

**IPCC Special Report on Global Warming of 1.5°C
Frequently Asked Questions**

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1 **FAQ 1.1: Why Are We Talking about 1.5°C?**

2
3 **Summary:** *Climate change represents an urgent and potentially irreversible threat to human societies and the planet. In recognition of this, the overwhelming majority of countries around the world*
4 *adopted the Paris Agreement in December 2015, the central aim of which includes pursuing efforts to*
5 *limit global temperature rise to 1.5°C. In doing so, these countries, through the United Nations*
6 *Framework Convention on Climate Change (UNFCCC), also invited the IPCC to provide a Special*
7 *Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global*
8 *greenhouse gas emissions pathways.*
9

10
11 At the 21st Conference of the Parties (COP21) in December 2015, 195 nations adopted the Paris
12 Agreement¹. The first instrument of its kind, the landmark agreement includes the aim to strengthen
13 the global response to the threat of climate change by ‘holding the increase in the global average
14 temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature
15 increase to 1.5°C above pre-industrial levels’.

16
17 The first UNFCCC document to mention a limit to global warming of 1.5°C was the Cancun
18 Agreement, adopted at the sixteenth COP (COP16) in 2010. The Cancun Agreement established a
19 process to periodically review the ‘adequacy of the long-term global goal (LTGG) in the light of the
20 ultimate objective of the Convention and the overall progress made towards achieving the LTGG,
21 including a consideration of the implementation of the commitments under the Convention’. The
22 definition of LTGG in the Cancun Agreement was ‘to hold the increase in global average temperature
23 below 2°C above pre-industrial levels’. The agreement also recognised the need to consider
24 ‘strengthening the long term global goal on the basis of the best available scientific knowledge...to a
25 global average temperature rise of 1.5°C’.

26
27 Beginning in 2013 and ending at the COP21 in Paris in 2015, the first review period of the long-term
28 global goal largely consisted of the Structured Expert Dialogue (SED). This was a fact-finding, face-
29 to-face exchange of views between invited experts and UNFCCC delegates. The final report of the
30 SED² concluded that ‘in some regions and vulnerable ecosystems, high risks are projected even for
31 warming above 1.5°C’. The SED report also suggested that Parties would profit from restating the
32 temperature limit of the long-term global goal as a ‘defence line’ or ‘buffer zone’, instead of a
33 ‘guardrail’ up to which all would be safe, adding that this new understanding would ‘probably also
34 favour emission pathways that will limit warming to a range of temperatures below 2°C’. Specifically
35 on strengthening the temperature limit of 2°C, the SED’s key message was: ‘While science on the
36 1.5°C warming limit is less robust, efforts should be made to push the defence line as low as possible’.
37 The findings of the SED, in turn, fed into the draft decision adopted at COP21.

38
39 With the adoption of the Paris Agreement, the UNFCCC invited the IPCC to provide a Special Report
40 in 2018 on ‘the impacts of global warming of 1.5°C above pre-industrial levels and related global
41 greenhouse gas emissions pathways’. The request was that the report, known as SR1.5, should not
42 only assess what a 1.5°C warmer world would look like but also the different pathways by which
43 global temperature rise could be limited to 1.5°C. In 2016, the IPCC accepted the invitation, adding
44 that the Special Report would also look at these issues in the context of strengthening the global
45 response to the threat of climate change, sustainable development and efforts to eradicate poverty.

46
47 The combination of rising exposure to climate change and the fact that there is a limited capacity to
48 adapt to its impacts amplifies the risks posed by warming of 1.5°C and 2°C. This is particularly true

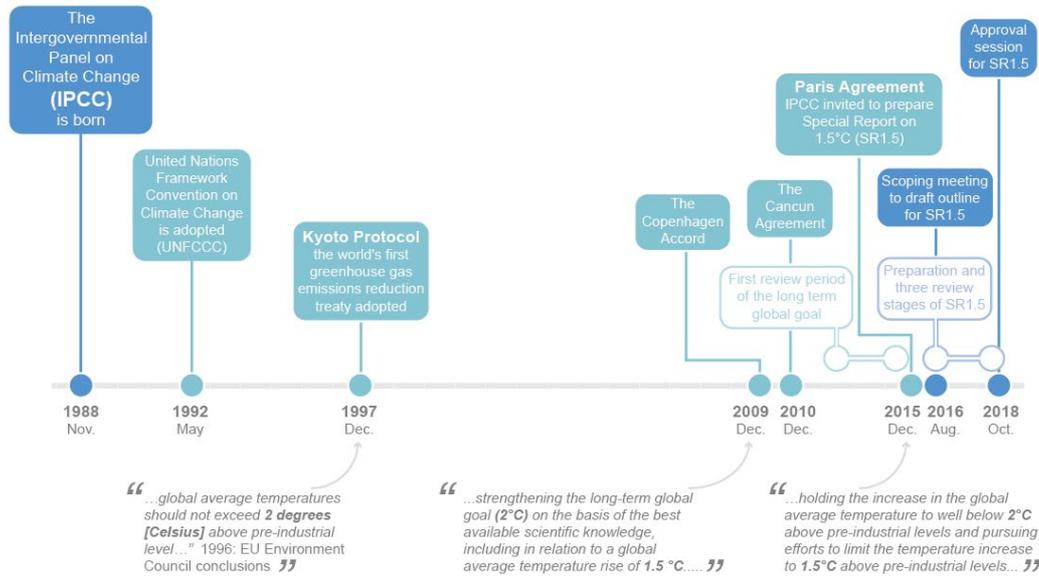
¹ Paris Agreement FCCC/CP/2015/10/Add.1 <https://unfccc.int/documents/9097>

² Structured Expert Dialogue (SED) final report FCCC/SB/2015/INF.1 <https://unfccc.int/documents/8707>

1 for developing and island countries in the tropics and other vulnerable countries and areas. The risks
 2 posed by global warming of 1.5°C are greater than for present-day conditions but lower than at 2°C.
 3

FAQ1.1: Timeline of 1.5°C

Milestones in the IPCC's preparation of the Special Report on Global Warming of 1.5°C and some relevant events in the history of international climate negotiations



4 **FAQ1.1, Figure 1:** A timeline of notable dates in preparing the IPCC Special Report on Global
 5 Warming of 1.5°C (blue) embedded within processes and milestones of the United Nations
 6 Framework Convention on Climate Change (UNFCCC; grey), including events that may be relevant
 7 for discussion of temperature limits.
 8
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1 **FAQ 1.2: How Close Are We to 1.5°C?**

2
3 **Summary:** *Human-induced warming has already reached about 1°C above pre-industrial levels at the*
4 *time of writing of this Special Report. By the decade 2006–2015, human activity had warmed the*
5 *world by 0.87°C (±0.12°C) compared pre-industrial times (1850–1900). If the current warming rate*
6 *continues, the world would reach human-induced global warming of 1.5°C around 2040.*

7
8 Under the 2015 Paris Agreement, countries agreed to cut greenhouse gas emissions with a view to
9 ‘holding the increase in the global average temperature to well below 2°C above pre-industrial levels
10 and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels’. While the
11 overall intention of strengthening the global response to climate change is clear, the Paris Agreement
12 does not specify precisely what is meant by ‘global average temperature’, or what period in history
13 should be considered ‘pre-industrial’. To answer the question of how close are we to 1.5°C of
14 warming, we need to first be clear about how both terms are defined in this Special Report.

15
16 The choice of pre-industrial reference period, along with the method used to calculate global average
17 temperature, can alter scientists’ estimates of historical warming by a couple of tenths of a degree
18 Celsius. Such differences become important in the context of a global temperature limit just half a
19 degree above where we are now. But provided consistent definitions are used, they do not affect our
20 understanding of how human activity is influencing the climate.

