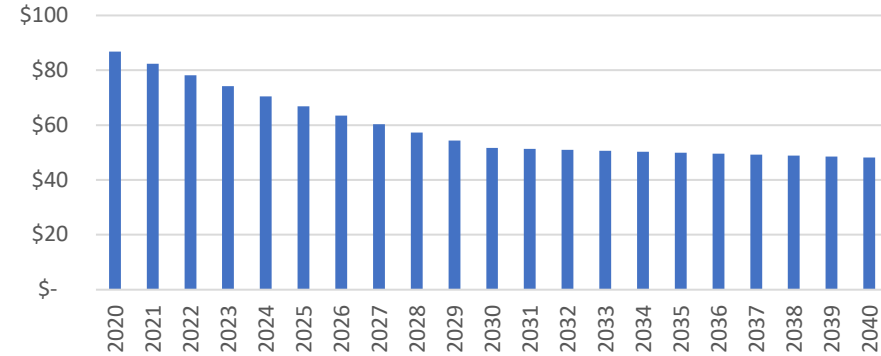
- Alberta continues predominantly as 'merchant' market, but some government contracting will occur
- Merchant generation projects will be developed based on wholesale electricity market revenues and contracts with non-government buyers (e.g., corporate PPAs)
- Key Power Advisory forecast supply mix changes (2030)
 - ~4,100 MW wind generation
 - ~1,000 MW solar generation
 - ~13,000 MW gas-fired generation (including dual fuel)
 - ~165 MW energy storage
- Wind, solar, gas-fired generation, and storage project developments driven by low costs

Levelized Cost Forecasts for Key Alberta Supply Resources

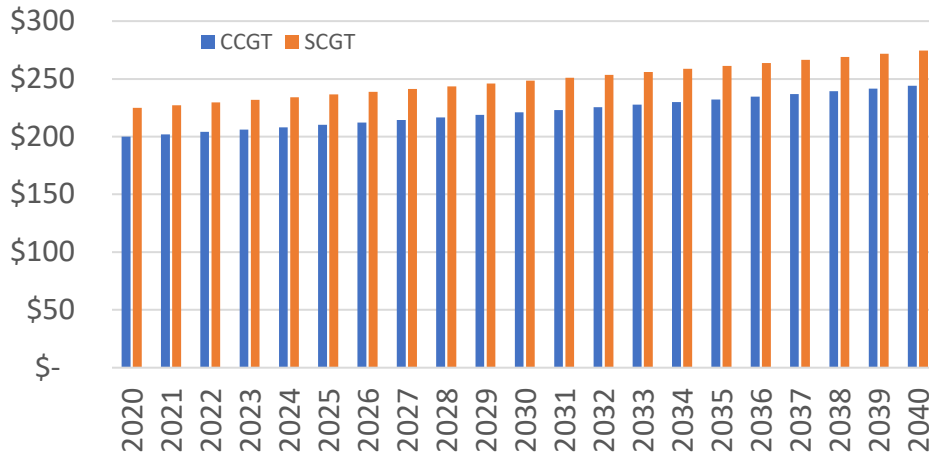
Wind Generation (\$/MWh)



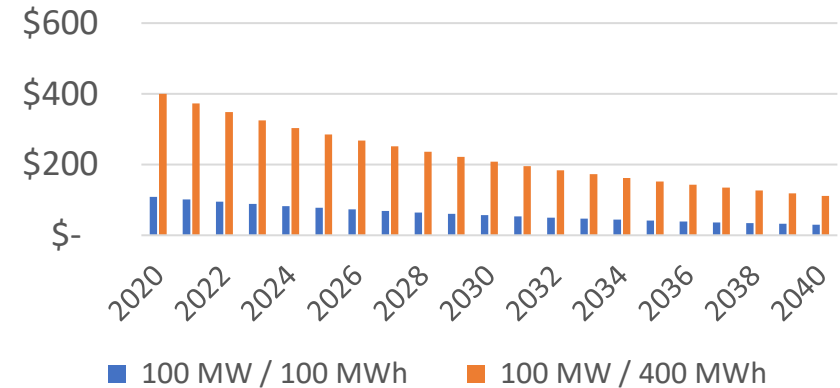
Solar Generation (\$/MWh)



