

Sustainable & Green Strategies

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Health Systems Decarbonisation: The Essential Shift

The health sector occupies a unique position as a contributor to carbon emissions but also a sector that pays for the damages of climate change through health impact. By decarbonising, the health sector has a dual opportunity to meet the challenges and benefit from sustainable changes. For this, a systems approach to change is needed that considers the most vulnerable and marginalised, ensuring a just transition.

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key points

- Decarbonising the health sector has the opportunity to not only help mitigate and adapt to climate change but also to improve public health and decrease the current and future burden on health systems.
- By rising to the challenges of decarbonisation and sustainability, the health sector will decrease its impact, and will also stand to gain from a number of co-benefits, inside and outside of public health, and act as an advocate to other sectors.
- Decarbonisation works hand in hand with health promotion and disease prevention, and efforts to improve population health will positively impact climate footprint.
- Technological improvements will not be enough to prevent climate; systems change is needed to move away from models based on fossil fuel extraction and consumption.
- International collaboration and support are essential in adapting to change and building provision, capacity and resilience.

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The Healthcare System and Carbon Footprint

Amid the pressing global issue of climate change, a comprehensive effort to decarbonise every facet of society has gained urgency. Surprisingly, the health

sector often evades attention in climate discourse despite its sizeable contribution to carbon emissions. If ranked as a country, the health sector would be the fifth-largest carbon dioxide emitter, accounting for 4.4% of global carbon emissions (Health Care Without Harm

and ARUP 2022), which accounts for more than the aviation and shipping sectors combined (Gabbatiss 2019). Carbon footprint varies across different systems; the average per capita health carbon footprint in 2014 (in Organisation for Economic Co-operation and Development (OECD) countries, and China and India) was 0.6 tonnes of carbon dioxide (tCO₂) per capita, varying between 1.51 tCO₂ per capita in the United States, and 0.06 tCO₂ per capita in India (Pichler et al. 2019). This emphasises the imperative of health sector decarbonisation, not only for mitigating climate change but also for bolstering the sector's resilience against climate-induced health and environmental crises. Systems thinking is needed to tackle such complicated problems.

In the context of this paper, the health sector refers to not only acute care facilities but also the structures for health protection and prevention, as well as organisational and social structures working towards health, such as disability and elderly care.

Climate change is a justice issue, and the disparities

The health sector's substantial carbon footprint stems from a number of factors in different scopes of emissions. Scope 1 emissions are related to the direct use of sector-owned or controlled resources, which encompass waste management, transportation, and on-site fuel combustion sources, such as boilers and gas appliances (Health Care Without Harm and ARUP 2022). Scope 2 emissions are indirect and come from the consumption of purchased energy from a utility provider, including electricity, heat and cooling (Health Care Without Harm and ARUP 2022). Scope 3 is by far the largest contributor to the health sector's carbon footprint, accounting for, on average, 71% of the footprint (Health Care Without Harm and ARUP 2022). These emissions are indirect and arise principally from procurement, goods and materials distribution, transportation including patient commuting, pharmaceuticals (including medical gases), construction, waste generated in operations (such as catering), and use of products by patients, all when not directly under the control of the sector (Health Care Without Harm and ARUP 2022).

The health sector plays a crucial role in spearheading the necessary global transformation needed to meet the challenges of climate change

between different populations highlight the inequity and inequality in health status. The Global North has contributed the most to a changing environment, yet it is the Global South that is suffering and will suffer more greatly from climate events (Deivanayagam et al. 2023; Hickel 2020; Intergovernmental Panel on Climate Change 2023). The Global South contributes the least to global emissions, yet they often have less capacity for health systems, technological, economic and infrastructure resilience to weather shifting climates (Intergovernmental Panel on Climate Change 2023). For example, the impacts of flooding on health sector operations and public health status in low-lying Pacific Island nations, including infectious disease risk (Paterson et al. 2018; WHO 2017), or the effects of prolonged drought in a sub-Saharan nation (Masih et al. 2014), stand to significantly impact health. The Global North need to not only decarbonise but also assist in boosting the resilience of nations that are bearing the brunt of the climate crisis, despite their negligible contribution to its cause.

