

## SCHEDULE F – PROJECT COMPLETION REPORT TEMPLATE

### VERY IMPORTANT:

**Timing:** You need to email a report, to your GMF project officer (contact info is in Schedule C), on the dates indicated in Schedule C or whenever FCM asks for such a report.

**Copyright:** Before you submit a report to FCM, make sure you hold the copyright for the report. If you're hiring a consultant to prepare the report, please make sure to get the copyright (see FCM's copyright tips document), or else FCM will not be able to disburse the Grant Amount.

**Accessibility for people with disabilities:** Please do not change the format, font, layout, etc. of this report. This template has been specially designed, following FCM's Accessibility Guidelines, in order to be accessible to people with disabilities.

**Confidentiality:** If your report contains any Confidential Information that you would prefer not be made available to the public (e.g. through a case study or other materials produced by FCM that relate to your Project), please submit two versions of the report:

- 1. Complete report including Confidential Information:** Please clearly label this report with the word "**Confidential**" or similar wording and FCM will treat it as confidential.
- 2. Abridged report excluding Confidential Information:** This report may be posted on the FCM website and otherwise made available to interested third parties, to help FCM meet its knowledge sharing objectives.

Please contact your project officer to receive an electronic copy of the Completion Report Template.

**Upon completion of the project, a copy of the Final Deliverable must be submitted along with this Completion Report.**

FCM will post your report on the [Green Municipal Fund™ \(GMF\) website](#). This is because one of FCM's mandates is to help municipal governments share their knowledge and expertise regarding municipal environmental projects, plans and studies.

### How to complete the Completion Report

The purpose of the Completion Report is to share the story of your community's experience in undertaking your project with others seeking to address similar issues in their own communities.

Please write the report in plain language that can be understood by people who are not specialists on the subject. A Completion Report is typically in the range of 5–10 pages, but may be longer or shorter, depending on the complexity of the project.

GMF grant recipients must enclose **final** copies of the Completion Report and the Final Deliverable with their final Request for Contribution. The reports, including all attachments and appendices, must be submitted in PDF format with searchable text functionality. Reports that are not clearly identifiable as final reports, such as those displaying headers, footers, titles or watermarks containing terms like "draft" or "for internal use only," will not be accepted by GMF. Additionally, reports must be dated. If you have questions about completing this report, please consult GMF staff.

<b>GMF number</b>	16858
<b>Name of lead applicant (municipality or other partner)</b>	Climate Challenge Network
<b>Name, title, full address, phone, fax and e-mail address of lead technical contact for this study</b>	Gillian Henderson Director, Programs 90 Eglinton Avenue East Toronto, ON M4P 2Y3
<b>Date of the report</b>	September 30, 2021

## 1. Introduction

- a) **Who was involved in doing the Feasibility Study, and what are their affiliations? Please include name, title and contact information. Those involved could include municipal staff, engineers and other consultants, a representative from a non-governmental organization, and others.**

### Municipalities

City of Barrie	Sadlon Arena
City of Brampton	Terry Miller Recreation Centre
Town of Caledon	Caledon East Community Complex
Town of Halton Hills	Acton Arena + Mold Masters Sportsplex
Township of King	Trisan Centre
City of Markham	Crosby Arena + Mount Joy Community Centre
City of Toronto	Downsview Arena

### Technical Committee

Cimco Refrigeration  
 Accent Refrigeration  
 Friar Architects  
 Energy Network Services Inc. (ENS)  
 AMP Solar  
 Solar Wall  
 Zamboni  
 Ontario Geothermal Association  
 Les Quinton, Parks & Recreation Manager, Town of Black Diamond  
 Colleen O'Shea, President, Greener Arena Solutions Inc.  
 RDH Building Science  
 University of Toronto  
 Enerlife Consulting Inc.

