NEJM Catalyst | Innovations in Care Delivery

ARTICLE

Decarbonizing Health Care: Engaging Leaders in Change

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Vol. 4 No. 5 | May 2023
DOI: 10.1056/CAT.22.0433

Health care leaders are often surprised to learn that their operations contribute significantly to a warming climate. In addition to their roles as responders to and victims of extreme weather events, health care organizations have an obligation to reduce their substantial greenhouse gas emissions as part of their overall mission to do no harm and to improve health. Representing close to one fifth of the U.S. gross domestic product, the health care sector can use its purchasing power to drive the transition to clean energy and a low-carbon supply chain for the rest of the nation. Moreover, much of the shift in focus to preventive models of care and safer, higher-quality care that reduces unnecessary utilization will naturally produce lower carbon footprints. With the Inflation Reduction Act of 2022, nonprofit organizations can now use the new tax credit provisions for renewable energy to support desired investments in buildings, energy infrastructure, and transportation, among others. Health care organizations and their global value chains can be influential and important catalysts for the journey to a net-zero carbon future. Here, the authors share recommendations for how leaders can build climate-smart strategies that take advantage of tax incentives and drive changes that can both energize their employees and build a more resilient system to care for their communities.

Climate Change and Health

Health systems face challenges of responsiveness and resiliency to the injury, displacement, and damage to ecosystems and their communities caused by the increased frequency and severity of weather events. For example, the extreme rainfalls and subsequent flooding in Pakistan during the summer of 2022 displaced about 33 million people, destroyed 1.7 million homes, and killed more than 1,500 people.[1] Outbreaks of waterborne diseases, such as cholera and diarrheal diseases, and vector-borne illnesses, such as malaria and dengue, affected thousands. Roads, bridges, and 1,460 health facilities were destroyed, hindering access to treatment for millions of people. Loss of food crops and livestock has compounded food shortages and malnutrition. In addition, depression, anxiety, and posttraumatic stress disorder have affected millions.[1]

This disaster and the many severe weather events in 2022 — such as the extreme heat waves and droughts in the United States, Europe, and Asia; intense hurricanes; and the dust storms in cities such as Salt Lake City, Utah, caused by evaporating lakes — imposed a much higher health burden on people with greater existing health risks, such as older adults, children, those with chronic conditions or disabilities, and those living in low-income and marginalized communities. The U.S. Department of Health and Human Services' new Office of Climate Change and Health Equity has specifically emphasized the need to protect oppressed and vulnerable groups suffering disproportionately from exposure to severe weather events.[2]

Climate Change and Health Care Delivery

Besides helping communities adapt to climate change, health systems also play a key role in mitigating the dangers of excessive carbon emissions. For example, the physical facilities of health systems contribute significantly to a warming climate. According to a 2018 report from the U.S. Energy Information Administration (within the U.S. Department of Energy), inpatient health care facilities represented the third most energy-intensive among all commercial buildings, operating at an intensity of 193,300 British thermal units (BTU) per square foot, nearly three times that of the average for all commercial buildings (70,400 BTU per square foot). Only food service (263,300 BTU per square foot) and food sales (232,000 BTU per square foot) surpassed inpatient facilities.[3] Factors that contribute to the intensity among inpatient facilities include their 24/7 operation with advanced systems for heating, cooling, and ventilation and their use of specialized energy-intensive equipment such as medical imaging and sterilization. Overutilization and waste multiply these effects. Although high, the energy intensity of inpatient facilities (in BTU per square foot) has declined 16% from 2012.[3]

> *"Inpatient health care facilities represented the third most energy-intensive among all commercial buildings, operating at an intensity of 193,300 British thermal units per square foot, nearly three times that of the average for all commercial buildings (70,400 British thermal units per square foot)."*

The Paris Agreement of 2015 contained national commitments across sectors and businesses. In close alignment, in 2022 the U.S. Department of Health and Human Services charged stakeholders to cut greenhouse gas (GHG) emissions in half by 2030 (compared with the 2008 baseline) and to achieve net-zero operations by 2050.[2] More than 100 of the largest U.S. hospital and health sector companies had signed on by November 10, 2022.[4] To meet this commitment, leaders can reduce emissions across a range of actions that will be discussed below, such as conserving building energy, transitioning to renewable energy, lowering the emissions from transportation (owned and leased vehicles), and careful use of anesthetic gases. In addition, significant reductions in associated emissions can be achieved through supply chain decisions, including the following: the purchasing and sourcing of medications, devices, construction materials, equipment, and food; better management of pharmaceuticals, such as metered-dose inhalers (MDIs); careful stewardship of other medical devices and supplies; and waste prevention (for additional references and resources, see Appendix).

