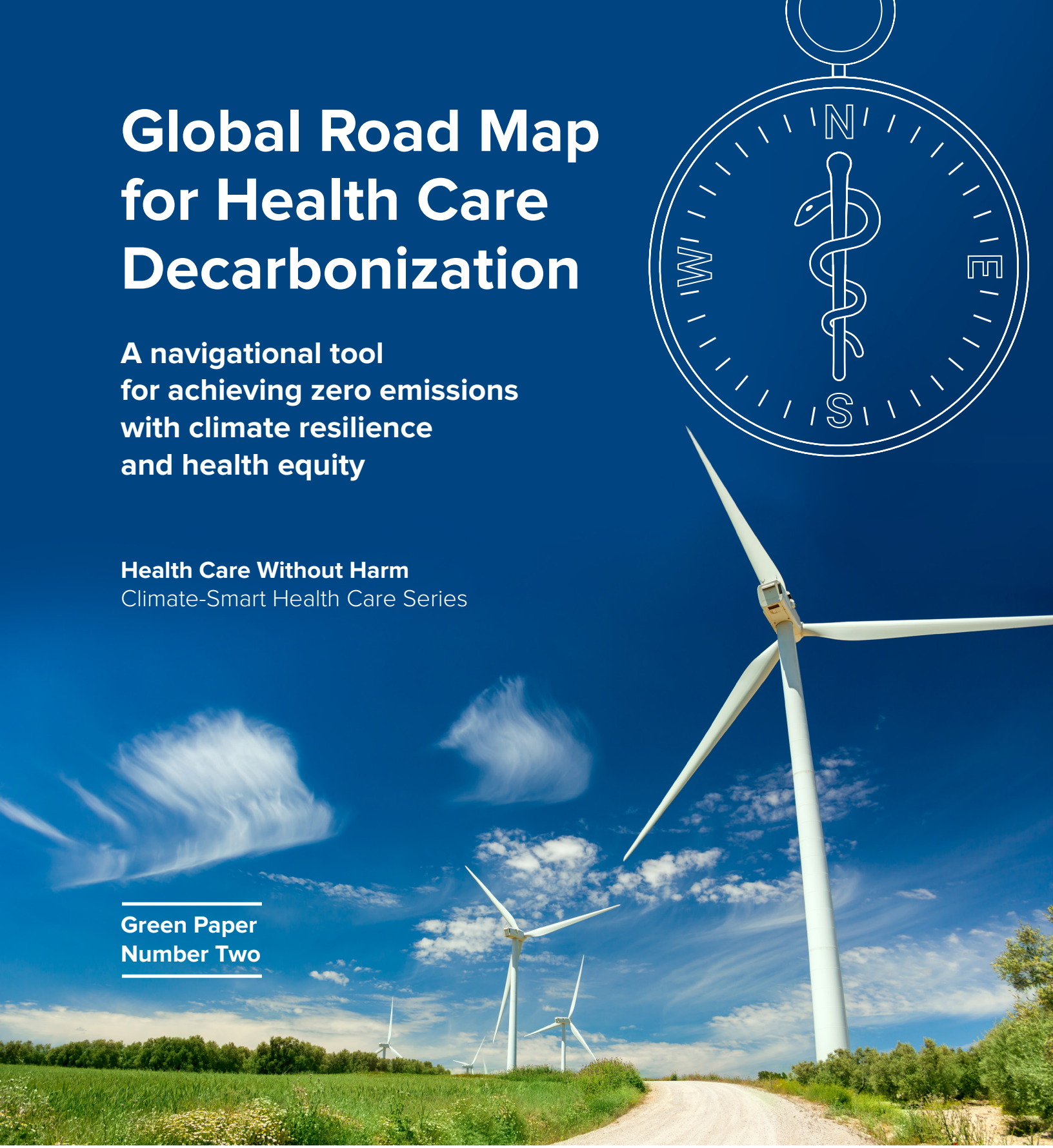
Global Road Map for Health Care Decarbonization

A navigational tool for achieving zero emissions with climate resilience and health equity



Health Care Without Harm
Climate-Smart Health Care Series

Green Paper Number Two

Health Care Without Harm

Produced in collaboration with ARUP

About this Road Map: This is the second in a series of research and policy papers that Health Care Without Harm and Arup have produced together to identify a set of actions the health sector can take to align itself with the ambition of the Paris Agreement while simultaneously achieving global health goals. Green Paper One defined health care's climate footprint and opportunities for action. This paper sets out a broad, overarching guide for the sector to move toward decarbonization. Future papers will continue to build out this vision.

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Technical advisory group: Health Care Without Harm established a technical advisory group to guide the development of the framework, methodology, analysis, and other research for this Road Map to ensure accuracy and integrity, integration of aspects unique to health care into climate footprint measurement, alignment with best practices in the field, flexibility for regional differences in health systems, and uptake by key stakeholders.
The advisory group, which met virtually at key moments in the project's development, is drawn from international organizations, health and health care institutions, climate organizations, and academic experts. Members include:

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Green pa·per
/grēn/ 'pāpər/

1. An environmental health policy paper.
2. A first draft document on a specific policy area circulated among interested parties who are invited to join in a process of consultation and debate. The objective of a Green Paper is to arrive at a consensus before drafting the official policy document, the white paper.

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healthcareclimateaction.org/roadmap

Health Care Without Harm seeks to transform health care worldwide so the sector reduces its environmental footprint and becomes a leader in the global movement for environmental health and justice. Health Care Without Harm has worked for 25 years with the health care sector to reduce its use of toxic chemicals and generation of waste, while transforming the supply chain and fostering climate action.

With offices in the United States, Europe, and Asia, a regional team in Latin America, and country-level partnerships with national organizations in Australia, Brazil, China, India, South Africa, and Nepal, Health Care Without Harm is a leader in mobilizing the health care sector to realize this vision.

Health Care Without Harm's staff of health professionals, researchers, and advocates work with hospitals, health systems, governments, and international agencies to accelerate health care decarbonization, resilience, and climate policy leadership around the world. Health Care Without Harm's Global Green and Healthy Hospitals Network has more than 1,450 institutional members across 72 countries, all working to bring the health sector into the climate movement and expand their healing mission beyond the four walls of their facilities.

ARUP

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The people at Arup are driven to find a better way and to deliver better solutions for our clients.

We shape a better world.

Abbreviation and terminology

Acronym	Full term
AR5	Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change
B2DS	Beyond 2 Degrees Scenario
BAU	Business as Usual
EEIO	Environmentally Extended Input-Output model
ETP	Energy Technology Perspectives (IEA report)
GHG	Greenhouse Gas
GHGP	Greenhouse Gas Protocol
GMRIO	Global Multi-Region Input-Output
IEA	International Energy Agency
INDCs	Intended Nationally Determined Contributions
IO	Input-Output (model)
NDC	Nationally Determined Contribution
RoW	Rest of World
RTS	Reference Technology Scenario

Foreword

It is becoming increasingly clear that the climate crisis is also a health crisis, and that while every sector has a role to play in protecting our planet's natural systems, the imperative for the health sector is especially strong.

Good Health for All is simply not possible in a +1.5 degree Celsius world. This means health leaders at all levels and in all countries have an urgent and pivotal role to play. They should address the health sector's own environmental impact and use all the influence they can muster to support others as they transform too. The Road Map sets out clear trajectories and practical actions that each health leader should consider.

This report is about actions that help transform societies toward a resilient, sustainable, and healthy future. It is specific about how health leaders can best contribute. It recognizes that, in the pursuit of universal health coverage, health systems face very different challenges and that the equitable pursuit of decarbonization pathways is essential. This includes equipping all health systems for the future stresses and shocks that climate change will bring.

Health leaders have many opportunities to contribute to climate action in ways that reflect the urgency of the climate crisis.

The modelling in the Road Map implies that innovative solutions are needed. The COVID-19 pandemic has shown that technical and operational challenges within the health sector can be solved at a breathtaking pace when they are sufficiently focused, adequately resourced, and receive consistent political support.

A similar well-directed effort is required to address the health impacts of climate change. This should be aimed at both ensuring resilient systems and protecting those likely to be most affected.

Health leaders have many opportunities to contribute to climate action and to do so unequivocally in ways that reflect the urgency of the climate crisis. I hope it will catalyze wider public engagement in regenerating and protecting the precious resources of our planet for the sake of everyone's health and well-being. This calls for urgent action now, implemented in ways that focus on the needs of those who are hardest to reach and are at risk of being left behind – both now and for years to come. The task is huge and there is no time to lose.

David Nabarro
Chair of Global Health
and Co-Director at IGHI Imperial College London
WHO COVID-19 Special Envoy

Executive summary

Context and background

THE HEALTH SECTOR HAS A RESPONSIBILITY TO TAKE CLIMATE ACTION.

The climate crisis is a health crisis. Climate change is the biggest health threat the world faces this century.[1]

Health care contributes to the problem. Health care makes up more than 4.4% of net global climate emissions. If it were a country, it would be the fifth largest climate polluter on the planet.[2]

Prevention, preparedness, and equity are paramount. Health care must become climate-smart, charting a course toward zero emissions that is inextricably linked with building resilience and meeting global health goals.

- **Decarbonization:** As one of the largest and fastest growing segments of the world economy, with a mission to heal, the sector must move quickly to decarbonize, transforming and aligning its growth and development with the ambition of the Paris Agreement to limit global warming to 1.5 degrees Celsius and achieve zero emissions.

- **Resilience:** A zero emissions health care agenda must also evolve in tandem with the health sector establishing infrastructure, systems, and community resilience to withstand the impacts of the climate crisis. There are many areas of synergy with decarbonization and health equity.

- **Health equity:** A climate-smart health care agenda must consider differing levels of health development and access between and within countries, so that it also contributes to achieving greater health equity and meeting global goals, like Universal Health Coverage (UHC)[i]. There are many areas of synergy with resilience and decarbonization.

The health sector can be a societal leader in protecting public and planetary health from climate change. By charting a course to zero emissions, health care can lead by example, while mobilizing its ethical, economic, and political clout to influence and accelerate change in other sectors of society.

The COVID-19 pandemic demands an acceleration of this transformation. The outbreak of COVID-19 has underscored the centrality of health and health care in disaster preparedness, while starkly highlighting how low-income communities and communities of color are most impacted by global crisis. Investment in COVID-19 response and recovery requires a level of resilience in the health care sector unappreciated before. COVID-19 response and recovery also provides an opportunity to build back better and invest in climate-smart (resilient and zero emissions) health care as a disaster preparedness and prevention strategy.[3]

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i UHC is defined by the Sustainable Development Goals as “including financial risk protection, access to quality essential health care services, and access to safe, effective, quality, and affordable essential medication and vaccines for all.”

Key findings

HEALTH CARE CAN SIGNIFICANTLY REDUCE ITS GREENHOUSE GAS EMISSIONS.

Health care's emissions are growing. Under a business as usual scenario—without climate action inside and outside the sector—health care's absolute global emissions would grow enormously from a 2014 baseline and more than triple by 2050, reaching six gigatons a year.

Fossil fuel combustion is the dominant source of health care climate emissions. The use of coal, oil, and gas to power hospitals, health care-related travel, and the manufacture and transport of health care products comprises 84% of all of health care's climate emissions across facility operations, supply chain, and the broader economy.

Countries' Paris Agreement commitments could cut projected health care emissions growth by 70%. If countries can meet the targets and commitments, they set to decarbonize their economies based on their pre-2017 Nationally Determined Contributions (NDCs) to the Paris Agreement, health care development will begin to decouple from climate emissions growth.

But health care's contribution to the climate crisis is still projected to grow and remain substantial. Even if the world's governments were to meet their Paris Agreement commitments up to 2017, health care's annual global climate footprint would still increase, reaching more than three gigatons a year by 2050.

Solutions exist. This Road Map highlights how health care can close the gap and significantly reduce its emissions beyond those that the Paris Agreement commitments would help achieve.

- It proposes actions with cumulative emissions reduction from 2014 to 2050 that add up to 44.8 gigatons of CO_2e.
- This cumulative reduction is equivalent to the entire world economy's global greenhouse gas emissions in 2017.
- It is analogous to leaving more than 2.7 billion barrels of oil in the ground each year for 36 years.

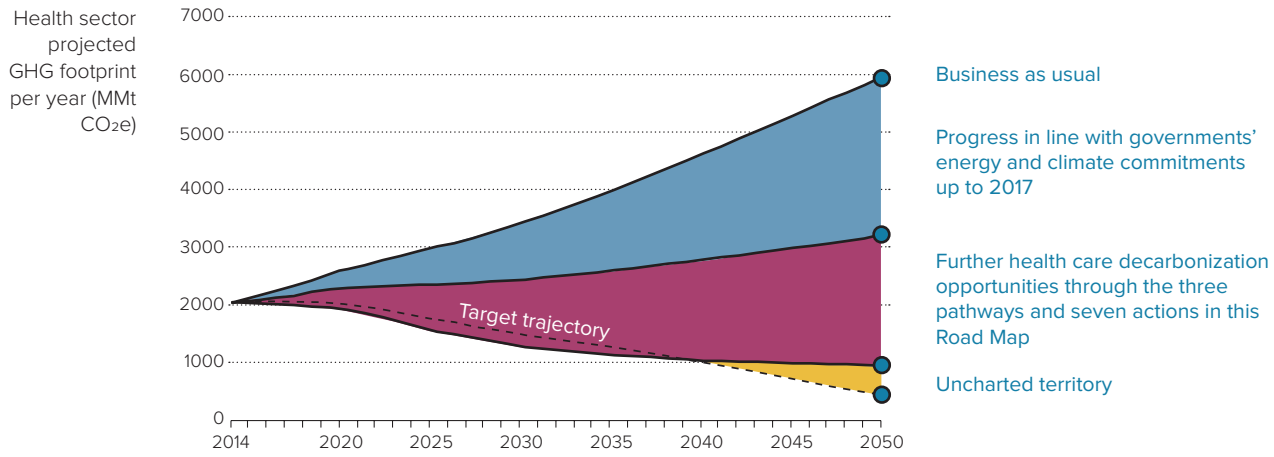


Figure i. Health Care Without Harm and Arup Global Road Map for health care decarbonization.

Charting a course toward zero emissions

All health systems must act. The nations of the world have agreed that all countries must help stabilize the global climate. It follows that all health systems, in every country, must be part of this effort to decarbonize.

Every health care institution together with the sector's suppliers and manufacturers in every country need to close in on zero emissions by the middle of the century. Such a fundamental transformation will require massive collaboration and innovation across this huge sector of society.

Health care decarbonization should be based on the principle of common but with differentiated responsibilities and respective capabilities.

- High-income countries, whose health systems are most responsible for global health care emissions (per capita and historically), need to act most quickly and take the greatest responsibility for addressing the climate crisis.
- Middle-income countries must invest in health system development that takes them on a pathway to zero emissions and avoids replicating the carbon-intensive health delivery model of wealthier countries.
- Low-income countries need to deploy low-carbon and zero emissions technology that enhances their ability to develop their health systems and provide health access and services to all.
- Ultimately, all health systems will need to be closing in on zero emissions by 2050. While those in developing countries might have a later emissions peak, all must begin navigating the transition now in order to avoid locking into a carbon-intensive development trajectory. This transition may require increased support from developed economies to strengthen the capacity of health systems in the developing world and improve their access to the necessary technology.

To decarbonize, health care must achieve a thorough transition to clean, renewable, healthy energy. Health care delivery, facilities, and operations, the sector's supply chain, and the broader economy must all transition from fossil fuels.

Health care climate solutions can be more cost-effective than business as usual. Climate-smart solutions can save health care systems operating costs and reduce countries' health care costs by reducing the burden of disease caused by pollution.

THREE PATHWAYS

By advancing decarbonization of the economic sectors that health care relies on, countries' full compliance with their Paris Agreement commitments will only take the health sector one stretch of the way to zero emissions (top wedge in Figure i). Assuming all NDCs submitted up to 2017 are met (and this will already require health sector involvement in advocacy efforts), there will still be a significant amount of emissions that can only be mitigated through interventions in and from health care.

The Road Map identifies three interrelated, overlapping decarbonization pathways that the sector needs to navigate in order to address these emissions. Spanning and connecting these paths are seven high-impact actions. To chart a course to zero emissions, health care must follow these interwoven pathways and implement related high-impact actions simultaneously (middle wedge in Figure i).

Pathway 1: Decarbonize health care delivery, facilities, and operations. Health care delivery and operations are at the core of the sector's climate footprint. Hospitals and health systems everywhere must take on their greenhouse gas emissions and implement interventions that will ultimately fully decarbonize every aspect of health care delivery and its supporting functions while maintaining and improving patient care.

Pathway 2: Decarbonize health care's supply chain. More than 70% of health care's climate footprint comes from "Scope 3" emissions, much of which originate in the global supply chain. This supply chain spans both Pathway 2 and Pathway 3. Pathway 2 includes reducing the direct emissions of grid electricity purchased by health care facilities. It also includes production, packaging, and the transport of products used in the health sector. Health systems can use procurement decisions to demand the decarbonization of their own supply chain and leverage the sector's collective clout by pooling purchasing power across countries and beyond borders. At the same time, health care manufacturers and suppliers must take immediate action to move toward zero emissions.

Pathway 3: Accelerate decarbonization in the wider economy and society. Every aspect of the health care supply chain and delivery is reliant on other industries that provide energy, chemicals, building materials, packaging, infrastructure, transport, food, and more. 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. Health care institutions and professionals can play a leadership role as advocates for society-wide decarbonization that reduces the burden of disease.

SEVEN HIGH-IMPACT ACTIONS

Getting to zero emissions will require a series of high-impact, cross-cutting actions that span the three pathways. The implementation of these actions will result in a major reduction of health care greenhouse gas emissions. The emissions reduction potential that each action delivers can be seen in Figure ii which is a detailed illustration of the middle wedge shown in Figure i.

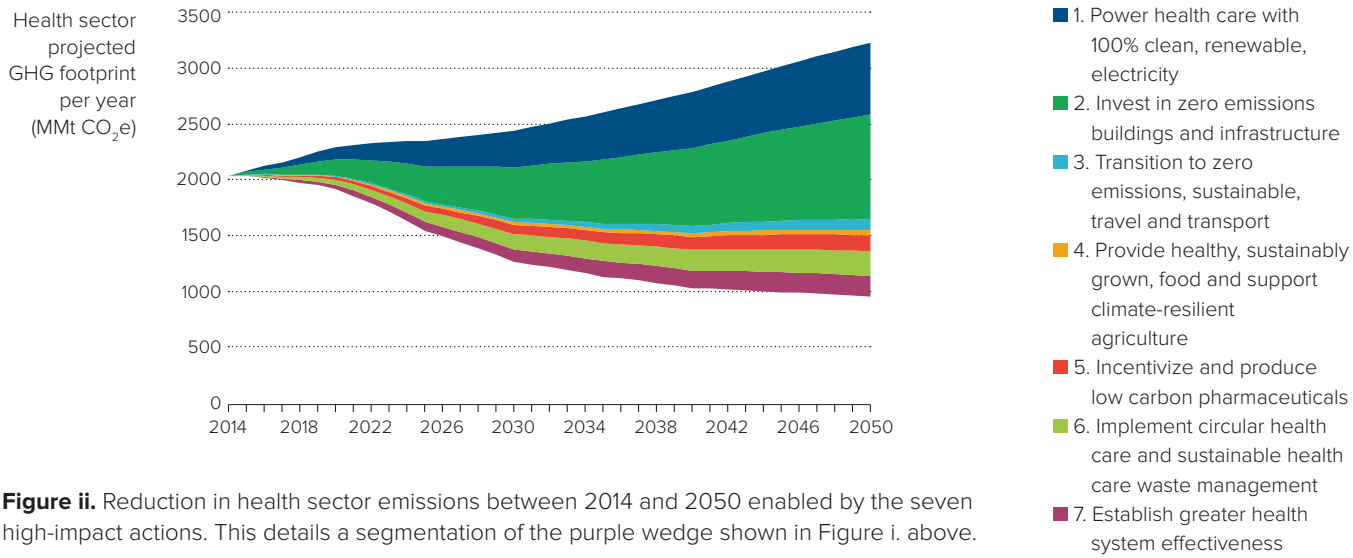


Figure ii. Reduction in health sector emissions between 2014 and 2050 enabled by the seven high-impact actions. This details a segmentation of the purple wedge shown in Figure i. above.