21
22 In principle, ‘pre-industrial levels’ could refer to any period of time before the start of the industrial
23 revolution. But the number of direct temperature measurements decreases as we go back in time.
24 Defining a ‘pre-industrial’ reference period is, therefore, a compromise between the reliability of the
25 temperature information and how representative it is of truly pre-industrial conditions. Some pre-
26 industrial periods are cooler than others for purely natural reasons. This could be because of
27 spontaneous climate variability or the response of the climate to natural perturbations, such as volcanic
28 eruptions and variations in the sun’s activity. This IPCC Special Report on Global Warming of 1.5°C
29 uses the reference period 1850–1900 to represent pre-industrial conditions. This is the earliest period
30 with near-global observations and is the reference period used as an approximation of pre-industrial
31 temperatures in the IPCC Fifth Assessment Report.

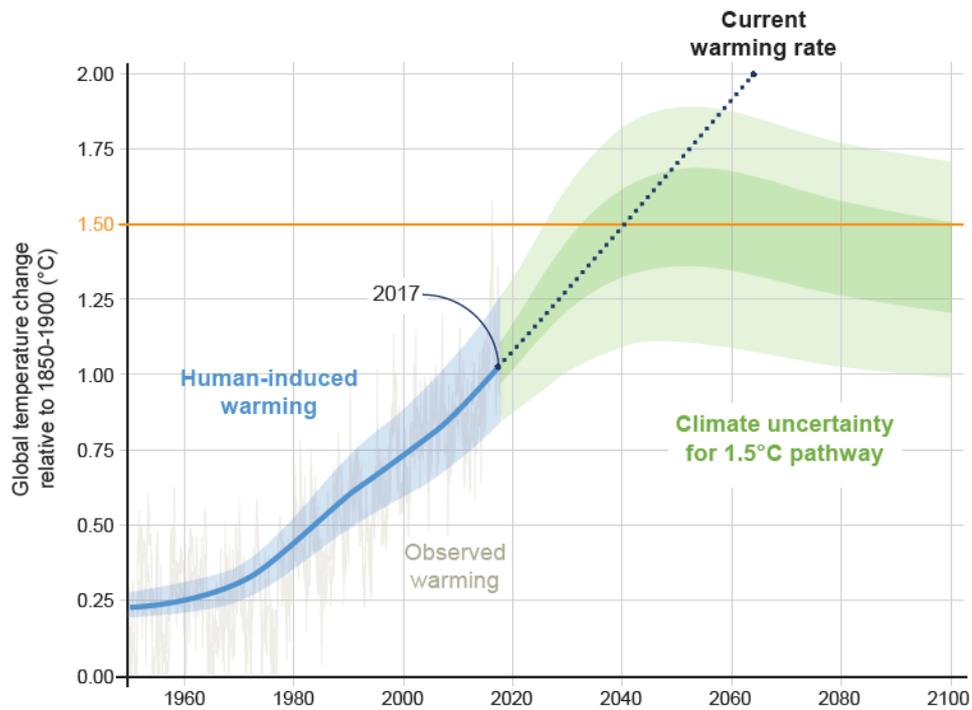
32
33 Once scientists have defined ‘pre-industrial’, the next step is to calculate the amount of warming at
34 any given time relative to that reference period. In this report, warming is defined as the increase in the
35 30-year global average of combined temperature over land and at the ocean surface. The 30-year
36 timespan accounts for the effect of natural variability, which can cause global temperatures to
37 fluctuate from one year to the next. For example, 2015 and 2016 were both affected by a strong El
38 Niño event, which amplified the underlying human-caused warming.

39
40 In the decade 2006–2015, warming reached 0.87°C (±0.12°C) relative to 1850–1900, predominantly
41 due to human activity increasing the amount of greenhouse gases in the atmosphere. Given that global
42 temperature is currently rising by 0.2°C (±0.1°C) per decade, human-induced warming reached 1°C
43 above pre-industrial levels around 2017 and, if this pace of warming continues, would reach 1.5°C
44 around 2040.

45
46 While the change in global average temperature tells researchers about how the planet as a whole is
47 changing, looking more closely at specific regions, countries and seasons reveals important details.
48 Since the 1970s, most land regions have been warming faster than the global average, for example.
49 This means that warming in many regions has already exceeded 1.5°C above pre-industrial levels.
50 Over a fifth of the global population live in regions that have already experienced warming in at least
51 one season that is greater than 1.5°C above pre-industrial levels.

FAQ1.2: How close are we to 1.5°C?

Human-induced warming reached approximately 1°C above pre-industrial levels in 2017



1
 2 **FAQ1.2, Figure 1:** Human-induced warming reached approximately 1°C above pre-industrial levels
 3 in 2017. At the present rate, global temperatures would reach 1.5°C around 2040. Stylized 1.5°C
 4 pathway shown here involves emission reductions beginning immediately, and CO₂ emissions
 5 reaching zero by 2055.

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1 **FAQ 2.1:** What Kind of Pathways Limit Warming to 1.5°C and Are We on Track?
2

3 ***Summary:** There is no definitive way to limit global temperature rise to 1.5°C above pre-industrial
4 levels. This Special Report identifies two main conceptual pathways to illustrate different
5 interpretations. One stabilizes global temperature at, or just below, 1.5°C. Another sees global
6 temperature temporarily exceed 1.5°C before coming back down. Countries' pledges to reduce their
7 emissions are currently not in line with limiting global warming to 1.5°C.*
8

9 Scientists use computer models to simulate the emissions of greenhouse gases that would be consistent
10 with different levels of warming. The different possibilities are often referred to as 'greenhouse gas
11 emission pathways'. There is no single, definitive pathway to limiting warming to 1.5°C.
12

13 This IPCC special report identifies two main pathways that explore global warming of 1.5°C. The first
14 involves global temperature stabilizing at or below before 1.5°C above pre-industrial levels. The
15 second pathway sees warming exceed 1.5°C around mid-century, remain above 1.5°C for a maximum
16 duration of a few decades, and return to below 1.5°C before 2100. The latter is often referred to as an
17 'overshoot' pathway. Any alternative situation in which global temperature continues to rise,
18 exceeding 1.5°C permanently until the end of the 21st century, is not considered to be a 1.5°C
19 pathway.
20

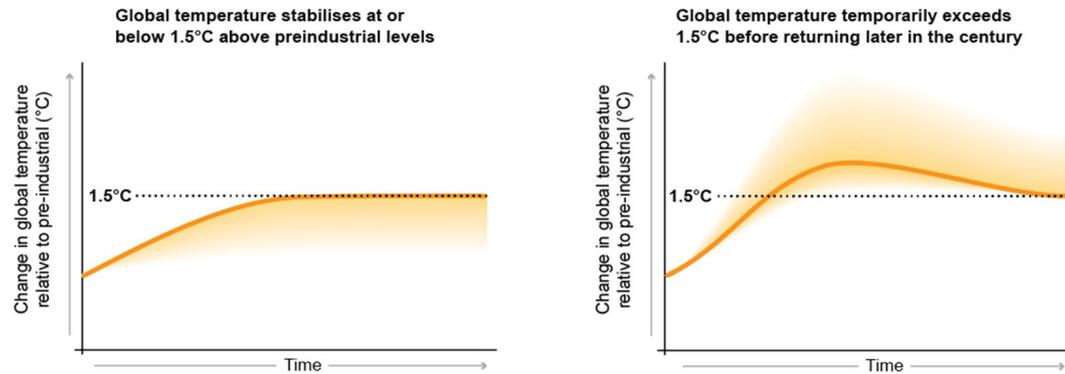
21 The two types of pathway have different implications for greenhouse gas emissions, as well as for
22 climate change impacts and for achieving sustainable development. For example, the larger and longer
23 an 'overshoot', the greater the reliance on practices or technologies that remove CO₂ from the
24 atmosphere, on top of reducing the sources of emissions (mitigation). Such ideas for CO₂ removal have
25 not been proven to work at scale and, therefore, run the risk of being less practical, effective or
26 economical than assumed. There is also the risk that the use of CO₂ removal techniques ends up
27 competing for land and water, and if these trade-offs are not appropriately managed, they can
28 adversely affect sustainable development. Additionally, a larger and longer overshoot increases the
29 risk for irreversible climate impacts, such as the onset of the collapse of polar ice shelves and
30 accelerated sea level rise.
31

