8 October 2018

HSBC Global Research

Does 1.5°C matter?

The difference half a degree can make

CLIMATE CHANGE
GLOBAL

- The UN's climate science body has released its long-awaited report on 1.5°C of warming – we are already at 1°C
- The report makes clear the benefits of aiming for 1.5°C vs 2°C, although the incremental costs are 3-4 times higher
- The path to 1.5°C is beset with difficulties on all sides – but the urgency to act on climate change will be felt at COP24

Wai-Shin Chan, CFA
Head, Climate Change Centre of Excellence
The Hongkong and Shanghai Banking Corporation Limited
wai.shin.chan@hsbc.com.hk
+852 2822 4870

Ashim Paun
Director, Climate Change Strategy
HSBC Bank plc
ashim.paun@hsbcib.com
+44 20 7992 3591

Payal Negi
Associate
Bangalore

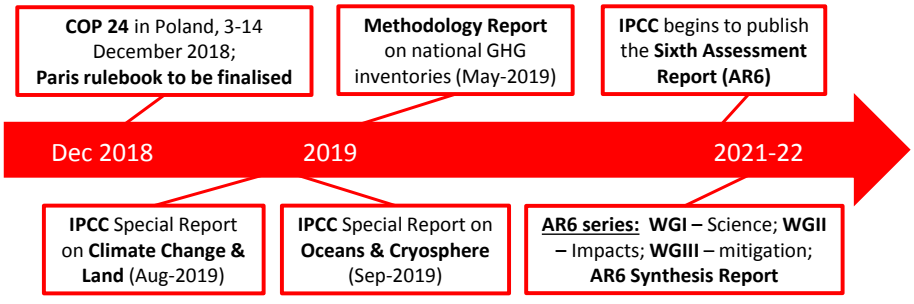
"**Limiting global warming to 1.5ºC would require rapid, far-reaching and unprecedented changes in all aspects of society.**" The Intergovernmental Panel on Climate Change (IPCC) released its *Special Report on Global Warming of 1.5 °C* (SR1.5). It collates the latest scientific findings (pathways, impacts, responses) on climate change at 1.5°C of warming, the lower target of the Paris Agreement.

Key findings: The threshold of 1.5°C of warming will be reached by 2040 on current emissions levels unless global carbon dioxide (CO_2) emissions decline by 45% by 2030 and reach 'net zero' by 2050. All emissions pathways modelled for 1.5°C warming require the removal of CO_2 from the atmosphere to some extent. Whilst feasible within the laws of physics and chemistry, climate actions to limit warming to 1.5°C face technological, economic and social challenges.

1.5°C vs 2°C: The report discusses the 'avoided physical impacts' of limiting warming to 1.5°C compared with 2°C. These include roughly 10cm more in sea level rises, significantly more ice-free Arctic summers and double the biodiversity loss at 2°C. It also examines the human angle such as impacts on livelihoods, health and food security. The marginal abatement costs are 3-4x higher for 1.5°C vs 2°C.

Urgency to act: SR1.5 is an important marker in terms of science as well as recognition of the plight of more vulnerable nations. The report is also a key input into the *Talanoa Dialogue* (an unofficial examination of progress on climate change taking place throughout 2018). We think the report will ramp up the public and societal pressure on governments and businesses to raise climate ambition levels.

The timeline for more IPCC reports in the coming years



Source: HSBC (based on UNFCCC and IPCC)

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1.5°C – a more ambitious climate target

The 21st Conference of the Parties (COP21) to the UN Framework Convention on Climate Change in December 2015 was tasked with reaching the Paris Agreement. As COP21 progressed, it became increasingly likely that the 1.5°C temperature limit would be mentioned alongside the traditional 2°C target as a way to build consensus across all nations, ie both developed and developing nations.

1.5°C is mentioned in the purpose of the Paris Agreement…

The purpose of the Paris Agreement (Article 2) states:

> *1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:*
>
> *a. Holding the increase in global average temperature to well below 2°C above pre-industrial levels and* ***to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels****, recognising that this would significantly reduce the risks and impacts of climate change;*

…and was seen as significant for vulnerable nations

The mention of a 1.5°C goal was highly significant because it recognised that the impacts of climate change – even with 2°C of warming – would be significant for many countries, especially least developed countries and small island states. Hence a lower target would possibly lower the impacts on these vulnerable nations.

