CHAPTER 3
ENVIRONMENTAL FACTORS

The range of environmental factors that have a material financial impact on investments – the 'E' in ESG – is broad and far-reaching. Environmental risks have continued to gain prominence and are generating heightened concern worldwide.

Environmental risks (including extreme weather, natural disasters and climate action failure) have dominated the rankings in the World Economic Forum's *Global Risks Report* since 2016, with biodiversity loss becoming a top five risk in 2020. While the COVID-19 pandemic has elevated infectious diseases to one of the top five global risks in the 2021 edition, four out of the top five risks by likelihood (five out of five in 2020) and three out of the top five by impact were related to the environment. By comparison, before 2010, no environmental risks featured in the top five. This marked contrast is testimony to the rapid rise of sustainability on the global agenda.

Growing awareness of environmental and climate impacts is reflected in increasing levels and scope of corporate disclosure (e.g. the adoption of the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD)) and the introduction of policies (e.g. the European Green Deal) to accelerate sustainable finance.

This chapter identifies and describes some of the key environmental factors and major external drivers that investment analysts and portfolio managers should consider when assessing material environmental risks and opportunities in their portfolios.

CHAPTER 3
ENVIRONMENTAL FACTORS

1 KEY ENVIRONMENTAL ISSUES

3.1.1	Explain key concepts relating to climate change from an evidence-based perspective, including: climate change; climate change mitigation; climate change adaptation and resilience measures.
3.1.2	Explain key concepts relating to other environmental issues from an evidence-based perspective, including: pressures on natural resources, including depletion of natural resources, water, biodiversity loss, land use and marine resources; pollution, waste and a circular economy.

Economics and the environment are inextricably linked. Consider the similarities between one widely used definition of economics – the study of "the relationship between ends and scarce means which have alternative uses"[1] – and a widely used definition of environmental sustainability – seeking "to meet the needs and aspirations of the present without compromising the ability to meet those of the future".[2] The use and depletion of natural resources and the trade-offs between present costs and future benefits are topics that have been central to economics since its inception as a discipline.

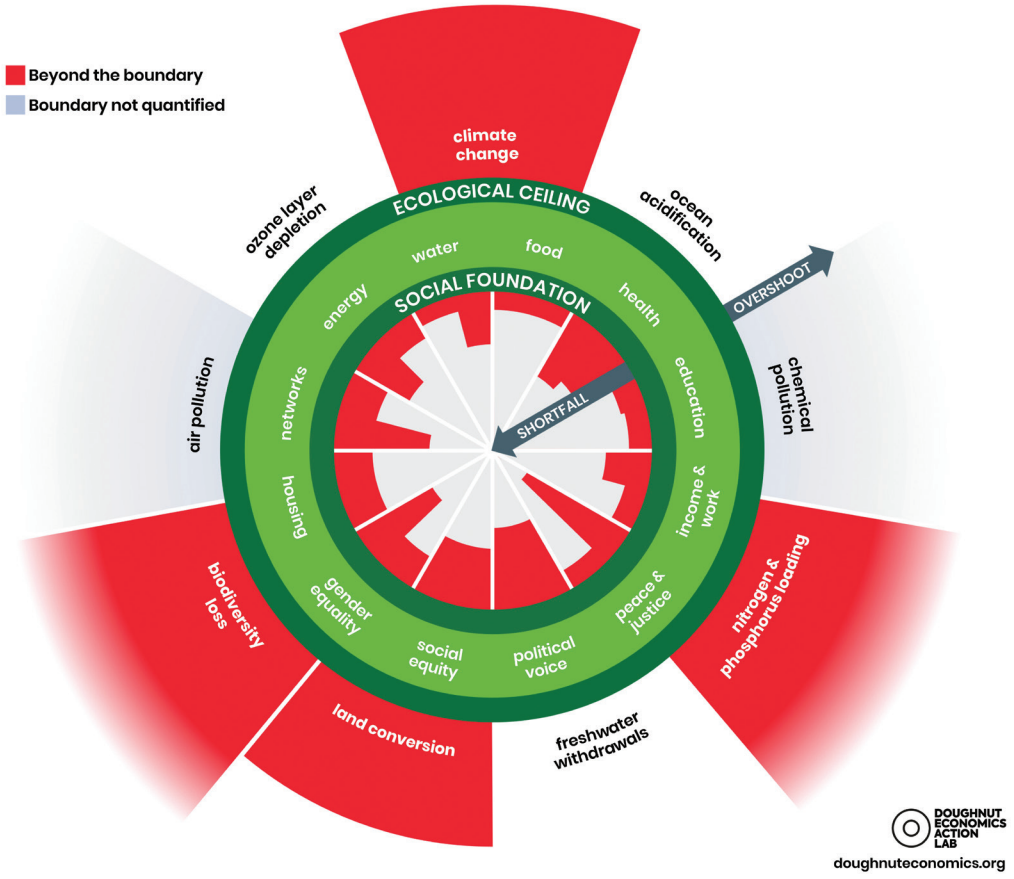
Less appreciated, historically, has been the dependency of the successful conduct of economic activity on a stable, habitable planetary system. However, in recent decades, the scientific community has issued increasingly stark warnings that the consequences of economic activities – notably the burning of fossil fuels for energy, but also other forms of pollution and environmental degradation – are jeopardising the very stability of the climate system, with dangerous, potentially catastrophic consequences.[3]

It has thus been suggested that investment and economic activities should be undertaken with a view to respecting 'planetary boundaries' – processes (such as climate-change-driven disruptions to the carbon cycle or the formation of the stratospheric ozone layer) that regulate the stability and resilience of the Earth system.[4] As such, working to avoid 'overshooting' boundaries could help not only to address environmental risks, but – through a more judicious and equitable use of natural resources – also important socioeconomic dimensions, such as employment and access to health.

According to an update by the Stockholm Resilience Centre from 2017, four of nine planetary boundaries have already been crossed as a result of human activity:

- climate change;
- loss of biosphere integrity;
- land-system change; and
- altered biogeochemical cycles (phosphorus and nitrogen loading).[4]

Figure 3.1: 'THE DOUGHNUT' – AN ILLUSTRATION OF PLANETARY BOUNDARIES AND SOCIAL FOUNDATIONS



Source: Raworth & Guthier, via World Economic Forum.[5]

Whilst it may be seen as a good in itself, the pursuit of environmental sustainability can also be justified by appeal to financial interest. Conversely, as societal preferences, regulation and technology change, ongoing investments in environmentally damaging activities may carry unrewarded risks, which can lead to losses in revenues and falling asset values.

There are numerous studies and frameworks that identify a range of environmental factors that are relevant to how investors assess risks and opportunities in their decisions. For the purposes of this syllabus, the environmental issues covered will include:

A. climate change;

B. pressures on natural resources (including water, biodiversity, land use and forestry, and marine resources); and

C. pollution, waste and a circular economy.

- Although this section will cover each issue separately, it is important to note that they are linked and have systemic consequences for business activities and vice versa, as further explained in **Section 2**.

