Policy Analysis and Rationale - '40-40-80' Above Code Energy Performance and 1% Dedicated Project Capital On-Site Energy Generation

Jurisdiction Scan

City of Edmonton is one of few major Canadian cities that has historically included an energy performance standard for new City buildings. The City of Toronto under the Toronto Green Standard requires all new large buildings in their city to achieve at least 15% better than the provincial energy code which references the 2011 National Energy Code for Buildings. City of Vancouver intends to implement its Zero Emissions Building Plan which will require its new municipal buildings to meet passive house standards and or use only low carbon fuel sources when viable, starting in 2018.

City-owned buildings / New Construction – Above Code Energy Performance

The existing City Policy C532 requires new City buildings to be built at minimum 30% better than the non-mandatory 1997 Model National Energy Code for Buildings (MNECB). As of November 1, 2016, the 2011 National Energy Code for Buildings (NECB) has been adopted by the Alberta Building Code and became mandatory.

Two separate studies were commissioned as part of this project to help inform the review and update of the Policy's above-code energy performance policy standards for new construction of City buildings. They were conducted by the consulting firms Morrison Hershfield and Perkins + Will.

Morrison Hershfield Study Findings and Recommendations

Morrison Hershfield provided a retrospective energy modeling and cost benefit analysis for five typical City building archetypes including: a library, a recreation centre, a police station, a low rise administration building and a fire hall**.** These building types cover two-thirds of the City-owned building portfolio by number;

The study found recently built new City buildings have been designed to achieve (Figures 1 and 2):

- 28% to 42% better energy savings than the mandatory 2011 NECB baseline;
- 27% to 39% better GHG savings than 2011 NECB baseline (an indicator not regulated by NECB); and

- 61 kWh/m2 to 113 kWh/m2 for annual heating demand (an indicator of the performance of the building envelope and ventilation system – not currently regulated by NECB).

Based on this analysis, the study recommended that the City of Edmonton adopt a new three-metric energy performance standard:

- 50% Energy Reduction over 2011 NECB;
- 50% Greenhouse Gas Emissions Reduction over 2011 NECB; and
- A maximum annual heating demand of 50 kWh/m2/year.

The analysis indicated that there are a wide range of design options that can meet the proposed new requirements, with varying levels of incremental capital cost and lifecycle cost benefit depending on the solution (Table 1).

Table 1: Expected results of a "50-50-50" Policy

		Expected Typical Economic Impact		
	Minimum Expected GHG Emissions Reduction (Over Current Practice	**Range of Incremental Capital Cost**	**Minimum Simple Payback (based on minimum Incremental Capital Cost) (Years)**	**NPV Cost Savings based on Minimum Simple Payback***
Fire Hall	25%	0.9% to 6.7%	18.4	0.3%
Administration	18%	0% to 6.5% (with boilers) 6.9% to 16.5% (with ground source heat pump)	0	1.4%
Recreation Centre	35%	1.4% to 4.1%	7.9	2.8%
Library	28%	0% to 3.5% (with boilers) 4.0% to 9.1% (with ground source heat pumps)	0	2.7%
Police Station	30%	1.7% to 7.8%	13.9	1.3%
*NPV cost savings = (B-A)/A X 100%, whereas A = Incremental Capital Costs of Energy Efficiency Measures and NPV of added O&M cost if any over a 30 year period; B = NPV of energy and carbon cost savings over a 30 year period.				

Perkins + Will Study Findings

A second study, conducted by the engineering consulting firm Perkins + Will provided two additional schematic designs derived from a new proposed City building currently under design. This building type is representative of one-third of the City-owned building portfolio by number.

The study involved a mixed administration and industrial building that was very difficult to optimize for energy performance due to the large service bay area with a large number (17) of rolling overhead bay doors that account for 11% of the fenestration and door to wall ratio (FDWR). The large surface area covered by the overhead doors plus the need to sufficiently heat large service bay during the winter made it very difficult to achieve even 20% above 2011 NECB. These findings validated the City's experience on past projects of similar archetypes such as EcoStations.

