1.0 **Reference: INFORMING DISTRIBUTED GENERATION RELATED FILING**
Exhibit B-1, p. 126; Exhibit B-2, BCUC IR 10.2; Exhibit C-10-6, p. 1; FortisBC Inc.'s (FBC) Application for a Community Solar Pilot Project, Exhibit B-1, pp. 6, 7, 13
Solar PV

On page 1 of Exhibit C10-6 Shadrack includes the following unit energy cost estimates:

- Kaslo NM#1 – 12kW Solar PV (self-installed): $65/MWh
- Kaslo NM #2 – 8.1 kW Solar PV (self-installed): $95/MWh
- Kaslo NM #4 – 7kW Solar PV (contractor installed): $175/MWh
- FortisBC Ellison Solar Garden: $463/MWh
- PPA Tranche 1 Energy – $46/MWh

FBC states on page 6 of its 2017 Application for a Community Solar Pilot Project (located at FBC's existing Ellison substation site) that the project has a capacity of 240kW and on page 7 provides the following table:

Table 4-1: Capital Cost Estimate

Item	Amount
Engineering and Construction	$ 858,284
FBC Communications & Consultation	42,500
Contingency	44,368
AFUDC	15,592
Project Total	**$ 960,744**

FBC estimates on page 13 of its 2017 Community Solar Pilot Project Application that the present value of the incremental revenue requirement for this project, divided by the present value of the annual kWh production over 40 years for the life of the array, results in a cost of $231/MWh.

FBC states in response to BCUC Information Request (IR) 10.2: "The Company seeks to neither advantage nor disadvantage DG regardless of size, type, or ownership."

FBC states on page 126 of its 2016 Long Term Electric Resource Plan Application that the long run market cost of portfolio A4 is $96/MWh.

1.1 Please explain why Shadrack assumed a 20-year solar PV life in the unit energy cost analysis, as opposed to the 40-year life assumed by FBC in the Community Solar Pilot Project Application.

Response:

Based on an initial discussion with customer-generator NM#1, who is a retired electrician by trade, it has been learned that a solar panel can deteriorate by up to 1% efficiency per year so that by year 20 the system should only theoretically create 80% of the energy that it did in year one. Thus in year 40 the system should only theoretically create 60% of the energy it did in year one.

The background document **1%/.5% Annual Solar PV Production Reduction over Twenty to Forty Years** actually shows that a 1% calculated reduction in production results in NM#1 producing 20.6% fewer kWh in year twenty-five and that the cumulative reduction from the 50 solar PV panels in kWh is the equivalent of .4% per annum.

Conversely, using FortisBC's own production reduction figures, at an annual step down rate of .5% as found in line 12 of Appendix B-1, only results in an overall reduction in production from the 720 panels in kWh of 17.7% over forty years and a cumulative reduction of only .23% per annum.

Subsequently I have found a generic BC Hydro calculation of pre-tax cost of capacity analysis that uses a 20 year "Economic Life" or "IPP Contract Life" scenario:

https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/info/pdf/info_iep_row_unit_cost_method.pdf

Consequently it is believed that FBC's proposed .5% decline in production over 40 years may be overly optimistic. Perhaps a question the Commission could ask FortisBC is: what is the manufacturer's warranty on their proposed solar PV panels.

In subsequent discussions I have learned that the panels purchased by Shadrack-Bauman have a life warranty of twenty-five years, which appears to be much closer to BC Hydro's amortization rate as identified to their customers on their website:

> "*Since 2004, over 900 customers have been participating in our net metering program.*
>
> *Over 95% of customers chose to install a solar photovoltaic system*
>
> *A typical home generally consumes 11,000 kWh/year. A typical solar installation on a residential roof is 4 kilowatt (kW) in size with 16 solar panels, which in B.C., generates 4,400 kWh of electricity over a year.*
>
> *On average, solar systems of this size can cost about $14,500. Based on BC Hydro's step 2 of its Residential Conservation Rate, payback on your investment is about 23 years (including savings from the Rate Rider and GST*" - (https://www.bchydro.com/energy-in-bc/acquiring_power/current_offerings/net_metering.html)

When Shadrack-Bauman purchased their 300 W panels in 2014 they were valued at $246.29 Canadian each, which is approximately 82 cents Canadian per watt. It is anticipated that the price per watt will continue to drop even further for solar panels over the next twenty years, as it is being reported from the US that a 64% decline in prices has occurred over the last five years. Further, and this may be true for FBC's proposed panels, it is anticipated that efficiency of solar PV panels is also going to improve considerably, as per information provided by Navigant Research and others.

So, at 79.4% efficiency at twenty-five years, and knowing how fast the industry is changing, it is not believed that a forty year amortization period is fiscally prudent, as the investor may actually want to change out the panels after twenty-five years or earlier to improve the efficiency of their system, especially if the panels themselves are half the price that they cost now.

Basically the industry will not run solar technology the same way that hydro technology has run and been refurbished, and a system like NM#1, for example, with fifty panels, could add one panel every two years to offset the loss in production at an additional cost of $176.25 per year, if the net metered energy to the customer was valued and priced appropriately by FBC.

Currently the way FBC values net metered power, and is now applying to structure the RS 95 tariff, it is highly unlikely that any customer-generator would want to maintain or increase their transfer of power to the FBC grid because it is not in their financial interest to do so.

1.1.1 Please recalculate the Kaslo NM#1, 3 and 4 unit energy cost ($/MWh) estimate using, where appropriate, similar assumptions as used by FBC in the Community Solar Pilot Project Application. For example, assume a 40-year life if the solar PV panels are similar.

Response:

Off Grid Cost @ 40 years

(NM#1 $38/MWh)
(NM#2 $65.7/MWh)
(NM#4 129.6/MWh)
Ellison Solar Farm $145.1/MWh

Off Grid Cost@ 20-25 years:

Kaslo NM#1 $56.5-$69/MWh
Kaslo NM#2 $97.9-$119.4/MWh
Kaslo NM#3 Not available as this system has not been operational for a year.
Kaslo NM#4 $235.6/$193.1/MWh
(Ellison Solar Farm $185.2-$216.1)

On Grid Cost @20-25 years:

Kaslo NM#1 $70.1-$82.6/MWh

Please refer to background documents: **Cost of NM#1 Solar PV System**, **Cost of NM#2 Solar PV System**, **Cost Of NM#4 Solar PV System**, **Update Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options**, **2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values** and **I%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years**.

A forty year amortization period for solar PV panels with a 25 year warranty is simply not fiscally feasible. Therefore the above costs per MWh use an approximately .4% annual reduction in solar PV production over a 25 year lifespan, which is believed to be more realistic than FBC's .23% per year production decline option over 40 years.

Based on the BC Hydro methodology
(https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/info/pdf/info_ie

p_row_unit_cost_method.pdf) I have re-calculated the Ellison Solar Farm UEC to include the $960,744 in capital costs plus $9,000 O&M that starts in 2019 with a 2% per annum rate of inflation. This has been a steep learning curve, so I may have missed some pertinent costs that others can add in subsequent to my submission.

Next, completely missing from FBC's production analysis is any factoring in of year to year variation due to availability of sunshine and the fact that temperature increase can lower production values. After one year's observations it is estimated that production of the Shadrack-Bauman system declines by between 1 kWh to 2 kWh per day once the temperature approaches 30 degrees Celcius. Temperatures are going to be even hotter in the Okanagan.

Climate information on Kaslo between 1920 and 2016, for example, indicates that precipitation has increased by 46.6%, 39% of that increase occurring between May and October, and that mean temperatures for January and February have risen by over 2 degrees Celcius and now reach an upper limit of 37.8 degrees Celcius in summer.

Finally, at a .4% decline in production per year, the question has to be asked as to whether the value of net metered kWh will rise sufficiently to allow investment in more panels to offset the decline in production. NM#1, for example, at a production decline of 7.7% between year one and year ten, could consider purchasing five more panels, one every two years, but that decision will be dependent upon whether or not FBC wants NM customers to maintain their level of production and transfer to the grid, and is prepared to pay an appropriate price for the power so transferred.

1.1.2 Does Shadrack consider that there are now, or could reasonably be over the next 5 years, customer owned solar PV installations that would have a unit energy cost to the customer: (i) lower than FBC's estimated long-run marginal cost of $96/MWh, or (ii) lower than FBC's PPA Tranche 1 Energy cost? Please explain.

Response:

Yes, self-built and self-installed net metered NM systems are already potentially at a price point where they can compete at the estimated long-run marginal cost of $96/MWh. However, at a twenty-five year amortization period, NM#4, in 1.1.1 above, indicates that installed solar PV is still 2 times higher than FBC's current long-run marginal cost (LRMC) of $96/MWh. In addition it is not feasible to lower those costs with a forty year amortization with panels that have a twenty-five year warranty.

That said, it is noted that solar PV costs have dropped 64% in the US over the last five years. Therefore it is believed that what is far more likely to happen, much like the cost of automobiles declined as mass production took off, is that the price per watt will continue to decline and thus newer systems like NM#4 and NM#3 will achieve parity with FBC's LRMC, but for different reasons than extending the amortization period to forty years.

We already know that solar PV at price per watt is outcompeting coal in open bidding in India and China, and that the market price of solar PV is now drawing level with natural gas, fracked or otherwise, in North America, and has already surpassed coal a long time ago.

So, beyond any socio-politico considerations of renewables vis a vis reduction of our carbon footprint in British Columbia and Canada, the cost benefit analysis now clearly indicates that a market case can be made for solar PV as an option to be considered in

Long Term Electric Resource and Long Term Demand Side Management Plans.

Next, in terms of NM#1 and NM#2, as stated to BCSEA IR#1.1.5, 11 of 15 (73%) NM installations in north Kootenay Lake are partially or completely self installed and 2 (13%) are known to have self-hooked up to the grid as well. What we do not know is what percentage overall of FBC NM and BC Hydro NM customer-generator installations are self-built and self-installed.

In this context NM#1, at a twenty-five year amortization rate, comes in at approximately 59% of the LRMC value, and NM#2 at 2% above the LRMC value. NM#1's off grid cost, at a twenty-five year amortization rate, is still 20.6% more expensive than the actual cost of FBC's PPA Tranche 1 energy in 2016, and is 46.9% above 2016 market prices as well (as found in Shadrack IR#1.10.iii for 2016 actual costs).

Completely missing from this analysis, however, and I am not sure how to calculate it in the full costings, is any valuation for the fact that FBC pays no fixed costs for accepting transfer of and/or purchase of net metered power, and, in addition, has no line loss costs if the electrical power is consumed in the neighbourhood where it enters the grid.

Clearly, comparing PPA Tranche 1 and market power purchases, and even FBC-produced power with net metered power, is a bit like comparing the price of apples and oranges, as net metered electrical power comes with both a line loss premium and virtually no transmission costs to the point of sale to the customer.

Therefore a much more important immediate consideration is the potential integration of renewables, DG and NM specifically, into the LTERM and LTDSM plans, when comparing twenty-five year NM#1 and NM#2 UEC amortization costs with those stated by FBC for DSM in Shadrack IR#1.10.v. In terms of cost comparisons, NM#1 outcompetes DSM actual costs for 2015, 2014 and 2013, "Incremental Costs" at the Base, High and Max plan levels, and is within the range for High and Max "UEC average" costs, and NM#2 at the High and Max "Incremental Cost" plan levels.

