EPCOR Water Services Inc.

Sustainability Value Analysis of the E.L. Smith Solar Farm Project

August 12, 2018

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Executive Summary

EPCOR Water Services Inc. ("EWSI") is planning to construct a solar farm on its property located at 3900 E.L. Smith Road to supply renewable energy to its E.L. Smith Water Treatment Plant ("the project"). The solar farm will have a peak generation capacity of approximately 12 megawatts ("MW"). If the solar farm produces more energy than the water treatment plant can use, any excess will be exported back to the electrical grid.

The proposed project will involve installing up to 45,000 solar panels on EWSI's property south of the E.L. Smith Water Treatment Plant and connecting the panels to the water treatment plant ("behind the meter) and EPCOR Distribution and Transmission Inc.'s ("EDTI") electrical distribution system. The existing fence at the Project site will be upgraded to safely and securely enclose the solar farm.

After submitting the project Business Case Report "Solar Farm at E.L. Smith Water Treatment Plant Capital Business Case" dated February 23, 2018 to the City of Edmonton's Utility Committee, the City requested that EWSI undertake a triple bottom line analysis ("TBL") of the project. A triple bottom line analysis provides an overview of the economic/financial, social and environmental impacts of the project. EWSI commissioned HDR Corporation ("HDR") to undertake the triple bottom line assessment.

A triple bottom line analysis of the solar farm project at E.L. Smith requires the project as defined to be compared to other specific and realistic alternatives. EWSI developed four other alternatives, as follows:

1. Grid Supply. This is the "Base Case" or "Business as Usual". In this alternative, EWSI would purchase conventional power from the electricity grid. EWSI would not purchase any green energy, or otherwise provide for any reduction in CO2 or other GHG emissions.
2. Grid Supply + Generic REC's.
3. Offsite Wind Farm.
4. Solar Project at E.L. Smith.
5. Offsite Local Solar Farm.

The triple bottom-line evaluation of renewable energy alternatives identifies and summarizes the trade-offs between the alternatives spanning financial, environmental and social considerations which are documented in both qualitative and quantitative terms. This Multiple Account Evaluation (MAE) framework recognizes that different stakeholders will have different perspectives on the relative importance of each of these criteria as well as the impact of each alternative on these same criteria. A combination of MAE and breakeven approaches is applied for the SVA. The MAE is appropriate in circumstances such as this where there is difficulty in applying social/environmental value to the land at EL Smith because the value depends on different stakeholders views. In this triple bottom line analysis, the break-even approach is used to attempt to monetize the environmental/social (ecosystem) value the decision maker would need to assign to the land at EL Smith to make the proposed Project equivalent to the offsite solar project.

The breakeven analysis is summarized in Figure 1. The blue bars in the charts represent the financial costs of each alternative while the red bars represent the emissions costs or benefits in the renewable cases. The yellow arrow highlights how significant any ecosystem damage would have to be at the E.L. Smith site for the Offsite Local Solar Farm to be preferable; this damage would have to be on average 25 times or more greater than the average values we see in the economic literature.

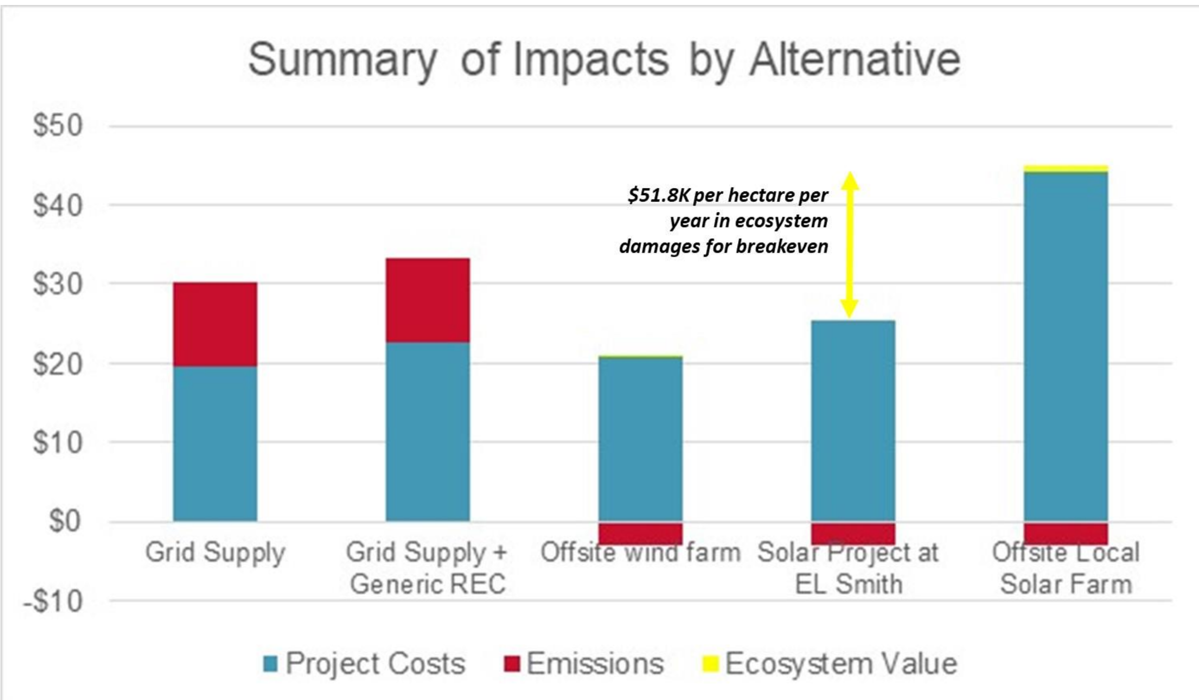

Figure 1: Break Even Analysis

Figure 2 also summarizes the differences between the ecosystem value estimates discussed previously from the TEEB database, from valuations in Greater Montreal, from valuations from the North Saskatchewan River (NSR) and from HDR[1]. There is quite a large gap between these estimates and the breakeven estimate of $51,800 per hectare per year.

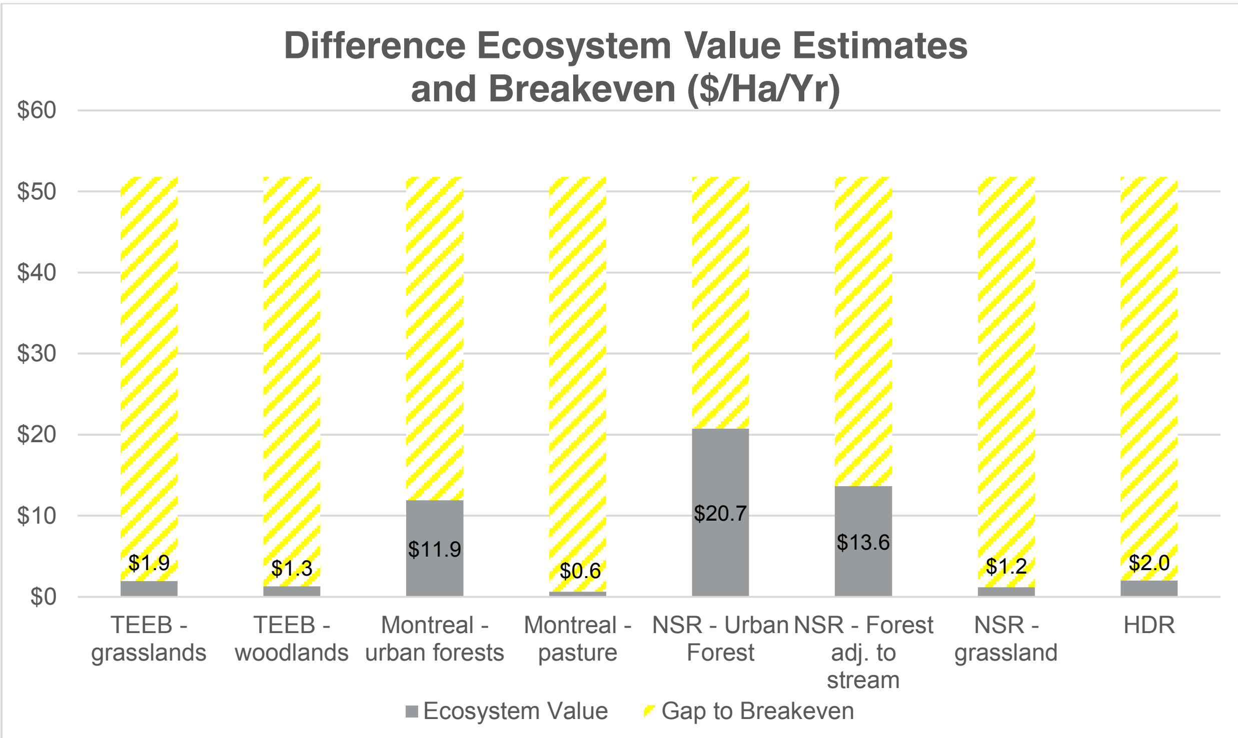

Figure 2: Difference Between Literature Estimates and the Breakeven Value

From an overall evaluation perspective, if additionality and having local generation are required, then really there are two alternatives: (i) the Solar project at E.L. Smith and (ii) the offsite local solar farm. The Solar project at E.L. Smith can be developed at a much lower financial cost with both these alternatives providing equivalent emission reduction benefits. Decision-makers will have to determine whether the project development at E.L. Smith could result in very significant ecosystem damages as highlighted in the breakeven analysis. This would seem implausible given the evidence in the economic literature and the findings of the Environmental Evaluation by Stantec Consulting.

[1] *These estimates from the literature were escalated to represent 2018 dollar values for comparison.*

Introduction and Background

EPCOR Water Services Inc. ("EWSI") is planning to construct a solar farm on its property located at 3900 E.L. Smith Road to supply renewable energy to its E.L. Smith Water Treatment Plant ("the project"). The solar farm will have a peak generation capacity of approximately 12 megawatts ("MW"). If the solar farm produces more energy than the water treatment plant can use, any excess will be exported back to the electrical grid.

The proposed project will involve installing up to 45,000 solar panels on EWSI's property south of the E.L. Smith Water Treatment Plant and connecting the panels to the water treatment plant ("behind the meter) and EPCOR Distribution and Transmission Inc.'s ("EDTI") electrical distribution system. The existing fence at the Project site will be upgraded to safely and securely enclose the solar farm.

In its 2017-2021 Performance Based Rate (PBR) Application, which was approved by City Council in October 2016, EWSI included a Green Power Initiative which commits EWSI to obtaining approximately 10 per cent of its power volumes from locally produced renewable sources starting in 2018. The proposed Solar Farm was sized to align with the $1.9 million per year funding which was already approved by City Council to ensure no incremental rate increases relative to the purchase green power option. As the proposed project was being developed, EWSI determined that the maximum size solar farm at the E.L. Smith site would be 12MW.

