Grand River Hospital 2019-2023 Energy Conservation and Demand Management Plan

JUNE 21, 2019

Under Ontario Regulation 507/18, Ontario's broader public sector organizations are required to develop and publish an Energy Conservation and Demand Management (ECDM) Plan by July 1, 2019. Technical advice and analysis for this ECDM Plan were provided by Enerlife Consulting Inc.

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Executive summary

Grand River Hospital has prepared this Energy Conservation and Demand Management (ECDM) plan (the Plan) that will reduce energy consumption and greenhouse gas (GHG) emissions, lower utility costs, upgrade building systems and provide a positive economic return on investment. The Plan presents energy savings achieved and lessons learned since the previous plan was posted in 2014, and lays out the goals, strategy and business case for the Hospital's energy efficiency investments over the next five years at its Kitchener-Waterloo and Freeport locations. We are committed to improving our energy efficiency, while maintaining occupant comfort and meeting the expectation of the general public and the Ministry of Health to deliver the highest quality of healthcare services to our community.

The Plan is well aligned with the emphasis on innovation and technology in Grand River's strategic plan. Our successes over the past 5 years reflect the hospital's culture of innovation and excellence. In 2019, Grand River has been recognized by Greening Health Care with its prestigious Leadership Award.

In the previously approved ECDM plan posted July 1, 2014, Grand River Hospital set an ambitious goal to reduce electricity and natural gas across both sites by 15% over the plan's 5-year term. Water use was not addressed in the 2014 plan, but measures to improve water use efficiency have been tackled. Our two sites together achieved 14.8% electricity and 10.9% natural gas savings in 2018 compared to our 2013 baseline, along with a 5.3% reduction is water consumption. These reductions lowered 2018 utility costs by almost $750,000, making Grand River one of the top-performers among the Greening Health Care member hospitals[1]. Further details on the measures implemented can be found in Part 2, Section 2 of the Plan. Table 1 summarizes actual results achieved.

Table 1 Energy and water savings in 2018 vs 2013 weather-normalized baseline – Grand River Hospital, both sites

Energy Type	Savings in 2018 vs 2013	Units	%	Cost savings
Electricity	3,920,390	kWh	14.8%	$588,059
Natural Gas	374,069	m3	10.9%	$112,220
Water	9,795	m3	5.3%	$50,542
Total	7,792,004	ekWh	12.6%	**$750,822**

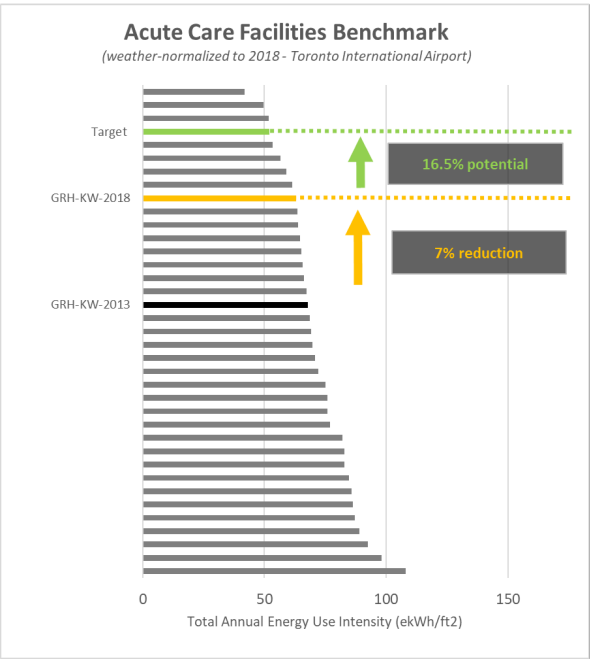
Our progress to date has been considerable. Lessons learned over the past 5 years can help us do even better in future and have been incorporated into the Plan. Key among these is the full engagement of our facilities operations staff in identifying and implementing opportunities to improve efficiency and being recognized for exceptional results.

Our goal for the next five years (2019 to 2023) is to further reduce energy use by 16.5% at the Kitchener-Waterloo (KW) site and by 21.1% at the Freeport (FP) site, and to cut water consumption by an additional 13.5% at the KW site, all measured against the new 2018 baselines. These improvements will move Grand

[1] Founded in 2004, Greening Health Care is the largest and longest serving program of its kind in North America, helping hospitals work together to lower their energy costs, raise their environmental performance and contribute to the health and well-being of their communities.

River into the top quartile of the benchmark charts of top-performing acute and continuing care hospitals, as shown in Figure 1 and Figure 2.

Figure 1 Grand River Hospital energy and water benchmarks for 2013, 2018, and 2023 target – Kitchener-Waterloo site



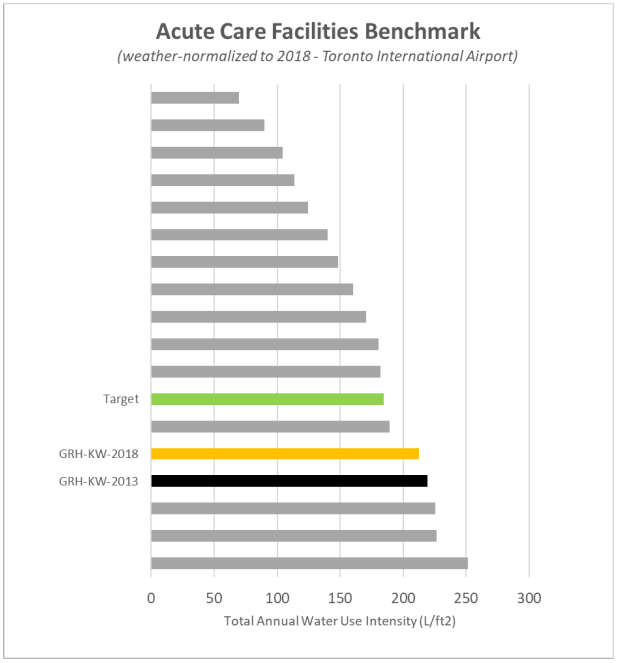
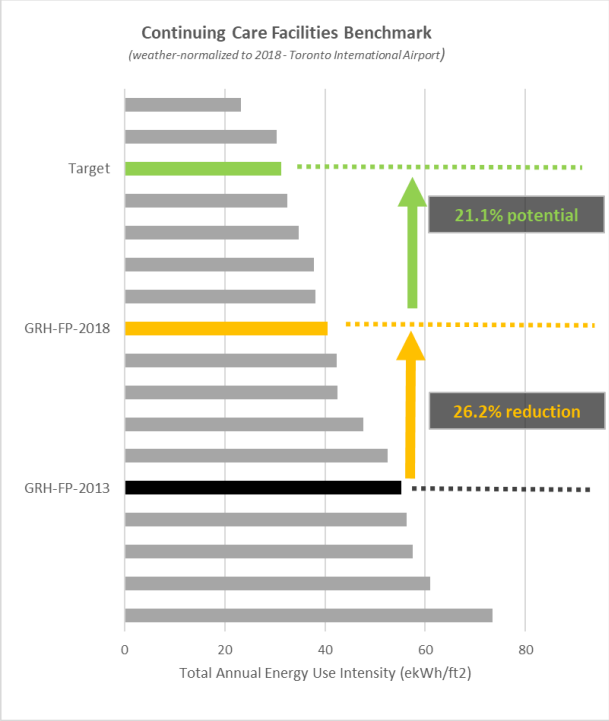
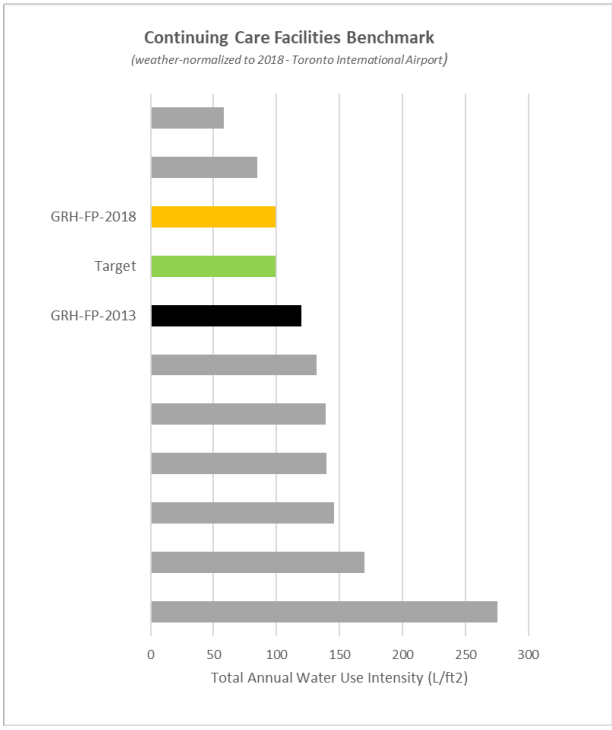


Figure 2 Grand River Hospital energy and water benchmarks for 2013, 2018, and 2023 target – Freeport site





The planned improvements prioritize continuing upgrading of building systems to improve occupant comfort as well as operating efficiency, and are described in Part 3, Section 3. Future capital renewal projects will incorporate energy efficiency standards. Where practical, Health Infrastructure Renewal Fund capital will be directed to projects which can deliver energy and water savings as well as replacement and upgrading of end-of-life building equipment and systems.

