GREENING HEALTH CARE
working together for healthier communities

Working Towards World-Class Energy Efficiency in Hospitals

A GREENING HEALTH CARE WHITE PAPER
PERFORMANCE UPDATE: OCTOBER, 2022

Hennick Bridgepoint Hospital, Toronto, Ontario

CLIMATE CHALLENGE NETWORK

This white paper is the fourth annual report arising from the ongoing Greening Health Care research 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 October 12, 2022. Recordings of that webinar are available through the following LINK. Greening Health Care is a program of the Climate Challenge Network www.climatechallengenetwork.org

For further information contact:

Lead author:
Ian Jarvis
President, Enerlife Consulting Inc.
ijarvis@enerlife.com

Table of Contents

1 Greening Health Care

Greening Health Care is a network of leading hospitals, healthcare groups and other organizations across North America working together to achieve deep energy and greenhouse gas emissions reductions in healthcare facilities. Members benchmark their performance and share best practices and success stories through workshops, webinars, a member website and the Annual Forum. Actual savings results are reported annually, and top-performing hospitals are recognized every year.

Greening Health Care conducts extensive data-driven research to address identified knowledge gaps, producing best practice reports, checklists and analytical tools to help hospitals accelerate their progress towards low carbon operations.

Greening Health Care 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
- Individual coaching on identifying the best savings opportunities
- Networking with a large group of hospitals facing similar challenges and opportunities
- Participation in applied research projects leading to best practice guides
- Recognition for success

2 Background

Since 2005, 19 new hospitals have opened across Ontario under the province's Alternative Financing and Procurement (AFP) delivery model[1]. Many of these have been delivered through Design-Build-Finance-Maintain (DBFM) agreements under which operational responsibility for the facilities is transferred to the private sector. Nineteen 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 2021 data.

Cortelluci Vaughan Hospital opened close to the top of the acute care hospitals benchmark chart in 2021.

We have 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 in each year from 2019 – 2022. This updated white paper presents the latest rankings along with the energy and greenhouse gas emissions savings potential derived from the 2021 utility data.

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

[1] Infrastructure Ontario (IO) states that in P3 project procurements, IO functions "as the procurement agent on behalf of government ministry, agency or other public body. Procurements for P3 projects proceed by way of a two-stage, public, open qualification process followed by an invitational request for proposals issued to prequalified parties." Source: https://www.infrastructureontario.ca/Major-Projects-Procurement/

are exceptional performers which are setting new standards while others have so far not reached the performance levels of which they should be capable.

The goals of this research are to:

1. Develop evidence-based recommendations for achieving and sustaining consistently high energy performance in all the existing operational hospitals and moving the lower performers up the benchmark chart.

2. Document performance metrics and lessons learned from these hospitals for use by owners and design teams of new hospitals under development which will enable them to:

- improve modeling, energy targets, design and operations
- achieve high performance from the outset

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 million/year. Contractual gain/pain share provisions should create financial incentives for all parties to achieve and maintain savings. 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 October 12th, 2022 presented and discussed the 2021 results with a panel of hospital representatives having in-depth experience of these projects. The list of panelists is provided in Appendix B.

3 Performance Trends Since Hospital Opening

Electricity and thermal results are shown in Table 1, presenting weather-normalized energy reductions recorded in 2021 compared against the year of hospital opening or the earliest year for which data were provided for this report.

Five have recorded double-digit total energy savings since their respective baseline year. Most have recorded thermal energy savings, including eight in double digits, which are attributed primarily to improved system scheduling and learning to harness the potential of their advanced central plants. Three of these showed small corresponding electricity increases reflecting greater use of their heat recovery chillers. There are important lessons to be learned from these results, including hospital 'C1' which was at the top of the benchmark chart in 2017 but has been losing ground ever since. Hospital 'A7' is among the lowest performers and has further deteriorated since opening. Hospital 'A3' has operationalized its combined heat and power plant resulting in the large increase in gas use and offsetting electricity savings. Hospital 'A1' is now both the top performing hospital and the most improved since opening. Ongoing discussions with top savers indicate that the improvements are resulting in large part from operational improvements including system scheduling and getting their advanced heating plants working properly. Lessons learned from these hospitals are expected to shorten the breaking-in period for future hospitals.

