

Getting It Right the First Time: Actual Energy Performance of Ontario's New Hospitals

A GREENING HEALTH CARE WHITE PAPER



This white paper is the result of a Greening Health Care research project directed by Enerlife Consulting. We acknowledge and appreciate the participation and support of the hospitals, Infrastructure Ontario and all those who played their parts in the data collection and workshops. Particular thanks to Markham Stouffville Hospital and William Osler Health System for hosting the workshops.

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1 Executive Summary

Since 2005, almost twenty new hospitals have opened across the province under Ontario's Alternative Financing and Procurement (AFP) delivery model¹. In 2018, [Greening Health Care](#) published a white paper on actual energy performance of Ontario's new hospitals, using 2017 utility data. This white paper uses 2018 utility data and conclusions from the Greening Health Care Forum held at Peel Memorial Centre on June 12th, 2019 to update the 2018 publication. The white paper further quantifies and characterizes the relative energy and water efficiency of 15 of these new hospitals which submitted data, and reviews progress made and lessons learned over the past year.

The goals of this research are:

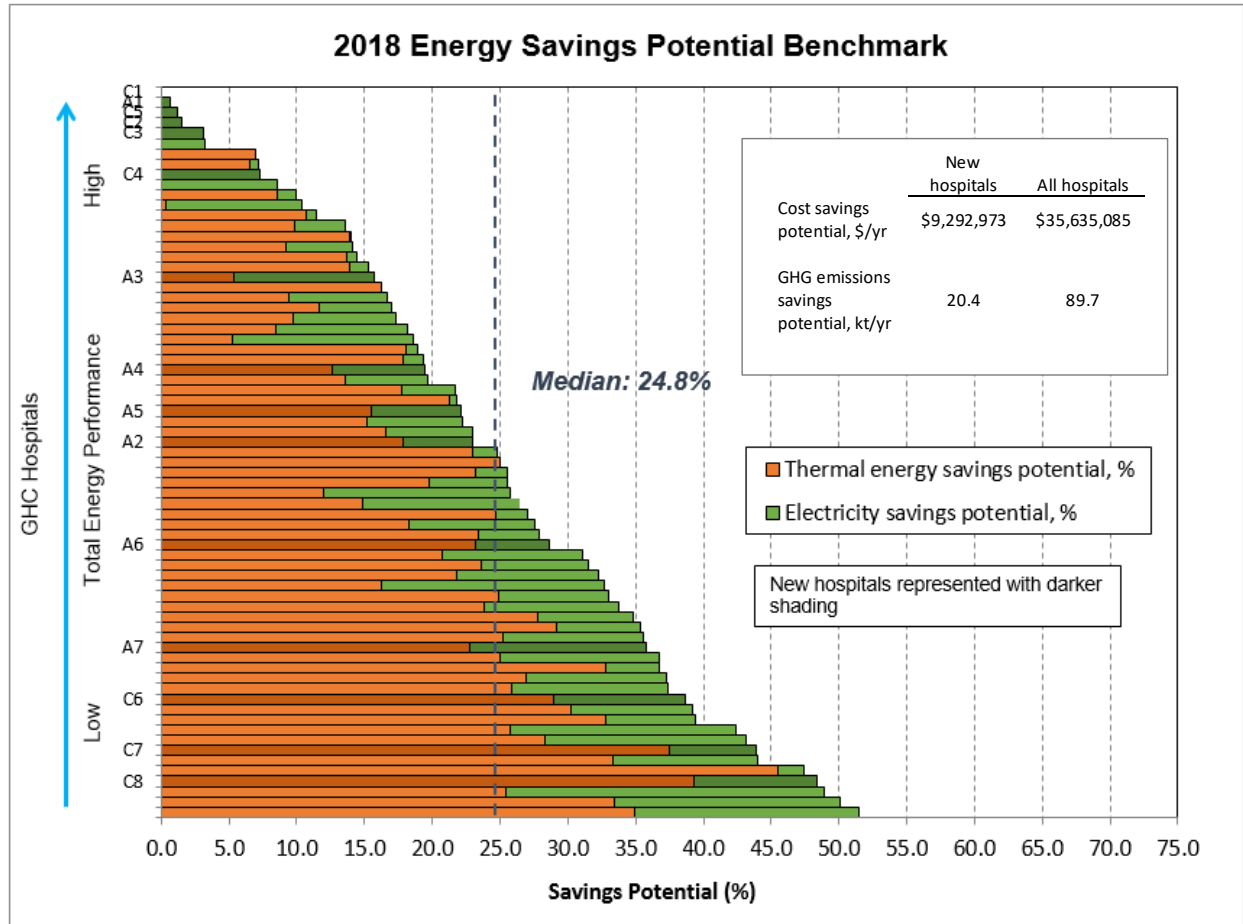
1. To develop evidence-based recommendations for achieving and sustaining high performance in the existing new hospitals which are the subject of this analysis; and
2. To apply lessons learned to new hospitals still in the pipeline which will raise the bar further still, enabling consistently high performance from the day they open their doors.

