D2.1-CA, December 2019

Auctions for the support of renewable energy in Alberta, Canada

Main results and lessons learnt

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1.1 Background

Canada is a large country with a sparse and heterogeneously distributed population. Canada's renewable resources can provide enough energy to meet the country's current energy demand, but the concentration of industries and residences in the southern part of the country means that the spatial dispersion of power demand is asymmetrical across the country's various provinces (Barrington-Leigh & Ouliaris, 2017). Significant renewable energy capacity has already been developed in Canada, especially in the form of hydropower generation, which had reached a total capacity of more than 80 000 MW in 2017. Wind, solar PV and biomass installed generation capacities have also been increasing over the last decade (NRCAN, 2019).

Canada's energy legislation is organised at the provincial level. The provinces which currently stand out as having comprehensive renewable energy programmes in place are Alberta and Ontario, with the former having featured Canada's most comprehensive renewable energy auction scheme to date. Ontario, which had relied on a standardized FIT system for quite some time, also recently began reviewing its energy legislation and support instruments, aiming to source renewable electricity from auctions from 2022 onwards (IESO, 2017). Given the infancy of Ontario's Market Renewal Programme, this chapter will primarily analyse the design elements and outcomes of Alberta's Renewable Electricity Programme, which is more developed.

1.1.1 The Rise and Fall of Alberta's Renewable Energy Programme (REP)

Alberta's wholesale electricity market had begun to undergo deregulation in 1995 with the introduction of the Electric Utilities Act (EUA), which had introduced the Power Pool Council as a central body to manage the electricity exchange in the Alberta Interconnected Electricity System (AIES). In the province's review of its energy market structure in 2005, the retention of the energy-only market was favoured over long-term capacity-based contractual obligations. In Alberta's energy-only market, the Alberta Electric System Operator (AESO) is the monopoly buyer of electricity sold by generators participating in the electricity market. Thus, electricity producers can only generate streams of revenue through the sale of power at the wholesale market price.

Consequently, there are no incentives, besides the wholesale market price, for generators to invest in additional generation capacities in the energy-only market (Hughes et al., 2017). The market price is a function of the volume of electricity produced in the system; with greater competition translating into smaller revenue margins. With growing shares of renewables connected to the AIES, the market price tends to fluctuate in correlation with the availability (and hence electricity production) of variable renewable energy capacities, i.e., the spot prices are low when the wind is blowing and the sun is shining, but are relatively high otherwise. This effectively reduces the incentives for new renewable energy capacity, as their generation profiles will most likely be aligned with those of existing plants of the same region, which in turn further reduces the revenue margins on the produced electricity (Bode & Groscurth, 2008), i.e., the cannibalisation effect (see for example Lopez, Steininger, & Zilbermann, 2017). This lack of sufficient incentive for potential project developers in Alberta's energy-only market is also reflected in the province's electric energy mix, i.e., the shares of installed net capacity per source (see Figure 1: Alberta's Electric Energy Mix, own computation based on the Alberta Utilities Commission (2019).). In 2015, 20 years after the deregulation of Alberta's energy market, the province's share of net installed wind capacity (the largest renewable energy source) accounted for (only) 10% of the total, while coal and gas each made up roughly 40% of the mix (Alberta Utilities Commission, 2019).

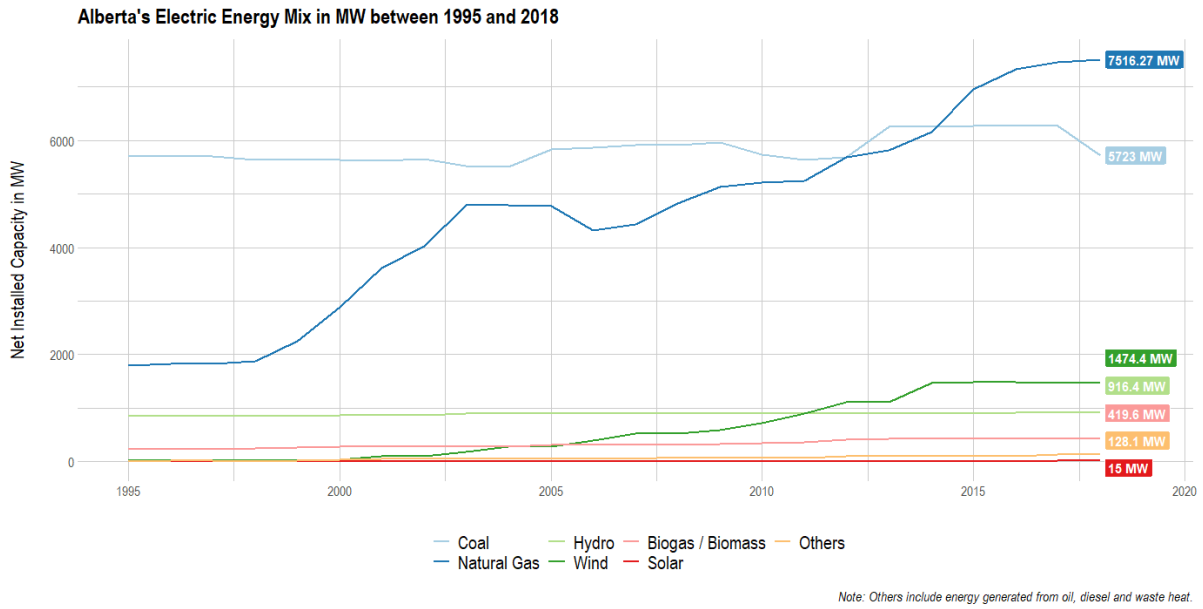

Figure 1: Alberta's Electric Energy Mix, own computation based on the Alberta Utilities Commission (2019).

