CanSIA
CANADIAN SOLAR INDUSTRIES ASSOCIATION | L'ASSOCIATION DES INDUSTRIES SOLAIRES DU CANADA

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Honourable Margaret McCuaig-Boyd,
Alberta Minister of Energy
Transmitted electronically to: minister.energy@gov.ab.ca

16 November, 2017

Dear Minister McCuaig-Boyd,

RE: Solar Electricity & future Rounds of the Renewable Electricity Program (REP)

CanSIA is the national trade association that represents the solar energy industry throughout Canada. We have been an active participant in multiple stakeholder and engagement processes since and including the development of the province's Climate Leadership Plan. We laud the work of your Government to grow the economy while taking action, including the "30% by 2030" renewable electricity target, in support of Canada's national emissions reductions.

CanSIA believes that solar electricity will contribute meaningfully to the policy objectives of your climate leadership. Utility-scale solar electricity generation's story in Alberta does not span decades as does that of coal, natural gas and wind energy. Despite there being seventy (70) utility-scale solar electricity generation facilities with a total installed capacity of 3,100 MW_{AC} in the AESO connection queue (as of November 2017), Alberta's first solar farm will not begin commercial operation until later this year in Brooks. However, due to rapid solar cost declines in recent years, estimated at 71% between 2012 and 2017 falling to between $59 to $117 per MWh (reference: AESO Long-term Outlook 2017), we expect that solar's story in Alberta is just beginning. Furthermore, we expect that the price discovery from Alberta Infrastructure's Negotiated Request for Proposals (NRFP) for 135,000 MWh of solar electricity will demonstrate beyond doubt the financial viability of this new non-emitting supply option for Alberta.

However, despite the extensive solar project development activity underway in the province and increasingly cost-competitive pricing, it is CanSIA's expectation that if future rounds of the province's Renewable Electricity Program (REP) are structured as is the first, utility-scale solar electricity generation facilities will not be contracted for many years in the province. The reason for this is that the first round of the REP is structured to award low-cost without taking value into consideration.

The purpose of this letter is to present you with new research commissioned by CanSIA (please find enclosed "*Assessing Alberta's Renewable Electricity Program (REP): Solar Electricity, the "Indexed-REC" & Cost to the Carbon Levy*") that examines the procurement structure of the first round of the Renewable Electricity Program (REP), with a view to highlighting design elements

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that, if implemented for future rounds, would improve the program's efficiency.

In summary, the analysis found that: i) a solar facility contracted at $50/MWh would result in a payment to the Carbon Levy averaging $10 million annually, whereas a wind facility contracted at $50/MWh would result in a payment from the Carbon Levy of on average $7 million annually; and ii) solar power contracted at $90/MWh equates to the same total cost to government as wind power contracted at $50/MWh. These results do not imply that a MWh from one renewable resource is inherently better or worse for the market or system than another, just that they differ in value based on the time and location of their generation.

We hope that this research is valuable for your considerations on the design and implementation of future rounds of the REP to ensure that the technology-neutral playing field is level. If technology-neutrality is to continue to be a guiding principle for the REP, CanSIA recommends that both cost and value are considered when selecting winning bidders.

We would welcome the opportunity to discuss the results of this research with you further at a time convenient to you.

Best regards,

John Gorman
President & CEO
Canadian Solar Industries Association (CanSIA)

CC:

- Matthew Williamson, Chief of Staff, Office of the Minister of Energy
- Ben Thibault, Ministerial Assistant (Electricity), Office of the Minister of Energy
- David James, Assistant Deputy Minister, Alberta Energy
- Mike Fernandez, Assistant Deputy Minister, Alberta Environment & Parks
- Mike Law, Senior Vice-President and Chief Operating Officer, AESO
- Elizabeth Moore, Vice-President, Commercial, AESO

November 16, 2017

Assessing Alberta's Renewable Electricity Program (REP): Solar Electricity, the "Indexed-REC" & Cost to the Carbon Levy

Executive Summary:

This report was commissioned by the Canadian Solar Industries Association (CanSIA) to examine renewable electricity cost implications to the Carbon Levy of the "Indexed-REC' in the first round of Alberta's Renewable Electricity Program (REP) to procure 400MW of utility-scale renewable electricity.

