**CLIMATE & CARBON LAW –**

**ENVIRONMENTAL PROTECTION & CARBON FREE FUTURE PROF G WALKER**

 [39,615]

**1. CLIMATE CYCLES & PROCESSES**

**(1) Solar Cycles & Brightness (7) Igneous Provinces**

**(2) Orbital Eccentricity (8) Volcanic Sulphur**

**(3) Axial Procession (9) Asteroid Impacts**

**(4) Angular Obliquity (10) Biological Processes**

**(5) Climatic Fluctuations (11) Anthropogenic**

**(6) Tectonic Movements (12) Unallocated Cause**

**2. CLIMATE CAUSE, IMPACT AND EFFECT**

**(1) Plant Photosynthesis (7) Oceanic (‘Blue Carbon’)**

**(2) Soil Absorption (8) Coastal Ecosystems**

**(3) Savanna Grasslands (9) Direct Carbon Capture**

**(4) Peat Methanogenisis (10) Weathering**

**(5) Tropical Rainforests (11) Geoengineering**

**(6) Boreal Forests (12) Solar Management**

**(1) Heat Waves & Droughts (7) Biospheric Damage**

**(2) Monsoons (8) Loss Animal Diversity**

**(3) Hurricanes & Typhoons (9) Econ Risk, Loss & Damage**

**(4) Glacial Melt (10) Human Health Weakness**

**(5) Rising Global Sea Levels (11) Displacement & Migration**

**(6) Ocean Acidification (12) Collapse Social Order & Society**

**3. CLIMATE RESPONSIBILITY & COUNTRY CONTRIBUTION**

**(1) China 16.4% (1) US 28.8% (1) Qatar**

**(2) US 15.7% (2) China 9% (2) US**

**(3) Brazil 6.5% (3) Russia 8% (3) Australia**

**(4) Indonesia 4.6% (4) Germany 6.9% (4) Russia**

**(5) Russia 4.6% (5) UK 7.8% (5) Germany**

**(6) India 4.2% (6) Japan 3.8% (6) UK**

**Sequencing or Irrelevance Arguments - New Information, Knowledge & Responsibility**

**(1) Only Historical Accident (7) Full Scientific Confirmation Damage**

**(2) No Timely Study or Quant (8) Responsibility Act on Proper Info**

**(3) No Timely Knowledge (9) Responsibility to Protect People**

**(4) No Timely Intent/Liability (10) No Justification Injure Own People**

**(5) Indirect Benefit Growth (11) No Justification Injure Other People**

**(6) Natural Damage Offset (12) No Justification Threat to Humanity**

**4. CLIMATE STUDY & OPINION [SCIENTIFIC OPINION]**

**(1) Cook 97% Scientific Opin (1) Stefan Rahmstorf 2004**

**(2) Ritchie 80-90 (2016) (2) Chris & Mark Hoofnagle 2009]**

**(3) Oreskes 75% (2004) (3) Nils Alex Morner Sea Levels**

**(4) William Happer, Ian Plimer (4) Brendan Demelle 10 Deniers**

**(5) IPCC (2018) 1.5C 2030/50 (5) J Inhofe, M Morano, C Horner,**

 **(6) B Lomborg M Ebell, S Milloy, P Michaels**

 **(6) M Ridley, C Mockton, F Singer, R Spencer & Mikaela Loach**

**5. CLIMATE ADVANTAGE**

 **(1) Employment [1.5 m by 2020] (7) Energy Security**

**(2) Innovation (8) Digital & Cyber Security**

**(3) Competiveness (9) Improved Infrastructure**

**(4) Efficiency (10) Economic Stability**

**(5) Investment & Reinvestment (11) Financial Market Stability**

**(6) Growth (12) Social Stability**

**6. CLIMATE RECOMMEDNATIONS**

 **(1) Earth Day (1970) (7) UN, *Climate Change & Poverty* (June 2019)**

**(2) Climate Justice (2000) & Bali (2011) (8) Earth for All (2020)**

**(3) Al Gore & Bill Gates, *Green Manifesto* (2021) (9) IRENA *World Energy Transitions* (2021)**

**(4) UK Stern *Climate Change* (Oct 2006) (10) ‘Our Planet, Our Future’ (2021)**

**(5) Mark Carney *Tragedy of Horizon* (2015) (11) UK Green Revolution (2020) &**

**(6) Climate Activism & Greta Thunberg CCC Progress Report (2021)**

 **School Strike August 2018 & Xiye Bastida (12) World Wild Fund (2021)**

**7. CLIMATE AGREEMENTS**

**(1) Air Pollution Convention 1979 (7) Warsaw Loss & Damage 2013**

**(2) Vienna Convention Ozone 1985 (8) Paris Agreement 2015**

**(3) Montreal Protocol CFCs 1987 (9) Kigali Accord HFC 2018**

**(4) IPCC (WMO & UNEP) 1988 (10) NATO Climate 2021**

**(5) UNFCCC New York 1992 (11) G7 Finance &Cornwall Summit 2021**

**(6) Kyoto Protocol 1997/2005 (12) Glasgow COP26 2021**

**8. CLIMATE SOLUTIONS**

**(1) Decarbonisation (1) Carbon Control - Project Drawdown (2016)**

**(2) Carbon Sequestration (2) IEA, *Energy* *Technology Perspectives* (2020)**

**(3) Bio En, Car Cap (BECCS) (3) IEA, *Net Zero by 2050 Roadmap* (May 2021)**

**(4) Carbon Markets & Pricing (4) Alternative Energy Sources (AES)**

**(5) Carbon Risk Modelling (5) Government, Fiscal & Taxation Policy**

**(6) Natural Carbon Recycling (6) Households & Individuals**

**(7) Reforestation (7) Markets & Investments**

**(8) Rewilding (8) Financial Stability, Regulatory & Monetary Policy**

**(9) Agriculture Conservation**

**(10) Biochar**

**(11) Blue Carbon**

**(12) Wetlands**

**9. ALTERNATIVE POWER ENERGY SOURCES (APES)**

 **ACCESS (Alternative Carbon Controlled Energy Source & Storage)**

 **RESPONSE (Renewable Energy Source & Production & Organised Network Storage Economy**

**or Environment)**

 **(1) Solar (APV, Roads, Buildings (Glass & Bricks), Space & Thermal)**

 **(2) Air (Land & Floating Turbines & Air Storage Heat Pumps (ASHP))**

 **(3) Marine (Tidal, Wave & Hydroelectric)**

 **(4) Geothermal**

 **(5) Bioenergy (Wood, Waste, Landfill & Biofuels (Biomethane & Biodiesel))**

 **(6) Mechanical & Kinetic (Car (Break systems), Trains & Batteries (Sand))**

 **(7) Nuclear (Fission, Fusion & Cold Fusion)**

 **(8) Hydrogen Economy**

 **(9) Large Energy Storage (LES)**

 **(10) Large Energy Transmission (LET)**

 **(11) Supergrids**

 **(12) SMART Global Energy Market (GEM)**

**10. CLIMATE FINANCE & REGULATION**

**Financial and Regulatory Core (1) Carbon Risk Disclosure**

**(1) Financial Stability Board (FSB) (2) Carbon Risk Modelling**

**(2) Basel Committee Bank Supervision (3) Carbon Risk Pricing**

**(3) Bank for International Settlements (4) Carbon Credit Assess**

**(4) Bank of England, FCA & PRA (9) Capital Reallocation**

**(5) OECD ‘Cquant’ (10) Full Product Pricing**

**(6) EU (11) Catastrophe &**

 **(5) Carbon Business Modelling Continuity Planning**

 **(6) Carbon Share Pricing (12) Financial & Social**

**(7) Carbon Investment Planning Stability Planning**

 **(8)Carbon Portoflio Management**

**11. CLIMATE & ENVIRONMENTAL LAW**

**(1) State Liability**

 **(2) Environment and Human Rights**

**(3) Environmental Principles**

**(4) Pollution**

**(5) Climate Change**

**(1) Sovereignty (7) Protect Common Agreed Values**

**(2) Exclusivity (8) Protect Global Open Relations**

**(3) Self-Determination (9) Protect Global Health & Security**

**(4) Equality (10) Protect Common Survival Species**

**(5) Non-aggression (11) Comply IPLaw**

**(6) Non-intervention (12) Comply PILaw**

**12. CLIMATE CONCLUSIONS AND COMMENT**

**‘CLIMATE 100 PROGRAMME’ (CLIP) Commitment & Delivery**

**Construct Complete & Integrated Carbon Agenda Regime (CAR)**

 **(1) Climate Cycles, Causation & Contribution**

 **(2) Climate Conflict, Causation & Compromise**

**(3) 12 ‘Rs’ Climate Adaptive Recommendations [CARS][CRECOs][CRISPS]**

**(4) 12 ‘Cs’ Climate High Integrated Policies & Principles [CHIPS]**

**(5) 12 ‘Financials’ Financial & Market Response [CFINs]**

**(6) 12 ‘Carbons’ Complete Decarbonisation [CARBONs]**

**(7) 12 ‘Ethics’ Climate Ethics [CimETHICs]**

**(8) 12 ‘Obligations’ Climate PILL [CliPILLs]**

**(9) 12 ‘Enviros’ & ‘Bios’ Environmental & Biospheric Protections [ENVIROs]**

**(10) 12 ‘EXOS’ & ‘GLOBALS’ Exogenous & Global Challenges [EXOs][GLOBALs]**

 **(11) Public and Private Commitment [‘Invisible Climate Correction’]**

 **(12) Social and Cultural Delivery**

 CLIMATE CLOSE

**(1) Climate Contribution**

**(2) Climate Correction**

**(3) Climate Coordination**

**(4) Climate Cooperation**

**(5) Climate Law**

**(6) Climate Future**

**CLIMATE & CARBON LAW –**

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*Humankind faces enormous challenge and threat with possible imminent Climate and carbon chaos and Climate and carbon crisis. This creates substantial danger but also enormous opportunity to rebuild and recreate a new world. Opinion continues to differ on specific causal positions and the extent to which climate damage is human and anthropogenic created or natural although global temperatures continue to rise and extreme events occur and recur. Climate change is a fact irrespective of causal explanation with humakind being a significant and inevitable aggravating factor in complex natural climate cycles and processes. The most significant danger that arises is then from the limits of recognition, acceptance, control and possible irreversibility and irredeemable adverse effect. The planet may imminently pass a point of no return. This raises difficult political and ethical issues of current and future inter-country, inter-cultural and inter-generational responsibility. The planet will survive although it is less clear whether Humankind will. Our species has arrived at a potentially terminal inflection point. We can continue with economic legacy models based on cold profit and destructive and exhaustive natural resource consumption and exhaustion or switch to responsible and sustainable new systems of balanced biospheric and ecosystem management. Solutions are available. It is simply whether we are prepared to assume the necessary shared costs and burden of transitioning to a new system of informed, progressive, responsible and inclusive sustainable global social and market capitalism. The global community has arrived at a common point with a shared and common problem to manage. We have one decision to take. We have one opportunity. We have one choice.*

A series of significant socio-environmental challenges have arisen with global temperature increases and global warming only forming one part of this. These include climate change and climate damage with water pollution and water security, food security, energy security, human health, loss of biodiversity and other natural or anthropogenic disaster risk management effects.[[1]](#footnote-1) A number of core biospheres have to be protected including land and grasslands, forests, jungle and boreal habitations, deserts and tundra as well as freshwater rivers and seawater oceans and the atmosphere. This will require work and commitment in a number different policy areas. These can be summarised for the purposes of this paper as including a necessary Climate or Carbon Action Policy (CAP) with a Carbon Reclamation, Elimination, Adaptation and Transition Economy (CREATE), Circular and Recycle Economy (CARE),[[2]](#footnote-2) Bio Economy System Technology (BEST) systems,[[3]](#footnote-3) biodiversity Species Protection and Inclusion Network (SPIN), City and Urban Regeneration Environment (CURE) and Sustainable Alternative Future Energy (SAFE) policies. All of this will require a combination of manmade or anthropogenic based solutions (ABSs) and nature based solutions (NaBSs). These, in turn, may only form part of a wider range of endogenous, exogenous and existential threats that may arise to mankind.[[4]](#footnote-4) This then creates a form of ‘Environmental Commons’ or ‘Environmental Tragedy’ and ‘Climate Commons’ or ‘Climate Tragedy’ after earlier land use commons abuse.[[5]](#footnote-5) All 7.8 billion people on earth have a common and collective responsibility to assist manage these exposures through individual and collegiate behavioural change.

Global warming is concerned with the rise in temperature in the climate system from pre-industrial levels to the present date. This has recorded a 1°C rise with 0.9°C of this being after 1970.[[6]](#footnote-6) The earth has warmed 1.2C since pre-industrial times.[[7]](#footnote-7) The IPCC’s Fifth Report projected that temperatures may exceed 1.5°C and possibly 2°C for most Representative Concentration Pathways (RCPs).[[8]](#footnote-8) RCP 2.6 may result in warming of 1.8°C by 2100. Temperatures may exceed 4.3°C and possibly 5.4°C under RCP 8.5.[[9]](#footnote-9) Different scenario model results were available with many projecting an increase above 1.5%.[[10]](#footnote-10) Projections were strengthened again under AR6 Working Group 1 Report in August 2021 which developed five Share Socio-economic Pathways (SSPs) with an estimated potential climate change between 1.5C and over 4C by 2100.[[11]](#footnote-11)

The earth’s atmosphere consists of a gaseous layer of around 10,000 kilometres (6,214 miles) above the earth’s surface.[[12]](#footnote-12) The atmosphere varies by air composition, temperature and pressure. The atmosphere consists of five layers with the troposphere (0-12km or 0‑7 miles), stratosphere (12-50km or 7-31 miles), mesosphere (50-80km or 31-50 miles), thermosphere (80-700km or 50-440 miles) and exosphere (700-10,000km or 440-6,200 miles). The ozone layer forms part of the stratosphere with ozone or trioxygen (O3) being an inorganic chemical molecule. The ozone layer is the lower part of the stratosphere (15-35km or 9-22 miles).

The earth operates with a climate balance or cycle with naturally created atmospheric gases creating a greenhouse effect. This creates a warm air pocket around the earth. Heat from the sun is absorbed and released from the earth’s surface as a form of thermal radiation which is retained in a gas pocket. The gases principally consist of carbon dioxide (CO2), ozone (O3), nitrous oxide (N2O) and methane (CH4) as well as water vapour (H2O). This prevents the surface of the earth being too hot and too cold. Without these gases, the planet would otherwise be around 33 degrees Celsius colder which would create freezing conditions.[[13]](#footnote-13) This creates a natural greenhouse effect even with these gases only consisting of around 0.04% and water vapour 0.25% of the earth’s atmosphere with the rest made up of around 21% oxygen and 78% nitrogen with 0.9% argon. Other gases including neon, helium and crypton only make up around 0.1%.[[14]](#footnote-14) Breathing by humans and animals as well as light conversion photosynthesis is only possible within the troposphere and the gas temperature balance created.

Increased global warming has arisen as a result of a combination of a depletion in the strength of the ozone layer, which increases ultraviolet absorption from the sun, and the consequent heat retention effects with the accumulation of harmful atmospheric gases including anthropogenic emissions. The ozone layer absorbs 97-99% of medium frequency ultraviolet light from the sun which would otherwise create unbearable heat conditions on the earth’s surface.[[15]](#footnote-15) The earlier use of chlorofluorocarbons (CF3) and hydrochlorofluorocarbons (HCFC),[[16]](#footnote-16) commonly used in refrigerants (propellants), (including aerosols), and solvents was brought under international control. This was referred to as creating a ‘hole in the ozone’ or ozone hole with a depletion in ozone levels.[[17]](#footnote-17) Reduced sunlight levels between 1961 and 1990 was referred to as ‘global dimming’. This led to international bans on fluorocarbons from 1978 and with 16 September being declared ‘Ozone Day’ (‘International Day for Preservation of the Ozone Layer’).

Greenhouse gases prevent the emission of reflected sunrays from the earth’s surface which increase temperature levels.[[18]](#footnote-18) The combined effect of increased absorption with decreased release of infrared radiation interferes with natural climate systems and cycles and raises global temperature levels. Temperature levels have increased substantially since the industrial revolution through anthropogenic effects. The global mean temperature for 2020 was calculated to be around 1.2°C (2.2°F) above pre-industrial times.[[19]](#footnote-19) The subsequent repair in the Ozone layer under the 1987 Montreal Treaty has nevertheless prevented temperatures from rising by up to a further 2.5C.[[20]](#footnote-20)

The Intergovernmental Panel on Climate Change (IPCC) has warned about damaging impacts as temperatures rise to 1.5°C (2.7°F).[[21]](#footnote-21) Governments undertook to keep temperatures ‘well under’ 2.0°C (3.6°F) in 2015 under the Paris Agreement adopted within the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. It was still estimated that temperatures may reach 2.8°C (5.0°F) by the end of the century with emissions having to be halved by 2030 and almost zero emissions by 2050.[[22]](#footnote-22)

A number of important sets of recommendations have been made and initiatives have been announced although it remains to be seen whether sufficient commitment and delivery can be secured. The US Biden Administration convened a Leader’s Climate Summit on 22-23 April 2021 with the US committing to reduce GHG emissions by 50-52% relative to 2005 by 2030 with other countries announcing similar reductions.[[23]](#footnote-23) UK prime minister Johnson committed the UK to a 78% reduction by 2035 with the EU agreeing to 55% by 2030.[[24]](#footnote-24) China would ‘phase down’ coal consumption over five years from 2025 with a 65% reduction by 2030 and while it would strengthen its NDC target and peak emissions by 2030 it would not be carbon neutral until 2060. [[25]](#footnote-25)The US approach to moving toward net zero was nevertheless still based on the adoption of new technologies rather than underlying social and behavioural change.[[26]](#footnote-26) Many other proposals are unfunded or uncommitted.

The purpose of this paper is to examine the arguments and circumstances behind the climate change and global warming debate. The nature of climate cycles and processes is examined and climate damage cause and loss considered. Correlative country contribution and responsibility is reviewed. Climate studies are considered with recommendations and possible solutions outlined. The potential benefits of climate investment and the creation of net zero carbo neutral economies are highlighted. The content of the principal international climate agreements adopted to date are reviewed and climate and environmental laws examined in further detail. The relevance of possible monetary and financial market solutions are considered the separately. A series of comments and recommendations on climate and environmental control are developed with specific reference to cycles, conflicts, objectives, guidelines, principles, tools, obligations, ethics and wider environmental and global responses and public and private commitment and social and cultural delivery. Some further final closing comments are made.

**1. CLIMATE CYCLES AND PROCESSES**

The climate has always operated through a series of natural interrelated processes and cycles. The earth has effectively been a ‘snowball’ and a ‘hothouse’ during different historical periods.[[27]](#footnote-27) Climate change is examined under paleoclimatology which examines climate change during different geological periods. A number of ice ages and warmer interglacial periods have occurred over the last 800 years. It is specifically understood that the earth will enter a further ice age within the following 1500 years without the effects of global warming.[[28]](#footnote-28)

CO2 levels have remained between 180-300 parts per million for around half a million years and then rose to 380ppm more recently. Carbon sinks store CO2 naturally principally through soil storage, plant photosynthesis and oceanic absorption through physiochemical and dissolved inorganic carbon (DIC) transfer. Plants and forests can act as carbon stores principally through photosynthesis. Oceans can act as solubility pumps with CO2 and other gases being water soluble with thermohaline circulation (THC) or ocean conveyor belt.[[29]](#footnote-29)

Climate changes are impacted by a number of natural events over time. These include solar cycles,[[30]](#footnote-30) volcanic sulpha, orbital wobbles,[[31]](#footnote-31) faintness of young sun, climate fluctuations,[[32]](#footnote-32) tectonic plate movements, large igneous provinces,[[33]](#footnote-33) possible asteroid impacts and other evolutionary events as well as heightened CO2 levels including anthropogenic CO2 increases.[[34]](#footnote-34)

[A significant element of climate change may be caused by planetary effects. These include through ‘Milankovitch Cycles’ tied to orbital circular and elliptical eccentricity,[[35]](#footnote-35) global precession (wobbles),[[36]](#footnote-36) and obliquity.[[37]](#footnote-37) The earth also experiences natural periods of higher temperature (hyperthermal events or fevers). This included the Paleocene-Eocene Therma Maximum (PETM) around 56 million years ago.[[38]](#footnote-38)

Natural climate causes include solar cycles (0.1-0.3°C every 30-160 years),[[39]](#footnote-39) volcanic sulfur (0.6-2°C cooling over 1-20 years), short-term climate fluctuations (0.1°C 2-7 years),[[40]](#footnote-40) Milankovitch Cycles (6°C),[[41]](#footnote-41) changes in eccentricity (100,000 year cycles), the earth’s orbit moves from a perfect circle (0.0034) to an elliptical (0.058) pattern.[[42]](#footnote-42) Axiel precession (26,000 years),[[43]](#footnote-43) changes in obliquity (41,000 year cycles),[[44]](#footnote-44) diminution of sun’s brightness (faint young sun),[[45]](#footnote-45) CO2 thermostat weathering (100,000 years),[[46]](#footnote-46) plate tectonics (30°C over 500 million years),[[47]](#footnote-47) asteroid impacts (20°C cooling with 5°C warming),[[48]](#footnote-48) biological changes (5°C over millions of years),[[49]](#footnote-49) lava and magma flows (3-9°C), large igneous provinces arise with major lava and underground magma flows which create methane and CO2 with acid rain, acid fog, mercury poisoning and ozone destruction and resulting in subsequent extinction events.[[50]](#footnote-50) ]

Natural carbon sinks principally consist of plants (photosynthesis), soil and oceans and include grasslands, agricultural lands, boreal (high altitude) forest, tropical rain forest, peat bogs, fresh water lakes and wetlands, costal ecosystems (including seagrass beds, kelp forests, salt marshes and swamps) and coral reefs.[[51]](#footnote-51) Natural processes are referred to as bio sequestration, generally excluded ocean sequestration (acidification) and geological (rock) sequestration. Oceanic sequestration is referred to as creating blue carbon. Natural carbon sinks can be protected or improved through new forestation (afforestation), reforestation, forest conservation, soil conservation, prairie restoration, open space protection (including grasslands and meadows), seagrass restoration, wetlands restoration and coral reef restoration.[[52]](#footnote-52) Artificial or synthetic carbon sinks use carbon capture or sequestration and storage. Carbon capture sequestration or storage (CCS) collects and holds carbon deposits. Difficulties nevertheless arise with leakage with carbon capture and utilisation (CCU) recycling or reapplying the carbon collected. Carbon capture includes pre-combustion capture and post-combustion capture.[[53]](#footnote-53)

Negative emissions technologies (NETs) or carbon dioxide removal (CDR) attempt to remove CO2s from the atmosphere including direct air capture (DAC) or direct air carbon capture and storage (DACCS) although this is generally less efficient and more costly.[[54]](#footnote-54) DAC generally either uses liquid chemical (hydroxide) solutions or solid capture (sorbent filter) capture.[[55]](#footnote-55) Other options include bioenergy with carbon capture and storage (BECCS). DAC could remove up to 10 Mt CO2 per year by 2030.[[56]](#footnote-56) Capture costs may nevertheless fall over time.[[57]](#footnote-57)

Countries have to develop low carbon economy (LCE) structures with energy based on electricity generated by non-fossil fuel sources such as wood burning, coal, natural gas and oil. Carbon is the sixth chemical element[[58]](#footnote-58) and the fourth most abundant element after hydrogen, helium and oxygen. The construction of LCEs includes developing low-emission development strategies (LEDS) to move towards adoption of carbon neutrality or (with carbon emission or offset) the construction of zero carbon economies (ZCEs). This would create a post-carbon economy with an inverse relationship between carbon emission and GDP growth.[[59]](#footnote-59) Climate neutrality includes principally CO2 as well as other greenhouse gases based on their carbon dioxide equivalents (CO2e or CO2eq).[[60]](#footnote-60)

[Average global temperature for 2016-2020 was 1.1°C above 1850-1900 levels.[[61]](#footnote-61) Global fossil CO2 emissions had increased by 62% between 1990 and 2019. The number of people facing flood risk would rise from 1.2 billion to 1.6 billion by 2050.[[62]](#footnote-62)

Current CO2 emissions were tempted to produce an increase of between 3-5°C by 2100.[[63]](#footnote-63) 2015‑2019 were the five warmest years on record with 2010-2019 the warmest decade. 2019 was the second highest year after 2016 due to El Nimo effects.[[64]](#footnote-64) Securing a 1.5°C increase would require global CO2 emissions to be reduced by 45% of 2010 levels by 2030 and net zero by 2050.[[65]](#footnote-65) Global greenhouse gas emissions would have to fall by 7.6% per year to secure the 1.5°C target.[[66]](#footnote-66) 2018 levels of greenhouse gases reached 407.8 parts per million in 2018.[[67]](#footnote-67)]

**2. CLIMATE CAUSE IMPACT AND EFFECT**

The difference in the radiation that the earth receives from the sun and re-radiates back is referred to as the earth’s energy budget. Global temperature levels have risen between 3-8°C over the last 10,000 years with the most significant rises during the last 200 years. Human generated or anthropogenic emissions are referred to as ‘manmade gases’ or ‘greenhouse gases’ (GHGs). Climate damage can result in global warming, air pollution, water pollution and land pollution.

Humans are estimated to have produced around 35 gigatonnes (39 billion tonnes) of CO2 each year over the last ten years with 28% being absorbed by soil and vegetation and 22% by the oceans. This leaves a 44% deficit which has unbalanced the natural carbon cycle.[[68]](#footnote-68) Manmade CO2 production in 2014 arises from energy generation (around 85%), land use (10%) and cement production (5%) as well as deforestation.[[69]](#footnote-69)

Arctic ice coverage has decreased by 43% between 1979-2016 with a total loss in volume of 77% as the ice sheet becomes thinner.[[70]](#footnote-70) The two largest ice sheets are Antarctica and Greenland. Snow land coverage has decreased by 216 square kilometres per year since 1966. Oceans comprise 70% of the surface of the earth. Sea levels have risen 0.8mm per year between 2002-2016. Sea levels were rise by 58 metres if the Antarctica ice sheet melted.[[71]](#footnote-71) The oceans absorbed 93% of atmospheric energy between 1971-2010 with sea temperatures rising 0.8°C between 1880-2015. The oceans absorbed 22% of anthropogenic CO2 which makes them warmer and more acidic. Higher ocean temperatures can create tropical cyclones where temperature levels rise above 26°C.[[72]](#footnote-72) Ninety three percent of reefs in the Great Barrier Reef in Australia were damaged by coral bleaching in 2016 with over 50% of shallow water reefs in the Pacific area being destroyed between February and October 2016.[[73]](#footnote-73)

Global warming increases the earth’s surface temperature and disrupts the water cycle. High summer temperatures on the land surface increased from 1 to 10% between 1951-1980 and 2001-2010. Average duration of wild fire seasons increased by 19% between 1979-2013.[[74]](#footnote-74) Higher temperatures create higher evaporation rates which can lead to surface level droughts and higher consequent precipitation which can cause floods. Eighteen percent of heavy global rainfall is attributed to global warming.[[75]](#footnote-75) Weather events resulted in the migration of 21.7 million people between 2008-2016 which was three times higher than refugees arising through war and violence.[[76]](#footnote-76) This can also result in cross-border as well as national migration. Heat also increases the risk of pathogenic disease transmission, in particular, through carriers or vectors such as mosquitoes. Tiger mosquitoes (*aedes albopictus*) spread from Asia into Southern Europe in recent decades.[[77]](#footnote-77)

Climate and carbon damage can result in significant damage and loss. These include the following:

(1) Global temperature increases;

 (2) Air pollution, water pollution and land pollution;

(3) Consequential human health damage;

 (4) Biodiversity decline;[[78]](#footnote-78)

 (5) Land use damage;[[79]](#footnote-79)

(6) Damage to agriculture and food production;[[80]](#footnote-80)

(8) Resource depletion and exhaustion;

(9) Higher oceanic acidity and coral reef damage;

(10) Increased extreme weather events;

 (11) Increased tectonic disturbances;

(12) Planetary impacts (including for example ocean sways and wobbling).

The IPCC prepared a Special Report on *Global Warming of 1.5°C* in 2018[[81]](#footnote-81) following an invitation by COP21 in 2016.[[82]](#footnote-82) Anthropogenic effects are considered to have increased global warming 1.0°C above pre-industrial levels (within a range of 0.8°C to 1.2°C) and likely to reach 1.5°C by 2030-2052.[[83]](#footnote-83) This is expected to continue although emissions are unlikely to produce global warming of 1.5°C from existing factors.[[84]](#footnote-84) Future climate related risks depend on rate, peak and duration of warming and on adaptation and mitigation options with global warming between 1.5°C - 2°C.[[85]](#footnote-85) Climate models project increases in land and ocean temperatures, hot extremes in most inhabited regions, heavy precipitation in several regions and drought and precipitation deficits in some regions.[[86]](#footnote-86) Detrimental impacts are generally lower where increases are limited to 1.5°C rather than 2°C.

89% of CO2 emissions arise from fossil fuel consumption and 68% from greenhouse gas emissions.[[87]](#footnote-87) The OECD has been modelling the cost, benefits and trade-offs of climate change mitigation since the end of the 1980s.[[88]](#footnote-88) Under a business-as-usual (BAU) baseline CO2 and greenhouse gas emissions would increase to around 525 parts per million (ppm) and 650 ppm in 2050 with a doubling from the 1970s to 2008 and a doubling again to 2050. Global temperatures would increase by around 2°C from pre-industrial times by 2050 and increase to 4-6°C by 2100.[[89]](#footnote-89)

 Climate mitigation policies may include carbon taxes, emissions trading (cap-and-trade) schemes (ETS), standards and technology supported policies (R&D and clean technology deployment) with a combination solution proposed.[[90]](#footnote-90) Market imperfections nevertheless remain especially with monitoring, enforcement and asymmetric information difficulties preventing emitters from responding to price signals with additional technical standards and information instruments being required and an overall effective policy balance secured.[[91]](#footnote-91) Carbon leakage, with all countries not adopting effective mitigation policies, may require countervailing tariffs (or border tax adjustments) on imports.[[92]](#footnote-92)

Effective Reducing Emissions from Deforestation and forest Degradation (REDD) policies have also to be incorporated within any meaningful global policy framework although separate implementation difficulties arise which may require separate funding or, for example, establishment of a separate REDD market with other carbon markets.[[93]](#footnote-93) An effective carbon market may be developed through the removal of environmentally harmful energy subsidies, linking and harmonising separate carbon markets, providing credit facilities for non-scheme members (such as through the Clean Development Mechanism (CDM) under the Kyoto Protocol), use of separate sectoral policies and carbon market regulation.[[94]](#footnote-94)

**3. CLIMATE RESPONSIBLITY AND COUNTRY CONTRIBUTION AND COMMITMENT**

In terms of climate responsibility, while China is the largest producer of CO2, the EU and US were responsible for more emissions between 1918 and 2012 than China.[[95]](#footnote-95) [The UK’s emissions are also high if these are calculated from the beginning of the industrial revolution in the 1700s.][[96]](#footnote-96)

A Climate Analytics 2015 report outlined the largest contributions to GHG emission creation between 1850 and 2012 with global temperature increases projected to 2100.[[97]](#footnote-97) The largest contributors consisted of US (20.2%), EU (17.3%), China (12.1%), Russia (6.2%), India (5.3%), and with Germany (3.9%) and UK (3.4%). Other studies have measured CO2 emissions[[98]](#footnote-98) and all GHA emissions.[[99]](#footnote-99) Separate figures are available for emissions per person.[[100]](#footnote-100)

In terms of historical emissions, the US, China, Russia, Germany and the UK are the largest emitters[[101]](#footnote-101) although Luxemburg, the UK, US, Belgium, Czech Republic and Germany are the largest on a per capita basis.[[102]](#footnote-102) Slightly different results emerge again if overshooting and undershooting of CO2 boundary fair share allocations are considered. The main over shooters (climate debtors) are the US, Russia, Japan, Germany, France and the UK[[103]](#footnote-103) with under shooters (climate creditors) China, India, Indonesia, Bangladesh and Nigeria.[[104]](#footnote-104) All high polluting countries must clearly attempt to reduce their emission rates. Difficult political issues arise in determining whether high polluting emerging economies are entitled to continue to damage the planet disproportionately on the basis of higher earlier historical developed country usage before the nature and importance of the issues involved were understood and measured.

[The IPCC recommended that carbon emissions had to be reduced by 41-58% by 2030 compared with 2010 levels to secure the 1.5°C global temperature increase target. Two thirds of global emissions were created by China, the USA, India, the EU27 and the UK. Emissions had increased around 15% between 2010 and 2021. China was responsible for around twice the emissions of the US. While coal-fired energy production had declined by around 11 GW in 2020, China had increased its capacity by 38 GW. China has also increased its wind and solar capability by 72 GW and 49 GW which was larger than any other country.[[105]](#footnote-105) The world would not be able to secure its IPCC objectives if China did not reduce emissions by 2030. China’s CO2 emissions were 11.5 GT CO2 in 2019 with three fifths of energy supply being generated by coal producing around 2201 GW. China intended to double its economy and GDP by 2035 under its 14th Five Year Plan. ]

 (1) US

The US had generated more carbon emissions than any other country. The Biden Administration undertook to provide $5.7 billion per year to assist developing countries manage climate change. The US’s climate debt could be partly offset through climate migration policies to allow climate migrants to live in the US.[[106]](#footnote-106)

The costs of energy wind production had fallen by 70% and solar by 90% over ten years. There was also a plentiful supply of cheap gas which had already assisted decarbonisation efforts. Regulatory changes could promote renewable energy production.

