

Working Towards Net-Zero GHG Emissions for New Hospitals

Engaging the World, learning from the best

A GREENING HEALTH CARE WHITE PAPER
NEW HOSPITAL PERFORMANCE UPDATE: JANUARY 2024



New Women's Hospital, Winnipeg Health Sciences Centre, Manitoba. #7 on our international rankings.

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This white paper is the sixth annual report arising from the ongoing Greening Health Care research into the operational energy performance of recently built hospitals. We acknowledge and appreciate the participation and support of the hospitals and all those who played their parts in data collection and the launch webinar held on October 12, 2023. Greening Health Care is a program of the Climate Challenge Network www.climatechallengenetwork.org with technical direction by Enerlife Consulting.

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1 Background

More than one thousand hospitals have opened across the United States and Canada over the past five years. As the hospital sector tackles the complex technical and financial challenges of decarbonizing North America's 8,500 existing hospitals, it is essential to make new hospitals as energy efficient as possible, with the smallest practicable carbon footprint.

Greening Health Care has been tracking and reporting on the actual energy and water performance of new hospitals for the past five years. The first white paper, documenting 18 Ontario hospitals opened since 2005 under the province's P3 delivery model, was published in July 2018. This latest update expands the reporting to 30 hospitals from 6 regions across North America.

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, a member website, and the Annual Forum.

Energy and water efficiency results to date for these hospitals have been mixed. There are a few exceptional performers who are setting new performance standards. A number started badly and have since shown steady and significant improvements. A majority have so far not reached the performance levels to which they were modeled and of which they should be capable. All these hospitals offer important lessons that can help underperforming new hospitals get better and enable all new hospitals in the pipeline to achieve even higher standards of efficiency – consistently “getting it right the first time.”

The overarching goals of this research are to:

1. Develop evidence-based recommendations for achieving and sustaining high levels of energy performance in all recently opened hospitals, moving lower performers up the energy efficiency benchmark chart.
2. Document performance metrics and lessons learned from high-performing hospitals, for use by owners and design teams of new hospitals under development, which will enable them to achieve high-energy performance from the outset.

There is a powerful economic incentive for raising the energy performance of these hospitals. Several of the low-performing new hospitals in this year's report have energy cost savings potential worth more than a million dollars per year, with the biggest inefficiencies found in commissioning and operations. Many were built under P3 contracts where gain/pain share provisions should create financial incentives for all parties to achieve and maintain savings. With escalating utility and carbon prices, life cycle cost savings can amount to tens of millions of dollars, repaying many times over any incremental up-front costs.

The climate case is equally compelling, with emissions intensities of low-performing new hospitals adding thousands of metric tons of unnecessary pollution to the atmosphere every year.

This Greening Health Care research is a journey of shared, evidence-based learning. Workshops and webinars, attended by hospitals, industry, utility companies and government, are held each year to review and discuss the latest results, consider lessons learned and propose actions which can help every new hospital achieve exceptional performance. The latest webinar, held on October 12th, 2023, presented 2022 results for all 30 participating hospitals and featured an in-depth case study of the commissioning and operational practices driving high performance at the New Women’s Hospital in Winnipeg, Manitoba. The recording of this workshop can be found at the link in [Appendix B](#).

Results shown in this report and in all public presentations are anonymous, with individual hospitals represented by codes (A codes are acute care, C codes are all forms of continuing care).

2 Performance Trends Since Hospital Opening

The energy performance of hospital facilities is rarely constant over time. Operational and maintenance missteps are the main causes of performance variations. This is particularly true of new hospitals with complex low-carbon central plants and building systems which require advanced commissioning, programming, and operational practices. Table 1 presents electricity and thermal energy (predominantly natural gas) results for 16 hospitals that have provided multiple years of data. Weather-normalized energy reductions shown were recorded in 2022, compared against the year of hospital opening or the earliest year for which data were provided.