Tables 2 and 3 below summarize the energy and water efficiency improvements included in the scope of the Plan for the KW and Freeport sites respectively. Manageable work packages will be prioritized and scheduled over the 5-year period based on capital availability and project management capacity. These projects are collectively projected to bring in almost $350,000 of utility company incentives and yield electricity and natural gas savings worth close to $650,000 per year at current utility rates (both sites combined). The associated GHG emissions reduction is 1,295 tonnes CO2e per year.

Table 2 Energy and water efficiency projects summary – Kitchener-Waterloo site

#	Measures *(Note 1)*	Budget Costs	Savings $/year	Incentives	Paybacks (with incentives)	GHG Emissions Reduction (tonnes CO2e)	Estimated Measure Life (years)
1	**Lighting & Controls**						
	LED retrofit	$443,396	$61,904	$41,269	6.5	8.3	15
2	**Ventilation**						
	Scheduling	$188,000	$70,707	$43,937	2.0	59.4	5
	Testing and air balancing, refurbish ductwork/dampers	$478,000	$135,287	$86,990	2.9	68.0	10
	Install VFDs	$117,000	$37,762	$16,607	2.5	25.0	15
3	**Building Automation**						
	System upgrade	$68,000	$77,257	$38,699	3.5	210.1	15
	Reprogramming	$75,000					
4	**Heating Plant**						
	Testing & design brief	$40,000					NA
	Optimize condensing tower loop	$60,000	$17,607	$5,335	3.1	102.2	15
	Heat Recovery Chiller	$215,000	$53,370	$18,674	3.7	356.7	25
5	**Cooling Plant**						
	Testing & optimization	$45,000	$8,028	$5,352	4.9	1.1	15
6	**Water**	$180,000	$34,529	$0	5.2	0.1	15
7	**Building Envelope**						
	Thermographic Analysis	$50,000	$12,325	$3,735	10.2	71.6	10
	Air Sealing, Re-insulation	$80,000					

#	Measures *(Note 1)*	Budget Costs	Savings $/year	Incentives	Paybacks (with incentives)	GHG Emissions Reduction (tonnes CO2e)	Estimated Measure Life (years)
8	**Contingency**	$200,000					
Total		**$2,239,396**	**$508,775**	**$260,599**	***Note 2***	**902.3**	

Note 1: Some measures are interrelated and cannot be implemented independently

Note 2: Overall simple payback is affected by program management costs discussed in Section 4. These costs are included in Figure 2 Cashflow model.

Table 3 Energy and water efficiency projects summary – Freeport site

#	Measures *(Note 1)*	Budget Costs	Savings $/year	Incentives	Paybacks (with incentives)	GHG Emissions Reduction (tonnes CO2e)	Estimated Measure Life (years)
1	**Lighting & Controls**						
	LED retrofit	$106,077	$13,886	$9,257	7.0	1.9	15
2	**Ventilation**						
	Scheduling	$97,000	$26,037	$14,850	3.2	50.5	5
	Testing and air balancing, refurbish ductwork/dampers	$177,000	$41,942	$24,258	3.6	75.1	10
	Install VFDs	$90,000	$17,508	$10,244	4.6	29.1	15
3	**Building Automation**						
	System upgrade	$286,000	$27,585	$11,796	3.1	127.4	15
	Reprogramming	$50,000					
4	**Heating Plant**						
	Testing & design brief	$15,000	$3,935	$11,806	8.0	75.4	15
	Boilers retrofit	$60,000					
	Pumps testing and install VFD	$23,000					
5	**Cooling Plant**						
	Testing & optimization	$23,500	$3,401	$2,267	6.2	0.5	15
6	**Building Envelope**						
	Thermographic Analysis	$20,000	$5,182	$1,727	11.2	33.1	10
	Air Sealing, Re-insulation	$40,000					
7	**Contingency**	$100,000					

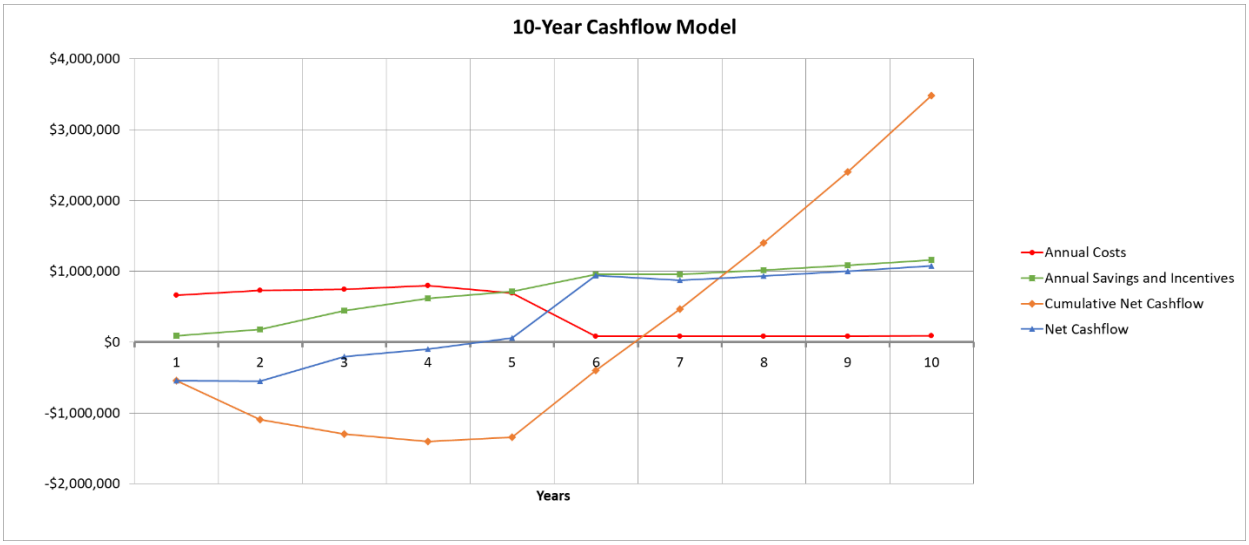
#	Measures *(Note 1)*	Budget Costs	Savings $/year	Incentives	Paybacks (with incentives)	GHG Emissions Reduction (tonnes CO2e)	Estimated Measure Life (years)
Total		**$1,087,577**	**$139,476**	**$86,207**	***Note 2***	**392.9**	

Note 1: Some measures are interrelated and cannot be implemented independently

Note 2: Overall simple payback is affected by program management costs discussed in Section 4. These costs are included in Figure 2 Cashflow model.

The business case for investment is summarized in the cash flow forecast presented in Figure 3. The forecast incorporates all project and ECDM program management costs, along with utility cost savings and estimated incentive receipts, phased in over the 5-year period and accounting for inflation as well as current utility cost escalation forecasts. Cumulative net cash inflow breaks even in year 6. Continuing, escalating savings yield a total cumulative net cashflow of $3.5 million at the end of 10 years after payment of all implementation costs.

Figure 3 Cashflow model



The rationale for investment is that this money is going to be spent anyway. Grand River chooses to spend it on upgrading building systems, organizational improvements and long-term savings rather than excessive payments to utility companies due to inefficient energy and water consumption.

Part 1: Introduction

1 About Grand River Hospital

Grand River Hospital was formed with the April 1995 merger of KW Health Centre and Freeport Health Centre. The hospital consists of two main sites offering acute and continuing care services: the Kitchener-Waterloo site (KW) and Freeport site (FP) with a combined total building area of 979,000 ft2 and 437 beds.

Table 4 Grand River Hospital sites

Site	Address	Building Area (ft2)	Description	Status in ECDM Plan
Kitchener-Waterloo site (KW)	835 King Street West, Kitchener	662,538	The main campus for acute care services	Primary focus
Freeport site (FP)	3570 King Street East, Kitchener	315,896	A rehabilitation and recovery centre	Primary focus

The organization has a long history of energy conservation initiatives. Our senior management is fully supportive of energy conservation projects and has a focus on the total life cycle costs of equipment replacements. Funding is made available for energy and water conservation initiatives and the savings generated have been shown to repay these investments.

2 Planning horizon and scope

The direct scope of the Plan covers our two primary sites. The planning horizon is the 5-year period from 2019 to 2023, prioritizing projects and organizational improvements which are manageable within this timeframe. We will continue to follow trends in technology and management practices in order to be well-prepared for future planning periods.

3 Other goals

Grand River aims to be a leader in energy efficiency and corporate sustainability among our peers. We will continue our collaboration with other hospitals through Greening Health Care and other organizations, working to raise the level of environmental sustainability across the healthcare sector as a whole. In particular we intend to extend our long-standing partnerships with St Mary's General, Cambridge and Guelph Wellington Hospitals to share best practices and performance results for our mutual benefit. We will continue to support events such as Earth Day which serve to reinforce a strong community sense of sustainability champions.