This absolutely confirms that, as a first step, FBC needs to start considering renewables, DG and NM, as part of a suite of DSM and conservation tools and options, rather than simply seeing NM as an orphan program, an anomaly, that has little or no financial value to the Company and all its customers.

And in this instance it needs to be reiterated what was stated to BCSEA in response to their Information Requests: that the NM#1, NM#2 and NM#4 UEC values quoted in 1.1.1 above are in primarily off grid costs, not the UEC values if a customer-generator is currently enrolled in FBC's Net Metering (NM) program. Please carefully review and consider background document **2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values**.

In 2016, NM#1, for example, produced 1.273 MWh more electricity than was purchased from FBC, but still ended up paying FBC a net $148.23 over the six billing periods for that year. This effectively amounts to a production surcharge or program enrollment fee to the customer-generator in FortisBC's net metering program.

FBC refers to it as a part of their required Basic Charge (and the GST) and actually wants to propose increasing the Basic Charge even more for NM customers in the next rate design application. But for NM#1 the additional cost amounted to a surcharge of 1.36 cents for every kWh they transferred to the FBC grid in 2016.

So the actual UEC for NM#1 as an enrolled customer in FBC's NM program ranges from $70.1-$82.6/MWh, depending on the amortization period, and if FBC's application to lower the Net Excess Generation (NEG) purchase rate to the PPA Tranche I values of between 4.7 cents and 5.6 cents were to be so ordered as the new rate for tariff RS95, the UEC value for NM#1 in 2016 would rise again to between $75.6/MWh and $89.2/MWh.

If the NM program is to be incorporated into the LTERP and/or the LTDSMP, the price point that FBC pays for net metered energy needs to be settled - in relation to whether a customer will be allowed to cover all of their annual costs of service delivery, before a different NEG price for excess generation kicks in, and even whether consistent NEG generation is allowed at all, especially if the intent is to expand the NM program as part of a suite of LTERP and LTDSMP options to be considered.

No customer-generator is going to want to enroll in a program from which they can be expelled/removed if they consistently produce NEG and/or into a program where the price for which they believe they contracted to produce electricity is reduced after they made their long term investment and commitment to enroll in FBC'S program.

1.2 Does Shadrack consider that, once solar PV panels are installed by a customer, the energy produced should be considered a long-term or short-term source of electricity? Please explain.

Response:

Customer-generated solar PV, indeed any renewable production under the NM program in aggregate, should be considered as part of the long term supply. This can be demonstrated by reviewing the impact that enrollment in a Net Metering program in the BCH Lardeau service area has had on a long term supply contract between FBC and BC Hydro, where wholesale sales dropped by approximately 1.6% annually between 2015 and 2016.

FBC has a wholesale contract with BC Hydro to supply power to the BCH Lardeau service area at the north end of Kootenay Lake. In BCUC IR#1.16.1 and Shadrack IR#2.18.ii, FBC provides data on the number of GWh wholesaled to this service area annually.

In March 2016 BC Hydro confirmed that they had 6 Net Metering customers within this service area with a solar PV nameplate capacity of 66 kW, and that according to BC Hydro's production formula these systems should have produced an aggregate of 66 MWh of electricity annually.

In April 2017 a Backwoods Solar representative confirmed that 8 persons were now net metering within this BC Hydro service area as of 2016 with a nameplate capacity of 80.8 kW, which again, using BC Hydro's production formula, should have created an aggregate of 90 MWh of electricity annually.

It should be relatively simple to cross-reference the names given by Backwoods Solar with BC Hydro's billing records to determine the exact aggregate amount of electricity transferred from these solar PV systems to BC Hydro's grid in 2016.

What was observed when FBC's response to BCUC's enquiry in IR#1.16.1 was first read, having previously learned from BC Hydro that there were 6 customers generating an aggregate of 66 MWh of solar PV electricity in 2016, was that the actual wholesale consumption dropped by .1 GWh between 2015 and 2016.

That, if the math is correct, is approximately 100 MWh, which is awfully close to the hypothetical 90 MWh that BC Hydro estimates could be generated by the 80.8 kW that Backwoods Solar believes is installed and net metering in the BCH Lardeau service area.

While it is understood that there are all kinds of reasons why the volume of a load may drop in any given year, and that wiser heads might have a more plausible explanation for the difference in variance and the percentage of difference in variance in BCH Lardeau between 2015 and 2016 (in FBC's response in BCUC IR#1.16.1), at least the Commission now has a discrete service area within BC where it can track the number of NM participants, the volume of MWh transferred each year to the grid from those customer-generators, the actual amount of solar PV production that is consumed by a given household and whether the long term volume of the load supplied by FBC to BC Hydro is lower as a result of NM aggregate transfer of electrical power to the grid.

It is believed that in the long run the empirical evidence will show that NM solar PV electricity, even acknowledging that it is intermittent on a daily basis, is reliable and firm within a specific billing period and annually, and therefore should be included within the LTERP and the LTDSM plans.

1.3 Does Shadrack consider that FBC is treating customer owned investments in solar PV on a level playing field with utility owned investments in solar PV? Please explain.

Response:

I'm not sure I'd use the term "level playing field", which might imply that FortisBC is somehow being purposely unfair to customer-owned investment. Instead I would start by agreeing with BCSEA's expert witness, Mr Grevatt of Energy Futures Group Inc when he proposes:

"...*that Fortis* [should] *modify its transmission planning process to consider non-wires alternatives' to construction, including aggressive energy efficiency and demand response initiatives, on an equal footing with traditional poles and wires solutions.*

In addition, Fortis should assess its expected distribution upgrade projects to determine if there is potential for deferment through the use of targeted DSM".

In the above noted context, FBC has made an application to expend $960,744 on the Ellison Solar Farm in Kelowna, and yet, at Shadrack IR#2.24.iii, the Company provides a table that shows that there are no fixed cost expenditures associated with the purchase of net metered electricity.

Why would a corporation want to set up a capital investment situation that would cause it to propose selling the power generated from this facility at 23.1 cents per kWh (presumably in order to make an adequate return on that investment), when it could actually receive/purchase power from its own net metering customer-generators for 10.117 cents per kWh and then resell that power at Tier 2 residential rate of 15.198 kWh and still make a return on the purchase of customer-generated electricity, without spending a nickel on fixed capital investments and O&M expeditures?

As Energy Futures Group Inc observe:

"*Fortis should perform a thorough analysis of both system-wide and geographically targeted DSM alternatives to future proposals for transmission and generation investments.*

Fortis should determine how much and what kinds of DSM (including demand response) would be needed to defer any future investments driven by growing demand."

Energy Futures Group Inc then goes even further and observes:

"*The Regulatory Assistance Project (RAP) states:*

'First, energy efficiency measures typically provide significant savings at the time of the system peak demand, and that time occurs when the line losses are highest.

The avoided line losses can add as much as 20% to the capacity value measured at the customer meter".

In contrast, when asked precisely about FBC's assessment as to the role of DG and NM in particular at Shadrack IR#1.4.ii:

"*Please list the documents and reference the sections where FBC has previously provided to the BC Utilities Commission cost-benefit analyses of the overall positive and negative financial and system stability attributes of Distributed Generation (DG) and Net Metering (NM) in particular.*

Response:

FBC is not aware of any such submissions to the BCUC".

And again at Shadrack IR1.6.v:

"*Has FBC considered a pilot program offering incentives to customers in remote and rural areas to install their own self-generation, such that the cost of electricity is offset, thus reducing overall cost to FBC and non-participarting NM customers?*

Response:

FBC has not considered such a pilot program. The question is focused only on costs, without considering the revenue that would be lost as a result of the load reduction. At the level of rates and cost for energy as they currently exist, and will exist for the foreseeable future, the loss of load as described would lead to an increase in rates to all customer".

Clearly FortisBC has not thought through the potential of purchasing customer-generated electrical power that comes without the cost of having to transmit it and without any line losses, as it can be sold directly in the neighbourhood where it enters the grid.

Between 2014 and 2016 the Shadrack-Bauman household consumed .8 MWh less grid electricity than before enrollment in FBC's NM program. If each of the 1,000 or so British Columbians enrolled in BC Hydro and FBC's NM program accomplished the same reduction on aggregate, they would consume 800 MWh less - .8 GWh less grid electricity.

Further, the Shadrack-Bauman household in 2016 also offset (transferred onto the grid from the NM system) 1.2 MWh of electrical power, and again, if each of the 1,000 households accomplished the same aggregate transfer, that is 1.2 GWh of power. The combined reduction in grid consumption represents 2 GWh of power annually from the production of just 1,000 NM customers.

So the issue of concern is not social, it is not even environmental, nor is it about creating a level playing field between Company and customer. It is about asking why would any company invest $960,744 to build a solar farm and pay an additional $524,206 in O&M to run it for forty years, only to sell that electrical power back to customers at 23.1 cents per kWh, when the Company could access 2 GWh of electrical power from 1,000 FBC NM customers, either at par with their pre-existing retail rates, or in the case of NEG, start at 10.117 cents per kWh and never ever exceed the Tier 2 rate of 15.198 cents per kWh?

Further, as stated previously, the 2 GWh of power comes with no fixed investment costs attached and no O&M costs, if it is used in the neighbourhood where it is transferred, and there are no line loss costs either. And if it is available during peak consumption, as is the case with any micro-hydro system year round, it comes with, according to Energy Futures Group Inc, a 20% premium on the amount and value being transferred.

So the answer to your question is no, this is not about having a level playing field between FBC and its customer-generators (though that would be a nice side-effect). Rather, it is about investing in an energy future that makes economic sense, not just for FBC, but for its customer-generators and all of FBC's other customers too.

It is about thinking outside the traditional electrical box, and about true consideration of a partnership with customer-generators to achieve energy self-sufficiency and conservation while simultaneously promoting small scale economic development in the remoter parts of rural BC and FortisBC's service area. This is after all a Company that generates less than 50% of its customer's required energy demand.

It is time, long overdue, to implement the original vision outlined by Premier Campbell as embodied in the *Clean Energy Act* and incorporated, through amendment, into the *Utility Commission Act*.

In their letter to the Commission on May 18th, 2016, seven FBC Net Metering customer-generators (6 from Kaslo and 1 from the Slocan Valley) asked the FortisBC Inc. Net Metering Program Tariff Update hearing panel to consider:

"*How could the program, as it is currently constituted, be tweaked to work to the mutual benefit of both customers and FortisBC, and within the mandate of the BC Utilities Commission?"* (E-2, FortsBC Inc Net Metering Tariff Update Program).

FBC currently has an application before the Commission to build a solar PV farm that would retail .28 GWh of electrical power in 2018 to its customers at 23.1 cents per kWh. Meanwhile 160 FBC NM customers are facing the possibility that the Company might succeed in lowering the amount paid for Net Excess Generation to 4.3 cents per kWh. At a hypothetical production level of 2 MWh per NM customer-generator, these 160 customers could be producing .32 GWh annually.