32 Countries that formally accept or 'ratify' the Paris Agreement submit pledges for how they intend to
33 address climate change. Unique to each country, these pledges are known as Nationally Determined
34 Contributions (NDCs). Different groups of researchers around the world have analysed the combined
35 effect of adding up all the NDCs. Such analyses show that current pledges are not on track to limit
36 global warming to 1.5°C above pre-industrial levels. If current pledges for 2030 are achieved but no
37 more, researchers find very few (if any) ways to reduce emissions after 2030 sufficiently quickly to
38 limit warming to 1.5°C. This, in turn, suggests that with the national pledges as they stand, warming
39 would exceed 1.5°C, at least for a period of time, and practices and technologies that remove CO₂
40 from the atmosphere at a global scale would be required to return warming to 1.5°C at a later date.
41

42 A world that is consistent with holding warming to 1.5°C would see greenhouse gas emissions rapidly
43 decline in the coming decade, with strong international cooperation and a scaling up of countries'
44 combined ambition beyond current NDCs. In contrast, delayed action, limited international
45 cooperation, and weak or fragmented policies that lead to stagnating or increasing greenhouse gas
46 emissions would put the possibility of limiting global temperature rise to 1.5°C above pre-industrial
47 levels out of reach.
48

FAQ2.1: Conceptual pathways that limit global warming to 1.5°C

Two main pathways illustrate different interpretations for limiting global warming to 1.5°C. The consequences will be different depending on the pathway



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FAQ2.1, Figure 1: Two main pathways for limiting global temperature rise to 1.5°C above pre-industrial levels are discussed in this Special Report. These are: stabilizing global temperature at, or just below, 1.5°C (left) and global temperature temporarily exceeding 1.5°C before coming back down later in the century (right). Temperatures shown are relative to pre-industrial but pathways are illustrative only, demonstrating conceptual not quantitative characteristics.

1 **FAQ 2.2:** What Do Energy Supply and Demand Have to do with Limiting Warming to 1.5°C?
2

3 ***Summary:** Limiting global warming to 1.5°C above pre-industrial levels would require major
4 reductions in greenhouse gas emissions in all sectors. But different sectors are not independent of
5 each other, and making changes in one can have implications for another. For example, if we as a
6 society use a lot of energy, then this could mean we have less flexibility in the choice of mitigation
7 options available to limit warming to 1.5°C. If we use less energy, the choice of possible actions is
8 greater – for example, we could be less reliant on technologies that remove carbon dioxide (CO₂)
9 from the atmosphere.*

10
11 To stabilize global temperature at any level, ‘net’ CO₂ emissions would need to be reduced to zero.
12 This means the amount of CO₂ entering the atmosphere must equal the amount that is removed.
13 Achieving a balance between CO₂ ‘sources’ and ‘sinks’ is often referred to as ‘net zero’ emissions or
14 ‘carbon neutrality’. The implication of net zero emissions is that the concentration of CO₂ in the
15 atmosphere would slowly decline over time until a new equilibrium is reached, as CO₂ emissions from
16 human activity are redistributed and taken up by the oceans and the land biosphere. This would lead to
17 a near-constant global temperature over many centuries.

18
19 Warming will not be limited to 1.5°C or 2°C unless transformations in a number of areas achieve the
20 required greenhouse gas emissions reductions. Emissions would need to decline rapidly across all of
21 society’s main sectors, including buildings, industry, transport, energy, and agriculture, forestry and
22 other land use (AFOLU). Actions that can reduce emissions include, for example, phasing out coal in
23 the energy sector, increasing the amount of energy produced from renewable sources, electrifying
24 transport, and reducing the ‘carbon footprint’ of the food we consume.

25
26 The above are examples of ‘supply-side’ actions. Broadly speaking, these are actions that can reduce
27 greenhouse gas emissions through the use of low-carbon solutions. A different type of action can
28 reduce how much energy human society uses, while still ensuring increasing levels of development
29 and well-being. Known as ‘demand-side’ actions, this category includes improving energy efficiency
30 in buildings and reducing consumption of energy- and greenhouse-gas intensive products through
31 behavioural and lifestyle changes, for example. Demand- and supply-side measures are not an either-
32 or question, they work in parallel with each other. But emphasis can be given to one or the other.

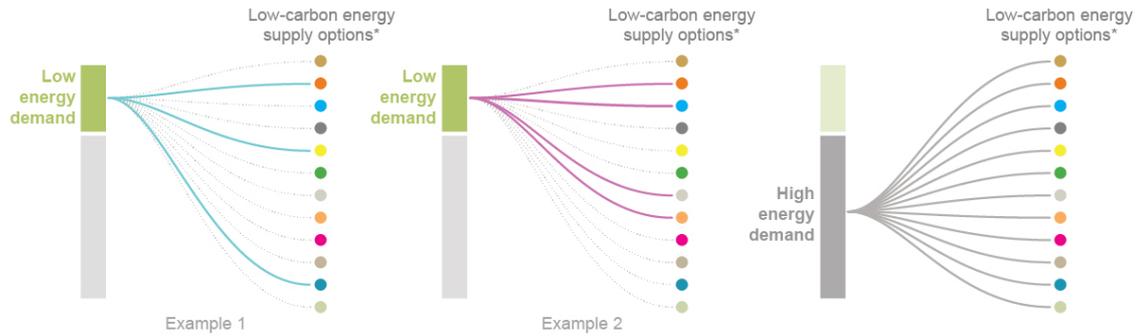
33
34 Making changes in one sector can have consequences for another, as they are not independent of each
35 other. In other words, the choices that we make now as a society in one sector can either restrict or
36 expand our options later on. For example, a high demand for energy could mean we would need to
37 deploy almost all known options to reduce emissions in order to limit global temperature rise to 1.5°C
38 above pre-industrial levels, with the potential for adverse side-effects. In particular, a pathway with
39 high energy demand would increase our reliance on practices and technologies that remove CO₂ from
40 the atmosphere. As of yet, such techniques have not been proven to work on a large scale and,
41 depending on how they are implemented, could compete for land and water. By leading to lower
42 overall energy demand, effective demand-side measures could allow for greater flexibility in how we
43 structure our energy system. However, demand-side measures are not easy to implement and barriers
44 have prevented the most efficient practices being used in the past.
45

FAQ2.2: Energy demand and supply in 1.5°C world

Lower energy demand could allow for greater flexibility in how we structure our energy system.

Low energy demand allows more choice about which low-carbon energy supply options to use to limit warming to 1.5°C.

With high energy demand, there is less flexibility as virtually all available options would need to be considered.



* Options include renewable energy (such as bioenergy, hydro, wind and solar), nuclear and the use of carbon dioxide removal techniques

1
 2 **FAQ2.2, Figure 1:** Having a lower energy demand increases the flexibility in choosing options for
 3 supplying energy. A larger energy demand means many more low carbon energy supply options
 4 would need to be used.
 5

FAQ 3.1: What are the Impacts of 1.5°C and 2°C of Warming?

***Summary:** The impacts of climate change are being felt in every inhabited continent and in the oceans. However, they are not spread uniformly across the globe, and different parts of the world experience impacts differently. An average warming of 1.5°C across the whole globe raises the risk of heatwaves and heavy rainfall events, amongst many other potential impacts. Limiting warming to 1.5°C rather than 2°C can help reduce these risks, but the impacts the world experiences will depend on the specific greenhouse gas emissions ‘pathway’ taken. The consequences of temporarily overshooting 1.5°C of warming and returning to this level later in the century, for example, could be larger than if temperature stabilizes below 1.5°C. The size and duration of an overshoot will also affect future impacts.*

Human activity has warmed the world by about 1°C since pre-industrial times, and the impacts of this warming have already been felt in many parts of the world. This estimate of the increase in global temperature is the average of many thousands of temperature measurements taken over the world’s land and oceans. Temperatures are not changing at the same speed everywhere, however: warming is strongest on continents and is particularly strong in the Arctic in the cold season and in mid-latitude regions in the warm season. This is due to self-amplifying mechanisms, for instance due to snow and ice melt reducing the reflectivity of solar radiation at the surface, or soil drying leading to less evaporative cooling in the interior of continents. This means that some parts of the world have already experienced temperatures greater than 1.5°C above pre-industrial levels.