To incentivize an accelerated move to net-zero operations, the Inflation Reduction Act of 2022 offers important incentives for nonprofit organizations. Before considering measurement and action commitments by leaders of health systems, we provide a brief overview of the opportunities available through this Act and an explanation of commonly used climate change terms and definitions.

The Inflation Reduction Act of 2022

The Inflation Reduction Act of 2022 provides significant tax credits for renewable energy that are for the first time refundable for tax-exempt entities, which include a majority of hospitals. This means that hospitals can receive direct payments — equivalent to the value of specified tax credits to profit-making institutions — for investing in energy infrastructure, zero-emissions electricity generation facilities or storage technology, alternative fuels, qualified commercial clean vehicles, and energy-saving commercial building updates such as interior lighting, heating, cooling, ventilation, or hot water systems, among others. The Act also provides funding to the U.S. Environmental Protection Agency to enhance product declarations of GHG emissions, which should facilitate supply chain management. In addition, funding provisions offer grants to community-based partnerships to reduce pollution and improve public health and climate readiness for disadvantaged communities.

Although many specifics will be determined in the regulatory rule writing, the opportunities for health systems to make major advances in emissions reduction are clearly more attractive with the Act. A summary of the provisions can be found in the October 3, 2022, "Inflation Reduction Act of 2022 (IRA): Provisions related to climate change" report from the Congressional Research Service.[5]

Decarbonization 101: A Glossary of Key Definitions

Greenhouse Gases

Greenhouse gases (GHGs) trap heat in the atmosphere. These include carbon dioxide (CO_2), which is approximately 75% of atmospheric GHGs, and even more potent gases of methane, nitrous oxide, and fluorinated gases (e.g., hydrofluorocarbons and anesthetics such as sevoflurane and desflurane). The current rate of CO_2 emissions exceeds the capacity of resorption by the Earth's natural carbon sinks (e.g., forests, wetlands, oceans) by about 100%, leading to accelerated increases in atmospheric CO_2 levels and associated rising global temperatures and severe weather events.

> “ *Significant reductions in associated emissions can be achieved through supply chain decisions.”*

CO_2 and CO_2 Equivalents

Measurements of carbon footprint or emissions are most commonly reported in terms of CO_2 and carbon dioxide equivalents (CO_{2e}). CO_{2e} is calculated by using the global warming potential of 1 ton of a gas relative to 1 ton of CO_2 over a given period of time (typically 100 years). For example, 1 ton of the general anesthetic desflurane is equivalent to 2,540 tons of CO_2; 1 ton of a similar anesthetic, sevoflurane, corresponds to 130 tons of CO_2.[6] As a point of reference, on average, a gasoline-powered car emits 1 ton of CO_2 per 2,500 miles driven — about the distance from Boston to Salt Lake City.[7]

Global CO_2 emissions in 2021 were 36.3 billion tons or gigatons (1 gigaton = 1 billion metric tons),[8] 2 billion tons higher than the prepandemic 2019 level of 34.3 billion tons of CO_2.[9] In 2019, estimated overall GHG emissions totaled 49.8 gigatons of CO_{2e}.[10] Emissions in the United States (5.982 gigatons of CO_{2e} in 2020, according to the U.S. Environmental Protection Agency[11]) and Europe have been declining but that decrease is more than made up for by rising rates in China, India, and other developing nations. Overall consumption in the United States on a per capita basis averaged around 14.7 tons in 2019[9] (down 30% from 1990[11]) but remains fourfold higher than the worldwide average.

