4

Trajectories

Navigating an uncertain future

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

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

The global emissions gap

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

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

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

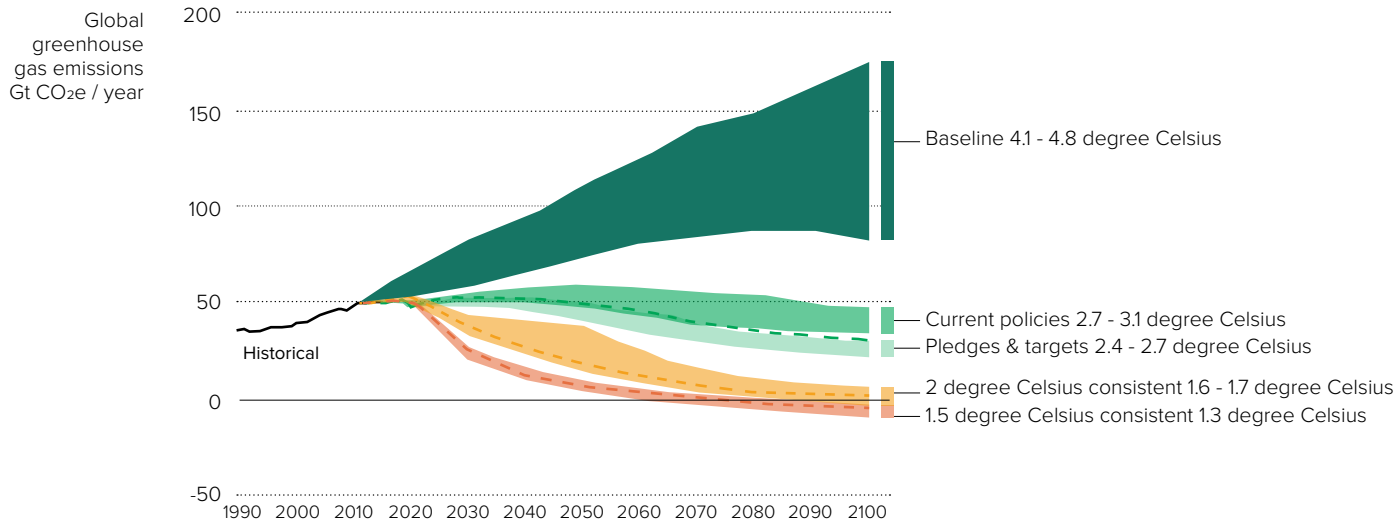


Figure 10. 2100 warming projections – emissions and expected warming based on pledges and current policies; source: Climate Action Tracker, September 2020. https://climateactiontracker.org/global/temperatures/. September 2020 update.