Extra warming on top of the approximately 1°C we have seen so far would amplify the risks and associated impacts, with implications for the world and its inhabitants. This would be the case even if the global warming is held at 1.5°C, just half a degree above where we are now, and would be further amplified at 2°C of global warming. Reaching 2°C instead of 1.5°C of global warming would lead to substantial warming of extreme hot days in all land regions. It would also lead to an increase in heavy rainfall events in some regions, particularly in the high latitudes of the Northern Hemisphere, potentially raising the risk of flooding. In addition, some regions, such as the Mediterranean, are projected to become drier at 2°C versus 1.5°C of global warming. The impacts of any additional warming would also include stronger melting of ice sheets and glaciers, as well as increased sea level rise, which would continue long after the stabilization of atmospheric CO₂ concentrations.

Change in climate means and extremes have knock-on effects for the societies and ecosystems living on the planet. Climate change is projected to be a poverty multiplier, which means that its impacts are expected to make the poor poorer and the total number of people living in poverty greater. The 0.5°C rise in global temperatures that we have experienced in the past 50 years has contributed to shifts in the distribution of plant and animal species, decreases in crop yields and more frequent wildfires. Similar changes can be expected with further rises in global temperature.

Essentially, the lower the rise in global temperature above pre-industrial levels, the lower the risks to human societies and natural ecosystems. Put another way, limiting warming to 1.5°C can be understood in terms of ‘avoided impacts’ compared to higher levels of warming. Many of the impacts of climate change assessed in this report have lower associated risks at 1.5°C compared to 2°C.

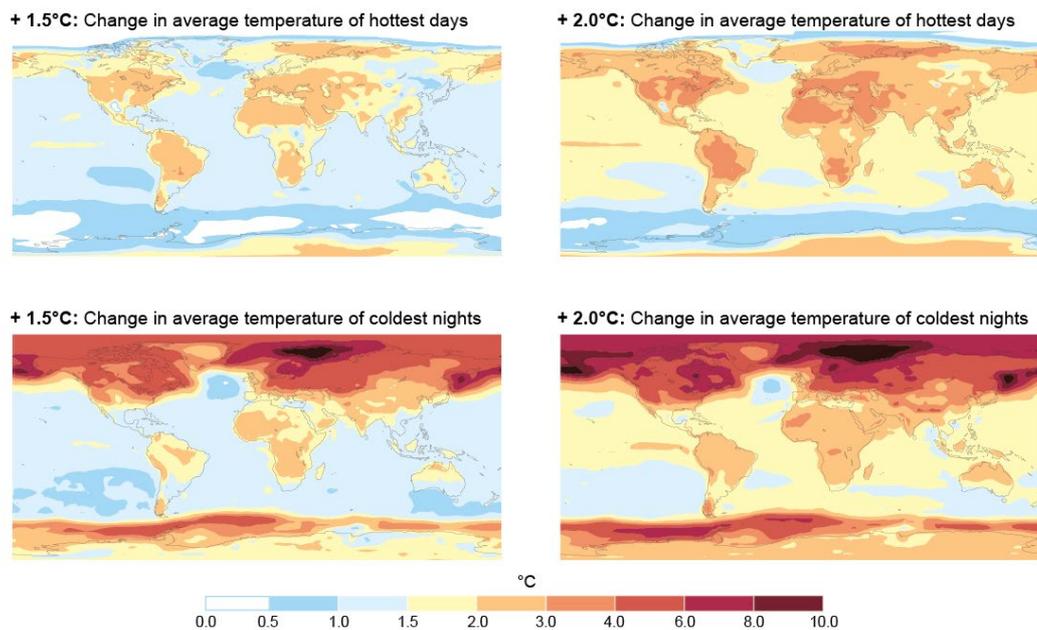
Thermal expansion of the oceans, resulting from delayed ocean mixing, means sea level will continue to rise even if global temperature is limited to 1.5°C, but this rise would be lower than in a 2°C warmer world. Ocean acidification, the process by which excess CO₂ dissolves into oceans and makes them more acidic, is expected to be less damaging in a world where CO₂ emissions are reduced and warming is stabilized at 1.5°C compared to 2°C. The persistence of coral reefs is greater in a 1.5°C world than that of a 2°C world, too.

1 The impacts of climate change that we experience in future will be affected by factors other than the
 2 change in temperature. The consequences of 1.5°C of warming will additionally depend on the
 3 specific greenhouse gas emissions ‘pathway’ that is followed and the extent to which adaptation can
 4 reduce vulnerability. This IPCC Special Report uses a number of ‘pathways’ to explore different
 5 possibilities for limiting global warming to 1.5°C above pre-industrial levels. One type of pathway
 6 sees global temperature stabilize at, or just below, 1.5°C. Another sees global temperature temporarily
 7 exceed 1.5°C before declining later in the century (known as an ‘overshoot’ pathway).

8
 9 Such pathways would have different associated impacts, so it is important to distinguish between them
 10 for planning adaptation and mitigation strategies. For example, impacts from an overshoot pathway
 11 could be larger than impacts from a stabilization pathway. The size and duration of an overshoot
 12 would also have consequences for the impacts the world experiences. For instance, pathways that
 13 overshoot 1.5°C run a greater risk of passing through ‘tipping points’, thresholds beyond which certain
 14 impacts can no longer be avoided even if temperatures are brought back down later on. The collapse of
 15 the Greenland and Antarctic ice sheets on the timescale of centuries and millennia is one example of a
 16 tipping point.

FAQ3.1: Impact of 1.5°C and 2.0°C global warming

Temperature rise is not uniform across the world. Some regions will experience greater increases in hot days and decreases in cold nights than others



18 **FAQ 3.1, Figure 1:** Temperature change is not uniform across the globe. Projected changes are shown
 19 for the average temperature of the annual hottest day (top) and the annual coldest
 20 night (bottom) with 1.5°C of global warming (left) and 2°C of global warming
 21 (right) compared to pre-industrial levels.
 22
 23

1 **FAQ 4.1: What Transitions Could Enable Limiting Global Warming to 1.5°C?**

2
3 ***Summary:** In order to limit warming to 1.5°C above pre-industrial levels, the world would need to*
4 *transform in a number of complex and connected ways. While transitions towards lower greenhouse*
5 *gas emissions are underway in some cities, regions, countries, businesses and communities, there are*
6 *few that are currently consistent with limiting warming to 1.5°C. Meeting this challenge would require*
7 *a rapid escalation in the current scale and pace of change, particularly in the coming decades. There*
8 *are many factors that affect the feasibility of different adaptation and mitigation options that could*
9 *help limit warming to 1.5°C and with adapting to the consequences.*

10 There are actions across all sectors that can substantially reduce greenhouse gas emissions. This
11 Special Report assesses energy, land and ecosystems, urban and infrastructure, and industry in
12 developed and developing nations to see how they would need to be transformed to limit warming to
13 1.5°C. Examples of actions include shifting to low- or zero-emission power generation, such as
14 renewables; changing food systems, such as diet changes away from land-intensive animal products;
15 electrifying transport and developing ‘green infrastructure’, such as building green roofs, or improving
16 energy efficiency by smart urban planning, which will change the layout of many cities.