Adding to this, the health sector's large carbon footprint paradoxically aggravates a range of health issues. The system will be burdened with further costs through increased service demand, escalated stress, and damage to infrastructure and social systems. Climate change poses an increasing risk to global public health and disease management, leading to a greater incidence of morbidity and mortality due to direct and indirect causes. Direct causes will include infectious disease and pandemic risk, as well as direct environmental stressors, such as heat, severe weather and flooding, while indirect causes will include decreased water security, distorted and strained food systems, forced migration and negative mental health impacts, among others (European Public Health Alliance 2023; WHO 2019). The effects of these proximate causes are unevenly felt across society and by both non-vulnerable and vulnerable populations. Vulnerable populations include older people, children, pregnant women, those with a mental illness or an underlying

condition like respiratory disease and diabetes, and people of lower socioeconomic status (Guivarch et al. 2021). Thus, decarbonising the health sector presents a dual opportunity: curtailing its contribution to global carbon emissions, thereby reducing its public health impact and enhancing the resilience of health services to climate change-induced health threats.

According to the WHO, the health sector plays a crucial role in spearheading the necessary global transformation needed to meet the challenges of climate change and having an opportunity for public health prevention in terms of climate change related risk (WHO 2019).

Strategies for Healthcare Decarbonisation

To drive and accelerate the decarbonisation of the health sector, several strategies have been developed, some of which are currently being deployed across various settings. As extensively outlined by Health Care Without Harm in a collation of recommendations from the World Health Organization and World Bank, these strategies fall into three areas: (1) facilities and operations, (2) supply chain, and (3) the wider economy and society (Health Care Without Harm and ARUP 2021). Table 1

shows an overview of actions in these areas. To achieve a more comprehensive scope, additional areas of action from various sources have been integrated, enhancing the overall coverage of healthcare decarbonisation.

By implementing these recommended changes in different areas of action, the healthcare sector could stand to drastically reduce its environmental and climate impact. In this process, however, the healthcare sector can also stand to profit from a range of related co-benefits for the health and wellbeing of populations, as well as its own operations, efficiency and resilience. With healthcare staff being among some of the most trusted professions in society (Ipsos 2022), such a healthcare system and its staff, with a focus on sustainability and low climate impact, will be able to inspire other sectors and wider society to take sustainability seriously.

Co-Benefits from Healthcare Decarbonisation

Decarbonisation must be a goal of all industries for a sustainable future. At the same time, it offers an opportunity for co-benefits while reimagining how sectoral activities are organised and re-centred around planetary health.

Area of action	Changes to be implemented	Sources
Renewable energy	This category involves focusing on energy efficiency and the use of renewable energy sources, enabling the sector to consume electricity with lower carbon intensity and influencing suppliers to adopt greater sustainability measures. The approach advocates for broader energy transitions, ambitious targets, policies, and research.	<ul style="list-style-type: none"> • (Health Care Without Harm & ARUP, 2021) • (Markandya et al., 2018) • (Romanello et al., 2021) • (World Health Organization, 2020b)
Zero emissions buildings and infrastructure	In this category, the focus is on building resilient, eco-friendly healthcare facilities. This includes optimising designs for natural ventilation and resource efficiency, such as telemedicine. Alongside this, green spaces and roofs are also promoted, serving dual purposes: they absorb CO ₂ and enhance the wellbeing of patients and staff. These strategies collectively form part of a broader environmental management system, advocating for sustainable land use and healthy communities.	<ul style="list-style-type: none"> • (Guenther & Vittori, 2013) • (Health Care Without Harm & ARUP, 2021) • (Health Care Without Harm, 2015) • (U.S. Department of Health and Human Services, 2014) • (World Health Organization, 2015) • (World Health Organization, 2020b)
Zero emissions and sustainable transport	For facilities and operations, this means transforming the transport modalities of staff and the vehicle fleet through active public transport incentives, vehicle upgrades and low emissions zones. In the supply chain and wider society, this means promoting and procuring sustainable vehicles, prioritising bulk orders, and advocating for clean and sustainable transport systems and mobility plans. There is also a role in preventing the need for transport, such as healthcare staff housing policies to reduce commute distance and stress.	<ul style="list-style-type: none"> • (Health Care Without Harm & ARUP, 2021) • (Shaw et al., 2014) • (United Nations, 2021)
Healthy, sustainable and resilient food systems	Inside the sector, this means providing nutritious, locally sourced and seasonal food provision, as well as low-carbon footprint foods, such as plant-based foods, and sensible use of water resources. Outside of the sector, this entails pushing for sustainable, plant-based foods, reducing food waste and packaging, and pushing for healthier agricultural systems.	<ul style="list-style-type: none"> • (Gerber et al., 2013) • (Health Care Without Harm & ARUP, 2021) • (Health Care Without Harm, 2023) • (Smith & Bustamante, 2014) • (World Health Organization, 2020a)

