Climate-Smart Healthcare

Low-Carbon and Resilience Strategies for the Health Sector

INVESTING IN CLIMATE CHANGE AND HEALTH SERIES

WORLD BANK GROUP

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This document is part of the "Investing in climate change and health" series, which aims to enable management and task teams with the tools and resources necessary to improve development action on climate change and health. Current documents in this series include:

- "World Bank approach and action plan for climate change and health" (2017)
- "Geographic hotspots for World Bank action on climate change and health" (2017)
- "Climate smart healthcare: low carbon and resilience strategies for the health sector" (2017)

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How to use this document

This report was designed to be a flexible tool, to be read through or in parts. Certain sections (e.g., those in the first section) may be more relevant to the preparation of background sections or policy documents, given their emphasis on climate change and health links. Other sections provide approaches and tools that can be directly extracted and built into projects and programs. These are primarily located in chapters two and three. More than 20 case studies* appear throughout to illustrate the practical value in connecting climate change and health.

Intended audience

This document is primarily directed to development staff working on health sector and health system projects and programs. However, much of the content may be useful to staff working on related issues in environment and natural resources, water, energy, transport, urban, or others. As a cross-cutting discipline, climate change and health issues are germane to projects in many disciplines. Though some of the language in this document is topical to WBG policies and procedures (e.g., "task team leaders," "global practices"), the document has value beyond this institution as other development banks, bilateral aid agencies, and communities are tackling common issues. Tools and approaches here can be applied in many of these contexts.

Policy makers and managers likely will find this document useful as it provides strong context for climate change impacts and opportunities within the health sector that may inform higher-level dialogue and decision making. Operational teams should find value in the specific tools and approaches here that can be integrated within development lending programs. The many examples should also provide useful context for all readers. More succinct operational guidance will be produced after publication of this document to provide tools useful for those involved in direct lending. This more robust document was produced as a necessary first step to contextualize this climate change and health work and consolidate background, mitigation, and adaptation resources in a single resource.

*Case studies

Case studies have been categorized and color-coded by region.

Africa	Middle East and North Africa
East Asia and Pacific	South Asia
Latin America and Caribbean	Global/Other

Contents

Foreword

Climate change is a risk multiplier that threatens to unravel decades of development gains. Among the most critical and direct risks to humans is the impact of climate change on health. Heat stress will worsen as high temperatures become more common and water scarcity increases; malnutrition, particularly in children, could become more prevalent in some parts of the world where droughts are expected to become more frequent; and water- and vector-borne diseases are likely to expand in range as conditions favor mosquitoes, flies, and water-borne pathogens. Worse still, these threats will be greatest in regions where the population is most dense, most vulnerable, and least equipped to adapt, pushing more people in poverty and reinforcing a cycle of environmental degradation, poor health and slow development.

Addressing these climate-associated health risks is critical. Alongside risk, there is opportunity. Responses to climate change have unearthed significant potential for improving both human health and the environment. Low carbon hospitals can draw upon the many advances made by the energy sector in developing cleaner and renewable resources. Pharmaceutical supply chains can benefit from more efficient and less polluting transport. And food and nutrition can be improved by the advances achieved through climate-smart agriculture.

Climate change challenges are multi-sectoral and so too are the solutions. At the World Bank Group, we are tackling different dimensions of these environment and health threats in different ways. For example, the 'Pollution Management and Environmental Health' Trust Fund addresses air pollution, toxic land pollution, and marine litter. Work on Climate-Smart Agriculture aims to sustainably increase food productivity and human well-being in a changing climate. We are putting in place a new operational framework for strengthening human, animal, and environmental health systems in response to disease threats. And within the health sector, we have made Universal Health Coverage core and increasingly considerate of climate change and resilience.

At the World Bank Group, we work with the broader development community to create solutions that can respond to and reduce these risks. Our work aligns with other global efforts aimed at improving environmental and human health, such as the work of the Climate and Clean Air Coalition, Global Alliance for Clean Cookstoves, One Health and Planetary Health communities, and broader efforts to achieve the Sustainable Development Goals.

In this report we identify climate and health challenges to establish a basis for health sector action and solutions. The health sector has a substantial role to play in both mitigating climate change through the adoption of low-carbon strategies, while also building resilience to climate impact in ways that plan for environmental change and expanded health threats. Taken together, these efforts comprise a "climate-smart" approach that will help health planners and decision-makers adjust to a new era of climate reality while improving health, environment, and development.

The work presented here is expected to assist the development community in further mainstreaming climate change and health into development operations so that we may address the emerging needs of vulnerable communities, particularly women and children. We are committed to working with development practitioners around the world on climate change and health, capitalizing upon associated opportunities and technologies, and contributing to the overall goals of ending extreme poverty and boosting shared prosperity.

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Acronyms

AIDS	Acquired Immune Deficiency syndrome
BEM	Building Energy Management
BREEAM	British Research Establishment Ltd—Environmental Assessment Method
CCSA	Cross-cutting solutions area
CFL	Compact Fluorescent Lightbulb
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
CPF	Country Partnership Framework
EDGE	Excellence in Design for Greater Efficiencies
GAVI	Global Alliance for Vaccines and Immunizations
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GP	Global Practice
HCWH	Health Care Without Harm
HFC	Hydrofluorocarbon
HIV	Human Immunodeficiency Virus
HNP	Health, Nutrition and Population (World Bank Global Practice)
HVAC	Heating, Ventilation, & Air Conditioning
IPCC	Intergovernmental Panel on Climate Change
kBTU/sf/yr	Kilo (x1000) British Thermal Unit per Square Foot per Year
LED	Light Emitting Diode
LEED	Leadership in Energy & Environmental Design
MAC	Marginal Abatement Curve
MATCCH	Mobilizing Action Toward Climate Change and Health
MDR-TB	Multi Drug Resistant Tuberculosis
NDGAIN	Notre Dame Global Adaptation Initiative
NHS	National Health Service (UK)
N_2O	Nitrous Oxide
PAHO	Pan American Health Organization
QALY	Quality Adjusted Life Year
SE4ALL	Sustainable Energy for All
SDG	Sustainable Development Goal
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
tCO_2	Tons of Carbon Dioxide
UNEP	United Nations Environment Program
UNFPA	United Nations Population Fund (previously UN Fund for Population Activities)
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Emergency Fund
UNITAID	Not an acronym, this is a global health initiative, hosted by WHO to tackle deficiencies in management of HIV/AIDS, Tuberculosis and Malaria
UNOPS	United Nations Office for Project Services
USAID	United States Agency for International Development
WHO	World Health Organization

Executive Summary

Climate Change Affects Health

Climate change is damaging human health now and is projected to have a greater impact in the future. Low- and middle-income countries are seeing the worst effects as they are most vulnerable to climate shifts and least able to adapt given weak health systems and poor infrastructure. The cumulative threats of climate change to health has been extensively discussed for decades and understanding is growing, but so too are the impacts.

Climate change could drag more than 100 million people back into extreme poverty by 2030 (World Bank, 2016), with much of this reversal attributable to negative impacts on health. There is clear and mounting evidence that health outcomes will predominantly be negatively affected by rising sea levels and temperatures, different patterns of precipitation, and more frequent extreme weather. Several of the emissions that drive climate change also affect health directly, resulting in respiratory and cardio-vascular disease.

An effective response to these new challenges will necessarily require engagement and coordination across many sectors. Chief among these is, of course, health. Hospitals, health centers and public health workers are first responders to the health effects of climate change. Health systems need to be resilient and remain operational to provide care during extreme weather events. They must also respond to the longer-term, climate-induced changes in disease patterns. While vastly differing in scale, each nation's health sector also releases greenhouse gases while delivering care and procuring products and technologies from a carbon-intensive supply chain.

An Opportunity for Low-Carbon Healthcare Solutions

Middle- and low-income countries increasing their investment in more robust health systems can seize the opportunity to support technology and management systems that are less expensive, more productive, and less carbon intensive. A low-carbon approach can provide effective, cheaper care while at the same time being 'climate smart'.

Low-carbon healthcare can advance institutional strategies toward low-carbon development and health-strengthening imperatives and inspire other development institutions and investors working in this space.

Low-carbon healthcare provides an approach for designing, building, operating, and investing in health systems and facilities that generate minimal amounts of greenhouse gases. It puts health systems on a climate-smart development path, aligning health development and delivery with global climate goals. This approach saves money by reducing energy and resource costs. It can improve the quality of care in a diversity of settings. Low-carbon healthcare strengthens health systems by increasing facilities' resilience to extreme weather events and other disasters, while also promoting approaches to adaptation. In low-resource, energy-poor settings, powering healthcare with low-carbon solutions can enhance access to care, contributing to institutional goals. At the WBG, this is particularly important for the advancement of universal healthcare for the poor and most vulnerable.

Key elements of low-carbon healthcare include:

- Health system design and models of care based on appropriate technology, coordinated care, emphasis on local providers, and driven by public health needs
- Building design and construction based on low carbon approaches
- Investment programs in renewable energy and energy efficiency
- Waste minimization and sustainable healthcare waste management
- Sustainable transport and water consumption policies
- Low-carbon procurement policies for pharmaceuticals, medical devices, food, and other products
- Resilience strategies to withstand extreme weather events

Such low-carbon approaches within a healthcare framework promise several co-benefits, including improved health through a reduction in environmental pollution and climate change, as well as more efficient, less costly health systems. Tailoring technology and models of care to the environment and disease burdens can further slow the rising burden of health-related expenses, and low-carbon healthcare can also stimulate and strengthen local economies.

A few health systems are already implementing low-carbon healthcare strategies in low- and middle-income settings in every WBG region, providing a growing wealth of experience and information.

Aligning Development Institution Strengths to Deliver on the Promise of Low-Carbon Healthcare

Given extensive experience and resources across both the health and climate areas, development institutions often have tools to work with a range of actors to find innovative solutions in all aspects of climate mitigation, low-carbon development, and health sector strengthening.

Specifically, development institutions can aim to encourage health ministries to develop a carbon baseline for their sector, identify carbon reduction targets where appropriate, and foster low-carbon health sector development. They can call for the introduction of low-carbon or carbon reducing, health-focused investment initiatives and catalyze health sector investment in renewable energy, energy efficiency, local transport systems, sustainable and safe water use, safe waste disposal, and the purchase of locally and sustainably produced food, wherever possible.

Development institutions can also advocate that industries in the healthcare supply chain develop low-carbon and environmentally sustainable manufacturing and distribution practices.

By prompting ministries of health to tackle climate change mitigation and foster low-carbon healthcare, the development community can help governments strengthen local capacity and support better community health. It can foster discussions that can help remove barriers in the system and generate further momentum across the sector by, among other things, tackling the lack of financial incentives for healthcare to deploy renewable energy and revising the requirements for diesel backup electrical generation to allow alternatives. Additionally, development advice should encourage opportunities for natural ventilation and natural lighting at health facilities and incentivize low-carbon innovations.

Supporting Resilient and Adaptive Health Systems

Building resilience to the health impacts of climate change is largely about risk reduction. It is widely understood and accepted that climate change will have broad impacts on human health and that it will be the poorest and most vulnerable that feel its full force. Though it may not be possible to diminish this risk of health impact to zero, the world can take steps to predict and prevent impacts, and build resilient health systems that will be sturdy in the face of future threats; whether be that pandemic outbreak, economic collapse, or global environmental change.

Health risks from climate change vary in both nature and type of climate risk that precipitates them. So far, there has been considerable discussion of the types of potential health impact, including infectious disease, undernutrition, and heat stress. Just as important, however, are the magnitude and pattern of risks from climate change, stemming from: the characteristics of the hazards created by changing weather patterns; the extent of exposure of human and natural systems to the hazard; the susceptibility of those systems to harm; and their ability to cope with and recover from exposure. To establish truly resilient systems, each of these components should be considered singly. Such an approach would establish starting points for efficient and effective resilience strategies and adaptation, like community vulnerability, a health system's capacity before, during and after exposure to a hazard, or the hazards created by a changing climate. Each of these categories highlights important areas for planning around adaptation and resilience. Climate change represents too broad a perspective, and a focus solely on this aspect makes assumptions about the roles of vulnerability and exposure that could prevent effective action.

To achieve rapid, yet long-term solutions to climate change, development institutions can build climate-sensitive health system resilience through investment in two areas: **Health system strengthening** to improve resilience and build capacity to prepare for the varied environmental impacts and health impacts caused by climate change; and **programmatic (e.g., disease-specific) responses** to address the changing burden of disease related to climate change.

The ultimate success of the development work on climate change and health will hinge upon integrating climate as a transversal element into routine work, informing and shaping components that are not specific to climate change and health, including investments in infrastructure and human resources. Climate change increases uncertainty across domains that influence both the supply of, and the demand for, health services, and this unpredictability demands that development operations are sufficiently flexible from the outset.

WBG operations, and health systems strengthening in general should focus on opportunities that align with comparative advantage. For example, adding climate-smart dimensions to ongoing projects or by raising the profile of climate-smart healthcare through higher-level policy dialogue with other international and national level actors. Lending for health, nutrition and population projects at the WBG has increasingly shifted from input-based financing (through investment project financing) to results-based financing (either through the Programs for Results or through investment financing tied to the results at the facility level), but the WBG still makes considerable investments in key health systems inputs. Areas most relevant for adaptation to climate change are infrastructure and supply chains and human resources for health.

A generalized risk of new hazards is insufficient for planning purposes, as not all areas are equally at risk, even within one country. This means that before major investments are made, potential climatic shifts at the local level and the impact on frequency, intensity and duration of extreme weather events should be assessed and factored into facility design. Secondly, responsible resilience planning must consider the location of new facilities, requiring exploration of existing catchment areas (and occasionally, disease profiles) that factor in climate projections or demographic projections based on current populations and trends in fertility and disease. Thirdly, redundancy is critical in supply chains as it enables service provision to continue unabated in the event of an extreme event that might render part of a health system inoperable.

Climate change and associated hazards also affect demand for health services, both by increasing (and occasionally decreasing) the burden of disease, and by influencing the movement of people. This means that the need for both general health staff and specialized expertise will shift, and if that is not properly factored into planning efforts, health outcomes will suffer.

There are several tools and approaches that can be integrated into development projects to increase resilience and improve adaptive capacity in projects. Some of them are specific to health impact, some to climate hazard, and some to both. Nevertheless, there is a menu of options from which to select to improve health sector resilience, including:

Early warning systems. These comprise interventions leveraging climate information to improve health outcomes that shift the focus from surveillance and response to prediction, preparedness, and prevention. They can address specific disease burdens, specific hazards or multi-hazard frameworks, and specific lead times.

Disaster preparedness systems. These have broad use well beyond climate and health impacts, although they can be critical tools for discrete hazards associated health impacts, such as in times of extreme heat, flooding, or other natural disasters.

Disease-specific responses. Many diseases, such as malaria, dengue, waterborne diseases and others, have specific programs and adjustments to these programs to include a climate response and can have significant impact.

Nutrition-focused responses. Climate change has significant effects on both the quantity and quality of food production; connecting climate and nutrition and highlighting multi-sector responses to nutrition challenges can enhance project impact and expand the circle of relevant stakeholders.

Naming a New Approach: Climate-Smart Healthcare

As hospitals and health systems explore opportunities for low carbon healthcare, they are finding significant overlap between mitigation or "sustainability" measures and climate change resilience interventions. Working on only one side of this equation sometimes makes sense, other times it does not. Nevertheless, there is value in establishing a collective term that includes both of these dimensions. Building upon the example of how globally recognized and significant climate-smart agriculture is, we shall refer to low carbon and resilient healthcare as simply *climate-smart healthcare*—enabling a new, user-friendly way of describing this critical and much needed work.

Approaches through Policy and Partnership

Development institutions can take several steps during operational and higher-level international dialogue to integrate climate-smart healthcare into their strategies and policies, thereby influencing the path of healthcare development in low- and middle-income countries:

- Support and fund health systems and sector actors to adopt key elements of climate-smart healthcare
- Integrate climate-smart healthcare into current health sector strategies for universal healthcare coverage

- Provide a blueprint for low-cost, health-promoting systems that reduce the burden of disease, mitigate greenhouse gas emissions and local pollution, and adapt new demands of efficiency and quality as well as to a changing climate
- Provide a blueprint for resilient systems that address both infrastructure-specific and disease-specific climate impacts
- Encourage the integration of low-carbon and resilience principles to measurement, planning, communication, investment, implementation, monitoring, and evaluation

Conclusion

The health sector contributes significant emissions worldwide through the energy and transport it relies on as well as the products that it manufactures, uses, and disposes of. It is also at the forefront of the fight against climate impacts, preventing and responding to human casualties caused by the changing environment. Climate mitigation, adaptation, and low-carbon and resilient health development strategies reduce emissions, build healthcare climate resilience, and provide significant health and economic co-benefits. Climate-smart healthcare will strengthen health sectors and communities by ensuring access to clean and independent energy, safe water, clean transport, and clean waste disposal mechanisms. It will stimulate the development and supply of sustainable products, while also preparing the sector for a future of known and unknown health-related climate hazards.

Operations Toolbox

Provided below is a quick reference guide for teams that may have interests in discrete aspects of climate-smart healthcare.

Tools for building low carbon healthcare:

Tools for addressing climate-related health impacts:

Starting points for country specific climate information and climate-health information:

- National Adaptation Plans (http://unfccc.int/adaptation/workstreams/national_adaptation_plans/items/6057.php)
- Nationally Determined Contributions (http://unfccc.int/focus/indc_portal/items/8766.php) (http://inde.worldbank.org)
- WHO Climate and Health country profiles (http://www.who.int/globalchange/resources/countries/en/)
- Climate Change Knowledge Portal (http://sdwebx.worldbank.org/climateportal/)

Programmatic recommendations for Task Teams:

- Consider low-carbon opportunities during project preparation phase.
- Consider climate change and health impacts during project preparation phase, particularly at the national and subnational level.
- Identify clear starting points and baselines for low-carbon healthcare. This might include calculating the carbon footprint, running other carbon diagnostics (p. 14), and assessing capacity in community, country, and region.
- Identify clear starting points and baselines for resilient and adaptive healthcare. This might include: assessing the vulnerability of a community and conducting climate health assessments to (i) determine capacity of health systems to prepare for, cope with, respond to, and recover from exposure to hazards and (ii) understand climate-related hazards (p. 29).
- Explore financial dimensions and cost savings of low-carbon and resilient healthcare (p. 25).
- Ensure low-carbon and resilient approaches are integrated throughout project design and implementation using proven tools and techniques.
- Draw on, replicate, and adapt existing initiatives and approaches in low-carbon and resilient healthcare (examples in colored boxes throughout report).
- Consult climate change mitigation and adaptation specialists throughout health sector project design and implementation, as well as experts specialized in climate change and health at WHO, WMO, and other academic, civil society, and intergovernmental institutions.
- Consult with specialists in related disciplines: energy, transport, urban, disaster management, risk management, etc.; low carbon and resilience thinking is sometimes more mainstreamed in these sectors and experts here may have valuable and progressive insight relevant to health sector projects.
- Employ climate-smart healthcare tools and strategies to educate other health specialists and policy makers about the value of low-carbon and resilient healthcare, both in terms of dollars and human lives saved.

The Global Framework for Addressing Climate Change, Health, and Sustainable Development

Goal 13 of the UN's Sustainable Development Goals[1] (SDGs) calls for urgent action to combat climate change and its impacts. Additionally, other SDGs also support climate mitigation, adaptation, and resilience, specifically: SDG 3 (health and well-being), SDG 7 (sustainable energy), SDG 12 (sustainable production and consumption), and SDG 15 (life on land/terrestrial ecosystems). Each are linked and progress in any one of these areas can lead to collective achievement toward broader development goals.

The World Health Organization identifies climate change as a global threat[2] increasing the likelihood of outbreaks of cholera and dengue, disruptions in food security, the ill health linked to indoor and outdoor pollution, and the need for emergency assistance following extreme weather events. These effects directly threaten the World Bank Group's (WBG) twin goals of ending extreme poverty and promoting shared prosperity. WBG's commitment to tackle climate change facilitates these goals and promotes human health and well-being.

