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Attachment 3

THE CITY OF Edmonton

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SROI | SUSTAINABLE RETURN ON INVESTMENT

The City of Edmonton

Prepared for:
The City of Edmonton
Edmonton, Alberta

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Decision Economics

Risk Analysis – Investment and Finance
Economics and Policy

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Background:

The City of Edmonton (City) retained HDR to conduct an economic assessment and provide decision support using HDR's Sustainable Return on Investment (SROI). For the City, SROI provides an objective, transparent and defensible sustainability business case framework to assess eight different district heating and sustainable investment alternatives for the future Blatchford community redevelopment.

District energy is a technology that utilizes centralized heating or cooling, along with a network of buried pipes to deliver steam or chilled water to a building, group of buildings or a defined geographic area. While district energy appears to provide other ancillary benefits to the City other than simply heating or cooling buildings, it requires a significant capital investment and does carry certain technical, financial and business risks. The City recognized that many of the questions associated with district energy can be addressed through a core set of principles which consider the quadruple bottom line of economic, financial, social, and environmental impacts.

More infrastructure owners and investors are wisely seeking to use economic analysis to comprehensively assess investment options to make the best use of their funds. Collaborative, risk-based triple or quadruple bottom line cost-benefit analysis is the best approach to understanding the overall net benefit of infrastructure projects. HDR has recognized that decision makers want information to enable budgetary decisions that reflect value-for-money comparisons of investment proposals among different projects. This includes the need to compare competing projects on a 'common language' basis – whereby environmental and social impacts must be converted into monetary values to estimate the overall impacts in comparable financial terms. By comparing specific infrastructure alternatives for the Blatchford redevelopment on an apples-to-apples basis, the City can show greater rigor in the decision-making process and create a defensible position for its capital budget allocation choices.

Sustainable Return on Investment (SROI) is an enhanced form of a cost-benefit analysis (CBA) - a systematic process for calculating and comparing benefits and costs of a project or policy, and is generally conducted to justify an investment or compare projects. The process builds on best practices in CBA and financial analysis methodologies, complemented by advanced risk analysis and stakeholder elicitation techniques. In this analysis, actual financial costs and benefits incurred by the City are accounted for, in addition to the monetized value of various social and environmental impacts to the district heating and renewable energy alternatives.

District energy is not a new concept or idea. In fact, the City developed feasibility studies in 1980 and 1992 to explore implementation of district energy. While district energy may not have been feasible for the City in the past, cities today are viewing district energy from a similar, but somewhat different perspective. The partnering of traditional financial analyses with a SROI approach provides a framework to comprehensively evaluate district energy.

The scope of HDR's services for this project was divided between Phase 1 and Phase 2. Phase 1 explored the concept of district energy at a high-level to provide the study with a certain level of context, explored other governmental district energy systems, and reviewed the currently envisioned district energy projects to consider feasibility at a very preliminary level. Phase 2 of the project is this Sustainable Return on Investment analysis, which provides a more detailed technical and financial analysis into the Blatchford Redevelopment. The inputs used by HDR's Economists in the creation of the SROI model were based on inputs provided by

Engineers from Stantec with additional engineering review provided by Engineers at HDR. The City also played an active role in defining the alternatives, as well as providing and reviewing the inputs for this SROI analysis.

SROI originated from a Commitment to Action by HDR to develop a new generation of public decision support metrics for the Clinton Global Initiative (CGI) in 2007. SROI was developed with input from Columbia University's Graduate School of International Public Affairs and launched at the 2009 CGI annual meeting. Since then, the SROI process has been used by HDR to evaluate the monetary value of sustainability programs and projects with a combined value of over $15 Billion. It has been used by corporations and all levels of government.

The study analyzes eight distinct alternatives (Alts 1 through 7b) and one combined alternative (Alt 8) relating to district energy alternatives and various other sustainability-related alternatives at the Blatchford redevelopment:

1. **District Energy, Economic Dispatch Natural Gas-Fired CHP**

   This alternative looks at installing combined heat and power (CHP) plants that would use natural gas to generate electricity for sale to the electric power grid while capturing waste heat for delivery to the district piping system. The district piping system will circulate thermal energy to customers in lieu of individual building boilers. Any shortfalls in thermal energy supply are met by using peak boilers at the plants. Contingencies for heat and energy losses were incorporated where applicable and no incremental emissions were considered between the CHP peak boilers and the expected individual customer boilers due to an expected similar efficiency rate.

