

Alberta Renewable Generation Investment Drivers



January 2021



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Content & Contacts

- AESO retained Power Advisory to review the key drivers of renewable energy investment in Alberta, namely revenue sources and costs. The goal of this effort was to provide a sense of the magnitude of potential investment over the next 20 years. Another topic of interest was to understand the key offtaker groups, namely large emitters wanting to offset carbon costs, the voluntary corporate PPA market and government entities.



December 2020

Kris Aksomitis, Director
Power Advisory LLC

kaksomitis@poweradvisoryllc.com

(587) 894-7150

www.poweradvisoryllc.com

Executive Summary – Key Assumptions

Power Advisory has developed a range of forecasts for the size of the potential PPA offtake market for renewable generation based on several key assumptions.

- Alberta carbon policy (TIER) will continue to allow offsets and credits for large industrial users to use in lieu of paying the carbon levy.
- The carbon policy will continue to treat all generation in the electricity market equivalently, i.e., all generators will be measured against the same carbon emission baseline intensity.
- Carbon prices will generally continue to rise to at least \$50/tonne over the next 20 years, with potential upside to \$170/tonne.
- Transmission policy will not be a barrier to continued renewable investment and congestion/congestion risk will not form a cap on new renewable investment.
- Renewable generation will continue to become relatively more competitive compared to new thermal generation. The report does not take a specific view on future renewable cost reductions but is based on the premise that renewable generation will continue to improve its competitive position in the market.

Executive Summary – Key Conclusions

Based on the analysis and results presented in this report Power Advisory a number of conclusions about the PPA offtake market are highlighted as particularly relevant in assessing future market trends.

- A key driver of the PPA offtake market is the economic attractiveness of renewable investment, i.e. the expected revenues exceed PPA contract price.
- The relative attractiveness of the market for different types of buyers is a function of carbon policy and the relative value of energy and renewable attributes.
 - Higher attribute value favours Alberta based load with carbon compliance obligations such as the oil and gas sector (large emitters).
 - Higher energy prices (via carbon tax passed into the electricity market) favour the voluntary market such as Alberta commercial load and Canadian corporate buyers seeking to meet sustainability objectives.
- Three types of buyers (government, large emitters and voluntary corporate buyers) are expected to be active in the Alberta market.
- All three types of buyers are also expected to potentially be active in building their own renewable capacity. This report does not differentiate between third party PPAs and a self-build renewable project. Self-build generation may or may not be onsite, and ranges in scale from small rooftop for commercial consumers to large grid connected projects for industrial consumers with carbon offset appetite.

Executive Summary – Key Conclusions

The largest challenge for renewable generation projects to moving forward from proposal to construction is securing a purchaser for some or all of the electricity and/or renewable attributes from the project.

- There is a near-term positive economic value with renewable projects (spot market revenues plus renewable attribute value) that is driving current interest in renewable generation
- Projects have been built with a merchant component (or entirely merchant) in the Alberta market
 - These projects rely on spot market electricity revenue, renewable offsets/credits and distribution credits to drive revenue in excess of current long-term contract prices that compensate for higher cost structures associated with higher risk
- Changes to the carbon price signal will be a major driver in future renewables investment and the types of contracts executed to support the investments
 - Carbon offsets and/or credits will be extremely valuable under the current Alberta carbon framework for buyers with compliance obligations (large emitters)
 - Higher carbon prices could also feed into higher electricity prices which would support voluntary corporate PPAs
 - A lower carbon allowance in the TIER system (currently 0.37t/MWh) would be positive for the voluntary market through higher electricity prices but potentially negative for the compliance buyer market due to reduced number of carbon credits per MWh

Executive Summary – Key Conclusions

Offtake agreements reduce project risk and financing costs.

- An offtake agreement is a key component for many projects to secure sufficient project financing (both debt and equity depending on the proponent and financing approach)
- The number of potential offtake partners in the market appears to be increasing with more 'corporate' PPA counterparties expressing interest
 - Several projects have been executed with offtake partners with no carbon obligation in Alberta
- Counterparties with carbon obligations in Alberta under TIER (large emitters and participants that have opted into the program) are also active in the market as potential buyers of renewable power with a primary goal of reducing carbon compliance costs
 - Several recent project announcements have been made with this type of buyer
- The potential for higher carbon prices (\$40/T in 2021 is already in place, \$50/T expected in 2022 and annual increases of \$15/T from 2023 through 2030) suggest the existing benefit of carbon offsets will grow rapidly absent further regulatory change
 - Reduction in the offset value for wind and solar as well as reductions in the emission performance credit (EPC) framework are a risk that could reduce the value of carbon benefits from renewable generation despite the higher carbon price framework
- It is important to note that the current framework fully prices carbon via the offset approach that minimizes electricity price impact while fully incenting reductions via carbon credits that can be monetized

Executive Summary – Types of Offtake Purchasers

There are a range of offtake purchasers and offtake agreement types that have different drivers with different key terms.

