WORLD
GOLD
COUNCIL

Gold and climate change:
Current and future impacts
Appendices

About the World Gold Council

The World Gold Council is the market development organisation for the gold industry. Our purpose is to stimulate and sustain demand for gold, provide industry leadership, and be the global authority on the gold market.

We develop gold-backed solutions, services and products, based on authoritative market insight, and we work with a range of partners to put our ideas into action. As a result, we create structural shifts in demand for gold across key market sectors. We provide insights into the international gold markets, helping people to understand the wealth preservation qualities of gold and its role in meeting the social and environmental needs of society.

Based in the UK, with operations in India, the Far East and the US, the World Gold Council is an association whose members comprise the world's leading gold mining companies.

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Appendix 1 – Gold's Carbon Footprint

Methodology note 1: calculation of Scope 1 and 2 emissions

To arrive at a comprehensive overview of gold mining's Scope 1 and 2 greenhouse gas (GHG) emissions, a number of alternative data sources and models were considered. Ultimately, the most accurate dataset was finally derived from the emissions and energy reported by the mining companies to either CDP (formerly the Carbon Disclosure Project) or via other public platforms, and their own company and sustainability reporting. The data represented 880 tonnes (t) of gold produced from 80 mines in 2017, and 172t of gold produced from 17 mines in 2018. A number of checks were made to ensure the data was sufficiently broad in its coverage to be representative of the wider population of (listed) gold mining operations. The data from both years was used to validate the relative degree of accuracy when extrapolating. The sample of mines for which 2017 data were available was reviewed to see if it was representative according to mine type, country, gold recovery rate and mine size. The following conclusions were drawn regarding this data:

- It was representative of different mine types
- It was slightly over-representative of countries with large production volumes
- It was broadly representative of mines by recovery rate/milled grade (volume of gold per tonne of ore)
- It was not representative of production ranges – small producing mines (under 5t per year) were considerably under-represented. However, this is not deemed significant for this study.

The data also suggested that average emissions vary by mine type, with:

- lower than average Scope 1 emissions in underground mines
- higher than average Scope 2 emissions in underground mines.

The higher ore grades and energy intensive nature of underground mining at least partially explain these differences. However, mine location was shown to be the key variable; if South African mines, which typically use high carbon electricity from the national grid, are removed from the sample, any difference between mine types becomes insignificant.

Additionally, several mines in the sample reported zero Scope 2 emissions; these are mines that are not grid-connected.

In conclusion, the dataset used as a sample (for extrapolating to global gold figures) was accepted as broadly representative of the population (for those factors that were significantly correlated with relative emissions); the population under study is also representative of global gold production and therefore can be judged to provide a reasonable basis for extrapolation.

Methodology note 2: calculation of Scope 3 emissions

We have included the following sources of Scope 3 emissions: upstream emissions from purchased goods and services, including upstream emissions related to the production and distribution of fossil fuels and electricity which are used by the gold industry; upstream emissions from waste and waste processing; and downstream emissions related to the processing of sold products (jewellery, investment bars and coins, and electronics). We analysed other sources of Scope 3 emissions as set out in the GHG Protocol, and concluded that these were either not material or simply not applicable.

Upstream emissions
We performed a high-level estimation of emissions from the following sources: transportation, capital goods, and business and employee travel. Our analysis indicated that emissions from these sources are around five orders of magnitude smaller than those from production of gold. In view of their relative immateriality, they are excluded from our calculation of gold's carbon footprint.

Downstream emissions
To evaluate downstream emissions, we calculated separate estimates for:

- Jewellery fabrication and distribution
- Investment products (bars and coins)
- Gold as a component in electronics.

Where gold-specific data upon which we could calculate associated emission levels was unavailable, we sought to identify closely aligned proxies and, if possible, cross-checked or aggregated these with less specific or higher-level data sources relating to gold.

The production of investment grade gold was taken as broadly equivalent to the refining process in terms of GHG emissions intensity, and therefore the intensity estimates for the refining of gold were applied to the production of bullion or bullion-backed products.

For estimates of gold's use in electronics, we restricted our focus to the fabrication process (for gold bonding wire and coatings). Data specific to gold wire production was unavailable, so proxy figures for fine copper wire (from Ecoinvent) were used. The relatively miniscule amounts of gold typically used in each final consumer product suggested any further calculations (for example, relating to electronic product transportation/distribution) would be unlikely to produce meaningful or material results.

Although there was very limited information regarding GHG emissions associated with global jewellery manufacturing, data from a major international gold jewellery fabricator and retailer was located that identified both annual GHG emissions and the proportion of its business (revenue) associated with gold products. This source also suggested the majority of its GHG emissions are associated with electricity usage at POS and retail outlets, with production accounting for a smaller proportion. These figures were assumed to be broadly representative and used to extrapolate a GHG emissions figure for the wider gold jewellery sector.

We acknowledge that artisanal jewellery production will likely have a quite different GHG emissions profile, but given that the industrialised sector is potentially much more energy-intensive, we anticipate our extrapolations to have overstated the global emissions profile of gold jewellery sector.

Looking at transportation, our analysis of downstream transportation again indicated emissions from this source were around five orders of magnitude smaller than those from production, and we have not included them.

Given gold's inert and enduring nature, we do not believe emissions from end-of-life treatment are applicable. Finally, regarding emissions from leased assets, we consider that any material emissions directly related to gold from leases and franchises should be included within companies' Scope 1 and Scope 2 reporting. We have therefore not included these categories in our Scope 3 estimates.