The accompanying "adoption decision" of COP21 "*Invites the Intergovernmental Panel on Climate Change to provide a special report in 2018 on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways*".

Box 1: What is the IPCC?

The Intergovernmental Panel on Climate Change (IPCC) was set up in 1988 by two UN agencies (The World Meteorological Agency, WMO; and the UN Environment Programme, UNEP) to assess the science relating to climate change. It publishes the Climate Assessment Reports every 6-7 years. The last series of reports was the fifth assessment cycle (AR5), published over 2013-14.

The IPCC consists of hundreds of scientists from a wide range of countries. The body does not conduct its own research but instead assesses the latest scientific papers on the topics in question. Lead authors, nominated by countries, lead reviews with many other scientists. Assessments are subject to multiple drafting and reviews before they are adopted by scientists in conjunction with governments.

The final round of review and approval for SR1.5 took place at the 48th session of the IPCC last week (1-5 October, *although it overran to Saturday, 6 October*) in Incheon, South Korea.

Box 2: IPCC terminology (Likelihood and confidence)

The IPCC uses specific terminology in describing how it reaches a finding. These are described in terms of '**likelihood**' and '**confidence**'. Most of the findings within the Summary for Policymakers (SPM) are 'likely' or above which corresponds to: Likely (>66%); Very likely (>90%); Extremely likely (>95%); Virtually certain (>99%).

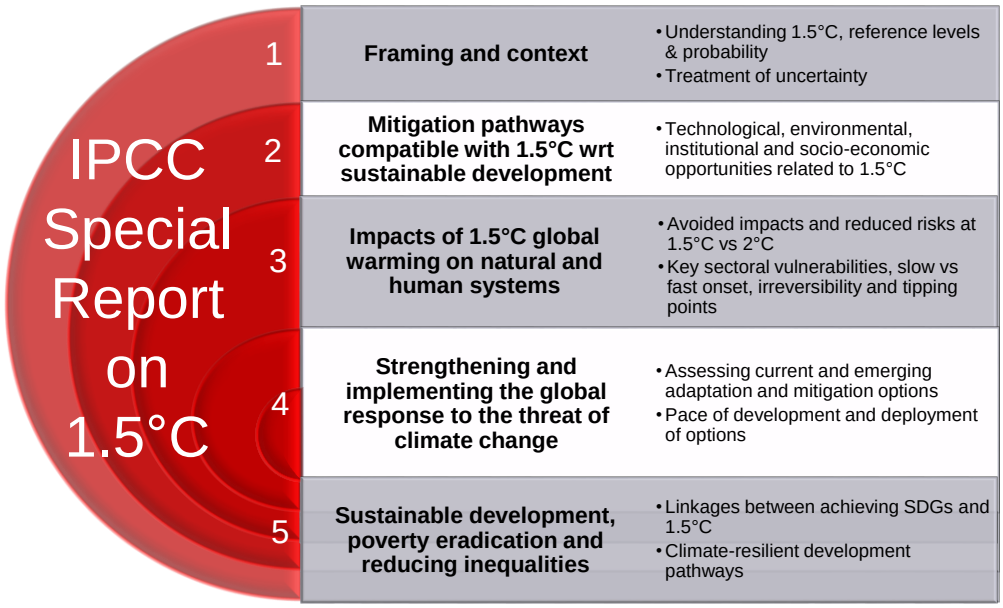
According to the IPCC, the confidence in the validity of a finding is based on "the type, amount, quality, and consistency of evidence…and the degree of agreement". These are expressed qualitatively in the form of: very low, low, medium, high, very high – confidence.

Key findings from SR1.5 (SPM)

A comprehensive report

This Special Report consists of five main chapters along with multiple annexes and runs to almost 1,200 pages long. A 33-page 'Summary for Policy Makers' (SPM) is based on the underlying report and presents its main findings. The SPM also focuses on the differences in impacts of limiting warming to 1.5°C compared with 2°C; the general conclusion is that the 0.5°C difference has profound consequences on the severity of the impacts.