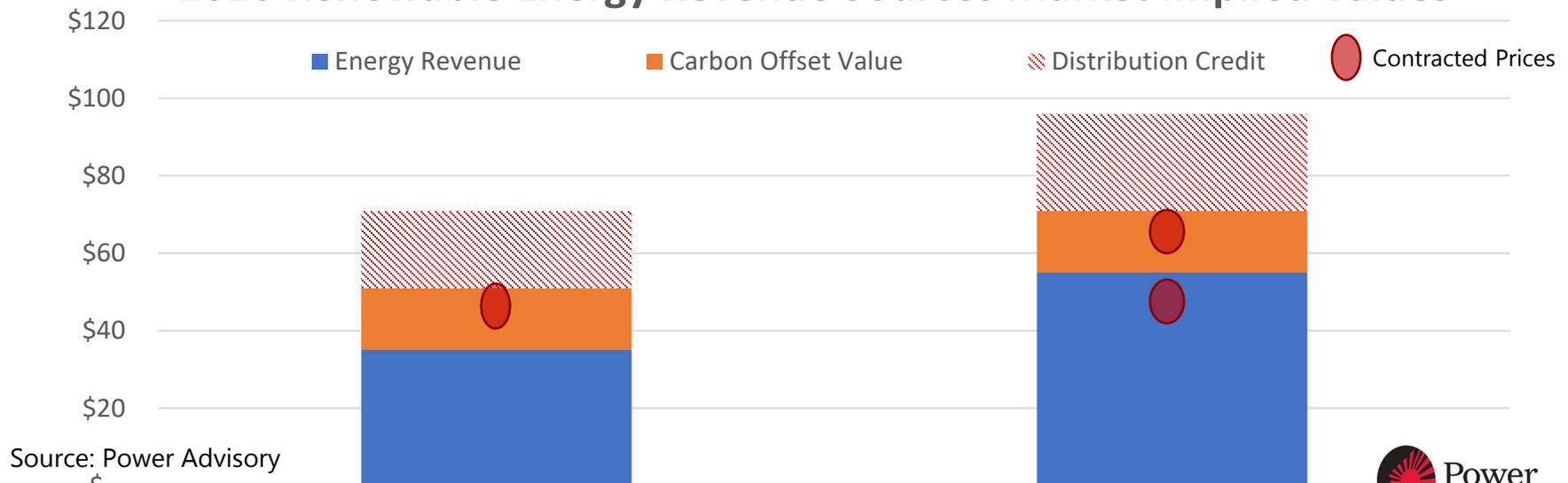
- There are 3 main types of buyers examined in this report:
 - Compliance buyers – Large emitters that have a TIER compliance obligation that buy renewable energy and carbon offsets/credits to reduce their carbon tax obligation
 - Corporate (Voluntary) buyers – Entities that procure renewable energy and/or carbon attributes to meet corporate sustainability goals (and do not use the offsets/credits to reduce carbon tax obligations)
 - Government entities – Similar to corporate PPAs government entities procure renewable energy and carbon attributes to meet sustainability goals
- All three types of buyers have transacted in Alberta historically and are currently active in the Alberta market
- Compliance buyers have also developed their own projects rather than transact with a third-party renewable developer
- Terms have ranged from 8 to 25 years
- Contracts have been executed for energy plus attributes as well as attribute-only contracts

Executive Summary – Key Revenue Sources

With 2020 market conditions a wind generator had energy and carbon value of about \$51/MWh (or \$70/MWh if distribution connected) and solar had implied value of \$71/MWh (\$90+/MWh if distribution connected) in the spot market.

- This compares to contracted prices that are reported to be in the low \$40/MWh range for wind and low \$60/MWh range for solar (energy plus offset contracts) suggesting the contracts are reflecting risk averse sellers and lenders (spot market premium) and an economic incentive for buyers to contract (particularly those with carbon tax obligations)
- Solar contract price of \$48/MWh excludes distribution credits (from Alberta Infrastructure procurement)
 - Distribution credits are available only to a subset of projects and are subject to anticipated risk

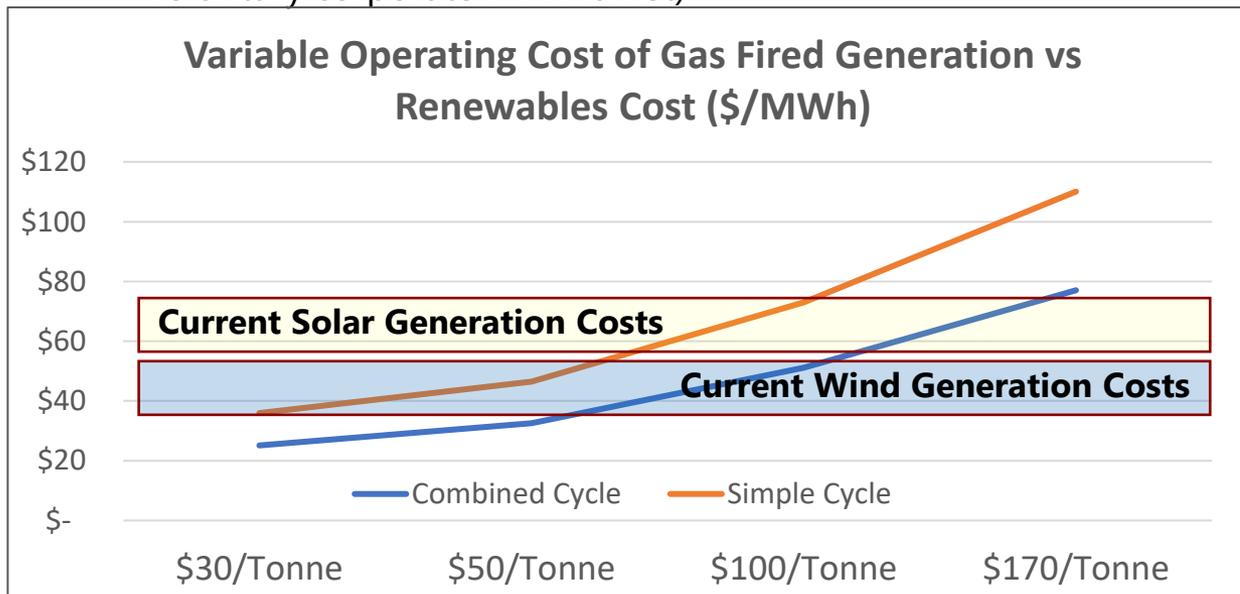
2020 Renewable Energy Revenue Sources Market Implied Values



Executive Summary – Impact of Carbon Policy

The potential for the carbon tax to increase to \$50/T in 2022 and to \$170/T by 2030 raises the value of renewable generation materially and results in a very strong signal for renewable generation to supply energy in the Alberta market provided the carbon value can be monetized.

- At \$2/GJ natural gas price the implied fuel cost plus carbon cost for natural gas generation exceeds the current price of wind and solar at \$170/T by large amounts
 - Whether the carbon value is captured through the energy price or through credits is expected to have an impact on the market and the likely contract counterparties (compliance obligations vs. voluntary corporate PPA market)



Wind and solar will cost effectively displace natural gas fired generation for energy (not capacity) even at current technology cost structures if carbon reaches \$170/T