Following Alberta's 2015 political elections, and the formation of the Climate Leadership Panel, the province's government had started to implement an economy-wide Climate Leadership Plan (CLP) to reduce greenhouse gas emissions. The CLP was anticipated to significantly affect Alberta's electricity market, in that it had demanded a comprehensive coal phase-out by 2030, to be replaced by the addition of renewable energy capacity and gas-fired generation. Recognizing the system's inability to sufficiently incentivize the investments necessary to meet the targets set out in the CLP, in January 2016 the AESO was tasked to develop a competitive process that would enable them to procure the needed generation of renewable electricity. The AESO suggested a Renewable Energy Programme (REP) which would call for 30% of Alberta's electricity generation to come from renewable sources by 2030 (AESO, 2019b). This 30-by-30 target had depended on 5000 MW of newly built renewable energy capacity (Olexiuk, Saric, Lemke, & Barre, 2017). The REP had also offered insights on the potential form, content, and stages of the competitive process and its payment mechanism for the procurement of additional renewable energy capacity (AESO, 2019h). The payments to awarded renewable energy projects are funded via revenues from the carbon levy payments made by large industrial GHG emitters in the State of Alberta (Institute, 2016). In late 2016, the AESO's REP recommendations were finally adopted by the Government of Alberta in the form of the Renewable Electricity Act, granting the AESO the official mandate to turn its recommendations into practice (AESO, 2019b). The Act called for renewable electricity support programmes and competitive processes to promote large-scale capacity (> 5MW) procurements while adhering to the reliability, safety and economic operation criteria established in the Electric Utilities Act (GoA, 2018b). As such, the Act implicitly opposed a restructuring of Alberta's wholesale electricity market, with renewable energy investments ought to be incentivized through the provision of additional revenue streams in the form of subsidy payments competitively allocated to generators[1].

[1] A caveat of the government's intention to leave Alberta's wholesale electricity market unregulated while simultaneously enacting the coal phase-out and the support programme for renewables had been that the development of wholesale market price becomes difficult

Launched in 2016, the Renewable Electricity Programme (REP) was intended to incentivize the deployment of renewable energy capacity in Alberta until 2030. However, the victory of the United Conservative Party in Alberta's general elections in 2019 meant a stark change of the province's energy policy objectives. With the intention to protect local oil and gas industries, the new administration abandoned the still young REP scheme and its renewable energy targets with immediate effect (Alberta MoE, 2019a). Three rounds of technology-neutral renewable energy auctions had been conducted successfully by the end of 2018. In early 2019, the former Government of Alberta directed AESO to follow through with the preparation of a fourth REP round (Alberta MoE, 2019b), but the mandate was withdrawn subsequent to the province's general elections in April 2019 under the new administration. (Alberta MoE, 2019a).

to predict. Acknowledging this concern, the GoA initially had decided to design a parallel capacity market to ensure the long-term sustainability of the province's electricity supply. However, this decision was withdrawn in mid 2019 under the new administration (AESO, 2019c).

2 Alberta's Renewable Energy Programme (REP)

The REP auction rounds were designed to feature three stages (AESO, 2019b):

1. The Request for Expression of Interest (REOI) stage was primarily meant to attract and assess the level of interest in the support mechanism and served as an introductive period which entailed information sessions in which potential bidders were given the chance to address the AESO with questions and concerns.
2. During the Request for Qualifications (RFQ) stage, bidders submitted project proposals and required documentation, but only as evidence of eligibility for qualification.
3. The Request for Proposals (RFP) asked the bidders to confirm their project proposals and to submit a final bid for support.

After a careful evaluation of alternatives, the AESO chose an Indexed Renewable Energy Credit (Indexed REC) payment mechanism to allocate the programme support to the winning bidder. Through this mechanism, the winning bidder receives a variable price premium per MWh produced, in exchange for Renewable Attributes[2]. The premium obtained equals the difference between the strike price (winning bid, or put differently, the lowest price at which the bidder is willing to implement the project) and the pool price as determined by supply and demand dynamics in Alberta's wholesale electricity market (see AESO (2018) for a discussion of how the pool price is determined in Alberta). With the Index REC payment mechanism, which is, in essence, a two-sided Contract for Differences scheme (Hughes et al., 2017), the successful bidder and the government will find themselves in one of three scenarios (see Figure 2: Possible Market Scenarios in the Index REC Mechanism, adapted from AESO (2019a).):

1. Strike Price above Pool Price: The pool price in the wholesale electricity market is below the competitively determined strike price so that the AESO is obliged to pay the difference to the generator, in order for the generator to reach its economic break-even point.
2. Strike Price equal to Pool Price: Where the pool price equals the strike price, neither AESO pays the generator, nor vise versa. The strike price equals the generator's marginal cost.

Strike Price below Pool Price: Whenever the pool price rises above the strike price, any financial support would create supernormal profits for generators. This would impose an inefficient drain on public budgets. Therefore, the Indexed REC mechanism demands generators to issue difference payments to the AESO.

[2] Renewable Attributes are tradable credits which can bring other forms of revenues or entitlements in addition to what generators may receive by offering electricity on the wholesale market. By transfering the Renewable Attributes to the AESO, the generator effectively accepts the AESO as the monopoly buyer (AESO, 2017).

