TOWN OF HALTON HILLS

REPORT

REPORT TO: Mayor Bonnette and Members of Council

REPORT FROM: Michael Dean, Senior Climate Change & Energy Planner

DATE: November 13, 2020

REPORT NO.: ADMIN-2020-035

RE: Low Carbon Design Brief for Town Hall

RECOMMENDATION:

THAT Report No. ADMIN-2020-035 dated November 13, 2020 regarding the Low Carbon Design Brief for Town Hall be received;

AND FURTHER THAT Council endorse Pathway 2 – Geothermal option as described in this report;

AND FURTHER THAT the new projects identified for Pathway 2 in the amount of $2,654,000 be included in the 2021 Capital Budget and 2022-2030 Capital Forecast for review by Budget Committee as set out in this report.

BACKGROUND:

The 2019 Corporate Energy Plan recommended that the Town develop a series of 'Low Carbon Design Briefs' (LCDB) which would provide a clear pathway to achieving net-zero carbon in Town facilities through staged implementation of retrofits and renewable energy projects. The creation of the LCDBs represents a new approach to facilities planning which allows the Town to coordinate new and planned capital upgrades in order to achieve energy and carbon reduction targets over a number of years. The Town of Halton Hills is part of a small, but growing number of municipalities taking this approach to transforming exiting buildings into net-zero carbon facilities.

The Low Carbon Design Brief for Town Hall (appendix 1), prepared for the Town by Internat Energy Solutions, is the first such study. In addition to providing a pathway for achieving net-zero carbon over time at the Town Hall, it also serves a proof-of-concept for the LCDB approach, which will be applied to all Town facilities.

COMMENTS:

Project Overview

Staff selected the Town Hall as the first facility to undergo a LCBD analysis for a number of reasons: major end-of-life equipment replacements, for example the building's heat pumps and make up air unit, provided an opportunity to integrate the net-zero pathway with planned improvements; as a high profile facility which serves as a main point of contact between the Town and the community, there is an opportunity to clearly convey the Town's commitment to its climate change goals by achieving net-zero in this facility; and, the Town Hall is the 5th largest emitter among the Town's facilities. LCBDs are also underway for Mold-Masters SportsPlex and Acton Arena which, when completed, alongside the Town Hall LCBD will cover 53% of the Town's total emissions from Facilities.

The Town Hall LCBD outlines four 'pathways' for energy efficiency and renewable energy projects at the Town, It is recommended for the Town to pursue Pathway 2: Geothermal, which involves an overhaul of the building's central heating and cooling plants to incorporate a geothermal exchange-based system. The existing heat pump hydronic loop will remain in place. Improvements to building automation and controls, as well as building envelope retrofit work will be included.

This approach has several advantages. It utilizes a renewable and passive source of energy and allows for the complete electrification of the site, the Town has experience with the implementation and operation of these systems in other buildings which will serve as an advantage. Although Pathway 4 is slightly more attractive from a financial perspective, key advantages to Pathway 2 over Pathway 4 include a lower associated residual value (decommissioning of building equipment before end of useful life), a less complex design and implementation process, and decreased staff impact. The anticipated impacts of Pathway 2 are summarized in table 1 below.

Table 1 Summary of Pathways Evaluated in LCDB

Pathway	Description	Total Construction Costs	Annual Energy Costs (present value)	Annual Energy Consumption	Annual GHG Emissions	Net Present Value	Internal Rate of Return
		$CAD		ekWh	$kgCO_2e$	$CAD	-
1	Optimize Existing	$3,220,900	$81,305 (21%↓)	596,240 (30%↓)	35,167 (45%↓)	$422,238	3.7%
2	Geothermal	$3,559,200	$86,972 (16%↓)	511,601 (40%↓)	10,232 (84%↓)	($25,697)	2.4%
3	HVAC Overhaul	$3,311,500	$90,490 (12%↓)	532,292 (37%↓)	10,646 (83%↓)	$30,383	2.6%
4	Maximum Savings	$3,815,100	$83,691 (19%↓)	494,298 (42%↓	9,846 (85%↓)	$59,818	2.7%

Process summary
In May 2020, the Town of Halton Hills hired Internat Energy Solutions (IESC) to complete a LCDB for Town Hall. The initial stage of the project involved collecting detailed background information on the existing facility and planned capital projects and conducting a site visit to gather additional information about the building.