Figure 1: The chapter outline of full Special Report on Global Warming of 1.5°C



Source: IPCC

The Earth has already warmed by around 1°C…

How much have temperatures on Earth already increased?

The IPCC finds that human activities have caused around 1°C of warming (in a *likely* range of 0.8-1.2°C) since pre-industrial times (defined as the 1850-1900 period). This refers to a **'Global mean surface temperature' (GMST),** which includes thousands of measurements from land and oceans (as well as over sea-ice).

2040

Year we could hit 1.5°C of warming (IPCC)

…but some regions are warming faster

When will temperature increases reach 1.5°C?

At the current pace of warming, the IPCC believes that temperature increases will hit the 1.5°C threshold around the year 2040 (in a range of between 2030 and 2052, with *high confidence*). However, it is important to note that different regions of the world may be warming faster due to local conditions. For example, SR1.5 finds that the Arctic is warming 2-3 times faster than the GMST; land areas are also warming faster than the GMST.

Emissions in 2030 need to be significantly below current projections

Based on the climate pledges that almost all nations put forward towards the Paris Agreement, the IPCC projects global greenhouse gas (GHG) annual emissions in the year 2030 to be around 52-58 $GtCO_2e$ (a 24-38% increase from roughly 42$GtCO_2e$ currently). It is not possible to limit warming to 1.5°C by century end at such a high rate of annual emissions in 2030 – most pathways require 2030 emissions to be 35$GtCO_2e$ or below. Current climate pledges are broadly consistent with warming of 3°C in the year 2100. However, it does not stop there; warming could continue to increase into the 22nd century.

What is the feasibility of limiting increases to 1.5°C?

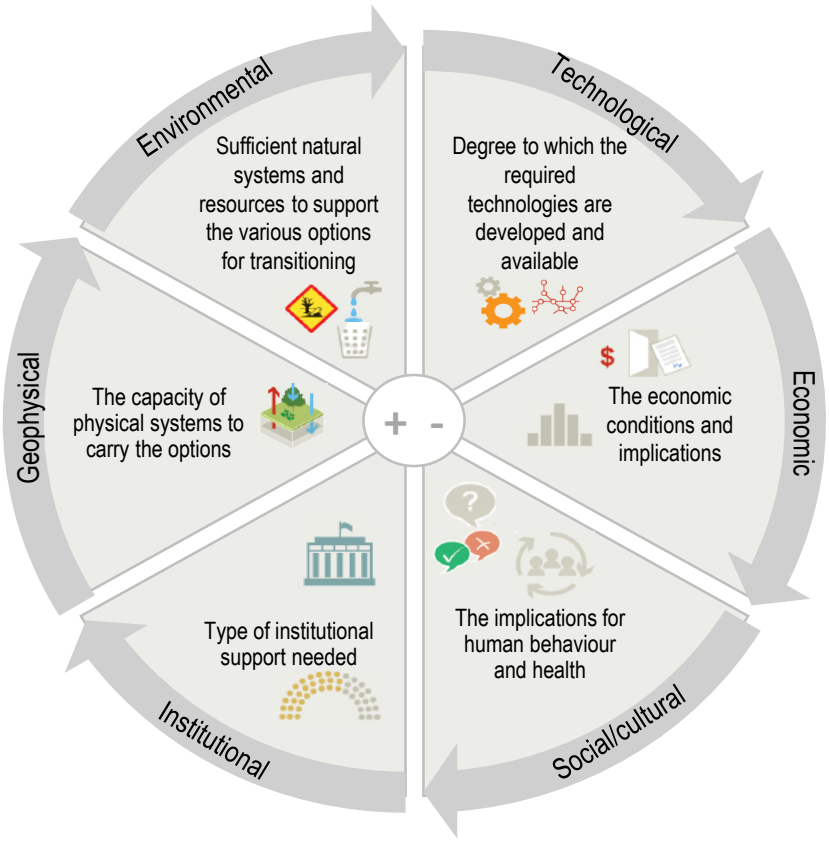
Limiting warming to 1.5°C is feasible…

There is no single response to the feasibility question. IPCC scientists break this down with possible transitions that "could enable limiting global warming to 1.5°C." The co-chair of IPCC Working Group III, Jim Skea, says "**Limiting warming to 1.5°C is possible within the laws of chemistry and physics but doing so would require unprecedented changes**".