THE SEVEN HIGH-IMPACT ACTIONS ARE:

1. **Power health care with 100% clean, renewable electricity.** Ensure that health care is powered by zero emissions electricity across the three pathways.

2. **Invest in zero emissions buildings and infrastructure.** Ensure every health care building and health product manufacturing facility and their infrastructure promote energy efficiency, zero emissions, and climate resilience.

3. **Transition to zero emissions, sustainable travel and transport.** Transition to 100% low or zero emission fleet vehicles and infrastructure, while encouraging active travel and public transport for patients and staff wherever feasible.

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

5. **Incentivize and produce low-carbon pharmaceuticals.** Reduce unnecessary pharmaceutical use, substitute high emissions products with more climate-friendly alternatives, and incentivize the production of affordable green, climate-smart medicine.

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.

7. **Establish greater health system effectiveness:** Reduce emissions by improving system effectiveness, including eliminating inefficient and unnecessary practices, linking carbon reduction and quality of care, and bolstering resilience.

UNCHARTED TERRITORY: BRIDGING THE HEALTH CARE EMISSIONS GAP

Beyond the seven high-impact actions, we project that without additional transformation, annual health care emissions will still stand at 1.1 gigatons in 2050. This health care emissions gap needs to be minimized over the course of the next three decades.

Bridging the gap will require scaling-up measurable health care climate action, while implementing new initiatives that will require research, innovation, and the exploration of health-based residual emissions management initiatives. It also presents an opportunity to rethink and redefine how health care is understood and delivered. Key areas for exploring opportunities to close the gap over time include:

- Investing in further research and seeding climate and health innovation centers to deepen emission reduction across the sector.
- Establishing Green UHC by integrating sustainability with Universal Health Coverage.
- Maximizing telehealth.
- Integrating climate-smart health care services and infrastructure into emergency response and pandemic preparedness.
- Addressing the social and environmental determinants of health by establishing disease prevention as climate change prevention and vice versa.
- Reinventing financing systems to support healthy people on a healthy planet
- Developing health sector-based residual emissions management solutions.

Driving change: High-level recommendations

THE ENTIRE SECTOR MUST MOBILIZE AND TRANSFORM ITSELF TO HELP PROTECT PUBLIC AND PLANETARY HEALTH FROM CLIMATE CHANGE.

Health care has an opportunity to be a climate leader, and by doing so, achieve not only a healthier planet and a healthier society, but also better health outcomes.

This Road Map contains a series of high-level recommendations, summarized here by key stakeholder groups.

GOVERNMENT ACTION

Declare climate change a health emergency: All governments can start by issuing a declaration that the climate crisis is a health emergency and requires concerted national and global action.

Develop national and subnational road maps: All governments should develop national and/or subnational road maps and action plans for health care decarbonization. As part of this effort, they should establish the systems and capacity to measure and track health care's climate footprint at the national, subnational, and facilities level.

Make zero emissions commitments: National health systems can make similar public commitments to the one made by England's NHS, which signaled its intent to reach net zero by 2045. Public hospitals, health systems, and government health services ready to commit to net zero can also join the UNFCCC's Race to Zero Campaign, by making a commitment to 50% emissions reduction by 2030 and net zero emissions before 2050.

Include health care in nationally determined contributions (NDCs): Health care decarbonization needs to be part of countries' NDCs under the Paris Agreement.

Take legislative, regulatory, and financial action: A thorough climate review of health care legislation, regulations, and financing mechanisms at the national and subnational levels, together with a set of specifically tailored policy recommendations and cost-benefit analyses, can help accelerate decarbonization and climate readiness in both public and private health care operations.

Develop health care climate leadership: Foster health care workforce capacity building and leadership development at all levels.

Put health into national and subnational climate policy: Following the approach of health in all policies, the health care sector should work closely with all relevant sectors to assure that governments develop strong cross-sectoral climate policies that protect public health from climate change while supporting health care decarbonization and resilience.

UNITED NATIONS AND OTHER INTERNATIONAL ORGANIZATIONS

A wide array of United Nations agencies, international financial institutions, bilateral agencies cooperation, and large foundations that provide health development assistance all need to play an important role in aligning and simultaneously achieving global health and global climate goals.

The United Nations Framework Convention on Climate Change (UNFCCC): The UNFCCC through the high-level champions can adopt this health care decarbonization Road Map, or a modified version of it, as one of its climate action pathways that outline the sectoral visions for a 1.5-degree climate-resilient world by 2050 and set out actions needed to achieve that future.

United Nations agencies: The World Health Organization (WHO), the UN Development Program (UNDP), the UN Environment Program, and other UN agencies have a crucial leadership role to play in advocating for and accelerating the decarbonization of the health care sector by providing essential policy and technical guidance to ministries of health around the world.

International financial institutions and bilateral cooperation: Institutions like the World Bank, regional development banks, bilateral aid agencies, and large foundations that provide significant support for health development in low- and middle-income countries must integrate climate-smart principles and strategies into their health aid, lending, and policy guidance. Those funding climate mitigation and adaptation—particularly the financial mechanisms of multilateral environmental agreements, like the Global Environment Facility and the Green Climate Fund—should integrate health into their programs and finance allocation criteria.

THE PRIVATE SECTOR

The private sector is omnipresent in health care—even in publicly-run health systems—and has a central role and responsibility to play in aligning health and climate imperatives. While government regulation can and must be an important function in establishing a framework for private sector transition to decarbonization, privately-owned health facilities and the "health care industry" more broadly must also exert leadership particularly in decarbonizing the global health care supply chain.

Private and nonprofit health care systems and facilities: Hospitals and health systems run by nonprofit corporations, religious organizations, and for-profit companies can all set ambitious targets for decarbonization, while integrating their efforts with resilience initiatives. Those hospitals and health systems ready to commit to net zero can also join the UNFCCC's Race to Zero Campaign, by making a commitment to 50% emissions reduction by 2030 and net zero emissions before 2050.

Manufacturers and suppliers: Manufacturers and suppliers can take a series of actions to decarbonize their manufacturing, packaging, and transport of products, create products that are themselves highly energy efficient and/or zero or low emissions, innovate and design their products for a circular economy that is sustainable, non-toxic, and minimizes waste and fosters reusability, and advocate for a decarbonization of the broader society and economy.

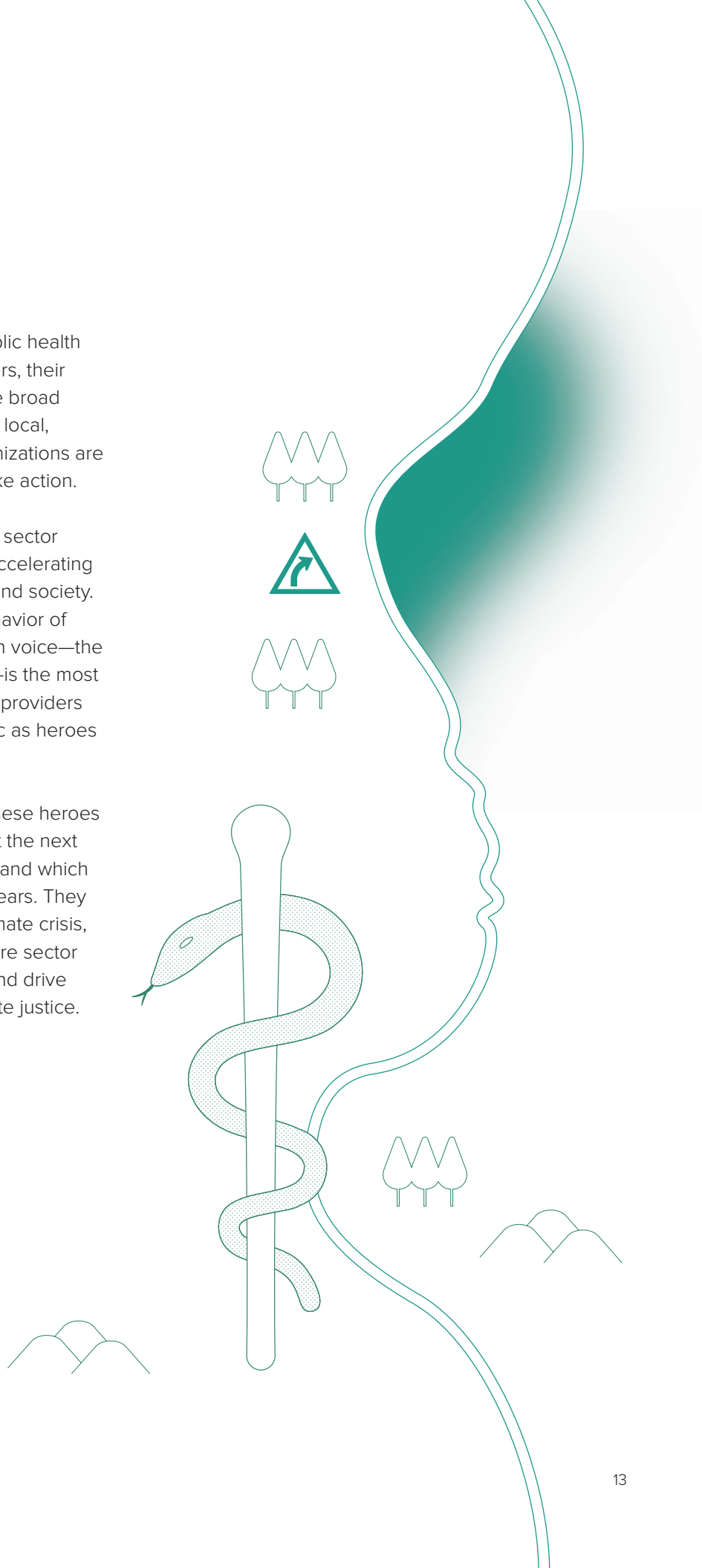
Health insurance and health finance: Insurers can set reimbursement schedules to favor cost-effective low emissions interventions over more carbon intensive actions. Institutions providing health care finance can set climate-smart criteria for health care construction, infrastructure, and the purchase of capital goods. All institutions with stock portfolios and retirement plans should divest from fossil fuels.

CIVIL SOCIETY

The tens of millions of doctors, nurses, public health professionals, and other health care workers, their professional associations, labor unions, the broad networks of health researchers, along with local, national, and global health advocacy organizations are critical to mobilizing health care itself to take action.

At the same time, civil society in the health sector must play a central role as advocates for accelerating decarbonization in the broader economy and society. Health professionals can influence the behavior of patients and policymakers alike. The health voice—the voices of doctors and nurses in particular—is the most trusted voice in most cultures. Health care providers are emerging from the COVID-19 pandemic as heroes who have served on the frontlines.

As we begin to move beyond COVID-19, these heroes can help lead their sector in warning about the next looming crisis, one that is already upon us and which will continue to accelerate in the coming years. They can help protect public health from the climate crisis, and, as part of that, help lead the health care sector itself to chart a course to zero emissions and drive change to achieve health equity and climate justice.



Content

Annexes

A. Technical report
B. Country fact sheets for 68 nations
C. Recommended interventions for implementing the seven high-impact actions
D. Four papers on disease prevention as climate prevention

(To access annexes please see: healthcareclimateaction.org/roadmap)

1

Introduction

Health Care and the Climate Crisis

"The pandemic has obligated us to reflect on the importance of human health and its relationship with the health of the planet. Climate change is a reality that affects all of humanity and therefore requires immediate coordinated action from all world leaders."

Alberto Fernández, President, Republic of Argentina

Delivering health on a warming planet

The COVID-19 pandemic has provided the world with a harrowing understanding of what a multidimensional crisis on a planetary scale looks like. Among other aspects, it has brought to the fore the centrality of the health sector as a frontline responder. It has shed light on the profound inequalities in health and health care access within and between countries. The pandemic has also highlighted the imperative to strengthen and transform our health systems to be prepared for future pandemics as well as other major health challenges of the 21st century, including climate change.

As the tendrils of the climate crisis have intertwined with and compounded the COVID-19 pandemic (and vice versa), the outbreak of the virus has demonstrated the interconnectedness of health and environment like never before. It has also underscored the urgency of climate action to protect the health of people and the planet alike from what the UN Secretary General calls "the defining issue of our time," and an "existential threat" to humanity.[4]

The Intergovernmental Panel on Climate Change's (IPCC) 2018 special report on global warming of 1.5 degrees Celsius documents the significantly more devastating impacts that could be expected at the 2°C Paris goal. Most importantly, it posits that we now have a decade left to institute "far-reaching and unprecedented changes in all aspects of society," in order to limit global average temperature rise to below 1.5 degrees Celsius with respect to pre-industrial levels by the end of the century. The only scenario in which this is possible is if we reach net-zero emissions globally by 2050.[5] To achieve this, we must accelerate the transformations in energy and land use, buildings, transportation, industry, urban development, and the health care sector itself. We must do so in order to avoid a deeper climate-health emergency that might make the COVID-19 pandemic pale in comparison.

While climate change impacts everyone, just as we have seen with COVID-19, those with the least access to wealth and health hit the hardest. In the case of the climate crisis, those least responsible for creating the problem—the nations and communities within nations who have consumed the least resources and emitted the lowest amount of greenhouse gases—bear the brunt of its impacts. Whether it be a small island state facing rising sea levels, a low-income country weathering climate-induced food insecurity, or an impoverished community located on the fence line of an oil refinery and breathing toxic air, the health impacts of climate change and its driving forces will not be borne equally or fairly. The most vulnerable—including low-income communities, women, indigenous peoples, the elderly, and children—will bear the brunt of climate impacts.[6]

At its heart, climate change raises a series of human rights issues (known collectively as "climate justice"), including an intimate interconnection with the right to health. For instance, there is a clear correlation between those countries facing the most severe climate threats with those needing to make the most progress toward universal health coverage. Indeed, unmitigated climate change will severely hinder countries' ability to achieve their health goals and may well reverse progress made over many decades and add to the burden of disease.[7]

Conversely, taking on climate change requires climate-smart health care to be a central part of the solution. This Road Map aims to help chart a course in that direction. By doing so, it intends to contribute to and catalyze a conversation among health leaders as to the profound structural and system changes necessary to address the greatest challenge of our generation and those that will come after us: recovering our planetary health while fostering an economy based both on justice and equity.

Health care's climate footprint

In September 2019, Health Care Without Harm and Arup issued Green Paper One, *Health Care's Climate Footprint*.[8] This first ever global estimate found that the health sector, whose mission is protecting and promoting health, makes a major contribution to the climate crisis and therefore has an important role to play in resolving it.

Specifically, Green Paper One found that, based on 2014 data, health care's climate footprint is equivalent to 4.4% of global net emissions (2 gigatons of carbon dioxide equivalent). To provide context, this global health care climate footprint is equivalent to the annual greenhouse gas emissions from 514 coal-fired power plants. If the health sector were a country, it would be the fifth-largest emitter on the planet.

The Green Paper concluded that health care must respond to the growing climate emergency not only by treating those made ill, injured, or dying from the climate crisis and its causes, but also by practicing primary prevention and radically reducing its own emissions in order to align with the 1.5 degree ambition of the Paris Agreement. The sector, the paper argued, must undertake this effort while simultaneously meeting global health goals, like universal health coverage and working to achieve the Sustainable Development Goals.

The paper also concluded that if the health sector around the world were to come together to address the climate crisis, it could influence more than its own footprint. If health care development, growth, and investment can align with global climate goals, the paper argued, the 10% of the world economy that health care represents, together with its political clout at every level of government, as well as its ethical influence as a trusted communicator, the sector could help provide leadership for a low-carbon, climate-smart, more equitable, and healthier future.

Over the past decade, growing legions in the health sector have all recognized climate change as the greatest global health threat in the 21st century.

To achieve this ambitious and necessary end, the paper made a series of recommendations, including developing a Global Road Map to chart the course for zero emissions health care by 2050. Such a road map, the paper argued, is necessary to identify key pathways forward, while establishing timelines and frameworks for action among and between countries.

This Road Map follows through on that recommendation. It effectively provides a plan and charts a course to get health care toward zero emissions. It considers health sector emissions across all its component parts. It drills down into these elements to establish where emissions are most prevalent and explores interventions that can contribute to reducing them. It does so at a global level, and in the accompanying appendix, at a country level for 68 countries.

The Road Map defines how wealthier countries—whose health sectors are the biggest climate polluters—must take the most rapid action to decarbonize. It explores how middle-income countries can invest in health care development that takes it on a pathway to zero emissions, and how low-income countries need access to low-carbon and zero emissions technology that enhance their ability to provide health access and services. It shows how all must act.

Reinventing health care in the 21st century

Under a business as usual scenario, health care's climate footprint will triple between now and 2050. This is not acceptable. The health sector must reinvent itself to address the urgent 21st century health threat of climate change. This requires system change both within and outside of the health sector.[9] It is at once an enormous challenge and also a timely opportunity.

Health care must do its part to contribute to, as the IPCC report calls for, a 45% reduction of global greenhouse gas emissions by 2030 (from 2010 levels) and "net zero" by 2050.[10] This Road Map aims to identify the pathways available for the health sector to help achieve that transformation.

As health spending continues to grow, the sector must decouple this growth from its climate emissions. The sector must reinvent ways to deliver care and how the products and technologies it uses are made, used, and disposed of. Health financing must be revamped to incentivize climate-smart health care. The health sector must team up with other sectors to accomplish this, while also working collaboratively to reduce the global burden of disease, and therefore the demand for resource intensive health care itself.

Carving a global path to zero emissions health care is just one component of the transformation that the climate crisis urgently requires health care to make. The health sector must also simultaneously build resilience—facility resilience[11] and systems resilience[12], while enhancing its role as an integral member of many communities to serve as an anchor for community climate and economic resilience. (see box: "health care climate resilience")

As it takes on the climate crisis, the health sector must also redouble its efforts to achieve the targets in UN Sustainable Development Goal Three (SDG 3), "Health and Well-Being." These nine targets range from reducing global maternal mortality, to ending epidemics like HIV-AIDS and other communicable diseases, to reducing premature mortality from non-communicable diseases, to reducing deaths from hazardous chemicals, air, water, and soil pollution. Perhaps most importantly, SDG 3 sets a target of achieving universal health coverage (UHC) by 2030 which includes "financial risk protection, access to quality essential health care services, and access to safe, effective, quality, and affordable essential medication and vaccines for all."[13]

Achieving SDG3 and fostering health equity requires a fundamental transformation of the sector including major increases in funding to expand access to health care. Decisions to implement UHC will lock in low- and middle-income countries' health delivery models for decades. It is vital that sustainability and climate-smart health care principles inform the models of UHC that countries adopt.

Decarbonization, climate resilience, and health equity can be mutually reinforcing. They are vital transformations that can often be delivered synergistically. If and how the health sector tackles them will define, to a large degree, its success or failure in taking on the challenges of the 21st century.

This Road Map takes as its point of departure the inextricably interconnected relationship between the need for comprehensive change in terms of health equity, health care climate resilience and adaptation, and health care decarbonization. Its navigational focus, however, is on the latter: how the sector can move toward zero emissions in the context of these other, related transformational priorities. It recognizes that the transformation required to decarbonize must go hand in hand with a broader and deeper transformation of the sector to thoroughly address climate change and to improve global health. In this regard, this Road Map is but one chart in what must be an atlas for health sector transformation.