In the first round of the REP, proponents of renewable electricity generation facilities propose a "strike-price" ($/MWh) that represents the payment they would receive for all electricity produced by their facility. Facilities with the lowest strike-price are contracted by the Alberta Electric System Operator (AESO). Using an "Indexed-REC" mechanism, when the power pool price is less than the strike-price, the generator is paid the balance (i.e. difference between the strike-price and the power pool price) from the Carbon Levy pool of funds. When the power pool price is higher than the strike-price, the difference is returned to the Carbon Levy.

Analysis was undertaken to examine the cost of electricity to the Carbon Levy through the "Indexed-REC" for various renewable electricity options using historic hourly power pool and generation data for years 2013 to 2016. The analysis found that: i) a solar facility with a strike-price of $50/MWh results in a payment *to the Carbon Levy* averaging $10 million annually, whereas a wind facility with the same strike-price *costs the Carbon Levy* on average $7 million annually; and ii) solar power with a $90/MWh strike price results in the same total cost to government as wind power with a $50/MWh strike price due to the former's generation profile weighted towards higher valued hours of the year.

These results demonstrate that facilities with the same strike-price can have widely different cost implications for the Carbon Levy. Low cost is certainly a desirable attribute for an electricity system. However, low-cost resources may individually provide little marginal system value. The most efficient approach would be to seek the highest net benefit, recognizing both value and cost, not simply ranking by cost alone.

The proposed method in the Climate Leadership Plan involved a competitively bid "adder" to the power pool price (a "REC"). This method would clearly differentiate the value of different generation profiles. It would also place significant market risk on investors in renewable electricity generation. In the absence of financial contracts to mitigate this risk, an alternative could be a "Benchmark-REC", where the contract settles between a strike price and a peer benchmark. This would mitigate market risk, while leaving the onus on the renewable developer to capture generation in hours valued higher than the benchmark. Future REP designs need to be modified to ensure that both a resource's cost and value are recognized when making procurement decisions.

1. Introduction

As part of its Climate Leadership Plan, Alberta set a goal to get 30% of its electricity from renewable resources by 2030.[1] In support of this goal, the Government of Alberta launched the Renewable Electricity Program (hereafter "REP"), an annual auction to procure a total of 5,000MW of utility-scale renewable electricity generation capacity by 2030. The first round of REP, which will contract 400 MW of capacity in December 2017, is *technology-neutral* meaning that any project that harnesses a renewable energy resource is eligible to compete against any other for the award of a contract.[2]

However, the REP is also *value-neutral* in the sense that competing resources are only differentiated by their cost, not their respective value. As a simple example, consider a facility producing all its electricity in the overnight hours when both demand and prices are low. Now consider a second facility producing all its energy in the peak hours of the day, where both demand and prices are high. Under the process for the first round of the REP, this superior profile of deliveries would not advantage the second resource: the two resources are differentiated only by cost. The implication of the lack of weight placed on value is explored in detail in this report.

2. Analysis

In this section, the cost-implications of the "Indexed-REC" are analyzed using representative solar and historical wind generation profiles. Solar and wind are compared as their delivery profiles present stark differences and the latter is expected to be the primary recipient of awards in the first round of the REP. Section 2a presents the hourly and seasonal generation profiles of solar and wind resources in Alberta used in the analysis; Section 2b illustrates the shape of power prices and the corresponding generation-weighted prices captured by the various resources; and Section 2c determines the cost implications to the Carbon Levy pool of funds at various Indexed-REC strike prices.

[1] The plan can be found at https://www.alberta.ca/renewable-electricity-program.aspx

[2] As defined in the Renewable Electricity Act, a renewable energy resource means "any energy resource that occurs naturally and that can be replenished or renewed within a human lifespan, including, but not limited to, (i) moving water, (ii) wind, (iii) heat from the earth, (iv) sunlight, and (v) sustainable biomass" [Bill 27 (2016), Section 1(l)].

