Enerlife consulting

Outdoor Ice Strategy and supporting research

PHASE ONE

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BUILDING TOWARDS A
SUSTAINABLE FUTURE

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TABLE OF CONTENTS

1 INTRODUCTION

The Parks and Recreation department of the Town of Halton Hills is creating an Outdoor Ice Strategy that reflects Council and residents' vision for outdoor winter recreational opportunities. As per the Project Charter, the Outdoor Ice Strategy will include the Town's current natural rinks, community operated volunteer rinks, Fairy Lake considerations, and potential new artificial/refrigerated/synthetic facilities, including a review of existing facilities and programs, programs and services, and a vision for future facilities including a more detailed feasibility review of future improvements.

The Town engaged Enerlife to provide two phases of information supporting the Outdoor Ice Strategy. The first phase was to provide a brief report summarizing research into outdoor rink operations, model the future local climate based on climate trends, and provide conclusions. This report addresses this initial phase including providing a modelled prediction of local weather and number of natural and mechanically created skating days in the future.

2 DETERMINANT OF OUTDOOR SKATING

Based on surveys conducted by Rink Watch, temperature is the primary determinant of whether outdoor skating is feasible. The following figure from Rink Watch's 2020-2021 Rink Watch report shows that 62% of non-skateable days were caused by temperature. [1]

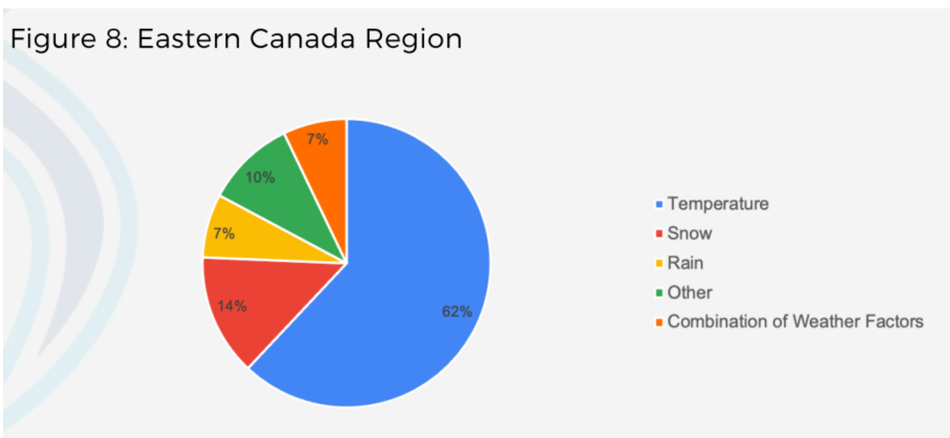


Figure 1 Reasons why rinks were not skateable for Eastern Canada Region

Other interfering factors can be mitigated through regular maintenance, including snow removal and flooding, or the presence of a shelter or cover that can reduce impact of precipitation or heavy sun. For this model, and to explore the effects of climate change on ice rinks, temperature will be the sole focus of the climate model. It assumes regular maintenance will be performed.

Based on Rink Watch's research, the following parameters defining good skating days have been used in the Town of Halton Hills climate model:

[1] https://www.rinkwatch.org/documents/rinkwatch_report_2020-2021.pdf

1. The first skating day occurs after five consecutive days where the maximum daily temperature does not surpass 0°C.
2. The last skating day is the first of five consecutive days where the daily average temperature is above -5.5°C.
3. A good skating day is one that occurs between the first and last skating day with an average temperature below -5.5°C.

3 NATURAL SKATING DAY MODEL

The model for the number of natural skating days was created using both historical weather from the closest reliable Environment Canada weather station in Kitchener, Ontario and predicted data using the Climate Atlas of Canada[2]. The Climate Atlas of Canada provides place-specific prediction of climate change. The predicted number of mild winter days (where mean temperature is at or below -5°C) was used to create the model. Historical climate data from the past five skating seasons was used to determine a baseline for the number of natural skating days. A relationship between the number of good outdoor skating days in the previous five seasons (using the conditions outlined by Rink Watch) and the number of mild winter days was created and used to linearly extrapolate the number of good skating days for future seasons until 2050.

As can be seen below, the model shows a decline in the predicted number of good outdoor skating days over time moving towards 2050. Enerlife has shared the excel model with the Town, so it can be used to support and determine the Town's Outdoor Skating strategy.

