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Sewer Heat Exchange Energy Centre - Blatchford Renewable Energy Utility

Business Case

Integrated Infrastructure Services | Blatchford Branch

City of Edmonton

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Change History

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Version #	Approver Name and Title	Signature	Signing Date
1	Adam Laughlin, Deputy City Manager, Integrated Infrastructure Services		November 4, 2022

1. Executive Summary

1.1. Sewer Heat Exchange Energy Centre - Blatchford Renewable Energy Utility

Blatchford Renewable Energy (BRE) is a city-owned utility providing sustainable heating, cooling and hot water energy services to the residents and businesses in the Blatchford community. Since the utility was established in 2016, BRE has developed an ambient temperature District Energy Sharing System (DESS) to support City Council's overall vision for Blatchford:

Blatchford will be home to up to 30,000 Edmontonians living, working and learning in a sustainable community that uses 100% renewable energy, is carbon neutral, significantly reduces its ecological footprint, and empowers residents to pursue a range of sustainable lifestyle choices.

The utility's first Energy Centre is connected to a large geo-exchange field under the first stormwater pond in the community. The utility constructed this infrastructure in 2018/2019 and it was commissioned for operation during the third quarter of 2019. The utility has been operating successfully since 2020 when the first customer building was connected to the utility. Currently, 45 customer buildings are receiving sustainable heating and cooling energy services.

In order to be able to continue to provide sustainable energy in alignment with the vision for Blatchford, BRE is working on a two pronged approach to plan and build its infrastructure for the next decade, based on updated development and construction scenarios for the community:

1. Upgrade of the existing Energy Centre One to provide energy for land development stages in Blatchford West. With the upgrades, Energy Centre One is expected to generate enough renewable energy to support the land development stages until approximately 2026 (based on current land sale projections). At full capacity, Energy Centre One will be able to generate 4.25 MW of heating and 4 MW of cooling energy.
2. Plan and design the Sewer Heat Exchange Energy Centre to provide energy for land development stages in the Blatchford Market Area which are slated to require services between 2026 and 2030. At full capacity, the Sewer Heat Exchange Energy Centre will be able to generate 12.1 MW of heating and 10.3 MW of cooling energy.

This business case focuses on the development of the Sewer Heat Exchange Energy Centre as it is a new facility and assumptions used for the design of the facility in the first business case in 2015 will need to be updated. Secondly, changes to external project conditions have occurred in the last few years, mainly around EPCOR's expected reduced sewer flow to the facility in the future. This business case also recognizes the increased financial pressure for the utility to close the initial funding gap that exists in its long term financial forecast while utility growth continues.

Three options were considered as part of this business case update:

Option 1: Status Quo - Sewer Heat Exchange Energy Centre

This option includes the continuation of the design and construction activities of the Sewer Heat Exchange Energy Centre, to be ready by 2026, in alignment with the utility master plan and the Blatchford sustainability goals.

Option 2: Alternative - Geo-Exchange Energy Centre

This option would include an equivalently sized geo-exchange based Energy Centre instead of the Sewer Heat Exchange Energy Centre, utilizing existing space in the development, for commissioning in 2026, in alignment with the Utility Master Plan and the Blatchford sustainability goals.

Option 3: Initial construction of peaking Energy Centre, in advance of the Sewer Heat Exchange Energy Centre

This option would see a temporary delay of the construction of the Sewer Heat Exchange Energy Centre, while providing the required thermal energy required for the community through a previously planned peaking Energy Centre (#4), which would be advanced sooner than in the planned order of development. This option is expected to result in an initially reduced capital and operating investment, however there would also be temporary deviation to the Blatchford sustainability goals, specifically related to carbon neutrality and the use of 100 per cent renewable energy. It would also include moving the construction of the Sewer Heat Energy Exchange Centre, likely into the next budget cycle of 2027 to 2030 or at a stage when energy demand would be required.

Based on the available information and data provided in this business case, Administration's recommendation is to fully advance option 3.

Option 3:

- results in the lowest initial capital costs, providing some financial relief in the utility long term funding gap.
- fully provides the necessary generation capacity to grow the utility customer base in the short term.
- provides the best opportunity to adjust utility capacity to development and building construction demand, which allows for the flexibility in utility development to be maintained.

While option 3 temporarily deviates from the long term sustainability goals, the impact on greenhouse gas emission (GHG) reduction and renewable energy production is relatively small and short lived. The future construction of the Sewer Heat Exchange Energy Centre will allow these goals to be achieved and maintained in the long run. Over the course of 25 years, the total cumulative GHG savings between choosing option 1 and option 3 differs by a negligible amount as option 1 is forecasted to result in saving 141,552 tonnes of GHGs and option 3 is forecasted to result in saving 140,226 tonnes of GHGs.

Additionally, the design work on the Sewer Heat Exchange Energy Centre up to this point remains valuable and will be utilized in the future when the construction of the Sewer Heat Exchange Energy Centre continues.

As a result of this recommendation, the estimated $0.6 million cost for the planning and design of this project would be incurred under an existing composite profile. A capital profile to construct the peaking Energy Centre of $14.7 million is requested for approval. In total,$15.3 million for the overall project will be integrated in the 2023 to 2026 capital and operating budget documents for Blatchford Renewable Energy. The project implementation within the Integrated Infrastructure Services (IIS) Department would follow the Capital Project Governance Policy C591 and the Project Development and Delivery Model.

2. Profile Background

Blatchford Renewable Energy (BRE) is the city-owned utility providing sustainable heating, cooling and hot water energy services to the residents and businesses in the Blatchford community. Since the utility was established in 2016, BRE has developed an ambient temperature District Energy Sharing System (DESS) to support City Council's overall vision for Blatchford:

Blatchford will be home to up to 30,000 Edmontonians living, working and learning in a sustainable community that uses 100% renewable energy, is carbon neutral, significantly reduces its ecological footprint, and empowers residents to pursue a range of sustainable lifestyle choices.

Blatchford is slated to become Canada's largest carbon neutral development entirely powered by renewable energy. At full build-out of Blatchford and the DESS, it is expected that annual greenhouse gas reduction will be around 30,000 tonnes of carbon dioxide as compared to a typical community of this size.

City Council approved the initial business case for the DESS in 2015. The utility's initial build-out presented in 2015 was based on the land development and sale forecast at the time and included capital and operating investments of up to six Energy Centres. Energy Centres are an essential part of the utility's renewable energy infrastructure as they are required to extract energy from a source which can then be sent through a network of underground pipes to homes and buildings where it can be used for heating, cooling and the production of hot water.

The utility's first Energy Centre is connected to a large geo-exchange field under the first stormwater pond in the community. The utility constructed this infrastructure in 2018/2019 and it was commissioned for operation during the third quarter of 2019. The utility has been operating successfully since 2020 when the first customer building was connected to the utility. Currently, 45 customer buildings are actively receiving sustainable heating and cooling energy services.

In order to be able to continue to provide sustainable energy in alignment with the vision for Blatchford, BRE is working on a two pronged approach to plan and build its infrastructure for the next decade, based on updated development and construction scenarios for the community. This approach includes:

1. Upgrading the existing Energy Centre One to provide energy for land development stages in Blatchford West. With the upgrades, Energy Centre One is expected to generate enough renewable energy to support the land development stages until approximately 2026 (based on current land sale projections). At full capacity, Energy Centre One will be able to generate 4.25 MW of heating and 4 MW of cooling energy.
2. Planning and designing the Sewer Heat Exchange Energy Centre to provide energy for land development stages in the Blatchford Market Area which are slated to require services between 2026 and 2030. At full capacity, the Sewer Heat Exchange Energy Centre will be able to generate 12.1 MW of heating and 10.3 MW of cooling energy.

This business case focuses on the development of the Sewer Heat Exchange Energy Centre for two key reasons:

1. It is a new facility, and assumptions used by the first business case in 2015 will need to be updated, and
2. Changes to external project conditions have occurred in the last few years, mainly around the expected sewer flow to the facility in the future.

This business case also needs to recognize the increased financial pressure for the utility to close the initial funding gap that exists in its long term financial forecast, while utility growth continues. BRE's financial model and outlook is currently being updated and the results are likely to impact the funding gap in the future.

2.1. Problem / Opportunity

Currently BRE is relying on the first Energy Centre in the community to provide sustainable energy services to the growing Blatchford neighbourhood. Current projections based on the development and construction scenario for Blatchford would see Energy Centre One reach its full capacity, including necessary redundancy considerations, by 2026.

With a forecasted development growth in the Blatchford Market area, including the Hangar 11 project and the NAIT development in Blatchford, a new Energy Centre is required to start operation in 2026 to provide a reliable source of energy.

To keep in line with the vision for Blatchford and the original business case for the DESS, the next major renewable energy source would be from the heat from the two combined sewer lines that meet under the future Blatchford Market area. A sewer heat exchange system works by capturing and transferring the heat from the sewers for use by the District Energy Sharing System. The expected development in the Blatchford market area will require 12.1 and 10.3 MW of heating and cooling energy respectively. The majority of this energy demand would need to be provided by the new Sewer Heat Exchange Energy Centre.

A high level summary of the wastewater and energy process flow can be found in Figure 1 below.

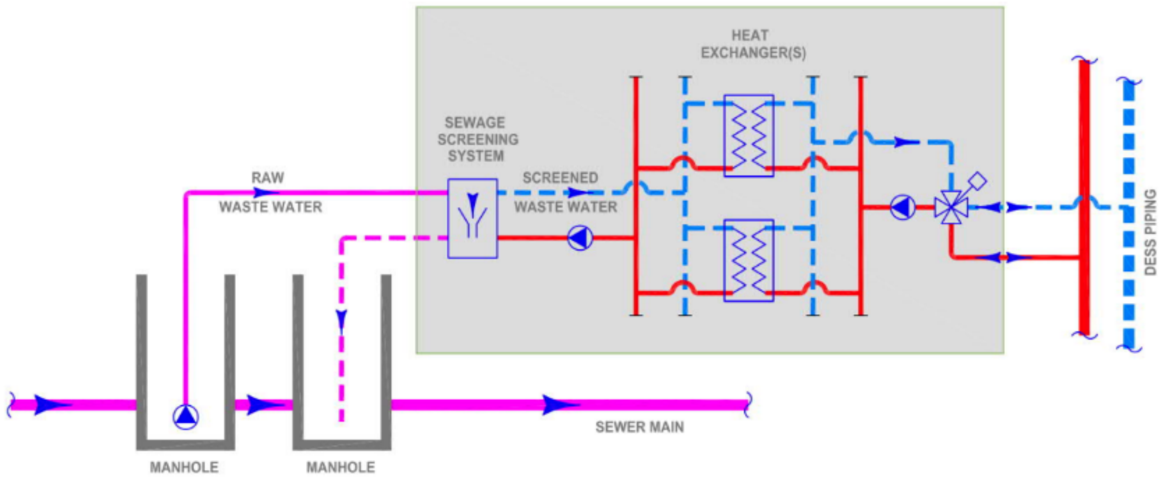


Figure 1: Waste Water and Energy Process Flow in the Sewer Heat Exchange Energy Centre

This new Sewer Heat Exchange Energy Centre would be connected to the utility's community-wide distribution piping system network and the other Energy Transfer Stations in the neighborhood so the utility can continue to provide sustainable energy services to Blatchford residents and businesses.

BRE is updating the original business case for the District Energy Sharing System, specifically the information on the Sewer Heat Exchange Energy Centre, for two main reasons:

- **Timing:**
  - The initial business case and assumptions for the Sewer Heat Exchange Energy Centre was developed in 2015. An update is needed as certain design assumptions, technology and cost factors have changed.
- **Update of Sewer Flow Forecast:**
  - During the concept design development phase of the project, EPCOR provided updates on the expected sewer flow forecast to Blatchford which occurred as a result of sewer diversion programming and the introduction of a lift station as part of the future LRT development in north west Edmonton.
  - The sewer flow to Blatchford is a critical variable for the expected energy output of the future Sewer Heat Exchange Energy Centre.

2.2. Current Situation

The original 2015 business case for Blatchford Renewable Energy incorporated the development of the Sewer Heat Exchange Energy Centre, which would provide the majority of renewable energy for the District Energy Sharing System in Blatchford. At the time, only a higher level of design work was undertaken. This combined with actual monitoring of sewer flow and temperatures were used to inform the initial business case.

In 2020, City Council approved the capital profile to plan and design the Sewer Heat Exchange Energy Centre, which allowed the utility to advance the design work. The results of this work and findings to date are described below, including a detailed review of the sewer flow update recommended by EPCOR.

With the pre-design phase completed in June 2021, four possible Sewer Heat Exchange Energy Centre locations were proposed based on the alignments of existing EPCOR combined sewer trunks within the Blatchford Redevelopment area and the available parcels presented in the overall Blatchford Land Use Concept. The preferred location, shown in Figure 2 below, is located close to the Princess Elizabeth Avenue and 109 Street intersection. This location was selected from an architectural land-use perspective with the intention to minimize the visual and space impact of the Energy Centre on the park.