Building a solar farm at E.L. Smith aligns with the objectives of the City of Edmonton's *The Way We Green: Environmental Strategic Plan* by converting a portion of EWSI's energy use to locally produced, renewable sources. The project also aligns with the City of Edmonton *Energy Transition Strategy* with objectives of generating 10% of Edmonton's electricity locally and to reduce greenhouse gas emissions. The project will also contribute toward the Government of Alberta's goal to have 30% of Alberta's energy come from renewable sources by 2030. The proposed solar farm will generate renewable energy to help power the existing E.L. Smith Water Treatment Plant, while reducing EWSI's greenhouse gas emissions[2].

After submitting the project Business Case Report "Solar Farm at E.L. Smith Water Treatment Plant Capital Business Case" dated February 23, 2018 to the City of Edmonton's Utility Committee, the City requested that EWSI undertake a triple bottom line analysis ("TBL") of the project. A triple bottom line analysis provides an overview of the economic/financial, social and environmental impacts of the project. EWSI commissioned HDR Corporation ("HDR") to undertake the triple bottom line assessment.

In the conduct of the triple bottom line analysis, HDR employed existing project information filed by EWSI with the Alberta Utilities Commission ("AUC") in March 2018 specifically:

- The Environmental Evaluation of the project (Attachment 13 to EWSI's Facility Application to the AUC).

[2] *Direct citations from the EWSI's August 23, 2018 EL Smith Solar Project Update.*

- A report summarizing the requirements of the Participant Involvement Program (Attachment 4 to EWSI's Facility Application to the AUC).
- The Solar Glare Analysis Report – E.L. Smith Solar Farm ("Glare Study") (Attachment 7 to EWSI's Facility Application to the AUC).

In addition, HDR took as input EWSI's E.L. Smith Solar Project Financial Analysis model which measured the direct financial consequences of each of the alternatives namely, capital, expenses, revenues and taxes. HDR provided specific feedback on the model and the alternatives throughout the project.

Project Alternatives

A triple bottom line analysis of the solar farm project at E.L. Smith requires the project as defined to be compared to other specific and realistic alternatives. EWSI developed four other alternatives, as follows:

1. Grid Supply. This is the "Base Case" or "Business as Usual". In this alternative, EWSI would purchase conventional power from the electricity grid. EWSI would not purchase any green energy, or otherwise provide for any reduction in CO2 or other GHG emissions.
2. Grid Supply + Generic REC's.
3. Offsite Wind Farm.
4. Solar Project at E.L. Smith.
5. Offsite Local Solar Farm.

The assumptions underlying the alternatives are based on EWSI's August 23 EL Smith Solar Project Update report.

In the non-E.L. Smith alternatives, it is assumed that the land at E.L. Smith remains as is, undeveloped and maintained for the potential future expansion needs of the E.L. Smith Water Treatment Plant. This site is predominantly perennial pasture[3].

Table 1: Summary of Project Alternatives

Alternative	Grid Supply	Grid Supply + Generic RECs	Solar Project at E.L. Smith	Offsite Local Solar Farm	Offsite Wind Farm
Green Energy %	Grid Mix	23%	23%	23%	23%
Locally Produced	-	-	✓	✓	-
Provides Additionality	-	-	✓	✓	✓
Annual Electricity Purchased (Consumed by EL Smith) (MWh)	9,636	14,000	14,000	14,000	14,000

[3] *Source: Environmental Evaluation for the E.L. Smith Solar Farm, Stantec Consulting Ltd., March 2018.*

Alternative	Grid Supply	Grid Supply + Generic RECs	Solar Project at E.L. Smith	Offsite Local Solar Farm	Offsite Wind Farm
Annual RECs produced by Project (MWh)	9,636	21,500	21,500	21,500	21,500

The balance of this report summarizes HDR's triple bottom line analysis of the project. The report is structured as follows: Section 2 provides a general overview of HDR's triple bottom line approach including how it was customized for evaluating the project; Section 3 provides the triple bottom line analysis including the approach, key assumptions, and outcomes; and Section 4 provides the key study conclusions.

HDR's Triple Bottom Line Approach – Sustainable Value Assessment

Policy-makers and infrastructure-owners increasingly seek an objective case for sustainability-oriented investments. Triple bottom line approaches to public investment analysis remain a critical tool for decision makers. To not undertake TBL to support decision making would imply that the environmental and social impacts of projects are not relevant thereby limiting decision criteria to only project financials. HDR's Sustainability Value Analysis ("SVA") takes the broadest view possible for estimating project public value and trade-offs across a triple bottom line to compare alternatives and communicate its features to support decision making. The methods applied are based on best practices in analysis and feature a combination of transparency, adaptability to project and client needs, and a focus on communicating the results in ways that are applicable to the client and its stakeholders and/or regulators. The triple bottom line framework reflects a holistic view of the project that takes into account not just the economic and financial aspects, but social and environmental impacts as well (see Figure 3).

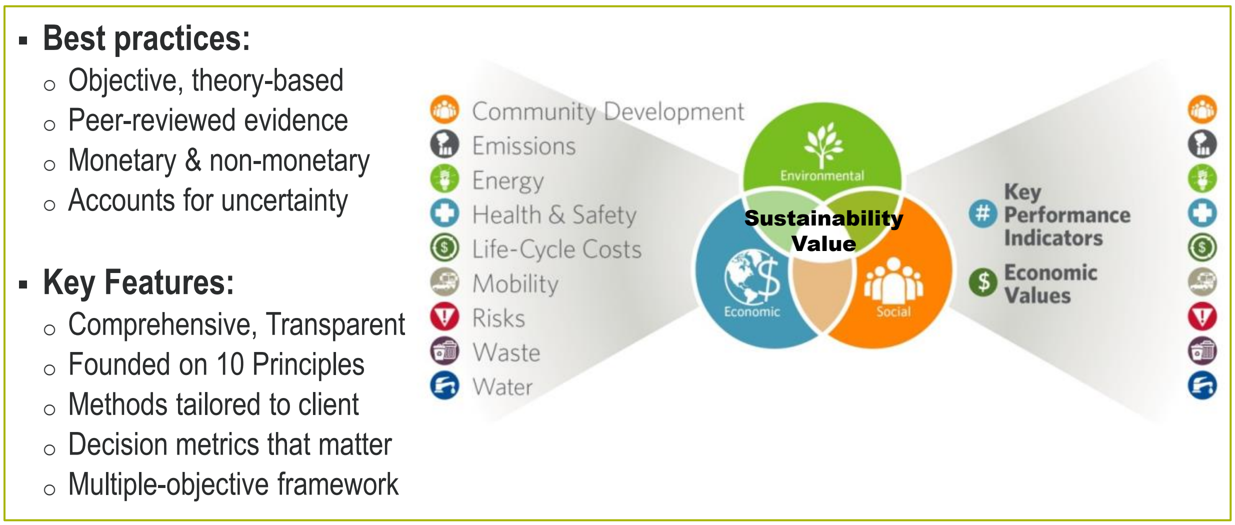

Figure 3: Overview of Sustainability Value Analysis

SVA provides a suite of evaluation methods that adapt to different levels of data availability, types of project owners, and project characteristics but are based on a common set of analytical principles. Depending on the type of project, the availability of data availability, the type of results needed by decision makers, SVA could apply:

- **Multi-Objective Decision Analysis ("MODA") -** a triple bottom line analysis where a group of specific economic/financial, social and environmental criteria or "accounts" are evaluated using scores and weights and scores to provide an ordinal ranking of the alternatives and to determine the preferred alternative.
    - **Advantages:** This approach gives a ranking of the alternatives and the highest scored alternative can be considered the preferred option.

  - **Limitations:** The weighting and scoring may not be aligned with decision making body's / regulator's perspective unless it is conducted directly by them.

- **Multiple Account Evaluation ("MAE") –** a triple bottom line analysis where a group of specific economic/financial, social and environmental criteria or "accounts" are evaluated. There is no overall weighting or scoring but rather the relative trade-offs between alternatives are evaluated are documented. The determination of what is the preferred alternative is left to the perspective of each individual decision maker based on the information presented:
  - **Advantages:** This approach provides an understanding of trade-offs between all the options and lets the decision makers make the ultimate decision based on this information as to what is optimal.
  - **Limitations:** The approach does not specifically determine the preferred alternative.

- **Sustainable Return on Investment ("SROI") –** a triple bottom analysis where it is feasible to assign monetary values to most the critical economic/financial, social and environmental criteria or "accounts" to provide a holistic return on investment estimate. SROI is equivalent to traditional "Cost Benefit Analysis" approaches but where stakeholders are directly engaged in the evaluation process. In addition, non-monetary outcomes are summarized and presented but are not directly included in the "return on investment" quantification:
  - **Advantages:** This approach gives a ranking of the alternatives based on a monetary valuation of all of the economic/financial, environmental and social criteria.
  - **Limitations:** It may be difficult to determine a monetary valuation of some criteria that are specific to the project itself without extensive primary research.

These three main approaches to SVA – MODA, MAE and SROI are quite similar with some minor subtleties; the preferred approach is selected based on the specifics of the project, the context and the study purpose. All of these SVA methods leverage the same core principles (see Figure 4) of analysis from economics and utilize the best available data on monetary valuation. At the same time, if such data is not available with a sufficient level of accuracy, alternative methods are applied to provide a reasonable measure of a project's cost-effectiveness for comparisons against a baseline and alternative investment options.

Another key feature of SVA is the application of risk analysis techniques to account for uncertainty in key drivers of costs, benefits / value. These methods provide additional information on the upside and downside risk in the selection of a project option. The risk analysis approach utilized again depends on the project specifics and data availability and include but are not limited to:

- Probabilistic risk analysis – all SVA inputs are treated probabilistically and modeled / simulated to yield probability based outputs.
- Sensitivity analysis – key input assumptions are varied or “shocked” individually to see the impact on the output of interest.
- Scenario analysis – a group of a limited number of input assumptions are varied or “shocked” together to see the impact on the output of interest.
- Break-even or threshold analysis – when data may be missing for one key input assumption, quantitative experiments are conducted to see how high or low that input value would have to be for a output metric to “break-even”.