…but dependent on many factors

The report considers the feasibility of (general) climate actions in terms of their environmental, technological, economic, social, institutional and geophysical possibility. This recognises, for instance, that some technologies may work but come at high cost; others may not pass cultural acceptance.

Figure 2: Various feasibility dimension in limiting warming to 1.5°C



Source: SR1.5, FAQs, IPCC

Box 3: Emissions pathways and the "overshoot"

Emissions pathways: Scientists use different models to project what could happen to global temperatures with emissions rising under various trajectories or pathways. A *1.5°C pathway* is one which gives a 50% or more probability of limiting warming to 1.5°C (with no overshoot), based on current knowledge.

Overshoot: SR1.5 also discusses an 'overshoot' – where global temperatures temporarily overshoot the 1.5°C target before returning to 1.5°C (or less) **by the year 2100**. The caveat is that the higher the overshoot, the higher the associated risks (ie climate impacts) as well as the higher reliance on 'negative emissions technologies' (see Box 4).

Limited overshoot: Any emissions pathway which (in the course of modelling) limits the overall warming to within 1.6°C (ie 0.1°C over the threshold) and then returns it to 1.5°C or below by the year 2100 is classified as having a 'limited overshoot'

Higher overshoot: Any emissions pathway which exceeds 1.6°C but then returns it to 1.5°C or below by the year 2100 is classified as having a 'higher overshoot'.

What needs to be done to limit warming to 1.5°C?

Net zero emissions are required by 2050

In order to limit temperature increases by 1.5°C, anthropogenic emissions of CO_2 (ie caused by humans) must decline by 45% (in an interquartile range of 40-60%) by 2030 from 2010 (*high confidence*). Emissions must further reach net zero (ie a balance between sources and sinks) by the year 2050 (interquartile range of 2045-2055) (*high confidence*).

45%

Required emissions reductions by 2030 (from 2010) for a 1.5°C pathway

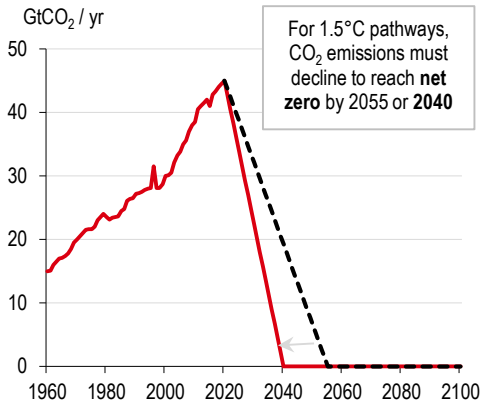
*For reference, the SR1.5 gives the required emissions reductions for the 2°C limit. These are a 20% decline by 2030 (10-30% interquartile); net zero by 2075 (2065-2080 interquartile) (*high confidence*).*

Non-CO_2 emissions must also decline

For non-CO_2 emissions, the 1.5°C limit requires roughly a 20% decline by 2030 and net zero by 2075 (*high confidence*). In particular, deep reductions of 35% or more are required for methane and black carbon by 2050, compared with 2010 levels.

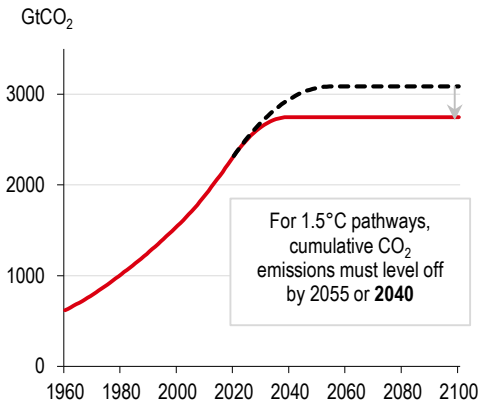
> **Faster CO_2 reductions result in a higher probability of limiting warming to 1.5°C**
>
> **IPCC SR1.5 (SPM)**

Chart 1: Required emission pathways



Source: SR1.5 SPM, IPCC
Note: lines denote stylized reduction pathways

Chart 2: Required cumulative emissions



Source: SR1.5 SPM, IPCC
Note: lines denote stylized reduction pathways

Box 4: Removing CO_2 from the atmosphere (negative emissions technology)

All emissions pathways that limit temperature increases to 1.5°C (with or without overshoot) require some amount of 'carbon dioxide removal' (CDR). In other words, no amount of 'lowering emissions alone' is going to limit warming to 1.5°C by the year 2100.