Table 1 Performance Trends Since Baseline

Hospital	2021 Performance Results			Baseline Year
	Total Energy	Electricity	Thermal (gas/steam)	
A1	22.8%	5.6%	43.9%	2015/16
C4	21.5%	9.5%	38.3%	2017/18
C8	21.3%	18.0%	22.9%	2016
C7	19.3%	10.0%	23.7%	2016
A4	12.5%	6.1%	16.2%	2011
C3	8.7%	-0.3%	17.2%	2017
A5	7.9%	-2.6%	18.6%	2019
C2	7.6%	-1.2%	14.7%	2017
C5	3.8%	1.5%	6.6%	2017
A6	2.7%	-4.5%	6.4%	2016
A2	2.7%	4.3%	1.5%	2014
A8	-	-	-	2011
A9	-	-	-	2020/21
C10	-	-	-	2021
C9	-2.2%	4.7%	-18.4%	2014
A7	-2.5%	-1.9%	-2.8%	2016
C1	-6.8%	-6.1%	-15.2%	2017
C6	-17.8%	15.9%	-22.9%	2013
A3	-25.5%	75.2%	-95.0%	2014

4 2021 Energy Use Results

Figure 1 presents 2021 performance in terms of percentage energy savings potential (measured against Greening Health Care good-practice targets[2]) for these new hospitals (darker shading) compared with the rest of the database of 55 member hospitals of varying ages and types in Ontario, Alberta and Manitoba. The new acute care hospitals are coded 'A' and the new non-acute hospitals (including complex continuing care, mental health and ambulatory care) are coded 'C'. Electricity savings potential is shaded in green and thermal (predominantly natural gas) potential in orange. Three of the new hospitals are now at or better than their total energy use targets with four others within 5%. Overall improvements have been made since 2017 for the group with 13 of the 19 now above the median in this benchmark ranking.