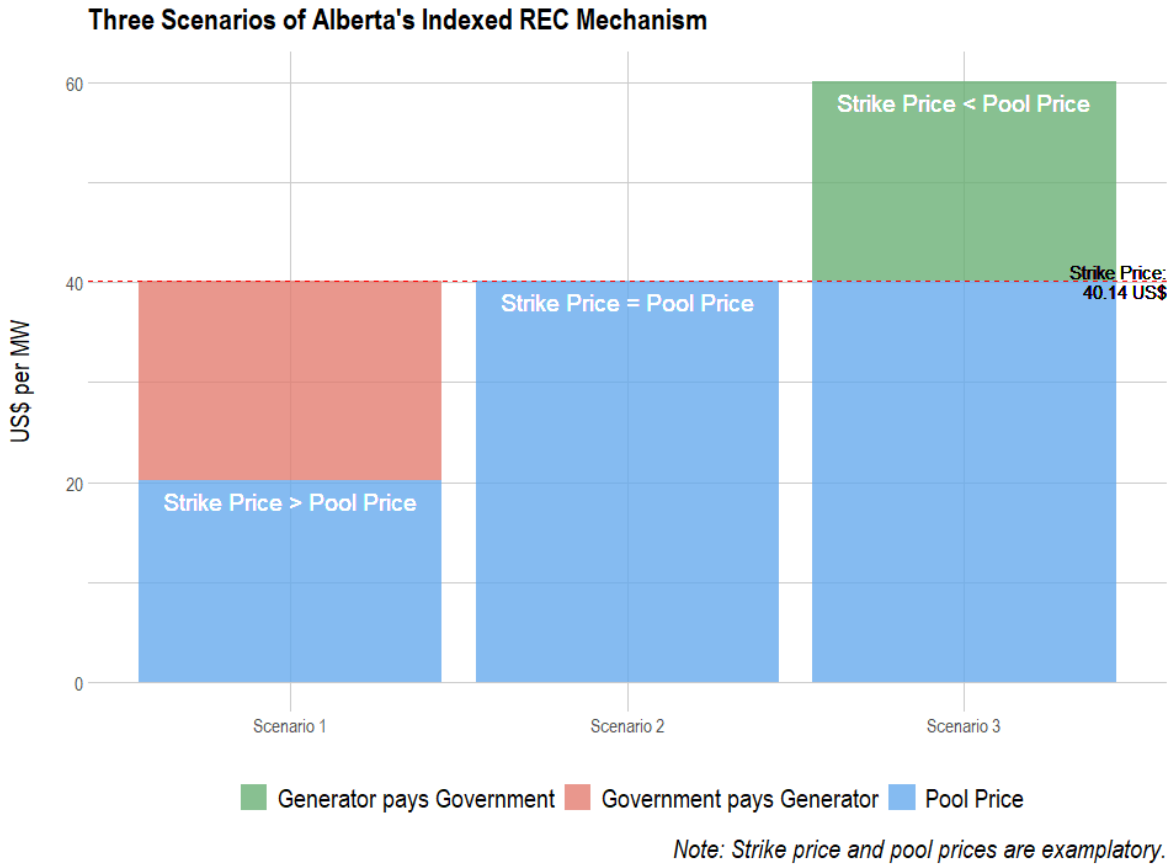

Figure 2: Possible Market Scenarios in the Index REC Mechanism, adapted from AESO (2019a).

Table 1: The main characteristics of the REP auction mechanisms in Alberta are summarized for rounds 1 to 3, based on (AESO, 2016).

Characteristics	Description of the Auction
Characteristics of the national electricity market	Alberta's energy-only market is managed by the Alberta Electricity System Operator (AESO), which is the Independent System Operator of the province. The AESO is responsible for the Alberta Interconnected Electric System (AIES), as well as for the design and implementation of the Renewable Electricity Programme (REP). Electricity generators participate in the electricity market by submitting hourly offers to the power pool for a specific quantity of electricity in MW for a specific price (CAD/MWh). The wholesale market price sets the pool price which is determined on an hourly basis.

	The AESO is the monopoly buyer of ancillary services and electricity sold to the power pool.
Name of the auction scheme	Renewable Electricity Program (REP) – Competitions for utility-scale renewable electricity generation in Alberta.
Contractual counterparty	**Auctioneer:** Alberta Electricity System Operator (AESO) **Off-takers:** Distribution Companies connected to the AIES
Main features	• Provincial level auction • Technology-neutral • CFD scheme
Technology focus and differentiation (eligible technologies)	Renewable energy projects, technology neutral.
Lead time before the auction	Between 7-11 months: 1. Request for Expression of Interest (REOI) 4-6 weeks 2. Request for Qualifications (RFQ) 4-6 month 3. Request for Proposal (RFP) 2-3 month
Min. / max. size of project	Projects must be ≥ 5 MW.
What is auctioned? Auctioned bids (in terms of budget, electricity or installed capacity)	Installed capacity (MW)
Budgetary expenditures per auction and per year	Budgetary expenditures are not explicitly stated and can only be predicted. The REP is however expected to be funded by Alberta's carbon levy (Hughes et al., 2017).
Frequency of auctions	No predefined procurement schedules, but overall and interim capacity targets are provided by the GoA (GoA, 2019). 5000 MW target, to be deployed by 2030 (Hughes et al., 2017).
Volume of the tender	**Round 1:** Procurement target of 400 MW. **Round 2:** Procurement target of 300 MW. **Round 3:** Procurement target of 400 MW.
Grid connection / access-related costs	Grid connection costs fall on the awarded bidder.
Balancing costs and Profile costs	Balancing costs and profile costs are not directly applicable, but the Renewable Energy Support Agreement (RESA) requires generators to bear the risk of annual forgone energy in times of oversupply (i.e., not sourced from the generator) up to a threshold of 200h, i.e. curtailment.

2.1 Design Elements of Alberta's REP Auctions

Table 2: General auction design based on (AESO, 2016).

Design elements	Description
Auction format	Technology-neutral renewable energy auction for Contract for Differences support scheme.
Eligible technologies and participation technologies?	Eligible projects are limited to new or expanded renewable electricity generation projects located in Alberta. Eligible technologies must meet Alberta's definition of renewable energy resources as defined in the Renewable Electricity Act (GoA, 2018b).
Auction procedure	Static
Pre-qualification requirements - Financial	Bidders must demonstrate sufficient financial strength to execute the project demonstrated through: • A sufficient net worth in relation to the project size in question displayed by past and present financial statements. • Confirming that there are no current or anticipated proceedings that would influence the bidders' current financial standing in a negative way. (Bidders must provide evidence of this during the auction qualification stage) • The confirmed willingness of financial involvement of a creditor as displayed through a signed document • Confirming equity contributions and describing how the bidder intends to secure equity contributions necessary to construct the project
Pre-qualification requirements - Material	Basic requirements of all three auction rounds: Bidders must be able to meet the following criteria: • Projects must be new or expanded development. • Capacity ≥ 5 MW • Projects must be located in Alberta. • Projects must generate electricity from resources that occur naturally and that are renewable. • Projects must connect to the existing grid infrastructures (Alberta Interconnected Electricity System, AEIS). • Developers must demonstrate the ability to meet a specific in-service date. • Developers must hold technical capacity and capability to develop their proposed projects, as evidenced by their involvement in recent projects of similar size and com-

	plexity, experience with project development, construction and operation, and the relevance of the participant's experience to the proposed project (AESO, 2016). • The projects must be a separately metered facility able to run for the 20-year term as set by the RESA. • Developers must have secured appropriate land rights over their proposed site and be reasonably expected to attain commercial operation by the deadline set in the RESA (Hughes et al., 2017). Specification criteria for round 2: • Following the commercial operation of the facility, equity ownership of at least 25 % by indigenous people is required to be maintained during a minimum time period of three years. • Indigenous communities are eligible as equity owners if they are located in the Province of Alberta and meet the Government of Alberta's definition as one or a combination of the following: o First Nation communities, Metis Settlements, Metis Nation of Alberta, and the Aseniwuche Winewak Nation; or o 100 percent Indigenous community-owned organization and/or business • All proposals for renewable energy projects participating in REP round 2 must be in compliance with the terms and conditions of any previous Government of Alberta funding
Auction volume	<u>Round 1:</u> Approx. 600 MW <u>Round 2:</u> 363 MW <u>Round 3:</u> 400 MW
Pricing rule	Pay as bid, two-sided Contract for Differences. The winning bidder is remunerated the difference between his strike price and the pool price. This may entail payments from the generator to the AESO.
Award procedure	Price only
Price limits	**Ceiling price:** a privately kept affordability threshold that the AESO and the GoA may use to determine accepted volumes and next steps.