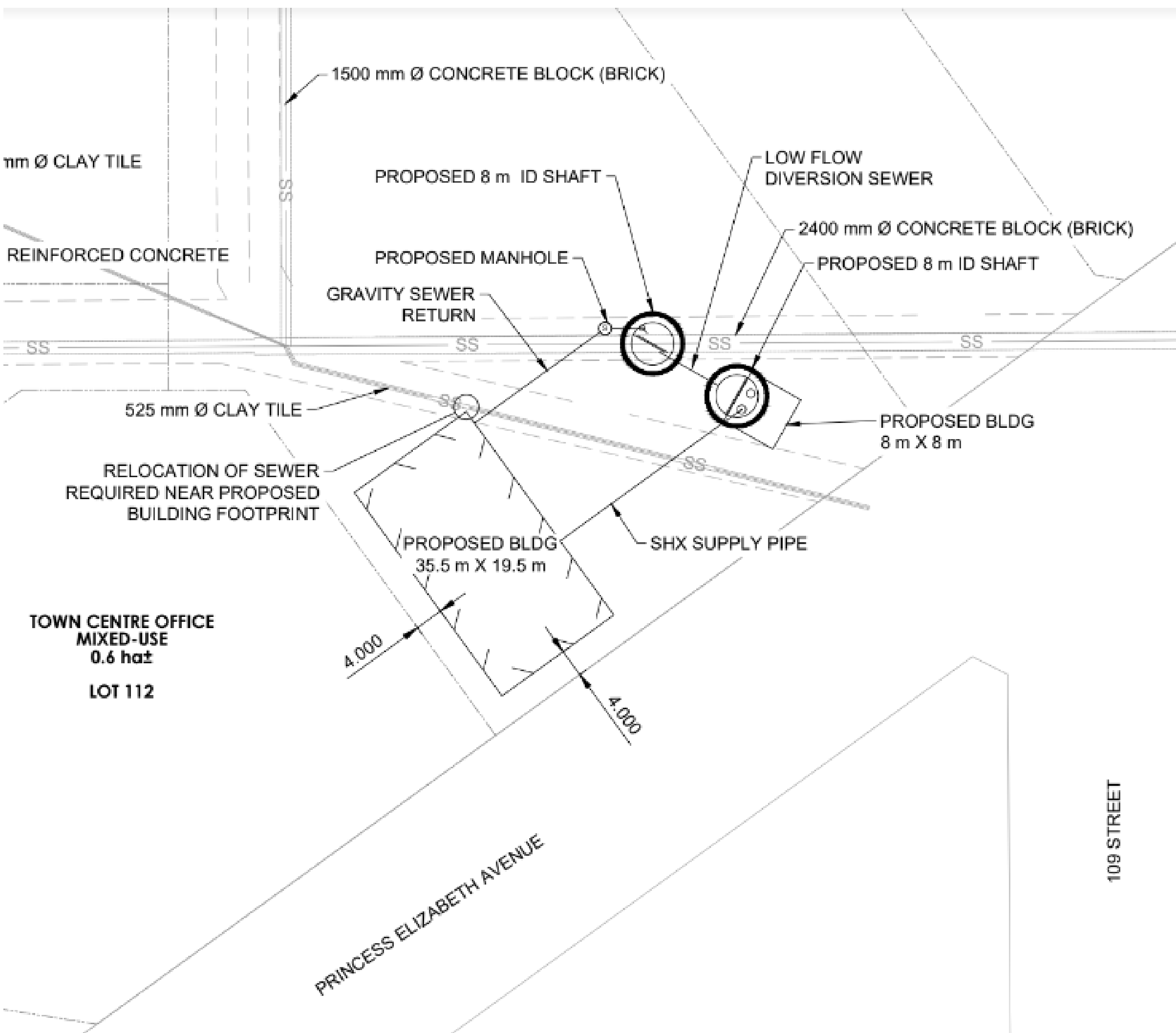


Figure 2: Proposed Location of the Sewer Heat Exchange Energy Centre

In addition, three sewer heat exchange technology options were presented and were narrowed down to two preferred options after performing a multi-criteria analysis assessment.
The sewage flow and temperature profiles were developed based on available monitoring data from a manhole located immediately upstream of the proposed tie-in location.

During the initial schematic design phase, which was completed in 2022, the established sewer flow data and analysis was utilized, however at this time and based on new information from EPCOR, the future sewer flow analysis was updated and led to a reduction in the sewer flow forecast for the project.

The two factors that would contribute to the reduction of the sewer flow forecast to Blatchford are:

- North Edmonton Sanitary Trunk (NEST) Future Diversion:
  - As growth in the region continues, sewer flows from North Edmonton are meant to be redirected to the Alberta Capital Region Wastewater Commission to offset the increase in flows coming from the communities south of Edmonton.
  - The timing of these diversions is dependent on the timing for the Metro Line LRT and the timing of development in the south;
- Water Use Trends and Design Guidelines Discussion Paper:
  - This was prepared by the One Water Planning team in EPCOR in June 2021 and concluded that a downward trend in water consumption in Edmonton due to efficiency has fundamentally changed how residential, multi-residential and commercial customers interact with the municipal water and sanitary sewer system.
  - Therefore, a reduction in future sewer flows can be anticipated in the sanitary system.

These factors impact the project as the reduction in flows will reduce the Sewer Heat Exchange Energy Centre capacity which will have an impact on the overall energy profile of the utility. The flow from monitoring data and the updated flow with all the forecasted factors are summarized in Table 1 below. EPCOR's projected year for full build-out and diversion of flow is anticipated to occur in 20 years.

Table 1: Comparison of 2021 and 2022 Sewer Flows

Item	Current Sewer		Blatchford Projected Sewer		Total	
Stage/Year	Year 0	Year 20	Year 0	Year 20	Year 0	Year 20
Pre-Design	325 L/s	325 L/s	0 L/s	127 L/s	325 L/s	452 L/s
Schematic Design	325 L/s	132 L/s	0 L/s	83 L/s[1]	325 L/s	215 L/s
Reduction %	0%	-60%	0%	-35%	0%	-52%

(1) Projected Average Sewer Flow includes commercial and residential flows.

The new sewer flow forecast was used to update the design, and is one of the key reasons that the Sewer Heat Exchange Energy Centre business case update is required. The business case update also considers the current restraints of the financial outlook and the existing funding gap during the early stages in the Utility's development.

The approach by aligning the diurnal sewer flow with the diurnal energy demand for Blatchford is used to optimize the size of equipment and maximize the energy output of the Sewer Heat Exchange Energy Centre. During the schematic design the two preferred sewer heat exchange technology options were further developed. After the comparative evaluation process utilizing a multi-attribute methodology which included an integrated risk assessment, the preferred option was determined to carry into Design Development. In addition, the preferred architectural concept was determined and also carried into the Design Development stage.

At the time of this business case development, the project Design Development is progressing. The approved option in the Schematic Design will be further developed with sufficient details on how all building components are incorporated to satisfy the project requirements.

3. Profile/Initiative Description

As part of the initial 2015 business case for the District Energy Sharing System, a detailed financial analysis provided an in-depth analysis of the financial performance of BRE, under the two build-out scenarios described below:

- Scenario 1A: 100 per cent renewable energy utilizing geo-exchange and sewer heat exchange.
- Scenario 1B: Renewable energy provided by geo-exchange and sewer heat exchange with peaking from natural gas boilers and cooling towers.

The management of peak loads ultimately determine overall system infrastructure capacity and drive capital expenditures for utilities. In order to ensure energy is available whenever it is required, energy systems must be designed and sized appropriately to not only provide normal base load system capacities (to meet average energy demand) but to also provide extra/back up capacity for the short periods of time when energy is at its highest (peak) demand. Since energy demand varies according to time of day and seasonal conditions, this additional capacity may only be used for minutes per day but must nonetheless be installed to prevent energy shortages and ensure the integrity of the DESS.

At that time, City Council selected Scenario 1B as the development path for the District Energy Sharing System, as peaking use would only minimally impact the sustainability goals with a statistically insignificant increase in greenhouse gas emissions in the long term, however it would come at a significantly reduced capital investment in the Utility.

The first Energy Centre was designed and started operation in 2019. It has been constructed to provide 100% renewable energy based on geo-exchange to its service area, which includes the first phases of land development on the west side of the Blatchford site. In total, the initial business case laid out six Energy Centres for the entire development, which include two based on geo-exchange, one sewer heat exchange energy centre, and three peaking energy centres, consisting of boilers and cooling towers.

As outlined in the Utility's Business Plan 2022 to 2025, a review and an update of the initial Utility Master Plan was conducted in 2021. This master plan, including modeling and forecast tools, will help Blatchford Renewable Energy plan for the infrastructure needed as these additional district energy nodes are constructed. It provides a roadmap for development of district energy infrastructure that works alongside the land development plans for Blatchford. The modeling tool will allow district energy planners to understand and respond to changes in land planning and development staging.

The key input variable for the master plan is the land development information, including land sale activities and builder construction timelines. Based on this information, the current District Energy Sharing System model includes 1,535,536 m2 of connected floor area to be constructed in the next few decades. The resulting net District Energy Sharing System loads are summarized in the following table.

Table 2: Total District Energy Loads in Blatchford

	Heating	Cooling
Peak	34,543 kW	46,601 kW
Annual	46,789 MWh	43,747 MWh

Future Energy Centres are currently planned to include geo-exchange, sewer heat exchange, and traditional heating sources such as boilers and cooling towers. Energy Centre boilers may consist of 'peaking' boilers designed to meet peak heating loads, or 'backup' boilers designed to provide backup capacity to sewer heat exchange or geo-exchange systems.

A strategy of several smaller distributed Energy Centres has benefits compared to having a single large Energy Centre designed for the full District Energy Sharing System load.

- Smaller Energy Centres can be located around the site to make use of various on-site renewable energy sources such as geo-exchange, sewer heat exchange and potentially other sources like e.g. NAIT and LRT waste heat exchange.
- Smaller Energy Centres can be built sequentially over the life of the project, reducing the initial capital investment.
- As the system grows and customer loads are confirmed, the design basis of future Energy Centres can be updated to accommodate revised forecast system loads.
- Distributed Energy Centres provide redundancy by supplying energy into the District Energy Sharing System from various locations. An outage at one Energy Centre, or in one segment of the distribution piping system, does not need to cause a widespread service outage.

Energy Centre service areas and the size of each Energy Centre have been developed based on the expected customer load. Each Energy Centre is being designed to service the approximate expected heating and cooling loads of the buildings within its respective service area. However, the sizing can only be approximate because energy can be shared between service areas and around the site (excess capacity from the Energy Centre in one service area can be used to make up for shortfalls in capacity in another service area). As such, each Energy Centre does not need to be sized exactly for the expected DESS load in the service area. Shortage of capacity at one Energy Centre can be made up for by increasing the sizing and bringing forward the timing of subsequent Energy Centres.

The service area for the planned Sewer Heat Exchange Energy Centre is the complete Blatchford Market area as depicted in Figure 3.

Figure 3: Service Area of the Sewer Heat Exchange Energy Centre in the Blatchford Market Area

As part of this business case update, three options that follow the development path are under consideration include:

- **Option 1: Status Quo - Sewer Heat Exchange Energy Centre**
  - This option includes the continuation of the design and construction activities of the Sewer Heat Exchange Energy Centre in alignment with the utility master

plan and the Blatchford sustainability goals.
  - This alignment would foresee the design and construction of the Sewer Heat Exchange Energy Centre between 2023 to 2026, with commissioning expected in 2026.

- **Option 2: Alternative - Geo-Exchange Energy Centre**
  - This option would include an equivalently sized geo-exchange based Energy Centre instead of the Sewer Heat Exchange Energy Centre, utilizing existing space in the development, for commissioning in 2026, in alignment with the Utility Master Plan and the Blatchford sustainability goals.
  - Space for additional geo-exchange fields was initially limited, but as sewer flows were adjusted, the opportunity to utilize this renewable energy technology re-emerged.

- **Option 3: Initial construction of peaking Energy Centre, in advance of the Sewer Heat Exchange Energy Centre**
  - This option would see a temporary delay of the Sewer Heat Exchange Energy Centre, while providing the required thermal energy required for the community through a previously planned peaking Energy Centre (#4), which would advance in the planned order of development of the utility.
  - This option recognizes the increased financial pressure for the utility to reduce the initial capital funding gap in the early years of the utility while community development growth continues.
  - This option is expected to result in a reduced capital and operating investment, however also in a temporary deviation to the Blatchford sustainability goals (carbon neutral and 100% renewable energy).
  - It would also include moving the construction of the Sewer Heat Energy exchange Centre, likely into the next budget cycle 2027 to 2030 or at a stage when energy demand would satisfy higher investment.

3.1. Initiative Justification

The justification for the initiative can be traced back to Blatchford Renewable Energy's role and requirement to provide sustainable heating and cooling services for the Blatchford Service Area. These requirements of this city-owned utility company are outlined in the Utility Bylaw 17943 and its Fiscal Policy C597A. The utility works hand-in-hand with the Blatchford land development program to provide utility services to buildings in Blatchford once they are in design and construction.

3.2. Anticipated Outcomes/ Critical Success Factors

The outcome of the initiative is for Blatchford Renewable Energy to supply reliable and sustainable thermal energy services for the development of the Blatchford Market Area. This supports the Blatchford vision and the Utility's Business Plan.

The specific anticipated outcomes translating into critical success factors of this initiative are:

- Operational Readiness:
  - Operational readiness by 2026 to support anticipated Blatchford development growth.
- Energy Supply:
  - Provision of required heating and cooling demand capacity, with sufficient redundancy.
- Operational Capacity:
  - Operational uptime of 100 per cent.
- Sustainability:
  - Supporting the Blatchford vision to achieve carbon neutrality and 100 per cent renewable energy.

3.3. Scope

The scope of this business case includes the review of the three options for achieving the anticipated outcomes stated above :

- Option 1: Status Quo - Sewer Heat Exchange Energy Centre
- Option 2: Alternative - Geo-exchange Energy Centre
- Option 3: Initial construction of Energy Centre Four, in advance of the Sewer Heat Exchange Energy Centre

3.4. Out of Scope

The following items are excluded from the scope of this business case:

- Updated Regulation:
  - Any updates on the regulatory provincial or federal framework for District Energy Systems are excluded.
- Distribution Piping System
  - In all options, the cost and timing of the distribution piping system construction, connecting the Energy Centre with the customers, is not included.
  - It is assumed that the distribution piping system is constructed on an as-needed basis, similar for all three options, based on the land development schedule.

4. Strategic Alignment

The vision for the Blatchford community development, which includes BRE and the District Energy Sharing System, is aligned with the major key planning documents of the City of Edmonton. It is connected and supports all four of City Council's strategic goals: Healthy City, Urban Places, Regional Prosperity and Climate Resilience.

It further aligns with Edmonton's City Plan and the "Greener as we Grow" and "A Community of Communities" Big City Moves:

- **Greener as we Grow**:
  - Edmonton is a city of possibility and passion. Our growth should drive climate resilience ahead and strengthen our natural systems. As a livable city, development and sustainability must be allies, not competitors. To lighten our collective footprint, Greener As We Grow is a commitment to use growth as a catalyst for good design and conscientious decisions. Greener As We Grow puts Edmontonians at the forefront of two important trends for our region—continuing to develop a healthy city while also paying attention to what will surely be one of the great challenges of our future: protecting and enhancing our land, air, water and biodiversity.
- **A Community of Communities**:
  - We are a big city getting bigger all the time, composed of distinct communities that come together to create a cohesive whole. This is central to Edmonton's appeal, because no matter how large we are, it always feels more like home when we are part of a community. In our districts. On our streets. In our open spaces. The people we say hello to when we are walking the dog, in the garden or on the move. This brings us together and makes us feel connected to one another and to the place where we live.
  - A Community Of Communities is about making big city life feel less anonymous and more personal. It's about welcoming new residents and developing housing, recreation, schools and employment in all of our districts that can be better accessed through all forms of transportation.
  - Edmonton's communities are its lifeblood and will continue to provide us with the opportunity to turn our time and attention to things that really matter, like connection with each other and to the greater good.

District Energy, in particular, represents a key strategy of Edmonton's Community Energy Transition Strategy. As outlined in the strategy, 36% of Greenhouse Gas Emissions Reductions are to come from Energy System Transformation. This includes both an emissions neutral electricity grid and a "City-wide decarbonized district energy network by 2050".

