Introduction

Founded in 1967, the Manitoba Métis Federation (MMF) is the official democratic and self-governing political representation for the National Government of the Red River Metis, the heart of the Manitoba Métis community. With over 600 staff and 7 different regions throughout the province, the Manitoba Métis Federation promotes the political, social, cultural and economic interest and rights of the Métis people in Manitoba. The MMF have many programs and services to help the community such as child and family services, education, housing, the development of natural resources and many more.

The Manitoba Métis Federation is located at 150 Henry Avenue in Winnipeg, Manitoba in the old Canadian Pacific Rail Building, originally constructed in 1959. The Manitoba Métis Federation strives to be a leading force in reducing greenhouse gas emissions and be a leader in green energy. In order to achieve this leading effort, the MMF approached MCW Consultants Ltd. as their Prime Consultant to complete a deep energy retrofit of their head office, reducing their carbon footprint and optimizing the aging building systems for years to come.

Energy Saving Measures

The accounted area for energy savings measures included the main building, the gift shop, the server room, kitchen/cafeteria and gym. The existing utility bills were observed and determined the existing yearly energy usages to be approximately 262,539 m^3 of natural gas and 1,433,916 kWh of electricity usage, equating to 522 tonnes of equivalent CO_2 emissions per year. Multiple energy saving measures were explored complete with costing with the expected payback for each measure. Ultimately, twelve measures were agreed upon exploring further within the design stage:

- The addition of a photovoltaic (PV) array on the usable roof space
- Heating boiler replacement

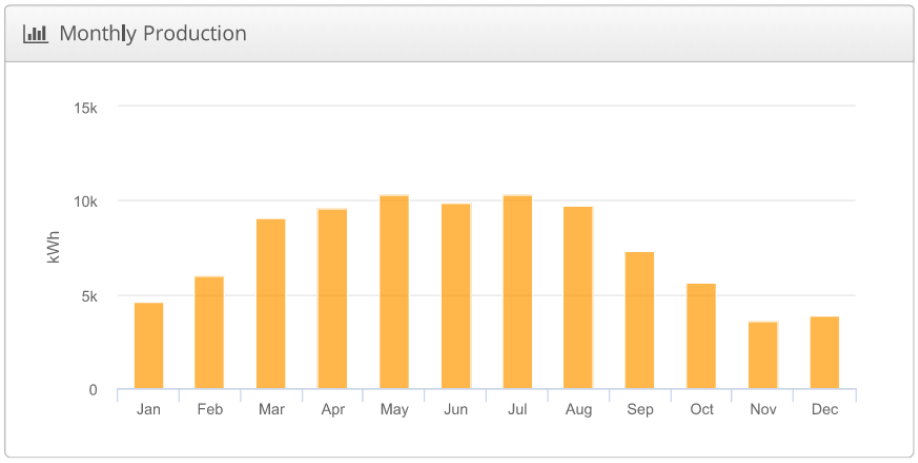
- Removing steam from the domestic hot water
- Replace entrance & penthouse heaters with electric heaters
- Provide new ventilation system complete with heat recovery ventilators
- Various Building Automation System (BAS) upgrades
- Occupancy sensor lighting control
- High efficiency window replacement with high performing window blinds
- South wall Solar Wall installation
- Door seal replacement
- Low flow shower heads
- Lavatory aerators

Photovoltaic Installation

With the use of HelioScope software, MCW evaluated the available roof space to determine the optimum configuration of solar panels on the roof of the existing building. MCW teamed up with Crosier Kilgour & Partners Ltd. for a full structural analysis of the existing roof structure and the stand design of the photovoltaic (PV) panels themselves to optimize the array to capture as much solar energy as possible.