The race to zero: A growing health care climate movement

Over the past decade, growing legions in the health sector—doctors, nurses, hospitals, health systems, ministries of health, academics, health NGOs, the World Health Organization, and other international bodies—have all recognized climate change as the greatest global health threat in the 21st century.[14] These leaders have taken a series of steps to identify the interconnectivity between public health and a healthy climate to advocate for solutions that will protect public health from climate change, to build greater resilience and responsiveness to the climate crisis, and to reduce their own emissions.

For instance, in a guidance for health facilities in low- and middle-income countries, the World Health Organization recently recognized that, "health care facilities and more broadly the health sector, though profoundly impacted by climate-related shocks and stresses, have an opportunity to significantly reduce global GHG emissions. Therefore, facilities can respond to the growing climate emergency by building resilience to extreme weather events and long-term stresses to continue protecting the health of their population and by reducing and even eliminating all environmental contaminants from their operations.[15]"

Health care, in low-, middle-, and high-income countries, also has the opportunity to chart a course to zero emissions. By doing so, it can leverage its powerful position as a trusted messenger to deliver the truth about the health impacts of climate change and the action necessary to address them, helping lead a global response to the climate emergency. It is already going in this direction.

In January 2020, England's National Health Service announced a commitment to become the first national health system in the world to achieve net zero climate emissions. By October, despite the challenges presented by COVID-19, the NHS issued a plan that lays out the direction, scale, and pace of change to get to net zero. The plan defines a set of trajectories to reach with an 80% reduction by 2032 and net zero by 2040 for the emissions they control directly. The NHS aims to be fully net zero by 2045 for the emissions they can influence, including the global supply chain. The report also begins to define the interventions required to achieve that ambition, including building 40 new net zero hospitals, retrofitting and upgrading existing buildings, installing onsite renewable energy, and transitioning NHS transport fleet to zero emission vehicles, including developing the world's first hydrogen-electric hybrid double-crewed ambulance.[16]

The NHS net zero plan also calls for leveraging the NHS purchasing power to achieve a net zero supply chain based on more efficient use of supplies, low-carbon substitutions, and product innovation, while ensuring that their more than 80,000 suppliers are decarbonizing their own processes. The plan seeks to avoid carbon offsets as much as possible and aims to spur innovation to address gaps in emissions reduction. Finally, it calls for a new health care service model that delivers health care based in sustainability, greater equity, and zero emissions. NHS's commitment makes it the world's climate flagship health system—one that shows hands on application of the contours of this Road Map that can help others chart their own course.

The same month that the NHS made its announcement, and in the midst of a COVID-19 surge in the country, the United States National Academy of Medicine published a scoping paper it commissioned to "propose potential strategies to mitigate the impact of the U.S. health care system on climate change." The paper called on the U.S. health care sector to move along a similar path as the NHS. Declaring, "it is now time for health care leaders and members of the health professions—among the most trusted people in society—to bend the arc of climate change toward planetary and human health," the paper called on U.S. health care, the single largest health care climate polluter on the planet, to take action. Calling it, "a crucial first step toward an eventual carbon-free

HEALTH CARE CLIMATE RESILIENCE

As health care navigates opportunities for decarbonization, institutions often find significant overlap with climate resilience or adaptation measures. The converse is also true, where many health care institutions prioritizing climate resilience find low-carbon solutions help achieve this agenda (Figure 1).

While this Road Map focuses on health care decarbonization, the connection with resilience is important to underscore. Indeed, resilience should form a cornerstone of the decarbonization agenda and vice versa. Health care climate resilience can be divided into three inter-related categories: facility and infrastructure resilience, systems resilience, and community resilience.

Facility and infrastructure climate resilience: The World Health Organization defines "climate resilient and environmentally sustainable health care facilities as those that anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stresses, while minimizing negative impacts on the environment and leveraging opportunities to restore and improve it, so as to bring on going and sustained health care to their target population and protect the health and well-being of future generations."

WHO identifies four core areas of health care facility resilience: 1. A skilled and informed health care workforce empowered to address environmental challenges. 2. Sustainable and safe management of water, sanitation, and health care waste services. 3. Sustainable energy services. 4. Appropriate infrastructure, technologies, products, and processes for the efficient functioning of the facility. WHO recommends that with climate change increasing the risk of severe impacts on health care facilities and placing complex, multifaceted, and unpredictable demands on health systems, all new investments in the health sector should contribute to building resilience to climate change.[17]

Health system climate resilience: System resilience is defined by WHO as "the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; as well as stay informed through lessons learned during the crisis and reorganize if conditions require it. It is the ability to absorb disturbance, to adapt and to respond with the provision of needed services." Health system resilience also relies on cross-sectoral collaboration to achieve improved solutions.[18]

Community resilience: Reducing health inequalities is a neglected and fundamental component of providing more sustainable and resilient health services. The health care sector's role in achieving community resilience can involve focusing on reducing inequalities and addressing social injustice through economic investment to address the social determinants of health. Such community-based efforts can reach further than simply managing disruptions or the symptoms of inequity. This should include investing in resilient primary

care systems and cadres of primary care workers, particularly in low- and middle-income countries[19]. Fostering community resilience should include supporting the right to livelihood and productive resources by making sure that no individual is living in food or energy poverty, lacks access to clean water and sanitation, access to safe housing, and that adults have the opportunity to work and significantly improve their ability to lead a healthier life.[20] Supporting community health education, strengthening local healing systems, supporting healthy food cultures, and addressing the needs of marginalized groups can all support community climate resilience. By addressing social determinants of health, communities, families, and individuals can be better positioned to respond to the impacts of climate change, including extreme weather events.

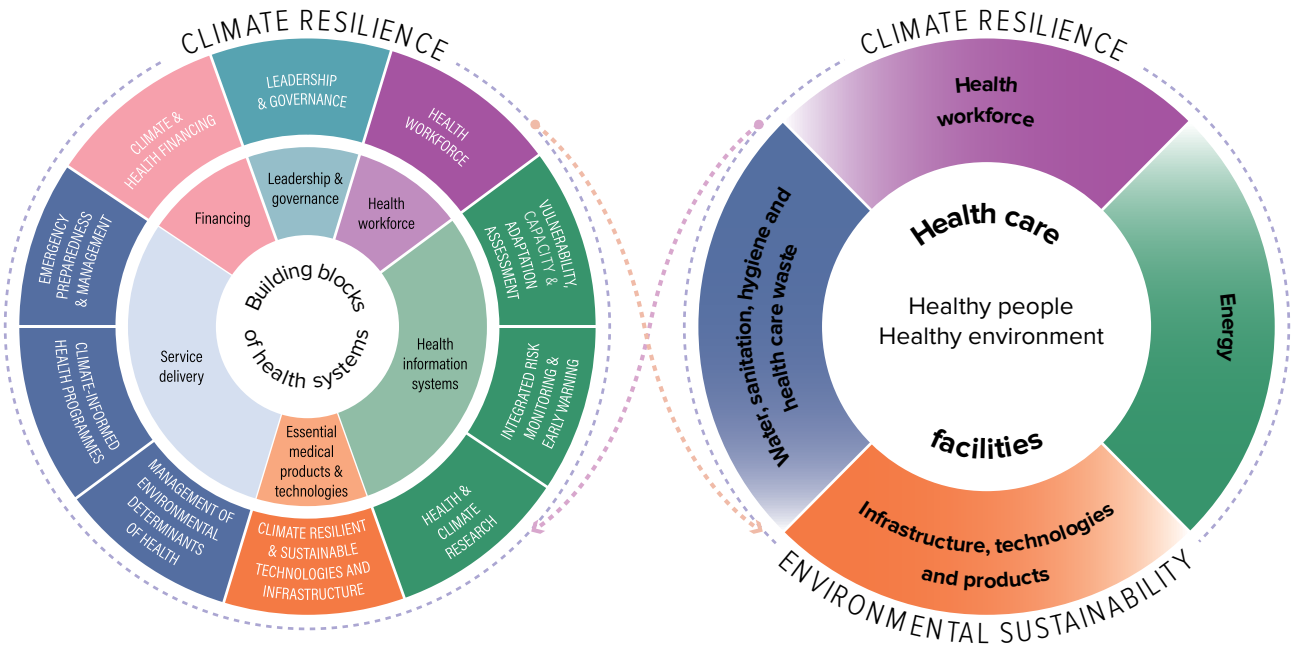


Figure 1. WHO's 2015 operational framework for climate-resilient health systems[21] (left) and new 2020 guidance for climate-resilient and environmentally sustainable health care facilities[22] (right)

health care system," the Academy stated, "the U.S. health care sector must reduce its carbon footprint by 50%, in absolute terms, by 2030 compared to a 2010 baseline." They suggested that this would be achieved by reducing the demand for services and by initiating a re-design of health services, the supply chain, infrastructure, and financing systems.[23]

The National Academy report builds on growing momentum for decarbonization in the U.S. health care sector with several major hospitals and health systems making commitments to carbon neutrality, primarily in their operational and purchased energy emissions (Scopes 1 and 2). These include Providence (881 hospitals and health centers), Cleveland Clinic (191 hospitals and health centers), Mass General Brigham (39 hospitals and health centers), and Kaiser Permanente (723 hospitals and health centers).

The momentum in the United States and the United Kingdom is also reflected in growing health care action across other health systems that are major climate emitters in Europe and in countries like New Zealand, where both the Auckland and Counties Manukau District Health Boards, representing a total of 45 hospitals and health centers, have also set plans to achieve carbon neutrality. The government of the Australian Capital Territory announced in 2020 that a new $500 million hospital being built in Canberra's south will be all-electric, ruling out the use of gas for heating and cooling equipment, allowing the hospital to become one of the first entirely powered by renewable energy.

Change is also afoot in low- and middle-income countries whose health systems are responsible for far fewer greenhouse gas emissions, particularly on a per capita basis. In many of these countries, low-carbon or net zero strategies sit in the context of achieving climate resilience. For instance, in the state of Chhattisgarh, India, the government has committed to solarizing all of its health centers and to making them

energy efficient in their operations. This strengthens the system's ability to deliver health, to withstand extreme weather events and other crises, and it puts the state's health systems on the road to 100% renewable electricity and zero emissions.[24] There are many other documented examples of hospitals and health systems across Asia, Africa, and Latin America implementing climate-smart health care strategies.[25]

Overall, hospitals, health systems, ministries of health, and other health organizations from around the world are coming together as part of a growing global health care climate movement. Many are part of Health Care Without Harm's Health Care Climate Challenge, a vehicle for health care institutions to commit to climate action along the three main pillars of mitigation, resilience, and leadership. Launched in 2015, the Climate Challenge has grown to include over 300 institutional participants from 34 countries who represent the interests of more than 22,000 hospitals and health centers. These institutions are setting mitigation and resilience targets and documenting their annual progress. From small, rural clinics to large, urban health systems, institutions from around the world are stepping up to the Climate Challenge and committing to be a part of the solution.

Beginning in 2021, Health Care Without Harm has teamed up with the UNFCCC High Level Champions to establish a health care component to the UNFCCC Race to Zero campaign. This will provide hospitals and health systems around the world the opportunity to become part of the UNFCCC's multisectoral Race to Zero.

Finally, several major health care manufacturers have made climate commitments. For instance, several pharmaceutical companies have pledged to source 100% renewable electricity, including, AstraZeneca (by 2025), Novo Nordisk (2030), Merck & Co. (2040), and Johnson & Johnson (2050).[26]

COVID-19 AND CLIMATE-SMART HEALTH CARE[27]

The COVID-19 pandemic provides both lessons and opportunities for transforming health care in the age of climate change. For instance, in some countries COVID-19 hastened a transition to telemedicine, an action which has significant climate benefits in terms of reducing emissions from patient travel and facility operation. In other nations, investment in onsite renewable electricity to power health in energy-poor settings has led to greater facility and systems resilience during the pandemic. As nations, international financial institutions, and health organizations invest in both health systems' ongoing COVID-19 response as well as in major pandemic recovery initiatives, there will be significant opportunity to leverage these trillions of dollars in investments to foster transformative change that puts the sector on a path to zero emissions and climate resilience.[28]

A wide array of climate-smart interventions—covering both adaptation and mitigation—can be incorporated into the different components of the pandemic response and recovery, including COVID-19 testing and treatment, ensuring stable supply of PPEs and other medical commodities, reducing vaccine waste, planning for COVID-19 vaccine procurement, equitable delivery and waste management, and preparing for long-term healthy and green recovery (Figure 2).

For instance, the emergency response to COVID-19 includes massive investments in cold chain technologies and infrastructure that risk locking many countries' health systems into carbon-intensive vaccine systems for decades to come. Conversely, investment in climate-smart, energy efficient cold chains provide for the possibility to build back better for climate-smart transformation that delivers vaccines and establishes a robust, low-emissions cold chain for the future.[29]

Health systems can implement crosscutting interventions that address both pandemic preparedness as well as climate resilience and adaptation, including integrated disease surveillance systems based on the One Health approach which includes robust information and early warning systems, adequate and well-trained human resources for health, effective systems for risk communication, and resilient, locally sourced supply chains.

Health care climate mitigation can also be incorporated into COVID-19 response activities through the deployment of renewable energy, energy efficiency, low-carbon procurement, and sustainable waste management.

Looking forward, the pandemic recovery phase provides an opportunity to build back better with climate-smart health care that fosters robust resilient, decarbonized health systems that contribute to universal coverage, broader societal climate mitigation and improved population health.

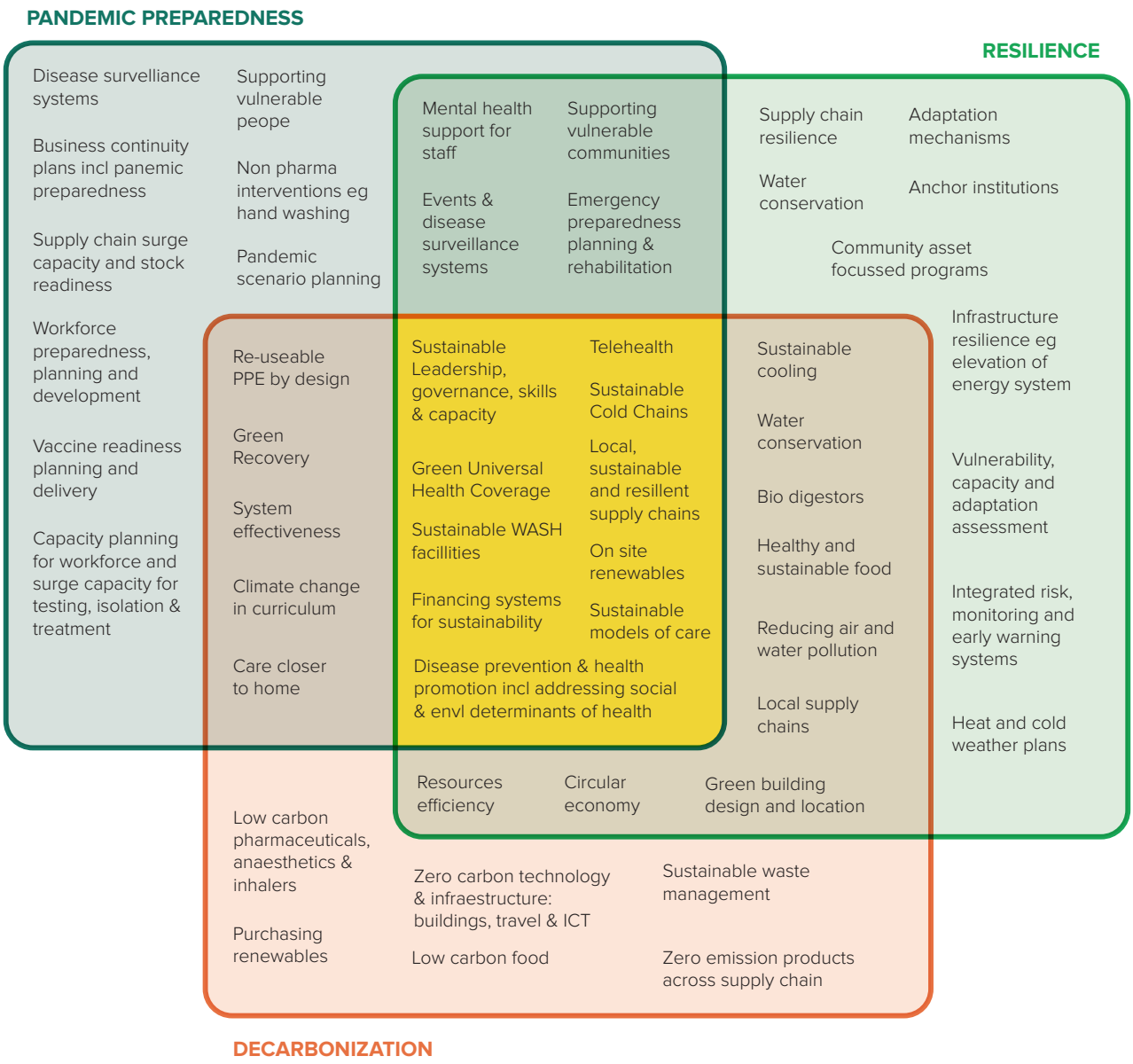


Figure 2. Health care decarbonization, resilience and pandemic preparedness often overlap. They can be mutually reinforcing and synergistic.

How to read this Road Map

This Road Map establishes a vision, a set of navigational tools, and a set of pathways by which the health care sector can chart a course toward zero emissions, while simultaneously building climate resilience and achieving global health goals (see Figure 3 for the Global Road Map infographic).

It is a living document to help traverse an ever-shifting landscape. It can be discussed, debated, amended, and tailored to national and local circumstances. It can be embraced by health care and climate leaders around the world as a navigational "North Star" or "Southern Cross" that can help the sector chart a course to reinventing itself and providing societal leadership in the age of climate change. It establishes a global vision, and, in Annex B, country specific information for 68 nations to begin to develop their own analysis and national road maps or action plans.

This Road Map provides a set of navigational tools and charts a course for health care to reach zero emissions, climate resilience and global health goals.

THE ROAD MAP IS DIVIDED UP INTO FOUR MAJOR SECTIONS:

1. **Understanding the topography:** Using a structural path analysis, this section deepens our understanding, derived from Green Paper One and other research, about health care's climate footprint operationally and within the global health care supply chain. Deeper understanding of this topography is essential to chart a course for transformation.

2. **Analyzing the sector's trajectories:** This section considers where the sector is now, the direction it is headed, and the course corrections that are needed to align with the ambition of the Paris Agreement and achieve zero emissions by 2050. It proposes four emissions trajectories for the health care sector, taking into account countries' common but differentiated responsibility for emissions and respective capabilities, levels of economic development, and development pathways in the health sector.
3. **Charting a course:** Based on the topography analysis and the forecasted trajectories, this section charts a course for health care climate action.

   Three pathways: Three main interrelated pathways set the contours of this course toward zero emissions. They are:

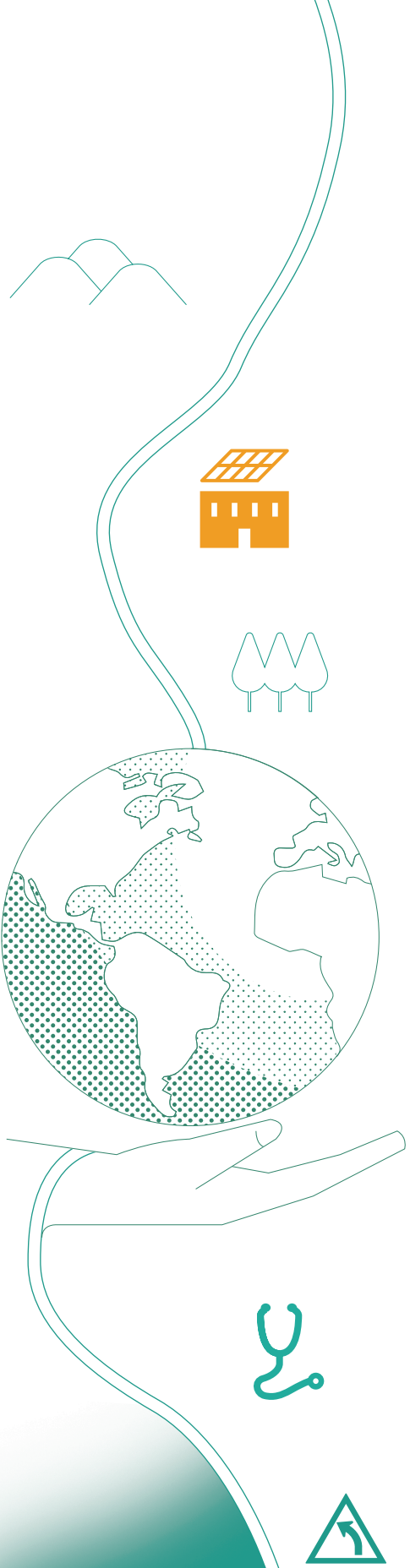
   - Decarbonize health care delivery and build resilience
   - Decarbonize the health care supply chain
   - Accelerate decarbonization in the wider society and economy

   To help guide the sector along each pathway, we provide a series of topline or high-level prescriptions.