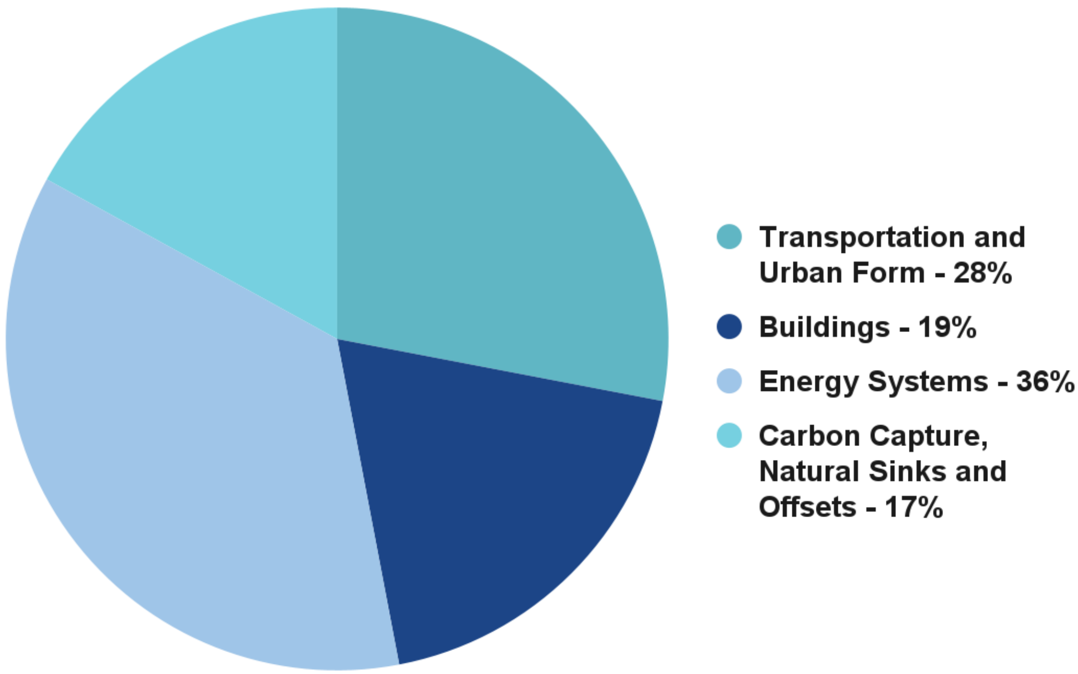


Figure 4: Emission Reduction Profile (for net zero in 2050)

The further development of the Blatchford District Energy Sharing System is one key action outlined in the Strategy, including the expansion and decarbonization of a District Energy network in the City.

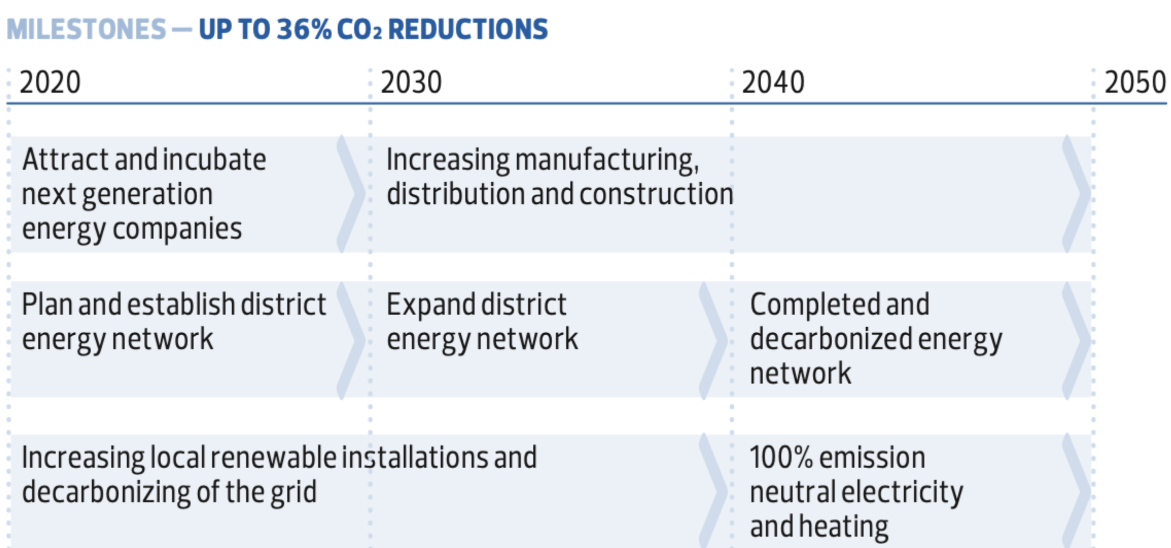


Figure 5: Greenhouse Gas Reduction Milestones for Energy Systems Transformation

The “Implementation of Renewable District Energy Systems” is also identified as a key strategic action in the Integrated Infrastructure Services Business Plan, supporting the strategic objective of the IIS Department to “Make transformational impacts in our community”. Blatchford Renewable Energy supports the Blatchford development by providing renewable heating and cooling energy to homes and buildings.

The following indicators, measures and targets are identified within Connect Edmonton or the City Plan as measures of progress towards the strategic goals this action may impact. The action listed above is deemed to be a significant contributor to achieving these goals.

ConnectEdmonton Climate Resilience Indicator(s)	City Plan Strategic Measure(s)	City Plan Target(s)
Renewable Energy Use Community Greenhouse Gas Emissions (GHG)	GHG Emissions / person in Edmonton Total GHG Emissions in Edmonton Total volume / number of carbon sinks in Edmonton Community GHGs expressed as % of carbon budget City GHGs expressed as % of carbon budget	Net per person GHG emissions are nearing zero Total community wide greenhouse gas emissions below 135 megatonnes carbon budget

5. Context Analysis

Given the current global climate emergency, investments in district energy infrastructure are accelerating the shift to lower carbon solutions for cities, communities and campuses. The 2015 United Nations Environmental Programme report “District Energy in Cities: Unlocking the Potential of Energy Efficiency and Renewable Energy” identifies modern district energy as the most effective approach for many cities to transition to sustainable heating and cooling, by improving energy efficiency and enabling higher shares of renewables. The report provides a list of various benefits for low carbon District Energy Systems which are summarized below:

- **Greenhouse Gas Reduction:** District Energy allows for a transition away from fossil fuel use and can result in a 30–50 per cent reduction in primary energy consumption.
- **Air Pollution Reduction:** By reducing fossil fuel use, District Energy Systems can lead to reductions in indoor and outdoor air pollution and the associated health impacts.
- **Energy Efficiency Improvements:** Linking the heat and electricity sectors through District Energy infrastructure and utilizing low-grade energy sources, such as waste heat or free cooling, can greatly improve the operational efficiency of new or existing

buildings.

- **Use of Local and Renewable Resources:** Through economies of scale and the use of thermal storage, District Energy Systems are one of the most effective means for integrating renewable energy sources into the heating and cooling sectors.
- **Resilience and Energy Access:** District Energy Systems can boost resilience and energy access through their ability to improve the management of electricity demand, reduce the risk of brownouts and adapt to pressures such as fuel price shocks (for example, through cost-effective decarbonization, centralized fuel-switching and affordable energy services).
- **Green Economy**: District Energy Systems can contribute to the transition to a green economy through cost savings from avoided or deferred investment in power generation infrastructure and peak capacity; wealth creation through reduced fossil fuel expenditure and generation of local tax revenue; and employment from jobs created in system design, construction, equipment manufacturing, and operation and maintenance.

Over the last few decades globally and in North America, significant growth in construction and operation of District Energy Systems has occurred. Figures 6 and 7 provide an overview of this growth measured by connected floor space in and beyond North America.

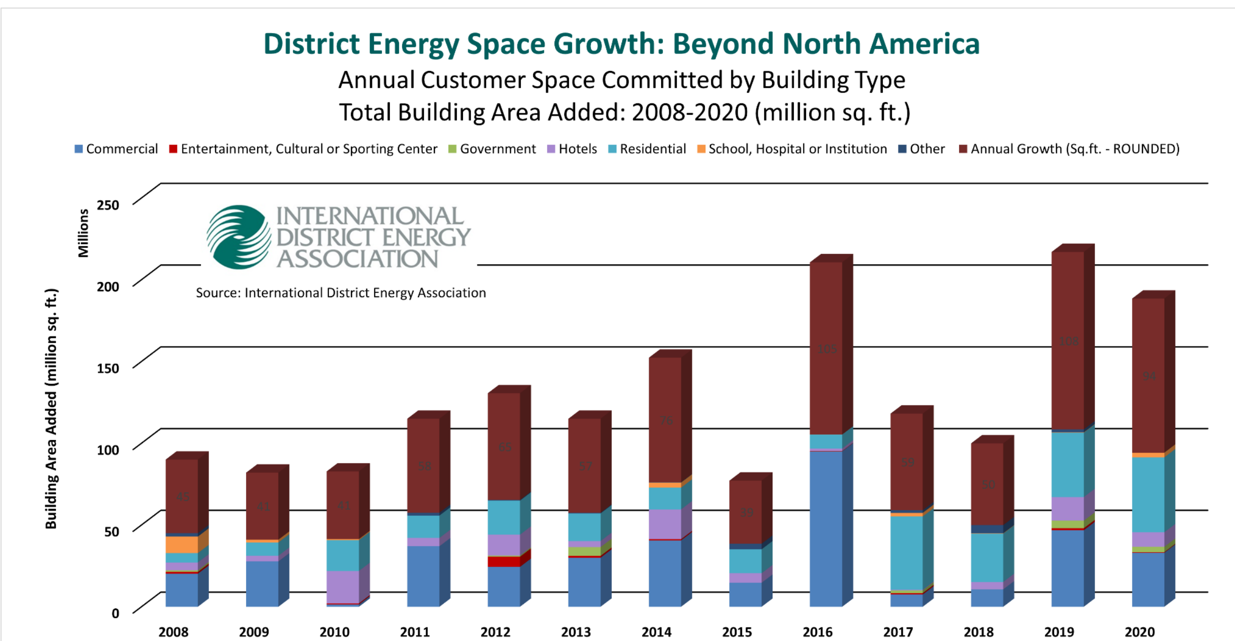


Figure 6: District Energy Growth beyond North America (IDEA, 2022)

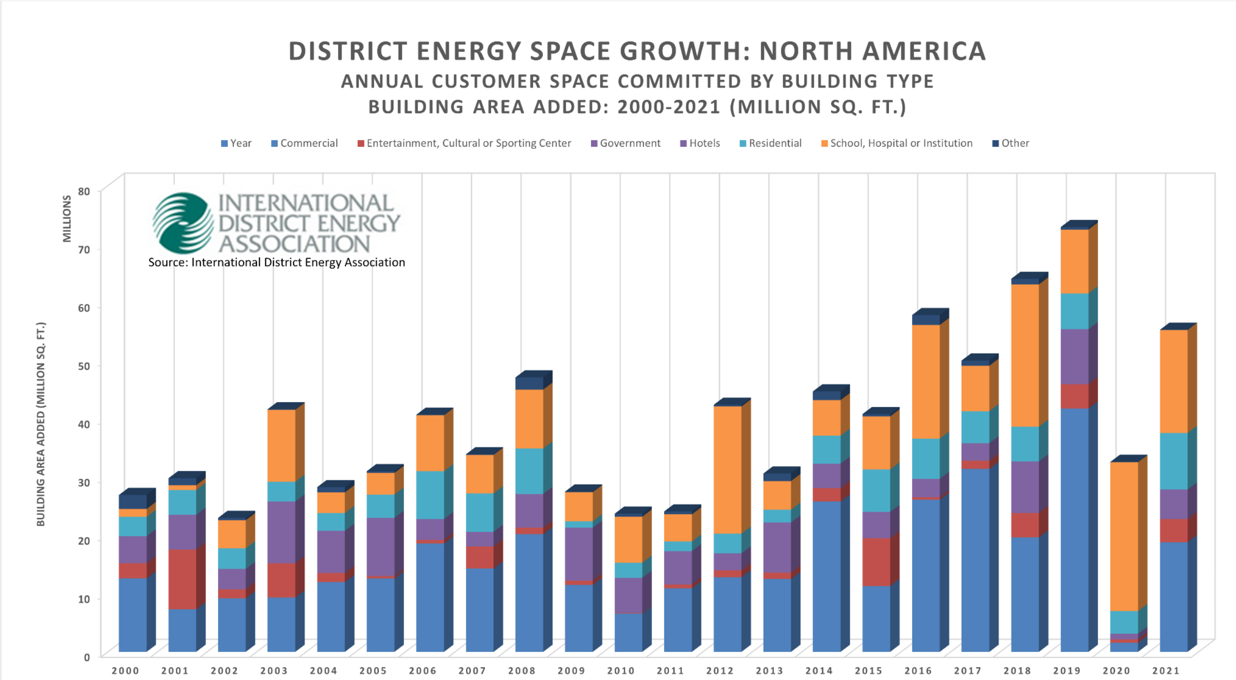
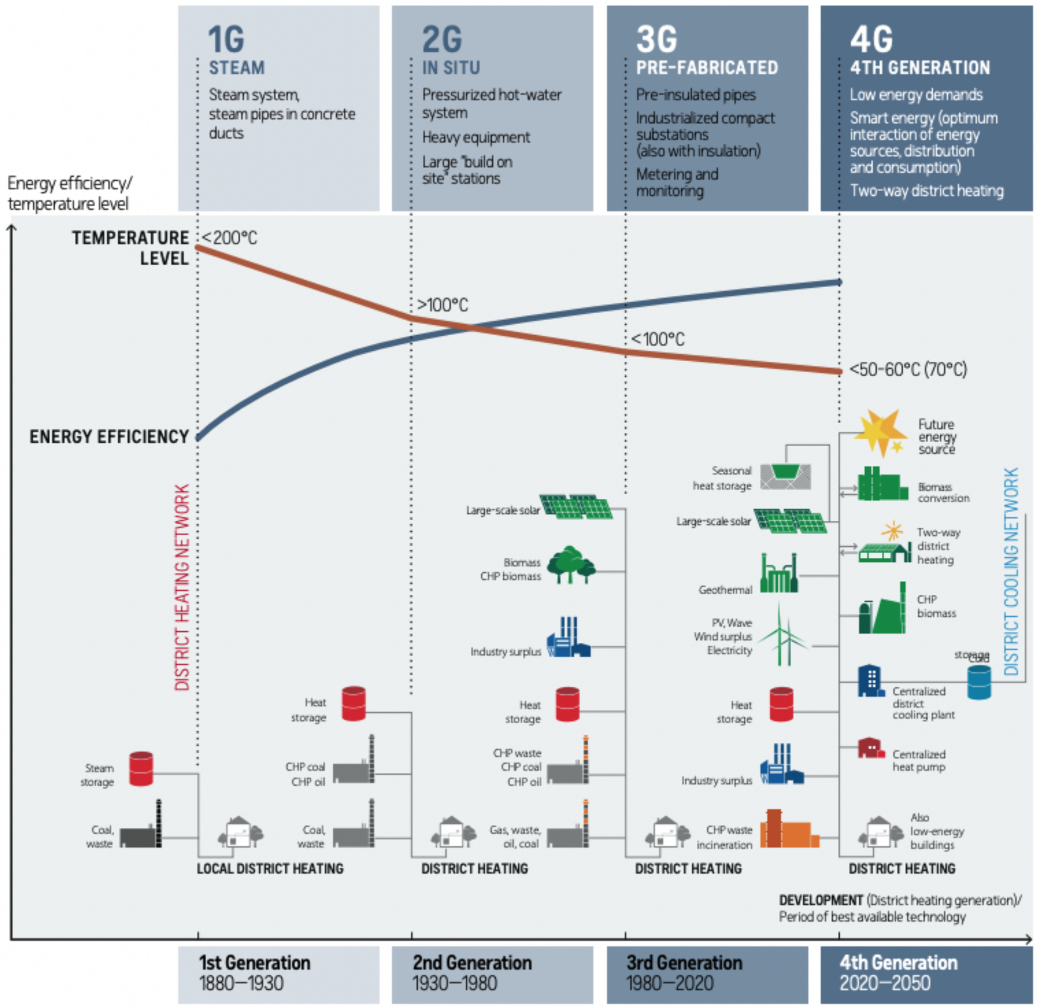


Figure 7: District Energy Growth in North America (IDEA, 2022)

The District Energy Sharing System in Blatchford is a heat pump based ambient temperature District Energy System. The utilization of renewables such as geo-exchange and the proposed Sewer Heat Exchange Energy Centre is the perfect integration of a" fourth generation" District Energy System, which are predominantly tackling the climate crisis and increasing energy resilience by providing sustainable heat and cooling energy through the decarbonization of traditional energy systems that use natural gas and electricity. The overall historical trend of District Energy Systems over time and aligned to temperature and energy efficiency is depicted in Figure 8 below.