   Economic Dispatch CHP operation maximizes the financial value of the district energy project by operating the CHP plant only when economically justified to do so. Waste heat is recovered during CHP operation, but total waste thermal energy collected is not as large as base load operation. The assumptions used for this economic dispatch option are a 45% capacity factor, with an average energy price of $95/MWh. Because this alternative would not normally operate during off-peak hours it would not displace coal-fired generation, hence greenhouse gas reduction is not as large as base load operation.

   The heat to power ratio was adjusted for seasonality based on Edmonton weather trends since residents would not require the full thermal energy output on warm days. The plants are assumed to continue to operate and sell the generated electricity to the power grid year round. Additionally, the model assumed a 90% diversity factor of the connected load (at this factor, the loss of the largest connected thermal unit will serve 90% of peak load). A diverse mix of customers, particularly residential and commercial, would be unlikely to have a simultaneous peak demand.

2. **District Energy, Base Load Natural Gas-Fired CHP**

   This alternative is similar to the first in that it looks at installing CHP plants. Base Load CHP operation, however, maximizes the production of waste heat to serve the thermal demand by operating the CHP plant as many hours as possible. As a result, the electric power pool price received may at times be less than what will cover the cost of production. The assumptions used for this base load option are an 80% capacity factor, with an average power price of $65/MWh. Because this alternative displaces coal-fired generation during off-peak hours, greenhouse gas emissions are reduced, thereby increasing social benefits.

3. **District Energy, Shallow Geoexchange**
   Shallow geoexchange involves using ground source heat pumps to transfer heat from the ground to the district piping system that provides thermal energy to customers. Like the CHP alternative, peak boilers are used to meet peak thermal energy demand.

4. **Solar PV**
   The solar photovoltaic (PV) alternative looks at installing solar panels on the rooftops of all buildings in the development (within the realm of feasibility) and using the electricity generated to reduce the quantity of electricity purchased from the grid.

5. **New Building Envelope**
   This alternative looks at constructing energy-efficient walls, roofs, and windows in all buildings in order to adhere to the Yellowknife standards which are the most stringent standards in Canada. The results are incremental over the National Energy Code for Buildings (NECB) 2011.

6. **Ethanol versus Natural Gas** In order to gauge the viability of using ethanol from municipal solid waste as a source of thermal energy instead of natural gas, this alternative compares the financial and social life cycle costs of the two fuel sources. Life cycle costs include impacts from upstream activities such as gas well drilling and waste processing to downstream activities such as power generation.

7. **Purchasing Green Power Certificates**
   a. **Purchasing Alberta Green Power Certificates**
   b. **Purchasing Ontario Green Power Certificates**

   These alternatives look at simply purchasing green power certificates from a provider in either Alberta or Ontario which implies paying a premium per unit of energy in exchange for a commitment from the provider to offset an equivalent quantity of electricity by generating clean energy from renewable sources. Ontario was chosen as the other province due to the next best pricing point and capacity availability of certificates. An important distinction between the parts of this alternative is that purchasing certificates in Ontario does not reduce criteria air contaminants in Alberta (which unlike greenhouse gases have localized impacts), and thus only greenhouse gas emissions provide value.

8. **District Energy, Shallow Geoexchange with Purchasing Alberta Green Power Certificates.** This alterative combines the shallow geoexchange alternative with the purchase of Green Power Certificates from Alberta. In this case, the electricity needs for the geoexchange system and for the entire Blatchford community are supplied with green electricity as opposed to purchasing off the grid in the case of the stand-alone geoexchange alternative (alternative #3).

Commentary:

An important caveat must be made for this analysis: the inputs provided at this stage in the redevelopment are the best available at this time and could be further refined with additional analysis by the City and Stantec. The purpose of the analysis at this juncture is to provide a high-level overview of possible outcomes of district energy technologies and sustainable investment alternatives in order to identify those potential options that should be looked at with more precision and those that should not be pursued. With further refined design and engineering inputs, HDR's Economists would be able to revaluate those alternatives that appear to be more favourable, to help determine the optimal combination of alternatives and prioritize capital spending to realize the maximum return both from a financial and sustainable perspective. To illustrate this, HDR would be able to analyze a combination of several alternatives to optimize the City's investment – as an example, some combination of Natural Gas

CHP, Geoexchange, and Improved Building Envelope; or some combination which includes the purchase of Alberta Green Power Certificates in the near-term and conversion to Solar PV once they become more affordable.