Seven high-impact actions: Spanning and connecting these paths are seven high-impact actions that the sector must take to transform health care into a decarbonized, climate-resilient sector. These actions address electricity, buildings, and infrastructure, travel and transport, food, pharmaceuticals, circular health, and improved system effectiveness. For each action area, in Annex C, we recommend specific interventions that follow the pathway contours described above.

Exploring uncharted territory: In this section, we begin to explore opportunities for further reductions to close the health care emissions gap over time. This uncharted territory includes ramping up telehealth, assuring investment in climate-smart UHC, reducing the burden of disease to reduce the need for resource-intensive health interventions, and other transformational changes. Identifying and forging these solutions to address this "last mile" of decarbonization is a crucial component of this effort that will require creativity and significant innovation.

4. **Driving change:** To embark on this course means driving change in a sector that spends $8 trillion a year, comprises 10% of world GDP, and employs 170 million workers. It requires leadership to build consensus for transformation at the local, national, and global levels. It also requires alignment with global climate and health goals, and cross-sectoral collaboration to achieve health equity, climate justice, and community resilience. In this final section of the Road Map, we propose a series of high-level policy recommendations for governments, international institutions, the private sector, and civil society.



How the Road Map charts a course toward zero emissions

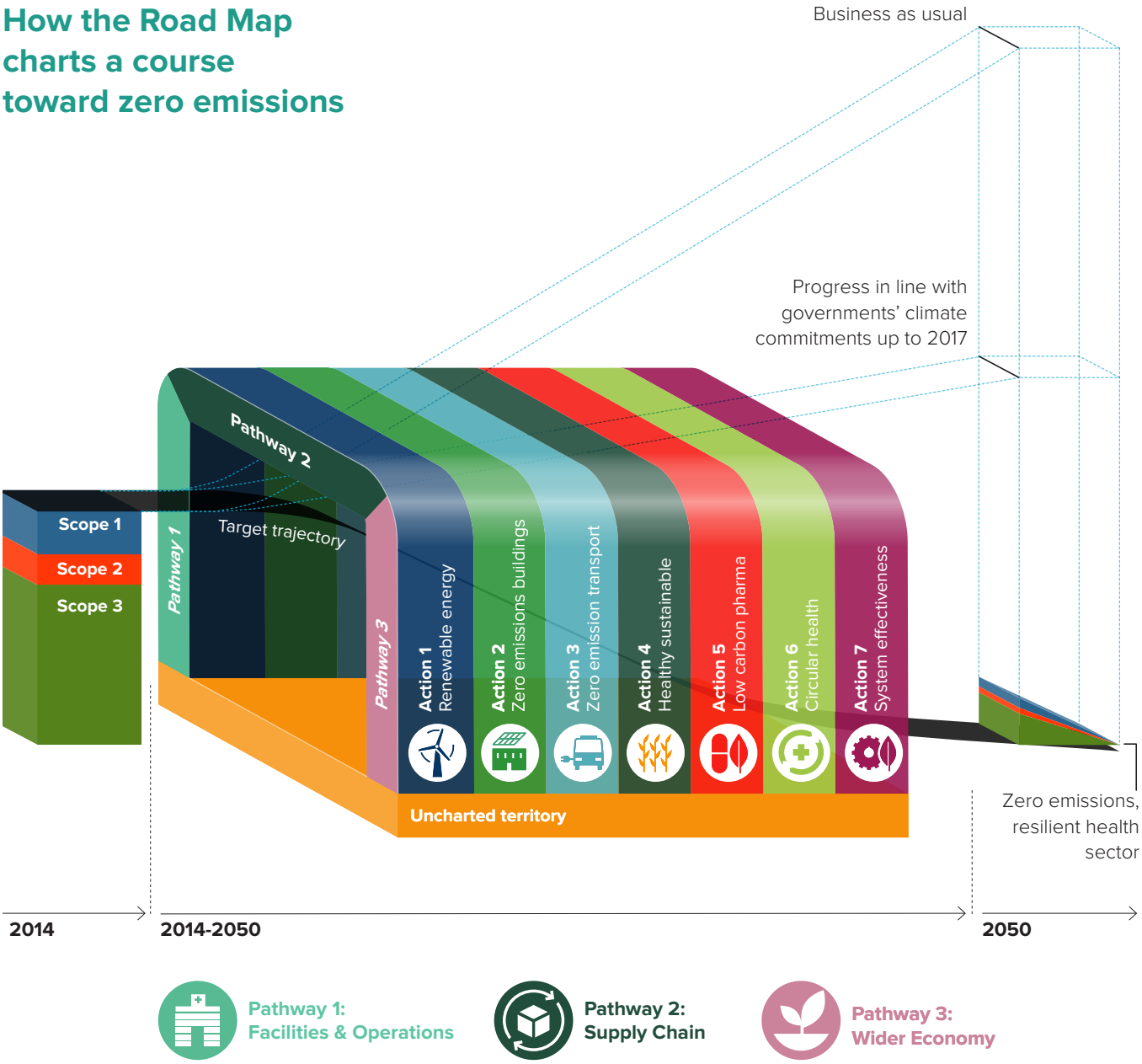


Figure 3. Assuming countries meet their initial Paris Agreement commitments, three intertwined pathways connected to seven high-impact actions come together to deliver health care decarbonization leading toward a zero emissions, resilient health care sector.

2

Methodology

Measuring and projecting global health sector emissions

Health Care Without Harm and Arup had the ambition to create a global health care sector GHG emissions Road Map with the goal to frame the conversation and catalyze climate action across the sector and its community of practitioners. There are few formalized or standardized approaches for establishing such an evidence-based approach, and none currently exists in the health care sector on a global scale with detail across nations.

To help bring definition to the scope, coverage, analysis, methodology, and formatting of what this Road Map might look like, Health Care Without Harm and Arup developed a structured approach across six components to provide the health care sector with a robust method and evidence base, which includes the following features:

- Reporting GHG emissions from the health sector and its supply chain to GHG Protocol Scope 1, 2, and 3 categories
- Laying the groundwork for future scenario analysis within IPCC emission pathways
- Reporting of national perspectives
- Projections based on specific health care trends
- Incorporation of climate actions that health care actors can make
- Granularity sufficient to inform supply chain actions

A full description of the methodology and its six component parts of developing the Road Map are in the Technical Report (Annex A). For summary purposes, Figure 4 provides an overview of the chronology and relationship between each step, with each referenced number linking to a summary of each component below.

The Road Map's goal is to catalyze climate action across the sector and its community of practitioners.

Step 1. We took Green Paper One as the starting point, while adding 25 additional countries bringing the total countries covered to 68, with a "rest of the world" (RoW) category to provide a baseline emissions profile in 2014 for the global health care sector. Further analysis was conducted, using a methodology called structural path analysis (SPA) to separate and break out Scope 3 emissions (i.e., those coming from indirect sources) into usable categories from which to explore health care system emissions.

Step 2. We selected a global warming scenario aligned with keeping warming at 1.5C from which national emission budgets and health care sector pathways within these could be prescribed. This is illustrated by the dashed line and its end point in Figure 4.

Step 3. We used data from the Institute for Health Metrics Evaluation[39] to model growth in health care demand from 2014 to 2050 for each of the 68 nations and RoW. This was used to generate a forecast emissions profile based on the premise of no future climate action has been termed Business as Usual (BAU). In projecting in this manner, the assumption is made that the structure of the health system and wider economy is consistent with the 2014 baseline throughout the projected period. This assumption, its limitations, and its impact on the modelling is described in more detail in the limitations section below and in the technical report (Annex A).

Steps 4 and 5 (highlighted as the blue and gray wedge's respectively in Figure 4). We overlaid the decarbonization actions that can be taken in the health care sector, its supply chain, and the wider economy at large. The interventions that make up these decarbonization pathways and actions are pulled from third party models and published evidence, alongside more focused and new research completed by Health Care Without Harm and Arup to determine the scope, scale, and pace of feasible actions.

Step 6. We applied these actions to each nation's situation, and as an aggregate at global scale for health care, thus presenting a single emissions decarbonization profile as the global health care decarbonization Road Map.

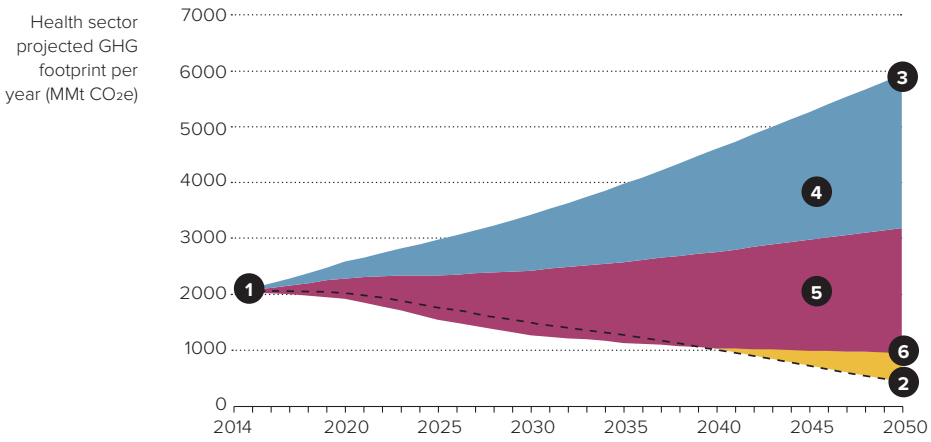


Figure 4. Workflow representation of the Health Care Without Harm and Arup global health care sector Road Map methodology. The numbers shown relate to the work step descriptions provided below.

Limitations and assumptions

The methodology incorporates assumptions and limitations that are considered appropriate for a 36-year emissions projection of a globally heterogenous sector. Please see the technical report (Annex A) for a more complete list and discussion of limitations and assumptions. A summary is provided in Table 1.

Limitation or assumption	Description
Static structure	The projection is based on a static model of the economy from 2014; no changes in the structure of the economy are considered. It is therefore a projection, not a prediction, and is just one of an undeterminable number of possible emissions futures and as such provides only a guide to how the sector can decarbonize at pace.
Consistent growth	The projected growth of the health sector assumes all parts of the system grow at a consistent rate within each country.
Boundaries between the health sector, health retail, and health organizations	The model uses expenditure data which aligns with the WHO's definition of health care, which includes activities, for example, the direct sale of pharmaceuticals to individuals by pharmacies. The boundary of the sector as a whole differs therefore from that of a typical national health provider, for example, the NHS. This is not a limitation as such, rather it is an important consideration when comparing the results of this study with organizational footprints, particularly those covering Greenhouse Gas Protocol (GHGP) Scope 3 emissions.
Homogeneous product	The model assumes a single emissions intensity for the health sector. This assumption holds for considering the sector as a whole but must be acknowledged when considering the impact on emissions of redeploying expenditure from one part of the health care system to another.
Emissions trajectories	The emissions trajectories presented represent plausible emissions pathways. They are an illustration of the effort required by countries to reduce emissions and achieve the budget allocated to the global health care sector. It should be emphasised that these are not forecasts.
Decarbonization trends	The data used to project decarbonization is well-cited and respected in literature. These projections are predictions, and as such are have a degree of uncertainty; however, they represent the best, most comprehensive studies available.
Decarbonization actions	The mitigation actions modelled in this study are not exhaustive, for example, no mitigation of direct emissions from waste, water, and sanitation is modelled. The projected estimates of avoided emissions are therefore likely to be underestimated.
Rebound effects	Where behavioral changes and expenditure reductions are modelled, the emissions impact of the resultant avoided expenditure potentially being redirected to other activities is not considered because it is very complex to model. Policy action can be considered alongside actions in order to limit the scale of any rebound effect.
Emissions trajectories	The model does not account for changing health demands (for example, changed distribution of infectious diseases) or changing the health cost base (from climate shocks e.g., higher insurance, more frequent extreme weather).

Table 1. Summary of methodology limitations and assumptions

3

Topography

Understanding the landscape of health care emissions

"Human health and climate change has been identified as a high priority issue for the National Academy of Medicine going forward... Decarbonization of the health sector [is] an ambitious and important goal."

Dr. Victor Dzau, President, National Academy of Medicine, United States

Health care's climate footprint: Green Paper One

In September 2019, Health Care Without Harm and Arup published Green Paper One, which found that, based on 2014 data, health care's climate footprint is equivalent to 4.4% of global net emissions (2 gigatons of carbon dioxide equivalent). The Health Care Without Harm-Arup paper built on, contributed to, and was validated by a growing body of evidence from national and international studies of health care's contribution to the climate crisis.[30]

The paper found that the top three emitters, the United States, China, and collectively the countries of the European Union, comprise more than half the world's health care climate footprint (56%). The top 10 health care emitters make up 75% of the global health care climate footprint (Figure 5). The United States health sector is the world's number one emitter in both absolute and per capita terms. It produces 57 times more emissions per person than does India.

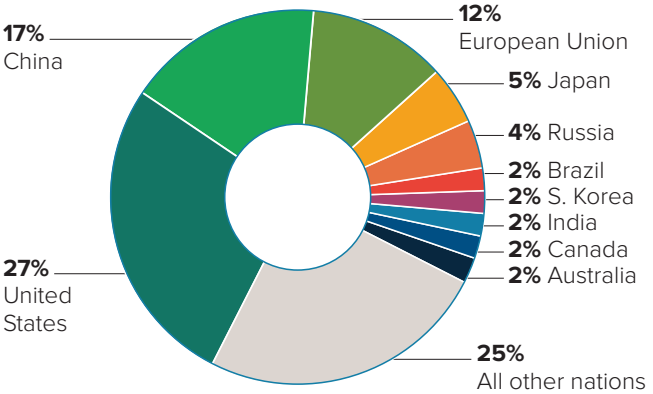


Figure 5. Top ten emitters plus all other nations and percentage of global health care footprint.

Source: Green Paper One.

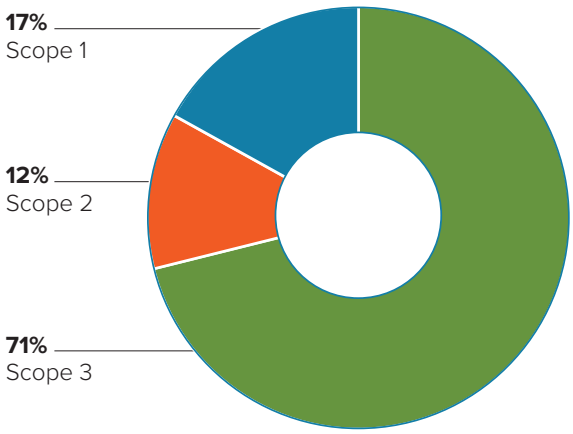


Figure 6. Global health care footprint split by GHGP Scopes.

Source: Green Paper One.

The paper also aligned its findings with GHGP categories, establishing that 17% of health care emissions were produced onsite (Scope 1), 12% were from purchased energy (Scope 2), and 71% came from indirect emissions (Scope 3) including the global supply chain (Figure 6.). Overall, and across all countries, the paper found that fossil fuel consumption is at the heart of health care's emissions because it inherently fuels the energy, manufacture, and transport of health care operations and products.

A further perspective of this is summarized in Figure 7 where the product sectors of the Scope 3 component are set out.

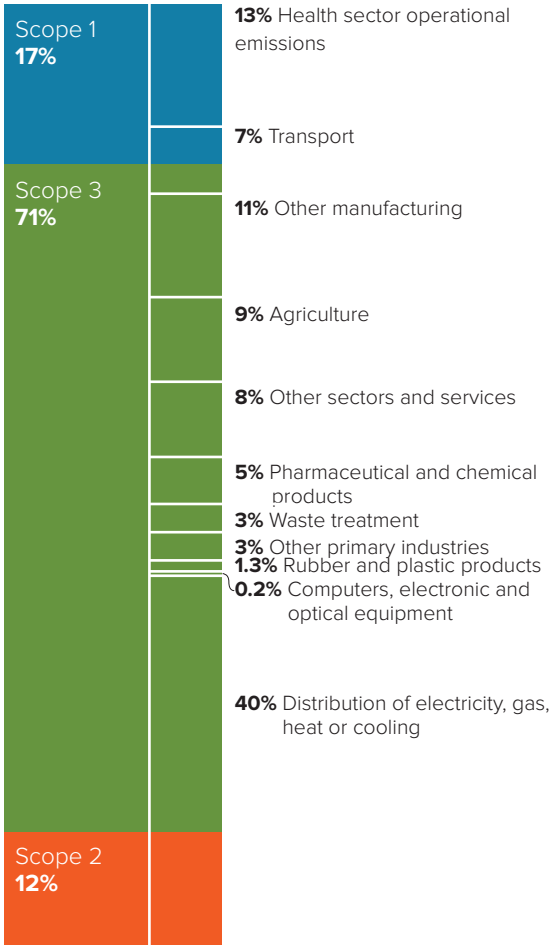


Figure 7. Global health care emissions as presented in the Green Paper One are split by production sector and by scope category.

Structural path analysis findings

Green Paper One presented Scope 3 data with limited granularity and descriptions of the sectorial categories shown in Figure 7 which did not match well with the categorizations more familiar to health care decision makers.

This Road Map addresses this issue by using a technique called Structural Path Analysis (SPA) to present the data in a more impactful and usable form. SPA is an advanced input-output modelling approach[ii] and a full description of the method and findings can be found in Annex A.

Green Paper One findings were modelled through an SPA. This generated outputs more familiar to, and actionable for, those engaged in health care policy, procurement, and supply chain management. Figure 8 shows a perspective of the SPA output, the significance of supply chain Scope 3 emissions, and the variation of distribution across many different categories. Business services, the food sector, construction, and pharmaceuticals stand out, with each making up between 5% and 12% of health care's climate footprint. Figure 9 shows the same emissions through the lens of Greenhouse Gas Protocol categories.

Implementing the SPA has enabled these results to be applied to the Road Map to inform future pathways and high-level actions essential for health care sector decarbonization. The findings of Green Paper One, together with the SPA, form the foundational analysis, or the topography upon which the Road Map is based.