<p>Low-carbon pharmaceutical systems</p>	<p>Inside the sector, this means promoting less medication-intensive medical management, and mitigating pollution from inhalers and anaesthetic gases, for example, by recapturing. Outside of the sector, this means incentivising change to lower pollutant pharmaceuticals, including medical gases, and advocating for healthier lifestyles less reliant on pharmaceutical intervention. In addition, it is important to encourage further research and development to exploit opportunities to diminish the environmental impact of pharmaceuticals and medical devices without compromising patient care. Further, production plants of pharmaceuticals and medical devices should be more environmentally-friendly, more decentralised, and closer to the end-users to reduce the need for global transportation.</p>	<ul style="list-style-type: none"> • (Health Care Without Harm & ARUP, 2021) • (Stockholm County Council, 2013) • (Wen & Liu, 2023)
<p>Circular and sustainable healthcare waste management</p>	<p>Inside the sector, this includes reducing waste, reducing incineration, increasing recycling and responsible disposal of potent global warming chemicals such as F-gases. Reprocessing and remanufacturing single-use medical devices should be seen as an opportunity. In related sectors, the health sector can encourage, procure and incentivise along the same principles and work to shift wider society and communities towards less waste-creating systems.</p>	<ul style="list-style-type: none"> • (Guzzo et al., 2020) • (Health Care Without Harm & ARUP, 2021) • (Health Care Without Harm Europe, 2020) • (MacNeill et al., 2020) • (Rizan et al., 2021)
<p>Increased health system efficiency</p>	<p>In facilities and operations, increasing organisational efficiency, decreasing over-intervention and unnecessary procedures, and internal review mechanisms with climate change in mind can help decrease carbon footprint. The sector can affect supply changes and the wider economy and society by ensuring strong information technology systems, efficiency and accountability of the services it engages with by providing a leading example of how other sectors can increase efficiency and decrease preventable emissions. Investment in preventative health, health promotion and primary care also has an important role to play in decreasing health system consumption by reducing the need for service utilisation, specialised services and interventions. Health staff education on sustainability will also be key.</p>	<ul style="list-style-type: none"> • (Beatson et al., 2008) • (Edwards et al., 2023) • (Health Care Without Harm & ARUP, 2021)
<p>Promote Telemedicine and Digital Health Services</p>	<p>Telemedicine has the potential to dramatically reduce travel-related emissions for both healthcare providers and patients. Its deployment should be part of a broader strategy involving consultations, remote monitoring, digital prescriptions, and long-distance follow-up care. Consideration should also be given to the energy efficiency of the technology platforms used and their compliance with data protection laws.</p>	<ul style="list-style-type: none"> • (Holmner et al., 2014) • (Lokmic-Tomkins et al., 2022) • (Purohit et al., 2021)
<p>Energy-Efficient Medical Devices</p>	<p>Transitioning to energy-efficient medical devices decreases electricity consumption and sets an example for suppliers, encouraging them to develop more energy-efficient products. This action should be aligned with a broader strategy that includes regular auditing of energy consumption, planned obsolescence, and eventual recycling or disposal of medical equipment in an environmentally friendly manner.</p>	<ul style="list-style-type: none"> • (Duque-Urbe et al., 2019) • (Guetter et al., 2018) • (Mohamed, 2020)
<p>Water Conservation Programs</p>	<p>By incorporating water-saving technologies such as low-flow faucets and water-efficient sanitation systems, healthcare facilities can drastically reduce their water consumption. This category should also include educational programs on water conservation, the monitoring and treatment of wastewater, and the potential for water recycling and reuse within the facility.</p>	<ul style="list-style-type: none"> • (Eckelman & Sherman, 2016) • (Gettler et al., 2023) • (Hernández, 2020) • (Priyalal et al., 2015)
<p>Local Sourcing of Medical Supplies</p>	<p>Sourcing medical supplies locally not only minimises the carbon footprint associated with transportation but also supports local economies. A comprehensive approach would involve creating a local procurement policy, fostering relationships with local suppliers, and performing a life-cycle assessment of products to ensure they meet environmental standards.</p>	<ul style="list-style-type: none"> • (Alderwick et al., 2021) • (Connor et al., 2010) • (Modisakeng et al., 2020)
<p>Green Roofs and Urban Green Spaces</p>	<p>Installing green roofs or investing in adjacent green spaces not only absorbs CO₂ but also enhances patient wellbeing. Such initiatives should be part of a broader environmental management system that may include the use of native vegetation, rainwater harvesting, and integrating therapeutic landscapes into healthcare settings for patient and staff wellbeing.</p>	<ul style="list-style-type: none"> • (Din et al., 2023) • (O'Hara et al., 2022) • (Ode Sang et al., 2022)
<p>Educate Staff and Patients</p>	<p>Developing and implementing sustainability training and awareness programs for healthcare professionals and patients can encourage the responsible use of resources. This education should extend beyond waste management to include energy conservation, sustainable commuting, and the impact of lifestyle choices on both health and the environment.</p>	<ul style="list-style-type: none"> • (Alderwick et al., 2021) • (Asaduzzaman et al., 2022)

