My Second Garage – Building Envelope and Energy Case Study

Submitted to:
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Quik-Therm Insulation Solutions Inc.

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EVOKE
Sensible building solutions

Introduction

Evoke Buildings Engineering developed a calibrated energy model for recently constructed buildings called My Second Garage (MSG) in Manitoba to explore the energy efficiency measures that have resulted in significant energy savings compared to a building built to the code minimum or typical construction. The facility is insulated with the Quik-Therm (QT) Matrix wall system and Matrix roof System, which is made up of two or more layers of Quik-Therm Air Dry Connect.

Efficiency Manitoba provided funding to the team of Quik-Therm Insulation, T2K Enterprises and Behlen for the MSG project during design development to demonstrate the benefit of an innovative and cost-effective solution for providing high levels of thermal insulation. Efficiency Manitoba subsequently provided further funding to use this project as a case study and analyze the comparison of the estimated energy savings from the energy model developed during design to the actual energy savings during operation and quantify how Quik-Therm Matrix System can contribute to energy, greenhouse emissions and utility cost savings.

Building Description

The facility is two single-storey buildings with twenty-six storage garages, and one maintenance bay. There are two rows of garages, with thirteen on each side. It is located at 105 Progress Way in Oak Bluff, MB.

Figure 1. MSG facility in Construction.

The buildings are manufactured steel buildings with the BEHLEN RIGID FRAME system that are exterior insulated on the walls and roofs using the Quik-Therm Matrix System. The Matrix system is supported by steel girts and purlins. Additional framing, sheathing, and membranes were not necessary as the Air Dry Connect and Matrix system functions as an all-in-one system for the control of heat, air, and moisture.

The installed Quik-Therm Matrix system has two layers of 3 inches (76 mm) of insulation for the walls and the installed Matrix system has two layers of 6 inches (152 mm) of insulation for the roof. Renderings of both can be seen in figures 2 and 3 below. Both insulation systems have plywood furring built into the insulation and metalized polymer facers. Thin brick and metal cladding is attached to the plywood furring and is supported by the Quik-Therm Matrix system.

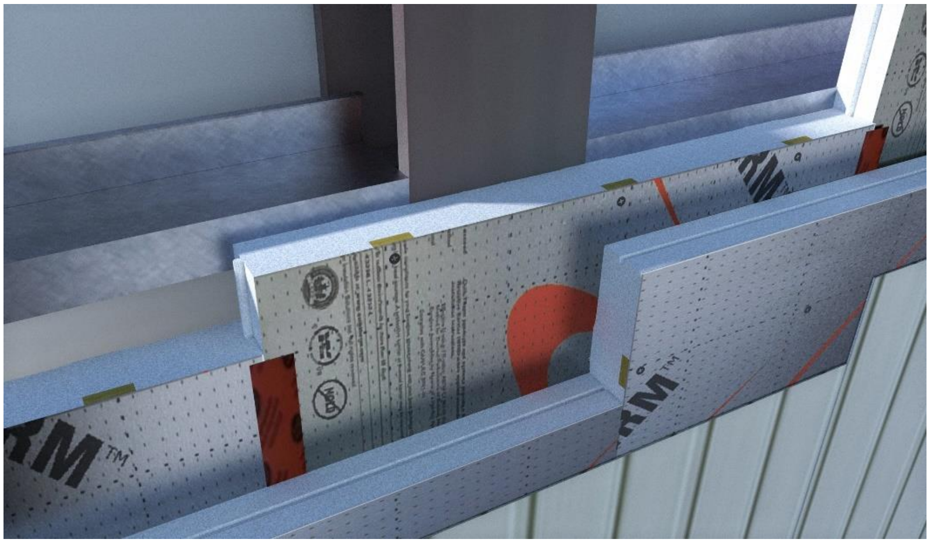

Figure 2. Quik-Therm Matrix System at the Walls (Cutaway)

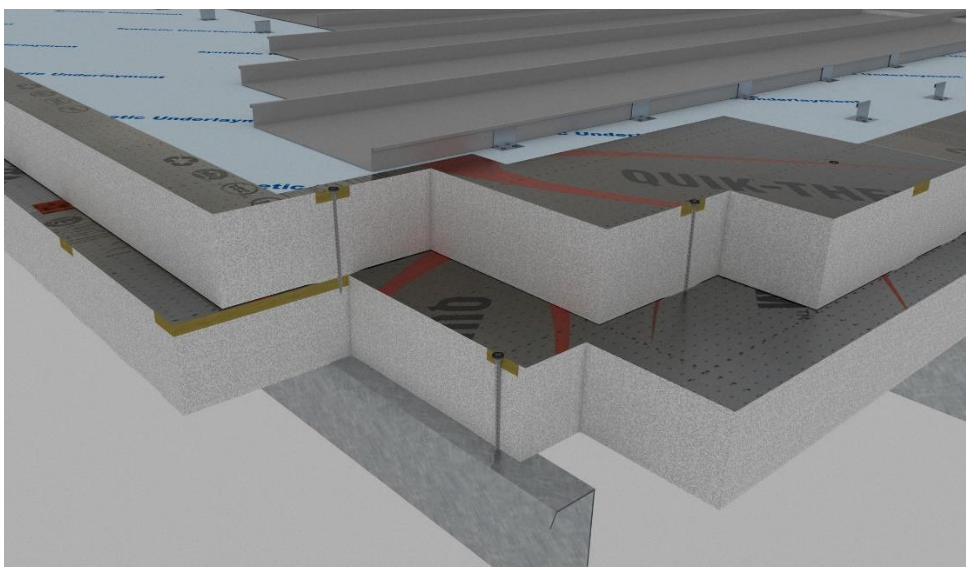

Figure 3. Quik-Therm Matrix System at the Roof (Cutaway)The Quik-Therm Air Matrix System forms a continuous layer around the building and are taped at joints to provide the air barrier continuity as seen in Figure 4.