## 2. The Feasibility Study

- a) **Describe the process that you undertook to make this feasibility study a reality, from concept, to council approval, to RFP, to final deliverable.**

Each of the participating municipalities is a member of the Mayors' Megawatt Challenge, a program working with municipalities since 2003 to reduce energy use and emissions in their own facilities. The idea of the pilot project began at the 2019 Mayors' Megawatt Challenge

Forum, which explored the practical ways that municipalities could go from vision to action for net zero carbon. A panel of expert speakers, including Matt Jungclaus from Rocky Mountain Institute, Dharmin Dhalia from the Town of Halton Hills and Professor Alexander Hay from Southern Harbour, spoke to zero-over-time for existing buildings, integrating climate goals with asset management, and climate resiliency respectively. Following this, the MMC team led a facilitated working session with member municipalities on organizational readiness for net zero carbon, identifying municipal priorities. The Roadmap to Net Zero Ice Rink cohort pilot project was developed based on these priorities.

Ice rinks were chosen as the pilot building type, as they are often the largest greenhouse gas emitters and typically account for 20-30% of the energy usage in municipal building portfolios. Seven member municipalities in Southern Ontario submitted nine rinks to the pilot project. These municipalities worked together with the pilot team and with leading industry experts to identify how to get existing ice rink facilities to net zero emissions. The pilot used a cohort approach so municipalities could learn from each other and reduce their individual risk. The pilot was designed to incorporate net zero readiness best practices not yet adopted by many of the municipalities. These best practices included early identification of prioritized projects, low carbon design brief, integrated design teams, life cycle costing, capital planning aligned with asset management, and zero-over-time planning.

A feasibility study was developed for each participating rink providing a high-level technical solution to reduce greenhouse gas emissions, including an outline of potential measures and lifecycle financial analysis for each measure in an incremental, over time approach. Solutions were aligned with individual municipal timelines – targets and urgency in getting to net zero, capital renewal timelines and asset management plans. A standard model was developed, based on collective learning from all participating ice rinks, plus generic considerations, to be applied to other ice rinks. Best practices and lessons learned will be shared through the Mayors' Megawatt Challenge program and will inform the 2021 Forum.

The individual studies for each participating rink are the culmination of three phases of work. During the first phase, the pilot team reviewed energy and building data, key drawings (mechanical and refrigeration), trend logs (as available), previous energy audits and building condition assessments, as well as the building's capital plan. Site visits were conducted to confirm data and information already received, collect additional information, and interview the building operator and facility manager to identify operational conditions and potential issues. An initial archetypal building model for arenas was developed in eQUEST software and referenced for measures in each specific participating rink. Measures were reviewed with facility staff to confirm details.

Following the site visit and measure reviews, Integrated Design Workshops were conducted bringing together building management, operators, energy managers, technical experts, and asset management to determine the best possible solution and plan for the rink. Participants reviewed the current performance of the rink and potential carbon reductions, low/no carbon measures that best fit municipal greenhouse gas emissions reduction goals for the facility, and measure implementation timelines. The workshops brought together technical and operational expertise, ensured operations and asset renewal were considered and that everyone had input at an early stage. This helped with buy-in and avoided costly omissions. Participants discussed how implementation and funding need to be done differently and what additional help would be required. Measures and associated costs were reviewed with the municipal finance group (including capital and procurement groups) either in the Integrated Design Workshops or in subsequent Capital Review Workshops, depending on staff availability.

The nine Roadmap to Net Zero feasibility reports map the retrofit and operational changes required to get each rink close to net zero emissions. They summarize the current energy and greenhouse gas performance, explore three potential target scenarios, and include each municipality's preferred measures, implementation timelines, and target greenhouse gas emissions. Findings and feedback from all municipal stakeholders have been incorporated in each final report.

**b) What were the objectives of the Feasibility Study (what was it seeking to determine)?**

The objectives of the Roadmap to Net Zero Ice Rinks pilot study were as follows:

- Aid municipalities in setting achievable carbon reduction targets for ice rink facilities and determine a roadmap to achieving them.
- Test the four-phase measure prioritization and zero-over-time approach to identifying, budgeting and planning low carbon measures. Focus initially on operational savings and high impact carbon measures to get early returns.
- Build the case for low carbon measures by comparing the upfront project costs and net present value of a "business as usual" like-for-like replacement of equipment with the project costs and net present value of the best possible low carbon measures.
- Introduce the Integrated Design process into measure development, bringing together facility staff and technical experts with capital and finance.
- Compare ice rink performance metrics to evaluate how ice rink building systems perform and whether there are opportunities for operational improvements or better efficiency when replacing the equipment.
- Assist municipalities in planning equipment renewal in advance to allow for low carbon options to be considered and costs budgeted.