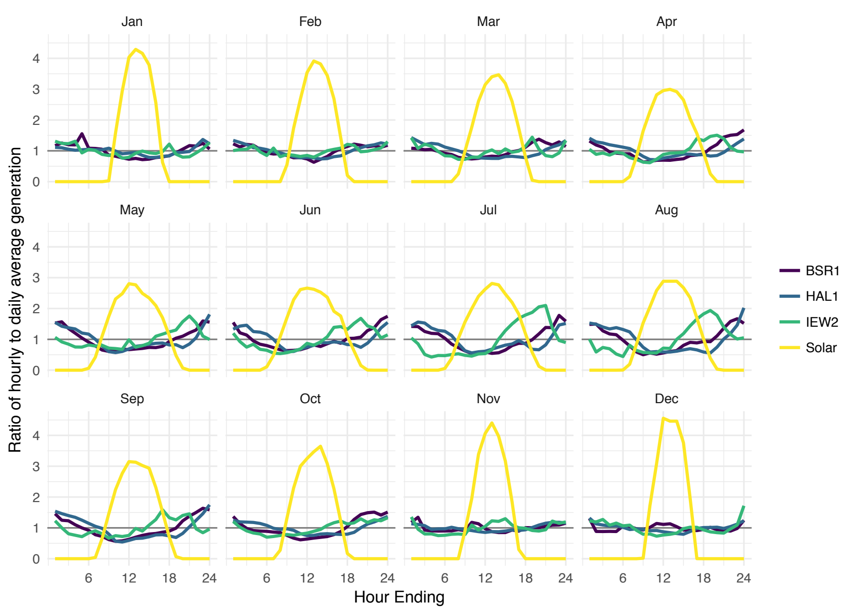
2a) Analysis: Benchmark Generation Profiles

In this section, benchmark hourly and seasonal generation profiles of solar and wind energy resources in Alberta are defined. For wind energy electricity generation profiles, three representative wind facilities are analysed, using data from 2013-2016: Summerview 2 (IEW2); Halkirk Wind Power Facility (HAL1); and Blackspring Ridge (BSR1).[3] Summerview 2 (IEW2) is located in Pincher Creek, an area of concentrated wind resources, and is likely indicative of facilities that will win the first round of the REP on account of higher capacity factors and lowest cost. Halkirk Wind Power Facility (HAL1) is located east of Red Deer and is included to highlight the difference in value due to being less correlated with the rest of Alberta's mostly-southern wind production. Blackspring Ridge (BSR1) is a newer, and the largest, wind facility in the province. BSR1 is located northeast of Pincher Creek area.

Due to the lack of performance data from operating solar electricity generation facilities, the benchmark solar generation profile, is modelled using the National Renewable Energy Laboratory's computer software "PV Watts".[4]

Figure 1 illustrates the hourly solar and wind generation profile across the 12 months of the year. The values plotted represent the ratio of generation in each respective hour to the daily average.

Figure 1: Hourly generation profile of wind and solar energy



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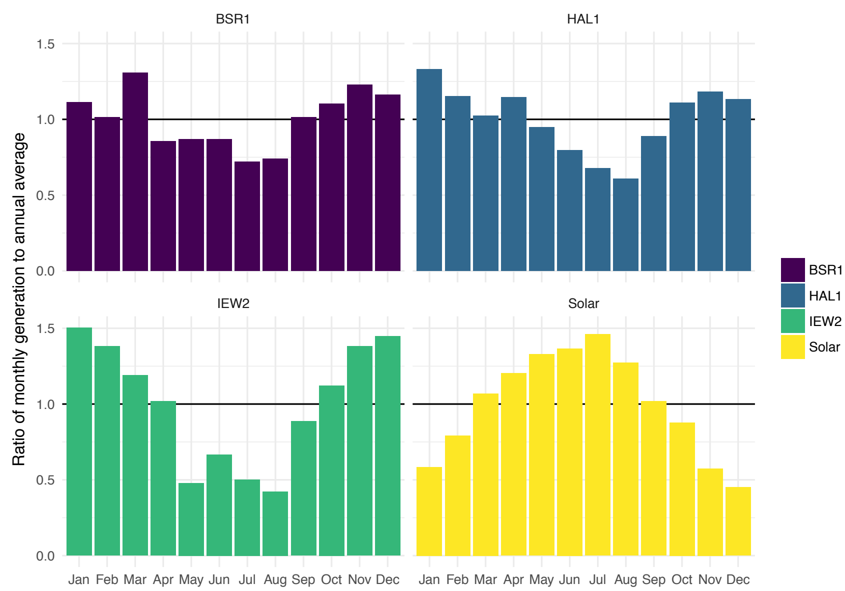
[3] BSR1 data begins in Apr 2014. 2016 data is through November.
[4] PV Watts is available online at PVwatts.nrel.gov. A Calgary location and pitch of 20˚ were assumed for the model.