All 1.5°C pathways require CO_2 to be removed from the atmosphere

CDR refers to the removal of CO_2 from the atmosphere (ie sucking it out) using technological means and storing it safely somewhere other than the atmosphere (eg underground, within products, etc). IPCC scientists state the need to use CDR, however, they caution against its current level of maturity (technologically and commercially) as well as its potential for other negative consequences. *Note that CDR does not include natural carbon sinks such as tree growth or ocean absorption of CO_2.*

Even the 1.5°C emissions pathways with "no or limited overshoot' still required roughly 100-1000$GtCO_2$ to be removed by CDR by the end of the century.

For 1.5°C pathways, some high emission sectors are discussed in the report. For example, for **energy** – (in pathway modelling) renewable energies are projected to make up 70-85% (interquartile range) of electricity supply in 2050; and **industry** – industrial emissions are projected to be 70-90% lower (interquartile range) in 2050 from 2010 levels.

A 'whole system' approach is required

However, the report finds that a "whole system" approach is required if warming is to be limited to 1.5°C. This means that all stakeholders, industries, companies and governments need to be involved with transformative actions. These include "Transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (*high confidence*)." There is no one single measure that can put us on the pathway to 1.5°C; the various emissions pathways modelled in the report afford a variety of mitigation actions. However, these face various challenges in terms of implementation (see Figure 2 for feasibility).

What are the (natural) physical impacts of 1.5°C warming?

Chapter 3 of the SR1.5 report examines the impacts of 1.5°C warming – specifically the results of higher temperatures and lower precipitation. These changes affect extreme weather, droughts and floods, sea levels and ice mass, ecosystems, food security as well as oceans and freshwater. It also provides more detail on certain regions such as coastal or low-lying areas, as well as the effect on human systems (health, well-being and poverty).

> **We are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice, among other changes**
>
> **Panmao Zhai, Co-Chair of IPCC Working Group I**

It is not always possible to quantify the impacts and so the likelihood statements and confidence levels are widely used here. Table 1 looks at some of the headline differences between the impacts at 1.5°C compared with those at 2°C, based on the SPM. It is important to note that even though the impacts may be lower at 1.5°C vs 2°C, nevertheless, there are still unpalatable consequences from 1.5°C. For example, the SR1.5 notes that "Sea level rises will continue beyond 2100 even if global warming is limited to 1.5°C in the 21st century (*high confidence*)."

Table 1: Some of the impacts of 1.5°C warming compared to 2°C warming

Impacts and risks	1.5°C	2°C	Confidence level	A summary of IPCC commentary
Temperature and precipitation				
Temperature extremes	High warming	Very High Warming	High	Warming of extreme hot days in mid-latitudes- +3°C at 1.5°C (+4°C at 2°C); extreme cold nights in high-latitudes to warm by +4.5°C at 1.5°C (+6°C at 2°C)
Droughts and precipitation deficits	Lower relative to 2°C		Medium	50% lower proportion of world population exposed to climate-change induced water stress at 1.5°C vs 2°C
Oceans and sea-levels				
Global mean sea level rise	0.26-0.77m	0.30-0.93m	Medium	The rise is roughly 10cm lower at 1.5°C resulting in 10 million fewer people exposed to the related risks at 1.5°C vs 2°C
Marine ice sheet instability	Irreversible	Irreversible	Medium	The instabilities (and melting) could be triggered around 1.5°C to 2°C
Loss of sea-ice	Lower relative to 2°C		High	One sea ice-free Arctic summer- per century at 1.5°C vs one per decade at 2°C
Risk to marine species	High	Very High	High	Coral reefs to decline by a further 70–90% at 1.5°C with larger losses (>99%) at 2ºC
Ocean acidification amplification	High	Very High	High	Will impact the growth, development, calcification, survival, and thus abundance of a broad range of species
Risk to fisheries and aquaculture	Lower relative to 2°C		Medium	Decrease in global annual catch for marine fishes- 1.5m tonnes (1.5°C) and more than 3m tonnes (2°C)
Biodiversity, land and ecosystem				
Loss of biodiversity	Over 50% loss for 6% of insects, 8% of plants and 4% of vertebrates	Over 50% loss for 18% of insects, 16% of plants and 8% of vertebrates	Medium	Figures refer to 'climatically-suited geographic range' of 105,000 species studied. Other associated impacts like, forest fires, spread of invasive species, etc. are lower at 1.5°C
Terrestrial land exposed	50% lower than 2°C	13%	Medium	Refers to land exposed to the transformation of ecosystems
Boreal forest degradation	Lower relative to 2°C		High	(Includes high-latitude tundra) 1.5°C to prevent thawing of 1.5-2.5 million sq.km. permafrost area over centuries