Why does FBC not set up a joint partnership with its NM customer-generators to market solar PV power at a blended rate of its solar farm price, and what it is currently paying for NM power at the current retail rate, which would likely lower the solar PV price to the Tier 2 residential rate of 15.198 cents per kWh?

As of 2016 in Idaho, for example, 45,000 homes have installed 359.3 MW of solar PV, at nearly 8 kW each, and are generating .61% of the state's grid electricity. It is time BC utility companies joined in on what is going on all across North America and the planet.

1.0 Reference: Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options

Exhibit C10-6, page 1

Mr. Shadrack provides a modified version of Table 8-1 from the LTERP that includes the addition of items related to four of FBC's Net Metering (solar PV) customers in Kaslo, B.C. and FBC's proposed Community Solar Pilot Project facility.

Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options

Resource Option	Unit Energy Cost ($MWh)	Unit Capacity Costs ($KW-year)
PPA Tranche 1 Energy	$46	N/A
PPA Capacity	N/A	$96 - $115
Gas - Fired Generation (SCGT)	N/A	$80 - $143
Market Purchases	$38	$169 -$355
Kaslo NM#1 – 12 kW Solar PV*	**$65**	**($1,333)**
Kaslo NM #2 – 8.1 kW Solar PV*	**$95**	**($1,728)**
Pumped Hydro Storage	N/A	$217
Gas - Fired Generation (CCGT)	$82 - $100	$147 - $279
Biogas	$77 - $101	$621 - $838
PPA Tranche 2 Energy	$85 - $130	N/A
Municipal Solid Waste	$134	$1,031
Onshore Wind	$111 - $145	$1,219 - $1,618
Run - of - River Hydro	$87 - $150	$1,230 - $1,924
Kaslo NM #4 – 7 kW Solar PV*	**$175**	**($2,570)**
Solar	$169 - $184	$1,399 - $1,413
Wood - Based Biomass	$118 - $188	$663 - $774
Similkameen Hydro Project	$202	$1,298
Geothermal	$132 - $217	$857 - $1,506
FortisBC Ellison Solar Garden**	**$463**	**$670**
Kaslo NM #3 – 6 kW Solar PV	**N/A**	**($2,333)**

1.1 Please provide the calculations used to determine the unit energy and unit capacity costs of the four solar PV facilities that were added to the referenced table, including all assumptions regarding capital costs, variable costs, credits from NM production, discount rates and other relevant items.

Response:

Please review background documents: **Cost of NM#1 Solar PV System**, **Cost of NM#2 Solar PV System**, **Cost Of NM#4 Solar PV System**, **Updated Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options**, **2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values** and **I%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years**, noting that only the UCC figure is available for NM#3 as their system has not yet been operating for a year.

Further you will note that all figures have been updated thanks to being able to access more explicit information. That said, there are no financing costs, interest charges, or amortization costs as all systems were purchased on a cash down basis, and there have been no O&M costs to date. NM#2 has added one panel and upgraded an inverter but that has been treated as additional capital cost.

The only maintenance undertaken by NM#1 on the 50 panels is to periodically hose them down to remove dust that accumulates from a nearby dirt road, and since the water is not yet metered there is no additional cost to the household of doing that.

Conversion rates were applied to all US equipment at the applicable rate at time of purchase and, where absent, 5% GST has been added in as well. Solar PV panel production has been reduced at a rate of 1% per annum, noting that the panels have a twenty-five year manufacturer's warranty.

In addition it is believed that, at a 1% annual reduction rate, weather variability, both in terms of available sunshine and temperature impacts on solar PV panel production, is taken into account. It has been observed that a 1 kWh to 2 kWh per day solar PV production reduction occurs with the Shadrack-Bauman system once air temperatures attain 30 degrees Celcius.

The UEC was calculated, as can be seen on the aforementioned background sheets, by dividing the total costs by twenty, twenty-five and forty years of solar PV panel production.

It is likely that FortisBC could corroborate all of NM#1's approximate production values by comparing several year's consumption values before enrollment in the Company's net metering program with the consumption values after enrollment in the Company's net metering program. Likewise the Company could also verify whether or not the NM#1 transfer value is an anomaly or in line with the other years of transfer data the Company has.

The background document, **2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values,** provides billing period by billing period comparison of what it costs NM#1 to purchase electrical service from FortisBC, and what NM#1 receives in credit for transfer of electricity to the Company's grid.

While there are three billing periods where NM#1 attains a net dollar ($) credit, at year end despite supplying 1.273 MWh more electricity during the 2016 billing year, NM#1 still ends up with a service charge of $148.23. In terms of real costs of enrollment in FortisBC's net metering program, this amounts to a 1.36 cents surcharge on each of the 10,879 kWh transferred to the Company in 2016.

The net effect is to increase the UEC by $13.60/MWh, which, while the value would vary depending on the size of Net Excess Generation (NEG), would be the case for each of FortisBC's net metering customers until the dollar values of NEG transfers achieve parity with the Company's annual cost of service for that customer-generator.

Further, should FortisBC be successful in its reconsideration application to lower the value of NEG to the BC Hydro PPA Tranche 1 rate, then the cost of service to NEG producing customers will rise even higher, as is shown in the evidence provided in the aforementioned background paper.

I have been unable to undertake the same calculations for NM#2 as I could not access the dollar ($) values for some of the transfers, as FBC appears to have changed billing methodology between 2016 and 2017, such that the dollar ($) value of transfers is no longer shown on the bill.

Likewise with NM#4 I cannot calculate a year's service charge costs and a year's transfer values with the information that was made available to me. If FortisBC would like to provide me with the same information as was on the six bills for NM#1 I could then undertake the same calculation as I did for NM#1, for NM#2 and NM#4. NM#3 had not been in production for a year so I could not do that UEC calculation.

Finally UCC calculations were initially undertaken by dividing total cost of construction and installation, as known at the time, by the nameplate capacity of the solar PV panels. Since the original value of NM#1 and the Company's own UCC "Solar" value appeared to be almost synchronous, it was assumed that the manner in which the calculation was initially undertaken was correct.

That said, I did wonder about the nomenclature "($KW-Year)" at the head of the UCC column. Unlike FortisBC's Ellison Solar Farm pilot project, there were no year over year O&M costs for any of the four Kaslo systems at point of calculation.

Upon reflection, and in order to compare the three systems for Kaslo with FBC's own Ellison Solar Farm pilot project's construction, installation and O&M costs, I have divided the UCC costs by the number of years for which the amortization period is calculated.

In future it might be useful to state the anticipated production life of each option being considered in Table 8-1 and the amortization period for each option as well.

That said I found a hypothetical pre-tax cost of capacity calculation undertaken by BC Hydro for a twenty year economic life/IPP contract period at:

https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/info/pdf/info_iep_row_unit_cost_method.pdf

This clearly indicates, unlike Table 8-1, that both capital investment and O&M UCC costs are calculated on a per annum basis, and in addition the value of the electrical power production is discounted against the annual capital and O&M cost.

That said, there are no O&M costs, and there is no electrical power discount for FBC NM enrollees that I have found, so I simply divided the initial UCC cost by the number of years production is projected to occur.

This has been a steep learning curve so I look forward to learning about any corrections to the figures I have provided for the Updated Modified Table 8-1.

1.1.1 Please explain why there is no unit energy cost provided for the Kaslo NM#3 – 6 kW Solar PV facility.

Response:

The system has not been operating for a year and hence there is not enough production information to calculate the UEC.

1.2 Please provide the calculation used to determine the unit energy and capacity costs for the Community Solar Pilot Project (Ellison), including all assumptions regarding capital and operating costs, depreciation, discount rate and other relevant items.

Response:

I simply took the numbers found at 2.2 in Community Solar Pilot Project Appendix B-1: Rate Derivation:

$877,490/3,793,218 = $0.23133/kWh and multiplied it by 2 to achieve a twenty year amortization period = 0.46266/kWh = $463/MWh UEC cost.

Upon reflection that may not be the best way to calculate the UEC, but then the Company is going to have to explain why it is using a production figure derived from line 13 of 3,793,218 kWh over forty years.

FortisBC Inc IR#1 Response

At line 12, if one uses the proposed energy efficiency step down rate of .5% annually, as proposed by FBC, one comes to a total production amount of 10,281,110 kWh by 2057 (year 40 if you use 2018 as year one), not 3,793,218 kWh. Here I note that my calculation for 2056 of a production level of 233,867 in **I%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years** kWh matches exactly that found on line 12 of Appendix B-1 in 2056.

Next, if I use the capital cost figure found on page 6 of the application in Table 4-1 of $960,744 and divide it by the 10,281,110 kWh of production over the 40 years, I create a UEC value of 9.3447 cents or $93.45/MWh.

Now I realize that FBC has to add in annualized operations and maintenance (O&M) costs, which they do starting at $9,000 per year in 2019 plus 2% inflation each year, which adds another $524,206 over forty years and creates a UEC value of 14.51 cents or 145.1/MWh. If not all or none of the $44,368 construction contingency in Table 4-1 is utilized during the construction phase, then that could be used to offset ongoing O & M over the following 40 years.

$145.1/MWh seems like an awful long way from a revenue requirement of $231/MWh. But I realize, for example, that I have not included the cost of capital if all or part of the $960,744 is borrowed for the lifespan of the project, and I certainly have not included the cost of displacing purchased BC Hydro PPA Tranche 1 power (if that is what 6.3.5 is all about).

My purpose of comparison is different than FortisBC's application in that I am trying to compare straight cost of construction, installation and O&M costs.

Further to that, it is observed 3,793,218 kWh is only 36.9% of what FBC says the solar farm system will produce over 40 years, as evidenced by the data provided in line 12.

In contrast the stated "PV of Annual Generation (Kwh)" for 2056, for example, is 22,957 in line 13 as compared to 233,867 kWh for the same year in 12. So I understand how the Company reaches/calculates 3,793,218 for a forty year period, but just do not understand why the Company would choose a value for 2056 that is 9.81% of what is actually going to be produced by the 720 solar panels at a .5% production step down rate.

As I said in the previous response, all of this has been a steep learning curve and I look forward to learning about corrections to the evidence I have presented, noting that I do not like the legalistic-adversarial approach that is now being taken in comparison to an earlier period (when I was first involved in Commission hearings nearly 30 years ago), when we all sat down around a table in South Slocan and had a discussion about the options that were being considered.

FortisBC Inc IR#1 Response

2.0 Reference: Solar Production, Transfers and Total Use as a Function of FBC Grid Purchase

Exhibit C10-6, page 3

2.1 Please explain the information provided on page 3. Specifically, what is meant by "FBC purchases", "Solar production", "Solar transfers", "Solar use" and "Total use".

Response:

"FBC purchases" represents the number of kWh purchased as a residential customer from the Company as found on the bi-directional meter for that particular billing period.

"Solar production" represents the number of kWh produced by the solar PV system during that particular billing period.

"Solar transfers" represents the number of kWh transferred from the solar PV system to FBC's grid as found on the bi-directional meter for that billing period.