The solar shape is pronounced and matches natural sunlight, peaking in the middle of the day and falling to zero in the overnight hours. The wind shape tends towards off-peak hours, where temperature gradients are larger and the wind blows more consistently.

The generation profiles of solar and wind also differ seasonally. Figure 2 plots monthly generation for solar and wind, normalized by their annual totals. Not surprisingly, solar generation is higher during the summer months whereas Alberta's wind generation is higher during the winter months. (This differs from Pacific NW wind facilities that tend to be at their highest during the spring months).

Figure 2: Seasonal profile of wind and solar in Alberta



2b) Analysis: Historic Power Pool Price Profiles

Currently, the Alberta power pool is a competitive energy-only market for electricity, with prices set based on the intersection of demand and supply for every hour of the year. The AESO is in the midst of developing a capacity market for Alberta, which will be run in conjunction with the energy market. The first capacity auctions are expected by 2019, with awards for a 2020/21 start.[5]

The energy-only market reflects the varying value of electricity for each hour of the year. Figure 3 plots the hourly profile of prices, by month, for 2013-2016. Not shown, but of note, in 2016 prices have been significantly flatter than in previous years due to an excessively large reserve margin for supply. Figure

[5] https://www.aeso.ca/market/capacity-market-transition/

4 presents the seasonal pattern of prices. While Alberta demand is winter peaking, the seasonal price pattern likely reflects outage (supply) driven seasonal price spikes over this time period (2013-2016).

Figure 3: Hourly profile of prices

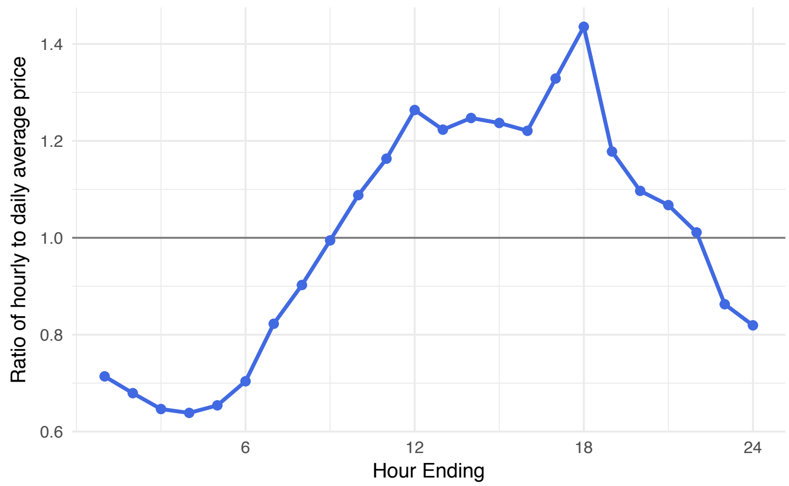
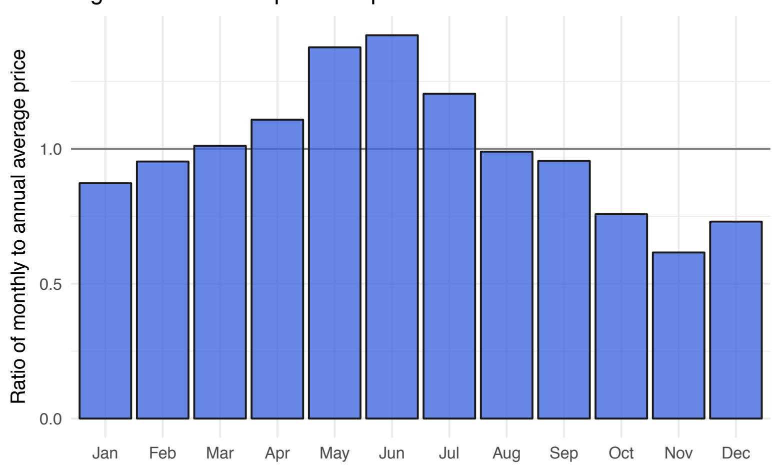