Source: Aalborg University and Danfoss District Energy, 2014

Figure 8: Historical Development of District Energy Networks, to the modern day and into the Future (Aalborg University and Danfoss District Energy, 2014)

Many jurisdictions see a role for expanded district energy in the low carbon energy transition, as can be seen in the City of Edmonton's Community Energy Transition Strategy goals around an expanded decarbonized district energy network. Global trends also see a more intensified move to a decarbonized heating and cooling world. Given geopolitical considerations and the availability and cost of natural gas as a heating fuel, more and more European jurisdictions are either supporting the generation of renewable natural gas or are completely banning new natural gas heating systems.

6. Alternatives

For the review of the original business case, three alternatives were considered:

- **Option 1: Status Quo - Sewer Heat Exchange Energy Centre**
    - This option includes the continuation of the design and construction activities of the Sewer Heat Exchange Energy Centre in alignment with the utility master plan and the Blatchford sustainability goals.
    - This alignment would foresee the design and construction of the Sewer Heat Exchange Energy Centre between 2023 to 2026, with commissioning expected in 2026.
- **Option 2: Alternative - Geo-Exchange Energy Centre**
    - This option would include an equivalently sized geo-exchange based Energy Centre instead of the Sewer Heat Exchange Energy Centre, utilizing existing space in the development, for commissioning in 2026, in alignment with the Utility Master Plan and the Blatchford sustainability goals.
    - Space for additional geo-exchange fields was initially limited, but as sewer flows were adjusted, the opportunity to utilize this renewable energy technology re-emerged.
- **Option 3: Initial construction of peaking Energy Centre, in advance of the Sewer Heat Exchange Energy Centre**
    - This option would see a temporary delay of the Sewer Heat Exchange Energy Centre, while providing the required thermal energy required for the community through a previously planned peaking Energy Centre (#4), which would advance in the planned order of development of the Utility.
    - This option recognizes the increased financial pressure for the utility to minimize and close the initial capital funding gap in the early years of the utility while community development growth continues.
    - This option is expected to result in an initially reduced capital and operating investment, however also in a temporary deviation to the Blatchford sustainability goals (carbon neutral and 100% renewable energy). The long term sustainability goals of the utility have not changed.
    - It would also include moving the construction of the Sewer Heat Energy Exchange Centre, likely into the next budget cycle 2027 to 2030 or at a stage when energy demand would satisfy higher investment.

All three options will be assessed based on the anticipated outcomes leading to the critical success factors for the Utility:

- Operational Readiness:
    - Operational readiness by 2026 to support anticipated Blatchford development growth.
- Energy Supply:
    - Provision of required heating and cooling demand capacity, with sufficient redundancy.
- Operational Capacity:
    - Operational uptime of 100%.
- Sustainability:
    - Supporting the Blatchford vision to achieve carbon neutrality and 100% renewable energy.

While all options are aligned with all critical success factors, Option 3 will deviate on a temporary basis from the goal of providing renewable energy from the District Energy Sharing System. The long term sustainability goals however are not affected.

7. Organizational Change Impact

Blatchford Renewable Energy is the owner and operator of the District Energy Sharing System, with support from internal City departments and external contractors. The City’s Facilities Maintenance Services Section is responsible for the Energy Centre's operation and maintenance.

A critical part of the Sewer Heat Exchange Energy Centre is the operation of the lift station, transporting the sewage and stormwater to the exchange system of the Energy Centre. Blatchford Renewable Energy has partnered with EPCOR for the potential operation of the lift station. As a result of this engagement, the only significant change in Option 2 would be that EPCOR would not be involved in the project, or in Option 3 that their involvement would be deferred till the future construction of the Sewer Heat Exchange Energy Centre.

Function	Option 1	Option 2	Option 3
City Resources			
Blatchford Renewable Energy - Ownership and management	No change	No change	No change
Facilities Maintenance Services - Operation and Maintenance	No change	No change	No change
Contract Resources			
EPCOR - Lift Station Operator for Sewer Heat Exchange Energy Centre	No change	Change - No lift station in scope	Change - involvement will be delayed
Others (Consultants, Contractors etc.)	No change	No change	No change

7.1. Stakeholder Impact

Key stakeholders and how they will be impacted by the Sewer Heat Exchange Energy Centre are summarized in the table below:

Stakeholder	City Relationship	Type of Impact	Impact of Recommended Option
City Council	Internal	Direct	Reputational impact to Blatchford sustainability goals and Community Energy Transition Strategy.
Blatchford Renewable Energy	Internal	Direct	Capital and operating costs, management of internal and external stakeholders.
Blatchford Land Development	Internal	Direct	Minimal impact as initiatives might change some access and visual conditions.
Facilities Maintenance Services	Internal	Direct	Will affect operation and level of support depending on what option is chosen.
IIS Planning and Design and Delivery Sections	Internal	Direct	Will affect operation and level of support depending on what option is chosen.
Blatchford Builders	External	Indirect	No impact. Builders will see the same infrastructure and energy delivery system for building integration.
Blatchford Renewable Energy Customers	External	Indirect	Some impact. Customers will see the same infrastructure and energy delivery system at their homes and buildings, however a temporary deviation in renewable content.
Edmontonians	External	Indirect	Reputational impact to Blatchford sustainability goals and Community Energy Transition Strategy

7.2. Business and Operational Impact

Options	Operational Strategy	Challenges	Benefits
Option 1	Continue with project design and delivery	Higher initial capital costs impact the utility's financial outlook and funding gap. Harder to stage with development.	Project delivery can continue as planned
Option 2	Re-design work would be needed for the additional geo-exchange fields, project planning and delivery methodologies to be determined, and an adjusted budget would need to be developed.	Re-design effort would be needed including additional costs. Implementation schedule would need to be reviewed. Existing land constraints for geo-exchange technology. Harder to stage with development.	Technology is well understood and experienced. Project capital costs will need to be updated. If initial lower investment is lower, this could be beneficial to the utility's financial outlook and funding gap.
Option 3	Re-design work would be needed due to the construction of the new Energy Centre, project planning and delivery methodologies to be determined, and an adjusted budget would need to be developed. Concept development of Sewer Heat Exchange Energy Centre will be valuable for future integration.	Re-design effort would be needed including additional costs. Implementation schedule would need to be reviewed. Project delay of the Sewer Heat Exchange Energy Centre might result in higher capital costs in the future (due to inflation).	Technology is well understood and experienced. Project capital costs are expected to be lower compared to options 1 and 2. Initial lower investment in the Utility could be beneficial to the Utility's financial outlook and funding gap. Easier staged with development progress. Sewer Heat exchange Energy Centre Design is advanced and can be picked up again in the future.

8. Cost Benefits

This section identifies overall value contribution and costs incurred to realize the proposed initiative.

8.1. Tangible Benefits

The tangible benefits and the impacts on all three options are listed in the table below:

Tangible Benefits	**Option 1-** Status Quo - Sewer Heat Exchange Energy Centre	**Option 2-** Alternative - Geo-Exchange Energy Centre	**Option 3-** Initial construction of Energy Centre Four in advance of the Sewer Heat Exchange Energy Centre
Provision of reliable thermal energy (heating and cooling)	Able to provide	Able to provide	Able to provide
Alignment with the sustainability targets for Blatchford	Yes	Yes	Temporary deviation. Targets are met in the medium term

8.2. Intangible Benefits

The intangible benefits and the impacts on all three options are listed in the table below:

Intangible Benefits	**Option 1-** Status Quo - Sewer Heat Exchange Energy Centre	**Option 2-** Alternative - Geo-Exchange Energy Centre	**Option 3-** Initial construction of Energy Centre Four in advance of the Sewer Heat Exchange Energy Centre
Operability of District Energy Sharing System	No impact on operability	No impact on operability	No impact on operability
Reputational risk	Aligned with Blatchford sustainability goals	Aligned with Blatchford sustainability goals	Temporary deviation from Blatchford sustainability goals. Targets are met in the medium term

8.3. Costs

This section describes, in depth, the comprehensive analysis comparing the feasible alternatives for this business case:

- Option 1: Status Quo - Sewer Heat Exchange Energy Centre
- Option 2: Alternative - Geo-Exchange Energy Centre
- Option 3: Initial construction of peaking Energy Centre, in advance of the Sewer Heat Exchange Energy Centre

For better overall integration in some of the analysis the full picture of the sequence of Energy Centres for the full build out of Blatchford Renewable Energy will be provided. This should be done rather than focusing on the next Energy Centre only. More details and utilized assumptions of the economical business case analysis are provided in attachment 1 of this business case.

- Capital Costs

Capital costs include those associated with buildings, mechanical systems, boilers, cooling towers, electrical, sewer heat exchange and geo-exchange technology costs, as well as owners overhead & engineering design costs. All costs are prepared to AACE (Association of Advancement of Cost Engineering) Class 5 level of accuracy and are shown in actual year of spent pre-tax dollars to be comparative to the energy and financial utility model constructed in 2018. For the purposes of comparing base costs, a recommended contingency of 40% is not included, however is incorporated for the budget request. An annual escalation of 2.35% is used.

Figure 9 provides an overview of the comparison between the capital costs for the Sewer Heat Exchange Energy Centre, a similar sized Geo-Exchange Energy Centre, and a peaking Energy Centre (#4). Note that the design size of the peaking Energy Centre is not directly comparable to the sizes of the Sewer Heat Exchange and Geo-Exchange Energy Centres, as its original design was slightly adjusted to bridge the demand gap of four years towards the planned Sewer Heat Exchange Energy Centre. Energy Centre #4 provides a heating capacity of 7.1 MW and cooling capacity of 11.3 MW, while the Sewer Heat and Geo-exchange Energy Centres are designed to 12.1 and 10.3 MW heating and cooling capacity respectively.

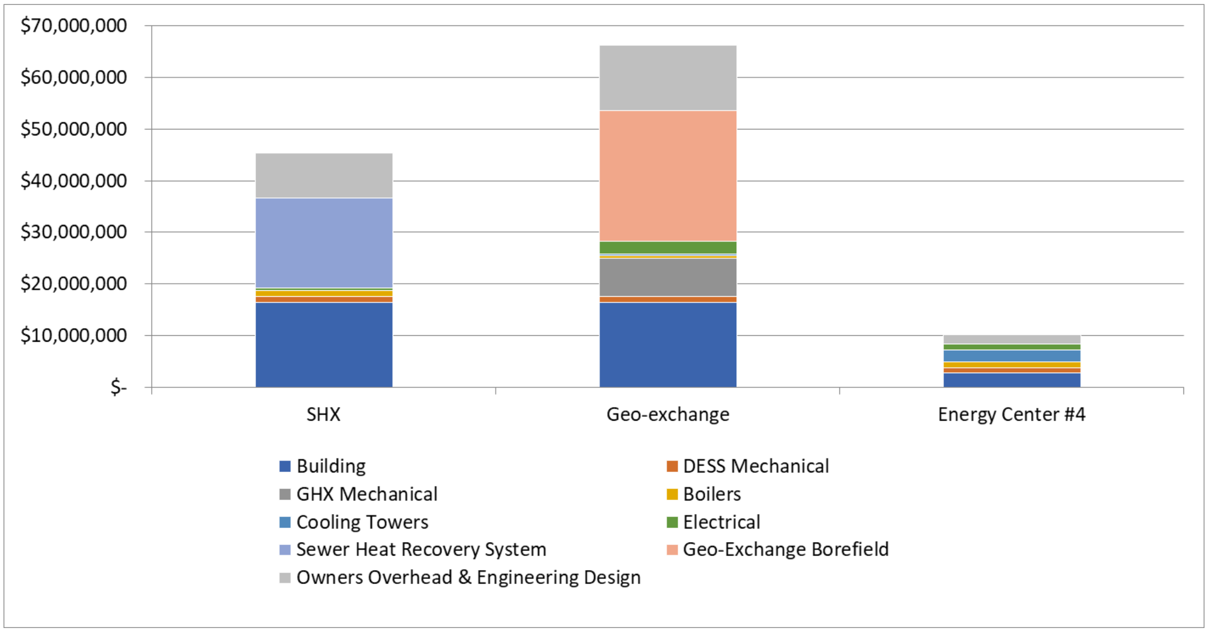


Figure 9: Capital Costs Comparison

The cost for the Sewer Heat Exchange Energy Centre is $45.3 million, lower than a comparable size Geo-exchange Energy Centre at $66.3 million. As expected, the capital costs for the peaking Energy Centre #4 is the lowest at $10.3 million.

Figures 10 and 11 present the full impact of capital costs for all Energy Centres in Blatchford shown in actual expected capital costs over time and cumulative capital spend. The difference in order versus all three options are noted and are shown comparatively.