"Solar use" refers to the net of production, less transfer to the FBC grid, that is used by the Shadrack-Bauman household during a particular billing period.

"Total use" refers to the net of grid purchases from FBC, total grid purchases less solar PV transfers, plus solar PV use for a particular FBC billing period.

2.1.1 What do the percentages represent and how are they calculated?

Response:

The percentage for "Solar production" represents the kWh value of the solar PV system's production in a particular billing period as compared to the number of kWh purchased from the Company, and is simply determined by dividing the number of kWh of production by the number of kWh purchased.

The percentage for "Solar transfers" represents the kWh value of the solar PV system's transfers in a particular billing period as compared to the number of kWh purchased from the Company, and is simply determined by dividing the number of kWh of transferred by the number of kWh purchased. It also helps determine when a NEG situation occurs and by what percentage NEG exceeds FBC grid consumption.

The percentage for "Total use" represents the net amount by which overall household consumption is reduced as compared to the amount purchased from the FBC grid, and is calculated by dividing "Total use" by FBC grid purchases and then subtracting 1. It is a way to measure whether combined grid purchases plus solar PV use are rising or falling in relation to overall household conservation and transfers from the solar PV system to the FBC grid.

3.0 Reference: Page 5: Twelve Best Solar Production Days in January and February 2017

Exhibit C10-6, page 5

The table on page 5 shows Mr. Shadrack's solar PV daily production for 12 days in January and February 2017.

3.1 Please provide a table of approximate sunset times in Kaslo for the period of November 15 through February 15.

Response:

Please find the attached table **Kaslo Sunset Times: November 15 to February 16** that shows the times at which the sun sets in Kaslo between November 15th through February 15th.

3.2 What is the estimated production of the solar panels at the expected time of FBC's winter peak, which is usually between the hours of 5 and 6 pm?

Response:

None that I am aware of. In FBC's Electric Tariff, BCUC 2, Tenth Revision of Sheet 2, however it is observed that in July and August "On Peak" hours are:

9.00 AM – 11.00 AM and 3.00 PM to 11.00 PM, Monday to Friday.

The Shadrack-Bauman solar PV system starts transferring electrical power at around 7.00 AM to 7.30 AM and does not shut down transfer until between 6.00 PM to 6.30 PM during these months.

For all other months "On Peak" hours are:

8.00 AM to 1.00 PM and 5.00 PM to 10 PM, Monday to Friday.

Between mid-October and the change in time in March, the solar PV system starts transferring electrical power no later than 9.00 AM and stops transferring between 3.30 PM and 4.30 PM.

If FBC is interested, I would be more than happy to measure "On Peak" transfer of kWh values for those times, to see what percentage of solar PV transfers occurs during those "On Peak" demand times.

FortisBC Inc IR#1 Response

That said, there are three ways, in general, that a customer-generator can assist FBC to shave peak power usage: through conservation, use of solar PV production to lower grid consumption, and transfer of solar PV production to the FBC grid.

Between October 10th, 2013 and February 14th, 2014, and between October 15th, 2014 and February 17th, 2015, the Shadrack-Bauman household used on average 9.7 kWh per day, of which I have come to understand that approximately 5 kWh is used to heat water for one to two hours between 6.00 AM and 8.00 AM. A further 1 kWh to 2 kWh is used to cook a midday meal on the electric stove, anywhere between 11.00 AM and 1.00 PM.

Between October 18th, 2016 and February 20th, 2017, average daily consumption from the FBC grid averaged 8.6 kWh - a reduction when compared to the two years prior to installation of the solar PV system of 1.1 kWh per day, or an 11.3% savings. In addition, an average of 1.2 kWh was transferred from the solar PV system to the FBC grid daily, for a total net down of 2.3 kWh per day, or a 23.7% savings.

This amounts to 287.5 kWh over the 125 day winter period, that would, if aggregated for 1,000 NM customers, add up to 287.5 MWh or .2875 GWh for the 2016/17 winter period.

While winter consumption reduction and production would not occur during the evening “On Peak” demand hours, it certainly does occur during the early morning and afternoon “On Peak” demand hours from 8.00 AM to 1.00 PM, for which FBC charges TOU residential customers a peak rate of 19.71 cents per kWh.

Thus the enrolled NM customer’s projected savings would allow FBC to either store an additional .2875 GWh of water behind their dams, or help to reduce early morning and afternoon “On Peak” demand spot market purchases by up to .2875 GWh, or a combination thereof.

That’s why it is important to report that, on five of the ten peak demand days that FBC had in the winter of 2017, the Shadrack-Bauman solar PV system reduced grid demand by, not the 23.7% average for the winter, but by 53.5% for half the days that FBC was running at peak consumption levels.

It is not the individual household results that should catch the imagination, but the aggregate potential of a growing number of customer-generators enrolling in the NM program and reducing consumption and transferring kWh at a time when transmission line loss saving potential, according to Energy Futures Group Inc, can reach as high as 20%:

FortisBC Inc IR#1 Response

"*Regulatory Assistance Project (RAP)*[report that]*:*

'First, energy efficiency measures typically provide significant savings at the time of the system peak demand, and that time occurs when the line losses are highest.

The avoided line losses can add as much as 20% to the capacity value measured at the customer meter".

Thus NM consumption reduction and production at 53.5% comes at a 20% premium and is therefore really worth, during some "On Peak" demand hours, a 64.2% saving of kWh consumption.

<u>BC Sustainable Energy Association and Sierra Club BC</u>
<u>Information Request #1 Response</u>

1.0 Topic: Resource Options
Reference: Exhibit C10-6, Evidence of Andy Shadrack, Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options

1.1 For the four Kaslo NM Solar PV entries, the figure under the heading "Unit Capacity Costs ($KW-year)" is in brackets, whereas the figure for the "FortisBC Ellison Solar PV" entry is not in brackets. Do the brackets here mean negative numbers? If so, please explain.

Response:

The brackets mean that I thought that these costs were tentative and quite crude, and as you can see from the three sets of documents I have filed, **Cost of NM#1 Solar PV System**, **Cost of NM#2 Solar PV System**, and **Cost Of NM#4 Solar PV System,** in response to the current round of Information Requests, I have now refined the construction and installation costs quite considerably as more information has been made available to me.

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1.2 What formula did Mr. Shadrack use for the "unit capacity costs ($KW-year)" of the resources that are not in Table 8-1? Was it the same formula as FBC used in Table 8-1?

Response:

Initially I simply divided the construction and installation costs by the kW nameplate capacity of each system, there being no annual O&M costs for any of the four systems to date – as per the aforementioned background documents.

As I stated to FortisBC in my response to their Information Request at 1.1:

"*Finally UCC calculations were initially undertaken by dividing total cost of construction and installation, as known at the time, by the nameplate capacity of the solar PV panels. Since the original value of NM#1 and the Company's own UCC "Solar" value appeared to be almost synchronous, it was assumed that the manner in which the calculation was initially undertaken was correct.*

That said, I did wonder about the nomenclature "($KW-Year)" at the head of the UCC column. Unlike FortisBC's Ellison Solar Farm pilot project, there were no year over year O&M costs for any of the four Kaslo systems at point of calculation.

Upon reflection, and in order to compare the three systems for Kaslo with FBC's own Ellison Solar Farm pilot project's construction, installation and O&M costs, I have divided the UCC costs by the number of years for which the amortization period is calculated.

In future it might be useful to state the anticipated production life of each option being considered in Table 8-1 and the amortization period for each option as well.

That said I found a hypothetical pre-tax cost of capacity calculation undertaken by BC Hydro for a twenty year economic life/IPP contract period at:

https://www.bchydro.com/content/dam/hydro/medialib/internet/documents/info/pdf/info_iep_row_unit_cost_method.pdf

This clearly indicates, unlike Table 8-1, that both capital investment and O&M UCC costs are calculated on a per annum basis, and in addition the value of the electrical power production is discounted against the annual capital and O&M cost.

That said, there are no O&M costs, and there is no electrical power discount for FBC NM enrollees that I have found, so I simply divided the initial UCC cost by the number of years production is projected to occur.

This has been a steep learning curve so I look forward to learning about any corrections to the figures I have provided for the Updated Modified Table 8-1."

1.3 Please explain how Mr. Shadrack arrived at a Unit Energy Cost of $65/MWh for Kaslo NM#1. In addition to the amortization period of 20 years, what numbers went into the calculation, such as the upfront costs, the operating costs (if any), the annual kWh, and the discount rate? If other numbers were used please provide them.

Response:

Please find attached a separate sheet entitled **Cost of NM#1 Solar PV System**, with the installation cost numbers it is believed you are looking for. This entire project was self-built and installed by an industrial electrician formerly employed in the Tumbler Ridge coal mines. It was paid for cash up front so there are no loan, carrying and interest charges associated with the system.

There are no other up front costs as the land was already owned by this FBC customer, and the logging undertaken to clear the site is providing firewood for many years to come. There have been no ongoing O&M costs for the three to four years this system has been operating, other than the fact that NM#1 periodically hoses down the 50 panels to clean off dust from a nearby gravel road.

The original annual kWh transferred to the FBC grid comes directly from the six FBC bills provided to the customer-generator in 2016. I then received production, consumption and transfer values for two years. I then used a step down productivity rate of 1% for twenty, twenty-five and forty years, noting that the manufacturer's warranty on the solar panels is for only twenty-five years.

Please review background document **I%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years** for an exact explanation as to how these values were created.

Finally I assume the question has to be answered as to why use a production reduction value of what effectively amounts to a .4% per year reduction for twenty-five years when FBC only uses what amounts to a .23% reduction value for forty years.

Beyond a need to know the manufacturer's warranty value on FBC's proposed solar panels, it is believed that impacts of climate change need to be factored into panel production values.

Weather extremes such as available sunshine and temperature are such that it is believed a more conservative value had to adopted to factor in that potential year-to-year production variance.

Already it is observed that a difference between spring peak production and summer peak production occurs when the air temperature approaches 30 degrees Celcius and higher of about 1 kWh or 2 kWh per day with the Shadrack-Bauman system.

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1.4 Is the unit energy cost of $65/MWh strictly the costs of the generation, or is it reduced to account for financial savings under the net metering program?

Response:

The updated cost of between $56.5/MWh and $69/MWh is strictly the cost of construction and installation, for an operational time frame of twenty to twenty-five years, with no operational costs, as there have been none so far over the nearly three to four years this system has been operational.

A review of FBC's six bills to this customer in 2016 reveals that the only cost saving to this customer-generator is that they do not currently pay any Tier 2 residential rates, due to NM transfers offsetting those purchased kWh.

As can be seen from the background document, **2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values,** the customer-generator produced and transferred 6.079 MWh valued at Tier 1 rates, and 4.8 MWh valued at Tier 2 rates. The customer-generator purchased 4.806 MWh valued at Tier 1 rates, and 4.8 MWh valued at Tier 2 rates.

The Net Excess Generation (NEG) was therefore 1.273 MWh, but since the customer's bills still showed that $148.23 was needed to cover the total cost of FBC service to the customer-generator, one has to actually add on a UEC cost for participating in FBC's NM program.