Source: SR1.5, SPM, IPCC

What are the social implications of 1.5°C warming?

The physical consequences of warming – even at 1.5°C – are already severe. These have a knock-on effect for livelihoods, especially for the vulnerable segments of society. The severity of the human impacts are lower for 1.5°C relative to 2°C of warming. For example, there could be "several hundred million" fewer people exposed to climate-related risks and susceptible to poverty for 1.5°C vs 2°C (*medium confidence*).

The existing risks to human health, livelihoods, food security, water supply, human security, economic growth increase with 1.5°C of warming, and even more so with 2°C of warming.

Table 2: The severity of risks to humans depends on the region, and much lower with 1.5°C than 2°C

Human related impacts and risks	1.5°C relative to 2°C	Confidence level	A summary of IPCC commentary
Risk of adverse consequences to human population	Lower	High	Regions at disproportionately higher risk include Arctic ecosystems, dryland regions, small-island developing states, and least developed countries
Risks to human health	Lower	High	Risks considered for ozone related morbidity, mortality, vector-borne diseases, urban heat islands
Reduction in agricultural yields	Lower	High	Food availability, production and livestock will be adversely affected
Risk to global aggregated economic growth	Lower	Medium	Countries in the tropics and the southern hemisphere will experience the largest impacts from warming as temperatures increase from 1.5°C to 2°C
Exposure to multiple and compound climate-related risks	Lower	High	For warming from 1.5°C to 2°C, risks across the energy, food, and water sectors could overlap spatially and temporally, creating new hazards, exposures, and vulnerabilities

Source: SR1.5, SPM, IPCC

What are the estimated economic costs of warming?

Estimates of the economic costs vary widely. Risks to global economic growth from climate change are generally expected to be lower at 1.5°C than at 2°C (*medium confidence*). However, these estimates exclude the associated costs of mitigation as well as the investment in (and benefits of) adaptation.

> **Many impacts, such as loss of human lives, cultural heritage, and ecosystem services, are difficult to value and monetize.**
>
> **SR1.5, SPM, IPCC**

Dollar estimates vary widely

The report only gives dollar estimates for a specific sectors in specific situations – but these have a very wide range and come with modest confidence levels based on the limited number of models which generate them. For example, for the energy sector, roughly USD900bn (with a range of USD180-1800bn) is required in energy-related mitigation investment from 2015-2050 for a 1.5°C pathway, however, this estimate was only generated from six models.

3-4x

Marginal abatement costs of 1.5°C vs 2°C

The SPM explicitly states – with *high confidence* – that the "discounted marginal abatement costs over the 21st century…are roughly 3-4 times higher" for 1.5°C than for 2°C. In our view, this is a very stark message – that it will cost much more to limit warming to 1.5°C vs 2°C, however, the benefits of doing so are potentially vast, if difficult to value.

What does 1.5°C of warming mean for adaptation?