PV panels convert solar energy into usable electrical energy, which can be used to offset and reduce the overall energy cost of the building, and ultimately reduce the building's reliance on utility power sources which result in third-party greenhouse gas emissions. The solar project utilizes a total usable portion of the roof, which was calculated to be 1,280m^2 (13,700 ft^2). Utilizing HelioScope, an advanced solar design tool, MCW was able to take the usable roof area and the location of the building to determine that with an optimized angle of approximately 40-degrees, the MMF building could support 168 solar panels, generating up to 73 kW of solar electricity for the building.

Resulting in an average of 246kWh/day, 90 MWh/year, which offsets the building power usage and reliance on Utility power.


Monthly Production
15k
10k
5k
0
kWh
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


HelioScope

Heating Source Conversion

Using the calculated building heating and cooling loads, MCW designed the removal of the existing inefficient (~70%) steam boilers. Removing the steam heat from the building included many different components including steam heating in winter months for domestic hot water generation, air-handling unit (AHU) heating coils and terminal steam space heaters. Replacing the steam boilers with high efficiency condensing boilers, boilers that are able to harness the sensible energy of natural gas combustion and the latent energy inherent in the combustion products allows the system to operate at extremely high efficiencies, upwards of 97%. This design included the reuse of the existing steam piping where applicable for the hot water supply distribution while demolishing the existing condensate piping to install new hot water return piping. In addition to the design, MCW had to also consider pumps, thermal expansion, makeup water, boiler venting and natural gas service alterations.

A glycol heating loop was included with the use of a hot water to glycol heat exchanger to provide 50% propylene glycol to the new hot water heating coils within the air handling units to avoid coil freezing during winter months. The heating boiler replacement, including all its components such as electrifying the domestic hot water heating and terminal space heaters, would reduce the natural gas usage by 80,274 m^3 and therefore reduce the carbon emissions by 163 tonnes of CO_2.

Upgraded Ventilation System

The existing mechanical systems in the Manitoba Métis Federation were previously providing a non-code compliant amount of fresh air ventilation to the building. The addition of a heating and cooling rooftop unit interconnected with a high efficient reverse flow heat recovery ventilator allows the system to effectively capture heat from the outgoing exhaust air streams and is then transferred to incoming cold ventilation air. While heat recovery ventilators have been common use for years, reverse flow heat recovery units operate slightly differently. The units push warm exhaust air over a series of thin plates that have a high mass, which warms up the plates. Simultaneously, the unit draws in cold ventilation air across a similar series of high mass plates which cools them. Every 90 seconds, a damper within the units changes position and reverses the flow. The ventilation air is drawn in across the plates that were just warmed by the exhaust air thus warming the air. This energy saving measure reduced the amount of CO_2 emitted by 25 tonnes per year. The addition of increased outdoor air ventilation into the space provides an upgrade in indoor air quality. This intangible upgrade can have far reaching effects on the health and well-being of the 230 full time staff and additional visitors the building sees.

Building Automation System (BAS) Upgrades

Controls played a large part in the energy saving strategy designed by MCW. The upgraded control system would consist of automatic controls to ensure systems don't overheat or overcool spaces due to faster response times and allow the building to isolate unoccupied portions of the building during any time of the day. The controls strategies were split into three main categories of concern: demand control ventilation, night setback and additional heating zones.

Demand control ventilation is an automatic adjustment that is controlled by the BAS, which modulates the volume of outdoor air into the building. This allows the system to provide an automatic reduction of outdoor air below design rate minimums when the actual occupancy of the building is less than the design occupancy. Providing less outdoor air to the building requires less energy to be consumed by using a decreased amount of natural gas to heat the outdoor air being provided to the building.

Night setback is an automatic adjustment that is controlled by the BAS, which automatically lowers the building temperature at night, which then reduces the amount of heating required to the building, which will reduce the amount of CO_2 emitted from the building to the environment.

Currently the building has two perimeter heating zones split into North/East and South/West. Creating additional heating zones in the building with the use of additional valves and pumps, which will be controlled by the BAS will allow the systems to shut off zones that are not occupied or turn down rooms

that are already comfortable, which will prevent the room from being overheated while other areas are colder and in need of the additional heat.