17 Because these different actions are connected, a ‘whole systems’ approach would be needed for the
18 type of transformations that could limit warming to 1.5°C. This means that all relevant companies,
19 industries and stakeholders would need to be involved to increase the support and chance of successful
20 implementation. As an illustration, the deployment of low-emission technology (e.g., renewable
21 energy projects or a bio-based chemical plants) would depend upon economic conditions (e.g.,
22 employment generation or capacity to mobilize investment), but also on social/cultural conditions
23 (e.g., awareness and acceptability) and institutional conditions (e.g., political support and
24 understanding).

25 To limit warming to 1.5°C, mitigation would have to be large-scale and rapid. Transitions can be
26 transformative or incremental, and they often, but not always, go hand in hand. Transformative change
27 can arise from growth in demand for a new product or market, such that it displaces an existing one.
28 This is sometimes called ‘disruptive innovation’. For example, high demand for LED lighting is now
29 making more energy-intensive, incandescent lighting near-obsolete, with the support of policy action
30 that spurred rapid industry innovation. Similarly, smart phones have become global in use within ten
31 years. But electric cars, which were released around the same time, have not been adopted so quickly
32 because the bigger, more connected transport and energy systems are harder to change. Renewable
33 energy, especially solar and wind, is considered to be disruptive by some as it is rapidly being adopted
34 and is transitioning faster than predicted. But its demand is not yet uniform. Urban systems that are
35 moving towards transformation are coupling solar and wind with battery storage and electric vehicles
36 in a more incremental transition, though this would still require changes in regulations, tax incentives,
37 new standards, demonstration projects and education programmes to enable markets for this system to
38 work.

39 Transitional changes are already underway in many systems, but limiting warming to 1.5°C would
40 require a rapid escalation in the scale and pace of transition, particularly in the next 10–20 years.
41 While limiting warming to 1.5°C would involve many of the same types of transitions as limiting
42 warming to 2°C, the pace of change would need to be much faster. While the *pace* of change that
43 would be required to limit warming to 1.5°C can be found in the past, there is no historical precedent
44 for the *scale* of the necessary transitions, in particular in a socially and economically sustainable way.
45 Resolving such speed and scale issues would require people’s support, public-sector interventions and
46 private-sector cooperation.

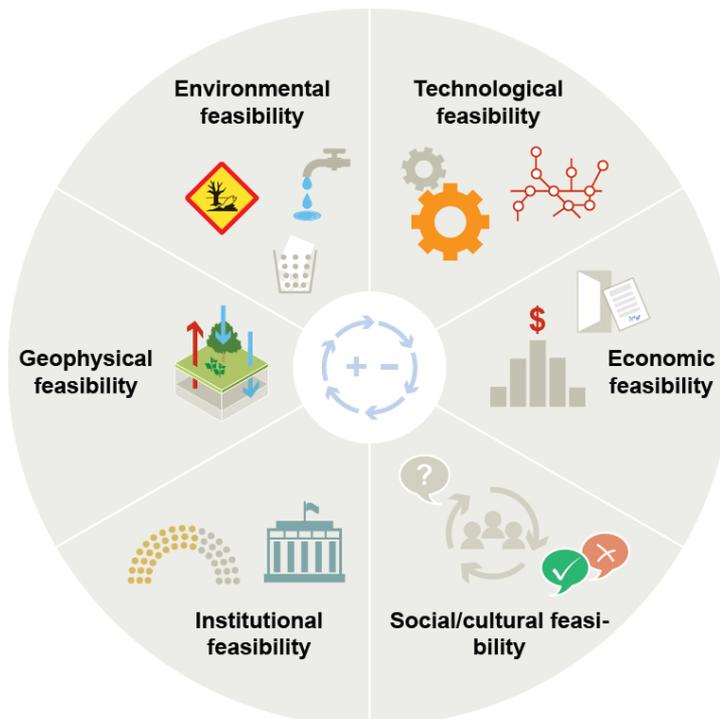
1 Different types of transitions carry with them different associated costs and requirements for
 2 institutional or governmental support. Some are also easier to scale up than others, and some need
 3 more government support than others. Transitions between, and within, these systems are connected
 4 and none would be sufficient on its own to limit warming to 1.5°C.

5 The ‘feasibility’ of adaptation and mitigation options or actions within each system that together can
 6 limit warming to 1.5°C within the context of sustainable development and efforts to eradicate poverty
 7 requires careful consideration of multiple different factors. These factors include: (i) whether
 8 sufficient natural systems and resources are available to support the various options for transitioning
 9 (known as *environmental feasibility*); (ii) the degree to which the required technologies are developed
 10 and available (known as *technological feasibility*); (iii) the economic conditions and implications
 11 (known as *economic feasibility*); (iv) what are the implications for human behaviour and health
 12 (known as *social/cultural feasibility*); and (v) what type of institutional support would be needed, such
 13 as governance, institutional capacity and political support (known as *institutional feasibility*). An
 14 additional factor (vi – known as the *geophysical feasibility*) addresses the capacity of physical systems
 15 to carry the option, for example, whether it is geophysically possible to implement large-scale
 16 afforestation consistent with 1.5°C.

17 Promoting enabling conditions, such as finance, innovation and behaviour change, would reduce
 18 barriers to the options, make the required speed and scale of the system transitions more likely, and
 19 therefore would increase the overall feasibility limiting warming to 1.5°C.

FAQ4.1: The different feasibility dimensions towards limiting warming to 1.5°C

Assessing the feasibility of different adaptation and mitigation options/actions requires consideration across six dimensions.



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22 **FAQ4.1, Figure 1:** The different dimensions to consider when assessing the ‘feasibility’ of adaptation
 23 and mitigation options or actions within each system that can help to limit warming to 1.5°C. These

- 1 are: (i) the environmental feasibility; (ii) the technological feasibility; (iii) the economic feasibility;
- 2 (iv) the social/cultural feasibility; (v) the institutional feasibility; and (vi) the geophysical feasibility.
- 3

FAQ 4.2: What are Carbon Dioxide Removal and Negative Emissions?

Summary: Carbon dioxide removal (CDR) refers to the process of removing CO₂ from the atmosphere. Since this is the opposite of emissions, practices or technologies that remove CO₂ are often described as achieving ‘negative emissions’. The process is sometimes referred to more broadly as greenhouse gas removal if it involves removing gases other than CO₂. There are two main types of CDR: either enhancing existing natural processes that remove carbon from the atmosphere (e.g., by increasing its uptake by trees, soil, or other ‘carbon sinks’) or using chemical processes to, for example, capture CO₂ directly from the ambient air and store it elsewhere (e.g., underground). All CDR methods are at different stages of development and some are more conceptual than others, as they have not been tested at scale.

Limiting warming to 1.5°C above pre-industrial levels would require unprecedented rates of transformation in many areas, including in the energy and industrial sectors, for example. Conceptually, it is possible that techniques to draw CO₂ out of the atmosphere (known as carbon dioxide removal, or CDR) could contribute to limiting warming to 1.5°C. One use of CDR could be to compensate for greenhouse gas emissions from sectors that cannot completely decarbonize, or which may take a long time to do so.

If global temperature temporarily overshoots 1.5°C, CDR would be required to reduce the atmospheric concentration of CO₂ to bring global temperature back down. To achieve this temperature reduction, the amount of CO₂ drawn out of the atmosphere would need to be greater than the amount entering the atmosphere, resulting in ‘net negative emissions’. This would involve a greater amount of CDR than stabilizing atmospheric CO₂ concentration – and, therefore, global temperature – at a certain level. The larger and longer an overshoot, the greater the reliance on practices that remove CO₂ from the atmosphere.

There are a number of CDR methods, each with different potentials for achieving negative emissions, as well as different associated costs and side effects. They are also at differing levels of development, with some more conceptual than others. One example of a CDR method in the demonstration phase is a process known as bioenergy with carbon capture and storage (BECCS), in which atmospheric CO₂ is absorbed by plants and trees as they grow, and then the plant material (biomass) is burned to produce bioenergy. The CO₂ released in the production of bioenergy is captured before it reaches the atmosphere and stored in geological formations deep underground on very long timescales. Since the plants absorb CO₂ as they grow and the process does not emit CO₂, the overall effect can be to reduce atmospheric CO₂.