Methodology note 3: final calculation of total emissions

Our analysis of data for multiple years allowed us to evaluate the quality and coverage of each data set relating to each Scope calculation. We have therefore used the most complete/representative annual datasets for each:

- 2017 data for Scope 1 and 2 (mine production) – cross-referenced against a smaller 2018 sample to ensure a representative set
- 2018 data for Refining/Recycling
- 2018 data for Scope 3 upstream
- 2018 data for Scope 3 downstream.

Appendix 2 – Net zero carbon transition pathways for the gold supply chain

Science-based targets

The table below shows the linear reduction rates (using 2018 as a base year), the target year, total reduction in annual emissions needed by the target year, the total budget for the period and the number of years during which emissions remain at 2018 levels.

Table 1: Estimated carbon budget for the gold mining sector, aligned with science-based targets

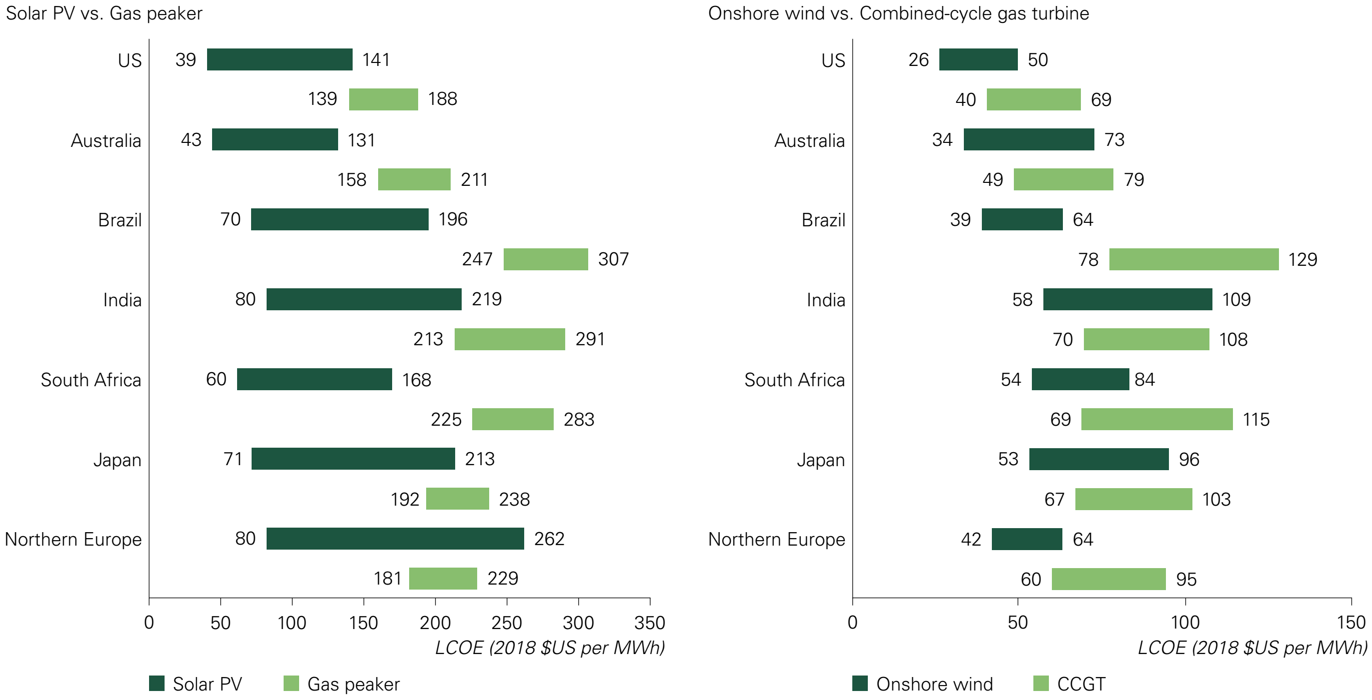
Target	% annual linear reduction	Target year	Reduction in annual emissions by target year	Total budget CO_2e, t	Equivalent years' emissions at current rates
Well below 2°C	2.5%	2050	80%	2,013,000,000	19
1.5°C	4.2%	2040	92%	1,261,500,000	12

Source: Anthesis; IEA "Energy Technology Perspectives" (2017)

Decarbonising electricity

The following charts offer further evidence of the cost benefits of transitioning to renewables over specific time horizons.

