5

Charting a course

Toward zero emissions health care

"The world's health sector facilities churn out CO_2... This is perhaps ironic — as medical professionals our commitment is to 'first, do no harm.' Places of healing should be leading the way, not contributing to the burden of disease." "

Tedros Adhanom Ghebreyesus, Director General, World Health Organization

Countries' health sectors have common but differentiated responsibilities and respective capabilities to get to zero emissions. High-income countries with high emissions health systems will need to follow radically steep or steady decline trajectories, while middle- and low-income countries will need to follow the early peak or late peak trajectories described in the previous chapter.

Recognizing these distinctions, the fact remains that every health care institution together with the sector's suppliers and manufactures in every country need to reach zero emissions by the middle of the century if the health sector is to do its part globally to minimize and reverse the climate crisis. Such a fundamental transformation will require massive collaboration and innovation at all levels of a huge sector of society that is at once highly globalized and deeply localized, that spans the public and private spheres, that makes up 10% of the world's gross domestic product, that is unequally resourced across countries, that unequally benefits populations within and between nations, and that touches most everyone on the planet.

As Diarmid Campbell-Lendrum, head of WHO's climate change unit says, "We really need climate-smart thinking to be an integral part of health system planning and implementation. For that to happen we need government-supported initiatives covering the full range of health system functions, including medical product development, supply chain design and management, and health information systems. We also need to think and act cross-sectorally, something that will require a whole of government approach."[44]

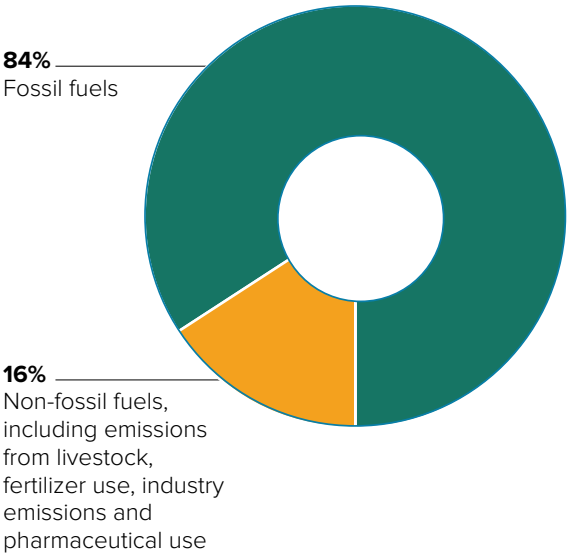


Figure 16. Proportion of health care's footprint attributable to fossil fuels in 2014

Indeed, in addition to the huge efforts needed within the sector, the decarbonization of health care is inextricably interlinked with the decarbonization of the wider economy. Health care systems change must take place in collaboration with other sectors of society who have to travel a similar path. Conversely, climate action in other sectors can make major contributions to protecting public health.[45]

Transformation must also occur in conjunction with meeting a series of interlinked health, equity, and climate priorities. These include maintaining and in many cases improving the quality of care patients receive, investing in disease prevention and addressing the social determinants of health to limit the need for many health care interventions, achieving universal health coverage, building climate resilience, and fostering a just transition for health care and other workers. Meeting these priorities provides an opportunity for well-established health systems

in wealthier nations to undertake health care reform that is cross-cutting, while low- and middle-income countries may have the opportunity to establish a new model of health system development that doesn't repeat the mistakes of high-income countries but instead develops solutions that work across these different agendas.

Emissions from fossil fuel energy to power, transport, and make products for health care as well as from fossil fuel derived products, like plastics, are the dominant source of health care emissions across all pathways and action areas. The combustion of coal, oil, and gas accounts for 84% percent of all of health care's climate emissions (Figure 16). The emissions from burning fossil fuels are also the main driver of outdoor air pollution, which according to WHO, kills more than 4 million people every year.[46] Recent research using updated modeling methods has estimated the mortality from lung-penetrating fine particle pollution—from fossil fuel combustion alone—could be more than double that figure, or 8.7 million premature deaths in 2018.[47] Regardless of the specific number, the evidence is clear that in addition to fossil fuel combustion being the primary driver of climate change, air pollution from fossil fuels is one of the greatest sources of morbidity and mortality in the world today. Transitioning to 100% clean, renewable, healthy energy in health care facilities and operations, in the global supply chain and the broader economy, will yield immediate health benefits from reduced particulate matter pollution while also preventing ongoing harm from climate disruption.

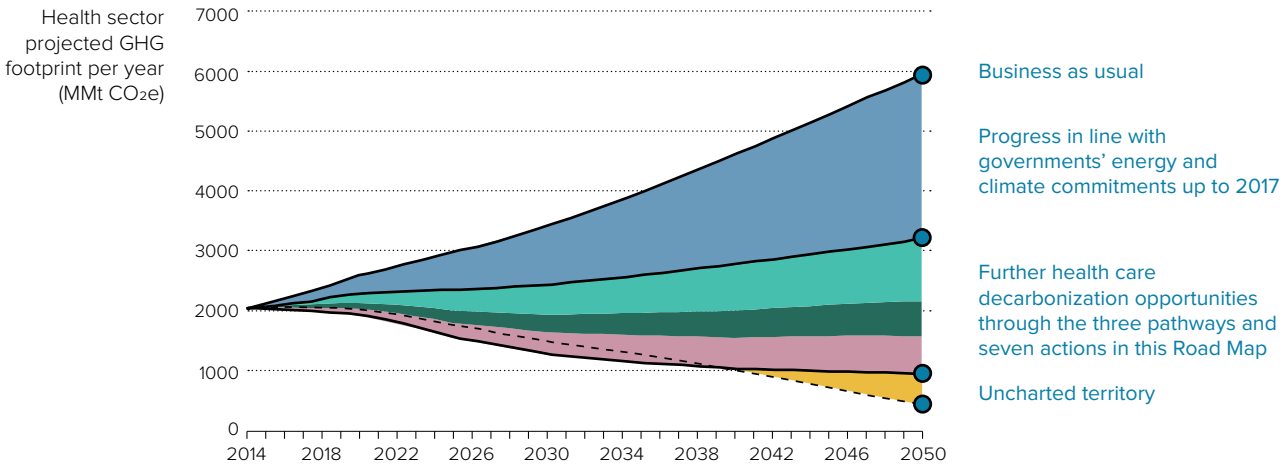


Figure 17. Top wedge (blue) is the projected impact of NDC commitments current in 2017 on the global health sector footprint between 2014 and 2050. Achieving NDCs will give a cumulative 45.4 Gt CO_2e reduction in emissions compared to the business-as-usual scenario. The remaining emissions across this period are predicted to reach 97.9 Gt, highlighting the need for more ambitious action on emissions. The middle wedge (three colors) is the projected reduction in health sector emissions for the three decarbonization pathways explored in this study between 2014 and 2050. These pathways assume a starting point where global NDC commitments up to 2017 are met. The bottom wedge is the emissions gap estimated from the Road Map modelling.

With this context in mind, we have identified three interrelated, overlapping decarbonization pathways that the sector should follow to chart a course toward zero emissions (Figure 17). Spanning and connecting these paths are seven high-impact actions (Figures 18a and b). To chart a course to zero emissions, health care must address these interwoven pathways and implement related high-impact actions simultaneously.

At the same time, the Road Map highlights that following these pathways and taking these actions alone is not sufficient to reach zero emissions. At the end of the road, so to speak, is a yawning health care "emissions gap" that lies between the sector and its decarbonized destination (Figure 17, uncharted territory). This gap represents the difference between what health care can achieve by following all pathways and implementing the seven high-impact actions, and what is necessary to get to zero. It highlights the need for the health care sector to act with urgency, to foster further innovation, and expand the realm of what is possible in relation carbon emissions reductions. At the end of this chapter (Section 6.3), the Road Map makes a foray into the wilderness of this uncharted territory to start identifying how to close the gap to zero emissions.

Three pathways to health care decarbonization beyond NDC commitments (2017)

To chart a course to zero emissions the sector must follow these three interwoven pathways simultaneously.

Pathway One: Decarbonize health care delivery, facilities, and operations

Facility and operational interventions can reduce health care's cumulative climate footprint by 2050 by 19.9 gigatons of CO_2e from a RTS baseline.

The maxim "first do no harm" applies as the point of departure for Pathway 1. Health care delivery and operations are at the core of the sector's climate footprint. Health care, dedicated to promoting health, preventing disease, and delivering health care services that restore and maintain health, must reduce and ultimately eliminate its direct contribution to the climate crisis—the biggest health threat of this century.

By taking on the greenhouse gases they are directly responsible for and putting themselves on a trajectory to zero emissions, hospitals and health systems can save money, clean up their own house, and provide leadership for the sector overall. These actions will not only prevent gigatons of carbon from reaching the atmosphere, thereby directly protecting public health from climate change (and air pollution), but they will also position health care to lead by example and have an important influence on the global health care supply chain as well as the broader society and economy.

Hospitals and health systems everywhere must implement interventions that will ultimately fully decarbonize every aspect of health care delivery and its supporting functions while maintaining and improving patient care. This transformation must include clinical care and support services, as well as facilities and infrastructure. Health care systems must take cost-effective action to move toward zero emissions energy, buildings, travel and transport, waste management, as well as low emission pharmaceuticals, sustainable food services, and more. Achieving these changes requires action by health facility and system leadership as well as initiative from the "ground-up" by clinicians and clinical care departments within facilities. Indeed, clinician leadership is central to health care decarbonization.

At the same time, low- and middle-income countries in particular will often require support from financing mechanisms, like the Green Climate Fund, the Global Environment Facility, multilateral development banks, and bilateral aid to make their health care systems climate-smart. As innovations emerge, it will also be important to ensure equitable access to new climate-smart technologies. This Road Map can be used as a basis for low- and middle-income countries to develop their own national and subnational plans for health care decarbonization. It can also help countries begin to identify potential cost savings and implementation costs, while identifying a pipeline of associated projects requiring finance, therefore increasing their eligibility and capacity to mobilize resources from wider range of sources, including international financing mechanisms.