Table 1: . Areas of action for healthcare decarbonisation



Healthcare spaces and processes can thus be purposely (re)designed to be more people- and community-friendly. Together with infrastructure resilience, indoor air quality can be improved by designing for better insulation, better natural ventilation, and more efficient heating and cooling in healthcare facilities, with the air exchange rate deliberately incorporated in the building design. The use of green spaces can counteract the heat island effect, encourage socialisation, and have beneficial effects on mental health and mild effects of physical activity (WHO 2016).

Additionally, with health experts emphasising that a diet rich in plant-based foods and with fewer animal-source foods brings about improved health, healthcare facilities should be leading the way in making sure the foods they offer are tailored to nutritional needs and do not further threaten climate stability (Department of Health and Social Care U.K. 2020). Food waste deserves a special mention too, as it has been estimated that it can range from 6% to 65% in healthcare facilities (Health Care Without Harm 2016). This comes with planetary and monetary consequences – according to the NHS Hospital Food Review, food waste costs are around £230 million annually only in the UK (Department of Health and Social Care U.K. 2020), at a time when climate change threatens food systems (European Public Health Alliance 2023).

Ensuring waste efficiency could greatly modify the effect of the health system on public health. With a significant percentage of the waste generated within healthcare facilities classified as hazardous, it is essential that it is handled and disposed of responsibly and that these processes are considered in healthcare systems with a view to increasing their sustainability (Health Care Without Harm Europe 2020). One of the notable co-benefits of efficiently managing waste would be lowering the risk of spreading environmental antimicrobial resistance (AMR), which on its own threatens to exert a massive burden on healthcare in the future (Marschang and de Stefani 2016). As with climate change, AMR risks creating a feedback loop of deterioration, impacting healthcare and provision. Rethinking the food systems in healthcare facilities would, therefore, have triple benefits for the people, planet and economy and improve population health, decreasing the burden from the health system.

The Progress of Healthcare Decarbonisation

Health sectors are beginning to rise to the task of decarbonisation, with a number of countries publishing plans to reduce their carbon impact. Whole-sector transformation has become the ambition of some health systems, such as the British National Health Service establishing in 2022 its Net Zero Plan to decrease their climate impact (NHS England 2022). Building upgrades, technological upgrades, such as energy efficiency management systems and artificial intelligence (AI), on-site renewable energy generation, staff transport modal shift and transport electrification, reducing the environmental impact of medicines and pharmaceutical, and reforming the way food and catering are managed, aim to greatly reduce emissions in all scopes. The Plan signals to the supply chain and procurement that they are expected to decarbonise as well. Patient care will lean more towards the prevention of chronic disease, focus on digitalisation, and on capacity building. Importantly, the Plan acknowledges the health inequalities of different populations, such as greater environmental hazard exposure faced by marginalised populations (for example, from air pollution), as well as less access to positive environments (such as green space) and the way that a changing climate will change energy needs.

Attention to the physical infrastructure and working with nature (often termed nature-based solutions) have seen physical health sector infrastructure reduce its environmental impact but also increase its adaptation capacity and resilience. Last year, a Bangladeshi hospital won the global award for best building (The Guardian 2022). The building uses natural ventilation, plans space, light and shade to reduce energy use and increase efficiency, uses rainwater collection and harvesting, plans access around anticipated staff and patient flow, and provides courtyards and focal points for people to meet (ArchDaily 2022). By paying attention to the surrounding climate and geographical needs, in this case, in terms of rain, flooding and severe storms, as well as energy and lighting needs, infrastructure can be planned to reduce climate impact and improve resilience to a changing climate while catering to population needs.

Strict emissions reporting requirements are essential for effectively reducing carbon emissions in the health sector, ensuring transparency and accountability. The Dutch government is making significant strides

in measuring healthcare emissions, which accounts for 4-8% (depending on the type of energy use and measure methodology) of the national carbon footprint, such as through the piloting of the Operation Zero methodology led by Health Care Without Harm (Health Care Without Harm n.d.). This initiative is a collaborative effort with the National Institute for Public Health and the Environment and the Ministry of Health, Welfare, and Sport. Phase one involved establishing a rigorous methodology to accurately measure carbon footprints, identify emission hotspots, and track progress. This included analysing emissions in material extraction, blue water consumption, land use, and waste generation. Drawing from the lessons learned, the pilot emphasised the importance of harmonising data with hard-to-measure sources, such as anaesthetic gas releases and employee commuting, to develop a comprehensive climate footprint analysis and decarbonisation roadmap.

