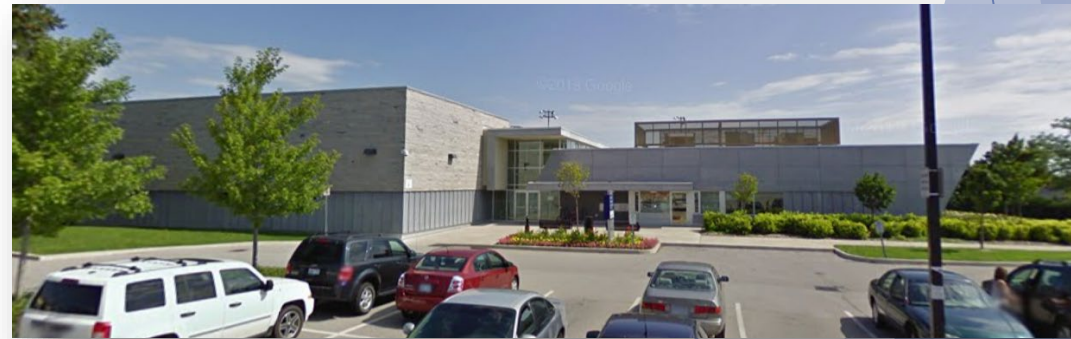
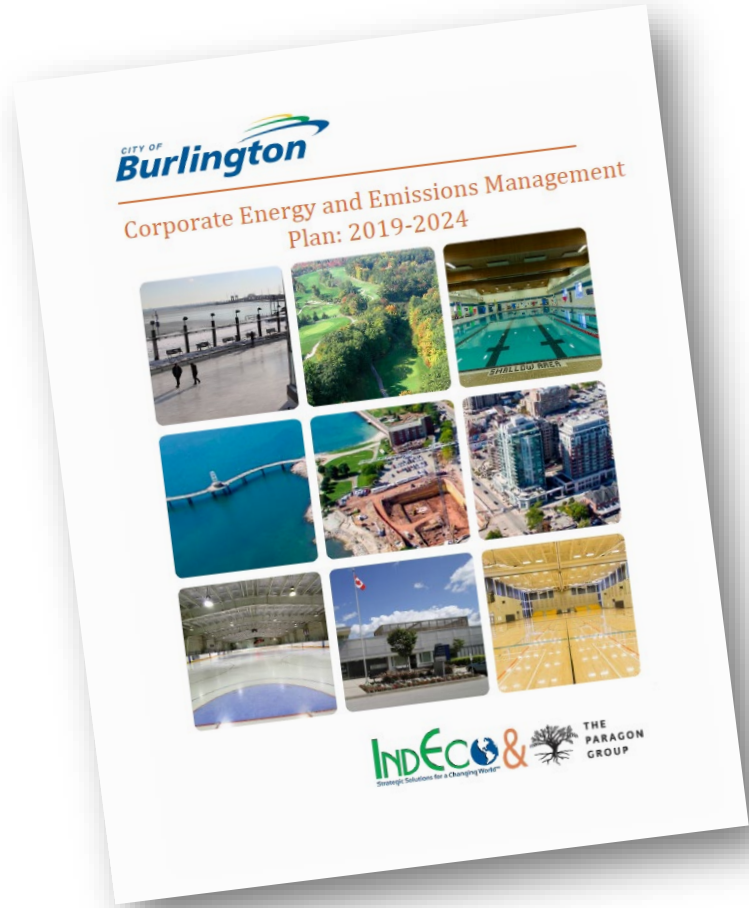




Deep Energy Retrofit Pathway Studies

Tom Pedlar - Corporate Energy & Emissions Coordinator

Why?



FCM - GMF - GHG Reduction Pathway Feasibility Study Funding

- ▶ Applied in June 2021
- ▶ Heard back with some comments from FCM in October 2021
- ▶ Approval from FCM for funding in December of 2021
- ▶ Agreement signed in March of 2022

- ▶ RFP for Consulting Issued in February 2022
- ▶ RFP for Consulting Awarded April 2022
- ▶ Studies began in April 2022
- ▶ Studies complete by June 2023

RFP Results & Details

- ▶ Followed the guideline given by FCM and modified as needed.
- ▶ Key points that we had added:
 - ▶ Licensed Quantity Surveyor in Ontario required for costing.
 - ▶ Geothermal Specialist required as part of the project team.
 - ▶ RETScreen Models of the pathway required at the end of the project.
 - ▶ Additional pricing included for air leakage testing at each building.
- ▶ Evaluation criteria were quite stringent.
- ▶ Lots of submissions (13) with varying levels of quality and price.
- ▶ DIALOG Design was chosen to perform our studies.
- ▶ Total cost for our studies was \$259,000+HST

Facilities Included

Brant Hills Community Centre & Library

- 20,000ft²
- Community Rooms, Gymnasiums (2), Library and Admin Spaces
- Original Construction 1980/2003

Appleby Ice Centre

- 140,000ft²
- 4 pad Arena with Community Rooms, Admin and Mechanical spaces
- Original Construction 1999/2009