Figure 4. Quik-Therm Matrix System provides a continuous insulation layer, the air barrier, and moisture barrier for the walls and roofs.

The entire slab on grade is insulated with 2 inches (51 mm) of XPS insulation and the perimeter grade beam has been insulated outboard of the structure with 4 inches (102 mm) of Quik-Therm Sub-Grade Insulation (SGI).

There are no windows in the building and only insulated overhead doors as openings. The Building Efficiency Technology Access Centre (BETAC) - Composite Wall Weatherization System Test Report showed that air leakage primarily occurs around the overhead doors, and the rest of the facility is airtight. During actual operations, when the building is operating typically and at much lower pressure than during the blower door test, relatively low air leakage rates appear to occur based on the calibrated energy model and appear to contribute to practical reductions and energy savings during typical operations.

The building is heated by an in-floor heating system, supplied via a condensing natural gas boiler. The building does not have mechanical ventilation and ventilation occurs naturally at the garage doors. There is an exhaust fan in the washroom.

Domestic hot water is provided by an electric heater.

Information Reviewed

Evoke has not conducted an on-site review and has relied on the following information:

- Issued for construction (IFC) drawings, for architecture, mechanical and electrical (2022)
- Available utility data for electricity and natural gas from November 2022 to April 2023.
- Shop drawings for overhead doors, and boiler.
- Energy modeling report by Crosier Kilgour & Partners Ltd. dated February 3rd, 2022.
- Discussions with operator for schedule setpoints, controls, etc.

Building Energy Use

In comparing the initial utility bills to the pre-construction compliance design model, the owner noted that the actual operating energy appeared to be significantly lower than anticipated based on the design stage energy model. In order to understand the source of the savings and in particular the contribution of the envelope, Evoke has developed a calibrated energy model to represent the actual operating energy.

The energy model was developed using EnergyPlus v22.2 and has been calibrated based on four months of actual and estimated electricity and natural gas utility bills. Weather data from April 2022 to April 2023 for the Winnipeg Airport weather station was used for calibration.

The following figure shows the utility bill energy use and calibrated model energy use for electricity and natural gas. As the building is newly built, the utility bills provided indicate that they are estimated by the utility provider for some of the months. For electricity, the estimated bills are much higher in comparison to the actual bills, therefore only the actual bill information is used to calculate the kW/day and applied to remaining months based on sunlight hours of that month. For natural gas, utility bills are estimated for two months out of four. The estimated months are comparable in usage to the actual months, so those values are not adjusted.

The calibrated modeling results are aligned with the usage data within the required range, as per ASHRAE Guideline 14. For more details on inputs, refer to Appendix A.