Future Directions of Healthcare Decarbonisation

While a number of developing fields will assist in the mitigation of the healthcare sector's impact on the environment and climate, technology alone will not resolve an issue deeply entrenched in a system of fossil fuel extraction and consumption. Systems change focused on shifting to cleaner systems based on energy efficiency, sustainability, and equity is the cornerstone of action in facing the climate crisis.

Tackling healthcare waste by developing cleaner, less plastic-based solutions can reduce environmental impact. Reducing systemic waste and promoting a circular economy based on decreased waste acceptance whilst allowing for recycling and safe disposal offers low-hanging fruit for the decarbonisation of the sector.

Technology is assisting this transition and presents various opportunities for the healthcare sector to decrease its impact, increase efficiency and resilience, and show global leadership to help protect the climate and global health. Telemedicine, popular during the COVID-19 pandemic, has been shown to be an effective intervention to reduce health sector-related emissions (Purohit et al. 2021). Promoting digital access and literacy can help aid in reducing climate impact. AI and Data Analytics also have the potential to streamline energy use in healthcare facilities, as outlined in the NHS Net Zero Plan. Machine learning algorithms,

for example, can be employed to analyse patterns of energy use, anticipate future energy requirements, and implement strategies for energy conservation (Benti et al. 2023).

Successful health sector decarbonisation demands robust policy frameworks at the national and international levels. These policy frameworks should incorporate specific emission reduction targets, incentives for adopting green practices, and rigorous enforcement of environmental regulations. Policy can help enable and nudge the healthcare sector to secure the necessary transformations through financing, taxation and ring-fencing, and research and development. The healthcare sector can also significantly contribute to promoting change through the enforcement of diligent procurement standards, food system standards, land use management, and advocacy. The healthcare sector has notable political power as an anchor institution in communities to advocate for change, which ultimately stands to greatly benefit the sector by protecting public health (Reed et al. 2019). Similarly, the sector can lead by example, including through the example of healthcare staff, who should be leaders and educators when it comes to sustainability.

All of society can contribute to the healthcare sector's decarbonisation, particularly through the application of a One Health and Planetary Health lens, which sees the health of people and the environment as inextricably linked. Policy approaches, such as Health-in-all-Policies (HIAP), take into account climate and can assist in decreasing morbidity and mortality, including from environmental exposures (such as air pollution) and chronic disease (such as cardiovascular disease related to transport noise). All policies have the potential to enable healthcare sector decarbonisation, working together to protect the environment and health.

The importance of prioritising population health cannot be overstated. The most sustainable impacts on healthcare can be achieved through reducing the need for healthcare and promoting a healthy lifespan, including into older age. Healthier populations with less need for healthcare (especially including older age populations) will mean a healthcare system using less resources and energy and producing less emissions. Robust measures to protect and promote population health will see a decrease in the impact of healthcare emissions.

Health equity and justice remain vital issues when looking at healthcare sector decarbonisation. Health inequities exist across society, including internationally and in terms of healthcare access. Action on the prevention of morbidity and mortality locally, regionally and internationally has a massive role to play in healthcare-related emissions. Ensuring that all populations, regions and nations have the resources to mitigate and adapt to climate change is essential in protecting health and ensuring health equity.

Conclusion

Decarbonising the health sector represents a unique opportunity to both mitigate climate change and improve public health outcomes. While the progress to date is encouraging, the path ahead is still long and requires sustained commitment. Ambitious actions and policies that 1) realise the tight interlinkage between healthcare sector emissions and public health and 2) see expenditure as the health investment that it is, are a vital component in protecting public health. All policies should take health and climate into consideration and work to reduce health inequity, both locally and

further afield. International justice will be a key pillar for necessary change. Systems change needs to occur, with a rapid, deep, sustained shift to sustainable, low or no-carbon methods. Technology and innovation will offer opportunities to increase efficiency and decrease impact. It is necessary for climate change to be recognised as a profound threat to public health, recognising the role of each sector within health systems in facing climate change and ensuring a just transition that protects the marginalised and vulnerable through effective policies. Finally, we must acknowledge that countries are not on the same footing to tackle this dramatic transformation. The way to mitigate carbon footprint in very sophisticated healthcare organisations will be different, especially when needing to build a resilient healthcare system in countries where the basic needs are not yet covered. Systems approaches to complicated problems and stakeholder engagement with a focus on equity and inclusion are essential to truly protect public health.

Conflict of Interest

None. ■

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