Table 1 Performance trends since opening

Every hospital provides lessons on achieving and sustaining high-energy performance. Together, they inform the recommendations in each of our annual reports. Six hospitals have recorded double-digit total energy savings since their respective baseline years. Most have recorded thermal energy savings, including nine that achieved over 10%, 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 heat recovery chillers. Hospital ‘C1’, which was at the top of the benchmark chart in 2017, is the only site to increase in both electricity and natural gas. Hospital ‘A7’ is among the lowest performers and has remained the same since opening. Hospital ‘A3’ uses a combined heat and power (CHP) plant resulting in the large increase in gas use and offsetting electricity savings. Hospital ‘A1’ is now both the top performing acute care hospital and most improved since opening.

Hospital	2022 Performance Results			Baseline Year
	Total Energy	Electricity	Thermal (gas/steam)	
C4	25.1%	8.2%	45.3%	2017/18
C5	21.1%	-1.3%	44.2%	2017
A1	19.7%	5.1%	36.6%	2015/16
C8	18.4%	16.1%	19.0%	2016
C7	17.6%	5.7%	23.0%	2016
C6	14.0%	13.5%	14.3%	2013
A4	9.2%	5.6%	11.2%	2011
C3	8.7%	-0.3%	17.2%	2017
A5	6.0%	-2.2%	14.1%	2019
A6	4.1%	-3.7%	8.1%	2016
C2	1.3%	-1.5%	3.6%	2017
A2	1.2%	5.1%	-1.8%	2014
A7	0.9%	-0.5%	1.6%	2016
C9	-2.2%	4.7%	-18.4%	2014
C1	-6.8%	-6.1%	-15.2%	2017
A3	-23.0%	71.9%	-86.9%	2014

Ongoing discussions with top savers indicate that the improvements are resulting in large part from operational measures, including system scheduling, control sequence changes and getting

their advanced heating plants working properly. Many hospitals struggle with commissioning deficiencies. Lessons learned can shorten the breaking-in period for future hospitals.

3 2022 Energy Use Results

Figure 1 presents weather-normalized 2022 performance for all 30 participating hospitals in terms of percentage energy savings potential (measured against Greening Health Care good-practice targets¹). The new hospitals (darker shading) are compared with the rest of the database of 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 have achieved or surpassed their total energy use targets with four others within 5%. Overall improvements have been made since 2017 for the group, with 18 of the 30 now above the median in this benchmark ranking.