**c) What approach (or methodology) was used in the Feasibility Study to meet these objectives?**

Various types of municipal ice rinks were included in the pilot project, from single pad to double and quadruple pad rinks, with some having significant other recreational space in addition to the rink. The study focused on facilities that do not have a pool. Two facilities already had heat recovery integrated in the refrigeration plant, although one of those facilities only has it on the newer of the refrigeration plants. One of the facilities is an Ontario Hockey League facility with the attendant facility requirements. Most of the rinks did not have facility-wide building automation systems.

Measures were identified and prioritized using a four-phase approach, incorporating a zero-over-time alignment of major capital upgrades at equipment end of life.

Costing incorporated life-cycle costing using net present value, following FCM's life cycle costing requirements for a GHG reduction pathway study, which is required before applying for a GHG reduction pathway retrofit or a GHG impact retrofit.

Each rink report provides three different scenarios of measures, timing, and actions with initial outlay of costs, emission savings, total net annual savings, simple payback, and net present value (NPV). Each of these scenarios considers a 30-year implementation timeline taking each facility to the end date for most municipal greenhouse gas reduction goals.

Analysis includes both upfront costs (initial outlay of costs) and life cycle cost analysis. Costing assumptions for measures were provided in the appendices of each report. They were based on costs from suppliers, rules of thumb and previous experience. Life cycle costing calculations

include the total cost of the measure including initial, operational and carbon costs, incorporating inflation and other considerations.

**d) Please describe any public consultations conducted as part of the Feasibility Study and their impact on the Study.**

No public consultations were conducted as part of this study. Significant effort was made to engage all internal stakeholders in the development process to facilitate implementation. Depending on staff availability, three to four separate engagements took place, after the initial measures and implementation plan had been drafted. The first was a review with facility staff, including operators where possible, to get feedback and input to the measures. The second was an Integrated Design workshop to review the proposed measures, costing, implementation plan and emission savings. The attendees also provided feedback on implementation assistance. The third was a Capital Review workshop with representatives from finance and procurement to review the measures, costing and implementation plan. One of the biggest benefits of this was the introduction and review of the life cycle costing methodology and net present value. None of the participating municipalities were actively evaluating projects using net present value, although some were planning to adopt it.

The project team also consulted a team of technical experts who made up the Technical Committee. They provided initial feedback on the foundations of the pilot study at the Co-creation workshop on August 16, 2020 and brought ideas from other projects in rinks. They brought in-depth subject matter expertise in ice rink operations, technologies, energy efficiency, sustainability and planning carbon reduction measures. These experts provided input to the original concept, initial measures and site-by-site technical knowledge for each rink.

### **3. Feasibility Study Findings and Recommendations**

**a) What were the environmental findings related to the options explored in the Feasibility Study? Please provide quantitative results and summary tables of these results (or the page numbers from the Feasibility Study report).**

Total and target energy use intensity (EUI) (pg7)

Participating rinks have wide range of current EUIs with Ice Rink 3 the highest total EUI of the group at 40.2 ekWh/ft<sup>2</sup> and Ice Rink 6 with the lowest at 26.5 ekWh/ft<sup>2</sup>. The average total EUI for the group of nine rinks is 34.1 ekWh/ft<sup>2</sup>.

The target EUI for each rink is energy intensity of the rink after all the planned measures are completed. Ice Rink 9 has the highest target EUI of the group at 24.3 ekWh/ft<sup>2</sup> and is the only rink with natural gas use remaining as, at the request of the municipality, only operational and low-cost measures were considered due to planned major renovations. As such, it has an EUI percentage reduction of 32.5%, the lowest in the group. Ice Rink 7 has the lowest target EUI of the group at 0 ekWh/ft<sup>2</sup> with a corresponding EUI percentage reduction of 100%. This municipality wished to understand what it would take to avoid the purchase of carbon credits.