Energy and water efficiency results to date for this group of 15 new AFP hospitals have been mixed. Figure 1 shows the 2018 percentage energy savings potential (measured against Greening Health Care good-practice standards) for these new hospitals, compared with the rest of the database of 65 hospitals of varying ages and types in Ontario and Alberta. The new acute care hospitals are coded A and the non-acute hospitals (including complex continuing care, mental health and ambulatory care) are coded C. One of the acute and four non-acute care hospitals are now at the top of the Greening Health Care energy efficiency rankings. Five others are below the median.

The Greening Health Care energy and water efficiency standards are based on top-quartile benchmarks for all hospitals and considered readily attainable in new hospitals without significant capital cost premium. In comparison with the other, older hospitals in the database, the 15 AFP facilities have the advantages of new equipment and the latest technology. Most feature advanced heating and cooling plant designs and fully digital building automation systems. Although the top few are exceeding the performance levels of the best of the existing stock, all are technically capable of much more. Energy and water use profiles provide some insight into the design and operational factors contributing to performance variability, and further research is recommended into building systems and operations to determine and document lessons learned.

¹ Under AFP, provincial ministries and/or project owners establish the scope and purpose of a project, while design and construction work is financed and carried out by the private sector. Typically, only after a project is completed will the province complete payment to the private-sector company. In some cases, the private sector will also be responsible for the maintenance of a physical building or roadway. Source: <http://www.infrastructureontario.ca/AFP-FAQs/>

Figure 1 Energy savings potential for new hospitals and Greening Health Care member hospitals



Weather-normalized analysis of 2018 electricity consumption for the 15 hospitals showed very little change from the previous year. Thermal energy (gas and steam) had a much wider variation. Four of the hospitals made substantial savings ranging from 11% to 40% from their weather normalized 2017 baselines. Two showed significant increases, by 14% and 10% respectively. The hospitals with the biggest improvements were already among the most efficient while the less efficient stayed about the same or got worse. Energy use trends and discussions with the top 3 savers indicate that the improvements resulted in large part from getting their heat recovery chillers (geothermal in one case) working properly.

Several of the new hospitals have utility cost savings potential worth more than a million dollars per year, and their collective potential is more than \$9 million/year. Contractual gain/pain share provisions should create incentives for all parties to achieve and maintain savings. There are significant economic as well as environmental benefits to “getting it right.”

The energy use characteristics of the less efficient new hospitals indicate where their inefficiencies lie, with excessive thermal (gas and steam) use having the biggest impact which also drives up greenhouse gas emissions. Most of the excess is found in base, non-weather sensitive consumption pointing to inefficient control of ventilation and heating systems.