Carbon Emissions Reporting Frameworks

The GHG protocol is the most common measurement system for measuring and reporting carbon emissions.[12] The GHG protocol classifies emissions into three *scopes*, as defined here:

- **Scope 1.** Direct emissions from owned or controlled sources. About 7% of total U.S. health care sector emissions are Scope 1 (excluding waste anesthetic gases and MDIs).[13]
- **Scope 2.** Indirect emissions from the generation of purchased energy, such as electricity, steam, heat, or cooling. These emissions are included in the organization’s GHG inventory, despite occurring external to the organization, because they result from the organization’s energy use. About 11% of U.S. health care emissions are attributed to purchased energy.[13]
- **Scope 3.** All indirect emissions other than Scope 2 that occur in the reporting entity’s value chain, including both upstream (supply chain) and downstream emissions and those in an organization’s investment portfolio, such as fossil fuel holdings. Scope 3 represents about 82% of U.S. health care emissions.[13]

As an example, the National Health Service (NHS) of the United Kingdom classified their 25 million tons of CO_{2e} emissions as follows:[14]

- **Scope 1.** All on-site fossil fuel use (e.g., emissions associated with fuel combustion in boilers, furnaces, and vehicles), anesthetic gases (nitrous oxide and fluorinated gases), and the emissions associated with fleet travel.
- **Scope 2.** Purchased energy, such as electricity, steam, heat, or cooling.
- **Scope 3.** Emissions related to water use and waste disposal; patient use of MDIs that use chlorofluorocarbon or hydrofluorocarbon propellants; business travel; staff commute; supply chain–associated emissions that included pharmaceuticals, equipment, business services, food, and other procurement; and commissioned health services. An example of a supply chain decision would be if a purchased computer was made using coal-fired energy, it would have a larger carbon footprint than one made with renewable energy.

The NHS defined a fourth category for patient and visitor travel, over which they had some influence (e.g., through greater use of telehealth), but that did not seem to fall within any of the three standard scopes.

> *“Hospitals can receive direct payments — equivalent to the value of specified tax credits to profit-making institutions — for investing in energy infrastructure, zero-emissions electricity generation facilities or storage technology, alternative fuels, qualified commercial clean vehicles, and energy-saving commercial building updates.”*

Limitations of Carbon Accounting

Regarding the largest category, Scope 3, the components have inherent measurement challenges and flaws. First, they require companies to gather emissions data from all their multiple-tier suppliers and customers, an incredibly complex task. Companies can use secondary data, based on industry averages, rather than actual and verifiable supplier and customer data. However, such use reduces their incentives to lower the actual emissions in their supply chains because such reductions would have an insignificant impact on the industry average and would also accrue to competitors that made no reductions in their supply chain emissions. Second, the Scope 3 concept also errs by treating supplier and customer emissions equally, even though companies have far more influence, control, and traceability over their upstream emissions (their suppliers) than their downstream operations (clinics or patients who use the end product). A third limitation is that Scope 3 results in multiplicative counting of carbon reductions; any GHG reduction in a multitier supply chain — including transportation, for example — can be claimed by all the companies at every step of the value chain.

The measurement problems inherent to Scope 3 can potentially be solved by shifting the analysis of carbon footprints from the entity to the product (output) level using an *E-liability* accounting method.[15] E-liability carbon accounting recursively calculates a product's carbon footprint as it travels down a supply chain and follows a process exactly analogous to how the cost of a purchased product reflects the value of all the resources used in its production and distribution, enabling an accurate calculation of any product's carbon emissions from "cradle to gate."

Carbon Reduction Targets: Carbon Net Zero, Net-Zero Emissions

As called for in the Paris Agreement of 2015, to keep global warming to no more than 1.5°C above preindustrial levels, emissions need to be halved by 2030 and reach net zero by 2050.[16] The terms *carbon net zero* or *net-zero emissions* refer to reducing CO_2 or GHG emissions to zero or as close as possible. Organizations may purchase carbon offsets to supplement their emissions reduction efforts. With recent investigations challenging the validity and benefits of certain carbon-offsetting programs, it is important to emphasize that offsets should not be viewed as a substitute for making real emissions reductions.[17-19] In addition, legitimate offset projects must result in permanent removal (because Scope 1 carbon emissions remain in the atmosphere for hundreds of years), and all such programs should be audited and accredited.