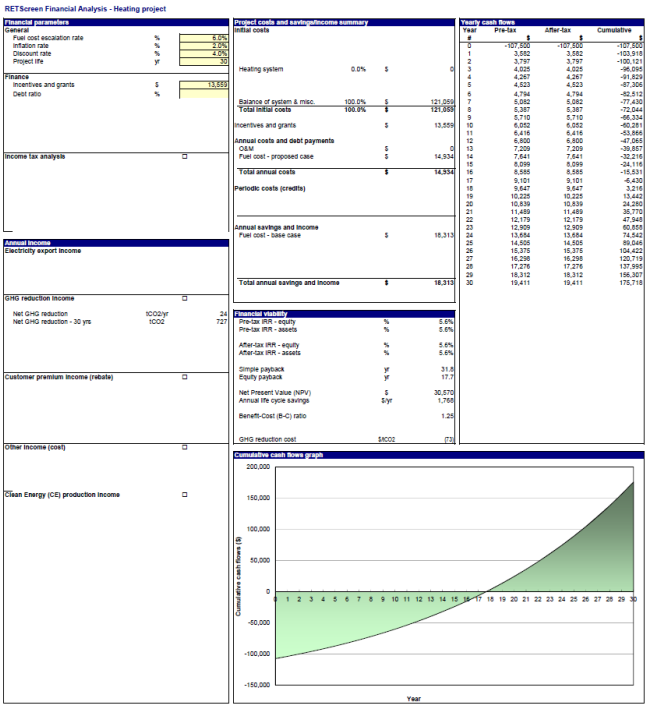
The various control strategies reduce the amount of energy used throughout each and every day with fine-tuned controls which will reduce the amount of CO_2 emitted by approximately 30 tonnes per year.

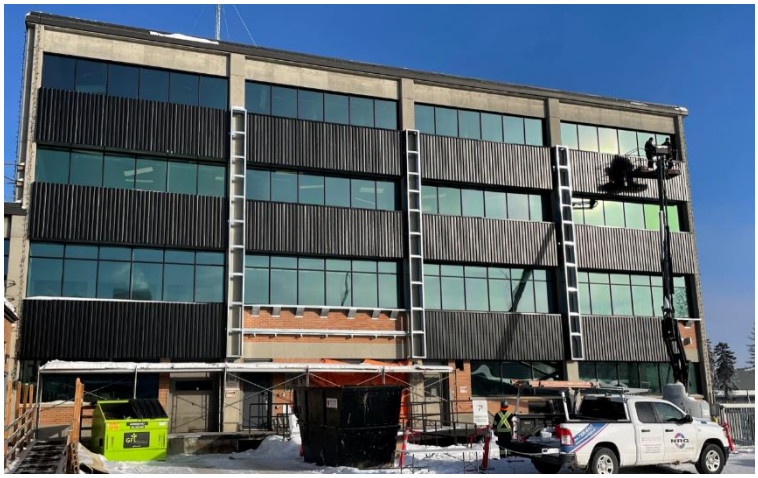
Building Envelope Strategies

Various architectural and building elements were investigated as part of the project. MCW partnered with MCM Architects Inc. for the architectural components of the project including washroom renovations, high efficiency window replacement, the installation of a Solar Wall, door seal replacement and high efficiency window coverings and blinds.

Upgrading all the windows for the entirety of the MMF building proved to be a complex design, as each window opening was an odd and inconsistent size where existing openings could not be made larger to suit fewer window types. The new upgraded windows were a 1/4” triple pane glass windows with the exterior pane containing a reflective finish, while the middle and inner pane contained a low-e finish with a 1/2” argon filled air space between each pane. In totality, the new windows provided a large performance upgrade bringing the new U-value of the window to U-0.178 (R-5.62), which was a 314% increase in performance from the existing windows throughout the building.