CHAPTER

1

The Imperative, Context, and Rationale for Development Community Engagement

Connecting Health and Climate Change

Climate change is impacting people's health now will continue to do so in the future if the root causes and effects are not rapidly addressed. Extreme heat, rising sea levels, changes in precipitation resulting in flooding and droughts, intense hurricanes, migrating disease vectors, and degraded air quality, directly and indirectly affect our physical, social, and psychological health.[3]

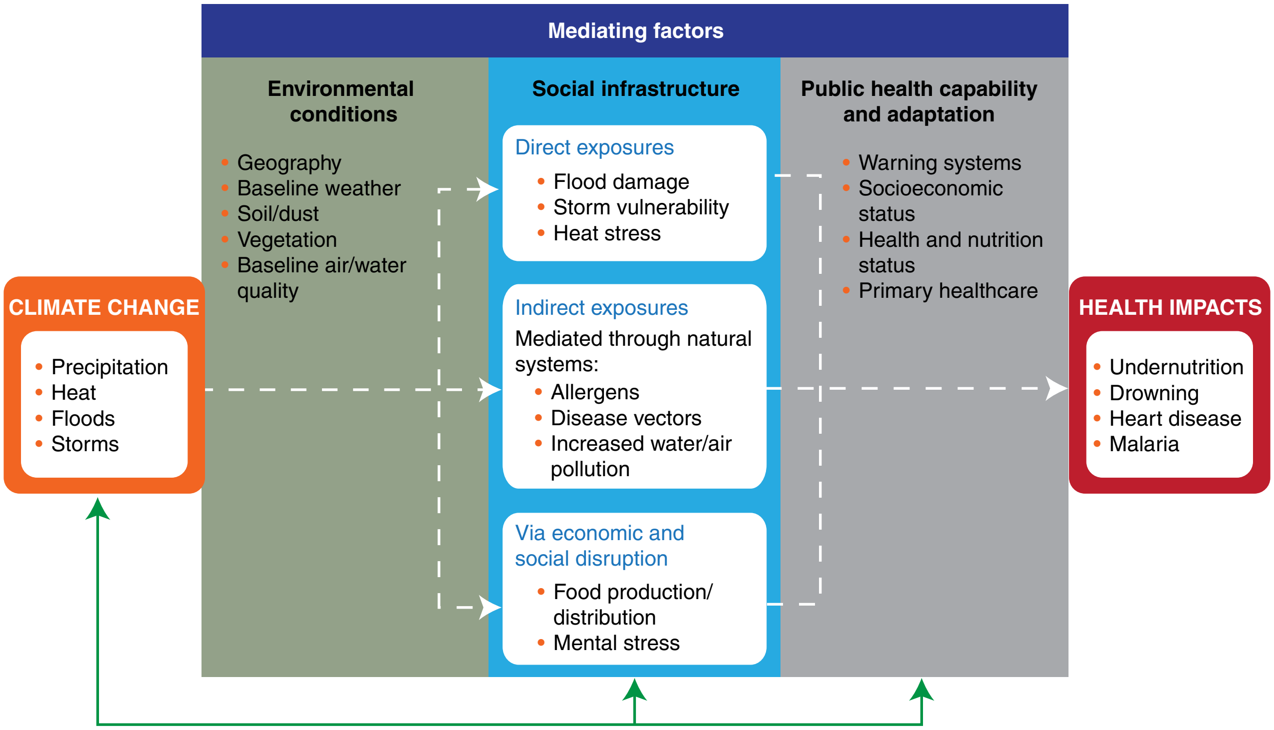
The Intergovernmental Panel on Climate Change (IPCC)[4] has described the types of impacts that climate change may have on human health outcomes globally, including:

- A risk of mortality and morbidity from an increase in the frequency or intensity of heatwaves, principally in older age groups and among the urban poor
- Increased risks of infectious disease, particularly in low-income countries following extreme weather patterns, flooding, and displacement
- An increase in vector-borne infections, particularly in populations at the margins of the current distribution of diseases
- An increase in the number of undernourished people in low-income countries, following more vulnerable food supplies in drought or flooding conditions
- Increases in morbidity and mortality following exposure to ozone and other air pollutants
- In some settings, the impacts of climate change may cause social disruption, economic decline, and displacement of populations. The health impacts associated with such socioeconomic dislocation and population displacement are substantial.

Many of the impacts of climate change and its drivers are preventable through a range of proven interventions (for both adaptation and mitigation) that can reduce emissions or increase resilience. According to the IPCC, there is substantial potential to reduce climate impacts on health across eight dimensions[5] by shifting to higher levels of adaptation than those currently proposed. Whether in infectious disease, heat waves, or natural disasters, history has shown that preparedness and response to threats can greatly limit the losses to health, human life and economies.

For example, in 1970 a Category 3 hurricane battered East Pakistan (present day Bangladesh) resulting in 500,000 deaths. Similar storms hit Bangladesh again in 1991 and 2007, causing 140,000 and 3,400 deaths, respectively. Collaborative adaptation over the intervening decades led to these dramatic reductions in lives lost (Smith et al., 2014) by increasing Bangladesh's resilience to natural disasters. The country shifted to a higher level of adaptation that included improving general disaster education (greatly assisted by rising literacy rates, especially among women), deployment of early warning systems (which included community mobilization), building a network of cyclone shelters, relocation efforts, and increasing connectivity of health facilities in high-risk areas.

Figure 1.1: Exposure pathways by which climate change affects health.



Source: Smith et al., 2014.

Mitigation, in addition to delivering long-term health effects by reducing the levels of greenhouse gas (GHG) emissions, can also have an immediate impact on health outcomes due to lower pollution levels. A significant proportion of morbidities (illnesses) and mortalities can be avoided with stringent climate mitigation, given air pollution's role as a co-emitted byproduct of fossil-fuel combustion. Additional health impacts are also avoidable through mitigation of black carbon and methane, the so-called short-lived climate pollutants or SLCPs (Rogelj et al., 2014).

Only 15 percent of countries that have developed plans for climate change refer to health,[6] and few countries have developed comprehensive multi-sector impact assessments. The World Health Organization (WHO) is developing national climate change and health impact assessments to supplement current global knowledge with information about regional and local vulnerabilities.

Climate change may undermine growth prospects and impose significant economic costs in several client countries. It will also hamper the path to universal health coverage (UHC) both by putting additional long-term stresses on health systems (e.g., through increased and altered patterns of disease transmission, increased direct effects such as heatstroke, reduced food production, population shifts) and by increasing the risk of extreme events (e.g., floods, cyclones, heat waves) that can cause morbidity and mortality while simultaneously damaging health infrastructure.[7] Conversely, more widespread adoption of UHC can fight climate change impacts in ways outlined briefly in Box 1.

It is important to recognize that the picture is not entirely bleak. As a recent Lancet Commission noted, tackling climate change could be the greatest global health opportunity of the 21st century:[8] "When climate change is framed as a health issue, rather than purely as an environmental, economic, or technological challenge, it becomes clear that we are facing a predicament that strikes at the heart of humanity. Health puts a human face on what can sometimes seem to be a distant threat. By making the case for climate change as a health issue, we hope that the crisis we face will achieve greater public resonance. Public concerns about the health effects of climate change, such as undernutrition and food insecurity, have the potential to accelerate political action in ways that attention to carbon dioxide emissions alone do not."[9]

Health Sector Contribution to GHG Emissions

The health sector contributes emissions worldwide through energy use, transport, and products manufactured, used and disposed of. Unfortunately, few countries have undertaken comprehensive

Box 1: Efforts to Achieve UHC Can Also Address Health and Climate through . . .

Short term:

- Diminished disease burdens in populations sensitive to climate impacts through greater efforts in prevention, education, and community health influence
- Earlier identification of health threats worsened by climate change and reduction of associated morbidities, e.g., respiratory and cardiovascular diseases
- More effective and immediate treatment of morbidity associated with heat stress or extreme weather impacts
- Better access to antibiotics, antiparasitic and antiviral drugs that can be used in acute outbreaks of vector-borne or waterborne diseases worsened by climate change
- Decreased morbidity from undernutrition or nutrient-deficiency associated diseases

Long term:

- Reduced overall climate vulnerability by improving access to and quality of healthcare
- Diminished climate-sensitive disease burdens through cumulative protection measures against certain transmissible diseases
- Diminished impact of mental health issues that could be worsened by climate impacts, including displacement
- Improved labor productivity and better financial returns that would otherwise be lost from climate-sensitive health impacts
- Improved childhood development and social outcomes from better nutrition and avoidance of stunting and impaired neurological development

healthcare carbon footprint measurements. One of the best examples is the United Kingdom where researchers at the U.K. National Health Service found the healthcare sector carbon footprint in England to be 26.6 million tons of carbon dioxide equivalent ($MtCO_2e$) in 2015, representing 39 percent of England's public sector emissions.[10]

In the United States, a study based on 2007 figures found that 8 percent of all emissions are healthcare related, of which about half are generated by the provision of care, and the remainder from manufacturing healthcare products and equipment.[11] A more recent study found that in 2013 U.S. healthcare emissions had reached 9.8 percent of the national total, or 655 million metric tons of carbon dioxide equivalents (see Annex 1A for a breakdown by national health expenditure category over the last decade, Annex 1B for US GHG emissions, and Annex 1C for a chart of other environmental health impacts from healthcare). If the U.S. healthcare sector were itself a country, the study points out, it would rank thirteenth in the world for GHG emissions, ahead of the entire U.K.[12]

In the European region, WHO reports that: "Healthcare provision accounts for approximately 10 percent of gross domestic product (GDP) in the WHO European Region. Health services in some developed countries are responsible for between 5 percent and 15 percent of carbon emissions."[13]

There is little information on the carbon footprint of the health sector in developing countries. The health sector in these nations is also frequently considerably less capital-intensive and studies are needed to accurately quantify healthcare's global contribution to climate change. However, it could be conservatively extrapolated, based on European and U.S. figures, that health systems in low- and middle-income countries may contribute to between 3 and 5 percent of their countries' greenhouse gas emissions (see Table 1.1 for examples). Averaging this with the higher-consuming developed nations, it is also possible to estimate that the health sector contributes, on average, 5 percent of all greenhouse gas emissions globally. Based on this figure, it could be conservatively estimated that the healthcare sector generated 2.6 billion out of the 52 billion metric tons of CO_2e emitted globally in 2011.[14]

Mitigation: Relevance of Healthcare to Low-Carbon Development

As nations and international institutions move toward low-carbon and low-emissions development strategies,[15, 16, 17] the health sector must also participate in this transition.

The Action Agenda from the WHO's Second Global Conference on Health and Climate in July 2016 helped define what such a transition might look like when it called on the health sector to, "lead by example, advancing models of low-carbon healthcare that improve access to healthcare services, reduce occupational and environmental health risks and save energy costs across high-, middle-, and low-income settings. This includes scaling up energy access for health facilities in low- and middle-income countries via renewable and other clean energy sources, reducing carbon emissions associated with healthcare in large facilities in high- and middle-income countries, and implementing sustainable, low-carbon procurement, energy efficiency, transportation, and healthcare waste management policies in all settings."

Development institution investment in this approach can help catalyze the transition to low-carbon healthcare by focusing in several key areas:

1. Carbon footprint reduction: While significant differences exist, every country has a health sector that provides care in similar ways, with comparable relations between caregivers and patients. Health expenditures also comprise a significant portion of GDP in most national economies.[18] Consequently, while differing in scale, each nation's health sector releases greenhouse gases while delivering care and by procuring products and technologies from a carbon-intensive supply chain.

While further study is necessary to quantify more comprehensively healthcare's contribution to climate change, there is no doubt that health systems in many countries contribute significant greenhouse gas emissions. This opens the door for health systems in every country to become leaders in contributing to the solution by forging a new model of low-carbon healthcare.

For instance, if Argentina, Brazil, China, India, Nepal, the Philippines, and South Africa reduced their existing healthcare emissions by 25 percent, they could take between 116 and 194 million metric tons of CO_2e out of the atmosphere every year. This would be the equivalent of removing between 24 million and 41 million passenger vehicles from the road, or decommissioning between 34 and 56 coal fired power plants, or installing between 29,000 and 49,000 wind turbines.[19]

2. Low-carbon development strategies for healthcare systems: Just as important as reducing healthcare's contribution to climate change is the need to foster 'climate-smart' development as middle- and low-income countries seek to invest in more robust healthcare systems. The imperative and opportunity exists to invest in and build these systems based on principles of low-carbon healthcare outlined in this paper. As the numerous examples below suggest, low-carbon healthcare can be economically beneficial while improving health outcomes and protecting public health from climate change through emission reductions. Low-carbon healthcare strategies can also improve health system resilience and performance, supporting adaptation to climate change through design and operational innovations.

Table 1.1: Estimated emissions from selected developing countries' healthcare systems.

COUNTRY	TOTAL GHG EMISSIONS[20]	HEALTH SECTOR EMISSIONS LOW ESTIMATE (3% OF TOTAL)	HEALTH SECTOR EMISSIONS HIGH ESTIMATE (5% OF TOTAL)
Argentina	372,873,000	11,186,190	18,643,650
Brazil	2,953,040,000	88,591,200	147,652,000
China	12,064,260,000	361,927,800	603,213,000
India	2,828,845,000	84,865,350	141,442,250
Nepal	33,160,000	994,800	1,658,000
Philippines	163,797,000	4,913,910	8,189,850
South Africa	451,483,000	13,544,490	22,574,150
Total	**15,541,545,000**	**466,246,350**	**777,077,250**

(All data is from 2011 and all units are mtCO_2e)

Table 1.2: Estimated potential for emissions reductions in metric tons of CO_2e.

COUNTRY	25% REDUCTION IN HC EMISSIONS LOW	25% REDUCTION IN HC EMISSIONS HIGH	50% REDUCTION IN HC EMISSIONS LOW	50% REDUCTION IN HC EMISSIONS HIGH
Argentina	2,796,548	4,660,913	5,593,095	9,321,825
Brazil	22,147,800	36,913,000	44,295,600	73,826,000
China	90,481,950	150,803,250	180,963,900	301,606,500
India	21,216,338	35,360,563	42,432,675	70,721,125
Nepal	248,700	414,500	497,400	829,000
Philippines	1,228,478	2,047,463	2,456,955	4,094,925
South Africa	3,386,123	5,643,538	6,772,245	11,287,075
Total	**116,561,588**	**194,269,313**	**233,123,175**	**388,538,625**

(All data is from 2011. All units are mtCO_2e)

Investment in low-carbon healthcare systems in less-developed countries and middle-income countries can also foster clean and independent energy, safe water, clean transport and clean waste disposal mechanisms. These can help create local capacity and services by strengthening the infrastructure needed for low cost, sustainable and resilient facilities while strengthening the market viability of low-carbon technologies.

Low-carbon healthcare brings added benefits to health, local economies, and in direct financial terms. The positive contribution to health is most easily demonstrated through reduced air pollution and its subsequent reduction in the burden of disease as described in the WBG Climate Change and Health Hotspot report.[21] WHO highlights low-carbon interventions that bring additional benefits such as easier access to healthcare facilities[22] and improved safety for health workers.

3. Leading by example: Healthcare providers and health sector institutions are individually and collectively respected by policy makers and the general population. A recent report of the most trusted professions around the world highlighted that medical professionals rank very highly.[23,24] As individuals trust their most vital problems to healthcare professionals and expect wise advice in prevention, it is logical this trust would extend to climate mitigation, resilience, and adaptation considerations. WHO has also highlighted that health professionals and institutions are well positioned to lead by example in mitigating against climate change.[25] For instance, reducing greenhouse gas emissions and developing climate resiliency in health systems can influence others to do the same (see case study of Georgetown Hospital in St. Vincent and the Grenadines in Case Study 19).

Low-carbon strategies can improve health system resilience and performance (Box 2), supporting adaptation to climate change through design and operational innovations including: siting health facilities for access to public transportation, on-site energy generation including solar photovoltaics and other renewable sources, natural ventilation, energy-efficient medical devices, and changes in health delivery, such as telemedicine.[26] Many of these strategies can yield significant operational cost savings as well as facility resilience in the case of short-term grid energy loss.[27]

Combined heat and power, or on-site cogeneration provides immediate savings in energy and enhances operational resilience and reliability.[28, 29] On-site renewable energy sources such as solar photovoltaics for electricity and thermal solar energy for heating reduce emissions from energy use, fuel production and transport by increasing reliability.[30, 31, 32, 33]

For instance, hospitals are finding measures that serve to reduce their dependence on large power grids and infrastructure also enable them to better withstand shocks, such as more frequent storms, that disable power grids and other infrastructure.[34]

To reduce the vulnerability of health facilities, WHO and the Pan American Health Organization (PAHO) launched the Safe Hospitals Initiative. The objective is to protect the operation of hospitals during emergencies and disasters so they may continue to provide appropriate and sustained healthcare services.[35] Building on the Safe Hospitals Initiative, the Smart Hospital Initiative in the Caribbean was launched to aid health facilities in becoming both more sustainable and disaster resilient.

Box 2: Mitigation of Climate Change, Its Effects and Benefits

Low-carbon healthcare is planned, built, and delivered with minimal emission of greenhouse gases. Many interventions to reduce emissions will also have other health and environmental benefits (co-benefits), for instance by reducing air-polluting toxins and reducing the associated burden of cardiovascular and respiratory diseases.

Climate mitigation directly or indirectly reduces carbon emissions and hence the severity of climate change and is viewed as mitigation or primary prevention.

Climate-sensitive disease mitigation reduces the impact that climate change can have on the burden of disease, and is regarded as adaptation or secondary prevention.

The benefits of climate change mitigation include:

- Declines in respiratory and cardiovascular diseases through reduced air pollution
- Fewer traffic-related injuries from clean, accessible transportation
- Improved safety for health workers, patients, and communities thanks to improved waste management, accessible facilities and safe water
- Lower infection risks through improved natural ventilation
- Reduced risk of exposure through less contact with toxic products and chemicals

Health System Resilience in the Face of Climate Change

All new investments in the health sector should contribute to building the resilience of the sector to climate change (Box 3). This is important for meeting new demands (e.g., higher temperatures, increased precipitation, and stronger storms) and also rising population pressures, local environmental degradation, and emerging infectious disease outbreaks, such as Ebola in West Africa, which has highlighted evident failures and insufficiencies of investments to build resilience to date.

Resilience is particularly important in the context of climate change given the complex, unpredictable, and multifaceted ways in which climate change affects health systems and infrastructure. Vulnerable health systems will be unable to cope with threats posed by climate change, so many of the specific proposals discussed in the remainder of the document are intended to build resilience.

Box 3: Features of a Resilient Health System

Kruk et al.[38] propose five elements for a resilient health system:

- Aware: up-to-date information about health system assets (including strengths and vulnerability) and potential threats;
- Diverse: able to respond to a range of threats;
- Self-regulating: able to contain threats before they overwhelm the system;
- Integrated: bringing together the key actors needed to support the system, both within the health sector (including public and private actors, and communities) and beyond it (e.g., transportation, education, media);
- Adaptive: flexible enough to transform in the face of challenges in ways that improve performance.

It is also important to recognize that the health community has a significant role to play in broader adaptation policy and societal resilience. The health sector must reframe climate change as a health issue[36] and position health as a cross-cutting theme for overall adaptation strategies.[37] It must also advocate for increased awareness and a better understanding of the relationship between climate and health specifically, while integrating evidence into both policy and practice.[38]

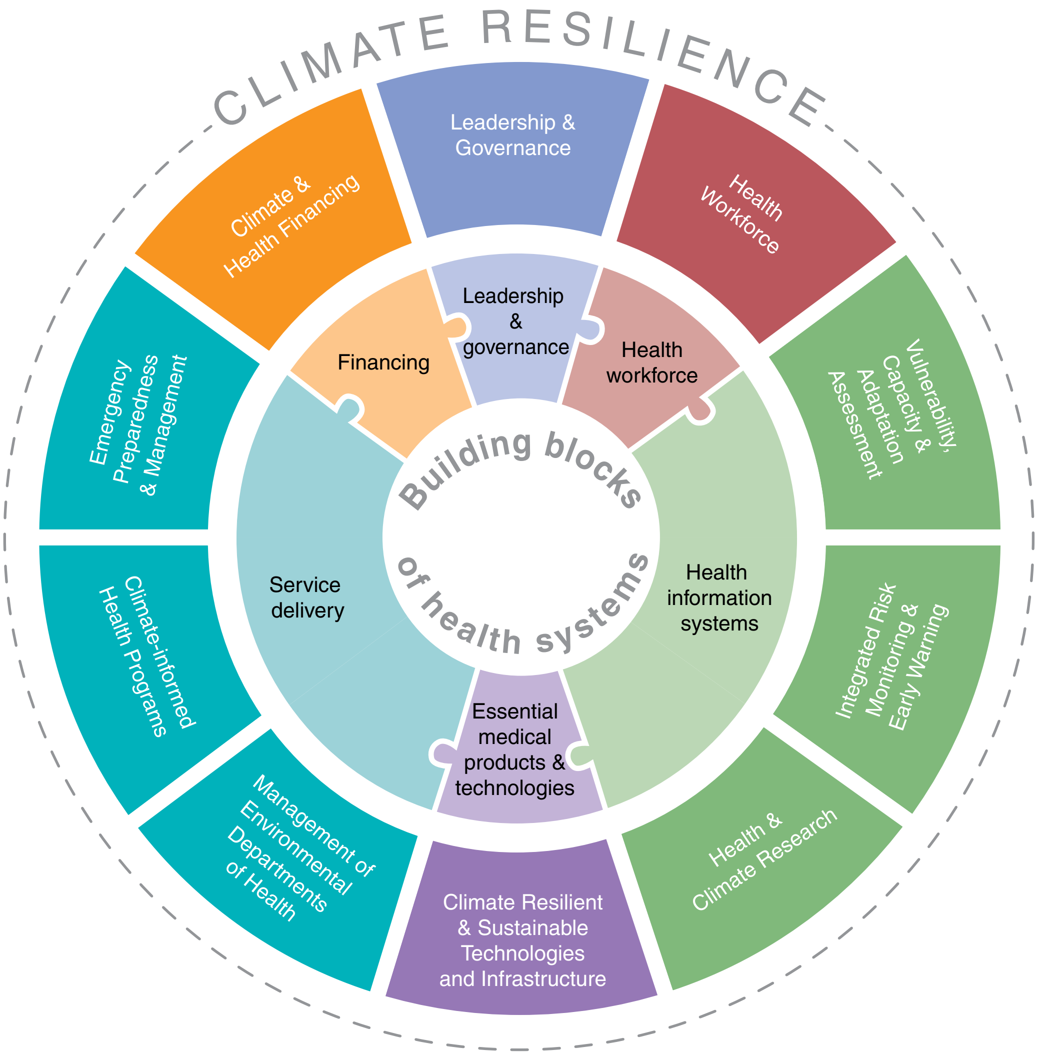
Recognizing the need for concrete guidance on how the health sector can better respond to the challenges and opportunities presented by a changing climate, WHO has recently published: *Operational framework for building climate resilient health systems*, aimed at public health officials and their partners, primarily in low- and middle-income countries (WHO, 2015). WHO defines a climate resilient health system as "one that is capable to anticipate, respond to, cope with, recover from, and adapt to climate-related shocks and stress, so as to bring sustained improvements in population health, despite an unstable climate." The framework is intended to support national adaptation planning and public health responses to a changing climate, and contains several useful elements for the broader international community.

For example, it introduces a set of considerations for building resilience that can be applied as a checklist or set of questions for assessing whether a proposed investment is contributing to building climate resilience. It asks whether the planned investment:

- Contributes to reduce vulnerability?
- Develops capacities?
- Adds long-term perspectives for actions to be put into place today?
- Employs adaptive management approaches (e.g., risk-informed, iterative, flexible, using models and scenarios to understand future contexts, embracing risk and uncertainty as ways to increase learning)?
- Ensures community approaches and voices to strengthen health action?