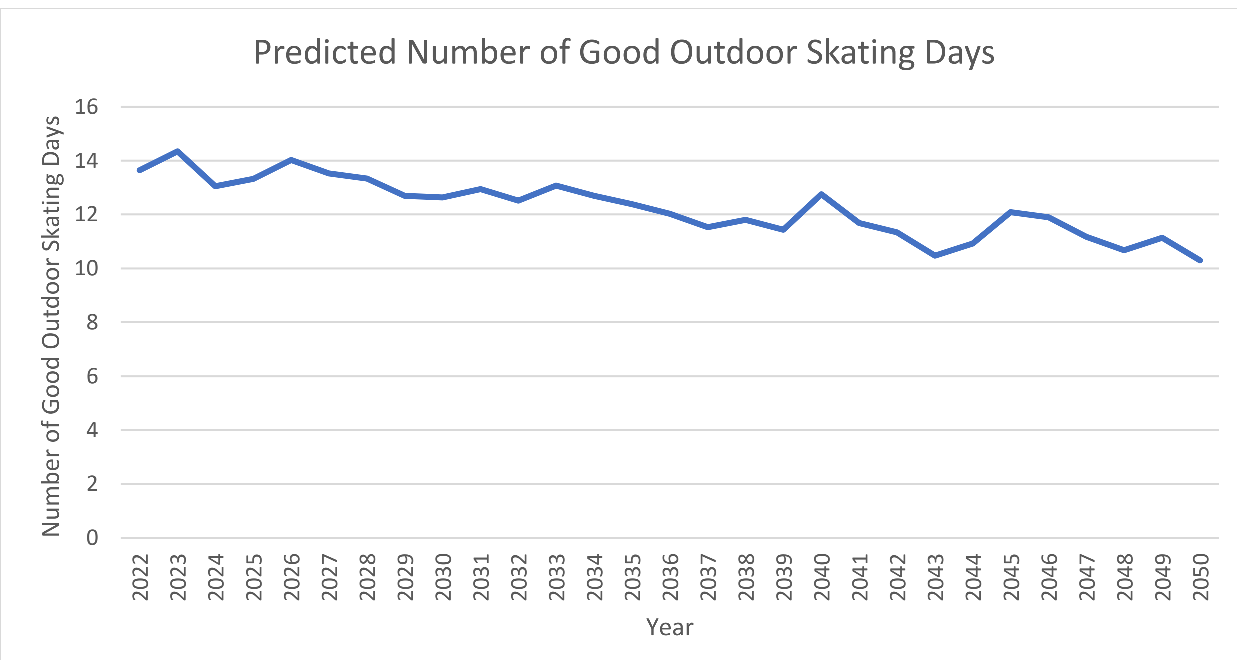


Figure 2 Predicted number of good skating days 2022 - 2050

[2] https://climateatlas.ca/

As the number fluctuates, Table 1 below outlines both the anticipated range of total skating days and the average number of good skating days for future outdoor skating seasons.

Table 1 Anticipated range of skating days and number of good skating days

Year Range	Predicted Range for Number of Skating Days	Average Number of Good Skating Days
2022-2030	26.80 – 40.20	13.40
2031-2040	24.64 – 36.96	12.32
2041-2050	24.38 – 36.57	12.19

From the results on Rink Watch, typically only 1/3 to 1/2 of skateable days had good or very good conditions. As per the definition above, this includes taking into consideration mid-season thaws. The range for number of skateable days range largely by rink, even between rinks that were very close together. There were various factors that impacted which rinks had longer or short seasons, as outlined below:

- Shade Cover: Rinks that installed tarps or had structures to protect from the sun were able to increase their number of skating days.
- Equipment Malfunction: Some rinks with short skating seasons reported issues such as pipes being frozen that resulted in them being unable to flood the ice surface.
- Maintenance: If people were not able to shovel after snowfall or flood the ice regularly then the ice surface would become bumpy and reduce skating quality.

These factors, as they are human controlled and not climate dependent, were not included in the analysis but are worth noting as they can cause significant impact on the quality and length of the skating season.

4 MECHANICALLY COOLED OUTDOOR RINK MODEL

Given the predicted decline of the number of naturally occurring skating days going forward, additional factors that impact skating days, and the variability of temperature during a skating season in the Town, an alternative would be to cool the ice surface mechanically. Mechanically cooling the ice surface, combined with proper maintenance, can ensure continuous skating days. A covering or roof would also be recommended, as one of the most significant factors in determining whether ice can be maintained is solar load. Solar loads are not easily tracked or predicted, as their intensity varies significantly. To simplify the analysis at this stage, it was assumed that to have a more reliable outdoor rink, it should be covered just enough to avoid direct sunlight on the ice. A cost for this shelter has not been included in the analysis, as the cost depends on the simplicity or complexity of the design.

Under the assumption that the outdoor ice would be covered, the following parameters would be used to determine if the ice would be skateable with a mechanical refrigeration plant.

For the purpose of this analysis, as mentioned above, Enerlife used an outdoor rink schedule for mechanically cooled rinks of November 27 to March 20 for a 114 day skating season.

Based on the definition mentioned in Section 2, the following outlines how many more days of ice use you should be able to get with a mechanical refrigeration plant and a covering for the ice.

Table 2 below shows the number of days in a season and the number of days that would require mechanical cooling to maintain a rink for a full season.