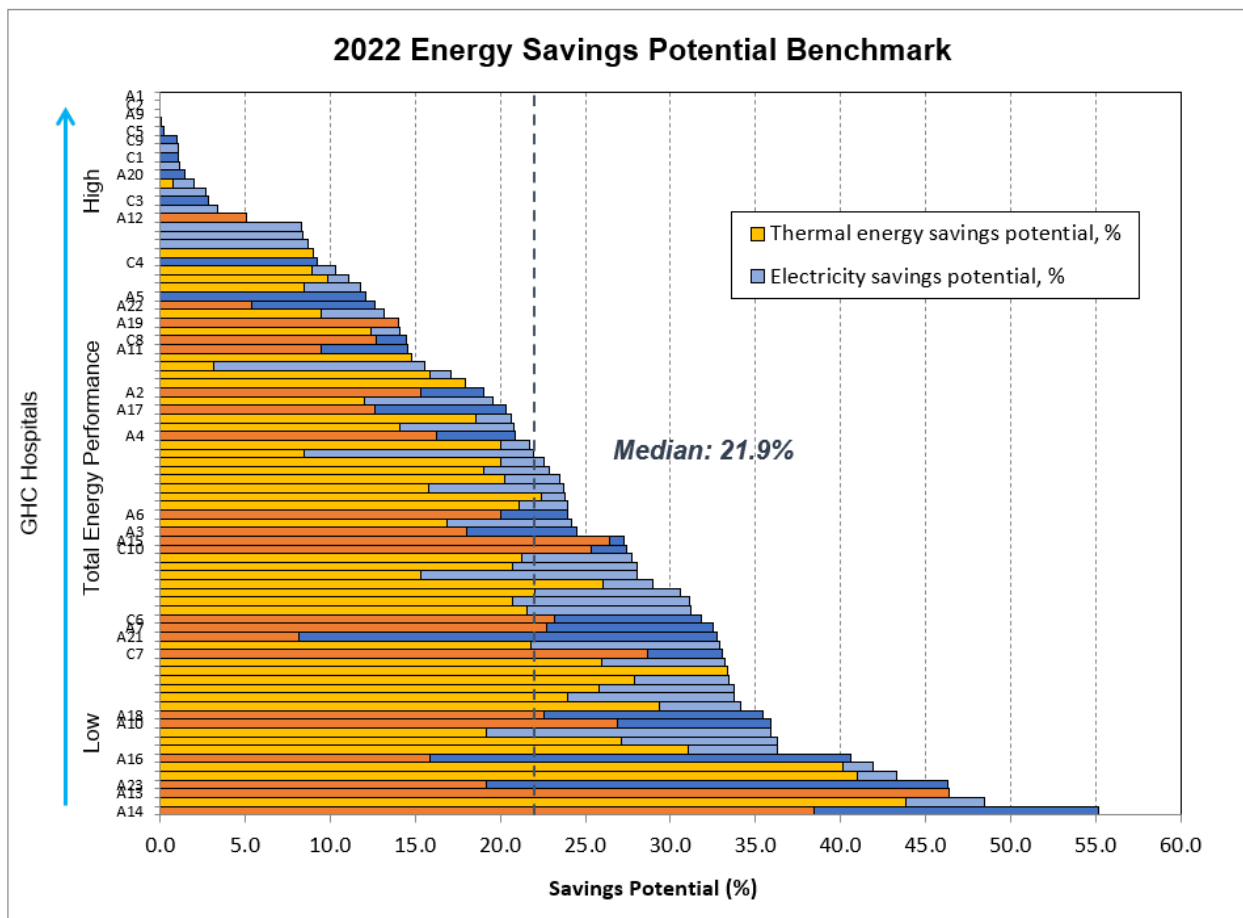


Figure 1 Energy performance new hospitals relative to other (older) Greening Health Care member hospitals

¹ Greening Health Care good-practice energy efficiency targets are based on top-quartile benchmarks for each hospital type in the database and considered readily attainable in new hospitals without significant capital cost premium.

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These 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 vs 2021 columns).

Actual and target energy use are presented in equivalent kilowatt hours per square foot of building area (ekWh/ft²)², divided into the base (non-weather sensitive) and weather-sensitive components. Targets are based on top-quartile benchmarks from the Greening Health Care database of current member hospitals of different types and ages adjusted for weather, heating source, and other material site variables.

Table 2: Top-10 Performing Hospitals

Prov/State	Code	Electricity (kWh/ft ²)					Thermal (ekWh/ft ²)					Total Energy (ekWh/ft ²)		Annual Savings Potential			Total Energy (GJ/m ²)		GHG Emissions kg/ft ²		
		Base		Cooling		Change vs 2021	Base		Heating		Change vs 2021	Actual	Target	%	Cost	GHG Emissions tonnes	Change vs 2021	Actual	Target	Actual	Target
		Actual	Target	Actual	Target		Actual	Target	Actual	Target											
ON	C2	13.7	13.7	0.7	0.7	-	6.2	6.2	8.6	8.6	-	29.2	29.2	0.0%	\$0	0	-	1.13	1.13	3.17	3.17
ON	A1	20.4	20.4	1.7	1.7	-0.7%	4.9	4.9	7.9	7.9	-12.2%	34.9	34.9	0.0%	\$0	0	-4.6%	1.35	1.35	3.03	3.03
ON	A9	19.8	19.8	1.4	1.4	1.5%	15.6	15.6	10.7	10.7	-28.4%	47.5	47.5	0.0%	\$0	0	-13.1%	1.84	1.84	5.51	5.51
ON	C5	13.0	13.0	0.9	0.9	-2.4%	2.9	2.9	4.9	4.9	36.6%	21.7	21.6	0.2%	\$3,912	1	15.7%	0.84	0.84	1.85	1.85
ON	C9	14.5	14.5	0.8	0.6	3.1%	1.1	1.1	10.1	10.1	26.9%	26.5	26.3	0.9%	\$12,910	3	15.2%	1.03	1.02	2.53	2.53
ON	C1	13.8	13.8	1.1	0.9	-	2.4	2.4	5.8	5.8	-	23.1	22.9	1.0%	\$15,927	3	-	0.90	0.89	1.97	1.96
MB	A20	14.2	14.2	2.2	1.5	-0.2%	13.7	13.7	19.4	19.4	8.0%	49.6	48.9	1.4%	\$18,138	1	5.5%	1.92	1.89	6.20	6.20
ON	C3	14.7	14.1	1.1	0.9	-	6.0	6.0	7.1	7.1	-	28.9	28.1	2.8%	\$30,336	6	-	1.12	1.09	2.90	2.88
CA	A12	20.1	20.1	2.4	2.4	-8.4%	22.5	19.0	3.2	4.2	-4.6%	48.2	45.8	5.1%	\$29,636	336	-8.2%	1.87	1.77	9.43	8.97
ON	C4	16.3	14.1	1.0	0.8	-0.5%	2.3	2.3	6.3	6.3	3.6%	26.0	23.6	9.2%	\$224,063	45	1.0%	1.01	0.91	2.12	2.05