(2) China

China confirmed in its 14th Five Year Plan that it would increase investment in renewable energies but with low emission targets. The US and EU attempted to move China towards accepting peak emissions by 2025 rather than 2030 and to end coal power investment.[[107]](#footnote-107) China separately rejected the EU proposal for a carbon border tax.[[108]](#footnote-108) The US and EU may fail to adopt a coordinated approach in dealing with China and with no effective common sanction.[[109]](#footnote-109)

(3) EU

The European Commission has a comprehensive Environment programme.[[110]](#footnote-110) This covers a number of policy areas.[[111]](#footnote-111) Nature based solutions support more sustainable and resilient societies.[[112]](#footnote-112) Nature based solutions generally consist of ecosystem restoration, adaptation and mitigation, management and protection as well as other infrastructure related projects.[[113]](#footnote-113) A separate typology of Nature-based solutions has been developed.[[114]](#footnote-114) The European Parliament Environment Committee approved the EU Climate Change law on 10 May 2021 which committed the EU to reducing greenhouse gas emissions by, at least, 55% by 2030 from 1990 levels and to eliminate

The EU ETS operates as the largest multi country, multi sector GHG emissions trading system in the world with more than 11,000 power station and industrial plant contributors which was set up in 2005. This is a mandatory cap-and-trade scheme which establishes a ceiling on emissions which will be reduced over time. Companies are awarded EU allowances (EUAs) or can purchase them through public options with allowances being traded on the carbon market. Companies are fined if their allowances do not cover their annual emissions.

Conflicting climate policies and philosophies had arisen with the US attempting to rely on innovation and private market solutions with the EU focusing on regulation and carbon pricing. The EU had established an Emissions Trading System (EU ETS) in 2005 as part of its energy and climate management policy.[[115]](#footnote-115) This covers around 40% of EU greenhouse gas emissions and was intended to secure the 55% reduction by 2030 and climate neutrality within the EU by 2050.[[116]](#footnote-116) This operates on a ‘cap and trade’ principal basis with installations being able to buy or receive allowances. Carbon prices had reached €40 per tonne by 2021. With the EU also proposing a cross-border tax through a Carbon Border Adjustment Mechanism (CBAM) with separate revisions to the Energy Tax Directive (ETD).[[117]](#footnote-117) The US has in contrast resisted carbon pricing and carbon taxation as well as the new EU proposal for cross-border carbon adjustments.[[118]](#footnote-118) It was accepted that the US lacked a comprehensive approach to climate legislation.[[119]](#footnote-119)

(4) UK

*UK government produced a paper on Green Revolution in 2020 with a Climate Change Committee (CCC) issuing a series of climate related progress reports. The CCC in the UK issued a third Climate Change Risk Assessment (CCRA3) in June 2021.[[120]](#footnote-120)*

*Global climate cooperation would be considered again at the COP26 in Glasgow in November 2021.[[121]](#footnote-121) The US and UK confirmed their resolution to work together to reduce emissions and rally all countries to strengthen their climate ambition.[[122]](#footnote-122) Net zero greenhouse gas emission would be reached by 2050 and temperature limits kept to 1.5°C. Finance and investment would support mitigation and adaptation policies to assist the most vulnerable adapt and respond to climate impacts. Work would also continue on finalising the Paris Rulebook and advancing other negotiation issues. The 26 United Nations Climate Change Conference (COP26) would be held in Glasgow between 1-12 November 2021.[[123]](#footnote-123)*

(5) Developed and Emerging Markets

Opinions differ as to how climate costs should be allocated. Emerging economies argue that a lead has to be assumed by more developed economies especially as they have historically contributed more to climate damage. Emerging economies argue for appropriate sequencing to allow them to move to low carbon technologies over a longer period of time. Other allocation principles may be considered. These may include, for example, proportionality (‘polluter pays’), basic need or Egalitarianism.[[124]](#footnote-124)

**4. CLIMATE STUDY AND SCIENTIFIC OPINION**

Climate generates strong emotive responses. CO2 only consisted of 0.04% of atmospheric content with 21% oxygen and 78% nitrogen. 97% of CO2 was produced naturally with only 3% of this being anthropogenic. Surface temperature warming increased slightly between 1910-1945 (around 0.45°C). It was expected that the Earth may enter a further cooling period within the new future rather than with temperature increases through global warming.[[125]](#footnote-125)

Disputes arose with regard to the scientific certainty of anthropogenic climate damage. A report in 2019 confirmed that 100% of scientists had reached agreement on the anthropogenic causes of global warming.[[126]](#footnote-126) Groups of climate change deniers and sceptics,[[127]](#footnote-127) in particular, in the US with international groups including ‘Clexit’ (Climate Exit).[[128]](#footnote-128) While not denying climate change, other commentators have questioned the more extreme or pessimistic positions adopted in reports and recommend that climate directed investments are otherwise targeted to resolving other global issues such as AIDS, malaria and malnutrition.[[129]](#footnote-129) Swedish paleogeophysicist, Nils Axel Mörner (1938-2020) has argued that sea levels have not been rising significantly and not as a result of global warming.[[130]](#footnote-130) Other more sceptical climate commentators include Professor William Happer, Princeton University, and Earth Scientist and Geologist, Ian Plimer.[[131]](#footnote-131)

[A number of commentators have questioned the causes or extent of the crisis.[[132]](#footnote-132) Danish political scientist, Bjorn Lomborg questions the exaggerated claims made in relation to climate change which may lead to unnecessary panic without rational assessment of the most appropriate action.[[133]](#footnote-133) Lomborg developed a Copenhagen Consensus in 2002 with the Environmental Assessment Institute (EAI) to develop priorities to advance global welfare using applied welfare economic theory.[[134]](#footnote-134) Other writers such as the American physicist, William Happer, attributes global warming to natural causes although this is questioned by other writers.[[135]](#footnote-135) Australian geologist, Ian Rutherford Plimer refers to the inevitability of climate change and questions the validity of the IPCC process.[[136]](#footnote-136)]

Other commentators have noted that the official climate estimates are based on only around 31 climate models all of which have been programmed to produce higher results than the actual climate data confirms.[[137]](#footnote-137) Only the Russian model was reported to have produced accurate results which were substantially lower than all of the predicted model outputs.[[138]](#footnote-138) It has been argued that overestimate modelling have been used to overstate the figures for funding and for regulatory purposes. The US Supreme Court, for example, held in 2007 that the Environmental Protection Agency (EPA) had authority to regulate car tailpipe emissions of greenhouse gases where levels may reasonably be anticipated ‘to endanger public health or welfare’ under the Clean Air Act 1963 as amended.[[139]](#footnote-139)

It was reported that 97% of scientists agreed that climate change was anthropogenic. This was principally based on two papers published in 2013[[140]](#footnote-140) and 2016.[[141]](#footnote-141) An earlier 2004 article stated the figure to be around 75%.[[142]](#footnote-142) The 2016 article rejects the results of a separate paper based on non-expert opinions.[[143]](#footnote-143) Many commentators have referred to the 97% figure as confirming that human activity is largely responsible for climate change although this is considered to be incorrect by others.[[144]](#footnote-144)

A separate debate arose with regard to the use of tree ring data and tabling in the IPCC reports. []

Other writers have claimed that some care may have to be exercised in applying the IPCC *Global Warming of 1.5°C 2018* Report.[[145]](#footnote-145) Interpretations have differed as to the significance of the 12 year period from 2018-2030 and 2030 deadline. 2030 was not provided as a final or absolute date with a 22 year range being provided between 2030 and 2052. This also only represented temperature increases arising as a result of anthropogenic effects.[[146]](#footnote-146) The report only states that global warming is likely to reach 1.5°C between 2030 and 2052 if it continues at the current rate.[[147]](#footnote-147) 1.5°C is also selected as a policy target rather than specific scientific requirement. Temperatures may also only reach 1.5°C by 2052 and arguably never arrive at that figure under a best case scenario. This is also not based on actual recorded temperatures but assumed projections with 2030 being the assumed worst case scenario based on anthropogenic causes. The rate of warming would have to be increased by three times current rates to reach 1.5°C by 2030. Any separate argument on irreversibility after a certain date also appears not to be fully made out. The contradictions have been raised by a number of commentators.[[148]](#footnote-148)

Rising global mean temperatures have to be accepted as a point of fact and anthropogenic factors as a material cause if not the only cause. It is therefore appropriate to construct informed and progressive responses and corrective policy programmes but without immediate short term reactionary actions that may cause more longer term damage. Balanced transitional programmes should be set in place to retain emission productions within controlled levels and to limit unmanageable temperature increases. This may allow the development of more efficient and effective responses that can realised the full benefits of the additional potential generated with the move from current destructive and wasteful to more constructive and progressive manufacturing, construction and consumption systems. New more inclusive and responsible capital and economic models can be developed. Markets have already been able to produce wealth at lower cost which process has to continue. More responsible balanced and inclusive forms of wealth production and redistribution have to be developed. An appropriate response must be developed to climate change as well as other environmental demands and wider social and global challenges.

More extreme forms of action would require outright bans on, for example, coal, gas and oil fired power stations. This could have substantial damaging economic effects especially in large economies such as China and India as well as other emerging and developed economies. Other extreme solutions would have to include geoengineering and carbon capture which have not been fully tested. All of this could create substantial economic damage, in particular, in poorer communities and societies. This could reverse poverty reduction and help promotion programmes in many countries. Abrupt forms of economic change could also trigger separate crises and uncertain consequences.[[149]](#footnote-149)

**5. CLIMATE AND CARBON RESPONSE ADVANTAGE AND BENEFIT**

Targeted climate action could result in $26 trillion in additional economic benefit between 2018 and 2030. This could produce 65 million new low carbon jobs, higher global GDP growth, increase female employment and reduce air pollution deaths by 700,000 with $2.8 trillion being raised in carbon price revenues and fossil fuel subsidies which could be reinvested in public utilities and services.[[150]](#footnote-150) The report recommended the adoption of carbon pricing and mandatory disclosure of climate related financial risks. There should be accelerated investment in sustainable infrastructure with clear national and sub-national strategies and programmes. Private sector innovation and advance supply chain transparency should be promoted. A people centred approach should be adopted with benefits being equitably shared and net implementation of a just transition.[[151]](#footnote-151) [The benefits are described essentially non-rivalrous with everyone benefitting at no additional cost.[[152]](#footnote-152)] Air pollution resulted in seven million deaths per year with a total cost of $5.11 trillion in welfare loss.[[153]](#footnote-153)

Investment in climate protection and carbon management can bring substantial benefit and advantage. These include:

(1) Lower aggregate global temperature;

(2) Increased human health condition;

(3) Biodiversity protection;

(4) Improved agricultural use and improved quality and volume of food production;

(5) Drinking water protection and stable water tables;

(6) Cheap, efficient and secure energy supply;

 (7) Improved and cheaper production efficiency;

 (8) Improved building construction;

 (9) Cheaper and more secure transport;

 (10) Increased scientific discovery and engineering innovation;

(11) Improved ocean conditions;

 (12) Stable tectonic, geological and planetary conditions.

The Global Commission on the Economy and Climate (GCEC) had been set up in 2013 by Norway, Sweden and the UK with Columbia, Ethiopia, Indonesia and South Korea. A series of reports were produced with the GCEC developing a New Climate Economy (NCE) project.[[154]](#footnote-154) The New Climate Economy would be strong, sustainable, balanced and inclusive and produce efficient liveable cities, low carbon, smart and resilient infrastructure and restore degraded lands with valuable forests being protected.[[155]](#footnote-155) This would require $90 trillion in infrastructure by 2030 which was more than the value of the current stock. A ‘use it or lose it’ policy was recommended. Countries had to accelerate the transition to a better, more inclusive, new climate economy through targeted improvements in the areas of energy, cities, food and land use, water and industry.[[156]](#footnote-156)

The two to three years to 2021 were critical to develop the necessary policy investment decisions to determine the next ten to fifteen years.[[157]](#footnote-157) Total low carbon growth could secure economic benefits of $26 trillion by 2030 on a conservative estimate basis.[[158]](#footnote-158) The report produces a roadmap for accelerate action to secure better growth and a better climate in reality with four specific recommendations made on carbon pricing and mandatory climate risk disclosure, investment in sustainable infrastructure, private sector and innovation support and the adoption of a people centric approach to ensure lasting, equitable growth and a just transition.[[159]](#footnote-159)

**6. CLIMATE RECOMMENDATIONS**

A number of other sets of recommendations have been made that by various that groups and bodies to attempt to understand and manage climate change. These reflect and private and official opinion and at the national and international levels.

**(1) Earth Day (1970)**

Earth Day is held on 22 April each year to support climate protection measures. Earth Day was launched in 1970 by US Senator Gaylord Nelson, Congressman Pete McCloskey and activist, Denis Hayes.[[160]](#footnote-160) This was originally referred to as the Earth Day Network. Earth Day 2021 was extended to 20-22 April 2021 with the theme ‘Restore Our Earth’[[161]](#footnote-161)

(2) Climate Justice (2000) & Bali Principles (2002)

Climate justice examines climate change from a political and ethical perspective. This was climate change as a rights issue was recognised at COP6 in The Hagen 2000 with the Bali Principles of Climate Justice being adopted at the 2002 Johannesburg Earth Summit.[[162]](#footnote-162) These attempt to restate climate issues in terms of human rights and environmental justice considerations. The principles were developed by a number of interest groups with a Climate Justice coalition and International Climate Justice Network being formed. The Bali Principles are presented in terms of a series of core principles advocated by representatives of peoples’ movements and activist organisations working for social and environmental justice. Twenty seven specific principles are formulated.[[163]](#footnote-163)

**(3) Al Gore (2006) and** Bill Gates (2021)

Former Microsoft CEO, Bill Gates, supported climate control as an advocate for global health and development, including disease and poverty, rather than as an environmentalist.[[164]](#footnote-164) Gates considered climate management in terms of ‘Green premia’ which represented the difference in cost between fossil fuel and carbon neutral activities.[[165]](#footnote-165) Four recommendations are made to mobilise capital to reduce these premia, low carbon product purchases (including using sustainable aviation fuel to cover travel mileages), expanding research and development, in particular, in relation to sustainable food production and influencing public policy and choice to support these other initiatives.

(4) **Stern Report UK (2006)**

Nicholas Stern, Professor of Economics at the LSE, has recommended that G7 countries invest $10 trillion on recovery following the Coronavirus crisis. The crisis provided the greatest economic, business and commercial opportunity to transition to a zero emissions and climate resilient world through a coordinated global programme of investment for recovery, reconstruction and transformation to boost physical, human, natural and social capital. Annual investment should be increased by 2% per year above pre-pandemic levels to raise $1 trillion over ten years. G7 countries also had to ensure a proper and timely rollout of vaccines across the world, in particular, by covering the $10 billion funding gap for the global vaccination programme, COVAX. Fossil fuel subsidies should be eliminated by 2025 with the removal of overseas support for fossil fuel investment and the adoption of a minimum corporate profit tax of 21%.

Climate mitigation costs are estimated to be around 1-2% GDP.[[166]](#footnote-166) The UK Stern Review estimated that the costs were around 1% of GDP in June 2008 although this was subsequently increased to around 2% GDP due to the faster occurrence of climate change.[[167]](#footnote-167) The Stern Review warned that failure to act could result in loss of global GDP of 5-20%.[[168]](#footnote-168) The ‘One Earth Climate Model’ estimates the cost to be around $1.7 trillion[[169]](#footnote-169)

It is reported that the UK has been able to decarbonise the electricity grid faster than any other developed nation.[[170]](#footnote-170) The UK had produced a ten point plan for a Green Industrial Revolution (GIR) in November 2020 which included £12 billion investment in clean energy machinery. The UK would promote ‘climate diplomacy’ at the UN Climate Conference in Scotland in 2021. A legally binding carbon emission decrease was provided for under the Climate Change Act 2008 under the labour government which was the first of its type. A power sector carbon tax was introduced by the Conservative Liberal Democrat government in 2013 with coal fired electricity production decreasing from 25% to 2% between 2015 and 2020.[[171]](#footnote-171) The UK Climate Change Committee (CCC) recommended the phasing out of gas fired electricity production by 2035. Wind electricity production was 25% in 2020 with solar 4%. Nuclear energy and, in particular, Hinkley Point C and Sizewell C, were necessary to secure the decarbonisation target. The additional 9% cost in low energy production had been offset by efficiencies in lightbulb and appliance use.[[172]](#footnote-172)

Further reforms were necessary in the areas of heating and transport including through the increased use of heat pumps in place of gas boilers[[173]](#footnote-173) and electric vehicles. This would require substantial investment in household energy production and insulation[[174]](#footnote-174) and in electrical vehicle charging installation. The Department for Business Energy and Industrial Strategy (BEIS) estimated that the UK would miss its 2030 emissions target by 8% with this increasing to 10% in 2031.

(5) Mark Carney & ‘the Tragedy of the Horizon’ (2015 )

Mark Carney noted in ‘Climate change is the Tragedy of the Horizon’[[175]](#footnote-175) that ‘once climate becomes a defining issue for financial stability, it may already be too late.’ Carney referred to three principal risks in terms of physical risk, liability risk and transition risk. Carney argued that by ‘managing what gets measured, we can break the Tragedy of the Horizon’ and that with ‘better information as a foundation, we can build a virtuous circle of better understanding of tomorrow’s risks, better pricing for investors, better decisions by policymakers, and a smoother transition to a low-carbon economy.’[[176]](#footnote-176)

Mark Carney provided a follow up speech on ‘A New Horizon’ in March 2019.[[177]](#footnote-177) Urgent action was again required in the areas of reporting, risk analysis and returns. Governments had to establish climate policy frameworks with the private sector making the necessary investment. Financial policymakers had to develop appropriate frameworks to allow markets to adjust efficiently. A market for the transition to a two degree world was being built as disclosure was improved, investors made better informed decisions and sustainable investment became mainstream. Finance can complement and potentially amplify but not substitute for climate policy action. Appropriate policy frameworks had to be time consistent, transparent and committed.[[178]](#footnote-178)

Mark Carney noted at the UN Secretary General’s Climate Action Summit in 2019 that, ‘A new, sustainable financial system is being built’ which would fund ‘the initiatives and innovations of the private sector’, ‘amplify the effectiveness of the climate policies’ of government and ‘accelerate the transition to a low carbon economy.’[[179]](#footnote-179) The task was described as being large, the window of opportunity short and the risks existential. Climate risks and resilience had to be brought into the heart of financial decision taking with climate disclosure becoming comprehensive, climate risk management transformed and sustainable investing mainstream.[[180]](#footnote-180) This could be secured through the adoption of a number of initiatives including on disclosure, risk management and the realising of recurrence. A practical and flexible framework for corporate disclosures of climate risks was developed by the Task Force on Climate related Financial Disclosures (TCFD). Capital providers had to improve their understanding and management of climate related financial risks as firms align their business model to this transition to a net zero economy. Financial markets had to switch sustainable investment to target ‘.......’ investment strategies, over looking high environmental, social and governance (ESG) stocks, and ‘maintain’ the strategies that reward the ESG targeting. A new common taxonomy of ESG measurement had to be developed such as through the creation of transition indices measuring the adoption of low carbon strategies as high carbon corporations ........................ other initiatives as the EU’s Green Taxonomy and Green Bond standard.[[181]](#footnote-181)

Mark Carney recognised that private finance had a critical role to secure an effective transition to a net zero carbon economy.[[182]](#footnote-182) Securing net zero would require whole economy transition with every company, bank, insurer and investor adjusting their business models to convert existential risk into the greatest commercial opportunity of our time.[[183]](#footnote-183) This would require $3.5 trillion of infrastructure investment every year.[[184]](#footnote-184) This would require public finance to support a fair and inclusive transition, development and blended finance to generate adaptation and resilience and mainstream private finance to assist companies redesign and realign their business models. The core objective for the private finance work at the COP26 was to ensure that every financial decision takes climate change into account. This could be achieved through enhanced disclosure, climate risk management and net zero investment. The City of London and the UK had to support the transition from the industrial revolution to the sustainable revolution based on innovation, resources and leadership.[[185]](#footnote-185)

Mark Carney has noted that one of ‘the biggest issues is [that] you cannot self-isolate from climate’.[[186]](#footnote-186) This was not an option and the crisis would become worse over time with crisis deaths become more severe than with the Coronavirus crisis.[[187]](#footnote-187) A key part of the solution was realising the potential benefits of the $170 trillion of private capital which was ‘looking for disclosure’. The most significant element in dealing with climate change would be the ‘proud of money’. Mark Carney had earlier warned that companies that did not move towards zero carbon emissions would be punished by investors and be bankrupt with the longer action was taken the more the risk of collapse would grow.[[188]](#footnote-188)

Mark Carney considered crisis in terms of value in his Reith Lectures 2020.[[189]](#footnote-189) Mark Carney promoted ‘the three Rs’ with Reporting, Risk and Return. Companies had to report fully on climate risks with investors assessing the risks on their portfolios and identify climate solving returns on investments. Investors would then adjust their portfolios, which will align capital flows to a transition to a net zero economy. Mark Carney warned that society knew the ‘the price of everything but the value of nothing’ following Oscar Wild. price was not always a good measure of value. Climate risk raised three sets of physical, transition and societal challenges. Society had to consider how it valued health, wealth and opportunity following the Coronavirus crisis and properly account for the *wo*rth of human existence. The more recent environmental emergency was based on a deeper crisis of values with the need to build a new ecosystem in which society’s values reassess the market’s conceptions of value.

**(6) Climate Activism (2018)**

Swedish environmental activist, Greta Thunberg advocated a ‘School strike for climate’ in August 2018 which led to a ‘Fridays for Future’ movement in schools. Thunberg addressed the 2018 United Nations Climate Change Conference (COP24)[[190]](#footnote-190) and the UN Climate Action Summit in New York in September 2019 having sailed from Plymouth to New York in the racing yacht *Malizia II*.*[[191]](#footnote-191)* Thunberg travelled to the COP25 in Madrid, Spain from Hampton, Virginia to Lisbon, Portugal by catamaran, *La Vagabonde*, in November 2019.[[192]](#footnote-192) Thunberg warned US lawmakers that history would hold them accountable for climate catastrophes if they did not stop subsidising fossil fuel production which were a disgrace. Thunberg was speaking to a virtual House of Representatives panel on the day that President Biden began the two day Earth Day summit meetings.[[193]](#footnote-193) Thunberg announced that she would change her Twitter bio to ‘Bunny hugger’ following UK prime minister Johnson’s comments that climate action was not an ‘expensive politically correct, green act of bunny hugging’ at the Earth Day Leaders’ Summit on 22 April 2021.[[194]](#footnote-194) Other activists include, for example, Mexican-Chilean Xiye Bastida[[195]](#footnote-195) and Mikaela Loach in the UK.[[196]](#footnote-196) The Green Party in Germany adopted an election manifesto to transform the country into a ‘socio-ecological economy’ by 2035.[[197]](#footnote-197)

(7) Climate Change and Poverty (2019)

The United Nations published a special report on *Climate change and poverty* in June 2019.[[198]](#footnote-198) Special Rapporteur Philip Alston warned that climate change would have devastating consequences for people in poverty and reverse 50 years of human rights progress in development, global health and poverty reduction. A genuinely transformative change is required in the ways that societies and economies were structured and in the human rights regime.[[199]](#footnote-199) Climate change will exacerbate existing poverty and inequality with developing companies assuming around 75-80% of the cost of climate adaptation.[[200]](#footnote-200) The poorest 3.5 billion people were responsible for 10% of carbon emissions with the richest 10% for 50%. The wealthiest 1% create 175 times more carbon that the bottom 10%.[[201]](#footnote-201) A number of initiatives have been adopted on human rights and climate change.[[202]](#footnote-202) Thirty years of conventions had secured little progress with too many countries ‘taking short-sighted steps in the wrong direction’.[[203]](#footnote-203)

The private sector had also failed with ‘over reliance on profit-driven actors’ almost guaranteeing ‘massive human rights violations, with the wealthy catered to and the poorest left behind.’[[204]](#footnote-204) The fossil fuel industry had taken almost no action to adjust its business model while accounting for most climate change.[[205]](#footnote-205) Governments were also complicit in subsidising the fossil fuel industry through $5.2 trillion or 6.3% of GDP.[[206]](#footnote-206) States, politicians and corporations had ‘consistently used bad economic arguments to stall climate action’ having adopted ‘a cynical and short-sighted approach.’[[207]](#footnote-207) Post-industrial poverty reduction in economic growth was described as being based on ‘unsustainable resource extraction and exploitation.’[[208]](#footnote-208) The developed country commitment to provide $100 billion a year by 2020 was ‘only a fraction of the finance needed to keep the average temperature increase to 2°C’[[209]](#footnote-209) and were inadequate to cover the $140-300 billion required annually by 2025-2030[[210]](#footnote-210) and $280-500 billion by 2050.[[211]](#footnote-211)

Climate change was described as ‘an emergency without precedent’ which required ‘bold and creative thinking from the human rights community.’[[212]](#footnote-212) A series of recommendations were made to recognise the urgency of transformational change, accept the threats to democracy and civil and political rights, revitalise economic and social rights, assume regulatory responsibility and reconsider human rights responses, in particular, by transcending traditional techniques, promoting community activism, building coalitions, agreeing human rights compliance solutions and bringing the United Nations human rights mechanisms to life.[[213]](#footnote-213) The human rights community is criticised for being as complacent as governments in response to the challenges that arose with much of this being ‘patently inadequate and premised on forms of incremental managerialism and proceduralism that [were] entirely disproportionate to the urgency and magnitude of the threat.’[[214]](#footnote-214) Climate change was ‘an unconscionable assault on the poor’ with a number of recommendations being made to attempt to correct this.[[215]](#footnote-215)

(8) ‘Earth for All’ (2020)

A separate EarthforAll was established in November 2020 at the UNFCCC Race to Zero Dialogues session on ‘Transformational Leadership’. This brings together researchers and policy makers to consider political and economic solutions, in particular, dealing with global energy, food, poverty, inequality and population challenges. The results are to be published in 2022 with the 20th anniversary of the first Earth Summit in Stockholm in 1972. This is led by teams from the Club of Rome, Norwegian Business School and Potsdam Institute for Climate Impact Research.[[216]](#footnote-216)

**(9) IRENA World Energy (2021)**

A number of recommendations were made by the International Renewable Energy Agency (IRENA) in its *World Energy Transitions Outlook 1.5°C Pathway* (March 2021). IRENA considered that renewable power, green hydrogen and modern bioenergy would dominate future world energy supply. Securing the 1.5°C climate pathway would require a combination of technologies including efficient energy production, decarbonised power systems, increased use of electricity in buildings, industry and transport, green hydrogen expansion with synthetic fuels and feedstocks and targeted sustainably sourced biomass. Energy transition investment had to increase by 30% to $131 trillion by 2050 ($4.4 trillion per year). Annual energy intensity improvements had to increase from 1.2% to 3%. Renewal energy use had to increase by eight times. Renewable power generation had to be raised from 2,500 to 27,500 GW by 2050. Electric vehicles had to increase from 4% to 100% of all vehicles with the vehicle stock rising from 7 million to 1.8 billion by 2050. Hydrogen demand had to be increased from 120 MT to 613 MT by 2050. Global emissions had to fall by over 50% by 2030 to below 15 GT to secure the 1.5°C carbon envelope.

**(10)** ‘Our Planet, Our Future’ (2021)

Eleven Nobel Laureates and 18 distinguished scientists and experts issued a statement on ‘Our Planet, Our Future’ as an urgent call for action.[[217]](#footnote-217) The summit had convened by the Nobel Prize Organisation in April 2021. The summit was convened to promote transformation to global sustainability to ensure human prosperity and equity. There was a need ‘to reinvent out relationship with plant Earth’ and to become ‘effective stewards of the global commons’. There was ‘an existential need to build economies and societies that support Earth system harmony rather than disrupt it.’ Humans were responsible for change in the biosphere during the last 12,000 year Holocene epoch. The future habitability of the Earth was dependent on ‘the collective actions humanity takes now’. Complexity had to be embraced with humanity facing increased network risks with the need to manage complexity and emergent behaviour.

This was the decade of action with effective planetary stewardship requiring an updating of the ‘Holocene mindset’. People had to act on ‘the urgency, the scale, and the interconnectivity between us and our home, planet Earth’, in particular, by enhancing social capital and promoting trust within and between societies. A foundation for effective planetary stewardship was proposed based on a wellbeing of people and nature policy assessment, mission driven innovation, education, information technology recirculation and regeneration of materials in business and finance, scientific collaboration and knowledge development. Global sustainability was the only way of ensuring ‘human safety, equity, health, and progress’ with humanity having only recently acknowledging its responsibilities. The long term potential of humanity was dependent on our ability ‘to value our common future’ by valuing ‘the resilience of societies and the resilience of Earth’s biosphere.’

**(11) UK Green Revolution (2020) and** CCC Progress Report (2021)

The Climate Change Committee (CCC) in the UK issued a third Climate Change Risk Assessment (CCRA3) in June 2021.[[218]](#footnote-218) The Climate Change Committee (CCC) was established as independent body to advise the government on establishing targets, to secure its climate objectives under the Climate Change Act 2008. The 2008 Act established carbon target and budgeting, trading schemes and assessments of the impact and adaptation to climate change as well as establish the CCC. The EU Emissions Trading Scheme (ETS) was replaced by the UK ETS on 1 January 2021.[[219]](#footnote-219) The four UK Administrations announced on 1 June 2020 that a UK ETS would be set up following an earlier consultation document.[[220]](#footnote-220)

The UK participated in the EU ETS scheme until the end of Phase III (2013-2020) with Phase IV running from 2021-2030. Emissions had been reduced by 21% during Phase III with around 1,000 UK power stations and industrial plants participating. 43% reductions were to be secured during Phase IV. The UK cap would be reduced by a further 5% with the scheme being aligned with the UK 2050 net zero target by 2024. A separate *Energy White Paper* was produced in December 2020.[[221]](#footnote-221) The government published a further *Industrial Decarbonisation Strategy* in March 2021.[[222]](#footnote-222) Guidance on participation in the UK ETS was published in March 2021.[[223]](#footnote-223) Emissions options would be conducted by the Intercontinental Exchange Inc (ICE).

The CCC’s Adaptation Committee published a third Climate Change Risk Assessment (CCRA3) in June 2021.[[224]](#footnote-224) Over 61 risks and opportunities were identified covering the environment, health, homes, infrastructure and the economy. The report concludes that adaptation action had failed to keep pace with the worsening reality of climate risk while the UK had the necessary capacity and resources to respond.[[225]](#footnote-225) Eight specific risk areas are identified for urgent action within two years.[[226]](#footnote-226) Ten principles for good adaptation planning are proposed with the risks and opportunities identified to be built into relevant National Adaptation Plans (NAPs) from 2023. A number of technical reports with additional summaries and briefings were provided.[[227]](#footnote-227)

[UK and global temperatures had risen by 1.2°C between 1850-1900 with UK sea levels rising by 16cm since 1900 and extreme weather events becoming more frequent. The UK may experience an additional 0.5°C increase in average temperature by 2050.[[228]](#footnote-228) Adaptation solutions were considered in terms of engineering,[[229]](#footnote-229) nature based solutions (NBSs),[[230]](#footnote-230) new or emerging technologies,[[231]](#footnote-231) behavioural,[[232]](#footnote-232) institutional,[[233]](#footnote-233) financial[[234]](#footnote-234) and data and R&D.[[235]](#footnote-235) A cost benefit analysis is provided of adaption measures within the CCRA3.[[236]](#footnote-236) Lack of adaptation over the previous five years had resulted in lock-in (inherent vulnerability from design, production or installation), irreversible impacts and increased costs.[[237]](#footnote-237) [The Government is required to conduct a UK Climate Change Risk Assessment (CCRA) every five years under the Climate Change Act 2008.]

The UK’s changing climate conditions were reviewed with an assessment of UK climate risk.[[238]](#footnote-238) Opportunities from climate change are reviewed separately.[[239]](#footnote-239) Good adaptation and the benefits from adaptation are considered separately.[[240]](#footnote-240) Government intervention is required in adaption due to the risk of uncertainty, information failure, policy failure, governance failure and behavioural barriers.[[241]](#footnote-241) Mitigation is required to reduce emission levels with adaptation managing vulnerability and exposure. Sector risks, synergies and trade-offs are considered especially in terms of the natural environment, infrastructure, people and communities, business and international aspects.[[242]](#footnote-242) Adaptation benefits a considered with regard to engineered solutions, nature based solutions, new and emerging technologies, behaviour, institutional, financial and data and R&D aspects.[[243]](#footnote-243) Wider adaptation benefits are also identified[[244]](#footnote-244)

Appropriate funding has to be provided within future iterations of the National Adaptation Plans (NAPs).[[245]](#footnote-245) The UK had already developed an active green finance market with around 80 green bonds listed on the London Stock Exchange raising over $24 billion. The Government launched the first sovereign green bond in 2020 to fund climate related projects with a National Environment Investment Readiness Fund (NEIRF) being established in 2021 to make projects more attractive to private investment.[[246]](#footnote-246) A £640 million Nature for Climate Fund was also created. Funds had to be made available for all adaptation measures and needs using public, private and third sector funding in national and local areas.