Greening Health Care will continue to support its member hospitals in becoming the most efficient they can be and to track and report on performance of all new hospitals over the coming years. Recommendations from this year's report are as follows:

- Further investigation and documentation of the common design and operational factors of the top-performing hospitals
 - consideration of best practice design and operations guides
- Audits of the worse-performing hospitals to identify inefficiencies and remedial measures
 - monitor and verify improvements over time
- A survey of all new hospitals to collect key data including process loads
- Development of energy models for hospitals in the pipeline calibrated to high-performance empirical targets derived from this research
- Consideration of DBFM process development to further improve:
 - alignment with and support for exceptional standards of energy, emissions and water efficiency; and
 - mechanisms for co-investment in efficiency improvements after construction
- Support for these hospitals to provide complete water use data and for all new hospitals to join this research in future years
- Comparative research into delivery models and performance outcomes of P3 hospital projects in British Columbia and other jurisdictions

2 Background

Over the past decade the Government of Ontario has made an unprecedented investment in new hospitals using an Alternative Financing and Procurement (AFP) delivery model. Many of these have been delivered using the Design-Build-Finance-Maintain (DBFM) model under which operational responsibility for the facilities is transferred to the private sector. Seventeen of these new hospitals, of different sizes and types, have now been operational for more than two years, and are the subject of this research. Eleven are members of the Greening Health Care program.

Greening Health Care has been tracking and reporting for several years on the actual energy and water performance of these new hospitals. In the spring of 2018, an open invitation was made to the seventeen hospitals to submit their utility data and facility information for a large-scale performance evaluation. Fifteen of the hospitals submitted data for the 2018 research and fourteen provided updated information this year. The first white paper was published in July 2018.

Two workshops, attended by hospitals, industry, utility companies and government, have been held to review and discuss the results, consider lessons learned and propose actions which can help every new hospital achieve exceptional performance from the outset. On May 31st, 2018 this discussion took place



Founded in 2004, [Greening Health Care](#) is the largest collaborative 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. Members manage data, assess their performance and track savings using a powerful online information system. They share knowledge and best practices to help plan, implement and verify improvements.

The program provides its members with:

- Energy and water targets and monthly online reporting of actual savings compared against baselines and targets;
- Workshops and webinars presenting case studies and best practices associated with top-performing and top-saving hospitals;
- Networking with a large group of hospitals facing similar challenges and opportunities;
- Participation in applied research projects leading to best practice guides; and
- Recognition for success.

at Markham Stouffville Hospital, with the second meeting happening on June 13th 2019 at the William Osler Health System's Peel Memorial Centre for Integrated Health and Wellness which is now among the top performers. The list of workshop participants is provided in Appendix A.

This updated white paper presents the new rankings and energy and water savings potential derived from the 2018 utility data, savings achieved since 2017 and conclusions and recommendations from the June 13 meeting.

3 2018 Energy Use Results

Table 1 summarizes the story for 2018, with weather-normalized electricity and thermal energy savings recorded in 2018 vs 2017 (% change columns) together with updated rankings and targets. The hospital codes are the same as used in the original report, with A prefixes denoting acute care hospitals and C being non-acute care including complex continuing care, mental health and ambulatory care. The table is intentionally anonymous, but the participating hospitals have all been informed of their own codes.

Actual and target energy use are presented in ekWh/ft², broken down into base (non-weather sensitive) and weather sensitive components. Targets are based on top-quartile benchmarks from the Greening Health Care database of 65 member hospitals adjusted for weather, heating source and known site variables.