Fire Station 2

- 8,300ft²
- 1 crew (2 truck) fire station
- Original Construction 1993

Fire Station 7

- 7,200ft²
- 1 crew (2 truck) fire station
- Original Construction 2001

GHG Reduction Pathway Study Process

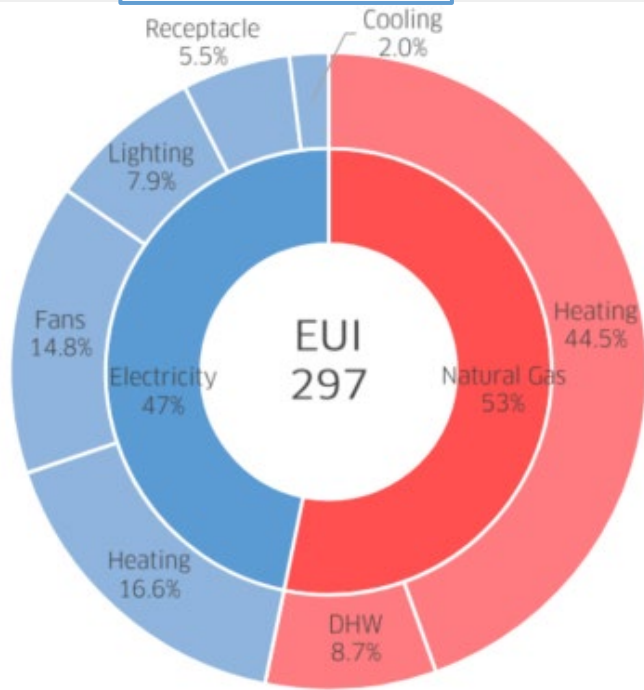
1. Site and Energy System Investigation
2. Calibrated Energy Model
3. Integrated Design Workshop
4. Measure Level Analysis
5. GHG Reduction Pathway Scenarios and Package Analysis
 1. 10 year plan to 50% reduction and a 20-year plan to minimum 80% reduction
 2. Short Term Deep Retrofit (2-5 years)
 3. Maximum Site Potential
 4. Optimized Outcome
6. Decision Making Workshop
7. Final Reports



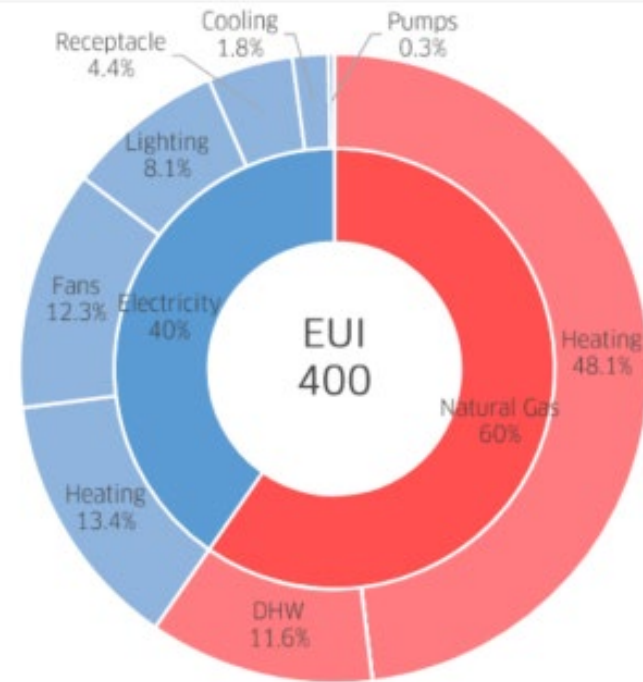
Results

Fire Stations 2 & 7

Fire Station 2



Fire Station 7



Fire Stations 2 & 7

Fire Station 2

ECM Tag	ECM Description	GHG Savings (%)	Capital Cost (\$)	Annual Energy Cost Savings (\$)	Lifecycle Cost Premium (\$)
BE-2	Roof Insulation Upgrade	91.6%	\$1,503,097	44.2%	\$800,507
BE-3a	High Performance Glazing				
BE-4	Air Sealing				
HVAC-2	Automated Exhaust System				
HVAC-8a	DHW Electrification				
HVAC-1,3,4	DOAS, HRV, DCV, Air-Source VRF				
RE-1	Photovoltaic Panels				

Fire Station 7

ECM Tag	ECM Description	GHG Savings (%)	Capital Cost (\$)	Annual Energy Cost Savings (\$)	Lifecycle Cost Premium (\$)
BE-3a	High Performance Glazing	89.3%	\$1,578,243	15.4%	\$1,020,565
BE-4	Air Sealing				
HVAC-2	Automated Exhaust System				
HVAC-8a	DHW Electrification				
HVAC-1,3,4	DOAS, HRV, DCV, Air-Source VRF				
RE-1	Photovoltaic Panels				