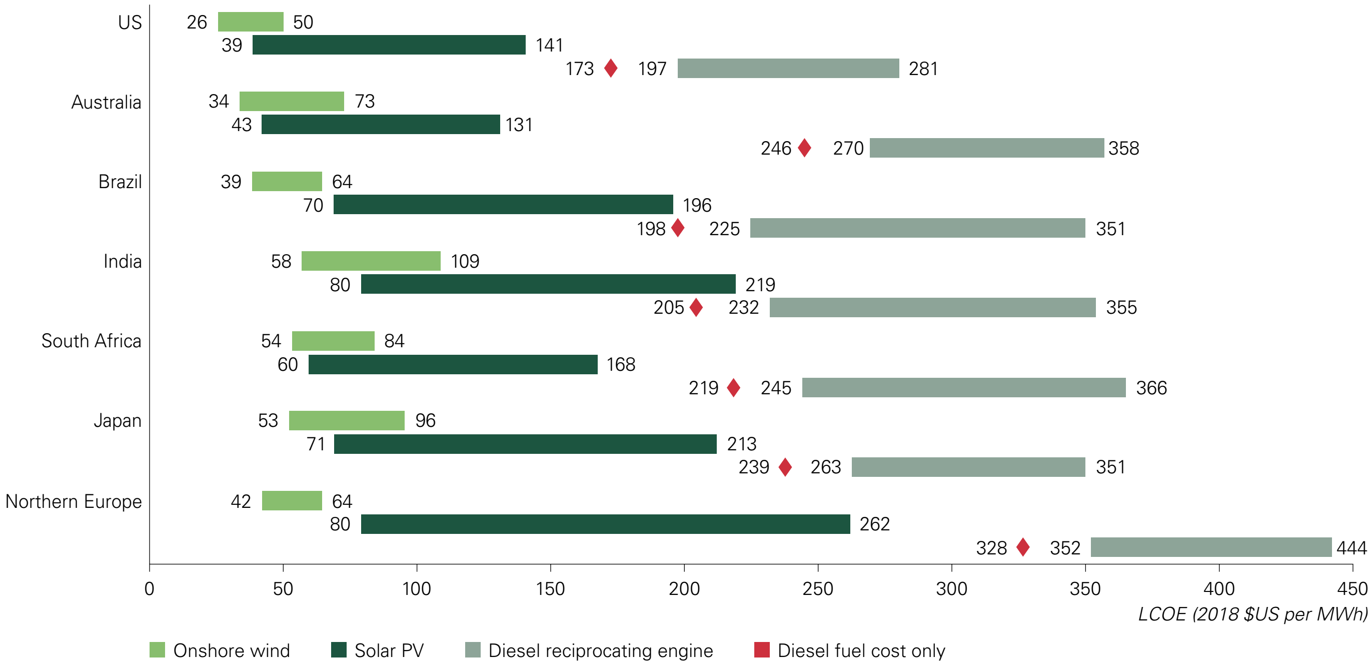
Chart 1: Life-time cost of electricity for solar PV and onshore wind compared with new-build gas generation with similar generation profile
(2018 US$ per MWh)



Source: Lazard, "*Lazard's Levelized Cost of Energy Analysis – Version 12.0*," November 2018. www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

Chart 2: Life-time cost of electricity for onshore wind and solar PV vs. diesel

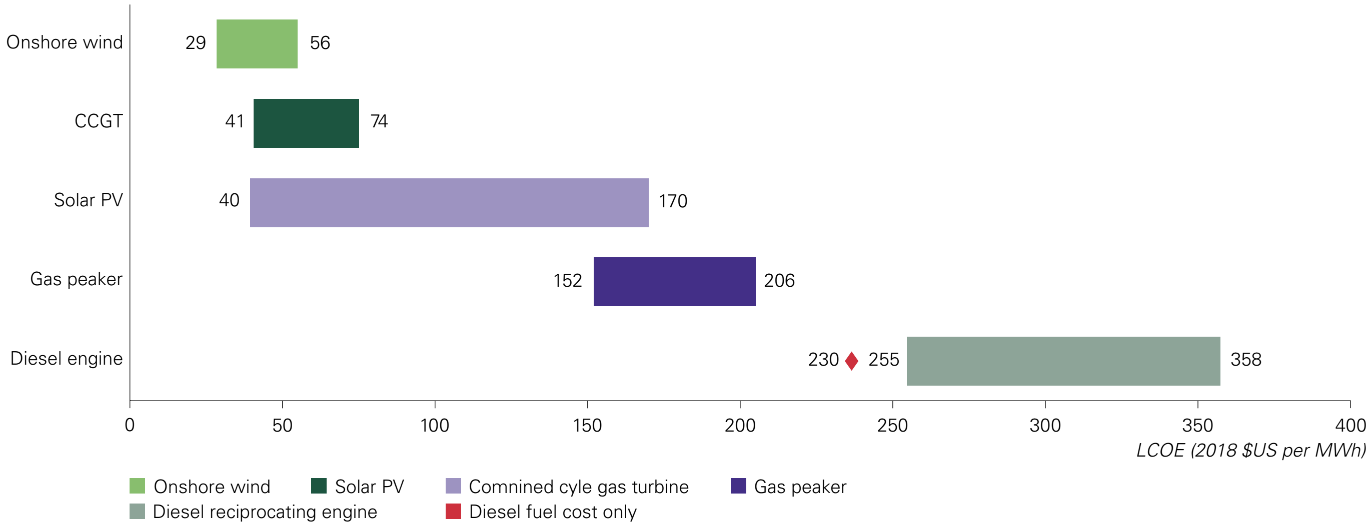
(2017 US$ per MWh)



Source: Lazard, "*Lazard's Levelized Cost of Energy Analysis – Version 11.0,*" November 2017, www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf; "*Lazard's Levelized Cost of Energy Analysis – Version 12.0,*" November 2018, www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

Chart 3: Life-time cost of electricity from solar PV and onshore wind vs. fossil fuel technologies

(2018 US$ per MWh; Diesel – 2017 US$ per MWh)



Note: LCOE for solar PV, onshore wind and gas is 2018 and in 2018 US$ and represents reported global average; LCOE and fuel cost of diesel is 2017 and in 2017 US$ and represents mean of reported regional averages (no global average reported). Levelized Cost of Electricity is defined as the average full cost per MWh generated over the lifetime of the project. LCOE is estimated from based on a power plant model representing an illustrative project for each relevant technology, with assumptions made on capital structure and required cost of debt and equity for the project.