A. Climate change

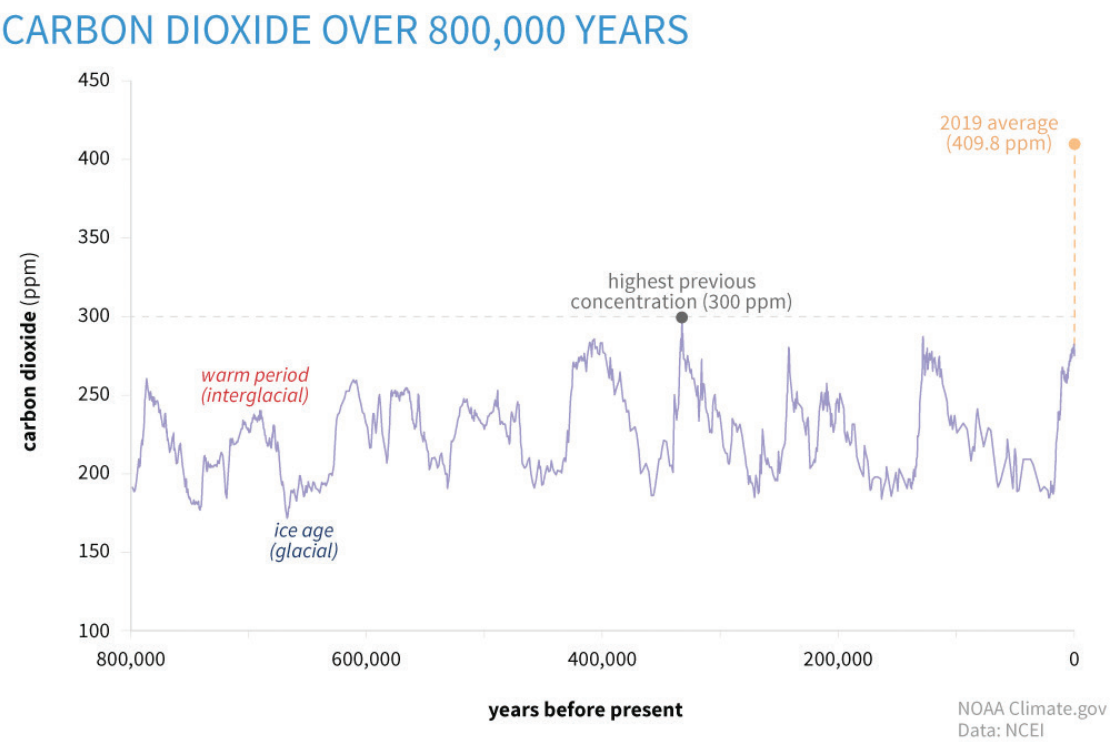
Climate change is defined as a change of climate, directly or indirectly attributed to human activity, that alters the composition of the global atmosphere and which is, in addition to natural climate variability, observed over comparable time periods.[i] It is one of the most complex issues facing us today and involves many different dimensions, including:

- science;
- economics;
- society;
- politics; and
- moral and ethical questions.

It is an issue with local manifestations (e.g. extreme weather events, such as more frequent and/or more intense tropical cyclones) and global impacts (e.g. rising global average temperatures and sea levels), which are estimated to increase in severity over time.

The main man-made driver of the warming of the planet is rising emissions of greenhouse gases (GHGs). They form a layer in the atmosphere that prevents increasing amounts of the heat reaching the Earth from the Sun from being radiated back into space. Carbon dioxide (CO_2) is the most significant contributor to the warming effect, because of its higher concentration in the atmosphere, which is at levels not seen since before Homo sapiens first appeared.[6]

Figure 3.2: CO_2 LEVELS IN THE ATMOSPHERE FOR PAST 800,000 YEARS



Source: NOAA (2020).[6]

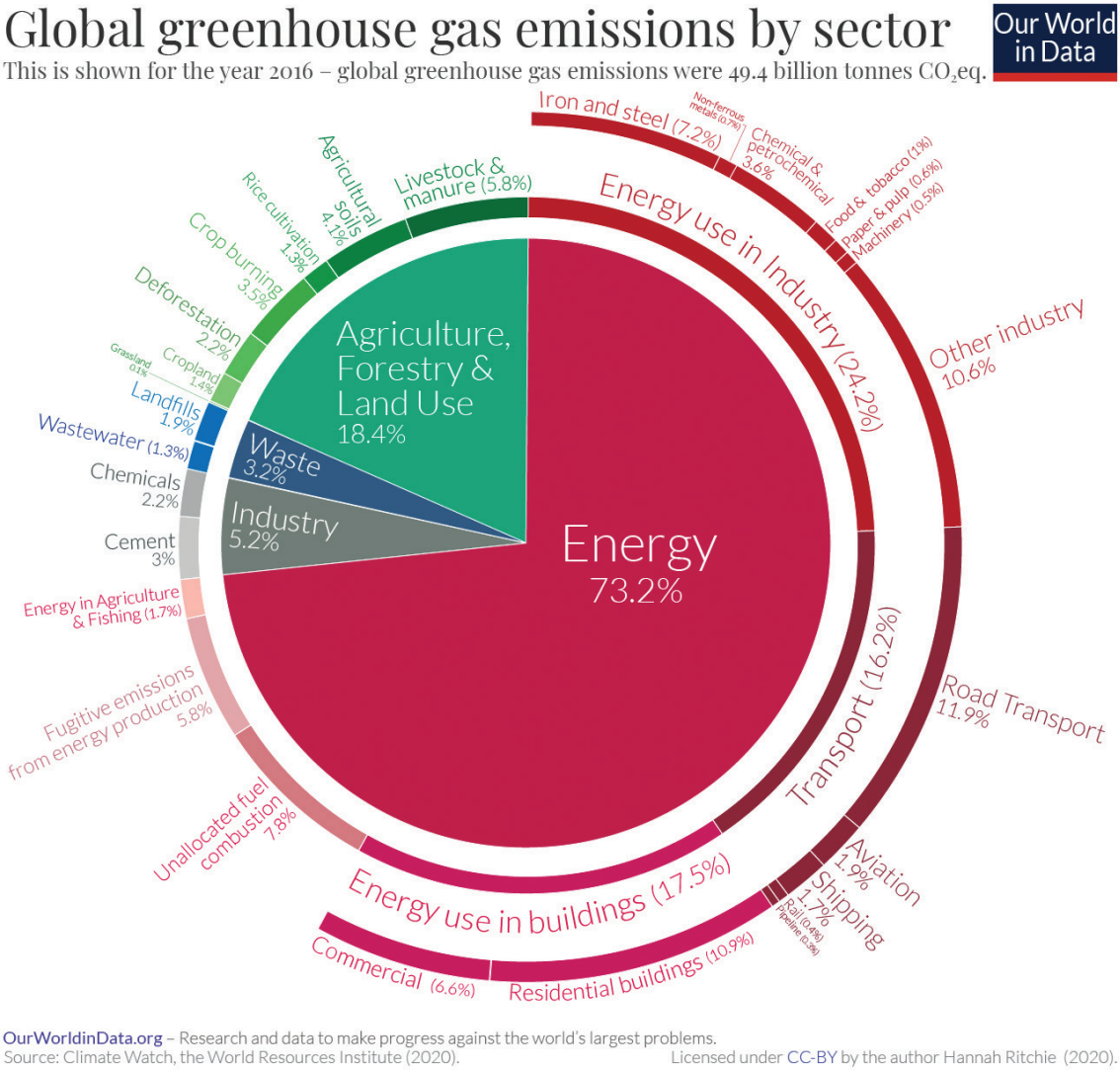
Much of this increase has occurred with the accelerated burning of fossil fuels since the industrial revolution, with more than half the CO_2 emissions from the late 17th century onwards occurring in the last 30 years.[7]

i Definition of climate change by the United Nations Framework Convention on Climate Change (UNFCCC).

Other important GHGs include methane, nitrous oxide and other fluorinated gases. Although the average lifetime in the atmosphere of such gases is shorter than that of carbon dioxide, they tend to "compensate" by having a higher 'warming potential' – 30 times stronger, in the case of methane, and over 23,000 times stronger for sulphur hexafluoride, when compared over a century.[8]

Emissions of GHGs primarily come from energy, industry, transport, agriculture and changes in land-use (such as deforestation), with CO_2 resulting from the burning of fossil fuels (e.g. in power plants, gas boilers and vehicles) comprising the highest share – around two-thirds - of all GHGs.[9]

Figure 3.3: GLOBAL GHG EMISSIONS BY ECONOMIC SECTORS



Source: World Resources Institute (2020).[10]

Limiting global warming has occasionally been compared with the case of an overfilling bathtub, which requires both turning off the taps and draining the tub – in other words, reducing both the **flow** of new emissions and the **stock** of existing GHGs in the atmosphere as close to zero as possible. The challenge is that, even if new emissions were to stop completely, some further global warming and associated changes to the climate are likely to be irreversible due to the already accumulated GHGs. One concerning possibility is that the world might be on course to breach certain 'tipping points'. Like a sand pile toppling when just a few more grains are added, this notion is used to describe abrupt – and potentially irreversible – changes to the Earth system in response to a relatively small change in warming.

Such potential tipping points include:

- The melting of the permafrost – frozen ground in the Northern hemisphere, the thawing of which would release the vast amounts of carbon it currently holds, thereby further accelerating climate change.
- The disintegration of the West Antarctic ice sheet – this holds enough ice to raise global sea levels by over three metres.
- The 'dieback' of the Amazon rainforest – changes in temperature and deforestation that would render the forest unable to sustain itself, making one of the world's largest natural stores of carbon emit more carbon than it absorbs.
- Melting Arctic ice sheets, causing a shutdown in the system of currents in the Atlantic Ocean that brings warm water up to Europe, which, among other consequences, may lead to 'widespread cessation of arable farming' in the UK and parts of Europe.[11]

Table 3.1 illustrates some of the socioeconomic impacts as a result of climate change.