As part of the comprehensive evaluation, HDR investigated and examined a list of possible impacts outside of the monetized value of GHG and CAC impacts related to these alternatives. These impacts included, but were not limited to: Reduction in Number of Outages Due to Back-Up of the DE System; Value of Reliability of Supply; Social Value of Public Relations Impacts; Community Development Impacts; District Energy and Impacts Due to Use of Renewable Energy Sources; and the Value of Flexibility. After significant research by HDR and input from the project stakeholder group, HDR determined that these impacts should be addressed qualitatively and not monetized in this case.

Given the laddered build-out of the Blatchford development over the course of the 25 year model, all capital costs and variable impacts were phased in specifically according to the planned timing and allocated on a per square foot basis. Stantec provided HDR with inputs by phase of development which was then applied to several matrices that were structured according to the development plans from the City. The matrices served to precisely allocate all relevant impacts for costs, energy use, solar panel installations, building envelope requirements, and all other aspects of the analysis. The build-out start years and the duration were all taken into account as they have a substantial impact on the time value of money. Phasing impacts are substantial, as all impacts to the model vary by year depending on the build growth.

Additional attempts at modeling impacts as precisely as possible include the implications of the power grid location and changing emissions intensities over time. The SROI model attributes different values to criteria air contaminants depending on the location of the emissions as effects are typically quite localized and higher density areas (e.g. urban) would carry much more serious implications than lower density areas (e.g. rural). HDR considered the location of all major providers to the power grid and valued CAC emissions accordingly. Next, in consideration of Alberta's initiatives to reduce emissions through carbon capture and storage as well as gradually retiring coal plants and targeting renewable sources of energy, the intensity factors of the power grid were gradually reduced throughout the study (less GHG and CAC amounts produced per unit of electricity). The result was a shift towards a cleaner power grid, but a higher relative dependence on natural gas facilities in urban environments. Emissions avoided would have been greater if the Blatchford development wasn't phased over time with an increasingly cleaner electricity grid.

All monetary values were converted to constant 2013 Canadian dollars by using the Consumer Price Index (CPI) and relevant discount factors. This conversion ensures meaningful comparison of dollar streams over the project lifecycle. Additionally, the model assumes a 6.37% real (8.5% nominal rate less 2% inflation) discount rate for financial impacts and a 1.96% real (4% nominal rate less 2% inflation) discount rate for social impacts. The only exception is for the ethanol and green power alternatives where a 4% nominal rate is used to discount all impacts because no private operator is involved. As much as possible, HDR used best-available research to apply escalation rates (above inflation) to inputs into the model (commodity prices, cost inputs, or benefit inputs). The SROI model is 27 years in length which encompasses 25 years of benefits accruing from 2015 to 2039 after the initial start of the build-out in 2014. The model assumes inflation of 2% per annum based on the midpoint of the Bank of Canada's target range of 1 to 3 percent. The model results are all mean expected values resulting from a Monte Carlo simulation, using 10,000 iterations with @Risk software.

Results:

The following section provides the results from the SROI analysis. Outputs are split into two perspectives: Financial Return on Investment (FROI), and Sustainable Return on Investment (SROI).

- Financial Return on Investment (FROI) metrics include only the cash impacts.
- Sustainable Return on Investment (SROI) adds the external non-cash impacts of that which affect society to the FROI (items such as greenhouse gases (GHG's) and criteria air contaminants (CAC's)).

The results are all risk-adjusted - HDR took into account the inherent uncertainty in the inputs, used probability distributions, and ran a Monte Carlo simulation to produce the expected outcomes.

