

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

A GREENING HEALTH CARE WHITE PAPER



Peel Memorial Centre for Integrated Health and Wellness

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This white paper is the third annual report arising from this ongoing Greening Health Care research project directed by Enerlife Consulting. We acknowledge and appreciate the participation and support of the hospitals and all those who played their parts in the data collection and launch webinar held on September 15, 2020.

For further information contact:

Lead author:

Ian Jarvis

President, Enerlife Consulting Inc.

ijarvis@enerlife.com



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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 its first white paper on actual 2017 energy performance of 15 of these new hospitals which had been in operation for at least a full year. This update presents 2019 results for 16 AFP hospitals, together with conclusions and recommendations from the Greening Health Care webinar held on September 15, 2020. The white paper further quantifies and characterizes their relative energy efficiency and reviews performance improvements made and lessons learned over the past year.

The goals of this research are:

1. To develop evidence-based recommendations for achieving and sustaining consistently high energy performance in all the existing hospitals; and
2. To document lessons learned for use by new hospitals under development which will enable them to achieve high performance from the outset – “getting it right the first time” – and raise the bar further still.

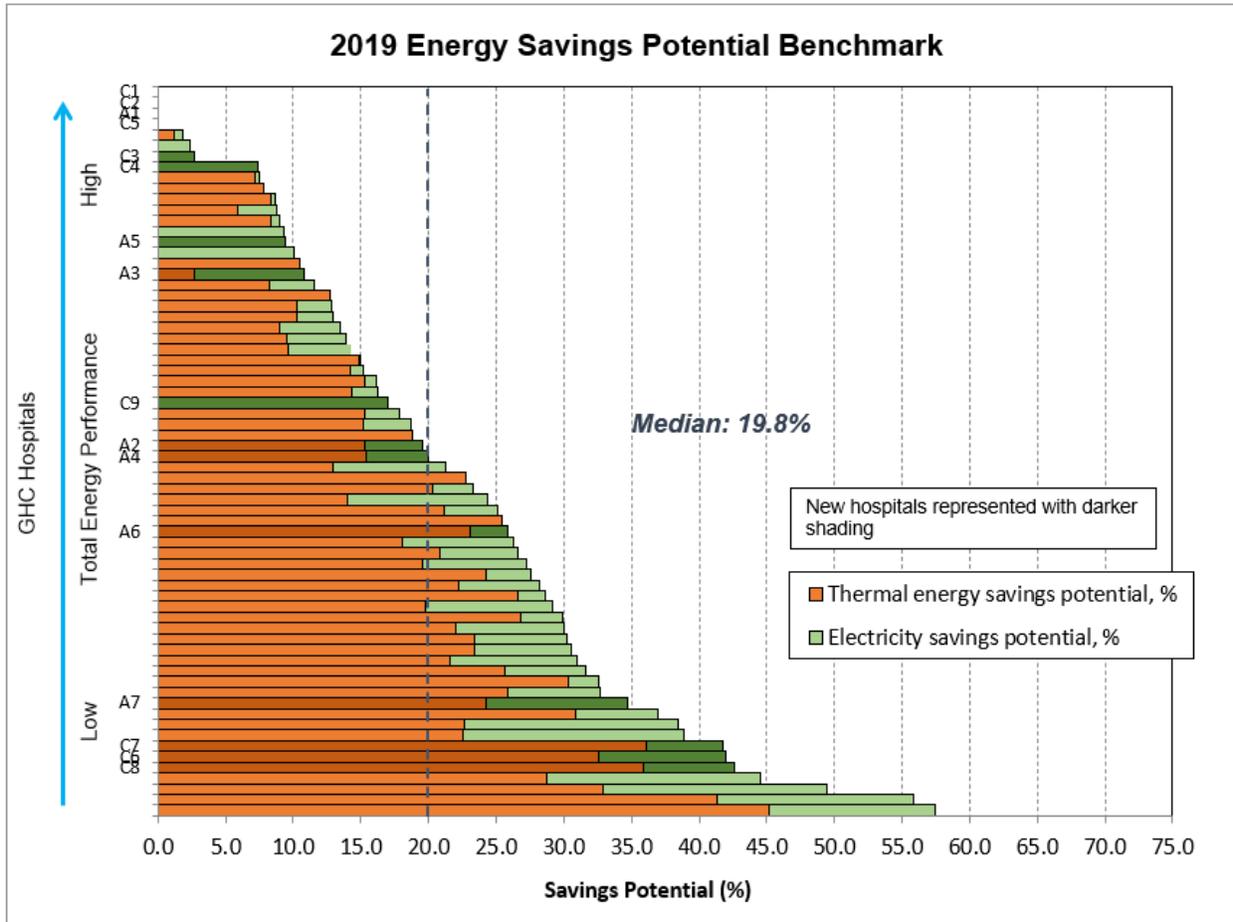
Energy and water efficiency results to date for these hospitals have been mixed.