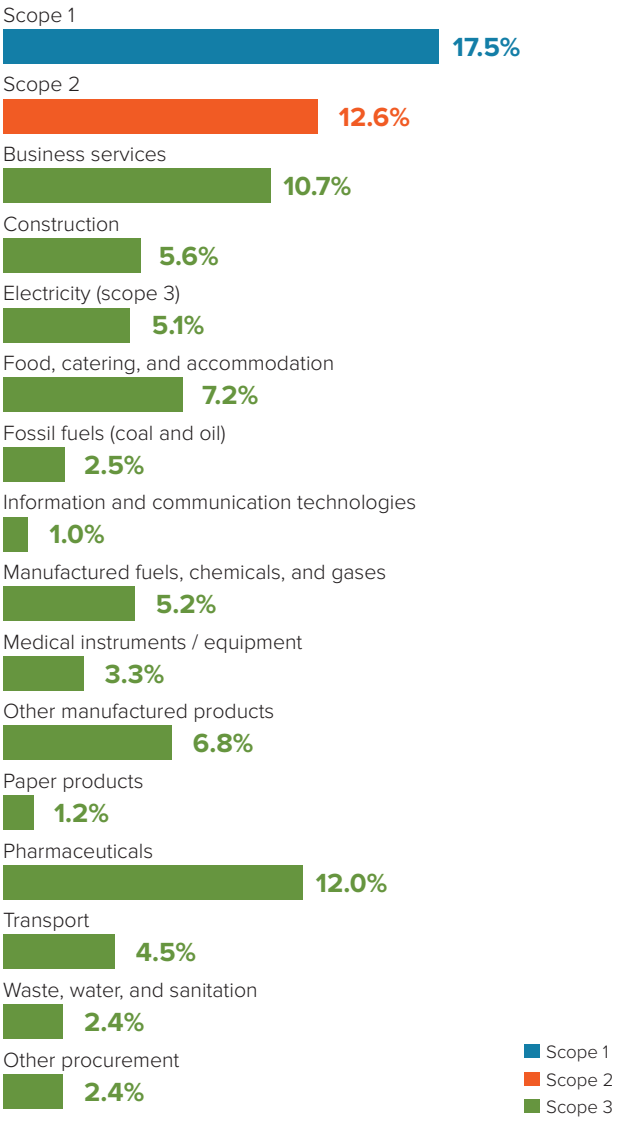


Figure 8. Health care's global emissions footprint by supply chain categories

ii Input-output analysis predicts emissions through coupling expenditure data with the emissions intensity per unit spend for sectors in the economy. To predict future growth in emissions, predicted changes in health expenditure have been used as this data is directly compatible with the IO methodology, which is introduced in the following paper: Kitzes J. An Introduction to Environmentally-Extended Input-Output Analysis. Resources. 2013; 2(4):489-503. https://doi.org/10.3390/resources2040489

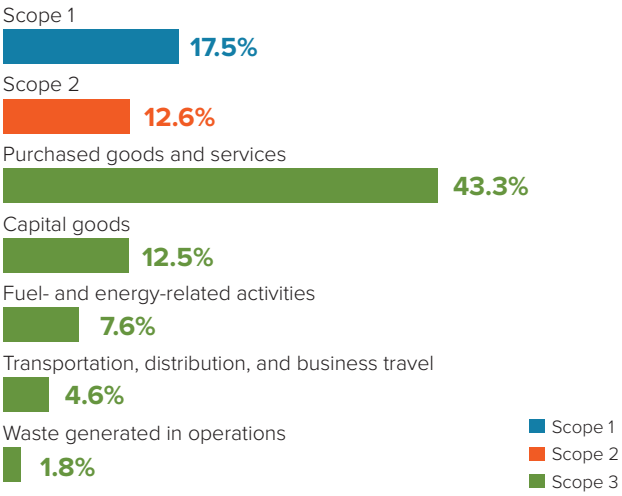


Figure 9. Health care's global emissions footprint by GHGP supply chain categories and sub-categories

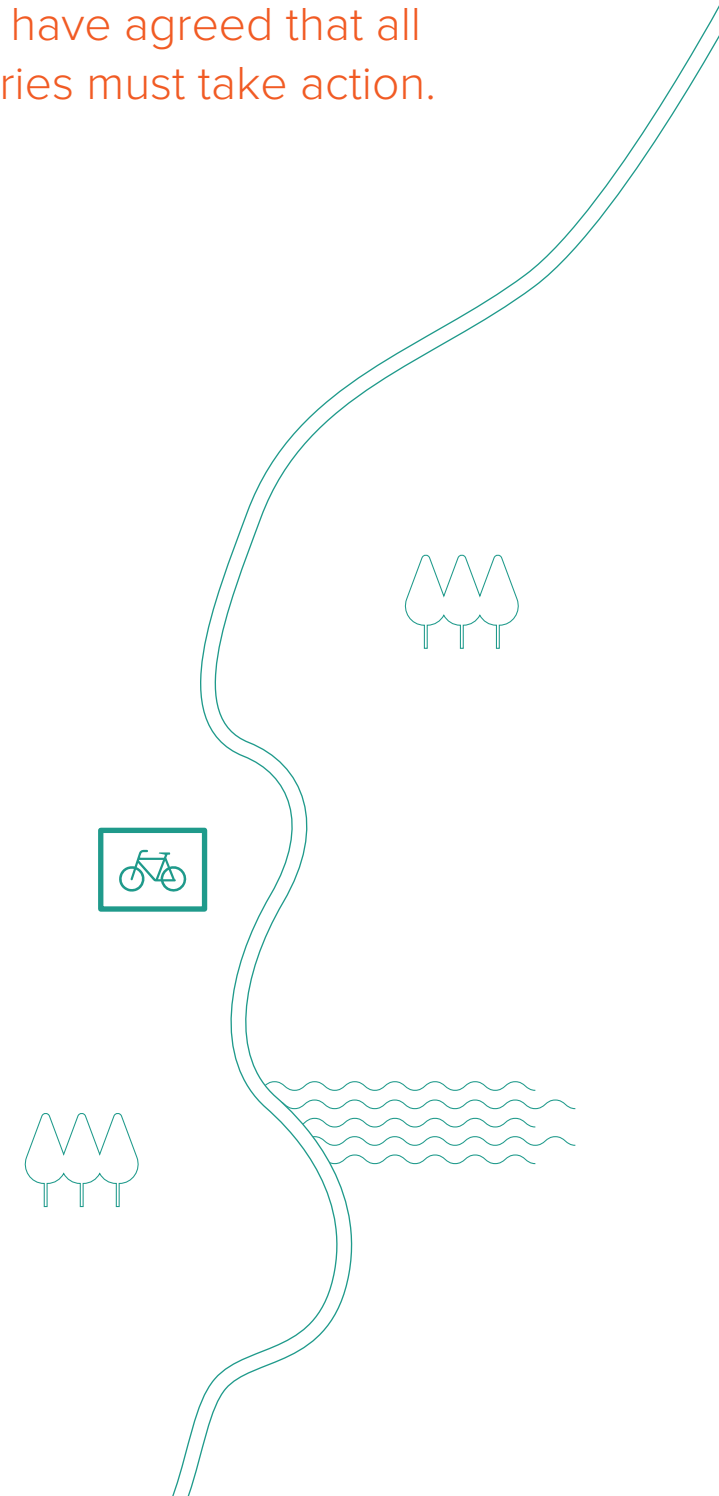
Broadening individual country coverage

The 43 nations covered in detail in the WIOD input-output model have a skew toward higher income nations. Other studies, making use of differing data sources and methodologies, have provided estimates for other nations. One such study, from Lenzen et al.[31], has produced a global health sector footprint based on Eora, a different input-output model, and provides the health sector footprint with a complementary set of nations to those in WIOD.

From Lenzen et al.'s work, 25 additional national footprints have been included in this study, thus expanding the number of low- and middle-income nations profiled. The additional nations are shown in Table 3, and all profiles are included in the country factsheets in Annex C. Integrating these published footprints for an additional 25 nations has allowed the Road Map to be more expansive than Green Paper One.

Because these footprints have been derived through a different methodology (Eora), using a different source of health sector expenditure, the sector definitions and activities covered differ from those in the WIOD based model. Target projections and anticipated growth in expenditure helped establish the reference case scenario (BAU) and target trajectories for the additional national footprints. However, the structure of the health care sector footprint for these nations was not available. The potential scale of emissions reduction for these nations is instead estimated using the global mean reductions derived from the WIOD model. These estimates are shown to highlight the potential savings if these health systems decarbonize in line with the global average, and therefore do not capture the expected variability associated with the national context. It is recommended that these nations further investigate their national health system footprint and potential to decarbonize to capture the national context in greater detail.

To hold climate change to 1.5 degrees and achieve the ambition of the Paris Agreement, the nations of the world have agreed that all countries must take action.



4

Trajectories

Navigating an uncertain future

"Never before in human history have we been so forewarned of a doomed destiny. But never before in human history have we been so forearmed with the knowledge and tools to alter the course of that destiny."

Dr. K. Srinath Reddy,
President of the Public Health Foundation of India

The global emissions gap

If the world continues along its current path, greenhouse gas emissions will rise inexorably and spur global warming beyond 4 degrees Celsius during this century. The ramifications of such a temperature increase are difficult to contemplate, but essentially would lead to massive coastal flooding, famine, widespread species extinction, the increased potential for devastating pandemics, and huge swaths of the planet becoming uninhabitable for humans accompanied by massive migration.

These phenomena would inevitably lead to a series of social impacts including the profound undermining of health infrastructure, the potential collapse of some health systems, and a growing burden of disease among much of the world's population. While such extreme changes may not manifest for some years, we are already seeing their precursors and have only a decade to change course and truly embark on a different direction if we are to avoid climate catastrophe.[32]

Under the Paris Agreement, the world's governments committed to alter their emissions trajectories to stabilize global climate change. However, when all government commitments under the Paris Agreement, known as Nationally Determined Contributions (NDCs), are added up (and many of these pledges are not being fulfilled), there is still what the UN Environment Program (UNEP) calls an "alarmingly high emissions gap" between the agreement's ambition of stabilizing global temperatures increase at or below 1.5 degrees Celsius and what governments have promised via their NDCs (Figure 10). Recognizing this gap, UNEP voiced "an urgent need for accelerated short-term action and enhanced longer-term national ambition if the goals of the Paris Agreement are to remain achievable.[33]"

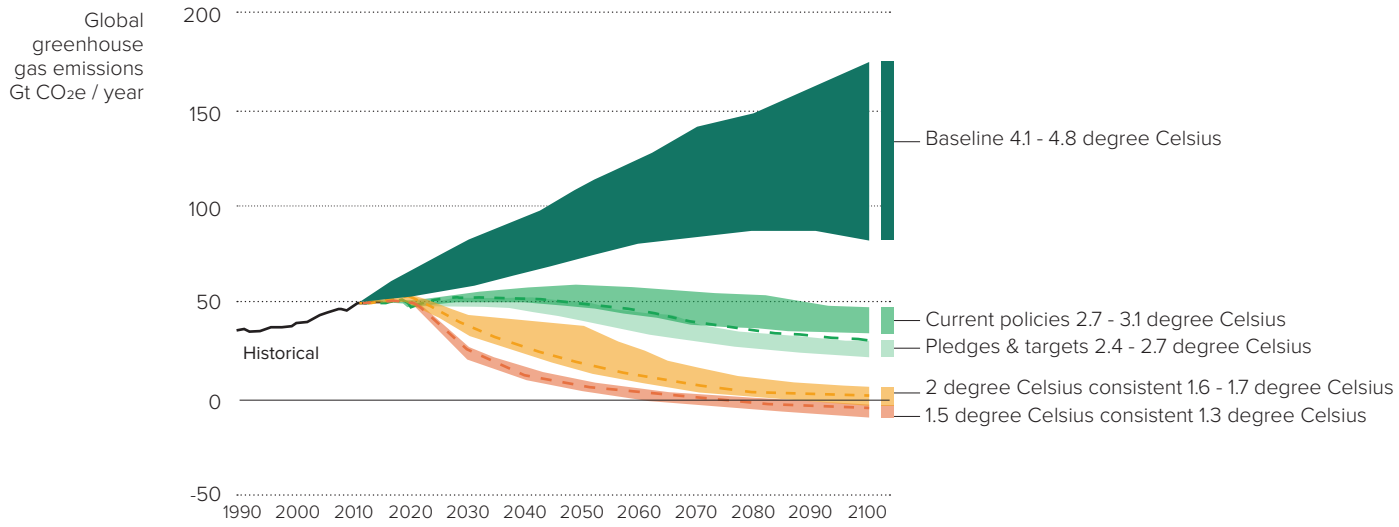


Figure 10. 2100 warming projections – emissions and expected warming based on pledges and current policies; source: Climate Action Tracker, September 2020. https://climateactiontracker.org/global/temperatures/. September 2020 update.

Decarbonization scenarios

As the impacts of climate change increase around the world, many national governments are in fact accelerating action, including developing enhanced NDCs in advance of COP26 in Glasgow to help implement the Paris Agreement. These national commitments, some of which are pledges for net zero emissions by or around 2050, may help close some of the gap, but they will not be enough. UNEP points out that action by subnational and non-state actors, including regional and local governments and businesses, is also key to enhancing future ambition.

By charting a course to decarbonization, while leveraging its ethical clout and joining forces with other sectors of society, the health sector, which is responsible for more than 4.4% of net global emissions, can play an important leadership role in this effort.

Closing the gap between where the current set of commitments get us and where we need to be to stabilize the global climatological balance means we need to fundamentally transform and decarbonize the world economy, particularly in the realm of energy. The International Energy Agency (IEA) has established two scenarios for technology and energy systems decarbonization that we have used as key markers in this Road Map.

First is the Reference Technology Scenario (RTS), which provides a baseline scenario that takes into account existing energy and climate-related commitments by countries, including Nationally Determined Contributions pledged under the Paris Agreement.

The second is the Beyond 2 Degree Celsius Scenario (B2DS), which sets out a rapid decarbonization pathway in line with international policy goals. The B2DS looks at how far known clean energy technologies could go if pushed to their practical limits, in line with the ambition of the Paris Agreement. The scenario features a rapid decline in GHG emissions from energy generation and use (Figure 11.).[34]

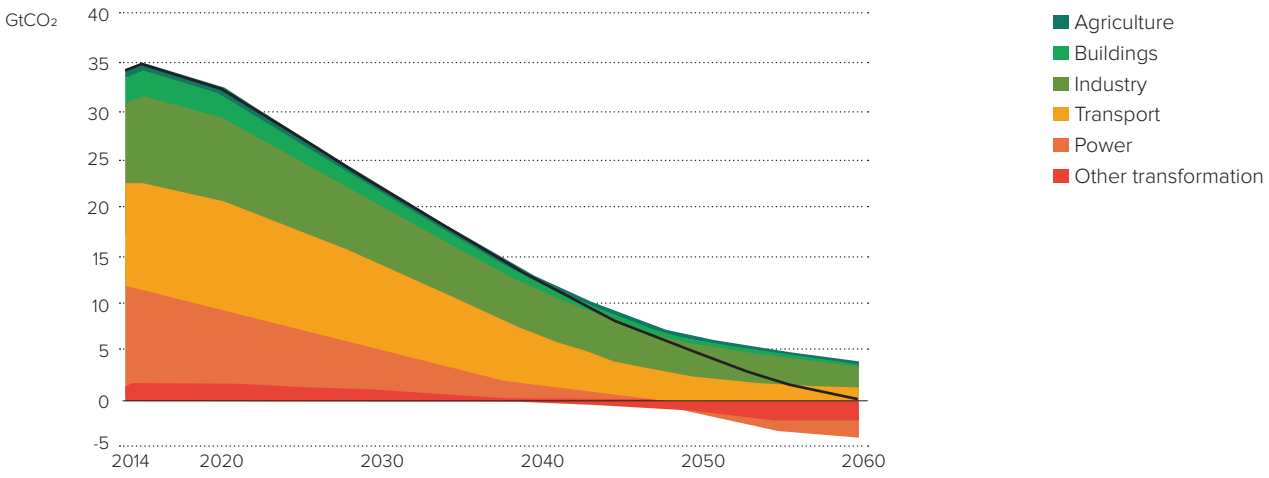


Figure 11. IEA B2DS featuring steep decline in CO_2 emissions from energy use and generation.[35]

B2DS is a highly ambitious scenario, featuring an aggressive uptake of low-carbon or zero emissions alternatives across the global economy. It is the one we use in this Road Map as a key scenario essential for achieving health care decarbonization.

As discussed throughout this paper, while health care needs to transform how it delivers both health and health care, it will also be essential for the health sector to participate in and help accelerate this profound energy transformation order to reduce its own emissions, and also to more broadly protect public health from climate change.

All health systems in every country must decarbonize while simultaneously striving to meet global health goals—two mutually reinforcing objectives.

Three global health care decarbonization scenarios

This Road Map establishes a business as usual baseline, and a set of three potential scenarios for global health care climate emissions reduction from 2014 to 2050. These scenarios show the course corrections the sector will need to make to align with the ambition of the Paris Agreement and achieve zero emissions by 2050.

These scenarios are based on health care's 2014 climate footprint, established in Green Paper One, alongside projections of health care spending growth from 2014 to 2050 as projected by the Institute for Health Metrics and Evaluation. This forecasting establishes the baseline and the basis for the three scenarios explained below and mapped out in Figure 11 and Figure 12.

Reference case: Business as usual

BAU assumes no change in the energy mix from 2014 onward as global health spending grows to more than $10 trillion in 2030 and $15 trillion in 2050. This BAU scenario, the black line in Figure 11 and Figure 12, estimates that without climate action, health care's global emissions would double on a per capita basis and more than triple in absolute terms, reaching more than 6 gigatons annually.

While demonstrating the danger of inaction, BAU will most assuredly not be the case. The world's energy mix is already beginning to shift away from fossil fuels and toward clean, renewable energy. As countries' energy systems become decarbonized, it has been shown that health care's climate footprint growth slows or even reverses relative to growth in health care expenditures. This decoupling, for instance, occurred between 2000 and 2014 in many European countries, where the health care footprint declined as the sector's spending grew, and in numerous other countries, like the United States, Canada, Australia, South Korea, and Japan, where it slowed relative to growth.[36]

Currently, most governments are still not on track to meet their Paris Agreement commitments. Thus, the BAU baseline is still an important reminder of the emissions growth trajectory the health sector is on without increasing efforts to decarbonize. It should provide a sobering impetus for the sector to advocate for countries to meet and exceed their Paris Agreement commitments.

Reference technology scenario: Meeting country climate commitments

The first scenario is based on the IEA RTS discussed in the section above. RTS assumes that countries will meet all of the commitments and targets they set as part of their Nationally Determined Contributions to the Paris Agreement up until 2017. It then models the emissions reductions achieved across the global economy and applies them to health care's climate footprint via the input-output modeling. The IEA does not consider the agriculture sector. We augment the RTS with the consideration of the decarbonization of agriculture from Popp et al.[37], a study that outlines emissions reduction from possible land-use changes. [iii]

iii Popp et al. uses a systematic interpretation of the Shared Socio-Economic Pathways (SSPs) to, for the first time, consider possible land-use changes and their consequences for the agricultural system and greenhouse gas emissions. The changes to the system they consider are summarized in Annex A. The change in emissions intensity arising from these changes, aligned to SSP2, are represented in the input-output model in the same way as the data from the IEA, and hereafter in this paper references to the RTS scenario include consideration of agriculture decarbonization.

Under the RTS scenario, the yellow line in Figure 11 and Figure 12, by 2050 health care's annual emissions will be reduced by 3.2 gigatons, or 53% from the BAU trajectory if countries can actually meet the targets and commitments they have already set. However, given growth trends in the sector, health care's annual global climate footprint would still be 40% greater in 2050 than it was in 2014, weighing in at 2.8 gigatons of carbon emissions every year, the equivalent of the annual emissions of 719 coal-fired power plants.

Below 2 degrees scenario: Accelerating climate action

B2DS is the IEA's highly ambitious scenario that drives the impacts of emissions down to well below 2 degrees. It contemplates a deep decarbonization of energy production and use. Similar to RTS, the emissions reductions potentially achieved under B2DS across the global economy are applied to health care's climate footprint via the input-output modeling.[iv]

There is a significant difference between RTS and B2DS (difference between the orange and yellow lines in Figure 11 and Figure 12) that would impact health care's climate footprint positively. We estimate that achieving the B2DS scenario of energy system decarbonization will eliminate two-thirds of health care's global climate footprint by 2050.