Part 2: Results from the past 5 years (2014-2018)

1 Energy and water progress compared to targets

In the previously approved ECDM plan posted on July 1, 2014, Grand River Hospital set a goal to reduce both electricity and natural gas at both sites by 15% over the plan's 5-year term. That plan budgeted an investment of $868,204 for energy conservation and demand management measures. The Hospital sites combined achieved 14.8% electricity and 10.9% natural gas savings in 2018, along with 5.3% water savings compared to the 2013 baseline, reducing energy costs by $750,822.

Table 5 Energy and water savings in 2018 vs 2013 weather-normalized baseline – Both sites

Energy Type	Savings in 2018 vs 2013	Units	%	Cost savings
Electricity	3,920,390	kWh	14.8%	$588,059
Natural Gas	374,069	m3	10.9%	$112,220
Water	9,795	m3	5.3%	$50,542
Total	7,792,004	ekWh	12.6%	**$750,822**

Table 6 Energy and water savings in 2018 vs 2013 weather-normalized baseline – Kitchener-Waterloo site

	2013 Target Savings		**2018 Actual Savings** (vs 2013 baseline)	
Electricity Reduction (kWh)	2,844,236	15%	1,896,157	10.0%
Natural Gas Reduction (m3)	374,547	15%	130,842	5.2%
Water Reduction (m3)	-		1,974	1.4%
Total Energy Reduction (ekWh)	6,720,798	15%	3,250,370	7.3%
Total Cost Reduction ($)			$333,862	

Table 7 Energy and water savings in 2018 vs 2013 weather-normalized baseline – Freeport site

	2013 Target Savings		**2018 Actual Savings** (vs 2013 baseline)	
Electricity Reduction (kWh)	1,127,916	15%	2,024,233	27%
Natural Gas Reduction (m3)	142,017	15%	243,227	26%
Water Reduction (m3)	-		7,820	1.4%
Total Energy Reduction (ekWh)	2,597,790	15%	4,541,637	26.2%
Total Cost Reduction ($)			$416,954	

The weather-normalized energy and water consumption trends shown in the figures below generally demonstrate steady improvement through this period, with occasional setbacks which are discussed under lessons learned. The blue points are actual monthly energy use and the red points are the comparative, weather-normalized 2013 baselines. Blue points below the red points signify real savings.

1.1 Energy and water use trends – Kitchener-Waterloo site

Figure 4 Electricity consumption in 2014-2018 vs 2013 weather-normalized baseline – KW site

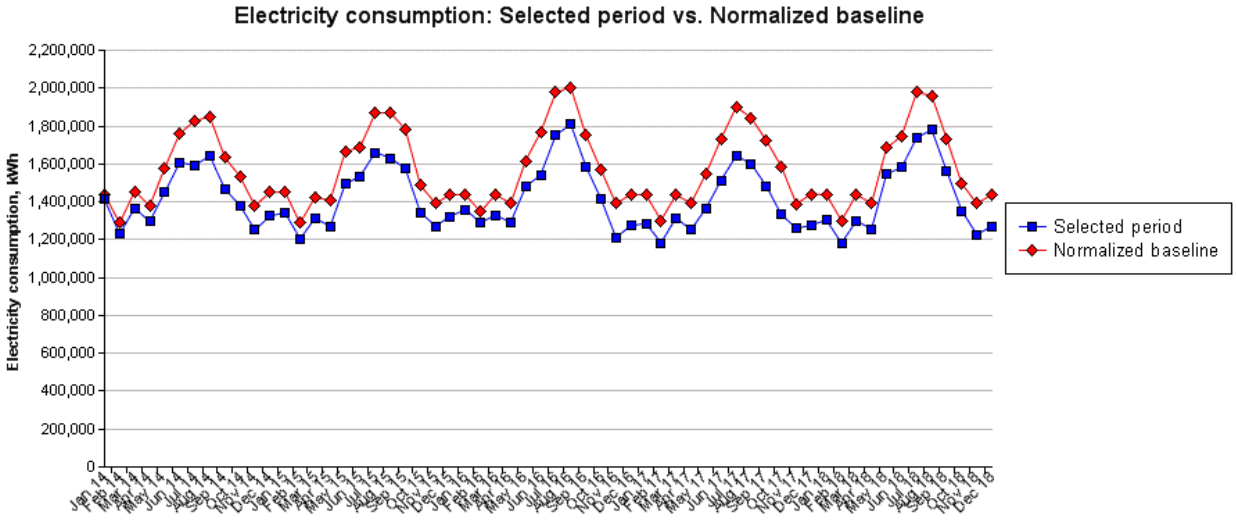
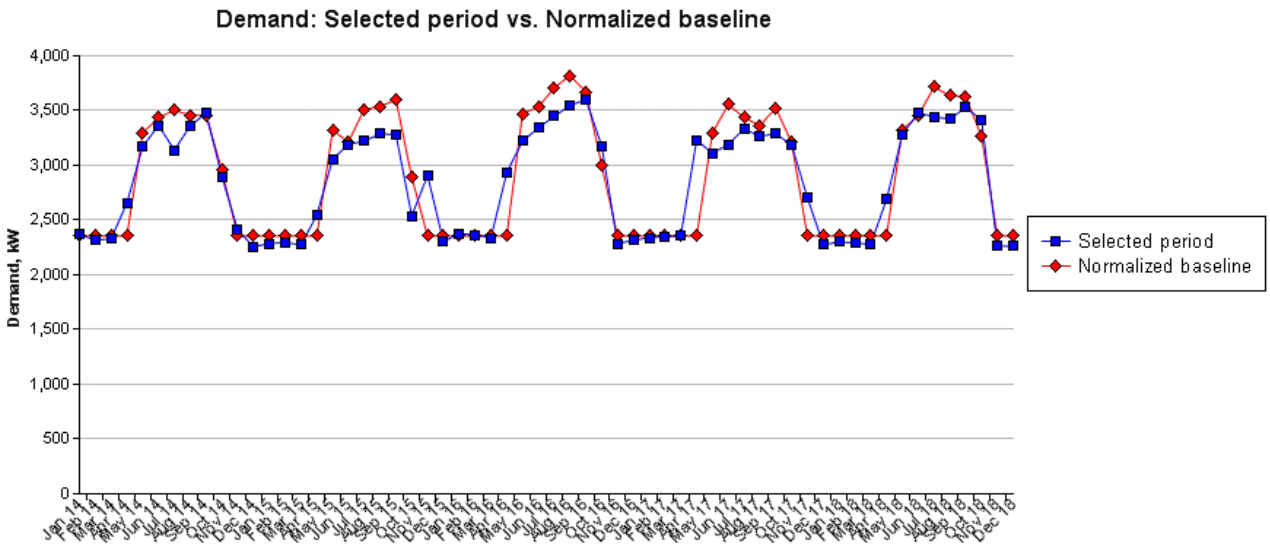
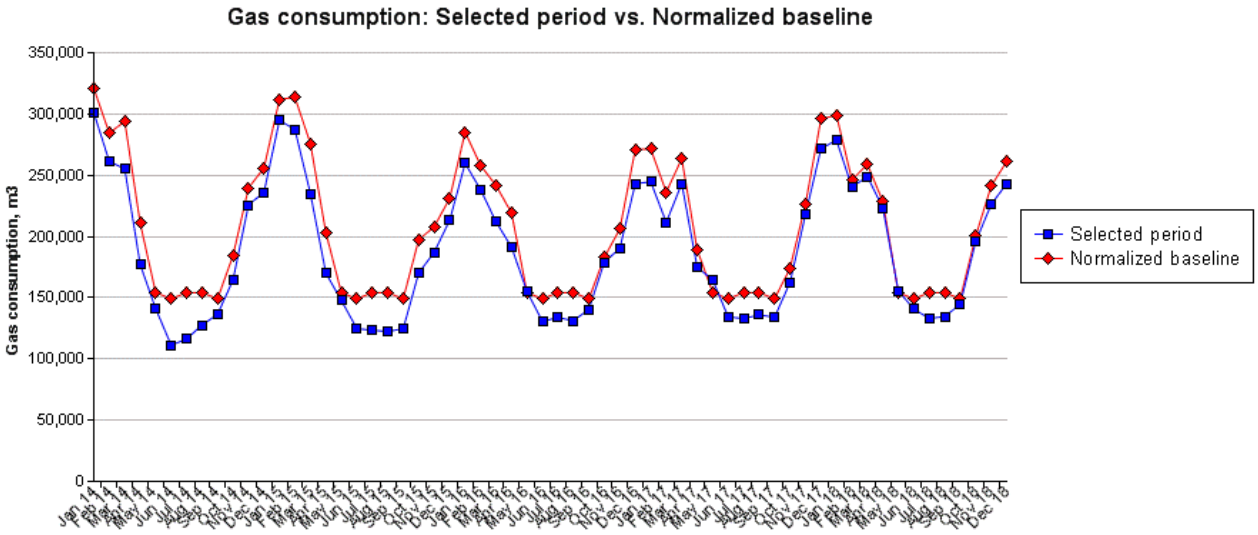