Table 3.1 SELECT SOCIOECONOMIC IMPACTS OF CLIMATE CHANGE

IMPACTED ECONOMIC SYSTEM	AREA OF DIRECT RISK	SOCIOECONOMIC IMPACT	HOW CLIMATE CHANGE EXACERBATED HAZARD
LIVEABILITY AND WORKABILITY	2003 European heat wave	US$15 billion (£12bn) in losses	2 × more likely
	2010 Russian heat wave	~55,000 deaths attributable	3 × more likely
	2013–14 Australian heat wave	~US$6bn (£4.8bn) in productivity loss	Up to 3 × more likely
	2017 East African drought	~800,000 people displaced in Somalia	2 × more likely
	2019 European heat wave	~1,500 deaths in France	~10 × more likely
FOOD SYSTEMS	2015 Southern Africa drought	Agriculture outputs declined by 15%	3 × more likely
	Ocean warming	Up to 35% decline in North Atlantic fish yields	Ocean surface temperatures have risen by 0.7°C (1.3°F) globally
PHYSICAL ASSETS	2012 Hurricane Sandy	US$62bn (£49.5bn) in damage	3 × more likely
	2016 Fort McMurray Fire, Canada	US$10bn (£8bn) in damage, 1.5 million acres of forest burned	1.5 to 6 × more likely
	2017 Hurricane Harvey	US$125bn (£99.8bn) in damage	8–20% more intense
INFRASTRUCTURE SERVICES	2017 flooding in China	US$3.55bn (£2.8bn) of direct economic loss, including severe infrastructure damage	2 × more likely
NATURAL CAPITAL	30-year record low Arctic sea ice in 2012	Reduced albedo effect, amplifying warming	70–95% attributable to human-induced climate change
	Decline of Himalayan glaciers	Potential reduction in water supply for more than 240 million people	70% of global glacier mass lost in past 20 years is due to human-induced climate change

Source: Woods Hole Research Centre and McKinsey Global Institute Analysis, summarising academic literature.[12]

In 2018, the Intergovernmental Panel on Climate Change (IPCC) estimated that human activities have caused approximately 1°C (1.8°F) of global warming above pre-industrial levels, and global warming is likely to reach 1.5°C (2.7°F) between 2030 and 2052, if it continues to increase at the current rate.[13] Note that these numbers are global averages, so warming in different regions may be much higher: warming over land has been twice that observed over oceans, for example.[14]

These differences of a few fractions of a degree may seem small, but are highly consequential. The IPCC further estimates that limiting warming to 1.5°C (2.7°F) instead of 2°C (3.6°F) by the end of this century could reduce 'climate-related risks to health, livelihoods, food security, water supply, human security and economic growth': around 400 million fewer people frequently exposed to extreme heatwaves and around 10 million fewer people exposed to rising sea levels, in addition to reduced impacts on vulnerable ecosystems such as the Arctic and warm water coral reefs (which 'mostly disappear' at 2°C (3.6°F)).[13]

Table 3.2: SELECTED IMPACTS OF CLIMATE CHANGE ACROSS DIFFERENT WARMING SCENARIOS

TEMPERATURE RISE	1.5°C (2.7°F)	2°C (3.6°F)	3°C+ (5.4°F)
Habitat loss		10% of animal and 20% of plant species losing over half of their habitat before end of the century.	~30% and 45% of animal species losing over half of their habitat before the end of the century.
Average drought length	9 months (global) 7 months (Africa)	11 months (global) 20 months (Africa)	18 months (global) 60 months (Africa)
Arable land		4.5 million km^2 of cropland decline.	5.7 million km^2 of cropland decline.
Arctic regions	Arctic summer sea ice is likely to be maintained.	The risk of an ice-free Arctic in summer is about 50% or higher.	The Arctic is very likely to be ice free in summer.

Sources: Various.[15]

Estimates of the economic costs of climate change vary, but suggest significant potential losses – a 2015 report suggested damages by 2100 equivalent to US$4 trillion (£2.9tn) in net present value,[16] whilst the IPCC suggests between US$54tn (£38.8tn) and US$69tn (£49.6tn) for a 1.5°C (2.7°F) and 2°C (3.6°F) scenario, respectively.[13]

There are, however, important caveats when approaching such results, which are highly dependent on assumptions and scenarios. First, under the standard economic practice of discounting, cashflows far into the future have very little present value. This, however, may be under-representing the risks of potentially catastrophic outcomes that could severely affect economies and countless human lives. This has been the argument of climate economist Martin Weitzman with his so-called **dismal theorem**, which suggests that standard cost-benefit analysis is inadequate to deal with the potential downside losses from climate change. However small their probability, as long as we cannot completely rule out scenarios of climate-induced civilisational collapse, their expected value must be properly understood as being equivalent to negative infinity, he argues.[17]

On a different, but related note, economist Nicholas Stern has argued that moral considerations warrant the use of a low discount rate when assessing future climate damages, in order to place adequate value on the lives and welfare of future generations.[18] The thrust of Stern and Weitzman's arguments is that the issue of how much society should invest today in order to safeguard a liveable climate in the future requires a different – mathematical and ethical – treatment to standard economic problems like 'would you prefer to receive £10 today or £100 in one year'.

Second, many economic models used to calculate future climate damages usually share the limitation of assuming negative impacts that ramp up only gradually, and usually do not model sharp discontinuities and 'tipping points'. In other words, they model a society that 'keeps warm and carries on', even though some of these scenarios approach the limits of adaptability and habitability.

For example, one widely used model estimates that 6°C (16.2°F) of warming would result in a sacrifice of only about 9% of global income by the end of the century.[19] However, it has been suggested that at global average warming of around 7°C (12.6°F) regions of the world would see combinations of temperature and humidity where the average life expectancy of a healthy adult becomes measured in hours (even if they sit in the shade, are resting and have access to water), as the human body can no longer cool itself through perspiration and breaks down.[20] Almost inevitably, models are calibrated based on past economic outcomes, but this presents a potential tension when dealing with what may be radically different future outcomes.

In summary, aiming to translate the physics of a changing climate into economic models can illuminate important questions, but, as always, it is important to scrutinise their assumptions.

Responding to climate change is usually presented in terms of two main approaches:

1. reducing and stabilising the levels of heat-trapping GHGs in the atmosphere (**climate change mitigation**); or
2. adapting to the climate change already taking place (**climate change adaptation**) and increasing climate change resilience.

However, this is not a binary option; some of the most effective climate policies pursue both objectives simultaneously. We will look at climate change mitigation and adaptation in the following sub-sections.

1. Climate change mitigation

Climate change mitigation is a human intervention that involves reducing the sources of GHG emissions (for example, the burning of fossil fuels for electricity, heat or transport) or enhancing the sinks that store these gases (such as forests, oceans and soil) in an attempt to slow down the process of climate change. The goal of mitigation is to:

- avoid significant human interference with the climate system;
- stabilise GHG levels in 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.[ii]

While discussions of climate change policy usually call for adaptation to the warming that is irreversible, the overarching framing is usually that of mitigation – i.e. trying to prevent what is not inevitable. The aim of the international *Paris Agreement* on climate change, for example, is to hold "the increase in the global average temperature to well below 2°C (3.6°F) above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C (2.7°F) above pre-industrial levels" by the end of the century.[21]

Examples of mitigation strategies include greater adoption and policies to promote sustainability across different areas, such as:

- **Energy** – deploying renewable energy sources (such as wind, solar, geothermal and hydro or biofuels from sustainable sources).
- **Buildings** – retrofitting buildings to become more energy efficient and using building materials and equipment that reduce buildings' carbon footprint.
- **Transport** – adopting more sustainable transportation and infrastructure, particularly in cities (such as electric vehicles, rail and metro and bus rapid transit), but also decarbonising shipping, road and air transport.

ii For instance, by 2100, global sea level rise would be 10 cm lower with global warming of 1.5°C (2.7°F) compared with 2°C (3.6°F). The likelihood of an Arctic Ocean free of sea ice in summer would be once per century with global warming of 1.5°C (2.7°F), compared with at least once per decade with 2°C (3.6°F). Coral reefs would decline by 70–90% with global warming of 1.5°C (2.7°F), whereas virtually all (> 99%) would be lost with 2°C (3.6°F).[13]

- **Land use and forestry** – improving forest management and reducing deforestation.
- **Agriculture** – improving crop and grazing land management to increase soil carbon storage.
- **Carbon pricing** – implementing carbon reduction policies which penalise heavy emitters and promote GHG emission reductions in the form of either a carbon tax or cap-and-trade mechanism.
- **Industry and manufacturing** – developing more energy efficient processes and products, as well as equipment and processes to facilitate carbon capture, power storage (e.g. batteries, pump systems), recycling efficiency, etc.