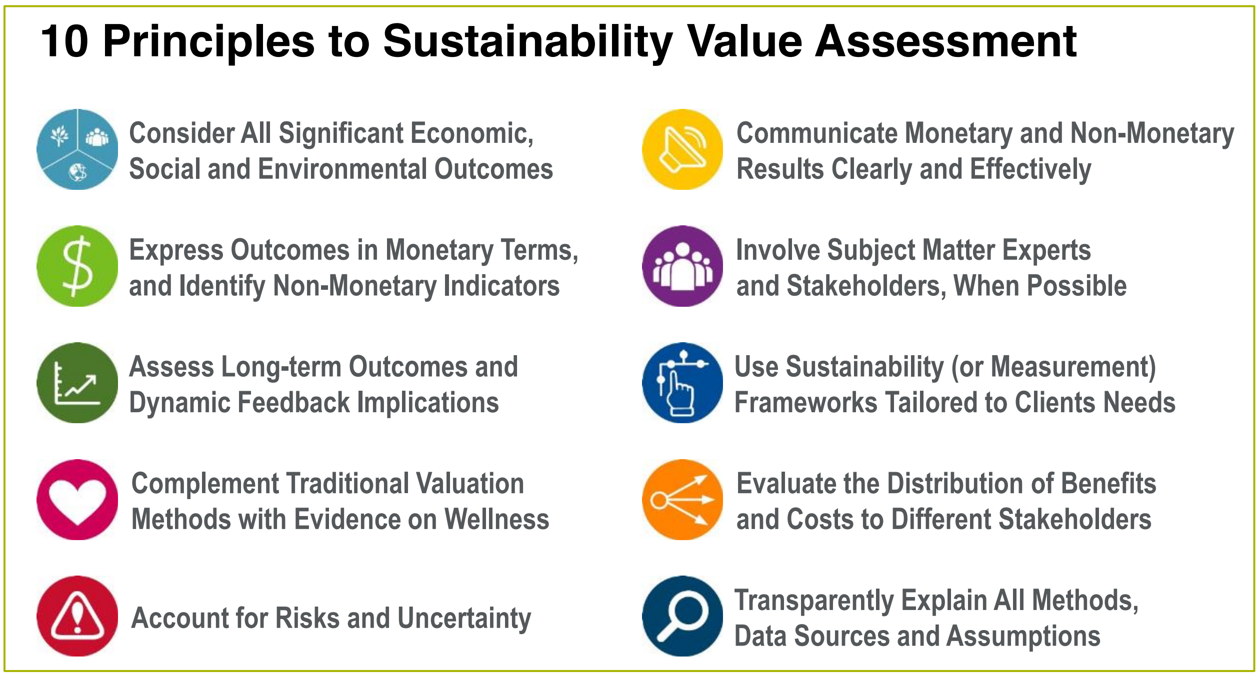

Figure 4: SVA Principles of Analysis and Communication

Sustainability Value Analysis of Alternatives

Study Approach

The SVA study process for the evaluation of the E.L. Smith with Behind the Meter Solar project included the following steps:

1. A review of existing project documentation from the AUC and Utility Committee submissions.
2. A review of EWSI's revenue requirement financial model of the alternatives.
3. Development of an initial list of key impacts for each of the alternatives.
4. A review of literature and past studies where such impacts were considered quantitatively and / or qualitatively.
5. A workshop with representatives from the EWSI Community Advisory Panel, the Miistakis Institute, City of Edmonton, the University of Alberta, Stantec Consulting Ltd., NAIT and project subject matter experts from EWSI where HDR presented and received feedback on the proposed study approach.
6. Meetings with those that expressed opposition to the project to get their perspective on the project and to acquire their specific input. All organizations that expressed opposition to the project were given the opportunity to meet with HDR.

Based on these steps, and in consideration of the range of potential project impacts, the data available, the objective of the study, and feedback from the workshop and meetings with project opponents, HDR made a determination of the specific approach to the SVA analysis of the E.L. Smith Behind the Meter Solar project – namely, a Multiple Account Evaluation combined with breakeven analysis. The main rationale for selecting the MAE framework is provided below:

- Some of the key impacts or considerations to be included in the SVA analysis are qualitative in nature and cannot be represented in a quantitative or monetary form. It is important to note that <u>the inability to quantify or monetize a specific effect in no way implies that the effect is not as important as the other effects that can be quantified</u>.
- At least one of the potential project impacts – the impact on the land at E.L. Smith - is quite uncertain as to the specific impact itself and how to value it in monetary or other terms. Different stakeholders may have different views on its importance and how to value it. That is the main reason, the MAE approach was augmented with breakeven analysis.
- The triple bottom line analysis was requested to provide additional insight to the project trade-offs for external decision makers / regulators. To independently assign weights to various impacts, as required be certain non-MAE approaches to provide a singular

project score or ordinal ranking could very well deviate with the perspective of decision makers.

From a handling of uncertainty perspective, HDR made a determination to use sensitivity analysis for key inputs with and break-even / threshold analysis. Again, the fact that some of the key project considerations could not be monetized eliminated the potential to use probabilistic risk analysis.

In the discussion that follows in the balance of this section, some of the rationale for these determinations will become more evident.

Limitations

In the conduct of the triple bottom line analysis, HDR employed existing information from previous project studies and analysis. This includes:

1. The project financial inputs were provided by EWSI. HDR translated the “revenue requirement” analysis into a cash flow based pro forma model to reflect the overall cash flows over the project lifecycle.

2. HDR relied on existing project reports that had been provided to the AUC. HDR did not independently verify the findings of these studies. HDR did make inquiries, had discussions on the specific assumptions through the project process and visited the proposed E.L. Smith project site. Through this process, nothing encountered was unexpected or looked unreasonable. Also, it should be noted that other than the feedback from the workshop and meetings with project opponents, primary data collection was not a part of this evaluation.

MAE Framework – Project Impacts or Effects

Through the triple bottom line analysis process, a range of project impacts or effects were identified for the range of alternatives analysis that spanned financial, social and environmental considerations. These are briefly summarized in the table below (note not all impacts are applicable to each alternative):

Table 2: Multiple Account Evaluation - Effects by Alternative

#	Account	Criteria	Description
F1	Financial	Total of All Financial Costs	The present value of all financial costs by alternative. This represents the costs to EWSI and therefore its rate payers of each of the alternatives.
F2	Financial	Levelized cost of all energy	A summary representing the average cost of energy by alternative.
F3	Financial	Levelized cost of renewable energy	A summary representing the average cost of the renewable energy source by alternative. Defined as: Net Present Value of Incremental Cost of Renewable Energy / Net Present Value of Energy Demand on Site
F4	Financial	Risk Management	Qualitative assessment of whether the alternative provides a hedge against escalating grid power price increases.
E1	Environmental	GHG Emission Damage Costs	Monetized value of GHG emissions by alternative.

#	Account	Criteria	Description
E2	Environmental	GHG Emissions Volumes	Volume of GHG emissions by alternative.
E3	Environmental	Avian mortality	Qualitative assessment of the potential impact of the alternative on avian mortality.
E4	Environmental	Ecosystem value – provisioning services	Qualitative assessment of the potential impact of the alternative on the ecosystem's provisioning services.
E5	Environmental	Ecosystem value – regulating services	Qualitative assessment of the potential impact of the alternative on the ecosystem's regulating services.
E6	Environmental	Ecosystem value – habitat services	Qualitative assessment of the potential impact of the alternative on the ecosystem's habitat services.
E7	Environmental	Ecosystem value – cultural and aesthetic services	Qualitative assessment of the potential impact of the alternative on the ecosystem's cultural and aesthetic services.
E8	Environmental	Ecosystem value at risk	The dollar value of the ecosystem value at risk (ecosystem value of land at the renewable site on a present value basis).
S1	Social	CAC Emission Damage Costs	The monetized value of criteria air contaminant emissions by alternative. The damages caused by these emissions are mostly localized and mostly represent health and respiratory effects and are considered a social effect.
S2	Social	CAC Emission Volumes	The volumes of criteria air contaminant emissions by alternative.
S3	Social	Economic Development	Qualitative assessment for the alternative to have a positive economic impact within the City of Edmonton.
S4	Social	Additionality – A new renewable resource	Qualitative assessment of whether the alternative provides additionality or a new renewable generation source.
S5	Social	Strategic Alignment – Alignment with City of Edmonton objectives for local generation	Qualitative assessment of whether the alternative aligns with the City of Edmonton Energy Transition Strategy objectives for local generation.
S6	Social	Strategic Alignment – Alignment with City of Edmonton and Province of Alberta objectives for GHG reductions	Qualitative assessment of whether the alternative aligns with the City of Edmonton and Province of Alberta objectives for GHG reductions.
S7	Social	Education Potential	Qualitative assessment of whether the alternative provides educational opportunities.
S8	Social	Corporate Leadership in Renewables	Qualitative assessment of whether the alternative demonstrates corporate leadership in renewables by EWSI.
S9	Social	Precedence – development in the North Saskatchewan River Basin	Qualitative assessment of whether the alternative sets a precedent for project development within the North Saskatchewan River Basin.

Assumptions

For effects that can be quantified or monetized, there are a number of specific assumptions used to develop the estimates. These are summarized here:

General Parameters

The overall study period for the project is 2019 to 2049. This represents a construction period of 1 year in 2019 and 30 years of operations for the alternatives from 2020 to 2049. All monetized impacts are estimated annually over the entire study period. All annual monetized impacts over this period are discounted to 2018 dollars using EWSI's weighted average cost of capital of 6.83 percent.

Energy Costs

For the “hard” financial cost inputs, the EWSI revenue requirement financial model inputs were utilized in the triple bottom line analysis. The specific assumptions, rationale and sources are documented in the EWSI’s August 23 Solar Project Update report. We highlight the following assumptions that are influential to the overall analysis:

- The energy capacity price forecasts are derived from the EDC Associates Limited, Q2 2018 Average Alberta Electricity Price forecast. Prices are held constant after 2032 to 2049.
- For exports of surplus power from the solar project alternatives, EWSI receives the Grid Price plus 15% due to favourable timing of surplus power production.
- For the two solar farm project alternatives, the capital cost for developing the project is $32.4 million.
- At the end of the useful life of the solar farm project alternatives, the projects are decommissioned, the equipment is removed and salvaged, and that the land is restored. It is assumed that there is no financial effect at the end of the study period; the decommissioning costs are assumed to equal the salvage value of the equipment.
- For the Offsite Local Solar Farm alternative, additional costs are incurred relative to the EL Smith with Behind the Meter Solar alternative:
    - Transmission line to substation costs of $484,000. Of the site options identified by EWSI, the lowest cost option was assumed in the business case and this triple bottom line analysis; costs at a selection of sites ranged from $484,000 to over $8 million.
    - Substation costs of $4.6 million.
    - Land acquisition costs of $385,000. Of site options identified by EWSI, the lowest cost option was assumed in the business case and this triple bottom line analysis; costs at a selection of sites ranged from $385,000 to over $28 million.
    - Additional annual O&M costs of $200,000 per year.
    - Additional capacity costs and wire charges due to the need to purchase more energy than the Solar Project at E.L. Smith alternative.
    - Revenues from generation are taxable due to the level playing field test. A tax rate of 27 percent is assumed.
- For the Grid Supply with Generic REC’s alternative, a REC cost of $12 per MWh.
- For the Interest in a Wind Farm alternative:

- The Net Present Value (NPV) of the wind alternative is based on a long-term contract price for wind power, based on the REP 1 auction results, plus premiums to account for the small size of the project and the need for firming. The base price and size premium are inflated at REP escalator of 20% of CPI.
- Additional capacity costs and wire charges due to the need to purchase more energy.
- For exports of power, EWSI receives the Grid Price less 40% due to the timing of power production.
- Revenues from generation are taxable due to the level playing field test. A tax rate of 27 percent is assumed.