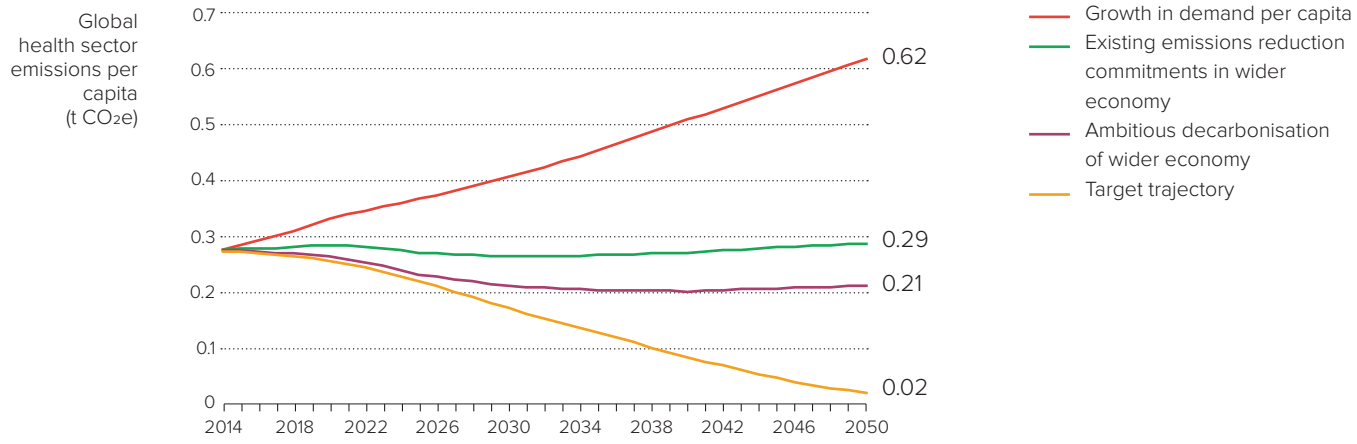


Figure 12. Per capita global health care emissions projections with no action or business as usual (Growth in demand), meeting Paris commitments made up to 2017 (RTS), ambitious decarbonization of the wider economy (B2DS), and deep decarbonization in health care (target trajectory—includes the three pathways, 7 high-impact actions and uncharted territory discussed in Chapter 6).

iv Further change in the agriculture sector was not considered for B2DS, presenting a further opportunity for action in the supply chain by addressing agriculture emissions that would contribute to health care emissions reduction.

This positive outcome would require the adoption of enhanced NDCs with significantly more ambitious mitigation commitments in every five-year updating cycle, as well as their full implementation by all parties to the Paris Agreement. It would also require non-state actors—business, local government, civil society, and the health sector—to drive this deep transformation of society's energy systems.

Indeed, health care cannot just sit by and ride these trajectories to decarbonization. Rather, to achieve them, as a societal leader and a large part of the global economy, it must play a central role in accelerating and implementing both RTS and B2DS by decarbonizing the energy embodied in its products and expended in its own operations and supply chains. To decarbonize, the health care sector must also advocate for broader societal shifts—policy change and technological transformation—both from its position within the government and from its position outside, by collaborating with other sectors to pressure for this change.

A 1.5 degree, zero emissions health care scenario

Given the projected global growth of health care, even if the world were to achieve the deep decarbonization envisioned in the B2DS scenario, health care's climate footprint would still be significant. In fact, under a B2DS scenario, while they would cease to grow, health care's climate emissions will be nearly the same in 2050 as they were in 2014. Unless the sector takes measures to reduce its own footprint across its operations and supply chain, health care's annual emissions would still be nearly 1.9 gigatons of CO_2e in 2050, the equivalent of emissions from about 500 coal fired power plants. Without additional action then, health care will remain a major climate polluter, perhaps making up a larger portion of overall global emissions.

Taking on its climate emissions (which can be seen in the difference between the orange and yellow lines and the gray line leading to zero emissions in Figure 12, will require the health care sector to take a series of actions to reduce emissions from its operations and its supply chain, while transforming how health and health care are delivered to prevent disease and reinvent care.

Health care is faced with a threefold task. To establish a trajectory to zero emissions will require simultaneous action to decarbonize delivery, facilities, and operations, to decarbonize its global supply chain, and to help lead the acceleration of a broader societal and economic transformation. How the sector can simultaneously walk these three pathways to decarbonization is the subject of Chapter 6 of this Road Map: "Charting a course toward zero emissions health care."

Achieving decarbonization in an unequal world: Four country-type trajectories for zero emissions health care

To hold climate change to 1.5 degrees and achieve the ambition of the Paris Agreement, the nations of the world have agreed that all countries must take action. It follows that all health systems in every country must be part of this effort by decarbonizing their systems and simultaneously striving to meet global health goals—two mutually reinforcing objectives.

This part of the Road Map establishes four different decarbonization trajectories for the health care sector and assigns each country to one of them, taking into account countries' common but differentiated responsibility for greenhouse gas emissions based on their levels of economic development, their gross domestic product, and health sector development pathways.

These trajectories differ based on profoundly disparate development levels between countries. Yet to achieve global health sector decarbonization, all countries, albeit on different trajectories, need to take action now to set a course toward zero emissions by 2050. All health care systems, public and private alike, must take thorough and ongoing action. All suppliers and manufacturers need to decarbonize. Health care professionals and their organizations, academics, and international agencies all need to play a role in making climate action a central pillar of the local, national, and global health agendas.

A global health care sector emissions budget

This Road Map establishes a global health care emissions budget. It quantifies the total amount of all health care institutions in the world that can collectively emit between 2014 (the baseline year of Green Paper One) and 2050 to decarbonize along a 1.5 degree pathway. The budget would allow the sector to meet the ambitions of the Paris Agreement yellow line in Figure 12, limiting its emissions to 50.3 gigatons of CO_2e over this 36-year period.

Another way to look at it is that the global average emissions from health care in 2014 was 0.27 tons CO_2e per capita (2 gigatons absolute annual emissions). To achieve alignment with the Paris ambition of 1.5 degrees, health care needs to stay within this 36-year budget totaling 50.3 gigatons of CO_2e (Table 2), while it reduces global per capita emissions to 0.05 tons CO_2e per year by 2050 (in Figure 12).

	1.5 degree Celsius scenario
Remaining cumulative emissions budget for the health sector from 2015 to 2050 ($GtCO_2e$)	50.3

Table 2. The global health care sector emissions

Common but differentiated responsibilities and respective capabilities

The climate crisis is evolving in a profoundly unequal world. In addition to the health and other impacts of climate change being much more severe in low-income countries and communities, a handful of wealthy countries' health systems emit substantially more greenhouse gases than everyone else, particularly on a per capita basis, and therefore bear an outsized responsibility for the problem. At the same time, many low- and middle-income countries need to extensively develop their health systems—including providing electricity to off-grid health centers—to meet the demand for basic health services.

Complicating matters further, many countries have internal health disparities that reflect inequality within a society. Many countries are simultaneously home to both highly developed hospitals and health facilities that are major resource consumers and extremely under-resourced health systems that struggle to provide basic services. Charting a course toward zero emissions can and must be designed to address these inequalities between and within nations.

Per capita emissions is an important metric for understanding the differences and for forging solutions to climate change on the basis of equity (Table 3 provides an analysis of per capita emissions of the 68 countries for which this Road Map has data).

Top emitters: (over 1t per capita)	**Major emitters: (between the 0.50t and 1t per capita)**	**Higher than average emitters: (between global average 0.28t and 0.50t per capita)**	**Lower than average emitters**	**Unknown**
Australia Canada Switzerland United States	Austria Belgium Denmark Estonia Finland Germany Ireland Japan Korea Luxembourg Netherlands Norway Russia Taiwan United Kingdom	Bulgaria Cyprus Czech Republic France Greece Italy Malta Poland Portugal Slovenia Spain Sweden European Union	Brazil China Croatia Hungary India Indonesia Latvia Lithuania Mexico Romania Slovak Republic Turkey	Rest of World
Additional nations				
Singapore	Iran Israel New Zealand Uruguay	Argentina Chile Kazakhstan Kuwait Mauritius North Macedonia South Africa	Colombia Ecuador Georgia Kenya Kyrgyzstan Malaysia Paraguay Peru Philippines Thailand Ukraine Uzbekistan Vietnam	

Table 3. Health care emissions per capita by country.

For instance, Green Paper One found that India, which has the seventh largest absolute health sector climate footprint in the world (39 Mt CO_2e), has the lowest health-related emissions per capita (0.03 metric tons) of all 43 nations in that WIOD study (lower than the .07 target). Meanwhile, the United States health sector, the world's number one emitter in both absolute and per capita terms (546Mt absolute; 1.72 metric tons per capita), produces 57 times more emissions per person than India does. Other top health sector emitters, like Australia, Canada, and Switzerland emit between 30 and 50 times more per capita than India does.

China, number two in terms of absolute health sector emissions, has per capita emissions (0.25t) that fall just below the world average (0.28t). This rate of emissions means that China's health sector produces six times more greenhouse gases per person than India's does. At the same time, China's health system emits one-seventh the greenhouse gases per capita as does the United States, one-third that of Korea, and just under one-half per capita than does the European Union.[38]

The outsized impact of the large health care emitters is a reflection of both how those health care systems are structured—the resource intensive processes and technologies used to deliver care—and also the huge global inequities in health spending.

Those countries with the lowest health care climate footprint spent less on health, and those with the biggest footprint spent considerably more. For instance, on average, low-income countries spent $120 per capita on health in 2014; lower-middle- and upper-middle-income countries spent $267 and $914 per capita, respectively, and high-income countries spent $5,221 per capita. The Institute for Health Metrics and Evaluation forecasts that that future per capita spending is projected to grow most in the high- and middle-income countries.[39] Figure 13 shows the disparities in health spending between nations.

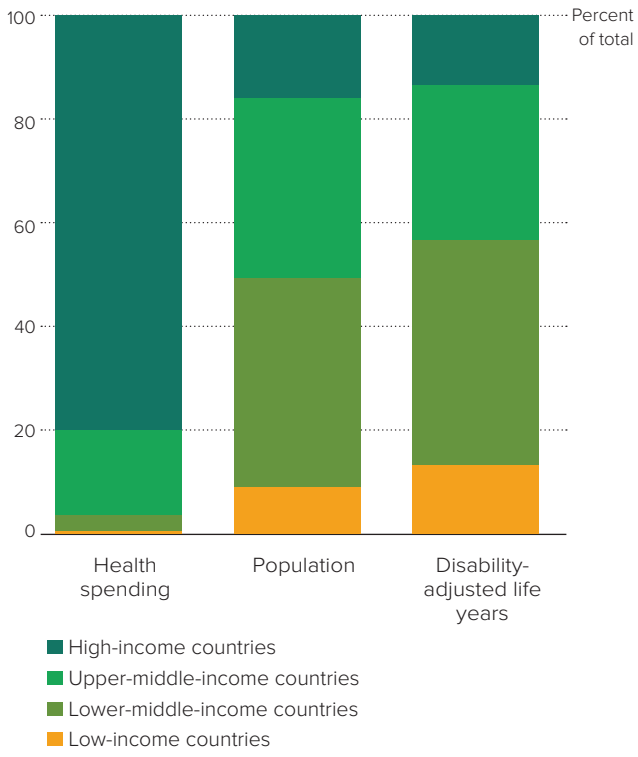


Figure 13. Health spending, population, and disability adjusted life years[v] by World Bank income group, 2017.[40]

Source: Financial Global Health Database 2019 and GBD 2017 study.

v A disability adjusted life year represents the loss of the equivalent of one year of full health and is considered more representative of the burden of disease than mortality rates.

The challenge is to achieve global decarbonization while at the same time meeting global health needs in the context of highly skewed global spending and very different health needs and outcomes in various parts of the world. In this context, emissions may need to continue to grow in some low- and middle-income countries in the coming years, while they simultaneously steeply decline in wealthier nations. At the same time, as all countries chart a course toward zero emissions, health spending needs to be decoupled from greenhouse gas emissions.

The vast inequality in responsibility for emissions, and at the same time, the collective responsibility of all to take climate action, is addressed in the United Nations Framework Convention on Climate Change and the Paris Agreement under the principle of "common but differentiated responsibilities and respective capabilities in light of different national circumstances."[41] What this means in practice is that the biggest per capita polluters must decarbonize the most, and the most quickly. Lower emitters must also take action, but along a different time frame that allows for Sustainable Development Goals, including Goal 3—good health and well-being—to be met. This Road Map outlines four trajectories for the health care sector to decarbonize based on this principle of common but differentiated responsibilities and respective capabilities.

Contraction and Convergence

The Road Map's four trajectories are based on and calculated using a "contraction and convergence" model.[42] This model takes the global health care emissions budget and divides it up between the four groups of countries shown in Table 4 based on national GDP. It establishes emissions reduction trajectories for each group (contraction), and ultimately converges at a common level of emissions per capita for all health sectors that is compatible with a 1.5 degree scenario. Table 4 lists the countries assigned to each trajectory.

Trajectory	Description	Peak year	Trend up to peak year	Rate of emission decrease
Steep decline	Nations are required to immediately begin a steep decrease in emissions per capita.	-	-	Steep
Steady decline	Nations are required to immediately follow a steadier decline in emissions per capita than the steep decliners.	-	-	Steady
Early peak	Nations are allowed to increase emissions up to a peak year of 2022, before steadily declining.	2022	Linear	Steady, as per steady decline
Late peak	Nations are allowed to increase emissions up to peak year of 2026, before steadily declining.	2026	Linear	Steady, as per steady decline

Table 4. Description and main characteristics of the four trajectories.

The trajectory types used in this Road Map are based on those used by C40 Cities in collaboration with Arup to define city trajectories and action as part of a cities route map produced in 2019 with the objective of achieving the goals of the Paris Agreement.[43]

As Figure 14 and Figure 15 show, these Road Map trajectories require a steep or steady decline in emissions from the wealthiest and biggest polluting health care sectors, while allowing room for an increase in emissions that peak between now and the end of the present decade. This supports greater equity, health sector growth, and development in health care sectors from low- and middle-income countries. The allocation of these across countries is summarized in Table 5.

It is important to underscore that while steep decline and late peak are very different trajectories, even the late peak countries will need to begin to decline by 2026 or shortly thereafter. Achieving any one of these trajectories will require immediate action by all health systems to begin to change course toward zero emissions. Part of this change can be for health systems to invest in climate preparedness or resilience to withstand the growing climate crisis and other emergencies, like pandemics. By building greater health care climate resilience, countries can often implement low-carbon strategies, like powering health in off-grid and grid-unstable settings, therefore steering in the direction of a zero emissions pathway. (see box: “health care climate resilience,” and Figure 1).

For wealthy countries assigned to the steep decline curve in Figure 14 and Figure 15, like the United States, Australia, and Germany, emissions per capita are modelled to reduce from an average of 1.1 tCO_2e per capita per year to zero emissions by the late 2040s. This steep decline curve aligns with the recently published NHS Net Zero plan of reaching zero emissions between 2045 and 2047.

At the same time, for low- and middle-income countries, like India and Indonesia, which are allocated to the late peak in Figure 14 and Figure 15, emissions per capita will grow from an average of 0.11 tCO_2e per capita per year in 2014 to a peak of 0.13 tCO_2e per capita per year in 2026, before reducing to 0.1 tCO_2e

per capita per year by 2050. Even with this budgeted emissions growth, it will be necessary for early and late peak countries to decouple their anticipated growth in health care spending and development from its current carbon intensity in order to set their trajectory to reach zero emissions.

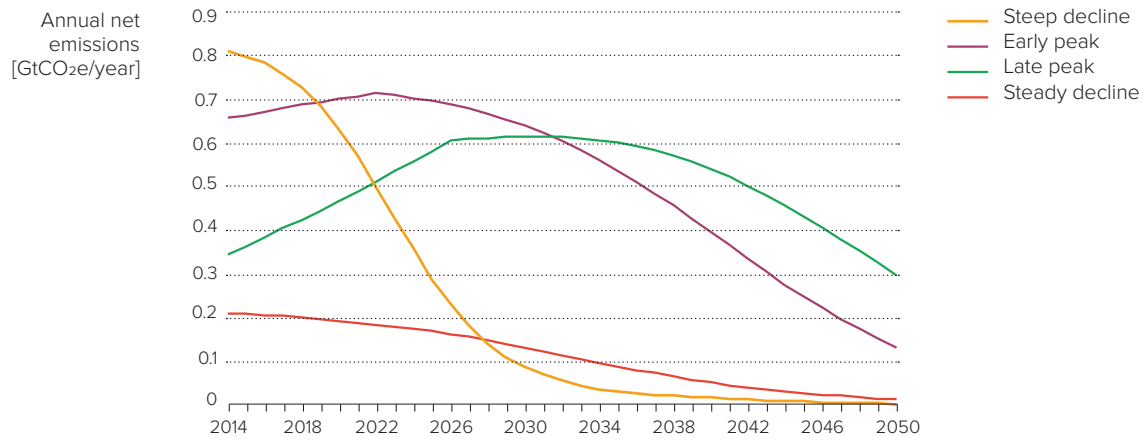


Figure 14. Four Decarbonization Trajectories - absolute emissions.

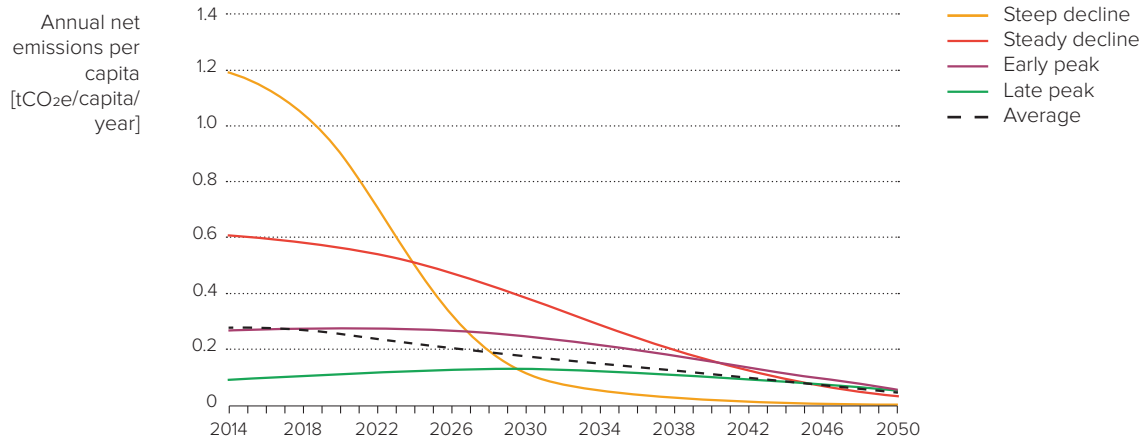
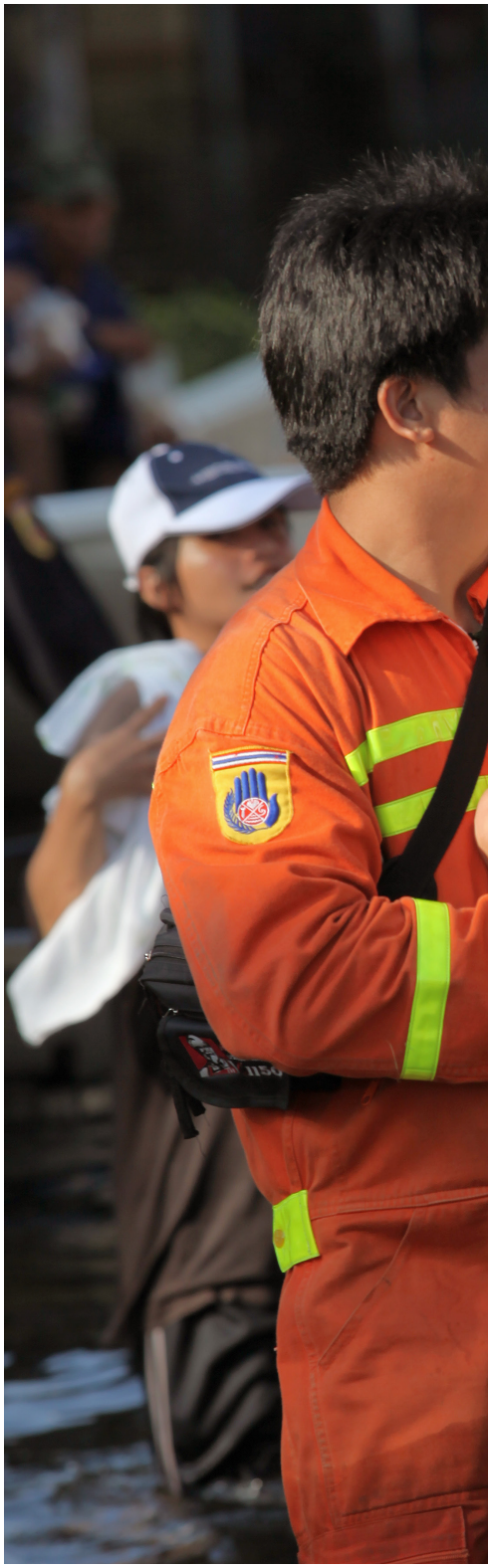


Figure 15. Four Decarbonization Trajectories – annual per capita emissions.