The Operational Framework contains 10 components that elaborate upon the six traditional building blocks of a health system in the specific context of promoting climate resilience (as shown in Figure 1.2). As resilience is addressed in the remainder of this document, approaches contained in the Operational Framework are applied to the context of development financing.

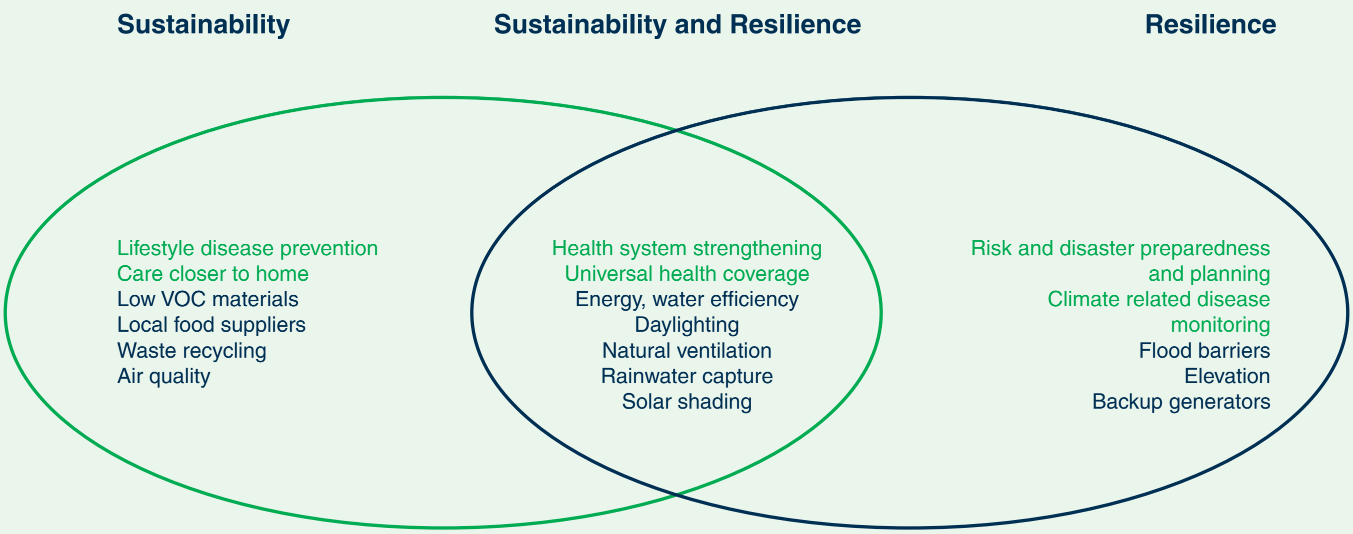
Figure 1.2: Building blocks of health systems that promote climate resilience.



Source: WHO, 2015.

Box 4: Climate-Smart Healthcare: The Intersection of Low-Carbon Healthcare and Resilience

The IPCC identified key risks from climate change that include flood impacts and landslides due to extreme precipitation, impacts on water availability, wildfire impacts, and heat-related mortality.[42] All significantly impact health in the communities where they occur. As first responders, hospitals and health centers need to be resilient to these impacts and remain operational during and immediately following these events to safely shelter patients in place and provide needed medical care to communities and responders.[43] As hospitals and health systems explore opportunities for low carbon healthcare, they are finding significant overlap between mitigation or "sustainability" measures and climate change resilience interventions. Accordingly, we propose a new term that captures both sides of climate-health impact and response equation: "climate-smart healthcare."



Source: Health Care Without Harm/World Bank.

Rationale for Development Community Engagement through the Model of the World Bank

Climate-smart healthcare is well aligned with both low-carbon development strategies[39] and health strengthening and transformation strategies promoted by the WBG.[40] Efforts to end extreme poverty and to promote well-being include promoting investments in the foundation of healthy societies. Climate-smart healthcare improves health by reducing the environmental impacts of healthcare and emphasizing the transformation required to an integrated approach across primary, secondary, and tertiary care, with financial and technical emphasis placed on primary care.

Climate-smart healthcare requires the matching of workforce skills to locations and tasks, and institutions that provide the highest quality of appropriate care as close to local communities as possible. In the past, technology constraints hampered such health-care planning. Today, advances in information technology provide a route for the seamless integration of such an approach with its immense co-benefits. As with the cell phone, these advances will allow low- and middle-income countries the advantage of high quality, economically viable healthcare.[41, 42]

Other World Bank work, such as *Turn down the heat*,[43] *Connecting climate change and health*,[44] and *Shaping an approach to climate change and health: geographic hotspots for World Bank action on climate change and health* have summarized the relationship between climate change and health and provide in-depth resources for better understanding this relationship. Additionally, the Climate Change CCSA and HNP have developed a Climate Change and Health Approach and Action Plan which further articulates many of these issues and contextualizes them within the WBG.

CHAPTER

2

Development Community Role Promoting Climate-Smart, Low-Carbon Healthcare Solutions

This section reviews the tools and approaches for low-carbon healthcare. Existing initiatives are presented as models from which further work can be built and integrated into development projects and programs. Details of methods are provided wherever possible. Case studies providing examples of country implementation appear throughout to establish a sense of real-world applicability.

Existing Initiatives

The Intergovernmental Panel on Climate Change (IPCC) identifies several interventions that can reduce carbon emissions.[45] Based on these, the World Health Organization issued a set of preliminary findings on the benefits and co-benefits of carbon mitigation in health facilities.[46] It reviewed published evidence on eight IPCC and four extra mitigation strategy impacts by considering the evidence of:

- improvements to health services
- reduced environmental and occupational health risks
- reduced risk of specific diseases
- improved health equity and access to healthcare services

The findings identified a range of mitigation measures common to structures and activities that might have special relevance to healthcare facilities for the provision of improved services. These are summarized in Table 2.1. The WHO findings also identify a need for more systematic measuring and benchmarking of health sector energy consumption and emissions, as well as of overall environmental performance in the context of 'greener' facility design and use of renewable energy sources.

Together with Health Care Without Harm, WHO has also issued a discussion document detailing seven aspects of a climate friendly hospital, alongside global examples of carbon mitigation in healthcare settings.[47] The seven components of a climate friendly hospital relate to driving energy efficiency, utilizing green building design principles, adopting alternative energy generation, clean transportation, sustainable food, clean waste management, and water conservation.

For example, Hospital General Dr. Agustino Neto in Cuba audited its energy consumption to identify areas for improvement in energy practices and subsequently reduced their energy consumption by 21 percent.[48] Peru's Hospital Nacional Dos de Mayo was designed to maximize natural ventilation (with high ceilings, large windows, and orientation to take maximum advantage of local prevailing winds) to keep the hospital air fresh and comfortable. In Rwanda, there are health clinics with no connection to the country's power grid, relying instead on more reliable and less polluting hybrid solar/diesel sources.

The 2020 Healthcare Climate Challenge, led by Health Care Without Harm's Global Green and Healthy Hospitals Network, can provide useful support for those seeking to assess their footprint, measure progress, and take part in a collaborative global effort. The 2020 Challenge has a three-pillar framework of mitigation, resilience, and leadership.[49] It sets an ambitious target to mobilize hospitals and health centers on every continent in a collective effort to reduce the health sector's greenhouse

Table 2.1: Mitigation strategies applicable to the health sector.

MITIGATION STRATEGY	ACTIONS	GHG IMPACT	HEALTH BENEFITS
Improve energy supply and distribution efficiency	• Fuel switching • Energy recovery • Distributed generation • Combined heat & power	• Reduced transmission losses • Reduced emissions from energy use, fuel production and transport	• Immediate energy savings and operational resilience/ reliability • Reduced air pollution exposures • Improved access to reliable healthcare • Better energy security
On-site renewable energy sources	• Solar photovoltaics • Thermal solar energy • Wind • Other renewable energy sources	• Reduced emissions from energy use, fuel production, and transport	• Improved operational resilience/reliability • Long-term energy savings • Reduced ambient air pollution • Better energy security
Reduced-energy devices	• Non-electric medical devices • Direct-current devices • Energy efficient appliances	• Reduced emissions from energy use, fuel production and transport	• Energy and operations savings and energy security • Improved functionality at night and device reliability • Improved diagnosis of tuberculosis with low-energy LED microscopes • Increased access to healthcare and energy security
Passive cooling, heating, and ventilation strategies	• Natural ventilation in healthcare settings • Evaporative cooling • Desiccant dehumidification • Underground earth-pipe cooling	• Reduced direct emissions from on-site energy production; reduced emissions from energy use, fuel production, and transport	• Energy and operations savings and energy security • Improved indoor air quality • Decreased transmission of airborne infections • Improved social welfare, productivity and patient health
Facility wastewater and solid waste management	• Advanced autoclaving of infectious healthcare waste • On-site wastewater pre-treatment and sanitation improvements • High-heat incineration of pharmaceuticals with pollution scrubbers	• Reduced energy emissions for waste and water treatment • Reduced greenhouse gas (GHG) footprint from waste treatment processes in some settings • Reduced aquifer and ecosystem damage	• Savings in waste/water disposal fees • Reduced waste volumes • Improved compliance with local air quality regulations/ guidelines • Improved hygiene around facility • Reduced methane and other emissions • Reduced risks of exposure to infectious agents and to diarrhea and other waterborne diseases
Reduced GHG emissions from anesthesia gas use and disposal	• Waste anesthetic gas recapture and scavenging	• Reduced direct emissions from anesthesia gas waste	• Anesthesia cost savings with reuse • Reduced health risks for health workers exposed to gas • Improved health worker productivity
Reduced procurement carbon footprint	• Better-managed procurement of pharmaceuticals, medical devices, business products and services, food/catering, and other facility inputs	• Reduced energy footprint in production and transport of unused pharmaceuticals and products	• Resource savings on unused/wasted products • Reduced risks from use of outdated/expired products

MITIGATION STRATEGY	ACTIONS	GHG IMPACT	HEALTH BENEFITS
Telehealth/ Telemedicine	• Home patient telemonitoring and guidance • Emergency response • Health worker advice & collaboration via mobile phones	• Reduced emissions from healthcare-related travel	• More cost-effective healthcare • Reduced risk of travel-related injuries • Improved management of chronic conditions, such as diabetes and heart disease, as well as emergency response • Better access to healthcare advice in poorly-resourced remote locations
Health facilities in proximity to public transport and safe walking/cycling	• Public transport options mapped during planning of buildings to locate new facilities nearby • Employee incentives for public active transport use and facilities	• Reduced transport-related emissions from health worker and hospital visitor travel	• Reduced traffic injury risk for health workers and hospital/ clinic visitors travelling to health facilities • Potential for active transport by healthcare workers to reduce risks of hypertension, cardiac disease and diabetes • Improved facility access for health workers and visitors who do not have cars
Conserve and maintain water resources	• Water-efficient fixtures, leakage management, water safety • Onsite water treatment and safe water storage in health facilities • Rainwater harvesting, greywater recapture/ recycling	• Reduced energy use for water extraction from surface/aquifer sources, therefore lower emissions • Reduced truck transit of water resources	• Improved performance due to better access to safe water • Savings in water fees • Reduced water contamination from health facility activities • Reduced disease transmission from unsafe water and drinking water • Improved access to safe, potable water in poorly resourced health facilities • Reduced aquifer and ecosystem damage • Better water security

Source: Adapted from the World Health Organization.[50]

gas emissions by 26 million metric tons annually by 2020. This is equivalent to taking 5.5 million cars off the road or installing 7,000 new wind turbines every year. It has mobilized a growing number of participants, representing more than 9,000 hospitals and health centers from 23 countries. Examples of accomplishments and commitments by 2020 Challenge participants[51] that could inspire others include:

- The Western Cape Government health system in South Africa has made commitments to reduce its carbon footprint from energy consumption in government hospitals 10 percent by 2020 and 30 percent by 2050 (based on 2015 levels). They are incorporating green design principles in building projects by, among other things, using natural light and ventilation where possible, curbing the use of air conditioning, replacing lights with efficient fluorescent and LED lighting in combination with light-colored walls, installing heat pumps for hot water, and including green spaces in facility design. Coal- and oil-fired boilers have been eliminated at nearly all hospitals. Annual savings from hospital laundry efficiency measures alone in just one hospital comprise more than 19 million liters of water, over 550 metric tons of CO_2e, and more than US$62,000[52] in costs.
- Albert Einstein Hospital in Sao Paulo, Brazil, developed and implemented a sustainability master plan in 2010 with initiatives that cut annual greenhouse gas emissions by 2,000 metric tons of CO_2 or 41 percent.
- South Korea's Yonsei University Health System has set targets to reduce GHG emissions from its facilities by 27 percent by 2020. Yonsei has instituted numerous low-carbon strategies including a building energy management system that reduces overall energy consumption by 10 percent through LED lights in parking structures and occupancy sensor lighting controls in restrooms that yield US$60,000 and $50,000 each in annual savings, respectively.
- The U.K.'s National Health Service (NHS) is working toward a 34 percent reduction in carbon emissions by 2020. Within the U.K., England's health sector achieved an overall reduction of 7.4 $MtCO_2e$ between 2007 and 2015; a 13 percent reduction despite an 18 percent increase in activity.[53] The NHS is a national public health and care system that has created a system-wide approach to low-carbon healthcare; this included a national analysis of its carbon footprint, nationwide strategies and implementation tools, and publicly reporting on progress.

- South Western Sydney Local Health District in Australia has reduced energy and water consumption, generating significant financial savings and reducing annual CO_2 emissions by 6,370 tons. In an effort that could be replicated in lower income countries, this local health district upgraded old and inefficient plant and equipment, including instituting lighting upgrades that saved $450,000 AUD per year.[54]

Some World Bank-supported projects have also shown considerable results in hospital greening. Designed to provide state-of-the-art medical care to patients, the Keserwan Medical Center (KMC) in Lebanon took an additional investment to achieve Excellence in Design for Greater Efficiencies (EDGE) certification that it expects will be repaid through lower utility expenses in little more than a single year. The EDGE certificate specifies savings of 21 percent in energy, 25 percent in water, and 26 percent in embodied energy (consumed by all the processes associated with production of a building) saving at KMC hospital. Medlife, a healthcare provider in Romania and a client of the International Finance Corporation (IFC), has committed to greater use of energy- and water-efficient technologies across its facilities, saving at least 20 percent on water and energy.

Many healthcare systems and organizations are moving toward a low-carbon model. The WBG can encourage the development community and help institutionalize this momentum, while providing support to those countries that have not yet started to consider low-carbon healthcare.

Powering health in low-resource settings: Strategies to provide reliable energy in low-resource settings also foster low-carbon, resilient healthcare. A study published by the World Bank and the WHO[55] explores the relationship between universal access to efficient modern energy services and universal health coverage. The report identifies a series of energy strategies aimed at improving the quality, safety, and accessibility of health services relevant to clinics and health centers at the primary and secondary tiers of health systems, which often struggle to access sufficient energy to power lighting, refrigeration, and basic medical devices.

Among 11 African countries assessed by WHO in 2014, an average of 26 percent of health facilities had no access to electricity. Only 34 percent of hospitals on average had reliable electricity across the eight countries for which such data was available. At the same time the report stated:

- In the same 11 Sub-Saharan African countries, hundreds of clinics and hospitals were using on-site solar photovoltaic (PV) power sources, either as a primary or backup source. “In Uganda, some 15 percent of hospitals used PV solar to complement grid electricity access, and in Sierra Leone, 36 percent of all health facilities and 43 percent of hospitals used solar systems in combination with other electricity sources.”
- About a dozen types of solar refrigerators for vaccine and blood storage are approved by WHO for sale at reduced prices to developing countries through pre-qualified procurement lists. Some can maintain the cold chain for a week or more without any electricity. Given they require over-sized solar arrays to ensure the cold-chain, surplus electricity from the refrigeration system is often generated and tapped for other health facility loads.[56]
- Health-focused intergovernmental agencies are rapidly expanding their investment in solar-powered vaccine refrigeration. Solar refrigeration represented 13 percent of all refrigerators and freezers procured by UNICEF in 2013, and this share is expected to grow. Since 2007, the Global Fund to Fight AIDS, Tuberculosis and Malaria has invested millions of dollars in the procurement of solar panels to power small-scale diagnostic tools and laboratories in Asian and African health clinics.
- Mini-systems, such as the “solar suitcase” (an example of a portable solar system), have filled a niche for low-cost solutions that target the most immediate energy needs of front-line health clinics that are without energy at all. These are used to facilitate night-time obstetrics services or emergency surgery in very small clinics and remote locations.
- Efforts by multilateral and bilateral institutions, such as the Powering Health initiative by the U.S. Agency for International Development (USAID), are focusing on large-scale investments in solar systems for developing country health clinics.

To scale up these positive examples, the report concludes that the “health and energy sectors need to design new policies, standards and regulations to support procurement, installation, and sustainable operation of energy technologies, as well as innovative financing structures to catalyze investment in modern energy systems.” This recommendation is particularly relevant to large development institutions, highlighting an opportunity for greater collaboration among sectors and programs. The successful evolution of integrated and embedded climate and health solutions will require new communities of practice, collaboration on analytical pieces and project design, and regularly discussion around common issues.

Relevance to Health Sector Strategy through the Lens of the WBG HNP Global Practice

The WBG can actively encourage the health sector to be climate smart, while simultaneously supporting the development of health and climate interventions in other global practices. Although every country has a different set of geographical, social, economic and demographic circumstances, key elements of low-carbon healthcare can be integrated into investments. These elements must be tailored to local circumstances to help communities thrive, be more sustainable, resilient, and healthy in a changing climate.

The WBG can integrate low-carbon healthcare into HNP's strategy for universal healthcare coverage. It can provide elements of a blueprint for low-cost health promoting systems that mitigate the burden of disease, adapt to new demands of efficiency and quality, mitigate greenhouse gas emissions and local pollution, and adapt to a changing climate.

The WBG's Climate Change Action Plan calls on the institution to strengthen and reinforce action on climate and health. The plan states that, subject to available resources, the WBG will increase its capacity to respond to the 72 eligible countries that have included health as a focus area in their Nationally Determined Contributions (NDCs); 40 under the International Development Association (IDA) and 32 through the International Bank for Reconstruction and Development (IBRD).

At a strategic level, the WBG will **stimulate climate-smart health care actions** by discussing the health effects of climate change, highlighting the opportunities for investing in low carbon solutions, and supporting greater climate resiliency across the health sector. It can also **strengthen capacity** by building climate-smart investments, raising awareness across the health sector and increasing communication amongst related sectors and the community, and supporting health creating models of care.

The WBG can encourage the following operational goals toward low-carbon healthcare:

- **Measurement:** Encouraging carbon footprint measurement and public reporting as a norm across health systems, at the facility, institutional, city, state/province and/or country/ministry levels
- **Planning:** Integrating low-carbon approaches into planning processes, including the integration of climate analysis and interventions into hospital safety assessments and planning (e.g., PAHO Hospital Safety Index together with carbon mitigation—SMART hospitals)[57]
- **Investment and implementation:** Stimulating investment in, and implementation of, low-carbon strategies such as renewable energy and energy efficiency, waste minimization and sustainable healthcare waste management, sustainable transport and water consumption, and low-carbon procurement policies for pharmaceuticals, medical devices, and other products
- **Monitoring and evaluation:** Tracking the health, economic, and climate impacts of multiple actions and programs in a systematic manner

Integration into WBG Project Preparation and Scoping

Every WBG health project or program could, feasibly, consider climate change mitigation options from the outset so that wider benefits can be realized. Currently, WBG-supported projects (beyond, but including HNP) are screened for climate change; i.e., the degree to which climate change stands to impact project outcome and success. This is but one step in mainstreaming climate considerations across projects. Another would be to consider how to reduce the impact of climate change by including low-carbon elements of project design; e.g., through the World Bank EDGE Green Building Certificate (which Bank projects are already encouraged to acquire). For instance, WBG should consider the possibility of integrating health systems into community or district energy schemes or public transportation systems that reduce air pollution. Another option would be to integrate climate and health considerations into the Social and Environmental Framework, drawing upon the expertise of safeguard specialists (see Annex 2 for updated World Bank Safeguard policies that mention health). These can be built into most projects when considered during the preparation, site selection, and scoping phases.

Low-carbon development requirements can be included in every health project specification and contract. This can stimulate project partners or contractors to audit their own carbon footprint, identify how it can be systematically reduced, and consider how to integrate a climate perspective into all aspects of project development.

Carbon mitigation can be encouraged while also building climate resilience. As such, the two should be incorporated as a linked approach. An example of this would be investing in shade creation, as this would naturally help minimize temperatures during heat waves and hence also reduce the need for high-energy air conditioning.

Projects already consider local air, water and soil pollution impacts but the scope should be expanded beyond local considerations to include global pollution. The WBG needs to consider carbon impact alongside health and financial issues to ensure it realizes any opportunities for further reductions and integrates a wider triple bottom line approach in project preparation, implementation, and evaluation. It should also consider a social value of carbon metric for energy projects that could be applied to health projects as well. The same lessons can of course be extended to other development institutions.

Projects and Interventions within the WBG

There are three phases essential to integration of climate-smart health aspects in any project or intervention (Table 2.2). The first relates to establishing baseline data and identifying areas of focus, and would relate to project identification, appraisal, and approval phases within the Bank. The second relates to engagement and planning for the areas of focus, and most closely correlates to WBG implementation. The third relates to monitoring and reporting progress, updating plans, and potential new areas of focus.

Table 2.2: Project intervention phases for integration of climate-smart considerations within the WBG as a model for other development institutions.