Source: Power Advisory

Executive Summary – Key Revenue Sources

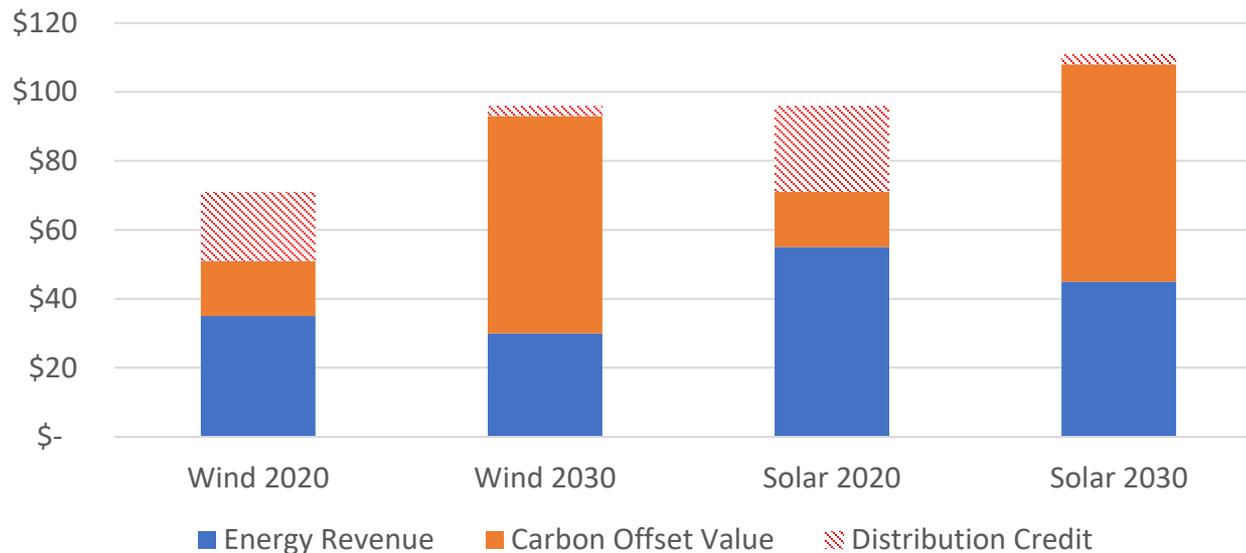
Energy market revenue, renewable attribute revenue (credits/offsets) and distribution credits are the key revenue sources.

- Energy market revenue is currently about \$35/MWh for wind generation and \$57/MWh for solar generation (merchant value based on currently technology and 2020 prices)
 - Energy market revenue is primarily influenced by overall electricity supply/demand conditions, renewable penetration, natural gas prices and carbon policy
- Renewable attribute revenue is set primarily by government policy and is a function of the price of carbon and the rate at which renewable generation creates offsets and credits
 - At current carbon prices and offset rates, a new renewable generation project creates about \$16/MWh in renewable offsets (2020 rates)
 - By 2030 a renewable generation project that comes online in 2021 or 2022 will create almost \$90/MWh in offset value if carbon price reaches \$170/tonne (note that the offset rate for renewable generation will be reduced materially for projects coming on later in the 2020s under the current approach)
- Distribution credits are highly variable and have recently been changed
 - For small projects, the value can reach \$20/MWh for wind and \$25/MWh for solar
 - Larger projects see comparatively less value from distribution credits
 - Distribution credits are likely to see falling value with changes to the transmission tariff

Executive Summary – Key Revenue Sources

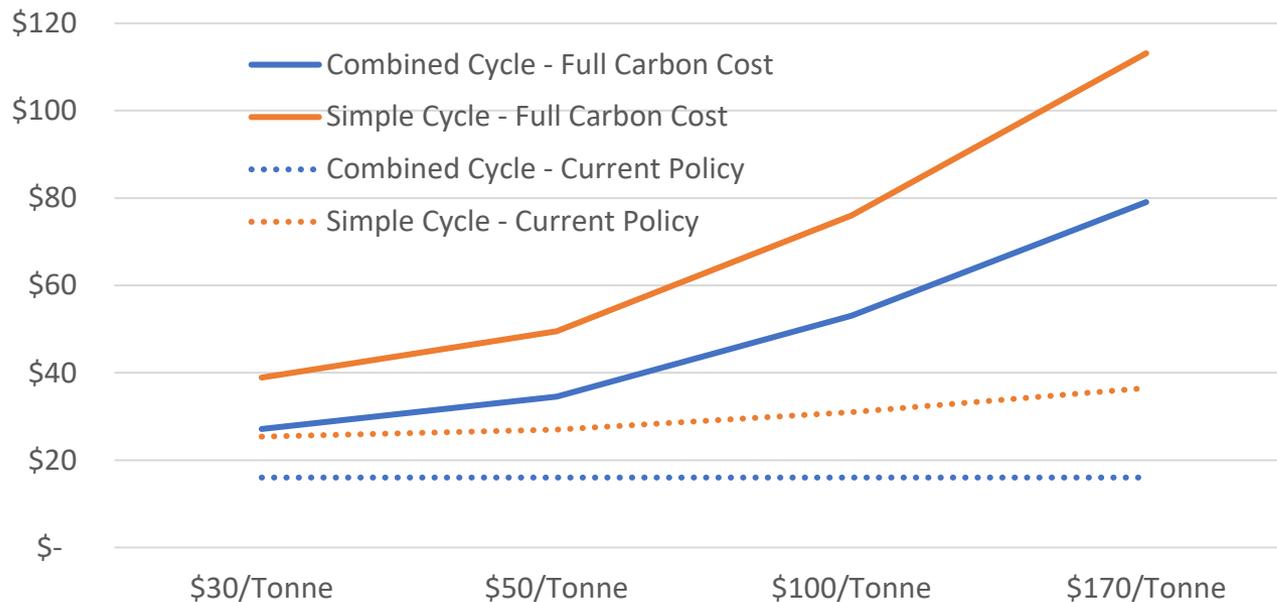
With current carbon policy but \$170/tonne carbon prices carbon credits become the most important revenue source for renewable generators. The graphic assumes lower energy prices for renewables due to increased penetration as well as dramatically lower distribution credits due to a potential tariff change. While indicative, the graphic illustrates that high carbon prices form a potentially large revenue source for renewable generation.