Table 2: Results of Perkins + Will Schematic Design Study for a mixed office and industrial building

Scenario	Energy Savings (compared to current Code requirements	GHG Savings (compared to current Code requirements)	Annual Heating Demand (kWh/m2/yr)	Incremental Capital
Original Design*	-10%	-7%	134	0%
20% Above 2011 NECB	20%	18%	100.1	3.3%
40% Above 2011 (interpolated)	40%			5 to 6.2%*
Net Zero Energy	64.4%	32% (without solar PV) 101% (with solar PV)	56.6	9.7%(without solar PV) 14.7% (with solar PV)
* The original design did not meet the new mandatory energy code because it was produced prior to the code coming into force. The 5.4% is interpolated assuming current practice would meet the new code; and the 6.4% was interpolated based on incremental capital to achieve 40% better than code from the original schematic design cost estimate.				

For the Net-zero site energy design (with solar PV), the incremental capital cost impact was 14.7%, of which approximately 4.9% was attributed to the solar PV and the remaining 10% largely attributed the ground source heat pump and an enhanced building envelope.

Rationale for Annual Heating Demand as a Metric

The annual heating demand metric (expressed as kilowatt hours per square meter) is aimed at achieving a durable building envelope that is resilient to climatic conditions. The lower the annual heating demand, the lower the energy consumption requirement for heating and cooling a building. From a lifecycle perspective, the lower the annual heating, the lower the risk of future fuel price volatility.

To achieve a low carbon future, buildings will ultimately need to achieve an annual heating demand of closer to 15 to 30 kilowatt hours per square meter (also known as passive house standards). Climatic conditions and high building ventilation needs (e.g. to address high humidity levels within a recreation centre) can greatly impact the building envelope's ability to achieve a low annual heating demand.

This metric is well-known and used to regulate new building construction in many parts of Europe. But is still a fairly new concept to the local building industry. City of Vancouver is the only Canadian jurisdiction that aims to implement an annual heating demand standard (via a requirement to achieve passive house standards) for its new City-owned buildings by 2018.

Stakeholder Consultation

Approximately two dozen local subject matter experts assisted in the evaluation and selection of the energy and carbon performance standards contained in the updated Policy. They included experts from various architectural, building sciences / engineering and energy modeling firms, and University of Alberta (Department of Mechanical Engineering). Most of them had worked with the City of Edmonton on previous building projects.e The following is a summary of their feedback on the three-metric energy performance standards:

- Nearly all participants expressed support for the general direction of the three-metric approach for ensuring new City buildings are built to a high, energy performance standard. They also agreed it was important for the City to lead-by-example in City buildings in order to build local capacity for sustainable building design.
- The majority of participants were supportive of the first two proposed standards (e.g. 50% better than 2011 NECB in terms of energy and 50% better than 2011 NECB in terms of GHG reductions). However, many had concerns with the building envelope metric of maximum 50 kilowatt hour per square meter for annual heating demand. Their concern stemmed mainly from a lack of familiarity with the metric. While participants felt the metric would be achievable for certain building types (e.g., administration building or libraries), they also felt it would be more aggressive for others

such as (e.g. fire halls, recreation centres, and industrial buildings). However, most agreed that a good balance between energy performance and architectural desire outcomes could be achieved with appropriate expertise.

- Role and responsibilities of the energy modeller or consultant need to be elevated within the project delivery model if the City wants to enable these subject matter experts to more effectively steer the design to be more mindful of energy performance throughout the design process.

Project Working Group Recommendations

Consensus was not reached amongst the project working group regarding the Morrison Hershfield's recommended 50-50-50 standard. Their lack of support stemmed mainly from uncertainty about the capital cost impact, and their lack of experience in implementing these high standards to an actual project. The Project Working Group also agreed that the third metric on annual heating demand was a new concept to the local building industry, and it would take time for capacity building. They recommend that steps first be taken to familiarize the industry with the metric, prior to aggressively restricting it.