Figure 5 Demand in 2014-2018 vs 2013 weather-normalized baseline – KW site



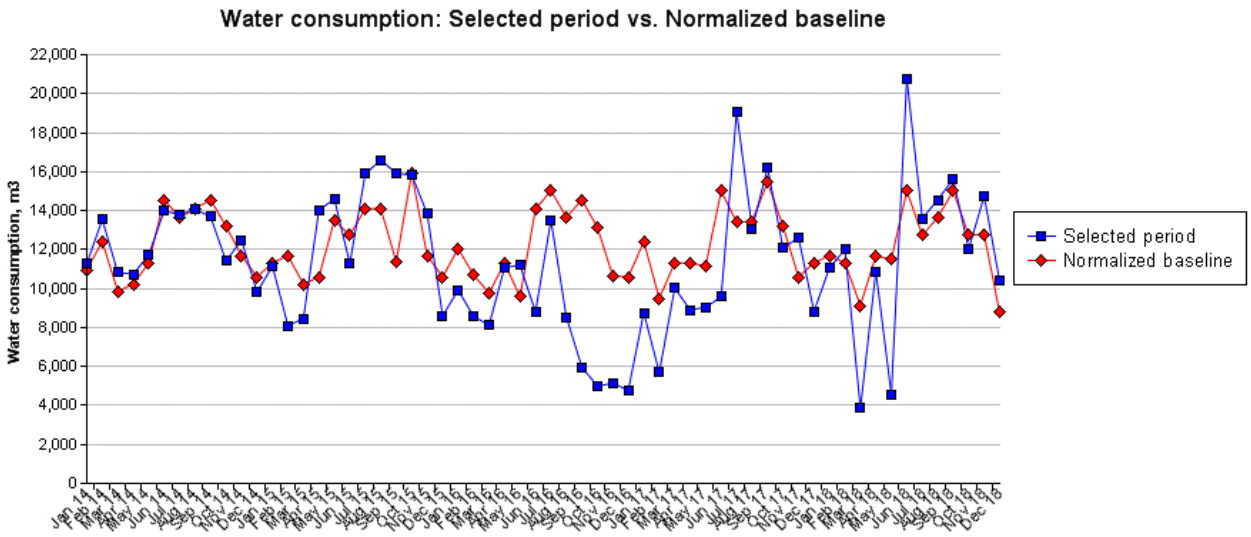
Savings during winter months (base electricity) are greater in consumption than demand, illustrating the impact of improved scheduling of building systems. Demand savings in summer attest to reductions in cooling loads due to control improvements.

Figure 6 Natural gas consumption 2014-2018 vs 2013 weather-normalized baseline – KW site



Gas savings are attributed to reduced reheat in air handling systems due to scheduling and control improvements. Summer consumption has been creeping back up over the past few years and this will be investigated further.

Figure 7 Water use 2014-2018 vs 2013 weather-normalized baseline – KW site



The big water use reduction in 2016 and the ongoing choppy consumption profile are attributed primarily to metering and billing anomalies, however significant savings have been achieved through better maintenance of cooling towers and trap primers. Consumption has been elevated for the past several months because the MRI is having to run on city water backup until its cooling equipment can be repaired.

1.2 Energy and water use trends – Freeport site

Figure 8 Electricity consumption in 2014-2018 vs 2013 weather-normalized baseline – FP site

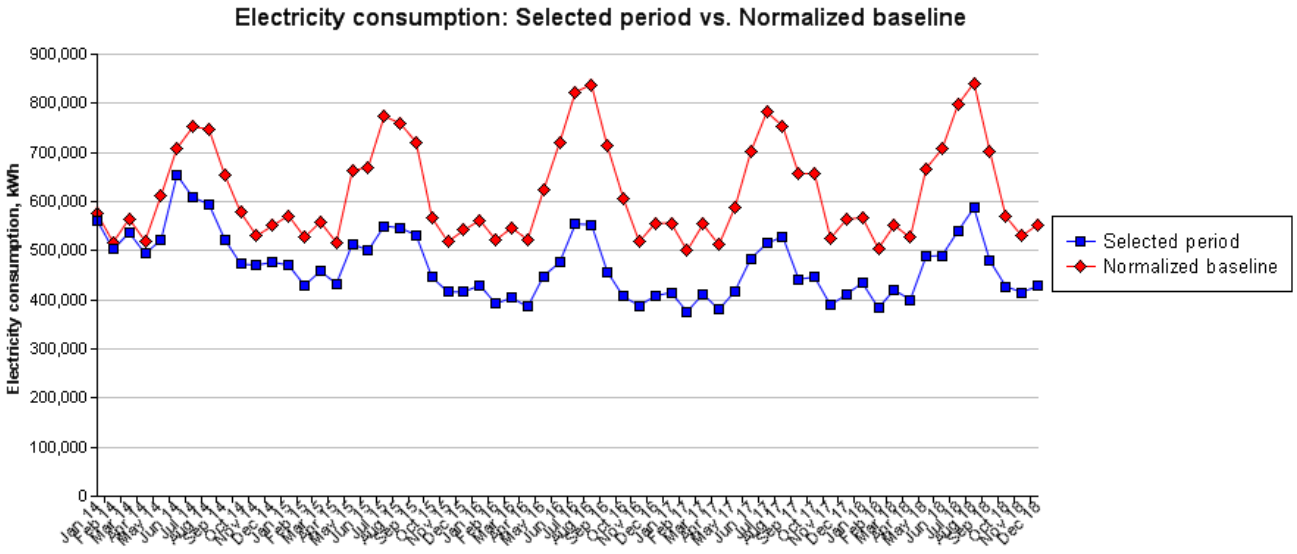
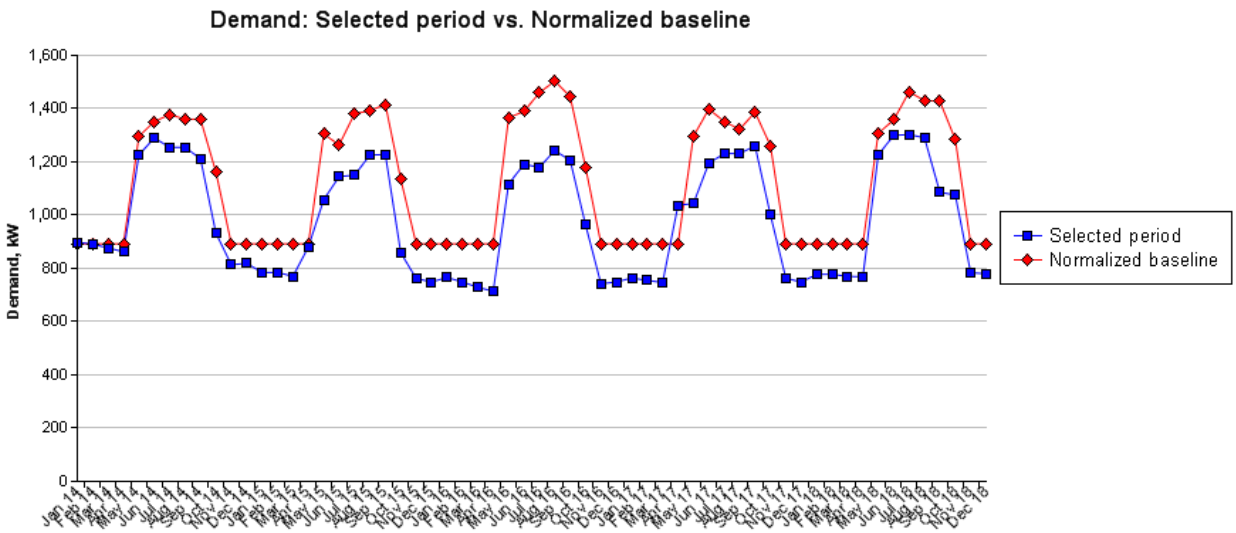
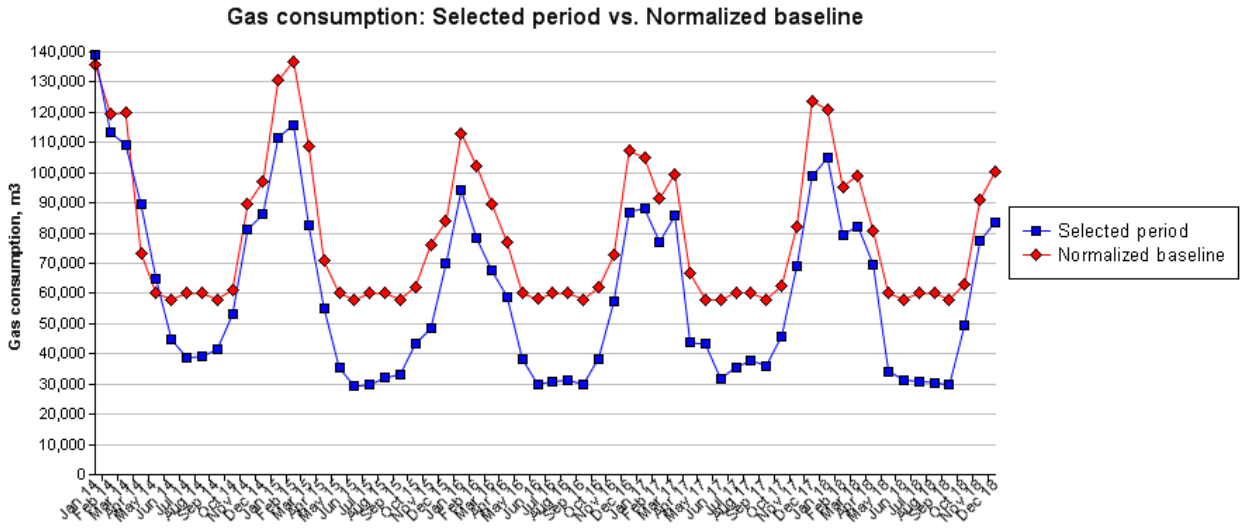