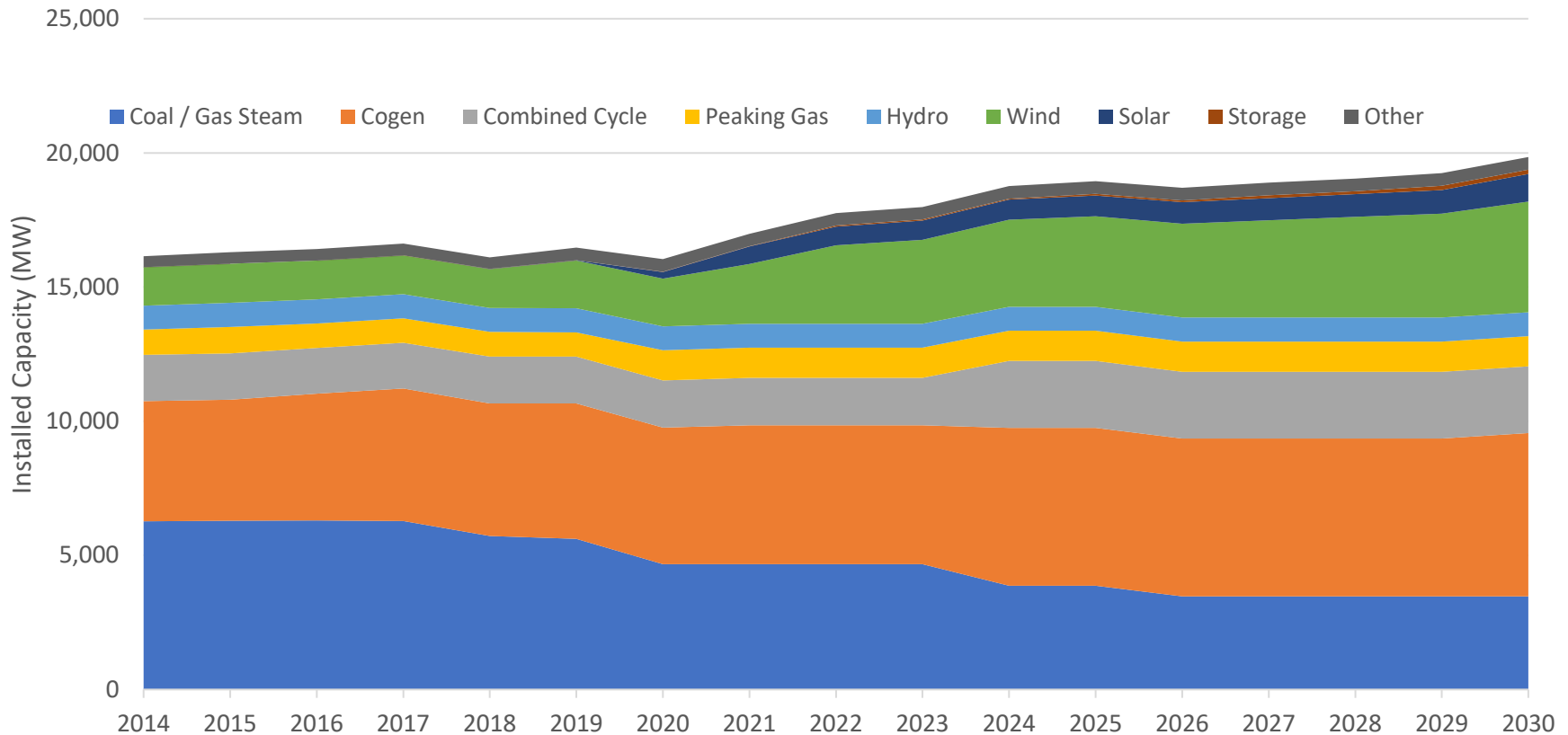
Gas-Fired Generation (\$/kW-year)



Storage (\$/kW-year)