Emissions

The two solar alternatives and the wind farm alternatives displace existing power production from the grid. To determine the fuel to be displaced, the marginal grid mix by year indicates the fuel to be displaced by lower cost alternatives at the margin. In general, prior to the complete phase out of coal, the marginal fuel displaced is primarily coal. After coal is phased out, natural gas becomes primary fuel to be displaced. The marginal grid mix is provided in Table 3:

Table 3: Marginal Mix by Year, Source: 2017 AESO Long Term Outlook

Marginal Grid Mix	2020	2030	2040	2049
Coal	52%	11%	0%	0%
Combined Cycle	28%	69%	86%	86%
Simple Cycle	5%	5%	2%	2%
Coal-to-Gas	3%	4%	0%	0%
Cogen	9%	9%	9%	9%
Hydro	2%	2%	2%	2%
Wind	0%	0%	0%	0%
Other	0%	0%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**

To derive volumes of emission from generation, the following emission rates were applied:

Table 4: GHG Emission Rates per KWh of energy generation

GHG Emissions	Coal	Combined Cycle	Simple Cycle	Coal-to-Gas
gCO_2e/kWh	1,032	380	545	624

Sources:

- *Coal Emissions: 2011 North American Power Plant Air Emissions database*
- *Natural Gas Emissions: Calculations by HDR from the 2017 AESO Long Term Outlook Data File*

Table 5: CAC Emission Rates per KWh of energy generation

CAC	NOx	$PM_{2.5}$	SO_2
Emissions Rates	**g/kWh**	**g/kWh**	**g/kWh**
Combustible Fuels	0.96	0.02	1.34

Source:

- *CAC emissions rates were calculated based on the 2016 National Pollutant Release Inventory data file*

Emissions can be estimated in volumetric and monetary terms. In general, the monetization of GHG emissions reflects the monetary value of damage to net agricultural productivity, human health, and property damages. Estimates of the social cost of carbon (SCC) provide a way to value CO_2 emission changes in cost-benefit analysis where the goal is to provide informed analysis to decision makers that quantifies the incremental mitigation benefits associated with a policy action. For GHG's, these damage estimates reflect a global effect.

Some of the monetized damages from GHG emissions may be internalized in electricity prices reflecting the carbon levy that thermal plants pay. The degree to which the carbon levy affects electricity prices is not explicitly identified or easy to isolate as there are many factors affecting prices in Alberta including the new Carbon Competitiveness Incentive Regulation ("CCIR"), the continuation of the growth in renewable generation and as well as the transition to a capacity market. From what is available in the literature on the impact of a carbon tax that reflects the social cost of carbon on electricity prices, an impact of 10 to 20 percent on electricity prices may be anticipated[4].

For criteria air contaminants, CAC emissions monetization values the negative health effects and associated healthcare costs associated with CAC emissions. These effects are more localized in nature.

Table 6: The Damage Cost Associated with the One Additional Tonne of Emissions, in 2018 dollars

Emission Type	$/tonne
CO_2e	$46.24
NOx	$1,135
$PM_{2.5}$	$385,349
SO_2	$5,356

Sources:

- *CO_2e: Environment and Climate Change Canada, Technical Update to Environment and Climate Change Canada's Social Cost of Greenhouse Gas Estimates, March 2016.*

[4] "Consequences of a carbon tax on household electricity use and cost, carbon emissions, and economics of household solar and wind", Ahmad F. Ghaith, Francis M. Epplin, Energy Economics, Volume 67, September 2017. Also derived from data contained in: "The Effect of Carbon Pricing on Canadian Households", prepared by Jennifer Winter, Assistant Professor, University of Calgary, for the Senate Standing Committee on Energy, the Environment and Natural Resources.

- *NOx, PM2.5: Victoria Transport Policy Institute, Transportation Cost and Benefit Analysis II – Air Pollution Costs.*
- *SO_2: Transport Canada, Estimating the Full Costs of Transport in Canada, August 2008.*

Avian Mortality

Wind projects are known to have higher avian mortality rates than other forms of power generation. Research indicates that fatality rates range between three to five birds per MW of wind capacity per year and fatality rates for bats can be substantially higher[5]. Research on avian fatalities from solar PV power generation is more much limited. One study cited evidence of 0.23 bird fatalities per MW of solar PV capacity[6].

These effects are treated qualitatively in the SVA with wind power generation expected to result in more avian fatalities than solar power generation.

Land Value Appreciation

For the Offsite Local Solar Farm alternative, land is acquired by EWSI and has a commercial value at the end of the study period in 2049. We have assumed that the commercial value of land appreciates at a rate of 3.4 percent per year – or roughly one half of EWSI's weighted average cost of capital. This is in line with historical land value appreciation rates in Edmonton since 1981[7].

Ecosystem Value or Total Economic Value of Land

The construction and deployment of new power generation facilities will require the use of land resources – approximately 55 acres (or 23.7 hectares) for two solar project alternatives. To not consider the impact on utilizing and potentially damaging such land resources historically had been a problem in project evaluations.

> *"At the political level, poor recognition of natural capital and ES has led to decisions that contribute to the degradation of the environment and threaten the future capacity of ecosystems to offer the same level of welfare." (Millennium Ecosystem Assessment), 2005. Ecosystems and human well-being: A framework for assessment. Washington.)*

Over the recent years, economic frameworks have been developed to measure the ecosystem value or total economic value of land in monetary terms[8]. These frameworks measure various elements of the ecosystem value of land spanning for key land service functions: provisioning services, regulating services, habitat services, and cultural amenity services to provide a holistic approach to measuring value (see Figure 5 for a topology and Table 7 for the definitions by specific service category). A database of ecosystem values by biome was also developed and

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[5] *Source: Wind Turbine Interactions with Wildlife and their Habitats, American Wildlife Institute 2014*
[6] *Source: A preliminary assessment of avian mortality at utility-scale solar energy facilities in the United States, Leroy J. Walston Jr. *, Katherine E. Rollins, Kirk E. LaGory, Karen P. Smith, Stephanie A. Meyers, Renewable Energy 92 (2016) 405e414, online February 20, 2016.*
[7] *Source: Statistics Canada, Cansim Table 18-10-0205-01 new housing price index, monthly. Note that commercial land price data was not available so the land value for new home prices in Edmonton was used as a proxy.*
[8] *See Chapter 1 of The Economics of Ecosystems and Biodiversity: The Ecological and Economic Foundations, as a reference, Rudolf de Groot et al., March 2010. Link: https://www.es-partnership.org/wp-content/uploads/2016/06/TEEB-D0-Chap-1.pdf*

named the TEEB Database - The Economics of Ecosystems and Biodiversity[9]. These valuations have been developed to help improve decision making and to enable decision makers to appropriately capture the potential environmental impacts of land use.

Ecosystem Services Value Topology

Total Ecosystem Value

Provisioning Services	Regulating Services	Habitat Services	Cultural and Amenity Services
1. Food (e.g. fish, game, fruit)	5. Local Climate and Air Quality	12. Habitat for species	14. Recreation & Mental & Physical Health
2. Raw Materials (e.g. fiber, timber, fuel wood, fodder, fertilizer)	6. Carbon Sequestration and Storage	13. Maintenance of genetic diversity	15. Tourism
3. Fresh Water (e.g. for drinking, irrigation, cooling)	7. Moderation of extreme events		16. Aesthetic appreciation & inspiration for culture, art and design
4. Medicinal resources (e.g. biochemical products, models & test-organisms)	8. Waste treatment		17. Spiritual experience and sense of place
	9. Erosion prevention and maintenance of soil fertility		
	10. Pollination		
	11. Biological control		

Figure 5: Topology of Ecosystem Services for Determining the Ecosystem Value of Land

[9] *Source: The TEEB Valuation Database: overview of structure, data and results, Sander van der Ploeg, Dolf de Groot & Yafei Wang, Foundation for Sustainable Development, December 2010.*

Table 7: Definitions of Ecosystem Service Components

	Category	Definition/Explanation
PROVISIONING SERVICES		
1	Food	Ecosystems provide the conditions for growing food. Food comes principally from managed agro-ecosystems but marine and freshwater systems or forests also provide food for human consumption. Wild foods from forests are often underestimated.
2	Raw materials	Ecosystems provide a great diversity of materials for construction and fuel including wood, biofuels and plant oils that are directly derived from wild and cultivated plant species.
3	Fresh Water	Ecosystems play a vital role in the global hydrological cycle, as they regulate the flow and purification of water. Vegetation and forests influence the quantity of water available locally.
4	Medicinal resources	Ecosystems and biodiversity provide many plants used as traditional medicines as well as providing the raw materials for the pharmaceutical industry. All ecosystems are a potential source of medicinal resources.
REGULATING SERVICES		
5	Local climate and air quality	Trees provide shade whilst forests influence rainfall and water availability both locally and regionally. Trees or other plants also play an important role in regulating air quality by removing pollutants from the atmosphere.
6	Carbon sequestration and storage	Ecosystems regulate the global climate by storing and sequestering greenhouse gases. As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues. In this way forest ecosystems are carbon stores. Biodiversity also plays an important role by improving the capacity of ecosystems to adapt to the effects of climate change.
7	Moderation of extreme events	Extreme weather events or natural hazards include floods, storms, tsunamis, avalanches and landslides. Ecosystems and living organisms create buffers against natural disasters, thereby preventing possible damage. For example, wetlands can soak up flood water whilst trees can stabilize slopes. Coral reefs and mangroves help protect coastlines from storm damage.
8	Waste-water treatment	Ecosystems such as wetlands filter both human and animal waste and act as a natural buffer to the surrounding environment. Through the biological activity of microorganisms in the soil, most waste is broken down. Thereby pathogens (disease causing microbes) are eliminated, and the level of nutrients and pollution is reduced.
9	Erosion prevention and maintenance of soil fertility	Soil erosion is a key factor in the process of land degradation and desertification. Vegetation cover provides a vital regulating service by preventing soil erosion. Soil fertility is essential for plant growth and agriculture and well-functioning ecosystems supply the soil with nutrients required to support plant growth.
10	Pollination	Insects and wind pollinate plants and trees which is essential for the development of fruits, vegetables and seeds. Animal pollination is an ecosystem service mainly provided by insects but also by some birds and bats. Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee.
11	Biological control	Ecosystems are important for regulating pests and vector borne diseases that attack plants, animals and people. Ecosystems regulate pests and diseases through the activities of predators and parasites. Birds, bats, flies, wasps,

	Category	Definition/Explanation
		frogs and fungi all act as natural controls.
HABITAT		
12	Habitats for species	Habitats provide everything that an individual plant or animal needs to survive: food; water; and shelter. Each ecosystem provides different habitats that can be essential for a species' lifecycle. Migratory species including birds, fish, mammals and insects all depend upon different ecosystems during their movements.
13	Maintenance of genetic diversity	Genetic diversity is the variety of genes between and within species populations. Genetic diversity distinguishes different breeds or races from each other thus providing the basis for locally well-adapted cultivars and a gene pool for further developing commercial crops and livestock. Some habitats have an exceptionally high number of species which makes them more genetically diverse than others and are known as 'biodiversity hotspots'.
CULTURAL & AMENITY SERVICES		
14	Recreation and mental and physical health	Walking and playing sports in green space is not only a good form of physical exercise but also lets people relax. The role that green space plays in maintaining mental and physical health is increasingly being recognized, despite difficulties of measurement.
15	Tourism	Ecosystems and biodiversity play an important role for many kinds of tourism which in turn provides considerable economic benefits and is a vital source of income for many countries. In 2008 global earnings from tourism summed up to US$ 944 billion. Cultural and eco-tourism can also educate people about the importance of biological diversity.
16	Aesthetic appreciation and inspiration for culture, art and design	Language, knowledge and the natural environment have been intimately related throughout human history. Biodiversity, ecosystems and natural landscapes have been the source of inspiration for much of our art, culture and increasingly for science.
17	Spiritual experience and sense of place	In many parts of the world natural features such as specific forests, caves or mountains are considered sacred or have a religious meaning. Nature is a common element of all major religions and traditional knowledge, and associated customs are important for creating a sense of belonging.