Table 3: Lower Performing Hospitals

Prov/State	Code	Electricity (kWh/ft ²)					Thermal (ekWh/ft ²)					Total Energy (ekWh/ft ²)		Annual Savings Potential			Total Energy (GJ/m ²)		GHG Emissions kg/ft ²		
		Base		Cooling		Change vs 2021	Base		Heating		Change vs 2021	Actual	Target	%	Cost	GHG Emissions tonnes	Change vs 2021	Actual	Target	Actual	Target
		Actual	Target	Actual	Target		Actual	Target	Actual	Target											
ON	A5	26.8	20.6	1.1	1.1	0.4%	14.9	14.9	9.3	9.3	-5.8%	52.1	45.8	12.1%	\$311,326	62	-2.4%	2.02	1.77	5.31	5.12
NY	A22	24.2	20.6	2.2	2.2	3.8%	11.5	11.5	11.9	9.2	-22.0%	49.8	43.5	12.6%	\$367,529	434	-3.8%	1.93	1.69	5.13	4.52
AB	A19	19.8	19.8	1.4	1.4	2.1%	26.2	19.0	23.6	20.8	-4.1%	70.9	61.0	14.0%	\$269,216	3,439	-2.2%	2.75	2.36	23.57	21.74
ON	C8	21.3	20.6	2.8	2.4	-2.1%	27.0	19.0	14.9	14.6	-4.8%	66.1	56.5	14.5%	\$240,983	682	-3.9%	2.56	2.19	8.49	6.91
CA	A11	23.4	20.6	4.9	4.9	0.5%	22.3	19.0	5.1	3.2	-17.7%	55.8	47.7	14.6%	\$200,293	687	-9.5%	2.16	1.85	10.95	9.38
ON	A2	22.9	20.6	1.7	1.7	0.4%	12.9	12.9	26.4	16.6	-1.7%	63.9	51.7	19.0%	\$655,632	1,847	-0.8%	2.48	2.01	8.01	6.13
CA	A17	24.7	20.6	2.5	2.5	5.0%	23.1	19.0	3.3	0.6	2.7%	53.7	42.7	20.3%	\$621,285	2,016	2.4%	2.08	1.66	10.53	8.41
ON	A4	22.9	20.6	3.3	2.3	-0.8%	32.0	19.0	14.7	15.8	-6.0%	72.9	57.7	20.8%	\$1,201,153	3,148	-4.0%	2.82	2.24	9.43	7.14
ON	A6	22.9	20.9	2.8	2.0	0.4%	30.1	16.1	16.1	15.7	3.4%	72.0	54.7	24.0%	\$1,354,752	4,204	2.3%	2.79	2.12	9.33	6.57
ON	A3	6.4	2.5	1.4	0.0	-13.4%	66.6	51.9	7.3	7.3	3.2%	81.7	61.7	24.5%	\$451,465	1,035	1.9%	3.16	2.39	13.92	11.03
CA	A15	11.3	11.3	4.8	4.3	8.8%	33.4	19.0	3.6	4.0	7.7%	53.2	38.7	27.3%	\$227,662	2,117	6.0%	2.06	1.50	10.22	7.51
ON	A7	27.9	20.8	3.4	1.2	1.2%	41.7	20.3	22.8	22.3	4.9%	95.8	64.7	32.5%	\$1,222,490	2,513	3.7%	3.71	2.51	12.87	8.56
MB	A21	44.7	20.6	2.3	1.5	-	17.9	17.9	36.2	28.0	-	101.1	68.0	32.8%	\$346,888	300	-	3.92	2.63	10.21	8.59
ON	C7	15.3	13.9	1.7	1.0	-4.5%	22.9	6.6	8.2	10.6	-1.1%	48.1	32.2	33.0%	\$621,271	1,775	-2.3%	1.86	1.25	6.25	3.64
AB	A18	28.0	18.7	4.6	1.0	-5.3%	29.3	19.0	37.4	25.3	4.8%	99.2	64.0	35.4%	\$184,467	1,605	1.7%	3.84	2.48	34.47	21.63
CA	A10	26.7	20.6	3.5	3.5	-4.4%	34.0	19.0	3.9	0.6	0.8%	68.1	43.7	35.9%	\$856,742	3,639	-3.3%	2.64	1.69	13.27	8.60
OR	A16	40.5	20.6	3.8	2.7	-3.5%	34.3	19.0	6.4	8.3	-2.6%	85.0	50.5	40.6%	\$844,772	893	-3.1%	3.29	1.96	8.87	5.74
ON	A23	43.3	18.7	5.9	2.3	2.1%	27.8	19.0	27.0	15.8	16.3%	104.0	55.9	46.3%	\$512,490	479	10.4%	4.03	2.16	11.62	7.08
CA	A13	20.2	20.2	4.2	4.2	-9.5%	53.7	19.0	4.0	0.6	6.0%	82.0	44.0	46.4%	\$358,553	4,067	2.0%	3.18	1.70	15.76	8.66
CA	A14	36.4	20.6	4.8	3.6	-7.2%	57.0	19.0	4.2	2.8	6.5%	102.3	45.9	55.2%	\$1,249,487	4,725	6.3%	3.96	1.78	19.86	9.01