Figure 1 presents 2019 performance in terms of percentage energy savings potential (measured against Greening Health Care good-practice targets) for these new hospitals (darker shading) compared with the rest of the database of 68 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'. Four of the new hospitals have now met or exceeded their Greening Health Care energy efficiency targets with four others within or close to 10% of their targets. Overall progress has been made with ten of the 16 now above the median in this ranking.

The Greening Health Care energy efficiency targets 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 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. The top few are exceeding the performance levels of the best of the existing stock and all are technically capable of reaching the top of the benchmark chart. Energy use profiles provide insight into the design and operational factors contributing to performance variability, and this ongoing research into building systems and operations will continue to identify 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 performance of the new AFP hospitals relative to other Greening Health Care member hospitals



Weather-normalized analysis over multiple years shows that all but two of the hospitals have made energy efficiency improvements. Six recorded double-digit total energy savings since 2016. The biggest improvements have been in thermal energy with eight hospitals showing double-digit savings, four of which are greater than 30%. Discussions with top savers indicate that the improvements are resulting in large part from getting their advanced heating plants working properly.

There is a powerful economic incentive for raising the performance of these hospitals. Several of the new hospitals have utility cost savings potential worth more than a million dollars per year, and their collective potential is \$7.5 million/year. Contractual gain/pain share provisions should create incentives for all parties to achieve and maintain savings.

The energy use profiles of the less efficient hospitals indicate where their inefficiencies lie. Excessive thermal (gas and steam) use has the biggest impact which also drives up greenhouse gas emissions. Most of the excess is found in base (year-round, non-weather sensitive) consumption attributed primarily to imbalances and inefficient control of ventilation and heating systems.

The 2019 results were presented and discussed with a panel of hospital representatives having in-depth experience of these projects by open webinar on September 15th. The recording of the webinar is posted on the Greening Health Care website at greeninghc.com. Conclusions and recommendations arising are detailed in Section 5 of this report, with the primary takeaways as follows:

1. High-performance energy targets drive high performance. Targets should be set empirically based on best in class standards with energy modeling used to develop the design and operational requirements to meet them.
2. The biggest energy reductions have come primarily from operational improvements to advanced central plants (particularly heat recovery chillers) and air handling systems. The changes generally involved little capital cost but intensive analysis and orchestration of complex systems.
3. The FM part of DBFM – building system operation and controls – is as important as design and build in meeting high performance goals. The FM Advisor should be engaged at the same time as the PDC Consultant, with integrated teams, including user groups, working together on designing to support high performance operations.
4. The collaborative team process between Project Co and the hospital laid out in the Project Agreement is effective in working together to drive high performance. Additional meetings and inclusion of other parties has been found worthwhile.
5. Greater sharing of information between hospitals will help achieve consistently high performance and inform continuous improvement.

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 the growing number of new hospitals over the coming years.

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 with 16 reporting 2019 data. Eleven are members of the Greening Health Care program.