Source: Lazard, "*Lazard's Levelized Cost of Energy Analysis – Version 11.0,*" November 2017, www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf; Lazard, "*Lazard's Levelized Cost of Energy Analysis – Version 12.0,*" November 2018, www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf

Methodology note 4: assumptions in energy demand calculations

We estimate total electricity demand for the gold industry to be in the order of c.50M–100M MWh per year. This is based on an analysis of costs reported on a mine site-by-site basis[1] scaled up to the whole industry and cross-checked against data reported by individual companies. Note that increasing or decreasing this estimate would change the absolute value of costs and benefits but would not change the direction. To keep modelling simple, we assume this demand remains steady over time and does not increase with increased production, nor decrease due to energy efficiency initiatives.

Table 2: Assumptions used to model economics of renewable electricity generation and storage

Item	Units	Business as usual	Replacement	Notes
Annual electricity demand	MWh	50M	50M	Assume 30% wind, 70% solar PV
Electricity cost (2018)	US$ / MWh	100	100	Same price assumed for purchased electricity and electricity generated on-site from fossil fuels – based on IEA data published 2018
Capital costs – onshore wind (2018)	US$ / MW	N/A	1.35M	Based on Lazard, 2018
Capital costs – solar PV (2018)	US$ / MW	N/A	1.84M	Based on Lazard, 2018
Capital costs – lithium ion battery storage (2018)	US$ / MW	N/A	1.25M	Assume 0.5MW per MW renewable energy; with 4 hour storage capacity. Costs are likely conservative as we assume 100% additional to renewable costs. E.g. NREL quotes combined solar + storage at 60% of individual components.
Capacity factor – onshore wind	%	N/A	46.5%	Conservative – assumes no improvement in capacity factor per se
Capacity factor – solar PV	%	N/A	22.5%	Conservative – assumes no improvement in capacity factor per se
Operation and Maintenance (O&M) costs – solar PV, batteries (2018)	US$ per kW	N/A	12 (each)	Costs are likely conservative as we assume 100% additional to O&M costs for renewable generation plant – in reality O&M cost of combined renewable + storage systems likely to be lower
O&M costs – wind (2018)	US$ per kW	N/A	32	
Inflation in capital costs – onshore wind	% per year	N/A	-4.0%	Consistent with BNEF, Lazard, NREL
Inflation in capital costs – solar PV wind		N/A	-3.7%	Consistent with BNEF, Lazard, NREL
Inflation in capital costs – batteries		N/A	-8%	Consistent with BNEF, Lazard, NREL
Inflation (Electricity cost, O&M for renewables, batteries)	US$ per year	2%	2%	
WACC	%	10%	10%	

Source: Bloomberg New Energy Finance, "*New Energy Outlook 2019*", https://about.bnef.com/new-energy-outlook/#toc-download; IRENA (2019), "*Renewable Power Generation Costs in 2018*," International Renewable Energy Agency, Abu Dhabi; www.irena.org/publications/2019/May/Renewable-power-generation-costs-in-2018; IRENA (2017), "*Electricity Storage and Renewables: Costs and Markets to 2030*," International Renewable Energy Agency, Abu Dhabi; Lazard, "*Lazard's Levelized Cost of Storage Analysis – Version 4.0*," November 2018 www.lazard.com/media/450774/lazards-levelized-cost-of-storage-version-40-vfinal.pdf; National Renewable Energy Agency, "*2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark*," October 2018, www.nrel.gov/docs/fy19osti/72401.pdf

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[1] Listed gold mine data from the S&P Global Market Intelligence mining data base.

Our business-as-usual scenario assumes this demand continues to be met by the same mix of purchased electricity and on-site generation as today, with prices increasing modestly with inflation. Note that our business-as-usual case only includes the costs of purchased electricity or fuel and does not include maintenance costs, costs incurred due to blackouts or brownouts, etc. We believe this makes our modelling conservative.

Our comparison case assumes that demand is replaced with renewable energy and battery storage over a ten-year period from 2021–2030, with equal amounts of energy and storage capacity commissioned in each year. We assume 30% onshore wind and 70% solar PV, backed with lithium-ion batteries at 0.5MW and four hours of storage capacity for every MW of renewable generation capacity. We have assumed costs and cost reductions for renewable energy technologies in line with those reported by leading analysts. We have assumed current (2018) capacity factors. We have included operations and maintenance costs for these technologies, again making our model conservative.