Case study

The race to net zero

Stabilising global average temperature rise at any level depends on achieving a balance between GHG sources going into and out of the atmosphere – i.e. reaching 'net zero' emissions. The earlier this point is reached, the less warming the world is likely to experience. The world's foremost assembly of climate scientists – the IPCC – has argued that limiting global temperature rises to 1.5°C (2.7°F) requires net zero CO_2 emissions around 2050, coupled with deep reductions in emissions of other GHGs like methane.[iii]

Net zero targets are increasingly being adopted by governments (e.g. the UK, the EU, China, Japan, Canada and South Korea), states and territories (e.g. Nevada in the USA, or Victoria and Queensland in Australia), and companies (e.g. Amazon, ArcelorMittal, BT Group, BP, Ikea, Qantas, Sony and Walmart). Most national commitments were made in 2020. The EU and the UK also set revised and more ambitious interim commitments for 2030, and have started publishing related policy (e.g. on energy and hydrogen).

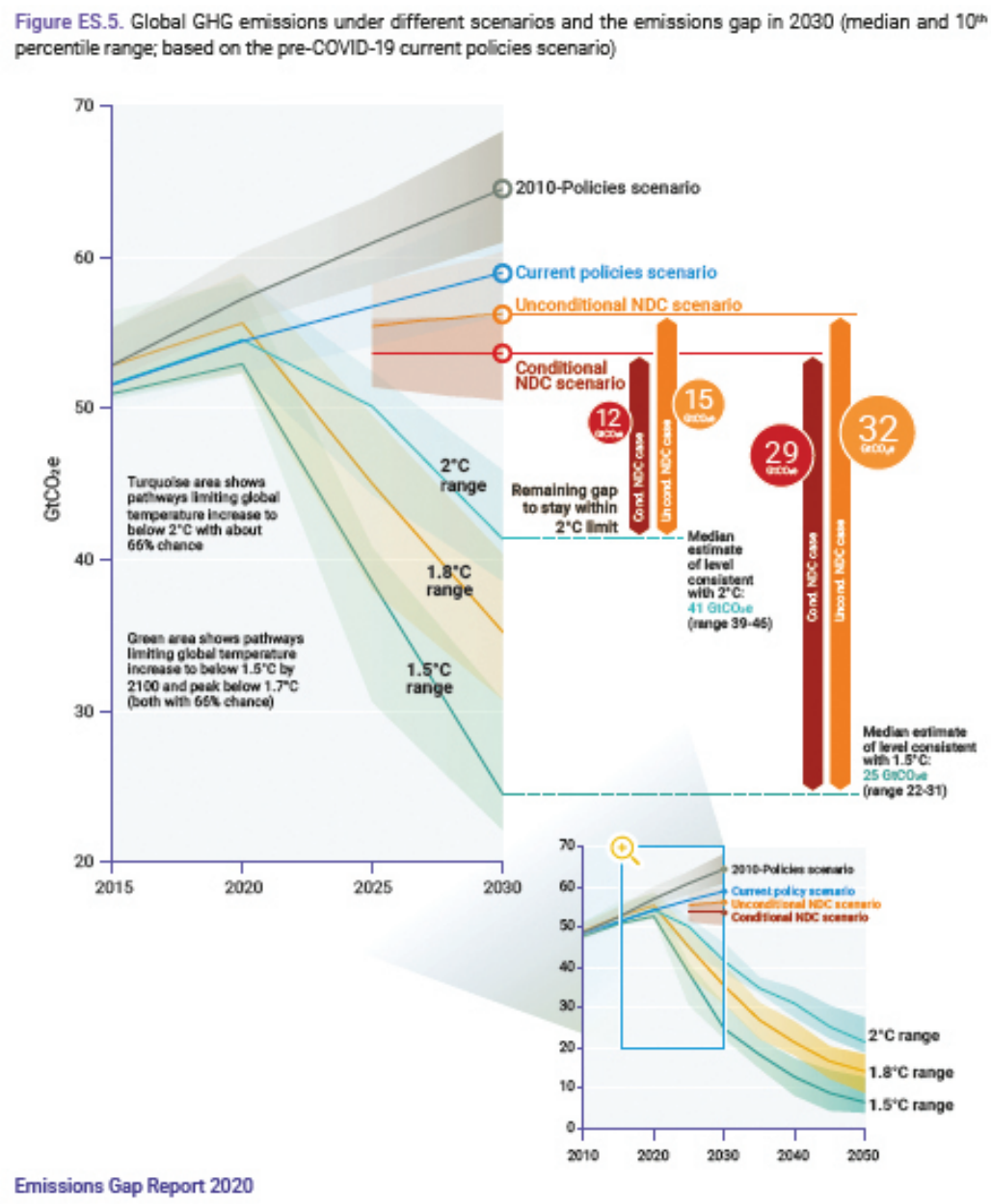
Whether such demanding targets can be met just with the scaled-up deployment of existing technologies,[22] or whether they require further technological research and development is the subject of ongoing debate. Modelled net zero pathways can therefore differ significantly in their emissions profile – with the role of interim targets (2025, 2030) and the assumed reliance on carbon capture and/ or offsets (e.g. in emissions-intensive companies' net zero commitments) coming under increased scrutiny.

The higher the ambition of mitigation policies, the higher the required upfront investment. In the energy sector alone, the International Chamber of Commerce (ICC) estimates that between US$1tn to US$4tn (£0.7tn to £2.9tn) of additional annual investment in energy supply, and around US$1tn (£0.7tn) in energy demand will be needed up to 2050 to limit warming to 1.5°C (2.7°F).[13] However, the ICC further notes that 'how these investment needs compare to those in a policy baseline scenario is uncertain'. In other words, even scenarios without climate mitigation require investments – in oil and gas extraction and transportation or in coal and gas power plants, etc. – and it is unclear how those costs may evolve alongside temperatures (for example, around half of the oil and gas fields in the Russian Arctic are estimated to be in areas where melting permafrost can cause severe damage to infrastructure such as pipelines and shipping terminals;[23] in mid-2020, such melting under a diesel storage tank caused the largest environmental accident in the Russian Arctic region).[24] As the world is already investing circa US$1tn (£0.7tn) yearly in the energy sector,[25] the important question is what kind of energy system is being financed and the extent to which today's investments risk locking in future emissions.

iii Note that this assumes the world will not significantly rely on what are currently speculative, expensive carbon capture technologies. It is technically possible to construct other temperature pathways, depending on modelling assumptions – the scale up of carbon capture, and the potential for reductions in non-CO_2 GHG globally. However, given the risks of 'tipping points' discussed in the previous section, caution is needed when considering the extent to which ongoing emissions will be compensated by future technological fixes.

Scientists have raised the possibility that the current rate of emissions, coupled with the insufficient strength of the policies so far announced by governments worldwide, may render certain mitigation goals increasingly unachievable. The United Nations' *Emissions Gap Report 2020* report states that "we are heading for a world that is 3.2°C (5.8°F) warmer by the end of this century, even with full implementation of unconditional nationally determined contributions (NDCs) under the Paris Agreement."[9] To illustrate the scale of the challenge, the COVID-19 pandemic led to the largest recorded drop in yearly CO_2 emissions – of circa 7%. It is estimated that similar reductions would be needed *each year* to 2030 to meet the 1.5°C (2.7°F) goal. The *Emissions Gap Report* also provides an overview of gaps against a number of policy scenarios, and notes that the "green pandemic recovery could shave up to 25% off the emissions we would expect to see in 2030 with implementation of unconditional NDCs – bringing the world close to the 2°C (3.6°F) pathway. The report identifies recovery measures to deliver these cuts."[9]

Figure 3.4: GLOBAL GHG EMISSIONS UNDER DIFFERENT SCENARIOS AND THE EMISSIONS GAP IN 2030 (MEDIAN AND 10TH AND 90TH PERCENTILE RANGE; BASED ON THE PRE-COVID-19 CURRENT POLICIES SCENARIO)



Source: UN (2020).[9]

This brings us to the actions needed in response to warming that cannot be averted; in other words – to climate adaptation.