Dividing $148.23 by the total transfer of 10.879 MWh produces, shall we say, a customer-generator enrollment charge of 1.36 cents per kWh. Thus actual NM#1 UEC costs are $56.5/MWh to $69/MWh plus the costs charged by FBC that were not covered by the transfer of 1.273 MWh of NEG.

In this instance, for 2016, the UEC plus $13.6/MWh of FBC charges creates an overall long term UEC of between $70.1/MWh and $82.6/MWh. Calculating this additional "enrollment fee" UEC would be necessary for all FBC NM customers who are not currently receiving a cash payout for their net NEG.

Further, if the value of NEG was lowered as applied for by FBC in their Net Metering Program Tariff Update application (and now reconsideration application), the UEC to this customer-generator would rise by a further $59.83 to $71.29, depending on whether NEG payout was reduced to PPA Tranche 1 costs of 4.7 cents or 5.6 cents per kWh. So the total long term UEC would rise to between approximately $75.7/MWh and $89.2/MWh.

Thus the only way to lower UEC $/MWh costs is to expand the amount of NEG transferred to FBC to offset the cost of the Basic Charge and GST, which starts to become extremely difficult to do if the transfer value is dropped to between 4.7 cents and 5.6 cents per kWh, as FBC has now changed its policy and is stating it does not want customer-generators to be consistently producing NEG.

Under these circumstances, there currently is no overt financial benefit to being enrolled in FBC's NM program, nor will there be until the Company has a change of heart in the way it views the value of NM transferred electrical power, or the Commission orders them to change the financial structure of the NM tariff.

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1.5 Would someone else be able to self-install a 12kW solar PV system with a Unit Energy Cost of $65/MWh based on amortization over 20 years, assuming they had a site with similar insolation characteristics and the ability to do the installation?

Response:

There is a long history of community self-generation of electricity in Kaslo and Mirror Lake, and on various homesteads dating back to the 1890's, as now embodied in, for example, the Argenta Land Co-op.

That said, the short answer to the question is yes, as found by the empirical evidence in north Kootenay Lake. There are currently 56 households/properties that are engaged in this latest phase of electrical self-generation construction and installation with a nameplate capacity of approximately 201.26 kW. At an estimated two persons per household this represents about 4.5% of the total population at the last Canadian census.

Twenty-nine with a capacity of 30.4 kW are completely off grid and twelve with a capacity of 25 kW have either gone completely off the grid or have withdrawn that portion of their service that their production now serves from the grid. Thus 73% of self generation households/individual properties have either never been on the grid or have partially or completely withdrawn from the grid, representing 25% of the self generation capacity.

What BCSEA, other intervenors, the Commission and FBC need to consider, however, is why only 15 households, .6%, are choosing to enroll in either BC Hydro's or FBC's NM programs, when 4.5% are engaged in self-production of electricity.

Obviously 56 households feel that self-generation of electricity is an economically viable option, but only 15 (26.8%) have thus far chosen to partner with their respective local utility. Why?

Of the 15 households who have chosen to Net Meter, 8 are with BC Hydro and 7 are with FBC, and their combined name plate kW value or capacity is approximately 145.86 kW. Of these 15, I can confirm that 11 (73.3%) are self-built, with at least 2 (13%) not hiring an electrician to complete installation.

The 8 BC Hydro NM installations represent 56.1% of capacity, and average 18.2 kW per installation, whereas the 7 FortisBC NM participants represent 43.9% and 9.1 kW per installation. In contrast, the average size of the off grid and semi-off grid installations is 1.35 kW.

Beyond the fact that BC Hydro NM customer-generators are installing at double the size of FortisBC NM participants, it seems somewhat obvious that NM customers in general are installing at a much larger capacity than their off grid and semi-off grid counterparts.

Self-building/self-installation, larger size and the ability to transfer self-generated power to the grid via local utility partners is obviously an important factor in considering if it is economically viable to enroll in an NM program.

And clearly the potential now exists for self-built and self-installed NM systems to be competitive with FBC's LRMC of $96/MWh.

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The Unit Energy Cost figures for self-installed "Kaslo NM#2 – 8.1 kW Solar PV" and contractor-installed "Kaslo NM#4 – 7 kW Solar PV" are $95/MWh and $175/MWh respectively, based on 20 year amortization.

1.6 Please provide the numbers that were used to calculate these unit energy cost figures.

Response:

Please find attached a separate a document entitled **Cost of NM#2 Solar PV System**, the updated installation cost numbers it is believed you are looking for, for NM#2. This entire project was self-built by a construction contractor of 40 years experience, who paid a local electrical contractor to hook the whole project up.

Please also find attached a separate document entitled **Cost of NM#4 Solar PV System**, the updated installation cost numbers it is believed you are looking for, for NM#4.

And please also find attached, as separate document entitled **I%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years**.

1.7 The two self-installed systems are $65/MWh and $95/MWh levelized UEC, and the contractor installed system is $175/MWh LUEC. Is the implication that installation costs are a substantial component of the total cost of a solar PV system?

Response:

It was initially believed that labour installation costs were an important factor in the cost of building and installing each system, but in fact labour costs only accounted for 13.3% of NM#2's costs and 8.8% of NM#4's.

The price differential between NM#2 and NM#4 appears to be primarily between the cost of roof versus ground mounting of the panels: 6.6% versus 36%.

The other important factor appears to be the difference in the exchange rate between the US dollar ($) and the Canadian dollar ($).

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1.8 Is Mr. Shadrack saying that a levelized unit energy cost of $175/MWh for contractor-installed 7 kW solar PV system in the Kaslo area is a benchmark cost, i.e., that anyone in the area could acquire a similar system at similar price?

Response:

No, the costs represent a particular state of cost in the Kaslo area at a particular date in time. I just wanted to get some actual costs on the table, as over the last year I have seen a lot of comments being made by the applicant, other intervenors and even the Commission, and it has felt like the FortisBC customer-generators were not allowed to be in the same conversation at all.

It is suggested that the best way to find out if these three costs represent actual levelized costs would be to survey all of the FBC NM participants, after first explaining what the terms UEC and UCC mean and how they are calculated.

If the desire is to ensure that a program is effective and capable of reaching its full potential as a DSM program and/or conservation tool, surely one would start out by trying to find out what the customers enrolled in the program actually thought about the program and what it cost the customer-generator in capital investment prior to enrollment.

FBC, for example, has done two surveys of customers on solar PV purchase in February of 2016 and December of 2016, but no survey of its own 160 NM customer-generators. In contrast, BC Hydro has just completed a survey of its 900 customer-generators in preparation for the filing of a third Net Metering Evaluation Report to BCUC and provides regular updates to all its customers about their program.

Why did FBC not survey its customer-generators prior to filing its Net-Metering Program Tariff Update application?

****

The evidence refers to FBC's explanation of why the unit energy cost estimates for solar power in FBC's resource options table are higher than unit energy cost estimates for solar power in the 2016 Seventh Northwest Power Plan document. FBC states:

"*Solar UEC [in FBC's resource options table] is different [than in the NWPP document] because smaller plants were evaluated in B.C., so they were not able to realize the same economies of scale. In addition, it is likely that the solar intensities of good sites were greater in the U.S. as they are closer to the equator*." [Exhibit B-2, BCUC 1.25.1, pdf p.86]

(FBC goes on to state that "*Renewables in the U.S. also are able to access a federal tax credit which does not have an equivalent in Canada.*")

FBC's Table 1 indicates that NW PP used an estimate of levelized unit energy cost of PV solar of \$91-\$121/MWh in 2012 US Dollars. FBC's Table 2 indicates that it used an estimate of levelized unit energy cost of PV solar of \$169-\$184/MWh in 2015 Canadian Dollars.

1.9 What is Mr. Shadrack's point about the FBC UEC for solar PV being higher than the NW PP UEC for solar PV? Is he saying that FBC's estimated unit energy cost for solar PV as a supply side resource should be lower than it is? If so, how does Mr. Shadrack respond to points about the size of the assumed solar PV installation, geographic differences in insolation, and the US federal subsidy for solar PV?

Response:

The point I am trying to respond to is the fact that FBC has been making statements about its NM program and the participants in that program without providing any actual empirical evidence from the 160 customer-generators themselves.

Do the Commission members, any of the other intervenors, or FBC know how many of the current FBC NM systems are partially or completely self-installed? FBC appears to be perfectly content to state that NM systems are not economically viable and that therefore those enrolling in their program must be doing it for some other social or environmental reason.

In the absence of any empirical evidence from FBC, it was decided to obtain costings from neighbours who had made the decision to enroll in the FBC program, about whom it was known that they did not like to throw money away unnecessarily.

Turns out those initial figures needed to be updated to be more accurate, but the truth is that at least there are now some actual recent construction and installation costs on the table to discuss.

A number of people who have installed solar PV systems are aiming to pay off their capital investment in a decade or less. A twenty to twenty-five year amortization period is in line with a manufacturer's panel warranty period of twenty-five years, and BC Hydro states that a customer should be able to pay off their investment after approximately twenty-three years.

There is also the fact that solar technology is changing so rapidly that it is highly likely that keeping a current commercial system around for more than a decade will not make any economic sense. That said, as you know, FBC has just filed an application to build an "In-House" solar PV farm using a 40 year amortization period.

The implications of that are, if the original solar PV costs in Table 8.1 of $169/MWh to $184/MWh are based on a 40 year amortization period, then the 24 panel Kaslo NM#4 - 7KW solar PV system is $39.4/MWh to $54.4/MWh cheaper than what FBC stated, and $15.5/MWh cheaper than FBC's 720 panel Ellison Solar Farm pilot project.

So the first question that now needs to be asked of FBC is: what is the amortization life span of the all original UEC values in Table 8-1 – forty years or some other length of time?

FBC's comments about size, geographic location in relation to insolation, and US federal subsidies are not relevant and a complete red herring in the context of the kind of analysis that should be done here in BC and Canada. But do not take my word for it. Let's look at what BC Hydro publicly states about its NM program on their website:

Since 2004, over 900 customers have been participating in our net metering program.

Over 95% of customers chose to install a solar photovoltaic system

.

A typical home generally consumes 11,000 kWh/year. A typical solar installation on a residential roof is 4 kilowatt (kW) in size with 16 solar panels, which in B.C., generates 4,400 kWh of electricity over a year.

On average, solar systems of this size can cost about $14,500. Based on BC Hydro's step 2 of its Residential Conservation Rate, payback on your investment is about 23 years (including savings from the Rate Rider and GST - (https://www.bchydro.com/energy-in-bc/acquiring_power/current_offerings/net_metering.html)

Based on BC Hydro's figures above, a 4KW system UCC comes in at only slightly more than NM#4's UCC: $3,625, or $3.6 cents per watt.

So it would appear that FBC's contention that the smaller the system the more uneconomical it becomes simply does not hold any truth, especially if you consider their proposed costs for building, installing and operating the Ellison Solar Farm pilot project in Kelowna is 6.1 cents per watt.

In the **Updated Modified Table 8-1: FBC Demand Side and Supply-Side Resource Options** all three of the Kaslo and BC Hydro solar PV net metering system costs now have a lower UCC than FBC's Solar Farm pilot project, and the calculations of how that was calculated are contained in the notes below the table and elsewhere.