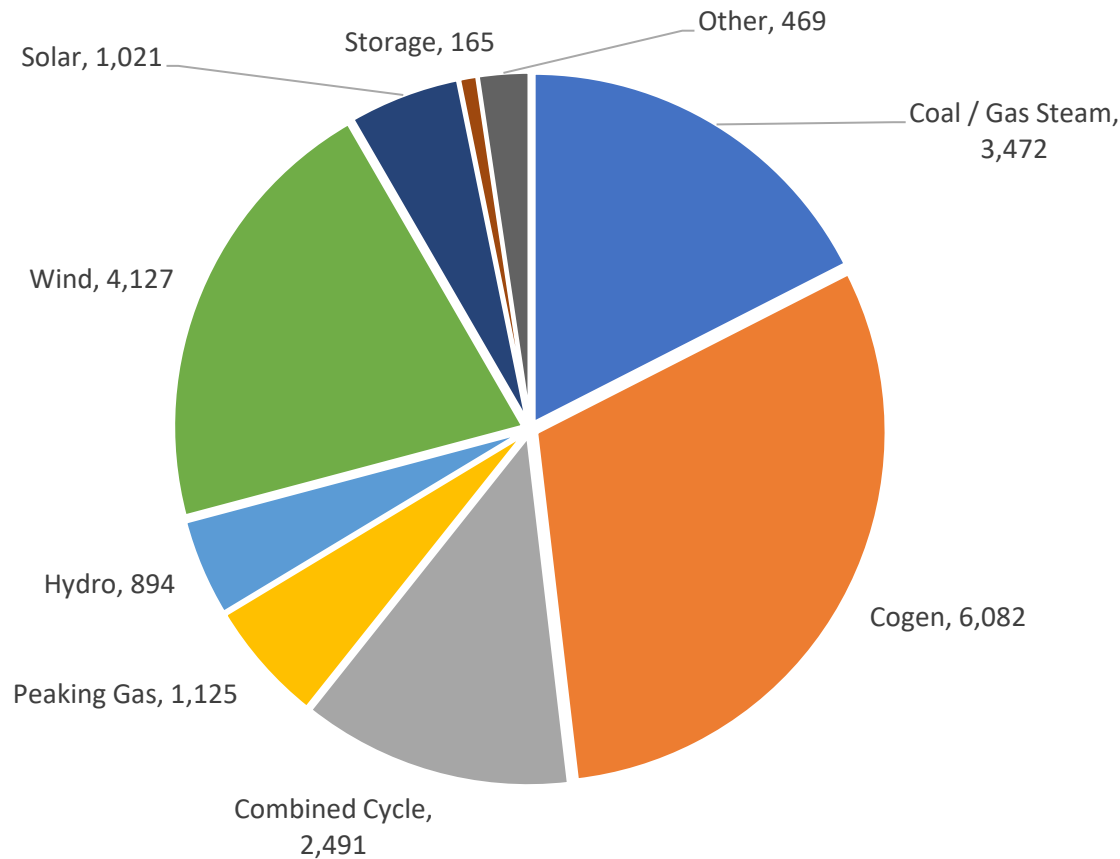


Alberta Electricity Generation Supply Mix Forecast



- Renewable generation > 5,000 MW (2030), wind generation accounting for majority

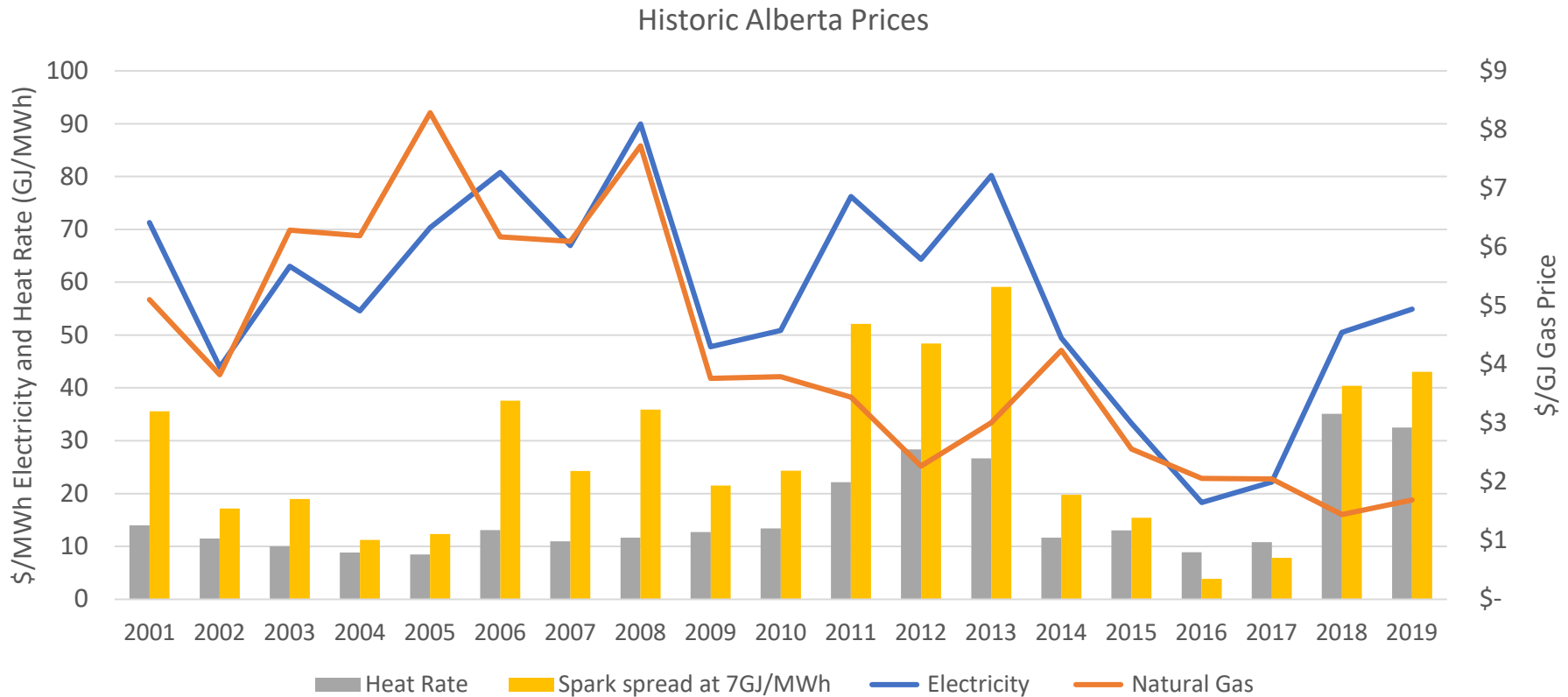
Alberta Electricity Generation Supply Mix Forecast