Source: TEEB Database documentation.

A summary of the results of the TEEB Database is provided in Table 8 by biome. In general, a there is a wide range of estimates by biome. The values for grasslands average $1,200 per hectare per year 2007 US$ per year per hectare with a maximum of $3,100 per hectare per year derived from 25 distinct estimates.

Table 8: Ecosystem Benefits (Value) by Biome, $000, per Hectare per year

Biome	# of Estimates	Mean	Median	Maximum
Coral reefs	96	$105.1	$280.2	$1,195.6
Coastal wetlands	96	$47.5	$50.6	$213.8
Open oceans	6	$49.0	$50.0	$84.0
Coastal systems	27	$27.9	$34.6	$79.6
Inland wetlands	81	$15.8	$15.9	$45.0

Biome	# of Estimates	Mean	Median	Maximum
Tropical forest	139	$5.1	$8.3	$23.2
Lakes	12	$7.4	$7.4	$13.5
Temperate forest	40	$1.3	$2.1	$4.9
Grasslands	25	$1.2	$1.3	$3.1
Woodlands	17	$0.8	$0.6	$2.0

Source: TEEB Database.

The use of such ecosystem values has become much more mainstream in recent years. Some recent outputs from Canadian studies are provided from valuing ecosystem values of the Greater Montreal area (2014) as well as the North Saskatchewan River Basin (2010). For valuing land cover types in Greater Montreal we see maximum ecosystem values ranging between $800 per hectare per year for pasture and rangelands to $20,000 per hectare per year for urban forests.

Table 9: Total Benefits by Land Cover - $000/Ha/Year, From Dupras et al - Greater Montreal (2014)[10]

Land cover type	Minimum	Mean	Maximum
Urban forests and woodlands	$8.0	$11.2	$20.0
Rural forests and woodlands	$1.2	$4.2	$13.5
Urban wetlands	$0.1	$5.3	$18.7
Pasture and rangeland	$0.5	$0.6	$0.8

For the study of the North Saskatchewan River basin, we find estimates ranging between $1,000 per hectare per year for grasslands/pastures/hayfields to up to $17,800 per hectare per year for urban forests. Wetlands are valued $161,400 per hectare per year.

Table 10: Total Benefits by Land Cover - $000/Ha/Year, 2007, Ecosystem Services in the North Saskatchewan River Basin

Land cover type	Value
Wetlands	$161.4
Forest: urban	$17.8
Forest: suburban	$14.8
Forest:adjacent to stream	$11.7
Forest: non-urban	$4.5
Forest	$1.1

[10] *Economic value of Greater Montreal's non-market ecosystem services in a land use management and planning perspective, Jérôme Dupras Département de géographie, Université de Montréal & Quebec Center for Biodiversity Science, Mahbubul Alam Betty & Gordon Moore Center for Science and Oceans, Conservation International Jean-Pierre Revéret École des sciences de la gestion, Université du Québec à Montréal, The Canadian Geographer / Le Géographe canadien 2014, xx(xx): 1–14*

Land cover type	Value
Grassland/pasture/hayfield	$1.0

HDR also independently looked at other recent studies from North America and the United Kingdom and found mean estimates for grasslands to average about $2,000 per hectare per year. Estimates for woodlands were about two times that of grasslands or averaged about $4,000 per hectare per year.

How to Use Ecosystem Values in Economics Evaluations

To appropriately reflect the potential consequences of development on land ecosystems, three steps are required:

1. Determine a reasoned estimate of the ecosystem value of the land in its undeveloped state.
2. Determine how the project will impact this ecosystem value (and for how long) – how much, if any, of this ecosystem value will be lost due to the development.
3. Combine (1) and (2) to develop an estimate of ecosystem damage or loss from project development.

As an illustration, Table 11 provides a summary of the Net Present Value of ecosystem damages for a project utilizing a 55 acre site for 31 years from 2019 to 2049 at varying levels of ecosystem value. *For simplicity of illustration, this analysis assumes that the project results in a total ecosystem value loss at the project site. However, in reality, the project site after development will likely retain at least some ecosystem benefits during the project period.*

A project developed on a 55 acre grasslands site with:

1) A mean ecosystem value of grasslands of $2,000/Ha/Yr; and,
2) That results in a total loss of this ecosystem value during the project period.

results in ecosystem damages valued at $0.8 million (on a present value basis). Similarly, for woodlands site with an average value of $4,000/Ha/Yr, the value of ecosystem damages for inclusion in an economic evaluation is $1.6 million. If we used the value from urban forests from the Greater Montreal study of $20,000/Ha/Yr, the value of ecosystem damages for inclusion in an economic evaluation is $7.6 million.

Table 11: Present Value of Ecosystem Damages, Millions of 2018 Dollars, Discounted at 6.83%, Inflation Assumed to be 2%

Undeveloped Ecosystem Value ($/Ha/Yr)	2019-2049
$1,000	$0.4
$2,000	$0.8
$4,000	$1.5

Undeveloped Ecosystem Value ($/Ha/Yr)	**2019-2049**
$10,000	$3.8
$20,000	$7.6
$30,000	$11.4
$40,000	$15.2
$50,000	$19.1

How to Use Ecosystem Values in This SVA

What is the ecosystem value of the land at potential project development sites?

For the Offsite Local Solar Farm and the Interest in a Wind Farm alternatives, ecosystem values from the literature review are utilized to capture the current ecosystem value at these two project sites:

- For the Offsite Local Solar Farm alternative, the average value from the literature review of $2,000/ha/yr is recommended[11]. The site itself is a generic grassland site within 40 km of the City of Edmonton. In the worst case scenario, if we assumed that the project resulted in total ecosystem damage over the project lifecycle, the present value of these effects over 31 years is $0.8 million.
- For the Interest in a Wind Farm alternative, an estimate lower than the average range from our literature is recommended given the more rural nature of the site. For analysis purposes, $1,000/ha/yr is recommended[12]. Wind farms use far less land directly than solar farms – about 10 percent of the solar farm[13] land use requirement so there would be less land use required here. Therefore, any ecosystem value damage impacts for this alternative would be negligible relative to other project impacts (at about $40,000 on a present value basis over 31 years).

Developing a reasonable estimate of the ecosystem value of the 55 acres of land at the E.L. Smith site is not as straightforward as that for a "generic site". Despite the range of ecosystem valuations presented above, no estimate in the literature represents a reasonable benchmark to the site. The 55 acre E.L. Smith site itself is quite unique in several ways:

1. The site itself is adjacent to an existing industrial site – the E.L. Smith Water Treatment Plant.
2. The site is adjacent to the North Saskatchewan River in the City of Edmonton.
3. While adjacent to the North Saskatchewan River, the site is not really visible from the River due to wooded areas adjacent to the River.
4. The site is visible to some (a limited number) of homes above the site and from Anthony Henday Drive.

[11] *Note sensitivity analysis would be conducted to determine if uncertainty around these estimates are influential to outcomes.*
[12] *Ibid.*
[13] Source: Environmental Impact of Renewable Electricity Generation Technolgies: A Lifecycle Perspective, Gavin Heath, NREL, 2016..

5. The site is visible from bike paths on both sides of the river.
6. The site is grasslands in a river valley and contained within an urban forest.

Therefore, our approach is to not specifically ascribe a specific ecosystem value for the site itself. Rather, when examining the MAE analysis, we use breakeven or threshold analysis to determine:

(i) how valuable the site would have to influence the outcome of the analysis under the assumption the worst case scenario that the project would eliminate all ecosystem value during the project lifecycle; and,
(ii) whether this value is plausible given the outcomes from the literature; in other words, we ask whether the threshold value falls within the range of the literature?.

What is the impact of the solar projects on the land ecosystem at potential solar[14] project development sites?

The potential impact of the solar project on the ecosystem has many different perspectives that have been analyzed and communicated. These are summarized:

- The Stantec *Environmental Evaluation for the E.L. Smith Solar Farm* produced by Stantec Consulting Ltd. (March 2018)[15]
  - The ecosystem components: groundwater, wetlands, acquatic species and habitat, air quality and noise were not considered to have a potential project interaction.
  - Terrains and soils - Potential residual effects on terrain and soils are anticipated to be not significant.
  - Surface Water Bodies and Hydrology - Potential residual effects resulting from Project activities include an increased surface water runoff volume and flow within the Local Assessment Area (“LAA”). With the implementation of mitigation measures, potential residual effects on surface water bodies and hydrology are anticipated to be not significant.
  - Vegetation Species and Communities - With the application of recommended mitigation measures, potential residual effects to vegetation species and communities are anticipated to be limited to the loss or alteration of plant communities within the Project Development Area (“PDA”). Given these plant communities are common in the LAA, potential residual effects on vegetation species and communities are anticipated to be not significant.
  - Wildlife Species and Habitat - With the application of recommended mitigation measures, potential residual effects on wildlife species and habitat are anticipated to be not significant.

[14] *Note, the ecosystem value of the land at the wind acquisition project site was negligible to start with so it was not a focus here due to materiality.*
[15] *Direct citations from report.*

- *Solar Glare Analysis Report – E.L. Smith Solar Farm by Solas Energy Consulting, January 2018*
  - The report stratified glare impacts by:
    - **"Green**" rated glare indicates a low potential for after-image.
    - "**Yellow**" rated glare indicates the potential for after-image exists.
    - "**Red**" rated glare indicates the potential for retinal damage.
  - The Analysis indicates that there is likely no incidence of red-grade glare.
  - Drivers using Anthony Henday Drive will not experience glare.
  - Natural obstructions that surround the project will help to completely or partially mitigate glare at most observation points.
  - Residences at higher elevations east and west of the project, and the pathway to the southwest, are predicted to be affected by limited number of minutes of glare.
  - The walking/bike path will have the most yellow-grade glare
  - Residences toward the south end of Heffernan Drive NW will experience green-grade glare.
  - The project has a low potential to result in hazardous glare conditions.