Based on the above rationale, the Project Working Group recommended that the City adopt the following modified version of the consultant-recommended 3-metric energy performance standards:

- Minimum 40% better energy savings above 2011 NECB;
- Minimum 40% better GHG savings above 2011 NECB; and
- Maximum 80 kwhr/sq.m for annual heating demand for all building types except for office buildings which will have a maximum of 50 kwhr/sq.m.

These recommendations will position the City of Edmonton at a strong starting point to meet the Net Zero Ready 2030 target for new building construction within the Pan-Canadian Framework on Clean Growth and Climate Change (that was adopted in late 2016 by all territories and provinces). To stay on the trajectory to meet and exceed the Net Zero Ready 2030 target and to always exceed the minimum energy code of the day, the Project Working Group will regularly review and update these energy performance standards.

From the strategic perspective of leading by example and more aggressively moving toward an ultimate Net Zero target for new buildings, a stronger case can be made for adopting the 50-50-50 standards as proposed.

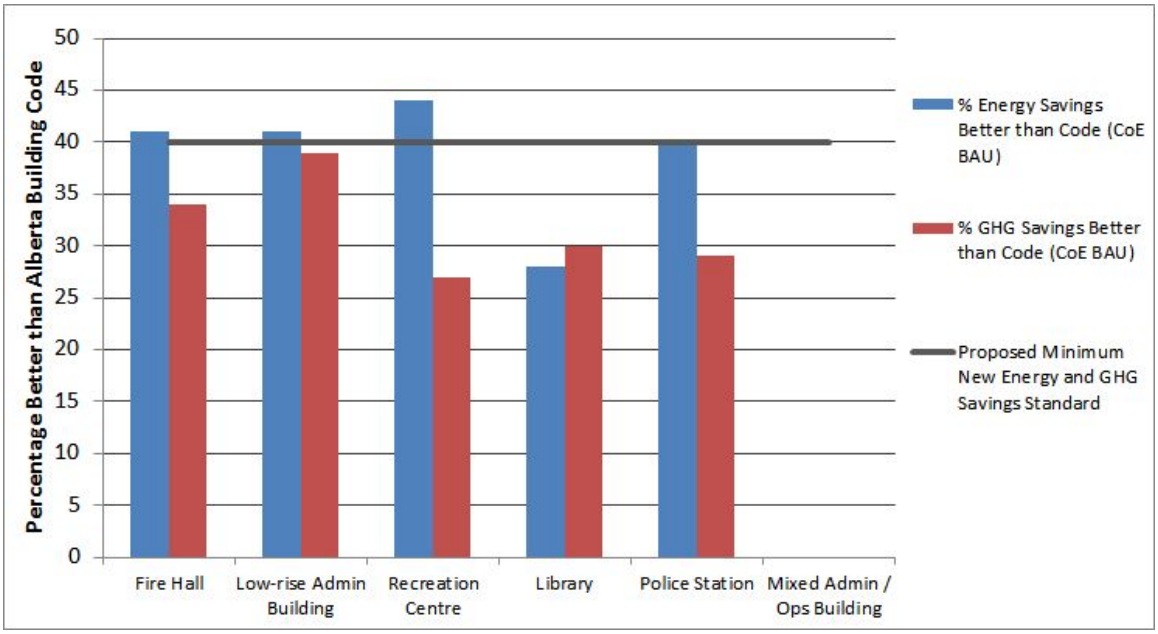


Figure 1: Energy and GHG savings above Code - Current Practice versus Proposed New Standard