**[LSDC]**

A London Sustainable Development Commission (LSDC) was set up in 2002 to provide independent advice to the Mayor of London on maintaining the position of London as a sustainable world class city. The Commission comprises experts across economic, social, environmental and London governance areas. A Green Finance work programme was proposed with the LSDC commissioning UK100 to develop the first stage of this. UK100 consists of a network of local government leaders supporting decision taking in towns, cities and rural areas. The LSDC produced a *Financing for a Future London* initiative to secure a fair transition to a resilient, circular and zero carbon London in March 2020.[[247]](#footnote-247)

**(12) World Wide Fund (2021)**

The World Wide Fund for Nature (WWF) estimates that the UK has to reduce its environmental footprint by 75% to secure target emission reductions by 2030.[[248]](#footnote-248) The report considers ecological, material, biomass, nitrogen, phosphorous and CO2 emission footprints.[[249]](#footnote-249) The UK per capita greenhouse gas footprint was six times the limit with per capita biomass consumption being double the limit. A series of recommendations were made in the areas of air pollution,[[250]](#footnote-250) chemical pollution,[[251]](#footnote-251) water pollution,[[252]](#footnote-252) greenhouse gas emissions,[[253]](#footnote-253) marine resource use,[[254]](#footnote-254) biomass consumption,[[255]](#footnote-255) degradation and land use change,[[256]](#footnote-256) nutrient use,[[257]](#footnote-257) water availability and flows[[258]](#footnote-258) and material consumption.[[259]](#footnote-259) Almost half of the UK carbon footprint was derived from imports with this having to be reduced by 33% by 2030. Savings should be possible without damaging the economy by reducing waste, increasing recycling and efficiency and using more sustainable production systems.[[260]](#footnote-260)

**WEF, *China Economic Growth & Emissions* (5 2021)**

**7. CLIMATE AGREEMENTS**

A series of important international treaties and agreements or understandings have been issued on climate convergence and action. Many of these are United Nations based although a series of initiatives have been brought forward by the G7 and G20.[[261]](#footnote-261) [A number of international and domestic initiatives have been adopted in response to climate concerns. This includes early agreements on air pollution and then more specific work on climate management. A series of overlapping initiatives have been created.]

(1) Air Pollution (1979)

International air travel measures were originally adopted under the 1944 Convention on International Civil Aviation (Chicago Convention) which set up the International Civil Aviation Organisation (ICAO).[[262]](#footnote-262) Early initiatives were adopted with relation to air pollution which included the 1979 Convention on Long-Range Transboundary Air Pollution (CLRTAP) which attempts to limit and reduce cross-boundary air pollution.[[263]](#footnote-263) Fifty one parties joined the Convention which came into effect on 16 March 1983. The Convention is administered by the European Monitoring and Evaluation Programme (EMEP) under the United Nations Economic Commission for Europe (UNECE). This was intended to establish agreed measures governing aerospace, aircraft registration and safety security and sustainability. Aircraft engine emissions were subsequently agreed in Montreal in 1981.[[264]](#footnote-264)

(2) Vienna Ozone Convention (1985)

The Vienna Convention for the Protection of the Ozone Layer was agreed in 1985 to manage manmade chlorofluorocarbons (CFCs).[[265]](#footnote-265) This provided for the Meeting of Ozone Research Managers to monitor ozone depletion and climate change with Conference of Parties (COP) reports being produced. CFC reductions were provided for under the Montreal Protocol on Substances that Deplete the Ozone Layer from 1989.[[266]](#footnote-266) The Vienna Montreal Conventions have been ratified by 196 countries and the EU. CFC damage had originally been identified by Frank Sherwood Rowland and Mario Molina at the University of California in 1973 with this work later being confirmed by British Antarctic Survey scientists, Jo Farman, Brian Gardiner and Jon Shanklin in 1985.[[267]](#footnote-267)

(3) Montreal Protocols CFCs (1987)

(4) Intergovernmental Panel on Climate Change (IPCC) (1988)

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organisation (WMO) and United Nations Environment Programme (UNEP). The objective is to provide regular scientific assessments on climate change and assess potential future risks with recommendations being made for adaption and mitigation.[[268]](#footnote-268) The IPCC operates through a Panel, Chair, Secretariat, Bureau, Working Groups, Executive Committee and Task Force on National Greenhouse Gas Inventories. The IPCC has adopted its own ‘Principles Governing IPCC Work’.[[269]](#footnote-269) The IPCC published a major *Summary for Policymakers* report in October 2018 which warned of global warming in excess of 1.5°C.[[270]](#footnote-270)

The IPCC Working Group III of the Fifth Assessment Report in 2014 highlighted the nature of climate change as a global commons problem with emission reductions imposing an economic cost but with the benefits spreading across the world unevenly.[[271]](#footnote-271) Climate change mitigation is non-excludable with it being difficult to deny the sheer global benefits to any specific individual or institution. The benefits were also non-rivalrous and could be enjoyed by countries or individuals without reducing the overall value received. These public good characteristics nevertheless created incentives for actors to act as free riders and benefit from other parties’ contributions. International cooperation was necessary to mitigate climate change with each country have to voluntarily consent to be bound to any agreed arrangements. A number of principles are developed to support international climate change policies. These include maximising global net benefits, equity and distributive justice, precaution and sustainable development.[[272]](#footnote-272)

An IPCC Special Report was issued at Incheon Republic of Korea, 8 October 2018. This was prepared by 91 authors and review editors from 40 countries with 6,000 scientific references cited. The report notes the ‘clear benefits to people and natural ecosystems’ of limiting global warming to 1.5°C compared to 2°C which would also ensure ‘a more sustainable and equitable society.’[[273]](#footnote-273) The consequences of 1°C of global warming were already being experienced with a number of climate change impacts being avoided by limiting global warming to 1.5°C. A number of necessary actions were already in place to limit global warming although further ‘rapid and far-reaching’ transitions were required in land, energy, industry, buildings, transport and city use. Anthropogenic CO2 emissions would have to fall by 45% from 2010 levels by 2030 and reach net zero by 2050. The IPC was assisted by three Working Groups on the Physical Science Basis (WGI), Impacts, Adaption and Vulnerability (WGII) and Mitigation of Climate Change (WGIII).[[274]](#footnote-274)

[The IPCC 2019 Special Report on Climate Change in Land had estimated that forestry, agriculture and land use represented 23% of greenhouse gas (GHG) emissions between 2007-2016. Other solutions include conservation, restoration and improved land management.[[275]](#footnote-275) Over one third of necessary emission reductions by 2030 may be secured through different forms of ‘natural climate solutions’ (NCS). These are principally based on conservation, restoration and improved land management actions to reduce greenhouse gas emissions and improve carbon storage in global forests, wetlands, grasslands and agricultural lands. This can also improve water filtration, flood buffering, soil health, biodiversity habitat and enhance climate resilience.[[276]](#footnote-276) The World Business Council for Sustainable Development (WBCSD) and the Nature4Climate (N4C) coalition produced a *Natural climate solutions: the business perspective* guide in September 2019.[[277]](#footnote-277) This focused on protecting, restoring and sustainably managing forest, grasslands, agricultural land and wetlands.]

(5) UNFCCC (1992)

A United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 in Rio de Janeiro to limit the effects of human intervention with the climate system.[[278]](#footnote-278) This was referred to as the Earth Summit or ECO92. The summit considered production patterns, alternative energy sources and public transportation improvements as well as water supply management. There were three levels of signatory states.[[279]](#footnote-279) Parties agreed to act to protect the climate system on the basis of common but differentiated responsibilities and respective capabilities with developed countries assuming a lead role (art 3(1)). Parties commit to climate change mitigation and adaptation (art 4). The summit resulted in the production of the Rio Declaration on Environment and Development,[[280]](#footnote-280) Agenda 21[[281]](#footnote-281) and the Forest Principle.[[282]](#footnote-282) Further documents were open for signature with the Convention on Biological Diversity,[[283]](#footnote-283) the UNFCCC[[284]](#footnote-284) and the Convention to Combat Desertification.[[285]](#footnote-285) A Commission on Sustainable Development (CSD) was established at the Earth Summit.[[286]](#footnote-286) The Rio de Janeiro Summit was the third Earth Summit which had been held every ten years (decennial) since Stockholm in 1972 and Nairobi in 1982.

[The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in May 1992 to limit dangerous human interference with the climate system.[[287]](#footnote-287) The Convention was agreed at the Rio de Janeiro Earth Summit on 3-14 June 1992. The objective is to stabilise greenhouse gas concentrations in the atmosphere at a level that prevent dangerous anthropogenic interference with the climate system with an appropriate level to be set within an agreed timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.[[288]](#footnote-288) A series of principles[[289]](#footnote-289) are also provided for with additional commitments.[[290]](#footnote-290)]

[The 1992 UNFCCC developed a number of principles based on equity and common but differentiated responsibilities and respective capabilities (CBDRRC) (art 3(1)), relative needs, vulnerability, burdens in countries of differing wealth (art 3(2)), precaution and cost effectiveness to ensure global benefits at the lowest possible cost (art 3(3)), sustainable development (art 3(4)) and cooperation (art 3(5)).]

(6) Kyoto Protocol (1997)

The Kyoto Protocol was adopted in December 1997 to extend the UNFCCC.[[291]](#footnote-291) Thirty six countries agreed to reduce their emissions during the first commitment period between 2008-2012. A Doha Amendment was agreed in 2012 with 37 countries agreeing to binding targets during a second commitment period to end 2020. A separate Paris Agreement was agreed in December 2015 with the commitment to keep global temperature rises to below 2°C (3.6°F) and to limit the increase to 1.5°C (2.7°F).[[292]](#footnote-292) Countries would also increase their ability to adapt to adverse impacts and promote climate resilience.[[293]](#footnote-293) Countries would attempt to secure global peaking of gas emissions as quickly as possible with countries entering into ambitious Nationally Determined Contributions (NDCs) to be reset every five years and registered with the UNFCCC Secretariat.[[294]](#footnote-294) Resets should be higher each time under a process of progression.[[295]](#footnote-295) The NDCs are nevertheless not binding with no formal sanction.[[296]](#footnote-296)

[The Kyoto Protocol was adopted in 1997 (under Art 17 UNFCCC) to reduce greenhouse gas emissions by, at least, 5% from 1990 levels within a first commitment period between 2008-2012 with a second commitment period being agreed under a Doha Amendment in 2012. The parties undertake to achieve their quantified emission limitation and reduction commitments (Art 3) to promote sustainable development to adopt a number of national policies and to cooperate to enhance the individual and combined effectiveness of their policies (Art 2(1) (a) and (b)). The parties undertake to limit and reduce aviation and marine bunker fuels working with the Independent Civil Aviation Organisation (ICAO) and International Maritime Organisation (IMO) (Art 2(2)).

Parties undertake to ensure that their aggregate anthropogenic CO2 equivalent emissions of greenhouse gases do not exceed their assigned amounts (Art 3(1)). Countries are to ensure that they have a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol (Art 5(1)). Parties may exchange emission reduction units (Art 6(1)). Additional reporting obligations are imposed (Arts 7 and 8). A separate COP is established under the Kyoto Protocol (Art 9). [The Protocol applies to six greenhouse gases.[[297]](#footnote-297)] The Protocol establishes a rolling set of commitment periods to reduce emissions. Relevant parties are set out in Annex 1. The commitments undertaken by the parties were set out in a Berlin Mandate based on the original UNFCCC. A clean development mechanism is established to assist parties not included in Annex 1 to achieve sustainable development and support the UNFCCC (Art 12). The COP is to act as the Meeting of Parties (MOP) to the protocol (Art 13(1)) with the Convention secretariat also acting as the secretariat to the protocol (Art 14). Additional provisions are included within the Paris Agreement (Art 16).[[298]](#footnote-298) A number of the other Convention provisions are reapplied.[[299]](#footnote-299)]

(7) Warsaw International Mechanism for Loss and Damage (2013)

The Warsaw International Mechanism (WIM) for Loss and Damage was adopted by COP19 on November 2013.[[300]](#footnote-300) The purpose is to enhance knowledge and understanding of comprehensive risk management approaches to address loss and damage, strengthen dialogue, coordination, coherence and synergies and enhance action and support including through financial provision, technology and capacity building. Loss and damage was referred to in the original UNFCCC although no mechanism was agreed despite requests by other parties including the Alliance of Small Island States (AOSIS) and Least Developed Countries Group.[[301]](#footnote-301) Creating disaster reduction strategies was referred to in the Bali Action Plan and Road Map agreed at COP13 in Bali, Indonesia in December 2007.[[302]](#footnote-302) The WIM acknowledges loss and damage associated with adverse effects although notes that this can be reduced by adaptation but again includes no compensation mechanism. This would be excluded again under the terms of the Paris Agreement in 2015.

(8) Paris Agreement (2015)

The greenhouse gases covered by the Paris Agreement consist of carbon dioxides, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons and hydrofluorocarbons.

While President Donald Trump had withdrawn the US from the Paris Agreement this was only with effect from 4 November 2020 with the Biden Administration re-joining on 20 January 2021.[[303]](#footnote-303)

The Paris Agreement was adopted on 12 December 2015 with countries to adopt their own reduction plans to keep average global temperatures to well below 2°C (3.6°F) and to limit the increase to 1.5°C (2.7°F). The objectives of the Paris Agreement are to hold the increase in global average temperature to well below 2°C above pre-industrial levels and to limit the increase to 1.5°C, increase the ability to adapt to the adverse impacts of climate change and foster climate resilience and to make finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient developments (Art 2(1)(a)-(c)).

Parties are to undertake and communicate ambitious efforts to implement relevant Nationally Determined Contributions (NDCs) (Arts 3, 4, 7, 9, 10, 11 and 13). Parties aim to reach global peaking of greenhouse emissions as soon as possible (Art 4). Parties should take necessary action to conserve and enhance sinks and reservoirs of greenhouse gases (Art 5). Parties may pursue voluntary cooperation to implement their NDCs to secure higher targets in the mitigation and adaptation actions and promote sustainable development and environmental integrity (Art 6). Parties establish a global goal or an adaption of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change to support sustainable development and ensure an adequate adaptation response (Art 7). Parties recognise the importance of averting, minimising and addressing loss and damage associated with the adverse effects of climate change including extreme weather events and slow onset events (Art 8).

Developed countries are to provide resources to assist developing countries in terms of mitigation and adaptation (Art 9). Parties agree a long term vision of realising technological development and transfer to improve resilience to climate change and reduce greenhouse gas emissions (Art 10). Capacity building is to be used to support the ability of developing countries (Art 11). Parties are to cooperate in enhancing climate change education, training, public awareness, public participation and public access to information (Art 12). An enhanced transparency framework for action and support is to be established (Art 13). The COP is to review implementation of the Agreement on a regular basis (Art 14) with an implementation and compliance mechanism established (Art 15).

(9) Kigali Accord (2018)

An Amendment to the 1987 Montreal Protocol was adopted in Kigali, Rwanda by 65 countries on 21 December 2018. Participants agreed to phase out HFCs by 80% over 30 years and replace them with environmentally supportive alternative refrigerants. While CFCs had been banned under the Montreal Protocol, HFCs were much more powerful greenhouse gases which had to be removed under the Kigali Amendment. Removal of HFCs and other short-lived climate pollutants (SLCPs) could reduce global warming by 0.5°C.

(10) North Atlantic Treaty Organisation (NATO) (2021)

The NATO Alliance confirmed its support for responding constructively to Climate Change in its Brussels Communique in June 2021.[[304]](#footnote-304) NATO endorsed the Action Plan to implement its NATO Agenda on Climate Change and Security in June 2021 to increase its awareness, adaptation, mitigation and outreach efforts while ensuring a credible deterrence and defence posture and upholding the priorities of the safety of military personnel and operational and cost effectiveness.[[305]](#footnote-305) NATO would incorporate climate change into its work and develop a mapping methodology to assist Allies measure greenhouse gas emission from military activities and installations.[[306]](#footnote-306) Allies would continue to diversify energy supplies to protect energy security.[[307]](#footnote-307)

(11) G7 & G20 (2021)

Forty representatives were invited by the incoming Biden Administration in the US to attend a virtual Leaders’ Summit on Climate in 22-23 April 2021.[[308]](#footnote-308) The US government undertook to reduce its emissions by 50-52% below 2005 levels by 2030 under its Nationally Determined Contribution (NDC) with the UK confirming that it would embed a 78% GHG reduction by 2035. The EU agreed a 55% reduction with Japan 46-50% and Canada 40-45%. China confirmed that it would join the Kigali Amendment and strengthen its control of non-CO2 greenhouse gases as well as control coal fired power generation projects and phase out coal consumption.[[309]](#footnote-309) [The Biden Administration confirmed that the US would rejoin the Paris Agreement following the Trump Administration’s withdrawal.[[310]](#footnote-310)]

[The Biden Administration proposed to bring forward energy sector reform within the US at the beginning of 2021. [[311]](#footnote-311) Fossil fuel emissions in power generation were to be removed by 2035 and the US economy carbon neutral by 2050. The objective is to limit climate increases to less than 2°C above pre-industrial levels which would require emission cuts of 7.6% for ten years with any delay requiring more severe reductions. No meaningful US climate reform had been adopted since 2009 (but without carbon pricing) with the Bush Administration not implementing the Kyoto protocol and the Trump Administration subverting climate reform.[[312]](#footnote-312) The US contributed to 10% of world greenhouse gas effluvia generation and was the second largest emitter after China. Further investment was required in low or zero carbon production, carbon capture, carbon storage, energy and electricity storage and energy and electricity distribution including through national electricity grid reforms.[[313]](#footnote-313) Further US reform is politically sensitive although possible.[[314]](#footnote-314)

It was estimated that the US would require around $2.5 trillion in investment over ten years to reverse earlier climate policies.[[315]](#footnote-315) It was estimated that US energy costs over the decade would be around $9.4 trillion in any case. A series of net zero scenarios can be developed to move towards a carbon neutral economy.[[316]](#footnote-316) Six pillars are identified.[[317]](#footnote-317) Major infrastructure targets are made.[[318]](#footnote-318) Eight priority actions can be identified.[[319]](#footnote-319) Full emissions neutrality may still require carbon pricing.[[320]](#footnote-320)]

[The UK Government hosted the G7 Summit in Carbis Bay, Cornwall on 11-13 June 2021 which was attended by G7 leaders as well as Australia, India, South Korea and South Africa. Prime Minister Boris Johnson issued a Statement on ‘The Road to COP’26. Sir David Attenborough had attended the meeting in advance of acting as the COP26 People’s Advocate.[[321]](#footnote-321) Prime Minister Boris Johnson confirmed that he would seek commitments from G7 members to support the transition to net zero, begin a green industrial revolution and build economies that can withstand whatever the changing climate creates with countries committing to $100 billion a year target investment and going further.[[322]](#footnote-322) Countries were asked specify specific actions that would be taken to support the COP26.]

G7 leaders meeting in Cornwell in June 2021 agreed to increase spending to assist poorer countries reduce carbon emissions and respond to global temperature increases to $100 billion per year through to 2025. The G7 agreed to phase out coal and to limit carbon leakage with companies relocating to avoid pollution controls. The lack of progress was criticised by campaign groups.[[323]](#footnote-323)

G7 Ministers responsible for Climate and Environment had earlier met virtually on 20-21 May 2021 with a number of commitments being made.[[324]](#footnote-324) Net zero energy specifically recognise the contribution of energy efficiency as ‘the first fuel’ to emissions reduction, energy security, economic growth, sustainable development, energy poverty alleviation and job creation. With the G7 supporting the IEA Energy Efficiency Hub (EEH) and Super-Efficient Equipment and Appliance Deployment (SEAD) initiatives with energy efficiency to be increased in the areas of lighting, cooling, refrigeration and motor systems.[[325]](#footnote-325) Additional pledges were made on net zero innovation and the environment.[[326]](#footnote-326)

The UK hosted the G7 Summit as part of its G7 Presidency in Carbis Bay, Cornwall on 11-13 June 2021. Australia, India, South Korea and South Africa were invited with G7 leaders. The final Communique confirmed ‘Our Shared Agenda for Global Action to Build Back Better’ with six specific commitments on the pandemic, economic growth, future prosperity, protecting the planet, strengthening the G7 partnerships and embracing values.[[327]](#footnote-327) Additional undertakings were made with regard to health, economic recovery and jobs, free and fair trade, future frontiers, climate and the environment, gender equality and global responsibility and international action.

(12) United Nations Climate Change Conference of the Parties (COP26) (2021)

The 26United Nations Climate Change Conference of the Parties (COP26) would be held in the UK on 1-12 November 2021. This represented the 26 UNFCCC, 16th meeting of the parties under the Kyoto Protocol (CMP16) and third meeting of the parties under the Paris Agreement (CMA3). The purpose was to bring parties together to accelerate action to secure the goals of the Paris Agreement and UNFCCC.[[328]](#footnote-328) The UK was committed to working with all countries and civil society, companies and individuals to support the COP26.[[329]](#footnote-329) The UK hosted a Global Summit on Climate and Development to support countries most vulnerable to climate change on 31 March 2021.[[330]](#footnote-330) The UK’s independent Climate Change Committee (CCC)[[331]](#footnote-331) produced a Sixth Carbon Budget in December 2020[[332]](#footnote-332) which recommended a 78% reduction in UK territorial emissions between 1990 and 2035 which brings forward the UK’s 80% target by 15 years.[[333]](#footnote-333)]

[The 26th United Nations Climate Change Conference (COP26) would be held in Glasgow on 31 October – 12 November 2021.[[334]](#footnote-334) This also constituted the 16th meeting of the parties under the Kyoto Protocol (CMP 16) and third meeting of the parties under the Paris Agreement (CMA 3). Business, Energy and Industrial Strategy Secretary, Alok Sharma, was appointed President of the Conference in February 2020. The Conference had to be postponed one year due to the Coronavirus crisis.]

The original announcement that COP26 would be hosted in Glasgow was made in August 2019 two weeks after Mr Johnson was appointed prime minister.[[335]](#footnote-335) Sir David Attenborough was appointed People’s Advocate in advance of the COP26 meeting in Scotland in November 2021.[[336]](#footnote-336) Attenborough considered that the challenges caused by climate change were more significant than those resulting from the coronavirus crisis. It was crucial to secure necessary agreement between nations to solve such worldwide problems. UK representation at COP26 would be led by Alok Sharma who replaced Claire O’Neill.[[337]](#footnote-337)

COP21 represented the first quinquennial review or Global ‘stocktake’ of the ‘Nationally Determined Contributions’ (NDCs) agreed under the Paris Agreement. This was the first review of the ratcheting mechanism to maintain global temperature rises to between 1.5-2°C above pre-industrial levels. Further commitments were required with the Climate Action Tracker estimating that earlier pledges would only secure a 3 degree result to around 3°C. Revised commitments were published during the Climate Conference in April 2021. It was hoped that COP26 could demonstrate leadership and bring countries together to secure the necessary commitments to respond to the climate challenge.

**8. CLIMATE SOLUTIONS**

Climate control can principally be secured either through various measures to reduce CO2 and other gas emissions which increase global temperatures or through different forms of carbon sequestration, capture and storage. Carbon levels can be controlled through artificial sequestration which creates artificial sinks which either prevent the release or capture of carbon generation.

A series of separate solutions have to be adopted in each of the key sector areas including energy, industry, agriculture and transport. Governments have to assume a leadership role specially in terms of policy and target development. Households and individuals have a separate responsibility in terms of consumption and life choices and behavioural change. Markets and investment will have a significant role in pricing climate risk and climate transition exposure and in ensuring that capital and funding is most effectively applied. Regulatory authorities and central banks will also be important in ensuring that necessary changes are adopted with regard to regulatory and monetary policy and fiscal policy in cooperation with government treasury departments.

[Climate responses require action targeted at mitigation to reduce and stabilise emissions and adaptation to respond to new climate conditions.[[338]](#footnote-338) This can be developed to create a five part programme based on prevention, containment, restoration, adaptation and shared commitment, ownership and benefits.[[339]](#footnote-339) This can create a sustainable new climate model.

**(1) Carbon Control, *Project*** ***Drawdown* (2016)**

Reference may also be made to securing ‘drawdown’ when increases in greenhouse gas emissions are stopped and begin to reduce.[[340]](#footnote-340) Specific solutions can be developed in the electricity,[[341]](#footnote-341) industry,[[342]](#footnote-342) buildings,[[343]](#footnote-343) engineering,[[344]](#footnote-344) food, agriculture and land use[[345]](#footnote-345) with land sinks,[[346]](#footnote-346) transportation,[[347]](#footnote-347) coastal and ocean sinks[[348]](#footnote-348) and health and education.[[349]](#footnote-349) Climate solutions include increased use of renewable energies, sustainable transportation, air pollution prevention, waste management and recycling and preservation of the oceans. Nature based solutions include re-forestation, rewilding and silvopasture which integrates foresting and grazing. Other factors include upgrading infrastructure, improving construction, increasing building insulation and reduce transportation including through remote working. Individuals can change their food and consumption patterns to become more sustainable and efficient including through the use of higher plant rich diets, reduce food waste, while monitoring and lowering their overall carbon footprints.] Reference is also made to the development of a circular economy based on the ‘3Rs of Reduce, Reuse and Recycle.[[350]](#footnote-350) Reduce plastic. Eat less meat and dairy. Reduce flying and transport. Reduce energy use.]

***Project******Drawdown****. Three of the key project solutions could reduce CO2 emissions by 269.02 gigatons with 1,500 gigatons being produced since 1751.[[351]](#footnote-351) Three key solutions include refrigerant management,[[352]](#footnote-352) onshore wind energy production[[353]](#footnote-353) and plant diet switching.[[354]](#footnote-354)*

(2) International Energy Agency (IEA), *Energy Technology Perspectives* (2020)

[Power, Industry, Agriculture & Transport]

A number of tools are available to manage emissions and climate damage in all key energy, industrial and other sectors. The IEA has considered how 800 different technology options could be used to assist secure delivery of a net zero emissions target by 2070 within a resilient and secure energy system.[[355]](#footnote-355) A Sustainable Development Scenario (SDS) is produced as a roadmap to deliver on climate and energy goals. Power sector transitioning could assist secure a one third reduction in emissions although 55% of emissions were generated by the transport, industry and building sectors. Electricity production would have to increase substantially with generation rising 2.5 times by 2050 under a Faster Innovation Case (FIC).

Additional improvements would be required in the areas of increases in hydrogen, bioenergy and carbon capture utilisation and storage (CCUS). Hydrogen production would have to increase with electrolysis being expanded from 0.2 GW to 3300 GW (double the electricity usage of the People’s Republic of China). Hydrogen could act as a bridge fuel in areas where electricity may not be sufficient or available such as in steel production or shipping. Under the FIC, 35% decarbonisation could be achieved through electrification, 25% CCUS, 20% bioenergy and 5% hydrogen. Private markets have a crucial role in mobilising capital and innovation although government action would be necessary to secure net zero emissions. Effective policy toolkits would be required to reduce emissions from existing assets, strengthen markets for technologies at an early stage of adoption, develop an upgrade infrastructure to allow technology deployment, promote support for research, development and demonstration and expand international technology collaboration.[[356]](#footnote-356) Over half of emissions reductions were based on technologies not yet commercially available under the SDS and 50% under the FIC.

The IEA considers the net zero transition in terms of CO2 emission in relation to eight areas of avoided (reduced) demand, hydrogen, bioenergy, other renewable sources, electrification, other fuel shifts, technology performance and CCUS.[[357]](#footnote-357) Electricity demand would increase from one fifth to 50% by 2020 and provide 20% of cumulative CO2 savings. Demand would expand by 30,000 TWh by 2070. Global hydrogen production would have to increase by seven times to 520 Mt and represent 13% of final demand. CCUS can store 3 Gt of emissions or produce 5 mb/d of clean aviation fuel. Over 70% of final energy demand would be satisfied by low carbon electricity generation, bioenergy, hydrogen and hydrogen based fuels.[[358]](#footnote-358) Industry, transport and building sector CO2 emissions would fall by 90%.[[359]](#footnote-359)

McKinsey have produced a cost curve for greenhouse gas reduction to measure the size and cost of measures to reduce greenhouse gas emissions.[[360]](#footnote-360) Costs of securing a 450 parts per million reduction scenario were dependent on the ability to capture all available abatement potential costing up to €40 per tonne. Total global cost would be around €500 billion in 2030 which was 0.6% of projected GDP. If more expensive approaches were required, the cost would rise to €1100 billion or 1.4% of GDP.

A GeGaLo index of geopolitical gains and losses had been calculated to determine the geopolitical implications of transition to renewable energy sources across 156 countries. The geopolitical changes that occur reflect a loss of power by high fossil fuel exporting nations and an increase in influence by importers and renewable energy supply providers increases.[[361]](#footnote-361) Effective regional and global commitments would be required with developed country leadership.[[362]](#footnote-362)

(3) IEA, *Net Zero 2050 Roadmap* (2021)

[The International Energy Agency (IEA) has examined energy supply issues including in relation to oil, gas and coal, renewable energy technologies electricity markets, energy efficiency, energy access and demand side management and supply.[[363]](#footnote-363) A number of policies have been promoted to enhance the reliability, affordability and sustainability of energy. The IEA has produced a *Net Zero by 2050 Roadmap*.[[364]](#footnote-364) Net zero by 2050 would require a total transformation of global energy systems. The IEA co-hosted a COP26 Net Zero Summit with the UK government in March 2021 and produced ‘Seven Key Principles for Implementing Net Zero’.[[365]](#footnote-365) 2050 net zero can be secured following the IEA Roadmap which is claimed to be cost effective and economically productive capable of securing a clean, dynamic and resilient energy economy dominated by renewables including solar and wind rather than fossil fuels. The Roadmap includes 400 milestones including no new fossil fuel supply investment from 2021 and no internal combustion passenger car sales by 2035.

The IEA *Net Zero by 2050 Report* sets out a global pathway[[366]](#footnote-366) with sectoral pathways[[367]](#footnote-367) with wider targets and implications.[[368]](#footnote-368) Current global pledges are reviewed.[[369]](#footnote-369) These cover around 70% of global economic activity and CO2 emissions with a significant gap still left to secure the 2050 target. Twenty two gigatonnes (GT) of energy related and industrial processed CO2 emissions would remain resulting in a global temperature of 2.1°C (50% probability) by 2100.[[370]](#footnote-370) The IEA develops a Net-Zero Emissions by 2020 Scenario (‘NZE’) based on certain assumptions.[[371]](#footnote-371) Additional population and GDP assumptions are made with energy and CO2 prices.[[372]](#footnote-372) Seven key pillars of decarbonisation are identified.[[373]](#footnote-373) ]

[[374]](#footnote-374) CO2 emissions had increased 60% from energy and industry sources since the UNFCCC was agreed in 1992. The IEA Roadmap contains 400 milestones to secure net zero by 2050. 2030 targets can be achieved principally using existing technologies with half of the additional reductions necessary coming from prototype or new technologies which required necessary investment. Global energy demand would be reduced by 8% by 2050 although this would support over two billion additional people and a global economy twice as large. 90% of electricity would be derived from renewable sources (with wind and solar PV providing 70% of energy) with the balance being based on nuclear sources. Fossil fuel usage would drop from 80% to 20% in areas without viable alternative low emission options but using carbon capture technology. Electricity would have to be made available to an additional 785 million people without access with clean cooking solutions provided to 2.6 billion at a costs of $40 billion per year or 1% of energy sector investment. Total energy investment would have to reach $5 trillion by 2030 although this would add 0.4% to global GDP growth.

**[Decarbonisation** **Pillars]**

The key pillars of decarbonisation are energy efficiency[[375]](#footnote-375), behavioural change[[376]](#footnote-376), electrification[[377]](#footnote-377), renewable use[[378]](#footnote-378), hydrogen[[379]](#footnote-379) and hydrogen based fuels[[380]](#footnote-380) with bioenergy[[381]](#footnote-381) and carbon capture, utilisation and storage (CCUS)[[382]](#footnote-382) [and carbon direct removal (CDR)].[[383]](#footnote-383) Annual energy investment would have to increase from $2 trillion globally to $5 trillion by 2030 and $4.5 trillion by 2050.[[384]](#footnote-384) This would rise from 2.5% global GDP to 4.5% by 2030 and 2.5% by 2050.[[385]](#footnote-385) Substantial investment would have to be made in electricity generation and nuclear power as well as in electricity networks.[[386]](#footnote-386) Specific uncertainties may arise in the assumptions and modelling used especially with regard to behavioural change, bioenergy use and CCUS adoption.[[387]](#footnote-387) Specific sector pathways are provided including in relation to fossil fuel supply, low emission fuel supply, electricity, industry, transport and buildings.[[388]](#footnote-388) Additional comment is made on the impact of achieving net zero by 2050 on the economy, energy industry, citizens and government.[[389]](#footnote-389)

Achieving Net Zero by 2050 is referred to as a monumental task.[[390]](#footnote-390) A number of overlapping milestones are identified in the Report.[[391]](#footnote-391) Delivery requires significant change by individuals and industry as well as full government commitment and ‘buy-in’ at all levels and in all countries.[[392]](#footnote-392) This will require an unprecedented level of global collaboration and recognition of the differences in difficulty experienced by all of the interest groups involved. The IEA NZE advocates the adoption of unequivocal long term targets by governments with explicit near term targets and measures to support the development of new infrastructure and technologies.[[393]](#footnote-393) Government policy will specifically have to ensure stable electricity supply and security[[394]](#footnote-394) and infrastructure stability.[[395]](#footnote-395) Tax revenues from fossil fuels will collapse by 90% of around $700 billion between 2020 and 2050 with these representing between 4-10% government revenue in developed economies and 3.5% in emerging markets.[[396]](#footnote-396) Alternative charging will have to be considered including on CO2 pricing, road fees and congestion charges and electricity taxation. Net zero will also require substantial advances in clean energy innovation development.[[397]](#footnote-397) This will also be dependent on securing significant and unprecedented levels of international cooperation between countries.[[398]](#footnote-398) Low international cooperation would result in substantially reduced innovation, technology demonstration, market coordination and emissions pathway del

(4) **Alternative Power Energy Sources (APES)**

Effected carbon management would require the design, development and adoption of a series of new ‘Alternative Power Energy Sources’ (APES). These include appropriate ‘Alternative Carbon Controlled Energy Source & Storage (ACCESS) devices. This would operate within a new ‘Renewable Energy Source & Production & Organised Network Storage Economy or Environment (RESPONSE). This new alternative programme would include their use and application of a series of innovative new devices and facilities covering each of the following:

 **(a) Solar (APV, Roads, Buildings (Glass & Bricks), Space & Thermal)**

 **(b) Air (Land & Floating Turbines & Air Storage Heat Pumps (ASHP))**

 **(c) Marine (Tidal, Wave & Hydroelectric)**

 **(d) Geothermal**

 **(e) Bioenergy (Wood, Waste, Landfill & Biofuels (Biomethane & Biodiesel))**

 **(f) Mechanical & Kinetic (Car (Break systems), Trains & Batteries (Sand))**

 **(g) Nuclear (Fission, Fusion & Cold Fusion)**

 **(h) Hydrogen Economy**

 **(i) Large Energy Storage (LES)**

 **(k) Large Energy Transmission (LET)**

 **(l) Supergrids**

 **(m) SMART Global Energy Market (GEM)**

(5) Government, Fiscal and Taxation Policy

Governments have to adopt appropriate climate policies, including clear targets and agenda. This should be set out in a proper legal framework insofar as possible such as under the UK Climate Act 2018. Other legal and regulatory measures should be adopted or revised as necessary.