Fire Stations 2 & 7

Fire Station 2



Fire Station 7



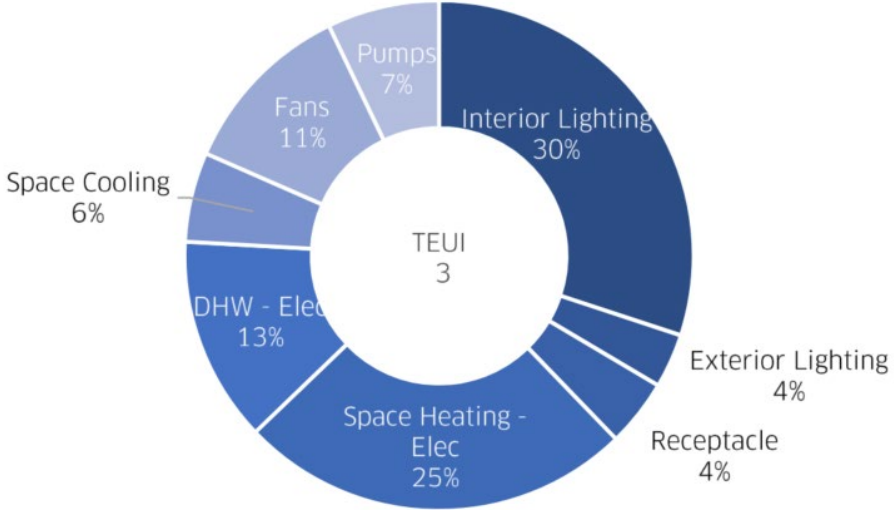
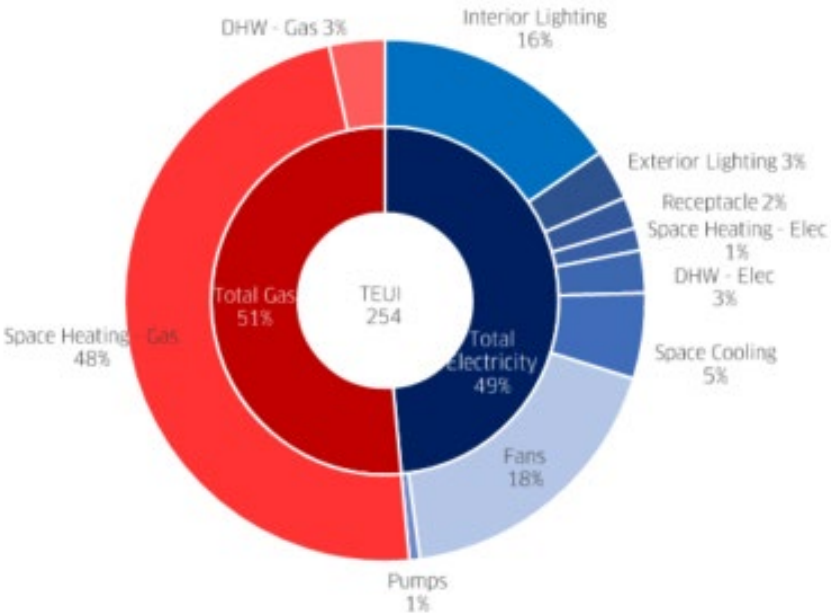
Fire Station 2

	Pathway BAU	Pathway 1	Pathway 2	Pathway 3	Pathway 4
TEUI (kWh/m ² a)	297.1	94.8	94.8	54.8	94.8
TEDI (kWh/m ² a)	141.8	125.3	125.3	106.4	125.3
Operational GHG (kgCO _{2e})	21,333	1,797	1,797	1,039	1,797
GHGI (kgCO _{2e} /m ²)	32.7	2.8	2.8	1.6	2.8
Energy Cost (\$)	14,682.6	8,186.1	8,186.1	4,731.9	8,186.1
Capital Cost	638,176.5	1,721,354.6	1,503,605.2	3,136,894.9	1,503,096.9
Incremental Capital Cost	-	1,083,178.0	865,428.6	2,498,718.4	864,920.3
30 Year Energy Costs (\$)	207,936.6	226,199.3	213,663.6	116,555.2	195,993.7
30 Year Carbon Costs (\$)	103,266.3	26,375.8	11,034.8	11,746.6	10,748.6
Total NPV (\$)	843,233.9	1,622,500.7	1,661,414.4	2,889,572.3	1,643,741.3
Total Incremental Cost NPV (\$)	-	1,150,283.6	1,044,825.0	2,342,074	1,094,059.7
30 Year Cost Premium (\$)	-	779,266.8	818,180.5	2,046,338	800,507.1
Lifecycle Premium / Tonne CO _{2e} (\$/tonneCO _{2e})	-	1,330	1,396	3,361	1,366
Peak Electrical Demand (kW)	Existing Capacity: 115.3	50.2	50.2	29.3	50.2