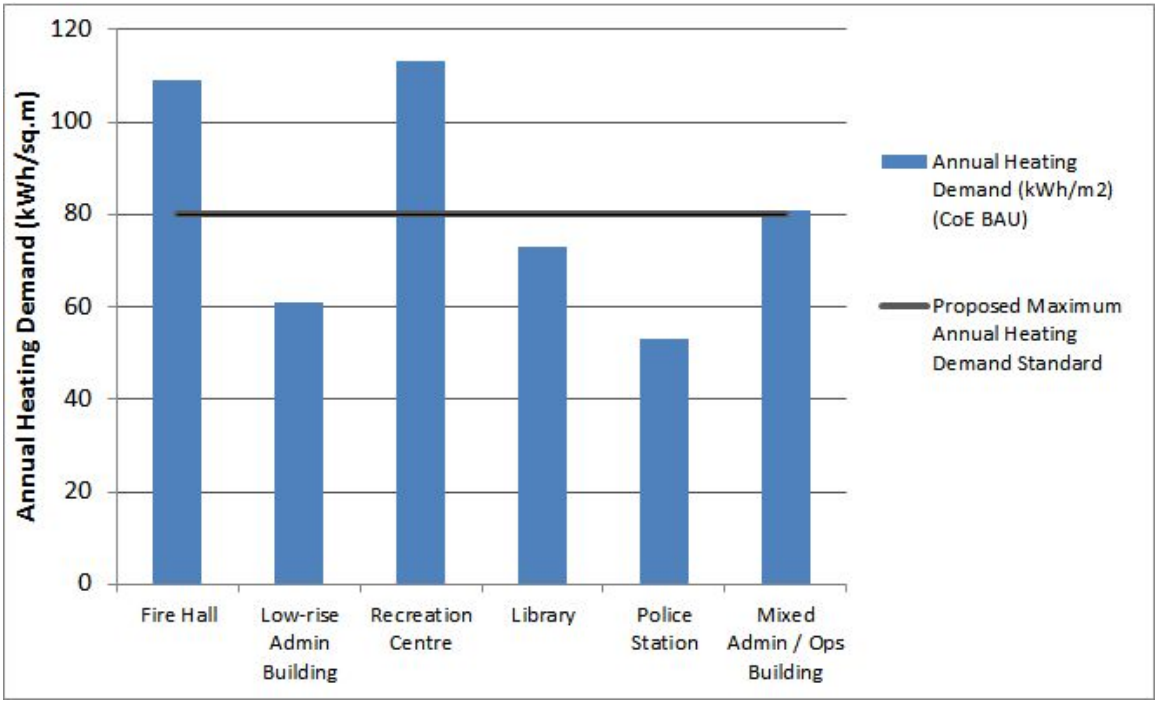


Figure 2: Annual Heating Demand - Current Practice versus Proposed New Standard

City-owned buildings / New Construction – On-Site Renewables Objective

Jurisdictional Scan

Only two major Canadian cities have a standard related to on-site renewables energy – City of Toronto and City of Vancouver. City of Toronto requires its own new buildings and the buildings of its Agencies, Boards and Commissions (ABCs) to, at a minimum, achieve 5% of a new building's total annual energy needs from on-site renewable energy. As previously explained, as part of the City of Vancouver's 'Zero Emissions Building Plan, "all new City facilities shall use only low carbon fuel sources or utilize equivalent near zero emissions approach wherever feasible starting in 2018."

Current Practice and Analysis

The cost of solar photovoltaic (PV) has decreased dramatically over the past few years; but the payback excluding incentives is still quite long (e.g. 20 years). While solar PV system are often explored in the early stages of City building projects, they are also often value engineered out of the project due to higher upfront cost and longer cost recovery, compared to other energy efficiency features. Combined heat and power generation (CHP) is a cost effective alternative energy technology (e.g., payback <6 to 12 years) that can reduce energy consumption and GHG emissions, especially in facilities that have consistently large baseline heating needs (e.g. recreation centres).

High level cost analysis on CHP (supported by information from ENMAX and ATCO) shows that installation of CHP units sized for a building's heating load could have a 0.25% to 0.5% incremental capital impact and would offset annual electricity between 5% to 26% and annual heating load between 8% and 31% depending on the building archetype. Table below outlines the cost results from three separate analyses for solar PV. The findings collectively show that a 5% onsite energy objective can be met and usually exceeded by using solar PV with a 1% incremental capital increase.

In terms of operationalization, introducing a 1% dedicated project capital to on-site energy generation could potentially enable both CHP and solar PV to be incorporated into a new building, and the combined technology will far exceed the minimum 5% annual building energy offset.