PHASE 1 PROJECT IDENTIFICATION, APPRAISAL AND APPROVAL	PHASE 2 IMPLEMENTATION	PHASE 3 EVALUATION
Baseline carbon footprint (and associated costs) to determine focus areas	Deploy diagnostic tools to refine focus areas	Measure and report progress through a transparent and public mechanism
Assess basic capacities of institutions, individuals, and technical and physical infrastructures	Engage with staff and communities about low-carbon and climate-smart approaches	Review areas of focus and update plans
Assess costs associated with low-carbon efforts	Develop systematic plans to establish timelines, actions and monitoring mechanisms, that build resilience too	
Estimate the impact of climate change in 5, 10 and 25 years to key local vulnerabilities	Communicate with institution(s), health professionals, local communities about the strategies and their role	
Assess climate mitigation opportunities in relation to energy efficiency, renewable energy and sustainable procurement strategies		

Within the first phase of project intervention, a climate-smart approach should consider a number of early assessment areas for low-carbon and climate mitigation strategies, including the reliability of energy supply and the availability (within a country or region) of renewable energy technologies and financing options for renewable energy technology. Additionally, it should seek to identify opportunities for: greater energy efficiency; improved waste management and segregation; improved water supply, conservation, and protection mechanisms; and engagement with supply chains to consider low-carbon approaches to products and services.

Health sectors have undertaken carbon footprint calculations to different levels in various countries and settings. This section details general diagnostic tools, as required under the second phase of project interventions, for health systems and organizations; specific tools related to intervention types are covered in Chapter 3.

Diagnostics

Many health sector organizations focus on direct energy use to calculate their organizational footprint and use this as a baseline for monitoring reductions. It is also possible to calculate a full footprint—including Scope 1, 2, and 3 emissions (Box 5)—and to do so at a system or national level, as the NHS has in England. However, such an approach might not be entirely possible in all countries.[58] Estimating a full carbon footprint can be achieved by using recent financial expenditure data and regionally-generated carbon intensities. This is achievable in most settings by matching the financial information details with appropriate product categories.

Carbon Diagnostics

The most commonly used indicator in climate change mitigation is carbon dioxide equivalent emissions (CO_2e). Various calculators and mechanisms are used worldwide to estimate carbon emissions in relation to building energy, travel, and supply chain analysis. These all rely on carbon intensity conversion factors that are updated on a regular basis because of efficiencies or changes to energy supply. For instance, as the automobile industry becomes more efficient in its use of fuel, its carbon intensity will reduce per kilometer driven. Where these factors are known, calculating the carbon footprint is straightforward. However, where it is less clear, such as the footprint of the supply chain, an estimation is required to help indicate where to focus efforts. As the sector gets more proficient at calculating footprints of different types of product, dependent on their provenance, these calculations will become more refined. In the meantime, estimator tools help prioritize action.

Baseline Diagnostics

It is important to specify which calculator and assumptions have been made in these calculations so that comparisons are based on equivalent levels of data.

Box 5: Sources of Greenhouse Gas Emissions[1]

Scope 1 on-site (energy) GHG emissions typically are generated by consuming a fossil fuel on site, such as burning oil or gas to heat or boil water or power an emergency electricity generator.

Scope 1 non-energy GHG emissions include on-site sources, such as wastewater treatment, incineration, and waste anesthetic gas emissions and fugitive emissions, such as refrigerants.

Scope 2 GHG emissions are indirect emissions from consumption of electricity, heat, or steam. These emissions typically are associated with electricity that is purchased from, or that is generated at, a power plant burning fossil fuel, such as coal or oil. It can also be emissions from purchased heating or cooling that might include steam and chilled or hot water.

Scope 3 GHG emissions are also indirect emissions, such as the production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related transmission and distribution losses not covered in Scope 2, as well as outsourced activities, waste disposal, etc.

The Greenhouse Gas Protocol developed by World Resources Institute and World Business Council on Sustainable Development represents a global standard for the measurement, management, and reporting of greenhouse gas emissions. It provides organizations and sectors guidance to support these calculations[59] and provides a benchmark so that comparisons can be made across countries and settings. Each standard outlines a basic approach for times when data is not as readily available, as may be the case in middle- and low-income countries.

Pharmaceutical Products

More specific guidance for pharmaceutical products and medical devices also exists. Purchasing divisions of health systems or ministries and companies can use this tool to identify the hotspots within key purchasing categories.

International Healthcare Carbon Emissions Reporting System

As part of the 2020 Health Care Climate Challenge, Healthcare Without Harm's Global Green and Healthy Hospitals (GGHH) initiative has developed a carbon reporting tool for participants, the first such international carbon reporting system for health facilities. It allows participants to assess their carbon footprint, track and report on carbon reduction, resilience, and leadership, and compare their progress with similar facilities in their region and globally.

Sustainability Diagnostics

Other tools with wider scope to assess sustainability exist and help to establish areas for development and action. These include EDGE Green Building application, which includes a hospital module to calculate energy, water, and embodied energy, as well as GHG emissions for projects in 125 countries. The Good Corporate Citizenship tool in the U.K. allows organizations to evaluate their position and determine where to invest efforts.

GHG emissions, and the health impact of pollutants are, of course, variable by country. The WBG report *Geographic Hotspots for World Bank Action on Climate Change and Health* has roughly characterized this impact and categorized countries at greatest health risk from co-pollutants of GHG emissions consistent with evaluations from the IHME Global Burden of Disease. As can be seen in Figure 2.1, air pollution has widespread and immediate health impacts that can further strengthen the case now for reducing emissions.

Low-Carbon Healthcare Interventions

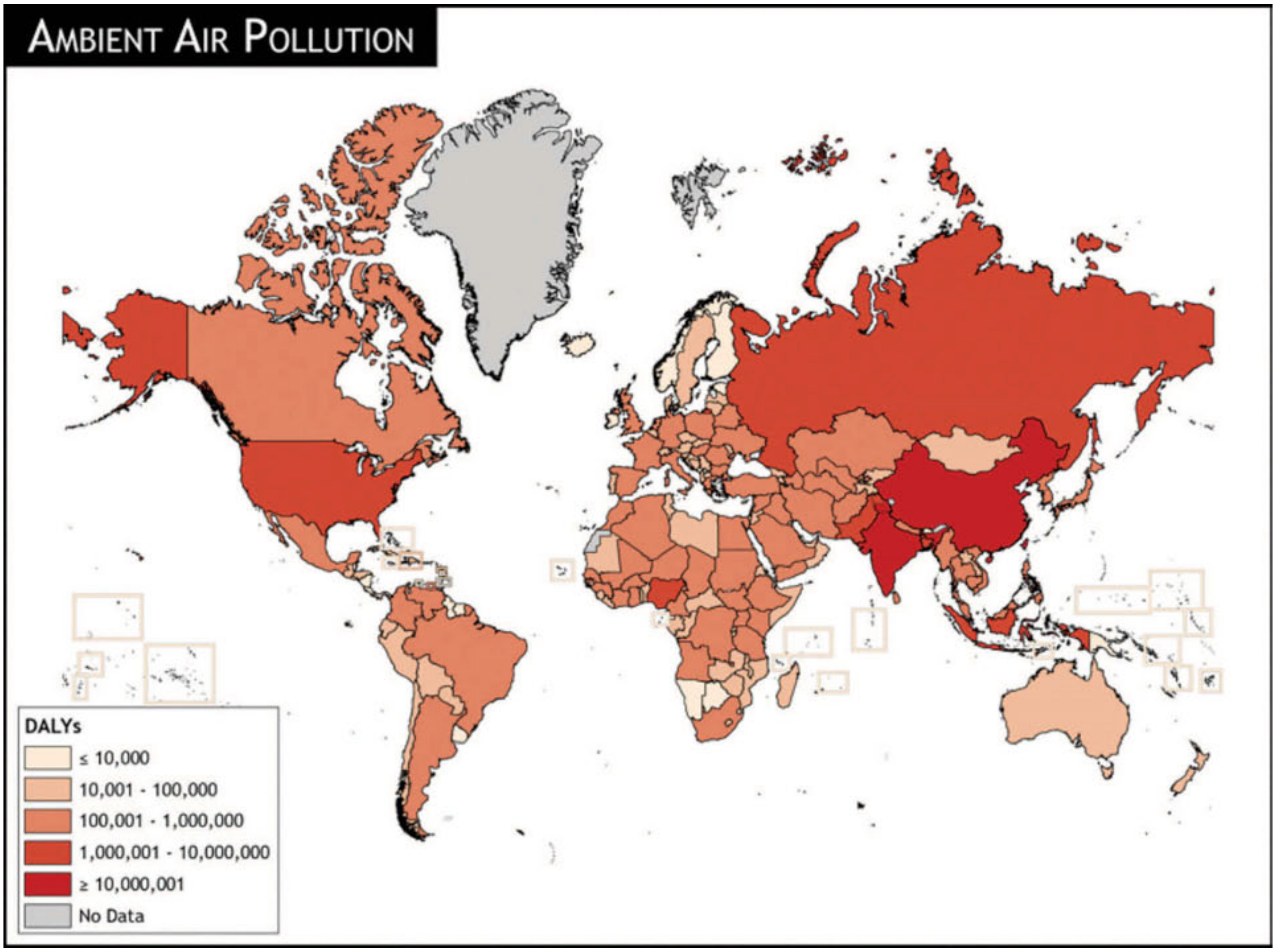
There are multiple opportunities to contribute to low-carbon healthcare development. This section summarizes low-emission interventions and solutions that are relevant to low- and middle-income countries under the main headings of infrastructure development, operational delivery, models of care, and financial considerations. The interventions described fall under the GHG emission reduction scopes, summarized in Table 2.3.

Infrastructure Development

This section addresses the planning, design, and construction of spaces to deliver healthcare services. Most of the interventions highlighted in this section apply to a wide range of care delivery settings, from inpatient to ambulatory. There are some design features, however, that are particularly important in patient care areas, such as providing access to daylight and views in patient rooms, which can lead to shorter patient stays.[60] As such, these features drive several design considerations that are especially important in hospitals.

The constant high demand for heating energy, primarily for heating water for sterilizers and domestic hot water, suggests that thermal heating systems (e.g., combined heat and power and solar water heating) are likely to be even more beneficial to healthcare facilities.

Figure 2.1: Burden of disease attributable to ambient air pollution.



Source: *Geographic Hotspots for World Bank Action on Climate Change and Health* (2016).

Building and system design and construction (also Table 2.4). The design and architecture of buildings should incorporate low-carbon approaches[61] by initially considering the siting and orientation of buildings to optimize solar shading and natural ventilation, which will help keep buildings comfortable. This is particularly important for in-patient bed unit areas. Configurations that feature narrow floor plates facilitate both daylighting and natural ventilation, and improve indoor environmental quality. The design of buildings should maximize the building envelope performance to avoid overheating in hot weather and heat loss in cold weather. Incorporating high efficiency heating ventilation and air conditioning (HVAC) equipment, high-efficiency electric lighting, and energy-efficient equipment will further reduce energy consumption. Other specific considerations might include:

- ***Passive solar heating and cooling strategies***, such as overhangs, shading devices and enhanced thermal envelope performance, moderate temperature changes, reducing the need for mechanical heating and cooling and cutting energy consumption.
- ***Natural and mixed mode ventilation*** can produce higher air exchange rates than typical mechanical ventilation systems while reducing energy demands and their resulting greenhouse gas emissions. The use of natural ventilation can improve reliability and resilience of health facilities, such as those designed to treat multi-drug-resistant tuberculosis in South Africa. WHO has produced guidelines for natural ventilation for infection prevention and control[62] and published a design for natural ventilation model for healthcare centers.[63]
- ***Preserving and enhancing the natural environment*** and vegetation is particularly suited to warmer climates with higher

Table 2.3: Climate-smart interventions and the related GHG scopes.

INTERVENTIONS TO REDUCE GHG EMISSIONS	SCOPE 1	SCOPE 2	SCOPE 3
Infrastructure development:			
Buildings' design and construction: new and retrofit	x	x	x
Operational delivery:			
Energy including efficiency and renewables	x	x	
Waste disposal			x
Water	x		
Transport and Travel including planning, own fleet and tele-solutions	x		x
Food including purchasing and waste reduction			x
Procurement and supply chain engagement			x
Pharmaceuticals			x
Waste anaesthetic gases and health sector refrigerants	x		
Service delivery and low-carbon models of care	x	x	x

precipitations and will ensure more shade, and improved rain-water management.

- ***Reducing water consumption*** in mechanical water treatment and delivery saves water and energy as well. Reducing the need for water, through native or drought tolerant planting, coupled with on-site rainwater harvesting and storm water management strategies that capture rainwater and recharge groundwater supplies, both reduce water consumption and enhance resilience to climate change.
- ***Building materials*** impact the health of building occupants and the health of the workers who create the materials and use them to build facilities. Using local materials reduces the energy consumed to transport them and supports local economies. Selecting materials that avoid the use of hazardous substances (e.g., mercury, lead, and cadmium) will reduce exposure by building occupants.
- ***Green building design*** tools and accreditation mechanisms exist, including a few specific to healthcare buildings. Examples include: EDGE certification system for hospitals, The Building Research Establishment Environmental Assessment Method, the Leadership in Energy and Environmental Design (LEED) for Healthcare, and the Green Building Council of Australia's Green Star–Healthcare. The latter two approaches were based upon the earlier Green Guide for Health Care.

These tools have mostly been designed in a developed world context, yet have been deployed in numerous developing countries. While the principles of clean energy and the appropriate siting of buildings remain, some features might need to be adjusted to account for specific climate variations and extreme weather vulnerabilities, and there are several examples of green building in healthcare in low- and middle-income countries.[64]

Case Study 1: Low-Carbon Building—India

Kohinoor Hospital in Mumbai[74] is committed to reducing its environmental impact while reducing costs to patients. The hospital opened in 2009 and is LEED certified, relies on low-energy light bulbs, uses photovoltaic power to heat its water, harvests rainwater, and treats its own sewage to reduce water use. Kohinoor Hospital also installed high-efficiency wall and window systems and an air-conditioning plant, resulting in an energy use intensity of 166 kwh/m^2/year (53 kBTU/ ft^2/year).

Case Study 2: Low-Carbon Building—Rwanda

Butaro Hospital,[65] a collaboration amongst Partners in Health, the Rwandan Ministry of Health, and MASS Design, reduces its energy consumption by using narrow floor plates, natural daylight, and natural ventilation, along with high-volume, low-speed fans and germicidal UV lights to provide energy efficient ventilation while controlling the transmission of airborne diseases. Local materials from the nearby Virunga Mountains were also used to decrease carbon footprint and contribute to the local economy. The overall approach reduced the facility's price tag by 1/3, saving US$2 million while producing over 4,000 jobs.*

* Mass Design Group, The Butaro District Hospital. https://massdesigngroup.org/work/design/butaro-district-hospital, last accessed 17 January 2017.

While green building tools have not specifically addressed climate resilience, many sustainable building strategies—from energy and water demand reduction to daylighting, to reliance on passive systems—enhance hospital and health sector resilience.

Building Retrofit

Many of the strategies for new buildings can be applied to retrofitting existing buildings, even though healthcare settings pose challenges in terms of their technical requirements. Retrofits should

Table 2.4: Low-carbon building interventions and benefits.

LOW-CARBON BUILDING DESIGN AND OPERATION CONSIDERATIONS		
CATEGORY	INTERVENTION	BENEFIT
Building Site and Context	Climate zone and biome identification	Energy savings by designing building to be responsive to specific local climate
	Site and orient building to maximize solar orientation and wind patterns	Reduces heat load and maximizing passive benefits of natural ventilation
	Site planting and reflective paving	Reduces heat island effect
	Preserve existing vegetation	Maximizes shading from mature trees; stabilizes soil and preserves habitat
	Accommodations for public transportation, bicycles and walking	Encourages active transportation and reduces transportation GHG emissions
	On-site renewable power generation	Reduces GHG emissions and increase resilience to climate change
Building Form	Narrow floor plates	Maximizes daylighting and natural ventilation*
Building Exterior	Enhanced building thermal envelope	Reduces heating and cooling load*
	Reflective roofing	Reduces solar heat load; reduces heat island impacts
	Renewable power generation	Reduces GHG emissions and increase resilience to climate change
	Shading by overhangs or planting	Reduces solar heat load
	Operable windows	Enables natural ventilation
	Use of local materials	Reduces energy to transport materials; supports local economies
Space Heating and Cooling	Natural ventilation	Energy savings from passive heating and cooling
	Zone temperature control	Reduces heating and cooling energy*
	Mixed mode ventilation	Reduces heating and cooling energy*
	Partial air recirculation	Reduces heating and cooling energy*
	Heat recovery	Reduces heating and cooling energy*
	Variable flow systems	Reduces fan energy
	Ground source heat pumps	Reduces heating and cooling energy
	Combined heat and power	Energy savings by using waste heat from power generation for thermal energy; reduces transmission losses for power; improves resilience
	Night or unoccupied setbacks	Reduces heating and cooling energy
	Commissioning building systems	Energy savings through more efficient systems operation
Lighting	Daylighting	Energy savings by using passive illumination*
	Low energy light fixtures	Reduces energy consumption
	Accessible lighting controls	Reduces energy consumption
	Automated lighting controls	Reduces energy consumption
Water Heating	Low-flow water fixtures	Reduces use of hot water
	Cold water detergents in laundry facilities	Reduces use of hot water
	Combined heat and power waste heat used to heat water	Energy savings from using waste heat for hot water
	Solar water heating	Reduces GHGs from heating water; energy savings from solar water heating

LOW-CARBON BUILDING DESIGN AND OPERATION CONSIDERATIONS		
CATEGORY	INTERVENTION	BENEFIT
Equipment	Include energy efficiency in equipment selection criteria	Reduces energy consumption
	Implement sleep mode on computer equipment	Reduces energy consumption
Operations and Controls	Energy management systems	Reduces energy consumption
	Turning off lighting and equipment when not in use	Reduces energy consumption

*As there is a clinical benefit to providing access to daylight and views in patient rooms (studies have shown that high levels of daylight in patient rooms can lead to shorter patient stays[67]), daylighting gains added significance in a hospital setting. Similarly, healthcare's need for heat create an opportunity for benefits from combined heat and power and solar water heating. These interventions drive design considerations that are especially important in hospitals.

Source: *Health Care Without Harm.*[68]

begin with an energy audit to maximize the value of the ensuing work.[66] An energy audit highlights the building systems that consume the most energy and can identify system deficiencies, such as leaks, that can generate energy savings and cost savings through routine maintenance and repairs. Improving the controls of building systems through recommissioning, adding building energy management systems, occupancy sensors, and hospital staff initiatives to turn off lights and equipment can fine-tune existing systems and reduce energy use.

Building system innovation in recent years has focused on energy and water conservation, resulting in new high-efficiency mechanical equipment. Replacing inefficient mechanical equipment, such as old boilers, with high-efficiency substitutes can also require significant capital outlays. Often hospitals begin retrofit efforts with incremental improvements, such as replacing existing lighting with high efficiency LED lighting before implementing more capital-intensive projects, using incremental savings to pay for the additional efficiency measures.

Case Study 3: Building Retrofit—South Africa

The Western Cape Government has eliminated the coal- and oil-fired boilers at nearly all its 53 hospitals. Annual savings from Lentegur hospital's laundry efficiency measures alone include more than 19 million liters of water, over 550 metric tons of CO_2e, and at least US$62,000 in costs. Extrapolating for all Western Cape Government hospitals, the savings would add up to US$3.3 million annually.

Augmenting existing systems with renewable sources, such as solar water heating, reduces the amount of heat energy needed from existing fossil fuel-based heating and cooling systems and reduces energy consumption. Changing processes can also reduce energy consumption, such as the use of cold-water detergents in a hospital laundry facility to reduce energy consumption.

Operational Delivery of Healthcare Functions

Low-carbon healthcare transcends all aspects of health sector delivery and so must include all operational aspects and subsequent impacts on energy, transport, and items purchased.

Energy

The healthcare sector is a major energy consumer. Many of its buildings operate continuously and require energy intensive interior climate and ventilation control for the safety and well-being of patients and staff. As such, fostering more efficient and sustainable energy use is essential in low-carbon healthcare.

Standard care delivery processes for most large hospitals require significant energy use (for heating water, temperature and humidity controls for indoor air, lighting, ventilation and numerous clinical processes) with associated significant financial cost and greenhouse gas emissions. For instance, in India a study of 140 hospitals found that multi-specialty facilities have an average annual energy consumption of 378 kWh/m^2 of built area, which is the most energy-intensive commercial sector in the country.[68]

Yet gains in energy efficiency can be made without sacrificing the quality of care. Hospitals in Mexico and Brazil, India, and Poland have implemented basic measures to save money, strengthen facility resiliency, and reduce energy demand by 20 to 30 percent.[65]

Healthcare facilities can also significantly cut greenhouse gas emissions and energy costs over time by using alternative forms of clean and renewable energy, such as solar and wind energy, and biofuels that do not undermine local food production or community land tenure.

Alternative energy sources can be used for lighting, heat generation, and pumping and heating water. These can be either standalone on-site installations or integrated with community-wide renewable energy installations.

Alternative clean, renewable energy makes both good environmental and economic sense, particularly when financing mechanisms are structured to support this shift. At the same time, given its formidable energy demands, health sector investment can play an important role in shifting the economies of scale and making alternative energy more economically viable for everyone.

For regions that have no access to reliable municipal electricity, alternative energy sources can fuel primary healthcare facilities in even the most remote areas. In energy-poor settings, the use of low-energy and no-energy medical devices, together with deployment of renewable energy sources, can improve access to basic health services. Finally, renewable energy sources give health facilities an advantage in terms of disaster preparedness and resilience, as on-site renewable energy sources are often less vulnerable to damage and disruption than traditional grid-based power systems.

Key steps for achieving energy efficiency in healthcare:[70]

1. Assess energy usage patterns and needs for the facility and community; measure and benchmark energy performance.
2. Develop an energy management plan.
3. Ensure equipment and systems are operating at peak performance to optimize energy efficiency.
4. Minimize energy use in, heating (including water), cooling, ventilation, and equipment.
5. Implement co-generation systems such as combined heat and power.
6. Empower staff to reduce energy consumption (e.g., Case Study 4).
7. Conduct regular energy audits and use results to inform awareness and retrofit programs.