Greening Health Care has been tracking and reporting on the actual energy and water performance of these new hospitals since 2018. The first white paper was published in July 2018 with updates issued in September 2019 and September 2020.

Workshops and webinars, attended by hospitals, industry, utility companies and government, have been held each year to review and discuss the results, consider lessons learned and propose actions which can help every new hospital achieve exceptional performance from the outset. The webinar held on September 15th, 2020 presented and

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.



The St Joseph's Healthcare Hamilton West 5th Campus is among the most efficient new hospitals in the Province.

discussed the 2019 results with a panel of hospital representatives with in-depth experience of these projects. The list of panelists is provided in Appendix B.

This updated white paper presents the latest rankings along with the energy and greenhouse gas emissions savings potential derived from the 2019 utility data. Energy reductions since 2016 are reported together with conclusions and recommendations from the September 15th webinar.

3 Performance Trends Since Hospital Opening

The electricity and thermal results are shown in Table 1, presenting energy reductions recorded since hospital opening or the earliest year for which data were provided for this report. Most have recorded thermal energy savings, including six by double digits which was attributed primarily to learning to harness the potential of their advanced central plants. Two of these showed electricity increases reflecting greater use of their heat recovery chillers. The hospital coded 'C1' was at the top of the benchmark chart in 2017 but both electricity and gas have been creeping up since then.

Table 1 Performance Trends Since Baseline

Hospital	2019 Performance Results			Baseline Year
	Total Energy	Electricity	Gas/steam	
A5	20.8%	-2.3%	32.5%	2017
C4	20.3%	7.8%	35.5%	2017/18
A1	19.1%	4.9%	34.8%	2015/16
C5	14.9%	-5.5%	34.1%	2017
C8	13.0%	8.8%	15.4%	2016
A4	12.4%	5.4%	16.1%	2011
C3	7.5%	-1.9%	15.4%	2017
C7	7.0%	0.0%	10.1%	2016
C6	6.2%	5.5%	6.7%	2013
A6	4.0%	-1.3%	6.6%	2016
C2	2.7%	-2.5%	6.6%	2017
A3	2.5%	-5.9%	8.0%	2014
A2	0.2%	4.0%	-2.6%	2014
C9	-	-	-	N/A
A7	-3.8%	-3.9%	-3.7%	2016
C1	-6.9%	-6.2%	-8.0%	2017

Lessons learned from these hospitals are expected to shorten this breaking-in period for future hospitals. The September 15th webinar also provided valuable insights into how the project development process and Project Agreement can better support facility management in achieving high performance at the outset – “getting it right the first time.”

4 2019 Energy Use Results

The 2019 update results are presented in Table 2, with updated rankings and target savings together with weather-normalized electricity and thermal energy savings recorded since 2018 (% change columns). The hospital codes are the same as used in prior year reports, with 'A' prefixes denoting acute care hospitals and 'C' being non-acute care including complex continuing care, mental health and ambulatory care.

Actual and target energy use are presented in equivalent kilowatt hours per square foot (ekWh/ft²), divided into base (non-weather sensitive) and weather sensitive components. Targets are based on top-

quartile benchmarks from the Greening Health Care database of 55 current member hospitals of different types and ages adjusted for weather, heating source and known site variables.