> "*One ton of the general anesthetic desflurane is equivalent to 2,540 tons of CO_2; 1 ton of a similar anesthetic, sevoflurane, corresponds to 130 tons of CO_2. As a point of reference, on average, a gasoline-powered car emits 1 ton of CO_2 per 2,500 miles driven — about the distance from Boston to Salt Lake City.*"

Leading the Movement to Climate-Positive Health Care

In her book *Greening health care: how hospitals can heal the planet*,[20] former Environmental Stewardship Officer at Kaiser Permanente (and coauthor on this article), Kathy Gerwig challenges what she refers to as the "cost myth." Initiatives such as installing on-site solar power, long-term purchases of new renewable energy generation, and waste reduction can yield a positive return on investment while also reducing GHG emissions. Examples include the following:

- Building energy systems that are optimized, reducing water consumption, and adopting other green building features can lower energy and operating costs.
- Renewable energy on-site and off-site can improve price stability and grid resilience.
- Reducing waste lowers costs and emissions, especially when fostering a circular system in which product materials are designed to have ongoing value and high carbon-emitting wastes, such as food, are diverted from landfills.

- Building and protecting facilities to lower the risks of damage from extreme weather and wildfires can reduce insurance and repair costs.
- Staff recruitment and retention costs can be favorably affected as health professionals seek to work where climate action is a priority.
- Investor-owned companies can avoid loss of value associated with risks that are not adequately addressed.
- Climate solutions can reduce patient visits and treatment from climate-related injuries and illnesses. Reducing air pollution from fossil fuel use reduces health risks and saves lives.

In September 2022, the U.S. Agency for Healthcare Research and Quality (AHRQ), in collaboration with the Institute for Healthcare Improvement and leaders from other organizations, published a primer filled with case studies and examples for health care systems to reduce carbon emissions.[21] The primer outlines four key steps for organizational leaders to take to mitigate climate change: setting goals, building the structural enablers to support measurement and improvement activities, selecting a discrete set of technical measures and normalization factors to enable benchmarking, and launching a set of improvement initiatives within each key measurement domain. We call attention to and summarize key aspects of these essential actions.

1. Set Zero-Emissions Targets

In line with the U.S. Department of Health and Human Services (and the Paris Agreement of 2015), health systems should set targets to reduce their emissions by half by 2030 (compared with a baseline from 2008) and to achieve net-zero emissions by 2050.[2] Although these aims are challenging, advocates argue that no other goals are commensurate with reducing the health crisis caused by climate change.

2. Establish Key Structural Enablers

To lead organizational change, a careful communication and operational strategy must be supported by key structural enablers. To manage the financing plan and resource commitments to carry out the climate action plan, health care organizations must establish a team, including executive leadership, and a data collection and management infrastructure. Among the key longer-term enablers are an active culture of sustainability with a trained workforce and procurement policies to prioritize suppliers based on environmental disclosures.

3. Understand Emissions

The AHRQ report recommends that organizations:

- Conduct an inventory of emissions from facility operations and purchased energy using the GHG protocol.

- Conduct a spend-based inventory for those emissions influenced through supply chain and investment portfolios and use available data to calculate other activities, such as commuting and business travel.
  - A recent publication from the NHS of the United Kingdom details their approach for calculating baseline emissions.[22]

- Implement normalization measures for benchmarking and comparisons between and among institutions.

- Recognize the limitations of carbon accounting methodology and consider new E-liability approaches.[15]

4. Prepare and Execute an Emissions Reduction Plan

In line with the framework of Scopes 1–3 that distinguishes between types of emissions in *direct* versus *indirect* control, the report highlights several of the greatest opportunities:

- Reduce emissions in direct control.
  - Reduce facility energy use through efficiency and design initiatives. The U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) certifications specify actions for new and existing buildings.[23]

  - Invest in renewable energy through on-site and off-site solar and wind installations.