Governments should ensure that public investment programmes fully support climate activities. This specifically applies with regard to energy and public transportation infrastructure. Government fiscal policy should be adjusted to ensure maximum support. Taxation policies should also be adjusted to incentivise private investment in climate management activities. This applies with regards to companies and individuals. Substantial funds may be released in this manner.

(6) Households and Individuals

Households and individuals can adopt a wide range of measures to adjust their purchase and consumption choices and living practices. Elective behavioural change could have a significant impact on climate management provided that this is supported by effective sector and government policies and response.

(7) Markets & Investment

Markets and investment practices can have a significant role in climate management to the extent that this impacts on the availability and distribution of capital and investment sources. Funding will be essential to developing necessary technologies. Existing and new financial markets can assist make the necessary funds available and redistribute capital as necessary to more climate-efficient applications. Investment analysis and the portfolio management industry can ensure that funds are redistributed and targeted as necessary from older damaging legacy industries to more efficient new uses.

Financial markets and investment managers have to consider incorporating green elements or credentials within indexes and portfolio. This is partly in response to policy and consumer pressure as climate sensitivity increases. It is also necessary accurately to reflect asset and investment prices as carbon and fossil fuel related investments become of less value especially in potentially dead or ‘stranded’ sectors. Accurate climate pricing will become a key element of portfolio management. Climate change has been referred to as ‘the greatest and widest ranging market failure ever seen’.[[399]](#footnote-399)

(8) Stability, Regulatory and Monetary Policy

Central banks are responsible for maintaining financial stability which includes protecting financial and payments systems from disturbance as a result of climate and transition risks. The UK Bank of England is specifically responsible for the promotion of the good of the people of the UK through the maintenance of monetary and financial stability.[[400]](#footnote-400) The Bank has been considering where, to what extent and how to respond to climate impacts since 2015.[[401]](#footnote-401) Climate change may specifically lead to physical risk, liability risks and transition risks as well as transition risks.[[402]](#footnote-402) Initial responses must be based on full disclosure of all relevant costs, opportunities and risks created by climate change which were initially considered by the Financial Stability Board (FSB) Enhanced Disclosure Task Force (EDTF) and with the proposed establishment of an industry led Climate Disclosure Task Force (CDTF).[[403]](#footnote-403) The Bank published an early policy statement to engage with firms dealing with climate related risks, including in the insurance area, and to enhance the resilience of the UK financial system through supporting orderly market transition measures.[[404]](#footnote-404) Climate was also considered in the recommendations contained in the *Future of Finance* report in 2019.[[405]](#footnote-405) The Bank published its own climate related disclosure measures in June 2020 with a subsequent Greener Bank programme to reduce the environment impact of its day to day operation.[[406]](#footnote-406)

Central banks have to assist manage risk within the economy and financial system. Physical risks can inflict damage on property and infrastructure, disrupt supply chains and food production, limit productivity, undermine human health and possibly lead to wider displacement and conflict.[[407]](#footnote-407) This can reduce asset values, lead to stranded assets or right-offs, reduce profitability, damage public finance and increase insurance costs. Assets have to be revalued and credit risk and collateral reassessed. Markets may not reflect physical, financial and transition risks[[408]](#footnote-408) This may arise as a result of inadequate climate disclosure, absence of cleared climate policies and firms’ failure to internalise emission costs.[[409]](#footnote-409) The remits of the Bank’s Financial Policy Committee (FPC) and Monetary Policy Committee (MPC) were revised with those of the Prudential Regulation Committee (PRC) and Financial Conduct Authority (FCA) were all amended to include climate change in addition to the Government’s ‘Building Back Better’ and revised financial services objectives.[[410]](#footnote-410) Central banks have then had to consider climate impact within their financial system, macroeconomic and monetary policy work.[[411]](#footnote-411)

**9. CLIMATE FINANCE AND REGULATION**

A number of initiatives have been adopted by financial market related bodies in relation to climate in recent years. This includes work by the FSB, Basel Committee on Banking Supervision, Committee on Payment and Market Infrastructure (CPMI),[[412]](#footnote-412) International Association of Insurance Supervisors (IAIS),[[413]](#footnote-413) International Organisation of Securities Commissions (IOSCO),[[414]](#footnote-414) International Monetary Fund and World Bank[[415]](#footnote-415) and Organisation for Economic Cooperation and Development (OECD).

(1) Financial Stability Board (FSB)

The FSB has been examining the financial stability impact of climate related risks, in particular, in relation to data availability and data gaps as well as reviewing regulatory and supervisory approaches within financial institutions. The FSB established a Task Force on Climate related Financial Disclosures (TCFD) in 2015 to develop voluntary disclosure recommendations for use by firms in working with lenders, investors and insurance providers. A substantial framework of disclosure recommendations was published in 2017[[416]](#footnote-416) following earlier work in 2016.[[417]](#footnote-417) The FSB notes that one of the essential functions of financial markets is to price risk in support of informed and efficient capital allocation decisions.[[418]](#footnote-418) Four key sets of recommendations were proposed that were intended to be adoptable by all organisations, including in financial filings, designed to solicit decision-useful forward looking information on financial impacts and provide a significant focus on risks and opportunities related to transitioning to a low carbon economy.[[419]](#footnote-419) [Seven principles for effective disclosures were produced.[[420]](#footnote-420)] Disclosures would focus on governance, strategy, risk management and metrics and targets.[[421]](#footnote-421) More specific recommended disclosures remain with regard to each of these factors[[422]](#footnote-422) with supplemental guidance for financial sector and non-financial groups.[[423]](#footnote-423) One thousand seven hundred organisations have expressed support for the TCFD recommendations with 60% of the world’s 100 largest public companies following the initiative. Further status reports were published.

The FSB produced a *Roadmap for Addressing Climate-related Financial Risks* in July 2021.[[424]](#footnote-424) This was produced for G20 endorsement at the G20 Finance Ministers and Central Bank Governors meeting in July 2021. The Roadmap is based on five sets of initiatives in relation to disclosures,[[425]](#footnote-425) data,[[426]](#footnote-426) vulnerabilities analysis,[[427]](#footnote-427) regulatory and supervisory practices and tools[[428]](#footnote-428) and interconnections.[[429]](#footnote-429) Each of these is considered in terms of a core goal and challenges and actions necessary to secure the objective. This focuses on short and medium term activities (2021-2023) with longer term targets. The FSB would coordinate with the G20 Sustainable Finance Working Group (SFWG) in the development of its G20 *Roadmap on Sustainable Finance* with the focus on climate-related risks rather than funding.[[430]](#footnote-430)

Climate change can create new forms of risk. These can be referred to as ‘green swan’ risks following earlier black swan exposures that refer to unpredictable events that may have a low probability of arising but does proportionate damaging effects.[[431]](#footnote-431) Green swans are similar[[432]](#footnote-432) to black swans although they also differ in terms of certainty of occurrence, severity and complexity.[[433]](#footnote-433) This requires the development of new risk management techniques or a ‘epistemological break’.[[434]](#footnote-434) Climate risks cannot be incorporated into traditional forms of risk analysis due to the uncertainty created by continuously changing physical, social and economic phenomenon. This may be understood in this paper as creating a form of emergence. Complex collective action problems arise in coordinating necessary solutions across a number of parties and agents. Central banks and other authorities have a responsibility to develop new forms of forward looking scenario based analysis in cooperation with governments, the private sector, civil society and the international community.[[435]](#footnote-435) This creates a new challenge in terms reconsidering financial stability in an age of climate change. Climate risks threaten traditional ecosystems, societies and economies and will have a significant impact on monetary and financial stability with many assets becoming stranded.[[436]](#footnote-436) Financial and price stability have to be considered with climate stability as constituting distinct but connected public goods with new quantitative and qualitative approaches being required to secure system resilience.[[437]](#footnote-437) Forward looking scenario based analysis will still be insufficient due to the deep levels of uncertainty involved and need for structural transformation.[[438]](#footnote-438) Climate risk management has to be incorporated into prudential regulation and monetary policy to the extent possible with central banks assuming a more proactive role.[[439]](#footnote-439) A five ‘C’ approaches proposed based on contribution to coordination to combat climate change.[[440]](#footnote-440)

(2) Basel Committee

The Basel Committee published a review of member authorities’ initiatives in relation to climate prepared by its high level Task Force on Climate related Financial Risks (TFCR) in April 2020.[[441]](#footnote-441) The TFCR was set up to provide a stocktake of members’ regulatory and supervisory initiatives on climate risks, prepare analytical reports and development effective supervisory practices to mitigate climate related exposures. The 2020 stocktake notes that a majority of members recognised the need to incorporate climate related financial risks within their regulatory and supervisory frameworks and had conducted relevant research. Certain operational challenges had been identified in terms of data availability, methodology and transmission channel mapping. Relevant issues were being discussed with banks with some work having been conducted on the development of principles based guidance with this not yet having been incorporated into prudential capital frameworks.[[442]](#footnote-442) The Committee was principally concerned with physical risks, including the costs and losses arising from an increased severity and frequency in extreme climate related events, and transition risks which were concerned with adjusting to the development of low carbon economies. [The stocktake report noted that a majority of countries had not adopted any explicit mandate with regard to climate related financial risks.]

The Basel Committee published two reports on climate related Transmission Channels and Measurement Methodologies in April 21.[[443]](#footnote-443) The first paper was concerned with the exposures that may arise to banks and the banking system with the second developing appropriate risk measurement frameworks and practices. The paper on risk drivers considers micro and macro-economic transition channel effects with climate related risks being dependent on geography, sector and economic and financial system development. Existing risk classifications, including credit, market, liquidity and operation and reputational risk,[[444]](#footnote-444) could be used to capture climate related exposures. There had nevertheless been inadequate research and data collection to understand the relevant linkages with further research being required.[[445]](#footnote-445) The paper considers risk drivers, transmission channels, geographical heterogeneity, amplifiers and mitigants.[[446]](#footnote-446) The Committee would attempt to identify gaps within its current framework as part of a mapping exercise.[[447]](#footnote-447) Further research would be conducted to examine risk drivers and transmission channels across all risk exposures.[[448]](#footnote-448) Physical drivers were considered in terms of acute and chronic drivers.[[449]](#footnote-449)] [Transition risk drivers were examined in terms of climate policies, technology, investor sentiment and consumer sentiment.[[450]](#footnote-450) Further uncertainties arose due to the speed of change, non-linear nature of effects (including tipping points) and geographic diversity.[[451]](#footnote-451)] [Heterogeneity was impacted by differences in the likelihood and severity of climate crises, structural differences and financial system variations.[[452]](#footnote-452) Effects may be amplified through interactions and interdependencies between drivers, feedback effects and combined impacts.[[453]](#footnote-453) Mitigants include proactive vulnerability reduction policies and reactive management such as through hedging, insurance, reinsurance, securitisation and asset sales.[[454]](#footnote-454)

[Five key findings were drawn.[[455]](#footnote-455)] The Committee’s related paper on *Measurement Methodologies* highlights the need for granular data and forward looking measurement methodologies to respond to the unique features within climate related financial risks. This had generally focused on mapping near-term transition risk drivers in bank exposures focusing on credit risk. Work was increasing although banks were still at an early stage of mapping relevant exposures. Future work included identifying measurement data gaps and risk classification methods as well as means of assessing long term climate phenomena of a non-standard nature.

(3) Bank for International Settlements (BIS)

**(4) Bank of England**

The Bank of England assisted establish the Central Banks and Supervisors’ Network for Greening the Financial System (NGFS) in December 2017 at the *One Planet Summit* in Paris.[[456]](#footnote-456) with seven other central banks and supervisory authorities. The NGFS produced a set of climate scenarios in June 2020[[457]](#footnote-457) with a supporting Guide to climate scenario analysis for central banks and supervisors.[[458]](#footnote-458) This identifies three representative scenarios of orderly, disorderly and hot house world conditions. Transmission channels are assessed in terms of transition and physical climate risks[[459]](#footnote-459) with financial risks[[460]](#footnote-460) and micro business household and macro channels.[[461]](#footnote-461) This is incorporated into the 2021 Climate BES.[[462]](#footnote-462) [The NGFS produced a report in April 2019[[463]](#footnote-463) on Climate change as a source of economic and financial risk with six key recommendations made.[[464]](#footnote-464)] Open letters have been published by senior officials involved on climate related financial risks with the objective of realising the opportunities created to contain the climate challenge following the coronavirus crisis.[[465]](#footnote-465) [The Bank has assisted establish the Sustainable Insurance Forum (SIF) to manage sustainability in the insurance sector through a network of supervisory and regulatory authorities.[[466]](#footnote-466) Separate *Principles for Sustainable Insurance* have been issued under the UN Environment programme.[[467]](#footnote-467)]

The UK PRA considered the impact of climate change on the insurance sector in 2015 with specific reference to physical, transition and liability risks.[[468]](#footnote-468) This was extended to include banks in 2018 with a shift from assessing this in terms of reputational to financial and strategic risk.[[469]](#footnote-469) Managing the financial risk from climate change in the banking and insurance areas was extended in 2019[[470]](#footnote-470) A six stage framework was developed for examining climate change risk in the insurance area in May 2019.[[471]](#footnote-471) An interim report of the UK’s Joint Government Regulator Taskforce on Climate-related Financial Disclosures (TCFD) was published in November 2020[[472]](#footnote-472) with a roadmap for climate related disclosures[[473]](#footnote-473) covering the periods from 2021 to 2022, 2023 and 24‑25. The PRA has been conducting separate stress tests for insurance companies[[474]](#footnote-474) with wider financial system’s resilience being built into the 2021 Biennial Exploratory Scenario (CBES) assessment.[[475]](#footnote-475) The PRA and FCA have set up in March 2019 a Climate Financial Risk Forum (CFRF) with financial sector representatives to develop capacity building and share best industry and regulatory practice with a number of working groups being set up.[[476]](#footnote-476)

[Climate impact and the transition to a Net Zero economy can also be considered for monetary policy purposes which is normally reviewed over a two to three year horizon. Macroeconomic variables may be impacted by supply side changes which also effect expected natural rates of interest and unemployment.[[477]](#footnote-477) This has to be incorporated into relevant modelling. The Bank has been conducting separate research on climate related matters.[[478]](#footnote-478) The Bank has also been attempting to green its monetary policy asset portfolio, in particular, through its Corporate Bond Purchase Scheme (CBPS).[[479]](#footnote-479)]

(5) OECD

The OECD has contributed to international climate negotiations and assisted countries develop relevant national and international commitments and contributions with the focus on environmental, economic, financial and social aspects of climate challenge.[[480]](#footnote-480) The OECD has published a number of papers in the areas of climate action and the economy, the Climate Change Expert Group (CCXG), climate finance, climate resilience and adaptation, low carbon transition, green finance and investment, land use, ecosystems, agriculture and climate change, transport and climate change, cities and climate change and nitrogen pollution.[[481]](#footnote-481)

(6) EU

**10. CLIMATE AND ENVIRONMENTAL LAW**

Difficulties arise in enforcing international environment law standards due to the need to establish state responsibility and causation especially in relation to non-state actors.[[482]](#footnote-482) Attention has accordingly focused on establishing international standards and cooperation in this area.[[483]](#footnote-483) The United Nations Environment Programme (UNEP) following the UN Conference on the Human Environment in Stockholm in June 1972.[[484]](#footnote-484) The United Nations General Assembly has produced a number of resolutions on the environment.[[485]](#footnote-485) The UNEP operates through a Committee of Permanent Representatives made up of accredited Permanent Representatives to the Programme[[486]](#footnote-486) The CPR was originally set up as a subsidiary of the Governing Council managed through a five member bureau. The UNEA has a separate Senior Management Team chaired by an Executive Director.

Climate matters are considered through UN Climate Change Conferences which act as global discussion fora. These include the Conference of the Parties (COP), the Conference of the Meeting of the Parties (CMP) to the Kyoto Protocol and Conference of the Meeting of the Parties to the Paris Agreement (CMA).[[487]](#footnote-487) The Conference of the Parties is made up of the COP, CMP and CMA which review implementation of the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and Paris Agreement.

Other UN agencies include the UNFCCC Secretariat (UN Climate Change),[[488]](#footnote-488) Intergovernmental Panel on Climate Change (IPCC),[[489]](#footnote-489) Green Climate Fund,[[490]](#footnote-490) UN Office for Disaster Risk Reduction[[491]](#footnote-491) and World Meteorological Organisation (WMO)[[492]](#footnote-492) and Inter-Agency Committee on Climate Change (IACCC) was established in 1991 with a separate Inter-Agency Committee on Sustainable Development (IACSD) established in 1992 following the Earth Summit Conference on Environment and Development (UNCED).[[493]](#footnote-493) The UN Commission on Sustainable Development (CSD) was also set up in December 1992 by the UN General Assembly to follow up on the UNCED. The CSD was replaced by the High-Level Political Forum on Sustainable Development (HLPF) in 2013 which is responsible for implementation of the 2030 Agenda for Sustainable Development and 17 Sustainable Development Goals (SDGs).[[494]](#footnote-494)

**(a) State Liability**

States are subject to a duty not to injure the rights of other states in carrying out sovereign activities.[[495]](#footnote-495) States may preach customary international law, *jus cogens* (peremptory norms).[[496]](#footnote-496) Diplomatic action may be possible or proceedings before the International Court of Justice and possibly international arbitration in qualifying cases.[[497]](#footnote-497) States were under a duty to protect international waterways[[498]](#footnote-498) which included protecting the rights of other states.[[499]](#footnote-499) The ICJ has extended this to include damage through injury by fumes[[500]](#footnote-500) with this including not allowing its territory to be used contrary to the rights of other states.[[501]](#footnote-501) While nuclear testing could be carried out, this had to be without prejudice to the ‘obligations of states to respect and protect the environment.’[[502]](#footnote-502) Principle 21 of the 1972 Stockholm Declaration provides that states have a responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other countries beyond the limits of national jurisdiction. Difficulties nevertheless arise in determining the appropriate standard of care to apply, causation and liability for non-state conduct.[[503]](#footnote-503) The general applicable standard of proof would be one of failure to undertake due diligence rather than strict liability with the need to establish injury and private conduct possibly covered depending upon the nature of the underlying obligations assumed.

The International Law Commission considered standards for imposing ‘International Liability for the Injurious Consequences of Acts Not Prohibited by International Law’ in 1978[[504]](#footnote-504) which was later issued in the form of ‘Draft Articles on Prevention of Transboundary Harm from Hazardous Activities’ in 2001 following objections to the extension of state responsibility into new international liability.[[505]](#footnote-505) The Articles apply to any ‘risk of causing significant transboundary harm through...physical consequences’ (art 1) with this including the ‘high probability of causing significant transboundary harm’ and ‘low probability of causing disastrous transboundary harm’ (art 2). States are to cooperate in good faith to prevent harm (art 4). The ILC adopted additional ‘Draft Principles on the Allocation of Loss in the Cause of Transboundary Harm Arising out of Hazardous Activities’ in 2006 to attempt to ensure proper compensation.[[506]](#footnote-506) States are separately required under the 1972 Stockholm Declaration to cooperate[[507]](#footnote-507) and under the 1992 Rio Declaration.[[508]](#footnote-508) [Establishing state liability has led countries to shift to promoting international cooperation.[[509]](#footnote-509)]

**(b) Environment and Human Rights**

Attempts have been made to establish a link between environmental rights and human rights.[[510]](#footnote-510) This may include the rights to life, adequate standard of living, health, and food although limited express provisions have tied these to environmental protection directly.[[511]](#footnote-511) Only limited reference was included within the 1992 Rio Declaration on Environment and Development. A set of Draft Principles on Human Rights and the Environment were agreed in 1994 by the UN Sub-Commission on Prevention of Discrimination and Protection of Minorities[[512]](#footnote-512) with a direct link created under the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters in 1998.[[513]](#footnote-513) Human rights and parallel environmental rights have to be balanced against economic development rights and the possible damage that non-sustainable development may cause.[[514]](#footnote-514) One solution may be to develop ‘debt for nature swaps’ with countries being able to convert external debt commitments into internal local environmental investment.[[515]](#footnote-515)

**(c) Environmental Principles**

A number of general principles may apply under International Law impacting on environmental cooperation and management. These may include territorial injury, precaution, sustainable development and polluter pays.[[516]](#footnote-516) States are under an obligation not to allow their territories to be used in a manner that may damage the interests of other states and by implication to inform them of any potential risk.[[517]](#footnote-517) The precautionary principle, special responsibility, is provided for under Principle 15 of the Rio Declaration and other measures.[[518]](#footnote-518) The special responsibility of larger countries was recognised under Principle 7 of the Rio Declaration and in Article 3(1) of the Convention on Climate Change.[[519]](#footnote-519) The need for sustainable development is recognised in Principles 3, 4 and 27 of the Rio Declaration and Article 3(4) of the Climate Change Convention with sustainable used referred to in the Biodiversity Convention.[[520]](#footnote-520) The polluter pays is provided for under Principle 16 of the Rio Declaration and other international conventions as well as OECD and EU documentation.[[521]](#footnote-521) The detailed nature of the requirement is still uncertain.[[522]](#footnote-522)

**(d) Pollution**

States are required not to use or permit their territory to cause injury in or to the territory of another state or persons or property there including through fumes.[[523]](#footnote-523) The injury would have to be serious and be established by clear and convincing evidence.[[524]](#footnote-524) Pollution has been defined by the OECD in terms of deleterious effects to human health, living resources and ecosystems.[[525]](#footnote-525) This was reused with minor amendment in the Geneva Convention on Long Range Transboundary Air Pollution 1979 and ILA Montreal Rules of International Law Applicable to Transfrontier Pollution 1982.[[526]](#footnote-526) States are nevertheless only required to gradually reduce and prevent air pollution with exchange of information and consultation but without any expression provisions on liability.[[527]](#footnote-527) Oversight was extended through the ‘Cooperative programme for the monitoring and evaluation of the long-range transmission of air pollutants in Europe’ (EMEP) with a series of additional protocols being adopted.[[528]](#footnote-528) The EMEP operates through a Steering Body, Secretariat and Bureau with a number of Task Forces with calibration being carried out through the Chemical Coordinating Centre (CCC).[[529]](#footnote-529) A further Stockholm Convention on Persistent Organic Pollutants (POPs) was agreed in 2001 which manages the production, use and import and export of 12 specific POPs.[[530]](#footnote-530)

**(e) Climate Change**

Separate attempts have been made to protect the ozone layer separately. The ozone layer forms part of the stratosphere and absorbs 97-99% of medium frequency (200-315 nm) ultraviolet light from the sun.[[531]](#footnote-531) The ozone layer is between 15-35 km (9-22 miles) above the earth.[[532]](#footnote-532) The ozone layer was identified in 1913 and measured from 1928.[[533]](#footnote-533) The atmosphere contains around 0.3 parts per million ozone with 10 parts per million within the ozone layer. Ozone levels were reduced through the release of manmade organohalogen compounds including chlorofluorocarbons (CFCs) and bromofluorocarbons (BFCs).[[534]](#footnote-534) Ozone ‘holes’ specifically emerged above the North and South Poles.[[535]](#footnote-535)

The Vienna Convention for the Protection of the Ozone Layer was agreed in 1985 and came into effect in 1988.[[536]](#footnote-536) Parties agreed to take appropriate measures to protect human health and the environment against adverse effects and to cooperate in the collection of relevant material and development of appropriate measures to control, limit, reduce or prevent human activities with an adverse effect on the ozone layer.[[537]](#footnote-537) A secretariat and dispute settlements mechanism were set up.[[538]](#footnote-538) This was followed by a Montreal Protocol with controlled substances[[539]](#footnote-539) being capped at 1986 levels with progressive reductions to be adopted over a ten year period.[[540]](#footnote-540) A Technology and Economic Assessment Panel (TEAP) and Implementation Committee were established. Ozone depletion had been identified by chemist, Frank Rowland and Mario Molina in 1973-1974 with the ozone hole identified by the Stratospheric Aerosol and Gas Experiment (SAGE) to satellite instruments launched in October 1984.[[541]](#footnote-541) A number of amendments were made to the Montreal Protocol.[[542]](#footnote-542)

The UN Framework Convention on Climate Change was agreed in 1992.[[543]](#footnote-543) [[544]](#footnote-544) This followed General Assembly resolutions in 1988 and 1989.[[545]](#footnote-545) A separate Hague Declaration on the Environment was produced in 1989 which recommended the establishment of an international authority in response to global warming. The objective of the UNFCCC is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system within a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened and enable economic development to proceed in a sustainable manner.[[546]](#footnote-546) A series of principles[[547]](#footnote-547) and commitments are specified.[[548]](#footnote-548) The UNFCCC also provides for research and observation as well as education, training and public awareness.[[549]](#footnote-549) A Conference of the Parties (COP) is established as the supreme body under the Convention to review its implementation and any legal instruments adopted.[[550]](#footnote-550) A separate secretariat is established with a subsidiary body for Scientific and Technological Advice (STA) with a separate body for Implementation.[[551]](#footnote-551) The Convention contains additional provisions on the provision of financial resources through a financial mechanism, communication and dispute settlements.[[552]](#footnote-552)

Other important international provisions include the Kyoto Protocol in 1997[[553]](#footnote-553) and Paris Agreement.[[554]](#footnote-554)

**11. CLIMATE AND ENVIRONMENTAL CONCLUSIONS & COMMENT**

We need to develop an appropriate ‘Controlled Linkage & Integrated Management of the Atmosphere, Technology & the Environment’ (CLIMATE). The have to develop necessary ‘Climate Laws & Integrated Management of the Atmosphere, Technology & Increased Carbon’ (CLIMATIC) control. It is necessary to construct an appropriate ‘Climate & Atmospheric Reduction & Balanced Order & Net 0’ (CARBON) agenda. We need are necessary ‘Climate Action Policy’ (CAP) or programme with a fully formulated ‘Climate Adaptive Transition’ (CAT) with necessary ‘Climate Action Technologies’ (CATs) of home. These has to be a suitable ‘Climate Law, Ethics & Regulatory Framework’ and ‘Climate Law, Ethics & Action for Net 0’ (CLEAN) programme. The can also be onsidered in terms of ‘Climate Action, Regulation & Ethics’ (CARE) and ‘Climate Action Policy & Ethics (CAPE). All of this can be achieved through the development of appropriate ‘Climate Law Integrated Protocols’ (CLIPSs).

The global current climate challenge can be considered in terms of opportunity and potential rather than cost and loss. An informed and progressive rather than critical and regressive policy approach can be adopted. It is possible to construct a new integrated and comprehensive climate agenda based on a number of programmes and sub-programmes. This can be set out and implemented through a Climate Action Protocol (CAP) framework. This could be agreed as part of a wider global crisis management agenda.[[555]](#footnote-555) This could also form part of a wider ‘Social Market, Atmospheric (climatic) Regulatory, Technology and Security’ (SMARTS) initiative or ‘Social Trade, Atmospheric (climatic) Regulatory, Technology and Security’ (STARTS) solutions.[[556]](#footnote-556)

It is possible to build new model solutions based on effective Climate, Action, Programmes (CAPs) with a meaningful Climate Action Programme for Integrated Technology and Law (CAPITAL) solution. Effective delivery is required with a proper Progressive Enabled Transition (PET) solution. This can secure a Climate Adjusted Reduction Balanced Order and Net neutral (CARBON) response complying with relevant Zero Environmental Balanced Rates Action (ZEBRA) and relevant Market Action Solutions and Target (MASTS).

An appropriate solution must consist of (a) energy, production, construction, agriculture and transport, (b) government, (c) markets and investment, (d) regulatory, monetary and fiscal policy and (e) creators and individuals. This has to be built on an appropriate policy and programme to secure Structured and Organised Climate Investment Advancement and Law (SOCIAL).

(1) Climate Cycles, Causation and Contribution

A substantial amount of residual climate confusion remains. Points of climate fact are clear and incontrovertible. Disagreements nevertheless remain in terms of climate causation and chain explanation or country appropriation. It has to be accepted that much of the rhetoric used is dramatic and arguably inflammatory. Emotive argument is used to promote interest and attention although this can often limit understanding and appreciation. We need to encourage contribution although this can distort or distract attention and engagement. This is not harmful of itself provided that a total more complete and balanced policy position and approach is adopted.

The specific degree of anthropogenic contribution remains unclear although the consequential negative impacts are unquestionable. Man is, at minimum, a significant aggravating factor if not solely and directly causing climate damage as a separate environmental event. Mankind has an arguably irrefutable duty or responsibility to manage its involvement and contribution for its own sake and in terms of current and future generations, other species or biodiversity and the condition of the planet. Climate loss and damage is real but arguably manageable.

Arguments on country contribution and cause can again only confuse argument and limit agreement. Earlier historical accumulations of toxins, including specifically higher CO2 levels, cannot be blamed before climate science had evolved and identified the issue and explained the factors or conditions concerned. High current polluters cannot use earlier historical examples to avoid or neglect their own current responsibility. Sequencing arguments are also only relevant where this does not adversely impact critical conditions on an irreversible and non-correctible basis. Climate causation will lead to an inevitable common catastrophe without targeted collective c0-action and co-responsibility. Transitioning programmes must be considered and applied although this again does not obviate moral responsibility or blame for failing to take necessary programmed action.

A substantial amount of uncertainty remains with regard to the detail and specific causes of climate change and climate relevant practice. Emotive language and argument can distract attention to relevant issues and promoting engagement and response. This may nevertheless disincentivise parts of society and distract attention from core points of action or undermine corrective action and clear objectives. Climate debate can become increasingly emotional and political especially with the linkages of two wider ideas of social justice and wealth generation and redistribution. Care must be exercised to involve significant climate conspiracies and distort attention or undermine corrective action. More progressive, balanced, informed, constructive and ultimately effective approaches should be adopted where possible.

It is still necessary to avoid inappropriate ‘atmospheric exaggeration’. The climate crisis is arguably not simply a human generated event with much of this involving natural processes. There has, however, been clear ‘anthropogenic aggravation’ and ‘natural cycle disruption’.

(2) Climate Conflict, Confusion and Compromise

While conflicting climate opinions may remain, an appropriate common climate response must be constructed. Individuals, societies, companies, governments and countries may have conflicting positions although convergence and compromise are essential. All parties must work to develop common, coherent and comprehensive workable and deliverable climate and carbon management policies. An appropriate reconciliation must be achieved.

A number of significant potential losses and costs have been identified. These include air, water and land pollution and environmental degradation, deleterious human health conditions, loss of biodiversity, food quality impairment and shortage, resource depletion and exhaustion, natural cycle damage, land use damage, oceanic damage, extreme weather conditions, tectonic disruption and planetary dislocation.[[557]](#footnote-557) This could inflict massive damage and devastation across communities and countries.

These externalities must be set against potential short, medium and longer term contributions. These include improved health, wider biodiversity, increased quality of food and volume of food production, healthier and improved water supply, increased employment, higher levels of private and public investment (including through targeted emissions charging), increased energy access and security, production efficiency, more stable and secure construction and building practices, improved scientific and engineering innovation, improved oceanic conditions, improved land use, less extreme weather events, geological and planetary balance and overall social and welfare improvements and higher quality of living conditions.[[558]](#footnote-558) All of this can bring substantial benefits and advantages across societies and economies.

Any assessment of the climate balance or equation must conclude that the benefits substantially and necessarily outweigh any potential loss or costs. The climate question ultimately resolves itself in terms of an inherent, irresistible and irrefutable inevitability. This creates an automatic need to respond with appropriate programmes and measures.

(3) Climate Action or Adaptive Recommendations (CARS) [Objectives]

An appropriate climate policy can support targeted and informed action and response. A simple initial outline programme can be created with, for example, reference to 3 or 4 ‘Rs’. These can then extended to include ‘Reduction, Reuse, Recycle, Reclaim, Redesign, Rebuild, Recreate, Regenerate, Restore, Replenish, Reform & Recover’. The objective is to create a an easy to use and refer to, understand and remember set of connected policy ideas to support discussion and debate and to inform and educate all interested parties.

A number of key objectives can be adopted through support climate initiatives. New concerns to be based on the following:

(1) Prevention and mitigation of carbon production and other climate effects;

(2) Restoration and revival of natural climate solutions and sink processes;

(3) Funding and investment in business technology solutions to support the transfer of existing energy production, construction, agriculture and other systems to carbon neutral alternatives;

(4) Carbon capture and storage;

(5) Adaptation in adopting of consistent systems to limit damaging effects; and

(6) Shared responsibility and ownership with common benefit and advantage.

These can be summarised in terms of curtailment, Correction, Contribution, Containment, Contribution and Commitment.[[559]](#footnote-559)

A more complete set of structured policies can also be developed. These may include the following:

(1) Inclusion;

(2) Quality;

(3) Minimum reduction and ......................... flooring;

(4) More substantive progressive reduction;

(5) Capital and trading centres;

(6) Leadership;

(7) ..........................;

(8) Capacity building;

(9) Technological innovation;

(10) Technology .................;

(11) Education and schooling;

(12) Policy monitoring, review and ....................

(4) Climate Response Policies & Principles

A series of core climate objectives can be identified. The objective is to support the design and implementation of common programmes and agenda. These can be summarised in terms of prevention, capture, restoration, adaptation, delivery and inclusion.

Climate and carbon damage must initially be prevented or mitigated. Every step must be taken to reduce climate and carbon loss. Temperatures may only be controlled through meaningful and effective prevention and mitigation techniques.