Fire Station 7

	Pathway BAU	Pathway 1	Pathway 2	Pathway 3	Pathway 4
TEUI (kWh/m ² a)	400.3	176.1	176.1	108.9	176.1
TEDI (kWh/m ² a)	177.8	190.8	190.8	131.8	190.8
Operational GHG (kgCO _{2e})	31,336	3,339	3,339	2,066	3,339
GHGI (kgCO _{2e} /m ²)	47.9	5.1	5.1	3.2	5.1
Energy Cost (\$)	18,015	15,210	15,210	9,412	15,210
Capital Cost	272,209	1,874,349	1,597,720	3,599,204	1,578,243
Incremental Capital Cost	-	1,602,140	1,325,511	3,326,995	1,306,034
30 Year Energy Costs (\$)	433,235	367,111	362,019	213,567	356,703
30 Year Carbon Costs (\$)	144,076	139,617	24,413	34,185	24,489
Total NPV (\$)	799,458	1,888,185	1,849,401	3,077,217	1,820,024
Total Incremental Cost NPV (\$)	-	1,696,455	1,619,945	2,854,225	1,593,524
30 Year Cost Premium (\$)	-	1,088,726	1,049,943	2,277,758	1,020,565
Lifecycle Premium / Tonne CO _{2e} (\$/tonneCO _{2e})	-	1,296	1,250	2,594	1,215
Peak Electrical Demand (kW)	Existing Capacity: 115.3	67.1	67.1	33.2	176.1