Building Energy Modeling
The data gathered during this phase was used to develop an energy model for the building. Energy modeling is the virtual or computerized simulation of a building (or site) that focuses on energy consumption, utility bills, and life cycle costs of various energy related items such as air conditioning, heating, lights, and domestic hot water. By creating the energy model the consulting team was able to clearly understand the energy uses at the facility and evaluate potential approaches to net-zero.

With the building model developed, IESC used parametric modeling and optimization to evaluate potential energy and emission reduction measures. In parametric simulations, rather than one static value for a design variable, a range of values are programed into the energy model. Applying these ranges across a set of design variables allows one to see the impact of each individual variable, or energy efficiency measure, both in isolation and in combination with any other measure, on pre-selected performance outcomes, such as annual energy use. These designs can then be used to assess the cost or impact of the various combinations of design options. In short, parametric simulations expose the full range of performance potential and performance risk of a particular building design. A visualization map (or parallel coordinates plot), produced from the resultant building performance simulations, offers a way of including energy design modeling directly in the design and decision-making process.

Another energy modeling technique that is frequently used to analyze high level design decisions is referred to as optimization. This type of study is slightly more refined than parametric studies, and typically includes the analysis of up to 10 design variables. The optimization algorithm efficiently searches for and identifies the design options that best meet the key design performance objectives defined by the user such as “minimize construction costs” and minimize carbon emissions.” Unlike parametric studies, in optimization studies it is often not necessary for the entire simulation to be performed as the algorithm “learns” how the design variables affect the design objectives and automatically eliminate “non-optimal” designs. This process becomes useful when key design variables are identified, and a more efficient simulation process is required.
Development of Retrofit Pathways

Once a complete understanding of the facility and its operations was obtained from the on-site work, data review, and baseline energy modeling, IESC held several internal brainstorming sessions, identifying all possible energy conservation measures (ECM), and renewable energy measures (REM) that could contribute to reaching the performance goals. The initial combination of these ECMs formed the basis of the four retrofit pathways that are presented in this report. IESC worked with sub-consultants and Town staff to determine the most appropriate design options for the energy

conservation measures outlined in each Pathway. From there, IESC worked with the Town in continuous communication and several review meetings, to obtain feedback and additional considerations with respect to the identified energy conservation measures and overall Pathways to ZCB certification.

Lifecycle Cost Analysis

IESC completed lifecycle cost (LCC) analyses for each of the retrofit Pathways identified. LCC analyses allow for the evaluation of the economic performance of a project, typically for the duration of its projected lifetime, taking into account the time value of money and various cash-flows in each year.

In the case of this design brief, where projects are expected to be completed over a 10-year time period, the LCC analysis has been initiated in year 10, when all projects have been implemented. It has been assumed that the total project cost will be incurred in year 10, as well as the total amount of operational cost savings. A 20-year projection has been analyzed in the LCC analyses, as a requirement of the Town is that a financial return be achieved within 20 years of project implementation.

In reality, there will be incremental costs and savings seen from year 1 to year 10 (10-year implementation period), with the total savings being realized after all projects are completed in year 10. Although high level project scheduling has been proposed, at this stage a detailed project implementation schedule cannot be assumed for LCC analysis purposes, which is why the above strategy has been used. The following costs and savings have been considered in each LCC analysis:

- Capital costs
- Building certification costs
- Operations & Maintenance (O&M) costs
- Replacement costs
- Utility cost savings
- Greenhouse gas (GHG) emissions savings
- Potential funding and incentive programs available
- An annual escalation rate applied to each energy utility:
- Discount rate of 2.5%

The Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated for each option.

Recommended Pathway: Pathway 2 – Geothermal

This pathway to ZCB certification involves an overhaul of the building's central heating and cooling plants to incorporate a geothermal exchange-based system. The existing heat pump hydronic loop will remain in place. Improvements to building automation and controls, as well as building envelope retrofit work will be included.

A detailed description of measures is included in the attached report (Appendix A). The measures required for this retrofit pathway are summarized below.