Climate change adaptation and resilience

Adapting to a changing climate involves adjusting to actual or expected future climate events, thereby increasing society's resilience to climate change and reducing vulnerabilities to its harmful effects. The faster the climate changes, the more challenging it is to adapt. The World Bank aptly describes adaptation and resilience as 'two sides of the same coin'.[26]

Most adaptation focuses on anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, but there may also be opportunities (such as polar melting opening new maritime trade routes or the growth of viticulture in previously colder areas).

In light of humankind's ability to survive – and even thrive – in hostile climates, it is tempting to assume that adaptation is the less costly option, compared to mitigation, but this is far from given. Consider one of the most obvious examples of adaptation: air conditioning (AC), the use of which is becoming increasingly common as incomes and populations rise, particularly in the world's warmer regions. AC units are both power-intensive and use powerful GHGs as refrigerants. By 2050, it is anticipated that air conditioning alone may result in GHG emissions equivalent to that of India, the world's third-largest emitter today, which would create a vicious circle of more global overheating, which requires more AC, and so on.[27]

Alternatively, it is sometimes suggested that, as CO_2 is a nutrient for plants, more CO_2 in the atmosphere will ultimately have a positive effect on agriculture around the world. However, other effects of climate change – notably increased droughts coupled with stronger floods – are accelerating soil erosion, with the world already losing around half a percent of its arable land every year;[28] Moreover, rising sea levels are threatening to flood the world's major rice-producing deltas. Coupled with signs of stagnating agricultural productivity, how the world will adapt to the food needs of a fast-rising global population is a crucial open question.

The more climate adaptation strategies are included in the investment plans of the finance sector and the industrial, agricultural and even defence sector strategies of governments, and the urban planning of municipalities, the higher their chances of success.

Examples of adaptation strategies include a variety of development plans on how to deal with:

- protecting coastlines and adapting to sea-level rise;
- building flood defences;
- managing land use and forestry practices;
- planning more efficiently for scarce water resources;
- developing drought resilient crops;
- protecting energy and public infrastructure; and
- developing clean cooling systems.

As mentioned earlier, researchers have observed that some of the most effective climate policies (such as the protection of coastal wetlands or the promotion of sustainable agroforestry) contribute to both adaptation and mitigation simultaneously.[29]

Not just an issue of government policy, adaptation is also increasingly being factored into corporate business plans. For example, water risks are proving to be an issue of increased importance in the mining sector, which requires sufficient water to convey or help separate the desired ores. It is estimated that up to 50% of global production of copper, gold, iron ore and zinc – metals with a key contribution to low-carbon energy technologies – is located in areas where water stress is already high.[30]

Too much water can also be a problem, as floods can shut down mines and cause significant local pollution. Close to half of the global production of iron ore and zinc is estimated to be in areas facing high flood risk.[30]

Case study

Escondida copper mine

Located in one of the most arid places on Earth, the Atacama desert in Chile, Escondida is the world's largest copper mine by production. BHP, the mining company operating it, has been planning a transition away from using fresh ground water.

In early 2020, BHP announced it was able to operate the mine using only desalinated water from the ocean. BHP already uses more than 50% of the water they need from the ocean in an effort to reduce pressure on fresh water resources, which are often also used by local communities.[31]

Cities and municipalities in particular are at the frontline of adaptation and resilience due to their high concentration of people, assets and economic activities. Representing 80% of global gross domestic product (GDP), cities are heavily exposed to climate change risks in the forms of:

- sea level rise;
- extreme weather events, such as flooding and drought; and
- increase in the spread of tropical diseases.

All of these will have an economic and social cost to cities' inhabitants, infrastructure, businesses and the built environment. At the same time, cities are a major contributor of GHG emissions, mainly from transport and buildings. Useful best practices of various cities' climate adaptation strategies include:

- incorporating flood risk into building designs (in New York) and planning for enhanced water absorption rates into city infrastructure ('sponge cities' like Wuhan); [32]
- modelling the impact of natural disasters on energy supply (in Yokohama); and
- analysing the resiliency to disruption of food supply systems (in Los Angeles and Paris).[33]

Estimates of the relative costs of adaptation to climate change vary. In their *Adaptation Gap Report 2020*, the UN Environmental Programme (UNEP) estimates that adaptation costs in developing countries alone are currently estimated to be in the range of US$70bn (£50bn), with the expectation of reaching US$140 to US$300bn (£100bn to £216bn) in 2030 and US$280 to US$500bn (£201bn to £359bn) in 2050".[34] And, as with mitigation, expected costs must be set against the context of potential benefits: The Global Commission on Adaptation in 2019 estimated that circa US$2tn (£1.4tn) of investment in adaptation measures would result in an over US$7tn (£5tn) return in avoided costs and other benefits.[35]

In late 2019, Climate Bonds Initiative published the first *Climate Resilience Principles*, which provide a framework for developing location-specific climate resilience measures and financing them in the green bond market.[36] A group of multilateral development banks have also put forward *A Framework and Principles for Climate Resilience Metrics in Financing Operations*, which provide guidance on how to create effective climate resilience projects and how to measure direct outcomes and wider system impacts.[37]

It is important to recognise that there can be trade-offs between adaptation/resilience and mitigation – for example, the decision to invest in an a desalination plant that helps prevent a potential water shortage in a crisis may be warranted, despite its high associated emissions. Understanding and assessing such potential conflicts is critical to building resilience with limited impact on mitigation efforts.

B. Pressures on natural resources

The relationship between businesses and natural resources is becoming increasingly important due to dramatically accelerating biodiversity loss and less secure access to natural resources. For the purposes of this syllabus, natural resources cover:

- fresh water;

- biodiversity loss;
- land use; and
- forestry and marine resources.

Natural resources also include non-renewable resources (such as fossil fuels, minerals and metals), which cannot be replenished quickly enough to keep up with their consumption.

Governments and businesses are having to deal with increased pressure on natural resources, caused by:

- population growth;
- health improvements leading to people living longer;
- economic growth; and
- the accompanying increased consumption in developed and emerging economies.

Simultaneously, these drivers are leading to the risk of resource scarcity. These developments are therefore compelling companies to become more efficient in the way that they use natural resources if they are to remain competitive and become more sustainable. This can help drive better financial management of resources, but also spur technological innovations that can have a beneficial impact on the bottom line in support of a more sustainable and resilient economy and society.

Depletion of natural resources

According to the UN, the current world population of 7.6 billion is expected to reach:

- 8.6 billion in 2030;
- 9.8 billion in 2050; and
- 11.2 billion in 2100.

The rising population will put increased strain on the world's natural resources, most notably in terms of access to food. This presents a number of related challenges.

1. "Modern agriculture is dependent on phosphorus derived from phosphate rock, which is a non-renewable resource and current global reserves may be depleted in 50–100 years. While phosphorus demand is projected to increase, the expected global peak in phosphorus production is predicted to occur around 2030", with the quality of remaining reserves expected to fall whilst its costs – and the global population – continue to rise.[38]
2. The world is already using half its vegetated land for agriculture. Avoiding worsening climate change, which itself would reduce agricultural productivity, requires feeding a rapidly-growing population without further deforestation.[39]
3. The issue is compounded by changes in lifestyle: "While population growth was the leading cause of increasing consumption from 1970 to 2000, the emergence of a global affluent middle class has been the stronger driver since the turn of the century."[40] From the rare earths and other metals that go into smartphones and computers, to the rising emissions associated with a higher standard of living (for example, bigger homes with higher heating and cooling needs, increased travel, and increased meat and dairy consumption), these dynamics are also set to increase the pressure on natural resources.

   To a certain degree, technological innovation and moving from a linear to a circular economy has the potential to reduce the need for virgin resources. The decoupling of economic activities from resource usage has been observed – for example, in the past decade the UK's GDP has risen by 18%, whilst its carbon emissions have fallen by about 30%.[41]

   However, a literature review of decoupling finds a mixed picture: "relative decoupling is frequent for material use as well as GHG and CO_2 emissions [but] examples of absolute long-term decoupling are rare."[42]

One reason is that relative improvements in efficiency (using fewer resources per unit of production) may be offset by increased consumption of a given product – an effect known as the **Jevons paradox**.[43]

Another aspect is the shift in the resources used. For example:

> *"Clean energy technologies generally require more minerals than fossil fuel-based counterparts. An electric car uses five times as much minerals as a conventional car and an onshore wind plant requires eight times as much minerals as a gas-fired plant of the same capacity."*[44]

So the issue of resource usage will remain a crucial issue for investors and policy-makers, who will have to navigate trade-offs and consider not just use efficiency but how to facilitate changing the whole model (moving from linear to circular in products, processes and ultimately the economy) to reduce the strain on natural resources.