Steep decrease	Steady decrease	Early peak	Late peak
Australia	Cyprus	Brazil	India
Austria	Czech Republic	Bulgaria	Indonesia
Belgium	Estonia	China	*Georgia*
Canada	Greece	Croatia	*Kenya*
Denmark	Korea	Hungary	*Kyrgyzstan*
Finland	Latvia	Mexico	*Philippines*
France	Lithuania	Poland	*Ukraine*
Germany	Malta	Romania	*Uzbekistan*
Ireland	Portugal	Russia	*Vietnam*
Italy	Slovak Republic	Turkey	*Rest-of-World*
Japan	Slovenia	*Argentina*	
Luxembourg	Spain	*Chile*	
Netherlands	Taiwan	*Colombia*	
Norway	*Israel*	*Ecuador*	
Sweden		*Iran*	
Switzerland		*Kazakhstan*	
United Kingdom		*Malaysia*	
United States		*Mauritius*	
Kuwait		*North Macedonia*	
New Zealand		*Paraguay*	
Singapore		*Peru*	
		South Africa	
		Thailand	
		Uruguay	

Table 5. Allocation of nations to the four contraction and convergence trajectories. Nations included from the Lenzen et al. study are shown in italics.



DEFINING TERMS: 1.5 C DEGREES, ZERO EMISSIONS, NET ZERO, AND CARBON NEUTRALITY

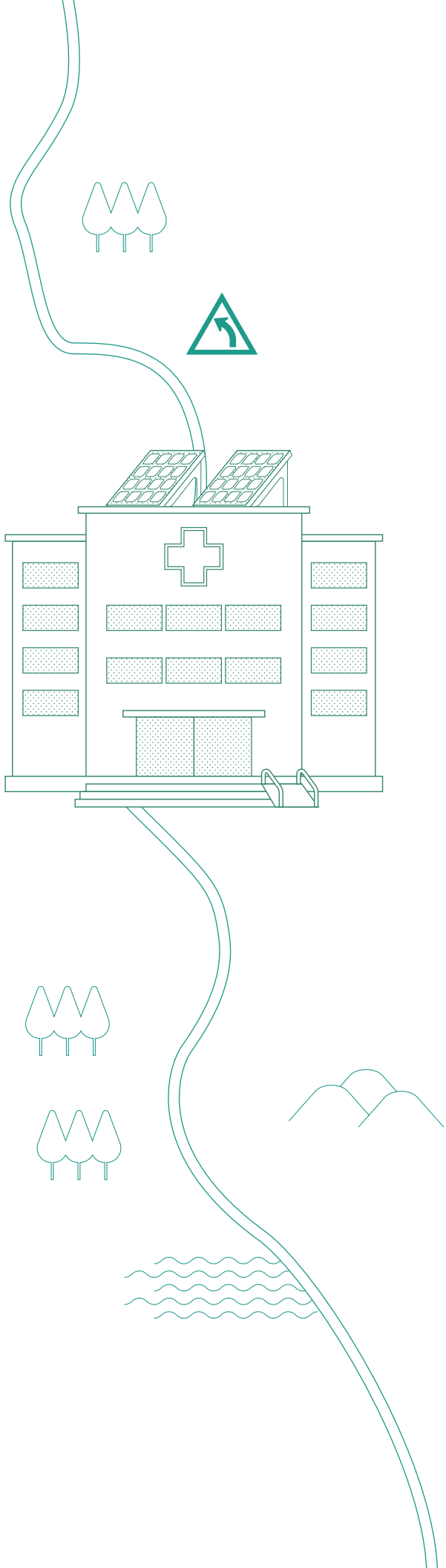
1.5 Degrees: This roadmap charts a course to zero emissions utilizing the IPCC global projections for a world compatible with 1.5 degrees Celsius. It suggests that global emissions must get close to zero by 2050. The modeling for this report establishes an overall global health sector emissions budget and presents a decarbonization trajectory for 2050. This trajectory corresponds to the total emissions reduction required for the sector to do its fair share in contributing to the possibility of limiting global temperature increase to 1.5C or below.

Ensuring rapid decarbonization between now and 2030 needs to be health care's immediate focus of attention to contribute to the 1.5C target. The efforts we make today, and over the next 10 years, will determine where the health sector arrives in the ensuing decades. Depending on the level of action now, the size of future health care emissions could vary considerably. Minimizing emissions as rapidly as possible now will reduce the risk of dangerous climate change and lessen the need for more drastic action in the future.

Zero emissions means just that. It is the point where an entity does not produce any CO_2 equivalent emissions and is totally emissions free, without any compensation mechanisms (e.g., offsets). It should be the ultimate goal of decarbonization. Most sectors are only likely to achieve this over time with significant investment, innovation and technological research.

Net zero and **carbon neutrality** are terms used to mark the point where an entity has achieved a balance between their emission reduction efforts and the compensation of remaining or residual emissions by engaging in emission removal activities (e.g., reforestation efforts or carbon capture) and/or purchasing an equivalent amount of offsets. Many offset schemes are highly questionable in their efficacy to achieve absolute emissions reduction, while also raising a series of ethical questions. Still, the term net zero is often preferred to carbon neutrality because it is more stringent and covers a wider scope of GHG emissions. It points to a faster pace of decarbonization across all scopes and then only considers compensation mechanisms for emissions that are particularly difficult to mitigate despite all the targeted interventions, investment, and focus.

Residual emissions in health care are expected to decrease over time as other sectors innovate and decarbonize, making alternative technologies and supplies widely available and the health care sector itself uses its political clout and purchasing power to move markets and promote innovation. The modeling for this report estimates that without additional transformation, annual health care emissions will still stand at 1.1 gigatons in 2050. This health care emissions gap will need to be minimized over the next three decades by deepening health care climate action through transformative innovation and/or with equitable and effective compensation mechanisms (see Uncharted Territory in Section 6.3).



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]

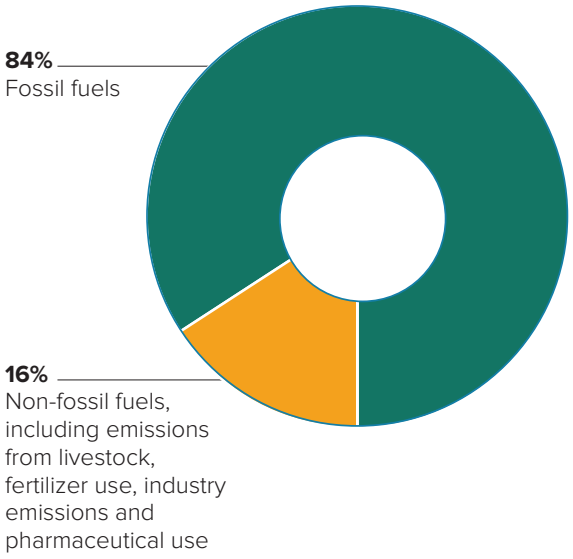


Figure 16. Proportion of health care's footprint attributable to fossil fuels in 2014

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.

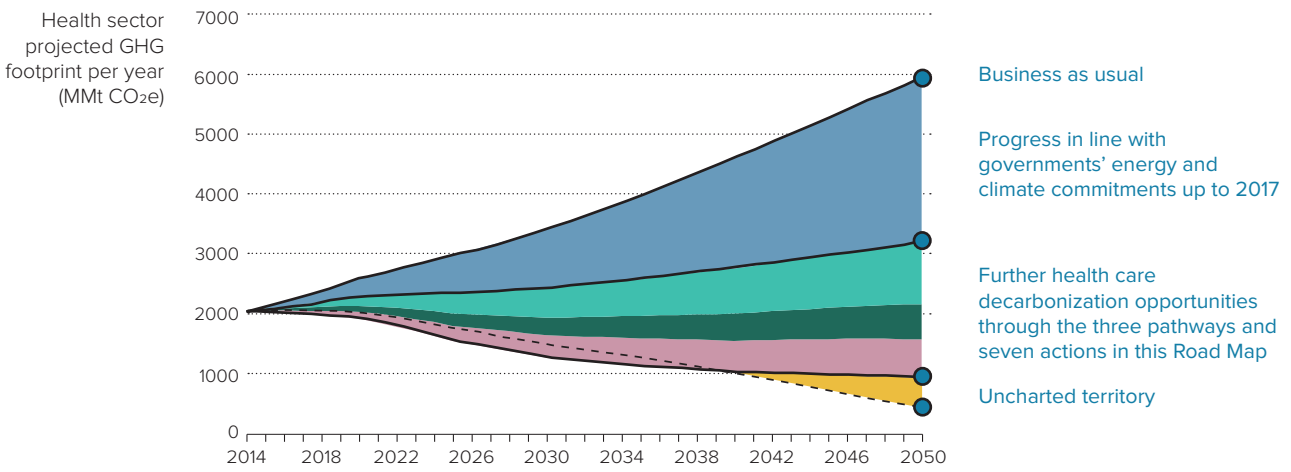


Figure 17. Top wedge (blue) is the projected impact of NDC commitments current in 2017 on the global health sector footprint between 2014 and 2050. Achieving NDCs will give a cumulative 45.4 Gt CO_2e reduction in emissions compared to the business-as-usual scenario. The remaining emissions across this 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[48]. 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.

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: 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.

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

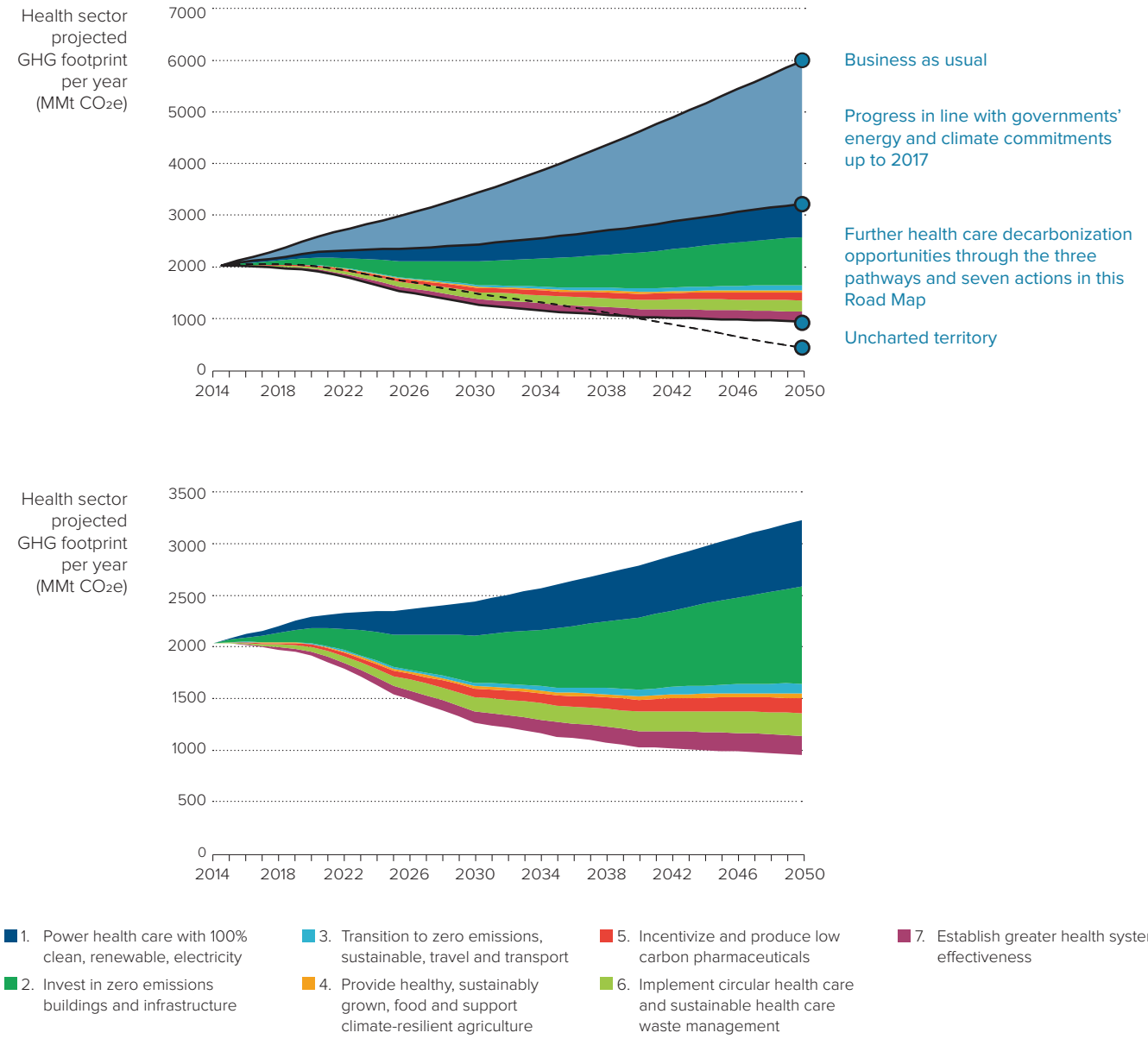
Getting to zero emissions will require a number of high-impact crosscutting actions in key areas that span the three pathways.

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 I 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 I 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 a UN Special Rapporteur[91] as a violation of human rights in many countries. 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.

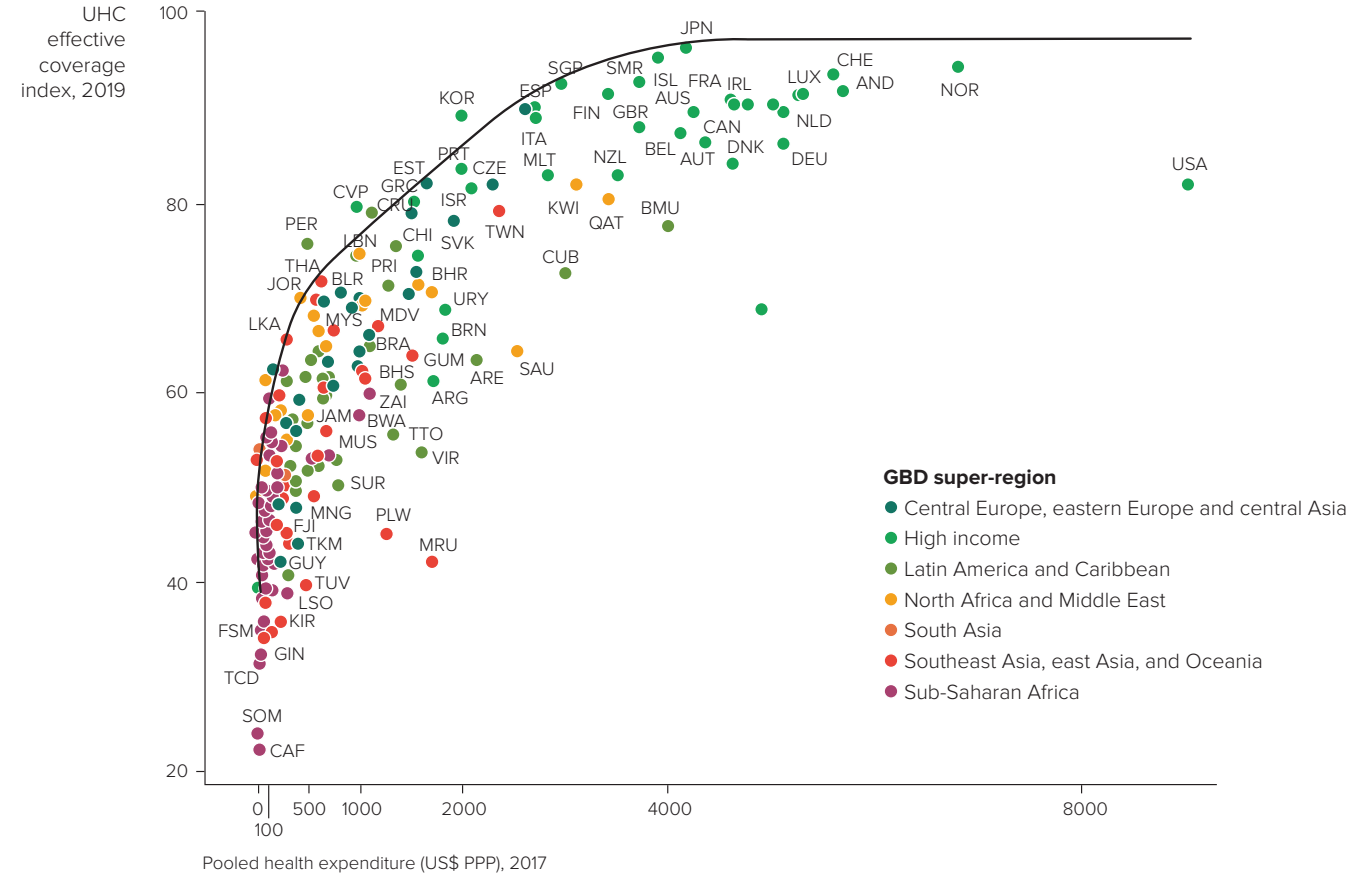


Figure 19. UHC effective coverage index frontier relative to pooled health spending per capita.

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.