Representative 2020 vs 2030 Revenue Sources



Executive Summary – Impact of Carbon Policy

Variable Operating Cost of Gas Fired Generation Impact of Offset Allowance of 0.37t/MWh



Source: Power Advisory

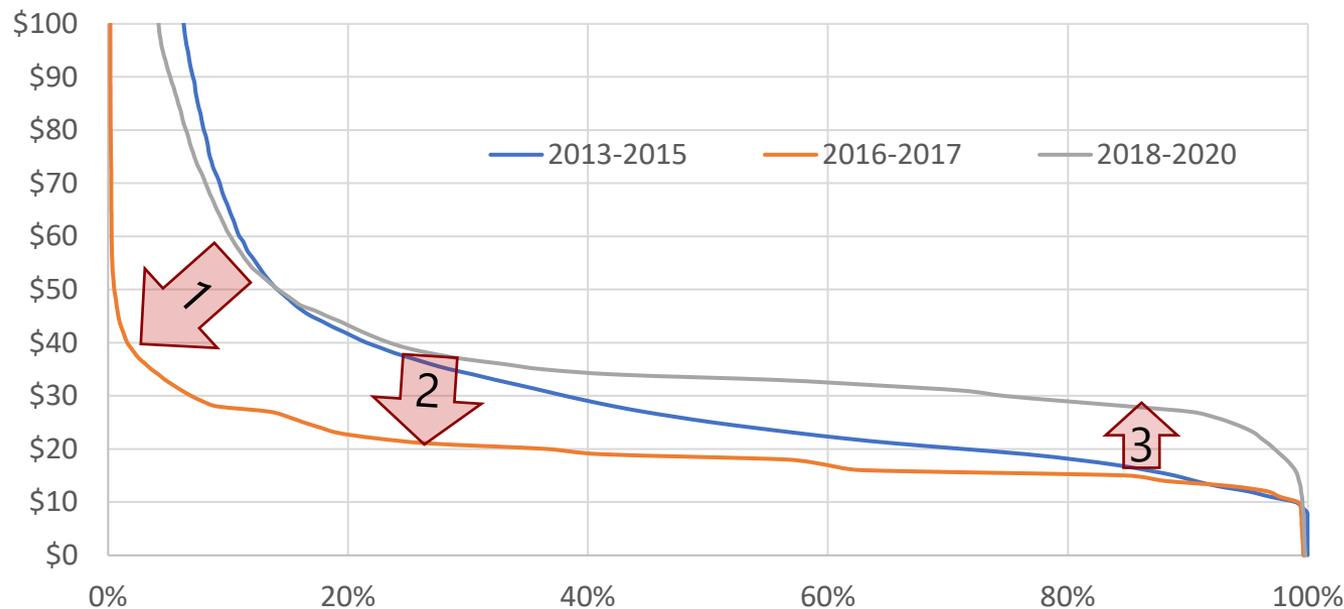
The current 0.37t/MWh allowance drastically limits the impact of the rising carbon price on energy market prices but creates the opportunity for offset/credit sales provided the compliance purchaser market is large enough to absorb the credits created.

- The higher carbon price is not expected to drastically impact electricity prices because the offset allowance shields most natural gas fired generators in the market and more efficient gas generators face very little carbon cost.
- While the current policy allows credits to be created to monetize carbon value there is risk the compliance market will not be large enough.
- Corporate PPAs become much more attractive as the offset level is reduced because energy prices would increase. In effect the increase in the carbon price has little impact on voluntary corporate PPAs unless it is paired with a reduction in the allowance level which would increase energy prices.

Executive Summary – Energy Market Revenues

Alberta Price Duration Curve

Key Factors and Impact on Renewable Generation



Source: AESO Data, Power Advisory analysis

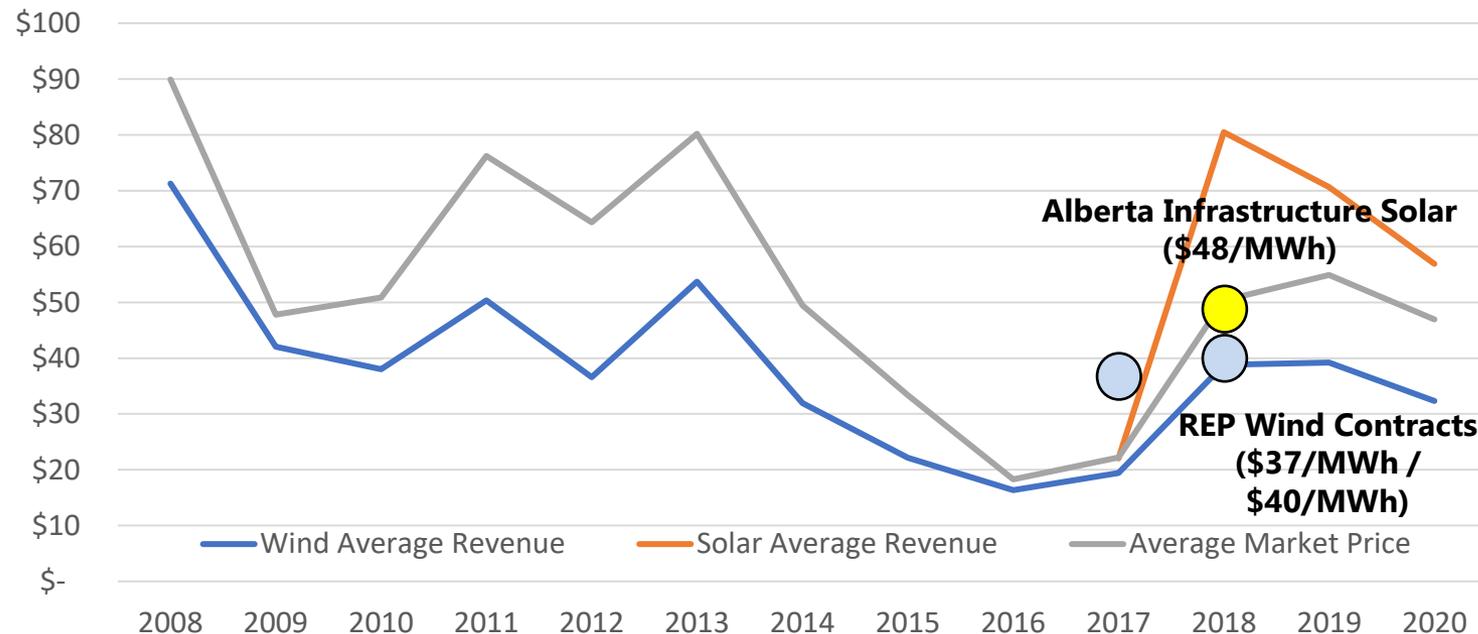
1. General supply/demand conditions drive the prevalence of 'scarcity' hours – wind and solar benefit to some degree
2. Natural gas price (higher or lower) shift prices in a large number of hours when gas generation is on the margin
3. Carbon tax lifted the 'floor' due to coal carbon intensity but this will fall back towards the blue line as the coal fleet is replaced with gas

The duration curves illustrate a number of factors that impact energy market revenues for wind and solar. Solar generation captures some of the capacity value from the high priced hours on the left of the curve though this benefit will dissipate over time as solar penetration grows.