Appendix 3 – Gold as an investment and climate-related risks

Table 3: Climate scenarios and macro-economic impacts

1.5°C /2°C	3°C	4°C
Demand/supply shocks or economic growth effects: Likely to reduce near term growth Increases in the price of a firm's inputs tend to result in higher costs Bottom up inflationary pressures build in response to higher unit costs Resources are diverted from productive investment to mitigation activities Climate policies 'crowd out' private investment and consumption Distortions from asymmetric climate policies In the short to medium term, compliance with environmental regulation forces companies to curb production or to devote some of their resources to emission abatement Policies that encourage innovation in low-carbon technologies can spill over to other industries and stimulate economic growth Co-benefits such as improvements in air quality and health, and sustainability of ecosystems; improvements in biodiversity and increased energy security In the short term, jobs will be lost in sectors directly affected by new climate change policies and will be gained in replacement industries. Because low-carbon technologies are more labour-intensive than other energy technologies, the short-term employment effect of climate policy should be positive, while labour productivity is likely to decrease In the medium term, climate change policies will create or destroy jobs along the value chains of the industries that are affected by those policies. In the long run, innovation and the development of new technologies could create opportunities for investment and net job creation, and improve labour productivity and economic growth.	Market impacts include effects on climate-sensitive sectors such as agriculture, forestry, fisheries and tourism; damage to coastal areas from sea-level rise; changes in energy expenditures (for heating or cooling); and changes in water resources Non-market impacts cover effects on health (such as the spread of infectious diseases and increased water shortages and pollution), leisure activities (sports, recreation and outdoor activities), ecosystems (loss of biodiversity) and human settlements (specifically because cities and cultural heritage cannot migrate) Estimates of total global damages also mask large variations across countries and regions. Damages tend to be greater for countries with higher initial temperatures, greater climate change and lower levels of development Larger dependence on climate-sensitive sectors, particularly agriculture. Populations in these countries are typically more vulnerable to climate change because of lower income per capita, limited availability of public services (such as health care), less-developed financial markets and poor governance. The same factors also restrain the adaptive capacity of the economy The regions likely to experience the most negative effects include Africa, South and Southeast Asia (especially India), Latin America and OECD Europe (if catastrophic risk is included). China, North America, OECD Asia and transition economies (especially Russia) should suffer smaller impacts and may even benefit, depending on the actual extent of warming Drastic changes in climate could also make obsolete many existing agricultural, distributional and associated industrial patterns, forcing the relocation or decommissioning of existing capital stocks and the relocation or retraining of labour. This would likely result in a significant decline in total factor productivity.	**Supply-side shocks** affecting the productive capacity of the economy: • Continuously changing climate will require more frequent adjustments to the capital stock, leading to a lower efficiency in its use in production • Diversion of resources from technology and innovation to reconstruction and replacement • Diversion of resources from technology and innovation to adaptation capital • Damage to capital stock and infrastructure due to extreme weather • Diversion of resources from productive investment to adaptation capital – fewer resources will be available for productive capital investment, leading to lower output growth • Lower productivity, food and other input shortages and price volatility • Risks to energy supply and price volatility • Demand/supply shocks or economic growth effects • Lower productivity, loss of hours worked due to natural disasters and extreme heat • Extreme temperatures could also lead to negative health effects and an increase in the mortality and morbidity of the population, for example due to the an increased incidence of diseases such as malaria • Increased speed of capital depreciation.

Table 4: Climate scenarios and macro-economic impacts

1.5°C	2°C	3°C	4°C
A sudden, unexpected tightening of carbon emission policies could lead to a disorderly re-pricing of carbon-intensive assets and generate a negative supply shock (transition risks). A rapid transition away from fossil-fuel-based energy production could lead to a reduction in the supply of energy and an upward shock to energy prices with adverse macroeconomic consequences Financial assets whose value depend on the extraction of fossil fuels and other carbon-intensive assets would become unusable or 'stranded,' requiring sudden and significant price adjustments. These could in turn lead to corporate defaults and financial instability, which could result in negative macroeconomic outcomes Near term growth is likely reduced Increases in the price of a firm's inputs tend to result in higher costs Bottom up inflationary pressures build in response to higher unit costs Moderated growth may also reduce downward inflationary pressures in the longer term Resources are diverted from productive investment to mitigation activities In the short to medium term, compliance with environmental regulation forces companies to curb production or to devote some of their resources to emission abatement Policies that encourage innovation in low-carbon technologies spill over to other industries and stimulate economic growth Climate policy may result in productivity growth if it improves the allocation of resources or increase their degree of utilisation Capital and technology flows could reduce the costs of mitigation by helping allocate abatement to the least costly destinations, while making abatement easier through the use of modern technology Transfers (from economies that buy permits to economies that sell them) could be potentially large and may cause real exchange rates in the recipient countries to appreciate considerably, making some sectors of their economies less competitive.	Current accounts tend to improve over time in economies with lower marginal abatement costs (for example, China and OPEC members) because reductions in investment outweigh reductions in savings. An exception to this pattern is the United States, where the current account worsens, because the marginal product of capital declines by less than in other countries, enabling the US to absorb increased savings from China and OPEC members. These capital inflows help support US investment and consumption If a reduction in carbon emissions is to be achieved entirely via a reduction in energy use, the resulting reduction in output could be substantial. If sufficient investment takes place in low-carbon energy sources at an early stage transition to a low-carbon economy could be achieved without causing a large negative supply shock.	Higher interest rates reduce capital accumulation and therefore GDP, which ultimately ends up lower than in the baseline scenario. Because a higher risk premium raises domestic savings it leads to depreciation of the real exchange rate in the short run and causes the current-account-to-GDP ratio to be higher than in the baseline scenario. After a few years, the improving external asset position causes the real exchange rate to appreciate. Changes in real exchange rates are driven by changes in production costs in the short run, whereas the adjustment path over time depends on real interest rate differentials The direction and magnitude of macroeconomic effects for individual countries, including financial transfers, are particularly sensitive to assumptions about elasticities of substitution in production, consumption, and trade The destruction of capital stocks due to natural disasters tends to reduce aggregate supply, while reconstruction efforts could increase aggregate demand. If a natural disaster generates a positive output gap and an upward pressure on inflation, then a central bank might consider tightening monetary policy. But a natural disaster could also have a large and persistent negative effect on demand – and thus generate a negative output gap – if it severely damages household and corporate balance sheets in affected areas and reduces their consumption and investment. A natural disaster could also undermine business confidence and trigger a sharp sell-off in financial markets, which in turn could increase the cost of funding new investments and thus reduce investment demand.	**Demand-side shocks** affecting the components of the aggregate demand, such as private (household) or public (government) consumption and investment, business investment and international trade • Uncertainty about climate events • Increased risk of flooding to residential property • Large insurance and financial losses due to business interruption and property damage costs; rising climate-related risks may overwhelm the financial sector's capacity • Disruption to import/export flows and price volatility • Greater volatility of headline inflation rates via increased volatility of food (and energy) price inflation • Mass migration, and increases in poverty, inequality, crime and social unrest Damages tend to be greater for countries with higher initial temperatures, greater climate change and lower levels of development Rich countries may be affected by spill-overs from climate change in poor countries; they would also face severe direct damage.