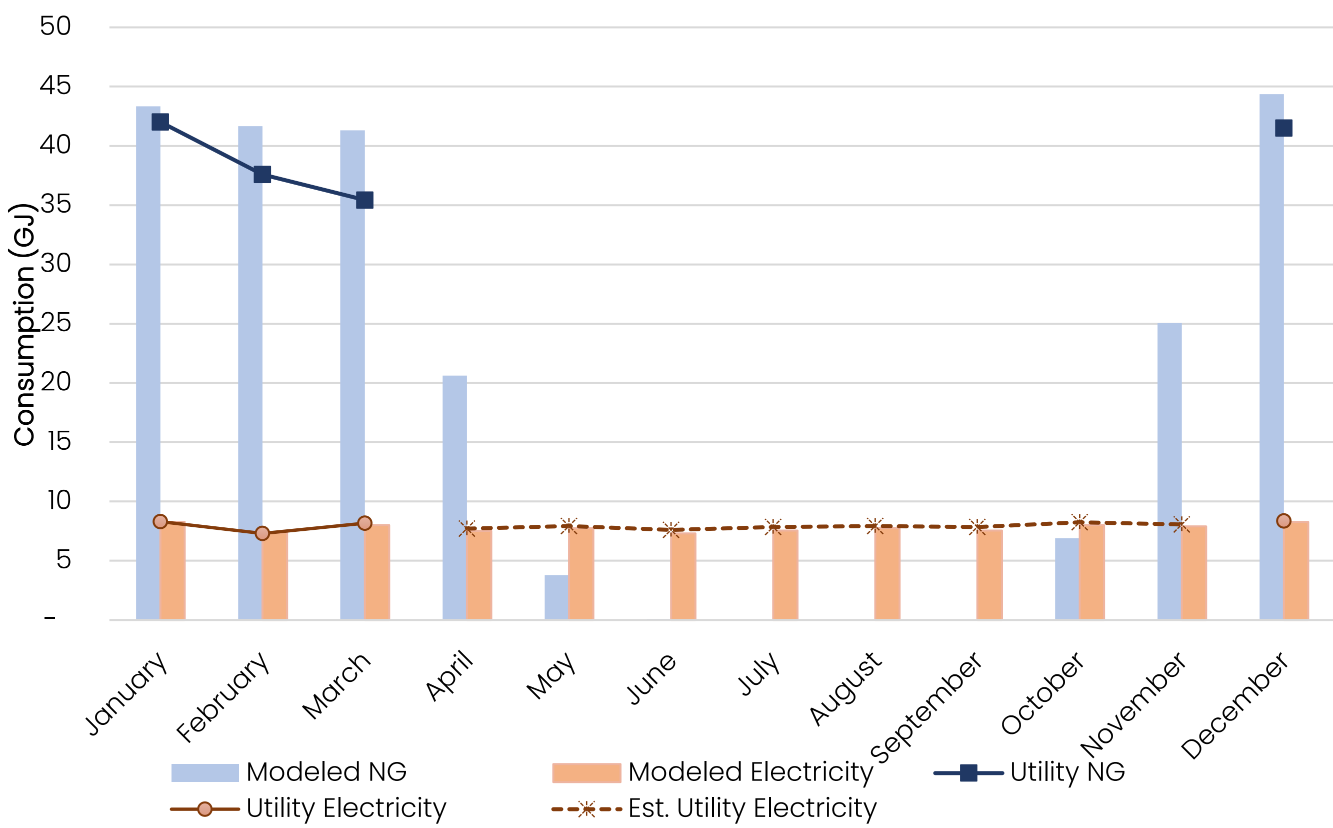

Figure 5. Monthly Utility Use and Calibrated Energy Model

An approximate energy end-use breakdown of the calibrated energy model is shown in figure 6 below.

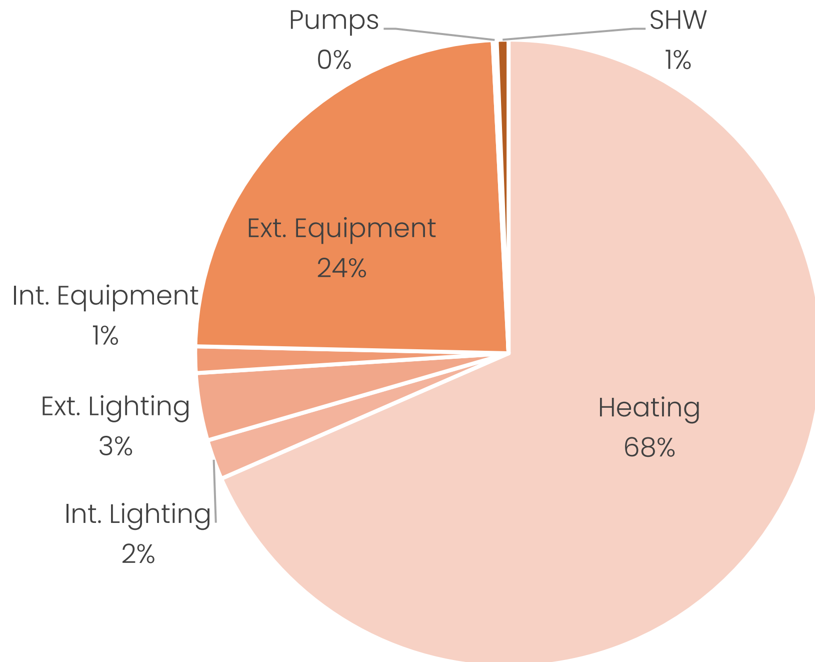

Figure 6. Energy End-Use Breakdown

Overall, the natural gas use is much larger than the electricity use, which is as expected since heating is supplied by natural gas, and there is minimal electricity usage at the facility. The heating load for the facility is dependent on the usage of garage doors. The decline in natural gas usage could be partly due to occupant behavior. A large portion of the electrical usage is from the exterior equipment loads, which include CCTV cameras, entrance signs, etc.

The calibrated energy model differs from the design modeling results in energy use intensity (EUI). The design model report shows an EUI of 140 kWh/m^2, while the calibrated model representing actual operations is 80 kWh/m^2, as illustrated in figure 7 below. The interior lighting has the largest end-use decrease, while the exterior equipment has the largest increase. The "TEDI" or thermal energy demand intensity, a measure of the heating needed over the year, is similarly much lower in the calibrated model and actual operations than was expected during design. Greenhouse gas emissions intensity, or GHGI, is also reduced.