Target EUIs for the other seven rinks range from 3.9 ekWh/ft<sup>2</sup> to 14.1 ekWh/ft<sup>2</sup>. The average target EUI for the group of nine rinks is 9.6 ekWh/ft<sup>2</sup>.

Greenhouse gas emission findings (pg 8)

Figure 2 on page 8 of the study shows the range of 2019 total emissions and target emissions for all participating rinks, in tonnes of carbon dioxide equivalent (CO<sub>2</sub>e). Ice Rink 1 has the highest 2019 total emissions at 628 tonnes CO<sub>2</sub>e and Ice Rink 9 has the lowest at 119 tonnes

CO<sub>2</sub>e. For all nine rinks combined, the total emissions are 2,441 tonnes CO<sub>2</sub>e, with an average of 271 tonnes CO<sub>2</sub>e.

Emissions reductions range from 99% for almost complete elimination of carbon emissions to 26% which are operational measures, with an average of 85%.

The breakdown of the total greenhouse gas emissions reductions by building system improvement measures is shown below on pg 9. Not surprisingly, the largest greenhouse gas emissions savings come from improvements to the refrigeration plant which include heat recovery. Refrigeration measures account for 29% of the emissions savings. Heating measures account for a significant part of the recommended measures with 21% of the emission savings. In most facilities, resurfacing measures, such as cold-water resurfacing technology, would have a significant impact on GHG reductions. Enclosure measures, such as insulation and window replacements, did not make as much financial sense as originally anticipated. These measures could be implemented for improving comfort but were not the best choice financially. Heat recovery and other measures were better investments for emissions reductions and energy savings.

- b) What were the financial findings related to the options explored in the Feasibility Study (for example, results of a cost-benefit analysis, financial savings identified, and so on)? Please provide quantitative results and summary tables of these results (or the page numbers from the Feasibility Study report).**

The individual feasibility studies provide three financial scenarios. The Business-as-usual scenario assumes a like-for-like replacement of existing equipment with no improvements, including no operational changes. The Low Carbon approach without funding looks at the operational improvements and equipment upgrades that provide the best emission reductions, immediate energy savings and are timed for end-of-life equipment replacement. The Low Carbon approach with funding is the Low Carbon approach but timed and funded in alignment with the GICB funding.

Table 1 on pg. 11 of the report shows the net present value (NPV) financial evaluation which indicates that, despite higher initial costs and without additional outside funding, the low carbon measures are much better investments than like-for-like replacement of equipment without operational changes. The financial picture is further improved if available grant funding can be used to finance the improvements.

Without funding, the low carbon measure costs were about \$46/ft<sup>2</sup> on average, with many of the measures focused on the ice rink. With funding, the average projects costs were just slightly higher than like-for-like replacement at \$19/ft<sup>2</sup>.

- c) Based on the environmental and financial findings above, what does the Feasibility Study recommend?**

The Roadmap to Net Zero Ice Rinks pilot study confirmed the validity of the four-step process to identify and prioritize the measures. It also confirmed the value of having a plan that will be implemented over time and aligned with asset management, equipment replacement timelines and emissions reduction goals. These are recommended for future feasibility studies.

In creating roadmaps to net zero carbon, it is important to consider the integration between the low carbon measures. Heat recovery is pivotal to the plans to significantly reduce carbon emissions in these rinks and will need to be more widely used and understood in the coming years as municipalities work to reduce emissions in their facilities. Many other measures

depend on the implementation of heat recovery. For example, replacing natural gas boilers with electric boilers was recommended after heat recovery is installed since heating a facility electrically is costly. As well, many of the ventilation measures and boiler plant measures use heat from the heat recovery system.