While sometimes costly, health care climate solutions themselves can often be more cost-effective than business as usual. Sustainability solutions, like investing in energy efficiency and renewable energy, greater health system effectiveness and efficiency, and practicing sustainable procurement can save health care systems significant amounts of money as they transition toward zero emissions. For instance, in England the NHS found that the provision of telehealth and telecare for people with long-term health conditions in the community could bring returns of £5.1M in health care savings, a reduction of 67,000 tons of CO_2 and 5,671 quality adjusted life years

over a five-year period. A study published by the Commonwealth Fund in the United States examines data from selected hospitals that have implemented programs to reduce energy use and waste and achieve operating room supply efficiencies. Generalizing results to hospitals nationwide, the analysis finds that savings achievable through these interventions could exceed $5.4 billion over five years and $15 billion over 10 years. While to date, no such study has been carried out focused on developing country health systems, a series of case studies produced by the Global Green and Healthy Hospitals Network provide anecdotal evidence for a number of economic benefits related to implementing climate-smart and environmental sustainability initiatives in health facilities in a diversity of low- and middle-income countries.[49]

PATHWAY ONE: TOP LINE PRESCRIPTIONS TO DECARBONIZE HEALTH CARE DELIVERY, FACILITIES, AND OPERATIONS

Make climate change prevention and preparedness a top priority within every health system and health facility, and across all departments of every hospital, health ministry, and health organization.

Governance

- Make an organizational commitment to a zero emissions trajectory by implementing decarbonization and building resilience; develop a Road Map and/or action plan.
- Establish governance mechanisms, including installing climate and sustainability expertise on the governing board and/or at a high level within the health ministry.
- Establish, where relevant, board accountability, and tie executive compensation and/or objectives to achieving decarbonization and other sustainability goals.
- Appoint a chief sustainability officer and team with strong backing from system leadership to lead the creation and/or implementation of a decarbonization road map and/or action plan.

Finance

- Integrate climate into the health system financial decision-making process.
- Build a financial and clinical case for climate action.
- Incorporate climate criteria with the aim of cost-effective decarbonization and resilience at all levels of health system financing. This includes the public and private health sector budget, aid, lending, and other forms of financing.
- Establish financial incentives to drive changes, like favorable remuneration for low-carbon modes of travel, tendering criteria that include a strong percentage of sustainability points, and clinical reimbursement schemes based on positive health outcomes connected to low-carbon pathways.

Operations

- Measure facility, clinical pathway, and system climate footprints, set targets and publicly report on progress.
- Dedicate human and financial resources to transform facilities to reorganize health care operations and clinical services toward zero carbon emissions while contributing to community resilience.
- Leverage investments in transforming health care facilities and operations to catalyze broader changes in the health care sector, communities served, and beyond.
- Build synergy with other sectors working for decarbonization.

Pathway Two: Decarbonize health care's supply chain

Interventions that put the immediate health care supply chain on a path to zero emissions can reduce health care's cumulative climate footprint by 2050 by 11.5 gigatons of CO_2e from a RTS baseline.

Leveraging health care demand for supply chain decarbonization, while encouraging supply chain companies to take on the challenge of achieving zero emissions production, packaging, and transport, is essential for health care decarbonization.

More than 70% of health care's climate footprint comes from Scope 3 emissions, most of which originate in the global supply chain. The global supply chain spans both Pathway 2 and Pathway 3; Pathway 2 quantifies the direct emissions that can be reduced from the sourcing electricity from the grid, as well as production, packaging, and transport of products used in the health sector, while Pathway 3 considers the economy-wide effects of decarbonizing primary production sectors.

The health sector can influence the carbon impact of every product necessary to the delivery of care. The sector can pool its collective purchasing power across countries and beyond borders to demand the decarbonization of its supply chain and ensure reductions from the production, transport, consumption, and disposal of every item it purchases. This can often lead to greater efficiency and significant savings.

At the same time, manufacturers and suppliers of pharmaceuticals, other chemicals, medical devices, food, building materials, and vehicles must also take immediate action and establish their own road maps toward zero emissions.

Education and Communications

- Invest in health care workforce leadership development and training in climate change prevention and preparedness.
- Integrate climate and health, including climate-smart health care into medical, nursing, and health professional education curricula.
- Mobilize health facility and system communications infrastructure to communicate to patients, staff, policy makers, and the public about the health impacts of climate change, the steps that hospitals and health systems are taking, and the broader changes necessary in society to address the climate crisis.
- Motivate and inspire health professionals to advocate for change within their own organization, with patients, in communities, and with policy makers.

PATHWAY TWO: TOP LINE PRESCRIPTIONS TO DECARBONIZE THE HEALTH SECTOR SUPPLY CHAIN:

Health systems

- Signal and reaffirm commitment to zero emissions transformation and the expectation that every supplier must integrate this pathway into their development plans.
- Estimate the carbon footprint of the supply chain to establish a baseline and identify priorities.
- Target items in the supply chain with the biggest climate footprint and build a collaborative, multinational, multi-health system procurement strategy to substitute these items and drive emissions reduction.
- Engage with manufacturers and suppliers to systematically reduce carbon and commit to circular economy approaches across their own organization and supply chains.
- Require high emitting suppliers to set science-based emission reduction targets in line with limiting climate change to 1.5 degrees.[50]
- Require full annual disclosure and verification from top suppliers that they have set targets that match the health sector ambition.
- Systematically review products and materials utilized and purchased to ensure that their production, consumption, and disposal do not contribute to climate change or other environmental and human rights problems.
- Ensure rigorous criteria in pre-qualification, procurement, and contractual mechanisms to incentivize lower- or zero-carbon products.
- Join other sectors in market transformation efforts as a means of building momentum for change.

Manufacturers and suppliers

- Commit to zero emissions in production, packaging, and transportation, and to producing products that are energy efficient, safe, reusable, and recyclable.
- Work with the health sector to ensure the design of products is consistent with health needs, zero carbon, contributes to a circular economy, and is in alignment with the Sustainable Development Goals.
- Drive innovation in sustainable and ecological materials as well as processes for zero emissions.
- Commit to full disclosure and verification of carbon reduction targets that match the health sector ambition, as well as to publicly report on progress in meeting those targets.
- Invest in staff education and training for climate change prevention, preparedness, and resilience.

Pathway Three: Accelerate decarbonization in the wider economy and society

Decarbonization of the wider economy and society has the potential to reduce health care's cumulative climate footprint by 2050 by an additional 13.4 Gt from a RTS baseline.

Wider societal decarbonization is crucial to the health sector achieving zero emissions, while also more broadly protecting the health of people and the planet from the impacts of climate change. Governments' commitments under the Paris Agreement (the RTS scenario discussed in the trajectories chapter, Section 5) get us part of the way there (see Figure 11). However, for health care to move closer to zero emissions there needs to be a deeper decarbonization in broader society (the B2DS scenario discussed in Chapter 5).

Every aspect of the health care supply chain and delivery is reliant on industries that provide energy, chemicals, building materials, packaging, infrastructure, transport, food, and more. Carbon emissions from these sectors, fueled primarily by a global economic system and grid infrastructure based on the combustion of coal, oil, and gas, are the main driver of the climate crisis. For the health sector to fully decarbonize, it must do so in tandem with many other sectors of the economy and society.

While decarbonizing health care depends on this broader societal transformation, at the same time the health sector, by acting to decarbonize its own operations and supply chain (Pathways 1 and 2), can contribute to this transformation and must influence these other sectors to accelerate change.

By mobilizing its ethical, political, and economic power, health care can also play a leadership role at all levels of society. Using multiple points of leverage, the sector can help move the world well beyond countries' existing commitments under the Paris Agreement to deeper decarbonization by hastening the transition to clean energy. Such engagement can help build a greener and more resilient infrastructure, produce more sustainable materials, and foster a transition to sustainable agriculture. Contributing to a virtuous circle, this broader societal transformation can generate a series of substantial health co-benefits.[51]

All countries can use climate action as a preventative health measure that can help reduce the burden of disease by reducing pollution, while also helping finance better health care delivery. For instance, one study conducted by the Mexican government found that by meeting the country's NDC and generating 43% of electricity from clean sources by 2030—and thereby reducing air pollution related diseases—the country could save USD $2.7 billion in health care costs, equivalent to 41% of the Health Ministry's annual budget in 2019.[52] Others have suggested that pro-climate measures like curbing fossil fuel subsidies could be accompanied by pro-health actions like recycling these subsidies into health subsidies, thereby reducing emissions, strengthening health systems, and softening the blow of an unpopular measure (increased energy and fuel costs) with a potentially popular policy (improved health and decreased health costs).[53]

PATHWAY THREE: TOP LINE PRESCRIPTIONS FOR THE HEALTH SECTOR ENGAGEMENT IN WIDER ECONOMIC AND SOCIETAL TRANSFORMATION

- Demonstrate leadership by making a health sector commitment to transition health care operations, facilities, and supply chains to a zero emissions and resilient future, while encouraging other sectors to do the same.
- Advocate, in every country, for government to meet and consistently ratchet up their Nationally Determined Contribution (NDC) to the Paris Agreement, and to include health care decarbonization commitments as part of their NDC.
- Advocate, from positions both inside and outside of government, for specific policies, regulations, and legislation that accelerate the transition toward zero emissions in key sectors, like energy, transportation, and agriculture, that affect both public health and health care's own climate footprint.
- Raise awareness and exercise leadership with other sectors in matters to address social and environmental determinants of health.
- Call for leadership and innovation across all sectors to respond to the health sector's specific needs for zero emission solutions (e.g., ambulances, cold chains, medical devices, anesthetics, back-up energy storage).
- Call for research and funding for materials and processes that deliver improved health, resilience, and reduce carbon to zero.