In contrast, none of FBC's proposed costings in the original Table 8-1 come with a size of unit generation attached to them or length of economic life operational time frame. So how do we compare the various options if we do not know the generation capacity of say a solar PV array versus a Gas Fired Generation plant, and the economic lifetime of each system?

Next let's actually look at insolation values for BC as created on a map from Natural Resources Canada data:

https://s3-us-west-2.amazonaws.com/ceavideos/CEEPQS+Webinars/SolarPVwebinar/3+Net+Metering+with+BC+Hydro+-+BC+Hydro.pdf

At the coast, insolation values are 900 kWh to 1,000 kWh and as low as 800 kWh to 900 kWh on the north coast, while in the Interior some regions are 1,000 kWh to 1,100 kWh in the West Kootenay, while the Okanagan is 1,100 kWh to 1,200 kWh, and parts of the East Kootenay, like around Kimberley, 1,200 kWh to 1,300 kWh. That's quite a range of 62.5% between low and high, so it turns out that 1,100 kW is not accurate on a regional and sub-regional basis across BC.

Next check out the penetration of state electricity generated by solar PV systems for Idaho, which is .61%, and then check out all of the southern US states to find out that, with the exception of Arizona, New Mexico, Nevada and California, Idaho has a higher percentage of solar PV grid generation penetration than all other southern US states, including Texas and Florida.

http://www.seia.org/state-solar-policy/idaho

Idaho is clearly not a southern US state closer to the equator, yet grid penetration of solar PV production, at .61%, is higher than Texas on the Gulf of Mexico.

All of which suggests that what actually needs to be undertaken is a complete survey of the roughly 1,060 NM customer-generators of both BC Hydro and FBC to see what the UEC and UCC costs actually are according to the region of the province, and what factors are influencing overall cost of construction, installation and operation.

Otherwise it is all basically speculation. The Shadrack-Bauman household, for example, calculates production in 2016 at .885 MWh per installed kW and the transfer value to FBC at .61 MWh per installed kW. However, it is not clear how that compares with neighbours who are also enrolled in the program.

So it is not clear if this production value is because the system is situated in the West Kootenay when comparing it to BC Hydro's suggested 1.1 MWh per installed kW, and/or whether weather was a factor in 2016 compared to other years.

The only way to make an accurate assessment, based on what is actually happening in terms cost of installation and production of NM systems, is to ask the customer-generators in those programs what their experience actually is.

When FBC first filed their NM Program Tariff Update application on April 15, 2016 they stated that as of March 31st they had 86 customer-generators enrolled in the program, and I now understand that has grown by 86% to 160 currently.

That tells me that interest in enrolling in net metering is rising and therefore should not those new customer-generators enroll in the best program the Company and BC Utility Commission can provide - one that is in the public interest and not just the interest of the Company?

****

The evidence provides a unit energy cost of $463/MWh for FBC's proposed Community Solar Pilot Project at the Ellison Substation, and a unit capacity cost of $670/KW-year. In the Community Solar Pilot Project application, FBC says that the price would be based on the cost and that "The price of electricity supplied under the FortisBC Solar Offset rate would be $0.231/kWh." [p.13, pdf p.20]

1.10 Please provide the details of how Mr. Shadrack calculated these unit energy cost and unit capacity cost figures.

Response:

I simply took FBC's amortization costs at face value as found at 2.2 in Community Solar Pilot Project Appendix B-1: Rate Derivation:

$877,490/3,793,218 = $0.23133/kWh and multiplied it by 2 to achieve a twenty year amortization period = 0.46266/kWh = $463/MWh UEC

In preparing answers for this round of Information Requests, I took another look at FBC's costings and the results of that analysis can be found in my response at FBC IR1.1.2. You might also like to review the answer I gave BCUC in IR#1.1.1 and the background information provided to BCUC for that answer.

1.11 Why is Mr. Shadrack's estimate of a unit energy cost of $463/MWH (or $0.463/kWh) so different than FBC's estimate of $0.231/kWh?

I originally halved their amortization period to twenty years for reasons stated in BCUC IR1.1.1

****

Mr. Shadrack's evidence includes data such as the following:
"April 19th FBC purchase 491/7.8 kWh
April 19th Solar production 419.6/6.7 kWh 85.5%
April 19th Solar transfers 280/4.4 kWh 57%
April 19th Solar use 139.6/2.2 kWhApril 19th
Total use 350.6/5.6 kWh 63 Days -(28.6%)"

1.12 What is the "/7.8" figure? (and "/6.7", "/4.4" etc.)

Response:

Apologies. I am so used to working with these calculations that I did not think to explain them. 7.8, etc, refers to the daily number of kWh purchased from FBC, produced by the system, transferred to FBC, and the net daily electrical household use rate for that particular billing period.

What I am trying to measure is to see if there is a consistently firm and reliable net down of consumption from the grid, both in terms of capacity required and in terms of net consumption, and if so for how long a duration in any given year.

****

1.13 Please confirm that the data illustrates a customer-owned solar PV system that is at times providing power to the grid and at times offsetting power that would otherwise have been drawn from grid, in accordance with the way the net metering program is supposed to work.

Response:

Confirmed.

****

1.14 Please explain the purpose of the percentages. Is the point that the amount of power that the customer's solar PV system generates is substantial in relation to the amount of power the customer purchases, i.e., that the customer's solar PV system provides to the grid a substantial amount of power relative to the amount of the customer's purchases from the grid, and reduces substantially the amount of power the customer would otherwise purchase from the utility?

Response:

Basically yes. The Shadrack-Bauman household started out some twelve years ago reducing our household electrical consumption, because we could not afford the $70,000 quoted to build a solar PV system that would replace our then electrical needs. Besides, at that time, we were not prepared to purchase and install a solar PV system at more than double what we paid for our house some 18 years earlier.

Everything except the water heater and electric cook stove are hooked into the system, while the cook stove and water heater remain directly linked to the grid. Between 5 kWh and 6 kWh of the 7.8 kWh daily use represents electricity purchased to heat water and the rest is related to using the electrical cook stove.

The 2.2 kWh solar system use represents all the other appliances and lights and drops off in winter as solar PV production drops, and is replaced by a higher level of purchase from FBC. But one of the reasons I wanted to track production is so that I could see what use there was of solar power, so that we knew that our consumption levels were not rising because we were now transferring power to FBC to offset our purchase.

We have thought about purchasing a solar oven to lower use of the electric stove, and we have thought about an alternative arrangement to heating the water with electricity, such as coiling copper pipe around our wood stove chimney.

But currently the cheapest option seems to be offsetting purchased electricity with our own solar PV production transferred back to FBC, though we are still pricing solar ovens as a consideration as to how we might further reduce electric stove use.

We also have twelve twelve-volt batteries so that we can keep our house and internet functioning when FBC grid service goes down, as it frequently does (especially in winter). I attach a copy of the specifications for these batteries to this IR response.

We could set the re-charge of the batteries up so that that it only occurred outside of peak consumption times, which would then maximize transfer of electricity from our system to FBC during peak times. However, thus far, FBC has seemed wholly uninterested in learning how NM systems could help it shave peak consumption, be it in the summer or winter.

The longest we have operated our solar PV system without any grid power back up is eighteen hours in the winter, using our wood stove for cooking and boiling water, and the batteries to power everything else.

We therefore find it disconcerting to have FBC loudly proclaim that solar PV systems are of absolutely no use in winter, when in fact our solar PV system has operated more reliably than FBC's grid system over the two winters we have had it up and running.

Here I want to say that I fully understand that FBC has absolutely no control over wind damage, snow avalanches and mudslides done to their transmission lines. These events are all a part of living in rural BC, especially in the mountains.

However, as the climate and weather change, and extremes become more extreme (as your own expert witness has so eloquently stated), how efficacious is it to continue planning and building a power grid that relies on transmitting all the generation from a few central nodes?

The purpose of providing the evidence should not be to focus on the individual systems per se, but to focus on considering what role an expanded NM enrollment could play in helping FBC meet LTERP and LTDSMP.

1.15 What is Kaslo #3, and why is the unit energy cost “N/A”?

Response:

It is a roof mounted system of similar size to NM#4, but has not yet been operational for a year or more, therefore there is no way to to quantify the UEC yet.

FortisBC Inc 2016 Long Term Electric Resource Plan & Long Term Demand Side Management Plan			
Shadrack Evidence Information Request #1 Key: Background Information			
Document	BCUC	BCSEA/SCBC	FortisBC Inc
Cost of NM#1 Solar PV System	1.1.1	1.1, 1.2 & 1.3	1.1
Cost of NM#2 Solar PV System	1.1.1	1.1, 1.2, 1.6 & 1.7	1.1
Cost Of NM#4 Solar PV System	1.1.1	1.1, 1.2, 1.6 & 1.7	1.1
2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values	1.12	1.4	1.1
Updated Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options	1.1.1	1.9	1.1, 1.2
I%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years	1.1 1.1.1	1.3	1.1
Kaslo Sunset Times: November 15 to February 15			3.1
Silicone Batteries Inc		1.14	

FortisBC Inc 2016 Long Term Electric Resource Plan & Long Term Demand Side Management Plan

Shadrack Evidence Information Request #1: Background Information

Cost Of NM#1 Solar PV System

50 Solar panels and Inverter $14,156.19* - 250 Watts per panel @ 66.9 cents per watt
Steel $1,768.46*
Rebar $74.03*
Welding rod $49.33*
Cement $61.11*
Travel expenses approximately $150
Miscellaneous permit, fittings, wire and electrical supplies $735*

Total cost $16,994.12*

* Includes conversion to Canadian dollars ($) and GST where applicable

UEC Calculation 13,399 kWh (composite of two years production divided by 2) times 20/25/40 years = 267,980/334,975/535,960 kWh times .9191/.8972/.8356 = 246,298/300,547/447,859**kWh, noting that FBC has up to four years of transfer values for a more refined assessment.

$16,994.12 cost of constructing system divided by 246,298/300,547/447,859** kWh system production.

UEC = 6.899/$5.654/3.795 cents per kWh or $68.99/$56.54/$37.95/MWh

UCC $16,994.12 divided by 12 kW capacity = $1,416.18/kW

Annualized UCC $1416.18/20/25/40 = $70.81/$56.65/$35.4 kW

Overall Cost per watt – $1.42

**The initial 13,399 kWh is a composite of two year's production of 26,797 kWh. A calculation of 1% reduction in production for each year for 20/25/40 years results in a cumulative step down in production of 16.6%, 20.6% and 31.7% respectively between the first and twentieth/twenty-fifth and fortieth years. This results in an effective average annual decline in production of .4% over the first twenty-five years, nearly double the rate of FBC's Ellison Solar Farm pilot project of only .23%.

During the two years for which production figures were made available, 20,141 kWh, 75.16%, of that production was transferred to FBC, thus 24.84% of the production was used for household consumption. During the same time period 19,383, kWh were purchased from the Company which gave a NEG surplus of 758 kWh, 3.91%, which amounted to 379 kWh per annum.