- ~20,000 MW (2030) generation supply capacity
 - Wind and solar generation ~5,150 MW
 - 2019-2030 new wind (~2300 MW), solar (1,000 MW) generation
 - 2030 all coal-fired generation retired

3. Alberta Wholesale Energy Price Forecast and Main Drivers

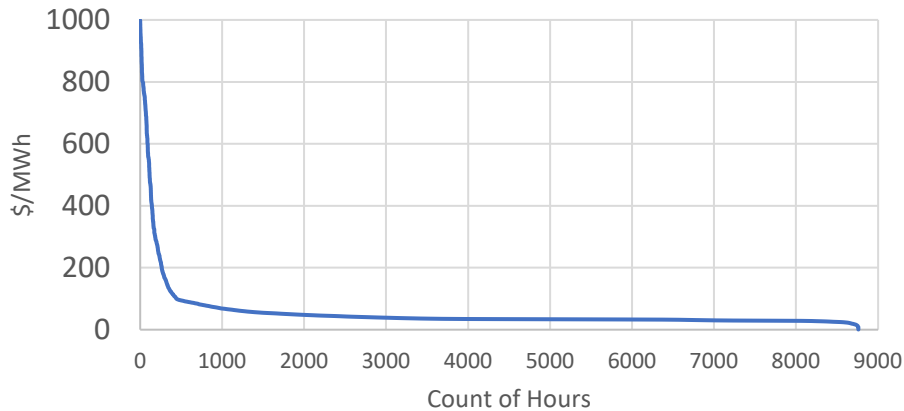
Alberta Prices – History and Fundamentals



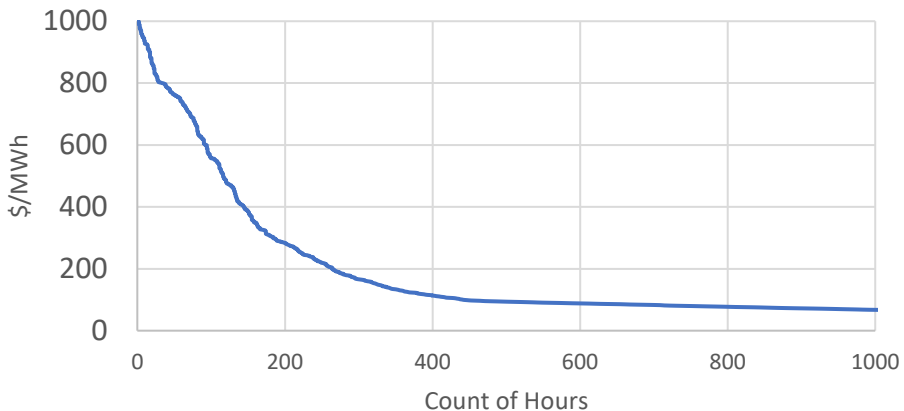
- ~\$57/MWh average wholesale electricity price (2001-2019)
- Natural gas prices trended downward last 12 years, electricity prices more cyclical

Alberta Wholesale Electricity Price Fundamentals

2019 Price Duration Curve
(All Hours)



2019 Price Duration Curve
(< 1,000 MW Supply Cushion)



- Prices driven by scarcity events
 - 2019, >\$100/MWh ~400 hours
 - Average price \$54.88/MWh (2019)
 - Excluding hours >\$100/MWh, average price \$39/MWh (2019)

- AESO price cap \$1,000/MWh
 - Prices increase <1,000 MW 'supply cushion'
 - Generator offer behaviour varies with market conditions