Seven high-impact actions

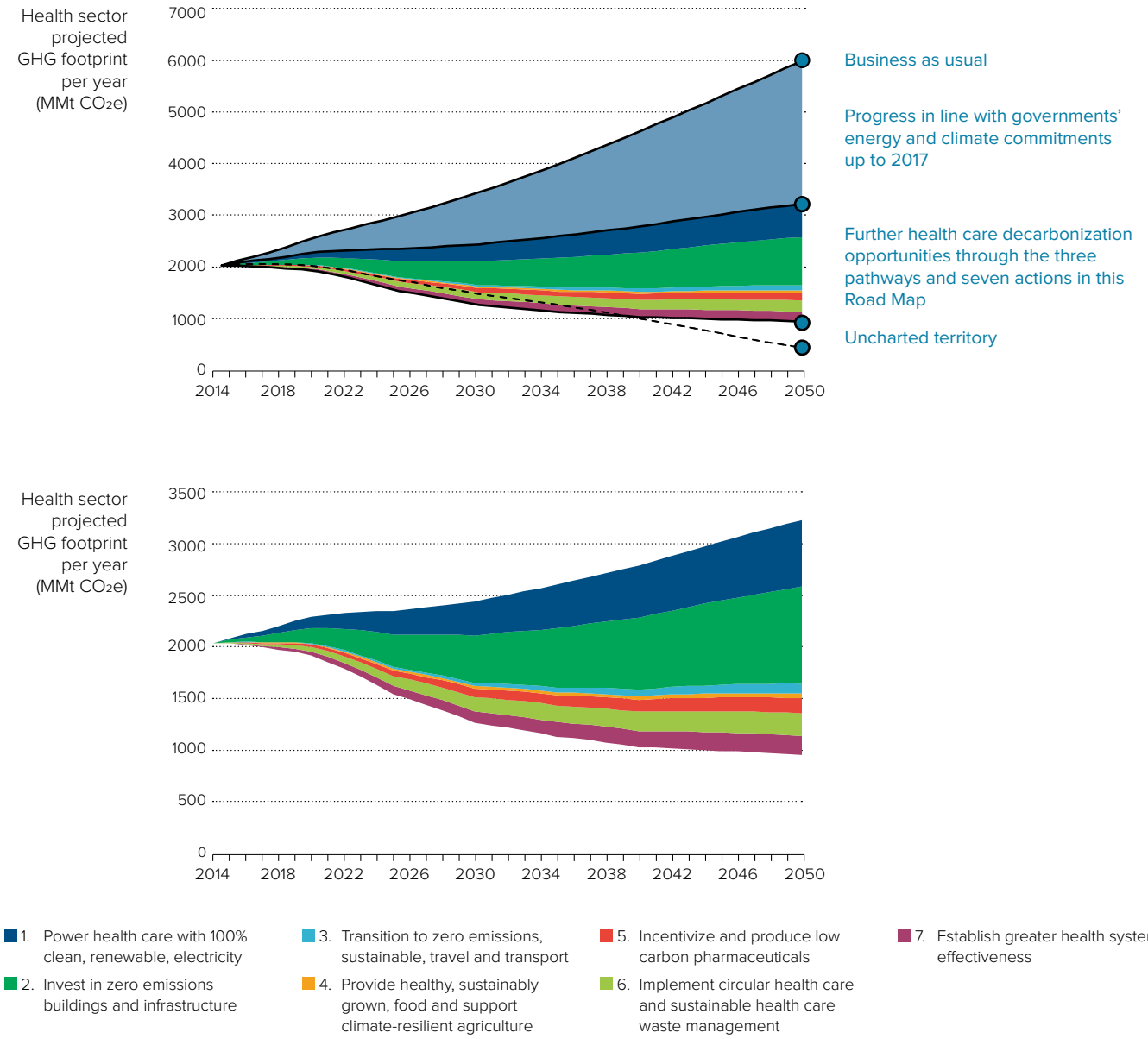
Getting to zero emissions will require a number of high-impact crosscutting actions in key areas that span the three pathways.

By implementing this set of seven high-impact actions, health care can put itself firmly on the road to zero emissions, while helping provide leadership for the rest of the world to travel in the same direction.

Implementation of these actions across the three pathways and along the country trajectories described in the previous chapter will result in a major reduction of health care greenhouse gas emissions. Cumulatively, these potential reductions from 2014 to 2050 total 44.8 gigatons of carbon dioxide equivalent (Figures 18a and b and Table 6). This is no small sum. By means of comparison, it is nearly equivalent to all CO_2e emissions generated across the planet in 2017 (47 gigatons excluding land use).[54]

When spread out and evenly averaged over the 36 years that the Road Map covers (2014-2050), the annual savings from implementing these high impact actions is 1.2 gigatons, or the equivalent of leaving more than 2.7 billion barrels of oil in the ground each year for 36 years.[55]

Many of these actions themselves are also interrelated. For instance, to decarbonize the health care sector must ultimately run on 100% renewable energy. This will require the installation of onsite renewables, like solar panels on hospital roofs, the development and implementation of new technology for thermal heating and cooling, the innovation of ultra-energy efficient buildings and medical devices, the deployment of onsite renewables to power supply chain factories, and the decarbonization of the grid from which both hospitals and supply chain manufacturers purchase their electricity.



Figures 18a and 18b. Resulting reduction in health sector emissions between 2014 and 2050 enabled though the seven high impact actions highlighted in the following pages.

Action	SPA categories	Cumulative emissions savings by 2050 (Gt CO_2e)
 **1. Power health care with 100% clean, renewable electricity**	• Scope 2: Purchased electricity including transmission, generation, and upstream supply chains	12.7
 **2. Invest in zero emissions buildings and infrastructure**	• Scope 1: Operation of buildings (including onsite combustion) • Construction	17.8
 **3. Transition to zero emissions, sustainable travel, and transport**	• Scope 1: Transport; • Scope 3: Travel and transport	1.6
 **4. Provide healthy, sustainably grown food and support climate-resilient agriculture**	• Food, catering, and accommodation	0.9
 **5. Incentivize and produce low-carbon pharmaceuticals**	• Pharmaceuticals	2.9
 **6. Implement circular health care and sustainable health care waste management**	• Manufacture and distribution of fossil fuels • Manufactured fuels, chemicals, and gases • Plastics • Medical Instruments/equipment • Other manufactured products • Paper products • Waste, water, and sanitation • Other procurement	4.8
 **7. Establish greater health system effectiveness**	• Business services • Information and communication technologies • System effectiveness	4.1
Total emissions saving from high impact actions		**44.8**

Table 6. Potential impact of seven high-impact health sector actions in reducing emissions. Please see Annex A for a definition of the SPA categories and a description of the activities covered under each.

Accompanying each action are multiple interventions that the sector can take along the three pathways. These interventions are described in Annex C. Some of these interventions are covered by the Road Map's emissions reduction modeling, others are not. For those interventions that are not, they can contribute to addressing the health care emissions gap described in the "uncharted territory" section below.

Under each of the seven interventions, there are a set of more specific implementation actions that can be taken, which are not fully detailed in Annex C. Health Care Without Harm, working together with the World Health Organization, the World Bank, and UNDP, have developed several frameworks and guidance documents for such implementation, which are also listed in Annex C. Health care policy makers and practitioners can consult these for more details.

Additionally, health care leaders who are considering how to move their systems to zero emissions would be well advised to consult the approach developed by England's National Health Service, particular in relation to decarbonizing health care delivery, facilities, and operations.[56]

Action 1. Power health care with 100% clean, renewable electricity.

Ensure that health care is powered by zero emissions electricity onsite through purchased energy and in the broader economy.

Action taken to decarbonize electricity purchased by the health sector can provide a cumulative emissions reduction of at least 12.7Gt CO_2e between 2014 and 2050.

The health care sector is a major consumer of electricity in most countries, with the bulk of this energy derived from the combustion of fossil fuels. This energy footprint spans facility operations, the global health care supply chain, and the broader context of most electrical grids' ongoing reliance on coal, oil, and gas.

In many low- and middle-income countries, health systems often operate in energy poor settings and require improved access to electricity in order to be able to operate optimally without disruptions from power cuts. Other facilities are in remote areas without access to the power grid. These health care facilities contribute marginally to emissions from electricity generation, and the priority is to grant them access to electricity as soon as possible. As WHO notes, in these situations, zero emissions solutions—like off-grid solar, wind, or small-scale hydroelectric energy—can provide clean, cost-effective, and reliable electricity to power health care facilities and local communities.[57]

Standard care delivery for most large hospitals in developed and developing countries requires significant electricity use (often alongside other energy sources) —for heating and pumping water, temperature and humidity controls for indoor air, lighting, ventilation, and numerous clinical processes—with associated significant financial costs and greenhouse gas emissions. Medical equipment, like X-Ray and MRI

machines, as well as air conditioners and other cooling equipment, can create high electricity (and energy inefficient) demand loads and therefore be costly to operate. Many health care buildings need to operate continuously and require energy intensive interior climate and ventilation control for the safety and well-being of patients and staff. This electricity is generated both onsite (see buildings section below) and also offsite, where electricity is purchased by health care systems from the power grid.

As discussed, a significant portion of health care's electricity-related climate footprint is derived from the fossil fuel intensity of the broader economy and society in which the sector operates. Therefore, for the sector to decarbonize, in addition to taking steps to reduce its operational footprint, it must advocate for the rapid decarbonization of the systems upon which it depends. For instance, health care must purchase electricity from the grid in the geographic area where it is based and therefore can influence local and/or national policy related to it.

Many health systems are already engaged, directly or indirectly, in policy and regulatory matters related to electricity at the local, subnational and national levels. Many health systems, particularly private ones, also have financial assets and/or pension funds invested in fossil fuels and can join other sectors of society in divesting those assets or using their power as investors to push those companies to transition to a zero carbon future.

These actions, in addition to underpinning the health care road to zero emissions, can have significant health benefits. For instance, according to a study in the Lancet, a rapid global transition to clean energy would not only help meet the Paris Agreement goals, but would also improve air quality to such an extent that the resulting health gains would repay the cost of the investment twice over.[58]

See Annex C for recommended interventions to implement 100% renewable electricity across the three pathways.

Action 2. Invest in zero emissions buildings and infrastructure

Ensure every health care building, health product manufacturing facility, and their infrastructure is used effectively, energy efficient, zero emissions, and climate-resilient.

By targeting electricity use and onsite generation while employing lower carbon and more circular construction practices, action on emissions from health sector buildings and infrastructure can lead to a cumulative emissions reduction of at least 17.8 Gt CO_2e between 2014 and 2050.

As of 2020, active health care construction projects tracked by one global research firm were valued at more than USD $500 billion dollars (including all projects from announced to execution stage). Regional project pipelines include North America at $159 billion, Europe at $138 billion, Asia-Pacific at $110 billion, Middle East and Africa at $77 billion, and Latin America at $20 billion.[59] Combined with this current construction, the health sector is set to grow and build a significant number of new facilities between now and 2050 in all regions. Together, with a significant number of existing health care buildings that will be retrofitted and refurbished over the next 30 years, it is clear that buildings and infrastructure is a huge area that the sector must focus on if it is to decarbonize.