Another idea gaining ground, is decoupling the definition of development and progress from GDP growth to a measurement of asset wealth and assigning economic value not just to produced capital and human capital, but also to natural capital, as proposed in the *Dasgupta Review*.[45] Historically, growth in produced capital has been at the expense of natural capital. And at the expense of countries rich in natural resources, many of which have been left behind in the distribution of benefits in the form of human capital development and left with the impact of natural capital depletion and increasing social inequities.

Water

Nearly 70% of the planet is covered by water, but only 2.5% of it is fresh water. Water is a vital natural resource, not only for human consumption, but also for a range of agricultural, industrial and household energy generation, as well as for recreational and environmental activities. It is critical to many industrial processes, including minerals extraction and cooling for industrial plants. Water demand is set to increase in all sectors.[46]

According to the World Economic Forum, water also connects these sectors into a broader economic system that must balance social development and environmental interests. As the world continues to face multiple water challenges, a decision to allocate more water to any one sector implies that less water will be available for other economic uses, for public water supply and other social services, or for environmental protection.[47]

Water scarcity is the lack of freshwater resources to meet water demand. Water scarcity is present on every continent and is one of the largest global risks in terms of potential impact over the next decade. UN Water reports that over two billion people experience high water stress across different countries, and about four billion people experience severe water scarcity at least one month of the year.[48]

The UN's **Sustainable Development Goal (SDG) 6** is the need 'to ensure availability and sustainable management of water and sanitation to all' by 2030.[49] Water scarcity – caused either by economic factors such as lack of investment or by physical impacts related to climate change – continues to cause major concern, especially among the developing and emerging economies.

Biodiversity loss

Biodiversity, land use and associated ecosystems provide a range of invaluable services to society that underpin human health, wellbeing and economic growth. Ecosystem services are the benefits that people and businesses, derive from ecosystems. Biodiversity, as defined by the Convention on Biological Diversity, means the "variability among living organisms from all sources including, among other things, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".[50]

Unfortunately, global biodiversity is facing a dramatic decline. In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published a landmark report, which showed that around one million animal and plant species are now threatened with extinction, many within decades, more than ever before in human history.[51] The report provides a stark and comprehensive set of scientifically proven

findings that highlight the deterioration of biodiversity and its ecosystem functions and services. According to it, humans have impacted over 75% of Earth's land areas and 66% of the oceans. This deterioration is caused by a combined result of land and sea use change, direct exploitation, climate change and pollution.

The World Wildlife Fund's (WWF) *Living Planet Report* from 2020 notes that the world's wildlife populations have plummeted by 68% since 1970, with this trajectory likely to be further exacerbated by global warming. A major driver of this decline is loss of habitat linked to overexploitation.[52] WWF further estimates that inaction on biodiversity may result in cumulative costs of circa US$10tn (£7.2tn) up to 2050, through changes to crop yields and fish catches, economic damages from flooding and other disasters, and the loss of potential new sources of medicine.[53]

Already, biodiversity loss is presenting challenges to industries such as fishery and agriculture. Around 75% of global food crop types directly rely on animal pollination;[54] given the decline in natural pollinators due to pollution and pesticides, US farmers paid circa US$300m (£215.6m) for artificial (sometimes manual) pollination in 2017. Medicine and health is another area of concern, with an estimated 70% of cancer drugs being organic or derived from organic substances.[54]

Biodiversity underpins ecosystem services, provides natural resources and constitutes our 'natural capital'. Some of these ecosystem services include:

- food;
- clean water;
- genetic resources;
- flood protection;
- nutrient cycling; and
- climate regulation, amongst many others.[55]

The Economics of Biodiversity: The Dasgupta Review from 2021 argues for assigning economic asset value to biodiversity to reverse its treatment as a free resource and attempt to halt depletion.[45] In the same vein, in 2020, De Nederlandsche Bank (the Netherlands' central bank) published an important report entitled *Indebted to Nature*, exploring the biodiversity risks for the Dutch financial sector, effectively identifying nature and biodiversity as a systemic risk.[56]

Natural capital

Natural capital is defined as:

> "the world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this natural capital that humans derive a wide range of services, often called ecosystem services, which make human life possible."[57]

The importance of taking a natural capital approach is explained in more detail in **Section 5**, which discusses investment opportunities.

It is estimated that the annual monetary value of ecosystem services is around US$125tn to US$140tn (£90tn to £100tn), more than one and half times the global GDP.[58] Biodiversity also has intrinsic value: the ideas that the beauty of nature is worth preserving and that mankind and other species should strive for a harmonious co-existence have been a mainstay of many cultures, religions and belief systems.[iv]

iv See, for example, the ***Convention on Biological Diversity***, signed by a majority of governments worldwide.

It is worth emphasising the potentially large **unrecognised value**. There are myriad interactions between different species, playing highly complex roles in cycling nutrients, regulating the numbers of (potentially invasive) plant and animal species, and even altering the formation of landscapes.

The Organisation for Economic Co-operation and Development (OECD) notes it is difficult to predict where biodiversity thresholds lie, "when they will be crossed, and what will be the scale of impact. Given this uncertainty and the potential impact of regime shifts, it is prudent to take a precautionary approach".[58] There is evidence that conservation can be effective: a 2009 paper found that conservation investments over more than a decade reduced extinction risk by almost a third for mammals and birds in 109 countries.[59] Without existing conservation efforts, the extinction risk of mammals, birds and amphibians would have been at least 20% higher, according to the IPBES.[60] This is not just a conservation issue, with the OECD noting the link between safeguarding biodiversity and human health:

> *"Land-use change resulting from agricultural expansion, logging, infrastructure development and other human activities is the most common driver of infectious disease emergence."*[61]

In summary, conserving nature and improving the sustainable use of natural resources is possible, but can only be achieved through transformative changes across economic, social, political and technological factors.

Land use and forestry

Land use management practices and forestry, also known as agriculture, forestry and other land use (AFOLU), have a major impact on natural resources including water, soil, nutrients, plants and animals. According to the IPCC, the AFOLU sector is responsible for 23% of total net anthropogenic emissions, mainly from deforestation, and agricultural emissions from livestock, soil and nutrient management.

Covering approximately 30% of the world's land area, or just under 4 billion hectares, forests are a vital part of the carbon cycle.[62] They convert the CO_2 in the air to oxygen, through the process of photosynthesis, and are a natural regulator of CO_2, with the world's tropical forests playing a particularly important role in sequestering carbon. The more trees, the less CO_2 and the more oxygen there is in the atmosphere.

Unfortunately, deforestation is accelerating: from 2001 to 2019, there was a total of 386 million hectares of tree cover loss globally, equivalent to a 9.7% decrease in tree cover since 2000 and 105 giga tonnes of CO_2 emissions, according to Global Forest Watch.[63]

The production of commodities (particularly relating to agriculture) is a key driver of deforestation – responsible for up to two-thirds of deforestation by some estimates.[64] As a result, there is increased investor focus on investee companies' contribution to deforestation. According to the CDP (previously the Carbon Disclosure Project), circa US$1tn (£0.7tn) of turnover in publicly listed companies is dependent on commodities linked to deforestation, including soy, palm oil, cattle and timber. The risks from these soft commodities can be transmitted across supply chains to affect companies' revenues, asset valuation or costs, which can impact the credit worthiness or market value of the debt or equity of investee companies.[65]

Companies with exposure to deforestation in their supply chains may face material financial risks, such as:

- supply disruption;
- cost volatility; and
- reputational damage.

By contrast, shifting business practices to adopt more sustainable land management approaches contributes to:

- agricultural and economic development, both locally and globally;
- the health and stability of forests and ecosystems, and the continued provision of ecosystem services at an increasing scale; and
- the reduction of GHG emissions from deforestation and degradation.

Sustainable agriculture will remain an issue of growing focus for policy-makers and companies. In 2019, the IPCC published its *Special Report on Climate Change and Land*, which warned that the stability of the global food supply is projected to decrease as the magnitude and frequency of extreme weather events that disrupt food chains increases.[66]

In summary, the protection and management of land resources plays a vital role in ensuring the balance of nature and health of the ecosystem. If not managed sustainably, this will negatively affect biodiversity, ecosystems and all the natural resources that underpin economic growth and human flourishing.