Support period	**Contract term:** 20 years
Favourable treatment of specific actors	No
Realization time limit	<u>Round 1:</u> December 1, 2019 <u>Round 2 & 3:</u> June 30, 2021
Penalties	In case the generator fails to achieve commercial operation by the target COD (date for commercial operation) the support period will be shortened for each day of delay on a day-for-day basis. When the generator fails to achieve commercial operation by the COD longstop date (18 months after the target COD), the AESO can terminate the RESA. In this case, the generator must pay, as liquidated damages, a sum equal to the completion and performance security (CAD 50,000 (USD 37,675)) per MW, calculated based on the contract capacity of the project).
Way of monitoring progress of realisation	Quarterly progress report by the generator.
Form of support auctioned	**Indexed Renewable Energy Credit,** managed through the Renewable Electricity Support Agreement RESA. **Contract Price:** RESA will forward a support payment to the electricity facility that equals the difference between the strike price and the pool price multiplied by the metered electricity generated by the facility. This metered electricity will, however, be capped at the contracted capacity. The electricity facility will receive the support payment per hour aggregated at the end of the month. **Payment:** For this time frame (each hour any month) there are two scenarios with respect to the direction of payment flows. In case the calculated difference between the strike price and the pool price is positive, the AESO shall pay this amount to the generator. If the difference is however negative, (i.e. the pool price is above the strike price), the generator shall pay the absolute value of this amount to the AESO. The settlement for each month is hereby scheduled on the same date on which the power pool settlement occurs under ISO rules.
In case of premium schemes describe the method of reference wholesale price calculation	-
Support level adjustments	20% of the strike price, which is an approximation of the percentage allocated to operation and maintenance costs, will be adjusted in line with the Consumer Price Index (Alberta, all items) (CPI).

Transferability of support right	Generator Assignment Prior to Commercial Operation: Before the commercial operation of the facility, the generator may not assign any of its rights or benefits without the consent of the AESO. Assignment After Commercial Operation by Either Party: Either party can assign its rights and benefits with prior consent of the other: • Generator Assignment to Affiliate: The generator can assign its rights and benefits to an affiliate acquiring the facility, given that the affiliate becomes bound by the terms of the RESA and provides the required security. • Assignment by the AESO: The AESO can assign its rights and benefits without the consent of the generator, given that the assignee agrees to be bound by the agreement.
Other	The design elements and auction framework were developed on the basis of comprehensive stakeholder consultation conducted by the AESO. All three rounds were overseen by an independent third-party Fairness Advisor to ensure they were administered in a fair and transparent manner and adhered to all confidentiality requirements, policies and guidelines.

2.2 Outcomes of Alberta's REP Auctions

Table 3: Auction outcomes based on (AESO, 2019c).

Characteristics of the auction round 1	Description
Prices	Lowest renewable electricity price in Canada until this point, with a weighted average price of CAD 37.35/MWh (USD 28.14).
Awarded volume/submitted volume	**Awarded Volume:** Approx. 600 MW, 200 MW more than planned due to better-than-expected bid prices for developers.
Level of competition	Twelve proponents submitted bid prices for 26 projects in the RFP stage. Three bids were awarded on Dec 13, 2017: • Proponent: **Capital power** Project: "Whitla Wind" Capacity: 201.6 MW • Proponent: **EDP Renewables Canada Ltd.** Project: "Sharp Hill Wind Farm" Capacity: 248.4 MW • Proponent: **Enel Green Power North America Inc.** Project: "Riverview Wind Farm" Capacity: 115 MW Project: "Phase 2 of Castle Rock Ridge Wind Power Plant" Capacity: 30.6 MW
Characteristics of the auction round 2	**Description**
Prices	New record on the most cost-effective utility-scale renewables programme. The weighted average price is CAD 38.69/MWh (USD 29.15).
Awarded volume/submitted volume	**Awarded Volume:** 363 MW
Level of competition	Nine Proponents submitted bid prices for 18 projects in the RFP stage. Five projects were awarded on Dec 17, 2018: • Proponent: **Capstone Infrastructure Corporation** Project: "Buffalo Atlee wind farm 1,2 & 3" Capacity: 48 MW • Proponent: **EDF Renewables Canada Inc.** Project: "Cypress Wind Power project" Capacity: 201.6 MW

	• Proponent: **Potential Renewables Inc.** Project: "Stirling Wind project" Capacity: 113 MW
Characteristics of the auction round 3	Description
Prices	CAD 40.14/MWh (USD 30.25)
Awarded volume/submitted volume	**Awarded Volume:** 400 MW
Level of competition	Eight Proponents submitted bid prices for 15 Projects in the RFP stage. Three projects were awarded on Dec 17, 2018: • Proponent: **TransAlta Corporation** Project: "Windrise project" Capacity: 207 MW • Proponent**: Potential Renewables Inc.** Project: "Jenner Wind Project 1" Capacity: 122.4 MW Project: "Jenner Wind Project 2" Capacity: 71.4 MW

3 Evaluation of Auction Results

3.1 Efficiency

The REP's support programme has reached high levels of efficiency over the course of the three auction rounds. The three REP rounds have procured a total of 12 individual projects at bid prices as provided below:

Table 4: Round Result Overview

	Average Weighted Bid Price / MWh	Minimum Successful Bid Price / MWh	Maximum Successful Bid Price / MWh
Round 1	CAD 37.35	CAD 30.90	CAD 43.30
Round 2	CAD 38.69	CAD 36.99	CAD 38.97
Round 3	CAS 40.14	CAD 38.60	CAD 41.49
2018 YTD Pool Price	~ CAD 51.00		

All of Alberta's REP rounds have been highly competitive in comparison to global bid price trends in onshore wind auctions (see Figure 3: Global Bid Price Trends in Onshore Wind Auctions in Comparison to REP Round Weighted Averages and Bid Ranges, own computation based on Wind Power Monthly (2019).) and at record levels for Canada. Lower bid prices in an onshore wind auction were only observed in Brazil (Lucena & Lucena, 2019; Wind Power Monthly, 2019).