In the three to four years that the system has been operating there have been no operating or maintenance costs whatsoever, and there are no financing, interest or discount costs as the system equipment was purchased on a “cash down” basis.

FortisBC Inc 2016 Long Term Electric Resource Plan & Long Term Demand Side Management Plan

Shadrack Evidence Information Request #1: Background Information

Cost Of NM#2 Solar PV System

27 300 W Solar panels and freight $7,242.45* – 300 Watts per panel @ 89.4 cents per watt
Roof mounts and shipping $1,024.5*
Fronius IG Plus V 6.0 - 600 W and shipping $2,776.8*
Electrical materials, permit $2,425.46*
Labour for electrical installation $1,981.88/13.3%
Total cost $15,451.09

* Includes adding an extra panel and upgrading the inverter, plus converting US dollars ($) to Canadian at 1.0869 and adding 5% GST to US materials

UEC Calculation 7,100** kWh produced in 2016/17 times 20/25/40 years = 142,000/177,500/284,000 kWh, times .9112/.8892/.8279 production reduction = 129,385/157,746/235,125 kWh

$15,451.09 cost of constructing system divided by 129,385/157,846/235,125 kWh

UEC = 11.94/9.79/6.57 cents per kWh or $119.4/97.9/$65.7/MWh

UCC $15,451.09 divided by 8.1 KW capacity = $1,907.54/kW

Annualized UCC $1,907.54/20/25/40 = $95.38/$76.3/$47.69 kW

Overall Cost per Watt = $1.91

** Between May 18th, 2016 and May 18, 2017 the NM#2 system produced 7,100 kWh

The bi-directional meter after one year read:

401 9,476 kWh purchase
402 4,968 kWh transfers

Net consumption 4,508 kWh

Net use of electricity is 2,132 kWh from solar PV system plus 4,508 kWh from FortisBC grid = 6,640 kWh

I am filing six bills which run from June 16th, 2016 to May 16, 2017, but quite frankly cannot understand how FortisBC achieved the billing for this customer, and therefore cannot make an exact analysis as to whether this customer was a net beneficiary or net loser under the NM program.

FortisBC Inc 2016 Long Term Electric Resource Plan & Long Term Demand Side Management Plan

Shadrack Evidence Information Request #1: Background Information

Cost Of NM#4 Solar PV System

24 Solar panels & circuit box (Backwoods) $9,640.02* -290 Watts per panel @ $1.39 per watt
Inverter (Backwoods) $3,069.63*
Cable (Wesco) $696.71*
Timber PV mounts and deliver** (Hammill Creek) $4,725*/19.4%
Excavator and landscaping** (Brenton Industries) $4,053*/16.7%
Electrician and Landscaper labour $2,142*/8.8%

Total cost $24,326.36*

*Includes converting US dollars ($) to Canadian at 1.1345 and adding 5% GST to material and Labour costs

UEC Calculation 5,670 kWh Fronius production between June 16th, 2016 and June 15th, 2017 times 20/25/40 years = 113,400/141,570/226,800 kWh times .9105/.8899/8276 for 1% decline in production each year = 103,249/125,978/187,698 kWh.

$24,326.36 cost of constructing system divided by 103,249/125,978/187,698 kWh system production

UEC = 23.56/19.31/12.96 cents per kWh or $235.6/$193.1/$129.6/MWh

UCC $24,326.36 divided by 6.96KW capacity = $3,495.2/kW

Annualized UCC $3,495.2/20/25/40 = $174.76/$139.81/$87.38

Cost per watt – $3.5

** This, like NM#1, is a land mounted array whereas NM #2 is a roof mounted array.

FortisBC Inc 2016 Long Term Electric Resource Plan & Long Term Demand Side Management Plan

Shadrack Evidence Information Request #1: Background Information

2016 NM#1 FortisBC Electrical Charges and Net Metering Transfer Values

	Total FortisBC Billing		**Customer Net Metering Values**		**Net Values**	
Billing Period	**Gross Sales MWh**	**Charge per MWh**	**Transfers MWh**	**Credit Value per MWh**	**Net Purchase**	**Charge/ Credit Per MWh**
Dec 16 to Feb 15	3.135	$137	1.147	$96	1.988	$161
Feb 15 to April 19	1.915	$130	1.972	$109	-(0.057) credit	$603.5
April 19 to June 16	.609	$157	2.627	$119	-(2.018) credit	-($108) credit
June 16 to Aug 16	.406	$184	2.613	$119	-(2.207) credit	-($107) credit
Aug 16 to Oct 17	.8 Estimate	$144	1.6 Estimate	$98	-(.8) credit	-($53) credit
Oct 17 to Dec 19	2.741	$139	.92	$98	1.821	$159
Total 2016*	4.806 Tier 1 4.800 Tier 2	$140	6.079 Tier 1 4.800 Tier 2	$110	-(1.273) credit	$116
	FortisBC Billing Without Basic Charge & Taxes					
Dec 15 to Feb 15	3.135	$121	1.147	$96	1.988	$136
Feb 15 to April 19	1.915	$107	1.972	$109	.057	-($15) credit
April 19 to June 16	.609	$98	2.627	$119	-(2.018)	-($126) credit
June 16 to Aug 16	.406	$98	2.613	$119	-(2.207)	-($123) credit
Aug 16 to Oct 17	.8	$98	1.6	$98	-(.8)	-($98)
Oct 17 to Dec 19	2.741	$121	.92	$98	1.821	$132
**Total 2016	9.606	$114	10.879	$110	-(1.273)	-($80) credit

The information and calculations above are taken directly from NM#1 customer-generator's six bills received in 2016. Total annualized cost of FortisBC residential electrical service to this customer-generator for 2016, including Basic Charge and taxes, was $148.23, even though they transferred 1.273 MWh more electricity than they purchased from the Company. The customer-generator paid $140 per MWh for service, but only received $110 credit for each MWh transferred to the Company's grid.

The $140 per MWh 2016 cost of service is $5.20 per MWh more than the mean value per residential household calculation made by FortisBC in the Net Metering Tariff Update hearings of 13.48 per kWh (B-10, IR#1.20.a, FortisBC Inc Net Metering Tariff Update).

The gross margin or markup to FortisBC was 27.3% for this Net Metering customer-generator, such that even though they had a Net Energy Generation (NEG) surplus of 1.273 MWh, the customer-generator still paid the Company an average of $116 per MWh on that surplus power. The customer did not financially break even on the cost of service, even though they produced a NEG surplus of 1.273 MWh.

On a straight kWh Dollar Bank basis, including Tier 1 and Tier 2 exchange at retail rates, the situation does not really change on an annualized basis. Yes, there are three billing periods out of 6 in 2016 where the dollar value per MWh of transfer credit exceeds the dollar value of the electrical power purchased from the Company.

The annualized cost of purchasing that electrical power from FortisBC, if Basic Charge and GST are not included, is $114 per MWh compared to the same credit value of $110 per MWh. Thus FortisBC still has a net margin or markup of $4 per MWh, 3.6%. The creation of the 1.273 MWh NEG surplus nets the customer a $102.21 payout, which amounts to $80 per MWh. So even when the Company actually has to purchase surplus power at retail rates from the Net Metering customer annually, they still have an $18 per MWh retail margin or markup (22.5%) over the retail price of $98 for Tier 1 power per MWh.

If the BC Hydro Tranche 1 rate, $47-$56 per MWh, had been used as the NEG payout value, the cost of the annual payout to the Company is reduced to between $71.29 and $59.83. Thus the margin or markup on what the Company purchases power for from the Net Metering customer soars to between 75% to 108.5% on a resale retail price of $98 for Tier 1 power per MWh.

If the current BC Hydro NM NEG rate was used, the cost to FortisBC would be a $127.17 annual payout to the customer, and the Company would be paying $99.9 per MWh. If FortisBC succeed in their reconsideration application, British Columbia will end up with a bifurcated Net Metering situation, one that was not anticipated by the provisions of the *Clean Energy Act* and the 2007 Energy Plan.

Updated Modified Table 8-1: FBC Demand-Side and Supply-Side Resource Options

Resource Option	Unit Energy Cost ($MWh)	Unit Capacity Costs ($KW-year)
PPA Tranche 1 Energy	$46	N/A
PPA Capacity	N/A	$96 - $115
Gas-Fired Generation (SCGT)	N/A	$80 - $143
Market Purchases	$38	$169 -$355
Kaslo NM#1 – 12 kW solar PV*	**($38) $56.5-$69**	**($1,416) ($35.4) $70.8-$56.7**
Kaslo NM #2 – 8.1 kW solar PV*	**($65.7) $97.9-$119.4**	**($1,907.5) ($47.7) $95.4-$76.3**
Pumped Hydro Storage	N/A	$217
Gas-Fired Generation (CCGT)	$82 - $100	$147 - $279
Biogas	$77 - $101	$621 - $838
PPA Tranche 2 Energy	$85 - $130	N/A
Municipal Solid Waste	$134	$1,031
Onshore Wind	$111 - $145	$1,219 - $1,618
Run-of-River Hydro	$87 - $150	$1,230 - $1,924
BC Hydro NM Typical Costings solar PV 4kW**	**$159.7**	**($3,625) ($90.6) $157.6**
FortisBC Ellison Solar Garden 240.2 kW***	**$145.1 ($185.2-$216.1)**	**($6,182) $154.6 ($204.3-$241.1)**
Kaslo NM #4 – 7 kW solar PV*	**($129.6) $193-$235.6**	**($3,495) ($87.4) $139.8-$174.8**
Solar	$169 - $184	$1,399 - $1,413
Wood-Based Biomass	$118 - $188	$663 - $774
Similkameen Hydro Project	$202	$1,298
Geothermal	$132 - $217	$857 - $1,506
Kaslo NM #3 – 6 kW solar PV*	**N/A**	**($93.32)**

FBC at BCUC IR#1.25.1, when comparing NW PP Solar PV costs to the Company’s own estimates, states:

“*Solar UEC is different because smaller plants were evaluated in B.C., so they were not able to realize the same economies of scale. In addition, it is likely that the solar intensities of good sites were greater in the U.S. as they are closer to the equator*”.
BC Hydro Net Metering Program:

https://s3-us-west-2.amazonaws.com/ceavideos/CEEPQS+Webinars/SolarPVwebinar/3+Net+Metering+with+BC+Hydro+-+BC+Hydro.pdf

BC Hydro presents the following comparative insolation values:

British Columbia = 1,100 kWh/kW****

Japan = 1,125 kWh/kW

Germany = 848 kWh/kW

**** In fact the map of BC, data courtesy of Natural Resources Canada, indicates that the coast is 900 kWh to 1,000 kWh and as low as 800 kWh, parts of the Interior as high as 1,100 to 1,200 kWh, the West Kootenay 1,000 to 1,100 kWh, and a part of the East Kootenay (around Kimberley) 1,300 kWh. That’s quite the range of around 62.5% between low and high.

*Kaslo NM #1 represents a self installed 12 kW solar PV system amortized over 20/25 years, (with 40 years in brackets) in line with a solar PV panel warranty of 25 years.

*KM#2 represents a self-installed, with electrical contractor hook up, 8.1 kW solar PV system amortized over 20/25/40 years (with 40 years in brackets), in line with a solar PV panel warranty of 25 years.