Executive Summary – Energy Market Revenues

Wind realized prices from the spot market have averaged \$35/MWh over the last 13 years and solar received prices have averaged \$64/MWh (volume weighted average from 2017 onwards with the first solar project).

Average Renewable Revenues vs PPA Prices (\$/MWh)



Source: Power Advisory calculations from AESO data

Executive Summary – Renewable Attribute Value

Though they are sometimes used interchangeably in this report, there are three terms that mean different things: carbon offset, emission performance credit (EPC), and REC.

- **Carbon Offset.** In Alberta, large emitters that have a carbon tax obligation can use either carbon offsets or emission performance credits (EPCs) to satisfy those obligations. The carbon offsets from wind and solar generation are currently set at 0.53t/MWh. The government allows renewable developers to lock in the rate for a given renewable energy project for up to 10 years, after which the project receives EPCs (or the project may lock in for 8 years and renew for 5 years at rate in effect at that time, for a total of 13 years). As a result, compliance buyers are more willing to sign PPAs for up to 10-13 years as the carbon value is known. The 0.53t/MWh ratio is in place through 2022, at which time it will likely be modified. Should the ratio be revised downward as expected, a new 2023 project coming online will not receive as many offsets per MWh for renewable energy.
- **Emission Performance Credit (EPC).** The EPC currently has a value of 0.37t/MWh, which is an industry wide benchmark for electricity. Any generation with an intensity below the benchmark can opt into the TIER protocol and create credits. The EPC credit rate is tied to the allowance rate for all generators within the TIER. Thus, for example, if the allowance rate falls to 0.35t/MWh, the EPC rate for renewables would also fall to 0.35t/MWh.
- **Renewable Energy Certificate or Credit (REC).** The REC is a more general term for the environmental attributes associated with renewable energy. In the US, "REC" is the commonly used term for this and in many jurisdictions, there are liquid REC markets where RECs can be bought and sold. The majority of voluntary corporate PPAs are for RECs. Some wind generators in Alberta have sold RECs under 20-year PPAs to offtakers in the US, mainly to PG&E in California. For Canadian corporates that enter into PPAs on a voluntary basis, those contracts may be for RECs (effectively renewable MWh), or for offsets or credits that are retired but not used for meeting compliance obligations. Since RECs in this context are not used for compliance purposes, the rate at which renewable energy creates credits or offsets is not as important.

Executive Summary – Financing Costs – Contracted Projects

The cost of capital is currently at historic lows.

- Typical financing costs for 15-20 year contracted renewable energy projects in Alberta with a creditworthy offtaker are shown below. The cost of debt is about 2.5%, while after-tax cost of equity is 8% for wind and 7% for solar.
- The debt service coverage ratio (DSCR) is a measurement of a project's available cash flow to pay current debt obligations. It is equal to net operating income / debt service. Typical multiples are shown below. This leads to debt/equity ratios in the 65%-85% range.
- Contract terms can impact these values. For contracts that involve a longer merchant period, or terms that introduce additional risk, the cost of debt will increase & the percent of debt (leverage) decreases, thereby increasing the cost of capital.
- It's important to note that lenders will not necessarily give credit for all potential revenue streams. While credit is given for energy revenue, some more speculative revenue streams such as distribution credits and uncontracted RECs may not be given credit, or be given a portion of the expected credit.

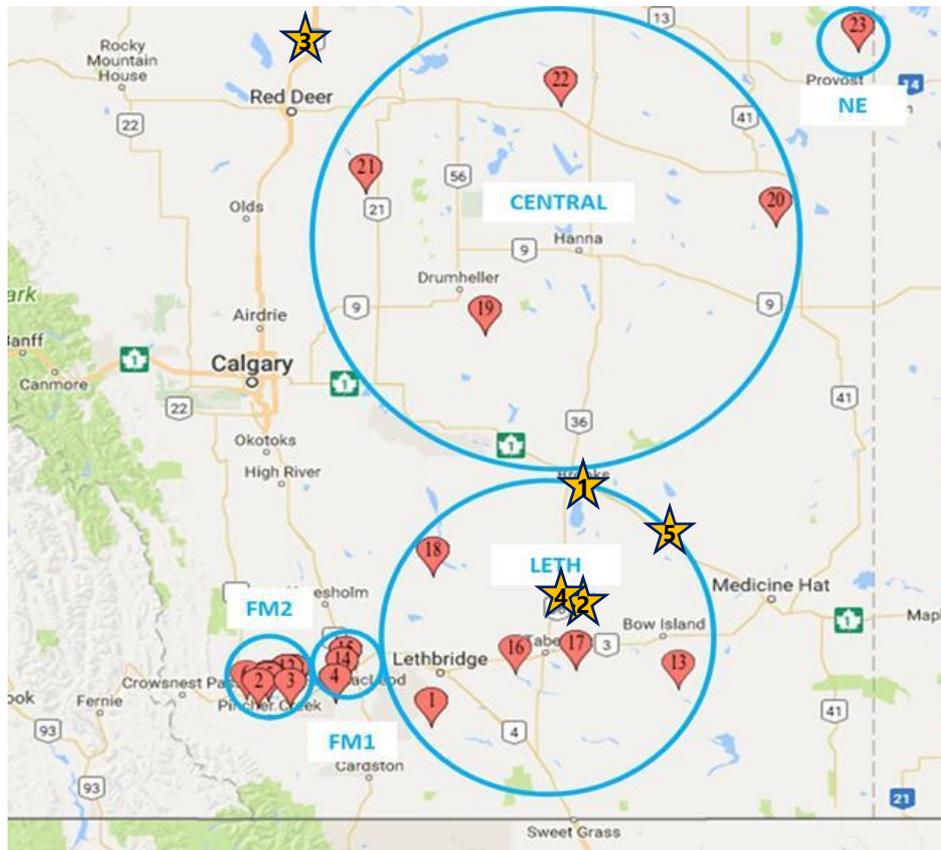
Typical Financing Assumptions

	Wind	Solar	Range
Cost of Debt	2.5%	2.5%	2.0%-3.5%
Cost of Equity	8.0%	7.0%	+/-1%
DSCR (P50)	1.4x	1.3x	+/-0.1
DSCR (P99)	1.0x	1.0x	1.0-1.05x
Typical Leverage	70%	75%	65%-85%

Source: Interviews, Power Advisory

Executive Summary – Siting Factors

Several factors go into siting wind and solar farms in Alberta. The vast majority of sites to date have been located in southern Alberta though Central Alberta is also an attractive location.