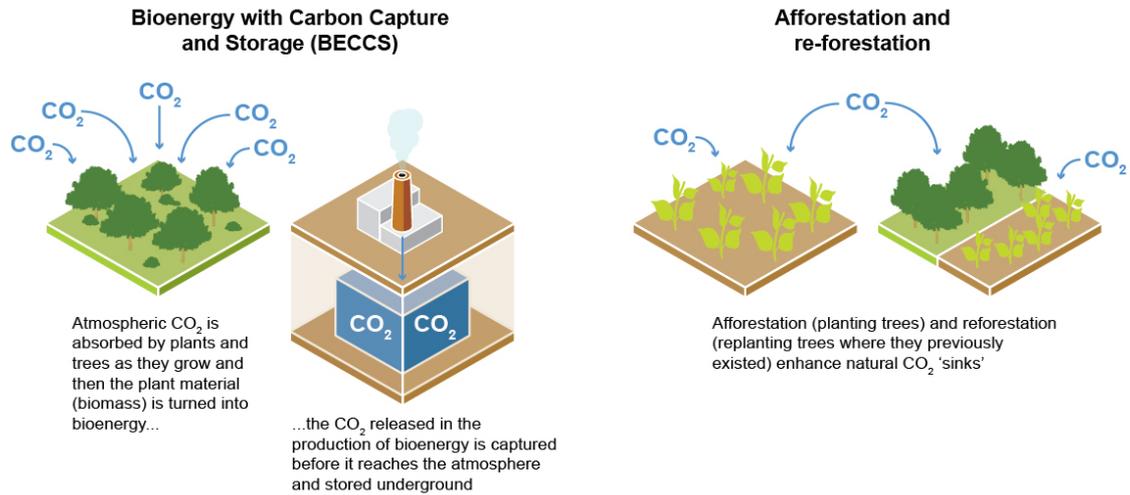
Afforestation (planting new trees) and reforestation (replanting trees where they previously existed) are also considered forms of CDR because they enhance natural CO₂ ‘sinks’. Another category of CDR techniques uses chemical processes to capture CO₂ from the air and store it away on very long timescales. In a process known as direct air carbon capture and storage (DACCS), CO₂ is extracted directly from the air and stored in geological formations deep underground. Converting waste plant material into a charcoal-like substance called biochar and burying it in soil can also be used to store carbon away from the atmosphere for decades to centuries.

There can be beneficial side effects of some types of CDR, other than removing CO₂ from the atmosphere. For example, restoring forests or mangroves can enhance biodiversity and protect against flooding and storms. But there could also be risks involved with some CDR methods. For example, deploying BECCS at large scale would require a large amount of land to cultivate the biomass required for bioenergy. This could have consequences for sustainable development if the use of land competes with producing food to support a growing population, biodiversity conservation or land rights. There are also other considerations. For example, there are uncertainties about how much it

- 1 would cost to deploy DACCS as a CDR technique, given that removing CO₂ from the air requires
2 considerable energy.

FAQ4.2: Carbon dioxide removal and negative emissions

Examples of some CDR / negative emissions techniques and practices



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FAQ4.2, Figure 1: Carbon dioxide removal (CDR) refers to the process of removing CO₂ from the atmosphere. There are a number of CDR techniques, each with different potential for achieving 'negative emissions', as well as different associated costs and side effects.

1 **FAQ 4.3: Why is Adaptation Important in a 1.5°C-Warmer World?**

2 **Summary:** *Adaptation is the process of adjusting to current or expected changes in climate and its*
3 *effects. Even though climate change is a global problem, its impacts are experienced differently across*
4 *the world. This means that responses are often specific to the local context, and so people in different*
5 *regions are adapting in different ways. A rise in global temperature from the current 1°C above pre-*
6 *industrial levels to 1.5°C, and beyond, increases the need for adaptation. Therefore, stabilizing global*
7 *temperatures at 1.5°C above pre-industrial levels would require a smaller adaptation effort than at*
8 *2°C. Despite many successful examples around the world, progress in adaptation is, in many regions,*
9 *in its infancy and unevenly distributed globally.*

10 Adaptation refers to the process of adjustment to actual or expected changes in climate and its effects.
11 Since different parts of the world are experiencing the impacts of climate change differently, there is
12 similar diversity in how people in a given region are adapting to those impacts.

13 The world is already experiencing the impacts from 1°C of global warming above pre-industrial
14 levels, and there are many examples of adaptation to impacts associated with this warming. Examples
15 of adaptation efforts taking place around the world include investing in flood defences such as
16 building sea walls or restoring mangroves, efforts to guide development away from high risk areas,
17 modifying crops to avoid yield reductions, and using social learning (social interactions that changes
18 understanding on the community level) to modify agricultural practices, amongst many others.
19 Adaptation also involves building capacity to respond better to climate change impacts, including
20 making governance more flexible and strengthening financing mechanisms, such as by providing
21 different types of insurance.

22 In general, an increase in global temperature from present day to 1.5°C or 2°C (or higher) above pre-
23 industrial temperatures would increase the need for adaptation. Stabilising global temperature increase
24 at 1.5°C would require a smaller adaptation effort than for 2°C.

25 Since adaptation is still in early stages in many regions, there are questions about the capacity of
26 vulnerable communities to cope with any amount of further warming. Successful adaptation can be
27 supported at the national and sub-national levels, with national governments playing an important role
28 in coordination, planning, determining policy priorities, and distributing resources and support.
29 However, given that the need for adaptation can be very different from one community to the next, the
30 kinds of measures that can successfully reduce climate risks will also depend heavily on the local
31 context.

32 When done successfully, adaptation can allow individuals to adjust to the impacts of climate change in
33 ways that minimize negative consequences and to maintain their livelihoods. This could involve, for
34 example, a farmer switching to drought-tolerant crops to deal with increasing occurrences of
35 heatwaves. In some cases, however, the impacts of climate change could result in entire systems
36 changing significantly, such as moving to an entirely new agricultural system in areas where the
37 climate is no longer suitable for current practices. Constructing sea walls to stop flooding due to sea
38 level rise from climate change is another example of adaptation, but developing city planning to
39 change how flood water is managed throughout the city would be an example of transformational
40 adaptation. These actions require significantly more institutional, structural, and financial support.
41 While this kind of transformational adaptation would not be needed everywhere in a 1.5°C world, the
42 scale of change needed would be challenging to implement, as it requires additional support, such as
43 through financial assistance and behavioural change. Few empirical examples exist to date.

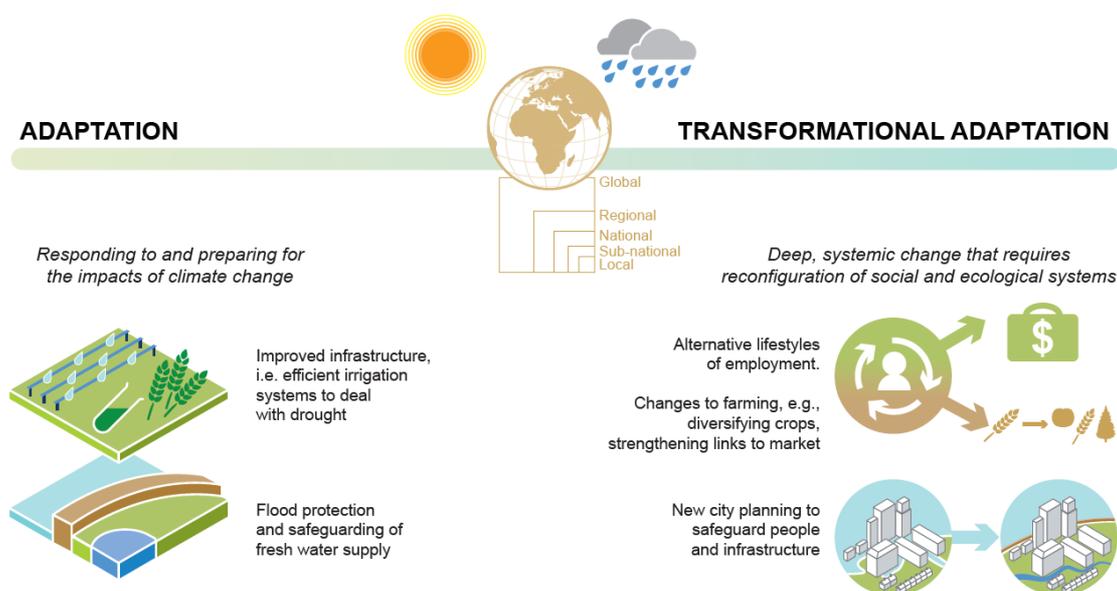
44 Examples from around the world show that adaptation is an iterative process. Adaptation pathways
45 describe how communities can make decisions about adaptation in an ongoing and flexible way. Such