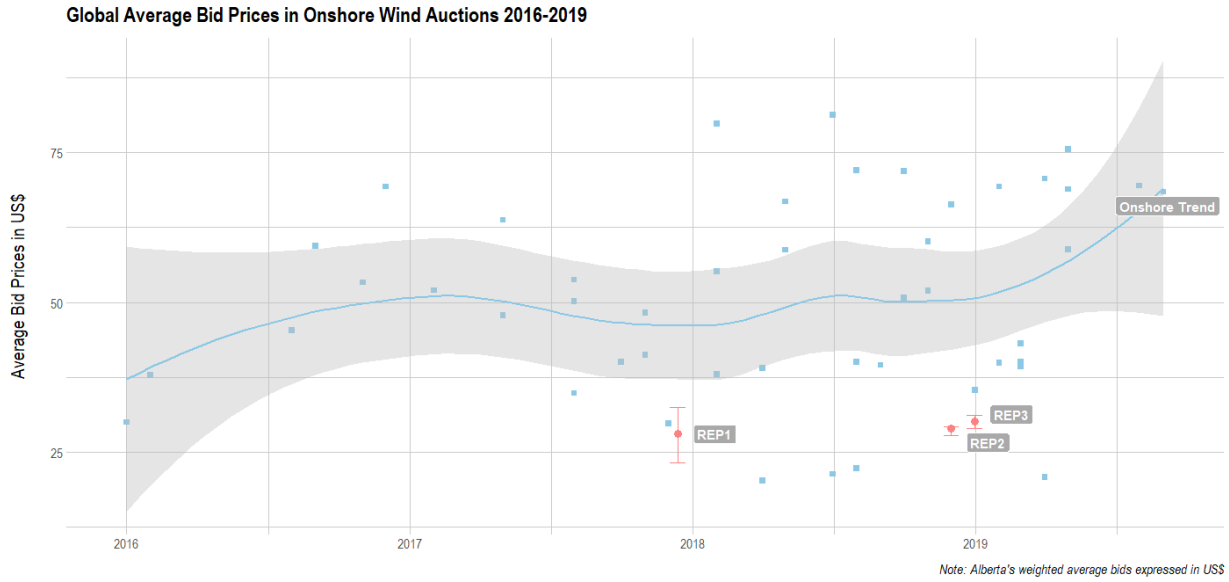

Figure 3: Global Bid Price Trends in Onshore Wind Auctions in Comparison to REP Round Weighted Averages and Bid Ranges, own computation based on Wind Power Monthly (2019).

Low bid prices as seen in all three REP rounds are most likely the result of market pressure inflicted by significant levels of competition and an efficient distribution of perceived risks. Round 1 attracted bids from 12 proponents, suggesting 26 projects. The second and third rounds, which were implemented in parallel, featured 9 bidders with 18 project proposals and 8 bidders proposing 15 projects, respectively. The number of potential bidders that had expressed interest in the REOI stages throughout all three rounds has ranged from 81 in the first- over 19 in the second- to 22 in the third round.

Clearly, REP round 1 has drawn the biggest interest from bidders in terms of the number of proponents and project proposals, and it is round 1 which has also procured the lowest MW/h price. Round 2 and 3 have been implemented in parallel, building on identical design elements (also to round 1), but with REP round 2 featuring indigenous ownership quotas. REP round 2 had seen lower bid prices than REP round 3 did. As such, differences in outcomes across REP rounds can only to a limited extent be attributed to changes in design elements between rounds, but have most likely stemmed from the interaction of the overall auction framework with changing external factors (such as the political climate, market price developments, etc.).

3.1.1 The Role of Transparency

Transparent auction design can drive down risk and uncertainties which project developers would otherwise incorporate in their bids (IRENA, 2015). As such, the high level of transparency as inflicted upon the REP scheme by the AESO's comprehensive stakeholder engagement efforts has likely contributed to driving down bid prices. On the other hand, AESO had been rather discreet with respect to future REP round schedules, in that it only ever disclosed interim energy mix targets (GoA, 2019). It is at least possible, that this lack of official signposting, in addition to the, at that time, looming change in administration, could have had an impact on bid prices especially in REP round 2 and 3. In the international context, it is normally the case that the higher the overall level of uncertainty, the higher the bid prices received.

3.1.2 The Choice of Payment Mechanism

A central determinant of the bid price in Alberta's REP auctions had also been the choice of payment mechanism. After diligent evaluation, the AESO had opted for a contract-for-difference scheme (CFD) over more rigid support schemes (AESO, 2019g; Hughes et al., 2017). From the perspective of the Government of Alberta, the CFD mechanism reduces budgetary burdens (as bidders not only loose eligibility for RESA payments when the pool price exceeds the bidder's strike price but have to pay the difference to the AESO). The scheme comes with the disadvantage of limiting the government's ability to anticipate and plan support costs. By setting a support ceiling (a privately kept affordability threshold in the Alberta case), the government sets the maximum volume of support it is willing to issue, but pool price fluctuations render robust estimation of the volume of support throughout the full support period difficult. From the perspective of project developers, the CFD scheme caters to one critical need: it effectively shifts the market price risk and opportunity (fluctuations in the pool price) away from generators to AESO. Under a more rigid support regime, where generators would bid for a fixed price premium on top of variable market price levels, bidders were required to internalise pool price fluctuations into their cost-revenue calculations. Through stakeholder consultations, potential generators had, however, signalled that this market price risk is one they find difficult to estimate and hence internalise, which would have likely raised prices in the auction and for end-users (AESO, 2019g). As such, the decision to implement a CFD scheme has certainly contributed to achieving high levels of efficiency in Alberta's REP auctions.

3.1.3 Eligibility of Projects in Development Stages and Betting on Rising Pool Prices

The eligibility of projects in the active development stage, while kept constant across REP rounds, has most likely heterogeneously affected competition levels in favour of round 1. By design, projects that had been permitted before the introduction of the REP scheme were able to benefit from the support scheme if they had not yet started commercial operation (Hughes et al., 2017). This has also been the case for project Phase II of Castle Rock Ridge in Pincher Creek, which entered the competitive process in round 1 while already being

under development. As such, round 1 saw higher levels of competition simply because fewer new renewable energy power projects took off following the introduction of the REP scheme without previously having successfully secured a RESA in one of the REP auctions.

The eligibility of development stage projects in the auction process can also bear risks related to adverse strategic behaviour, which may have artificially reduced bid prices in the REP auctions. It can be rational for projects under development to underbid their economic breakeven point (a strike price below marginal cost) if failure to secure the RESA would otherwise result in the incurrence of high sunk costs (because projects lacking support may need to be terminated, as they are unlikely able to compete with pool prices). Strike prices below marginal cost result in the incurrence of short-term losses, which would need generators to bet on rising market prices and falling technology costs in the future. Under the REP scheme, however, the developer can only ever turn his venture profitable when he is able to lower marginal generation costs to equal the strike price. Under the CFD regime, the rationale for engaging in strategic betting is as such, limited, as developers cannot hope for rising pool prices to recoup initial losses. This portrays an important strength of the CFD scheme, especially with respect to Alberta's coal phase-out plans: Even where pool prices are anticipated to rise, bidders have no incentive to underbid their economic breakeven point, as supernormal profits are not possible under the CFD regime.