A Solar Wall is a dark metal cladding filled with small perforations and a gap of air between the newly installed Solar Wall and the existing exterior of the building. The Solar Wall is then run to the existing outdoor air intake for the building with the use of motorized dampers. This allows the building to pre-heat the incoming outdoor air into the building with solar energy. With warmer air entering the system, less energy is needed to heat it further. In addition, the wall that is covered by the Solar Wall is able to recapture heat lost through the exterior wall in which the Solar Wall is covering, which effectively doubles the R-value of the existing wall. The wall that the Solar Wall is installed on has a big factor on the amount of energy saved. In the case of the Manitoba Métis Federation, the best wall to install the Solar Wall on was the south facing side, as it has the highest solar gain and was also able to tie directly into the outdoor air intake for the air handling units in the basement. With a program provided by Natural Resources Canada called RETScreen International, we were able to input all of our building information and calculate the total initial cost, the amount of energy saved, the greenhouse gas reduction, and the payback period. This proved to be a complex strategy as the MMF were concerned about maintaining the heritage look to the building's brick face. Therefore, MCW worked closely with the supplier of the Solar Wall and the Manitoba Métis Federation to ensure the colour, location and design of the solar wall maintained the integrity and architectural appearance of the existing building exterior.





While maintaining the integrity and heritage impression of the building, the various architectural and building envelope measures reduce the amount of energy used, which will reduce the amount of CO_2 emitted by approximately 41 tonnes per year.

Plumbing Fixture Replacement

MCW worked with the MMF to maintain their primary land-management goal of preserving and maintaining a clean water supply, a core value of the Métis people, by installing low flow plumbing fixtures throughout the building. This accomplished both a reduction in water usage and contributed to the overall energy saving goal of the project.

Upgrading all the plumbing fixtures in the washrooms of the Manitoba Métis Federation building to low-flow fixtures or automatic sensing and flushing fixtures would decrease the amount of energy consumption by requiring less water to be used and heated in the building. To achieve this lower water consumption, the fixtures need to either be modified or replaced. Each lavatory will be modified with the use of aerators. This will reduce the amount of water coming through the faucet by mixing the incoming water with air. The aerator separates the flow into smaller streams by acting as a sieve. It creates less area for the water to flow through and therefore, reduces water usage. Assuming the water used while one is washing their hands is approximately two thirds (2/3) hot and one third (1/3) cold, the Manitoba Métis Federation will save an estimated $1,206 of electricity costs per year by reducing the amount of hot water required by reducing the flow to each

lavatory. The total estimated savings by modifying each lavatory with an aerator is $4,273 per year including water usage.

Each urinal and water closet will be replaced with automatic sensing and flushing flush valves. This will reduce the amount of water by consuming a lower amount of water per flush in addition to automatically flushing, which saves an estimation of 1,871 m^3 of water. The total estimated savings by modifying each urinal and water closet with an automatic sensing and flushing flush valve is $8,644 per year.

Each shower will be replaced with a low-flow shower head. This will reduce the amount of water by providing less water over the duration of people showering. Assuming the water used while one is showering is approximately two thirds (2/3) hot and one third (1/3) cold, the Manitoba Métis Federation will save an estimated $314 of electricity costs per year by reducing the amount of hot water required by reducing the flow to each shower. The total estimated savings by upgrading the shower heads to a low-flow shower head is $1,108 per year including water usage.