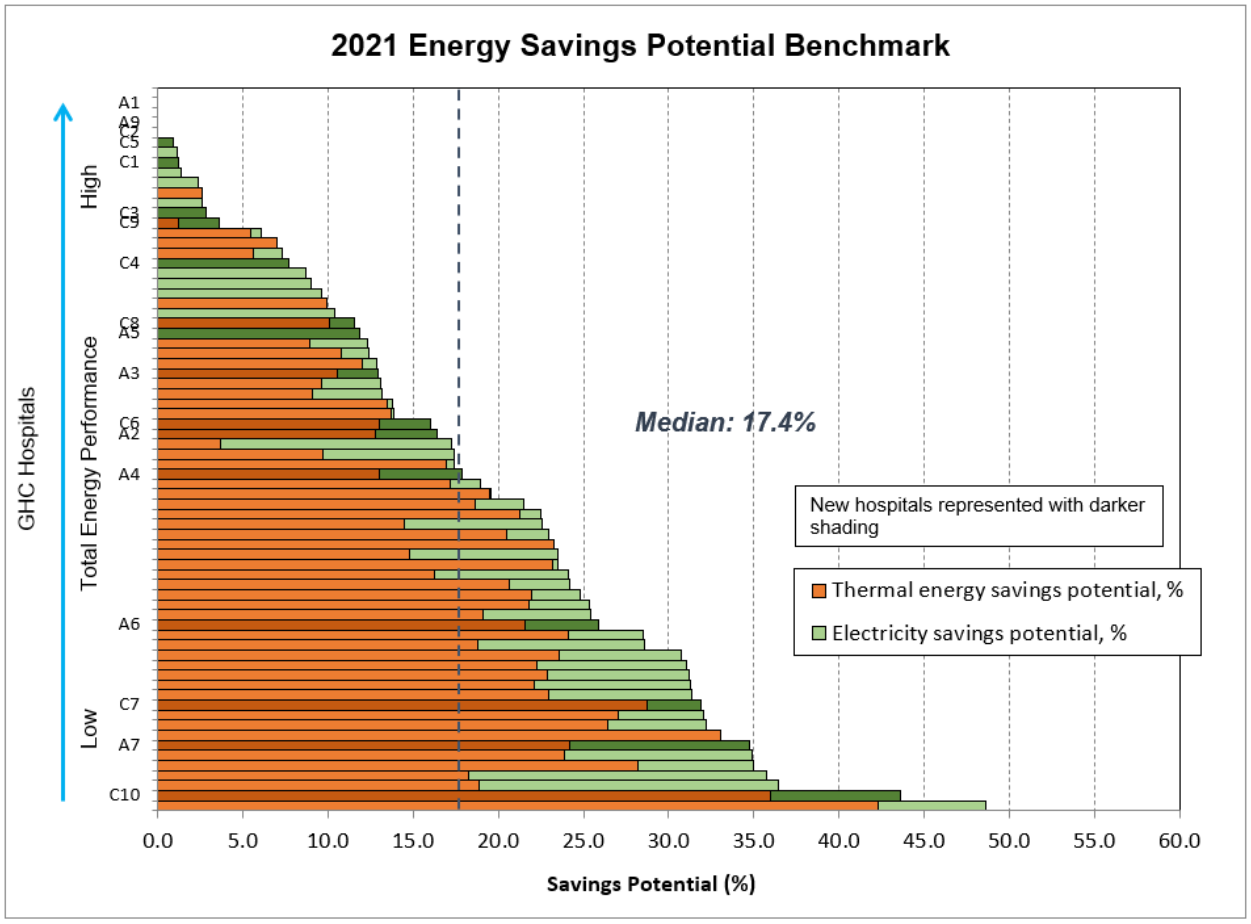

Figure 1 Energy performance of the new AFP hospitals relative to other (older) Greening Health Care member hospitals

The results are expanded in Table 2 with energy components, cost and emissions savings potential, and weather-normalized electricity and thermal energy savings recorded over the past year (% 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.

[2] Greening Health Care good-practice energy efficiency targets are based on top-quartile benchmarks for all hospitals in the database and considered readily attainable in new hospitals without significant capital cost premium.

Actual and target energy use are presented in equivalent kilowatt hours per square foot of building area (ekWh/ft2)[3], 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 other material site variables.