Figure 9 Demand in 2014-2018 vs 2013 weather-normalized baseline – FP site



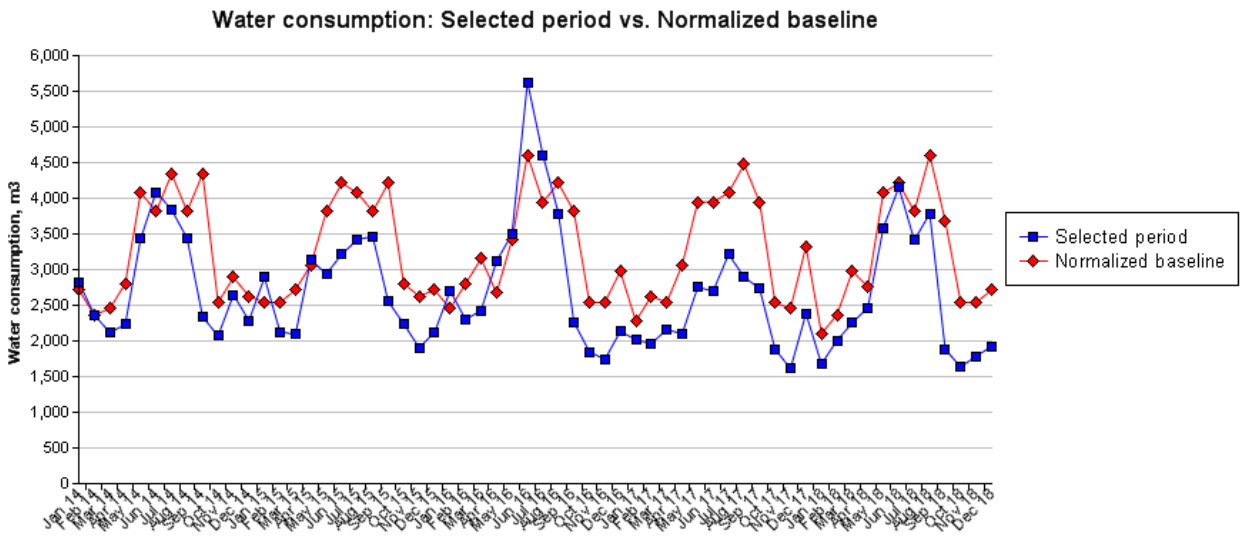
Substantial consumption and demand reductions, particularly during summer months, attest to the remarkable, award-winning effectiveness of the HVAC system improvements and lighting retrofits implemented during this period.

Figure 10 Natural gas consumption 2014-2018 vs 2013 weather-normalized baseline – FP site



The HVAC system control improvements, including equipment scheduling, have also resulted in substantial reductions in gas use, particularly during summer months when overcooling of ventilation air supply has been lowered, thus requiring less reheat.

Figure 11 Water use 2014-2018 vs 2013 weather-normalized baseline – FP site



Water consumption has been substantially lowered through improved maintenance tackling leaks and losses.

2 Measures implemented in 2014-2018

The biggest contributing factor to the energy and water savings was the hiring of our own building automation system (BAS) technician to monitor and adjust the building systems to optimal levels. After sending the technician for certified CEM training, he also acted as a mediator to solve building system issues and incorporate staff ideas for new ways to further save energy and water.

At the **KW site**, the following measures have been implemented during the period of the 2014 ECDM Plan:

1. Ventilation Scheduling
   - Installed approximately 60 VFDs and implemented new scheduling for all units where applicable
   - Used VAV boxes – building is 95% DDC controls – to close off the dampers and isolate unoccupied zones
   - Air supply scheduled for departments not occupied 24/7
2. Supply Air Temperature Reset
   - SAT resets on most AHUs based on OAT for some units and by polling reheat valves on others, resulting in reduced cold and hot calls as well as energy savings
3. Boiler and Heating Plant Refurbishment
   - Previously 3 Volcano hot water boilers ran during the summer. Installed 3 Spirax Sarco heat exchangers – two “easy heat” systems and one “quick heat” system – transferring the load to the short-cycling steam boilers and allowing the hot water boilers to be shut down
   - Then replaced the 3 Volcanos with 4 Fulton Condensing HW boilers, and currently installing 3 new Miura steam boilers
   - Reset steam pressure from 95PSI to 85PSI

- Replaced hundreds of reheat valves which were passing
- Eliminated 8 secondary pumps as the primary pumps had enough head and flow to overcome pressure drop in the entire loop
- Added new drives on primary and secondary pumps

4. Chiller Optimization
   - Initially, chilled water pumps speed was capped 75%, causing flow issues on equipment at end of loop
   - Primary variable system was run at constant speed most of the time
   - Removed the 75% cap to increase flow
   - Revised sequence of operations and fixed valves
   - Converted primary constant-only to variable flow system
   - Reset supply water temperatures
   - Resulted in increased system capacity and eliminated the requirement for a planned third chiller

5. Free cooling

[The hospital's CEM and electrician came up with this idea]

   - Installed a heat exchanger to provide free cooling during winter
   - Extended central plant CHW loop for summer operation, as it is more efficient than using the 35-ton air cooled chiller
   - Free cooling eliminated the use of air-cooled chiller in winter
   - Total budget $62,000, 0.8 year payback, $20,000 incentive
   - Created a website portal to monitor the system

6. Lighting LED installations from 2014 to 2018
   - 500 Fixture replacements

7. Water Cost Reductions
   - Using RO water from power house to supplement water softener brine tanks
   - Installed two water-saver units on new sterilizers which now use 70% less water per cycle
   - Replaced and repaired leaking solenoid valves on cooling towers
   - Replaced water cooled condensers with air cooled
   - Installed electronic float sensors on our cooling towers to replace old float valves thus reducing the amount of overflow

8. Equipment
   - Bio-Medical Waste Containers – Replace old inefficient refrigeration equipment with new high efficient equipment
   - Air compressors - fixed leaks, eliminated two 10 HP compressors

9. Understanding Load Increases
   - New CT scanner installed May/18 – consumes twice as much electricity as old unit
   - Two radiation bunkers added. Five out of six are running, increasing operating hours

At the **FP site**, the following measures have been implemented during the period of the 2014 ECDM Plan:

1. Ventilation Systems

- Air testing was completed
- The AHU inlet guided vanes were adjusted to 100% open position and VFDs installed to optimize fan speeds and flow requirements
- Main floor departments are only occupied during the day, but zone dampers were not functional or seized for years
- Pneumatic dampers were fixed which enabled the scheduling of the main floor
- Supply Air Temperatures reset

2. Chiller Plant
   - System pressure was too high to overcome CHW coil valve close off pressure
   - Valves were leaking and overcooling the spaces causing comfort issues
   - Installed VFDs, reduced the pump speed to maintain pressure
   - Set up primary variable flow system to work properly
3. Lighting LED installations from 2014 to 2018
4. Three large Clever Brooks boilers are now on standby while two smaller PK Boilers carry the load

3 Lessons learned

There have been many successes over the past five years and lessons were learned which will help us do even better in future. These lessons have informed the development of the Plan, and are summarized as follows:

1. Improved efficiency reduces the required capacity of plant and equipment. The previously planned $1.5M chiller plant expansion was made unnecessary by the cooling load reductions achieved through energy efficiency improvements. We now consider cooling, heating and electrical load optimization when planning for new equipment.
2. Listening to staff and implementing their ideas on ways to save energy and water, along with support from management, has created a positive culture of conservation. Our whole team has become energy conscious and continues to look for new opportunities to improve systems and eliminate waste. We've been able to send our staff for further training at half the cost through utility company support. Our staff have been empowered to run with an idea until a solution is found and to keep trying new methods if the first solution isn't feasible. We will continue to invest in their training and support.
3. As a team we will track our monthly savings reports closely to promptly identify variances and take appropriate action. We will investigate the increasing summer gas use at the KW site and inconsistencies in water use.
4. Notwithstanding the big gas savings achieved so far, Greening Health Care targets indicate substantial remaining potential, particularly in base (summer) consumption. We will examine heating plant and ventilation system operations to identify further savings.
5. Our building automation system has been key to the successes to date. We will continue to invest in keeping the technology up to date.

