

Identifying Opportunities for Greenhouse Gas Reductions and Cost Savings in Hospitals: A Knowledge Translation Tree

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TABLE 1.
Descriptions of interventions, cost estimates and GHG savings (from the greatest to the smallest GHG impact)

Intervention	Description/definition	Cost or savings estimate (first year)	Cost or savings explained: Numbers prorated to a 200-bed hospital	GHG reduction estimate: Metric tonnes (T) of CO2 equivalent units	GHG reduction explained: Prorated to a 200-bed hospital over one year
Instituting a leadership strategy	A strategy to decrease GHGs is the overarching intervention for any facility. A hospital can choose a strategy that already exists, or create a novel approach.	Cost: \$50,000	Administrative time spent creating or borrowing a sustainability strategy.	>5,000 T	The leadership strategy can drive the hospital to make all, or many, of the interventions in this article. Without the strategy, it is difficult for individuals or green teams to make significant gains.
Decarbonizing investments	Hospital foundations have investments, and a certain percentage would be in FF funds. There are significant GHG savings created by divesting from FFs. It is possible to divest by 60–85%.	Cost: \$0	We assumed no change in rate of return after divesting from FFs.	2312 T	We looked at the amounts held in the foundations of three urban hospitals in Ontario and took the lowest amount and prorated it to a smaller 200-bed hospital. This amount is \$21 million. The market has approximately 192 T CO2eq per million US dollars in sales. Low carbon funds have 48 T per million (Cleary and Hakes 2021; Frankel et al. 2015).

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A new low-carbon building	New buildings operate with minimal GHG production.	Cost: \$250 million	In Ontario, a new hospital costs over \$1 million per bed. A 200-bed hospital could cost \$250 million.	1,840 T	We consulted Greening Health Care,* which provided a comparison of the new Humber River Hospital (2015) to a standard, older Ontario hospital of approximately 30,000 square feet.
Replacing oil and gas boilers	Oil and gas boilers produce a large component of a hospital's GHG contribution. Upgrading to energy-efficient boilers can reduce GHG production.	Cost: \$1 million	Greening Health Care reported the average cost of upgrading gas and oil boilers in Ontario to be \$750,000 to \$1 million.	1,035 T	Grand River Hospital (232 beds) reported that their upgrade in 2012 resulted in one-year GHG savings of 1,201 T (Greening Health Care 2018). This estimate did include an in-house technician to align use with wing and room occupancy patterns.
Sustainable procurement contracts	Hospitals work with procurement agencies that award contracts to companies for everything from gowns to MRI machines to medications and use scoring systems to decide how contracts are awarded. If sustainability is part of the scoring system, it motivates companies to develop sustainable products.	Cost: \$10,000	Adapting a new procurement scoring system would be a small administrative cost to the organization. Assumed a \$10,000 cost.	>500 T	The supply chain represents 54–62% of the GHG footprint in the healthcare sector (Eckelman and Sherman 2016; Tennison et al. 2021). Sustainable procurement strategy would result in large CO2 reductions.†
OR ventilation setbacks	Other countries (such as the UK and the US) do not run their OR ventilation at full settings during off-hours, whereas in Canada, hospitals may not “set back” their ventilation settings because of safety concerns regarding infectious diseases.	Savings: \$75,000	Greening Health Care reports that Ontario hospitals can save an average of \$75,000 annually.	460 T	Greening Health Care reported that Ontario hospitals' GHG savings were approximately 460 T CO2eq annually (Greening Health Care 2018).

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Desflurane reduction	<p>Anesthetic gases are released directly into the atmosphere, unfiltered, following their use and are considered GHGs.</p> <p>Desflurane has a considerably greater GHG burden per unit in comparison to other gases.</p>	Savings: \$18,000	Financial savings in a 400-bed hospital in Ontario from eliminating desflurane use was \$30,000 annually.	318 T	Sudbury Health Sciences North Hospital (454 beds) decreased GHG production by 723 T (Caycedo-Marulanda and Mathur 2022).
Plant-rich diet for patients	We looked at the GHG changes associated with providing a more plant-based diet and decreasing the quantity of meat products provided. We chose an increase of 20% more plant-rich items.	Cost: \$1,000	Local Ontario hospitals that had switched to plant-based meals reported that their costs were roughly unchanged.	169 T	A study conducted across three hospitals in California (total of 1,078 beds) found a reduction of 1,648 T CO2eq annually with the reduction of meat products in patient meals (Lagasse and Neff 2010).
Adding an energy manager	A dedicated energy manager is hired to oversee and optimize all aspects of a hospital's energy use.	Cost: \$100,000	An energy manager in Ontario earns approximately \$100,000 per year.	136 T	A large hospital monitored electricity savings year by year over a five-year period and converted the average amount of electricity saved per year to GHG savings.
Deprescribing strategy	<p>Deprescribing is done to decrease unnecessary medications, errors, interactions and side effects.</p> <p>Pharmaceutical production and disposal release a significant amount of GHGs.</p> <p>A deprescribing program could decrease medication use by at least 5%.</p>	Savings: \$>1 million	<p>Financial data were obtained from a large Ontario hospital.</p> <p>Based on their numbers, a 200-bed hospital would spend \$23 million per year on medications.</p>	>100 T	<p>Pharmaceuticals contributed to 25% of Canadian healthcare GHG emissions in 2015 (Eckelman et al. 2018).</p> <p>A deprescribing campaign to reduce in-patient medication use by 5% would result in a CO2 reduction over 100 T.†</p>