Figure 4: Seasonal profile of prices



The hourly and seasonal profiles of prices and generation suggest solar delivers energy in more valuable hours as compared to wind. This is borne out by a calculation of weighted average prices. Table 1 lists generation-weighted prices for solar and wind, as compared to simple annual averages from 2013 through 2016.[6]

[6] I use historical, rather than forward prices, because the critical component – hourly price shape – is not available on a forward basis. An alternative would be to project historical hourly shapes onto forward monthly prices, to the extent they are available.

Amongst the wind facilities, Halkirk generally has higher realized prices due to it being geographically distant from the bulk of Alberta's wind farms. This highlights the value, from a price perspective, of having production occur at times that differ with the bulk of the concentrated wind fleet. Averaging across all three facilities, the wind "discount" relative to average prices is roughly -$26 in 2013, -$17 in 2014, and -$10 in 2015. Solar captures a "premium" above the average power pool price ranging from $59/MWh in 2013, to $28/MWh in 2014, and $20/MWh in 2015. In 2016, low volatility in the power pool has resulted in neither the solar premium nor with wind discount being of much significance (plus and minus $2).

Table 1 - Simple average and generation-weighted prices ($ per MWh)

	Simple average	*Solar benchmark*	*Wind average*	*HAL1*	*BSR1*	*IEW2*
2013	80.19	139.08	54.15	60.35	n/a	47.95
2014	49.42	77.20	32.34	35.50	31.63	29.89
2015	33.34	53.55	22.73	24.82	22.73	20.65
2016	17.83	19.39	16.06	16.09	15.90	16.20

2c) Analysis: Indexed-REC costs to Carbon Levy

Having benchmarked solar and wind energy generation profiles, and defined their respective historic power pool price captures, the cash flows from an Indexed-REC are now analysed for each resource.

For this analysis, we normalize all facilities to be the *energy equivalent* of the 150MW, 34.5% capacity factor Halkirk Wind Facility. This avoids differences in REP cash flows simply due to level differences in prices and/or generation, and focusses on the role that the profile of generation plays in the REP calculation. Thus, all calculations are for facilities with a notional amount of 52 average MW of generation across the year, or roughly 455 gigawatt hours. For a solar farm, this would represent a facility of roughly 300MW capacity.

The REP cash flow is calculated as the difference between actual pool price and the REP auction clearing strike price, multiplied by the generation for each respective hour, then summed over all hours of the term[7].

$$REP = \sum_{t} Generation_t * (Strike\ Price - Actual\ Price_t)$$

Table 2 presents annual payments to/from the REP for solar and wind energy, for the years 2013 through 2016. From this table, we see the effect of price levels, price volatility and different generation profiles.

At high price levels, notably 2013, both wind and solar result in payments *to* the government. Solar's generation profile, however, results in a significantly higher payment ($40 million vs approximately $2.5 million averaged across Halkirk and Summerview in the $50 REP case).

In 2014 and 2015 we see a similarly large difference in REP payments between solar and wind of $14 to $20 million. In 2016, the difference is small (less than $1 million) due to very little price volatility resulting in limited value from the better shape.