3) Participant Involvement Program – General Input (Attachment 4 to AUC Submission)

- EWSI has met the AUC's guidelines for a PIP for a power plant of 10 megawatts (MW) or greater. EWSI has notified approximately 17,400 landowners, occupants, residents, and other potentially interested parties within 2,000 metres of the edge of the project site boundary and has engaged in personal consultations with landowners, occupants, and residents located within 800 metres of the edge of the project site boundary. At the time of this filing, EWSI's Stakeholder Tracking System ("STS") includes over 890 participants, which consists of: (i) participants located within 800-metres of the edge of the project site boundary; (ii) other interested parties that EWSI identified for consultation (see section 2.1); and (iii) individuals who were not within the 800-metre boundary but opted into the consultation process.
- Of the approximately 17,400 participants that received information about the project (of which EWSI consulted with approximately 720 participants), approximately 230 participants expressed comments and/or concerns. The vast majority of parties who were consulted on the project were appreciative of the information but had little response or concern except that of a very general nature. Others provided EWSI with detailed feedback, which was used in combination with field studies and other information to reduce the project area and inform other project planning decisions.
- The following topic areas were mentioned by participants during EWSI's PIP. These are listed below from most to least frequent: project location and land use;

technical details; wildlife, environment and tree removal; regulatory; project need; visual; rates and billing; noise; cost; construction; contractor inquiries; glare; consultation; schedule; flooding; health; maintenance; water treatment plant inquiries; property value; sourcing of materials; and safety[16].

- Feedback from project opponents was also documented. Specifically,
  - The North Saskatchewan River Valley Conservation Society ("NSRVCS") expressed concern that the proposed fence will obstruct wildlife movement along the North Saskatchewan River, in particular at the southeast tip of the Project boundary where the Project is closest to the river[17].
  - The Sierra Club of Canada – Prairie Chapter - the Sierra Club expressed concerns regarding the project location and stated that they are opposed to any development within the North Saskatchewan River Valley. They advised that their main concern with the project is contextual and related to the cumulative impact of projects in the river valley[18].

3. From the workshop session, specific items were raised related to specific impacts that could affect the ecosystem value at the E.L. Smith site and other solar sites. In general:
   - The ecosystem components related to provisioning and regulating services described above were not considered to be materially impacted after the implementation of mitigation measures.
   - Regarding habitat services, the conclusion was re-enforced that the Environmental Evaluation by Stantec concluded that: "*The application of recommended mitigation measures, potential residual effects on wildlife species and habitat are anticipated to be not significant".*
   - An issue was raised that the fencing around the solar project area could impair the movement of species near the North Saskatchewan River.
   - An issue highlighted was the "lake effect" of the solar farm on birds potentially resulting in avian mortality.
   - It was noted that there was not a significant amount of concern about the project raised through the Participant Involvement Program by individuals – other than specific input from opposition groups.
   - There were comments that with the application of mitigation measures that some of the vegetation under the solar farm panels could actually improve the habitat.
   - There was discussion that EWSI has already made adjustments to the project development plan based on feedback received through the Participant Involvement Program.

[16] *Direct citations.*
[17] *Source – PIP.*
[18] *Source – PIP.*

- There was recognition that the project site is adjacent to the North Saskatchewan River and that for some the location would raise concerns for some residents for the ecosystem components of cultural and amenity services.
- There was discussion of the solar project at EL Smith could provide an opportunity for education related to environmental sustainability and greenhouse gas reduction. Given the proximity to schools, population, etc. educational information could be developed adjacent to the site and walking trails highlighting key aspects of the project and the importance of environmental protection.
- There was discussion relating to how the project could demonstrate EWSI's commitment and leadership in sustainability.

4. Groups that had expressed opposition to the project were invited to meet with HDR to provide their feedback on the proposed solar farm at EL Smith. Two groups accepted the opportunity to participate. A representative from each of these two groups, the Edmonton River Valley Conservation Coalition and the North Saskatchewan River Valley Conservation Society, participated in a discussion. The main themes expressed during those discussions are as follows:
    - The historical importance of the North Saskatchewan River to the City of Edmonton.
    - It was highlighted that the River running through the City is a very attractive feature unique and the preservation of the River and surrounding areas from any industrial development is critical.
    - The importance of the River being a place that residents can access for recreation and relaxation within minutes of the homes in the City makes Edmonton a much more attractive place to live as well as to being an attraction for tourists.
    - There were concerns that the project would negatively impact the aesthetics of the area and that green space is going to become vitally more important in the future as the City grows and expands.
    - There was a concern raised that the project development at EL Smith is inconsistent with the goals of the North Saskatchewan River Valley Area Redevelopment Plan, Bylaw 7188. The major goals of the North Saskatchewan River Valley Area Redevelopment Plan are:
        1. *To ensure preservation of tile natural character and environment of the North Saskatchewan River Valley and its Ravine System*
        2. *To establish a public metropolitan recreation area*
        3. *To provide the opportunity for recreational, aesthetic and cultural activities in the Plan area for the benefit of Edmontonians and visitors of Edmonton.*

iv. *To ensure the retention and enhancement of the Rossdale and Cloverdale communities in the River Valley*[19].

- There were concerns raised that the project itself would negatively impact wildlife movement.
- There was concern that if this project is allowed to proceed it could set a precedent and lead to further industrial development near the basin.
- There was strong support for the solar farm concept within the City of Edmonton but not at the EL Smith site. The feedback was that an alternative that considered roof top solar within the City should be considered as an alternative.
- There were concerns raised that if the site is developed it could be a lost opportunity for developing trails and recreational facilities in the area.
- There was commentary that the development at the E.L. Smith site could negatively impact EWSI's corporate reputation.

Summary

From the project documentation and direct feedback, the largest area of potential risk of ecosystem value loss at the E.L. Smith site relates to cultural and aesthetic services. There is a risk that the project could negatively impact to some degree recreation, mental and physical health, tourism, aesthetic appreciation and inspiration for culture, art and design aspects of ecosystem value. While these impacts could also be realized at alternative project sites, the location of the project adjacent to the North Saskatchewan River would make the risk of a negative impact higher at EL Smith.

There may also be offsetting positive impacts to cultural and aesthetic services. Through collaboration with educational and research institutions, Indigenous communities, neighbouring residential communities, the City of Edmonton and special interest groups, EWSI will take full advantage of opportunities to design the Project and surrounding features to meet community integration objectives outlined below:

- Integrate the Project into the North Saskatchewan river valley and plan for future trails proposed in the City of Edmonton's Ribbon of Green.
- Provide educational opportunities about the history and cultural resources of the land in collaboration with Indigenous communities.
- Enhance the Project aesthetics and the overall viewscape.
- Create a multi-functional area.
- Establish long-term partnerships to support educational and research opportunities associated with solar energy generation[20].

[19] *Citation from the North Saskatchewan River Valley Area Redevelopment Plan Office Consolidation September 2017.*
https://www.edmonton.ca/residential_neighbourhoods/plans_in_effect/North_Saskatchewan_River_ARP_Consolidation.pdf

The next potential area of risk of ecosystem damage (or ecosystem value loss) relates to habitat services and the movement of wildlife near the project area. There is some potential risk of impact, however, the Environmental Evaluation by Stantec concluded that "with the application of recommended mitigation measures, potential residual effects on wildlife species and habitat are anticipated to be not significant." It should be noted that EWSI plans to implement the mitigation measures identified in the Environmental Evaluation by Stantec Consulting.

For provisioning and regulating services, there does not appear to be risk of material impacts in general after mitigation measures.

In general, the EL Smith site would potentially have greater risk of ecosystem value loss than other solar site locations due to its proximity to the North Saskatchewan River.

[20] *From Section 3.2 of EWSI's August 23, 2018 EL Smith Solar Project Update.*

Outcomes – Multiple Account Evaluation

The Multiple Account Evaluation framework reports in a matrix format the impact of various project alternatives across a number of specific criteria. The intent of the MAE is to highlight the trade-offs between various project alternatives to help facilitate decision making.

Table 12: Summary of Multiple Account Evaluation by Alternative

#	Account	Criteria	Grid Supply	Grid Supply + Generic REC's	Offsite Wind Farm	Solar Project at E.L. Smith	Offsite Local Solar Farm
F1	Financial	Total of All Financial Costs (NPV, $M)	$19.6 M	$22.5 M	$20.9 M	$25.4 M	$44.1 M
F2	Financial	Levelized cost of all energy ($/MWh)	$105.83	$121.54	$112.74	$136.82	$237.85
F3	Financial	Levelized cost of renewable energy ($/MWh)	$0.00	$15.71	$6.91	$30.99	$132.02
F4	Financial	Risk Management	No effect	No effect	A new renewable resource would hedge against energy cost increases.	A new renewable resource would hedge against future energy cost increases.	A new renewable resource would hedge against energy cost increases.
E1	Environmental	GHG Emissions – Damage Costs $M	$6.2 M	$6.2 M	-$1.6 M	-$1.6 M	-$1.6 M
E2	Environmental	GHG Emissions - tonnes	217,331	217,331	-78,433	-78,429	-77,936
E3	Environmental	Avian mortality	No effect.[21]	No effect.	Wind energy has a higher avian mortality rate than other forms of generation, including solar – 3 to 5 fatalities per MW of capacity.	Solar PV energy has a lower avian mortality rate than wind energy.	Solar PV energy has a lower avian mortality rate than wind energy.
E4	Environmental	Ecosystem value –	No effect.[22]	No effect.	Less land use required.	With mitigation, no	With mitigation, no

[21] *Note: The assumption is that in the absence of a new renewable resource to serve the EL Smith Water Treatment plant energy needs, no other new generation would be required; existing facilities would continue to serve EL Smith needs.*

#	Account	Criteria	Grid Supply	Grid Supply + Generic REC's	Offsite Wind Farm	Solar Project at E.L. Smith	Offsite Local Solar Farm
		provisioning services			With mitigation, no significant effect	significant effect as highlighted in Environmental Assessment.	significant effect.
E5	Environmental	Ecosystem value – regulating services	No effect.	No effect.	Less land use required. With mitigation, no significant effect anticipated.	With mitigation, no significant effect as highlighted in Environmental Assessment.	With mitigation, no significant effect anticipated.
E6	Environmental	Ecosystem value – habitat services	No effect.	No effect.	Less land use required. With mitigation, no significant effect anticipated.	The potential negative effect on habitat services is marginally greater than the other alternatives due to potential impacts of wildlife movement in an urban forest corridor. The Environmental Assessment concluded: *"Wildlife Species and Habitat - With the application of recommended mitigation measures, potential residual effects on wildlife species and habitat are anticipated to be not significant."*	With mitigation, no significant effect anticipated.
E7	Environmental	Ecosystem value of land – cultural and amenity services	No effect.	No effect.	Less land use required and a more rural are With mitigation, no significant effect anticipated.	The potential negative effect on cultural and amenity services is greater than the other alternatives given the proximity to population, residences, trails and the North Saskatchewan River.	The site is not as close to population or a river basin. With mitigation, no significant effect anticipated.