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Reusable gowns	Gowns used both in the wards for contact precautions and in the OR are either disposable items or reusable items, which are sent to cleaning services to be washed and sterilized	Cost: \$0	In Ontario, an urban hospital had a small cost saving with reusable gowns, whereas a rural hospital had a cost increase. Therefore, we chose no change in cost.	86 T	Reusable surgical gowns reduce GHGs by 1,079 kg CO2eq per 1,000 gowns (Vozzola et al. 2020). An Ontario hospital estimated that 80,000 gowns were used for in-patient care annually.
Bike stations	Many hospitals install bike stations (ranging in size and cost) to encourage employees to bike to work by providing a safe location to store bikes.	Cost: \$10,000	Most facilities that provide bike stations received co-funding. Data from a hospital installing a 22-spot bike locker indicated a rough cost of \$10,000.	53 T	A new 22-bike station might encourage 11 extra employees to bike to work regularly. Note that increasing active transportation to work is a multifactorial dilemma, and in Ontario, seasonal weather is also an issue. Each new biker would eliminate the use of one full-sized gas vehicle driven 20,000 km annually, which would eliminate 5 T CO2eq (Plug'n Drive 2015).
Retrofitting LED lights	Replacing older lighting sources with LED lighting has the potential to significantly reduce energy expenditures.	Cost: \$73,000	Kingston General Hospital (440 beds) reported an estimated annual cost savings of \$77,000 (Kingston Health Sciences Centre 2019).	37 T	Hamilton Health Sciences' Juravinski Hospital Site (228 beds) reported GHG savings of 37 T CO2eq with their 2020 LED retrofit (Hamilton Health Sciences 2021).
Reusable "sharps" containers	Needles are disposed in "sharps" containers. These containers are either disposable and are disposed with their contents or are reusable and taken to facilities where their contents are disposed and the container is sterilized and re-used in the hospital.	Savings: \$12,000	Practice Green Healthcare estimates an average cost reduction of \$12,000 (Practice Greenhealth 2016).	30 T	A study done at Northwestern Memorial Hospital (8,850 beds) indicated a GHG reduction of 127 T CO2eq in one year with transition to reusable sharp containers (Grimmond and Reiner 2012).

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Zero-emission EV chargers	A facility with an EV charger may encourage more employees to drive EVs to work and make EV use more accessible in Ontario.	Cost: \$16,000	<p>We looked at the cost of a level-2 charging station (208–240 V, requires six to eight hours to charge).</p> <p>Hospitals are responsible for paying the cost of electricity; we assumed that this would limit the number of EV chargers available (we chose four).</p> <p>Level-2 chargers cost \$2,000–\$3,000, each with a cost for installation.</p>	19 T	<p>Adding four EV chargers might encourage the use of at least two more EV drivers.</p> <p>In Ontario, the replacement of one full-sized gas vehicle with an EV vehicle travelling 20,000 km annually equates to a saving of approximately 5 T CO₂eq annually (Plug'n Drive 2015).</p>
Choosing Wisely Canada for MRIs	The Choosing Wisely program was developed to educate clinicians on how to minimize the use of unnecessary tests and investigations (Choosing Wisely Canada 2017).	Savings: \$255,000	<p>We estimated an average MRI cost in Ontario to be \$739 (Salazar 2021).</p> <p>We assumed 10 MRI scans each day for a year and a 10% reduction in MRI use over one year.</p>	10.8 T	<p>Using one MRI machine for one year with typical use is estimated to emit 107.8 T CO₂eq (CADTH 2021; McAlister et al. 2022).</p> <p>We assumed a 10% reduction in MRI use over one year.</p>
Reducing MDIs	<p>Respiratory inhalers can be delivered via an MDI or a DPI.</p> <p>The propellant used in MDIs results in increased GHG emissions.</p> <p>However, MDIs are necessary for patients who are too weak to use a DPI.</p>	Cost: \$0	If patients are on the Ontario Drug Benefit plan, the cost to the hospital is approximately equal.	7 T	<p>A decreased use of in-patient MDIs of 10% should be possible.</p> <p>A total of 8,259 in-patient MDIs were reported to be used annually at a large Ontario hospital.</p> <p>We calculated GHG savings via GHG differential of MDI versus a DPI (a difference of 28 kg CO₂eq per inhaler) (Jeswani and Azapagic 2019).</p>

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Choosing Wisely Canada for CBCs	We looked at reducing the use of CBCs as a specific example of routine laboratory testing (Choosing Wisely Canada 2021).	Savings: \$117,000	Chose a goal of 10% reduction of CBCs processed per year. Cost per test is \$11, and the cost of performing the test is \$15 (Hale 2015).	0.5 T	Each CBC was found to emit 116 g CO2eq (Ma et al. 2019). A total of 12,500 CBC tests were done per month at a large Ontario-based hospital. We estimated a 10% reduction of CBCs per year.
Water station	A water station allows employees to bring their own reusable water bottles to refill, therefore, reducing the need for single-use plastics, specifically plastic water bottles.	Cost: \$3,000	A water station in Ontario cost approximately \$2,000 and installation was \$1,000.	0.5 T	We compared the carbon equivalent of tap water to bottled water and found a GHG difference of 16 kg CO2eq per 100 L (Fantin et al. 2014). The use of a water station over one year at a small Ontario hospital was approximately 3,375 L (estimating 500 mL per use).

*Greening Health Care is a program delivered by the non-profit Climate Challenge Network (greeninghc.com).

† Procurement is likely significantly higher than 500 T of CO2eq (discussed in text).

‡ It remains difficult to set CO2eq targets for the reduction of overprescribing based on limited research to date.

CBC = complete blood count; CO2eq = carbon dioxide equivalent; DPI = dry powder inhaler; EV = electric vehicle; FF = fossil fuel; GHG = greenhouse gases; LED = light-emitting diode; MDI = metered dose inhaler; MRI = magnetic resonance imaging; OR = operating room.