Any toxious emissions must then be captured and contained. Appropriate sequestration techniques have to be applied to ensure effective containment. This may involve natural or artificial or synthetic sequestration technologies. A range of collection and storage devices can be developed for short and longer term carbon management purposes.

Natural cycles and systems must be restored properly without any longer term damage or dilution. Revival or restoration programmes should be applied to ensure that natural cycles operate effectively with natural resources only being used on a non-exhaustible and sustainable basis. Earlier forms of consumption economics must be resisted in favour of longer term continuous supply policies.

Individuals, businesses and governments can adopt effective adaptation policies to allow them to be able to respond to damaging climatic events.

Delivery involves commitment and engagement to ensure that all appropriate correction programmes are adopted and properly implemented. This would require necessary funding and political support at the domestic and international levels. Appropriate monitoring and review systems should also be in place to support and confirm achievement and success. Failure would be identified and explained as part of the ongoing monitoring and parallel accountability and transparency processes established.

Successful completion can also be supported through inclusion and common ownership which also necessarily generates shared responsibility and accountability. Everyone may be impacted by common damaging events which requires a common response. This, in turn, necessitates common engagement and inclusion.

A series of general climate principles can be identified. These would guide other policy and programme initiatives. These can be summarised in terms of sovereignty, access, security, sustainability, continuity and accountability.

Countries have sovereignty in terms of climate policy management which corresponds with their larger political and territorial sovereignty. This also connotes sovereign responsibility. This extends to managing climate damage on their own territory as well as neighbouring territories with this arguably extending to cover all other territories in the world due to the wider impact of significant climate deterioration. This reflects general Public International Law obligations of countries.[[560]](#footnote-560)

Climate access corresponds with other forms of access such as to energy and internet and digital systems. The peoples of the world arguably have a right to enjoy a clean environment. This is reflected in various international conventions and agreements including in terms of fundamental human rights.[[561]](#footnote-561) This also implies climate justice which connotes individual and social and community access. This also implies country access with an appropriate division or distribution of climate management costs. This arguably also implies leadership by the larger countries and largest omitters.

Climate security corresponds with, for example, energy and digital security in terms of the right to continued and stable access. This constitutes a form of stability and quality of condition or service. This also implies inter-generational responsibility in terms of societies not inflicting irreversible damage on future generations.[[562]](#footnote-562)

Sustainability involves the longer term management of safe and stable climate conditions. This implies responsible resource management. This, in turn, connotes the responsible management of natural resources to prevent depletion and exhaustion. New forms of sustainable economics and practices must be developed to ensure that all forms of energy supply, production, construction, engineering and consumption operate on a efficient and manageable basis long term.

Individuals, businesses and governments must be responsible and accountable for their climate and carbon impact and footprint. While this may only involve moral explainability at the individual level, businesses and governments may be subject to wider financial penalties. This may also extend to country compensation where countries breach international agreements or inflict material damage on neighbouring or other territories. Accountability also involves transparency and disclosure. A number of new risk management models are being developed applicable to financial and other institutions with associated disclosure templates being used.

Systems and societies must also be resilient and continuous. While continuity is implied in sustainability, this also arguably involves longer term stability and ability to withstand impact and damage. This would include production processes with supply disruptions and building construction especially against extreme weather events. This would involve another shift in economics from short term to longer term production design and manufacturing methodologies. Continuity can also be considered to extend to protecting species and biodiversity as well as the human species protection.

Climate Adaptive Transition (CAT)

It is essential to adopt an appropriate transition programme. This could be set out in an agreed Climate Augmented Transition (CAT) framework using necessary ‘Climate Adjustment Technologies (CATS). Industries and economies had to transition from high carbon to low carbon usage. This would include disposing of existing carbon assets, restructuring plant and manufacturing and production processing facilities, developing new business plans and models, reallocating staff and securing necessary finance and investment. The adoption of harder short-sighted immediate responses may cause more difficulty and uncertainty including unforeseen consequences. Not allowing major firms to transition effectively may only lead to quick disposals with increased emission results.[[563]](#footnote-563) This may also increase short term and longer term pricing and create unnecessary economic disruption and loss. Longer term difficulties may arise with regard to low or zero value stranded assets. All of this would have to be considered in developing effective climate transition programmes.

(5) Climate & Carbon Tools & Solutions CARBONS ACCESS RESPONSE

A number of appropriate climate correction or solution policies can be developed over time. These could partly be directed at individual, social or community, business, government and country action. This can also be considered in terms of the nature or source of the responsive world. Twelve core corrections can be identified in terms of enhanced individual or lifestyle choices, business sector responses, carbon sequestration, carbon pricing and charging (including carbon allowances and trading), carbon risk modelling, carbon disclosure and accountability, social and community carbon management initiatives, investment and taxation incentives, technological innovation, regulatory management conditions, legal sanctions and enforcement, regional and global agreements and state liability under Public International Law.[[564]](#footnote-564) A series of sector initiatives could also be adopted specifically with regard to energy, industry, construction, engineering, food, agriculture and land use, carbon sinks, transportation, oceans health, and social or recreational activities.[[565]](#footnote-565) A number of specific climate and carbon corrections can be adopted within each of these response fields and sub-fields.[[566]](#footnote-566)

A number of the core objectives and principles identified can be restated or summarised in terms of ............... tools or practices. These may consist of reduction, reuse and reapplication, recycling, reactivation, reclamation, restoration, replenishment, regeneration, redesign or rebuilding and review and revision. The purpose would be to ensure that all production, construction and consumption secured the proper objectives of prevention, capture, restoration, adaptation, delivery and shared responsibility as well as the parallel principles of sovereignty, access, security, sustainability, accountability and continuity.[[567]](#footnote-567) This would create a meaningful, complete and comprehensive climate and carbon management framework and agenda.

(6) Climate Financials

Government investment and fiscal policy has to be directed towards supporting climate efficient projects. This would specifically include infrastructure investment, in particular, in relation to energy transmission and public transportation. Investment is also required in relation to charging points for electrical vehicles which could be installed in all public car parks. Charging points could also be fitted to existing electrical facilities such as lighting lamp posts where this does not create any security issue. Public investment would also support higher employment levels either through direct official employment in climate related functions or through private employment incentives.

Taxation policies must also be adjusted to support climate efficient investment. This would apply both with regard to corporation tax allowance and individual income tax as well as capital gains tax and inheritance tax. A range of allowances could be made available to support investment in climate solutions and redirect corporate and private funds into climate efficient applications.

Other public agency policies have also to be revised as necessary. This would specifically include central bank functions in relation to financial stability and monetary policy. Central banks have to monitor and manage climate related exposures in terms of market stability threats. This may also be relevant in managing monetary policy operations.[[568]](#footnote-568) Regulatory policy is also to be applied to ensure that firms take into consideration all relevant direct and indirect climate and transition risks. This must be fully reflected in asset pricing as well as in capital and regulatory compliance. This would apply in the financial as well as other public utility areas.

(7) Climate Ethics

It is also important to establish an appropriate ethical framework to promote wider compliance and good conduct outside the scope of any narrow or hard law regulation in place. Ethical frameworks create a more inclusive and purposeful environment within which more general principles are applied and objectives secured. These can still be supported by an appropriate sanction regime where necessary or promoted through separate incentive or reputation regimes.[[569]](#footnote-569) Common sets of principles have already been developed in other areas of new technology including, for example, with regard to energy and internet rights.[[570]](#footnote-570) An equivalent set of climate principles could be developed. These would partly implement the more general climate principles already referred to.[[571]](#footnote-571) These could specifically include sovereignty and responsibility, access and justice, security and stability, sustainability and resource management, continuity and resilience as well as accountability and disclosure. These could be supplemented by such more specific principles as minimum 2% temperature targeting, net zero carbon emission targeting, NDC identification and progressive reduction, damage limitation, carbon pricing, technological development and cooperation, assistance and capacity building, full transitioning, controlled sequencing, education and public awareness, monitoring and review and full adherence.[[572]](#footnote-572) These can be discussed, clarified and finalised at the international level as necessary.

(8) Climate Obligations

Climate Cooperation and Coordination

All parties must properly participate in ensuring that all of these separate measures are properly applied and administered in practice. Effective common action requires climate correction cooperation at every level. Decision taking and responses must also be coordinated where necessary at the national, regional and global levels. This can be monitored through a wide series of private initiatives, including through non-government organisations (NGOs), and official and appointed inter-government organisations (IGOs). A series of private and official reports are produced on an annual, intermittent or occasional basis.[[573]](#footnote-573) The power of modern social media may be sufficient to ensure that all necessary public information is made available and properly disseminated. Governments, NGOs and IGOs should supplement this where necessary. Websites already, for example, provide information on temperatures and emission volumes.[[574]](#footnote-574)

(9) Environmental Policies

Climate and carbon control has to be extended to include other wider environmental issues. These include atmospheric pollution, ozone depletion and global warming with marine pollution and diversity and species protection with other possible extra-hazardous substance damage. All this has to be considered in an integrated manner. An appropriate set of supporting policies must then be developed as part of a wider ‘Climate or Carbon Action Policy’ (CAP). This includes developing a ‘Carbon Reclamation, Elimination, Adaptation & Transition Economy’ (CREATE) with a ‘Circular & Recycle Economy’ (CARE) using appropriate ‘Bio Economy Systems Technology’ (BEST). This has to be supported by a complete Biodiversity ‘Species Protection & Inclusion Network’ (SPIN) within a new ‘City & Urban Regeneration Environment’ (CURE) was appropriate ‘Sustainable Alternative Future Energy’ (SAFE) policies. This would, as noted, use Alternative Power Energy Sources (APES), Alternative Carbon Controlled Energy Source & Storage (ACCESS) and work within an informed Renewable Energy Source & Production & Organised Network Storage Economy or Environment (RESPONSE). These could be expressed in terms of a set of ‘Earth Network Values & Integrated Regulation Official Standards’ (ENVIROS) or ‘Biodiversity Integrated Official Standards’ (BIOS).

(10) Exogenous & Global Challenges

All this could I will be built into a larger international response programme to manage other forms of the contingent global threats and exposures. These would include biological or Contagious events, natural or tectonic disasters which threatened Habitation, Atmospheric impacts, Regulatory market or infrastructure failures, Technological maldesign or misuse and threats to Security and stability principally through warfare. The these can be summarised in terms of a CHARTS agenda or set of global ‘Social, Market, Atmospheric, Regulatory, Technological & Safety’ (SMARTS) challenges and corresponding set of integrated ‘Social, Market, Atmospheric, Regulatory, Technological & Safety’ (STARTS) solutions.[[575]](#footnote-575)

(11) Climate Law, Regulation & Ethics

An appropriate legal framework must be in place to ensure that all parties are fully aware of their rights and entitlements as well as obligations and duties in relation to climate and carbon damage. These laws can then be revised over time to create a meaningful control structure within which all rights can be exercised and duties discharged. Existing international conventions and agreements can be revised as necessary with governing principles or Public International Law being clarified to the extent required.[[576]](#footnote-576) A basic legal architecture can be constructed for application in the technology area.[[577]](#footnote-577) This is essentially based on digital data definition, personal identification, property, contract, remedies, offences, infrastructure, service provision and applications, business applications, regulation and an effective International Private Law (IPL) and Public International Law (PIL) regime.[[578]](#footnote-578) This can be reapplied in the energy and carbon management area. It is essential to ensure that an effective control and liability regime is in place.

The core legal framework can be supported through the development of appropriate regulatory and supervisory systems in any more particular sector or other areas. Regulation is concerned with the imposition of specific obligations on institutions in any particular market or sector.[[579]](#footnote-579) Supervision refers to the parallel process of monitoring compliance with regulations or the more general stability of the specific market or sector.[[580]](#footnote-580) A parallel regulatory architecture can be constructed.[[581]](#footnote-581) This is based on regulation, supervision, prudential standards, business requirements, authorisation procedures, supervision, enforcement, redress, additional or supplementary provisions, guidelines, remedies and judicial review. An appropriate regulatory framework can then be constructed for application in any particular sector or service area. Relevant laws and regulations can be monitored over time as conditions and requirements change and develop.

A full programme of measures could be set out in an appropriately drafted Crisis Action Protocol (CAP) or Protocols (CAPs). This could incorporate the separate objectives, principles, tools and practices, responses and sector solutions as well as commitment and delivery measures referred to.[[582]](#footnote-582) More detailed information could specifically be included on responses of solutions and sector measures.[[583]](#footnote-583) The purpose of the CAP would be to draw all of the relevant measures together in a single framework document to ensure ease of understanding and application and operation. More specific technical standards could be set out in annexes or side protocols or through internet or virtual linkages. This could then operate under a wider Modular Action Protocol (MAP) frames which could, in turn, be subsumed within a larger global or international crisis management framework.[[584]](#footnote-584)

(12) New Climate and Carbon Neutral Future

The purpose of all of these measures would be to create a new climate and carbon management framework which could be immediately adopted and applied on a continuous basis. This could assist ensure compliance with the agreed temperature targeting set out in the Paris Agreement and Glasgow COP26 Communique. It will not be possible to contain climate and carbon damage through a single response or limited number of responses adopted by a particular group of counterparties. Individuals, businesses and governments in all societies in all countries will have to change their conduct to adopt a total complete and comprehensive package of responses. Climatic and other scientific studies have identified the necessary tools and solutions which simply have to be implemented. It is possible to adopt a common collective response to a common convergent problem.

**12. CLIMATE COMMENT**

Climate conditions reflect natural cycles and effects. These are nevertheless highly sensitive and can be disrupted by anthropogenic impacts. It remains unclear to what extent mankind is principally and directly responsible for climate changes although this certainly creates significant damaging climate effects and results. Mankind is at minimum a significant aggravating factor of climate damage and changes in mankind’s behaviour and conduct is the only way to limit and manage these effects.

A number of means are available to reduce climate warming results as well as to prevent carbon release, recovery or sequestration of carbon and carbon storage. It should be possible to manage temperature levels through a combination of these efforts. This only requires informed and progressive planning with necessary political engagement and commitment.

Carbon investment may create a new field of carbon economics. Investment in alternative technologies can generate substantial green returns. This may also bring direct benefits in terms of cheaper and more stable energy supplies in the long run as well as other indirect benefits in terms of improved transportation, construction and manufacturing. The failure to act may also lead to longer term costs which more than outweigh any shorter term investment requirements. New carbon economics, finance and investment can lead to substantial carbon returns as well as carbon efficiency and carbon loss management.

Mankind has enjoyed the naturally generated and massive available resources and benefits of the earth for hundreds of years. This has resulted in substantial social advance. Mankind must nevertheless learn to adopt more responsible and sustainable extraction, use and recycling practices to protect natural resource availability. New forms of inclusive and corrective capitalism can be constructed in the private and public sectors. A more informed and progressive rather than destructive and regressive model can be developed. A new more tolerant, sensitive and adaptive approach can be developed.

The world has arrived at specific decision and action or inflection point. Communities and countries can accept the damaging and aggravating effects of anthropogenic activity on climate patterns and cycles. They can recognise their common need, or common greed, and common responsibility and liability. The necessary tools and solutions are available with these being continually improved and more forthcoming through persistent and resistant technological advance. The alternative is to accept the damage, loss and devastation that may otherwise arise through our collective and prescient failure and degenerative irresponsibility.

Climate study is a complex process that involves a large of number interconnected disciplinary investigations. The science is still not precise and exact. Much of this has been complex and confused. Uncertainties remain with regard to specific causal or connections, chains and explanations. Anthropogenic conduct is nevertheless an irresistible and irrefutable aggravating factor in climatic impacts and effects. Natural processes may correct this although only over extended eras of time. The planet will survive although mankind may not.

Societies and governments have to construct a coordinated programme of action to respond to the global challenge created. This requires collective involvement and inclusive participation. This must then be implemented through timely and effective common action and a necessary common commitment. Traditional forms of economics and finance have to be adjusted with business and government practices being upended as required. While this may impose immediate costs and loss, this may be more than compensated for by longer term improvements in economic efficiency, technological innovation, scientific discovery and advance, higher living standards and the overall adoption of more sustainable and resilient living practices.

Mankind may still be able to establish a safe, stable and continuous relationship with the planet that it inhabits. New challenges create new opportunities and a possible new future. Difficulties bring forward decision taking and decisions generate choice. Humankind has the opportunity to respond in an effective and timely manner. We can build new carbon sensitive and sustainable economic models. We can develop a new form of balanced, respectful and inclusive capitalism. We have one choice and one future.