Table 2: Updated targets and rankings with 2021 energy savings vs 2020

Hospital	Electricity (kWh/ft2)					Thermal (ekWh/ft2)					Total Energy (ekWh/ft2)		Annual Savings Potential		
	Base		Cooling		Change vs 2020	Base		Heating		Change vs 2020					
	Actual	Target	Actual	Target		Actual	Target	Actual	Target		Actual	Target	%	Cost	GHG Emissions tonnes
A1	20.3	20.3	1.7	1.7	0.7%	3.5	3.5	7.1	7.1	3.4%	32.7	32.7	0.0%	$0	0
A9	19.6	19.6	2.0	2.0	-	6.5	6.5	13.1	13.1	-	41.2	41.2	0.0%	$0	0
C2	13.7	13.7	0.7	0.7	2.7%	6.2	6.2	8.6	8.6	12.9%	29.2	29.2	0.0%	$0	0
C5	12.5	12.5	1.1	0.9	3.0%	4.3	4.3	7.2	7.2	6.3%	25.1	24.9	0.9%	$20,508	4
C1	13.8	13.8	1.2	0.9	-	2.4	2.4	5.6	5.6	-	23.0	22.7	1.2%	$18,800	4
C3	14.7	14.1	1.2	0.9	-	6.0	6.0	7.1	7.1	-	29.0	28.1	2.8%	$29,924	6
C9	15.2	14.8	0.9	0.6	16.9%	0.7	0.7	13.8	13.4	-39.1%	30.5	29.4	3.6%	$40,780	31
C4	16.1	14.8	1.3	0.6	0.7%	2.4	2.4	6.2	6.2	-7.5%	26.0	24.0	7.7%	$186,355	37
C8	20.8	20.6	3.0	2.4	3.0%	28.0	19.0	11.0	13.6	3.2%	62.8	55.5	11.5%	$180,956	516
A5	26.5	20.6	1.6	1.6	-2.7%	15.9	15.9	6.1	6.1	-2.7%	50.1	44.2	11.8%	$293,530	59
A3	3.6	2.9	3.3	2.0	-	67.3	51.0	8.0	15.7	-	82.2	71.6	12.9%	$205,270	595
C6	14.2	14.1	1.5	1.0	-	16.3	7.8	6.7	10.3	-	38.6	33.3	13.9%	$182,740	734
A2	22.6	20.6	2.2	2.0	-1.2%	13.0	13.0	23.5	15.7	-0.5%	61.3	51.3	16.4%	$571,592	1,483
A4	22.6	20.6	3.6	2.3	-4.1%	28.4	19.0	14.4	14.8	-0.8%	69.0	56.7	17.8%	$1,080,637	2,413
A6	22.7	20.9	3.3	2.0	-7.0%	31.5	16.1	15.0	14.7	1.4%	72.5	53.7	25.9%	$1,473,915	4,559
C7	15.3	13.9	1.1	1.0	5.0%	19.7	6.6	10.1	9.9	12.0%	46.2	31.5	31.9%	$527,785	1,702
A7	28.2	20.8	4.2	1.4	-2.0%	48.0	20.3	15.4	19.9	-4.4%	95.8	62.5	34.7%	$1,311,501	2,679
C10	15.9	14.1	3.8	1.0	-	21.2	7.8	18.2	10.3	-	59.1	33.3	43.6%	$794,595	2,378

Legend:

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

Some important insights can be drawn from this table:

1. Seven hospitals have now met their Greening Health Care good practice total energy use targets or are within close range of 5%.
2. The utility cost savings potential is around $7.0 million/year with six hospitals over $500,000/year.

[3] To convert to kBtu/sf, multiply by 3.412; to ekWh/m2, multiply by 10.764; to GJ/m2, multiply by 0.03876

3. 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 inefficiency under low loads and steam distribution losses.
4. The hospitals near the top continued to make electricity savings, while the ones towards the bottom generally saw increases.
5. There was a wide range of thermal energy results in 2021, from double-digit savings to a double-digit increases.

5 Conclusions and Recommendations

A focus of attention in the coming year is on the six lowest performing new hospitals. In comparison with the other, generally older hospitals in the database, the AFP facilities have the advantages of new equipment and the latest technology. They feature advanced heating and cooling plant designs and fully digital building automation systems. The top few (as expected) are exceeding the performance levels of the best of the existing stock and all 19 are technically capable of reaching the top of the benchmark chart. Their 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. The lowest performing sites (C10, A7, C7, A6, A4 and A2) with greater than 15% savings potential, are together costing over $5,500,000/year and more than 13,500 tonnes of preventable greenhouse gas emissions.

In 2022 we also introduced results of our supplementary research into the building system level metrics of the high performing hospitals – the individual system energy intensities, derived from analysis of sub-meter data, which make up their overall exceptional performance. The report *Achieving High Performance Building Systems in Healthcare Facilities – Phase 1* is posted on the Greening Health Care website as of November, 2022.

The following conclusions are derived from the data analysis and the proceedings of the annual workshops and webinars held between 2018 to 2022:

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. Significant year on year energy reductions are being recorded by a majority of hospitals, offering important lessons for continuous improvement.
3. Without high performance targets and effective gain/pain share mechanisms there is little incentive for Project Cos to make improvements.
4. The M (Maintain) part of DBFM – building system operation, maintenance and controls – is as important as Design and Build in meeting high performance goals. The FM (Facilities Maintenance) Advisor should be engaged at the same time as the PDC (Planning, Design and Compliance) Consultant, with integrated teams, including user groups, working together on system design which supports high performance operations.
5. The introduction of new system-level performance metrics which can be used to better calibrate energy models and targets and to support performance-based commissioning.