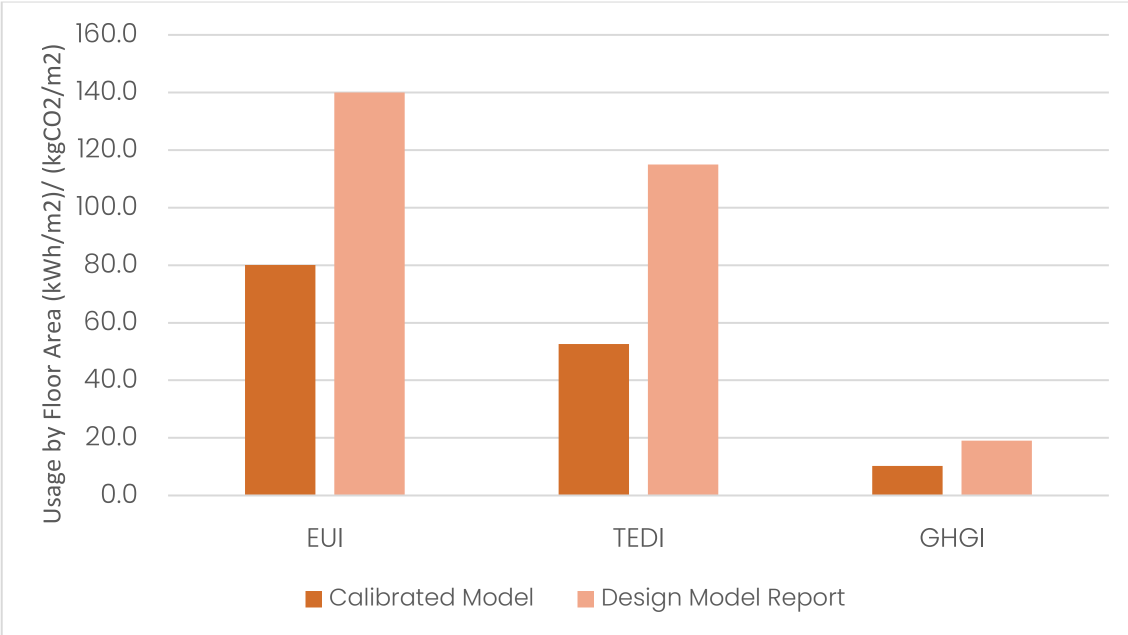

Figure 7. Comparison of Design Model and Calibrated Model

Lighting savings in actual operations versus the design stage model are largely based on improved controls. The design uses a 30-minute timer to shut off lights when the space is unoccupied. Given a relatively low frequency within each individual garage, the frequency of lighting use is lower and the effectiveness of the lighting controls is better than the NECB compliance inputs used in the design model. In addition, the as-designed lighting power is lower than what was carried in the design stage model, as the final lighting design had not been completed at the time of the design energy model.

The increased exterior load is due to design elements that are frequently not considered in detail in typical compliance modelling, and are typically very minimal, such as entrance signs and CCTV cameras. These only become a large portion of the energy use here due to the large number of these design elements. These components also get a bigger share of the pie than they would have otherwise because the building uses less electricity overall.

Most interesting to this study, there is a significant decrease in heating energy (natural gas use) compared with the design energy model. Thermal performance of the envelope and its impact on the energy model is relatively well understood and is modeled largely consistently between the design model and the calibrated model. In fact, the calibrated model accounts for additional thermal bridging that is seen in the real world but is not required to be considered in NECB 2011 compliance modelling (see the Building Envelope Thermal Performance section below for further discussion.) However, significant heating savings are still observed compared with the design energy model.

In our calibration we noted two major factors contributing to heating savings. First, the use of in-floor heating systems combined with a highly efficient envelope that allows a steady temperature to be maintained allows the building to maintain temperatures very efficiently. Second, infiltration rate appeared to be lower than expected by the compliance model, which appears to be due to the primarily natural ventilation present in the building and the lack of mechanical penetrations.

MSG utilized Quik-Therm's Matrix system. The use of the high-performance envelope introduced system selection benefits. The design had earlier included individual PTAC systems for heating and ventilation, but that was able to be replaced with a more efficient in-floor heating system with natural ventilation. In discussion with Quik-Therm, they noted this was due to the heating load reduction achieved by the envelope system. This design change not only introduced cost savings for procurement of the heating system, but it also lowers operational costs, and improves air tightness in the facility.

The calibrated model points to airtightness as one of the significant sources of heating savings. Air leakage testing showed that air leakage primarily occurs around the overhead doors, and the rest of the facility is airtight. This is expected as overhead doors are typically leaky, and this facility has a substantial number. As a result, this case study does not serve as the best illustration of the degree of building air tightness that may be obtained by using this approach for the envelope system. The air leakage testing report indicated the facility is in the median range compared to other facilities in Manitoba. During actual operations, when the building is operating typically and at much lower pressure than during the blower door test, relatively low air leakage rates appear to occur based on the calibrated energy model and appear to contribute to practical reductions and energy savings during typical operations. This is likely due to a combination of natural ventilation and the lack of mechanical penetrations. Modeled infiltration rate in the calibrated model is less than half of the NECB default modeled rate.

There is also a heating energy reduction based on reduced thermostat setpoints compared with NECB defaults that were likely carried in the design model (the design energy modelling report does not specifically mention thermostat setpoints but does generally follow NECB space defaults); actual operations have the thermostat set to 18°C for garages and 20°C for the maintenance bay, whereas NECB defaults would be 22°C during the day. High performing envelopes can assist in maintaining comfort conditions across a broader range of temperatures (e.g. by reducing localized cold spots near the envelope), and an in-floor radiant system can help maintain comfort conditions at lower air heating temperatures as occupants tend to perceive the same level of comfort at lower thermostat setpoints when using radiant systems. However, it is likely that this temperature reduction is driven primarily by operational choices based on the building use rather than primarily by occupant comfort influenced by design, given the primary storage use and intermittent occupancy of the building. The calibrated model also carries a further reduction in modeled thermostat setpoint to account for the efficiency of radiant floors, as outlined in NECB, which is supported by the calibration.