Indeed, it is imperative that the planning, design, and construction of spaces to deliver health care services be oriented around zero emissions. This requires reutilizing, or sourcing reutilized building materials like steel girders, whenever possible. It also necessitates employing or innovating alternative, ecologically sustainable materials that contain low or zero "embodied" carbon. It further requires design and construction of highly energy efficient all-electric buildings that run on renewable energy (see Action 1 above as well). Investment in energy-efficient, renewable energy powered buildings can save significant financial resources over time. Innovating and improving renewable energy solutions for thermal heating and cooling will also be necessary to contribute fully to zero emissions health care buildings and infrastructure.

The COVID-19 pandemic presents an additional challenge and opportunity for the health care sector to move toward zero emissions buildings and infrastructure. Successful and universal deployment of COVID-19 vaccines will require major infrastructure and building investments to address cold chain capacity gaps, particularly in low- and middle-income countries. Without strategic intent, these investments could inadvertently lock-in unhealthy, polluting infrastructure and technology accompanied by higher operating costs. Alternatively, by following a clear set of climate-smart principles, these investments could be channeled toward affordable, energy-efficient, resilient vaccine delivery systems.[60]

Additionally, every effort should be made in the planning, design, and refurbishment of facilities to ensure that space utilization is maximized and only absolutely necessary buildings are constructed. For instance, the need for large, resource-intensive health care buildings, as well as extensive outpatient facilities, can be reduced by the widespread adoption of telehealth and care closer to home (see the uncharted territory section below). More broadly speaking, health care infrastructure in the 21st century should be conceived and planned as part of a new model of practice that takes climate, UHC, broader questions of health equity, and technological advances all into account.

Design and construction must also take the climate crisis' growing impacts on health care infrastructure into account. The health sector must design for the requirements not only of a zero emissions world, but also to withstand the growing onslaught of storms, floods, droughts, and fires. For instance, the siting of buildings and selective use of building materials can ensure both climate mitigation and resilience.[61] Ultimately, health care facilities are on the frontlines and must remain operational during extreme weather events, other emergencies, and disruptions.[62]

To set a course to climate-smart, resilient buildings and infrastructure, health care leaders can avail themselves of a set of green building design tools and accreditation mechanisms, including tools specifically for health care buildings.[63] While these tools have mostly been designed in a developed world context, they have also been successfully deployed in numerous developing countries. A diversity of examples of green buildings in health care from low- and middle-income settings also exist and have been well documented.[64] One study conducted by the Harvard T.H. Chan School of Public Health found that buildings designed with the LEED green building tool in the United States, China, India, Brazil, Germany, and Turkey, averted 33 million metric tons of CO_2 from entering the atmosphere, resulting in USD $2.7 billion in health savings.[65]

See Annex C for recommended interventions to implement zero emissions buildings and infrastructure across the three pathways.

Action 3. Transition to zero emissions, sustainable travel and transport

Transition to zero emission fleet vehicles and infrastructure, while encouraging active travel and public transport for patients and staff wherever feasible.

Over the course of the next 30 years, health care emissions can be reduced by at least 1.6Gt CO_2e cumulatively until 2050 by reducing business mileage, shifting to zero emissions or lower carbon modes of travel, and optimizing the use of vehicles over time.

Implementing zero emissions or low carbon travel and transport strategies is a key component of decarbonizing health care and will also have a significant beneficial impact in terms of reducing air pollution and its associated health impacts. Promotion of active transport, like walking or cycling, can also reduce carbon emissions while leading to improved population health outcomes. Limiting business travel in favor of virtual meetings has an important impact in reducing systems' climate footprint.

As technological innovation advances, health care systems will increasingly be able to procure electric and/or hydrogen fleet vehicles and infrastructure such as onsite charging stations. In some circumstances, bicycles, e-bikes, or motorcycles might be more effective at delivering the required service due to traffic congestion or limited road access. Health care's purchasing power and political influence can help accelerate the broader market transformation required to build economies of scale and make these modes of clean transportation more universally accessible, thereby reducing the global burden of disease brought on by transportation related air pollution and climate change.

Health care can help move the world to deeper decarbonization by hastening the transition to clean, renewable energy.

While we have not been able to model and measure the global climate footprint of patient transport and staff commutes in this report, this is another important factor for health care development planners to consider. Health systems are the largest employers in many jurisdictions, while they receive thousands of patients and their families every day. For instance, Great Ormond Street Children's Hospital in central London with over 240 thousand patient visits ensured these were less polluting by actively targeting idling vehicles, using walking maps, and encouraging the use of low-carbon vehicles or public transport.[66] Health facility planning with access to public transportation also improves access to facilities for patients and health workers.[67] Health facilities co-located with public transportation hubs can support cleaner patient and staff travel. Health leaders can also advocate for more sustainable modes of public transit, as well as for safe modes of active transport, thereby contributing to a broader transition to clean and sustainable transport systems. Additionally, many forms of service delivery can be achieved through telehealth strategies that provide quality health care and reduce patient transportation emissions.

See Annex C for recommended interventions to implement zero emissions, sustainable travel and transport across the three pathways.

Action 4. Provide healthy, sustainably grown food and support climate-resilient agriculture

Provide healthy, locally, and sustainably produced fresh and seasonal food with zero food waste.

Overall, these actions can save at least 0.9 Gt of carbon equivalent emissions by 2050.

Nutritious food is not only a pillar of good health, but is also served in many health care settings. At the same time, the Intergovernmental Panel on Climate Change estimates that agriculture and land use change are responsible for nearly a quarter of global emissions.[68] Livestock production is responsible for approximately 60% of these agricultural and land use change emissions.[69] In many countries, health systems purchase significant amounts of food and can help to reduce the climate impact from agriculture by purchasing and serving healthy foods that are produced less carbon intensively. [70]

Health systems often operate their own internal food management systems, from the selection of menus, to choices of food sources, to the preparation and distribution of meals for patients, staff, and often visitors. They also must manage residual food waste. Action at every step of the health care food pathway can lower carbon equivalent emissions and provide nutritious food. Some examples include reducing the amount of meat served by creating plant-forward meals and increasing meat free options, purchasing locally and sustainably grown and produced foods, reducing, recovering, and repurposing food waste, and using energy and resource efficient kitchen equipment.

Health systems' procurement of sustainably, locally produced food can also help build more sustainable, equitable, biodiverse, and resilient local agricultural economies and communities. This in turn can also support improved population health. By leveraging health care demand for food to help foster low-carbon, sustainable, and equitable agriculture, health systems can support local community-based agriculture, generate food preparation jobs, and develop a source of healthy food for their internal systems.[71]

More broadly, health interventions for good nutrition and the reduction of red meat consumption in order to address related non-communicable diseases, like heart disease and obesity, can also help significantly reduce greenhouse gas emissions in the wider economy. By reducing the burden of disease such interventions may also have the additional impact of reducing health care's own footprint by curbing the demand for health interventions to treat those diseases (see the uncharted territory section and Annex D for more details).

See Annex C for recommended interventions to implement sustainable and locally grown food across the three pathways.

Action 5. Incentivize and produce low-carbon pharmaceuticals

Reduce unnecessary pharmaceutical use, substitute high emission products with more climate-friendly alternatives, and incentivize the production of green, climate-smart medication.

Action on the emissions arising from the production and utilization of pharmaceuticals can reduce the cumulative health sector footprint by 2.9 Gt CO_2e between 2014 and 2050.

Encouraging innovation for safe, low-carbon pharmaceutical production and the development of

green pharmaceuticals[72] is crucial for decarbonizing the sector and reducing its overall environmental footprint. In some countries, pharmaceuticals made up a major portion of the sector's climate footprint. These countries include China (33.5%), Japan (19.4%), and South Korea (24.4%) (Annex B, Country Fact Sheets).

All medication carries a carbon footprint. Reducing this footprint should be considered as part of effective and safe clinical practice, particularly where alternatives are available, like lower carbon pharmaceuticals, social prescribing, or interventions that improve health through personalized support and community engagement. Indeed, the health sector has a responsibility to minimize the use and waste of pharmaceutical products, assuring that they are prescribed and utilized as effectively and efficiently as possible. This can also be a driver for many other health improvement and medicine optimization initiatives.[73]

The National Institute of Clinical Excellence in England has already demonstrated that environmental impacts can be included in the evaluation of the overall effectiveness of medication.[74] The Swedish Medicines Wise List also proposes improved prescribing practice that includes environmental considerations.[75]

Improved management and sustainable procurement processes for pharmaceuticals can reduce the overall quantity of products manufactured and purchased. This can lead to reduced emissions from reduced energy footprint in production of unused/expired pharmaceuticals and products and their transport. It can also reduce the amount of energy required for waste disposal due to reduction and substitution of toxic chemicals. For instance, reducing pharmaceutical use by 2.5% was identified as one of the highest impact carbon reduction intervention in a study in England.[76]

The pharmaceutical industry utilizes chemical components that are part of a complex supply chain that could shift to bio-based solutions and sustainable chemistry. The industry must also move toward clean and zero emissions medicine production that protects the climate and the health of fence line communities that are located adjacent to what are often highly toxic, petrochemical-based industrial facilities.

An important place to start addressing pharmaceuticals' climate impact is with the high potency gases currently used both in inhaler propellants and in anesthetic practice. The available data indicates that the combined emissions from these two pharmaceutical uses represents at least 0.9% of the global health sector footprint. Transitioning to available alternatives and action to prevent emissions from operating rooms presents a real opportunity to act on this significant contributor to climate change.

Metered-dose inhalers (MDIs), typically used for the treatment of asthma and other respiratory conditions, use hydrofluorocarbons as propellants. These gases are highly potent greenhouse gases, with warming potentials between 1,480-2,900 times that of carbon dioxide.[77] While global data on emissions from MDIs is not available, UNFCCC Annex A nations report data on emissions from this source.[78] For these countries, emissions from MDI use totaled 6.9MtCO_2e, an additional 0.3% on top of the global health care footprint. The full global emissions from MDIs can be expected to be substantially greater than this figure if data were available from non-Annex A countries. Alternative delivery mechanisms to MDIs without the high global warming potential propellants, like dry powder-based inhalers, are available and suitable for the majority of patients.