Table 1 2018 vs 2017 energy savings with updated targets and rankings

Hospital	Electricity (kWh/ft ²)					Thermal (ekWh/ft ²)					Total Energy (ekWh/ft ²)		Savings Potential	
	Base		Cooling		% change vs 2017	Base		Heating		% change vs 2017	Actual	Target	%	Cost
	Actual	Target	Actual	Target		Actual	Target	Actual	Target					
C1	13.5	13.5	0.9	0.9	-3.7%	2.9	2.9	7.1	7.1	-14.1%	24.4	24.4	0.0%	\$14,421
A1	19.7	19.4	2.0	2.0	-0.8%	8.0	8.0	11.5	11.5	12.1%	41.2	40.9	0.7%	\$58,910
C5	13.1	12.8	0.7	0.7	-3.4%	2.7	1.0	6.3	7.9	40.2%	22.7	22.5	1.2%	\$93,205
C2	12.8	12.8	1.6	1.2	0.5%	9.5	7.8	8.1	9.7	3.2%	32.0	31.5	1.5%	\$50,630
C3	14.9	14.1	1.3	1.2	0.0%	5.7	5.7	8.4	8.4	11.4%	30.3	29.4	3.1%	\$28,270
C4	16.9	15.6	2.0	1.2	3.7%	1.9	1.9	9.2	9.2	19.0%	30.1	27.9	7.2%	\$468,403
A3	25.5	19.4	3.3	2.7	-3.1%	27.2	19.0	9.2	13.9	4.0%	65.2	55.0	15.7%	\$401,689
A4	23.5	19.4	3.2	2.7	-1.6%	25.8	19.0	15.7	13.9	-2.8%	68.2	55.0	19.4%	\$1,219,922
A5	23.9	19.4	2.0	2.0	-	25.9	19.0	16.2	12.6	-	68.1	53.0	22.1%	\$325,130
A2	22.6	19.4	2.3	2.3	0.1%	12.4	12.4	25.0	13.9	-2.5%	62.4	48.0	23.0%	\$611,757
A6	22.8	19.2	3.2	2.6	-3.8%	28.5	18.6	21.4	13.8	2.8%	75.9	54.2	28.6%	\$1,608,019
A7	28.5	20.2	6.6	2.7	0.9%	42.0	23.5	16.7	13.9	0.6%	93.8	60.2	35.8%	\$1,652,987
C6	18.2	14.6	2.9	1.2	-2.1%	24.6	7.8	9.8	10.5	-10.0%	55.6	34.1	38.7%	\$154,012
C7	17.1	13.9	1.6	1.1	-0.2%	25.2	6.6	12.8	10.1	-0.7%	56.7	31.8	43.9%	\$1,256,645
C8	26.3	19.4	4.0	2.7	-2.3%	43.7	14.3	16.6	10.4	-1.8%	90.5	46.7	48.3%	\$836,178

Legend:

	Savings Potential < 5%
	Savings Potential 5% to 25%
	Savings Potential > 25%

² Conversion to kBtu/ft² is calculated by multiplying the ekWh/ft² by a factor of 3.412
 Conversion to GJ/m² is calculated by dividing the ekWh/ft² by a factor of 25.8

Some important information can be drawn from this table:

1. Very little change in electricity use (% change) from 2017 to 2018
2. Significant change in gas use with 4 hospitals showing double-digit savings and 2 with double-digit increases
3. Overall improvement in energy efficiency with the biggest savings seen in the hospitals which were already in the upper half of the table
4. Biggest energy and emissions savings potential found in thermal energy use, particularly base thermal which is typically associated with reheat in air handling systems, boiler plant efficiency under low loads and steam distribution losses
5. Biggest utility cost savings potential found in base electricity use which is typically associated with fan power, lighting and equipment

4 2018 Water Use Results

Table 2 presents the corresponding 2018 water savings vs 2017 (% change) together with 2018 actual and target water consumption metrics for the nine hospitals which reported their water use. 5 hospitals updated their water use data for 2018. Only one reduced its consumption and the rest all increased. The hospitals indicating no ‘% change’ did not update their data.