Case Study 4: Energy Efficiency—South Africa

Victoria Hospital, Cape Town empowered hospital workers through its "switch it off campaign." Cleaners and housekeepers in this 180-bed secondary facility seek to ensure that unused lights and hospital equipment are switched off. This project resulted in the small but not insignificant saving of US$8,400 annually and boosted the morale of the cleaners and housekeepers, making them feel more recognized within the hospital.

Energy Efficiency and Capital Intensive Medical Equipment Provision and Replacement

Equipment such as X-Ray machines can be energy-intensive and therefore costly to operate, and can generate significant heat while operating. Often the equipment is not in constant use, but cannot be easily shut down to be available when needed. More attention is required to improve the energy efficiency of major medical equipment, along with the need for reliable functionality.[71,72]

When selecting energy efficient equipment[73, 74] it is important to assess the energy consumption of the equipment in standby and sleep mode, the heat output and the energy that will be needed to cool the space around the equipment, and the lifecycle of the product (where and how it is manufactured, transported, used, and disposed of). The energy efficiency of medical equipment also should be viewed alongside the need for reliable functionality.[75, 76] For example, among low-energy and carbon-neutral equipment, LED microscopes are more reliable and operate on daylight or low light[77] and solar cold-chain refrigeration for medications and vaccines provides reliable temperature control.[78, 79]

Case Study 5: Energy Efficiency and Health Co-Benefits—Mexico

Torre de Especialidades in Mexico City reduces pollution by actively removing smog from the surrounding air. The hospital is surrounded by a giant, honeycomb-like screen that is coated with titanium dioxide, which converts smog into benign chemicals upon contact. The screen also blocks sunlight, which reduces the amount of energy it takes to cool the air within the hospital.

On-site renewable energy can serve those areas without access and enable health facilities to operate out of daylight hours and provide a wider range of services.[80] On-site renewable energy sources such as solar photovoltaics or wind for electricity, and thermal solar energy for heating water provides a low-carbon and reliable form of energy for facilities in low-, middle-, and high-income settings alike.[81, 82, 83]

Small-scale hydroelectric power can also provide a source of renewable energy for health facilities in developing countries. For instance, a WHO and WBG report on energy in resource constrained settings[84] identified hospitals in Rwanda, Zambia, Uganda, and the Democratic Republic of Congo (DRC) that use or have developed hydropower facilities individually or in tandem with nearby communities. One example cited is in DRC where the Catholic University of Graben-Butembo has invested heavily in solar and hydroelectric projects with support from USAID.

Minimizing or eliminating the use of fossil fuels on-site by switching to renewable sources can reduce GHGs that contribute to climate change and improve local air quality by eliminating air pollutants associated with burning fossil fuels. Where facilities are already supplied by centralized grid power systems, installing on-site renewables can yield significant operational cost savings as well as facility resilience in times of short-term grid disruption.[85]

Co-generation, or combined heat and power (CHP), provides immediate energy savings and improves operational resilience and reliability.[86, 87] Hospitals and commercial building developers in countries such as India, China, and Brazil, are exploring and investing in CHP systems as either a primary or backup energy source.[88]

The WBG is actively partnering with the Sustainable Energy for ALL (SE4All) initiative,[89] which calls on governments, businesses, and civil society to increase access to electricity and clean household fuels and expand the use of renewable energy and energy efficiency. These have a direct correlation to resilience in many countries because healthcare facilities can be energy self-sufficient. The WBG also has developed a toolkit for the deployment of renewable energy.[90]

Case Study 6: Renewable Energy—Uganda

Uganda health centers with solar PV for lighting improved their night services, especially maternal care, and were better able to handle emergencies due to more reliable electricity. Information and communication services improved, as members of staff could finally charge their mobile phones, and the health centers reduced their lighting costs compared to the use of kerosene lamps. Benefits to health from reduced air pollution, and to the quality of services through improved and more reliable lighting are significant co-benefits of installing on site renewable energy.

Case Study 7: Renewable Energy—USA

Gundersen Health in the U.S. achieved energy independence by reducing energy consumption and using multiple renewable energy generation systems. Its regional partnerships in energy creation include dairy digesters (renewable energy through manure/methane use), turbines, and a landfill gas-to-energy initiative. Local projects also include geothermal energy and a biomass boiler. By integrating its energy systems with the local agricultural economy, Gundersen Health engaged with the community, contributed to the local economy, and converted its neighbor's waste into energy for the hospital. Gundersen's accomplishments include improved energy efficiency of over 40 percent, resulting in annual savings of nearly US$2 million from conservation alone. Many of Gundersen's strategies are readily applicable to low- and particularly to middle-income settings.

Waste Management

The health sector generates significant volumes of waste that must be safely disposed of, including infectious waste such as sharps and bandages, human tissue, and other hazardous waste including heavy metals, pharmaceuticals, and other chemicals. The UN Special Rapporteur has cited mismanagement of healthcare waste as a violation of human rights in many countries.[91] A recent review concluded that approximately 50 percent of the world's population is at risk from occupational, environmental, or public health threats from improperly treated medical waste.[92]

The incineration of healthcare waste involves the generation of climate-relevant 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 such as dioxins and furans.[94,95] Under low-carbon healthcare, it is essential that healthcare waste management is conducted safely to protect patients, health workers and surrounding communities, as well as with minimal environmental impact. Waste minimization is the baseline point for effective waste management processes.

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.[96] Alternatives to incineration for healthcare waste treatment have been recommended to reduce the emission of dioxins and furans required by the Stockholm Convention.

Because less than 20 percent of waste in healthcare settings is hazardous,[97] it is necessary to effectively segregate waste to ensure that only hazardous waste receives special treatment as required, while other wastes can be recycled or reprocessed as in other industrial sectors. WHO has called for the phasing-out of incineration[98] as a long-term strategy and, together with the UN Development Programme (UNDP) and Health Care Without Harm, has modeled alternative technologies in seven countries in a project funded by the Global Environmental Facility. Additional research is needed in regards to the healthcare waste treatment methods that mitigate climate change.

Anesthetic Waste Gases

Controlling waste anesthetic gases can have a significant impact on a hospital's overall greenhouse gas emissions. For example, the impact of Nitrous Oxide (N_2O) on warming the atmosphere is almost 300 times that of CO_2.[99] Anesthetics, such as isoflurane, desflurane, and sevoflurane, have been estimated to have a global warming potential 500 to 3,700 times that of equivalent amounts of CO_2 over a 20-year period.[100, 101, 102] A study by the NHS SDU[103] in England found that, for acute care organizations such as hospitals, the global warming impact from waste anesthetic gases is equivalent to around half the emissions used to heat buildings and water. An anesthetic gases calculator tool is available to support calculations and establish a baseline from which to reduce GHGs.

There are several practical carbon mitigation strategies related to anesthetic gas use that can be adopted and included in professional anesthesiology training programs. These gases can be either captured and reprocessed or substituted for alternatives such as total intravenous anesthesia, as well as neuraxial or peripheral nerve blocks, which have much lower carbon footprints. For instance, desflurane and N_2O can be restricted to cases where they may reduce morbidity and mortality over alternative drugs. Clinicians can avoid unnecessarily high fresh gas flow rates for all inhaled drugs. There are also waste anesthetic gas capturing systems.[104]

Case Study 8: Anesthetic Gas Waste—Brazil

In 2012, Sao Paulo's Albert Einstein Hospital conducted a study that identified that N_2O contributed to more than 50 percent of the GHG emissions it was tracking (7,220 tCO_2e out of a total of 12,998 tCO_2e). Research shows that these gases accumulate in the atmosphere and contribute to climate change. The hospital created an interdisciplinary team to increase awareness of the issue, and reduced its use of N_2O for anesthetic procedures by 23 percent.

Water

Water use and its treatment can be energy intensive, carrying a carbon and financial cost that can be minimized through low-carbon, water-efficient strategies. The wide variation of uses throughout a typical hospital offers many opportunities for water consumption management, engaging all departments and personnel. Depending on the climatic zone and availability of water as a natural resource, it also presents an opportunity to manage the use of water to ensure access to reliable potable water, water conservation, and the sound management of wastewater discharge.

Water efficiencies can be achieved through technology such as rainwater harvesting, grey water reuse, air conditioning condensate capture, water-saving faucets, low-flow sanitary fixtures, and water efficient equipment and systems. Additionally, optimizing cooling tower water consumption by eliminating once-through cooling, and behavior change (e.g., timely repair of leaks and use management) also can have an impact.[105]

Another key factor is the resilience of water management systems in times of emergency, both climate-induced and otherwise. Floods can overwhelm municipal potable water delivery. Droughts can challenge the reliability of water supply. Seismic events can damage water treatment and conveyance infrastructure. Access to potable water can be interrupted, causing public health crises. Designing redundancy and reserve storage capacity into the supply and disposal systems to enable continued delivery of healthcare services during a water supply crisis is a key element of quality healthcare delivery.[106]

Case Study 9: Low-Carbon Waste Management—Nepal

Bir Hospital in Kathmandu installed 248 solar panels with the support of the World Bank, providing 60KVA of electricity for critical care units. Bir Hospital also received international recognition for its waste reduction efforts, which are considered as much a humanitarian feat as an environmental one. The hospital cut its medical waste in half and now recycles 55 percent of all waste, which provides income to the hospital. Bir uses autoclaves to treat its infectious waste, including sharps, reducing emissions from small-scale incinerators. The hospital is experimenting with new methods to reduce waste further, including vermicomposting and a biogas system that turns food waste into biogas is generating 1KW of electricity for cooking in the hospital kitchen. All contribute to reducing carbon emissions, as less waste needs to be incinerated, and rely on alternative forms of energy.

Case Study 10: Transportation—Tunisia

The Kasserine region of Tunisia piloted an approach to increase the energy efficiency of the distribution of vaccines and temperature-sensitive drugs. The existing distribution system was modified to store vaccines and medicines in the same buildings and to transport them along prescheduled and optimized delivery circuits. Electric utility vehicles, dedicated to the integrated delivery of vaccines and medicines, improved the regularity and reliability of the supply chains. Solar energy, linked to the electricity grid at regional and district stores, supplied over 100 percent of consumption, meeting all energy needs for storage, cooling, and transportation. Supply trips were scheduled, integrated, and reliable. Energy consumption was reduced.

This initiative cut the recurrent cost of electricity and reduced the release of carbon to the atmosphere. Such an approach could be particularly relevant in countries where energy costs threaten the maintenance of public health services in areas of low population density. In these countries where the mobility of health staff and the timely arrival of supplies is at risk, there is considerable potential to reduce energy costs and release recurrent budgets to other service needs while also improving the effectiveness of the supply chain.

Transport and Travel

Implementation of low-carbon travel and transport strategies is a key component of low-carbon healthcare and can also have a co-beneficial significant impact in terms of reducing air pollution and its associated health impacts. The following are three key strategies to foster low-carbon transport and travel:

- **Transportation planning.** Promote integrated travel planning with municipal agencies so patients and staff can access services easily and, wherever feasible, reduce the reliance on roads. Health facility planning with access to public transportation improves access to facilities for patients and health workers.[107] For instance, a new health facility might be sited close to a main bus terminal or with an easy pedestrian link from the railway station.
- **Tele-health.** Many forms of service delivery can be achieved through tele-health strategies that provide quality healthcare and reduce transportation emissions. Tele-health offers the ability to make the health sector more resilient, smaller, less resource-intensive, and more cost-effective. For instance, telemedicine services can reduce demands on space in often crowded healthcare facilities. Cost savings realized also free up resources for delivery of more healthcare services.
- **Low-emission vehicles.** Health service fleets could be migrated to low-emission type vehicles such as electric cars, with recharging located in the hospital grounds. In some circumstances, bicycles or motorcycles might be more effective in delivering the required service, due to traffic congestion, for example.

Food

Food is not only a pillar to good health, but is also provided in many healthcare settings. Low-carbon healthcare considers both the nutritious value of food and the ways in which carbon impact of food manufacture, delivery, and waste can be reduced.

The IPCC estimates that agriculture and land use change are responsible for 24 percent of global emissions, greater than emissions from industry and more than the combined emissions of transportation and buildings.[108] Health systems in many countries purchase significant amounts of food and can help to reduce the climate impact from agriculture by purchasing and serving foods that are produced less carbon-intensively.

There are four key purchasing and operational strategies for healthcare to reduce its climate impact from food service:

Reduce the use of meat and cheese: Livestock production contributes 14.5 percent of the world's GHG emissions.[109] Beef and cheese have the highest climate impact of all foods as cows consume more feed, and their digestive system produces more methane (a GHG 72 times more powerful than CO_2) than other livestock.[110] Even eliminating meat for one day each week, where culturally feasible and without reducing the nutritious value of the diet, can help reduce emissions. A healthy, balanced, and low-carbon diet can be beneficial to health by reducing risk factors for diseases such as diabetes, cardiovascular disease, and hypertension.

Purchase sustainably-grown foods: The manufacture and use of nitrogen fertilizers is the second-highest source of GHGs from food production. N_2O is released into the atmosphere when nitrogen fertilizers are manufactured and applied to fields. Agriculture is responsible for 60 percent of global N_2O emissions.[111] Healthcare facilities can reduce their climate impact while supporting local economies by purchasing local food that is organically or sustainably grown.

Reduce food waste: Preventing food waste and diverting unused food from landfills is another powerful way to reduce climate impact. If it were a country, food waste would be the third largest source of GHG emissions globally.[112] When food is discarded, the waste embodies all the associated emissions from its production and it generates significant quantities of methane when decomposing in landfills. Halving wasted food globally by 2050 could reduce emissions by an estimated 4.5 Gigatons (Gt).[113] Healthcare facilities can work to prevent food waste by conducting an audit to identify reduction opportunities. In cases where waste cannot be avoided, it can be diverted from landfills for use in animal feed, composting, or generation of biogas (see Case Study 9 from Nepal).

Use energy-efficient technologies for cooking and dishwashing (see preceding section on energy).

Case Study 11: Low-Carbon Food—Taiwan

Tzu Chi Hospital, Taiwan is a Buddhist hospital that provides vegetarian food only. The hospital's cafeteria is supplied by an organic farm within the compound which is also used as horticultural therapy for patients with mental health challenges. The Hospital is proud to be reducing carbon emissions, promoting a healthy diet, promoting a natural and healing environment as well as encouraging more well-being in staff and patients. The hospital calculates during the period of 2010–2014 they saved over 2,000 tons of carbon emissions through serving over 2 million vegetarian meals in their cafeteria and food court. Cultural differences mean that this approach may be harder to translate to other countries, however in many contexts, steps towards a more balanced and less meat-orientated diet is beneficial.

Case Study 12: Less Meat, Fewer Emissions—USA

The University of Washington Medical Center in Seattle has used several strategies to reduce the amount of meat it purchases and serves including hosting "Meatless Mondays," increasing vegetarian options, reducing meat portion sizes, and focusing more on vegetables and other forms of protein, such as fish and beans. The facility's efforts have cut food consumption-related GHG emissions in the facility by 11.8 percent.

Procurement and Supply Chain

Supply chain-related emissions accounts for at least 65 percent of the carbon footprint of England's National Health Service and 82 percent of the carbon footprint of UNDP-administered Global Fund for HIV/AIDS and Tuberculosis projects in Tajikistan.[114,115] It may be extrapolated that proportions are similar in other health settings and, as such, procurement represents a major potentially significant contributor to low-carbon healthcare. A large percentage of NHS England's procurement carbon footprint rests with pharmaceuticals (21 percent) and medical devices (11 percent). By engaging with its supply chain to stimulate changes across industrial sectors, healthcare can support the development of low-carbon products and innovative solutions in these areas and others.

Case Study 13: Procurement—UN

The UN interagency initiative on sustainable procurement in the health sector counts 10 members (UNDP, UN Environment Programme, UN Population Fund, UN Refugee Agency, UNICEF, UN Office for Project Services, WHO, GAVI, the Vaccine Alliance, the Global Fund to Fight AIDS, Tuberculosis and Malaria, and the UNITAID initiative). They are committed to establishing sustainable practices in the procurement of health sector products and services. Its focus includes GHG emissions, resource depletion (water, energy and material consumption), and chemical pollution. These UN agencies have developed a joint strategy to engage systematically with suppliers and manufacturers and expect to establish evidence-based standards, implement environmental product specifications and criteria, and engage with supply chain and global health financing groups.

Within the WBG itself, procurement is a critical phase of a project and ensuring that it is sustainable can have considerable impact over the lifecycle of a project. A first step in this direction could be for health systems or for financers, like the WBG, to require suppliers to estimate their carbon footprint, and of their products, as part of any contract. Identifying an organization's top 10 suppliers is a useful starting point to discuss its approach to climate change mitigation and to integrate requirements into contractual clauses. For instance, suppliers could be asked to reduce packaging and make it more reusable, to consolidate supplies for ease of transportation, to consider using more local produce, and to reduce the carbon footprint of manufacturing. Small- and medium-sized enterprises (SMEs) might require support given their smaller size, though they are generally well placed to help encourage local economies. The U.K.'s Procuring for Carbon Reduction tools[116] provide a framework to estimate the carbon footprint of procurement activities and guidance to establish an approach going forward. The Sustainable UN initiative (SUN, also known as 'greening the blue')[117] also has a variety of procurement tools available, including criteria for shipping and freight to reduce carbon.

Pharmaceuticals

The carbon footprint of pharmaceuticals is estimated at 21 percent of the overall footprint of the health sector in England,[118] a significant number that is viewed as a conservative estimate.[119] Work is underway to identify the relative difference between product categories, including a report detailing the top 10 most relevant drugs used in the NHS.[120] Propellant N_2O inhalers, for instance, represent 4.3 percent of the carbon footprint in the health sector in England.[121] These products are most often manufactured in emerging economies where their production has environmental health impacts on those communities. Encouraging innovation for safe, low-carbon pharmaceutical production and the development of 'green pharmaceuticals'[122] is crucial across the sector. At the same time, the health sector has a responsibility to minimize the use and waste of pharmaceutical products, ensuring that they are prescribed and utilized as effectively and efficiently as possible.

Improved management and sustainable procurement processes for pharmaceuticals can reduce the overall quantity of products manufactured and purchased. This would lead to reduced emissions from waste disposal, particularly of hazardous waste, and cut the energy required for waste disposal due to reduction and substitution of toxic chemicals. It would also diminish the energy footprint of production of unused/expired pharmaceuticals and products, and their transport. For instance, reducing pharmaceutical use by 2.5 percent was identified as the highest-impact carbon reduction intervention in a study in England.[123]

The health sector's influence on the use and disposal of pharmaceuticals can lead to strategies that will reduce the carbon footprint and improve the efficiency of services by:

- Establishing clear prescribing practices and only prescribing medicines when necessary. This is a driver for many other health improvement and medicine optimization initiatives.[124]

- Encouraging early patient diagnosis and management/intervention and supporting patient compliance that will promote longer, healthier living and reduce GHG emissions.[125]
- Reducing and greening the packaging of pharmaceuticals. Pharmaceutical packaging is a US$20-billion industry, expected to grow to US$78 billion by 2018.[126, 127] Most pharmaceutical packaging is destined for landfill or incineration, presenting a significant opportunity for greening this segment of the healthcare supply chain.
- Minimizing wastage in medicine usage. The NHS estimates that £300 million a year is wasted in prescribed medicines and has identified ways of addressing this through waste reduction campaigns, support to care homes and repeat prescription management approaches.[128]
- Ensuring low-carbon product manufacture, transport, and delivery through systematic engagement with the supply chain (see Case Study 13 on UN procurement).

Health sector refrigerants: Hydroflourocarbons (HFCs) are man-made greenhouse gases used in air conditioning, refrigeration, and other applications. Many HFCs are short-lived climate pollutants, remaining in the atmosphere for less than 15 years. Though they represent a small fraction of the current total greenhouse gases (less than 1 percent), their warming impact is particularly strong and, if left unchecked, HFCs could account for nearly 20 percent of climate pollution by 2050.[129] WHO is proposing that future specifications require that healthcare refrigerants with a high global warming potential, such as HFCs, be phased out over 2 years.[130]

Service Delivery and Models of Care

Every aspect of health sector delivery comprises opportunities for climate-smart approaches. Many of these can be considered by delivering healthcare through less infrastructure-intensive mechanisms; for instance, through telemedicine and the use of mobile technology and applications. Support for chronic disease management can often be more effective through mobile phone apps and telemedicine can provide alternative ways of providing expert support to rural facilities.

Clinics can also be brought closer to communities by utilizing local facilities such as schools, libraries or town halls, and by providing support for care to be provided at home. Likewise, clinics within communities can provide other services: local farming, water treatment, composting of community food waste, and essential public health infrastructure, and health management support. With appropriate local backing, many hospitalizations can be avoided. These approaches, while fostering better health outcomes, are also low-carbon. Studies on tele-health, tele-care and home monitoring methods have documented improved outcomes for a wide range of health conditions, including diabetes, mental health, high-risk pregnancy monitoring, heart failure, cardiac disease, lung disease, orthopaedic conditions, and chronic wounds.[131, 132]

Low-carbon models of care that naturally utilize less resources and focus on improving health in communities are closely aligned with models being developed in low- and middle-income countries, particularly in rural and remote areas. These models provide a useful approach that could be adopted worldwide.[133]

Financial Considerations

Low-carbon healthcare can bring multiple benefits to societies where access to clean energy, safe water, clean transportation and clean waste management are far from universal. The effect of these measures can save lives, protect public health, and support local economic growth.

Many initiatives can save money over the short, medium and long term. Greater impact can be realized through better calculation of the indirect financial returns, such as improved health (from reduced pollution), improved resilience through renewable energy, improved supply chain management, and stimulation of local economies.