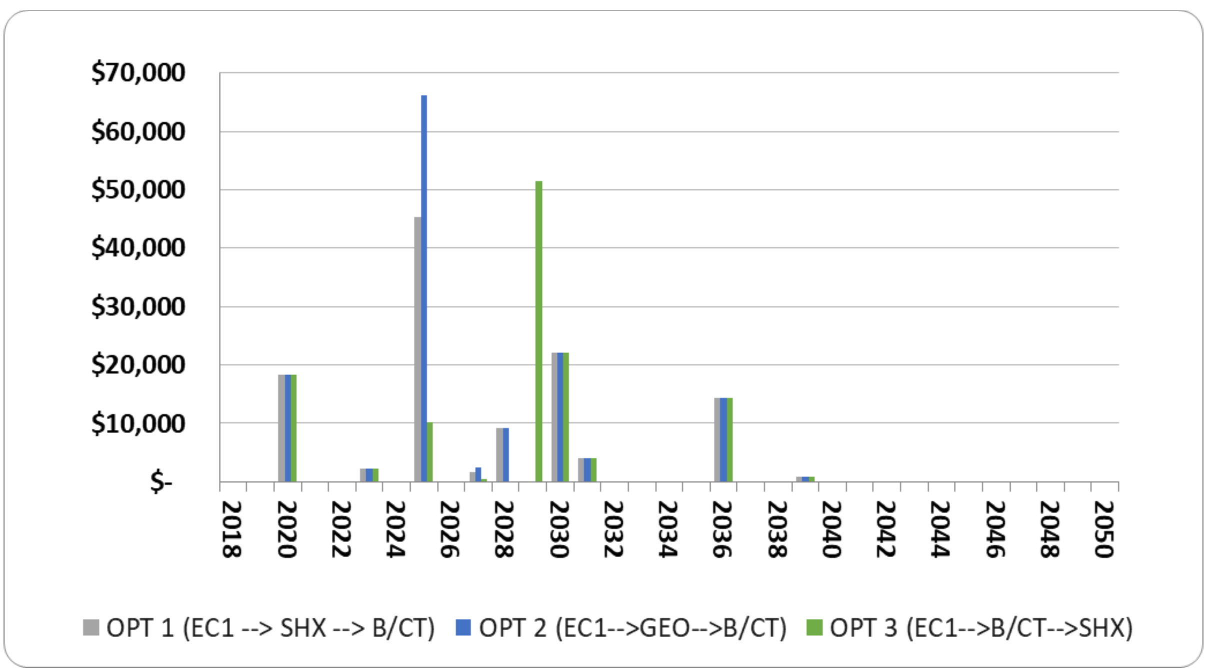


Figure 10: Energy Centres Capital Costs Over Time

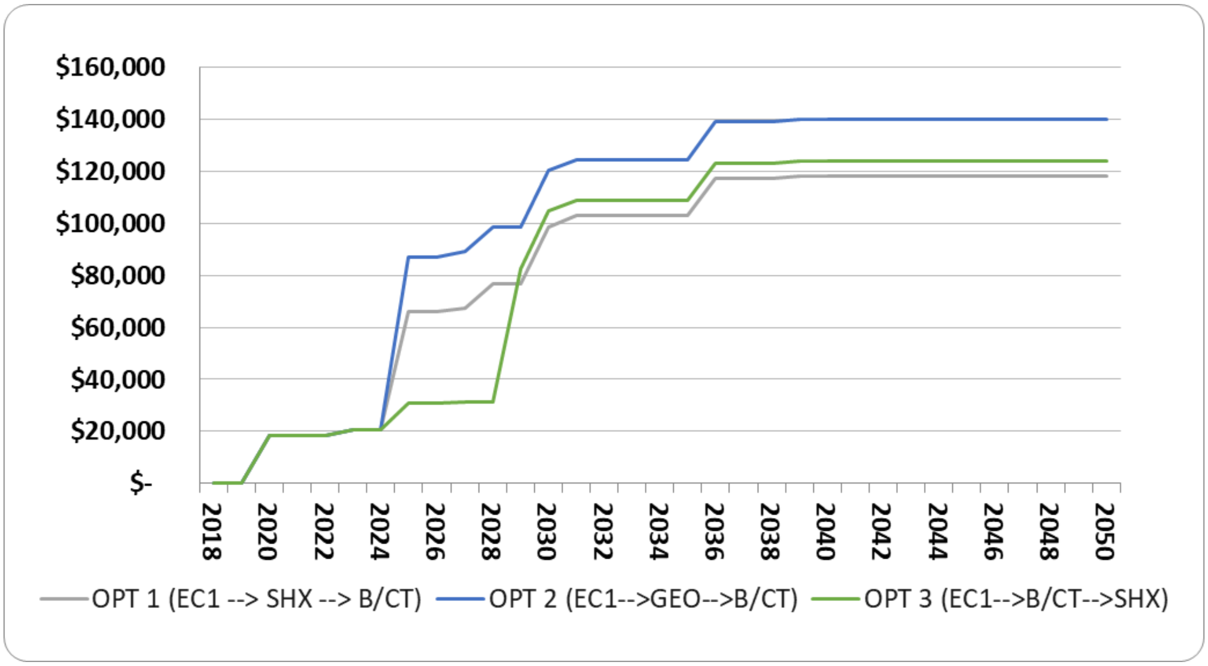


Figure 11: Energy Centres - Cumulative Spend

While option 1 has the lowest capital costs for all Energy Centres over the full buildout of Blatchford ($118.2 million), option 3 is only slightly behind with $124.1 million. The reason for that slight difference is the delayed costs, due to inflation, for the Sewer Heat Exchange Energy Centre. Option 2 has the highest overall costs with $139.9 million, caused by the higher cost of the comparable Geo-exchange Energy Centre. The reduced capital spend in the years between 2024 and 2028 in option 3 is quite visible compared to options 1 and 2, where initial investment for Sewer Heat Exchange or Geo-exchange Energy Centre happens earlier in the life of the Utility.

- Operating Costs

Figure 12 provides an overview of the comparative operating impact, shown in dollars per kilowatt hour between all three options.

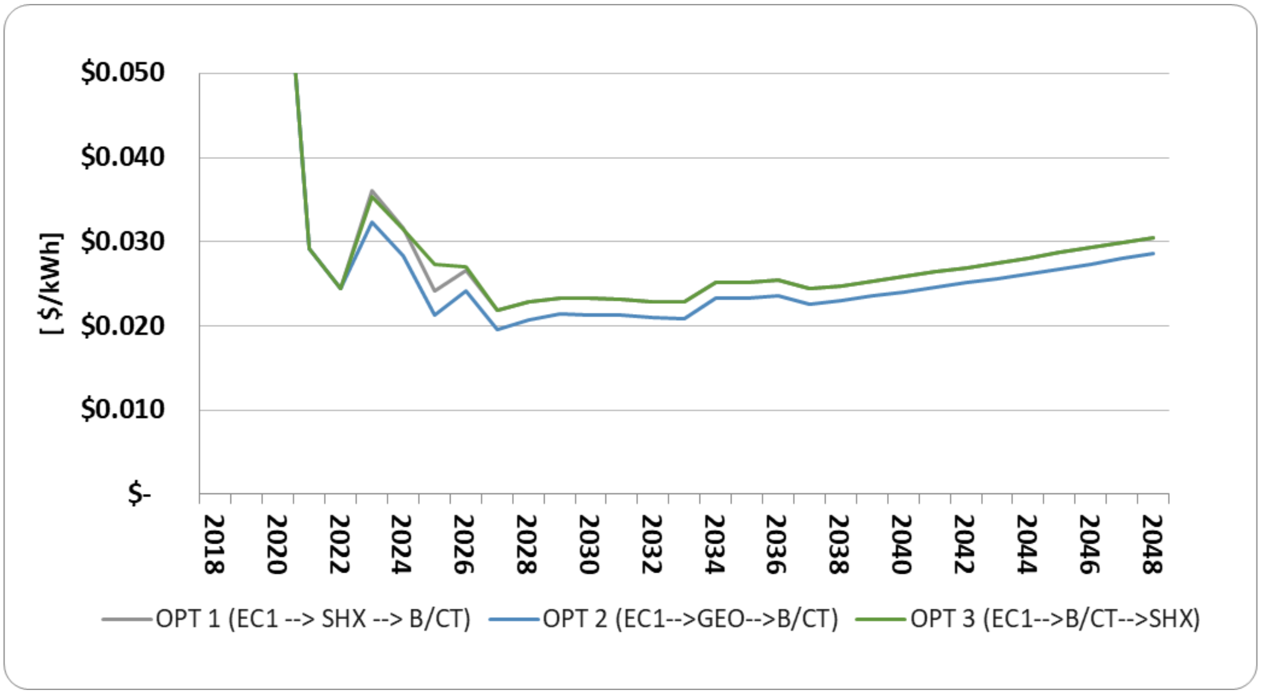


Figure 12: Operating Cost Comparison between all three Options in [$/kwh]

From the operating perspective option 2 provides a slight advantage compared to option 1 and 3. This is a result from a slightly easier and cost effective operation of the Geo-exchange Energy Centre, though overall the difference is quite small. What becomes evident is the reduction in overall operating costs when more generation capacity is coming online, with costs slightly rising in the later years, when planned maintenance costs are increasing and start affecting the ongoing operating costs. One of the major benefits, however, of this District Energy Sharing is its relatively low operating costs per kWh provided.

- Present Value of the Project Costs

The present value of the project costs of the pure Energy Centre costs, operating costs (fuel, operations and maintenance), and the total value of both, for each option, is provided in the following table. The lowest present value represents the best investment decisions for the Utility.

Table 3: Comparative Present Value of the Project Costs Analysis for all three Options

($000's)	OPT 1 (EC1 → SHX → B/CT)	OPT 2 (EC1 → GEO → B/CT)	OPT 3 (EC1 → B/CT → SHX)
Energy Centres Capital PV	$75,466	$90,473	$73,028
Fuel, Operation & Maintenance PV	$14,941	$13,812	$14,992
Total PV EC Capital + O&M	$90,407	$104,286	$88,019

As expected the present value of the project costs for Energy Centres capital in option 3 is the lowest as initial high investment, compared to option 1 and 2, is delayed. Option 3 is followed by option 1 and 2, given the initial higher capital investment of the Sewer Heat Exchange and Geo-exchange Energy Centre. The present value of the project costs for operating costs (fuel, operation and maintenance) shows a slight advantage for option 2 followed by 1 and 3, which are almost equal. This is because of a slightly lower operating costs for the initial Geo-exchange Energy Centre as mentioned above. However, over the total present value of capital and operating investment shows option 3 rising to the top, followed by option 1 and 2. Again, this is not surprising given the initial delay of capital investment while the utility grows. Figure 13 shows the present value of Energy Centres spent over time. Looking at the present value of spend option 3 provides the lowest option over time, compared to option 1 and option 3. This is going hand in hand with the results of the present value analysis in table 3.

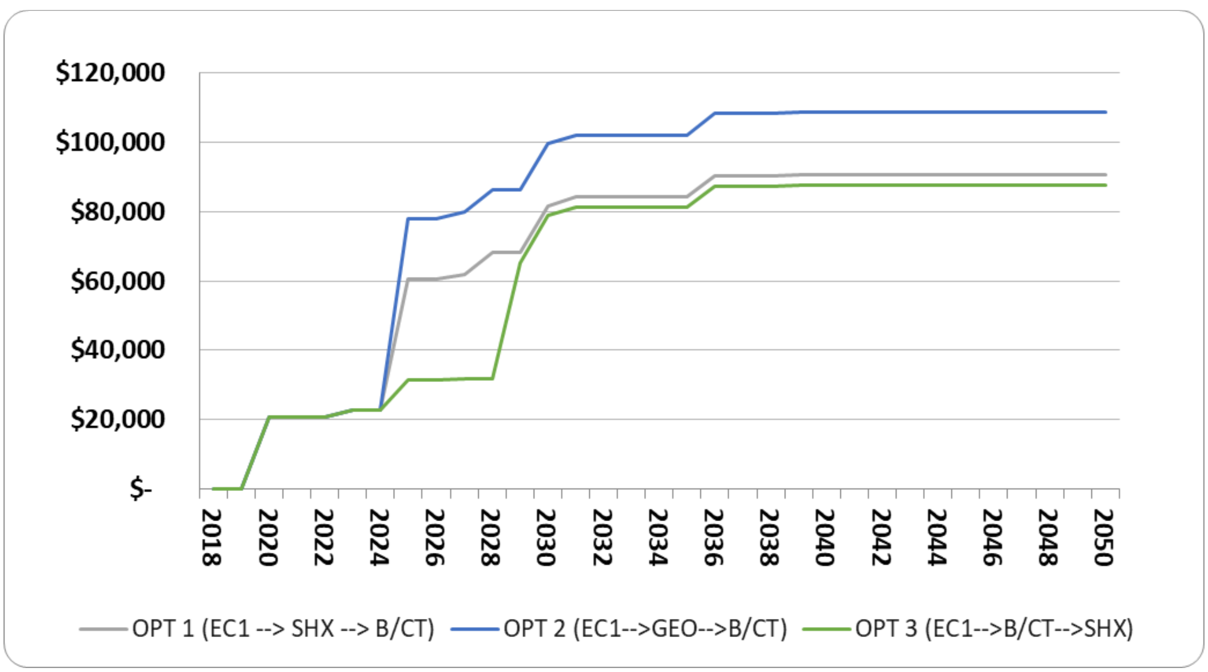


Figure 13: Energy Centres Cumulative Present Value of Spend

8.4. Greenhouse Gas Benefits and Renewable Energy Provision

The vision for Blatchford is one of a carbon neutral community, entirely powered by renewable energy. The following figure provides comparative information on the anticipated greenhouse gas emissions reduction from the District Energy Sharing System over time and as a total over a 25 year time frame. As presented previously, the full build out of Blatchford Renewable Energy is considered here, with the options 1 to 3 providing the difference in order of Energy Centre construction.

Figure 14 provides a comparative analysis of all three options over time. The achieved greenhouse gas emissions reductions are from the operation of the District Energy Sharing System only, and do not take into account the additional greenhouse gas reductions from the improved green building codes for the buildings in Blatchford, the sum of the two would constitute the total greenhouse gas emission reductions.