As is often the case in energy modelling, the heating and overall energy savings observed in actual operations compared with the design energy model are due to complex interactions and choices in both the building design and operation of the building. Some of the reduction is due simply to design energy modelling using standardized schedules or operating inputs that were, in this case, overly conservative. Some of the heating energy savings are due to operations and use such as thermostat setpoints and frequency of door opening. And some of the heating energy savings are due to the envelope performance, both directly via airtightness and thermal performance, and indirectly by facilitating selection of mechanical systems as well as facilitating maintaining temperatures and comfort levels.

The specific impact of envelope thermal performance is separated out and quantified in the following section using the calibrated energy model.

Building Envelope Thermal Performance

The building opaque assemblies at MSG exceeds the prescriptive requirements of the current energy standard for Manitoba (NECB 2011). The high level of thermal insulation is a significant contributing factor to the energy savings that are being realized at the MSG buildings.

Thermal bridging of closely spaced repetitive structural members, such as steel studs, are included in thermal transmittance calculations for NECB 2011. However, the impact of fasteners and thermal bridging at junctions, such as the roof-to-wall, window-to-wall, and edge of floors can be ignored. The stated assumption in NECB 2011 is that impact of thermal bridging at interface details is negligible if the insulation is installed tight to penetrations and between components. For compliance to NECB 2011, the assemblies at MSG do not have thermal bridging that impacts the opaque U-value.

Research and development done in the past decade has shown that thermal bridging related to secondary structural attachments and at junctions has a significant impact. This is relevant when assessing the energy use of buildings in operation and going forward for newer versions of NECB. Thermal bridging at junctions and secondary structural components will need to be accounted in Manitoba once NECB 2020 is adopted.

Calculation of the overall thermal transmittance was conducted in accordance with NECB 2020 and includes the impact of thermal bridging at junctions, which includes linear transmittances at roof-to-wall, edges of floors, door perimeters secondary structural members. A comparison between the performance of the MSG Opaque above-ground assemblies, to NECB 2011 and NECB 2020 prescriptive requirements is summarized in Table 1.

Table 1. U-Value of MSG Opaque Above-ground Assemblies versus Maximum U-Value for NECB Prescriptive Requirements, BTU/ft^2· hr·°F (W/m^2 K)

Above-ground Opaque Building Assembly	Thermal Bridging at Junctions not Included		Thermal Bridging at Junctions Included[1]		Meets NECB 2020 U-Value Requirement
	NECB 2011 Prescriptive	MSG Assembly U-Value	NECB 2020 Prescriptive	MSG Overall U-Value	
Walls	R-27 (U-0.037/USI-0.210)	R-29.6 (U-0.034/USI-0.192)	R-26.4 (U-0.039/USI- 0.215)	R-22.1 (U-0.045/USI-0.257)	Yes[2]
Roofs	R-35 U-0.029/USI-0.162	R-52.1 (U-0.019/USI-0.109)	R-46.9 (U-0.021/USI-0.121)	R-46.9 (U-0.021/USI-0.121)	Yes

The comparison shows how the building envelope thermal performance at MSG is significantly better for the roof and slightly better for the walls than the prescriptive requirements for NECB 2011. In addition, the floors at MSG are fully insulated below the slab with R-10 XPS insulation and R-16.7

[1] Thermal bridging at junctions is required to be Included for NECB 2020.

[2] Wall U-value requirement determined using building envelope simple trade-off path.

outboard of the grade beam. This is compared to the prescriptive requirement that translates to approximately R-7.5 around the slab in contact with the ground.

MSG will also exceed the minimum requirements of NECB 2020 given that:

- the roof meets the prescriptive requirements,
- the walls almost meet the prescriptive requirements and can comply using the simple trade-off path in section 3.3 of NEBC 2020 by trading off the slightly lower wall performance with the less windows and door area, and
- the grade beam and floor insulation levels exceed the prescriptive requirements.

Table 2 outlines the benefits of the enhanced building envelope performance at MSG in comparison to the NECB 2011 minimum requirements. The wall savings were calculated using the building envelope simple trade-off by recognizing that less wall insulation is needed for compliance in relation to the window and door performance.

The results in Table 2 do not consider typical construction and thermal bridging, which would de-rate effective thermal performance of an NECB 2011 compliant envelope. A scenario considering typical construction and effects of thermal bridging are discussed below in figure 9. This comparison of code minimum (table 2) and a likewise code compliant scenario which also accounts for real-life thermal bridging effects as well as the other synergistic effects of improved envelope performance (figure 9 below) further illustrates the impacts of those effects.

Table 2 provides utility cost saving estimates in $ saved per square foot of floor area compared with the same facility using NECB 2011 prescriptive envelope. It provides three scenarios of Manitoba, Nunavut, and Ontario representing the as-operated MSG energy use but substituting current utility rates in each of these provinces. In these results, a fuel switch is not contemplated; electricity use is representative of current facility electricity use (for lighting, CCTV, etc).