- Replace all existing units with new insulated glass units (IGU), or curtain wall façade
- Install Building Automation System (BAS) equipped with various controls including Central plant monitoring and control, Zone temperature and humidity monitoring and control, Lighting control (ON/OFF scheduling), Occupancy sensor-based control system.
- Replace all existing lighting systems, fixtures/lamps with their LED equivalent
- Install EnergyStar rated appliances and office equipment
- Installation of a carport solar photovoltaic (PV) system in the existing outdoor parking lot with a total capacity of 190 kW
- Install geothermal system and borehole field to provide heat rejection/absorption to existing heat pump loop
- Existing heating boilers and cooling tower to be used as backup for geothermal system
- Replace existing MUA with a water source heat pump unit to be integrated into existing heat pump loop, and geothermal loop
- Replace all water source heat pumps with high efficiency units
- Replace existing gas fired DHW heater with a hybrid heat pump water heater

Implementation, Scheduling and Logistics

First stage (Years 1 to 5)

- Capital projects already planned:
  - MUA replacement
  - BAS installation
  - Water source heat pump replacement with high efficiency units
- Other recommended project implementations:
  - replace all existing Window units with new high-performance insulated glass units (IGU)
  - Replace all existing lighting systems, fixtures/lamps with their LED equivalent, and install EnergyStar rated appliances and office equipment

Second stage (Years 6 to 10) – Target ZCB Certification

- Central plant: Install geothermal system and integrate into existing hydronic heat pump loop
- Domestic hot water (DHW): replace existing gas fired heater with a hybrid heat pump water heater
- Renewable energy systems: Installation of a carport solar photovoltaic (PV) system in the existing outdoor parking lot

Discussion

Pathway 2 provides best outcome with lowest number of logistical barriers to execution. While pathways 3 and 4 have a higher NPV, and pathway 4 has a slightly higher GHG reduction, both involve significant interventions in the existing HVAC system to replace the existing hydronic loop system with a VRF system.

Advantages:

- Use of existing building distribution network (heat pump hydronic loop)
- Potential for full site electrification
- Ability to tie in with capital projects already planned

Disadvantages:

- Implementation time and complexity (geothermal borehole field)

While pathways 3 and 4 provide superior NPV and pathway 4 also provides slightly higher GHG savings and energy reductions, staff are not recommending these options due to their complexity and the level of disruption to building operations required for such a significant rebuild of the existing HVAC system.

The Town is also undertaking a Town Hall Master Plan to determine how to meet future space needs for the facility. While an expansion of the existing Town Hall has been evaluated, at the time that this report was produced no decision had been made on whether to move ahead with the construction of additional floor space. As a result, the LCDB has been designed to be implementable regardless of any future expansion to the facility.

The potential expansion of the Town Hall during the 10-year retrofit plan, would have an impact on several aspects of design and project implementation. The first consideration, involves the potential renewable energy systems that may result with a building expansion. The need for additional parking spaces with the increased occupancy of the building may create the need for the construction of a new parking structure on the site, which would present the opportunity for additional PV capacity and system installation. In addition, the expansion has been discussed as taking place on the southeast portion of the building, which encompasses the curtainwall section. This presents the opportunity to re-design this façade of the building and open the discussion to building integrated photovoltaics (BIPV) to replace the curtainwall.

Upon building expansion, it is likely that the new section of the building will have a standalone HVAC system, isolated from the systems in the original building. If the building expansion took place simultaneously as a combined project with an HVAC system retrofit, it would be possible to integrate the two systems. However, if the expansion is completed before or after the main building's HVAC system retrofit, it would force the systems to have to be sized and designed independently.

The above considerations are unlikely to be a significant barrier to implementation. Because the renewable energy systems would be implemented in the second half of the period to 2030, it is likely that any impact from a potential building expansion would be known before the projects were initiated. The approach to retrofitting the HVAC system will be determined as potential for a future building expansion is understood in greater detail. Most of the efficiency projects recommended in pathway 2 would be undertaken regardless of the expansion.