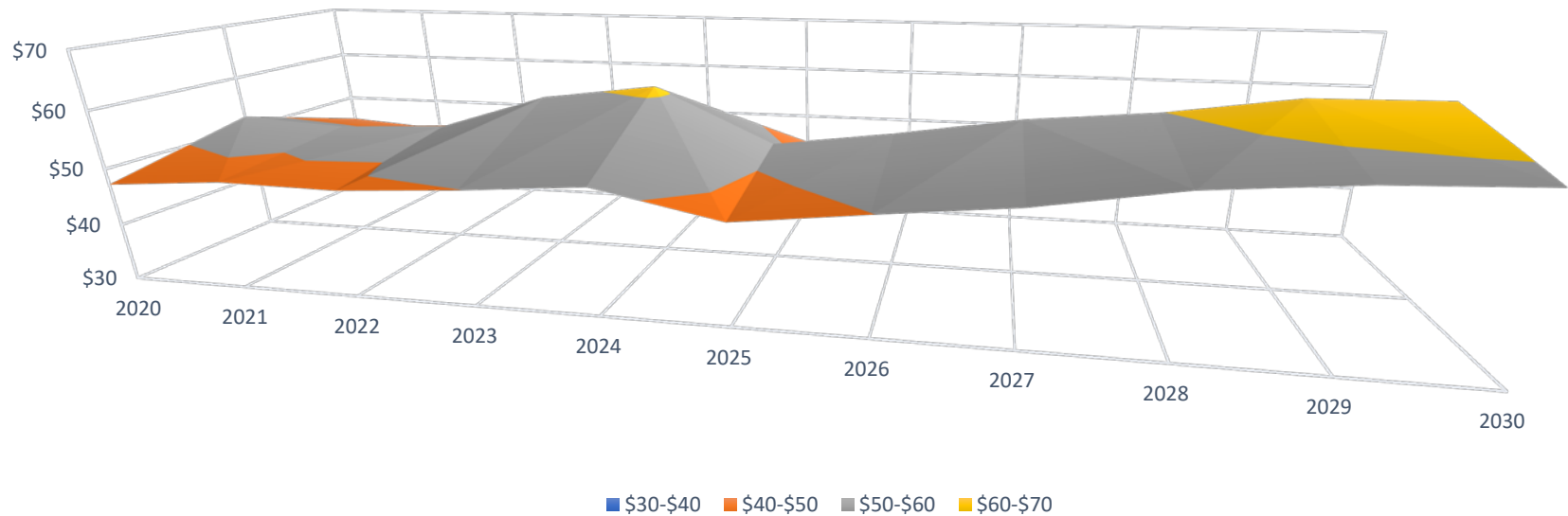
- Prices strongly influenced by hours with 'tight' market conditions
 - Prices 80%+ hours strongly tied to generator short-run marginal cost

Alberta Carbon Tax and Prices

- Provincial carbon policy – TIER (Technology Innovation and Emissions Reduction)
 - TIER sets 'best gas' standard against applicable generators measured
 - Standard currently 0.37 tonne/MWh
 - Emissions taxed (or credited) to extent intensity differs from standard
- e.g., simple-cycle gas turbine generator with 0.5 tonne/MWh emissions rate
 - Carbon tax paid based on $(0.5 - 0.37) * \text{carbon price}$
 - $0.13 * \$30/\text{tonne} = \$3.90/\text{MWh}$ (2020)
- Renewable generation receives credit on same basis
 - e.g., $0.37 \text{ tonne/MWh} * \text{carbon price}$, since no direct emissions
- Carbon tax escalation starting in 2030, Power Advisory assumption (\$50/tonne in 2022) same as Canadian government regulation
- Carbon prices key impact on generation dispatch merit order in Alberta wholesale electricity market, therefore impacting prices