Adaptation for 1.5°C warming is generally easier

The report addresses adaptation (preparing for the consequences of climate change) in terms of needs, limits and implementation. In general, "Most adaptation needs will be lower for global warming of 1.5°C compared to 2°C (*high confidence*)." This makes sense because the impacts of warming at 1.5°C are generally less severe. The limits to adaptation are also less pronounced at 1.5°C but these limits vary by sector and region. In terms of implementation, adaptation will be less challenging (relative to 2°C) for various regions such as small islands and least developed countries as well as for ecosystems in general (including food and health).

Besides benefits, are there any risks with limiting warming to 1.5°C?
The IPCC recognises that the various mitigation and adaptation actions sometimes come with consequences that are not fully recognised. It specifically links these to sustainable development and looks at the *synergies* (co-benefits or positive effects) as well as the *trade-offs* (unintended negative effects). The main rationale for including such a discussion in the report is to draw attention to various issues as highlighted in the UN's 'Sustainable Development Goals' as well as encourage decision-makers to plan for more synergies than trade-offs. The report demonstrates the overwhelming (overall) synergies of mitigation action.

Table 3: Many climate actions co-benefit sustainable development, but these have to be appropriately thought out

1.5°C	SDGs	Confidence level
Synergies (positive effects)	**Potential positive impacts**	
Redistributive policies across sectors and populations to achieve 1.5°C	SDGs 3 (health), 7 (clean energy), 11 (cities and communities), 12 (responsible consumption and production), 14 (oceans)	High
Increase investments in physical and social infrastructure	Enhance resilience and adaptive capacities of the society	High
Adaptation options to reduce vulnerability of human and natural systems	Ensure food and water security, reduce disaster risk, poverty and inequality, improve health conditions, and maintain ecosystem services	High
Mix of Adaptation and mitigation options	Enable rapid, systematic transition in urban and rural areas	High
Pathways with low energy demand, material consumption and GHG intensive food consumption	Eradicate poverty and reduce inequality	High
Trade-offs (negative effects)	**Potential negative impacts**	
Mis-managed mitigation strategies	SDGs 1 (poverty), 2 (hunger), 6 (water), 7 (energy access)	High
Maladaptation in multiple sectors	Increase water use, gender and social inequality, undermine health conditions, and encroachment on natural ecosystems	High
Large-scale land-related deployment, Poorly implemented CDR (Carbon dioxide removal) options	Concerns Food production and security	Very high
Mix of Adaptation and mitigation options (ex. Bioenergy crops cause land encroachment needed for agricultural use)	Undermine food security, livelihoods, ecosystem functions and services and other aspects of sustainable development.	High

Source: SR1.5, SPM, IPCC

Conclusions

This Special Report espouses the benefits of limiting warming to 1.5°C compared to the more well-known target of 2°C. There is a strong sense of urgency as the window to contain this temperature increase is closing rapidly. Extreme weather events from recent years show the potential physical impacts even at this lower limit.

A key message of the report is that there is no single solution, that no single sector or country can go it alone. A 'whole system' approach is required for which international cooperation important as it is a "critical enabler for developing countries and vulnerable regions".

Investors have, and will continue, to step up climate engagement with corporates and their supply chains. We think the pressure to disclose meaningful (ie science-based) strategies as well as be more transparent on climate data will only increase. Climate strategies have thus far focused on fitting in with 2°C of warming, we think these may evolve to 1.5°C of warming – as per the words of Hans-Otto Pörtner "Every extra bit of warming matters".

> **Every extra bit of warming matters**
> **Hans-Otto Pörtner, Co-Chair of IPCC Working Group II**

What happens next to the science?

SR1.5 offers a glimpse into the latest scientific thinking on climate change – four years after AR5 but a few years before the full suite of the Sixth Assessment Report (AR6) Cycle, which will be published 2021-22. In 2019, the IPCC will also release an updated methodology report – the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories* (May 2019); as well as two further special reports:

- Special Report on Climate Change and Land (August 2019)
- Special Report on the Ocean and Cryosphere in a Changing Climate (September 2019)

What next for the global climate process?

The 24th Conference of the Parties (COP24) will take place in Katowice, Poland (2-14 December 2018). The SR1.5 is a formal input into the *Talanoa Dialogue* (ministerial level discussion at COP24) and it is hoped it will add to the sense of urgency in finalising the operational guidelines (rulebook) of the Paris Agreement in December.