Table 2 - Summary of REP cash flows for 52aMW-equivalent facility (annual $)

$50/MWh Strike-Price *(positive=cost to government)*

	HAL1	BSR1	IEW2	Wind average	Solar benchmark	*Difference between Solar & Wind*
2013	-$4,824,459	n/a	$925,841	-$1,949,309	-$39,882,314	*-$37,933,005*
2014	$6,696,106	$7,065,269	$8,847,688	$7,536,354	-$12,180,273	*-$19,716,627*
2015	$11,585,146	$13,054,524	$13,654,928	$12,764,866	-$1,587,342	*-$14,352,207*
2016	$12,589,271	$14,343,149	$13,645,476	$13,535,965	$12,707,759	*-$818,206*

[7] For example, if the strike-price is $50/MWh, and generation occurs in the off-peak, when prices are $15. The generator would collect $15 from the power pool for the physical sale of each MWh produced, and, additionally, the government would pay the generator $35 for that hour. If, however, generation occurs during a high-priced period, when prices are $75, the generator would receive the $75 from the power pool for their physical generation but pay the government $25 for each MWh produced. In both scenarios, the generator receives a net fixed price of $50. In effect, generators are no longer concerned with when they generate, simply how much they generate. Thus, for generation with lower realized prices, the REP becomes more beneficial.

$65/MWh Strike Price

	HAL1	BSR1	IEW2	Wind average	Solar benchmark	*Difference between Solar& Wind*
2013	$2,169,746	n/a	$7,684,010	$4,926,878	-$33,166,326	*-$38,093,204*
2014	$13,620,905	$12,835,898	$15,447,374	$13,968,059	-$5,464,286	*-$19,432,345*
2015	$18,487,386	$20,234,681	$20,632,636	$19,784,901	$5,128,646	*-$14,656,255*
2016	$18,157,436	$20,652,543	$19,700,861	$19,503,613	$18,934,870	*-$568,743*

Note: Positive values are payments to generators; negative (red) values are payments from generators. Values represent annual dollars for a "Halkirk energy-equivalent" facility, i.e. approximately 52 aMW or 455 annual GWh of energy. For solar, this is a roughly 300MW capacity facility. For smaller facilities scale down accordingly. BSR1 for 2014 is calculated from Apr-Dec and scaled up to an annual value.

Just how big are these technology-neutral "Indexed-REC" differences? One way to answer this is to consider what solar strike price would cost the government the same amount as wind under a $50 per MWh strike price for an equivalent amount of energy. In other words, how much more could the government pay for solar per MWh and receive the same amount of energy at the same total cost to the Carbon Levy pool of funds, given its superior generation profile?

The answer to this question differs by year. In years with more pronounced peak prices, the difference is greater. In 2013, the solar REP price equivalent to a $50/MWh REP for wind reached $133 per MWh. Table 3 lists these solar REP prices, by year, that match the cost of a $50/MWh REP for wind procurement. On average, a $90/MWh Indexed-REC for solar results in the same total cost to government as a $50/MWh Indexed-REC for wind over the 4-year period studied.

Table 3 - Wind-equivalent solar REP prices

	WIND REP	SOLAR REP
2013	$50	$133
2014	$50	$93
2015	$50	$81
2016	$50	$52
AVERAGE	**$50**	**$90**

3. Alternative recommendation

The design of the first round of the REP does not recognize the differing generation profile of facilities. As a result, it is expected to reward the lowest-cost, likely highest capacity factor wind electricity generation facilities in the province. These facilities will not be exposed to the problem that geographically-concentrated wind generation brings. Namely, as wind facilities locate near each other, they tend to be either on or off in unison (i.e. when the wind is blowing locally). This results in low prices when the wind is blowing, and high prices when it is not.

This negative relationship is likely to be amplified as more wind comes onto the system in a concentrated location. Under the "Indexed-REC' approach in the first round of the REP, wind generators are protected against this negative correlation between actual prices and their generation. Thus, it will be the government, through the Carbon Levy funds, paying an increasing amount as more concentrated variable generation exacerbates the discount to average prices. Diversity of resources, both in the form of geographically distributed wind as well as other resources, such as solar, dampen the correlation between individual generation and prices, ensuring resources deliver more system value and lessening the demands on the REP.