  - Phase out natural gas used for heating and cooling buildings by transitioning to renewable energy, such as geothermal, hydrogen, and biomass.

  - Purchase zero-emissions fleet vehicles.

  - Switch to lower-emission anesthetic gases (eliminate use of desflurane), consider waste anesthetic gas–capturing systems, and reduce nitrous oxide waste, especially from centrally piped systems.

- Reduce emissions through influence.

- Encourage suppliers to reduce their operational emissions over which they have direct control (buildings, fleets, and purchased energy) and apply procurement policies that prioritize companies which perform carbon disclosures with a target for emissions reduction.

- Switch from carbon-intensive MDIs to low-carbon alternatives and monitor unnecessary use of MDIs.

- Reduce waste.
  - Minimize single-use devices and activate reprocessing/remanufacturing of products as allowed by the U.S. Food and Drug Administration.

  - Shift from disposable items to reusables where advantageous; eliminate single-use plastics wherever possible.
  - Implement circular systems in which materials that have lasting value can be maintained through repair and recapture rather than disposal.
- Reduce business travel.
- Incentivize commuting by mass transit, walking, and bicycling; optimize remote work.
- Reduce patient and visitor trips through transit shuttles and by consolidating appointments.
- Promote local and seasonal menus while reducing reliance on meat and dairy products.
- In addition, value-based care and quality initiatives can align with reduced emissions so that linking climate and quality initiatives can create reinforcing benefits.
  - Prioritize care that is high quality/high value. Preventive health care avoids illnesses while reducing health care costs and emissions associated with treating diseases.
  - Eliminate inefficient and unnecessary practices.
  - Reduce unnecessary pharmaceutical use.
  - Include GHG emissions data on leadership and quality performance dashboards.

Here, we provide brief descriptions of recent efforts by a United States–based system and the United Kingdom's national system.

Illustrative Examples

Boston Medical Center: Investing in Green Energy and Sustainable Returns

Boston Medical Center (BMC) is a safety-net, not-for-profit, academic medical center serving a large indigent patient population. BMC has committed to a strategic goal of reducing the environmental impact of its operations, both to improve the health of its community and to strengthen the resiliency of its critical care hospital infrastructure. Since 2011, BMC has reduced its carbon emissions from energy consumption by more than 90%, and in 2022, the system signed onto the U.S. Department of Health and Human Services Health Sector Climate Pledge. Among the green initiatives implemented across the system are the following:

- **Reducing operating room carbon footprint.** BMC substituted sevoflurane (1 ton = 130 tons CO_2) for desflurane (1 ton = 2,540 tons CO_2), converted to light-emitting diode (LED) bulbs, installed motion sensors to reduce lighting in unoccupied spaces, and increased waste recycling.

- **Solar power purchase agreement.** Through a joint investment with the Massachusetts Institute of Technology and the Post Office Square Redevelopment Corporation, BMC will generate the equivalent of 100% of its expected electricity consumption at a 650-acre, 60-megawatt solar facility in North Carolina. The 25-year solar energy purchase is expected to produce 146-gigawatt hours of emissions-free power per year and a reduction of 119,500 metric tons of CO_2 emissions.[24]

- **Rooftop farm.** At more than 7,000 square feet atop its power plant, BMC has a rooftop farm that yields 5,000 pounds of produce annually, providing fresh food to hospitalized patients, cafeterias, the Preventive Food Pantry, the Teaching Kitchen, and a weekly in-hospital farmers market. The bulk of the produce, about 70%, goes to the Preventive Food Pantry.

- **Campus consolidation and efficient use of utilities.** BMC completed a clinical campus redesign in 2018 to consolidate into a single clinical campus and reduced electricity consumption by 11 million kilowatt hours. Together with more than 30 energy efficiency projects, including a thermal energy agreement to use recycled *green steam* as a by-product of electricity generation to provide heat to the hospital, BMC has achieved 20 million kilowatt hours or more in annual energy savings. Taken together, BMC has reduced electricity consumption by 42% since 2011.