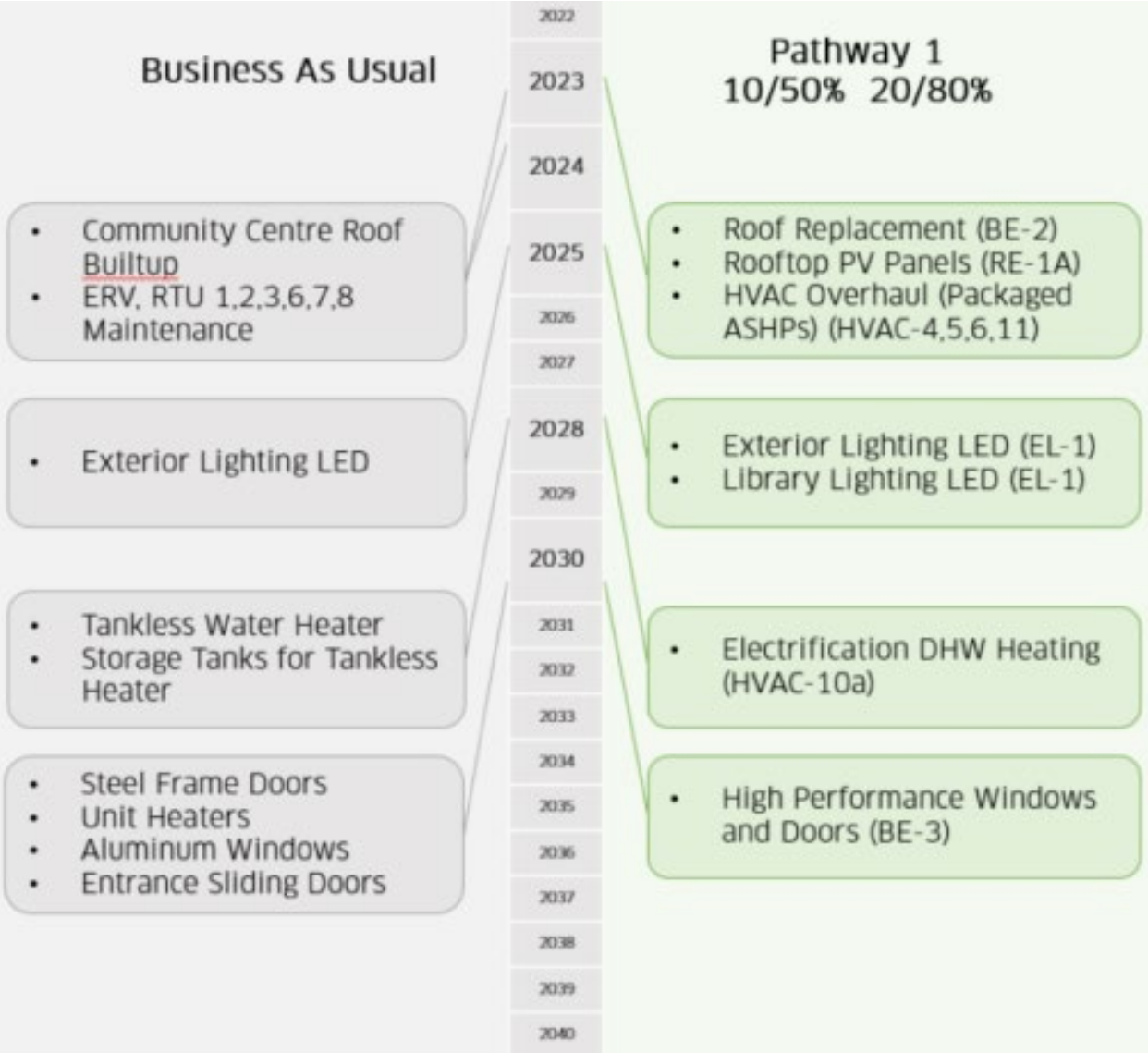
Brant Hills Community Centre



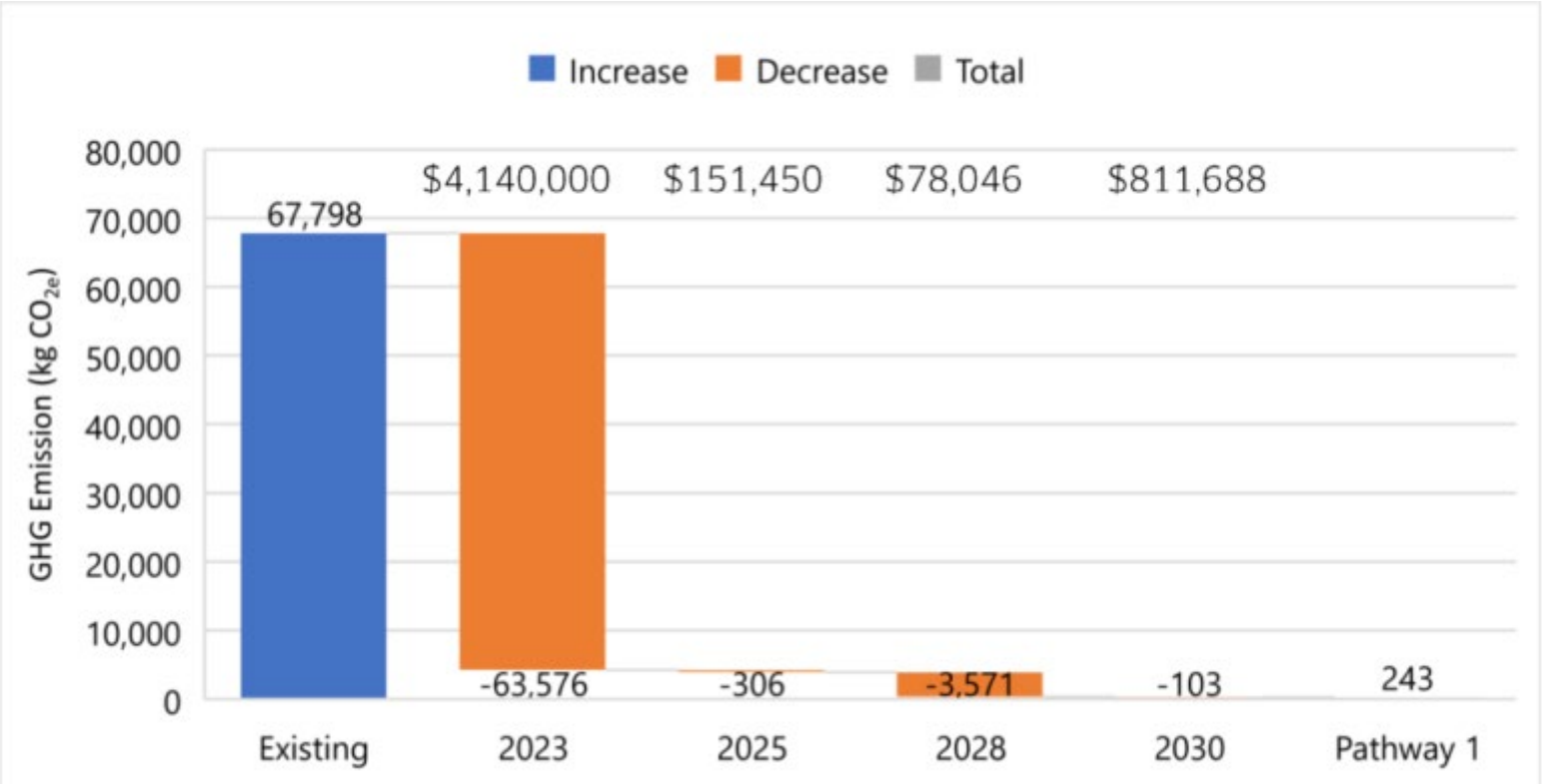
Brant Hills Community Centre

ECM Tag	ECM Description
BE-2	Roof Insulation Upgrade
BE-3	High Performance Glazing and Doors
HVAC-4,11	Packaged ASHP with Heat Recovery and DCV
HVAC-10a	Electric DHW Heater
EL-1	LED Technology
RE-1a	Rooftop Photovoltaic Panels