Table 5: Physical damage and transition milestones

Item	Notes
Oceans	Sea level rise (cm) % increase in ocean acidity % decrease in the Atlantic meridional overturning circulation Loss of fin fish and fisheries Loss of coastal ecosystems and protection Loss of bivalves and bivalve fisheries Inundation and destruction of human/coastal infrastructure and livelihoods
Ice	Probability of ice-free Arctic summer at least once before hitting temperature limit Global glacier mass loss during the 21st century (mm) Loss of habitat Increased productivity but changing fisheries
Temperature	% number of hot days Annual maximum daily temperature Warm spell duration Frequency of warm extremes over land Frequency of cold extremes over land
Rainfall	Average rainfall Consecutive dry days Maximum consecutive 5-day precipitation Rainfall intensity Frequency of rainfall extremes over land
Drought	% less water availability Water stress Changes in urban population exposure to severe drought at the global scale Average drought length (months) Population exposed to water scarcity Global population exposed to severe drought
Storms and flooding	Global annual number of tropical cyclones % increase in the strongest North Atlantic cyclones % increase in the population affected compared to the impact simulated over the baseline period 1976–2005 Global population flooded in coastal areas
Crops and food security	Average maize crop yield change Average wheat crop yield change Changes in ecosystem production Shift and composition change of biomes (major ecosystem types)
Nature	Proportion of plant species losing >50% of their climatic range Proportion of insect species losing >50% of their climatic range Proportion of mammal species losing >50% of their climatic range Proportion of bird species losing >50% of their climatic range Average warming across drylands Average warming across humid lands
Economy	Global per capita GDP in 2100 Annual flood damage losses from sea level rise Global impact on GDP of energy demand for heating and cooling Risk in tourism (sun, beach and snow sports)
Health	Suitability of drylands for malaria transmission Suitability of humid lands for malaria transmission Heat-related morbidity and mortality Occupational heat stress Ozone-related mortality Undernutrition
Forest	Heat wave and forest fire risk
Primary energy	% of renewable energy % of nuclear % of fossil
Electricity generation	% of renewable energy % of nuclear % of fossil % increase in power generation
Transport	Sales of electric vehicles and LPG vehicles
Buildings	% increase in energy consumption Share of electrification
Policy and economic frameworks	Price of carbon emissions (USD2010 / t CO_2eq) Global economic damages due to climate change

Methodology note 5: analysing asset sensitivity to climate-related risks

The methodological steps for this analysis were as follows:

1. Defined and described the four different scenarios based on (IPCC and IEA) definitions
2. Defined the projected transition and physical-related impacts for each scenario over the time periods 2030, 2050 and 2100 in terms of likely policy interventions and anticipated physical impacts. We sought to answer how each risk factor will change over time for each scenario

   In line with the IPCC science, it is assumed that the differences in additional physical climate impacts related to following each scenario are not really pronounced until the second half of the century. The potential transition and economic impacts on the other hand are considered to be much nearer term
3. Identified the main asset classes (and assets) to be assessed for comparison purposes. These are the same as those used in the World Gold Council's '*The relevance of gold as a strategic asset*', 2019 edition
4. Defined the composition (by sector and industry) of the stocks and commodity asset classes

   A sector is a broad grouping of companies that have similar economic characteristics. Sectors, in turn, are broken down into sub-categories known as industries. This allows a closer grouping of similar businesses. The level of analysis in this assessment tool is carried out at sector level
5. Make a qualitative judgement of the level of sensitivity of the potential annual returns for each asset class to climate-related factors based on each of the scenarios. We sought to answer how sensitive each sector/asset class is to the main impacts and scenarios

   Depending on the scenario, a qualitative judgement was made as to the respective financial drivers, and the likelihood and magnitude of impact on the asset or asset class. The financial driver assumptions are based upon the anticipated transition or physical impacts on revenue, costs and asset values

   A *multiple* is calculated for each asset or sector by multiplying the *likelihood score* by the *magnitude*. (See *Risk weightings: Climate risks and potential impacts* section, below.)

   Likelihood x Magnitude = Multiple

   For US stocks and commodity indexes, a weighted average for the asset class is calculated based on index composition by sector/asset. (See *Asset definition* section, below)

   Weighted Average = Sum of asset multiples x asset class weighting

This analysis is easier to apply at the sector level initially, and at the two ends of the time line (2030 and 2100), whereby transition and physical impacts are more pronounced.

To enable clearer analysis and accentuate the results, this was carried out initially for the two extreme positions of 1.5°C scenario transition impacts in 2030 and physical impacts in 2100. The results for the other scenarios were then interpolated from these two extreme-end scenarios by adding or subtracting an appropriate increment for each increase or decrease in temperature (under the different scenarios) and over the respective timescales.