The NHS Sustainable Development Unit (SDU) in the UK has shown that it is possible to calculate returns in terms of social, economic, and environmental benefits. It has estimated healthcare savings totaling £5.1 million through tele-health and tele-care services for people with long-term health conditions, while also yielding a reduction of 67,000 tons of CO_2 and an improvement of 5,671 Quality Adjusted Life Years (QALY).[134]

A study published by the US Commonwealth Fund examines data from selected hospitals that have implemented programs to reduce energy use and waste and achieve operating room supply efficiencies. After standardizing metrics across the hospitals studied and generalizing results to hospitals nationwide, the analysis found that savings achievable through these interventions could exceed US$5.4 billion over 5 years and US$15 billion over 10 years. Given the return on investment, the authors recommended that all hospitals adopt such programs and, in cases where capital investments could be financially burdensome, that public funds be used to provide loans or grants, particularly to 'safety-net hospitals.'[135]

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, some of which are cited in this paper, provide anecdotal evidence for a series of economic benefits related to implementing environmental sustainability initiatives in health facilities in a diversity of economic settings.[136] This is clearly worth exploring further to develop a systematic evidence base.

Calculating return on investment

There are tools for calculating the best returns for reducing emissions in the health sector. These are based on standard return on investment (ROI) calculations, linked to carbon emissions reductions on a yearly basis. The NHS marginal abatement cost curve (MACC)[137] (Figure 2.2) lists several health-related carbon interventions that showed returns in fewer than 5 years. Most interventions it identified saved money and carbon. The curve has been recently updated and identified yearly savings of £414m and 1MT CO_2 by 2020 through changes that also benefit people's health.[138] Other examples of this include: a UNDP-developed marginal abatement cost curve for global health fund projects in Montenegro and Tajikistan[139] as well as the WBG EDGE Tool, which can provide ROI estimates for hospitals.

Some interventions require upfront investment, such as the installation of renewable energy. However, such investments fuel economic growth, create new employment opportunities, enhance human welfare, contribute to a climate-safe future, and yeld economic returns in the medium term.[140]

Increasingly, power purchase agreements in some countries enable institutions such as hospitals to contract for renewable energy without needing to provide the initial funding for the capital investment in the applied renewable technology.[141] The International Renewable Energy Agency provides assessments as to the renewable energy development potential in several countries.[142]

Case Study 14: Renewable Energy—Zimbabwe

A UNDP pilot study on renewable energy planning for rural health centers and clinics in Zimbabwe found that a power source using a hybrid system based on PV panels brings significant carbon savings compared to the business as usual (BAU) solution of burning fossil fuel derived diesel. The carbon payback of the system was determined at less than 2 years, with it being cost-neutral compared to the BAU system in only 4 years.

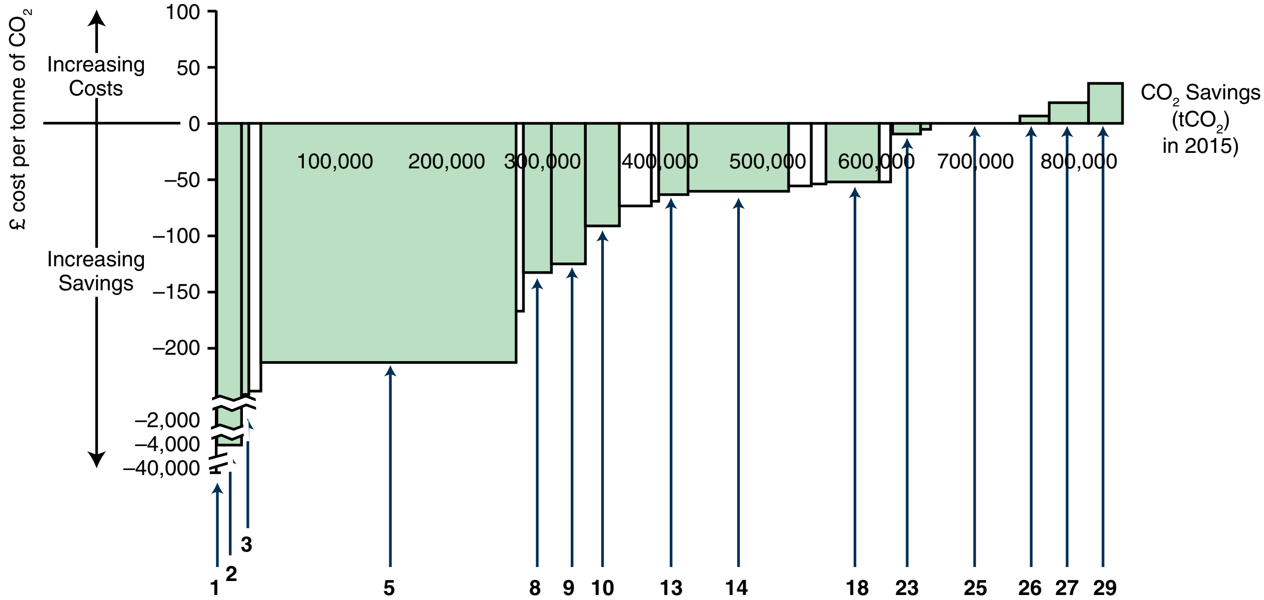
Immediate Gains, Co-Benefits, and Return on Investment

Many processes and interventions can begin at a local level and bring swift financial returns, principally through efficiency savings (e.g., by closing doors in a colder climate, and switching off lights and computers). These require attention to the education, involvement, and sense of ownership among staff.[143] The costs of such education can be recouped within less than a year.[144] Approaches that support changes in behavior (e.g., in reduced air conditioning, improved waste segregation and better water conservation) can be implemented immediately, with the promise of financial returns through lower costs (see Case Study 4 from South Africa). The Carbon Trust has developed a calculator to help calculate potential savings through such behavioral change. The main investment is capacity building through time, communication to raise awareness, and the resourcefulness to advance these types of projects.

Monitoring the Economic Benefits of Lowering Emissions

The WBG developed and published a model in the *Climate-Smart Development Report*[145] to calculate the benefits of climate-smart developments by quantifying the lives saved, jobs created, crops protected, energy saved, GDP gains, and reduced emissions. This approach could easily be applied to low-carbon healthcare and provide valuable and much-needed additional information to support its implementation. Additionally, the World Health Organization announced at the 2nd Global Conference on Climate and Health (July 2016) the formation of a working group on the economics of health and climate change to explore related issues and which is likely to generate further resources that could be used in understanding and advocating for health sector interventions around climate change.

Figure 2.2: NHS marginal abatement cost curve (MACC) with interventions.



This table illustrates just some of the carbon saving measures that the NHS could implement. Not all are numbered above. Some CO_2 savings are too small to depict on this scale of graph.	(£/tCO_2)—SAVINGS + COSTS	CO_2 SAVINGS (tCO_2/YR)	£000 SAVINGS (£000/YR)
1 Packaging of medical equipment	–40,299	2	+81
2 Reduce drug wastage	–3,987	22,430	+89,428
3 Teleconferencing to replace 5% of business miles	–2,038	6,827	+13,913
4 Decentralisation of hot water boilers in non-acute/PCT	–240	10,612	+2,547
5 Combined heat and power installed in acute trusts	–213	232,331	+49,487
6 Variable speed drives	–168	5,508	+925
7 Introduce hiberation system for ambulance stations	–135	1,096	+148
8 Improve heating controls	–134	26,551	+3,558
9 Improve lighting controls	–127	29,686	+3,770
10 Energy efficient lighting	–91	30,140	+2,743
11 Voltage optimisation	–75	29,364	+2,202
12 Improve the efficiency of chillers	–71	7,313	+519
13 Roof insulation	–65	25,928	+1,685
14 Energy awareness campaign	–61	92,549	+5,645
15 Building management system optimisation	–56	20,610	+1,154
16 Improve insulation to pipework, and/in boiler house	–55	11,195	+616
17 Install high efficiency lighting/controls—ambulance trusts	–55	2,999	+165
18 1 degree C reduction in thermostat temperature	–53	49,144	+2,605
19 Improve the efficiency of steam plant or hot water boiler plant	–52	8,933	+465
20 Upgrade garage and workshop heating	–49	214	+10
21 Boiler replacement/optimisation for HQ/control centres	–12	171	+2
22 Improve building insulation levels in ambulance trusts	–12	951	+11
23 Wall insulation	–8	25,928	+207
24 Office electrical equipment improvements	–4	7,957	+32
25 Travel planning	0	81,524	0
26 Insulation—window glazing and draught proofing	+6	25,928	–156
27 Electric vehicles	+19	36,969	–702
28 Wind turbine	+25	245	–6
29 Biomass boiler	+35	30,533	–1,069
Total		**823,638**	**179,987**

CHAPTER

3

Development Community Role Promoting Climate-Smart Resilience in Healthcare

This section reviews the current state of climate change resilience, adaptation planning and implementation in the health sector, with a focus on low- and middle-income countries and identified climate/ health impact hotspots. Various tools are listed, as are approaches to integrating these into development operations. Ultimately, this section describes how health lending and investment can build resilience and adaptive capacity in response to climate change.

Diagnostic Tools That Can Help Assess the Impact of Climate on Health

Building resilience to the health impacts of climate change is largely about risk reduction. It is widely understood and accepted that climate change will have broad impacts on human health and that it will be the poorest and most vulnerable that feel the full force of impact. Though it may not be possible to diminish this risk of health impact to zero, more can be done to predict and prevent impacts, and build resilient health systems that will be sturdy in the face of future threats, whether pandemic outbreak, economic collapse, or global environmental change.

It is also important to note that health risks from climate change vary in both their nature as well as the type of climate risk that precipitates them. So far, there has been considerable discussion of the types of health impact: infectious disease, undernutrition, heat stress, and so on. The magnitude and pattern of risks from climate change, however, are also important and are due to: the characteristics of the hazards created by changing weather patterns; the extent of exposure of human and natural systems to the hazard; the susceptibility of those systems to harm; and their ability to cope with and recover from exposure. To establish truly resilient systems, each of these components should be considered individually. In doing so, it should become clear that the starting point for efficient and effective resilience strategies and adaptation must encompass: the vulnerability of a community; the capacity of health systems to prepare for, cope with, respond to, and recover from exposure to a hazard; or the hazards created by a changing climate. Each of these categories highlights important areas for adaptation and resilience planning. Simply focusing only on climate change is too broad a frame, and makes assumptions about the roles of vulnerability and exposure that could prevent effective action.

Improving understanding of the discrete and varied risks that climate change poses for health allow for concentration on the most vulnerable populations and the most susceptible regions. Development lending must target the correct geographies, populations, and causal factors. Awareness of potential climate-related risks is also important to ensure that a project is not derailed during implementation.

As awareness of the linkages between climate and health has grown, so too has the number of information sources and diagnostic tools that quantify impacts to support improved decision making. Information sources and tools can be characterized in multiple ways but for the purposes of this exercise it will be most helpful to consider two: global and national.

Global Resources and Tools to Assess the Impact of Climate on Health

Many tools and resources available globally can be useful for understanding a country's climate change/health links. Some of those might be specific to health, others to climate information, and others yet that combine health and climate information. Drilling further into this framework, it can be helpful to characterize tools in three ways: (i) those that provide a snapshot of the climate and health situation in a country; (ii) those that offer a step-by-step process related to climate change and health; and (iii) those that provide access to data and analytical tools that can be used to derive estimates of local climatic conditions through a combination of observations, modeled information, and technologies (such as remotely sensed data from satellites).[146] Each of these have different operational utility (Table 3.1). Snapshots and those that provide data are perhaps most useful during early phases of project development or anytime later when it is important to make a case for climate and health investment, while also providing important background information. Those that provide step-by-step processes, conversely, may be most useful in project design as unique tools are necessary to inform different components and stages of investment.

Table 3.1: Examples of tools relevant to assessing climate and health impacts.

TOOL	SOURCE (& LINK)	TYPE	DESCRIPTION[147]
Health and Climate Profiles	World Health Organization	Snap shot	"Relevant and reliable country-specific information about the current and future impacts of climate change on human health, the opportunities for health benefits from climate mitigation actions, and current policy responses at country level"
Climate Change Knowledge Portal	World Bank Group	Snap shot	"A quick reference source for development practitioners to better integrate climate resilience into planning and operations . . . a common platform to access, synthesize, and analyze the most relevant data and information for disaster risk reduction and adaptation to climate change"
Protecting Health from Climate Change: Vulnerability and Adaptation Assessment	World Health Organization	Step-by-step process	"Guidance on conducting a national or subnational assessment of current and future vulnerability (i.e., the susceptibility of a population or region to harm) to the health risks of climate change, and of policies and programmes that could increase resilience, taking into account the multiple determinants of climate-sensitive health outcomes"
Climate screening tools (including one specifically for health)	World Bank Group	Step-by-step process	"A systematic way to undertake due diligence and flag potential risks for projects in the health sector"
Building Resilience Against Climate Effects (BRACE) Framework	U.S. Centers for Disease Control and Prevention	Step-by-step process	"Five-step process that allows health officials to develop strategies and programs to help communities prepare for the health effects of climate change" (US-focused but with approaches that are applicable elsewhere)
Climate Data Library	International Research Institute for Climate and Society (Earth Institute, Columbia University)	Data/analytical tool	"Online data repository and analysis tool that allows a user to view, analyze, and download hundreds of terabytes of climate-related data"
Forecasts in Context	International Federation of Red Cross and Red Crescent Societies	Data/analytical tool	"Information [about rainfall patterns and forecasts] that can be used for humanitarian decision making around the world . . . It also provides information on the types of early action that can be taken based on these maps"
Global Risk Data Platform	UNEP/UNISDR	Data/analytical tool	"Spatial data information on global risk from natural hazards . . . visualise, download or extract data on past hazardous events, human and economical hazard exposure and risk from natural hazards"

National Sources of Climate Information for Health Decision Making

While the global resources provide a starting point for assessments of major climate impacts on health, information on local climate conditions is often typically available at the national level for health decision making and planning. Understanding environmental drivers (changing sea levels, storms, heat) and the varied health impacts, when taken with population vulnerability, establishes an important nexus of factors to consider in resilience planning.

National meteorological services are critical sources of information. As the mandated focal point for national climate data and services, they are crucial to supporting rigorous adaptation planning and should be engaged as a key ally for health and cross-sector investments in resiliency. Some development institutions, like the WBG, are already prioritizing engagement of national meteorological services through global investments in observational networks and infrastructure[148] and these can be further leveraged so that improved national climate data can be accessed by the health community and other sectoral stakeholders, overcoming significant traditional policy and technical constraints, especially in low- and middle-income countries.[149]

Institutional partnerships between ministries of health and meteorological services, along with collaborations to support the use of improved climate data at a relevant scale for health decision making, provide innovative opportunities for evidence-based policy and practice. The meteorological services have been charged with serving the health community, in particular, as one of five priority areas advanced by the Global Framework for Climate Services.[150] Engagement of meteorological services provides a primed entry point for national climate and health policy issues and provides a central coordinating mechanism with other sectors, as well as tapping the most relevant source of country-owned climate information.

It is worth highlighting that weather station coverage is a challenge, particularly in Africa and in parts of Latin America.[151] The distribution of existing stations is often uneven, concentrated along major roads and in urban areas. Where station records exist, they are often of poor quality, with significant data gaps. In some countries, capacity constraints and restrictive policies make what little data that does exist hard to access.

Table 3.2: Tools for development of climate health assessments, early warning, resilience, etc.

Africa Real Time Environmental Monitoring System (ARTEMIS)
Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)
Committee on Earth Observation Satellites (CEOS)
Emergency Prevention System (EMPRES) for Transboundary Animal and Plant Pests and Diseases
European Space Agency data sets
Food and Agricultural Organization (FAO) GeoNetwork
Global Risk Identification Programme
Group on Earth Observation (GEO)
International Research Institute for Climate and Society
Goddard Spaceflight Center (US National Aeronautics and Space Administration)
RVF Activity Database (Kenya, Zimbabwe)
SERVIR Regional Visualization and Monitoring System
US Department of Defense Global Emerging Infections Surveillance Program
US National Oceanic and Atmospheric Climate Prediction Center (including ANHRR)
World Animal Health Information Database (WAHID)

Case Study 15: Improving Malaria Evaluation and Planning—East Africa

Changes in climate influence patterns of malaria transmission. Climate services that can follow malaria trends and help predict the impact of climate variability on malaria transmission are becoming critically important in allocating malaria control and elimination resources.

National meteorological agencies and national malaria control programs in East Africa are developing tools and partnerships to utilize climate data to inform public health decision making, particularly on malaria impact assessments and other areas of malaria planning. The Ethiopian National Meteorology Agency and the Tanzanian Meteorological Agency—with technical support from the Institute for Climate and Society, the Columbia Global Centers/Africa, the Roll Back Malaria Partnership, and the US President's Malaria Initiative—have launched the Enhancing National Climate Services (ENACTS) Initiative. This is improving the availability and relevance of climate information to serve the needs of decision makers around malaria programming. In consultation with national malaria control programs, the initiative is developing high-resolution data and tools for mapping malaria high-risk areas, determining seasonality and best timing of malaria interventions, investigating trends over time, and putting in place resources for early preparedness. By integrating all ground-based observations with proxy satellite and other data, ENACTS' products overcome issues of data access and quality, introducing rigorous and spatially complete data services that serve national stakeholder needs.

In 2014, these ENACTS products were used by national malaria control programs in Ethiopia and Tanzania to monitor and prepare for the forecasted El Nino and the potential for increased malaria transmission, including map rooms and other data visualization tools that have supported historical impact assessments.

The Enhancing National Climate Service (ENACTS) initiative is one innovative approach to expanding access to climate information national decision making and has been backed by the Weather and Climate Information and Services for Africa under the UK's Department for International Development (DFID). Other decision making tools and information systems that leverage national climate information are featured in the forthcoming WMO/WHO publication *Climate Services for Health: Global Case Studies of Enhancing Decision Support for Climate Risk Management and Adaptation* (other are referenced in Table 3.2).[152] Central to these efforts is the need to support national climate observation systems, in addition to strengthened national health information systems.

Climate Change and Health Approaches, Interventions Viable for Health Sector Finance

Climate-smart activities can be included in development lending in the form of a project component (or subcomponent) that is flagged specifically for climate change and health. It may be that a project component is designed specifically to match a climate and health opportunity—or is rather part of a broader project design that has not explicitly considered climate. For example, early warning systems are useful for pandemics, but also have utility for climate and weather impact. Expanding the scope of one such project component to include climate can both enhance the impact of a project and enable involvement in other areas (e.g., meteorological services) and establish new avenues for access to funding, such as climate finance.

The ultimate success of development work on climate change and health will vary by institution. Within the WBG, this relies on integrating climate as a transversal element into the routine work of HNP, informing and shaping components that are not specific to climate change and health, including infrastructure and human resources investments. This would mean that, for example, an analysis of the effects of climate change on medium-term changes to disease dynamics and the implications for the population catchment area should be undertaken before a new hospital receives financing. It should also be taken in tandem with an assessment of low-carbon options as described in Section 2.

Considering climate change as a transversal element that affects all health operations requires recognizing the unique challenges posed by climate change and its related impacts. First, climate change increases uncertainty across several domains that influence both the supply of, and the demand for, health services and that unpredictability requires integrating response flexibility into development operations. Storms can threaten basic infrastructure. Heat can undermine energy grids and prove fatal for nonclimate controlled hospital rooms. And rising sea levels can erode the very ground upon which hospitals are built. Adaptive management throughout the course of project implementation therefore is also necessary, as climate change can easily disrupt a project, regardless of the quality of project design during the development of a Project Appraisal Document.

Second, the adoption of a mixed health systems approach in development projects takes on increasing importance. Taking again the example of the WBG, in most countries in which it works, private sector and civil society organizations (including faith-based organizations) deliver a considerable fraction of healthcare. These nonstate actors can provide an important element of redundancy in the health system, which is particularly important given the stresses that climate change can exact on the system. The service provision by nonstate actors can contribute significantly to building resilience and to ensuring the continuity of services in the event of a natural disaster or a pandemic.[153]

Health System Responses to Build Resilience, Adapt to Climate Change

Development finance for health goes to a variety of areas. At the WBG, this includes issues such as child health, HIV/AIDS, tuberculosis, nutrition, injuries, and non-communicable diseases. However, the largest single area of lending does not have a programmatic-specific focus but is directed to multifaceted strengthening of health systems strengthening: almost exactly half of the WBG's HNP commitments have been for improving health systems performance over the past decade, totaling nearly US$12 billion.[154] With the WBG's strong emphasis on universal health coverage, the focus on health systems is likely to be maintained or increased in the coming years.

As noted above, climate change and its spectrum of hazard-related impacts poses multiple threats to health systems. The WBG's (and other institution's) emphasis on health systems strengthening means that a considerable share of the overall portfolio is vulnerable to disruption due to climate change. However, there are also key opportunities for development. The WBG, for example, is currently placing considerable emphasis on emergency preparedness and rapid response in the health sector (e.g., in the form of the Pandemic Emergency Facility). Integrating climate considerations in this work is an important way to ensure that these investments are more effectively able to address the threats faced by client countries.

Investing in health systems strengthening to improve resilience and build capacity to adapt to climate change can also be understood as assisting health systems in five areas, which are defined in the US Department of Health and Human Services' Sustainable and Climate Resilient Healthcare Infrastructure Toolkit. Understanding the unique role that healthcare plays during and following extreme weather events, the vulnerabilities that may exist to providing uninterrupted care, and the investments that are required to improve health system resilience must consider all these factors, many of which have been discussed in the earlier sections of this document, including:

- Understanding climate risk and community vulnerabilities
- Land use, building design, and regulatory context
- Infrastructure protection and resilience planning
- Essential clinical care service delivery planning
- Environmental protection and ecosystem adaptation

Case Study 16: Resilient Passive Energy—Sudan

Salam Centre for Cardiac Surgery is resilient to the harsh climate and sand storms of the desert. The hospital reduces mechanical cooling demands through passive technologies, such as thick masonry walls with extensive insulation, deep overhangs, and high-performance windows. To alleviate the significant dust infiltration from dust storms, a thermal labyrinth filters and precools outdoor air, reducing the demand on the solar-powered water heating and chilling equipment.