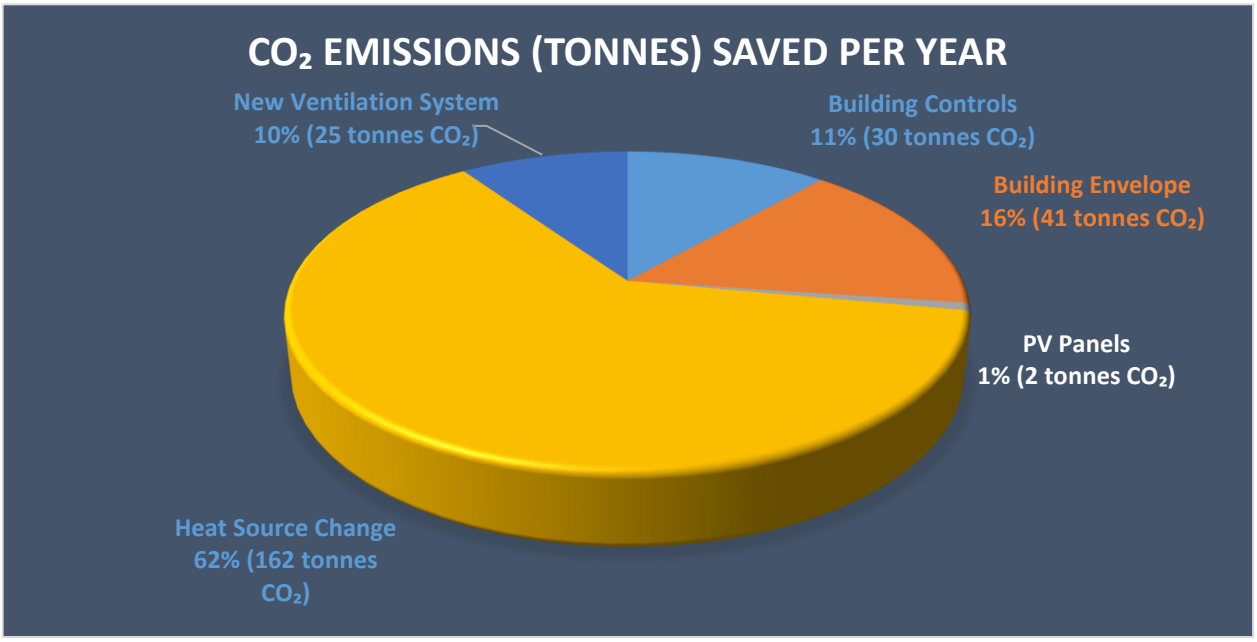
Order of Operation

The construction of the projects created complexity with planning and coordinating the phasing of the work with not only the contractors performing the work but also the Manitoba Métis Federation building itself as it would remain occupied during the duration of the construction. With all the proposed upgrades to the Manitoba Métis Federation building, the order in which the upgrades were completed was crucial to minimize the amount of energy consumed, and the amount of CO_2 emissions to the environment. In addition, the order of operation will decrease the amount of re-work to be done and cost associated with that work.

The first recommended change to be completed would be the new ventilation system, which will complete all roof work and ducting. Following the completion of all roof work, the installation of the photovoltaic panels can be completed with the remaining roof area. Following the completion of the ventilation system, the window replacement and Solar Wall can take part simultaneously with coordination on the south wall. Once the building envelope and new ventilation system was completed, the new hot water boilers and the remainder of the mechanical modifications and controls can take place simultaneously with coordination. This will allow for the boilers to be sized accordingly to the changes that would have already been completed and allow the smaller boilers.

Greenhouse Gas and Energy Reductions

With all of the energy saving measures incorporated in this project and the phasing of construction that was proposed in recommended order of operation, the total amount of Greenhouse Gas emissions saved per year is estimated to be 261 tonnes of CO_2 per year. The Manitoba Métis Federation building would have reduced an estimated amount of CO_2 emitted to the environment by 2,871 tonnes by 2030 and reduced an estimated amount of CO_2 emitted to the environment by 8,091 tonnes by 2050.



Conclusion

In conclusion, the project was complex, unique and carried a broad scope of mechanical, electrical and architectural innovations to address the needs and desires outlined by the Manitoba Métis Federation. The systems, while complex, are robust and capable of providing reliable results. Working around existing constraints, interdisciplinary coordination ensured that advanced and functional mechanical systems were designed and installed while maintaining the integrity of the existing structural and architectural features of the building. Through the application of sound engineering knowledge and principles, the project represents in its own way what engineering is at its very core: Providing practical solutions through design and implementation of engineered plans to improve the quality of life for those affected.