6. Further progress requires better information about our aging building systems and how they are performing. We will invest in system testing and documentation.
7. We can make more use of our membership in Greening Health Care for identifying the best measures, sharing experience with other hospitals, supporting staff training and reporting on and being recognized for our results.

Part 3: The plan for the next 5 years (2019-2023)

Grand River Hospital is working towards top-quartile positioning in the Greening Health Care energy efficiency/savings potential benchmark charts. The hospital is aiming to further reduce energy use by 16.5% at the Kitchener-Waterloo (KW) site and by 21.1% at the Freeport (FP) site, as well as cut water consumption by an additional 13.5% at the KW site, all measured against the new 2018 baselines. The projects and management/organizational measures described below are together designed to achieve this goal, delivering utility cost savings worth $645,000 per year at 2018 rates and an annual GHG emissions reduction of 1,295 tonnes CO2e.

1 2018 baseline

The table below presents 2018 energy and water use, costs and emissions for Grand River Hospital.

Table 8 Grand River Hospital energy and water use and expenditure, by site

Site	Energy Type	2018 Use	Units	2018 Costs ($)	Greenhouse Gas Emissions (tonnes CO2e)
Kitchener-Waterloo site					
	Electricity	17,165,607	kWh	$2,574,841	343
	Natural Gas	2,328,754	m3	$698,626	4,462
	Water	141,356	m3	$729,398	1.7
Freeport site					
	Electricity	5,496,899	kWh	$824,535	110
	Natural Gas	680,172	m3	$103,786	1,303
	Water	31,365	m3	$90,972	0.4
Total					
	Electricity	22,662,506	kWh	$3,399,376	453
	Natural Gas	3,008,927	m3	$802,412	5,765
	Water	172,721	m3	$820,370	2

2 Benchmark positioning and targets

Greening Health Care sets rational good practice energy and water targets for its member hospitals based on top-quartile performance of comparable buildings in the Greening Health Care database and adjusted for weather and material site specific variables. The figures below show the positioning of Grand River's two sites in 2013, 2018 and at the performance level which is the goal for the Plan. With the improvements made since 2013 both KW and Freeport are now among the mid-efficiency hospitals for energy use. The goal is to reach the top quartile.

Figure 12 Grand River Hospital energy and water benchmarks for 2013, 2018, and 2023 target – Kitchener-Waterloo site

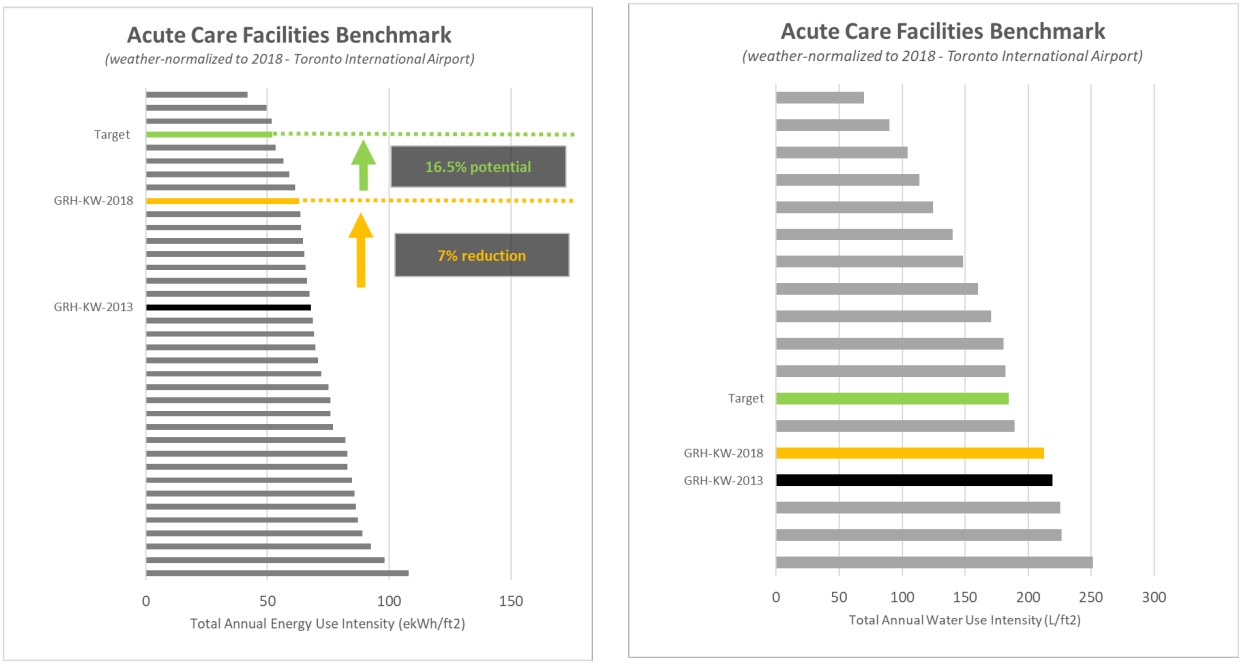


Figure 13 Grand River Hospital energy and water benchmarks for 2013, 2018, and 2023 target – Freeport site

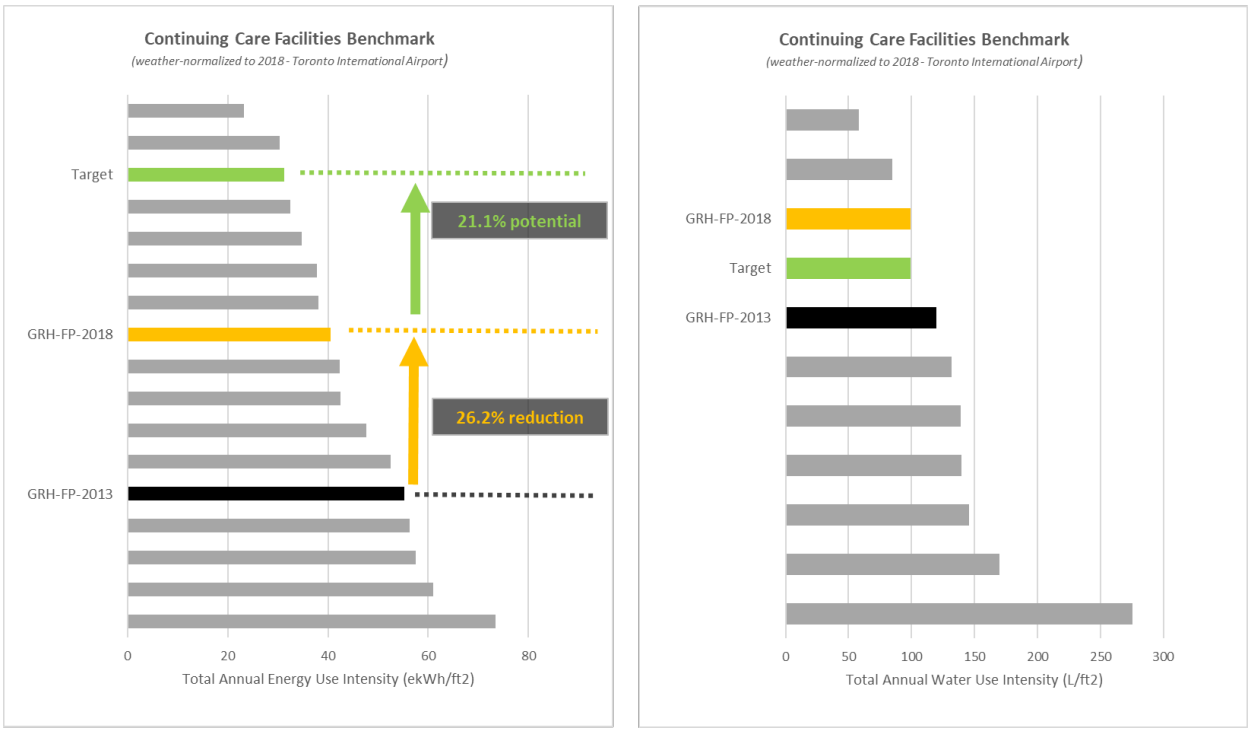


Table 9 below presents Grand River's actual and target energy intensities once the measures included in this Plan are implemented. Achievement of these targets will result in $645,000 in annual utility cost savings[2].

Targeted savings potential is further separated by energy components, which help us direct our efforts to the building systems with the biggest opportunities:

- Base electricity systems are fans, pumps, equipment and lighting, with moderate savings potential expected mostly in lighting and fan power;
- Cooling electricity systems are chiller plants and local AC units with moderate savings potential through further improvements in controls;
- Base thermal systems are primarily reheat in ventilation systems along with domestic hot water, sterilizers, and kitchens - this is the biggest area of savings potential through improved system controls and heating plant operations;
- Heating thermal systems are space and ventilation heating and humidification with minimal savings potential.