Table 2: Updated targets and rankings with 2019 energy savings vs 2018

Hospital	2019 Rank	2018 Rank	Electricity (kWh/ft2)					Thermal (ekWh/ft2)					Total Energy (ekWh/ft2)		Savings Potential		Total Energy GJ/m2	GHG kg/ft2
			Base		Cooling		Change vs 2018	Base		Heating		Change vs 2018	Actual	Target	%	Cost		
			Actual	Target	Actual	Target		Actual	Target	Actual	Target							
C5	1	3	14.1	14.1	0.3	0.3	-4.0%	3.3	3.3	6.3	6.3	-5.6%	24.0	24.0	0.0%	\$0	0.9	2.1
C1	1	1	13.9	13.9	0.8	0.8	-3.6%	1.9	1.9	8.3	8.3	7.2%	25.0	25.0	0.0%	\$0	1.0	2.2
C2	1	4	13.8	13.8	0.6	0.6	-3.0%	9.5	7.8	8.0	9.6	7.8%	31.9	31.9	0.0%	\$0	1.2	3.5
A1	1	2	20.7	20.7	1.2	1.2	-2.9%	4.9	4.9	8.7	8.7	31.4%	35.5	35.5	0.0%	\$0	1.4	3.0
C3	5	5	14.6	14.1	1.2	0.8	-1.6%	5.9	5.9	8.8	8.8	4.6%	30.6	29.7	2.7%	\$30,478	1.2	3.0
C4	6	6	16.4	14.8	0.9	0.6	5.0%	2.3	2.3	7.5	7.5	37.2%	27.1	25.1	7.4%	\$186,991	1.1	2.2
A5	7	9	25.9	20.6	1.3	1.3	-	14.2	14.2	15.4	15.4	29.2%	56.7	51.4	9.5%	\$111,247	2.2	6.0
A3	8	7	25.4	20.6	2.3	1.9	-	26.9	19.0	9.7	16.0	-	64.4	57.5	10.8%	\$301,669	2.5	7.3
C9	9	-	19.7	14.8	0.4	0.4	-	1.2	1.2	7.9	7.9	-	29.2	24.3	17.0%	\$286,181	1.1	2.1
A2	10	10	23.2	20.6	1.8	1.8	-2.4%	13.8	13.8	23.8	14.2	1.5%	62.6	50.3	19.6%	\$691,725	2.4	7.5
A4	11	8	23.3	20.6	2.8	2.3	0.8%	27.2	19.0	16.9	14.2	-5.5%	70.1	56.0	20.0%	\$1,135,983	2.7	8.7
A6	12	11	22.6	20.9	2.1	1.8	2.2%	31.4	16.1	17.0	15.4	6.0%	73.1	54.3	25.8%	\$1,274,351	2.8	9.5
A7	13	12	28.4	21.3	5.0	1.8	-0.7%	46.1	23.5	18.8	17.5	0.2%	98.3	64.1	34.8%	\$1,346,478	3.8	12.7
C7	14	14	16.3	13.9	1.7	1.0	1.8%	26.4	6.6	10.4	10.4	3.9%	54.7	31.9	41.8%	\$900,187	2.1	7.2
C6	15	13	18.8	14.6	2.3	1.0	-2.5%	22.4	7.8	15.4	10.8	-0.8%	58.9	34.1	42.0%	\$555,932	2.3	7.4
C8	16	15	25.5	20.6	2.9	2.3	4.3%	34.7	14.3	20.5	10.9	11.0%	83.6	48.0	42.6%	\$947,597	3.2	10.8

Legend:

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

Some important insights can be drawn from this table:

1. Four hospitals have now met the Greening Health Care good practice targets in all energy components with four more within or near 10%.
2. Energy related greenhouse gas emission from several hospitals are approaching 2.0 kg/sf which can be compared to the Ontario median of 7.0 kg/sf.
3. The remaining utility cost savings potential is around \$7.5 million/year.
4. The biggest energy and emissions savings potential is 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. Only two hospitals made significant electricity savings with an overall increase in consumption from 2018 to 2019.
6. Most made thermal energy savings with four hospitals showing double-digit savings.