Alberta Wholesale Electricity Price Forecasts

Alberta Wholesale Price Forecast – Forecast Scenario Outcomes

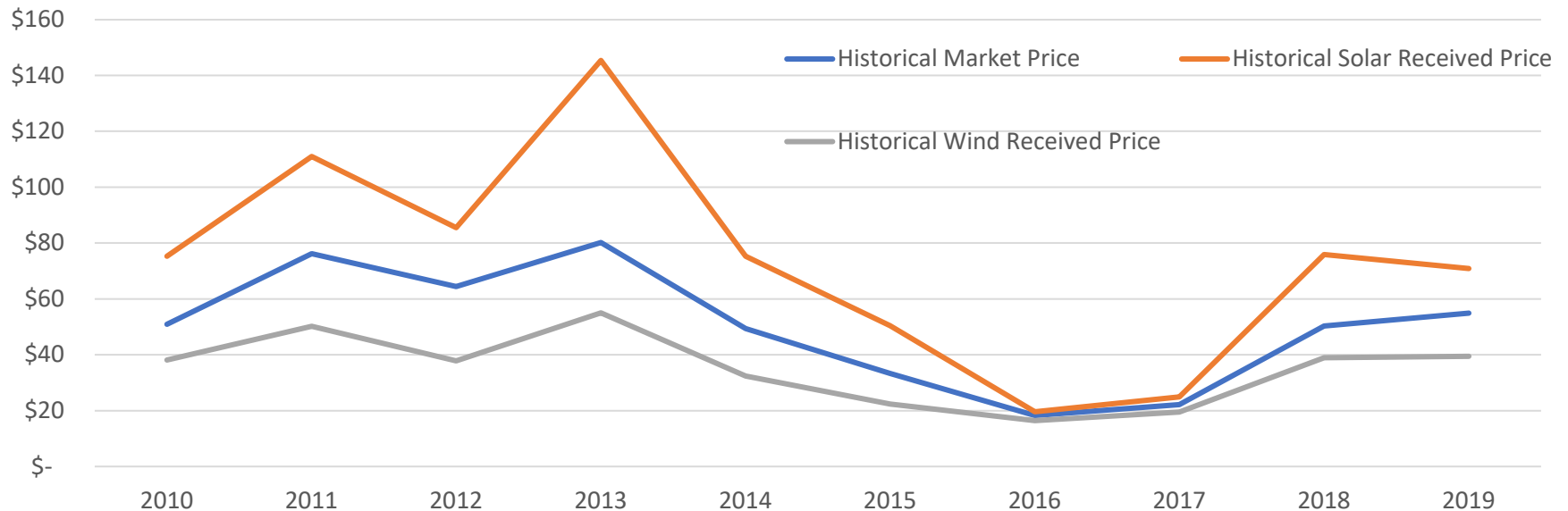


- Forecast price range function of different supply mix scenarios, etc. driven by multiple scenarios (demand growth, supply additions, generation retirements, etc.)
- Near-term, prices forecast in \$40/MWh-\$50/MWh (multiple scenarios), prices in late 2020s forecast \$60/MWh+

4. Considerations for Prospective Suppliers and Buyers of Corporate PPAs

Corporate PPA Price Hedge on Renewable Energy Output and Wholesale Electricity Price

Renewable Energy Output Received Prices (2010-2019)

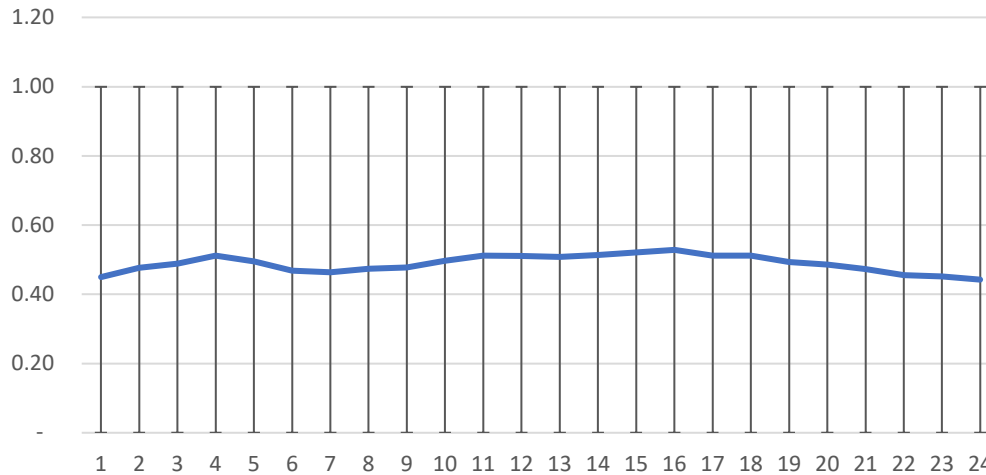


- Wind and solar energy output historically correlated with wholesale electricity prices
 - Cost of attributes difference between PPA price and realized price for energy output

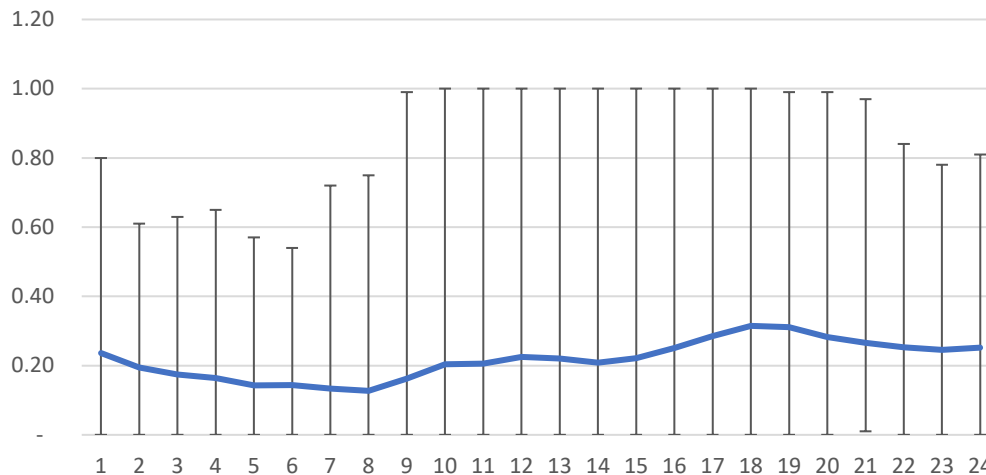
- e.g., Corporate PPA (2010)
 - \$73/MWh solar PPA would have resulted in 'break even' position on contract-for-differences (CfD) for 10-year period (implies \$0/tonne carbon value)
 - Similarly for \$35/MWh wind PPA