6. Seven of the 19 hospitals (the success stories so far) are now at or close to the top of the Greening Health Care energy efficiency charts, providing valuable lessons learned and best practices for the owners and design teams of future new hospitals.
7. 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 required intensive analysis and orchestration of complex systems.
8. 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 recommendations for continuing the progress towards consistently high standards of energy efficiency in existing hospitals and in all new hospitals opening in the years to come.

1. Have a strong team and champions in place to ensure the hospital's vision is incorporated into the design specifications and maintained through construction and ongoing operations.
2. 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.
3. Establish the energy target and efficiency strategies very early in the development process.
4. Mutually beneficial mechanisms are needed to coinvest where retrofits are required after hospital opening to achieve energy savings within an acceptable payback period.
5. Strategic goals, including energy targets, must be established at the earliest stage of development and championed and refined throughout the development process and life of the hospital.
6. Energy targets should be periodically updated over the life of the hospital as new technology and knowledge become available.
7. With DBF (Design-Build-Finance) contracts, where the hospital, not Project Co, is responsible for ongoing operations and maintenance, advanced, performance-based building system commissioning can ensure that energy targets are met.
8. The collaborative team process between Project Co and the hospital laid out in the Project Agreement can be effective in working together to drive high performance. Additional meetings and inclusion of other parties have been found worthwhile.
9. Greater sharing of information between hospitals will help achieve consistently high performance, inform continuous improvement and raise the bar for energy efficiency standards.

6 Appendix A

Hospitals included in report

Hospital	Type	Building Area ft2	Year Opened
Centre for Addiction and Mental Health - Queen Phase 1B	Continuing Care	385,000	2013
Centre for Addiction and Mental Health – Queen Phase 1C	Continuing Care	585,000	2020
Cortellucci Vaughan Hospital	Acute Care	1,200,000	2020
Halton Health Services - Milton District	Acute Care	330,000	2018
Halton Health Services - Oakville Trafalgar Memorial	Acute Care	1,525,000	2016
Humber River Hospital	Acute Care	1,825,000	2015
Niagara Health - St Catharines Site	Acute Care	980,000	2013
North Bay Regional Healthcare	Acute Care	700,000	2011
Providence Care Kingston	Continuing Care	620,000	2017
Sault Area Hospital	Acute Care	585,000	2011
Sinai Health System - Bridgepoint Active Care	Continuing Care	680,000	2013
St Joseph's Healthcare Hamilton - West 5th Campus	Continuing Care	855,000	2014
St Joseph's London - Parkwood Institute	Continuing Care	435,000	2015
St Joseph's London - Southwest Centre	Continuing Care	245,000	2013
Waypoint Atrium	Continuing Care	340,000	2014
William Osler Health System - Brampton Civic	Acute Care	1,370,000	2007
William Osler Health System - Peel Memorial	Ambulatory Care	590,000	2017
Women's College Hospital	Ambulatory Care	430,000	2015
Woodstock General Hospital	Acute Care	360,000	2011
		14,040,000	

7 Appendix B

October 12, 2022 New Hospitals Performance Report Launch Webinar Panelists

https://greeninghc.com/event/working-towards-world-class-energy-efficiency-in-hospitals/

Name	Hospital	Position
Amir Gill	Niagara Health System	Director Facilities Engineering, Capital Planning, Biomedical Engineering
Lauren Seager	Women's College Hospital	Director, Facilities & Operations
Erica Brabon	Women's College Hospital (Black & McDonald)	Director, Energy & Sustainability
Vrund Pandya	Women's College Hospital (Black & McDonald)	Energy & Sustainability Technical Specialist