1. These are collectively referred to as global environmental challenges for the purposes of this paper with Climate protection and global warming only forming parts of this. On EU Environmental issues, see, for example, European Commission, *Environment*. <https://ec.europa.eu/research-and-innovation/research-area/environment_en>. [↑](#footnote-ref-1)
2. A Circular (and Recycle) Economy refers to the development of responsible production processes to maintain sustainable systems. Reference may also be made to Sharing and Caring Economies based on common or collective use which limits resource depletion. [↑](#footnote-ref-2)
3. A Bio Economy uses natural processes for food and other supply production. [↑](#footnote-ref-3)
4. G A Walker, ‘Endogenous, Exogenous and Existential Risk – New Global Solutions’ *The International Lawyer* (Spring 2022). [↑](#footnote-ref-4)
5. The ‘Tragedy of the Commons’ refers to the historical abuse of land pastures by overgrazing with the actions of a limited number damaging the common interests of all. [↑](#footnote-ref-5)
6. World Meteorological Organisation (WMO) *WMO Statement on the State of the Global Climate in 2018* (2019) WMO1233. [↑](#footnote-ref-6)
7. Leslie Hook, ‘Ozone recovery helps reduce global warming’ *Financial* *Times* (19 August 2021). [↑](#footnote-ref-7)
8. IPCC, Fifth Assessment Report (AR5) (2014). [↑](#footnote-ref-8)
9. Climate Nexus, ‘RCP 8.5: Business-as-usual or a worst-case scenario?’ RCP 2.6 was 0.9-2.3°C, RCP 4.5 1.7‑3.2°C, RCP 6 2.0-3.7°C and RCP 8.5 3.2-5.4°C. Keywan Riahi et al, ‘RCP 8.5 – A scenario of comparatively high greenhouse gas emissions’ *Climate Change* (13 August 2011) 33(2011)109. For comment, *ClimateNexus.org* <https://climatenexus.org/climate-change-news/rcp-8-5-business-as-usual-or-a-worst-case-scenario/> [↑](#footnote-ref-9)
10. Projections include Consistent 1.5°C, Consistent 2°C, Optimistic net zero targets 2.1°C, Pledges & targets 2.3-2.6°C, Current policies 2.7-3.1°C and Baseline 4.1-4.8°C. Climate Action Tracker, ‘2100 Warming Projections’ <https://climateactiontracker.org/global/temperatures/>. [↑](#footnote-ref-10)
11. IPCC, Sixth Assessment Report (AR6) (2021). [↑](#footnote-ref-11)
12. National Geographic, ‘Atmosphere’ *Resource Library* available [https://www.nationalgeographic.org/ encyclopedia/atmosphere-rl/](https://www.nationalgeographic.org/%20encyclopedia/atmosphere-rl/). [↑](#footnote-ref-12)
13. David Nelles and Christian Serrer, *Small Gases, Big Effect* (Allen Lane 2021). [↑](#footnote-ref-13)
14. National Geographic, ‘Atmosphere’ *Resource Library* available [https://www.nationalgeographic.org/ encyclopedia/atmosphere-rl/](https://www.nationalgeographic.org/%20encyclopedia/atmosphere-rl/). [↑](#footnote-ref-14)
15. The ozone layer can absorb 97-99% of medium frequency ultraviolet light (200-215 nanometre (.......) wavelengths). National Aeronautics and Space Administration (NASA), ‘The Ozone Layer’ available <https://www.nas.nasa.gov/about/education/ozone/ozonelayer.html>. [↑](#footnote-ref-15)
16. CF3s and HCFCs principally consist of carbon (C), hydrogen (H), chlorine (CI) and fluorine (F). [↑](#footnote-ref-16)
17. The ozone layer is made up of around ten parts per million of ozone with the atmospheric average being 0.3%. Ozone levels had decreased by 4% annually from the late 1970s. Joe Farman, Brian Gardiner and Jonathan Shanklin, ‘Large losses of total ozone in Antarctica reveal seasonal CIOx/NOx interaction’ *Luther* (1985) 315 (6016) 207-210. [↑](#footnote-ref-17)
18. NASA, ‘The Causes of Climate Change’ <https://climate.nasa.gov/causes/>. [↑](#footnote-ref-18)
19. World Meteorological Organisation, ‘The State of the Global Climate 2020’ (14 January 2021). [↑](#footnote-ref-19)
20. This contributed to a direct 1.7C saving and 0.8 indirect saving. Paul Young et al, ‘The Montreal Protocol protects the terrestrial carbon sink’ Nature (18 August 2021) 596, pages 384–388. For comment, ‘Ozone recovery helps reduce global warming’ (n 4). [↑](#footnote-ref-20)
21. IPCC, ‘Summary for Policymakers’ (2018) SR15, 3-24. [↑](#footnote-ref-21)
22. IPCC SR15 (2018) ch2, 95-96. See also Climate Action Tracker, *Warming Projections Global Update* (December 2019). [↑](#footnote-ref-22)
23. The Obama Administration had undertaken to cut emissions by 26-28% by 2025. Climate reforms were included within the Biden Administration $2 trillion infrastructure package announced on 31 March 2021. Leslie Hook and James Politi, ‘US to propose emissions cut of at least 50% by end of decade’ *Financial Times* (22 April 2021). [↑](#footnote-ref-23)
24. Canada agreed 40-45%, Japan 46% and India 33-35% by 2030. Leslie Hook, Camilla Hodgson and Christian Shepherd, ‘US aims to lead by example as countries pledge climate action’ *Financial Times* (22 April 2021). [↑](#footnote-ref-24)
25. <https://climateactiontracker.org/countries/china/> . [↑](#footnote-ref-25)
26. The US approach was based on green technologies and private sector innovation and investment. This ‘techno-optimism’ was contrasted with an EU multipronged approach combining innovation investment and regulation with carbon pricing with the market driven Emissions Trading Scheme (ETS) to secure behavioural change. Mehreen Khan, Leslie Hook, Victor Mallet and Katrina Manson, ‘New US climate strategy opens up old fault lines with Europe’ *Financial Times* (23 April 2021). [↑](#footnote-ref-26)
27. Howard Lee, ‘How Earth’s Climate Changes Naturally (and Why Things Are Different Now)’ *Quanta Magazine* (21 July 2020). [↑](#footnote-ref-27)
28. Lee, ‘How Earth’s Climate Changes Naturally (and Why Things Are Different Now)’ (n). [↑](#footnote-ref-28)
29. This is also referred to as meridional overturning circulation (MOC) caused by temperature and density or salinity (salt) and other wind, tidal and other factors. See Wunsch, ‘What is the thermohaline circulation?’ *Science* (2002) 298 (5596) 1179-81. [↑](#footnote-ref-29)
30. The magnetic field of the sun reverses (flips) every 11 years with larger (grand solar minima) resulting in reduced solar activity for decades. This can lead to cooling of around 0.2 - 0.3°C. Ibid. [↑](#footnote-ref-30)
31. The earth, moon and other planets can change positions through different effects including changes in eccentricity (over 100,000 year cycles), axial precession or rotational axis (26,000 year cycle) and changes in obliquity variations in the angle of the orbital plane (41,000 year cycles). Ibid. [↑](#footnote-ref-31)
32. These include the El Niño-Southern Oscillation, North Atlantic Oscillation and Indian Ocean Dipole which effect rainfall and temperature. Ibid. [↑](#footnote-ref-32)
33. Lava floods and underground magma movements. Ibid. [↑](#footnote-ref-33)
34. Ibid. [↑](#footnote-ref-34)
35. The earth’s orbit around the sun varies from a circular to an elliptical pattern over 90,000-100,000 years with elliptical movements creating additional solar radiation. [↑](#footnote-ref-35)
36. The direction of the northern hemisphere shifts to and from the sun which increases warming effects over 27,000 year cycles. [↑](#footnote-ref-36)
37. The tilt of the earth on its axis shifts between 22.1 and 24.5 degrees every 41,000 years. [↑](#footnote-ref-37)
38. Temperatures rose 5-8°C over a 20,000 year period due to an increase in CO2 levels in the atmosphere attributed to volcanic eruptions and possible comet impact. Recent anthropogenic CO2 production was nevertheless higher than during the natural PETM period. See, for example, Jim Daley, ‘Earth’s Orbital Shifts May Have Triggered Ancient Global Warming’ *Scientific American* (3 September 2019). [↑](#footnote-ref-38)
39. The sun’s magnetic field switches (flips) every 11 years with 25 separate ‘grand solar minima’ occurring over the last 11,000 years creating longer periods of reduced solar effects including ‘Little Ice Ages’. The ‘Maunder Minimum’ resulted in a reduction in solar energy of 0.04-0.8° between 1645 and 1715. The earth has also continued to rise in temperature while solar activity has diminished over the last half century. Howard Lee, ‘How Earth’s Climate Changes Naturally (and Why Things Are Different Now)’ *Quanta Magazine* (21 July 2020) available <https://www.quantamagazine.org/how-earths-climate-changes-naturally-and-why-things-are-different-now-20200721/>. [↑](#footnote-ref-39)
40. These include the El Nino-Southern Oscillation which transports tropical Pacific Ocean waterflows with the North Atlantic Oscillation and the Indian Ocean dipole. Ibid. [↑](#footnote-ref-40)
41. Orbital movements (wobbles) occur as the relative position of the sun, moons and other planets shifts with up to 25% degree variations in sunlight levels. Overlapping cycles occur over 23,000, 41,000, 100,000, 405,000 and 2,400,000 year periods. The earth is approaching an ice age over the next 1,500 years through a period of reduced northern sunlight. Ibid. [↑](#footnote-ref-41)
42. Ibid. [↑](#footnote-ref-42)
43. The earth’s axis rotates. Ibid. [↑](#footnote-ref-43)
44. Variations occur in the earth’s rotational axis angle or tilt between 22.1-24.5 degrees. [↑](#footnote-ref-44)
45. The brightness of the sun has been reduced by 0.009% every million years and has fallen by 48% since the beginning of the solar system 4.5 billion years ago. Ibid. [↑](#footnote-ref-45)
46. Natural thermostat weathering processes adjust chemical reaction speeds to neutralise CO2 increases. Silicate mineral chemical reactions remove CO2 which is held in the form of limestone although CO2 is released through volcanic eruptions, metamorphic rock processes and carbon oxidization. Fossil fuel production nevertheless creates 100 times CO2 than volcanic output which cannot be naturally neutralised. Ibid. [↑](#footnote-ref-46)
47. Large landmass movements reset the weathering thermostat over millions of years with the planet cooling over the last 50 million years. CO2 levels were 1,000 parts per million (above the 415 parts per million today) during the dinosaurs Jurassic and Cretaceous periods with average temperatures 5‑9°C warmer and with sea levels 250 feet higher. Ibid. [↑](#footnote-ref-47)
48. Around 190 craters have been formed although only the Chicxulub asteroid had a major climatic impact through the vaporisation of parts of Mexico around 63 million years ago with dust and sulfur cooling the planet by 20°C which acidified the oceans and lead to the extinction of the dinosaurs. Temperatures recovered and rose by a further 5°C due to atmospheric CO2 created through vapourised Mexican limestone. Ibid. [↑](#footnote-ref-48)
49. Oxygen levels rise through photosynthetic cyanobacteria processes which began three billion years ago with methane and CO2 levels falling 2.4 billion years ago and ‘snowball’ climates created over a 200 million year period. Further climate changes arose 717 million years ago with the evolution of larger oceanic life forms. Terrestrial biospheres were created through plant evolution 230 million years subsequently which led to a further ice age 455 million years ago. Ibid. [↑](#footnote-ref-49)
50. Temperatures rose 5-9°C following an increase in CO2 to 8,000 parts per million during the end-Permian event 252 million years ago. Temperature increases also followed the Paleocene-Eocene Thermal Maximum (PETM) event 56 million years ago and end-Triassic and early Jurassic events. Ibid. [↑](#footnote-ref-50)
51. Conserve Energy Future, ‘What are Carbon Sinks?’ [https://www.conserve-energy-future.com/ carbon-sinks.php](https://www.conserve-energy-future.com/%20carbon-sinks.php). [↑](#footnote-ref-51)
52. Ibid. [↑](#footnote-ref-52)
53. National energy technology laboratory (NETL) ‘Carbon Capture Programme’. [https://netl.doe.gov/ coal/carbon-capture](https://netl.doe.gov/%20coal/carbon-capture). [↑](#footnote-ref-53)
54. DAC could use a quarter of global energy supply by 2100. Direct Air Carbon Capture and Storage (DACCS) could require 300 EJ per year energy input by 2100 with subsequent availability leading to a possible global temperature overshoot of 0.8°C. Giulia Realmonte et al, ‘An inter-model assessment of the role of direct air capture in deep mitigation pathways’ *Nature Communications* (2019) 3277(10). [↑](#footnote-ref-54)
55. IEA, *Direct Air Capture* (June 2020). [↑](#footnote-ref-55)
56. There were around 15 DAC plants worldwide in 2020. The IEA develops a Sustainable Development Scenario (SDS) 2010-2020 which increases DAC from 9000 tCO2/year to 10 Mt CO2/year by 2030. Ibid. [↑](#footnote-ref-56)
57. The IEA estimated that capture costs were around $100-1000/t with Carbon Engineering estimating that this could be reduced to $94/232/t. Ibid. [↑](#footnote-ref-57)
58. Carbon is non-metallic tetravalent with four electrons to form covalent chemical bonds. Different states or allotropes include graphite, diamond, amorphous carbon, nanocarbon, carbon nanofoam and atomic or diatomic carbon. Samara Carbon Allotrope Database (SACADA). <https://www.sacada.inf>. [↑](#footnote-ref-58)
59. A post-carbon economy can be defined as one in which carbon emission levels and growth move in opposite directions. McKinsey identify the costs and effectiveness of over 200 mechanisms to reduce carbon emissions. These were estimated to cost €200-350 billion annually by 2030 which was less than 1% of projected global GDP. This would require up-front financing of €530 billion by 2020 and €810 billion by 2030. Jeremy Oppenheim and Eric Beinhocker, ‘Shaping the post-carbon economy’ *The Guardian* (25 April 2009). [↑](#footnote-ref-59)
60. The global warming potential (GWP) of all greenhouse gases can be assessed as the amount of heat absorbed in the atmosphere compared to CO2 which is set at a GWP of 1. United States Environmental Protection Agency (EPA), ‘Understanding Global Warming Potentials’ <https://www.epa.gov/ghgemissions/undertanding-global-warming-potentials>. [↑](#footnote-ref-60)
61. WMO, *United in science* (2020). [↑](#footnote-ref-61)
62. Ibid. [↑](#footnote-ref-62)
63. IPC, ‘Global Warming of 1.5°C’ (2018). [↑](#footnote-ref-63)
64. Ibid. [↑](#footnote-ref-64)
65. Ibid. [↑](#footnote-ref-65)
66. United Nations environment programme, *Emissions Gap Report 2019* (26 November 2019). [↑](#footnote-ref-66)
67. WMO, *Greenhouse Gas Bulletin* (22 November 2018) 14. [↑](#footnote-ref-67)
68. Nelles and Serrer, *Small Gases, Big Effect* (n). [↑](#footnote-ref-68)
69. Ibid. [↑](#footnote-ref-69)
70. Nelles and Serrer, *Small Gases, Big Effect* (n). [↑](#footnote-ref-70)
71. Ibid. [↑](#footnote-ref-71)
72. Ibid. [↑](#footnote-ref-72)
73. Ibid. [↑](#footnote-ref-73)
74. Ibid. [↑](#footnote-ref-74)
75. Ibid. [↑](#footnote-ref-75)
76. Ibid. [↑](#footnote-ref-76)
77. Ibid. [↑](#footnote-ref-77)
78. 680 species have been driven to extinction by human activities since the 16th century. 40% of species are threatened with extinction. 10% of the 5.5 million insect species are threatened with extinction. 47% of land based mammals may have been negatively impacted by climate change. 33% of marine fish stocks have been harvested at unsustainable levels. Intergovernmental Science Policy Platform of Biodiversity and Ecosystem Services cited in ‘Global diversity in rapid decline, UN scientists warn’ *Financial Times* (6 May 2019). [↑](#footnote-ref-78)
79. 85% of wet lands have been lost between 1700 and 2000. 33% of land devoted to crop or livestock production has been lost. There has been a 45% increase in raw timber production since 1970. Total urban land use has increased by 100% since 1992. Ibid. [↑](#footnote-ref-79)
80. There has been a 70% increase in invasive alien plant species since 1970. Ibid. [↑](#footnote-ref-80)
81. IPCC, *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* (2018). [↑](#footnote-ref-81)
82. Decision 1/CP.21 (2016) para 21. [↑](#footnote-ref-82)
83. IPCC, *Summary for Policymakers* (2018) para A.1 and Figure SPM.1. [↑](#footnote-ref-83)
84. Para A.2. [↑](#footnote-ref-84)
85. Para A.3. [↑](#footnote-ref-85)
86. Para B.1. [↑](#footnote-ref-86)
87. JGJ Olivier and JAHW Peters, ‘Trends in global CO2 and total greenhouse gas emissions’ PBL Netherlands Environmental Assessment Agency (2020). [↑](#footnote-ref-87)
88. OECD, ‘Economics of Climate Change Mitigation’ [https://www.oecd.org/env/cc/ economicsofclimatechangemitigation.htm](https://www.oecd.org/env/cc/%20economicsofclimatechangemitigation.htm). [↑](#footnote-ref-88)
89. OECD, *The Economics of Climate Change Mitigation: Policies and Options for Global Action Beyond 2012* (September 2009) Executive Summary. 11. [↑](#footnote-ref-89)
90. 13. [↑](#footnote-ref-90)
91. Ibid. [↑](#footnote-ref-91)
92. 14. [↑](#footnote-ref-92)
93. 14-15. [↑](#footnote-ref-93)
94. 15-20. [↑](#footnote-ref-94)
95. Ibid. [↑](#footnote-ref-95)
96. [↑](#footnote-ref-96)
97. Marcia Rocha et al, *Historical Responsibility for Climate Change – from countries emissions to contribution to temperature increase* (November 2015) Climate Analytics. [↑](#footnote-ref-97)
98. China 9697 million tonnes (MT) (28.6%), US 5420 MT (16%), India 1967 MT (5.8%), Russia 1829 MT (5.4%), Japan 1243 MT (3.7%), Germany 810 MT (2.4%) and UK 470 MT. PBL Netherlands Environmental Assessment Agency, *Trends in Global CO2 Emissions* (2012). [↑](#footnote-ref-98)
99. China 7216 MT (16.4%), US 6931 MT (15.7%), Brazil 2856 MT (6.5%), Indonesia 2046 MT (4.6%), Russia 2028 MT (4.6%), India 1870 MT (4.2%), Japan 1387 MT (3.1%) and Germany 1005 MT (2.3%). Duncan Clark, ‘Which nations are most responsible for climate change? *The Guardian* (21 April 2011). [↑](#footnote-ref-99)
100. Quatar 360.9 tonnes, US 17.3 tonnes, Australia 17 tonnes, Russia 11.6 tonnes, Germany 9.3 tonnes, UK 7.8 tonnes, China 5.4 tonnes with a world average of 4.5 tonnes. [↑](#footnote-ref-100)
101. US 339,174 MT (28.8%), China 105,915 MT (9%), Russia 94,679 MT (8%), Germany 81,194.5 MT (6.9%), UK 68,763 MT (5.8%), Japan 45,629 MT (3.87%). Ibid. [↑](#footnote-ref-101)
102. Luxemburg 1,429 tonnes, UK 1,127 tonnes, US 1,126 tonnes, Belgium 1,026 tonnes, Czech Republic 1,006 tonnes, Germany 987 tonnes, Estonia 877 tonnes, Canada 780 tonnes, Kazakhstan 682 tonnes and Russia 666 tonnes. Ibid. [↑](#footnote-ref-102)
103. US 41.5 allocated budget gigatonnes of CO2, Russia 27.2 gigatonnes, Japan 21.5 gigatonnes, Germany 18.4 gigatonnes, France 13.3 gigatonnes and UK 13 gigatonnes, Japan 21.5 gigatonnes, France 13.3 gigatonnes and UK 13 gigatonnes. Jason Hickel, ‘Quantifying national responsibility for climate breakdown: an equality-based attribution approach for carbon dioxide emissions in excess of the planetary boundary’ *The Lancet* (1 September 2020) 4(9) e399-e404. [↑](#footnote-ref-103)
104. [↑](#footnote-ref-104)
105. Nicholas Wagner, Paul Durrant and Dolf Gielen, ‘Here’s how China can achieve economic growth without increasing emissions’ *World Economic Forum* (12 May 2021). [↑](#footnote-ref-105)
106. Senator Markey, reintroduced legislation to Aid People Displaced by Climate Change and Support Global Resilience on 22 April 2021. Jeremy Deaton, ‘The U.S. owes a massive climate debt. One way to pay it: Let in climate migrants’ *Fast Company* (10 April 2021). [↑](#footnote-ref-106)
107. Karl Mathiesan and Zack Colman, ‘US and EU search for a China climate doctrine that works’ *Politico* <https://www.google.com/amp/s/www.politico.eu/article/u-s-and-eu-search-for-a-china-climate-strategy-after-snub/amp/>. [↑](#footnote-ref-107)
108. Cate Cadell, ‘China says CO2 border tax will damage global climate change fight’ *Reuters* (27 November 2019). [↑](#footnote-ref-108)
109. Ibid. [↑](#footnote-ref-109)
110. European Commission, ‘Environment’ (n). [↑](#footnote-ref-110)
111. Biodiversity, bioeconomy, circular economy (recycling), climate action, environmental observation, Nature based solutions, Nitrogen and phosphorous pollution, Oceans and Seas, Urban development and water. Ibid. [↑](#footnote-ref-111)
112. The Commission defines nature based solutions as, ‘Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions.’ European Commission, ‘Nature-based solutions’ [https://ec.europal.eu/info/ research-and-innovation/research-area/environment/nature-based-solutions\_en](https://ec.europal.eu/info/%20research-and-innovation/research-area/environment/nature-based-solutions_en). [↑](#footnote-ref-112)
113. E Cohen-Shacham, G Walters, C Janzen and S Maginnis (eds), *Nature-based solutions to address global societal challenges* (Gland Switzerland 2016) available [https://portals.iucn.org/library/node/ 46191](https://portals.iucn.org/library/node/%2046191). [↑](#footnote-ref-113)
114. Hilde Eggermont et al, ‘Nature-based Solutions: New Influence for Environmental Management and Research in Europe’ *Gaia-Ecological Perspectives for Science and Society* (2015) 24 (4) 243-248. [↑](#footnote-ref-114)
115. European Commission, ‘EU Emissions Trading System (EU ETS)’ https://ec.europa.eu/clima/policies/ets\_en. [↑](#footnote-ref-115)
116. The programme covers 11,000 factories, power stations and installations with net heat in excess of 20 MW within the EU and EEA. Ibid. [↑](#footnote-ref-116)
117. This would impose a carbon price on imports of goods from outside the EU without equivalent carbon price mechanisms. The announcements were made on 23 July 2020. European Commission, ‘Commission launches public consultations on energy taxation and a carbon border adjustment mechanism’ [https://ec.europa.eu/ taxation\_customs/news/commission-launches-public-consultations-energy-taxation-and-carbon-border-adjustment-mechanism\_en](https://ec.europa.eu/%20taxation_customs/news/commission-launches-public-consultations-energy-taxation-and-carbon-border-adjustment-mechanism_en). [↑](#footnote-ref-117)
118. ‘New US climate strategy opens up old fault lines with Europe’ (n). [↑](#footnote-ref-118)
119. Ibid. [↑](#footnote-ref-119)
120. Climate Change Committee, *Independent Assessment of UK Climate Risk* (16 June 2021). Section 6(11) below. [↑](#footnote-ref-120)
121. Section 9(12). [↑](#footnote-ref-121)
122. Cabinet Office, ‘Joint statement from COP26 President-Designate Alok Sharma and US Special Presidential Envoy for Climate John Carry from his visit to London’ (6 March 2021). [↑](#footnote-ref-122)
123. This would include the 26 UNFCC, 16th meeting of the parties under the Kyoto Protocol (CMP16) and third meeting of the parties under the Paris Agreement (CMA3). (n). [↑](#footnote-ref-123)
124. See, for example, James P Bruce, Hoe-Song Yi, Erik F Haites (eds), *Climate Change 1995 – Economic and Social Dimensions of Climate Change* (1996) IPCC Working Group III. [↑](#footnote-ref-124)
125. Patrick Michael, ‘The Truth About Global Warming’ (n). [↑](#footnote-ref-125)
126. James Powell, ‘Scientists Reach 100% Consensus on Anthropogenic Global Warming’ *Bulletin of Science, Technology & Society* (20 November 2019). [↑](#footnote-ref-126)
127. Climate sceptics include, for example, British US physicist Freeman Dyson, Danish scientist Bjørn Lomborg, American libertarian Myron Ebell (Director of Global Warming and International Environmental Policy at the Competitive Enterprise Institute (CEI) Washington DC), Japanese scientist Kiminori Itoh (author of *Lies and Traps in the Global Warming Affair* (Japanese only)), Norwegian US Nobel prizewinning physicist Ivar Giaever, American physicist William Happer, Australian geologist Ian Plimer (*Heaven and Earth: Global Warming – The Missing Science* (Connor Court Publishing Australia 2009), American author Michael Crichton, American economist Alan Carlin and American climatologist Patrick Michaels. For comment, Joe Weisenthal, ‘The 10 Most-Respected Global Warming Skeptics’ *Insider* (30 July 2009). On the origins of denialism in the US, Ross Gelbspan, *The Heat is On* (1997); and Gelbspan, *Boiling Point* (2004). [On climate conditions between 1984‑2017, Worldwatch Institute, *State of the World* (SoW). The Worldwatch Institute was set up by Lester Brown as an independent research institute in 1974 to examine global environmental issues. It attempts to accelerate the transition to a sustainable world that can secure human needs. Its mission objectives were to support universal access to renewable energy and nutritious food, expansion of environmentally sound jobs and development, transformation of cultures from consumerism to sustainability and an end to population growth through healthy and intentional childbearing. Worldwatch institute, ‘Mission’ [https://web.archive.org/web/20190930002909/ http:/www.worldwatch.org/mission](https://web.archive.org/web/20190930002909/%20http%3A/www.worldwatch.org/mission). [↑](#footnote-ref-127)
128. ‘After Brexit, Clexit’ <https://clexit.net/wp-content/uploads/2016/07/clexit.pdf>. [↑](#footnote-ref-128)
129. See, for example, Bjørn Lomborg, *The Skeptical Environmentalist* (Cambridge University Press Cambridge 2001). Lomborg questioned the results of the Worldwatch Institute’s *State of the World* (n) for misapplying short term trends on a long term basis and consequent conclusions drawn. [↑](#footnote-ref-129)
130. Mörner argued that sea levels only rose around 1mm per year between 1986-1996 and that total levels would not exceed 200mm. were caused by natural factors including solar activity. Sea levels would not rise by 2m. Mörner had been the reviewer of the UN Intergovernmental Panel on Climate Change chapter on sea level impact. Nils Axel Mörner, ‘The Greatest Lie Ever Told’ ( ); Mörner, ‘Rising credulity’ *Spectator* (3 December 2011); and Mörner, ‘The expected sea level changes in the next century’ (29 January 2003) *Sea Level Changes from Coastal Evolution, Research Topic (RT).* For comment, Cliff Ollier, ‘Review of ‘The Greatest Lie Ever Told’’ *New Concepts in Global Tectonics Newsletter* (September 2007) 44, 55-7. [↑](#footnote-ref-130)
131. See, for example, Ian Plimer, ‘Climate Change Delusion and the Great Electricity Rip-Off’ (Connor Court Publishing 2017). [↑](#footnote-ref-131)
132. These include, for example: (a) Senator James Inhofe (Republican-Oklahoma) and Chairman of the Senate Committee on Environment and Public Works; (b) Marc Morano, Executive Director ClimateDepot.com and Director for the Committee for a Constructive Tomorrow (CFACT); (c) Chris Horner, Senior Legal Fellow for the Energy and Environment Legal Institute (EELI); (d) Myron Ebell, Director of Energy and Global Warming Policy at CEI; (e) Steve Milloy, Director of External Policy and Strategy at Murray Energy Corp; (f) Patrick Michaels, Director of the Center for the study of science at the Cato Institute; (g) Bjorn Lomborg, Founder and President of the Copenhagen Consensus Center (CCC); Viscount Matthew Ridley, Member of the UK House of Lords; (h) Christopher Walter Monckton, former member UK Independence Party; (i) Frederick Singer, founder of the Science & Environmental Policy Project (SEPP); and (j) Roy W Spencer, University of Alabama. For discussion, Brendan DeMelle, ‘Top 10 Climate Deniers *Before the Flood* <https://www.beforetheflood.com/explore/the-deniers/top-10-climate-deniers/>. [↑](#footnote-ref-132)
133. Bjorn Lomborg, *The Sceptical Environmentalist* (Cambridge University Press Cambridge 2001); and Bjorn Lomborg, *Cool It* (Knopf Publishing Group 2007). [↑](#footnote-ref-133)
134. Bjorn Lomborg, *Global Crises, Global Solutions* (Cambridge University Press Cambridge 2004). [↑](#footnote-ref-134)
135. ‘William Happer Interview’ *TheBestSchools* (12 February 2016); Raymond Brusca, ‘Professor denies global warming theory’ *The Daily Princetonian* (6 July 2009). [↑](#footnote-ref-135)
136. Hendrik Gout, ‘Ian Plimer: A question of faith’ *independentweekly.com.au* (11 August 2009). [↑](#footnote-ref-136)
137. The models are reported to have been tuned (‘parameterised’) which uses parameter estimation targeting to produce results within an expected range. Frédéric Hourdin, ‘The Art and Science of Climate Model Tuning’ *Bulletin of the American Meteorological Society* (2017) 98(3) 589-602. [↑](#footnote-ref-137)
138. Patrick Michael, Cato Institute, interviewed on ‘Live, Liberty & Levin’, ‘The Truth About Global Warming’ Fox News available. [↑](#footnote-ref-138)
139. The EPA is required to set emission standards for air pollutants from motor vehicles or motor vehicle engines under S202(a)(1) of the Clean Air Act (CAA) 42 U.S.C. SS7521(a)(1). Twelve states and a number of cities took action against the EPA to regulate emission levels after the EPA argued that it lacked authority and declined to do so. The EPA issued a subsequent endangerment finding in 2009 having identified six greenhouse gases (including carbon dioxide, nitrous oxide and methane) that may endanger public health and welfare. The Supreme Court dismissed challenges by three states and other parties against the finding. *Massachusetts v Environmental Protection Agency* 549 U.S. 497 (2007). Chief Justice John Roberts wrote that dissenting opinion supported by Justices Clarence Thomas and Samuel Alito which argued that the connection between CO2 and rising sea levels was too speculative to establish causation. Justice Antonin Scalia issued a separate dissenting on the basis that the Clean Air Act did not require specific action to be taken by the EPA with it being inappropriate for the Court to substitute its judgement. CO2 regulations were introduced for motor vehicles and stationary sources of CO2 (including powerplants, refineries, cement production facilities and other large facilities) in 2010. [↑](#footnote-ref-139)
140. The study examined 11,944 climate journal abstracts between 1991-2011 matching ‘global climate change’ or ‘global warming’. 66.4% of abstracts had no position on anthropogenic global warming (AGW), 32.6% supported AGW, 0.7% rejected it and 0.3% were uncertain as to the causes of global warming. 97.1% of abstracts with a position on AGW supported AGW. 97.2% supported AGW in a second stage of the study which asked authors to rate their own papers. John Cook et al, ‘Quantifying the consensus on anthropogenic global warming in the scientific literature’ *Environmental Research Letters* (2013) 8 1-7 024024. 67% (4,014) [↑](#footnote-ref-140)
141. 90-100% of published climate scientists supported AGW in six independent studies conducted by co-authors of the paper. Cook et al conclude that the 97% consensus figure is ‘robust and consistent with other surveys of climate scientists and peer-reviewed studies’. John Cook et al, ‘Consensus on consensus: a synthesis of consensus estimates on human-caused global warming’ *Environmental Research Letters* (2016) 11 1-8 048002. [↑](#footnote-ref-141)
142. This reviewed 928 articles between 1993-2003. Naomi Oreskes, ‘The Scientific Consensus on Climate Change’ *Science* (3 December 2004) 5702 (306) 1686. [↑](#footnote-ref-142)
143. The earlier papers omitted systematic differences between raters, do not include a number of abstracts and do not discuss relevant procedures to ensure independence between raters. Richard SJ Tol, ‘Comment on ‘Quantifying the consensus on anthropogenic global warming in the scientific literature’’ *Environmental Research Letters* (2016) 11 048001. [↑](#footnote-ref-143)
144. Ritchie considers that statements by former President Obama and former Secretary of State, John Kerry, are wrong as the studies confirm that the majority of papers take no position. Ritchie estimates the proper range to be around 80-90% with a separate survey concluding 84%. Earl J Ritchie, ‘Fact Checking The Claim Of 97% Consensus On Anthropogenic Climate Change’ *Forbes* (14 December 2016). [↑](#footnote-ref-144)
145. IPCC, *Global Warming of 1.5°C – Summary for policymakers* (2018) (SPM). <https://www.ipcc.ch/sr15/> [↑](#footnote-ref-145)
146. IPCC, ‘Cumulative emissions of CO2 and future non-CO2 radiative forcing determine the probability of limiting warming to 1.5°C’ Table SPM (n) 8. [↑](#footnote-ref-146)
147. Para A.1, 6. [↑](#footnote-ref-147)
148. See, for example, ‘12 Years to Disaster? How Climate Activists Distort the Evidence’ YouTube ( ). [See, for example, Aaron Brown, ‘No One Can Predict Future Climate, So Stop the Scaremongering’ *RealClearMarkets* (3 February 2020). See also Aaron Brown, ‘Climate Change – 12 Years to Disaster? How Climate Activists Distort the Evidence’ (30 April 2021) YouTube.] [↑](#footnote-ref-148)
149. [Other commentators have adopted Thunberg’s 2030 position. See, for example, democratic House of Representative, Alexandria Ocasio-Cortez. See, for example, ‘Pay for Green New Deal now or spend even more later’ *Financial Times* (3 February 2019); and ‘A Green New Deal must put people first’ *Financial Times* (9 April 2021). [↑](#footnote-ref-149)
150. Global Commission on the Economy and Climate, *Unlocking the Inclusive Growth Story of the 21st Century: Accelerating Climate Action in Urgent Times* (2018). [↑](#footnote-ref-150)
151. Ibid. [↑](#footnote-ref-151)
152. See, for example, R Cornes and T Sandler, *The Theory of Externalities, Public Goods, and Club Goods* (Cambridge University Press Cambridge 19686). [↑](#footnote-ref-152)
153. WMO, *Greenhouse Gas Bulletin* (22 November 2018) 14. [↑](#footnote-ref-153)
154. GCEC, *Better Growth, Better Climate: The New Climate Economy Report* (September 2014); GCEC, *Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate* (July 2015); and GCEC, *The Sustainable Infrastructure Imperative: Financing Better Growth and Development* (October 2016). [↑](#footnote-ref-154)
155. 8. [↑](#footnote-ref-155)
156. Economic savings of $17 trillion could be generated through the development of more compact, connected and coordinated cities which could produce up to 3.7 gigatonnes per year of CO2 savings over 15 years. Ibid. [↑](#footnote-ref-156)
157. 9. [↑](#footnote-ref-157)
158. 12. Sixty five million new low carbon jobs could be created by 2030 with 700,000 premature deaths being avoided through air pollution. Carbon pricing could generate $2.8 trillion in government revenues by 2030. Ibid. Financial firms managing $86 trillion in assets had committed to climate related financial risk disclosures. Failure to take appropriate action could lead to $12 trillion in stranded fossil fuel assets being produced by 2035 with the global financial crisis only resulting in $250 billion of stranded mortgage assets. 14. [↑](#footnote-ref-158)
159. 14-16. [↑](#footnote-ref-159)
160. Nelson was a junior senator from Wisconsin who had been concerned following the damage caused by the Santa Barbara oil spill in January 1969. Nelson and McCloskey asked Hayes to organise a student event to raise public awareness. Attention had also switched to focus on living organisms, the environment and public health following Rachael Carson’s book, *Silent Spring* (1962). ‘Origins of Earth Day’ [https://www.earthday.org/ history/](https://www.earthday.org/%20history/). [↑](#footnote-ref-160)
161. This included five primary programmes: the Canopy Project, Food and Environment, Climate Literacy, Global Earth Challenge and Great Global CleanUp. ‘Earth Day 2021’ <https://www.earthday.org/earth-day-2021/>. [↑](#footnote-ref-161)
162. *Bali Principles of Climate Justice* (29 August 2002). [↑](#footnote-ref-162)
163. These can be summarised in terms of: (1) the sacredness of Mother Earth, ecological unity and the independence of all species; (2) the need to reduce and eliminate the production of GHGs and local pollutants; (3) the rights of indigenous peoples and affected communities to represent and speak for themselves; (4) government responsibility; (5) the need for leadership; (6) opposition to transnational corporations in maintaining unsustainable production and consumption patterns and lifestyles; (7) recognition of the principle of ecological debt by industrialised governments and transnational corporations; (8) strict liability for past and current life-cycle impacts; (9) the rights of victims to receive compensation, restoration and reparation for loss of land, livelihood and other damages; (10) moratorium on fossil fuel exploration and exploitation; (11) clean, renewable, locally controlled and low-impact energy resources; (12) access to affordable and sustainable energy; (13) market based solutions including carbon trading and carbon sequestration should be subject to the principles of democratic accountability, ecological sustainability and social justice; (14) protection of the rights of workers in extractive, fossil fuel and GHG producing industries; (15) avoidance of costs externalisation to the environment and communities in line with a just transition; (16) protection of cultures and biodiversity; (17) confirmation of fundamental rights to clean air, land, water, food and healthy ecosystem; (18) avoidance of the commodification of nature and its resources; (19) public policy based on mutual respect and justice for all peoples free from any form of discrimination or bias; (20) right to self-determination of indigenous peoples; (21) rights of participation of indigenous peoples and local communities; (22) protection of women’s rights; (23) confirmation of the right of youth as equal partners in the climate change movement; (24) opposition to military action, occupation, repression and exploitation of lands, water, oceans, peoples and cultures and other lifeforms; (25) education of present and future generations; (26) individual and community responsibility; and (27) confirmation of the rights of unborn generations to natural resources, a stable climate and a healthy planet. Ibid. [↑](#footnote-ref-163)
164. Bill Gates, ‘My green manifesto’ *Financial Times* (19 February 2021). [↑](#footnote-ref-164)
165. Bill Gates, *How to Avoid a Climate Disaster* (Penguin UK 2021). [↑](#footnote-ref-165)
166. See, for example, John Rhys, ‘Can cost benefit analysis grasp the climate change nettle? And can we justify ambitious targets?’ *Oxford Martin School* (25 February 2019). [↑](#footnote-ref-166)
167. Nicholas Stern, *Stern Review on The Economics of Climate Change* (31 January 2010) HM Treasury. See also Juliett Jowit and Patrick Wintour, ‘Cost of tackling global climate change has doubled, warns Stern’ *The Guardian* (26 June 2008). [↑](#footnote-ref-167)
168. Ibid. [↑](#footnote-ref-168)
169. University of Technology, Climate and Energy College and German Aerospace Centre, ‘One Earth Climate Model’ (2019). See also Sven Teske, *Achieving the Paris Climate Agreement Goals* (Springer 2019). [↑](#footnote-ref-169)
170. CO2 emissions had fallen by 44% between 1990 and 2020. Coal was not used in electricity production in summer 2020 with the four remaining coal burning power plants to be decommissioned. ‘Cutting carbon – big on clean energy’ *The Economist* (20 February 2021) 19-20. [↑](#footnote-ref-170)
171. Ibid. [↑](#footnote-ref-171)
172. Ibid. [↑](#footnote-ref-172)
173. Gas boilers were historically preferred over electricity due to the higher energy density and higher temperatures. 85% of 21 million houses were heated using gas. Ibid. [↑](#footnote-ref-173)
174. The government took the decision not to make new homes carbon neutral in 2015 which allowed the continuing installation of gas boilers and low quality insulation. [↑](#footnote-ref-174)
175. Mark Carney, ‘Climate change is the tragedy of the horizon’ (2021) Lloyd’s of London. [↑](#footnote-ref-175)