Table 2 Mechanical cooling requirements

Year Range	Number of Days in Skating Season	Estimated Number of Good Days in Skating Season Refrigeration Plant Could Maintain	Predicted Range for Number of Natural Skating Days	Average Number of Good Skating Days	Additional Skating Days Mechanical Cooling Would Provide
2022-2030	114	108	26.8 – 40.2	13.4	67.8 - 81.2
2031-2040	114	99	24.6 – 37.0	12.3	62.4 - 74.8
2041-2050	114	98	24.4 – 36.6	12.2	61.7 - 73.9

Mechanically cooled ice surfaces have the benefit of reliability regardless of the weather or variation in temperature during the winter season and avoid interrupted skating days. Mechanical systems can function in warmer days that would render natural rinks unusable.

5 COSTS FOR MECHANICAL ICE SURFACE

In the absence of site-specific details such as size, orientation and shading, for illustrative purposes, Enerlife specified and received costing for mechanical refrigeration of standard outdoor rink of 16,000 ft2 of ice surface. The general rule of thumb for sizing refrigeration system is 1 TR of refrigeration capacity per 200 ft2 of ice surface. An outdoor rink of 16,000 ft2 would require an 80 TR system costing about $1.3 million for a CO_2 system.[3]

These prices would include:

- supply and installation of the refrigeration equipment
- supply and install the refrigerated piping only in the skating surface
- supply of glycol for chilled skating surface loop
- start-up and commissioning

This does not include:

- provision of a room enclosure for refrigeration package and foot print to support gas cooler (typically on roof)
- main power feeds
- civil work and concrete for ice skating surface
- roof or covering for ice surface

[3] Prices and details provided by Jonathan Berney, CIMCO Refrigeration

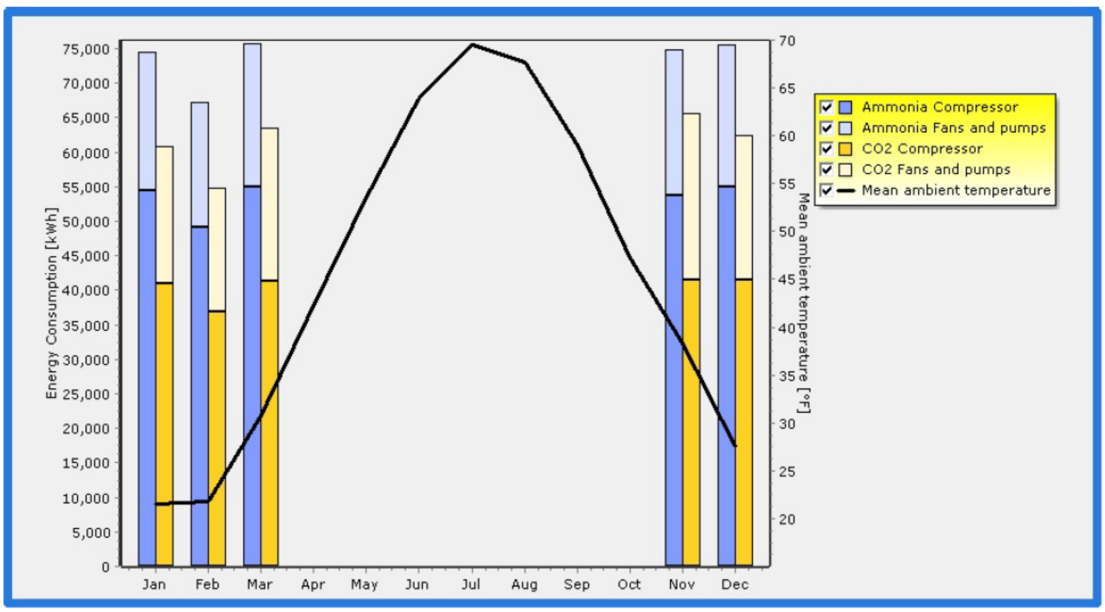
Options for the refrigeration system would be use ammonia or carbon dioxide. Prices have been provided for CO2 as it is a more climate friendly option and it is safer and better suited to a plant that is likely to be lightly staffed. If ammonia would be considered, the initial installation would be 10% cheaper but would be less energy efficient to run.

5.1 Operating costs

The ongoing operating costs of operating the mechanical system would include costs such as staffing, an ice resurfacing machine (if used) and energy costs. Estimates for staffing costs and the cost of purchasing an ice resurfacing machine have not been included in this report.

The figure below illustrates the comparison of energy use of ammonia and carbon dioxide systems. Using an estimated cost of $0.15/kWh, the annual energy costs for these example systems would be approximately $46,050 for the CO2 system and $55,050 for the ammonia system. Assuming the 114 day season, this would be $403.95 per day for the CO2 system and $482.89 for the ammonia.

Energy consumption graph



The diagram above shows the energy consumption per month of the simulated systems. Each bar equals the sum of the compressor energy consumption and the energy consumption of additional equipment (condenser and evaporator fans and pumps used in the system).

Figure 3 Comparison of energy consumption of ammonia and CO2 compressors