The IPCC reports will be used to exert pressure not only on governments but also businesses to raise ambition levels – ie set stricter targets, more in line with science.

The global climate calendar: upcoming events

2018	Location	Event
12-14 October	Bali, Indonesia	Annual meetings of IMF and WB
22-23 October	Osaka, Japan	9th World convention on Recycling and Waste Management
22-25 October	Geneva, Switzerland	World Investment Forum, UNCTAD
22-26 October	London, UK	73rd Session of Marine Environment Protection Committee (MEPC), IMO
23-25 October	Norrkoping, Sweden	Fifth Nordic Conference on Climate Change Adaptation
24-26 October	Bonn, Germany	Fourteenth meeting of the Adaptation Committee
29-31 October	Bonn, Germany	19th Meeting of the Standing Committee on Finance (SCF 19)
05-09 November	TBA	30th Meeting of the Parties to the Montreal Protocol
19-20 November	Paris, France	6th Global Summit on Climate Change
22-23 November	Romania	8th International Conference on Environment and Climate Change
26-27 November	Japan	World Summit on Climate Change & Global Warming
30 November-1 December	Buenos Aires, Argentina	G20 Leaders' Summit
02-14 December	Katowice, Poland	24th session of the Conference of the Parties (COP 24), UNFCCC
05-06 December	Vancouver, Canada	9th International conference on Global Warming, Climate Change and Pollution control
2019		
14-17 January	Abu Dhabi, UAE	World Future Energy Summit, 2019(WFES)
22-25 January	Davos, Switzerland	World Economic Forum Annual Meeting, 2019
11-13 February	New Delhi, India	World Sustainable Development Summit (WSDS)
27 February- 01 March	Cartagena, Colombia	12th Annual forum of developing country investment negotiators
14-16 March	London, UK	5th International conference on pollution control & Sustainable Environment
23-24 April	Vancouver, Canada	6th World congress on Climate Change & Global Warming

Source: HSBC

Disclosure appendix

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Issuer of report
The Hongkong and Shanghai Banking Corporation Limited
Level 19, 1 Queen's Road Central
Hong Kong SAR
Telephone: +852 2843 9111
Fax: +852 2596 0200
Website: www.research.hsbc.com

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Global Climate Change & ESG Team

Climate Change Centre of Excellence

Head, Climate Change Centre of Excellence
Wai-Shin Chan, CFA +852 2822 4870
wai.shin.chan@hsbc.com.hk

Director, Climate Change Strategy
Ashim Paun, CAIA +44 20 7992 3591
ashim.paun@hsbcib.com

Alternative Energy

Industrials / Clean Technology Analyst
Sean McLoughlin +44 20 7991 3464
sean.mcloughlin@hsbcib.com

Head of Alternative Energy, Asia-Pacific
Evan Li +852 2996 6619
evan.m.h.li@hsbc.com.hk

Hebe Zhou +852 2914 9973
hebe.j.zhou@hsbc.com.hk

Environmental, Social and Governance (ESG) Research

Asia

Head of ESG Research, Asia Pacific
Wai-Shin Chan, CFA +852 2822 4870
wai.shin.chan@hsbc.com.hk

Europe

Ashim Paun, CAIA +44 20 7992 3591
ashim.paun@hsbcib.com

Laurie Fitzjohn-Sykes, CFA +44 20 7992 3689
laurie.fitzjohn-sykes@hsbc.com

Lucy Acton +44 20 3359 3365
lucy.acton@hsbc.com

Tarek Soliman +44 20 3268 5528
tarek.soliman@hsbc.com

Americas

Head of ESG Research, Americas
Tessie Petion +1 212 525 4866
tessie.d.petion@us.hsbc.com

Equity Strategy

Global Equity Strategist, Global Head of Equity Sector Research, Head of Americas Research
Ben Laidler +1 212 525 3460
ben.m.laidler@us.hsbc.com

Amit Shrivastava +91 80 4555 2759
amit1.shrivastava@hsbc.co.in

Green Bonds Research

Green Bonds and Corporate Credit Analyst
Michael Ridley, PhD +44 20 7991 5918
michael.a.ridley@hsbc.com