3.1.4 Betting on Falling Technology Costs

In the three REP rounds, respective project lead periods were tightly defined, allowing for between two (REP round 1) and two and a half (REP round 2 and 3) years for implementation of successful project proposals, respectively. According to the AESO's analysis, transmission capacities were capable of catering to the needs accompanying such aggressive timelines. The AESO's REP scheme also ensured the sufficiency of existing transmission assets by directing new renewable energy projects to be located exclusively as such that they do not require extensive connection investments (AESO, 2019g). On the other hand, time constraints on obtaining legal permitting and documentation may had deterred some competition, and as such could have adversely affected the winning price levels.

To some extent it may be argued that the short lead times may not have necessarily been harmful. Looking at an admittedly quite extreme example, in Germany's 2017 offshore wind auctions, which had featured more extensive lead times (projects are required to start commercial operation by 2025), observed bid prices that significantly undercut expectations, because bidders had bet on market and technology developments anticipated to be evolving during the lead time, which is expected to render projects profitable (Hochberg & Poudineh, 2018). If and when project developers consider that favourable market conditions are not materialising, they can withdraw from support agreements, where penalties do not constitute a sufficient disincentive to remain from doing so. The lead periods as set out in the REP scheme have unlikely been the chief cause of such underbidding.

3.1.5 Grid Connection

In the REP auction rounds, the grid connection costs are borne by the generator. This increases the investment needs of project developers, which is usually reflected in bid prices. Further, the RESA sets out that generators are spatially limited to deploy capacity only where they can readily connect to existing transmission capacity (AESO, 2019g). In theory, such spatial restriction can negatively affect a project's efficiency (although not necessarily the system efficiency as a whole), as projects may not be developed where resources are most abundant. In practice, in Alberta, existing grid infrastructure coincides with the province's wind and solar resource-abundant regions (AESO, 2019a), such that the REP's limitations on project geographies have potentially had only marginal effects on bid prices.

3.2 Effectiveness

Renewable capacity expansion targets in all three REP auctions were oversubscribed. As such, an ex-ante analysis would currently arrive at the result that the effectiveness of the auction design should be assessed positively (Winkler, Magosch, & Ragwitz, 2018). With only lenient pre-qualification criteria as had been the case in the REP auctions, the effectiveness of the support scheme was only limited through generator's investment willingness and the AESO's support price caps, i.e., a privately held affordability threshold meant to assure the AESO's control over budgetary expenses. However, it must be taken into account that assessments of effectiveness certainly depend critically on an evaluation of realization rates.

The discontinuation of the REP scheme in 2019, and with it the implicit withdrawal of the declaration to support 5000 MW of additional renewable energy by 2030, allows for no firm evaluation of the overall effectiveness of the scheme beyond the potential capacity expansions stemming from the three auction rounds. Nevertheless, the aggregated 1363 MW that had been procured in the first year of the programme comprised already more than a fifth of what was initially planned until 2030.

3.3 Actor Diversity

Actor diversity in Alberta's REP auctions had been explicitly limited by the ≥5 MW project size restriction, which effectively discriminated against smaller actors. However, it is unlikely that many small-scale projects/developers would have been able to compete in the auction scheme, even where project size restrictions were absent. Bargaining power of energy industry companies and large corporations are commonly found to increase those bidder's competitiveness (Fell, 2019). This notion finds support in the awarded capacities in the three REP rounds: the successful project with the lowest awarded capacity had been the Castle Rock Ridge Wind Power Plant with a capacity 30.6 MW, which, however, is an extension to an existing plant.

An interesting aspect of Alberta's technology-neutral renewable energy auctions is the exclusive representation of wind projects among the successful proposals. This is contrasting experiences with mixed auctions in Germany (and Greece), where solar PV has repeatedly proven its ability to come out on top in direct competition to wind (Bundesnetzagentur, 2019). In Germany, the auction's technology concentration has likely stemmed from implicit technology biases imposed by the auction scheme. More precisely, the German framework does not allow for geographical adjustments that are common to Germany's wind only auctions (Germany's reference yield model does not apply) (Endell & Quentin, 2017). In Alberta, the technology bias is most likely also of implicit nature: A major determinant of the lack of competitiveness of solar PV projects is the significantly higher investment need for solar PV projects of capacities of above 5 MW, which would need to be reflected in bid prices. In terms of static efficiency, the REP scheme is a success. However, this notion fails to internalize the added benefits of balancing solar PV and wind generation (solar PV offering unique benefits as its production profile matches consumption behavior more closely), the strong and rapidly proceeding cost reduction dynamics of solar PV technologies (Kost et al., 2018), as well as the definitely growing opposition to the expansion of wind capacity (problems of the NIMBY variety) (Colton, Fast, Gattinger, Gehman, & Winter, 2016).

3.4 Indigenous Community Engagement

Alberta's Climate Leadership Plan (CLP) encourages a just and inclusive energy transition, that also takes the interests of indigenous communities into account. The province's auction scheme had incorporated these considerations into the second REP auction (and in the canceled 4th Rep round), which had the objective to procure projects that feature indigenous partnerships (GoA, 2018a). Explicitly, the auction design called for equity ownership of at least 25 % by indigenous people, which was to be maintained during a minimum time period of three years (AESO, 2019g). Through the reflection of interest of diverse stakeholders and especially indigenous communities, economic opportunities and benefits can be distributed in an inclusive and just manner, which is likely to undermine potential opposition and may help solve conflicts of interest over land and resource use (Lucas, Leidreiter, & Cabré, 2017; Nkoana, 2018). According to national news outlets, indigenous leaders welcomed the considerations offered in REP round 2 and were eager to invest in renewable

energy projects (Healing, 2018). The high threshold and the fact that community engagement is purely based on equity investment may, however, limit the effectiveness of the policy scheme and potentially fails to share benefits with those most vulnerable. But on the other hand, it (i.e. the high threshold and being based on equity investment) also reduces the degree of distortion in the auction outcome.