Operational improvements can provide significant energy savings early on. These include adjusting temperature and humidity set points, scheduling building systems to run smoothly and only when needed, lighting controls, and adjusting ice thickness and water per flood. Successful implementation of these measures requires greater control of building operations. Few of the arenas in the study had comprehensive BAS systems, yet they are crucial tools for operating ice rinks optimally and finding energy and emission savings. All rinks considering greenhouse gas emissions reduction plans should install or expand their BAS and/or reprogram it. With operational measures, operator training is also critical and was identified by most municipalities as an area where additional support would be needed. By focusing on implementing operational improvements and leveraging high emissions reductions measures early, municipalities can achieve early returns and improve the net present value of the investment in measures.

Switching to cold water ice resurfacing, after testing as appropriate, can provide significant savings and emissions reduction. To adopt this measure widely, more opportunities are needed for conversation and consultation with operators in buildings where this has been implemented successfully. MMC conducted a webinar on this subject, making connections within the pilot. The webinar recording is available on the program website. Addressing barriers like this is fundamental to getting high impact measures implemented that require operator buy-in and operational change.

#### **4. Lead Applicant's Next Steps**

- a) **Taking the Feasibility Study's recommendations into account, what next steps do you as the municipality plan to take? What potential benefits or internal municipal improvements would result from these next steps?**

The overall aim of the pilot project was to accelerate action on reducing emissions in municipal buildings. MMC will be building on the feasibility studies from this pilot to help municipalities implement the recommended measures and extend this approach to other ice rinks and building types.

Additional steps are outlined on page 12 of the *Roadmap to Net Zero Ice Rinks Pilot Study Completion Report*.

#### **5. Lessons Learned**

**In answering the questions in this section, please consider all aspects of undertaking the Study — from the initial planning through each essential task until the Final Study was prepared.**

- a) **What would you recommend to other municipalities interested in doing a similar Feasibility Study? What would you do differently if you were to do this again?**

These are explored in greater depth on pages 13 – 15 of the *Roadmap* report but in summary:

1. Gather building documentation and data early
2. Install and fully use a Building Automation System (BAS)
3. Use an integrated approach to developing the plan for the archetypal rink and each individual rink

4. Planning out measures over time and aligning with equipment replacement
5. Lifecycle costing using net present value, as outlined by FCM, allowed the pilot and municipal teams to evaluate the viability of the measures over the equipment life.

**b) What barriers or challenges (if any) did you encounter in doing this Feasibility Study? How did you overcome them?**

The primary challenge for this pilot was the timing and the impact on implementation timelines. The pilot started just as the COVID-19 pandemic began and municipal buildings were closed to the public for much of that time. It significantly delayed data gathering and site visits, as neither visitors nor staff could go to the buildings.

Collecting building and trend data for the rinks took longer and was more difficult than anticipated.

Due to COVID-19 restrictions, it was challenging to bring together municipal teams for site visits consultations, interviews, Integrated Design workshops and Capital Review workshops.

## **6. Knowledge Sharing**

**a) Is there a website where more information about the Feasibility Study can be found? If so, please provide the relevant URL.**

- Initial findings and plans for the *Roadmap* pilot study were presented at FCM's Sustainable Communities conference in 2020. The link to highlights and the agenda of the conference can be found here: <https://fcm.ca/en/events-training/conferences/past-conferences/sustainable-communities-conference-2020>.
- The MMC program will work to support municipalities with their implementation of these and other plans. All of the key findings from the Roadmap to Net Zero Ice Rinks pilot study and participant case studies will be covered in depth at our Annual Forum in November 2021. It and other information supporting greenhouse gas reduction in municipal facilities are posted on the Mayors' Megawatt Challenge website at <https://mayorsmegawattchallenge.com/>
- Recordings of webinars that cover topics germane to reducing greenhouse gas emissions in arenas and in other municipal facilities can also be found here at <https://mayorsmegawattchallenge.com/events/>

**b) In addition to the Feasibility Study results, has your Feasibility Study led to other activities that could be of interest to another municipality (for example, a new policy for sustainable community development, a series of model by-laws, the design of a new operating practice, a manual on public consultation or a measurement tool to assess progress in moving toward greater sustainability)? If so, please list these outcomes, and include copies of the relevant documents (or website links).**

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