Table 2. Annual Energy Cost Comparison per Province

Scenario	Annual Energy Use		Annual Total Energy Costs by Utility Bill by Floor Area ($/ft²)						Carbon Tax Impact [3]
			Manitoba[4]		Nunavut[5]		Ontario[6]		
	Electricity (kWh)	Gas (GJ)	Electricity	Gas	Electricity	Gas	Electricity	Gas	
NECB 2011	26,000	356	$0.24	$0.43	$1.18	$1.26	$0.33	$0.20	+$0.22
MSG	25,890	202	$0.23	$0.24	$1.17	$0.72	$0.33	$0.12	+$0.13

As seen in Nunavut's case, as natural gas prices rise, the cost savings are significantly increased with the Quik-Therm Matrix System. Future carbon taxes will also play a large role in cost savings related to energy efficiency savings as the price of natural gas is expected to increase significantly.

[3]Future Federal is the additional cost of $120/ton of emissions, implemented by 2030.
[4]Manitoba utility cost: Electricity - $0.1/kWh, Natural Gas - $13.2/GJ, based on MSG's current utility costs.
[5]Nunavut utility cost: Electricity - $0.5/kWh, Natural Gas - $39/GJ, based on average advertised cost.
[6]Ontario utility cost: Electricity - $0.14/kWh, Natural Gas - $6.3/GJ, based on average advertised cost.

Figure 8 below illustrates the same utility savings in $ per square foot contrasting with electrically heated facility instead of natural gas. The savings in the electric heated case is significantly higher because of the higher cost for electricity, in comparison to current natural gas prices. The price difference between fuels is expected to become closer with increasing carbon taxes and natural gas costs.

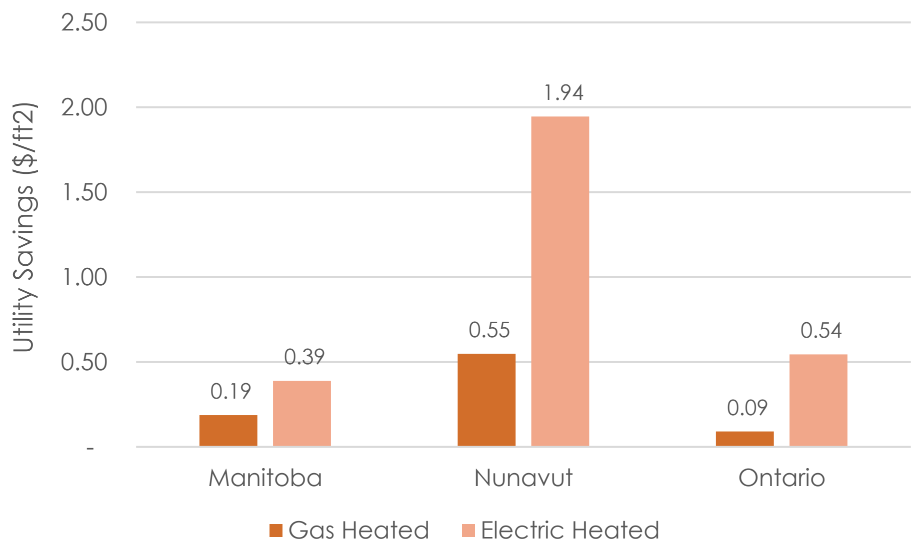

Figure 8: Utility Savings by Province for Gas Heated vs Electric Heated Facility

To compare the impact of the envelope on the whole facility, MSG's calibrated model was modified to represent "typical" construction and modeled against MSG"s performance. The "Typical" construction model for the facility is based on experience with similar facilities, as well as discussions on what the initial design for this facility was contemplated to use.

The mechanical system was modified to use single zone RTUs that cycle on a load; RTUs would typically be used for these facilities. This adds fan power and mechanically driven ventilation, and requires a higher temperature setpoint to achieve comfort conditions.

The infiltration was set to code values; this is in the range of what we would expect to see in operations if typical penetrations and systems were used.

The roof and below grade were set to NECB 2011 prescriptive values. The wall effective R-value was de-rated to include thermal bridging impacts on top of the NECB prescribed minimum; this represents how a typical minimally code-compliant building would actually operate.

As illustrated in figure 9 below, once these additional effects that are enabled by the higher performance envelope are accounted for, and the fact that NECB 2011 code minimum does not include for the full impacts of thermal bridging that would be seen in typical construction, there are considerable annual utility savings. These savings are further highlighted when the cost of natural gas is higher, as seen in Nunavut's case.