Decarbonization scenarios

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

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

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

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

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

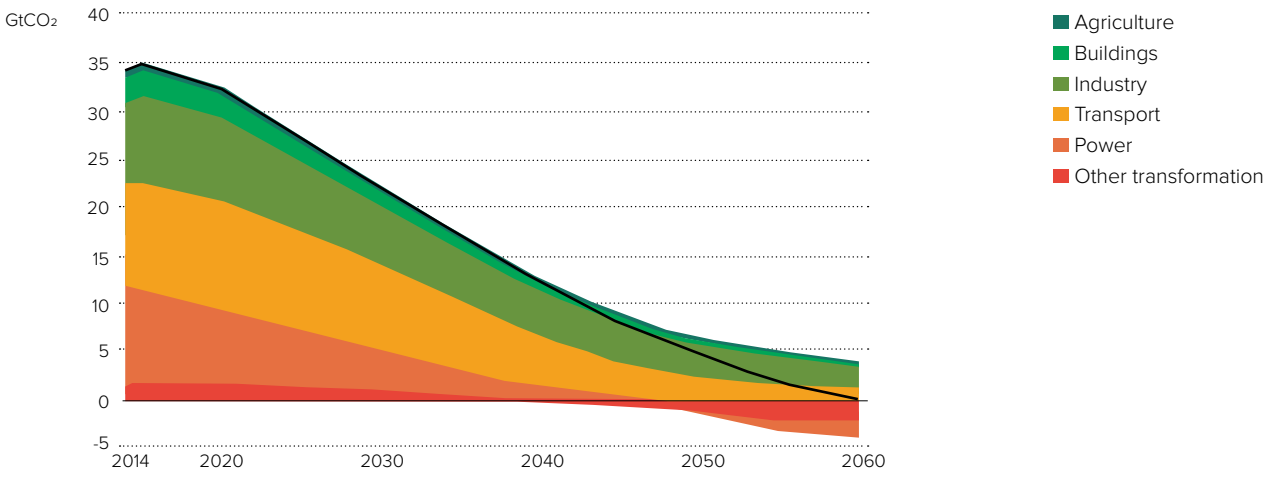


Figure 11. IEA B2DS featuring steep decline in CO_2 emissions from energy use and generation.[35]

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

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

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

Three global health care decarbonization scenarios

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

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

Reference case: Business as usual

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

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

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

Reference technology scenario: Meeting country climate commitments

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

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

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

Below 2 degrees scenario: Accelerating climate action

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

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

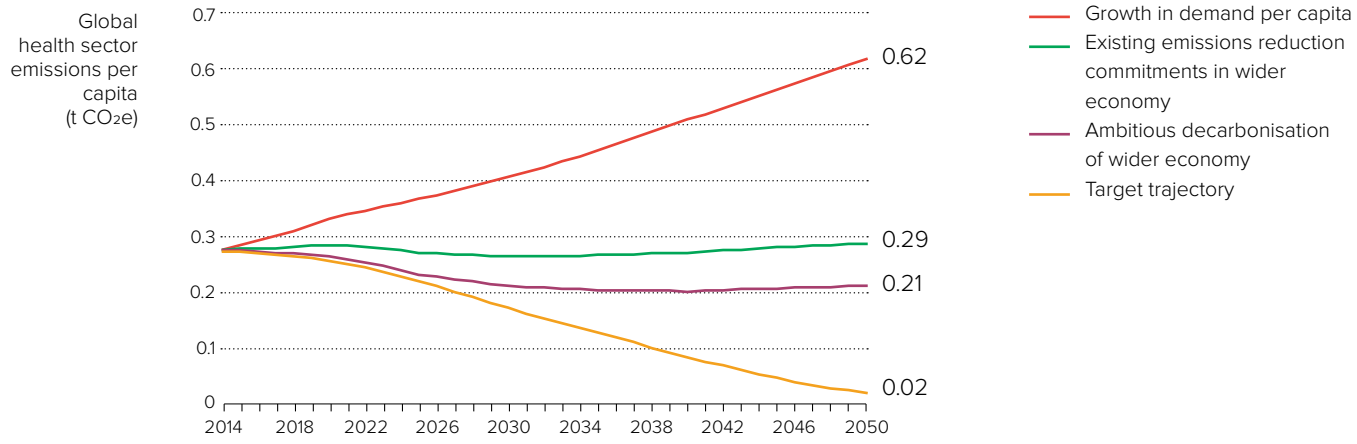


Figure 12. Per capita global health care emissions projections with no action or business as usual (Growth in demand), meeting Paris commitments made up to 2017 (RTS), ambitious decarbonization of the wider economy (B2DS), and deep decarbonization in health care (target trajectory—includes the three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

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

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

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

A 1.5 degree, zero emissions health care scenario

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

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

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

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

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

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

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

A global health care sector emissions budget

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

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

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

Table 2. The global health care sector emissions

Common but differentiated responsibilities and respective capabilities

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

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

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

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

Table 3. Health care emissions per capita by country.