Table 2 2018 vs 2017 water savings with updated rankings and targets

Hospital	Water (litres/ft2)					Total Water (litres/ft2)		Savings Potential	
	Base		Cooling		% change vs 2017	Actual	Target	%	Cost
	Actual	Target	Actual	Target					
C8	53.6	53.6	13.7	13.7	-15.5%	67.3	67.3	0.0%	\$0
A1	99.9	99.9	25.0	25.0	-6.1%	124.9	124.9	0.0%	\$0
A2	138.0	138.0	0.0	0.0	-	138.0	138.0	0.0%	\$0
A6	128.0	128.0	19.6	19.6	-	147.6	147.6	0.0%	\$0
C4	61.6	61.6	14.7	12.3	-	76.2	73.9	3.1%	\$5,251
A4	170.7	140.1	7.1	7.1	-	177.7	147.1	17.2%	\$167,415
A3	181.7	140.1	26.3	26.3	21.4%	208.0	166.3	20.0%	\$125,238
C5	84.7	50.0	0.0	0.0	-89.6%	84.7	50.0	40.9%	\$81,567
A7	295.1	140.1	0.0	0.0	-8.9%	295.1	140.1	52.5%	\$360,462

Legend:

	Savings Potential < 5%
	Savings Potential 5% to 25%
	Savings Potential > 25%

Where the billing data are consistent enough to allow it (otherwise Cooling Actual and Target show 0), base water use for domestic fixtures, kitchens, process loads such as dialysis and other year-round uses is separated from the additional use in summer, typically associated with cooling towers and grounds watering.

Information obtained so far is less complete than for energy, but the following observations can be made:

1. Generally low water use for these new hospitals compared with the overall database likely reflects more water efficient fixtures and less leaks and losses compared against mostly older facilities in the database
2. Hospital C4 shows significant cooling water savings potential and has high cooling electricity use
3. Lessons are to be learned from:
 - a. hospital A3 with significant 2018 savings moving it closer to target
 - b. hospital C5 with major increase
 - c. hospital A7 as the highest user moving further away from its target

5 Conclusions and Recommendations

The following conclusions are derived from the data analysis and the proceedings of the two workshops held in 2018 and 2019:

1. Despite the efforts to date put into improved design and contractual incentives to maximize utility savings, new hospitals in Ontario are mostly falling short of meeting their energy and water efficiency potential.
2. The overall performance shortfall in 2018 for the 15 hospitals analyzed in this white paper is costing more than \$9 million/year in excess utility costs and emitting more than 20,000 tonnes CO₂e/year of excess greenhouse gas emissions.
3. Five of the hospitals (the success stories so far) are now at the top of the Greening Health Care energy efficiency charts and merit study to determine and communicate lessons learned and best practices.
4. Improvements to the other ten hospitals can deliver large savings and contribute to lessons learned. Since they have new, up-to-date technology and equipment the necessary work is expected to be low-cost building system adjustments, operations and controls and to generate a high ROI for the hospitals.
5. This research and the results to be achieved can position Ontario at the forefront of energy efficiency and sustainability in the hospital sector.

These conclusions lead to a number of recommendations for continuing the work towards consistently high standards of energy efficiency in the 17 new hospitals which were eligible to participate in this research in 2018 and in all of the new hospitals opening in the years to come:

1. Conduct in-depth study into the design, operational and management factors contributing to the high performance of the top-5 hospitals.
2. Work with the ten lower-efficiency hospitals in a performance improvement process to at least meet and preferably exceed the Greening Health Care good practice energy and water targets.
3. Apply lessons learned to develop and communicate a best practices guide for use by hospitals, design teams and facility managers.
4. Apply lessons learned to inform further improvements to the DBFM process and Project Agreement in support of more consistent delivery of exceptional energy, water and emissions performance.
5. Continue this ongoing research, analysis and performance reporting to collect additional site-specific information (in particular process loads) which could help account for differences, to track

improvements over time and to capture lessons learned. Include full energy and water reporting for all 17 eligible hospitals and additional hospitals as they come on stream.

6. Engage with British Columbia and other jurisdictions making use of P3 contracts for hospitals to compare and learn from processes and outcomes.