Some important insights can be drawn from this table:

1. Ten new hospitals have now met or are within 10% of their Greening Health Care good practice total energy use targets.
2. The utility cost savings potential for the 20 lower performing hospitals is close to \$7.0 million/year, with six over \$500,000/year. Over a 30-year period, this has a combined cost avoidance of close \$500 million.
3. Collectively these hospitals are emitting close to 40,000 metric tons of excess annual greenhouse gas emissions.

² To convert to kBtu/sf, multiply by 3.412; to ekWh/m², multiply by 10.764; to GJ/m², multiply by 0.03876

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 inefficiency under low loads, and steam distribution losses.
5. Three of the top performers reported energy increases in 2022 while two others showed double-digit savings.
6. Half of the low-performing group reported annual increases in 2022.

4 Conclusions and Recommendations

Three of these new hospitals, one in ten, are achieving exceptional energy performance. Another seven are performing well, within 10% of current Greening Health Care top quartile energy benchmarks for all hospitals. These top-ten hospitals continue to inform and inspire stronger energy targets and best practices. Most are still working on further improvements, promising even higher standards in the progression towards low carbon and net zero emissions.

The other 20 participating hospitals have yet to achieve the energy and emissions targets to which they were modeled and of which they are technically capable. Together they are costing millions of dollars of excess utility expenditures and tens of thousands of metric tons of avoidable emissions.