In order to prevent this situation, generators should be aligned with the actual prices received in the market, to some degree. The proposed method to do this in the Climate Leadership Plan involved a competitively bid "adder" to the power pool price. Facilities would receive the pool price when they generate, plus a fixed top-up. This method clearly differentiates value across different generation profiles, but also places significant market risk on renewable developers. In the absence of financial contracts to mitigate market risk, an alternative, which finds a middle ground in terms of risk, could be a "Benchmark-REC".

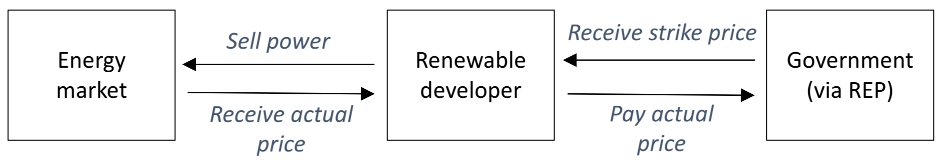
Similar to the Indexed-REC, the Benchmark-REC pays the difference between a fixed price, determined by auction, and a floating price. In this case, however, the floating price is not a facility's actual generation, but rather the weighted average of benchmark set of facilities.

The benchmark selection has many options. For example, it could be all prior REP-awarded facilities, or it could be limited to contemporaneously awarded facilities. Germany has recently transitioned from a Feed-in-Tariff style renewable procurement to an auction based mechanism that uses a "market-premium", akin to the benchmark-REC contract. They have chosen to set separate benchmarks for separate technologies to directly control the amount of procurement within each technology type. The benchmark could also be set regardless of technology so that facilities compete across technologies.

The reference period could be monthly averages to align with reasonable payment periods, or it could be annual averages to better incorporate seasonal differences.

The concept is illustrated below. First, we see the now-familiar Indexed-REC structure. The renewable facility sells power into the market, receiving their actual price, but then the Indexed-REC swaps that out for a fixed strike price. The net payoff is that the renewable facility receives the strike price.

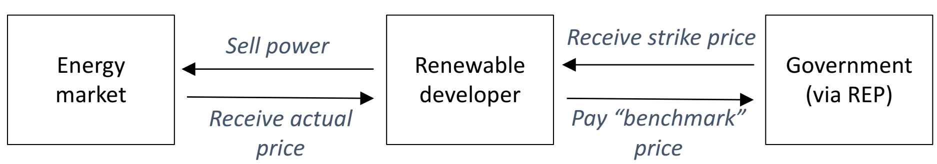
“Indexed-REC” design



Net Payoff: Receive strike price

Under the Benchmark-REC, actual price is replaced by the floating benchmark price. Now the net payoff includes a term for actual prices, thus creating some alignment between the developer’s returns and market prices.