Anesthetic gases: Substituting anesthetic gases and controlling waste gases may have a significant impact on a health system's overall greenhouse gas emissions. For example, the impact of Nitrous Oxide (N_2O) on warming the atmosphere is almost 268 times that of carbon dioxide.[79] Anesthetics, like

isoflurane, desflurane, and sevoflurane, are estimated to have a global warming potential 500 to 3700 times that of equivalent amounts of CO_2 in a 20-year time frame[80, 81] and 130 to 2500 in a 100-year time frame., A study by the NHS in England found that for acute care organizations, like hospitals, the impact of global warming impact from waste anesthetic gases is equivalent to around half the emissions used to heat buildings and water.[82] For regions where full coverage is available in the UNFCCC data, nitrous oxide anesthesia adds an additional 0.7% to the North American and 1.0% to the European Union's health care footprint. For fluorinated gases used in anesthesia, global emissions in 2014 were estimated to be 3.1±0.6MtCO_2e, including veterinary and laboratory medicine.[83] When combined, these estimates add an additional 0.2% to the global health care footprint. Due to increasing adoption of the high potency gases, the footprint from anesthetic gases can be expected to increase. Anesthetic gases therefore contribute at least 0.6% of health care's global climate impact. Wider adoption of waste anesthetic capture and reuse systems may have the potential to be an effective health care-specific climate mitigation measure, however further research is required to determine its full potential.

See Annex C for recommended interventions to incentivize and produce low-carbon pharmaceuticals across the three pathways.

Action 6. Implement circular health care and sustainable health care waste management

Implement circular economy principles to procure supplies, deploy clean technologies, reduce the volume and toxicity of health care waste, and manage waste sustainably.

Action in these areas can lead to a reduction in cumulative health sector emissions of at least 4.8 Gt CO_2e between 2014 and 2050.

A circular economy approach entails gradually decoupling economic activity from the consumption of finite resources and designing waste out of the system.[84] It can reduce emissions, conserve resources, and minimize waste.[85] Transitioning to a circular economy for health care requires a systemic redesign of supply chains and health care delivery. Such a redesign begins with business planning and shifting the business model to a 'product-as-a-service' approach and reverse logistics, so that owners realize value in recovering materials.[86]

Changed business strategies will mean new material strategies. Materials need to be non-toxic, reusable, recycled and recyclable, durable, low-carbon, and renewable. Supply chains should be geographically as short as possible.

In all cases, all materials will need to be healthy and safe, as it makes no sense to endlessly cycle materials that have a toxic impact on people and the biosphere. Similarly, waste disposal needs to be reduced to an absolute minimum, as materials lost from the loops of installation and return, or consumption and decomposition need to be replaced by virgin resources taken from nature.

A growing number of organizations including OECD, the EU, UNEP, and the Ellen MacArthur Foundation are working to build principles and approaches to a circular economy.[87] Others are seeking to ensure that this approach is relevant for and inclusive of low- and middle-income countries.[88]

The health care sector has become increasingly reliant on single-use disposable medical devices, particularly in high-income countries. Some low-complexity medical devices such as syringes and needles are best designed

for single use and should be recycled as part of a circular health care approach. Other high- and medium-complexity devices can be redesigned for circularity, including greater longevity, reprocessing and re-use of materials.[89]

Fossil fuel-based plastics have become indispensable in the health care sector, facilitating the work of health care professionals all over the world. The low price of plastic and its relative ease of manufacturing have led, however, to an overuse of plastic products and packaging in health care, often in situations where they are not needed. However, like all other sectors, health care can examine how it can reduce its consumption and ensure that what it does use is safely and sustainably disposed. Health care professionals at all levels have an essential role in reducing the impact of the plastics that they use and dispose of. They can also be a role model for their local community and share lessons from their own experience to advise and inspire wider changes.[90]

Waste minimization, for instance, through developing package-less solutions and segregation (for safe collection, sterilization for reuse, and/or recycling) is an important component of the circular economy and the baseline point for effective waste management processes. It requires a concerted effort across the supply chain from product design, designation of materials used in products, packaging, product reuse, repurposing, reprocessing, and recycling.

At the same time, the health sector generates significant volumes of waste that must be safely disposed of, including infectious waste, like sharps and bandages, human tissue, and other hazardous waste (e.g., heavy metals, pharmaceuticals, and other chemicals). The mismanagement of health care waste has been reported by the UN Special Rapporteur as a violation of human rights in many countries.[91] A 2009 review concluded that approximately 50% of the world's population is at risk from occupational, environmental, or public health threats from improperly treated medical waste.[92]

The incineration of health care waste involves the generation of climate emissions, mainly CO_2 and nitrogen oxides, a range of volatile substances (metals, halogenic acids, products of incomplete combustion) and particulate matter, plus solid residues in the form of ashes.[93] Small-scale incinerators, the most common treatment technology used in developing countries, emit greenhouse gases and other toxic pollutants, like dioxins and furans.[94] Decarbonizing health care will require that waste management is conducted with minimal emissions and other environmental impacts while ensuring safety to protect patients, health workers, and surrounding communities.

Alternatives to incineration for health care waste treatment have been recommended to reduce the emission of dioxins and furans required by the Stockholm Convention on Persistent Organic Pollutants. As little as 20% of waste in health care settings is hazardous.[95] Effective waste segregation is necessary to ensure that only hazardous waste receives special treatment as required, while other wastes can be recycled or reprocessed. WHO has called for phasing out incineration as a long-term strategy.[96] Autoclaving, recycling, bio-digestion, and other sustainable health care waste management technologies have lower carbon footprints than incineration. For instance, a pilot project comparing cost and CO_2 emissions from incineration and outdoor burning of immunization waste compared with treatment using an autoclave showed that autoclaves produced less greenhouse gas emissions and were less expensive to operate.[97] Additional research is needed regarding the health care waste treatment methods that mitigate climate change.

The health sector and every individual who works to influence or deliver quality care can ensure that the use of every product includes consideration of whether it is necessary and how and where it is disposed of. This includes gloves, uniforms, anesthetics gases, inhalers, all medical devices, and any product used

in health care. The management, reuse, recycling, or disposal of products and materials is an important consideration for health care as it addresses its climate footprint, contribution to air pollution, and other environmental health issues.

See Annex C for recommended interventions to implement circular health care and sustainable health care waste management across the three pathways.

Action 7. Establish greater health system effectiveness:

Reduce emissions by improving system effectiveness, eliminating inefficient and unnecessary practices, linking carbon reduction and quality of care, and improved resilience.

Greater health system effectiveness can contribute to a cumulative reduction in global health sector emissions of at least 4.1 Gt CO_2e between 2014 and 2050, with the potential to exceed this saving through ambitious and transformative action.

The health sector must align its efforts to decarbonize and build resilience with initiatives to improve its delivery of care. A trajectory toward zero emissions must be designed to improve health care quality and delivery and vice versa. By purposefully bringing these two priorities together, the health care sector can achieve multiple wins, like improved quality of care, better use of resources, decarbonization, and financial savings.

As a recent paper commissioned by the U.S. National Academy of Medicine puts states, "Improving the quality and safety of health care delivery is a fundamental climate strategy. Over-prescribing, over-treating, preventable medical errors, and delivery of low-value care all lead to increased demand for services and preventable carbon emissions. Thus, the climate movement and the quality movement are tightly connected."[98]

For instance, models of care for individual specialties or treatments will need to be guided by both quality and carbon criteria. This will involve reviewing the way care is delivered, how materials are used and disposed of, and making sure that every action and decision takes sustainability and climate into account.

In this context, countries can learn from one another's experiences and outcomes.[99] For instance, there is a 20-fold difference between cataract surgery in Wales compared to India with similar patient outcomes. And within the United Kingdom, the carbon footprint of renal dialysis can vary four times depending on technique and location.[100] When inevitable tradeoffs arise, like balancing energy intensive infection control measures with reduced energy use, careful adaptive management based on rigorous data collection and analysis will need to be employed to forge solutions.[101]

Avoidance of unnecessary treatment can both improve quality of care and reduce emissions. For instance, health systems could target overtreatment and overprescribing as an important line of action in combatting climate change that reduces the use and therefore the demand for unnecessary procedures and pharmaceuticals. Making sure that only effective treatments are targeted will help make sure that health sector capacity is best adapted to serving the needs of the population. Addressing the efficiency and effectiveness of the broad categories of health care business services, as well as information and communication technology are also important steps.

Aligning health system effectiveness, UHC, and emissions reduction

A system's effectiveness in ensuring quality health outcomes and delivering universal health coverage (UHC) varies significantly, even though every health system is working to achieve greater health gains and to optimize the use of resources available. Different pathways and different levels of effectiveness in achieving UHC can affect the level of emissions a health system generates. The more efficient a health system is in achieving the global health goal of UHC, the more aligned with global climate goals it may become.

The Institute for Health Metrics and Evaluation has published a paper that plots the relationship between health per capita expenditure and UHC outcomes.[102] Figure 19 illustrates every country's parity cost per capita spent on health care mapped to an aggregate of 17 UHC indicators.[103] It suggests that increases in health expenditure can improve UHC coverage, but the effectiveness of each additional dollar spent varies greatly between countries and has diminishing returns as health care spending per capita increases. This has a direct correlation to health care emissions.

Countries that achieve an optimum balance are demonstrating more effective models of UHC delivery.