Brant Hills Community Centre



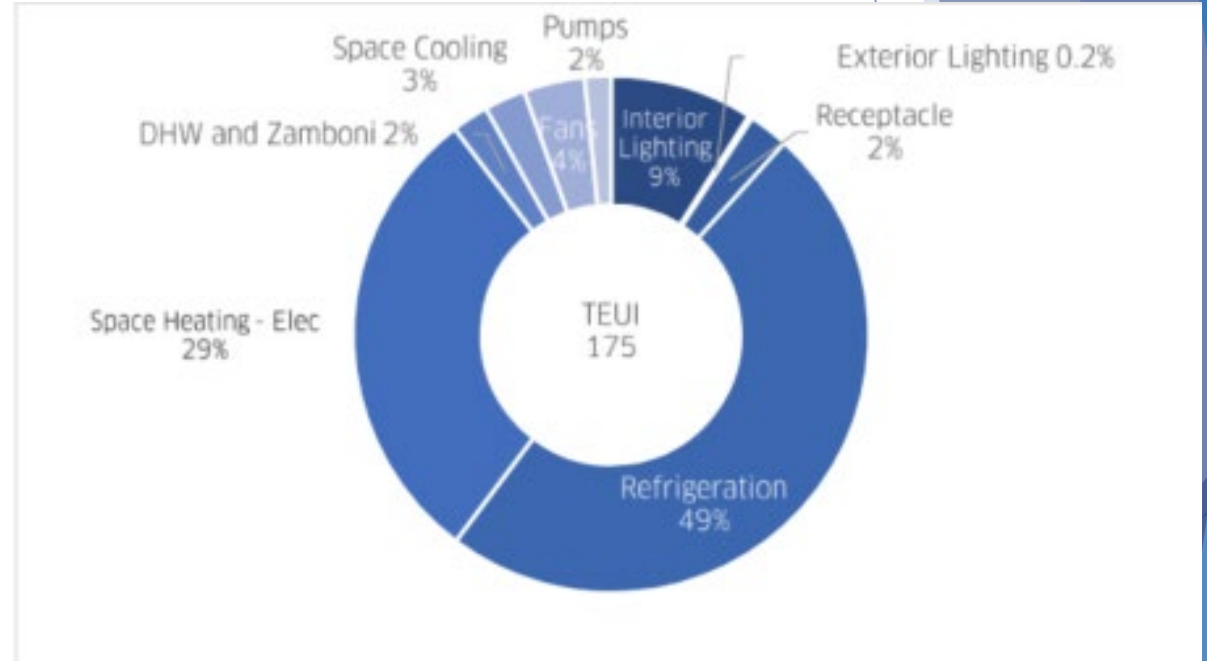
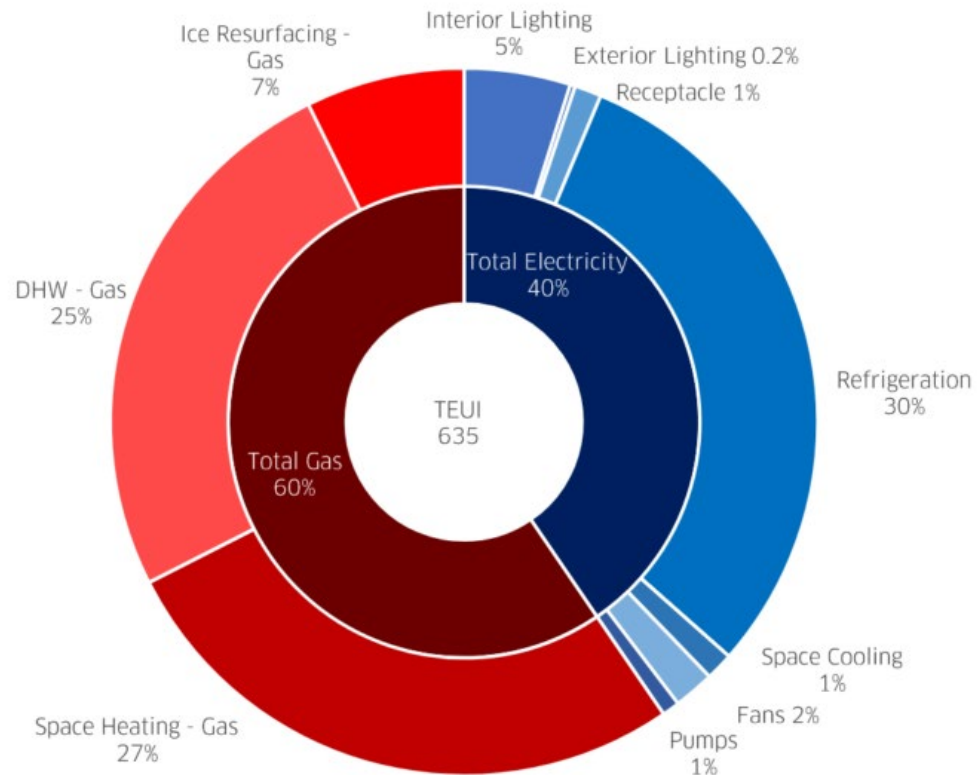
Brant Hills Community Centre



Brant Hills Community Centre

	Pathway BAU	Pathway 1	Pathway 2	Pathway 3	Pathway 4
TEUI (kWh/m ²)	246.7	3.3	3.3	0.0	3.3
TEDI (kWh/m ²)	100.7	68.0	68.0	45.9	68.0
GHGI (kgCO ₂ e/m ²)	26.7	0.1	0.1	0.0	0.1
Energy Cost (\$)	\$61,768	\$1,488	\$1,488	\$0	\$1,488
Capital Cost (\$)	\$1,434,700	\$5,181,184	\$5,181,184	\$7,838,668	\$5,181,184
Incremental Capital Cost (\$)	-	\$3,746,484	\$3,746,484	\$6,403,968	\$3,746,484
30-Year Energy Costs (\$)	\$1,482,835	\$35,520	\$38,879	\$2,532	\$35,520
30-Year Carbon Costs (\$)	\$321,761	\$2,875	\$1,174	\$1,739	\$2,875
NPV (\$)	\$3,087,673	\$5,048,451	\$5,221,237	\$7,336,350	\$5,048,451
Incremental Cost NPV (\$)	-	\$3,765,374	\$3,938,160	\$6,053,273	\$3,765,374
30-Year Cost Premium (\$)	-	\$1,960,778	\$2,133,565	\$4,248,677	\$1,960,778
Lifecycle Cost Premium Per Tonne of GHG Avoided (\$/tonCO ₂ e)	-	\$1,900	\$1,988	\$3,044	\$1,900
Peak Electrical Demand (kW)	831 kW existing capacity	85.3	85.3	69.8	85.3