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

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

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

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

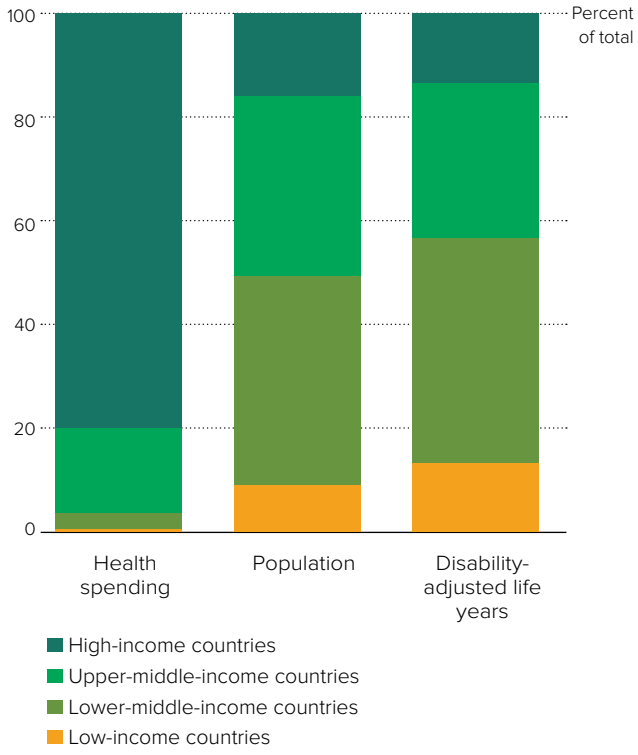


Figure 13. Health spending, population, and disability adjusted life years[v] by World Bank income group, 2017.[40]

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

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

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

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

Contraction and Convergence

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

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

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

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

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

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

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

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

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

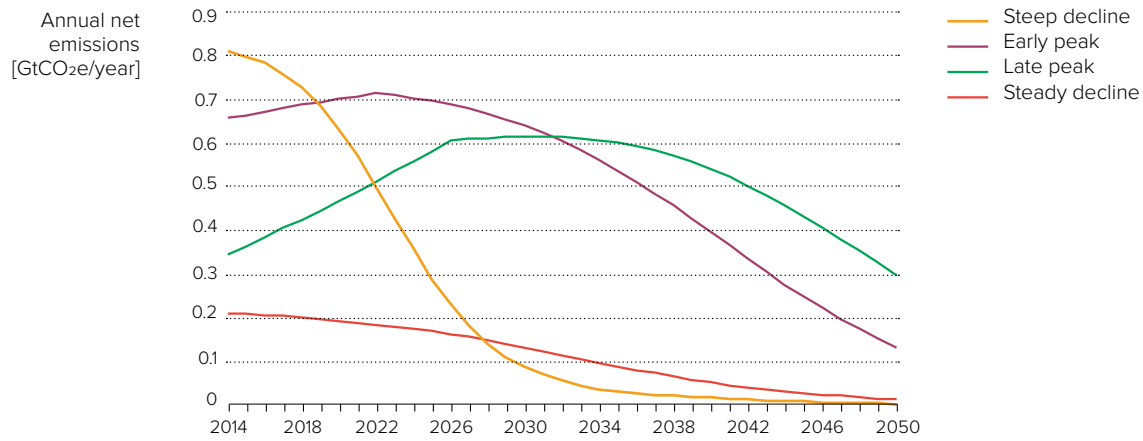


Figure 14. Four Decarbonization Trajectories - absolute emissions.