> *"With recent investigations challenging the validity and benefits of certain carbon-offsetting programs, it is important to emphasize that offsets should not be viewed as a substitute to making real emissions reductions."*

NHS in England: How a Nation Proposes to Reach Net-Zero Carbon by 2040

In October 2020, the NHS outlined a plan to get to net-zero carbon emissions.[14] The plan commits the NHS to net zero by 2040 for emissions it controls directly and 2045 for wider emissions it can only influence. The plan was developed by looking at the emissions baselines of the NHS in 1990 and modeling the impact of best practice interventions and innovations that will cut emissions to set an ambitious but realistic target for net zero. The NHS standard contract requires each NHS organization to publish a 3-year green plan detailing how they will reduce their emissions in line with the national trajectory. These plans will build on the priority actions already underway across the NHS, which include, for example, the following:

- **Buildings.** Upgraded LED lighting, improvements to building fabric and ventilation, and increased use of on-site solar panels are reducing energy consumption across the NHS estate. This will be further supported by a new net-zero carbon hospital standard for any new NHS buildings.

- **Travel and transport.** Increased use of ultralow-emission vehicles, including a hydrogen–electric zero-emission ambulance,[25] is cutting emissions from NHS travel and transport.

- **Medicines.** Use of desflurane has been reduced from more than 20% in 2018 to approximately 3% of all anesthetic gases in 2022, with a number of NHS hospitals eliminating its use altogether.[26] Improved supply, demand, and stock management, and repairs to manifold leaks have helped reduce nitrous oxide emissions across secondary care. Prescribing and effective use of lower-carbon inhalers are being incentivized across primary care and pharmacists, supported by a new National Institute for Health and Care Excellence patient decision aid.[27]

- **Sustainable procurement and waste reduction of food.** Food and catering services amount to approximately 6% of total emissions in the NHS; however, the cost of food waste in the NHS was estimated at £230 million annually, equivalent to about 39% of the total food budget, and this was suspected to be an underestimate.[28,29] The Greener NHS program is working with catering leads, dietitians, and suppliers to increase provision of healthier, locally sourced food for patients, staff, and visitors to cut emissions relating to agriculture, transport, storage, and food waste across the supply chain and on the NHS estate.

- **Supply chain.** All NHS purchasing now includes a minimum 10% scoring criteria assessing how suppliers will contribute to the net-zero targets of the NHS and its wider social value in contract delivery. Next steps include requiring all suppliers to publish a carbon reduction plan for their direct emissions.

Looking Ahead

Health care organizations have an obligation to reduce their substantial GHG emissions as part of their overall mission to do no harm and to improve health. Many of the existing key priorities for improving health — including a focus on preventive models of care and safer and higher-quality care that reduces unnecessary utilization — naturally produce lower carbon footprints and a more resilient system. Moreover, given its significant supply and resource utilization, health care is well positioned to benefit by shifting from a linear to a circular health care economy, considering the full life cycle of products in its supply chain calculations. Representing nearly 20% of the U.S. gross domestic product, the health care sector can use its purchasing power to drive the transition to clean energy and a low-carbon supply chain for the rest of the nation. Leaders who have taken on these challenges have found that effective communication, measurement tools, and specific and quantifiable short- and long-term goals have elicited greater than expected employee engagement across initiatives, accelerating success. Aided by the significant new tax credit provisions for renewable energy, health care organizations can better afford desired investments in buildings, energy infrastructure, and transportation, among others. Health care executives should act with urgency to reduce harm and improve resiliency, all while bettering their organizational performance by improving patient care, enhancing employee engagement, and eliminating waste on the journey to a net-zero carbon future.

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Appendix

Additional resources

Disclosures: Vivian S. Lee is Editor-at-Large for NEJM Catalyst Innovations in Care Delivery. *She has recused herself from the review process for this paper. Dr. Lee, Kathy Gerwig, Emily Hough, Kedar Mate, and Robert Biggio have no conflicts of interest, financial or otherwise, to disclose. Robert Kaplan serves as an uncompensated officer and director of the E-liability Institute, San Rafael, California, USA.*

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