Corporate PPA Price Hedge on Renewable Energy Output

Average and Range of Wind Energy Winter Output



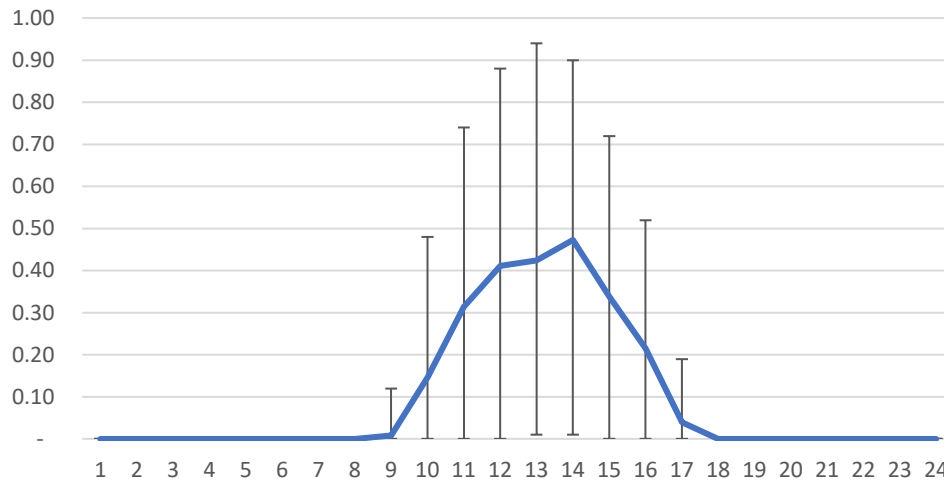
Average and Range of Wind Energy Summer Output



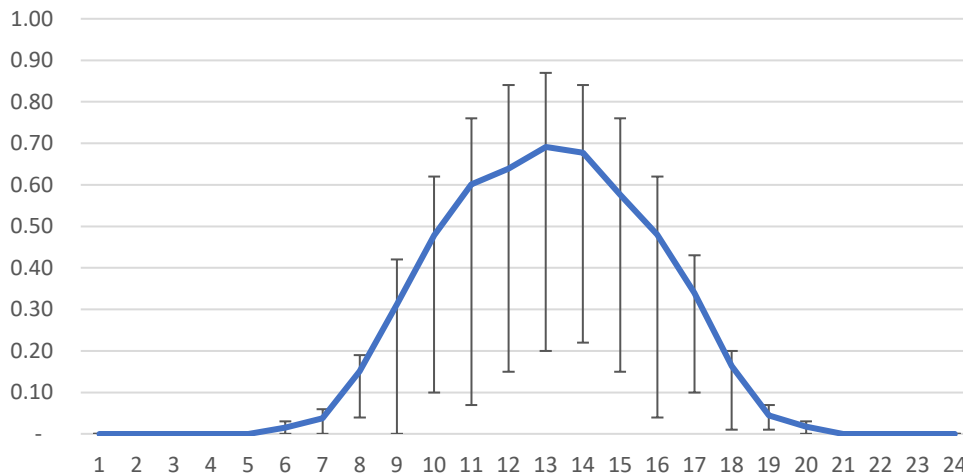
- On average, wind energy output higher in winter by roughly double summer
- Hourly wind energy output from single historical year per grid location can range from ~0 to full output through course of any given month
- Therefore, wind energy output variability results in large swings in how correlated received prices for wind energy output are to actual wholesale electricity prices

Corporate PPA Price Hedge on Renewable Energy Output

Average and Range of Solar Energy Winter Output



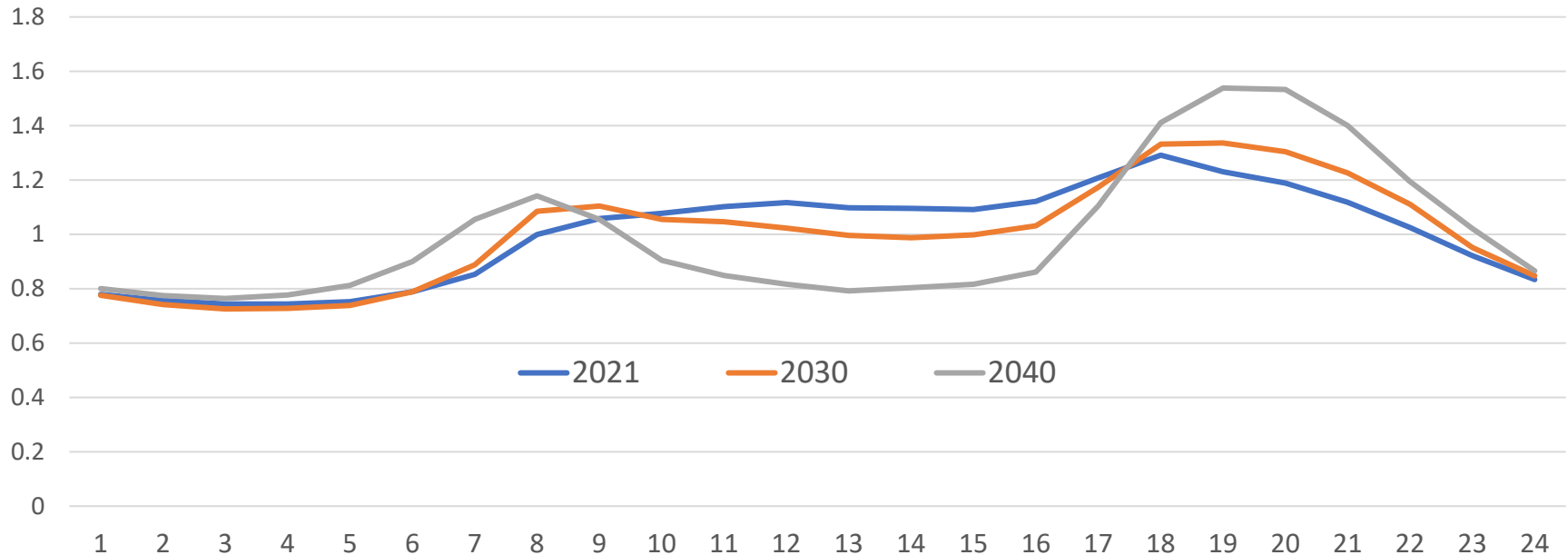
Average and Range of Solar Energy Summer Output