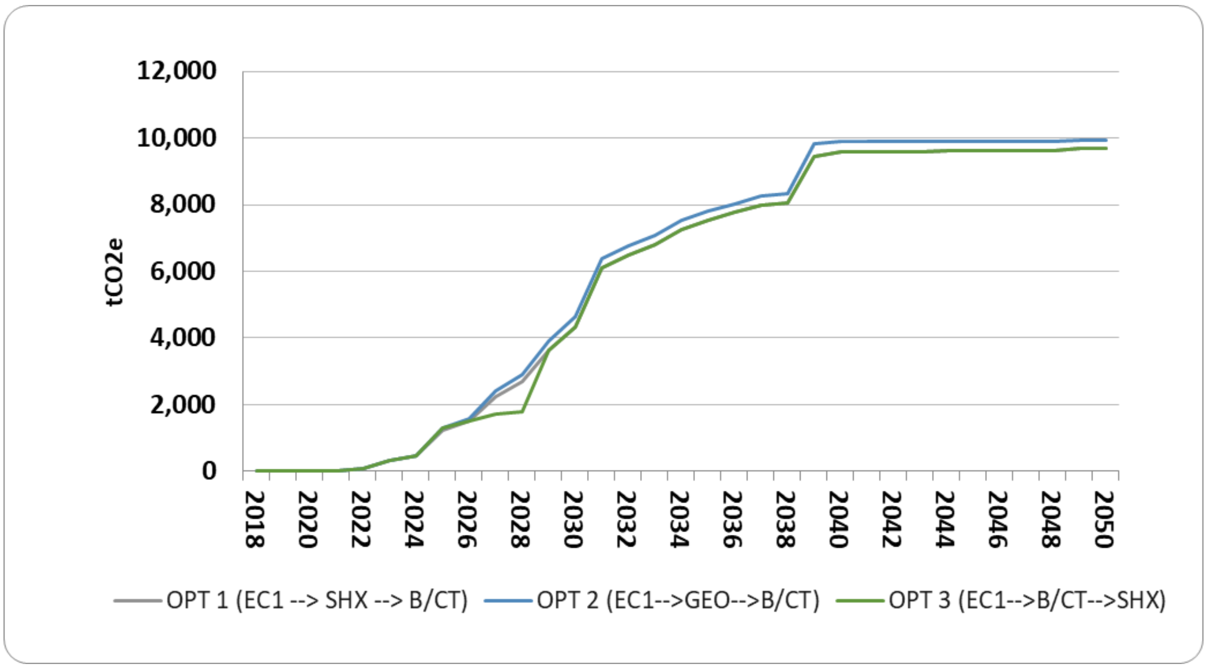


Figure 14: Greenhouse Gas Reduction over Time

The temporary small impact of advancing the peaking Energy Centre (#4) utilizing fossil fuel can be seen, especially through its expected timeline of maximized operation between 2026 and 2030. This temporary deviation is adjusted with the Sewer Heat Exchange Energy Centre coming online in 2030. The temporary loss of GHG emissions going forward with option 3 compared to option1 and 2 would be 1,326 and 6,888 tonnes of greenhouse gas emissions respectively. As can be seen in figure 15 the total cumulative GHG emission reductions over 25 years for options 1, 2 and 3 are 141,522, 147,114 and 140,226 respectively, with option 2 being the highest followed almost equally between option 1 and option 3, showing the small impact of the delay of the Sewer Heat Exchange Energy Centre for four years. Any further delay for the Sewer Heat Exchange Energy Centre project would extend the impact further.

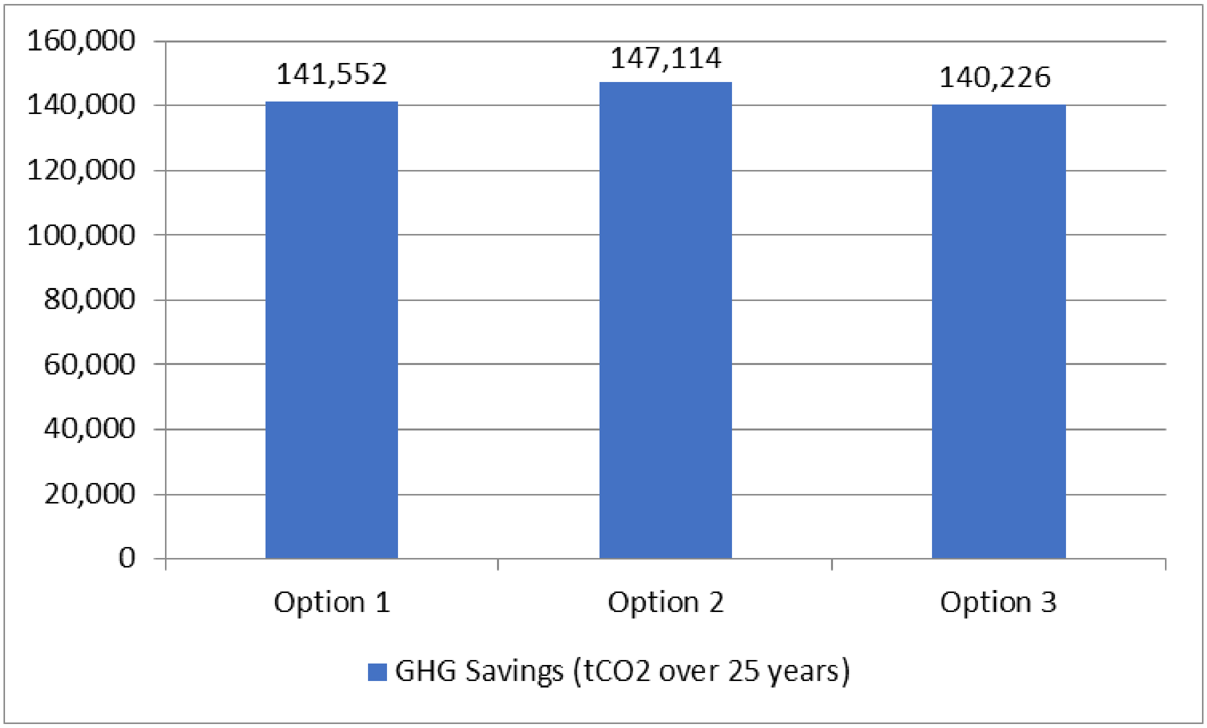


Figure 15: Total Greenhouse Gas Savings over 25 Years

The impact of renewable energy provision over time is shown in Figure 16. This figure shows the difference between providing renewable energy options earlier on , for example from the Sewer Heat Exchange or Geo-exchange Energy Centres, compared to the peaking Energy Centre utilizing fossil fuel, non-renewable energy. Similar to the drop in greenhouse gas reduction as a result of pulling ahead the Energy Centre #4, figure 15 shows the drop in renewables to the Blatchford Renewable Energy mix. It's important to note that the drop never goes below 57% and that it would increase right away in 2030 to the expected levels of close to 100% renewable energy provisions.

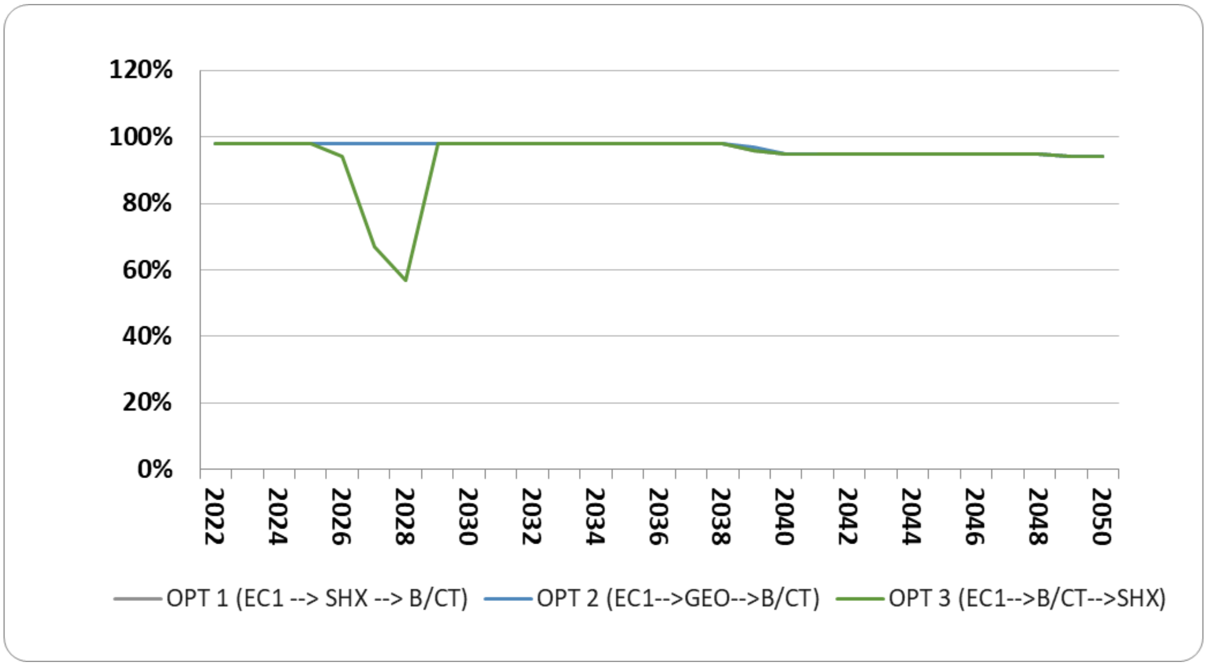


Figure 16: Provision of Renewable Energy Over Time

8.5. Impact of Development Pace

The project team also looked at the impact of the development pace on the present value of the project costs analysis. For that purpose a 25% faster and slower than anticipated development pace was assumed. Main finding is that option 3 continues to show the lowest present value across all three growth scenarios (fast, anticipated, slow). Comparing the slow, baseline, and fast development growth scenarios, we find that, in the slow scenario, the present value of option 3 decreases more than the other options—meaning it becomes more financially attractive the slower the development goes. Conversely in the fast scenario, the present value for option 3 increases more—tightening the gap especially between option 3 and 1.

Table 4: Comparative Present Value of Project Costs Analysis for all three Options (25% Slower Development Scenario)

($000's)	OPT 1 (EC1 → SHX → B/CT)	OPT 2 (EC1 → GEO → B/CT)	OPT 3 (EC1 → B/CT → SHX)
Energy Centres Capital PV	$73,049	$88,260	$70,023
Fuel, Operation & Maintenance PV	$13,522	$12,400	$13,625
Total PV EC Capital + O&M	$86,571	$100,660	$83,647

Table 5: Comparative Present Value of Project Costs Analysis for all three Options (25% Faster Development Scenario)

($000's)	OPT 1 (EC1 → SHX → B/CT)	OPT 2 (EC1 → GEO → B/CT)	OPT 3 (EC1 → B/CT → SHX)
Energy Centres Capital PV	$79,442	$94,622	$78,961
Fuel, Operation & Maintenance PV	$16,843	$15,777	$16,840
Total PV EC Capital + O&M	$96,285	$110,399	$95,801

9. Key Risk(s)

A detailed risk matrix and analysis was developed for this initiative. In tables 6,7 and 8 key risks categories and descriptions were rated and comments provided to compare between all three options. Only one high risk rating was found, based on the significantly higher capital costs of option 2. Appendix 1 includes the full risk matrix.

Table 6: Risk Matrix - Option 1

Risk description	Risk Rating	Comments
Environmental	Low	Achieves the objectives in the short and long run.
Economical/ Financial	Medium	Second most expensive option therefore increasing the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended energy output available.
Technology	Low	Proven technology however not alot of local project experience
Operational	Low	Anticipate short term higher operating costs attributed to developing operational procedures and getting to know what is required to operate.
Development Impact	Medium	Staging this facility would be challenging given the commitment required to divert the deep sanitary trunk which is a costly component of this facility.

Table 7: Risk Matrix - Option 2

Risk description	Risk Rating	Comments
Environmental	Low	Achieves the objectives in the short and long run.
Economical/ Financial	High	Most expensive option therefore increases the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended energy output available. Staging of the facility might be available to mitigate risk.
Technology	Low	Proven technology however will be challenging to fit all boreholes within the intended area. Mitigated through expanding into the park area which may lead to other implications.
Operational	Low	Utility currently operating a similar facility therefore minimal risk.
Development Impact	Low	Facility is able to be staged to align with the pace of development.

Table 8: Risk Matrix - Option 3

Risk description	Risk Rating	Comments
Environmental	Low	Achieves the objectives in the medium and long run.
Economical/ Financial	High	Least expensive option therefore reducing the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended. Can be staged to further mitigate.
Technology	Low	Standard technology conventionally and historically used for providing energy.
Operational	Low	Standard familiarity with many similar systems operated by the Utility.
Development Impact	Low	Facility is able to be staged to align with the pace of development.

10. Conclusion and Recommendations

10.1. Conclusion

In order to be able to continue to provide sustainable energy in alignment with the vision for Blatchford, BRE is currently working on its approach to plan and build its infrastructure for the next decade, based on an updated development and construction scenarios for the community. While this initially includes upgrading the existing Energy Centre One to provide energy for land development stages in Blatchford West which are anticipated to require services between now and 2026, this business case focuses on the planning and design of the Sewer Heat Exchange Energy Centre to provide energy for land development stages in the Blatchford Market Area which are slated to require services from 2026 on.

This business case focuses on the development of the Sewer Heat Exchange Energy Centre for two key reasons:

1. It is a new facility, and assumptions used within the initial business case from 2014 will need to be updated, and
2. Changes to external project conditions have occurred in the last years, mainly around reduced expected sewer flow to the facility in the future.

This business case also recognizes the increased financial pressure for the utility to close the initial funding gap that exists in its long term financial forecast, while utility growth continues.

Three distinct options were analyzed and reviewed from various angles in order to to determine the best way forward for Blatchford Renewable Energy:

- Option 1: Status Quo - Sewer Heat Exchange Energy Centre
- Option 2: Alternative - Geo-Exchange Energy Centre
- Option 3: Initial construction of peaking Energy Centre, in advance of the Sewer Heat Exchange Energy Centre

10.2. Recommendation

Based on the available information and data provided in this business case the recommendation is to advance option 3:

- Initial construction of peaking Energy Centre, in advance of the Sewer Heat Exchange Energy Centre

In comparison with the alternatives (option 1 and option 2), option 3 results in the lowest initial capital costs and hence provides some financial relief in the utility long term funding gap, while fully providing the necessary generation capacity to grow the utility customer base. Given the impacts of land development in Blatchford and the builder construction timelines on many external factors, option 3 also provides the best ability to adjust utility capacity to development and building construction, so flexibility in utility development can be maintained.

While option 3 temporarily deviates from the short term sustainability goals, the impact on GHG emission reduction and renewable energy production is relatively small and short lived as in the medium term, and with the future construction of the Sewer Heat Exchange Energy Centre these goals will be re-achieved and maintained. Additionally, the design work on the Sewer Heat Exchange Energy Centre up to this point is valuable information and will be utilized in the future when the construction of the Sewer Heat Exchange Energy Centre will continue.

As a result of this recommendation, a project budget ask totalling $15.3 million ($10.8 million base capital cost + 40% contingency) will be brought forward and is integrated in the 2023 to 2026 budget documents for Blatchford Renewable Energy. The planning and design portion of the project will be funded through the existing capital profile CM-83-8383 (Blatchford Renewal Energy Util P+D Growth) in the estimated amount of $0.6 million, resulting in a budget request of $14.7 million for the delivery of this project.

10.3. Project Resourcing and Implementation Strategy

If approved by Council the development of option 3 will follow the Project Development and Delivery Model (PDDM) as directed by City Policy C591- Capital Project Governance. This approach will ensure enhanced capital infrastructure project oversight. This process involved structured reviews of projects at key points (Checkpoint #1-5) throughout the Integrated Infrastructure Services project life cycle.

This model operates within a Develop/Deliver approach where teams work together through all phases of the project. A project management team has been established by the develop phase Project Sponsor and lead the project up to the completion of the Checkpoint #3. The deliver phase Project Sponsor has assigned an experienced project management team who are actively involved in supporting the project. Program Managers, Supervisors, Directors, Branch Managers are overseeing the project and involved when necessary. Project Manager provides reporting through the Project Management Information System (e-Builder) and the Building Edmonton - Capital Project Explorer.

The resources are available to review engineering design via Engineering Services in the Integrated Infrastructure Services department. The team will work together to ensure further reliability, design quality, accuracy, and transparency in estimates of budget and schedule for projects.