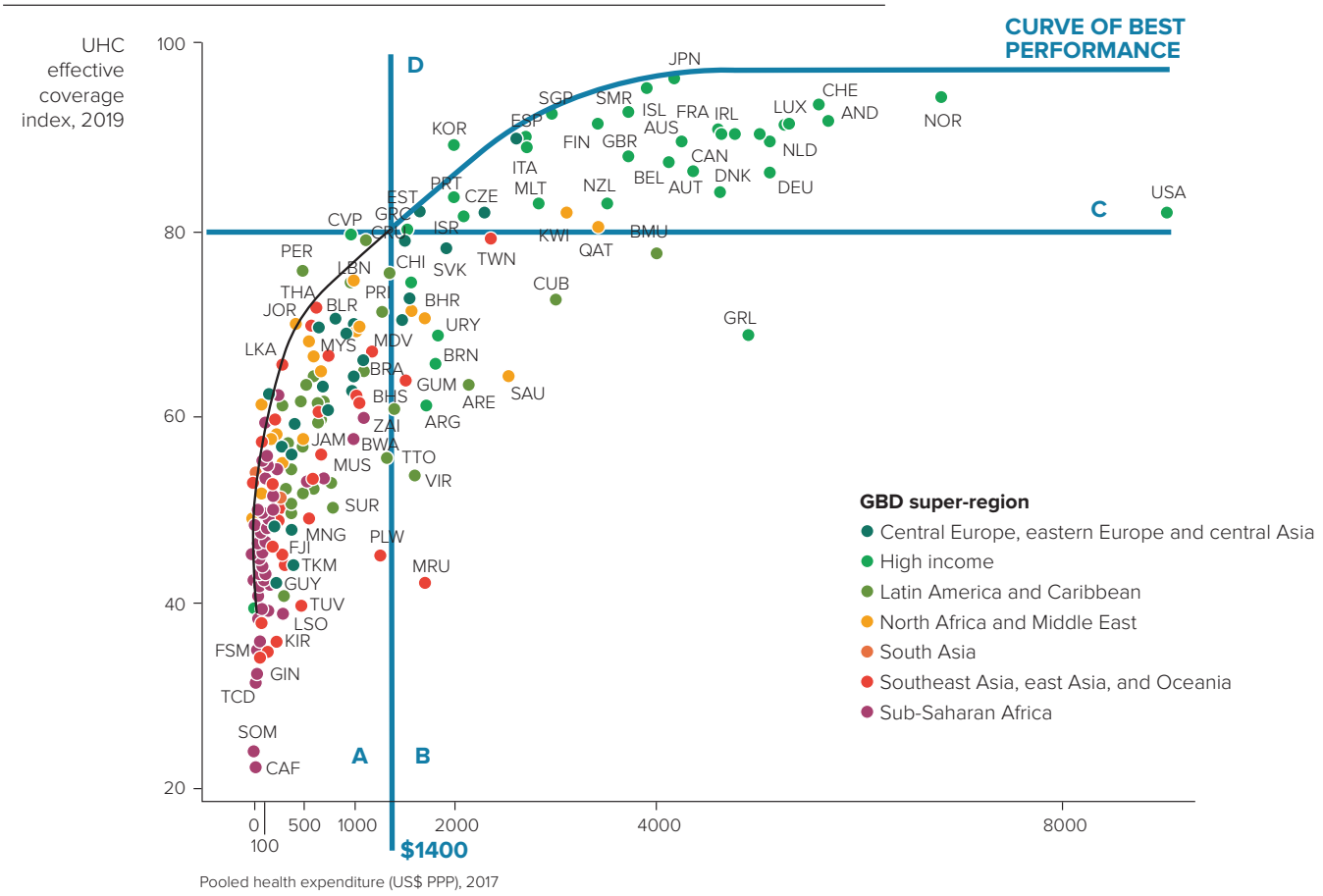


Figure 20. Allocating countries to one of four groups based on a chosen position of UHC coverage of 80, with a health expenditure of $1400 per person per year.

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.

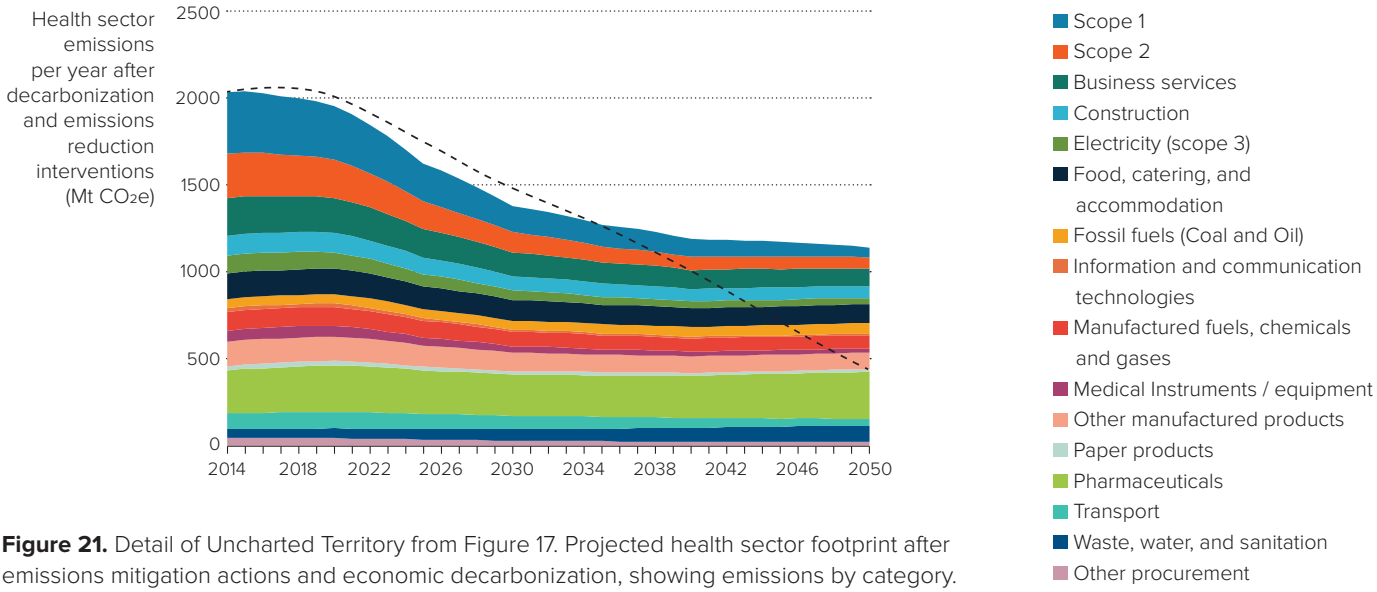


Figure 21. Detail of Uncharted Territory from Figure 17. Projected health sector footprint after emissions mitigation actions and economic decarbonization, showing emissions by category.

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**

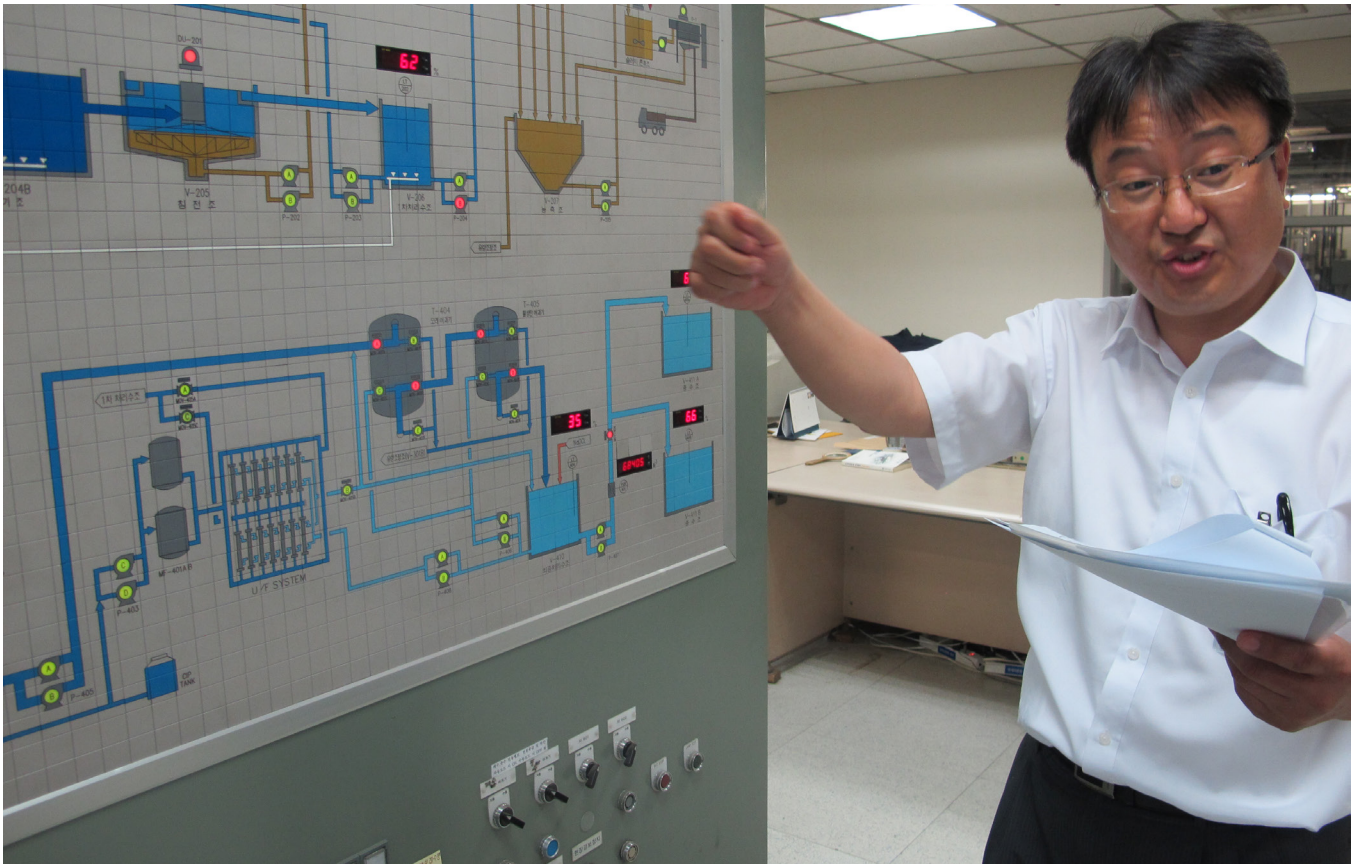
Table 6. Potential climate benefits in terms of health care emissions reductions of four major health interventions

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.

6

Driving change

High-level policy recommendations

"Governments, international agencies, and civil society all must act to put health care on the track to zero emissions, build resilience, and protect people's health from climate change."

Dr. Esperanza Cabral, former Secretary of Health, the Philippines

Government action

Health care has an opportunity to be a climate leader, and by doing so, achieve not only a healthier planet and a healthier society, but also better health outcomes. By embracing this Road Map—the four country type trajectories, the three pathways, and the seven priority action areas discussed in the previous chapters—the sector can begin to chart a course to zero emissions that is just and equitable. This, in turn, could provide leadership to help drive and accelerate the broader societal transformation necessary to protect public health from climate change.

To get there, the entire sector must mobilize and transform itself, while working in collaboration with other sectors of society to navigate into the future. The following are a series of high-level recommendations.

Health care has an opportunity to be a climate leader. By doing so it can foster both planetary health together with better health outcomes.

National and sub-national health authorities control numerous policies and financial levers that are essential for health care decarbonization. High-level actions that they can take include:

PUT CLIMATE INTO HEALTH CARE POLICY

Declare climate change a health emergency: All governments can start by issuing a declaration that the climate crisis is a health emergency and requires concerted national and global action. The declaration can commit health authorities to taking action to prepare health systems for the impacts of climate change and prevent greenhouse gas emissions by addressing their own climate footprint.

Zero emissions commitments: Ministries of health and national health systems can make similar public commitments to the one made by the United Kingdom's NHS, which signaled its intent to reach net zero by 2045 and has released an initial action plan to do so.[115] Health ministries and government health services, as well the hospitals and health systems under their jurisdiction, can also participate in a global, health sector-wide initiative to take climate action: the Health Care Climate Challenge, which supports hospitals and health systems in a growing list of more than 34 countries to prevent climate emissions, build resilience, and take leadership action.[116] Those hospitals, health systems, and government health services ready to commit to net zero can join a collaboration between the Challenge and the UNFCCC, which is a health care component of the Race to Zero Campaign—the largest ever global coalition of net zero initiatives—by making a commitment to 50% emissions reduction by 2030 and zero emissions before 2050.[117]

National road maps and measurement tools: In order to establish and implement a systematic decarbonization policy, governments at all levels need to develop their own road maps. These road maps

should include establishing the ability to measure, track, and report on the sector's full footprint at the national level using granular national data. The road maps should also include an action plan for implementing decarbonization strategies across the three pathways and seven action areas described in the previous chapter and the capacity to track progress over time using a standardized approach.[118] National and subnational health systems should provide individual facilities and groups of hospitals a similar capacity so that they may take action for decarbonization from the bottom up.[119]

Legislative and regulatory action: A series of laws, rules, and regulations specifically govern health sector activity in every country. These regimes usually do not take climate into account and often can be revised to reduce emissions while protecting health and maintaining the quality of care. A thorough climate review of health care legislation and regulations at the national and subnational levels, together with a set of specifically tailored policy recommendations, can help accelerate decarbonization and resilience. Governments should also estimate the overall financial benefits and/or costs of implementing such policies and set up the appropriate financing mechanisms to cover them. These can include earmarked budgetary resources and a pipeline of bankable projects that in some cases can be financed through bilateral and multilateral cooperation.

PUT HEALTH CARE INTO CLIMATE POLICY

Nationally determined contributions: Under the Paris Agreement, every nation must make a NDC—a voluntary commitment to emissions reduction—and strengthen that commitment over time. In the lead up to the global climate negotiations in Glasgow in late 2021, Argentina, which established health as a crosscutting issue its NDC submission to the UNFCCC, also became the first nation to include health care decarbonization in an NDC. The Argentine NDC calls for an assessment of greenhouse gas emissions from the health care sector and the establishment of measures to reduce those emissions.[120] Other governments can build on Argentina's initial efforts and make pledges to implement climate-smart health care as part of their global climate commitments.[121]

National and subnational climate policy: The implementation of government climate policy, of both the legislative and regulatory variety, is usually embedded in and executed by a series of different entities, including environment, energy, finance, agriculture, and foreign ministries. Many of these policies affect or have the potential to impact health and the provision of health care. Conversely, the health sector has the potential to affect these policies. Following the approach of health in all policies, the health care sector should work closely with all relevant sectors to assure that governments develop strong cross-sectoral climate policies that protect public health from climate change while supporting health care decarbonization and resilience.

United Nations and other international organizations

A wide array of United Nations agencies, international financial institutions, and bilateral cooperation agencies or large foundations that provide health development assistance all need to play an important role in aligning and simultaneously achieving global health and global climate goals.

The United Nations Framework Convention on Climate Change (UNFCCC): Under the leadership of its high-level climate action champions, the UNFCCC has developed a set of climate action pathways that outline the sectoral visions for a 1.5-degree climate-resilient world by 2050 and set out actions needed to achieve that future. These pathways provide an overview of the transformational actions and milestones needed for system transformations within sectors.[122] Through the work of the high-level champions, the UNFCCC can adopt this Road Map, or a modified version of it, as a health care climate action pathway that encourages the sector to move toward zero emissions in the context of the Paris Agreement. The UNFCCC secretariat can also encourage national governments to include health care decarbonization in their NDCs.

United Nations agencies: The World Health Organization (WHO), the UN Development Program (UNDP), the UN Environment Program, and other UN agencies have a crucial leadership role to play in advocating and accelerating the decarbonization of the health care sector. WHO can provide essential policy and technical guidance to ministries of health around the world, particularly in low- and middle-income countries, where the transition to zero emissions and resilience must be accompanied by simultaneously addressing other pressing health needs, including UHC.[123] UNDP is playing a leading role in implementing climate-smart health care on the ground, through its Solar for Health initiative,[124] and through its leadership in addressing the climate footprint of the global health care supply chain in collaboration with other UN agencies[125] and Health Care Without Harm.[126] Both of these initiatives can be scaled up to support climate-smart health care.

International financial institutions and bilateral cooperation agencies: Institutions like the World Bank, regional development banks, bilateral aid agencies, and large foundations that provide significant support for health development in low- and middle-income countries will also need to play a central role in shaping health care policy, investment, and overall health development strategies. These strategies will need to align countries' commitments to the Paris Agreement with the imperative of developing the health sector, achieving UHC, and attaining the Sustainable Development Goals. To do so, these multilateral development banks and aid agencies must integrate climate-smart principles and strategies into their health aid, lending, and policy guidance.[127] Those branches of these institutions funding climate mitigation and adaptation, as well as climate-focused financial mechanisms like the Green Climate Fund and the Global Environment Facility, should similarly integrate health care decarbonization and resilience into their programs.[128]

The private sector

The private sector presence in health care manifests a multitude of forms. Be it nonprofit, religious, and for-profit corporations owning and running health facilities and systems, or companies that produce most all the goods in the global health care supply chain, the private sector is omnipresent even in publicly run health care systems. It has a central role and responsibility to play in aligning health and climate imperatives.

Government regulation can and must play a central role in establishing a framework for private sector transition to decarbonization. This includes oversight of private health care systems and facilities, as well as that of manufacturers and suppliers of everything health care consumes. Health systems—both public and private—can also aggregate their demand for products and thereby influence manufacturers and suppliers to change their production and distribution practices. At the same time, privately owned health facilities and the health care industry more broadly must respond to the climate crisis, take responsibility, demonstrate leadership, and move toward zero emissions.

Private and nonprofit health care systems and facilities: Hospitals and health systems run by nonprofit corporations, religious organizations, and for-profit companies all should set ambitious targets for decarbonization, taking action along the three pathways and seven action areas discussed in the previous chapter. They should also pair their decarbonization efforts with resilience initiatives that bolster infrastructure, engage with multisectoral systems, and support equitable community health and wealth. They should collaborate with and support public health authorities and systems, as well as civil society to build a sector-wide approach.

Similar to government-run hospitals, they can participate in a global health care movement to take climate action through the Health Care Climate Challenge, which supports hospitals and health systems in a growing list of more than 34 countries working to prevent climate emissions, build resilience, and take leadership action.[129] Those hospitals and health systems ready to commit to net zero can join a collaboration between the Challenge and the UNFCCC which is a health care component of the Race to Zero Campaign discussed above.

Manufacturers and suppliers: As discussed in the previous chapter, there are a series of actions that suppliers and manufacturers can and should take to decarbonize their manufacturing, packaging, and transport of products used in health care. Health care systems' demand can incentivize this, while agile companies can anticipate and help propel the transformation that is now underway. These companies can also, if they so choose, exert leadership. They can join the effort to advocate for the decarbonization of the broader society and economy, particularly the electrical grid, on which most of their factories depend. They can produce products that are highly energy efficient and/or zero or low emissions when they are deployed in a health care setting, which contributes to the reduction of health care facilities' climate footprint and reduces energy costs. Finally, they can innovate and design their products for a circular economy that minimizes waste and fosters reusability.

Health insurance and health finance: Health insurance payers (private or public) and financial investment companies are important influencers in the sector and can leverage their clout to support climate-smart health care. Actions payers can include setting reimbursement schedules to favor cost-effective, low-emissions interventions that produce equal or better health outcomes over more carbon intensive actions. Health care finance can set climate-smart criteria for health care construction, infrastructure, and purchasing capital goods. Public and private health systems and health companies can also divest their investment portfolios currently sunk into fossil fuels and instead invest in clean, healthy, renewable energy.

Civil society

Civil society in the health sector is as vast as it is diverse. It ranges from the tens of millions of doctors, nurses, public health professionals, and other health care workers to their professional associations, a broad network of health researchers and academia, and local, national, and global health advocacy organizations.

This panoply of health actors is a critical element to mobilize the health care itself to decarbonize and become resilient while achieving climate justice and health equity. Many health professionals work in the health facilities themselves and are important voices advocating for change. Others work at organizations that can influence hospitals and health professionals at national or even global levels. Health care professionals can deploy a time-honored health sector science-based approach to research and document problems and solutions. Additionally, they can organize for change by building off decades of experience taking on the scourges of HIV-AIDS, big tobacco, and now COVID-19.

At the same time, civil society in the health sector must play a central role in accelerating decarbonization in the broader economy and society. The health voice—the voice of doctors and nurses—is the most trusted voice in most cultures. That trust has only grown during the COVID-19 pandemic.

As we begin to move beyond COVID-19, health professionals in every country must now turn their attention and help lead the sector in warning their societies about the next looming crisis—one that is already upon us and which will increasingly take on emergency proportions. They must call for a rapid transition from fossil fuels and industrialized agriculture to clean renewable energy and sustainability. They must do so to protect public health from the climate crisis and help lead the health care sector itself to chart a course to zero emissions and drive change that will achieve health equity and climate justice.

A final word

Transformational change often does not occur in a linear fashion. Rather, it happens rapidly and with little warning. We are living under the looming shadow of such radical change in the form of an accelerating climate emergency. At the same time, we can draw hope from a world that is becoming more aware of this existential threat and rapidly accelerating its response, setting the stage for transformational change in the direction of decarbonization. It is a race against time and a race against ourselves. We must urgently forge this burgeoning drive for change into an all-inclusive worldwide movement for healthy people on a healthy planet. The health sector must help lead the way.

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