The assessment results draw on expert knowledge of the different assets and sectors, and their likely climate-related exposure, rather than a Delphi or similar multi-party method for attributing risk values. This was the simplest and most practical route, but multi-party analysis could represent a useful extension of the analysis.

Table 6: Risk weightings: Climate risks and potential impacts

Likelihood	
Virtually certain	4
Very likely	3.5
Likely	3
More likely than not	2.5
About as likely as not	2
Unlikely	1.5
Very unlikely	1
Exceptionally unlikely	0.5
Unknown	0

Magnitude of impact	+	−
High	5	-5
Medium-high	4	-4
Medium	3	-3
Medium-low	2	-2
Low	1	-1
Unknown	0	0

Asset selection

Table 7: US stocks = S&P 500 sector breakdown by market value

Sector	%
Communication services	10.33
Consumer discretionary	10.11
Consumer staples	7.18
Energy sector	5.51
Financials	13.63
Healthcare	15.21
Industrials	9.33
Information technology	19.85
Materials	2.71
Real estate	2.96
Utilities	3.18
	100.00

Source: www.thebalance.com/what-are-the-sectors-and-industries-of-the-sandp-500-3957507

Chart 4: MSCI EM (Emerging Markets) Index

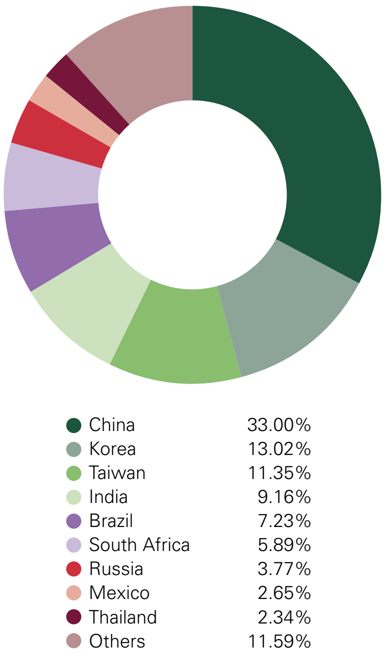

Table 8: MSCI EAFE (Europe, Australasia and Far East) index countries

Europe			Australasia	Middle East
Austria	Germany	Portugal	Australia	Israel
Belgium	Ireland	Spain	Hong Kong	
Denmark	Italy	Sweden	Japan	
Finland	Netherlands	Switzerland	New Zealand	
France	Norway	United Kingdom	Singapore	

Table 9: Commodities = the 2017 target weights and composition for the Bloomberg Commodity Index

Commodities	%
Energy	30.57
Natural gas, Brent Crude oil, WTI crude oil, ULS diesel, unleaded gasoline	
Grains	23.46
Corn, soybeans, wheat, oil soybean meat, HRW wheat	
Industrialised metals	17.39
Copper, aluminium, zinc, nickel	
Precious metals	15.29
Gold, silver	
Softs	7.22
Sugar, coffee, cotton	
Livestock	6.07
Live cattle, lean hogs	

Source: www.bloomberg.com/company/announcements/2017-target-weights-for-the-bloomberg-commodity-index-announced/

Glossary

Business as usual: A scenario used for projections of future emissions assuming no action, or no new action, is taken to mitigate the problem. Some countries are pledging not to reduce their emissions but to make reductions compared to a business as usual scenario. Their emissions, therefore, would increase but less than they would have done.

Carbon budget: A tolerable quantity of greenhouse gas emissions that can be emitted in total over a specified time. The budget needs to be in line with what is scientifically required to keep global warming and thus climate change "tolerable." Carbon budgeting should not be confused with the use of targets, thresholds or caps to set emissions reduction goals.

Carbon Capture and Storage (CCS) – also, Carbon Capture and Sequestration / Carbon Control and Sequestration: The process of capturing and storing carbon dioxide (CO_2) before it is released into the atmosphere. The technology can typically capture up to 90% of CO_2 released by burning fossil fuels in electricity generation and industrial processes.

Carbon Capture and Use (CCU): A new branch of science and technology focused on the capture and transformation of carbon dioxide (CO_2) into commercially viable products such as bio-oils, chemicals, fertilisers and fuels.

Carbon footprint: The term 'carbon footprint' is used to mean the total mass of greenhouse gas emissions caused by an organisation, product or process over a given time period. A carbon footprint considers all seven of the Kyoto Protocol greenhouse gases: CO_2, methane (CH_4), nitrous oxide (N_2O), sodium hexafluoride (SF_6), nitrogen trifluoride (NF_3), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs).

Climate-related physical and transition risks: The Task Force on Climate-related Financial Disclosures (TCFD) divides climate-related risks into two major categories: (1) risks related to the transition to a lower-carbon economy and (2) risks related to the physical impacts of climate change.

1. **Transition risks** Transitioning to a lower-carbon economy may entail extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organisations.