3.5 Post Realization Period

The implementation of awarded projects may be delayed or even terminated, as a result of force majeure, economic miscalculation, or for strategic reasons. Some of these risks can be mitigated where auctions are designed appropriately. A comprehensive analysis of the post realization period of Alberta's REP auction is not possible to date, given that successful projects from round 1 are not required to start commercial operation until the end of 2019. As such, Table 5: Post-auction phase for Projects that were awarded a RESA in Round 1 provides only an overview of how the REP scheme aims to ensure realization, as well as the current status of REP round 1 projects. The timely delivery of awarded capacity is central to the effectiveness of the scheme.

Table 5: Post-auction phase for Projects that were awarded a RESA in Round 1

Indicator	Description
Penalties actually applied	The Sharp Hill Wind Farm failed to meet its target COD which was December 1, 2019. Thus, the support period for this project will be shortened for each day of delay on a day-for-day basis. In case the generator fails to achieve commercial operation by the COD longstop date (18 months after the target COD), the AESO can terminate the RESA. The other three projects awarded in Round 1 developed according to schedule.
Realisation rate	- Whitla Wind (Capital Power) has connected a 202 MW generator effective on September 1, 2019, and is thus already under commercial operation (AESO, 2019f) - Sharp Hill Wind Farm (EDP Renewables Canada Ltd.) is still under construction. Its COD is delayed due to a drawn-out regulatory approval process. The facility is, however, expected to operate towards the end of 2020 – one year behind schedule (Gallant, 2019). - Riverview Wind Farm (Enel Green Power North America Inc.) has connected a 105 MW generator effective on November 1, 2019 and is thus already under commercial operation (AESO, 2019e). - Castle Rock ridge phase II Wind Power Plant (Enel Green Power North America Inc.) has connected a 29 MW generator effective on November 1, 2019 and is thus already under commercial operation (AESO, 2019d) Developers that had obtained a RESA in REP round 1 can receive support

	already since the 1st of April, 2018 (Electricity & Recommendations, 2017).
Change of ownership after realisation	In February 2018, Enel sold a minority stake of its two wind projects, Riverview (115 MW) & Castle Rock Ridge phase II (30.6 MW) to AIMCo • Enel and AIMCo signed an agreement for the sale of a 49% stake in the wind projects. The price for this stake will be finalised at the commercial operation of the wind farms. • Enel will build the projects and continue to operate them once completed with their remaining 51% majority ownership. • The transaction is expected to be finalised by the end of 2019 (Enel Green Power, 2018). There was no change in ownership for the other projects that were awarded a RESA in round 1.
Timeline of future auctions	Originally there had been plans to publish details on a fourth auction round in mid-2019 but due to a change in government the REP programme was discontinued and no further auctions will take place (AESO, 2019g)

3.5.1 The REP under Alberta's New Administration

At the time of writing it is generally understood that Alberta's new administration will continue to support projects that had been successful in REP rounds 1-3, and that already awarded contracts are not to be cancelled. This is good news on fragile grounds, as awarded RESAs feature an optional termination clause. In theory, the AESO is entitled to terminate the RESA at any time before the commercial operation date for respective REP rounds, "for any reason whatsoever or for no reason at all" (AESO, 2017). With the COD of REP rounds 2 and 3 laying well ahead (mid-2021), all that project developers can hope for is political goodwill.

4 Conclusions

Alberta's Renewable Electricity Programme (REP) had been highly successful in the three years since its initiation. All three REP auction rounds were oversubscribed, yielding record low strike prices for Canada and beyond. The overall success of the programme had, presumably, stemmed from the considerable preparation on which it was built, as well as from the diligent choice of payment mechanism. It is, however, too early to make definite claims about the effectiveness of the scheme, as only successful projects from REP round 1 have very recently reached COD. Nevertheless, promising is the fact that three of the four projects started operation without delays.

In future REP rounds, the AESO may have tackled the outstanding issues revolving around designing more technology-neutral support instruments, as well as the question as to how community engagement can become more comprehensive. On the other hand, the government of Alberta is running parallel schemes offering rebates on solar PV deployment and has recently seen a successful public-sector solar PV-only auction aimed at supplying the provincial government's electricity needs (Canadian Solar, 2019). The public sector project also heavily draws on indigenous community engagement via equity stakes. Whilst in general terms the engagement through equity stakes may not be the most effective at distributing benefits in a fair and inclusive manner, it represents a form of community engagement that is least likely to distort the outcome of the auction (i.e. to arrive at efficient support prices).

Finally, it is unclear why the RESA awarded in the REP scheme features a seemingly arbitrary termination clause which may leave developers in jeopardy. The new government has announced that signed contracts will not be cancelled, but for the moment, Alberta's current administration has also not given any specific indication of plans to revive the programme, or its components, any time soon.

5 References

AESO. (2016). *Renewable Electricity Program Factsheet*. (May). Retrieved from www.aeso.ca

AESO. (2017). *Renewable Electricity Support Agreement Round 1*.

AESO. (2018). *How is the Pool Price for Electricity Determined ?*813.

AESO. (2019a). *2019 Transmission Capability Assessment for Renewables Integration*. (March).

AESO. (2019b). About the program. Retrieved September 17, 2019, from https://www.aeso.ca/market/renewable-electricity-program/about-the-program/

AESO. (2019c). Capacity market update » AESO. Retrieved September 24, 2019, from https://www.aeso.ca/market/capacity-market-update/

AESO. (2019d). New Asset Castle Rock Ridge 2 (CRR2) Notice » AESO. Retrieved December 5, 2019, from https://www.aeso.ca/market/market-updates/new-asset-castle-rock-ridge-2-crr2-notice/

AESO. (2019e). New Asset Riverview (RIV1) Notice » AESO. Retrieved December 5, 2019, from https://www.aeso.ca/market/market-updates/new-asset-riverview-riv1-notice/

AESO. (2019f). New Asset Whitla (WHT1) Notice » AESO. Retrieved September 19, 2019, from https://www.aeso.ca/market/market-updates/new-asset-whitla-wht1-notice/

AESO. (2019g). Renewable Electricity Program. Retrieved September 2, 2019, from https://www.alberta.ca/renewable-electricity-program.aspx

AESO. (2019h). REP Program. Retrieved September 2, 2019, from https://www.aeso.ca/market/renewable-electricity-program/about-the-program/

Alberta MoE. (2019a). *REP Discontinued Direction Letter*.

Alberta MoE. (2019b). *REP Round 4 Direction Letter*.