[22] *Note: The assumption is that in the absence of a new renewable resource to serve the EL Smith Water Treatment plant energy needs, no other new generation would be required; existing facilities would continue to serve EL Smith needs.*

#	Account	Criteria	Grid Supply	Grid Supply + Generic REC's	Offsite Wind Farm	Solar Project at E.L. Smith	Offsite Local Solar Farm
						There are positive impacts of the project as well due to the demonstration site and the potential for partnerships and collaboration.	
E8	Environmental	$ Value of Ecosystem Value at Risk (ecosystem value of land at the renewable site – Present Value)	$0	$0	< $0.1 M (assumes a value per hectare per year of $1,000 & less of a land use footprint)	Greatest ecosystem value at risk. Magnitude to be evaluated through threshold analysis.	$0.8 M (assumes a value per hectare per year of $2,000)
S1	Social	CAC Emissions - $M	$4.5 M	$4.5 M	-$1.4 M	-$1.4 M	-$1.4 M
S2	Social	CAC Emissions - volumes	NOx: 559 tonnes SO_2: 774 tonnes $PM_{2.5}$: 14.4 tonnes	NOx: 559 tonnes SO_2: 774 tonnes $PM_{2.5}$: 14.4 tonnes	NOx: -241 tonnes SO_2: -344 tonnes $PM_{2.5}$: -6.2 tonnes	NOx: -241 tonnes SO_2: -344 tonnes $PM_{2.5}$: -6.2 tonnes	NOx: -241 tonnes SO_2: -344 tonnes $PM_{2.5}$: -6.2 tonnes
S3	Social	Economic Development	No effect	No effect	Wind farm site likely in rural Southern Alberta so no direct economic impact in Edmonton.	With the site in Edmonton, local economic impact from project costs.	With the site not directly in Edmonton, less economic impact per $1 of project costs. However, this option requires greater expenditure.
S4	Social	Additionality – A new renewable resource	No additionality.	No additionality.	Additionality – a new renewable resource.	Additionality – a new renewable resource.	Additionality – a new renewable resource.
S5	Social	Strategic Alignment – Alignment with City of Edmonton objectives for local generation	Not aligned.	Not aligned.	Not aligned.	Aligned with City of Edmonton Objectives.	Aligned with City of Edmonton Objectives (offsite solar project assumed to be within 40km radius of the city of Edmonton.
S6	Social	Strategic Alignment – Alignment with City of Edmonton and Province of Alberta objectives for GHG reductions	Not aligned.	Corporate alignment - EWSI offsets its carbon footprint through REC purchases. However, from a	Aligned with City of Edmonton and Province of Alberta objectives.	Aligned with City of Edmonton and Province of Alberta objectives.	Aligned with City of Edmonton and Province of Alberta objectives.

#	Account	Criteria	Grid Supply	Grid Supply + Generic REC's	Offsite Wind Farm	Solar Project at E.L. Smith	Offsite Local Solar Farm
				societal perspective, there is no incremental effect without additionality.			
S7	Social	Education Potential	No effect.	No effect.	A new renewable site has the potential to be leveraged for educating the public on environmental sustainability. However, little proximity to population would limit its potential effectiveness.	An educational and cultural demonstration site within the Edmonton river valley has the potential to be leveraged for educating the public on environmental sustainability. This alternative has the greatest access to population, schools etc. and therefore the greatest potential.	A new renewable site has the potential to be leveraged for educating the public on environmental sustainability. However, little proximity to population would limit its potential effectiveness.
S8	Social	Corporate Leadership in Renewables	No effect.	Through REC purchases, EWSI demonstrates environmental commitment.	Greatest effect with EWSI developing new renewable generation resources.	Greatest effect with EWSI developing new renewable generation resources.	Greatest effect with EWSI developing new renewable generation resources.
S9	Social	Precedence – development in the North Saskatchewan River Basin	No effect.	No effect.	No effect.	Development in the North Saskatchewan River Basin. Bylaw 7188[23] does provide for development for projects that are deemed essential. The draft Ribbon of Green report designates EL Smith lands as an "Active Working Landscape", and sets out a list of compatible uses,	No effect.

[23] *North Saskatchewan River Valley Area Redevelopment Plan, Bylaw 7188: It is a policy of this Plan that major public facilities shall not be constructed or expanded unless their location within the River Valley is deemed essential and approved by City Council.*

#	Account	Criteria	Grid Supply	Grid Supply + Generic REC's	Offsite Wind Farm	Solar Project at E.L. Smith	Offsite Local Solar Farm
						facilities and infrastructure that may be appropriately developed at the site. Developments that improve the sustainability of existing operations, or expansions of power, water and wastewater utilities, are among the appropriate uses listed.	

Outcomes – Monetized Effects

The effects that can be monetized, namely the specific project financial impacts and the monetization of emissions, are summarized in Table 13 for each of the alternatives. On a pure financial cost basis, the least cost option is the Grid Supply alternative with net cash flows of $19.6 million. The most costly alternative is the Offsite Local Solar Farm with net cash flows of $44.1 million.

The Offsite Local Solar Farm alternative is $18.7 million more expensive than the Solar Project at EL Smith alternative primarily due to two factors:

1. There are significant incremental costs for the Offsite Local Solar Farm alternative including land acquisition, interconnection and substation costs; and,
2. The income generated form an Offsite Local Solar Farm alternative (owned by EPCOR) is taxable (at 27%). Income from the Solar Project at EL Smith owned by EPCOR would not be taxable.

The Offsite wind farm option is the lowest cost alternative for renewable energy sources with additionality, however, it does not represent a local generation resource.

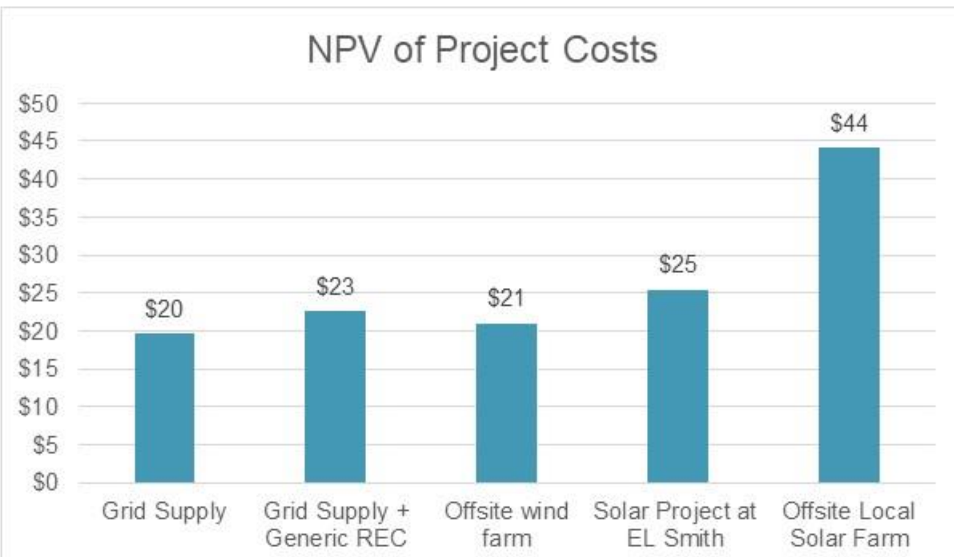

Figure 6: Net Present Value of Project Financial Costs, Millions of 2018 Dollars

Table 13: Summary of Monetized Effects to Society, Net Present Value in Millions of 2018 Dollars

	Grid Supply	Grid Supply + Generic REC	Offsite wind farm	Solar Project at EL Smith	Offsite Local Solar Farm

	Grid Supply	Grid Supply + Generic REC	Offsite wind farm	Solar Project at EL Smith	Offsite Local Solar Farm
Capital Costs	**$0.0**	**$0.0**	**$0.0**	**$27.3**	**$32.4**
12 MW System	$0.0	$0.0	$0.0	$27.3	$27.3
Land Value	$0.0	$0.0	$0.0	$0.0	$0.4
Interconnection Costs	$0.0	$0.0	$0.0	$0.0	$4.8
Salvage Value	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**-$0.1**
Contract / O&M Costs	**$19.6**	**$22.5**	**$23.3**	**$3.9**	**$24.0**
Conventional Energy	$19.6	$19.6	$23.3	$1.3	$19.6
REC Purchases	$0.0	$2.9	$0.0	$0.0	$0.0
AESO Compliance	$0.0	$0.0	$0.0	$1.5	$1.5
O&M	$0.0	$0.0	$0.0	$1.1	$2.9
Net Revenues	**$0.0**	**$0.0**	**-$2.4**	**-$5.8**	**-$12.2**
Gross Revenues	$0.0	$0.0	-$3.3	-$5.8	-$16.7
Less Taxes	$0.0	$0.0	$0.9	$0.0	$4.5
Net Cash Flows	**$19.6**	**$22.5**	**$20.9**	**$25.4**	**$44.1**
Emissions Costs (damage)	**$10.7**	**$10.7**	**-$3.0**	**-$3.0**	**-$3.0**
GHGs	$6.2[24]	$6.2[25]	-$1.6	-$1.6	-$1.6
CACs	$4.5	$4.5	-$1.4	-$1.4	-$1.4
Total Monetized Effects	**$30.3**	**$33.2**	**$17.9**	**$22.4**	**$41.1**

When the monetary value of emissions are considered, the three non-REC renewable project alternatives improve relative to the grid supply alternatives. The grid supply alternatives generate emission related damages of $10.7 million[26]. In contrast, the renewable options actually generate sufficient power to both serve the needs at EL Smith and to displace additional non-renewable generation from the grid and therefore have a net positive emission effect of about $3.0 million.

[24] If the portion of the Alberta carbon levy that internalized in electricity rates was deducted from the monetized effects of GHG emissions, the reduction in the GHG impact could be in the $1M - $2M range.
[25] Ibid.
[26] Note while REC purchases enable EPCOR to claim the benefits of renewable generation, without additionality there is no net emission reduction effect to society.

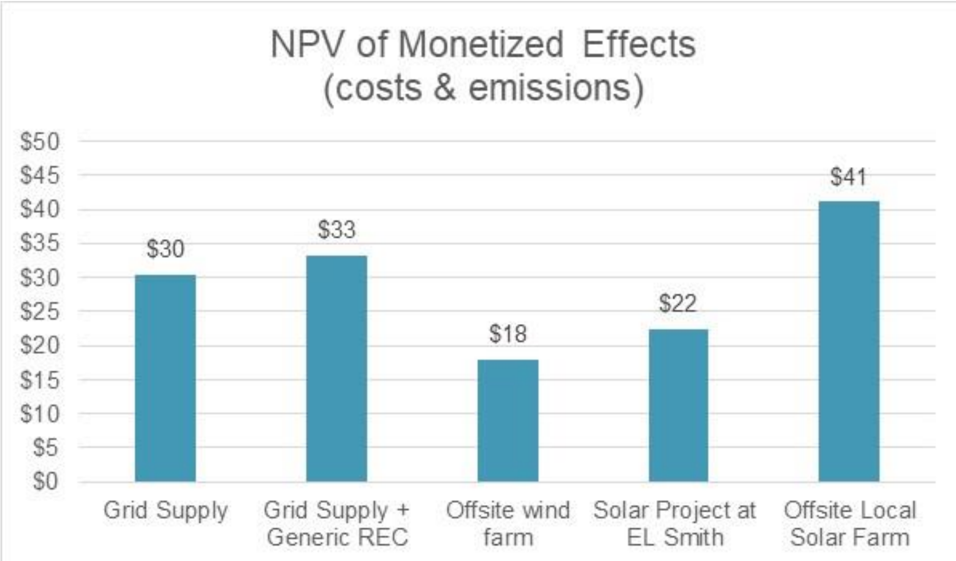

Figure 7: Net Present Value of Monetized Effects, Millions of 2018 Dollars

Without considering the other factors identified in the MAE analysis, this analysis indicates that:

1. The Solar Project at EL Smith project has a positive business case from a societal perspective relative to the grid supply alternative or the business as usual case. The emissions benefit relative to the Grid Supply option offset the additional financial costs to yield a net benefit of approximately $8 million (e.g., $22.4 million versus $30.3 in monetized costs).
2. The Offsite Local Solar Farm does not have a positive business case from a societal perspective as total monetized effects are approximately $11 million higher (e.g., $41.1 million versus $30.3 in monetized costs).
3. The Solar Project at EL Smith project is significantly less costly (e.g., almost $19 million) than the Grid Connected Local Solar project.