Marine resources

Absorbing 50 times more CO_2 than the atmosphere, the ocean is the planet's largest carbon sink, with photosynthetic microorganisms on its surface layer also producing over half of the world's oxygen.[67] It is one of the most valuable natural resources.

The OECD estimates that ocean-based industries contribute roughly €1.3 trillion (£1.1tn) to global gross value added. Oceans provide seafood and are widely used for transportation (shipping). They are also mined for minerals (salt, sand and gravel as well as some manganese, copper, nickel, iron and cobalt, which can be found in the deep sea) and drilled for crude oil. The oceans' resources are a source of economic growth and are also known as the **blue economy**. According to the World Bank, the blue economy is the "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem".[68]

→ *Blue economy as an investment opportunity is discussed in Section 7 of this chapter.*

Communities in close connection with coastal environments, small islands (including Small Island Developing States), polar areas and high mountains are particularly exposed to ocean change, such as sea level rise. Low-lying coastal zones are currently home to around 680 million people (nearly 10% of the 2010 global population), projected to reach more than one billion by 2050.[69]

Due to the increase in the human population, the oceans have been overfished, with a resulting decline of fish critical to the economy. In 2015:

- 33% of marine fish stocks were being harvested at unsustainable levels;
- 60% were fished to maximum capacity; and
- only 7% harvested at levels lower than what can be sustainably fished.[51]

The control of the world's fisheries is a controversial subject, as production is unable to satisfy the demand, especially when there are not enough fish left to breed in healthy ecosystems. Environmental finance think-tank Planet Tracker estimated in 2020 that 'if historic trends continue and coastal ecological health continues declining, total production forecasts for coastal farmed Atlantic salmon to 2025 may be 6% to 8% lower than predicted, equivalent to US$4.1bn' (£3bn). However, there are options to address this: by improvements in traceability and sustainability certifications, which have lower impacts on biodiversity, Planet Tracker estimates that 'the typical seafood processor can double its EBIT [earnings before interest and tax] margin, which is currently at a low 3%, mainly due to lower recall, product waste and legal costs'.[70]

C. Pollution, waste and a circular economy

Air pollution

Clean air is essential to health, the environment and economic prosperity.

Increased air pollution:

- adversely affects the environment;
- has a negative impact on human health;
- destroys ecosystems;

- impoverishes biodiversity; and
- reduces crop harvests as a result of soil acidification.

Indoor and outdoor air pollution are together responsible for more than one-tenth of all deaths globally each year, according to the World Health Organization (WHO). Evidence by the WHO further shows that more than 90% of the world's population live in areas with levels of air pollution that exceed WHO guidelines. Urban air pollution is predicted to worsen, as migration and demographic trends drive the creation of more megacities.

Pollution is the largest environmental cause of disease and premature death in the world today. According to findings published in October 2017 by the Lancet Commission on Pollution and Health, diseases caused by pollution were responsible for an estimated 9 million premature deaths in 2015 – 16% of all deaths worldwide – which is three times more deaths than from AIDS, tuberculosis and malaria combined, and 15 times more than from all wars and other forms of violence.[71]

New research, published in February 2021 in the journal *Environmental Research*, has focused on isolating the impact of fossil fuel combustion and concludes that:

> *"the burning of fossil fuels – especially coal, petrol, and diesel – is a major source of airborne fine particulate matter ($PM_{2.5}$), and a key contributor to the global burden of mortality and disease…. The greatest mortality impact is estimated over regions with substantial fossil fuel related $PM_{2.5}$."*[72]

Using new modelling, the scientists estimated that parts of China, India, Europe and the northeastern USA are among the hardest-hit areas, suffering a disproportionately high share of 8.7m annual deaths attributed to fossil fuels, compared to a 2017 study, which had put the annual number of deaths from all outdoor airborne particulate matter — including dust and smoke from agricultural burns and wildfires — at 4.2m.[73] These findings lend further support to the focus on reducing fossil fuel emissions.

Water pollution

Water is essential to all living organisms. Yet water pollution is one of the most serious environmental threats faced. Water pollution occurs when contaminants (such as harmful chemicals or microorganisms) are introduced into the natural environment through the ocean, rivers, streams, lakes or groundwater. Water pollution can be caused by spills and leaks from untreated sewage or sanitation systems and industrial waste discharge. Plastic waste has also found itself in waterways.

Case study

Water-related fines

Partially due to increased public interest litigation, fines for water pollution are increasing around the world.

In 2014, Chinese media reported what was at the time the largest ever fine levied in the country – whereby six companies were fined a total of 160m yuan (£18.1m) for chemical discharges into rivers.[74]

In 2020, the US Environmental Protection Agency announced its largest ever fine relating to the Clean Water Act – with almost US$3m (£2.2m) charged to a horseracing facility for repeated discharge of animal waste into New Orleans waterways.[75]

Waste and waste management

In view of the concerns about growing pressures on natural resources – combined with opposition to all types of pollution – waste and waste management has, in recent decades, become a bigger priority for policymakers, businesses and citizens. Increasing consumption and waste levels are putting more pressure on space for landfill waste, which in turn is causing landfill taxes to rise. Alongside tougher regulation on how waste is

handled and managed, businesses are becoming increasingly incentivised to help economies, notably through recycling and by adopting a circular economy business model.

A recent striking example of the public's concern over excessive waste is the campaign against plastics, especially in relation to the serious damage that they are doing to the oceans. This has led to actions by national and local authorities on waste management, and greater responsibility conferred on businesses to manage their waste responsibly.

In most developed countries, domestic waste disposal is funded from national or local taxes, which may be related to income, or property values. Commercial and industrial waste disposal is typically charged for as a commercial service, often as an integrated charge that includes disposal costs. This practice may encourage disposal contractors to opt for the cheapest disposal option such as landfill or incineration – which generate GHG emissions and contribute to local pollution – rather than opting for solutions such as re-usage and recycling.

Although many consumer products (such as metal cans and glass bottles) are recyclable, recycling practices are very uneven across (and sometimes even within) countries. However, there has been growing public concern with excessive waste, particularly single-use plastics and the serious damage that they are doing to the oceans and marine wildlife. This has led to actions by national and local authorities on waste management, and greater responsibility conferred on businesses to manage their waste responsibly. Coupled with a slowdown in the ability to export hazardous waste, including plastics, to a rising number of Asian countries (most notably China), this puts further pressure on regions such as Australia, Europe and North America to develop their own recycling and waste management solutions onshore.

A financial mechanism, which is growing in popularity in the consumer space, is the use of fees and taxes, including a charge on plastic bags, designed to discourage waste and promote recycled usage. The *European Strategy for Plastics in a Circular Economy*, agreed in January 2018, requires that all plastic packaging must be reusable or recyclable by 2030. This trend has material implications for investors. As the use of oil for transportation declines amid a shift to electric vehicles, numerous companies in the oil industry are looking towards petrochemicals – and plastics in particular – as an alternative source of growth. Yet, if policymakers implement stricter recycling measures in response to ongoing public pressure, think-tank Carbon Tracker estimates up to US$400bn (£288bn) of investments in new petrochemical facilities might become 'stranded', unprofitable assets.[76]

Conversely, there are opportunities in better waste management, from the reuse or transformation of recovered waste (for example, using old tyres to create road surfacing, or expanded recycling programmes under the TerraCycle initiative)[77] to finding new ways to break down waste into less harmful or useful materials (such as graphene).[78]

A global commitment by companies led by the Ellen MacArthur Foundation and the UN Environment Programme (UNEP) has set a benchmark for 'best practices' to address the plastic waste and pollution system.[79] In a sign of the times, the International Criminal Police Organization (INTERPOL) has also started tracking criminal trends in the global plastic waste market.[80]