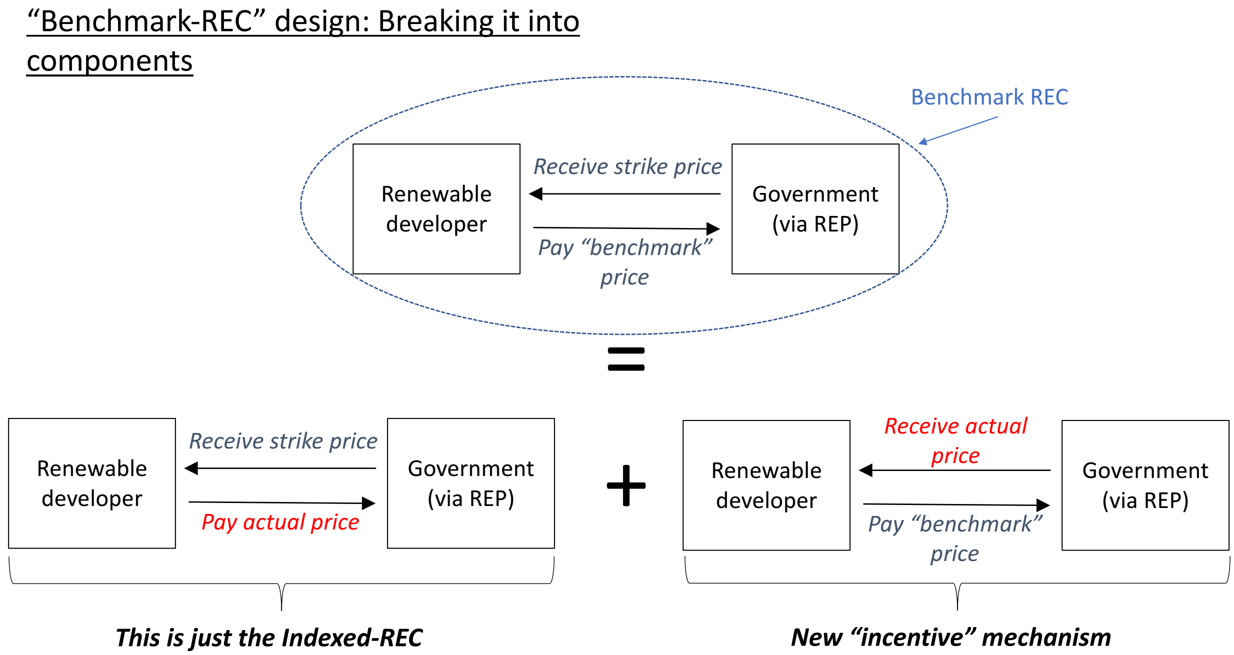
“Benchmark-REC” design



Net Payoff: Receive strike price + (Actual – Benchmark)

Incentive mechanism!

To provide more intuition for the concept, we illustrate by splitting the Benchmark-REC (circled in blue) into two components simply by adding and subtracting ‘Actual Price’ (below). In other words, the Benchmark REC which pays the difference between Strike Price and Benchmark Price is the equivalent to two contracts, the first paying the difference between Strike Price and Actual (bottom left), and the second paying the difference between Actual and Benchmark (bottom right).



We undergo this exercise to highlight the two specific roles played by the Benchmark-REC. The first piece, *Strike – Actual*, is simply the Indexed-REC itself. This mitigates general market risk for the developer. The second piece, *Actual – Benchmark*, is new. This piece creates an incentive mechanism for developers to "beat the benchmark". This provides benefits, and thus incentive, for wind facilities to locate in areas outside the concentrated region negatively correlated to prices, and for other technologies, such as solar, with superior generation profiles.

Importantly, the apportionment of risk is sensible. The Indexed-REC component mitigates general price movements, while the incentive mechanism component puts the onus on the renewable developer to capture generation in hours valued higher than the benchmark. The latter risk being best placed with the developer, as they are most in control of location and design considerations.

4. Conclusion

To conclude, low cost is certainly a desirable attribute of an electricity system. However, individually low-cost resources may provide little marginal system value. A better metric is to weigh marginal system value (to the extent they are reflected in hourly prices) vs cost. A ranking of resources would seek the highest *net* benefit between value and cost, not simply rank by cost alone.

The Benchmark-REC aligns the incentives of developers with the value of their energy to the system. And it does so without placing all market price risk in the hands of developers, potentially driving up costs due to higher required rates of return where financial instruments to mitigate the risk are lacking.

Future REP designs need to be modified to ensure that both a resource's cost *and* value are recognized when making procurement decisions. This is not to suggest first round award winners are unsuitable – the lowest cost resources likely rank within the best 5,000 MW, even from a value perspective. However, over time, the lack of connection between the price a facility receives and the value it provides will increasingly become a drain on the government's Carbon Levy pool of funds.

The government should strongly consider the Benchmark-REC for future REP auctions.

About the author:

Mr. Blake Shaffer has extensive experience in the electricity sector, having worked for 15 years as a senior trader at BC Hydro (Powerex), Lehman Brothers, Barclays Capital, and as Head Trader at Transalta Corporation. More recently, Mr. Shaffer served as a Policy Advisor for the Government of Alberta on various energy-related matters. He holds a MPhil (Economics) from Cambridge University and a BSc (Honours, Environmental Science) from Queen's University. He is currently completing his PhD in Economics at the University of Calgary.