Table ES 1: Summary of Results (Mean Expected Values)

Blatchford	Economic Dispatch CHP	Base Load CHP	Shallow Geoexchange	Solar PV	New Building Envelope	Ethanol vs. Natural Gas	Green Power Certificates - AB	Green Power Certificates - ON
Metrics	Mean Values	Mean Values	Mean Values	Mean Values	Mean Values	Mean Values	Mean Values	Mean Values
Financial Return on Investment								
Net Present Value (NPV)	($10,644,588)	($15,059,609)	($16,511,929)	($61,815,758)	($1,500,780)	($1,778,555)	($27,300,402)	($40,950,603)
Discounted Payback Period	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Internal Rate of Return (%)	6.8%	6.0%	0.2%	1.0%	6.4%	N/A	N/A	N/A
Benefit to Cost Ratio	0.95	0.94	0.89	0.49	0.84	0.19	0.00	0.00
Sustainable Return on Investment								
Net Present Value (NPV)	$70,258,999	$127,212,534	($52,213,849)	($8,146,967)	$7,597,612	($1,628,023)	$74,092,743	($33,375,444)
Discounted Payback Period	22 y 9 m	21 y 8 m	N/A	N/A	18 y 2 m	N/A	11 y 11 m	N/A
Internal Rate of Return (%)	13%	17%	N/A	5%	12%	N/A	N/A	N/A
Benefit to Cost Ratio	1.24	1.32	0.80	0.93	1.80	0.34	3.71	0.18
Potential Social Return on Required Subsidy/Cost to the City								
Required Subsidy/Cost to the City	$10,644,588	$15,059,609	$16,511,929	$61,815,758	$1,500,780	$1,778,555	$27,300,402	$40,950,603
Social Impacts	$80,903,587	$142,272,143	($35,701,920)	$53,668,791	$9,098,392	$150,532	$101,393,145	$7,575,159
Potential Social Return on Subsidy	660%	845%	-316%	-13%	506%	-92%	271%	-82%
Net GHG Emissions Avoided Over Study Period	707,783	1,245,220	-42,289	677,593	138,794	1,191	1,278,728	188,593
Annual Equivalent Number of Cars Taken Off the Road Over Study Period	5,898	10,377	-352	5,647	1,157	10	10,656	1,572

Table ES 2: Summary of Results (Mean Expected Values): Additional Alternative

Blatchford	Blatchford Shallow Geoexchange with Green Power Certificates
Metrics	Mean Values
Financial Return on Investment	
Net Present Value (NPV)	($45,374,200)
Discounted Payback Period	N/A
Internal Rate of Return (%)	N/A
Benefit to Cost Ratio	0.75
Sustainable Return on Investment	
Net Present Value (NPV)	$128,230,162
Discounted Payback Period	20 y 6 m
Internal Rate of Return (%)	24%
Benefit to Cost Ratio	1.45
Potential Social Return on Required Subsidy/Cost to the City	
Required Subsidy/Cost to the City	$45,374,200
Social Impacts	$173,604,362
Potential Social Return on Subsidy	283%
Net GHG Emissions Avoided Over Study Period	2,594,522
Annual Equivalent Number of Cars Taken Off the Road Over Study Period	21,621

As an additional point of interest from the City, HDR was requested to produce results using a combination of two of the alternatives above – the Shallow Geoexchange with the purchase of Green Power Certificates from Alberta. The green power purchased will offset the additional electricity needed with the geoexchange system that would have otherwise have been purchased from the Alberta grid (as is the case in the stand-alone Geoexchange alternative).

Metrics include the Benefit-Cost Ratio (BCR), Internal Rate of Return (IRR), Discounted Payback Period (DPP), and Net Present Value (NPV) for each of the alternatives. The DPP is the period of time required for the benefits of an investment to recover the sum of the original cost of the investment, on a discounted cash flow basis. The IRR is the discount rate at which the net present value of a project would be zero and represents the annualized effective compounded return rate which can be earned on the invested capital, and is compared relative to the cost of capital. The BCR is the overall “value for money” of a project, expressed as the ratio of the benefits of a project relative to its costs, with both expressed in present-value monetary terms. NPV is defined as the present value of total benefits over the life of the investment minus the present value of total costs over the same period. NPV is the principal measure of a capital investment’s economic worth. A positive value means that the investment would furnish benefits to the region whose total economic value exceeds the capital costs and operating funds needed to build and run the project. A negative value means that the investment would exhaust more capital and operating funds than it would generate in the form of economic value.