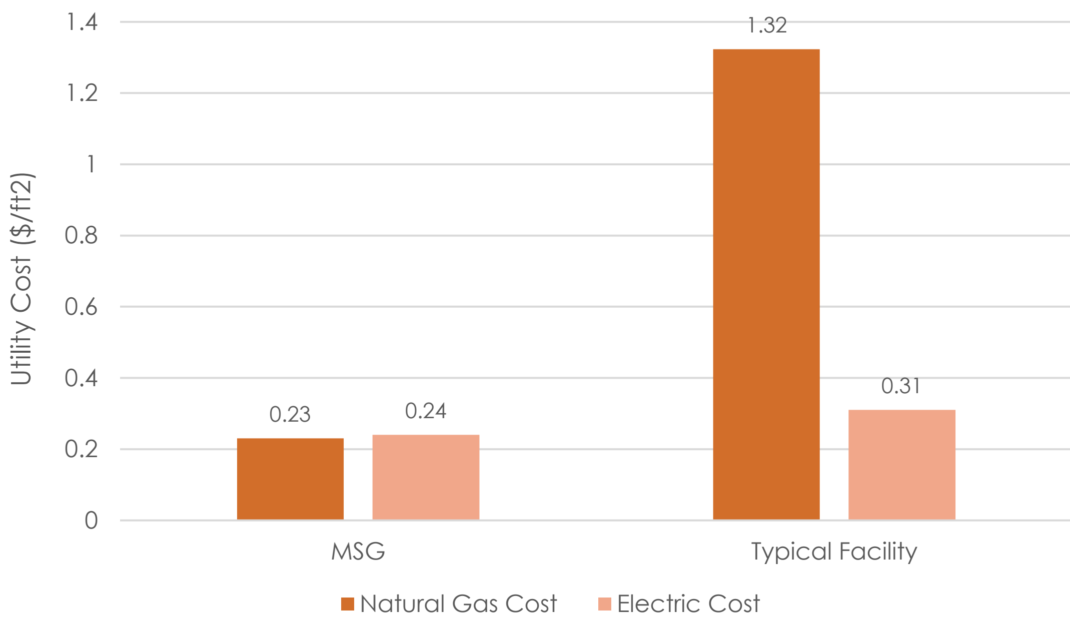

Figure 9: Utility Costs comparing MSG with a Typical Facility

Mitigating Thermal Bridging for Manufactured Steel Building Systems

Jurisdictions across Canada are adopting more stringent energy codes and standards that address thermal bridging as part of the goal of meeting targets for net-zero buildings for 2030 in new construction. For example, Manitoba is looking at adopting NECB 2020 in November 2023.

NECB 2020 poses a challenge for metal buildings in cold climates. Not only are the prescriptive U-Value requirements lower (more stringent), but thermal bridging must also be fully accounted for in U-Value calculations to determine compliance. The Quik-Therm systems utilized at MSG demonstrate how to mitigate thermal bridging and the insulation levels that are needed to comply.

The interface details accounted for 20% of the heat flow accounted in the overall wall U-value at the MSG facility. Reducing thermal bridging at interface details to 20% is considered a good level of mitigation for steel and concrete buildings[7]. Nevertheless, the walls at MSG do not meet the NECB 2020 prescriptive requirements despite the high insulation levels and high level of thermal bridging mitigation. However, compliance to NECB 2020 for the walls can be demonstrated using the simple building envelope trade-off or by adding more insulation.

Meeting the NECB 2020 building envelope requirements puts the MSG facility ahead of its time for a manufactured steel building and provides guidance to solutions going forward. Common steel building insulation systems are challenged by a few ways:

1. Meeting an effective R-value of R-47 for roof assemblies is pushing the limits to what is practical for some systems,

[7] ZEBx, www.zebx.org/playbook-dealing-with-thermal-bridging-in-net-zero-energy-ready-building-design/

2. Mitigating thermal bridging at interfaces requires changes to the standard details for insulation systems that use fibrous insulation or have metal skins (insulated metal panels), and
3. Data is not readily available for the common steel building insulation systems to meet more stringent U-values requirements when comprehensive thermal bridging calculations are required.

More insulation and high levels of thermal bridging mitigation are required for the insulation systems that use fibrous insulation layers. Industry will need to evaluate what it will take for these systems to meet the 2020 NECB requirements and if these systems are still cost-effective. In the meantime, Quik-Therm systems can meet the new requirements once implemented.

Conclusion

In comparing the initial utility bills to the pre-construction compliance design model, T2K Enterprises or Owner noted that the actual operations appeared to be lower than anticipated based on previous modelling. The building is used as a case study to compare potential impacts of energy improvements in several locations.

In our calibration we noted two major factors contributing to heating savings. First, the use of in-floor heating systems combined with a highly efficient envelope that allows a steady temperature to be maintained allows the building to maintain temperatures very efficiently. Second, infiltration rate appeared to be lower than expected by the compliance model, which appears to be due to the primarily natural ventilation present in the building and the lack of mechanical penetrations.

In the initial energy modeling report, complete thermal bridging was not accounted for, as it was not required by code. Accounting for thermal bridging shows the increased importance of evaluating and considering thermal performance for new and existing buildings, while meeting more stringent energy codes and standards. While the MSG facility already achieved NECB 2020 prescriptive values for the roof and can achieve compliance for the wall values using the simple building envelope trade-off, other systems may have struggled to meet these same requirements without changes to standard practice and additional analysis.

The Quik-Therm Matrix system is to be well positioned to meet the NECB 2020 requirements in a cost-effective manner compared to available options and current industry practice.

The cost analysis shows that improving the thermal performance of the envelope results in ongoing utility cost savings compared with code minimum or typical construction across several locations.

Sincerely,

Evoke Buildings Engineering Inc.