Operating wind farm



Operating solar farm

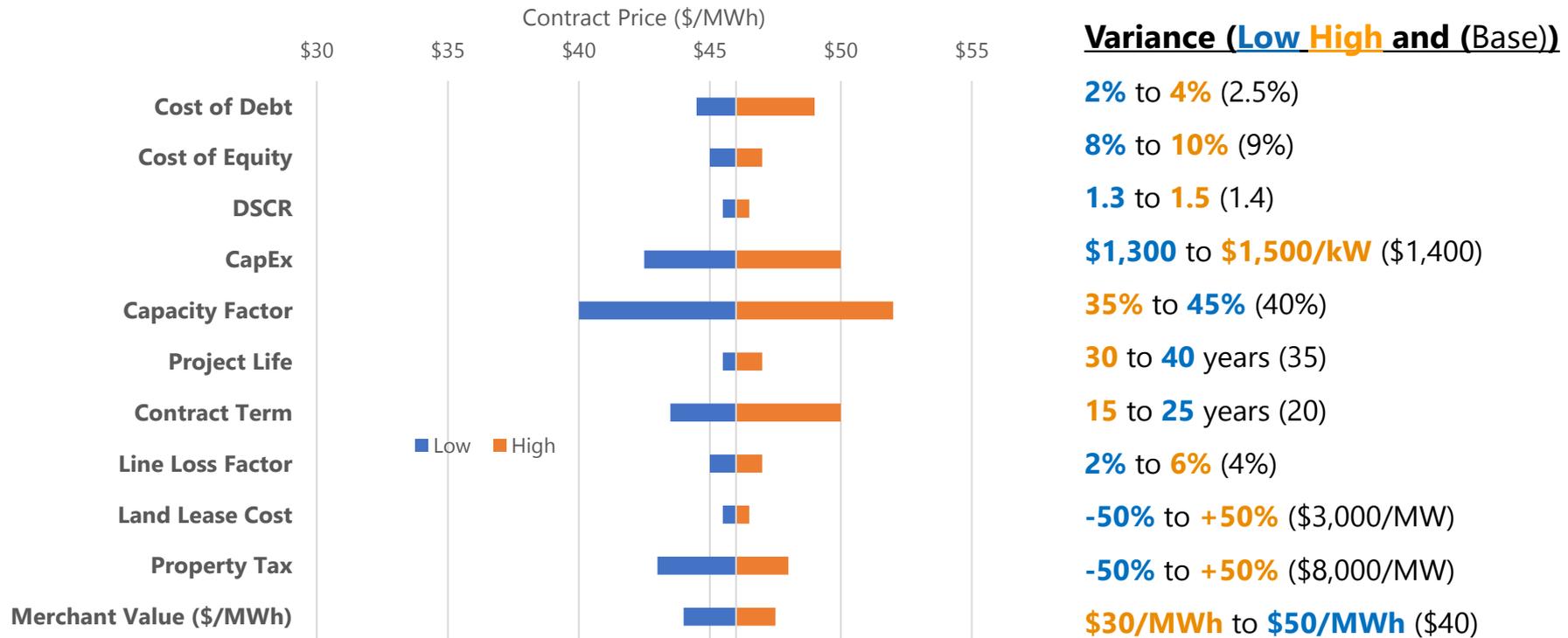
Siting Factors

- Wind/Solar Resource
- Interconnection Costs
- Generating Unit Owner's Contribution (GUOC)
- Line Losses
- Property taxes
- Land Lease costs
- Availability of land for acquisition or lease
- Civil costs
- Environmental impacts
- Local opposition

Source: AESO, Power Advisory, December 2020

Executive Summary – Wind Project Cost Drivers

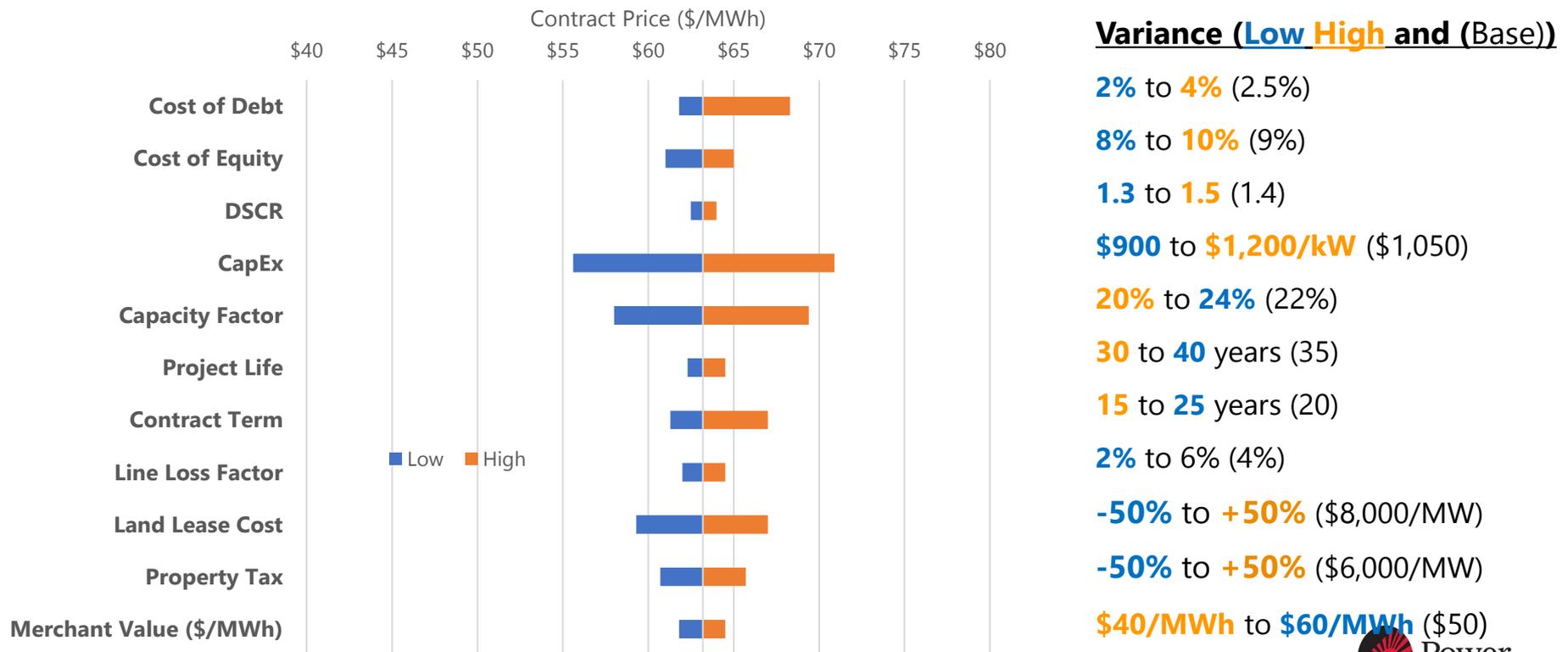
The most important cost drivers for wind are illustrated in the graphic below and illustrate the relative importance of each in developing a competitive project. The costs below represent costs for a contracted project – merchant projects have higher cost structures for debt and equity due to increased risk.