1 pathways allow for pausing, evaluating the outcomes of specific adaptation actions, and modifying the
 2 strategy as appropriate. Due to their flexible nature, adaptation pathways can help to identify the most
 3 effective ways to minimise the impacts of present and future climate change for a given local context.
 4 This is important since adaptation can sometimes exacerbate vulnerabilities and existing inequalities if
 5 poorly designed. The unintended negative consequences of adaptation that can sometimes occur are
 6 known as ‘maladaptation’. Maladaptation can be seen if a particular adaptation option has negative
 7 consequences for some (e.g., rainwater harvesting upstream might reduce water availability
 8 downstream) or if an adaptation intervention in the present has trade-offs in the future (e.g.,
 9 desalination plants may improve water availability in the present but have large energy demands over
 10 time).

11 While adaptation is important to reduce the negative impacts from climate change, adaptation
 12 measures on their own are not enough to prevent climate change impacts entirely. The more global
 13 temperature rises, the more frequent, severe, and erratic the impacts will be, and adaptation may not
 14 protect against all risks. Examples of where limits may be reached include substantial loss of coral
 15 reefs, massive range losses for terrestrial species, more human deaths from extreme heat, and losses of
 16 coastal-dependent livelihoods in low lying islands and coasts.

FAQ4.3: Adaptation in a warming world

Adapting to further warming requires action at national & sub-national levels and can mean different things to different people in different contexts



17

18 **FAQ4.3, Figure 1:** Examples of adaptation and transformational adaptation. Adapting to further
 19 warming requires action at national and sub-national levels and can mean different things to different
 20 people in different contexts. While transformational adaptation would not be needed everywhere in a
 21 world limited to 1.5°C warming, the scale of change needed would be challenging to implement.

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23

24

1 **FAQ 5.1:** What Are the Connections between Sustainable Development and Limiting Global
2 Warming to 1.5°C above Pre-Industrial Levels?
3

4 **Summary:** *Sustainable development seeks to meet the needs of people living today without
5 compromising the needs of future generations, while balancing social, economic and environmental
6 considerations. The 17 UN Sustainable Development Goals (SDGs) include targets for eradicating
7 poverty; ensuring health, energy and food security; reducing inequality; protecting ecosystems;
8 pursuing sustainable cities and economies; and a goal for climate action (SDG13). Climate change
9 affects the ability to achieve sustainable development goals, and limiting warming to 1.5°C will help
10 meet some sustainable development targets. Pursuing sustainable development will influence
11 emissions, impacts and vulnerabilities. Responses to climate change in the form of adaptation and
12 mitigation will also interact with sustainable development with positive effects, known as synergies, or
13 negative effects, known as trade-offs. Responses to climate change can be planned to maximize
14 synergies and limit trade-offs with sustainable development.
15*

16 For more than 25 years, the United Nations (UN) and other international organizations have embraced
17 the concept of sustainable development to promote well-being and meet the needs of today's
18 population without compromising the needs of future generations. This concept spans economic,
19 social and environmental objectives including poverty and hunger alleviation, equitable economic
20 growth, access to resources, and the protection of water, air and ecosystems. Between 1990 and 2015,
21 the UN monitored a set of eight Millennium Development Goals (MDGs). They reported progress in
22 reducing poverty, easing hunger and child mortality, and improving access to clean water and
23 sanitation. But with millions remaining in poor health, living in poverty and facing serious problems
24 associated with climate change, pollution and land-use change, the UN decided that more needed to be
25 done. In 2015, the UN Sustainable Development Goals (SDGs) were endorsed as part of the 2030
26 Agenda for Sustainable Development. The 17 SDGs (Figure FAQ 5.1) apply to all countries and have
27 a timeline for success by 2030. The SDGs seek to eliminate extreme poverty and hunger; ensure
28 health, education, peace, safe water and clean energy for all; promote inclusive and sustainable
29 consumption, cities, infrastructure and economic growth; reduce inequality including gender
30 inequality; combat climate change and protect oceans and terrestrial ecosystems.
31

32 Climate change and sustainable development are fundamentally connected. Previous IPCC reports
33 found that climate change can undermine sustainable development, and that well-designed mitigation
34 and adaptation responses can support poverty alleviation, food security, healthy ecosystems, equality
35 and other dimensions of sustainable development. Limiting global warming to 1.5°C would require
36 mitigation actions and adaptation measures to be taken at all levels. These adaptation and mitigation
37 actions would include reducing emissions and increasing resilience through technology and
38 infrastructure choices, as well as changing behaviour and policy. These actions can interact with
39 sustainable development objectives in positive ways that strengthen sustainable development, known
40 as synergies. Or they can interact in negative ways, where sustainable development is hindered or
41 reversed, known as trade-offs.
42

43 An example of a synergy is sustainable forest management, which can prevent emissions from
44 deforestation and take up carbon to reduce warming at reasonable cost. It can work synergistically
45 with other dimensions of sustainable development by providing food (SDG 2) and clean water (SDG
46 6) and protecting ecosystems (SDG 15). Other examples of synergies are when climate adaptation
47 measures, such as coastal or agricultural projects, empower women and benefit local incomes, health
48 and ecosystems.
49

50 An example of a trade-off can occur if ambitious climate change mitigation compatible with 1.5°C
51 changes land use in ways that have negative impacts on sustainable development. An example could
52 be turning natural forests, agricultural areas, or land under indigenous or local ownership to
53 plantations for bioenergy production. If not managed carefully, such changes could undermine

1 dimensions of sustainable development by threatening food and water security, creating conflict over
 2 land rights and causing biodiversity loss. Another trade-off could occur for some countries, assets,
 3 workers and infrastructure already in place if a switch is made from fossil fuels to other energy
 4 sources without adequate planning for such a transition. Trade-offs can be minimized if effectively
 5 managed, as when care is taken to improve bioenergy crop yields to reduce harmful land-use change
 6 or where workers are retrained for employment in lower carbon sectors.

7
 8 Limiting temperatures to 1.5°C can make it much easier to achieve the SDGs, but it is also possible
 9 that pursuing the SDGs could result in trade-offs with efforts to limit climate change. There are trade-
 10 offs when people escaping from poverty and hunger consume more energy or land and thus increase
 11 emissions, or if goals for economic growth and industrialization increase fossil fuel consumption and
 12 greenhouse gas emissions. Conversely, efforts to reduce poverty and gender inequalities and to
 13 enhance food, health and water security can reduce vulnerability to climate change. Other synergies
 14 can occur when coastal and ocean ecosystem protection reduces the impacts of climate change on
 15 these systems. The sustainable development goal of affordable and clean energy (SDG 7) specifically
 16 targets access to renewable energy and energy efficiency, which are important to ambitious mitigation
 17 and limiting warming to 1.5°C.