Project Funding

The costs associated with the projects identified in the LCDB over 10 years total $3,560,000 as listed in Table 3 below. [1]

Table 2 Low Carbon Design Brief Pathway 2 Capital Projects

Item	$CAD
Replace Heat Pumps and MUA	$353,000
Building Automation System	$495,000
Window and entrance replacement	$557,000
Ceiling Finishes	$58,000
Replace DHW Heater	$19,000
Lighting, devices, heating	$606,000
Fittings and Equipment	$34,000
Geothermal System	$444,000
Carport PV Arrays	$994,000
Total	**$3,560,000**

Out of the total $3,560,000, $906,000 of Town Hall related projects have already been identified in the 9-year capital forecast (2021-2029) approved in principle as part of the 2020 budget process. As a result, an additional funding of $2,654,000 required in order to implement the Pathway 2 program between 2021 and 2030. Accordingly, it is recommended that the new projects identified for Pathway 2 in the amount of $2,654,000 be included in the 2021 Capital Budget and 2022-2030 Capital Forecast for review by Budget Committee.

Staff will continue to investigate external funding opportunities, including incentive programs available through Utilities and Capital Projects stream of the Green Municipal Fund.

The Town has also recently established an Energy Revolving Fund intended to reinvest reduced utility costs from energy efficiency projects into new projects. Any savings arising from the energy efficiency related projects in the first 5 years of the LCDB program will be deposited into this reserve and utilized for the financing of the LCDB program.

Further, a growing number of organizations, including Enbridge and others, are offering geothermal energy utility services. These geothermal utility providers cover the design, installation, and maintenance costs associated with the installation of geothermal systems. The facility owner enters into an agreement to pay a monthly fee for a certain period, typically 10-20 years – with a buy-out option. The advantages of pursuing a geothermal utility model are:

- No up-front capital costs

[1] costs estimates derived from LCDB report have been rounded to the nearest thousand

- Reliable cost structure
- Not responsible for system performance and maintenance

Town staff are investigating the feasibility and financial implications of working with a geothermal utility to complete the design and installation of the proposed geothermal system.

RELATIONSHIP TO STRATEGIC PLAN:

By reducing energy consumption and GHG emissions associated with Town facilities and advancing the Corporate Energy Management Plan, the recommendations in this report support the achievement of the Town's climate change mitigation goals and thus are aligned with a key strategic priority as set out in the Town's Strategic Plan.

FINANCIAL IMPACT:

As discussed above, total new capital expenditures associated with the Pathway 2 program are $2,654,000. The projects identified in this report have been included in the 2021 Capital Budget and 2022-2030 Capital Forecast and funded from the Capital Replacement reserve in principle for review by Budget Committee. Following the approval of the 2021 budget, if and when any external funding materializes from the staff investigations as noted above, the program funding will be adjusted and reported to Council.

CONSULTATION:

Staff consulted with members of the Low-Carbon Transition Steering Committee and the Corporate Energy Management Team, as well as staff from Finance and Facilities at various times throughout the development of this report.

PUBLIC ENGAGEMENT:

No public engagement was conducted as part of this project

SUSTAINABILITY IMPLICATIONS:

The Town is committed to implementing our Community Sustainability Strategy, Imagine Halton Hills. Doing so will lead to a higher quality of life.

The recommendation outlined in this report advances the Strategy's implementation.

This report supports the environmental health pillar of Sustainability and in summary the alignment of this report with the Community Sustainability Strategy is Excellent.

COMMUNICATIONS:

Successful implementation of the recommendations in the LCDB will require buy-in from the facility users, primarily Town Staff. As a result, the planned projects and any anticipated impacts on user experience of the facility should be communicated throughout the organization. In addition, , the LCDB should be used as a demonstration

project to communicate to the Halton Hills community an innovative approach to achieving net-zero in an existing building and a clear demonstration of the Town's commitment to taking action on climate change within its own operations.

CONCLUSION:

The LCDB has provided a clear pathway to achieving net-zero carbon in one of the Town's highest profile facilities. Furthermore, it sets a model which can be followed to achieve net-zero in other facilities, an essential component of the overall Corporate Energy Plan and corporate GHG reduction goals.

By implementing the recommendations in the LCDB the Town will make significant steps towards achieving this vital component of the Low Carbon Transition Strategy and will demonstrate leadership in climate change mitigation both within the Halton Hills community and to municipalities pursuing similarly ambitious climate action.

Reviewed and Approved by,

Dharmen Dhaliah, Senior Manager of Climate Change and Asset Management

Richard Cockfield, Director of Strategic Planning

Chris Mills, Acting Chief Administrative Officer