176. Ibid. [↑](#footnote-ref-176)
177. Mark Carney, ‘A New Horizon’ (21 March 2019) European Commission Conference on *A global approach to sustainable finance*. [↑](#footnote-ref-177)
178. Ibid. [↑](#footnote-ref-178)
179. Mark Carney, ‘Remarks given during the UN Secretary General’s Climate Action Summit 2019’ (22 September 2019) New York. [↑](#footnote-ref-179)
180. Ibid. [↑](#footnote-ref-180)
181. Ibid. [↑](#footnote-ref-181)
182. Mark Carney, ‘The Road to Glasgow’ (27 February 2020) Guildhall, London. [↑](#footnote-ref-182)
183. Ibid. [↑](#footnote-ref-183)
184. <https://www.iea.org/news/deep-energy-transformation-needed-by-2050-to-limit-rise-in-global-temperature>. [↑](#footnote-ref-184)
185. Ibid. [↑](#footnote-ref-185)
186. Sharanjit Leyl, ‘Mark Carney: Climate crisis desk ‘will be worse than Covid’’ BBC News (5 February 2021). [↑](#footnote-ref-186)
187. ‘When you look at climate change from a human mortality perspective, it will be the equivalent of a coronavirus crisis every year from the middle of this century and every year, not just a one-off event. So it is an issue that needs to be addressed now’. Ibid. [↑](#footnote-ref-187)
188. Damian Carrington, ‘Firms ignoring climate crisis will go bankrupt, says Mark Carney’ *The Guardian* (13 October 2019). [↑](#footnote-ref-188)
189. Mark Carney*, ‘*[From Moral to Market Sentiments](https://www.bbc.co.uk/sounds/play/m000py8t)*’* (2 December 2020)*; ‘*[From Credit Crisis to Resilience](https://www.bbc.co.uk/programmes/m000q3sp)*’* (9 December 2020)*; ‘*[From Covid Crisis to Renaissance](https://www.bbc.co.uk/programmes/m000q8yc)*’* (16 December 2020)*; and ‘*[From Climate Crisis to Real Prosperity](https://www.bbc.co.uk/programmes/m000qkms)*’* (23 Dec 2020)*.* <https://www.bbc.co.uk/programmes/articles/43GjCh72bxWVSqSB84ZDJw0/reith-lectures-2020-how-we-get-what-we-value>. [↑](#footnote-ref-189)
190. Greta Thunberg, ‘Greta Thunberg: Are We Running Out Of Time To Save Our Planet?’ *NPR/TED* (7 June 2019) <https://www.npr.org/2019/06/07/730383662/greta-thunberg-are-we-running-out-of-time-to-save-our-planet?t=1619728756081>. [↑](#footnote-ref-190)
191. Jonathan Watts, ‘Greta Thunberg sets sail for New York on zero-carbon yacht’ *The Guardian* (14 August 2019). [↑](#footnote-ref-191)
192. Emily Holden, ‘Greta Thunberg leaves US with simple climate crisis message: vote’ *The Guardian* (12 November 2019). [Thunberg had stated in 2018 that, ‘I was diagnosed with Asperger’s Syndrome, OCD [obsessive compulsive disorder], and selective mutism. That basically means I only speak when I think it’s necessary. Now is one of those moments...’ Thunberg, ‘School strike for climate – save the world by changing the rules’ *TEDxStockholm* (24 November 2018) <https://youtube/EAmmUIEsN9A>. [↑](#footnote-ref-192)
193. Susan Cornwell, ‘Tax breaks for fossil fuels ‘a disgrace,’ Greta Thunberg tells U.S. Congress’ *Reuters* (22 April 2021). [↑](#footnote-ref-193)
194. ‘Greta Thunberg changes Twitter bio to ‘bunny hugger’ after Boris Johnson’s climate summit remarks’ *Evening Standard* (23 April 2021). [↑](#footnote-ref-194)
195. Xiye Bastida was co-founder of Re-Earth Initiative and an organiser of Fridays for Future New York City and a member of the People’s Climate Movement and former member of Sunrise Movement and Extinction Rebellion. The Re-Earth Initiative followed a global digital protest event on 22 April 2020 with people being asked to make an individual and systemic climate pledge on Earth Day with the Re-Earth Initiative intended to reimagine the future, reconnect with the planet and redefine collaborations with stated values of inclusivity, accessibility and unity. <https://reearthin.org/about>. See also Nylah Burton, ‘Meet the young activists of color who are leading the charge against climate disaster’ *VOX* (11 October 2019). [↑](#footnote-ref-195)
196. Shona Elliott, ‘Greta Thunberg supports Scottish climate activists in court battle over UK oil and gas strategy’ *The Scotsman* (31 May 2021). Three activists had launched a legal challenge to the UK government’s continued support for fossil fuel production in the North Sea following the government’s earlier refusal to halt exploration activity. [↑](#footnote-ref-196)
197. ‘Greens vow to turn Germany into ‘socio-ecological economy’ *Financial Times* (13 June 2021). [↑](#footnote-ref-197)
198. Philip Alston, ‘Climate change and poverty: report of the Special Rapporteur on Extreme Poverty and Human Rights’ (17 July 2019) A/HRC/41/39. [↑](#footnote-ref-198)
199. Para 2. [↑](#footnote-ref-199)
200. Para 11. [↑](#footnote-ref-200)
201. Para 14 citing Oxfam, ‘World’s richest 10% produce half of carbon emissions while poorest 3.5 billion account for just a 10’ (2 December 2015). [↑](#footnote-ref-201)
202. Paras 16-29. [↑](#footnote-ref-202)
203. Paras 30-31. [↑](#footnote-ref-203)
204. Para 33. [↑](#footnote-ref-204)
205. The fossil fuel industry accounted for 91% of global industrial greenhouse emissions and 70% of all human made emissions. Paras 34 and 35 citing CDP, ‘The carbon majors database. CDP carbon majors report 2017’ (2017). [↑](#footnote-ref-205)
206. Para 72 citing IMF, ‘Global fossil fuel subsidies remained large: an update based on country-level estimates’ (May 2019) Working Paper 19/89. [↑](#footnote-ref-206)
207. Para 39. [↑](#footnote-ref-207)
208. Para 54. [↑](#footnote-ref-208)
209. I Michael, Westphal et al, ‘Getting to 100 billion: climate finance scenarios and projections to 2020’ *World Resources Institute* (May 2015) 5. [↑](#footnote-ref-209)
210. Oxfam, ‘Climate finance shadow report 2018’ (2018) 6. [↑](#footnote-ref-210)
211. UNEP, ‘Cost of adapting to climate change could take $500 million per year by 2050’ (10 May 2016). [↑](#footnote-ref-211)
212. Para 62. [↑](#footnote-ref-212)
213. Paras 63-87. [↑](#footnote-ref-213)
214. Para 88. [↑](#footnote-ref-214)
215. Ibid. [↑](#footnote-ref-215)
216. Till Kellerhoff, ‘New initiative on transformational economics, EarthforAll, launched’ (19 November 2020) <https://www.clubofrome.org/impact-hubs/reframing-economics/new-initiative-on-transformational-economics-earth4all-launched/>. [↑](#footnote-ref-216)
217. Brian Schmidt et al, ‘Our Planet, Our Future – An Urgent Call for Action’ (29 April 2021) <https://www.nationalacadamies.org/news/2021/04/nobel-prize-laureates-and-other-experts-issue-urgent-call-for-action-after-our-planet-our-future-summit>. [↑](#footnote-ref-217)
218. Climate Change Committee, *Independent Assessment of UK Climate Risk* (16 June 2021). [↑](#footnote-ref-218)
219. House of Commons Library, *The UK Emissions Trading Scheme* (4 May 2021) no 212. [↑](#footnote-ref-219)
220. UK Government, *The future of UK carbon pricing* (21 May 2019); and UK Government, *The future of UK carbon pricing UK: Government and Devolved Administrations’ Response* (June 2020). [↑](#footnote-ref-220)
221. UK Government, *Energy White Paper: Powering our Net Zero future* (14 December 2020). [↑](#footnote-ref-221)
222. UK Government, *Industrial Decarbonisation Strategy* (March 2021). [↑](#footnote-ref-222)
223. Department for Business, Energy & Industrial Strategy (BEIS), *Guidance – Participating in the UK ETS* (10 June 2021). [↑](#footnote-ref-223)
224. CCC, *Independent Assessment of UK Climate Risk* (16 June 2021). [↑](#footnote-ref-224)
225. Priorities consisted of: (a) risk to the viability and diversity of terrestrial and freshwater habitats and species from multiple hazards; (b) risk to soil health from increased flooding and drought; (c) risks to natural carbon stores and sequestration from multiple hazards; (d) risk to crops, livestock and commercial trees from multiple hazards; (e) risk to supply of food, goods and vital services; (f) risk to people and the economy from climate related power failure; (g) risk to human health, wellbeing and productivity; and (h) multiple risks to the UK from climate change impacts overseas. CCC (n) Figure 1. [↑](#footnote-ref-225)
226. The Government had to: (a) adopt a vision for a well-adapted UK; (b) integrate adaptation into other policies; (c) adapt to 2% degree and assess the risk for 4% degree; (d) avoid lock-in; (e) prepare for unpredictable extremes; (f) assess interdependencies; (g) understand threshold effects; (h) address inequality; (i) consider opportunities; and (j) provide necessary funding, resourcing, metrics and research. CCC, (n) Figure 2 12. [↑](#footnote-ref-226)
227. Valuation, Wildfire, Projections comparison, Opportunities, Flood projections, Water projections, Behaviour, Thresholds, Interacting risks, Socioeconomic dimensions and Improving accessibility Reports. <https://www.theccc.org.uk/publication/independent-assessment-of-uk-climate-risk/>. [↑](#footnote-ref-227)
228. 13. [↑](#footnote-ref-228)
229. Improved building design and retrofit, roads resurfacing, flood defence investment and drainage. CCC (n) Table 1 27. [↑](#footnote-ref-229)
230. Increasing plant diversity, habitat creation, peatland restoration, soil conservation, increased blue carbon (coastal and marine vegetation), green sustainable urban drainage and urban greening. Ibid. [↑](#footnote-ref-230)
231. Precision farming, new crop and livestock varieties, remote sensing, new designs for infrastructure assets, use of digitalisation and big data for monitoring, evaluation and management. Ibid. [↑](#footnote-ref-231)
232. Changing timing of agricultural practices, information sharing, public engagement and skills development in adaption. Ibid. [↑](#footnote-ref-232)
233. Adaptation standards, supply chain diversification, regulation and adversary services. Ibid. [↑](#footnote-ref-233)
234. Insurance, risk disclosure and adaptation finance. Ibid. [↑](#footnote-ref-234)
235. Monitoring and surveillance, inspections, forecasting, research and decision support tools. Ibid. [↑](#footnote-ref-235)
236. Figure 4 28. [↑](#footnote-ref-236)
237. 28-29. [↑](#footnote-ref-237)
238. Chs 1 and 2. [CRA3 risks and opportunities are summarised in Table 2.2, 60 with impact on societal goals in Table 2.4 67-70. The more significant risk pathways modelled with risk ratings between 2020 and 2080 are provided in Table 2.5, 74.] [↑](#footnote-ref-238)
239. 77-80. [↑](#footnote-ref-239)
240. Chapter 3. The UN climate change regime Adaptation cycle is reproduced in Figure 3.1, 91. [↑](#footnote-ref-240)
241. Table 3.1, 92. [↑](#footnote-ref-241)
242. Table 3.3 102-104. [↑](#footnote-ref-242)
243. Table 3.4 106-107. [↑](#footnote-ref-243)
244. 111-112. [↑](#footnote-ref-244)
245. 113-114. [↑](#footnote-ref-245)
246. Ibid. [↑](#footnote-ref-246)
247. LSCD, *Financing for a Future London* (March 2020). This outlined current initiatives and challenges with a route map being provided to 2050. [↑](#footnote-ref-247)
248. WWF, *Thriving Within Our Planetary Means* (June 2021). Summary Table B, 6-7. [↑](#footnote-ref-248)
249. 4. [↑](#footnote-ref-249)
250. Comply with the European Environmental Bureau’s ‘Maximum Technically Feasible Reductions’ (MTFR) for pollutants set out in the *A Critical Guide to the New NEC Directive* and lowering air pollution contribution. Ibid. [↑](#footnote-ref-250)
251. Chemical pollutants must be reduced to or below safe safeguards and social and ecological systems restored. Ibid. [↑](#footnote-ref-251)
252. Protect, enhance and restore all bodies of water to ensure good ecological and good chemical status by 2017. [↑](#footnote-ref-252)
253. Reduce GHG emissions by 39% (including on international shipping and aviation) and reduce overseas carbon footprint through import consumption by 33%. Ibid. [↑](#footnote-ref-253)
254. Secure marine resources through 100% sustainable means by 2030. [↑](#footnote-ref-254)
255. Reduce biomass consumption by 50% by 2030. [↑](#footnote-ref-255)
256. Ensure that UK supply chains of agricultural and forest commodities involve no deforestation or ecosystem conversion by 2023, halt degradation of domestic environments and minimise environmental degradation. Ibid. [↑](#footnote-ref-256)
257. Reduce nitrogen and phosphorous by, at least, 80% by 2030. [↑](#footnote-ref-257)
258. All surface water bodies and, at least, 90% of ground water bodies must meet sustainable abstraction and ecological flow requirements by 2030. [↑](#footnote-ref-258)
259. Reduce material consumption by 40% by 2030. Ibid. [↑](#footnote-ref-259)
260. 5. [↑](#footnote-ref-260)
261. See generally United Nations, ‘Climate Reports’ [https://www.un.org/en/climatechange/ reports](https://www.un.org/en/climatechange/%20reports). [↑](#footnote-ref-261)
262. Convention on International Civil Aviation (7 December 1944). [↑](#footnote-ref-262)
263. *Convention on Long-Range Transboundary Air Pollution* (13 November 1979). [↑](#footnote-ref-263)
264. Chicago Convention, *Environmental Protection: Aircraft Engine Emissions* (1981) Annex 16, vol 2. [↑](#footnote-ref-264)
265. *Vienna Convention for the Protection of the Ozone Layer* (22 March 1985). [↑](#footnote-ref-265)
266. *Montreal Protocol on Substances that Deplete the Ozone Layer* (16 September 1987). [↑](#footnote-ref-266)
267. See, for example, Reiner Grundmann, *Transnational Environmental Policy: Reconstructing Ozone* (Routledge London 2002). [↑](#footnote-ref-267)
268. IPCC, ‘About the IPCC’ <https://www.ipcc.ch/about/> [↑](#footnote-ref-268)
269. IPCC, ‘Principles Governing IPCC Work’ (October 1998). [↑](#footnote-ref-269)
270. IPCC, *Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments* (8 October 2018). [↑](#footnote-ref-270)
271. IPCC, *Climate Change 2014: Mitigation of Climate Change* (2014) ch 13, para 13.2.1.1. [↑](#footnote-ref-271)
272. Para 13.2.1.2. [↑](#footnote-ref-272)
273. IPCC, ‘Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments’ (8 October 2018) IPCC Press Release. [↑](#footnote-ref-273)
274. <https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/>. [↑](#footnote-ref-274)
275. 37% of emission reductions by 2030 could be secured through natural solutions with 20 specific proposals recommended. Bronson W Griscom et al, ‘Natural climate solutions’ *Proceedings of the National Academy of Sciences* (31 October 2017) 114 (44) 11645-11650. [https://www.nature.org/en-us/what-we-do/our-insights/ perspectives/natural-climate-solutions/](https://www.nature.org/en-us/what-we-do/our-insights/%20perspectives/natural-climate-solutions/) [↑](#footnote-ref-275)
276. Ibid. [↑](#footnote-ref-276)
277. World Business Council for Sustainable Development and Nature4Climate, *Natural climate solutions: the business perspective* (23 September 2019). [↑](#footnote-ref-277)
278. United Nations, *United Nations framework convention on climate change* (1992) FCCC/INFORMAL/84 <https://unfccc.int/resource/docs/convkp/conveng.pdf>. [↑](#footnote-ref-278)
279. These consisted of developed countries (Annex I), developed countries with special financial responsibilities (Annex II) and developing countries. [↑](#footnote-ref-279)
280. The Rio Declaration produced 27 principles to assist countries secure sustainable development with human beings being entitled to live healthy and productive lives in harmony with nature. United Nations, *Rio Declaration on Environment and Development* Annex I of General Assembly, *Report of the United Nations Conference on Environment and Development* (3-14 June 1992) A/CONF.151/26 [https://www.un.org/en/ development/desa/population/migration/generalassembly/docs/globalcompact/a\_conf.151\_26\_vol.1\_declaration.pdf](https://www.un.org/en/%20development/desa/population/migration/generalassembly/docs/globalcompact/a_conf.151_26_vol.1_declaration.pdf). [↑](#footnote-ref-280)
281. Agenda 21 consisted of an action plan to support sustainable development with 14 articles focusing on social and economic dimensions, conservation and management of resources for development, strengthening the role of major groups and implementation. <https://sustainabledevelopment.un.org/content/documents/agenda21>. [↑](#footnote-ref-281)
282. The Forest Principles consisted of a non-legally binding authoritative statement of principles for a Global Consensus on the Management, Conservation and Sustainable Development of all types of Forests. Annex III. [https://web.archive.org/web/20170701164258/http:/www.un.org/documents/ga/conf151/aconf15126-3annexIII.html](https://web.archive.org/web/20170701164258/http%3A/www.un.org/documents/ga/conf151/aconf15126-3annexIII.html). [↑](#footnote-ref-282)
283. The Convention on Biological Diversity (CBD) was adopted on 5 June 1992 to conserve biological diversity, ensure sustainability and the fair and equitable sharing of the benefits of genetic resourcing. The Convention provided for the establishment of a governing Conference of the Parties (COP) and a CBD Secretariat in Montreal, Quebec Canada. <https://www.cbd.int/convention/text/>. [↑](#footnote-ref-283)
284. (n). [↑](#footnote-ref-284)
285. The Convention was adopted on 17 June 1994 based on the principles of participation, partnership and decentralisation with a permanent Secretariat of the UNCCD being established. <https://www.unccd.int>. [↑](#footnote-ref-285)
286. <https://www.un.org/esa/dsd/csd/csd_aboucsd.shtm>. [↑](#footnote-ref-286)
287. *United Nations Framework Convention on Climate Change* (9 May 1992). [↑](#footnote-ref-287)
288. Art 2. [↑](#footnote-ref-288)
289. (1) The Parties should protect the climate system for the benefit of present and future generations of humankind on the basis of equity and their common but differentiated responsibilities and capabilities; (2) the specific needs and special circumstances of developing country Parties have to be given full consideration; (3) the Parties should take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effect; (4) the Parties have a right to and should promote sustainable development; and (5) the Parties should cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all countries allowing them better able to address the problems of climate change. Art 3. [↑](#footnote-ref-289)
290. Art 4. [↑](#footnote-ref-290)
291. *Kyoto Protocol to the United Nations framework convention on climate change* (11 December 1997) <https://unfccc.int/resource/docs/convkp/kpeng.html>. [↑](#footnote-ref-291)
292. Art 2(a). United Nations *Adoption of the Paris Agreement* (12 December 2015) FCCC/CP/2015/L.9/REV.1. [↑](#footnote-ref-292)
293. Art 2(b). Climate resilience can be considered to be involved with stress absorption, continuation and adaptation and reorganisation. See, for example, C Folke, ‘Resilience: The emergence of a perspective for socio-ecological systems analyses’ *Global Environment Change* (2006) 16(3) 253-267. [↑](#footnote-ref-293)
294. Arts 3 and 4. [↑](#footnote-ref-294)
295. Arts 3 and 9(3). [↑](#footnote-ref-295)
296. See, for example, Daniel Bodansky, ‘The Legal Character of the Paris Agreement’ *Review of European Comparative & International Environmental Law* (2016) 25(2) 142-150. [↑](#footnote-ref-296)
297. Carbon dioxide (CO2); Methane (CH4); Nitrous Oxide (N2O); Hydrofluorocarbons (HFCs); Perfluorocarbons (PFCs); and Sulphur Hexafluoride (SF6). [↑](#footnote-ref-297)
298. The COP of the UNFCCC is to act as the Meeting of the Parties (MOP) under the Paris Agreement. A secretariat is established (Art (17). Subsidiary bodies (Arts 18-19). Signature (Art 20). Entry into force (Art 21). Application (Art 22). Amendment (Art 23), dispute settlement (Art 24), voting (Art 25), depository (Art 26), no reservations (Art 27), withdrawal (Art 28) and original text (Art 29). [↑](#footnote-ref-298)
299. The subsidiary body for Scientific and Technological Advice (STA) and Implementation are to act under the Protocol (Art 15). The COP is to adjust the multilateral consultation process set up under the UNFCCC as appropriate (Art 17). The COP is to determine relevant principles, modalities rules and guidelines to verify report and account for emissions trading (Art 17). The COP is to establish relevant non-compliance procedures and mechanisms (Art 18) with the Convention dispute settlement mechanism reapplying (Arts 18-19). Additional provisions are included on amendment (Art 20), annexes (Art 21), voting (Art 22), depository (Art 23), signature (Art 24), entering into force (Art 25), no reservations (Art 26), withdrawal (Art 27) and authenticated text (Art 28). [↑](#footnote-ref-299)
300. United Nations, *Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts* (November 2013). [↑](#footnote-ref-300)
301. MJ Mace and Roda Verheyen, ‘Loss, Damage and Responsibility after COP21: All Options Open for the Paris Agreement’ *ResearchGate* (July 2016) *Review of European* 25(2) 197-214. [↑](#footnote-ref-301)
302. United Nations, ‘Report of the co-facilitators of the dialogue on long-term cooperative action to address climate change by enhancing implementation of the Convention’ (3-14 December 2007) FCCC/CP/2007/L.7/Rev1. [↑](#footnote-ref-302)
303. ‘Biden returns US to Paris climate accord hours after becoming president’ *The Guardian* (20 January 2021). [↑](#footnote-ref-303)
304. NATO, *Brussels* *Summit* *Communique* (14 June 2021) para 3 available <https://www.nato.int/cps/en/natohq/news_185000.htm>. [↑](#footnote-ref-304)
305. NATO, *Agenda on Climate Change and Security* (June 2021) para 58 available <https://www.nato.int/cps/en/natohq/official_texts_185174.htm> . [↑](#footnote-ref-305)
306. Ibid. [↑](#footnote-ref-306)
307. Para 59. [↑](#footnote-ref-307)
308. ‘Leaders’ Summit on Climate’, <https://www.state.gov/leaders-summit-on-climate>. [↑](#footnote-ref-308)
309. ‘Leaders’ Summit on Climate Summary of Proceedings’ *The White House* (23 April 2021). [↑](#footnote-ref-309)
310. Antony J Blinken, Secretary of State, ‘The United States Officially Rejoins the Paris Agreement’ (19 February 2021) US Department of State. [↑](#footnote-ref-310)
311. Guy Faulconbridge, ‘G7 should invest $10 trillion to stoke climate-friendly recovery – PM Johnson told’ *Reuters* (10 May 2021). [↑](#footnote-ref-311)
312. Two thirds of Americans considered that the federal government was not taking sufficient action in relation to climate change. ‘America’s better future’ *The Economist* (20 February 2021) 9. [↑](#footnote-ref-312)
313. Specific difficulties arose in the US with the collapse in temperature in Texas in February 2021 being aggravated by an ineffective state grid connection system. See, for example, ‘The freeze in Texas’ *The Economist* (20 February 2021) 29. [↑](#footnote-ref-313)
314. The Biden Administration may be obstructed by Senate Filibuster although a reconciliation procedure may allow passage of a bill containing simpler measures. ‘America’s better future’ *The Economist* (20 February 2021) 9. [↑](#footnote-ref-314)
315. Eric Larson et al, *Net-Zero America – Potential Pathways, Infrastructure, and Impacts* (15 December 2020) Princeton University available <https://environmentalhalfcentury.princeton.edu/sites/g/files/toruqf331/files/2020-12/princeton_nza_interim_report_15_dec_2020_final.pdf>. [↑](#footnote-ref-315)
316. These include: (1) high electrification (e+); (2) less high electrification (e-); (3) high biomass (e-B+); (4) renewable constrained (e+re-); and (5) 100% renewable (e+re+). Ibid. [↑](#footnote-ref-316)
317. (1) End-use energy productivity, efficiency and electrification; (2) clean electricity; (3) bioenergy and other zero-carbon fuels and feedstocks; (4) CO2 capture, transport, usage and storage; (5) reduced non-CO2 emissions; and (6) enhanced land sinks. 37-264. [↑](#footnote-ref-317)
318. (1) Quadrupling wind and solar capacity to 600 gigawatts; (2) increasing power transmission capacity by 60%; (3) doubling the share of residential heating supplied by heat pumps and tripling the share in commercial buildings; and (4) providing for 50 million electric cars with 3 million charging stations. Ibid. [↑](#footnote-ref-318)
319. (1) Build societal commitment, investment, environment and delivery capability; (2) improve end-use energy productivity and efficiency; (3) electrify energy demand, in particular, in transportation and building; (4) decarbonise and expand electricity; (5) prepare major expansion and transformation of bioenergy industry; (6) build infrastructure including electricity transmission and CO2 transport and storage; (7) enhance land sinks and reduce non-CO2 emissions; and (8) innovate to enlarge a net-zero carbon technology toolkit. 326. [↑](#footnote-ref-319)
320. ‘The switch-America has done too little to fight rising temperatures. Joe Biden wants to change that’ *The Economist* (20 February 2021) 15-18, 18. [↑](#footnote-ref-320)
321. Attenborough stated that, ‘Tackling climate change is now as much a political and communications challenge as it is a scientific or technological one. We have the skills to address climate change in time, all we need is the global will to do so...Decisions taken at this G7 meeting, at the Biodiversity COP in China, and COP26 in Glasgow are the most important decisions humanity has ever taken.’ G7, ‘The Road to COP: Statement by the UK Presidency of the G7’ (17 June 2021). [↑](#footnote-ref-321)
322. Ibid. [↑](#footnote-ref-322)
323. William Schomberg and Elizabeth Piper, ‘More needed: G7 nations agree to boost climate finance’ *Reuters* (13 June 2021). [↑](#footnote-ref-323)
324. These included accelerating progress under the Paris Agreement, securing a net zero G7, building back better and increasing resilience through a net zero pathway, aligning Nationally Determined Contributions (NDCs) and long term strategies (LTSs) ensuring that more people would be protected from climate impacts, mobilising and aligning finance to support a green recovery, unleashing the potential of the Paris Agreement and supporting the transition to a net zero economy. ‘G7 Climate and Environment: Ministers’ Communique’ (21 May 2021) London. [↑](#footnote-ref-324)
325. Ibid. [↑](#footnote-ref-325)
326. The G7 would reset its relationship with nature and build on the G7 Metz Charter on Biodiversity and Leaders’ Pledge for Nature. The G7 committed to mainstreaming nature including support of the Dasgupta Review on the Economics of Biodiversity and The Economics of Ecosystems and Biodiversity (TEEB) initiatives. The G7 would assist prevent and combat Zoonoses and antimicrobial resistance (AMR) under a ‘One Health approach’. The G7 would also support the transition to the sustainable and legal use of natural resources. Ibid. [↑](#footnote-ref-326)
327. G7, ‘Carbis Bay G7 Summit Communique’ (11-13 June 2021) [https://www.g7uk.org/wp-content/ uploads/2021/06/carbis-bay-g7-summit-communique-pdf-430kb-25-pages-1-1.pdf](https://www.g7uk.org/wp-content/%20uploads/2021/06/carbis-bay-g7-summit-communique-pdf-430kb-25-pages-1-1.pdf). [↑](#footnote-ref-327)
328. <https://ukcop26.org>. [↑](#footnote-ref-328)
329. <https://www.gov.uk/government/topical-events/cop26>. [↑](#footnote-ref-329)
330. British High Commission, ‘UK to host Global Summit on Climate and Development’ (2 March 2021). [↑](#footnote-ref-330)
331. The Climate Change Committee (CCC) was set up under the Climate Change Act 2008 and was renamed from the Committee on Climate Change. The CCC was first chaired by Lord Turner of Ecchinswell. <https://www.theccc.org.uk>. [↑](#footnote-ref-331)
332. Climate Change Committee, *Sixth carbon budget* (9 December 2020). [↑](#footnote-ref-332)
333. This would be achieved through the adoption of low carbon solutions, expansion of low carbon energy supplies, reduced demand for carbon intensive activities and removal of land and greenhouse gas emissions. <https://www.theccc.org.uk/publications/sixth-carbon-budget/>. [↑](#footnote-ref-333)
334. <https://ukcop26.org>. [↑](#footnote-ref-334)
335. Leslie Hook, ‘UN climate talks set to be held in Glasgow’ *Financial Times* (10 September 2019). [↑](#footnote-ref-335)
336. Tom Williams, ‘David Attenborough warns climate change poses bigger threat than Covid’ *Metro* (10 May 2021). [↑](#footnote-ref-336)
337. O’Neill was reported to have been dismissed the launch of COP26 with rumours that the venue would be moved from Glasgow to London. The head of summit position had been offered to David Cameron and William Hague. Camilla Hodgson and Jim Pickard, ‘UK under pressure to re-energise UN climate summit in Glasgow’ *Financial Times* (18 February 2020); and Jim Pickard, Camilla Hodgson and Mure Dickie, ‘ExCeL London sounded out as alternative climate talks venue’ *Financial Times* ( ). O’Neill criticised government preparations following Whitehall inviting political tribalism and a ‘cavalier’ approach by senior figures. Cecilia Keating, ‘ ‘Extraordinary ineptitude’: Former COP26 President Claire O’Neill accuses Number 10 of ‘cavalier’ attitude to Climate Summit’ *BusinessGreen* https://www. businessgreen.com/news/4024277/extraordinary-ineptitude. O’Neill was dismissed by the government on 31 January 2020 with this requiring a Ministerial appointment with Perry criticising former political strategies, Dominic Cummings for a critical briefing released on the same day. [O’Neill was separately reported to have described the Scottish government’s conduct as being disgraceful in hiring the adjacent Glasgow Science Centre for use as a base during the summit. Ibid.] [Claire O’Neill (nee Perry), former Minister of Energy and Clean Growth, was initially appointed President of COP26.] [↑](#footnote-ref-337)
338. NASA, ‘Responding to Climate Change’ <https://climate.nasa.gov/solutions/adaptation-mitigation/>. [↑](#footnote-ref-338)
339. Climate damage has to be managed and prevented. Carbon has to be contained or captured either through release avoidance, production prohibitions or sequestration. Natural environments and processes have to be restored with a revival of natural capital and systems generation and operation. People have to adapt to new climate conditions as well as realise all of the possible additional economic, welfare, health and lifestyle benefits available. There has to be a shared commitment to this process as well as shared ownership and shared distribution of the benefits generated. [↑](#footnote-ref-339)
340. ‘Project Drawdown’ <https://www.drawdown.org>. [Paul Hawken, Amory Lovins and L Hunter Lovins, *Natural Capitalism* (US Green Building Council 2000). This develops a new form of business management of the LS’s natural capital in the form of resources such as geology, soils, air, water and living organisms. Industrial capitalism is criticised for liquidating its own capital in the form of income which destroys natural resources and ecosystem services such as agroecosystems, forest ecosystems, grassland ecosystems and aquatic ecosystems. Historical capitalism can destroy natural capital and natural cycles. A new industrial revolution has to be based on resource conservation with more effective manufacturing, natural recycling, a switch from quantity to quality and investment in natural capital with the restoration and sustainable management of natural resources. Economies have to manage the availability and functionality of natural capital with destructive business models avoided.] Hawken developed a separate comprehensive plan to Reverse Global Warming which was published in April 2016. This is referred to as project Drawdown. <https://www.drawdown.org>.] [↑](#footnote-ref-340)
341. Solutions can reduce or sequester 200.6 – 440.2 gigatonnes CO2 equivalent between 2020-2050. Solutions include biomass power, building automation systems, building retrofitting, concentrated solar power, distributed energy storage, distributed solar photovoltaics, district heating, dynamic glass, geothermal power, green and cool roofs, grid flexibility, high-efficiency heat pumps, high-performance glass, insulation, landfill methane capture, LED lighting, low-flow fixtures, methane digesters, micro wind turbines, micro grids, net zero buildings, nuclear power, ocean power, offshore wind turbines, onshore wind turbines, small hydro power stations, smart thermostats, solar hot water, utility scale energy storage, utility scale solar photovoltaics, waste to energy processes and water distribution efficiency. <https://www.drawdown.org/sectors/electricity>. [↑](#footnote-ref-341)
342. Industry solutions can reduce or sequester 128.8 - 143.8 gigatonnes of CO2 between 2020-2050. These include alternative cement, alternative refrigerants, bio plastics, composting, landfill methane capture, methane digesters, recycled paper, recycling, refrigerant management and waste-to-waste energy processes. https://www. drawdown.org/sectors/industry. [↑](#footnote-ref-342)
343. Building improvements can reduce 73.7 – 141.2 gigatonnes CO2 equivalent between 2020-2050. Solutions include biogas for cooking, building automation systems, improved clean cookstoves, high efficiency heat pumps, low flow fixtures, refrigerant management and solar hot water. [https://www.drawdown.org/sectors/ buildings](https://www.drawdown.org/sectors/%20buildings). [↑](#footnote-ref-343)
344. Engineered sinks can reduce CO2 equivalent levels by 2.22 – 4.39 gigatonnes specifically through biochar production (with biomass being baked without oxygen). <https://www.drawdown.org/sectors/engineered-sinks>. [↑](#footnote-ref-344)
345. Improvements can reduce CO2 equivalent levels by 204.2 – 273.9 gigatonnes. Solutions include coastal wetland protection, conservation agriculture, farm irrigation efficiency, forest protection, grassland protection, improved rice production, indigenous peoples’ forest tenure, nutrient management, peatland protection and rewetting, plant rich diets, reduced food waste, regenerative annual cropping, sustainable intensification for smallholders and rice intensification systems. <https://www.drawdown.org/sectors/food-agriculture-land-use>. [↑](#footnote-ref-345)
346. CO2 equivalent levels can be reduced by 243.1 – 387.8 gigatonnes. Solutions include abandoned farmland restoration, bamboo production, conservation agriculture, managed grazing, multistrata agroforestry, perennial biomass production, perennial staple crops, silvopasture temperate forest restoration, tree intercropping, tree plantations and tropical forest restoration. <https://www.drawdown.org/sectors/land-sinks>. [↑](#footnote-ref-346)
347. CO2 equivalent levels can be reduced by 58 - 97.4 gigatonnes. Solutions include bicycle infrastructure, car-pooling, efficient aviation, efficient ocean shipping, efficient trucking, electric bicycles, electric cars, electric trains, high speed rail lines, hybrid cars, public transport, telepresence and walkable cities with increased pedestrianisation. <https://www.drawdown.org/sectors/transport>. [↑](#footnote-ref-347)
348. CO2 equivalent levels can be reduced or sequestered by 1.07 – 1.48 gigatonnes. Solutions include coastal wetland protection and restoration. <https://www.drawdown.org/sectors/coastal-and-ocean-sinks>. [↑](#footnote-ref-348)
349. CO2 equivalent levels can be reduced or sequestered by 85.42 gigatonnes through the adoption of improved health and education policies. <https://www.drawdown.org/solutions>. Ibid. [↑](#footnote-ref-349)
350. <https://solarimpulse.com/climate-change-solutions>. [↑](#footnote-ref-350)
351. ‘Three Climate Change Solutions that could actually happen’ YouTube available. [↑](#footnote-ref-351)
352. 196 countries and the EU agreed in Montreal in 1987 to phase out chlorofluorocarbons (CFCs) by 1996 used in refrigerants which reversed the emergence of an ozone hole in the atmosphere. CFCs were nevertheless replaced by hydrofluorocarbons (HFCs) which are powerful greenhouse gases and have 1,000-9,000 times the ability to trap heat in the atmosphere. 170 countries agreed under the Kigali Rwanda Accord to phase out HFCs over an eight year period through the use of natural refrigerants such as ammonia and propane which could result in a 0.5°C reduction in global temperatures with the removal of 56.8 gigatons of CO2. This is estimated to be the equivalent of taking all of the cars in the world off the road for 90 years. Our Changing Climate (OCC), ‘3 Climate Change Solutions that could actually happen’ YouTube. [↑](#footnote-ref-352)
353. Denmark was able to source 47% of its electricity production from wind turbines with 29% from onshore wind sources. Turbines have a low land footprint which does not limit farming, recreation or conservation. If wind production could be increased from 4 to 26% this would require increase investment and energy production subsidies with ethical climate neutral sourcing of relevant raw materials as well as effective storage and energy transport capacity. 26% of global energy production through wind turbines would reduce CO2 by 147 gigatons by 2050. [↑](#footnote-ref-353)
354. ..................................... production through animal land usage, deforestation, transportation and ................... effects with animal and agriculture production making a ................ of global .................. generated and using 45% of habitable land application. CO2 levels could be reduced 65.03 gigatons with a 60% ...................... could be offset through the ................. current ...........support subsidies through natural plant production. Ibid. [↑](#footnote-ref-354)
355. IEA, *Energy Technology Perspectives 2020* (10 September 2020). IEA, ‘Overview’ (n). [↑](#footnote-ref-355)
356. Ibid. [↑](#footnote-ref-356)
357. IEA, ‘Technology needs for net-zero emissions’ (n). [↑](#footnote-ref-357)
358. IEA, ‘Energy transformations for net-zero emissions’ (n). [↑](#footnote-ref-358)
359. Ibid. [Avoided demand (elective factors such as transport shifts, urban planning strategy, material efficiency and temperature settings), technology performance (efficiency improvements in power and heat generation and end use), electrification (fossil fuel to non-fossil fuel production), bioenergy, other renewables (other renewable sources other than bioenergy and heat pumps), other fuel shifts (fuel mix adjustments and low carbon production including nuclear) and CCUS (carbon capture utilisation and storage). [↑](#footnote-ref-359)
360. McKinsey, ‘A cost curve for greenhouse gas reduction’ *McKinsey Quarterly* (1 February 2007) Exhibit 1. <https://www.mckinsey.com/business-functions/sustainability/our-insights/a-cost-curve-for-greenhouse-gas-reduction>. [↑](#footnote-ref-360)
361. Indra Overland et al, ‘The GeGaLo index: Geopolitical gains and losses after energy transition’ *Energy Strategy Reviews* (2019) 26, 100406. [See also OECD, ‘Cost-Effective Actions to Tackle Climate Change’ (2009); and OECD, ‘Addressing International Competitiveness in a World of Non-uniform Carbon Pricing: Lessons from a decade of OECD analysis’ (November 2010).] [↑](#footnote-ref-361)
362. 20-24. [↑](#footnote-ref-362)
363. The IEA was set up in Paris in November 1974 following the 1973 oil crisis within the OECD framework. The IEA examines oil supply issues and provides other energy related statistical data and reporting. It produces an annual *World Energy Outlook* and *Energy Technology Perspectives*. The IEA has 30 member countries and 8 association country members. <https://www.iea.org>. [↑](#footnote-ref-363)
364. IEA, *Net Zero by 2050 – A Roadmap for the Global Energy Sector* (May 2021). [↑](#footnote-ref-364)