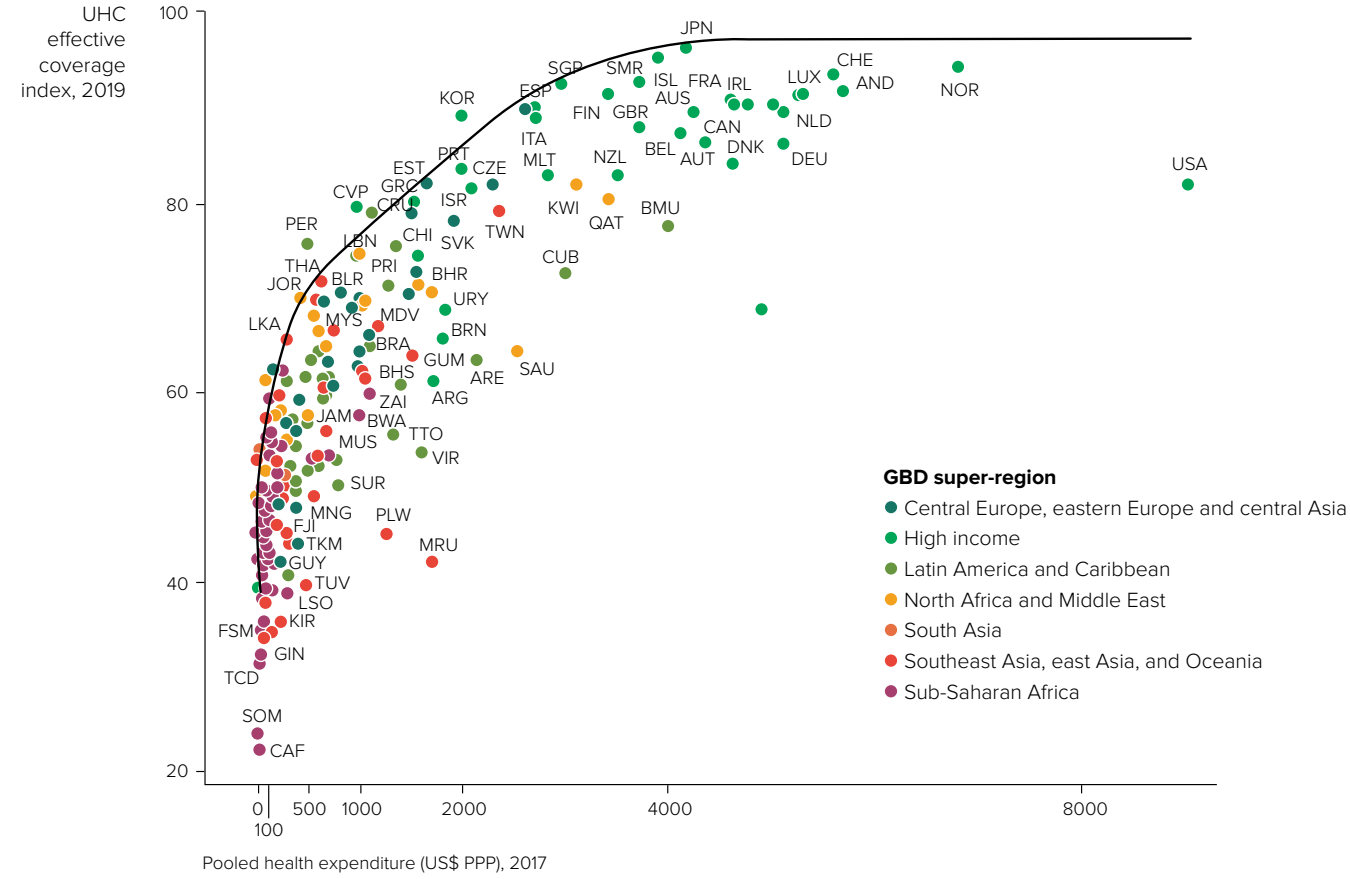


Figure 19. UHC effective coverage index frontier relative to pooled health spending per capita.

Most countries, particularly low- and middle-income nations, will need to increase their health care spending to achieve UHC and will need to do so in a climate-smart fashion (see Green UHC section below). At the same time, some wealthier countries can achieve more effective health coverage by reducing their spending, thereby becoming more effective in their allocation of resources as well as in their design of the models of care. These reductions can also lead to a reduction in carbon emissions, thereby aligning effectiveness, UHC, and climate objectives.

Figure 20 quadrant C identifies countries where, by improving health systems' effectiveness, expenditure reductions can be achieved while also maintaining the level of UHC outcomes. Assuming, these countries can become more efficient and effective in how they spend their health resources and achieve a projected 20% reduction of expenditure by 2050, we estimate that this efficiency measure will also allow them to reduce their cumulative climate emissions from 2014 to 2050 by 1.9 Gt of CO_2e, which is roughly equivalent health care's entire climate footprint in 2014 (for more detail see the technical report in Annex A).

See Annex C for recommended interventions to establish greater health system effectiveness across the three pathways.

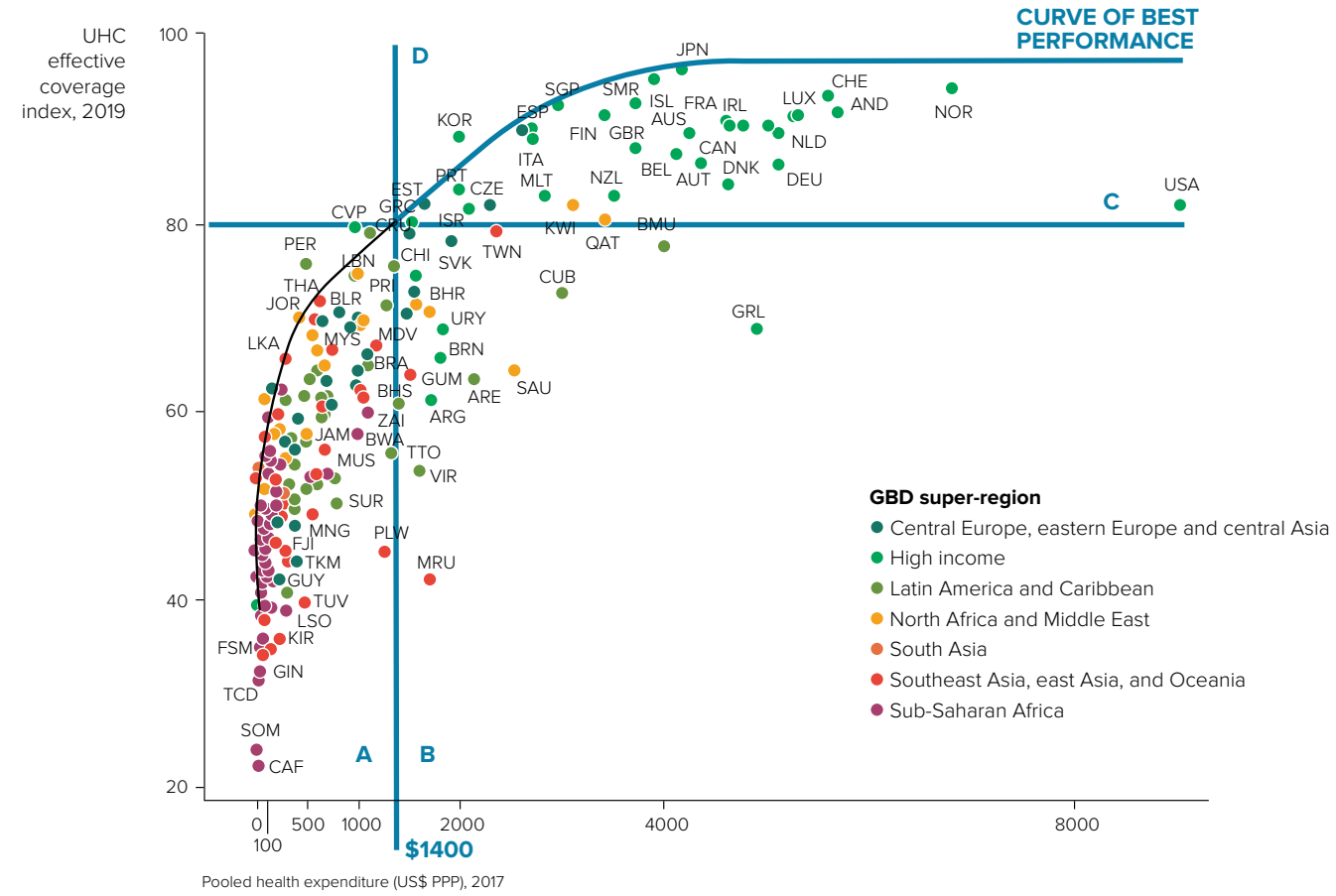


Figure 20. Allocating countries to one of four groups based on a chosen position of UHC coverage of 80, with a health expenditure of $1400 per person per year.

Uncharted territory: Bridging the health care emissions gap

Even if the sector were to successfully achieve all the interventions modeled above across health care operations, the supply chain and wider social and economic decarbonization, we estimate that, without additional action, annual health care emissions will still stand at 1.1 gigatons in 2050.

These remaining emissions need to be minimized over the course of the next three decades through measures that will require research, innovation, and the exploration of bespoke health sector residual management initiatives. Navigating this uncharted territory and addressing the health care emissions gap also presents an opportunity to rethink and redefine how health care is understood and delivered.

Figure 21 below illustrates the size and nature of the gap, and it shows in detail what is represented in Figure 17 as "uncharted territory." It shows the full emissions gap against the overall pathway trajectory for the health sector through 2050. The categories of emissions illustrated are the remaining emissions after all the decarbonization actions described earlier that we have been able to model are achieved.

Figure 20 highlights areas that the Road Map's modeling forecasts will require greater focus to close the gap. Scope 1 and 2 emissions are reduced proportionally over time, whereas other supply chain areas, like pharmaceuticals and food, grow in their share. This projected shift in emissions patterns over the next three decades will require a shift in response over time, including establishing innovative new solutions.