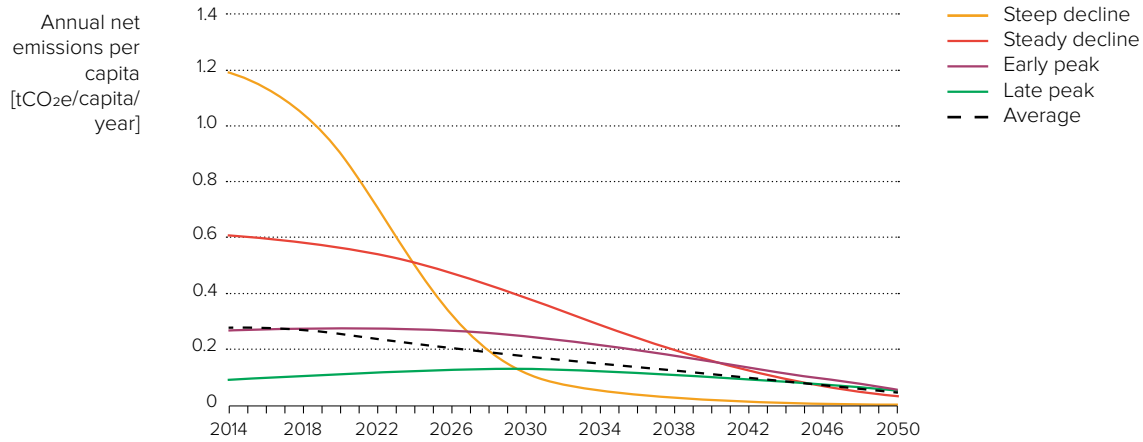
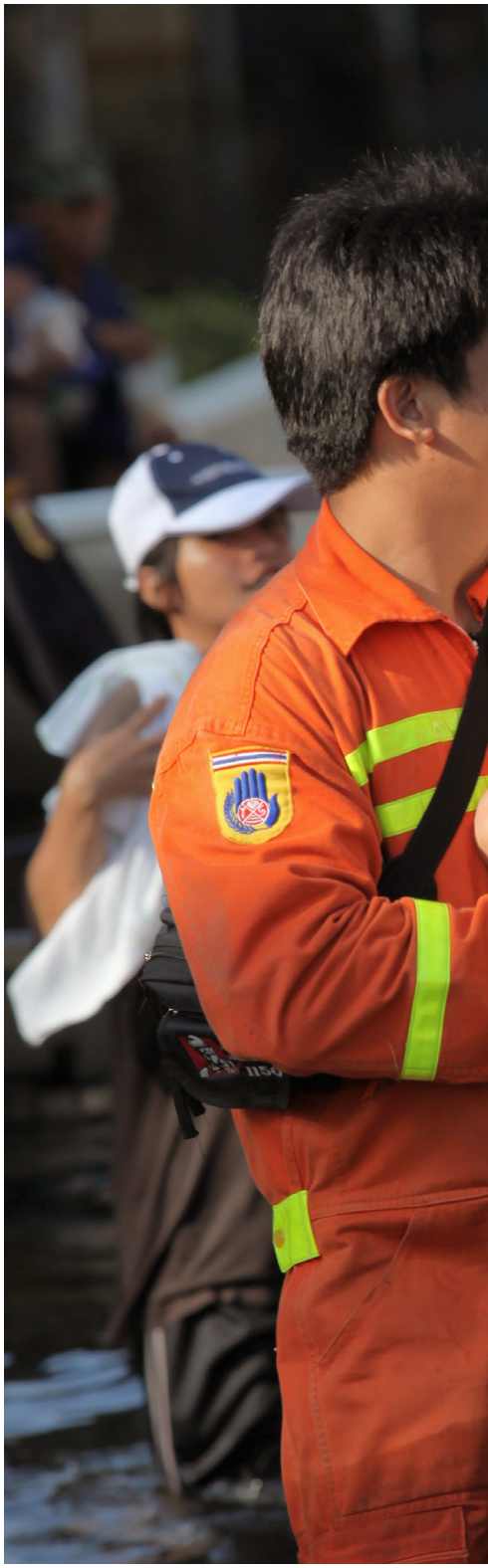


Figure 15. Four Decarbonization Trajectories – annual per capita emissions.

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

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



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

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

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

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

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

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