Outcomes – Monetized Effects and Potential Ecosystem Effects

In the analysis summarized above, effects other than financial costs and emissions were not considered. A critical limitation to this analysis is that it does not consider the potential effect on the ecosystem of using land at the two solar farm alternative sites.

For the Offsite Local Solar Farm alternative site, we have assigned an ecosystem value for the undeveloped site of $2,000/ha/yr. Due to the unique nature of the Solar Project at EL Smith alternative site, a value for the undeveloped site is not assigned. The key question becomes, if potential ecosystem damages (or loss of ecosystem value) are factored in, does the Solar Project at EL Smith alternative still appear to be preferable?

To put this question into perspective, breakeven analysis is applied to the worst case scenario. That is, we assume that the solar project alternatives result in a total eradication of all ecosystem value during the 31 year project development and operational period. For the Offsite Local Solar Farm alternative, the total monetized effects increase by the ecosystem loss of $0.8 million[27] to $41.9 million on a present value basis.

For these two solar alternatives to be equal on a total monetized cost basis, the Solar Project at EL Smith ecosystem damage would have to be $51.8 thousand per hectare per year and this entire amount would have to be completely eradicated with the project development for the two solar alternatives to equal. This is many times greater than any specific estimate we have found in the literature. For example:

- Valuations for grasslands typically averages about $2,000 per hectare per year.
- Average valuations for urban Montreal ranged from $600 per hectare per year for pasture and rangeland to $11,200 per hectare per year for urban forecasts and woodlands (see Table 9). The maximum value for urban forecasts and woodlands was $20,000 per hectare per year.
- Valuations for the North Saskatchewan River Basin was $1,000 per hectare per year for Grassland/pasture/hayfield and $17,800 per hectare per year for urban forests (see Table 10).

However, the Environmental Evaluation by Stantec did not point to any evidence of total ecosystem destruction.

In summary, if the expected damage to the ecosystem at the EL Smith site is expected to be in excess of $51.8 thousand per hectare per year, than the Offsite Local Solar Farm would be the preferred solar alternative. Otherwise, the Solar Project at EL Smith alternative is preferred (with all other factors held constant).

The breakeven analysis illustrates that to justify a solar alternative not at the EL Smith, decision makers would have to place an extraordinarily high ecosystem value on the EL Smith site and that the project development there would result in very significant ecosystem damages. Neither the literature on ecosystem valuation nor the conclusions of the Environmental Evaluation support that outcome.

[27] *Represents 31 years of ecosystem loss of $2000/Ha/Yr.*

Conclusions

The triple bottom-line evaluation of renewable energy alternatives identifies and summarizes the trade-offs between the alternatives spanning financial, environmental and social considerations which are documented in both qualitative and quantitative terms. This Multiple Account Evaluation framework recognizes that different stakeholders will have different perspectives on the relative importance of each of these criteria as well as the impact of each alternative on these same criteria. A combination of MAE and breakeven approaches is applied for the SVA. The MAE is appropriate in circumstances such as this where there is difficulty in applying social/environmental value to the land at EL Smith because the value depends on different stakeholders views. In this triple bottom line analysis, the break-even approach is used to attempt to monetize the environmental/social (ecosystem) value the decision maker would need to assign to the land at EL Smith to make the proposed Project equivalent to the offsite solar project.

The breakeven analysis is summarized in Figure 8. The blue bars in the charts represent the financial costs of each alternative while the red bars represent the emissions costs or benefits in the renewable cases. The yellow arrow highlights how significant any ecosystem damage would have to be at the E.L. Smith site for the Offsite Local Solar Farm to be preferable; this damage would have to be on average 25 times or more greater than the average values we see in the economic literature.

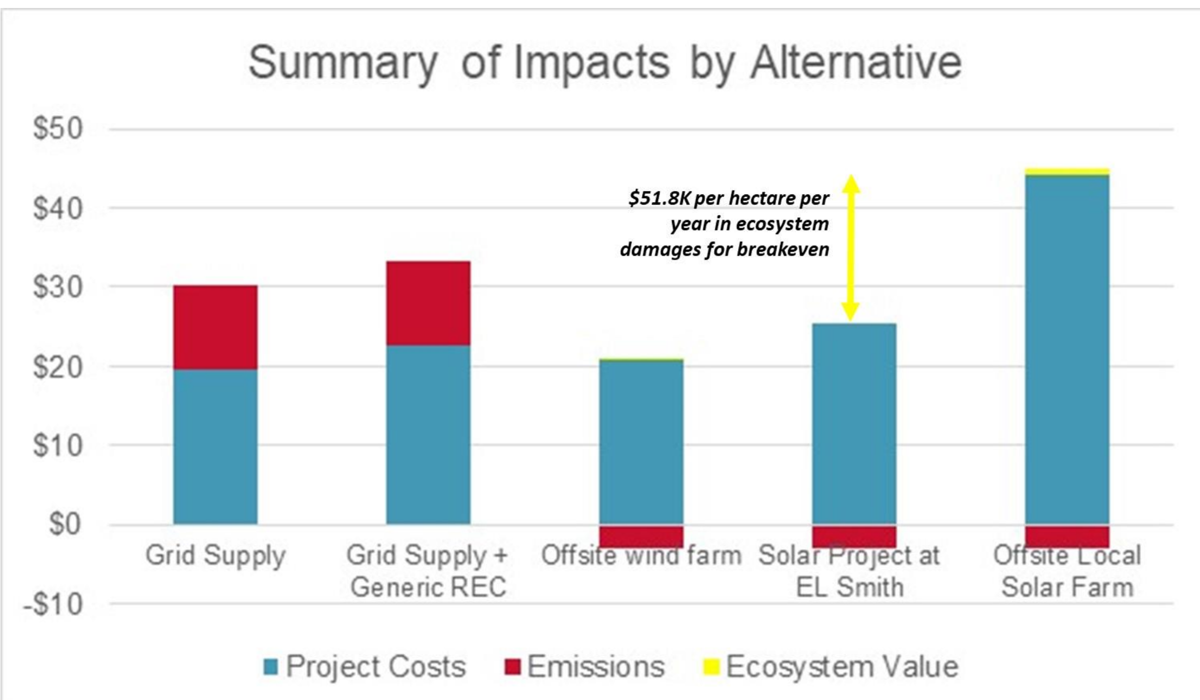

Figure 8: Break Even Analysis

Figure 9 also summarizes the differences between the ecosystem value estimates discussed previously from the TEEB database, from valuations in Greater Montreal, from valuations from the North Saskatchewan River (NSR) and from HDR[28]. There is quite a large gap between these estimates and the breakeven estimate of $51,800 per hectare per year.

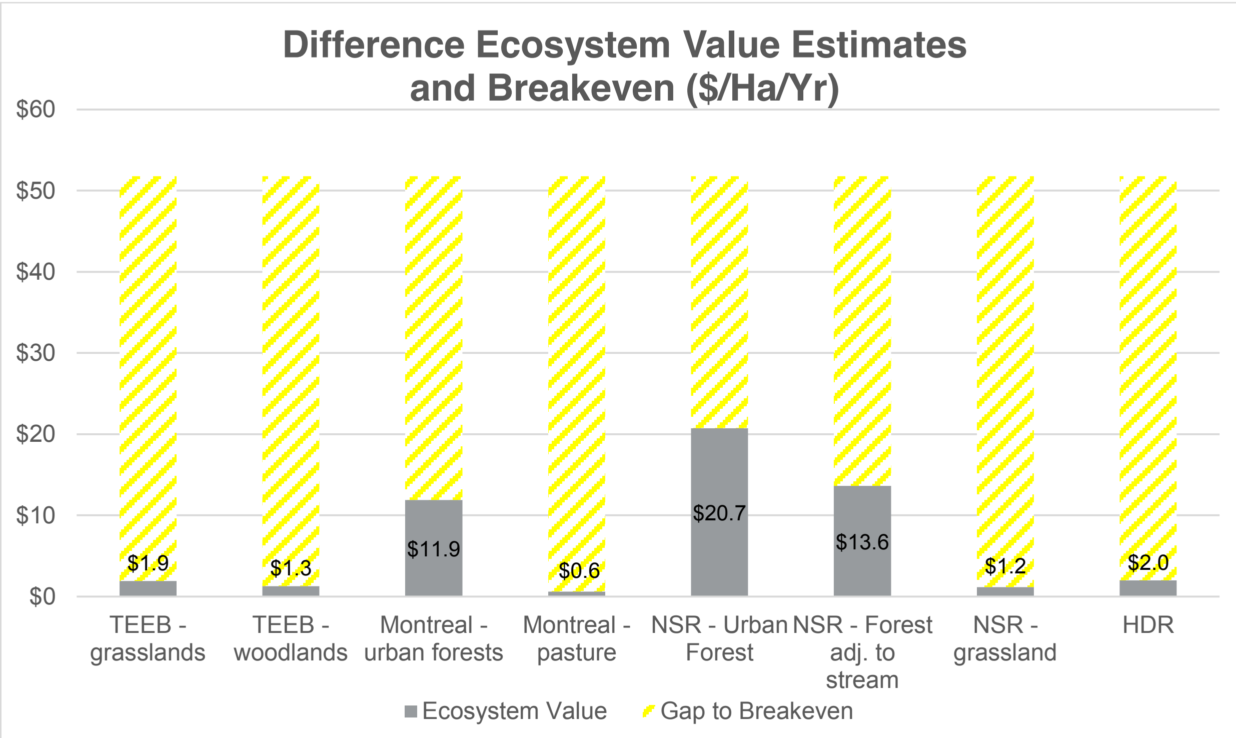

Figure 9: Difference Between Literature Estimates and the Breakeven Value

From an overall evaluation perspective, if additionality and having local generation are required, then really there are two alternatives: (i) the Solar project at E.L. Smith and (ii) the offsite local solar farm. The Solar project at E.L. Smith can be developed at a much lower financial cost with both these alternatives providing equivalent emission reduction benefits. Decision-makers will have to determine whether the project development at E.L. Smith could result in very significant ecosystem damages as highlighted in the breakeven analysis. This would seem implausible given the evidence in the economic literature and the findings of the Environmental Evaluation by Stantec Consulting.

[28] *These estimates from the literature were escalated to represent 2018 dollar values for comparison.*