Table 9 Hospital energy targets

Hospital Site	Base Electricity (kWh/ft2)		Cooling Electricity (kWh/ft2)		Base Thermal (ekWh/ft2)		Heating Thermal (ekWh/ft2)		Total Energy (ekWh/ft2)		Annual Savings Potential	
	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	%	Cost
KW Site	22.9	20.0	3.0	2.6	25.3	18.3	11.1	11.1	62.3	52.0	16.5%	$505,454
Freeport Site	15.8	14.3	1.6	1.3	12.0	6.1	10.3	9.7	39.7	31.3	21.1%	$139,476

[2] Energy and water unit pricing used in cost savings potential numbers are $0.15 per kWh electricity, $0.30 per m3 of natural gas and $5.16 per m3 of water consumption.

3 Energy efficiency measures

Table 10 and Table 11 summarize the required retrofit projects and other measures together with their costs and savings, payback, and estimated GHG emissions reduction. Measures are described in more detail below.

Table 10 Energy and water efficiency projects summary – Kitchener-Waterloo site

#	Measures *(Note 1)*	Budget Costs	Savings $/year	Incentives	Paybacks (with incentives)	GHG Emissions Reduction (tonnes CO2e)	Estimated Measure Life (years)
1	**Lighting & Controls**						
	LED retrofit	$443,396	$61,904	$41,269	6.5	8.3	15
2	**Ventilation**						
	Scheduling	$188,000	$70,707	$43,937	2.0	59.4	5
	Testing and air balancing, refurbish ductwork/dampers	$478,000	$135,287	$86,990	2.9	68.0	10
	Install VFDs	$117,000	$37,762	$16,607	2.5	25.0	15
3	**Building Automation**						
	System upgrade	$68,000	$77,257	$38,699	3.5	210.1	15
	Reprogramming	$75,000					
4	**Heating plant**						
	Testing & reconfiguration	$40,000					NA
	Optimize condensing tower loop	$60,000	$17,607	$5,335	3.1	102.2	15
	Heat Recovery Chiller	$215,000	$53,370	$18,674	3.7	356.7	25
5	**Cooling Plant**						
	Testing & optimization	$45,000	$8,028	$5,352	4.9	1.1	15
6	**Water**	$180,000	$34,529	$0	5.2	0.1	15
7	**Building Envelope**						
	Thermographic Analysis	$50,000	$12,325	$3,735	10.2	71.6	10
	Air Sealing, Re-insulation	$80,000					
8	**Contingency**	$200,000					
Total		**$2,239,396**	**$508,775**	**$260,599**	***Note 2***	**902.3**	

Table 11 Energy and water efficiency projects summary – Freeport site

#	Measures *(Note 1)*	Budget Costs	Savings $/year	Incentives	Paybacks (with incentives)	GHG Emissions Reduction (tonnes CO2e)	Estimated Measure Life (years)
1	**Lighting & Controls**						
	LED retrofit	$106,077	$13,886	$9,257	7.0	1.9	15
2	**Ventilation**						
	Scheduling	$97,000	$26,037	$14,850	3.2	50.5	5
	Testing and air balancing, refurbish ductwork/dampers	$177,000	$41,942	$24,258	3.6	75.1	10
	Install VFDs	$90,000	$17,508	$10,244	4.6	29.1	15
3	**Building Automation**						
	System upgrade	$286,000	$27,585	$11,796	3.1	127.4	15
	Reprogramming	$50,000					
4	**Heating Plant**						
	Testing & reconfiguration	$15,000	$3,935	$11,806	8.0	75.4	15
	Boilers retrofit	$60,000					
	Pumps testing and install VFD	$23,000					
5	**Cooling Plant**						
	Testing & optimization	$23,500	$3,401	$2,267	6.2	0.5	15
6	**Building Envelope**						
	Thermographic Analysis	$20,000	$5,182	$1,727	11.2	33.1	10
	Air Sealing, Re-insulation	$40,000					
7	**Contingency**	$100,000					
	Total	**$1,087,577**	**$139,476**	**$86,207**	***Note 2***	**392.9**	

3.1 Lighting and controls

- Conduct a lighting audit of both sites to identify the best solutions which meet required light levels and power density standards
- Continue conversion to LED technology using in-house staff with priority to 24/7 and high maintenance areas
- Install occupancy sensors in 24/7 areas with intermittent occupancy

3.2 Ventilation

- Scheduling air supplies based on occupancy

  - Fine-tune existing schedules in consultation with departments
  - Re-program/retrofit airflow control boxes to allow zone controls in clinical areas
- Testing and Re-balancing
  - Conduct comprehensive testing of air handling systems, verify airflows against CSA requirements and supply/return/exhaust balance
  - Identify and repair/replace malfunctioning equipment and air leakage
  - Analyze static pressures, implement retrofits to prevent undue pressure losses
- Variable Frequency Drives
  - Install VFDs on the few remaining fans which do not have them.
- System Renewal
  - Based on test results, seek HIRF and other capital funding to replace systems and equipment which is beyond its useful life
  - Plan for replacement when funding available
- Documentation
  - Work towards a complete library of electronic drawings and documentation

3.3 Building automation system

- System Upgrade
  - Upgrade network to separate from the hospital network – increase network speed
  - Provide server space to store 2 years of trend log data for selected systems – at present data are archived on local controllers
  - Front end replacement for both sites
  - Staged replacement of Freeport controllers
- System Programming
  - Analyze trend logs for each building system and make programming adjustments as indicated to optimize efficiency

3.4 Heating plant

- Conduct plant and equipment testing and analysis and prepare a design brief for each site identifying the long-term vision of the high-efficiency, low-carbon plant configuration and including:
  - Immediate plant refurbishment and control improvements
  - Optimization of existing heat recovery equipment
  - Loads and plant capacities for hot water and (KW site) high- and low-pressure steam

  - Applications for heat recovery chillers
  - Applications for solar thermal installations
- Prepare steam distribution system schematic for the KW site to show equipment served and identify lines which could be shut down in summer months

3.5 Cooling plant

- Conduct testing of chillers, pumps and cooling towers, analyze trend logs
- Implement VFDs where indicated
- Adjust programming of plant sequencing and chilled and condenser water temperature control as indicated

3.6 Water (KW site)

- Complete repairs to get the MRI chiller off city water cooling
- Implement real-time water meter monitoring through the BAS with alarms to notify operators of leaks and losses

3.7 Building envelope

- Conduct targeted exterior thermographic scans for both sites
- Implement local air sealing and re-insulation as indicated to avoid discomfort and save energy

3.8 Renewable energy

There are no existing renewable energy installations at either facility. Possible application of solar thermal at the KW site will be considered in the Heating Plant Design Brief (see Section 3.4 above).

4 Management and organizational alignment

Further management and organizational development form an essential part of the Plan to enable and support conservation project delivery and continuous efficiency improvement, and to sustain savings over time.

4.1 Strategic alignment

Explicit reference to sustainability in Grand River's quality improvement and other strategic reporting will be considered to further reinforce with stakeholders its importance to the hospital.

4.2 Energy management, reporting and team-building

We will continue to enable energy management effectiveness by implementing an integrated performance reporting system. Enhanced transparency and motivation will be achieved through regular communication of actual savings results to all stakeholders, in particular facility operations staff, beginning with monthly savings and progressing over time towards weekly and real-time reporting. Regular team meetings will continue, reviewing results, identifying solutions and brainstorming new ideas, with documentation of action items and follow up on implementation.

4.1 Integrated Building Performance Team

We will fully integrate our building automation system into facility operations and maintenance through a team-based approach to monitoring performance through trend logs, optimizing and verifying control strategies, fine-tuning operations and responding to comfort and operational issues through our closed-loop work order system.

4.2 Staff training and support

Further enhancement of staff capability in energy management and building automation will be achieved by defining job-specific expectations, providing on-the-job training opportunities and working with service providers to provide necessary training and support. Roles and responsibilities for future hires will be formalized.

We will make greater use of our membership in Greening Health Care by incorporating case studies into our in-house training, exposing more of our staff to the program's networking, workshops and webinars, earning recognition for our achievements and continuing to participate in the program's applied research into areas of opportunity for Grand River.

4.3 Facility renewal and renovations

We will put in place and reinforce design and operational standards to ensure renovations consistently deliver high-performance, and that HVAC service levels and user guidelines (such as space temperature set-points) are communicated and followed.

4.4 Occupant engagement and communications

We will communicate results achieved to the broader hospital community together with how occupants can help with further energy and water efficiency improvements through operational and behavioural changes.