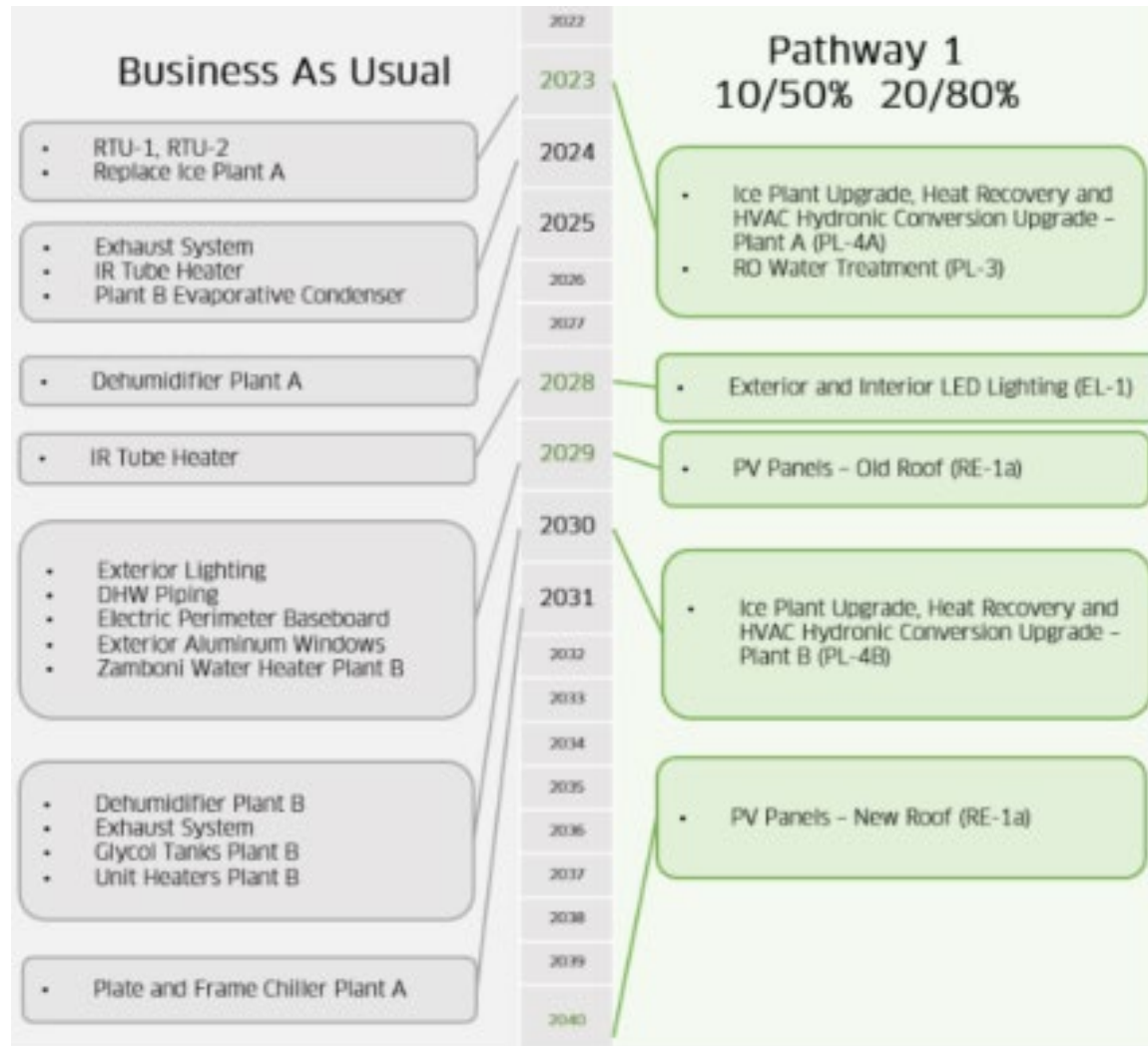
Appleby Ice Centre



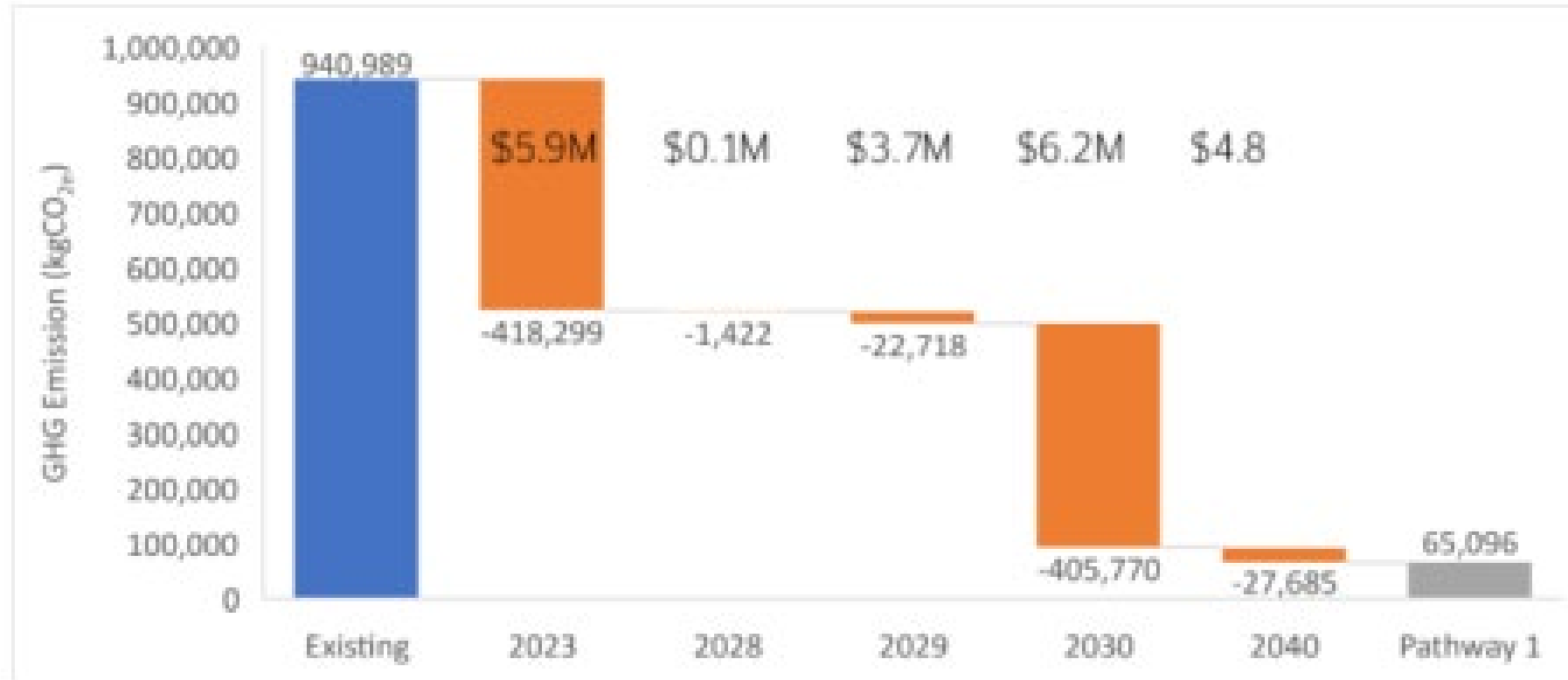
Appleby Ice Centre

ECM Tag	ECM Description
HVAC-7	Electric DHW + Ice Resurfacing
HVAC-11	Packaged Air Source Heat Pumps c/w HRV
EL-1	LED Technology in Rink 3 and 4
PL-4A	Ice Plant Upgrade, Heat Recovery and HVAC Hydronic Conversion Upgrade - Plant A
PL-4B	Ice Plant Upgrade, Heat Recovery and HVAC Hydronic Conversion Upgrade - Plant B
PL-3	Reverse Osmosis Water Treatment
RE-1a	Rooftop Photovoltaic Panels

Appleby Ice Centre



Appleby Ice Centre



Appleby Ice Centre

	Pathway BAU	Pathway 1	Pathway 2	Pathway 3	Pathway 4
TEUI (kWh/m2)	631	175	175	110	175
TEDI (kWh/m2)	101	14	14	9	14
GHGI (kgCO2e/m2)	76	5	5	3	5
Energy Cost (\$)	\$690,737	\$399,254	\$399,254	\$252,298	\$723,731
Capital Cost (\$)	\$2,972,600	\$20,820,085	\$18,751,184	\$43,835,745	\$20,820,085
Incremental Capital Cost (\$)	-	\$17,847,485	\$15,778,584	\$40,863,145	\$17,847,485
30-Year Energy Costs (\$)	\$18,270,973	\$12,497,225	\$11,418,209	\$11,273,446	\$12,497,225
30-Year Carbon Costs (\$)	\$4,555,025	\$674,600	\$338,117	\$556,130	\$674,600
NPV (\$)	\$25,446,129	\$30,299,811	\$29,479,798	\$44,335,905	\$30,299,811
Incremental Cost NPV (\$)	-	\$27,679,680	\$26,859,667	\$41,715,774	\$27,679,680
30-Year Cost Premium (\$)	-	\$4,853,682	\$4,033,669	\$18,889,776	\$4,853,682
Lifecycle Cost Premium Per Tonne of GHG Avoided (\$/tonCO2e)	-	\$1,055	\$1,024	\$1,548	\$1,055
Peak Electrical Demand (kW)	831 kW existing capacity	1198	1145	1198	1198

Lessons Learned / Changes

- ▶ Timeline for future studies
- ▶ Timelines for Analysis of each building



Questions?