- ***Policy and legal risks:*** Policy actions around climate change continue to evolve. Their objectives generally fall into two categories – policy actions that attempt to constrain actions that contribute to the adverse effects of climate change or policy actions that seek to promote adaptation to climate change. Some examples include implementing carbon-pricing mechanisms to reduce GHG emissions, shifting energy use toward lower emission sources, adopting energy-efficiency solutions, encouraging greater water efficiency measures, and promoting more sustainable land-use practices. The risk associated with and financial impact of policy changes depend on the nature and timing of the policy change.
- Another important risk is litigation or legal risk. Recent years have seen an increase in climate-related litigation claims being brought before the courts by property owners, municipalities, states, insurers, shareholders, and public interest organisations. Reasons for such litigation include the failure of organizations to mitigate impacts of climate change, failure to adapt to climate change, and the insufficiency of disclosure around material financial risks. As the value of loss and damage arising from climate change grows, litigation risk is also likely to increase.
- ***Technology risk:*** Technological improvements or innovations that support the transition to a lower-carbon, energy efficient economic system can have a significant impact on organizations. For example, the development and use of emerging technologies such as renewable energy, battery storage, energy efficiency, and carbon capture and storage will affect the competitiveness of certain organizations, their production and distribution costs, and ultimately the demand for their products and services from end users. To the extent that new technology displaces old systems and disrupts some parts of the existing economic system, winners and losers will emerge from this "creative destruction" process. The timing of technology development and deployment, however, is a key uncertainty in assessing technology risk.
- ***Market risk:*** While the ways in which markets could be affected by climate change are varied and complex, one of the major ways is through shifts in supply and demand for certain commodities, products, and services as climate-related risks and opportunities are increasingly taken into account.
- ***Reputation risk:*** Climate change has been identified as a potential source of reputational risk tied to changing customer or community perceptions of an organisation's contribution to or detraction from the transition to a lower-carbon economy.

2. ***Physical risks:*** Physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) in climate patterns. Physical risks may have financial implications for organizations, such as direct damage to assets and indirect impacts from supply chain disruption. Organisations' financial performance may also be affected by changes in water availability, sourcing, and quality; food security; and extreme temperature changes affecting organisations' premises, operations, supply chain, transport needs, and employee safety.
    - ***Acute risk:*** Acute physical risks refer to those that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods.
    - ***Chronic risk:*** Chronic physical risks refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves.

CO_2e: 'CO_2e' or 'carbon dioxide equivalent' is a unit of measurement of greenhouse gases that allows the different gases to be compared on a like-for-like basis relative to one unit of CO_2. For a given mass of a specific greenhouse gas, CO_2e represents the mass of CO_2 that would have the same global warming impact over a specified number of years (most commonly 100 years). CO_2e is calculated by multiplying the mass of each non-CO_2 greenhouse gas by its 100-year global warming potential. For example, methane (CH4) has a 100-year global warming potential of 28. Therefore 1 tonne of methane is equivalent to 28t of CO_2e.

Global warming potential: An index measuring the global warming impact following an emission of a unit mass of a given greenhouse gas, accumulated over a chosen time period, relative to that of the reference gas, CO_2. The global warming potential represents the combined effect of the differing times these gases remain in the atmosphere and their effectiveness in causing global warming.

Greenhouse gases: The Kyoto Protocol includes seven key greenhouse gases emitted by human activities that contribute to anthropogenic climate change, including carbon dioxide, methane, nitrous oxide and fluorinated gases.

HFO: Heavy Fuel Oil or 'residual fuel oil' is the high viscosity, tar-like mass that remains after distillation of crude oil, commonly used for used for marine diesel engines and for burning in furnaces, boilers and lanterns.

kW: Kilowatt: a unit for measuring power that is equivalent to one thousand watts.

kWh: Kilowatt hour: the kilowatt hour is a unit of energy equivalent to one thousand watts expended for one hour of time.

Levelised: The levelised cost of energy (LCOE) is a measure of a power source that allows comparison of different methods of electricity generation on a consistent basis. The LCOE can also be regarded as the average minimum price at which electricity must be sold in order to break-even over the lifetime of a project.

Low carbon economy: An economy based on low carbon power sources that therefore has a minimal output of GHG emissions into the biosphere, but specifically refers to CO_2.

Mitigation Action that will reduce man-made climate change. This includes action to reduce greenhouse gas emissions or absorb greenhouse gases in the atmosphere.

MW: Megawatt: a unit for measuring power that is equivalent to one million watts. One MW is roughly equivalent to the energy produced by 10 automobile engines.

MWh: Megawatt hour: the megawatt hour is a unit of energy equivalent to one million watts of power expended for one hour of time.

MWp: Megawatt peak output: a metric of the maximum output of a photovoltaic power device or plant.

Net-zero emissions: Long-lived greenhouse gases like CO_2 accumulate in the atmosphere. Therefore, their emissions must be reduced to zero in order to stop their cumulative warming effect from increasing and to stabilise global temperatures. Some activities, such as afforestation, actively remove CO_2 from the atmosphere. 'Net-zero' emissions means that the total of active removals from the atmosphere offsets any remaining emissions from the rest of the economy. The removals are expected to be important given the difficulty in entirely eliminating emissions from some sectors.

Primary gold supply: This refers to the supply of gold from the mining process. For the purpose of this report, the primary gold mining process has been split into four key activities: 1 Mining: the process of extracting gold-containing ore from the ground, using explosives and heavy machinery. 2 Milling: grinding the ore into smaller particles to improve recovery rates. 3 Concentrating and smelting: separating the gold from the crushed ore by chemical leaching, followed by purifying to Dore bars (60-90% pure gold) using heat. 4 Refining: the final purification step to 24 carat gold.

Recycling: The process of recovering gold via re-refining. Approximately 25-30% of demand is met by recycled gold, primarily from the jewellery industry.

Renewable energy (or renewables): Energy that is collected from renewable resources that are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat.

United Nations Sustainable Development Goals: The UN Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

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