Alberta Utilities Commission. (2019). Annual Electricity Data - Installed Capacity. Retrieved September 16, 2019, from http://www.auc.ab.ca/pages/annual-electricity-data.aspx

Barrington-Leigh, C., & Ouliaris, M. (2017). The renewable energy landscape in Canada: A spatial analysis. *Renewable and Sustainable Energy Reviews*, *75*(November), 809–819. https://doi.org/10.1016/j.rser.2016.11.061

Bode, S., & Groscurth, H. (2008). Incentives to invest in electricity production from renewable energy under different support schemes. *Arrhenius Institute for Energy and Climate Policy*, (March), 1–19. Retrieved from http://www.groscurth.eu/fileadmin/redaktion/pdf/arrhenius_DP_1E.pdf

Bundesnetzagentur. (2019). *Ergebnisse der gemeinsamen Ausschreibungen nach dem EEG*. Retrieved from https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2019/20190418_Ausschreibungen.html?nn=265778

Canadian Solar. (2019). Canadian Solar Won 94 MWp of Subsidy-Free Electricity Contracts in Alberta's Public Power Auction | Canadian Solar Inc. Retrieved December 5, 2019, from http://investors.canadiansolar.com/news-releases/news-release-details/canadian-solar-won-94-mwp-subsidy-free-electricity-contracts

Colton, J., Fast, S., Gattinger, M., Gehman, J., & Winter, J. (2016). Energy Projects, Social Licence, Public Acceptance and Regulatory Systems in Canada: A White Paper. *SSRN Electronic Journal*, *9*(20). https://doi.org/10.2139/ssrn.2788022

Electricity, R., & Recommendations, P. (2017). *AESO Renewable Electricity Program Key Provisions of the Renewable Electricity Support Agreement*. 1–16.

Endell, M., & Quentin, J. (2017). *RES Act 2017: New auction system with specific reference to onshore wind Content*. 53. Retrieved from https://www.fachagentur-windenergie.de/fileadmin/files/EEG/FA_Wind_RES_Act_2017_New_auction_system.pdf

Enel Green Power. (2018). Enel sells minority stake in two Canadian wind projects - enelgreenpower.com. Retrieved September 19, 2019, from https://www.enelgreenpower.com/es/medios/press/d/2018/02/enel-sells-minority-stake-in-two-canadian-wind-projects

Fell, H. (2019). *The Shift from Feed-In-Tariffs is Hindering the Transformation of the Global Energy Supply to Renewable Energies*. (1).

Gallant, C. (2019). Wind farm near Oyen suffering from approval process delays - Medicine Hat NewsMedicine Hat News. Retrieved December 5, 2019, from https://medicinehatnews.com/news/local-news/2019/09/25/wind-farm-near-oyen-suffering-from-approval-process-delays/

GoA. (2018a). *Climate Leadership Plan - Implementation Plan 2018-19*. (June), 18. Retrieved from https://open.alberta.ca/dataset/da6433da-69b7-4d15-9123-01f76004f574/resource/b42b1f43-7b9d-483d-aa2a-6f9b4290d81e/download/clp_implementation_plan-jun07.pdf

GoA. (2018b). *Renewable Electricty Act, SA 2016, c R-16.5*.

GoA. (2019). Long-term renewables plan powers jobs, investment | alberta.ca. Retrieved September 24, 2019, from https://www.alberta.ca/release.cfm?xID=62600ACA2C8C4-9C9C-1198-C73B9AB0471F6EDF

Healing, D. (2018). Indigenous leaders welcome chance to invest in Alberta renewable power auction | National Post. Retrieved September 24, 2019, from National Post website: https://nationalpost.com/pmn/news-pmn/canada-news-pmn/indigenous-investors-required-in-second-round-of-alberta-renewable-power-auction

Hochberg, M., & Poudineh, R. (2018). Renewable Auction Design in Theory and Practice: Lessons from the Experiences of Brazil and Mexico. In *Oxford Institute for Energy Studies*.

Hughes, C., Graham, C., July, C., Brown, A., Schubert, T., & Hand, E. (2017). EARTH, WIND, AND FIRE: POWER INFRASTRUCTURE IN ALBERTA'S NEW AGE CAMERON. *Management*.

IESO. (2017). What is the Market Renewal Program? Retrieved September 24, 2019, from http://www.ieso.ca/Market-Renewal/Background/Overview-of-Market-Renewal

IRENA. (2015). *Renewable Energy Auctions - A Guide to Design*. Retrieved from www.irena.org

Kost, C., Schlegl, T., Thomsen, J., Nold, S., Mayer, J., Hartmann, N., … Saad, N. (2018). Fraunhofer ISE: Levelized Cost of Electricity - Renewable Energy Technologies, March 2018. *Fraunhofer ISE: Levelized Cost of Electricity - Renewable Energy Technologies*, (March).

Lopez, J., Steininger, K., & Zilbermann, D. (2017). The Cannibalization Effect of Wind and Solar in the California Whole Sale Electricity Market. *Progress in Photovoltaics: Research and Applications*, *21*(1), 121–136. https://doi.org/10.1002/pip.1254

Lucas, H., Leidreiter, A., & Cabré, M. M. (2017). Renewable Energy Tenders and Community Empowerment: Latin America and Caribbean. *REN21 - Renewable Energy Policy Network for the 21st Century*, 60. Retrieved from http://www.ren21.net/wp-content/uploads/2017/09/LAC-Report.pdf

Lucena, J. de A. Y., & Lucena, K. Â. A. (2019). Wind energy in Brazil: an overview and perspectives under the triple bottom line. *Clean Energy*, *3*(2), 69–84. https://doi.org/10.1093/ce/zkz001

Nkoana, E. M. (2018). Community acceptance challenges of renewable energy transition: A tale of two solar parks in Limpopo, South Africa. *Journal of Energy in Southern Africa*, *29*(1), 34–40. https://doi.org/10.17159/2413-3051/2018/v29i1a2540

NRCAN. (2019). Renewable energy facts. Retrieved September 3, 2019, from https://www.nrcan.gc.ca/renewable-energy-facts/20069

Olexiuk, P., Saric, D., Lemke, K., & Barre, J. (2017). *AESO kicks off Renewable Electricity Program*. (September 2017).

Wind Power Monthly. (2019). Tender Watch. Retrieved from https://www.windpowermonthly.com/tender-watch

Winkler, J., Magosch, M., & Ragwitz, M. (2018). Effectiveness and efficiency of auctions for supporting renewable electricity – What can we learn from recent experiences? *Renewable Energy*, *119*, 473–489. https://doi.org/10.1016/j.renene.2017.09.071

AURES II is a European research project on auction designs for renewable energy support (RES) in the EU Member States.

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