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

Every year this research uncovers new success stories and best practices, together with insights into process failures causing bad outcomes. There is evidence of progress being made. Coordinated and collaborative action is needed across all jurisdictions, engaging all parties in evidence-based process improvements that can deliver consistently high energy and emissions performance for all new hospitals. We simply must get it right with the billions of dollars of investment in new facilities if we are to meet emissions reduction targets for the thousands of older hospitals that lack the technological advantages of their new counterparts.

Specific recommendations for this year's report are grounded in the cumulative lessons learned since we began this work in 2017:

1. **Modeling and Energy Targets:** top performers began with an emphasis on energy efficiency and ambitious energy targets. Greening Health Care has documented building system-level metrics from high-performing new hospitals which were published in November 2022 in the report *Achieving High Performance Building Systems in Healthcare Facilities – Phase 1* posted on the Greening Health Care website. New hospital modeling should be calibrated to these empirical standards.
2. **Performance-Based Commissioning:** traditional functional commissioning practices are insufficient to meet high operational performance. Performance-based commissioning goes beyond verifying that equipment works as intended, to demonstrate that modeled system operation and utility demand profiles have been achieved.

3. **Operational Excellence:** the most important factor in meeting high performance goals is building systems' operation, maintenance, and controls. The FM (Facilities Maintenance) Advisor should be engaged at the same time as the PDC (Planning, Design and Compliance) Consultant, working with integrated teams, including hospital user groups, on design specifications that support high-performance operations. The biggest energy reductions seen through this research have come from operational improvements to advanced central plants and air handling systems, involving little capital cost but requiring intensive analysis of complex systems.
4. **Partnership:** Achieving and sustaining high performance is a team endeavor, requiring shared goals and multi-year, mutually beneficial relationships. Mechanisms are needed to coincide where retrofits are identified after hospital opening to achieve further energy savings within an acceptable payback period. Energy targets should be periodically updated over the life of the hospital as new technology and knowledge become available.
5. **Leadership:** the linkages between climate change and human health have been well documented, giving hospitals an even stronger stake in reducing emissions. At the project level, having a strong team and champions in place ensures the hospital's vision is incorporated into the design specifications and maintained through construction and ongoing operations. At the board and executive level, ensuring high energy and emissions performance should be a strategic priority.
6. **Collaboration:** sharing of information between hospitals will avoid repeating past mistakes, helping achieve consistently high performance, inform continuous improvement, and raise the bar for energy efficiency standards.

Appendix A Participating Hospitals

Hospitals reporting in 2022 for this report:

Anaheim Medical Ctr, CA
Brampton Civic Hospital, ON
Bridgepoint Active Care, ON
Cortellucci Vaughan Hospital, ON
Fort Saskatchewan Community Hospital, AB
Fresno Hospital, CA
Humber River Hospital, ON
Memorial Sloan Kettering - David H Koch Center,
Milton District Hospital, ON
Modesto Medical Ctr, ON
New Women's Hospital, MB
Niagara Health - St Catharines, ON
North Wellington Health - Groves Memorial, ON
Oakville Trafalgar Memorial, ON
Peel Memorial Hospital, ON
Providence Care Kingston, ON
San Diego Hospital Campus, CA
San Leandro Hospital Campus, CA
Sault Area Hospital, ON
Selkirk Regional Health Centre, MB
South Health Campus, AB
St Joseph's Healthcare Hamilton, ON
St Joseph's London - Parkwood Institute, ON
St Joseph's London - Southwest Centre, ON
Vacaville Hospital, CA
Waypoint Atrium, ON
Westside Hospital, OR
Women's College Hospital, ON
Woodland Hills Medical Center, CA
Woodstock General Hospital, ON

Appendix B Webinar Panelists

October 12, 2023, New Hospitals Performance Report Launch Webinar Panelists

<https://greeninghc.com/event/ghc-new-hospitals-webinar-learning-from-the-best/>

Name	Hospital	Position
Myles Boonstra	Shared Health Manitoba	Director of Environmental Sustainability and Energy
John Ramshaw	Health Sciences Centre, Winnipeg	Supervisor of Environmental Systems