5 Conclusions and Recommendations

The following conclusions are derived from the data analysis and the proceedings of the workshops held in 2018 and 2019 and the webinar held on September 15th, 2020:

1. Despite the efforts to date put into improved design and contractual incentives to maximize utility savings, many of the new AFP hospitals in Ontario are falling short of meeting their energy and water efficiency potential, costing millions of dollars annually and emitting thousands of metric tonnes of excess greenhouse gas emissions.
2. Substantial year on year energy reductions are being recorded and offer important lessons for continuous improvement.
3. Without effective gain/pain share mechanisms there is little incentive for Project Cos to make such improvements.
4. Eight of the hospitals (the success stories so far) are now at or close to the top of the Greening Health Care energy efficiency charts and providing valuable lessons learned and best practices.
5. The biggest energy reductions have come primarily from operational improvements to advanced central plants (particularly heat recovery chillers) and air handling systems. The changes generally involved little capital cost but intensive analysis and orchestration of complex systems.
6. This research and the results being achieved can position Ontario at the forefront of energy efficiency and sustainability in the hospital sector.

These conclusions lead to seven recommendations for continuing the progress towards consistently high standards of energy efficiency in these operational hospitals and in all of the new hospitals opening in the years to come:

1. High-performance targets drive high energy performance. Targets should be set empirically based on best in class standards with energy modeling used to develop the design and operational requirements to meet them.
2. Mutually beneficial mechanisms are needed to coinvest where retrofits are required to achieve energy savings within an acceptable payback period.
3. Strategic goals, including energy targets, have to be established at the earliest stage of development and championed and refined throughout the development process.
4. Energy targets should be periodically updated over the life of the hospital as new technology and knowledge become available.
5. The FM part of DBFM – building system operation and controls – are as important as design and build in meeting high performance goals. The FM Advisor should be engaged at the same time as the PDC Consultant, with integrated teams, including user groups, working together on designing to support high performance operations.
6. The collaborative team process between Project Co and the hospital laid out in the Project Agreement is effective in working together to drive high performance. Additional meetings and inclusion of other parties has been found worthwhile.
7. Greater sharing of information between hospitals will help achieve consistently high performance and inform continuous improvement.

6 Appendix A

Hospitals included in report

	Hospital	Type	Building Area ft2	Year Opened
1	Centre for Addiction and Mental Health - Queen New Sites	Continuing Care	385,000	2013
2	Halton Health Services - Milton District	Acute Care	330,000	2018
3	Halton Health Services - Oakville Trafalgar Memorial	Acute Care	1,525,000	2016
4	Humber River Hospital	Acute Care	1,825,000	2015
5	Niagara Health - St Catharines Site	Acute Care	980,000	2013
6	North Bay Regional Healthcare	Acute Care	700,000	2011
7	Providence Care Kingston	Continuing Care	620,000	2017
8	Sault Area Hospital	Acute Care	585,000	2011
9	Sinai Health System - Bridgepoint Active Care	Continuing Care	680,000	2013
10	St Joseph's Healthcare Hamilton - West 5th Campus	Continuing Care	855,000	2014
11	St Joseph's London - Parkwood Institute	Continuing Care	435,000	2015
12	St Joseph's London - Southwest Centre	Continuing Care	245,000	2013
13	Waypoint Atrium	Continuing Care	340,000	2014
14	William Osler Health System - Brampton Civic	Acute Care	1,370,000	2007
15	William Osler Health System - Peel Memorial	Ambulatory Care	590,000	2017
16	Women's College Hospital	Ambulatory Care	430,000	2015
17	Woodstock General Hospital	Acute Care	360,000	2011
TOTALS	17		12,255,000	

7 Appendix B

September 15, 2020 New Hospitals Performance Report Launch Webinar Panelists

Name	Hospital	Position
Cliff Harvey	Niagara Health System	Chief Planning Officer
Lorie Pella	West Park Healthcare Centre	Director of Campus Redevelopment
Grace Pan	Humber River Hospital	Director - Redevelopment
Chris Mackey	Providence Care Kingston	Director Facilities Management
Lauren Seager	Women's College Hospital	Director, Facilities and Operations
Amir Gill	Niagara Health System	Director Facilities Engineering, Capital Planning, Biomedical Engineering
Eddie Camilleri	William Osler Health System	Corporate Energy Manager