18
 19 The link between sustainable development and limiting global warming to 1.5°C is recognized by the
 20 SDG for climate action (SDG 13), which seeks to combat climate change and its impacts while
 21 acknowledging that the United Nations Framework Convention on Climate Change (UNFCCC) is the
 22 primary international, intergovernmental forum for negotiating the global response to climate change.

23
 24 The challenge is to put in place sustainable development policies and actions that reduce deprivation,
 25 alleviate poverty and ease ecosystem degradation while also lowering emissions, reducing climate
 26 change impacts and facilitating adaptation. It is important to strengthen synergies and minimize trade-
 27 offs when planning climate change adaptation and mitigation actions. Unfortunately, not all trade-offs
 28 can be avoided or minimized, but careful planning and implementation can build the enabling
 29 conditions for long-term sustainable development.
 30

FAQ5.1: The United Nations Sustainable Development Goals (SDGs)

The link between sustainable development and limiting global warming to 1.5°C is recognised by the Sustainable Development Goal for climate action (SDG 13)



31
 32 **FAQ 5.1, Figure 1:** Climate change action is one of the United Nations Sustainable Development
 33 Goals (SDGs) and is connected to sustainable development more broadly. Actions to reduce climate

- 1 risk can interact with other sustainable development objectives in positive ways (synergies) and
- 2 negative ways (trade-offs).
- 3
- 4

FAQ 5.2: What are the Pathways to Achieving Poverty Reduction and Reducing Inequalities While Reaching the 1.5°C World?

Summary: *There are ways to limit global warming to 1.5°C above pre-industrial levels. Of the pathways that exist, some simultaneously achieve sustainable development. They entail a mix of measures that lower emissions and reduce the impacts of climate change, while contributing to poverty eradication and reducing inequalities. Which pathways are possible and desirable will differ between and within regions and nations. This is due to the fact that development progress to date has been uneven and climate-related risks are unevenly distributed. Flexible governance would be needed to ensure that such pathways are inclusive, fair and equitable to avoid poor and disadvantaged populations becoming worse off. Climate-resilient development pathways (CRDPs) offer possibilities to achieve both equitable and low-carbon futures.*

Issues of equity and fairness have long been central to climate change and sustainable development. Equity, like equality, aims to promote justness and fairness for all. This is not necessarily the same as treating everyone equally, since not everyone comes from the same starting point. Often used interchangeably with fairness and justice, equity implies implementing different actions in different places, all with a view to creating an equal world that is fair for all and where no one is left behind.

The Paris Agreement states that it ‘will be implemented to reflect equity... in the light of different national circumstances’ and calls for ‘rapid reductions’ of greenhouse gases to be achieved ‘on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty’. Similarly, the UN SDGs include targets to reduce poverty and inequalities, and to ensure equitable and affordable access to health, water and energy for all.

The principles of equity and fairness are important for considering pathways that limit warming to 1.5°C in a way that is liveable for every person and species. They recognize the uneven development status between richer and poorer nations, the uneven distribution of climate impacts (including on future generations) and the uneven capacity of different nations and people to respond to climate risks. This is particularly true for those who are highly vulnerable to climate change, such as indigenous communities in the Arctic, people whose livelihoods depend on agriculture or coastal and marine ecosystems, and inhabitants of small island developing states. The poorest people will continue to experience climate change through the loss of income and livelihood opportunities, hunger, adverse health effects and displacement.

Well-planned adaptation and mitigation measures are essential to avoid exacerbating inequalities or creating new injustices. Pathways that are compatible with limiting warming to 1.5°C and aligned with the SDGs consider mitigation and adaptation options that reduce inequalities in terms of who benefits, who pays the costs and who is affected by possible negative consequences. Attention to equity ensures that disadvantaged people can secure their livelihoods and live in dignity, and that those who experience mitigation or adaptation costs have financial and technical support to enable fair transitions.

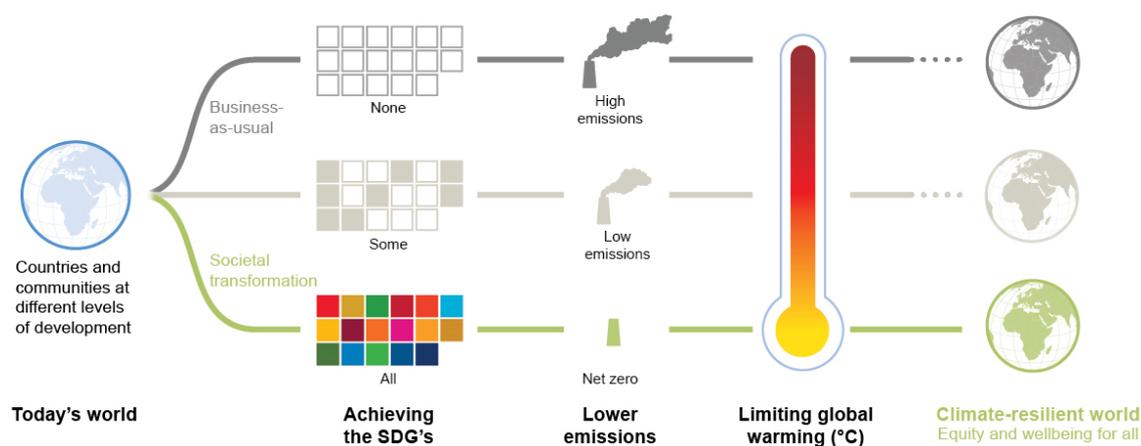
CRDPs describe trajectories that pursue the dual goal of limiting warming to 1.5°C while strengthening sustainable development. This includes eradicating poverty as well as reducing vulnerabilities and inequalities for regions, countries, communities, businesses and cities. These trajectories entail a mix of adaptation and mitigation measures consistent with profound societal and systems transformations. The goals are to meet the short-term SDGs, achieve longer-term sustainable development, reduce emissions towards net zero around the middle of the century, build resilience and enhance human capacities to adapt, all while paying close attention to equity and well-being for all.

The characteristics of CRDPs will differ across communities and nations, and will be based on deliberations with a diverse range of people, including those most affected by climate change and by

1 possible routes towards transformation. For this reason, there are no standard methods for designing
 2 CRDPs or for monitoring their progress towards climate-resilient futures. However, examples from
 3 around the world demonstrate that flexible and inclusive governance structures and broad participation
 4 often help support iterative decision-making, continuous learning and experimentation. Such inclusive
 5 processes can also help to overcome weak institutional arrangements and power structures that may
 6 further exacerbate inequalities.
 7

FAQ5.2: **Climate-resilient development pathways**

Decision-making that achieves the United Nation Sustainable Development Goals (SDGs), lowers greenhouse gas emissions, limits global warming, and enhances adaptation, could help lead to a climate-resilient world



8
 9 **FAQ 5.2, Figure 1:** Climate-resilient development pathways (CRDPs) describe trajectories that
 10 pursue the dual goals of limiting warming to 1.5°C while strengthening sustainable development.
 11 Decision-making that achieves the SDGs, lowers greenhouse gas emissions and limits global warming
 12 could help lead to a climate-resilient world, within the context of enhancing adaptation.
 13

14 Ambitious actions already underway around the world can offer insight into CRDPs for limiting
 15 warming to 1.5°C. For example, some countries have adopted clean energy and sustainable transport
 16 while creating environmentally friendly jobs and supporting social welfare programmes to reduce
 17 domestic poverty. Other examples teach us about different ways to promote development through
 18 practices inspired by community values. For instance, *Buen Vivir*, a Latin American concept based on
 19 indigenous ideas of communities living in harmony with nature, is aligned with peace; diversity;
 20 solidarity; rights to education, health, and safe food, water, and energy; and well-being and justice for
 21 all. The Transition Movement, with origins in Europe, promotes equitable and resilient communities
 22 through low-carbon living, food self-sufficiency and citizen science. Such examples indicate that
 23 pathways that reduce poverty and inequalities while limiting warming to 1.5°C are possible and that
 24 they can provide guidance on pathways towards socially desirable, equitable and low-carbon futures.
 25
 26
 27