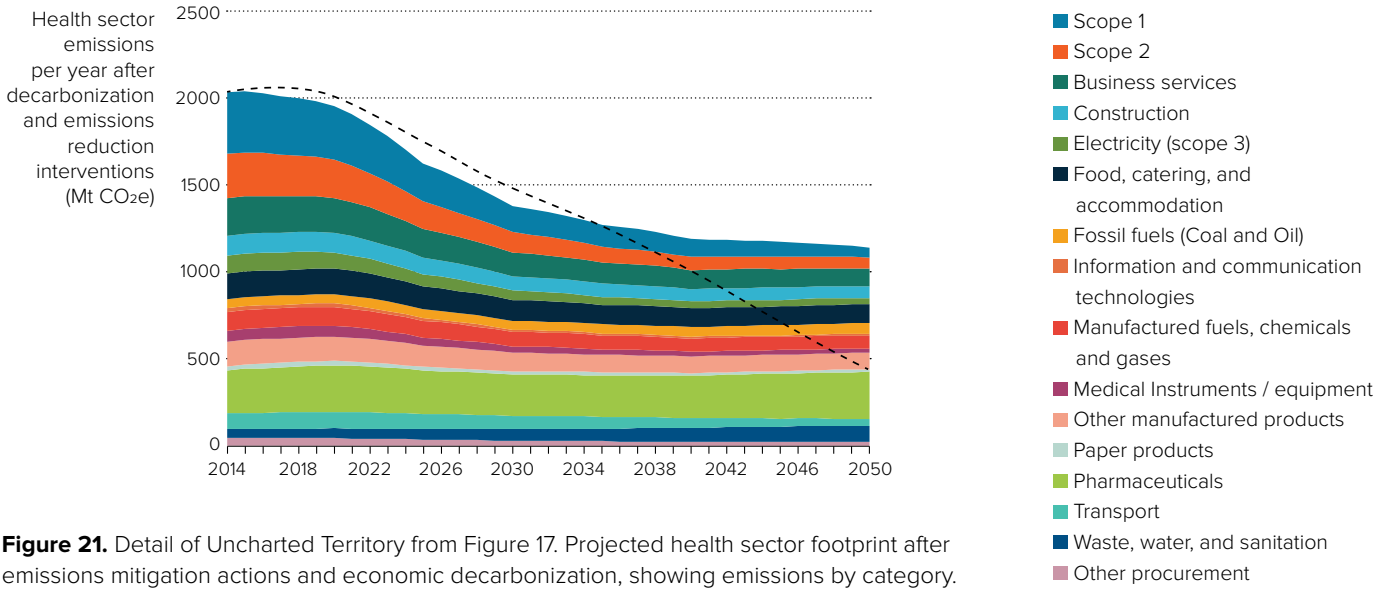


Figure 21. Detail of Uncharted Territory from Figure 17. Projected health sector footprint after emissions mitigation actions and economic decarbonization, showing emissions by category.

Another area of increase in terms of its forecasted proportion of health care's climate footprint is water and sanitation, including solid waste, as well as water, sanitation, and hygiene, also known as WASH. WASH is essential to any safe health care provision and is sorely lacking in many low- and middle-income countries. It is an important goal to improve WASH in health facilities. There are a series of strategies for climate-smart WASH, like rainwater harvesting, energy efficient water delivery, and wastewater treatment, that can simultaneously address health care's footprint while expanding WASH.[104]

This section delves into this uncharted territory and identifies an initial set of opportunities for action. It is terrain that we have not been able to systematically plot, measure, or model with the methodology of this Road Map. Rather, by considering the question of how to address these residual emissions, we aim to begin an exploration and discussion about further reductions that are needed to close the gap over time. These opportunities can also provide a chance to reinvent how health is delivered in the interest of greater equity and improving the quality of care.

The sooner the sector is able to navigate these residual emissions, the easier it will be to get to get to zero emissions. Indeed, taking action today to start minimizing this gap and addressing this "last mile" of decarbonization is crucial to ensure the sector can achieve its part in an emission-free world. The following aspects could play a significant role.

Seed climate and health innovation to deepen emission reduction in the seven high-impact action areas

As the practice, operations and management of health care provision evolve in the 21st century, the technology, materials, and culture of the sector will also need to evolve. Climate action for zero emissions and resilience will need to become major criteria, which help determine the direction of these innovations in the sector whether they are in the fields of telemedicine, pharmaceutical production, novel treatments of disease, or other areas of "uncharted territory." Investing in and seeding this innovation is essential.

The model we have used is inherently limited, in that it can only partially measure global emissions reductions in each of the seven high-impact action areas. Therefore, we have not been able to model, on a global scale, all the emissions reductions that could be achieved by all of the specific interventions proposed. We know from country-specific, or health system-specific, evidence that they are cost-effective interventions and if scaled fully across the globe, could significantly reduce the health care emissions gap presented in this Road Map. These areas need to be more systemically mapped out and innovations need to be developed to scale the next generation of climate-smart interventions.

Furthermore, few countries have established granular measurement, analysis, or tracking for their health care climate footprint. As a navigational tool, this global Road Map draws the basic outline of the directions we must go (and the country fact sheets provide an initial sketch for 68 nations), but the national-level details are uncharted.

What's more, entire specialties have yet to assess their specific contribution to the climate crisis and how best

to mitigate it. Most treatments and their alternatives have not been fully analyzed with a climate lens. We also already know that several areas need health care specific solutions, including systematically developing low-carbon care pathways, designing clinically suitable low-carbon and toxic free materials that can be reused or recycled, reducing the carbon emissions of medical research, merging quality assurance with sustainability, building green UHC, and more. Developing and deepening understanding at all of these levels is necessary to identify, sharpen, and innovate the most appropriate solutions.

The health sector must take responsibility for the elements that are specific to it by encouraging research and innovation in health and in other related sectors. Time is running out, and it is vital to accelerate these efforts. Establishing and investing in a series of climate and health innovation centers or funds that focus on achieving zero emissions and climate resilience in health care could deepen and accelerate decarbonization through the seven high-impact action areas and identify innovative paths forward.

Establish green UHC by integrating sustainability and resilience with universal health coverage

The climate crisis threatens the delivery of universal health coverage in a number of ways, including the risk it poses to health delivery services, to population health, and to health financing.[105] Extreme climate events have direct impacts on health care buildings and infrastructure while putting health workers at risk. Climate disruptions in one part of the world can put health care supply chains at risk in another, which impacts service delivery. Climate change will increase the overall burden of disease. The climate crisis could drag more than 100 million people back into extreme poverty by 2030 with much of this reversal attributable to negative impacts on health.[106]

In the era of climate change, the patterns of health needs are likely to change significantly, while the demand for services is likely to shift because of human migration triggered by climate disruption. As the climate crisis evolves, it will also generate financial crises that could negatively affect health system financing. Ultimately, if we are unable to keep global temperature rise to 1.5 C, then UHC may be unattainable.

Delivering and further developing universal health coverage needs to take these and other risks posed by the climate crisis into account. By integrating sustainability and climate-smart health care into UHC, a number of opportunities to build more robust and effective health systems.

Health policy makers and practitioners need to integrate health system strengthening, decarbonization, and resilience building into a coherent approach to health investment and delivery. For instance, UHC should, by design, ensure that health care is powered by renewables to increase access, resilience, and emissions reduction. This will

also ensure that waste is minimized and managed sustainably, products utilized are environmentally friendly and designed for reuse, vaccine cold chains are climate-friendly, and health systems are focused on upstream health interventions and community resilience. Over time, these investments can generate savings in building and infrastructure costs allowing financial resources to be used for health services.

All of these measures can ultimately improve both health access and health outcomes, build greater facilities, systems, and community resilience, while reducing health care's climate and environmental footprint. To meet global health and climate goals, green UHC needs to become the norm and should be integrated into health investment, planning, and service delivery.

Maximize telehealth and close the last mile for hard-to-reach locations and communities

The evolution of the internet and online systems has heralded a new era that could drive down 15% of global greenhouse emissions by minimizing transport requirements.[107] Along these lines, many forms of health service delivery can be achieved through telehealth strategies that provide quality health care and reduce both transportation and facility emissions. Overall, telehealth offers the ability to make the health sector more resilient, smaller, less resource-intensive, and more cost-effective.

For instance, during the COVID-19 pandemic, many health systems transformed their appointment systems to offer online medical visits wherever possible. In the United States, this resulted in improved convenience, increased access to care from a distance—especially for patients living in rural areas—and decreased health care costs.[108]

Naturally, telehealth helps minimize patient travel and in turn contributes to reduced greenhouse gas emissions, decreased air pollution, and a healthier community. While our estimates of health care's global footprint were unable to include patient travel, we know that it is can be a significant part of health care's footprint in many countries. For instance, in the United Kingdom, patient journeys make up about 8% of the NHS's carbon footprint.[109]

As telehealth becomes more commonplace, it can also reduce demands on large health care facilities, thereby potentially reducing the use of and need for some carbon intensive buildings and infrastructure. In a climate-smart health care system of the future characterized by locally provided health services and telehealth, resource intensive hospital care should become a last resort, retained only for those whose health care cannot safely be delivered closer to home.[110]

It is important to avoid increasing inequities when poor communities are less connected. At the same time, telehealth has the potential to increase health equity by improving access for isolated communities, helping shift to community-based care, and free up resources for the delivery of more health care services.[111] While guaranteeing universal access to a broad range of medical treatments and health care services should continue to be prioritized, a focus on digitalization and telehealth can help assure that many services can reach low-income communities and those that are more isolated, and that these communities receive the same access to these services as the general public.

Integrate climate-smart health care services and infrastructure into emergency response and pandemic preparedness

The health sector is often the frontline responder in times of crises and will have a growing role to play in the face of pandemics and mounting climate-related emergencies. Ensuring the resilience of staff, systems, and infrastructure is crucial to a responsive service where operations need to focus on ensuring that the most marginalized communities do not fall even further behind.

At the same time, the health sector's vast networks of emergency and disaster response—based in local health systems, national ministries, and international organizations—can implement decarbonization and sustainability measures that align their work with the sector's trajectory to zero emissions while also improving the effectiveness and resilience of the care they give. The Pan-American Health Organization's Smart Hospitals Program, for instance, integrates sustainability components into its disaster preparedness checklists.[112] Much more can be done to integrate climate-smart strategies into emergency response planning and disaster preparedness (and vice versa). Doing so enables a more effective and resilient approach and can help develop capacity to build back stronger and more sustainable services following shocks.

The health sector also needs to respond proactively with a community-orientated focus in order to reduce the burden of disease that could grow because of these emergencies and be even more costly to remedy. Supporting community-based resilience can help build health into ways of living and working by minimizing inequalities, mitigating social determinants of health, and addressing social injustices.

Establish disease prevention as climate change prevention

In theory, reducing the burden of disease can also reduce health care's climate emissions by reducing the need to treat those diseases. As Dr. Rene Salas and her colleagues write in the BMJ, "Primordial and primary prevention—including poverty and inequality reduction, strong social networks, tobacco and substance abuse control, healthy diets, and physical activity—are intrinsic to the transformation because they reduce the need for health care and therefore for energy and resource intensive treatments." [113]

As part our exploration of uncharted territory in this Road Map, and as a way to test this theory, we explored the potential health care emissions reductions from four major health interventions aimed at addressing global health priorities: curbing tobacco use, lowering meat consumption, reducing obesity, and tackling ambient air pollution.