Alex Blue, P.Eng. (BC, AB, ON), LEED AP BD+C, BEMP
Principal, Building Energy Specialist

Appendix A: Detailed Energy Model Inputs

PROJECT INFORMATION

Project Name	My Second Garage (MSG)
Stage of Project	Calibrated Energy Model
Project Identifier	Newly Built
Location (Jurisdiction)	Winnipeg
Project Address	105 Progress Way, Winnipeg, MB.
HDD Below 18 °C	5670
Climate Zone	7A
Building Description	Storage Garage
Building Area	Conditioned Floor – 1,024 m^2
Utility Rates	Based on utility data provided. Electricity: \$0.1/kWh Natural Gas: \$13.2/GJ
GHG Emission Factors	Based on Manitoba Hydro published data. Electricity: 0.004 $kgCO^2$/kWh Natural Gas: 0.186 $kgCO^2$/kWh

MODELLING SOFTWARE INFORMATION

Software	EnergyPlus v22.2
Simulation Files	MSG_Calibrate_R3.idf
Weather File	MB_WINNIPEG-IAP_718520_23-22.epw

LOADS AND SCHEDULES

Space Types	Lighting LPD (W/m^2)	Occupants (m^2/Occ.)	Plug loads (W/m^2)	DHW (W/person)	Schedules
Electrical	5.4	200	1	0	NECB K
Garage	4.4	1000	0	0	NECB K
Maintenance	4.5	20	5	90	NECB E
Washroom	9.8	30	1	0	NECB K

Lighting Notes	The LPDs are based on a takeoff. Lighting for garage is scheduled on a 30-minute timer, with opening 1 to 2 days a week. The electrical room and washroom are on a 2hour/day schedule.
Occupancy Notes	Occupancy is using NECB 2011 default.
Plug Load Notes	NECB 2011 default is used.
DHW Notes	NECB 2011 default is used.
Exterior Lighting	654W, controlled by photocell.
Temperature Setpoints	Building is heated only, with thermostat set to 18°C for garages, and 20°C for maintenance bay. Since the building has in-floor heating, the thermostat is adjusted by 2°C in the model, as per NECB.
Additional Loads	Exhaust fans and entrance sign is based on drawings. CCTV estimated to be 40W per camera.

BUILDING ENVELOPE

OPAQUE ENVELOPE	
Exterior Walls	R_{eff}-22.4 Quik-Therm Matrix System. 6" of rigid insulation. Including thermal bridging of fasteners, overhead doors, base of wall and roof transitions.
Exterior Roofs	R-47 Quik-Therm Matrix System. 12" of rigid insulation. Including thermal bridging.
Below Grade Slab	Ffactor-0.18 2" of insulation on entire slab floor and 4" insulation for 12" on grade beam. Based on table A6.3, from ASHRAE 90.1.
GLAZING	
Overhead Doors	U-0.324/R-17, as per cut sheet.
Window-to-wall Ratio	~28%
SHADING	
Exterior Building Shades	N/A
AIR TIGHTNESS	
Infiltration	The air leakage report shows moderate air leakage in comparison to Manitoba buildings. The building's infiltration modeled is reduced because the building has natural ventilation and lack of mechanical penetrations. This would result in lower values than the typical 0.112 conversion used for converting testing pressure at 75 PA to ambient pressures. The estimating natural ventilation formula, from A.Bhatia's natural ventilation report is based only on temperature differential and wind speed. Based on the calibration, it appears the actual infiltration is between the two methods. As the natural ventilation analysis would not include the impacts of opening large garage doors, which is expected to increase ACH when opened. Modeled as: 0.1 L/s/m^2 (For comparison the NECB assumed for modeling is 0.25 L/s/m^2)

MECHANICAL SYSTEMS

HVAC SYSTEM	
Garage and Maintenance	**System Type:** In-floor heating via condensing natural gas boiler. No cooling. **Performance:** Boiler: 95% effectiveness. **Fans:** No mechanical ventilation supplied. **Others:** Exhaust fan in washroom, and mechanical room.
DOMESTIC HOT WATER (DHW)	
DHW Load	As per NECB.
DHW Heating Equipment	Electric heater.

Appendix B: BETBG Calculations

Building thermal bridging calculations for the base case calibration scenario.

Enhanced Thermal Performance Spread Sheet SI Units

Change Units

Clear Field Area Method

Select Area Calculation (Choose One)	Area	Units
◉ Sum of Active Clear Field Areas (Default)	04	m2
○ User Defined Area	User Opaque a	m2

Overall Opaque Wall Thermal Performance	
Opaque USI-Value (W/m2K)	0.256
Effective RSI-Value (m2K/W)	3.9

Proposed Building Entries

Add/Remove Detail	Transmittance Type	Include	Transmittance Description	Area, Length or Amount Takeoff	Units	Transmittance Value	Units	Source Reference	Heat Flow (W/K)	%Total Heat Flow
								Totals	1496.0	100%
Add Clear Field	Clear Field	☑	Main Wall	5837.04	m2	0.203	W/m2K		1182.9	79%
Remove Clear Field	Clear Field	☐								
Add Linear Interface Detail	Linear Interface Detail	☑	Door Perimeter	255.53	m	0.300	W/mK	6.3.1-A	76.7	5%
Remove Linear Interface Detail	Linear Interface Detail	☑	Base of Wall at Door	84.19	m	0.100	W/mK	6.2.1-A	8.4	1%
Remove Linear Interface Detail	Linear Interface Detail	☑	Base of Wall at Grade	861.51	m	0.100	W/mK	6.2.1-A	86.2	6%
Remove Linear Interface Detail	Linear Interface Detail	☑	Wall to Roof	945.70	m	0.150	W/mK	6.4.1-A	141.9	9%