- Solar energy output over twice in summer compared to winter
- Very low capacity factors on some winter days
- Solar energy output currently strongly correlated with on-peak wholesale electricity market prices
 - However, little to no solar energy output in Alberta
- Correlations may change in future, as more solar generation develops and when storage develops

Corporate PPA Price Hedge on Renewable Energy Output

Forecast Hourly Wholesale Electricity Price Shapes



- Hourly wholesale electricity price shape forecast to evolve over time driven by changing supply mix
 - Hourly price shape and volatility will impact realized wholesale prices for renewable energy
 - Key impact – as solar generation uptake increases, price peaks move away from daytime hours
 - Impact realized in California, daytime prices much lower than early morning and evening prices
 - Storage flattens effects to some degree

Potential Changes to Alberta Carbon Policies

- Renewable generation also have option to create offsets rather than performance credits
 - 0.53 tonne/MWh offset can be guaranteed for 8 years based on the current offset value
 - Performance credits measured against 0.37 tonne/MWh allowance so new renewable generation projects have incentives to opt into offset protocol
 - All renewable generation projects (rather than just new) can opt into performance credit protocol and sell credits to covered entities in Alberta
- Buyers without a carbon obligations in Alberta may benefit from reduction in their Output Based Obligation (OBA) because this results in higher received prices for renewable generation
 - In effect, carbon prices become embedded in wholesale electricity prices
 - Key question – how long will renewable create offsets be used as one measure of corporate sustainability goals?
- Buyers with a carbon obligations in Alberta likely prefer higher OBA because it provides more options for compliance
 - e.g., older renewable generation projects and cogeneration create credits

Renewable Generation Energy Output Curtailment Risk in Corporate PPAs

- Curtailment risk in Alberta arises from three reasons
 - Transmission congestion
 - Supply surplus (i.e. as indicated by \$0/MWh wholesale electricity prices)
 - Operational limits (e.g., generation ramp rate limitations)
- Transmission congestion risk site specific, but in some locations correlated with low wholesale electricity market prices (to extent congestion caused by high energy output from group of projects)
- Supply surplus risk can result with low demand (e.g., COVID-19 related) and high hydroelectric energy output conditions (typical during spring)
 - Under corporate PPAs this curtailment may benefit buyers
 - Lost credits primary cost
- Operational limits occur when wind generation ramps up at high rates and AESO uses curtailment rules for short periods of time
 - Relationship to wholesale electricity market prices unlikely to be consistent, but potentially somewhat correlated with low market

5. Future Key Canadian Markets for Corporate PPAs

Corporate PPA Outlook and Potential Across Canada

- Alberta will continue to be prime market for corporate PPAs – due to market structure and design
- In general other markets in Canada have much more limited opportunity at present
 - Presence of vertically-integrated utilities typically in hydroelectric generation rich provinces
 - Lack of open and transparent wholesale electricity market with customers being exposed to 'true' prices/rates that can be hedged
 - Lack of net metering and settlement framework
- However, Nova Scotia and Ontario are potential growth markets for corporate PPAs
 - Nova Scotia government modifying *Electricity Act* enabling more development of renewable generation, creating Green Choice Program
 - Resulting from COVID-19 related issues, Ontario government made recent changes to default electricity prices and deferral of key charges (e.g., Global Adjustment (GA)) – opening potential to reform prices and rates for electricity customers
 - Reform to GA has potential to 'unlock' customer hedges through corporate PPAs, and enable 'merchant' renewable generation investments



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