While there is considerable data on the emissions reduction that the world can achieve by reducing air pollution or meat consumption, we asked the question, if the world were to meet internationally established health goals in these four areas, could we measure the additional health care climate emissions reduction that might accompany such a health accomplishment?

We based our modeling on goals like the WHO's target of 30% relative reduction in prevalence of tobacco use by 2025 from 2010 levels and then extended target and applied a reduction in smoking prevalence of 60% by 2050. For a reduction in meat consumption, we used the target set by the EAT-Lancet Commission of reducing global per capita meat consumption to 43 g/day by 2050 from current levels, recognizing that to achieve better nutrition some countries may increase their meat consumption. For obesity, we assumed that the body mass index of obese citizens would be reduced in class to overweight. And for air pollution,

we assumed meeting the WHO's stated goal of a two-thirds reduction in air pollution by 2030 and then extended that to an additional two-thirds reduction between 2030 and 2050. We then estimated the health care cost savings from each of these reductions and plugged them into our Road Map input-output model for estimating climate footprint and reduction (for details on methodology see Annex A, and in-depth papers on each health intervention in Annex D).

We recognize that this approach is necessarily flawed in that it may well be that the spending and hence emissions averted by these interventions will simply be reallocated to a later point in a person's life or to another part of a health system budget. This is otherwise known as a rebound effect, which is difficult to model specifically and therefore often not considered in climate modelling exercises.

Despite these limitations, the results we have generated are illustrative of both the climate impact of unhealthy lifestyles that lead to major health problems and expenses, and the potential climate benefits of top priority health interventions. These findings underscore the need for further research and greater understanding of the role that individual and population health can play in contributing to reduced climate impact.

Recognizing these limitations, the modeling for these interventions (described in more detail in Annex A) allows us to estimate that together these interventions could result in cumulative reductions from 2014 to 2050 of about 1.5 gigatons of carbon emissions. This could contribute to reducing health care's emissions gap by about 8%.

Putting it in perspective, when taken together (and understanding the caveat that these health costs may be replaced by others) the potential savings over the 36-year projections in the Road Map is analogous to not burning more than 4 billion barrels of oil, or shutting down 468 coal fired power plants for one year (see Table 6).

Area of Intervention	**Cumulative health care emissions reduction (MMT CO_2e)**	**Number of coal plants annual emissions equivalence**	**Number of barrels of oil emissions equivalence**
Tobacco	770	198	1,780,000,000
Air pollution	238	61	550,000,000
Obesity	215	55	515,000,000
Meat	350	90	812,000,000
Total	**1573**	**404**	**3,657,000,000**

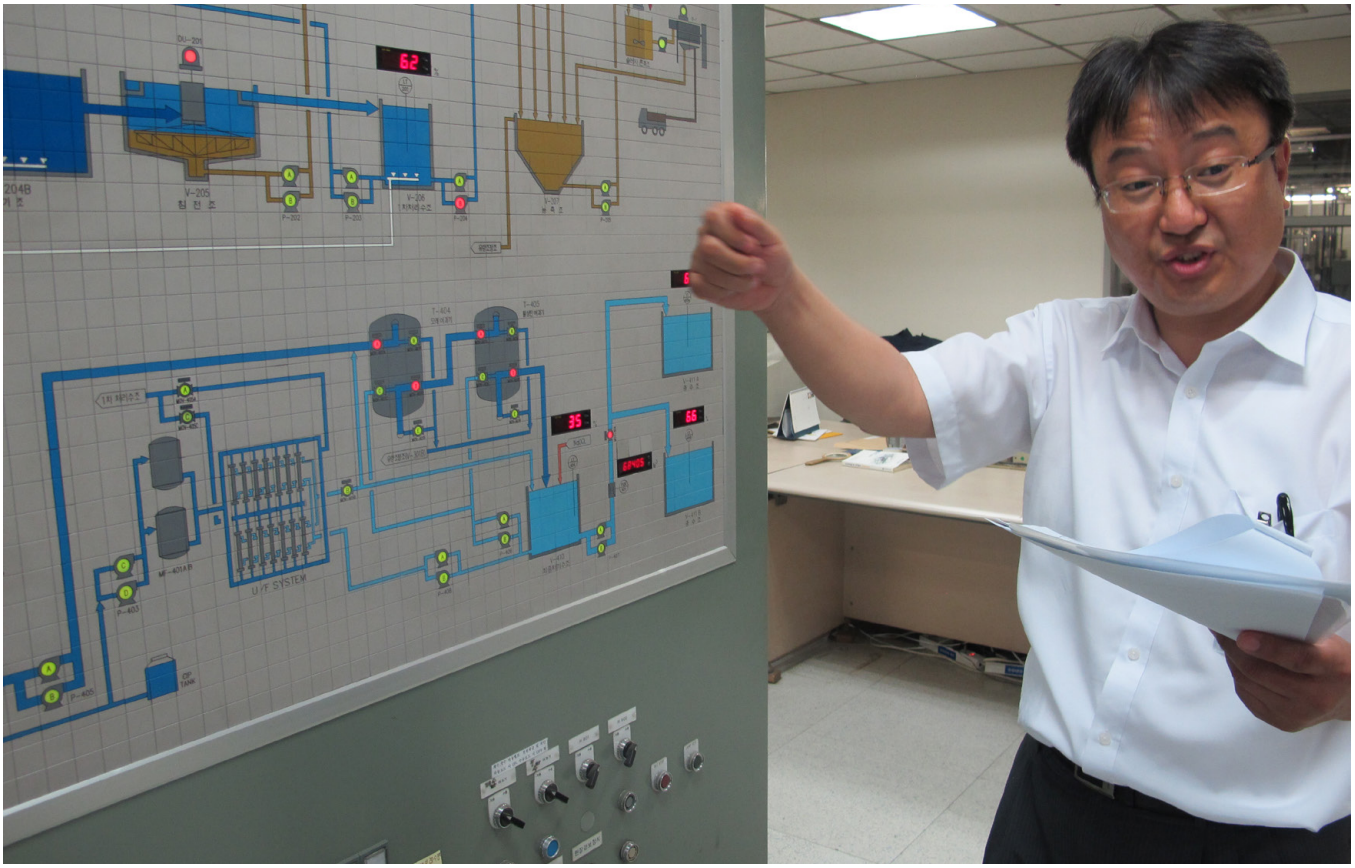
Table 6. Potential climate benefits in terms of health care emissions reductions of four major health interventions

Reinvent financing systems to support healthy people on a healthy planet

As it invests in health care, the financial sector and many of its health-sector focused financial mechanisms can help drive the sector toward zero emissions by incentivizing decarbonization wherever possible, providing business models that build in a focus on health and resilience and integrate the philosophy of a circular economy. These new business models can ensure that a health sector focus on reutilizing materials for construction and other purposes, providing services like safe medical device servicing, and making value out of remaining components becomes the new norm.

Public and private financial institutions that offer grants, loans, and other incentives can ensure that these instruments are used to accelerate investment in a climate-smart sector by supporting the implementation of clean renewable energy, sustainable and reuseable materials, as well as innovation and research that will provide the solutions for a decarbonized and resilient world. Every health investment should be considered for both its social and environmental return as part of the decision-making process.

Both private and public health insurance schemes can ensure that low-carbon pathways are incentivized. They have a significant influence on national models of care that develop through their reimbursement practices, benefit packages, and care protocols. This influence is increasing rapidly



around the world with the adoption of national health insurance programs geared to achieve UHC. Yet many of these schemes are supporting the development of reactive financially unsustainable and carbon intensive models of care. Payers should seek to adopt more sustainable, climate-smart models of care.

Both private and national health insurance plans can make sure that low-carbon pathways are incentivized through their reimbursement mechanisms for individuals and institutions. Health care payers have a major influence on the models of care that develop in a health system (public or private), primarily through their reimbursement models, benefit packages, and care protocols. Currently, these models are increasing rapidly around the world with the adoption of national health insurance models geared to achieve UHC. Yet many of these schemes are inadvertently supporting the development of Western-style, reactive models of care, which do not produce the best health outcomes and are financially unsustainable and carbon intensive. Payers (whether public or private) should seek to adopt or be supported to leverage their financial influence to create more sustainable, climate-smart models of care which will be better for them financially (in the long run) for their beneficiaries and also for the planet.

Ultimately, health care financial protocols will need to redefine what return on investment means to include savings from climate action and establishing bottom lines to reflect environmental and social goods.

Develop health sector-based alternatives to carbon offsets

Despite all the efforts the health sector may take to decarbonize, some obstinate emissions will remain, even as they may get smaller over time. The sector should strive to ensure that these residual emissions are managed in a way that will support a healthier and more sustainable future. The health sector has a key role to play in that the management of residual emissions promotes health, equity, and community resilience.

The health sector can be at the forefront of developing an approach to address the most persistent remaining emissions by establishing bespoke health-based solutions that focus on health investments as a means of decarbonizing. Such solutions would go beyond current offset options to ensure that any health sector offsets actually enhance health, reduce inequity, and build resilience, while reducing emissions. Typical offsets, like nature-based solutions (carbon sink enhancement), will not provide sufficient compensation for the level of residual management that is needed in the world and are often not considered sufficiently permanent nor equitable.[114]

The health sector could identify innovative solutions by investing in the communities in which health systems are anchored as a means of improving health and reducing emissions. For instance, this could be achieved by identifying specific additional interventions that improve people's lives and reduce emissions permanently. Such interventions could include upstream initiatives that enhance community health, improve equity, and build resilience, like local schemes that improve public housing, nutrition, or public transport, reduce air pollution locally, minimize the use of toxic materials, or reduce the need for highly intensive medical care.

Further work is needed to define this approach. This could include defining what such interventions might look like, how to measure both the community benefit, and the reduction in carbon emissions. It will also be important to ensure additionality (with regards to previously committed mitigation action), provide verification, and secure permanence of the solutions. Avoiding double counting of emissions reductions may require national authorization procedures, public international registries, and other transparency mechanisms.

This is clearly a complex area of uncharted territory, with many ethical and practical landmines. The next step is for robust research into how such health-based solutions and interventions might support permanent emissions reductions that can meet the strictest criteria of standard offsets while avoiding their pitfalls.