10.4. Project Responsibility and Accountability

Roles	Responsibilities
Profile Owner: • Blatchford Branch	• Budgeting for the profile by allocating and approving project budgets • Cash flowing for the profile • Tracking and reporting for the profile • Tracking funding sources for the profile • Prioritizing work within the profile • Variance Reporting for the profile • Accountable for outcomes of the program(s) within profile • Providing direction on project outcomes

Project Sponsor:
• Infrastructure Planning and Design
• Infrastructure Delivery
	• Providing direction for the execution of the project
	• Enabling appropriate budget to be available to complete the project
	• Assigning resources (people) for the project
	• Supporting achieving project objectives including
	  ○ Securing additional resources and budget
	  ○ Elevating Issues and removing barriers

Project Manager	Responsible for delivering the project, which includes duties related to management, communication, reporting, review and approval.
Consultants	Undertakes consulting and design work in accordance with the prescribed scope, standards, and specifications provided by the City of Edmonton
Contractors	Performs work in accordance with a project's plans and specifications.
Corporate Procurement and Supply Services Branch	Procurement services
Subject Matter Experts	Provide support to the project and review of key project deliverables

11. Review and Approval Process

11.1. Business Case Sign Off

The business case has been developed by the project team lead by the Blatchford Branch within the Integrated Infrastructure Services Department. The project team consists of members of the Facility Planning and Design section of Integrated Infrastructure Services (IIS), Financial Services and Utility Regulation Sections, and external support by a consulting team consisting of Associated Engineering and Pinchin. All project team members have participated in the project and have reviewed the documentation generated to develop the business case, as well as the business case itself.

Project Team Members

Name	Title	Section / Branch/Department	Signature
Tom Lumsden	Blatchford Development Manager	Blatchford/ Integrated Infrastructure Services	
Christian Felske	Director	Renewable Energy Systems/ Blatchford/ Integrated Infrastructure Services	
Daniel Alberkant	Engineering Program Manager	Renewable Energy Systems/ Blatchford/ Integrated Infrastructure Services	
Trevor Jarvis	General Supervisor	Facility Planning and Design/ Integrated Infrastructure Services	
Guangyu Men	Project Manager	Facility Planning and Design/ Integrated Infrastructure Services	
Jeff Olsen	Manager	Regulatory and Financial Strategies/ Financial and Corporate Services	
Irene Tan	Senior Accountant	Waste Services/ Financial and Corporate Services	

12. Appendices

The following pages identify suggested Value Management tools and reports to be incorporated into an actual business case

Appendix A Technical Memo for Business Case Analysis

MEMO

Date:	October 25, 2022	**File:**	2021-3975
To:	Christian Felske	**Page:**	Page 1 of 12
From:	Owen Mierke, P.Eng., Andrew Byrnes, P.Eng.		
Project:	Blatchford District Energy Sewer Heat Exchange		
Subject:	SHX Energy Centre Business Case Assessment		

The Blatchford Sewer Heat Exchange Facility (SHX Energy Center) Design Development has recently been completed and the City of Edmonton is progressing towards a checkpoint to decide on continuing with the next phase of the project. Accordingly, the City of Edmonton has requested an assessment of the business case for the proposed SHX facility as part of the Blatchford District Energy Sharing System, and to compare the proposed SHX Energy Centre to two (2) other viable technology options. This memo outlines our approach and the results of the analysis for alternative means of building out the Blatchford Renewable Energy Utility (BRE).

1 EVALUATION CRITERIA

The following three evaluation metrics were used for the evaluation of each option:

1. Net present value (NPV) of total cost over 25-years.
2. Total Greenhouse Gas (GHG) emissions over 25-years (and reduction compared to a natural gas baseline).
3. Operating cost of energy produced ($/kWh heating, $/kWh cooling).

Net Present Value

Yearly costs for each option over 25 years have been determined using the District Energy Sharing System (DESS) Masterplan Modeling tool (prepared by Associated Engineering (AE) and Pinchin). The model uses inputs such as land development parcel details, buildout timing, density, and energy use intensity estimates for Blatchford, as provided by the City of Edmonton. The model calculates the necessary energy centres capacity, cost, timing, energy delivery, fuel use, and GHG emissions across various DESS buildout options. The model also calculates capital, maintenance, and fuel costs of the full DESS energy centres portfolio over the buildout of the Blatchford project. Capital equipment replacements, energy transfer stations, and utility operational overheads are not included in the model.

Using the Masterplan Modelling tool, net present value (NPV) has been determined for each option. For only energy centre capital and fuel plus O&M are included in the comparison. Other utility costs such as equipment renewals, distribution piping system costs, utility administration overheads, and debt servicing expense are not included, but are assumed to be comparable under all three options.

NPV has been calculated using the City's required discount rate and inflation assumptions. A discount rate is used to discount future costs and is based on the owner's weighted average cost of capital. A discount rate of 6.3% has been provided by the City. Inflation of 2.35% per year has been assumed as requested by the City.

Contingency allowance was discussed with BRE, and it was agreed that contingency should not be included in this comparative analysis for any option since it would only inflate the costs equivalently across the options with no benefit to the analysis.

Carbon Emissions

Carbon emissions—and carbon emissions reductions versus a natural gas baseline—from each option has been compared to assess alignment with the City's objectives for a "net zero carbon community fueled by 100% renewable energy". Total GHG emission reduction numbers over 25 years have been determined for each option along with year by year carbon savings.

Operating Cost of Energy

The analysis has also determined year-by-year O&M cost in $/kWh for each option to compare to the established energy rates for the Utility. For economic viability of the Utility, it is important that the primary energy generation assets produce thermal energy (heating and cooling) with an operating cost that is less than the Utility's selling price of thermal energy. Electricity and gas rates paid by Blatchford Renewable Energy are escalated at 2% per year. Utility maintenance expenses are escalated at 2.35% per year—in line with the City's general inflation forecast.

These three metrics will allow the utility to compare the options based on project total cost, project financial viability within the existing rate structure, and alignment with sustainability vision for Blatchford.

2 OPTIONS EVALUATED

Three options have been evaluated to meet the future energy needs of the Utility within Blatchford and the Blatchford Market area which is considered the service area for the SHX Energy Centre. Utilizing the Blatchford DESS Masterplan modelling tool three Masterplan Scenarios were generated to model each of the options described below.

In all cases it is assumed that the current facility, Energy Centre 1(EC-1) full buildout is completed as planned (with 2 x 1MW heat pumps and 3x 1MW boilers) and with a final total capacity of 4.25 MW heating (includes N+1 redundancy) and 4.0 MW cooling.

In all options evaluated, the fourth, fifth, and sixth energy centres are assumed to be a size and type as per the current DESS Masterplan and constructed in their normally planned sequence.

2.1 Option 1 - SHX Energy Centre (BASELINE)

This option considers constructing SHX Energy Centre as the next energy centre for commissioning in 2026 as proposed in the SHX Energy Centre Design Development Report (Draft Issued September 2022). The proposed SHX energy centre has been evaluated with the following key attributes:

Table 2-1: Option 1 - SHX Energy Centre

Description	SHX EC
Peak Heating Capacity	**12. 1 MW**
Peak Cooling Capacity	**10.3 MW**
Annual Renewable Heating	**29,000 MWh**
Annual Cooling	**28,000 MWh**
Estimated Capital Cost*	**$32.23 million**

* Excluding engineering, construction manager fee, permits, city overhead, taxes, and contingency.

Subsequent energy centres EC-2, 3, 4, and 5 are constructed in sequence as per the DESS Masterplan baseline scenario.

2.2 Option 2 – Comparable Geoexchange Energy Centre

This option considers constructing an equivalent geoexchange-based energy centre as an alternative to the SHX Energy Centre. In this option, the geoexchange energy centre would have the same 12.1 MW peak heating, and 10.3 MW peak cooling capacity as the proposed (Option 1) SHX energy centre. In Option 2 the SHX energy centre would not be constructed. The cost estimate for the geoexchange energy centre was based on Energy Centre 1 actual costs scaled up to achieve a similar annual renewable heating/cooling energy delivery.

2.3 Option 3 – Boiler/Cooling Tower Energy Centre (Postponing SHX)

This option considers postponing the construction of the proposed SHX Energy Centre by 4 years and bringing forward the construction for a future (planned) Boiler and Cooling Tower 'peaking' Energy Centre (B/CT Energy Center) to meet the interim DESS load growth.

Under this option, boiler and cooling tower-based Energy Centre #4 (EC-4) – originally planned to be the third energy centre constructed – is brought forward as the second energy centre to be constructed. The SHX Energy Centre is therefore pushed back to be the third energy centre constructed. Energy centre EC-4 has a peak heating capacity of 7.1 MW and a peak cooling capacity of 11.3 WM which is sufficient to meet the expected DESS load growth during the interim period until SHX is constructed.

In this option, due to the possibility that the B/CT Energy Center (EC-4) will need to start construction prior to any suitable customer buildings being designed, it has been budgeted to be a standalone building. Options 1 and 2 assume the B/CT Energy Center (EC-4) will be built within the parking garage of a future customer building.

3 ANALYSIS

3.1 Modelling Inputs and Assumptions

The Blatchford DESS Masterplan Model (Prepared by AE and Pinchin, September 2022 version) was used to model the three utility buildout options described above. Blatchford buildout timeline, parcel statistics, and energy use intensities are as provided by the Blatchford Redevelopment Office's 2021 buildout forecast. The following key modelling inputs have been used:

Table 3-1: Modelling Inputs

Input	Value
Capital and maintenance expense escalation rate:	2.35%
Discount rate:	6.3%
Natural Gas Rate:	$1.79 / GJ
Electricity Blended Rate:	$58.10 / MWh
Escalation rate for ATCO gas and EPCOR electricity:	2.0%
Natural Gas GHG Intensity (all years):	0.180 tCO_2e/MWh
Electricity GHG Intensity (2022):	0.549 tCO_2e/MWh
Electricity GHG Intensity (2035):	0.268 tCO_2e/MWh

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3.2 Results Summary Matrix

Table 4-1 summarizes the NPV of capital cost, NPV of fuel plus O&M costs, and total GHG emissions savings over 25 years for the three options. Net present value of costs is presented with base year of 2020 (the first year of project construction).

Table 4-1
Results Summary Matrix

	OPTION 1 (EC1 --> SHX --> B/CT)	OPTION 2 (EC1-->GEO-->B/CT)	OPTION 3 (EC1-->B/CT-->SHX)
Energy Centres Capital NPV ($000's)	$75,466	$90,473	$73,028
Fuel, Operation & Maintenance NPV ($000's)	$14,941	$13,812	$14,992
Total NPV EC Capital + O&M ($000's)	$90,407	$104,286	$88,019
25-Year GHG Savings (tCO_2e)	141,552	147,114	140,226

Option 3 shows the lowest NPV of energy centre capital cost. This is largely due to the postponement of the significant capital investment associated with the SHX Energy Centre. Option 2 shows the lowest NPV of Fuel plus O&M costs due to the slightly higher efficiency and lower maintenance costs associated with Geoexchange Energy Centre versus SHX Energy Centre. Option 3 has the lowest Total (Capital + O&M) NPV.

3.3 Sensitivity to Development Schedule

For each option we have conducted a sensitivity analysis on the pace of Blatchford DESS load growth. Three load growth rates were evaluated:

1. **Fast - 25%** - faster rate of load growth than expected.
2. **Expected** - Based on the current DESS Masterplan load growth schedule.
3. **Slow - 25%** - slower rate of load growth than expected.

Changes in load growth rate can be caused by:

- Deviation in the assumed pace of land sales (likely equal to or slower than assumed).
- Deviations from the expected customer building sizes (may be higher or lower than assumed).
- Deviations from the expected customer building energy use intensities (likely equal to or higher than assumed).

The sensitivity analysis provides an assessment of the performance across this range of uncertainties.

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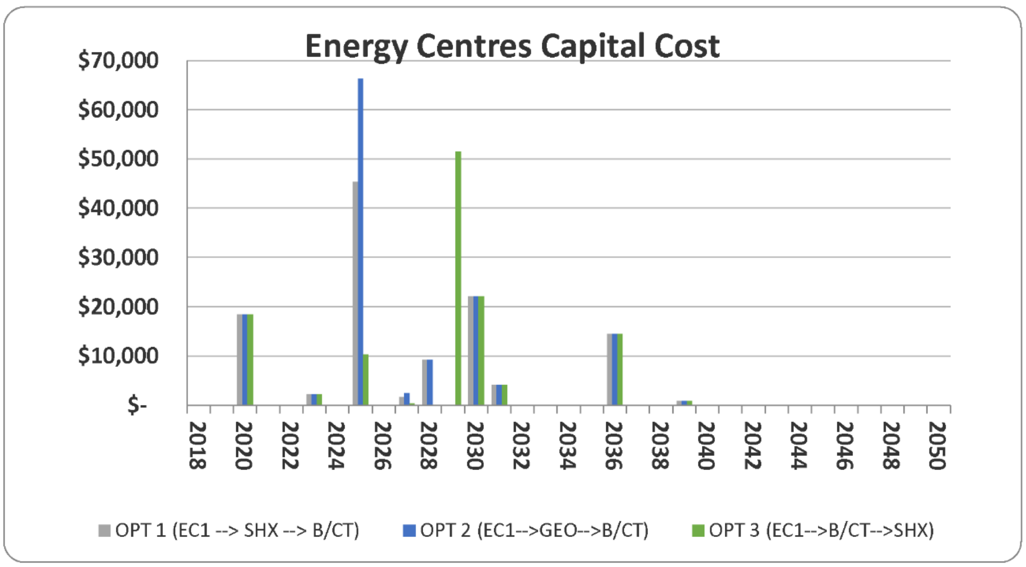
Under the Slow scenario, Option 3 still has the lowest Total NPV of $83.6 million and is $2.9 million Total NPV less than Option 1. Under the fast growth scenario, Option 3 again has the lowest total NPV of $95.8 million and is $0.5 million Total NPV less than Option 1.

The sensitivity results illustrate that if the development proceeds slower than forecast, Option 3 becomes a more financially attractive option. If the development proceeds faster than forecast, Options 3 and 1 become closer in Total NPV. Refer to **Appendix A** for the detailed summary of the results of the sensitivity analysis.

3.4 Capital Costs

The timing and capital cost of all energy centres (EC-1, SHX, 2, 3, 4, and 5) has been estimated for each option using the DESS Masterplan modelling tool. The expected magnitude and timing of capital expenditures for all energy centres is presented in the following figure.



All options include the same expenditure in 2020 (actuals for EC-1). Expenditures in 2025 – 2029 vary between the three options based on whether a SHX, Geoexchange, or Boiler / Cooling Tower type energy centre is constructed as the next energy centre. Future energy centres constructed in 2030 and beyond are identical in all three options.