4.5 Project and program management and support

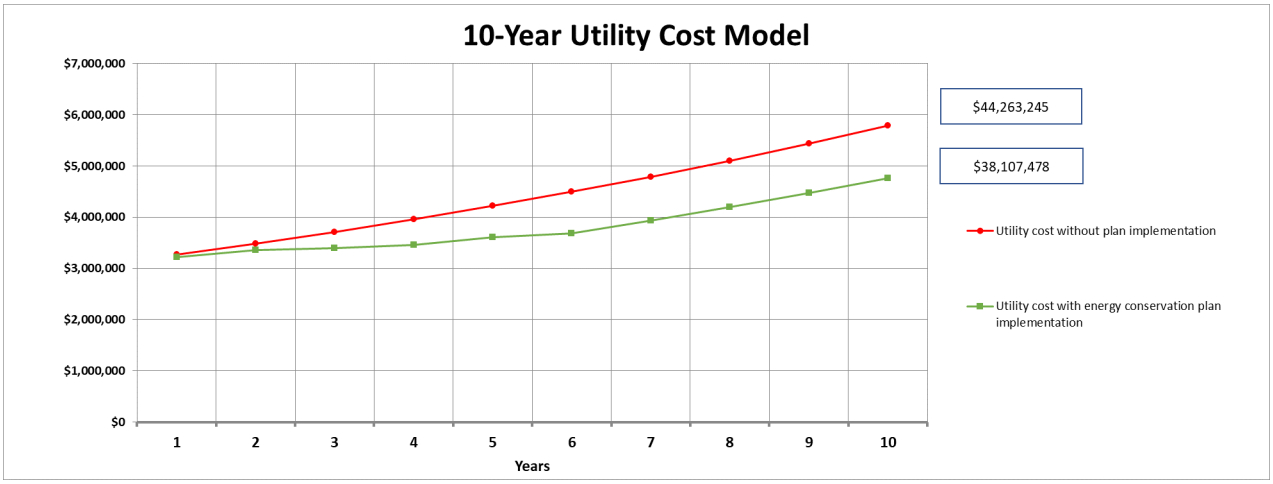
Our facilities management team has proven very effective at identifying and implementing efficiency improvements and demonstrating results. Moving to the next level and generating the magnitude of operating cost savings presented in the Plan will require additional time, particularly in project management, system monitoring and verification and internalizing the results of system testing and BAS trend log capability. An energy program management budget of $100,000/year is included in the financial analysis and cash flow forecast to pay for additional resources that will be needed to keep the work on track. We will explore the possibility of an energy manager position funded in part by our electric utility company.

5 Project timelines and financial forecast

5.1 Utility cost forecast

Figure 14 shows the 10-year annual utility cost forecast for the hospital, with and without implementation of the project.

Figure 14 Utility cost forecast over the next 10 years



With current utility price escalation forecasts, the hospital's annual utility costs (electricity, natural gas and water) can be expected to rise from $3.27 million in 2018 to $5.8 million in 2028, for a ten-year total spend of more than $44 million. Implementation of the ECDM Plan is projected to lower that expenditure by almost $1.6 million over the 5-year period of the Plan, while maintaining those savings over 10 years will provide cumulative savings of over $6 million due to implementation of the measures. These utility cost savings will fully repay the total investment in energy and water efficiency improvements and provide a positive net cash flow to hospital operations.

5.2 Phasing of work and annual implementation costs

Table 12 below presents the initial distribution of project costs over the 5-year term which are used in the financial model presented in Section 5.3. The first order of business following plan approval will be to confirm manageable work packages for the first 2 years which address capital availability and project delivery capacity and provide the greatest financial and operational benefits.

Table 13 shows the resulting annual project costs based on the initial distribution together with ECDM program management costs discussed in Section 4.5 above (accounting for inflation).

Table 12 ECDM plan work phases

Measure	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Lighting Controls	20%	40%	60%	80%	100%					
Ventilation	25%	50%	70%	90%	100%					
Building Automation	25%	50%	75%	90%	100%					

Measure	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
Heating plant	10%	25%	50%	75%	100%					
Cooling Plant	10%	25%	50%	75%	100%					
Water Conservation	20%	40%	60%	80%	100%					
Building Envelope	0%	10%	20%	50%	100%					
Contingency	20%	40%	60%	80%	100%					

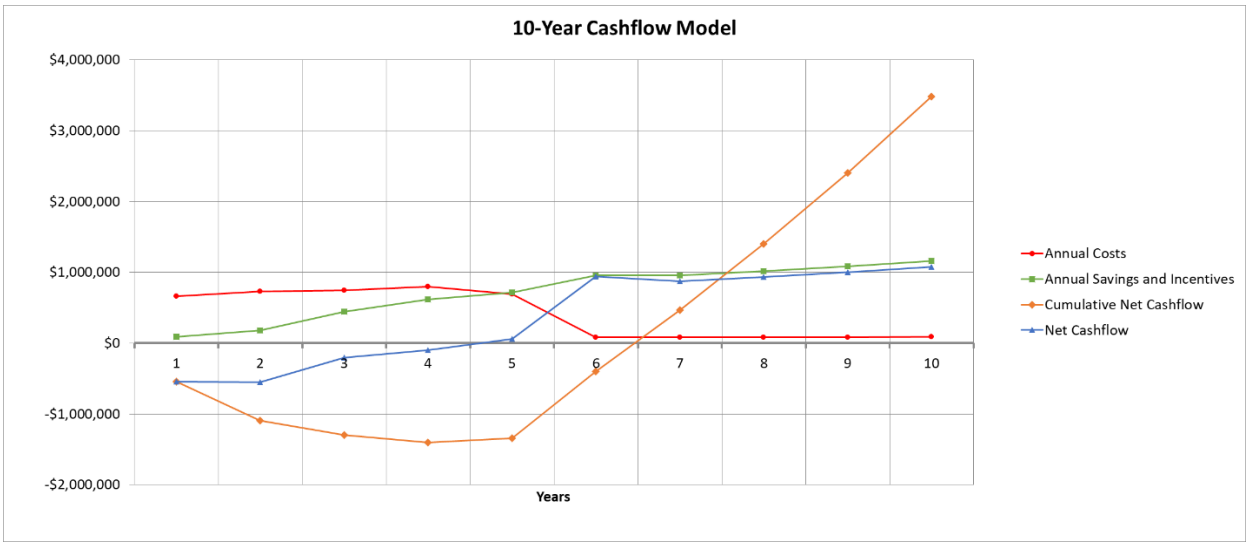
Table 13 Annual costs

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Total
Project cost (with inflation)	$660,545	$721,210	$729,575	$737,153	$644,483	-	-	-	-	-	$3,492,965
Program cost (with inflation)	$100,000	$102,500	$105,063	$107,689	$77,267	$79,199	$81,179	$83,208	$85,288	$87,420	$908,812
Total cost	**$760,545**	**$823,710**	**$834,637**	**$844,842**	**$721,750**	**$79,199**	**$81,179**	**$83,208**	**$85,288**	**$87,420**	**$4,401,777**

5.3 Cash flow and Internal Rate of Return

The cashflow model in Figure 15 and Table 14 below includes inputs from project costs, energy savings and utility incentives, together with ECDM program management costs. The model provides an internal rate of return of 18.9% and payback period of 5.7 years.

Figure 15 Cashflow model



The 10-year costs, savings, and incentives as well as key assumptions are summarized below.

Table 14 Cashflow model

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Total
Total cost	$760,545	$823,710	$834,637	$844,842	$721,750	$79,199	$81,179	$83,208	$85,288	$87,420	**$4,401,777**
Incentives	$31,963	$36,579	$98,333	$79,094	$37,793	$63,045	$0	$0	$0	$0	$346,806
Savings	$58,897	$139,783	$345,669	$538,362	$678,402	$893,277	$953,702	$1,018,315	$1,087,413	$1,161,314	$6,875,135
Total incentives + savings	$90,860	$176,363	$444,002	$617,456	$716,195	$956,322	$953,702	$1,018,315	$1,087,413	$1,161,314	**$7,221,941**
Cumulative net cashflow	-$637,722	-$1,285,069	-$1,577,372	-$1,725,664	-$1,693,426	-$753,258	$119,265	$1,054,372	$2,056,497	$3,130,391	
Net cashflow	-$637,722	-$647,347	-$292,303	-$148,292	$32,238	$940,168	$872,523	$935,107	$1,002,125	$1,073,894	18.9%

Assumptions

Inflation	2.5%	Elec. rate at 1st year ($/kWh)	$0.15
Electricity escalation rate	6.9%	Gas rate at the 1st year($/M3)	$0.30
Demand escalation rate	6.9%	Water rate at 1st year ($/M3)	$5.16
Gas escalation rate	5%	Electricity incentives ($/kWh)*	$0.10
Water escalation rate	8%	Gas incentives ($/M3)*	$0.20

**Rates are based on current utility company incentive program structure, subject to change*

6 Immediate next steps

- Senior management sign-off and posting the Plan on the Grand River website
- Determination of the year 1-2 work plan

Management sign-off

I confirm that Grand River Hospital's senior management has reviewed and approved this 2019-2023 Energy and Conservation and Demand Management Plan.

Signature: _____

Name: _____ Date: _____

Title: _____