6 Appendix A

Hospitals included in report

Hospital		Energy Data Included		Water Data Included	
		2017	2018	2017	2018
1	Centre for Addiction and Mental Health - Queen New Sites	YES	YES	NO	NO
2	Halton Health Services - Milton District	YES	NO	NO	NO
3	Halton Health Services - Oakville Trafalgar Memorial	YES	YES	NO	NO
4	Humber River Hospital	YES	YES	YES	YES
5	Niagara Health - St Catharines General Hospital	YES	YES	YES	NO
6	North Bay Regional Healthcare	NO	NO	NO	NO
7	Providence Care Kingston	YES	YES	YES	NO
8	Sault Area Hospital	YES	YES	YES	YES
9	Sinai Health System - Bridgepoint Active Care	YES	YES	YES	NO
10	St Joseph's Healthcare Hamilton - West 5th Campus	YES	YES	NO	NO
11	St Joseph's London - Parkwood Institute	YES	YES	NO	NO
12	St Joseph's London - Southwest Centre	YES	YES	NO	NO
13	Waypoint Atrium	NO	NO	NO	NO
14	William Osler Health System - Brampton Civic	YES	YES	YES	NO
15	William Osler Health System - Peel Memorial	YES	YES	YES	YES
16	Women's College Hospital	YES	YES	YES	YES
17	Woodstock General Hospital	YES	YES	YES	YES
TOTALS	17	15	14	9	5

Greening Health Care workshop, June 13, 2019, Peel Memorial Centre

Name	Organization
Paul Morrison	Enbridge
Frank Cammalleri	Enerlife Consulting
Ian Jarvis	Enerlife Consulting
Michael Pagel	Enerlife Consulting
David Threinen	Honeywell
Mohammed Nadim	Honeywell
Jason Poirier	JCI-Johnson Controls Canada
Kristi O'Neil	Michael Garron Hospital
Tim Miller	Muskoka Algonquin Healthcare
Cliff Harvey	Niagara Health System
Simba Mohamed	North York General Hospital
Kurt Monteiro	Smith + Andersen
Stasia Bogdan	St Joseph's Healthcare
Aaron Wouters	Trillium Health Partners
Kendra Rainford	West Park Healthcare Centre
Lorie Pella	West Park Healthcare Centre
John Marshman	William Osler Health System

Greening Health Care workshop, May 31, 2018, Markham Stouffville Hospital

Name	Organization
Colin Maughn	Alectra Utilities
Nezar Hanna	Armstrong Fluid Technology
Bill Nankivelli	BH Architects
Venkat Srinivas	Crossey Engineering Ltd.
Fred Stanton	Ecosystem
Servanne Fowlds	Ecosystem
Paul Torkan	Ellis Don
Brian Cox	Ellis Don
Amandeep Deol	Enerlife Consulting
Ian Jarvis	Enerlife Consulting
Michael Pagel	Enerlife Consulting
Sean Cole	Infrastructure Ontario
Shahriar Ghahremanian	Infrastructure Ontario
Jason Poirier	JCI-Johnson Controls Canada
Predrag Majkic	JCI-Johnson Controls Canada
Peter Ronson	Markham District Energy
Maria Pavone	Markham Stouffville Hospital
Rob Bowes	Markham Stouffville Hospital
Jeff Jerome	North York General Hospital
Rob Simpson	Ontario Shores Centre for Mental Health Sciences
Albert Iwasaki	Plenary Group
Joseph Nazareth	Region of Peel
Vic Tavaszi	Ross Memorial Hospital
Andrew Blair	Sinai Health System
Ryan Chang	Sinai Health System
Tracey Clatworthy	Sinai Health System
Kurt Monteiro	Smith + Andersen
Bertha Lai	Smith + Andersen
Michael Lithgow	Sunnybrook Health Sciences Centre
Jason Choy	Toronto and Region Conservation
Jana Jedlovska	Toronto Hydro
Mehdi Motakefpour	Toronto Hydro
Jen Wynne	Trillium Health Partners
Allan Wu	UHN: University Health Network
Ted Kesik	University of Toronto
John Marshman	William Osler Health System
Chris Wilson	
Richard Tremblay	