Table 2: Various Study Results on Annual Building Energy Offsets Achieved by Dedicated Project Capital for Solar PV

On-Site Solar PV Studies	Incremental Capital	Offset of Annual Building Energy
Internal City of Edmonton analysis	1%	3.5 to 12% (based on business-as-usual energy

		performance)
Morrison Hershfield	1%	5 to 13% (if 50-50-50 energy standards is met) 4% to 10% (if pro-rated to 40% better energy savings than NECB)
Perkins + Will	4%	100% (if Net Zero Ready with ground source heat pump)

The following table shows the various percentage of dedicated project capital for deployment of solar PV and the corresponding range of offset in annual building energy use that could be achieved for a new building.

Table 4: Incremental Capital Investment vs. Annual Building Energy Offset based on 40% better than 2011 NECB

Percentage of dedicated project capital	**Percentage of Offset in Annual Building Energy (by solar PV only)**
1%	4 to 12%
2%	9 to 24%
3%	13 to 36%
4%	17 to 48%
5%	21 to 60%
6%	26 to 72%
7%	30 to 84%

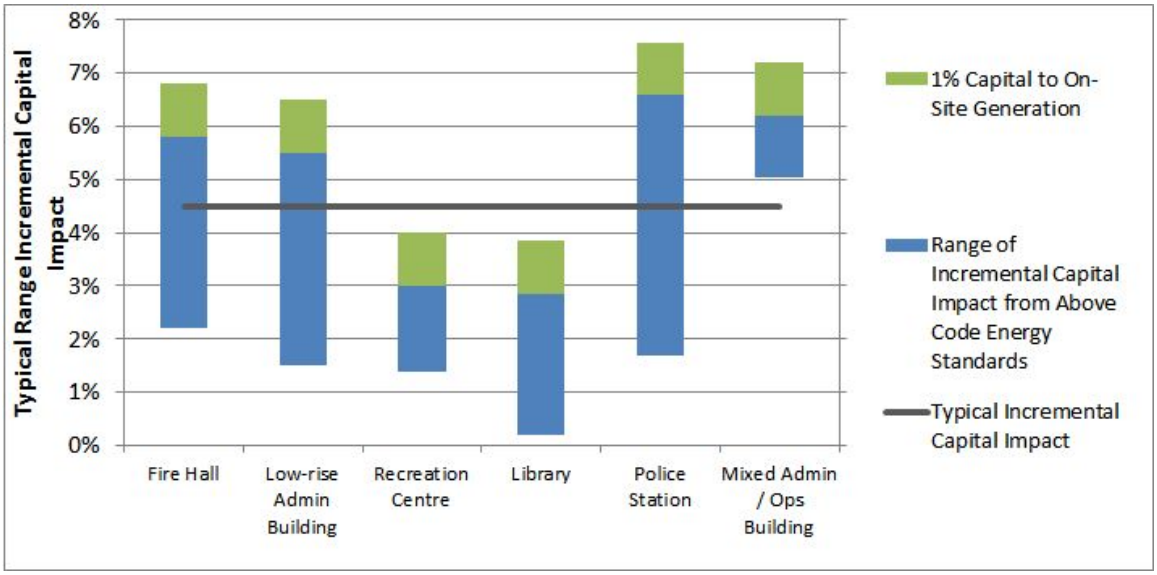
Morrison Hershfield's analysis specifically showed that for some types of City buildings, net-zero energy buildings (i.e. buildings that produce as much energy as they consume) could be achieved starting at an incremental capital cost of 6% such as in the case of a fire hall. However, the analysis also showed that there could be site constraints that would need to be must be addressed (e.g. in situations where the the size of a solar installation exceeds the size of roof, a therefore ground-mounted or wall-mounted solar would need to be must be incorporated into design).

Updated Policy

Based on the analysis, the project working group proposes that a minimum 1% of a new construction building project's total capital be dedicated to a combination of renewable and or alternative on-site energy generation technology.

Budget / Financial Implications

Figure below shows the range of incremental capital increase for meeting the 40-40-80 energy performance standards and the 1% dedicated capital for on-site renewable and alternative energy generation for different building archetypes.



Incremental Capital Impact of the New Energy-Related Policy Standards on Typical New City Building Projects