Source: Power Advisory

Executive Summary – Solar Project Cost Drivers

The most important contract cost drivers for solar are illustrated in the graphic below and illustrate the relative importance of each in developing a competitive project. The costs below represent costs for a contracted project – merchant projects have higher cost structures for debt and equity due to increased risk.



Source: Power Advisory



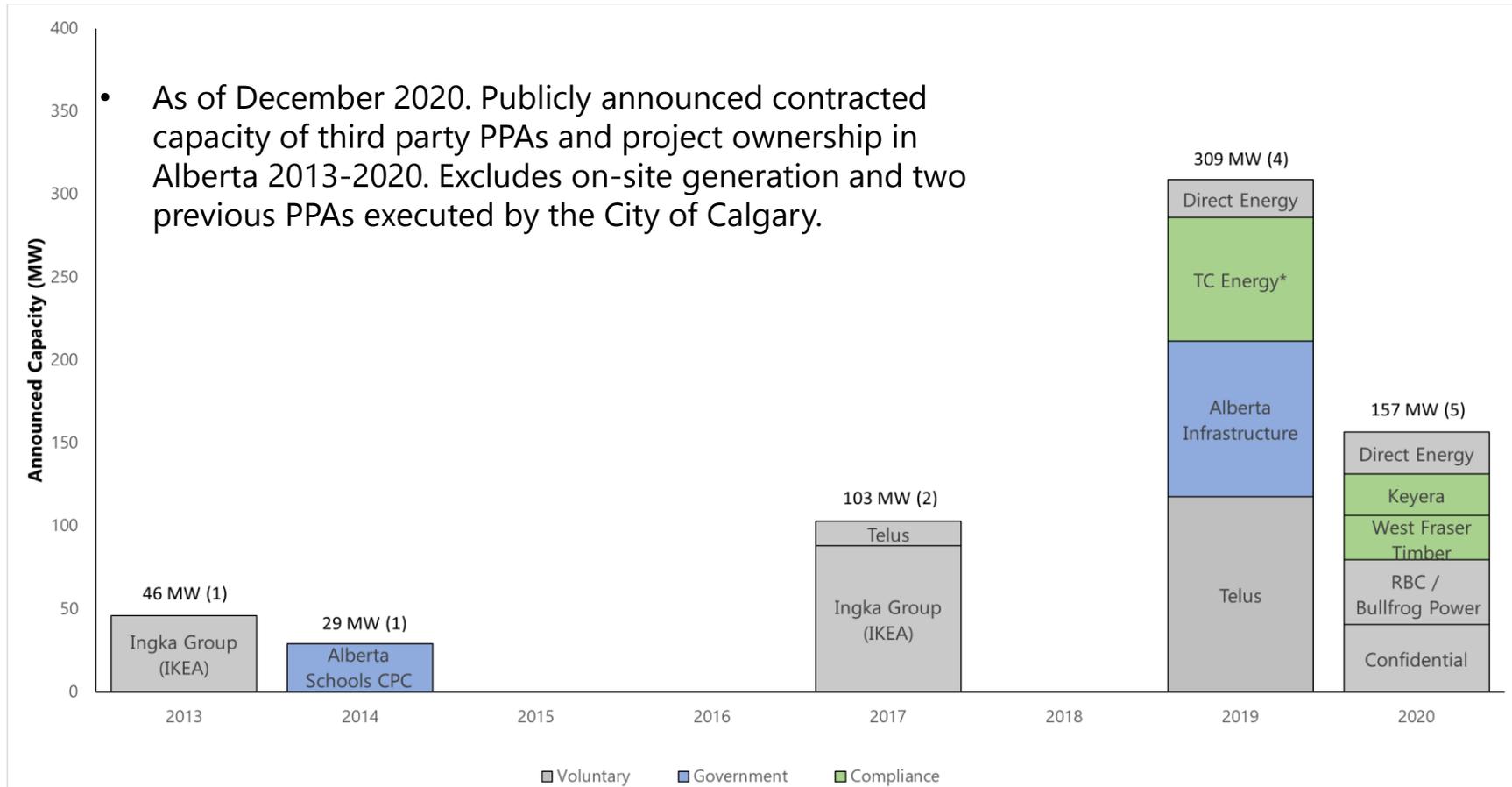
Executive Summary – Notes on Project Costs

Capital cost assumptions are presented based on Power Advisory analysis of projects currently under development. The costs as reported are for large transmission connected projects and exclude factors such as interest during construction and owner's overhead costs.