*KM#4 represents a contractor-installed 6.96 kW solar PV system amortized over 20 /25/40 years (with 40 years in brackets), in line with a solar PV panel warranty of 25 years.

** BC Hydro Net Metering Typical Costings of a 4 kW solar PV system is calculated by taking both financial and production information and observing a 23 year amortization rate as stated by BC Hydro on their website.

https://www.bchydro.com/energy-in-bc/acquiring_power/current_offerings/net_metering.html

*** FortisBC Ellison Solar Garden pilot project is given a 40 amortization rate, with 20/25 years in brackets for comparison with the three Kaslo and one BC Hydro NM installations as per specifications found in the FBC application.

UEC @20 years = $960,744 plus $205,564***** O& M divided by 5,397,874 kWh = 21.61 cents per kWh and $216.1/MWh

UEC @25 years = $960,744 plus 273,855***** divided by 6,664,885 kWh = 18.52 cents per kWh and $185.2/Mwh

UEC@ 40 years + $960,744 plus $524,206***** divided by 10,232,967 kWh = 14.51 cents kW and $145.1/MWh.

UCC $960,744 capital cost plus O & M cost $524,206***** = 1,484,950 divided by (720 Panels @ 0.335 kW/panel) 240.2 kW = $6,182.14

Annualized UCC 40 Years (with 20/25 years in brackets) $960,744 capital cost plus O & M $524,206***** = 1,484,950 divided by 240.2 divided by 40 = $154.55/MWh

(20/25 year 0 &M cost of $197,464/$265,761***** = $1,158,208/1,226,505 divided by 240.2 kW divided by 20/25 = $241.09/$204.25)

***** $9,000 a year O&M calculated at 2% inflation per annum

FBC estimates income requirement on page 13 of its 2017 Community Solar Pilot Project Application:

$ 877,490/3,793,218 kWh = $0.231 per kWh

FortisBC Inc 2016 Long Term Electric Resource Plan & Long Term Demand Side Management Plan **Shadrack Evidence Information Request #1: Background Information** **1%/.5% Annual Solar PV Production Reduction Over Twenty to Forty Years**					
Year	BC Hydro 4/kW*	NM#1 12/kW**	NM#2 8.1/kW**	NM#4 6.96 kW	Ellison Solar Farm Pilot Project 240.2/kW***
1	4,400	13,399	7,100	5,670	282,939
2	4,356	13,398	7,029	5,613	281,524
3	4,312	13,264	6,959	5,557	280,116
4	4,269	13,131	6,889	5,502	278,716
5	4,227	13,000	6,820	5,447	277,322
6	4,184	12,870	6,752	5,392	275,935
7	4,143	12,741	6,685	5,338	274,556
8	4,101	12,614	6,618	5,285	273,183
9	4,060	12,488	6,651	5,232	271,817
10	4,019	12,363	6,486	5,180	270,458
11	3,979	12,239	6,421	5,128	269,106
12	3,939	12,117	6,357	5,077	267,760
13	3,900	11,996	6,293	5,026	266,421
14	3,861	11,876	6,230	4,976	265,089
15	3,822	11,757	6,168	4,926	263,764
16	3,784	11,639	6,106	4,877	262,445
17	3,746	11,523	6,045	4,828	261,133
18	3,709	11,408	5,985	4,779	259,827
19	3,672	11,294	5,925	4,732	258,528
20	3,635	11,181	5,866	4,684	257,235
Cummulative Decline in Production	.9104 80,118	.9191 246,298	.9112 129,385	.9105 103,249	.9539 5,397,874
21	3,599	11,069	5,807	4,638	255,949
22	3,563	10,958	5,749	4,591	254,669
23	3,527	10,849	5,692	4,545	253,396
24	-	10,740	5,635	4,500	252,129
25	-	10,633	5,578	4,455	250,868
Total	90,807	300,547	157,846	125,978	6,664,885
Cumulative Decline in Production	.8973	.8972	.8893	.8889	.9422

Year	BC Hydro 4/kW*	NM#1 12/kW**	NM#2 8.1/kW**	NM#47.96/kW**	Ellison Solar Farm Pilot Project 240.2/ kW***
26		(10,527)	(5,522)	(4,410)	249,614
27		(10,421)	(5,467)	(4,366)	248,365
28		(10,317)	(5,412)	(4,323)	247,124
29		(10,214)	(5,358)	(4,279)	245,888
30		(10,112)	(5,305)	(4,237)	244,659
31		(10,011)	(5,252)	(4,194)	243,435
32		(9,911)	(5,199)	(4,152)	242,218
33		(9,812)	(5,147)	(4,111)	241,007
34		(9,713)	(5,096)	(4,070)	239,802
35		(9,616)	(5,045)	(4,029)	238,603
36		(9,520)	(4,994)	(3,989)	237,410
37		(9,425)	(4,944)	(3,949)	236,223
38		(9,331)	(4,895)	(3,909)	235,042
39		(9,237)	(4,846)	(3,870)	233,867****
40		(9,145)	(4,797)	(3,832)	232,967
Cumulative Decline in Production		.8356 (447,859)	.8279 (235,125)	.8276 (187,698)	.9084 10,281,110

* BC Hydro specify a 23 year amortization period on their website as typical for NM customer-generator enrollees

** NM#1, NM#2 & NM#4 all have a solar PV panel warranty period of 25 years

*** Production reduction for Ellison Solar Farm pilot project has been left at FortisBC's .5% per annum

**** This figure matches the figure found on line 12 of Appendix B-1

Kaslo Sunset Times: November 15 to February 15 (from http://sunrise.maplogs.com/kaslo_bc_canada.97407.html?year=2016 and year=2017)			
November 15-30	December 1-31	January 1-31	February 1-15
04:02:20 PM	03:48:32 PM	03:58:16 PM	04:44:10 PM
04:01:09 PM	03:48:04 PM	03:59:21 PM	04:45:53 PM
04:00:00 PM	03:47:40 PM	04:00:28 PM	04:47:35 PM
03:58:54 PM	03:47:18 PM	04:01:38 PM	04:49:18 PM
03:57:50 PM	03:47:00 PM	04:02:49 PM	04:51:02 PM
03:56:49 PM	03:46:44 PM	04:04:03 PM	04:52:45 PM
03:55:50 PM	03:46:32 PM	04:05:19 PM	04:54:28 PM
03:54:53 PM	03:46:23 PM	04:06:37 PM	04:56:11 PM
03:54:00 PM	03:46:17 PM	04:07:56 PM	04:57:54 PM
03:53:09 PM	03:46:14 PM	04:09:18 PM	04:59:38 PM
03:52:21 PM	03:46:15 PM	04:10:41 PM	05:01:21 PM
03:51:35 PM	03:46:19 PM	04:12:06 PM	05:03:04 PM
03:50:53 PM	03:46:26 PM	04:13:32 PM	05:04:47 PM
03:50:13 PM	03:46:36 PM	04:15:00 PM	05:06:29 PM
03:49:37 PM	03:46:49 PM	04:16:29 PM	05:08:12 PM
03:49:03 PM	03:47:06 PM	04:17:59 PM	
	03:47:25 PM	04:19:31 PM	
	03:47:48 PM	04:21:04 PM	
	03:48:14 PM	04:22:38 PM	
	03:48:43 PM	04:24:13 PM	
	03:49:15 PM	04:25:49 PM	
	03:49:50 PM	04:27:26 PM	
	03:50:28 PM	04:29:04 PM	
	03:51:09 PM	04:30:42 PM	
	03:51:53 PM	04:32:22 PM	
	03:52:40 PM	04:34:01 PM	
	03:53:29 PM	04:35:42 PM	
	03:54:21 PM	04:37:23 PM	
	03:55:16 PM	04:39:04 PM	
	03:56:14 PM	04:40:46 PM	
		04:42:28 PM	

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DW12-100

SILICONE BATTERY 12V-100AH

HIGH TEMPERATURE ENDURANCE AND PERFORMANCE

60 MINUTES FAST RECHARGE • ENVIRONMENTAL FRIENDLY

GENERAL FEATURES

Patent protected proprietary electrolyte is non-corrosive hence battery lasts longer with more charging cycles

Extreme high and extreme low temperature performance: -40°C to +70°C

Performs extremely well in hot outdoor environment; VRLA loses 50% of charging cycles for every 8°C increase in temperature about 25°C, Silicone batteries only lose around 20% under the same condition

1,700 to 2,200 charging cycles for 50% depth of discharge

Self-discharge rate approximately 20% in 2 years

Fast recharge capability, 90% capacity can be recharged in 60 minutes

30% - 50% higher specific energy than VRLA

PRODUCT SPECIFICATION

Nominal Voltage:

12V

Rated Capacity:

20 Hour Rate (1.80V/Cell)	112.00AH
10 Hour Rate (1.80V/Cell)	110.00AH
5 Hour Rate (1.60V/Cell)	87.80AH
1 Hour Rate (1.20V/Cell)	82.50AH

Dimension and Weight:

Length: 331mm ± 2mm

Width: 175mm ± 2mm

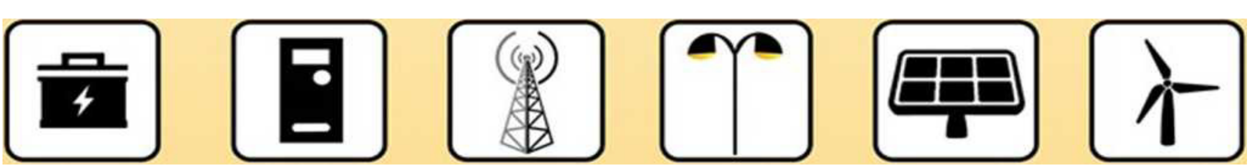
Height: 225mm ± 2mm

Weight: 28.0kg ± 0.5kg

Operating Temperature Range:

Discharging	-40°C to +70°C
Charging	-20°C to +50°C
Storage	-20°C to +50°C

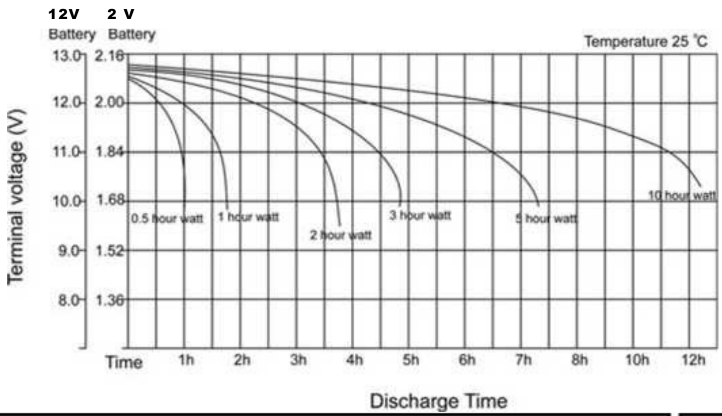
APPLICATIONS:



SILICONE BATTERIES INC.

ADVANCED SILICONE POWER BATTERY

Hour - Watt Discharging Curves



Charging Performance Curves