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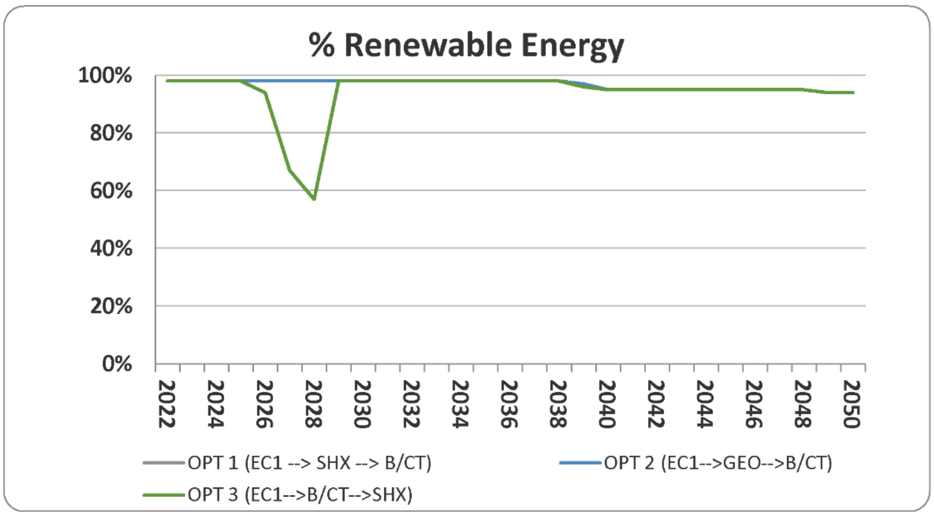
3.5 Carbon Emissions Impact

The Masterplan Model was used to estimate the "% Renewable Energy" being delivered by the Blatchford DESS every year under each of the three options. The year-by-year renewable energy performance is shown in the following figure.



All three options deliver similar overall renewable energy fraction at full buildout (94%). Option 3 relies on gas boilers for meeting a larger percentage of the DESS loads earlier in the system buildout and hence provides a lower '% Renewable Energy' from 2026 until 2029. Once the SHX energy centre is constructed in 2029, Option 3 can deliver the same overall renewable energy fraction as the other options.

Option 3 offers a lower cost approach, but with a temporary deviation from the City's renewable energy target. Measures such as renewable natural gas or biofuel purchases could be investigated to help close this temporary gap however would increase the operational costs.

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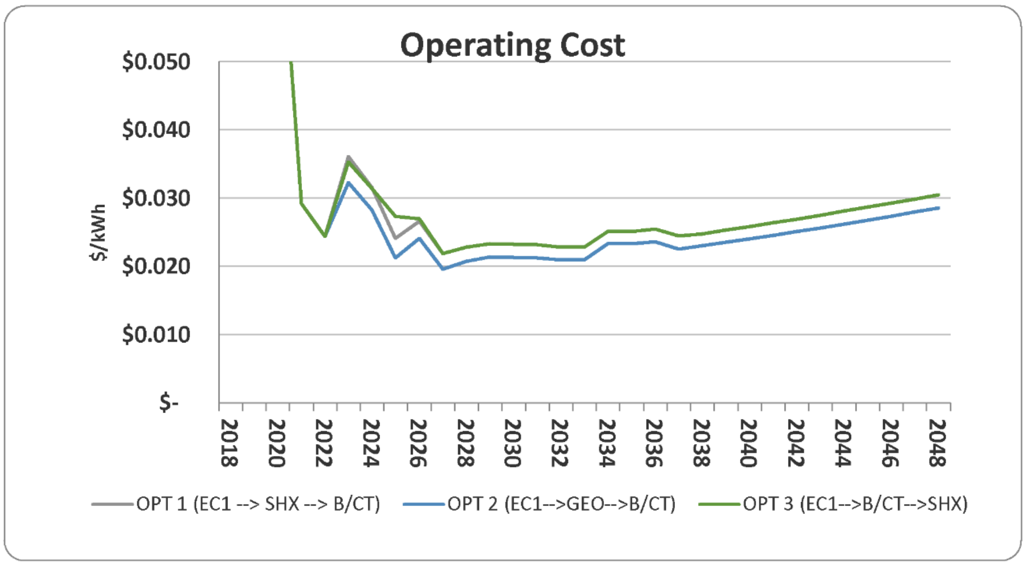
3.6 Operating Cost Comparison

Year-by-year fuel and O&M expenditures were estimated for each year using the DESS Masterplan Model and divided by the annual kWh of thermal energy delivered by the DESS. The year-by-year cost per kWh is presented in the following figure.



Operating costs in $/kWh are high early in the utility development because the amount of annual thermal energy sold is low in relation to the utility operating costs. As annual thermal energy sales grow, the operating cost in $/kWh declines. Over time, operating costs stabilize in $/kWh and escalate gradually with assumed inflation and fuel rate increases. All three options offer similar $/kWh cost profiles with Option 2 offering a slightly lower cost due to lower O&M and higher efficiency compared to SHX. A slight increase in $/kWh is seen in Option 3 between 2025 – 2029 due to the cost of natural gas fuel purchases for the boiler and cooling tower energy centre.

4 RISK

We have developed a risk matrix for each of the options with the following categories assessed:

- Environmental/ GHG: Utility's sustainability objectives of 100% renewable energy and GHG Emission reductions are reduced or delayed in achieving.
- Economical/ Financial: Utility financing capital without corresponding customer base therefore reducing utility income.
- Technology Risks: Energy generation technology risk and ability to serve the Blatchford Market Area.
- Operational Risks: Facility is challenging to operate and maintain given the equipment and processes installed.
- Development Impact: Challenge to stage the buildout of the facility to align with the pace of development growth.

Each option was assessed against each category summarizing the Risk Likelihood and Risk Impact to determine the Risk Score (Severity). The risk matrix for each option can be found in **Appendix B**.

Option 3 presented the lowest risk scores when evaluated against the five (5) risk categories given that it is fairly low in cost, provides a more conventional means of heating and cooling and is scalable to align with the pace of development and corresponding energy demand.

Option 1 had a medium financial risk score given that it is second highest in cost for the three options therefore increased risk of spending capital without a corresponding customer base. Option 1 also had a medium development impact risk score given the challenge of scaling the facility to align with the pace of development. The risk scores for the remaining (3) risk categories were considered low.

Option 2 had a high financial risk score given that it is considered the highest cost for the three options therefore increased risk of spending capital without a corresponding customer base. Option 2 risk scores for the other four (4) risk categories were considered low.

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5 CLOSURE

This memo was prepared for the City of Edmonton to summarize an assessment of the business case for the Blatchford District Energy Sharing System Sewer Heat Exchange. The services provided by Associated Engineering Alberta Ltd. in the preparation of this memo were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Yours truly,

Andrew Byrnes, P.Eng.
Project Manager, Alternative Energy (Pinchin)

Owen Mierke, P.Eng.
Project Manager

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MEMO

APPENDIX A – SENSITIVITY ANALYSIS – PACE OF DEVELOPMENT

Client	City of Edmonton	**Author**	AByrnes
Project #	0282549.000	**Revision**	1
Project Name	Blatchford SHX Energy Centre - Business Case Assessment	**Date**	21-Oct-22
Sheet Description	Results Summary Table		

Sensitivity Results Comparison

Slow (-25%), Baseline, Fast (+25%) Development Pace Scenarios

Table A-1: Blatchford Energy Centre Buildout Scenarios Comparison - FAST

($000's)	OPT 1 (EC1 --> SHX --> B/CT)	OPT 2 (EC1-->GEO-->B/CT)	OPT 3 (EC1-->B/CT-->SHX)
Energy Centres Capital NPV	$79,442	$94,622	$78,961
Fuel, Operation & Maintenance NPV	$16,843	$15,777	$16,840
Total NPV EC Capital + O&M	**$96,285**	**$110,399**	**$95,801**
25-Year GHG Savings (tCO_2e)	**164,019**	**168,249**	**164,045**

Table A-2: Blatchford Energy Centre Buildout Scenarios Comparison - BASELINE

($000's)	OPT 1 (EC1 --> SHX --> B/CT)	OPT 2 (EC1-->GEO-->B/CT)	OPT 3 (EC1-->B/CT-->SHX)
Energy Centres Capital NPV	$75,466	$90,473	$73,028
Fuel, Operation & Maintenance NPV	$14,941	$13,812	$14,992
Total NPV EC Capital + O&M	**$90,407**	**$104,286**	**$88,019**
25-Year GHG Savings (tCO2e)	**141,552**	**147,114**	**140,226**

Table A-3: Blatchford Energy Centre Buildout Scenarios Comparison - SLOW

($000's)	OPT 1 (EC1 --> SHX --> B/CT)	OPT 2 (EC1-->GEO-->B/CT)	OPT 3 (EC1-->B/CT-->SHX)
Energy Centres Capital NPV	$73,049	$88,260	$70,023
Fuel, Operation & Maintenance NPV	$13,522	$12,400	$13,625
Total NPV EC Capital + O&M	**$86,571**	**$100,660**	**$83,647**
25-Year GHG Savings (tCO2e)	**120,557**	**125,747**	**119,669**

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APPENDIX B – RISK MATRICES

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Risk Register

CP9255 Blatchford Sewer Heat Exchange - Business Case Development
Option 1: Status Quo - Sewer Heat Exchange Energy Centre

Risk Identification				Prior to Risk Response Risk Assessment			
Risk ID	Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Likelihood	Risk Impact	Risk Score	Comments
1	Development Design	Environmental	Environmental/GHG: Utility's sustainability objectives of 100% renewable energy and GHG Emission reductions are reduced or delayed in achieving	Rare(1)	Major (3)	Low	Achieves the objectives in the short and long run.
2	Development Design	Financial	Economical/Financial: Utility financing capital without corresponding customer base therefore reducing utility income	Likely (4)	Major (3)	Medium	Second most expensive option therefore increasing the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended energy output available.
3	Development Design	Technology / Equipment	Technology: Energy generation technology risk and ability to serve the Blatchford Market Area	Unlikely (2)	Major (3)	Low	Proven technology however not alot of local project experience, promoting reliability hence the unlikely rating for likelihood.
4	Development Design	Commercial	Operational: Facility is challenging to operate and maintain given the equipment and processes installed	Unlikely (2)	Moderate (2)	Low	Anticipate short term higher operating costs attributed to developing operational procedures and getting to know what is required to operate
5	Development Design	Commercial	Development Impact: Challenge to stage the buildout of the facility to align with the pace of development growth	Possible (3)	Major (3)	Medium	Staging this facility would be challenging given the committment required to divert the deep sanitary trunk which is a costly component of this facility.

Risk Register

CP9255 Blatchford Sewer Heat Exchange - Business Case Development
Option 1: Status Quo - Sewer Heat Exchange Energy Centre

Risk Identification				Prior to Risk Response: Risk Assessment			
Risk ID	Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Likelihood	Risk Impact	Risk Score	Comments
1	Development Design	Environmental	Environmental/GHG: Utility's sustainability objectives of 100% renewable energy and GHG Emission reductions are reduced or delayed in achieving	Rare(1)	Major (3)	Low	Achieves the objectives in the short and long run.
2	Development Design	Financial	Economical/Financial: Utility financing capital without corresponding customer base therefore reducing utility income	Likely (4)	Major (3)	Medium	Second most expensive option therefore increasing the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended energy output available.
3	Development Design	Technology / Equipment	Technology: Energy generation technology risk and ability to serve the Blatchford Market Area	Unlikely (2)	Major (3)	Low	Proven technology however not alot of local project experience, promoting reliability hence the unlikely rating for likelihood.
4	Development Design	Commercial	Operational: Facility is challenging to operate and maintain given the equipment and processes installed	Unlikely (2)	Moderate (2)	Low	Anticipate short term higher operating costs attributed to developing operational procedures and getting to know what is required to operate
5	Development Design	Commercial	Development Impact: Challenge to stage the buildout of the facility to align with the pace of development growth	Possible (3)	Major (3)	Medium	Staging this facility would be challenging given the committment required to divert the deep sanitary trunk which is a costly component of this facility.

Risk Register

CP9255 Blatchford Sewer Heat Exchange - Business Case Development
Option 2: Alternative - Geo-Exchange Energy Center

Risk Identification				Prior to Risk Response Risk Assessment			
Risk ID	Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Likelihood	Risk Impact	Risk Score	Comments
1	Development Design	Environmental	Environmental/GHG: Utility's sustainability objectives of 100% renewable energy and GHG Emission reductions are reduced or delayed in achieving	Rare(1)	Major (3)	Low	Achieves the objectives in the short and long run.
2	Development Design	Financial	Economical/Financial: Utility financing capital without corresponding customer base therefore reducing utility income	Almost Certain (5)	Major (3)	High	Most expensive option therefore increasing the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended energy output available. Staging of the facility might be available to mitigate risk.
3	Development Design	Technology / Equipment	Technology: Energy generation technology risk and ability to serve the Blatchford Market Area	Unlikely (2)	Major (3)	Low	Proven technology however will be challenging to fit all boreholes within the intended area (Storm Pond). Mitigated through expanding into the park area which may lead to other implications such as developable area or Municipal Reserve allocation.
4	Development Design	Commercial	Operational: Facility is challenging to operate and maintain given the equipment and processes installed	Unlikely (2)	Moderate (2)	Low	Utility currently operating a similar facility therefore minimal risk.
5	Development Design	Commercial	Development Impact: Challenge to stage the buildout of the facility to align with the pace of development growth	Unlikely (2)	Major (3)	Low	Facility is able to be staged to align with the pace of development.

Risk Register

CP9255 Blatchford Sewer Heat Exchange - Business Case Development
Option 3: Delay SHX and Construct Energy Centre 4 (B/CT Energy Centre)

Risk Identification				Prior to Risk Response: Risk Assessment			
Risk ID	Stage/Phase	Category (ERM or main impact type)	Risk Description (Event and Consequence)	Risk Likelihood	Risk Impact	Risk Score	Comments
1	Development Design	Environmental	Environmental/GHG: Utility's sustainability objectives of 100% renewable energy and GHG Emission reductions are reduced or delayed in achieving	Unlikely (2)	Major (3)	Low	Achieves the objectives in the medium and long run.
2	Development Design	Financial	Economical/Financial: Utility financing capital without corresponding customer base therefore reducing utility income	Unlikely (2)	Major (3)	Low	Least expensive option therefore reducing the magnitude of risk with respect to tied up capital should the development pace not align with the construction of this facility and intended. Can be staged to further mitigate.
3	Development Design	Technology / Equipment	Technology: Energy generation technology risk and ability to serve the Blatchford Market Area	Rare(1)	Major (3)	Low	Standard technology conventionally and historically used for providing energy.
4	Development Design	Commercial	Operational: Facility is challenging to operate and maintain given the equipment and processes installed	Unlikely (2)	Moderate (2)	Low	Standard familiarity with many similar systems operated by the Utility.
5	Development Design	Commercial	Development Impact: Challenge to stage the buildout of the facility to align with the pace of development growth	Unlikely (2)	Major (3)	Low	Facility is able to be staged to align with the pace of development