These can be thought of as two primary dimensions to development engagement in strengthening health system resilience: Ensuring that the type of health systems strengthening that the institutions routinely finance better incorporates climate change adaptation, and consideration of the type of new investments to improve its support to the health sector in light of climate change.

The work that development institutions perform in both areas should draw to the greatest extent possible on existing national-level agreements on priorities for the intersection of climate and health issues. UNFCC National Adaptation Plans described below are an important source of these agreements and can be useful starting points for understanding what can be done around climate and health.

Making Approaches to Investing in Health Systems Climate Resilient

At the WBG, HNP lending has increasingly shifted from input-based financing (through investment project financing) to results-based financing (either through the Programs for Results or through investment financing tied to the results at the facility level). However, the WBG still makes considerable investments in key health systems inputs. The areas that are most relevant for adaptation to climate change are infrastructure and supply chains, and human resources for health.

Case Study 17: Resilience to Grid Power Cuts, Renewable Energy—Nepal

In response to unpredictable power cuts from the energy grid, Nepal's Gunjaman Singh Hospital switched to solar power with backup batteries. The solar panels power the hospital and the doctors' quarters, including power for the x-ray machine and the waste autoclave.

Infrastructure and Supply Chains in WBG HNP Lending

Infrastructure has diminished as a share of the HNP portfolio but the WBG continues to lend for the construction or refurbishment of hospitals, health centers, and other health facilities. It also makes investments in strengthening supply chains for health commodities and medical equipment, which are weak in many of the countries in which the WBG operates. There are three key ways in which WBG investments must adapt in preparation and response to climate change and which hold lessons for other development institutions aiming to do similar.

First, the Increased Risk of Extreme Weather Events Should Be Factored into Construction Planning

The risks of heat waves, extreme precipitation, and coastal flooding increase as temperatures warm.[155] Many of these require shifts in construction approaches to place an increased emphasis on materials and techniques that can withstand extreme weather events that were previously too rare to be factored into facility design. Additionally, extreme events can disrupt the supply of water, sanitation, and electricity services to health facilities, which necessitates planning for, and possibly investing in, backup options, and ensuring that the infrastructure is located out of harm's way. A number of these systems have the benefit of also contributing to climate change mitigation (e.g., installing solar panels or wind turbines to provide a locally-controlled energy supply may be valuable from the perspective of ensuring the continuity of services and may also contribute to reducing a facility's carbon emissions).

A generalized risk of increased extreme events is insufficient for planning purposes, as not all areas are equally at risk, even within one country. This means that potential climatic shifts at the local level and the impact on frequency, intensity, and duration of extreme weather events should be assessed and factored into the facility design before major investments are made. There are tools for this purpose in high-income settings[156] but these are not yet widely available for low- or middle-income countries, though many of the approaches used are generally applicable.

In the absence of specific tools, a potential avenue involves partnering with national meteorological services or efforts that work with local climate data (e.g., the ENACTS initiative) to quantify risks associated with climate change. Even short of having access to good quality local data, there are practical steps that can be taken (Table 3.3).

Case Study 18: Adapting Services in Nonclimate Controlled Healthcare Settings—India

Healthcare infrastructure without air conditioning in urban areas is of high concern given the effects of the urban heat island. There is increasing evidence that newborns and pregnant women are particularly vulnerable to extreme heat. During the 2010 heat wave in Ahmedabad, India, when temperatures reached as high as 46.8°C, a retrospective review of hospital records at the city's SCL General Hospital found that neonatal intensive care unit (NICU) admissions increased dramatically.

During 2010, the maternity ward was located on the top floor of the non–air-conditioned hospital and under a dark tar roof, making it the hottest area in the building. As a response to the high rate of admissions and neonatal mortality in 2010, the maternity ward was moved to the ground floor in 2012. It was found that, at 42°C, there was a 64 percent reduction in heat-related admissions to the NICU after moving the ward to a lower, cooler floor.

The Second Way in Which Climate Change Affects Investments in Health Infrastructure Is Around the Location of New Facilities

Planning for new hospitals and health centers is typically done based on existing catchment areas (and occasionally disease profiles) or on demographic projections based on current populations and trends in fertility and disease trends. Climate change affects both by shifting the patterns of disease transmission (which can result in, for example, the spread of a pathogen to areas in which it was not previously present) and by shifting populations themselves, due to factors such as increasing desertification or increasing urbanization as a result of increased food insecurity. Although these shifts often unfold over a relatively long time horizon (> 10 years), major health infrastructure investments such as new hospitals are planned for even longer timeframes and so decisions about where to locate new facilities should systematically factor in assessments of the likely impact of climate change on the populations to be served and the disease profile of the population.

The Third Important Shift Is an Embrace of Redundancy in the Supply Chain System

Redundancy is a useful feature of resilient health systems as it enables service provision to continue unabated in the event of an extreme event that renders part of a health system inoperable. One way to do this without causing significant inefficiencies is to ensure that there are multiple systems coexisting in one country, with private sector supply chains operating as a complement to central medical stores run by the public sector. This approach has been adopted in several African countries, even without consideration of climate change (especially for products that have stringent dosing requirements, such as antiretrovirals, or strict cold chain needs, such as some immunizations) but it becomes even more important in a context of increased extreme events.

The implication for development financing is that supply chains could be assessed for their ability to withstand extreme events and, if deficiencies are identified, projects should consider investing in alternative supply chains. This could either take the form of investing directly in the development of an alternative system outside the central medical store (e.g., such as by using performance-based financing mechanisms to support facilities to purchase quality products on the market) or it could focus on improving the quality of existing private sector supply chains. This latter option is particularly important in contexts in which a robust private sector already provides some redundancy but where there are concerns about the quality of the products found in the private sector. In this case, investments could be in the form of strengthening regulatory systems to ensure that poor quality products do not end up in facilities.

Given these considerations, before embarking upon significant investments in major infrastructure, project teams should seek to answer three central questions:

- Do the assumptions (e.g., on utilization rates) that underpin the economic modeling associated with the investment reflect possible shifts in disease patterns related to climate change?
- What impact will climate change have on the catchment area for the facility being built or renovated? Will climatic shifts, particularly in rural areas, result in catchment reductions agriculture is increasingly difficult in the area? Will climate change increase the pace of urbanization?
- Has the construction plan considered the possibility of increased frequency, intensity, and duration of extreme weather events?

Table 3.3: Resilient building design considerations.

CATEGORY	INTERVENTION	BENEFIT
Building Site and Context	Climate zone identification	Understand extreme weather risks and long-term climate stressors and impacts on population health
	Site and orient building to maximize solar orientation and wind patterns	Buildings remains habitable if and when mechanical systems are inoperable
	Implement site landscaping, planting and reflective paving	Reduces heat island effect; reduces indoor temperatures; stabilizes soil
	Multiple access points	Connection to two or more roads provides redundancy to road damage/blockage following event
	Ensure storm water management systems function; use permeable paving in wet climates	Reduces impacts from flood events; provides safe routes for water flow
Building Form	Narrow floor plates	Maximizes daylighting and natural ventilation; building remains habitable when systems fail
	Location of critical clinical services above flood levels or out of harm's way	Ensures that critical clinical services can continue uninterrupted during and after weather events
	Include provisions for patient surge during and following an event	Locating emergency services to allow for rapid expansion of treatment area during or after an event improves ability to care for patients
Building Exterior	Enhanced building thermal envelope; reflective roofing	Reduces heating and cooling load, allowing building to operate longer on a fixed thermal energy supply, or reduces the size of installed renewable energy sources
	Renewable power generation	Reduces or eliminates dependence on utility grid; improves reliability
	Stronger exterior walls and roofs; wind and water resistant exterior	Enables building to withstand damage from extreme wind and rain events
	Use of local materials	Reduces length of time hospital is disrupted if damaged from weather event
Space Heating and Cooling	Natural ventilation	Reduces dependence on mechanical systems; maintains habitable conditions
	Combined heat and power	On-site electrical generation reduces dependence on utility grid; less likely to be damaged or interrupted by weather event
	Location of critical energy plant	Locate critical energy and utility services above flood level and out of harm's way
Lighting	Daylighting	Maintains habitable conditions without need for energy systems
	Low-energy light fixtures	Reduces energy consumption; allows building to operate longer on a fixed supply of fuel
Water Supply and Heating	Develop two independent water sources; municipal, on-site well, on-site bottled or potable water storage	Redundancy in water sources improves ability to operate when one source is lost
	Low-flow water fixtures	Reduces amount of water that requires heating
	Solar water heating	Reduces GHGs from heating water; Improves likelihood of maintaining hot water if utility services are disrupted
Sewage Treatment	Backup or on-site sewage treatment	If municipal sewage system is damaged or lost, hospital can remain safely operational
Supply Chain	Designate areas for additional clinical/ food supplies	If transportation systems are disrupted, facility can continue to function

Human Resources for Health

Climate change and associated hazards affect demand for health services both by increasing (and occasionally decreasing) the burden of disease and by influencing the movement of people. This means that the need for both general health staff and specialized expertise will shift and that health outcomes will suffer if this is not properly factored into planning efforts.

For example, the spread of malaria to a higher elevation means that health workers who have not historically needed to treat the disease will need to be trained in its management, and the overall burden of disease may also increase, necessitating redeployment of staff. Projections of the ways in which climate change affects future needs must inform the investment decision making process.

The planning of investments in human resources for health—in particular longer-term financing for large-scale capacity development—should be based on rigorous assessment of future needs, rather than simply relying on historical data.

Extreme weather events can disrupt transport and travel, inflicting significant damages on homes of healthcare workers. Hospitals in vulnerable locations must often shelter not only many healthcare workers during and after events, but their extended families as well. Accordingly, investments in human resources for health may also need to anticipate such circumstances.

Additionally, financing should shift to focus more heavily on the development of institutional capacities, which is critically important for assisting countries to cope with the unpredictable consequences of climate change.[157] A key issue is building capacity to anticipate and prepare for risks and to manage complex emergencies. Building resilience in the health workforce is challenging and demands a long-term view and investment that could exceed the duration of a typical development project.[158]

Community engagement is also critical, both in emergency preparedness and in responses to the aftermath of an extreme weather event or a pandemic. Investment to strengthen community capacities is essential for building resilience of the system and avoiding some of these many negative consequences of a changing climate.[159]

Case Study 19: Resilience to Increased Weather Events—St. Vincent and the Grenadines

Georgetown Hospital participated in the PAHO Smart Hospital initiative and was refurbished to be resilient to hurricanes, as well as to ash from a neighboring volcano. The hospital strengthened its roof, installed a water storage system and solar panels to generate electricity, and took other energy efficiency measures that reduced energy consumption by over 60 percent. After a hurricane struck St. Vincent, the hospital remained operational and had a working supply of water that supported the hospital and neighboring communities. Some members of the community who worked on the construction of the hospital recognized the advantages of solar power and added solar panels to their homes, reducing their energy costs and making their homes more resilient to the impacts of hurricanes.

Potential Areas for Develoment Investment in Resilience and Adaptive Capacity

Case Study 20: Innovative Heat Wave Early Warning System and Action Plan—India

Ahmedabad is a growing urban center of 7 million people in Gujarat state, western India. During an extreme heat wave in 2010, the city registered 1,344 additional deaths. Following this event, the Ahmedabad Municipal Corporation and a coalition of national and international experts came together in 2013 to develop and implement an early warning system and the first Heat Action Plan (HAP) for a city in India. Updated in 2016, the Ahmedabad HAP utilizes best practices on early warning systems and heat adaptation by focusing on four key strategies:

- **Building public awareness and community outreach (communication)** using traditional (pamphlets, advertisements, radio, etc.) and new media tools (SMS, WhatsApp, etc.) to communicate the risks of heat waves as well as what to do to avoid heat-related illness and death.
- **Initiating an early warning system and interagency coordination** that put in place formal communication channels to alert government agencies, hospitals, community groups and the public about predicted extreme temperatures.
- **Capacity building among healthcare professionals** based upon training to recognize and respond to heat-related illnesses.
- **Reducing heat exposure and promoting adaptive measures** by mapping high-risk areas to increase outreach and prevention activities, such as providing cooling spaces and drinking water on extreme heat days.

Based on positive initial results that show reductions in heat-related morbidity and mortality in the city, several other cities and regions in India are developing HAPs based on the Ahmedabad model.

Early Warning Systems

Early warning systems represent a growing field of interventions leveraging climate information to improve health outcomes that shift the focus from surveillance and response to prediction, preparedness, and prevention.[160] Recent investments in early warning systems have provided case studies for both disease and hazard early warning systems, from the forecasting and control of meningococcal meningitis epidemics in West Africa to heat wave early action plans in India.[10]

Early warning systems can address specific disease burdens (malaria, dengue, cholera, meningitis, etc.), specific hazards or multi-hazard frameworks (heat waves, floods, cyclones, hurricanes, droughts, fires, pollution, etc.) or specific lead times (e.g., from short-term planning around extreme weather events to medium-term planning around seasonal or decadal forecasts). Investments in early warning systems can also provide value added to existing funding for health systems strengthening and overall emergency response preparedness.[161]

The cornerstones of early warning systems are risk models built on climatic and health information. There are some tools available globally to assist with this, such as those contained in the IRI Climate Data Library (see, for example, the Malaria Early Warning System,) and the US Geological Survey's Early Warning and Environmental Monitoring Program. Many of the existing early warning systems have developed customized risk models for the local conditions[162] and some of the tools exist to assist with this process are listed in Table 3.4.

Few low- or middle-income countries have scaled up early warning systems to the national level. This creates a significant investment opportunity for development institutions, which can pass along the lessons from past efforts to create such systems to inform this kind of scaling up.[163]

For example, successful early warning systems depend on early action actually being taken and the response component of this type of intervention should be considered at the outset. The International Federation of Red Cross and Red Crescent (IFRC) Climate Centre has invested heavily in its "Early Warning > Early Action" campaign[164] and in 2012 piloted a health risk management project that focused on deploying early warning systems to reduce the burden of diarrheal disease in Kenya and Tanzania and dengue fever in Indonesia and Vietnam.[165] In addition to early warning system design, it prioritized education campaigns, improved coordination for early detection through local committees, climate-informed contingency planning, best practices for disease prevention in communities at risk, and strengthened institutional partnerships.

Disaster Preparedness Systems

Disaster risk reduction has emerged as a unique field of its own, with multiple internationally agreed frameworks for action, a UN body devoted to the area (the UN Office for Disease Risk Reduction), and a global partnership managed by the WBG (the Global Facility for Disaster Risk Reduction), among other initiatives.

Table 3.4: Select early warning risk management tools.

TOOL	SOURCE	GENERAL OR HEALTH SECTOR-SPECIFIC	YEAR
Heatwaves and Health: Guidance on Warning-System Development	World Meteorological Organization and World Health Organization	Health	2015
Using Climate to Predict Infectious Disease Epidemics	World Health Organization	Health	2005
Developing Early Warning Systems: A Checklist	United Nations International Strategy for Disaster Reduction	General	2006
Guidelines on Early Warning Systems and Application of Nowcasting and Operation Warnings	World Meteorological Organization	General	2010
Implementing Hazard Early Warning Systems	Global Framework for Disaster Risk Reduction	General	2011
Climate Information and Early Warning Systems Communications Toolkit	United Nations Development Programme	General	2016

A full survey of this area and the ways that it can apply to the health sector is beyond the scope of this paper, but there are several tools that WHO has developed that are specific to the health sector and that are useful resources in specific situations:

- The WHO Hospital Safety Index[166] is used to assess a hospital's capacity to function in the event of a major disaster or emergency. This tool could be applied in the context of an HNP investment in a health facility in an area that is prone to disasters, to determine actions to be taken to strengthen its disaster preparedness.
- The PAHO Health Sector Self-Assessment Tool for Disaster Risk Reduction[167] identifies weakness in a health system with regard to disaster preparedness. This tool is particularly useful in the context of project preparations in a setting in which a government is seeking WBG support in this area.

Using Climate Information to Strengthen Health Preparedness

Shifting away from a culture of response and relief to disaster preparedness (and in some cases prevention) requires new frameworks for the integration of climate information derived from probabilistic forecasts. The International Federation of Red Cross and Red Crescent Societies reported in 2013, for example, that it used seasonal forecasts to act prior to flooding events in the Sahel, stocking and pre-positioning emergency relief items in several West African countries.[168] These efforts required international assistance and community engagement that could be mobilized based on likely, though not certain, information and leveraged institutional learning around regional flooding events in 2008.[169]

Case Study 21: Cholera Treatment Center in Port au Prince—Haiti

Following the 2010 Haiti earthquake, cholera, a disease that had not existed in the country for more than a century, proliferated. Weak public systems were powerless to protect against a chain of events triggered by the environmental shock, and thousands became ill and perished. In response, public health officials and doctors at Les Centres GHESKIO teamed up with architects and designers at MASS Design Group to build a state-of-the-art treatment center that would enable responders to treat the ill while also preventing recontamination of water. The facility also incorporated elements of sustainable design to minimize energy use and environmental impact.

These efforts illustrate the critical links between mitigation and adaptation. New facilities and interventions are necessary to respond to emerging climate-related health impacts. There is also considerable opportunity to integrate low-carbon and environmentally friendly strategies, enabling a truly climate-smart approach.

Potential Programmatic Responses to Climate Change

Although health systems strengthening is the largest single area of HNP investment for the WBG, considerable resources are still directed to programmatic areas. Other development institutions have different priorities, though many also have discrete realms of programmatic investment. The areas that are most directly impacted by climate change are malaria and other vector-borne diseases, food- and waterborne diseases, and nutrition.

Adapting Approaches to Vector-, Food-, and Waterborne Diseases in Response to Climate Change

The approaches to controlling malaria, most other vector-borne diseases, and most food- and waterborne diseases are well established: protocols for prevention and treatment already exist for malaria, schistosomiasis, cholera, and other diseases.

Climate change will not affect this, and so will not change what types of services are supported in certain investments: malaria control in the context of climate change still involves long-lasting insecticide treated bednets, artemisinin-containing combination therapies, and indoor residual spraying, just as it does in the absence of climate change.

It is *where* these are to be provided that is most affected by climate change. Climatic changes are shifting the geographical distribution and/or seasonality of several vectors for disease. Diseases likely to be impacted by the changing climate include malaria, dengue fever, chikungunya, schistosomiasis, African trypanosomiasis, West Nile virus, Hanta virus, Japanese encephalitis, Rift Valley Fever, and Lyme disease. Climate change is also increasing the risk of many food- and waterborne diseases. Diseases such as cholera become more common as a result of warmer temperatures and of extreme weather events (e.g., flooding).

WHO has attempted to quantify the impact of climate change on three key climate-sensitive causes of morbidity and mortality: malaria, dengue fever, and diarrheal diseases, outlined in Table 3.5.[170]

The implication for development investments is that climate change increases the importance of having good access to data: historical predictions become less accurate as a result of climate change, increasing the risk that programmatic responses will be misaligned with disease patterns. This requires the use of the diagnostic tools covered earlier to analyze the seasonality and timing of interventions, map populations at risk, and monitor trends. This also highlights the potential value of investing in early warning systems.

This increased need for climate data can be built directly into health sector programming. For example, the US President's Malaria

Table 3.5: WHO assessment of potential impact of climate change on three significant diseases.

DISEASE	PATHOGEN	VECTOR	MECHANISM OF ACTION AND PREDICTED IMPACT OF CLIMATE CHANGE
Malaria	*Plasmodium falciparum*	Various *Anopheles* mosquitoes (particularly *A. gambiae)*	Influenced by both temperature and rainfall, so complex and nonlinear (also strongly related to economic growth): expansions to some new geographies likely (particularly in Asia and South America) but transmission declines in hotter temperatures
Dengue fever	Dengue virus (flavovirus)	Primarily *Aedes aegypti* and *Aedes albopictus* mosquitoes	Likely expansion of geographical range, particularly in Sub-Saharan Africa (although also strongly related to economic growth)
Diarrheal diseases	Multiple (e.g., *E. coli,* rotavirus, salmonella)	Multiple	Limited data make predictions challenging but likely temperature-related increase in mortality, particularly in South Asia and Sub-Saharan Africa

Case Study 22: Malaria in Ethiopia

Malaria is a major public health problem in Ethiopia, although its mountainous terrain reduces the risk of infection among the greater population. As part of a broader effect to scale up the malaria response in the country, the Federal Ministry of Health collaborated with the National Meteorological Agency, with financial backing from the Global Fund to Fight AIDS, Tuberculosis and Malaria.

The National Meteorological Agency focused on supporting decision making in malaria programming through forecasting tools based on rainfall and temperature patterns. Both the National Meteorological Agency and the Federal Ministry of Health concentrated on providing regular communications to the subnational level to assist regional program managers.

Initiative funded a national climate analysis in Tanzania in 2012, leveraging historical climate data to better evaluate the impact of its malaria control interventions over the preceding decade.[18]

Climate Change Implications for Development Approaches to Nutrition

Climate change has significant effects on both the quantity and quality of food production, resulting in higher food prices and reduced caloric intake, increasing the risk of undernutrition and stunting, particularly in children. Additionally, climate change influences the composition of diets, with reduced consumption of fruits and vegetables expected to be a major risk factor for ill health. One recent study found that mortality related to these effects far exceeded the estimated deaths from undernutrition.[171]

These shifts have two primary impacts on financing for nutrition. The first is to increase demand for nutrition services, both in the setting of populations that are already struggling with chronic food insecurity and by those who are newly confronted with nutrition-related challenges as a result of extreme events. Poor and disadvantaged populations—especially women and children—are likely to bear the brunt of the effects of climate change on nutrition, which calls for programmatic responses that are tailored to the specific needs of those who cannot afford basic nutrition.

The implications are significant for the development community and particularly the WBG given their emphasis on stunting: modeling of the impact of climate change on nutrition suggests that in 2030 the number of moderately stunted children could increase by approximately 3.6 million and the number of severely stunted children could increase by 3.9 million.[172] This suggests that WBG targets on stunting will be harder to reach, requiring increased investments in nutrition.