Additional outputs include: the ‘Required Subsidy/Cost to the City’ which is simply the NPV of each alternative from a financial perspective; ‘Social Impacts’ are the total present value social/environmental benefits less the sum of the total present value social/environmental costs (in other words the difference between the FROI and SROI NPV’s); ‘Net GHG Emissions Avoided’ are the total greenhouse gas savings less additional greenhouse gases produced over the 25 year study period; and ‘Cars Taken Off the Road’ are the annual equivalent number of cars taken off the road over the 25 year study period (CO_2-equivalent tonnes avoided over the study period was converted into “passenger vehicles”).

Conclusions

A detailed description of the metrics above and the rationale for the results can be found in Section 5 of this report; however, due to the breadth and complexity of this discussion, a broader overview of the results follows:

HDR has completed a risk-adjusted Sustainable Return on Investment (SROI) analysis for eight independent, but not necessarily mutually exclusive alternatives, and one combined alternative. The first three alternatives (economic dispatch CHP, base load CHP, and shallow geoexchange) focused on a district energy system, while the latter five alternatives aimed to identify other methods of reducing emissions for the Blatchford development. The final alternative combines a district energy system with a method of reducing emissions (shallow geoexchange with green power certificates).

From a quadruple-bottom line (economic, financial, social, and environmental) perspective, only the district energy CHP facilities, the new building envelope, purchasing Alberta green power certificates, and the combined geoexchange and Alberta green power certificates are viable alternatives. That being said, from a purely financial standpoint, none of the alternatives generate an expected return high enough for a private operator and would require a subsidy or additional cost to the City. This shifts the focus from the pure financial aspects to the overall societal benefits that can be reaped from each alternative and how they compare to the overall costs.

Specifically, the district energy, economic dispatch natural-gas fired CHP system requires a substantial subsidy, but provides a high return to society. The base load CHP system requires a slightly higher subsidy, but yields a much greater benefit to society, making it the best outcome in terms of expected return on subsidy. The CHP natural gas alternatives show such positive results because: the facilities generate significant amounts of excess electricity (far exceeding the demand at Blatchford), which is sold into the grid (natural gas is less emission-intensive than coal); and the CHP system is capturing the waste heat which is produced in the production of electricity, which otherwise would be lost. The shallow geoexchange facility is negative in all aspects of the analysis and would thus be a poor use of capital. However, the additional analysis of the geoexchange combined with Alberta green power certificates does exhibit much better results and generates the largest net positive social benefits of each of the alternatives because of the clean, renewable heat that it generates and the clean, renewable power that is purchased. The solar photovoltaic system requires a very high financial cost and despite providing substantial environmental benefits, does not compensate for the costs. The new building envelope appears to be the third best alternative (from a return on subsidy metric) but carries much less weight than other alternatives in terms of the magnitude of the associated costs and benefits. The substitution of ethanol for natural gas in thermal energy generation incurs costs several times higher than the environmental benefits. The purchase of Alberta green power certificates provides a simple and very effective way to exchange financial costs in terms of premium paid against significant emissions avoidance from the emissions intensive Alberta power grid; it is also the fifth-best performing alternative based on the societal return to subsidy. The purchase of Ontario green power certificates, however, does not have the same effect, as premiums are higher and the emissions avoided are much lower due to Ontario’s cleaner grid and the exclusion of CAC impacts to that province.

The alternatives with positive SROI results would all provide significant benefits to society and better yet could potentially be implemented simultaneously. Both of the CHP options, the enhanced building envelope, purchasing Alberta green power certificates, and the combined geoexchange with Alberta green power certificates provide triple-digit percentage returns to society in relation to the subsidies required.

Moreover, The Phase 1 Report identified the high cost of serving low demand customers on a DE system. An opportunity to improve the financial results of the Blatchford District Energy system could include a re-evaluation of the concept of connecting every customer to the DE system. A lower thermal demand limit could be established below which the DE system would not serve a Blatchford customer. A review of the high thermal demand customers may present an opportunity to shorten the distribution piping system and increase the scale of each energy transfer system. This customer selection strategy may improve the financial economics of the DE system, and reduce the City subsidy further improving the prospects of the alternative.