- Solar projects represent costs for single axis tracker technology and are based on DC installed capacity (typical installations are 1.3 MW of DC to 1 MW AC)
- Cost assumptions are reflective of a typical competitive project

Executive Summary – Alberta PPAs by Buyer Type

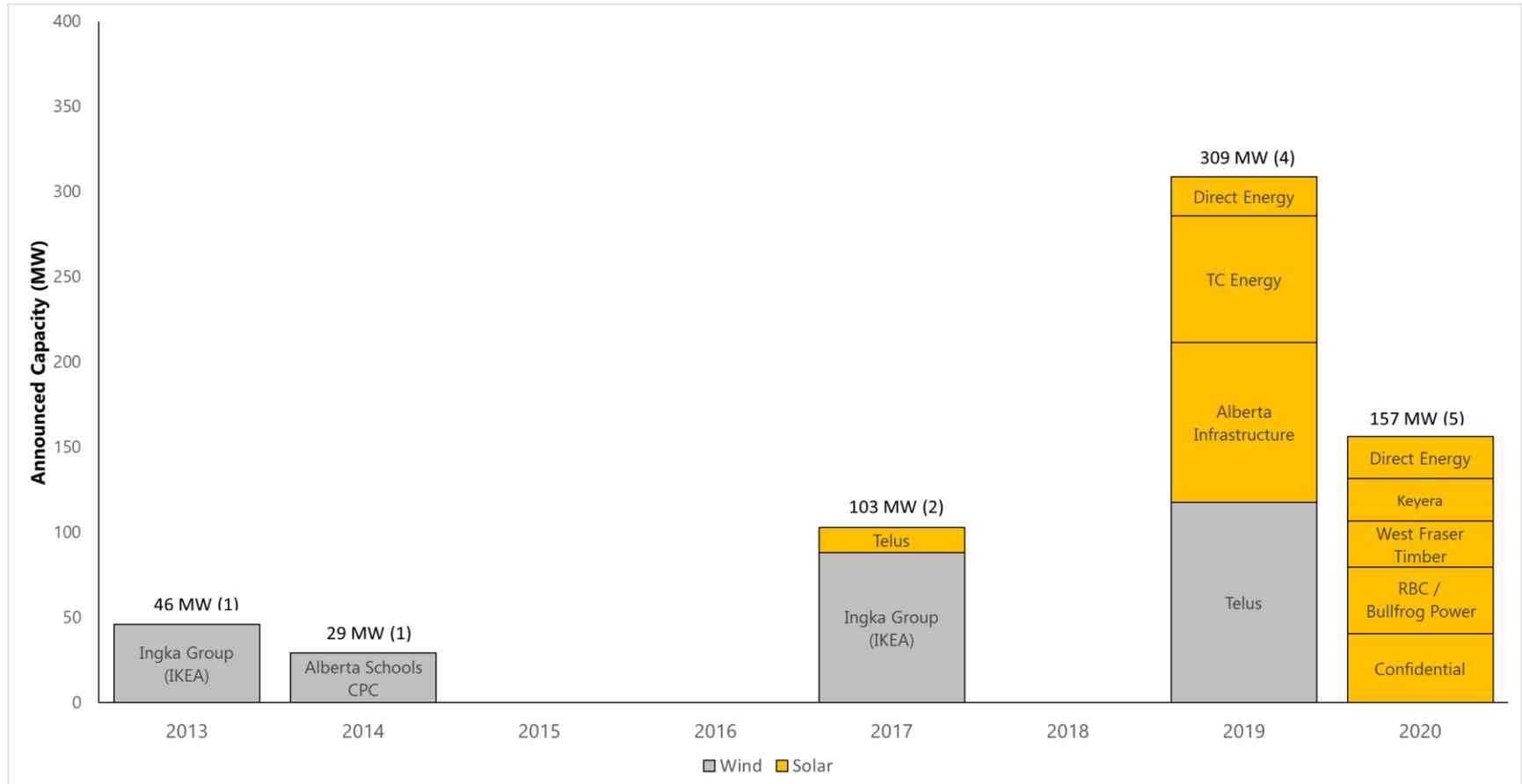
Alberta PPAs, 2013-2020 (MW)



Source: News articles, Power Advisory

Executive Summary – Alberta PPAs by Technology

Alberta PPAs, 2013-2020 (MW)



Source: News articles, Power Advisory

Executive Summary – Offtake Agreement Market Size

The size of each segment of PPA market is driven by inter-related factors that influence the attractiveness of renewable energy investment for specific market segments. Higher carbon credit values, for example, may drive more PPAs with compliance buyers. Fewer carbon credits per MWh (by reducing the carbon allowance) would benefit voluntary buyers through higher energy prices but hurt compliance buyers due to fewer credits per MWh.

Key Drivers of PPA market size:

- Economic value – do market revenues exceed PPA costs? This is currently the case, particularly for compliance buyers.
- Carbon policy – reductions in the carbon allowance reduce attractiveness of renewable energy for compliance buyers but increase attractiveness for voluntary buyers because energy prices would be expected increase.
- Carbon price – higher carbon prices can increase the attractiveness of renewable energy for both compliance buyers and voluntary buyers depending on the structure of carbon credits.
- Cost of renewable generation – as renewable generation costs fall, the size of the potential market increases
- Viability of storage – storage can be used to both increase the value of renewable energy and mitigate the delivery risk (timing), making renewable energy more valuable to buyers.
- Transmission capability – can the system absorb new generation and is there congestion risk

Executive Summary – Offtake Agreement Market Size

The potential size of the offtake agreement market is likely to be driven primarily by either corporate PPAs (voluntary) or the compliance market (for offsets/credits) but it is unlikely both will see large uptake as they are competitors to a degree. The table also includes self-build generation which is expected to occur within all market segments.

- The estimate of the offtake market is divided into:
 - Compliance market – entities purchasing renewable generation for the primary purpose of reducing carbon compliance costs (TIER covered entities)
 - This market also includes entities that build their own generation rather than contract with a third party
 - Voluntary (Corporate) PPA market – voluntary purchases of renewable generation for the primary purpose of meeting ESG targets
 - Government entities – federal, provincial, municipal and other public entity purchases of renewable energy for the primary purpose of meeting environmental goals
- The most likely driver of the High Case is strong uptake of renewables from the compliance market driven by rising carbon taxes and the ability to reduce costs via the purchase of credits

MWH/yr	Government	Voluntary	Compliance	Total	MW _{AC} - Wind	MW _{AC} - Solar
Low Case	850,025	1,545,599	3,504,000	5,899,624	1,497	3,061
Base Case	2,550,074	3,377,420	7,008,000	12,935,494	3,281	6,712
High Case	2,975,087	4,579,552	14,016,000	21,570,639	5,472	11,193



Kris Aksomitis

kaksomitis@poweradvisoryllc.com

(587) 894-7150