As with vector-, food-, and waterborne diseases, the effect on individual nutrition project is manifold. It is altering distribution, while not necessarily requiring a fundamentally new nutritional approach (though does increase the importance of improving information systems to anticipate climate-related shifts). Additionally, CO_2 is changing the concentration of proteins and micronutrients in many cereal crops. This can have significant impact on those communities already facing nutrition stresses, highlighting a greater imperative to diversify food sources and prepare for climate shocks.

The second effect is to increase the importance of multi-sector responses to nutrition challenges, as it will not be possible to address all of the nutrition-related challenges posed by climate change within the health sector. Collaboration with the agriculture sector will be critical, given the long-run effects of climate change on food security. The social protection sector is another important partner, particularly given the disproportionate effect on poor women and children.

Cross-sector collaboration is often challenging, but the Investing in the Early Years initiative, for example, is creating an important opportunity to strengthen engagement between Global Practices. The climate change perspective is not yet sufficiently represented but should be embedded within the basic approach of the initiative. For example, analysis of the projected impact of climate change on stunting patterns should be systematically included in action plans.

CHAPTER

4 Policy and Partnership

Development institutions can engage at the national level around climate change and health policy along two distinct paths: (i) the focused inclusion of a climate perspective in health dialogue between development actors and government counterparts, particularly ministries of health and of finance; and (ii) the participation of development staff in broader climate policy fora.

The Climate Perspective in Ongoing Health Policy Dialogue

Staff of the WBG, like many other development institutions, are constantly engaged in policy dialogue with client governments. Diving deeper into these interactions within the WBG may shed light on relevant processes at other development institutions and illuminate clearer paths forward for all. For example, the Country Partnership Framework (CPF) used within the WBG provides a framework by articulating how the WBG will support a country's national development plan while advancing the WBG's twin goals of ending extreme poverty and promoting shared prosperity. Given its impact on the economic development prospects of many countries, climate change should increasingly feature in Country Partnership Frameworks (CPFs) and in the analytical work that precedes it (particularly the Systematic Country Diagnostic). The connection between climate change and health should emerge as part of this process. The WBG should be conducting focused analytical work into the ways climate change is affecting health (and the pathways through which this contributes to dampening economic development) and how the health sector can both mitigate and adapt to climate change to further emphasize the links between climate change and health.

Analytical work in this area can also enrich policy dialogue with both ministries of health and of finance. While important for defining priorities for operational lending, it is an important means for the WBG and other development institutions to play a thought-leadership role, helping governments identify emerging issues for the health sector. There is considerable scope for increasing the extent to which the development community addresses climate change in this dialogue. A more systemic approach to commissioning analytical work on the links between climate change and health at the national level would be a first step, with the results of this work influencing the process of identifying key priorities in the health sector.

A second key area in which the development institutions can play an important role in policy dialogue is around financing for climate and health work. Considerable investment in climate change is occurring; a partial estimate put total private and public international financing at US$391 billion in 2014.[173] The majority of finance is for mitigation (particularly renewable energy), while US$25 billion was provided from public sources[174] for adaptation, particularly in East Asia and the Pacific (46 percent), Sub-Saharan Africa (13 percent), and Latin America and the Caribbean (12 percent). The health sector has been excluded from this financing despite the opportunities that abound for health sector mitigation via low-carbon healthcare strategies and the sector's significant and rising costs related to adaptation.

Accordingly, the costs associated with health sector adaptation to climate change or the implementation of low-carbon strategies are borne almost exclusively by traditional sources of financing for the sector (e.g., ministry of health budgets, out-of-pocket payments, insurance mechanisms, development assistance for health). There is an untapped opportunity to help countries access climate financing for health, a topic that government officials repeatedly raised at the Second Global Conference on Health and Climate in July 2016.

There are several global climate financing mechanisms that can provide resources for climate change and health work, including[175] The Global Environment Facility, The Green Climate Fund, The Adaptation Fund, and The Least Developed Country Fund. There are also some programs with development and aid agencies, such as DFID, the Nordic Development Fund, USAID, and others that may fund climate and health initiatives.

Development institutions have significant expertise partnering with climate funds[176] but this has not been a focus within the health sector to date and there is considerable scope for development staff to play a more active role in supporting governments accessing these funds.

Development institutions often have one other important comparative advantage in policy dialogue: they can bring a multi-sector perspective to looking at health outcomes. This is particularly important because of the key roles the water and sanitation and the agriculture sectors (which are themselves sensitive to changing climatic conditions) play in determining health outcomes. The WBG, in particular, also has significant investments in other areas that influence health, including transportation, urbanization, and social protection. Recognizing these links and broadening policy dialogue on health to encompass these sectors can further boost development community contributions.

Engagement with Governments and Other Stakeholders

Many countries have outlined their approaches to climate change through Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs), or fully-developed strategies.[177, 178] Several health ministries have also developed adaptation plans to respond to climate change and established extreme weather event response mechanisms.[179] Yet, so far, few health ministries have developed national climate mitigation or low-carbon healthcare approaches.

The WBG has been involved in development of green building codes for 10 countries, which includes minimum energy and water saving requirements for health care projects. This initiative, which establishes mandatory guidelines, was implemented in collaboration with local governments. These codes are developed with extensive local market study and public consultation, and they consider the costs and returns of each of the proposed requirements under code.

The WBG, and other similarly engaged institutions, are positioned to discuss approaches to climate change with governments and ministries by:

- Encouraging health ministries to develop a carbon baseline for their sector, identify carbon reduction targets where appropriate, and develop low carbon health sector development
- Stimulating health ministries to develop resilience and adaptive strategies both for new health system infrastructure and disease-specific impacts
- Advocating for the introduction of low-carbon, carbon reduction and health creating investment schemes
- Calling for iterative risk assessments that qualify and quantify health related climate hazards
- Catalyzing health sector investment in renewable energy, energy efficiency, local transport systems, sustainable and safe water use, safe waste disposal, and the purchase of locally- and sustainably-produced food where appropriate
- Encouraging the health sector to develop partnerships with meteorological agencies and climate information service providers to prepare and plan for health-related climate hazards
- Encouraging industries in the healthcare supply chain to develop low carbon and environmentally sustainable manufacturing and distribution practices
- Stimulating innovative solutions in all aspects of climate mitigation, low carbon development, and resilient health strengthening approaches

Helping ministries of health in tackling climate change mitigation and adaptation can be a means of strengthening local capacity and supporting better health in communities. Development leaders can foster discussions that can help remove barriers in the system and generate further momentum across the sector.

Engaging with the private sector and international agencies to support the health sector in low- and middle-income countries can foster joint initiatives for integrating climate-smart healthcare into their core goals. This would parallel a similar effort through ministries of health and development, such as that the UNDP is developing with several other UN agencies.[180]

Participation of Health-Focused Development Staff in Broader Climate Policy Fora

The landscape for national climate policy is often complex. Governance varies among countries, with different modes of engagement: national task forces, interagency working groups; elevated bureaus; appointed focal points under executive branches; and the vertical programming of climate policy within sector and impact areas. However, there are good examples of national governance of climate processes generating concrete action to combat the drivers of climate change and adaptation to climate impacts.[181] Existing avenues of engagement on climate policy should be prioritized across low- and middle-income countries: the NAP and NDC processes as well as improved coordination with national meteorological services (around available information and tools relevant to stakeholders and decision making at the national level). While past performance has been weak, the active engagement of the health sector and the integration of health priorities through these governance mechanisms and institutional partnerships provide critical opportunities for overall adaptation planning and policy, in addition to health-sector driven approaches.[182]

In 2010, the 16th Conference of Parties (COP 16) to the UN Framework Convention on Climate Change (UNFCCC) established a process to support least-developed countries in identifying and implementing NAPs, specifically to address medium- and long-term adaptation needs.[183] This process built on almost a decade of experience gained by least-developed countries through the National Adaptation Programs of Action (NAPAs; see Box 6), introduced in 2001 to address the most urgent and immediate national adaptation needs.[185] The initial NAPAs, while primarily championed by ministries of environment and their partners, resulted in an unprecedented country-led cataloging and ranking of proposed activities across sectors in the NAPA priorities database.[186]

While the NAP process provides a key entry point for national climate policy dialogue and country-led adaptation priorities, the health sector has historically been underrepresented in this process. In 2010, WHO evaluated the inclusion of health within the first generation NAPAs and concluded that only 11 percent of the 459 priority projects focused on health explicitly. Only 4 percent of the portfolio of the Least Developed Country Fund had been applied to health adaptation, despite 95 percent of the NAPAs identifying health as a priority sector.[187] Over time, health has been more recognized, to some degree. A recent study found that of 184 NDCs, 65.8 percent make mention of health, with 74.4 percent of those referring to it in the context of adaptation and 23.1 percent with regard to mitigation.[188] Nevertheless, these inclusions are rarely more than passing mentions and the international climate community still has work to do to fully integrate health.

Climate-sensitive sectors, such as agriculture, water, and energy have more successfully accessed climate-related funding and have engaged in national climate policy, suggesting there is considerable scope for further engagement by the health sector in international climate processes. Development institutions have several avenues available in emphasizing health within the international climate discourse, including policy dialogue with ministers of environment, health, and finance, stakeholder engagement on the periphery of the international climate negotiation process, and participation in civil society and policy-oriented events aimed at influencing climate policies.

Development institutions also have a range of significant technical resources that can augment the political dialogue by identifying national goals for health adaptation and mitigation planning, while positioning health as integral to stronger societies and the transition to a low-carbon economy. For instance, the 2014 *WHO Guidance to Protect Health from Climate Change Through Health Adaptation Planning*[189] serves as a robust and tailored resource for national governments and partners in the health community seeking to align health adaptation planning to the NAP process (see Box 7).

Box 6: The National Adaptation Plan Process[184] and Nationally Determined Contributions

The National Adaptation Plan (NAP) process was established in 2010 by the COP under the Cancun Adaptation Framework. According to the UNFCC, under the NAP, least-developed countries "are invited to identify their medium- and long-term adaptation needs and develop and implement strategies and programs to address these needs, building upon their experience in preparing and implementing National Adaptation Programs of Action (NAPAs)."

The objectives of the NAP process are: to reduce vulnerability to the impacts of climate change, by building adaptive capacity and resilience; and facilitate the integration of climate change adaptation, in a coherent manner into relevant new and existing policies, programs and activities (particularly development planning processes and strategies) within all relevant sectors and at different levels, as appropriate.

The COP also mandated the Least Developed Countries Expert Group to deliver technical support and the Global Environment Facility to provide financial support to those countries preparing NAPs.

In anticipation of an historic international climate agreement at the December 2015 UNFCCC Conference of Parties in Paris, many countries described climate actions they intended to take after 2020. Such statements came to be known as Intended Nationally Determined Contributions, pairing national policy with the global framework. The use of "intended" ceased following ratification of the Paris Agreement, and these declarations are now called Nationally Determined Contributions (NDCs).

Potential Partners for Health and Climate Projects

Academic work highlighting the impact of the climate on health has been available for decades, yet most countries and international organizations have placed little emphasis on the intersection of

Box 7: Recommended Steps in Health National Adaptation Planning (HNAP) (WHO, 2014)

1. Align the health adaptation planning process with the national process for developing a National Adaptation Plan
2. Take stock of available information
3. Identify approaches to address capacity gaps and weaknesses in undertaking the HNAP
4. Conduct a health vulnerability and adaptation assessment, including short- to long-term adaptation needs in the context of development priorities
5. Review implications of climate change on health-related development goals, legislation, strategies, policies and plans
6. Develop a national health adaptation strategy that identifies priority adaptation options
7. Develop an implementation strategy for operationalizing HNAPs and integrating climate change adaptation into health-related planning processes at all levels, including enhancing the capacity for conducting future HNAPs
8. Promote coordination and synergy with the NAP process, particularly with sectors that can affect health, and with multilateral environmental agreements
9. Monitor and review the HNAP to assess progress, effectiveness and gaps
10. Update the health component of the National Adaptation Plans in an iterative manner
11. Outreach on the HNAP process, including reporting on progress and effectiveness

climate and health. One consequence is that many countries have capacity constraints in this area, with limited technical expertise to access climate information and use it to shape health programming, despite some notable efforts at the political level.[190]

There are few sources of technical assistance and financing in this area. WHO is a key technical partner in most countries as it has the longest and most sustained history of climate and health work among international organizations. It has also produced a range of global publications and materials[191] and been involved in several climate change and health projects at the country level.[192]

Other institutions running and advising climate and health projects in multiple countries include UNDP (which has generally worked closely with WHO), the Center for Health and the Global Environment at the University of Washington, the International Research Institute for Climate and Society at Columbia University, the World Meteorological Organization, USAID, Germany's Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the Red Cross/Red Crescent Climate Centre. Given confluence with the other climate agendas, the much larger set of actors working on mitigation, resilience, and disaster risk reduction represent important sources of technical expertise.

Finally, it is important to highlight institutional internal capacity that can be used to strengthen the climate sensitivity of health programming. Within the WBG, for example, relevant technical expertise can be found in the Climate Change Group, at the IFC, and in global practices such as Environment and Natural Resources, Energy, Transport, and Urban Global Practices.

CHAPTER

5 Conclusion

The health sector contributes significant emissions worldwide through energy use, transport, and through products manufactured, used, and disposed of. It is also at the forefront of the response to climate impacts, preventing and diminishing human casualties. Climate mitigation, adaptation, and low-carbon and resilient health development strategies reduce emissions, build healthcare climate resilience, and yield significant health and economic co-benefits. Climate-smart healthcare will strengthen the health sector and communities by ensuring access to clean and independent energy, safe water, clean transport, and clean waste disposal mechanisms. It will also stimulate the development and supply of sustainable products, while preparing the sector for a future of known and unknown health-related climate hazards.

Fundamentally, climate-smart solutions can be a cornerstone of universal healthcare and sustainable development. By integrating climate-smart principles into health sector strategies, development institutions can establish low-carbon, resilient, and adaptive programs that set precedents for other sectors, while sharply responding to pressing climate needs.

The authors of this document have drawn on the resources of many other institutions and experts, and hope that others will use this work in their own efforts to amplify and accelerate the rate of positive change toward more sustainable climate and health futures.

APPENDIX

1

Climate Change Glossary

CO_2: Carbon dioxide is the most prevalent greenhouse gas. CO_2 emissions result from the combustion of fuel, from land use changes and from some industrial processes.

CO_2e: Carbon Dioxide Equivalent. There are six main greenhouse gases, which cause climate change and are targeted by the Paris Agreement. Each gas has a different global warming potential. For simplicity of reporting, the amount of each gas emitted is commonly translated into a carbon dioxide equivalent (CO_2e) amount so that the total impact from all sources can be summed to one figure.

GHG: Greenhouse gases (GHG) include carbon dioxide, nitrous oxide, methane, hydro fluorocarbons, per fluorocarbons and sulphur hexafluoride. They trap heat in the earth's atmosphere, such that a rise in levels of GHG increases temperature—the so-called greenhouse effect.

GHG Categories include direct or Scope 1 emissions, which are emissions directly controlled by an organization (mostly through the burning of fossil fuels). Scope 2 relates to indirect emissions from electricity, heat and steam purchased elsewhere but consumed and managed on-site, and Scope 3, which forms the bulk of indirect emissions, relate to the extraction, production and transportation of purchased materials and services procured.

GHG Protocol: The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions.[193]

Direct Carbon Emissions: Emissions resulting from on-site combustion of fuels which produce CO_2 emissions, for example, the fossil fuel burned to heat water for a hospital. In addition, some processes emit other greenhouse gases. For instance, the production of certain chemicals produces methane (CH_4) and the use of anesthetic gasses leads to nitrous oxide (N_2O) emissions.

Indirect Carbon Emissions: Emissions that are a consequence of an organization's activities but occur off-site. For example, a medication or appliance dispensed by a healthcare provider has emissions produced during its manufacture, transportation, usage and disposal. These are counted as indirect emissions of the healthcare provider.

ANNEX

1A Carbon Emission Hotspots Across the Health Sector in England by Setting

An illustration of a carbon hotspot analysis. The pattern will vary across countries and settings and can help identify focus areas. Size of dots corresponds to impact in each sector. Color corresponds to type of hotspot. Yellow: travel ad transport; green: energy; light blue: pharmaceuticals, medical devices and gases; dark blue: commissioned services.

ANNEX

1B U.S. Healthcare GHG Emissions

Absolute U.S. healthcare greenhouse gas emissions (MtCO$_2$-e) by national health expenditure category and U.S. total for 2003–2013.

EXPENDITURE CATEGORY/YEAR	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Hospital care	184	188	195	200	206	210	218	222	226	233	238
Physician and clinical services	57	60	62	65	65	68	69	70	72	74	77
Other professional services	7	8	8	8	8	8	9	9	9	10	10
Dental services	11	12	12	12	12	12	12	12	12	12	11
Other health, residential, and personal care	20	21	22	22	23	23	24	25	25	25	26
Home healthcare	9	10	11	12	13	13	14	15	15	16	17
Nursing care facilities and continuing care retirement communities	35	36	37	37	38	39	39	39	40	40	41
Prescription drugs	59	63	65	68	71	71	72	69	68	67	68
Durable medical equipment	12	13	14	15	16	16	16	16	17	17	18
Other nondurable medical products	11	11	12	12	13	13	13	13	14	15	15
Government administration	13	13	14	14	13	13	13	13	14	14	15
Net cost of health insurance	7	7	7	8	8	8	8	8	8	8	9
Government public health activities	28	28	28	28	29	30	31	31	29	29	29
Research	12	12	13	12	12	12	12	13	12	12	11
Structures and equipment	45	47	50	51	57	62	59	60	65	70	71
Healthcare total	**511**	**529**	**547**	**563**	**584**	**600**	**608**	**615**	**626**	**643**	**655**
U.S. total[a]	**7073**	**7208**	**7245**	**7182**	**7308**	**7096**	**6636**	**6849**	**6727**	**6502**	**6673**
Healthcare % of U.S. GHG emissions	**7.2%**	**7.3%**	**7.6%**	**7.8%**	**8.0%**	**8.5%**	**9.2%**	**9.0%**	**9.3%**	**9.9%**	**9.8%**

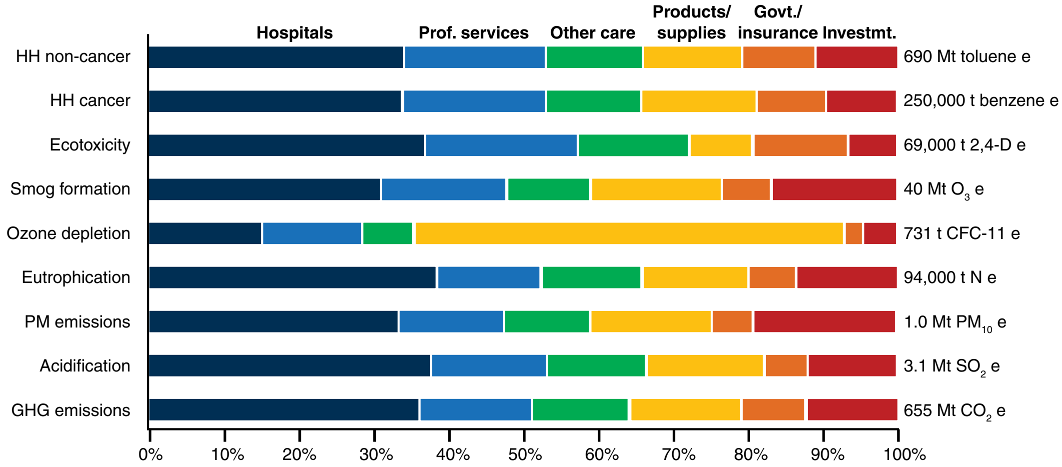
[a]US national emissions are from the annual US Greenhouse Gas Emissions Inventory conducted by the USEPA.

Eckelman MJ, Sherman J (2016) Environmental Impacts of the U.S. Healthcare System and Effects on Public Health. PLoS ONE 11(6): e0157014. doi:10.1371/journal.pone.0157014 http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0157014

ANNEX

1C

Environmental/Health Impacts of U.S. Healthcare Activities



Eckelman MJ, Sherman J (2016) Environmental Impacts of the U.S. Healthcare System and Effects on Public Health. PLoS ONE 11(6): e0157014. doi:10.1371/journal.pone.0157014. http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0157014

ANNEX

2

Community Health and Safety Safeguard

In August, 2016, the World Bank Board of Directors approved a review and update of World Bank Safeguard policies. These are salient in many ways to this work. Relevant excerpts that deal with health are listed below.

Excerpts:

ESS4: Community Health and Safety 101. ESS4 consolidates into one standard the existing practices related to the impacts of projects on communities. It incorporates OP/BP 4.37, Safety of Dams, and also captures many of the World Bank's provisions regarding the design and safety aspects of infrastructure, equipment, products, services, traffic, and hazardous materials. It requires borrowers to develop and implement measures to address possible community exposure to disease as a consequence of project activities and to address emergencies through contingency planning. ESS4 includes requirements on security personnel (both government and private) that are similar to the provisions of some other MDBs.

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49. ***Many of the investment projects the World Bank supports advance the realization of human rights expressed in the Universal Declaration of Human Rights, including through better healthcare, education, and social protection, and better access to such services.***

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57. ***Climate change is among the most pressing development issues of this generation.*** *The World Bank recognizes the fundamental importance of this issue and has developed an institution-wide strategy to address it. The proposed ESF includes a range of climate change considerations, including GHG emission estimation in the proposed ESS3: Resource Efficiency and Pollution Prevention and Management, and climate change adaptation in ESS4: Community Health and Safety.*

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153. ***Additional resources would be needed for the new steady state to cover, in particular, the fixed costs associated with hiring additional staff for new areas covered by the ESF, as well as variable and overhead costs required to deliver project support across the Bank's IPF pipeline and portfolio.*** *Incremental costs would be associated with: a) Broader scope of practice due to new topic areas (labor, community health and safety, stakeholder engagement), new processes (ESCP, risk classification, social assessment), and the assessment of borrowers' ES frameworks. . .*

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