365. (1) Sustainable recoveries can provide a once in a generation down payment toward net zero; (2) clear, ambitious and implementable net zero allied roadmaps to 2030 and beyond are critical; (3) transitions are faster when learning is shared; (4) net zero sectors and innovation are essential to achieve global net zero; (5) mobilising, tracking and benchmarking public and private investment will support achieving net zero; (6) people centred transitions are morally required and politically necessary; (7) net zero energy systems must be sustainable, secure, affordable and resilient. IEA, ‘Seven Key Principles for Implementing Net Zero’ (28 April 2021) <https://www.iea.org/news/seven-key-principles-for-implementing-net-zero>. [↑](#footnote-ref-365)
366. IEA, *Net Zero by 2050* (n). Section 2. [↑](#footnote-ref-366)
367. These include: (a) fossil fuel supply; (b) low emissions fuel supply; (c) electricity sector; (d) industry; (e) transport; and (f) buildings. Section 3. [↑](#footnote-ref-367)
368. (a) Economy; (b) energy industry; (c) citizen; and (d) government. Section 4. [↑](#footnote-ref-368)
369. Chapter 1. [↑](#footnote-ref-369)
370. 48. [↑](#footnote-ref-370)
371. A hybrid model is developed using the IEA’s *World Energy Model* (WEM) which produces the *World Energy Outlook* with the *Energy Technology Perspectives* (ETP) model. These are combined with other models including the International Institute for Applied Systems Analysis (IIASA) Greenhouse Gas-Air Pollution Interactions and Synergies (GAINS) model with the IIASA’s Global Biosphere Management Model (GLOBIOM) and International Money Fund (IMF) Global Integrated Monetary and Fiscal (GIMF) model. Box 2.1 49. [↑](#footnote-ref-371)
372. The 7.8 billion global population would increase by 750 million by 2030 and reach 2 billion by 2050. Section 2.2.1, 50. The global economy would be 45% larger by 2030 and 100% by 2050. Section 2.2.1 50-51. Oil prices would fall to US$35 per barrel by 2030 and $25 per barrel by 2050. CO2 prices would increase to $130 per tonne (tCO2) by 2030 and $250 tCO2 by 2050. Section 2.2.2 51-53. Global energy related and industrial process CO2 emissions would fall to 21 GtCO2 by 2030 and to zero by 2050. Total advanced economy emissions would fall to zero by around 2045 with the remaining 0.2 GtCO2 of emerging market emissions being offset by advanced economy improvements by 2050. Section 2.3 53. Total fuel use would fall from 460 EJ in 2020 to 120 EJ by 2050. Total energy supply would fall by 550 exajoules (EJ) by 2030 and be around the same as in 2010 by 2050 even with three billion additional people and a GDP three times larger. Section 2.4.1 56-58. Total final consumption would fall from 435 EJ in 2019 to 340 EJ in 2050 (as opposed to an estimated 640 EJ) through energy efficiency and a 100% increase in electricity with increased use of hydrogen, bioenergy, carbon capture, utilisation and storage (CCUS) and carbon direct removal (CDR). Figure 2.9 61 and Figure 2.11 63. [↑](#footnote-ref-372)
373. (a) Energy efficiency; (b) behavioural changes; (c) electrification; (d) renewable energy supply; (e) hydrogen and hydrogen based fuel; (f) bioenergy; and (g) carbon capture, utilisation and storage (CCUS). Section 2.5 and Figure 2.12. [↑](#footnote-ref-373)
374. IEA, ‘Pathway to critical and formidable goal of net-zero emissions by 2050 is narrow but brings huge benefits, according to IEA special report’ (18 May 2021) Press release. [↑](#footnote-ref-374)
375. Energy efficiency is necessary to avoid total energy consumption being 300 EJ or 90% higher by 2050. Section 2.5.1. [↑](#footnote-ref-375)
376. 40% of reductions arise from low carbon technology adoption with 55% through technology use and engagement and 8% through behavioural change. Behavioural change is principally based on reducing excessive or wasteful energy use, transport switching and materials efficiency gains. Section 2.5.2. [↑](#footnote-ref-376)
377. 20% of the total reduction is based on low emission electricity supply by 2050 despite a doubling in demand (11,000 TWh) between 2020 and 2050. Section 2.5.3. [↑](#footnote-ref-377)
378. Renewable use increases from 29% in 2020 to over 60% by 2030 and 90% by 2050 including a 500% increase in wind and solar power generation. 2050 renewable energy composition includes hydropower (12%), bioenergy (5%), solar power concentration (2%) and geothermal (1%). Section 2.5.4. [↑](#footnote-ref-378)
379. Hydrogen use expands from 90 Mt in 2020 to over 200 Mt in 2030 and 530 Mt by 2050. 30% of this consists of hydrogen based fuels including ammonia and synthetic liquids and gases. Section 2.5.5. [↑](#footnote-ref-379)
380. [↑](#footnote-ref-380)
381. The use of solid biomass for cooking would be reduced to zero by 2030 due to its unsustainability, inefficiency and polluting effects with modern bioenergy supply increasing from 40 EJ in 2020 to 100 EJ by 2050. Section 2.5.6. [↑](#footnote-ref-381)
382. Capture volumes would increase from 40 Mt CO2 per year in 2020 to 1.6 Gt by 2030 and 7.6 Gt by 2050. 95% of captured CO2 would be stored in permanent geological sites with 5% providing synthetic fuel including for aviation. Section 2.5.7. [↑](#footnote-ref-382)
383. Section 2.5. [↑](#footnote-ref-383)
384. Section 2.6. [↑](#footnote-ref-384)
385. Investment would be made in fossil fuels, hydrogen, electricity systems, electrification, efficiency, bioenergy, other renewables, CCUS and other areas with sectors specifically including buildings, transport, industry, infrastructure, electricity generation and fuel production. Figure 2.22, 81. [↑](#footnote-ref-385)
386. Electricity generation would increase from $500 billion to $1600 billion in 2030 with nuclear investment doubling by 2050. Network investment would increase from $260 billion to $800 billion by 2030 and thereafter to ensure security and a stable power mix. CCUS investment would rise to $160 billion by 2050. Section 2.6. [↑](#footnote-ref-386)
387. Section 2.7. [↑](#footnote-ref-387)
388. Section 3. [↑](#footnote-ref-388)
389. Section 4. [↑](#footnote-ref-389)
390. Section 4.1, 152. [↑](#footnote-ref-390)
391. See, for example, Figure 4.1 on policies, infrastructure and technology deployment between 2020-2050. [↑](#footnote-ref-391)
392. 153. [↑](#footnote-ref-392)
393. Figure 4.1 (n). [↑](#footnote-ref-393)
394. Electricity supply has to be balanced and withstand generator or grid outages with specific difficulties arising in integrating alternative energy supplies through converters. Research is being conducted into integrating new alternative supply sources into existing generator models. Section 4.5.1 and Box 4.1, 178-179. [↑](#footnote-ref-394)
395. Infrastructure issues include long distance transmission, local distribution, grid substations, EV charging and network digitalisation. Section 4.5.2. [↑](#footnote-ref-395)
396. OECD, (2020). [↑](#footnote-ref-396)
397. Section 4.5.4. [↑](#footnote-ref-397)
398. This is specifically necessary in relation to: (a) providing effective international demand signals and economies of scale; (b) managing trade and competitiveness; (c) promoting innovation, demonstration and diffusion; and (d) promoting carbon dioxide removal (CDR) programmes. Victor, Geels and Sharpe (2019). [↑](#footnote-ref-398)
399. Nicholas Stern, *The Economics of Climate Change: The Stern Review* (Cambridge University Press 2007). [↑](#footnote-ref-399)
400. Andrew Bailey, Governor Bank of England, ‘Tackling climate for real: the role of central banks’ (1 June 2021) Reuters Events Responsible Business 2021. [↑](#footnote-ref-400)
401. Mark Carney, former Governor Bank of England, ‘Breaking the tragedy of the horizon – climate change and financial stability’ (28 September 2015) Lloyds of London. Mark Carney referred to climate change as the ‘Tragedy of the Horizon’ with significant costs imposed on future generations through the business cycle, political cycle and technocratic authority mandates including central banks. Carney later referred to the two paradoxes of ‘the future will be past’ and ‘success if failure’. Mark Carney, ‘Resolving the climate paradox’ (22 September 2016) Arthur Burns Memorial Lecture, Berlin. [↑](#footnote-ref-401)
402. Carney (n) 4-5 and 10-11. [↑](#footnote-ref-402)
403. Carney (n) 14-15. [↑](#footnote-ref-403)
404. Matthew Scott, Julia van Huizen and Carsten Jung, ‘The Bank’s response to climate change’ *Quarterly Bulletin* (16 June 2017) Q2 98-109. [↑](#footnote-ref-404)
405. Huw van Steenis, *Future of Finance* (June 2019) Ch 5 on promoting a smooth transition to a low-carbon economy 80-89. [↑](#footnote-ref-405)
406. Bank of England, *The Bank of England’s climate-related financial disclosure 2020* (June 2020). [↑](#footnote-ref-406)
407. Bailey, ‘Tackling climate for real’ (n). [↑](#footnote-ref-407)
408. See, for example, IMF, *Global Financial Stability Report* (April 2020) chapter 5 ‘Climate Change: Physical Risk and Equity Prices’. [↑](#footnote-ref-408)
409. Bailey (n). [↑](#footnote-ref-409)
410. UK Government, ‘Climate considerations now fully embedded across UK principal financial regulators’ (24 March 2021) <https://www.gov.uk/government/news/climate-considerations-now-fully-embedded-across-uk-principal-financial-regulators>. [↑](#footnote-ref-410)
411. Bailey (n). [↑](#footnote-ref-411)
412. [↑](#footnote-ref-412)
413. [↑](#footnote-ref-413)
414. See, for example, IOSCO, ‘IOSCO steps up its efforts to address issues around sustainability and climate change’ (14 April 2020); IOSCO, ‘IOSCO sees an urgent need for globally consistent, comparable and reliable sustainability disclosure standards and announces its priorities and vision for a Sustainable Standards Board under the IFRS Foundation’ (24 February 2021). See also, IOSCO, *Report on Sustainability-related Issuer Disclosures* (June 2021) FR04/21. [↑](#footnote-ref-414)
415. [↑](#footnote-ref-415)
416. FSB, *Recommendations of the Task Force on Climate-related Financial Disclosures* (June 2017). [↑](#footnote-ref-416)
417. FSB, *Recommendations of the Task Force on Climate-related Financial Disclosures* (December 2016); and FSB, *Phase 1 Report of the Task Force on Climate-related Financial Disclosures* (May 2016). [The FSB submitted a proposal to the G20 to create the Task Force on Climate-related Financial Disclosures (TCFD) modelled on its Enhanced Disclosure Task Force (EDTF). FSB, ‘Disclosure task force on climate-related risks’ (9 November 2015).] [↑](#footnote-ref-417)
418. II. [↑](#footnote-ref-418)
419. Figure 1 III. [↑](#footnote-ref-419)
420. (1) Disclosures should represent relevant information; (2) disclosures should be specific and complete; (3) disclosures should be clear, balanced and understandable; (4) disclosures should be consistent over time; (5) disclosures should be comparable among companies within a sector, industry or portfolio; (6) disclosure should be reliable, verifiable and objective; and (7) disclosures should be provided on a timely basis. Figure 6, 18. [↑](#footnote-ref-420)
421. Figure 2 V. [↑](#footnote-ref-421)
422. Figure 4, 14. [↑](#footnote-ref-422)
423. Figure 5, 15. [↑](#footnote-ref-423)
424. FSB, *Roadmap for Addressing Climate-related Financial Risks* (7 July 2021). [↑](#footnote-ref-424)
425. Section 2.1. [↑](#footnote-ref-425)
426. Section 2.2. [↑](#footnote-ref-426)
427. Section 2.3. [↑](#footnote-ref-427)
428. Section 4. [↑](#footnote-ref-428)
429. Section 4.5. [↑](#footnote-ref-429)
430. G20 SFWG, *Roadmap on Sustainable Finance* ( ). [A stylised overview of the four blocks within the FSB roadmap is provided.] Figure 1, 11. [↑](#footnote-ref-430)
431. Black swan events include disproportionate low probability occurrences with the non-computability of the event and psychological biases that lead to a lack of individual and collective expectation which can generally only be explained after the fact. This can be considered in terms of fat-tailed probability distributions. Nassim Nicholas Taleb, *The Black Swan: the impact of the highly improbable* (Penguin London 2ed 2010). [↑](#footnote-ref-431)
432. Climate risks are fat-tailed although they cannot be understood in terms of traditional risk management approaches based on historical data extrapolation and normal distribution assumptions. Patrick Bolton, Morgan Després, Luiz Awazu Pereira da Silva, Frédéric Samama and Romain Svartzman, *The green swan* (January 2020) Box A3. [↑](#footnote-ref-432)
433. Ibid. [↑](#footnote-ref-433)
434. Epistemological ruptures or breaks were developed by the French philosopher, Gaston Bachelard (1884-1962) to refer to the removal of earlier ‘epistemological obstacles’ that prevented knowledge realisation. Gaston Bachelard, *The Formation of the Scientific Mind: A Contribution to a Psychoanalysis of Objective Knowledge* (Beacon Press 1986). [↑](#footnote-ref-434)
435. Ibid. [↑](#footnote-ref-435)
436. Ch 2. [↑](#footnote-ref-436)
437. OECD (2019); and Schoon and Van der Leeuw (2015). Ch 5. [↑](#footnote-ref-437)
438. Ch 3. [↑](#footnote-ref-438)
439. The office specifically recommends: (1) carbon pricing supplemented with; (2) long termism and sustainable finance; (3) coordination between green fiscal policy, prudential regulation and monetary policy; (4) international monetary and financial coordination and reform; and (5) integration of natural capital international and corporate accounting systems. Ch 4. [↑](#footnote-ref-439)
440. Box B4. [↑](#footnote-ref-440)
441. Basel Committee, *Climate-related financial risks: a survey of current initiatives* (2020). [↑](#footnote-ref-441)
442. Introduction. [↑](#footnote-ref-442)
443. Basel Committee on banking supervision, *Climate-related risk drivers and their transition channels* (April 2021); and Basel Committee *Climate-related financial risks – measurement methodologies* (April 2021). [↑](#footnote-ref-443)
444. Table 1 32. [↑](#footnote-ref-444)
445. Basel Committee, *Climate-related risk drivers and their transmission channels* (n) 1. [↑](#footnote-ref-445)
446. Chs 2, 3 and 4. [↑](#footnote-ref-446)
447. Section 5.1. [↑](#footnote-ref-447)
448. Section 5.2. [↑](#footnote-ref-448)
449. Section 2.2. [↑](#footnote-ref-449)
450. Section 2.3. [↑](#footnote-ref-450)
451. Section 2.4. [↑](#footnote-ref-451)
452. Section 4.1. [↑](#footnote-ref-452)
453. Section 4.2. [↑](#footnote-ref-453)
454. Section 4.3. [↑](#footnote-ref-454)
455. Executive summary 1-3. [↑](#footnote-ref-455)
456. The NGFS had 66 members and 13 observers from 2020. <https://www.ngfs.net/en>. [↑](#footnote-ref-456)
457. NGFS, *NGFS Climate Scenarios for central banks and supervisors* (June 2020). [↑](#footnote-ref-457)
458. NGFS, *Guide to climate scenario analysis for central banks and supervisors* (June 2020). [↑](#footnote-ref-458)
459. Transition risks include policy and regulation, technology development and consumer preferences. Physical risks consist of chronic (including temperature precipitation, agricultural productivity and sea level damage) and acute (heatwaves, floods, cyclones and wild fires). 9. [↑](#footnote-ref-459)
460. Credit risk, market risk, underwriting risk, operational risk and liquidity risk. [↑](#footnote-ref-460)
461. NGFS, *Climate Scenarios* (n) 9. [↑](#footnote-ref-461)
462. (n). [↑](#footnote-ref-462)
463. NGFS, *A call for action – Climate change as a source of financial risk* (April 2019). [↑](#footnote-ref-463)
464. (1) Integrating climate related risks into financial stability monitoring and micro-supervision; (2) integrating sustainability factors into own-portfolio management; (3) bridging the data gap; (4) building awareness and intellectual capacity and encouraging technical assistance and knowledge sharing; (5) achieving robust and internationally consistent climate and environment related disclosures; and (6) supporting the development of a taxonomy of economic activity. Chapter 2. [↑](#footnote-ref-464)
465. Mark Carney, Former Governor of the Bank of England, François Villeroy de Galhau, Governor of Banque de France and Frank Elderson, Chair of the NGFS, ‘Open letter on climate-related financial risks’ (17 April 2019); and Andrew Bailey, Mark Carney, François Villeroy de Galhau and Frank Elderson, ‘The world must seize this opportunity to meet the climate challenge’ *The Guardian* (5 June 2020). [↑](#footnote-ref-465)
466. The SIF acts as a platform for insurance supervisors and regulators, to deal with sustainability issues impacting consumers, firms and markets to exchange knowledge and identify best practice. <https://www.sustainableinsuranceforum.org>. [↑](#footnote-ref-466)
467. (1) Embed in decision making environmental, social and governance issues relevant to insurance business; (2) work together with clients and business partners to raise awareness of environmental, social and governance issues, manage risk and develop solutions; (3) work with governments, regulators and other stakeholders to promote widespread action across society on environmental, social and governance issues; and (4) demonstrate accountability and transparency in regularly disclosing publicly progress in implementing the principles. <https://www.unepfi.org/psi/the-principles/>. [↑](#footnote-ref-467)
468. PRA, *The impact of climate change on the UK insurance sector* (September 2015). [↑](#footnote-ref-468)
469. PRA, *Transition in thinking: The impact of climate change on the UK banking sector*. [↑](#footnote-ref-469)
470. PRA, *Enhancing banks and insurers’ approaches to managing the financial risks from climate change* (October 2018) CP23/18 and PS11/19. [↑](#footnote-ref-470)
471. This is based on: (1) identify business decisions; (2) define materiality; (3) conduct background research; (4) assess available tools; (5) calculate impact; and (6) report and action. PRA, *A framework for assessing financial impacts of physical climate change: A practitioner’s aid for the general insurance sector* (22 May 2019). [↑](#footnote-ref-471)
472. HM Treasury, *Interim Report of the UK’s Joint Government Regulatory TCFC Taskforce* (November 2020). [↑](#footnote-ref-472)
473. HM Treasury, *A Roadmap towards mandatory climate-related disclosures* (November 2020), Figures 1 and 2 5-8. [↑](#footnote-ref-473)
474. PRA, *Insurance Stress Test for 2019* (18 June 2019). [↑](#footnote-ref-474)
475. This includes specific features on the 2021 BES, scenario narratives, scenario specification, modelling approaches and firm submissions. Bank of England, *The 2021 biennial exploratory scenario on the financial risks from climate change* (December 2019). [↑](#footnote-ref-475)
476. Four working groups have been set up on: (1) Risk management; (2) Scenario Analysis; (3) Disclosure; and (4) Innovation. Bank of England, ‘Climate Financial Risk Forum’ <https://www.bankofengland.co.uk/climate-change/climate-financial-risk-forum>. [↑](#footnote-ref-476)
477. Bailey, ‘Tackling climate for real’ (n). [↑](#footnote-ref-477)
478. See, for example, Sandra Batten, Rhiannon Sowerbutts and Misa Tanaka, ‘Let’s talk about the weather: the impact of climate change on central banks’ (May 2016) Staff Working Paper No 603; and Sandra Batten, *Climate change and the macro-economy: A critical review* (January 2018) Staff Working Paper No 706. [↑](#footnote-ref-478)
479. Ibid. See also Andrew Bailey, ‘Tackling climate for real: progress and next steps’ (3 June 2021) Green Swan 2021 Global Conference. [↑](#footnote-ref-479)
480. OECD, ‘Climate change’ <https://www.oecd.org/env/cc/> [↑](#footnote-ref-480)
481. <https://www.oecd.org/environment/cc/climate-publication.htm>. [↑](#footnote-ref-481)
482. Malcolm Shaw, *International Law* ( ) ch 13. [↑](#footnote-ref-482)
483. Shaw (n) ch 14 and 641. [↑](#footnote-ref-483)
484. The UNEP is based in Nairobi, Kenya and works with other environmental conventions, secretariats and inter-agency bodies. It has an Executive Director and operates through a Governing Council made up of 58 members. Its work focuses on climate change, disasters and conflicts, ecosystem management, environment governance, chemicals and waste, resource efficiency and environment under review with an overarching commitment to sustainability. UN, ‘Why does UN Environment Programme Matter?’ <https://www.unep.org/about-un-environment/why-does-un-environment-programme-matter>. [↑](#footnote-ref-484)
485. These include Resolutions 2398 (XXII); 2997 (XXVII); 34/188; 35/8; 37/137; 37/250; 42/187; 44/244; 44/228; 45/212; 47/188; 69/220; and 70/1. See UN, ‘UN Documentation: Environment’ available <https://research.un.org/en/docs/environment/unep>. [↑](#footnote-ref-485)
486. UNEP, *Environment Assembly rules or procedure* (May 2016) UNEP/EA.3/3. See also UNEP Organisation Chart <https://wedocs.unep/org/bitstream/handle/20.500.11822/35352/uneporg.pdf>. [↑](#footnote-ref-486)
487. This also includes the Subsidiary Body for Scientific and Technological Advice (SBSTA) and Subsidiary Body for Implementation (SBI). <https://research.un.org/en/climate-change/un>. [↑](#footnote-ref-487)
488. The UNFCCC Secretariat was set up in 1992 in Geneva with this being moved to Bonn, Germany in 1995. The Secretariat consists of around 450 staff who manage the UN Climate Change under the UNFCCC which was agreed in 1992 and came into effect on 21 March 1994. [↑](#footnote-ref-488)
489. The IPCC was established by the UNEP and WMO in 1988 and has 195 member countries. The IPCC monitors climate change data and potential environmental and socioeconomic impacts. [↑](#footnote-ref-489)
490. The Green Climate Fund (GCF) was established at the COP16 in Cancun (Decision 1/CP.16) to act as an operating entity for the Financial Mechanism set up in Art 11 of the Convention. The GCF is governed by a Board and supports projects, programmes, policies and other activities in developing countries related to the COP. [↑](#footnote-ref-490)
491. The UN Office for Disaster Risk Reduction (UNDRR) was established in December 1999 to manage the International Strategy for Disaster Reduction (GA Resolution 54/219). The UNDRR is based in Geneva, Switzerland and has five regional offices. Its function is to coordinate disaster reduction including in the areas of climate change adaptation, investment, constructing disaster resilient cities, schools and hospitals and strengthening international DRR. <https://www.undrr.org>. [↑](#footnote-ref-491)
492. The WMO was set up in 1950 as a specialised UN agency to promote international cooperation on atmospheric science, climatology, hydrology and geopolitics. WMO, ‘History of the WMO’ https://public. wmo.int/en/about-us/who-we-are/history-of-wmo. [↑](#footnote-ref-492)
493. <https://unsceb.org/inter-agency-committee-sustainable-development-iacsd>. [↑](#footnote-ref-493)
494. The HLPF operates under the authority of the Economic and Social Council (ECOSOC) and the General Assembly. Its purpose is to strengthen sustainable development governance within the UN under Resolution A/RES/66/288 and Resolution A/RES/67/290. This work includes managing the Earth Summit 1992 Agenda 21, The Johannesburg Plan of Implementation, Barbados Programme of Action (BPOA) 1994, Mauritius Strategy, Rio 2012 (RIO+20) and LDC-IV. [↑](#footnote-ref-494)
495. US Attorney General, Judson Harmon, *Opinion Attorney General* 274, 283 (1895) cited in Shaw (n) 645 (n28). [↑](#footnote-ref-495)
496. Art 38(1) of the Statute of the International Court of Justice refers to the sources of International Law as consisting of: (a) Conventions; (b) International custom; (c) General principles of law recognised by civilised nations; and (d) Judicial decisions and teachings of the most qualified publicists. General principles of law may, for example, include reparation, survival of rights, *res judicata*, no divesting of jurisdiction, estoppel, damages, acquired rights and binding agreements as well as good faith. Shaw (n) 74-77. Customary law may specifically include obligatory measures or *ius cogens* (peremptory norms) and general procedural standards *erga* *omnes*. Shaw (n) 92. The International Law Commission attempted to list *ius cogens* to include the unlawful use of force, genocide, slavery and piracy with torture being added. ILC, *Yearbook of ILC* (1966) Vol II 248. To qualify as a *ius cogens*, this had to be established as a proposition of general international law and accepted as a peremptory norm by the international community of states as a whole. Shaw (n) 94. Any measures conflicting with *ius cogens* were void under art 53 of the Vienna Convention or became void from the date of emergence of a new *ius cogens* under art 64. [↑](#footnote-ref-496)
497. Shaw (n) 645. [↑](#footnote-ref-497)
498. *International Commission of the River Oder* PCIJ, Series A, No 23 (1929); 5 AD, 83. [↑](#footnote-ref-498)
499. *Palmas* 2 RIAA, 829, 839 (1928). [↑](#footnote-ref-499)
500. *Trail Smelter* arbitration 33 AJIL, 1939, 182 and 35 AJIL, 1941, 684; 9 AD, 315. [↑](#footnote-ref-500)
501. *Corfu* ICJ Reports, 1949, 4, 22; 16 AD, 155, 158. [↑](#footnote-ref-501)
502. *Request for an examination of the Situation in Accordance with Paragraph 63 of the Nuclear Tests Case 1974*, ICJ Reports, 1995, 288,306; 106 ILR, 1, 28. See also *Legality of the Threat of Use of Nuclear Force* ICJ Reports, 1996, para 29; 35 ILM, 1996, 809, 821. For comment, Shaw (n) 646. [↑](#footnote-ref-502)
503. Shaw (n) 647-651. [↑](#footnote-ref-503)
504. ILC, *Yearbook of the ILC* (1978) Vol II, Part 2, 149. [↑](#footnote-ref-504)
505. ILC, *Report of the ILC on its 53rd session*, 379. [↑](#footnote-ref-505)
506. A/61/10, 110. [↑](#footnote-ref-506)
507. ‘International matters concerning the protection and improvement of the environment should be handled in a cooperative spirit’ Principle 24 1972 Stockholm Declaration (n). [↑](#footnote-ref-507)
508. ‘States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth’s ecosystem.’ Principle 7 1992 Rio Declaration. States are also to ‘develop national law regarding liability and compensation for the victims of pollution and other environmental damage’ and ‘cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction. Principle 13 1992 Rio Declaration. [↑](#footnote-ref-508)
509. 653. [↑](#footnote-ref-509)
510. Shaw, ‘International Environmental Law’ (n) ch 14 and 642-645. See also Dupuy and Viñuales, *International Environmental Law* ( ) ch 10. [↑](#footnote-ref-510)
511. The preamble to the 1972 Stockholm Declaration noted that the environment was essential to ‘the enjoyment of basic human rights – even the right to life itself’ with Principle 1 stating that, ‘Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being.’ For other references, Shaw (n) 642. [↑](#footnote-ref-511)
512. E/CN.4/Sub.2/1994/9. [↑](#footnote-ref-512)
513. [↑](#footnote-ref-513)
514. Principle 8 of the Stockholm Declaration 1972 (n); and Principle 2 of the Rio Declaration 1992 (n). See also art 19 of the OECD and CIS, *Energy Charter Treaty* (Lisbon 1994). For comment, Shaw (n) 644. [↑](#footnote-ref-514)
515. FG Minujin, ‘Debt-for-Nature Swaps: A Financial Mechanism to Reduce Debt and Preserve the Environment’ *Environmental Policy & Law* (1991) 21, 146. [↑](#footnote-ref-515)
516. For discussion, Shaw (n) 653-660. [↑](#footnote-ref-516)
517. *Corfu Channel* Case (n) ICJ Reports, 1949, 4, 22; 16AD, 155,158. [↑](#footnote-ref-517)
518. ‘In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities’ and where ‘there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.’ Principle 15 Rio Declaration (n). Shaw (n) 657-658. [↑](#footnote-ref-518)
519. ‘States have common but differentiated responsibilities’ with ‘the developed countries [acknowledging] the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command. Principle 7 Rio Declaration (n). Parties should also act ‘on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities’. Article 3(1) Convention on Climate Change (n). [↑](#footnote-ref-519)
520. The right to develop must ‘equitably meet developmental and environmental needs of present and future generations’. Principle 3. Environmental protection must constitute an integral part of the development process to secure sustainable development under Principle 4. Sustainable development must be supported by cooperation in the development of international law. Principle 27. ‘Parties have a right to, and should, promote sustainable development’ under Article 3(4) Climate Change Convention (n). Sustainable development was referred to in the Gabčíkovo-*Nagymaros Project* case ICG Reports, 1997, 7,78; 116 ILR, 1. Shaw (n) 658-659. [↑](#footnote-ref-520)
521. OECD Council Recommendations C(74)223 (1974) and C(89)88; and EC Treaty art 174. [↑](#footnote-ref-521)
522. See, for example, Boyle, ‘Making the Polluter Pay?’ 365. Shaw (n) 659-660. [↑](#footnote-ref-522)
523. *Trail Smelter* case 35 AJIL, 1945, 716; 9 AD, 317. [↑](#footnote-ref-523)
524. Shaw (n) 661. [↑](#footnote-ref-524)
525. Pollution is ‘the introduction by man, directly or indirectly, of substances or energy into the environment resulting in deleterious effects of such a nature as to endanger human health, harm living resources and ecosystems, and impair or interfere with amenities and other legitimate uses of the environment.’ OECD Recommendation Doc. C(1974)224. [↑](#footnote-ref-525)
526. Shaw (n) 660-661. [↑](#footnote-ref-526)
527. Arts 3, 4 and 5. [↑](#footnote-ref-527)
528. EPA, ‘EMEP (European Monitoring and Evaluation Programme)’ [https://www.eea.europa.eu/themes/air/ links/institutions/emep-european-monitoring-and-evaluation-programme](https://www.eea.europa.eu/themes/air/%20links/institutions/emep-european-monitoring-and-evaluation-programme).; and <https://www.emep.int>. [↑](#footnote-ref-528)
529. EMEP, ‘EMEP History and Structure’ <https://www.emep.int/emep_overview.html>. [↑](#footnote-ref-529)
530. POPs are prohibited and/or eliminated under art 3. Existing stockpiles and wastes are to be managed safely and in an environmentally sound manner (art 6). The Convention also includes provisions on implementation plans (art 7), extensions (art 8), information exchange (art 9), public information, awareness and education (art 10), research, development and monitoring (art 11), technical assistance (art 12), financial resources and mechanisms (art 13), reporting (art 15), effectiveness evaluation (art 16) and non-compliance (art 17). The specific POPs covered are listed in Annex A as amended. UNEP, *Stockholm Convention on Persistent Organic Pollutants (POPs) Text and Annexes* (Revised 2019). [↑](#footnote-ref-530)
531. NASA, ‘The Ozone Layer’ available <https://www.nas.nasa.gov/about/education/ozone/ozonelayer.html>. [↑](#footnote-ref-531)
532. ‘Ozone Basics’ [https://www.archive.org/web/20171121051325/http://www.ozonelayer.noaa.gov/science/ basics.htm](https://www.archive.org/web/20171121051325/http%3A/www.ozonelayer.noaa.gov/science/%20basics.htm). [↑](#footnote-ref-532)
533. The ozone layer was discovered by French physicist, Charles Fabry and Henri Buisson, with a spectrophotometer (Dobsonmeter) being developed by the British meteorologist, Gordon MB Dobson. CT McElroy and PF Fogal, ‘Ozone: From discovery to protection’ *Atmosphere Ocean* (2008) 46. [↑](#footnote-ref-533)
534. Energy Information Administration, ‘Halocarbons and Other Gases’ (1997). [↑](#footnote-ref-534)
535. A Douglass and V Fioletov, ‘Stratospheric Ozone and Surface Ultraviolet Radiation’ in WMO, *Scientific Assessment of Ozone Depletion: 2010* (2011). [↑](#footnote-ref-535)
536. The ozone layer was described as ‘the layer of atmospheric ozone above the planetary boundary layer’ art 1(1) Vienna Convention for the Protection of the Ozone Layer (1985). [↑](#footnote-ref-536)
537. Art 2. [↑](#footnote-ref-537)
538. Arts 7 and 11. [↑](#footnote-ref-538)
539. Annex A. [↑](#footnote-ref-539)
540. Levels would be reduced by 20% over ten years and then by a further 50%. *Montreal Protocol on Substances that Deplete the Ozone Layer* (1987). Exceptions were provided for industrial rationalisation between parties and developing country activity. Art 5. [↑](#footnote-ref-540)
541. NASA, ‘SAGE II: Understanding the Earth’s Stratosphere’ [https://www.nasa.gov/centers/langley/news/ factsheets/sage.html](https://www.nasa.gov/centers/langley/news/%20factsheets/sage.html). [↑](#footnote-ref-541)
542. London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997), Beijing (1999) and Montreal (2007). [https://web.archive.org/web/20140823064226/http://ozone.unep.org/new\_site/en/treaties/treaties\_decisions-hp.php?sec\_id=343](https://web.archive.org/web/20140823064226/http%3A/ozone.unep.org/new_site/en/treaties/treaties_decisions-hp.php?sec_id=343). [↑](#footnote-ref-542)
543. 31 ILM 1992, 849. [↑](#footnote-ref-543)
544. *UN Framework Convention on Climate Change* (1992) FCCC/INFORMAL/84. [↑](#footnote-ref-544)
545. General Assembly resolutions 43/53 (1988); and 44/207 (1989). See also UNEP Governing Council Decision on Global Climate Change (25 May 1989). [↑](#footnote-ref-545)
546. Art 2. Adverse effects and climate change are defined as changes in the physical environment or biota resulting from climate change that have significant deleterious effects on the composition, resilience of productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare. Art 1(1). Climate change means any change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. [↑](#footnote-ref-546)
547. Parties should protect the climate system for the benefit of present and future generations of humankind on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities with developed countries assuming a lead in combating climate change. Art 3(1). The specific needs and special circumstances of developing countries are to be given full consideration. Art 3(2). Parties are to take precautionary measures to anticipate, prevent or minimise the causes of climate change and mitigate its adverse effects. Art 3(3). Parties have a right to and should promote sustainable development with policies and measures being appropriate to specific conditions and integrated with national development programmes with economic development being essential to adopting measures to deal with climate change. Art 3(4). Parties should cooperate to promote a supportive and open international economic system that leads to sustainable economic growth and development. Art 3(5). [↑](#footnote-ref-547)
548. Art 4. [↑](#footnote-ref-548)
549. Arts 5 and 6. [↑](#footnote-ref-549)
550. Art 7. [↑](#footnote-ref-550)
551. Arts 8-10. [↑](#footnote-ref-551)
552. Arts 11 and 12 with 13-14. Additional provisions are included with regard to amendments (Art 15), annexes (Art 16), protocols (Art 17), voting (Art 18), depository (Art 19), signature (Art 20), interim arrangements (Art 21), ratification, acceptance, approval or accession (Art 22), entry into force (Art 23), reservations (Art 24), withdrawal (Art 25) and authentic texts (Art 26). [↑](#footnote-ref-552)
553. Section 8(6). [↑](#footnote-ref-553)
554. Section 8(7). [↑](#footnote-ref-554)
555. GA Walker, ‘Endogenous, Exogenous and Existential risk’ *The International Lawyer* (Spring 2022) Section. [↑](#footnote-ref-555)
556. Walker (ibid). Section 11(10) below. [↑](#footnote-ref-556)
557. Section 5. [↑](#footnote-ref-557)
558. Section 6. [↑](#footnote-ref-558)
559. A key element of this .................. adoption of an effective ‘Climate Augmented Transition’ (CAT) ............ with ................... ‘Climate Adoption Technology’ (CATS). It may be economical and desirable or impossible to attempt to convert many existing energy, production, construction, transportation or other processes to other useful solutions or usages. ........................... processes may have to be established with possibly more than one interim phases being adopted. This may, for example, apply with the conversion of ........................... into natural gas and then biomass systems and then carbon clean production. CO2 damage from petrol car combustion can be reduced immediately through the electro-system of appropriate exhaust and emission systems with car production switching from petrol to hybrid and then full electric vehicle (EV) ....................use. The adoption of aggressive carbon neutral targets and solutions may be inefficient in terms of climate management and economically devastating and ............... damaging ..................................of high unemployment levels in carbon related industries. More progressive, ................................................ more economical and climate target efficient. [↑](#footnote-ref-559)
560. Section 10 (5). [↑](#footnote-ref-560)
561. Section 9 and 10 (2). [↑](#footnote-ref-561)
562. Section 10 (6). [↑](#footnote-ref-562)
563. Pressure on large international oil production companies (BigOil) resulted in a disposal of assets to smaller operators who may not necessarily be subject to the same environmental objectives. It was estimated that around $140 billion of assets would be sold in the oil and gas area which may only increase rather than decrease emissions as well as increase all prices and costs of energy production which would in turn limit decarbonisation investment. See, for example, Anjili Raval, ‘A $140bn asset sale: the investors cashing in on BigOil’s push to net zero’ *Financial Times* (6 July 2021). [↑](#footnote-ref-563)
564. Section 10 (1). [↑](#footnote-ref-564)
565. Section 8 and (nn). [↑](#footnote-ref-565)
566. Ibid. [↑](#footnote-ref-566)
567. Sections 11 (4) and (5). [↑](#footnote-ref-567)
568. Section 9(5). [↑](#footnote-ref-568)
569. The high level Principles for Businesses (PRIN) set out in the Financial Conduct Authority (FCA) Handbook are enforceable by the FCA through the imposition of appropriate penalties including fines or the restriction or withdrawal of permission and authorisation. PRIN 1 is specifically based on integrity which firms have to comply with on a continuing basis. The same principles apply to senior managers within financial institutions under the COCON rules. A parallel regime is created for Fundamental Rules under the Prudential Regulation Authority (PRA) Rulebook. G.A. Walker, ‘Banks and Banking’ in Walker, Purves and Blair, *Financial Services Law* (OUP Oxford 4ed 2019) ch 16, paras . [↑](#footnote-ref-569)
570. See, for example, . [↑](#footnote-ref-570)
571. Section 10 (5). [↑](#footnote-ref-571)
572. GA Walker, ‘Endogenous, exogenous and existential risk’, Section . [↑](#footnote-ref-572)
573. See, for example, IPCC; and IEA. [↑](#footnote-ref-573)
574. [↑](#footnote-ref-574)
575. Walker, ‘Endogenous, Exogenous & Existential Risk’ (n). [↑](#footnote-ref-575)
576. Section 10. [↑](#footnote-ref-576)
577. G.A. Walker, ‘Technology Law, Regulation & Ethics’ *The International Lawyer* (forthcoming). [↑](#footnote-ref-577)
578. Ibid. [↑](#footnote-ref-578)
579. GA Walker, *International Banking Regulation, Law Policy & Practice* (Kluwer Law) (n1). [↑](#footnote-ref-579)
580. Ibid. [↑](#footnote-ref-580)
581. Walker, ‘Technology Law, Regulation & Ethics’ (n). [↑](#footnote-ref-581)
582. Section 10 (4) – (7). [↑](#footnote-ref-582)
583. Section 8 (nn). [↑](#footnote-ref-583)
584. GA Walker, ‘Endogenous, exogenous and existential risk’ (n) Section . [↑](#footnote-ref-584)