Circular economy

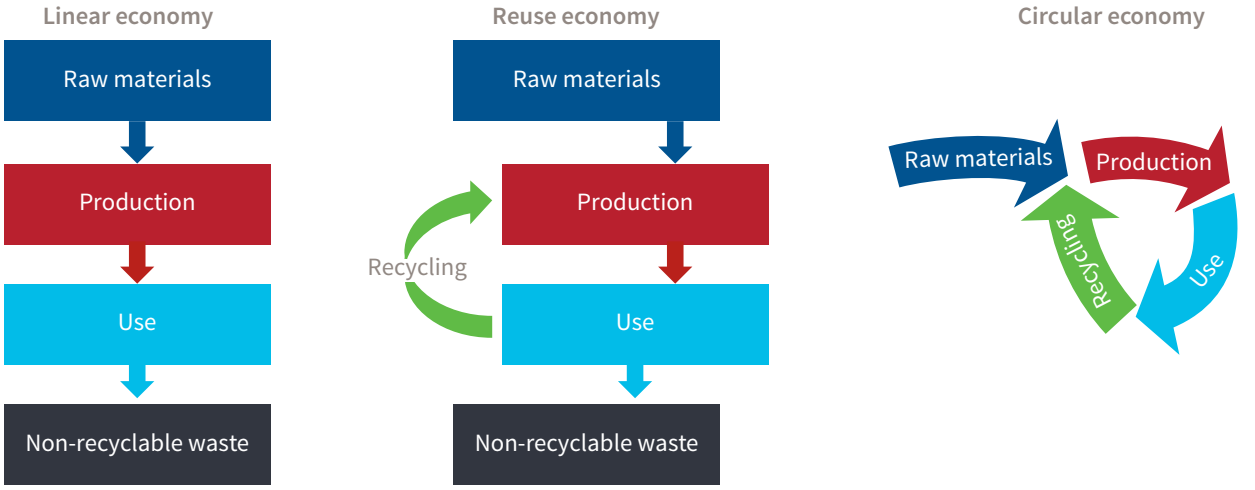
The **circular economy** is an economic model that aims to avoid waste and to preserve the value of resources (raw materials, energy and water) for as long as possible. It is an effective model for companies to assess and manage their operations and resource management (see **Figure 3.5**) as it is an alternative approach to the use-make-dispose economy. The circular economy is based on three principles:

1. design out waste and pollution;
2. keep products and materials in use; and
3. regenerate natural systems.[81]

The government of the Netherlands has developed a programme for a circular economy, aimed at:

"preventing waste by making products and materials more efficiently and reusing them. If new raw materials are needed, they must be obtained sustainably so that the natural and human environment is not damaged."

Figure 3.5: FROM A LINEAR TO A CIRCULAR ECONOMY



Source: Government of the Netherlands.[82]

A recent report from the Ellen MacArthur Foundation stresses the importance of a circular economy as a fundamental step towards achieving climate targets.[83] To illustrate this potential, the paper argues that changes in the sources and use of energy could help halve the emissions associated with the production of goods; however, the other half of emissions comes from the use of materials, not energy. Applying circular economy strategies in just five key areas (cement, aluminium, steel, plastics, and food) can eliminate almost half of these remaining emissions. By 2050, the cumulative impact of these strategies would be equivalent to eliminating all current emissions from transport.[83]

→ *Circular economy will also be covered Section 7 on investment opportunities.*

2 SYSTEMIC RELATIONSHIPS BETWEEN BUSINESS ACTIVITIES AND ENVIRONMENTAL ISSUES

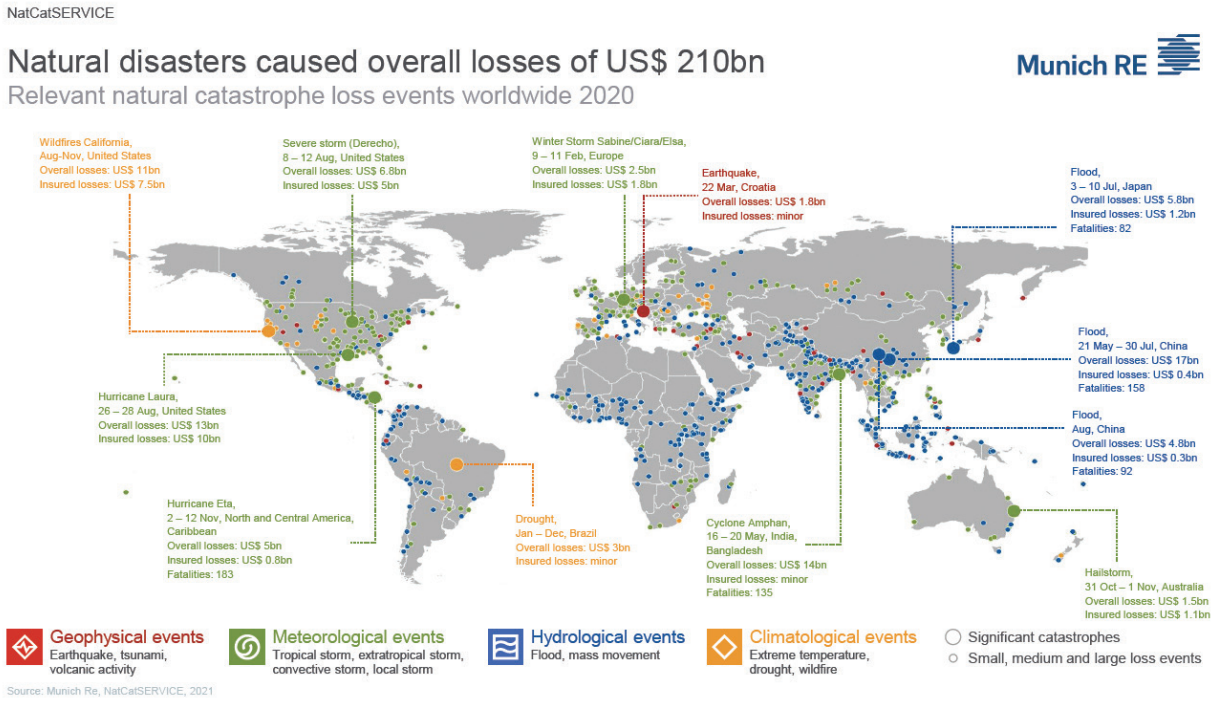
3.1.3	Explain the systemic relationships between business activities and environmental issues, including: systemic impact of climate risks on the financial system: climate-related physical and transition risks; the relationship between natural resources and business; supply, operational and resource management issues; supply chain transparency and traceability.

Much of the understanding of key environmental factors in respect of business and investment centres on specific issues, such as climate change and unsustainable natural resource consumption and production – and on the negative impacts that businesses, consumption habits and investment demand are having on the health of natural capital stocks. There is, however, less of an understanding of how businesses and financial activities depend on natural resources and properly functioning ecosystem services. Due to the difficulty in valuing and measuring natural resources, these detrimental impacts have not been fully priced into the costs of doing business (also known as pricing 'negative externalities'). If such costs were to be fully internalised by businesses or their investors, there could be significant market disruptions.

Systemic risks to the financial system: physical and transitional risks

Over the last 20 years, environmental themes have become an increasingly important consideration of the business agenda. Of note is the growing appreciation of the **physical risks** of climate change, stemming from more frequent or severe weather events such as flooding, droughts and storms. The associated costs are rising: inflation-adjusted losses from extreme weather events have increased fivefold in recent decades.[84] In 2020, Munich Re estimate such losses to be over US$200bn (£143.8bn), with both overall losses and insured losses significantly higher than in previous years. Losses from the historic wildfires in the western USA alone are estimated to be around US$16bn (£11.5bn), with a similar loss figure due to floods in China.[85]

Figure 3.6: GLOBAL ECONOMIC LOSSES FROM EXTREME WEATHER EVENTS IN 2020



Source: MunichRe and NatCatService.[85]

Insurers and reinsurers are particularly exposed to these effects, across both sides of their balance sheet. Their investment assets can be impacted if, for example, storms and floods affect real estate in their portfolio. Their liabilities can be affected if extreme weather leads to increases in property insurance claims, or extreme-weather-induced diseases and mortality lead to increases in life insurance claims.

As the Bank of England notes, physical risks can have significant macroeconomic effects:

> *"For instance, if weather-related damage leads to a fall in house prices (and so reduces the wealth of homeowners) then there could be a knock-on effect on overall spending in the economy".*[86]

There are also company- and sector-level implications, given the supply chains of a globalised economy.

Case study

2011 Thai floods

In 2011, Thailand experienced its worst flooding in five decades, with US$45bn (£32.4bn) of economic damages resulting in US$12bn (£8.6bn) in insurance claims. Although flooding is not uncommon in the region, the effects of the floods were felt across the globe: over 10,000 factories of consumer goods, textiles and automotive products had to close, disrupting the supply chain for businesses such as Sony, Nikon and Honda, resulting in either reduced or delayed productions. Many of these international businesses lodged contingent business interruption claims with their insurers and reinsurers, which cost Lloyd's of London US$2.2bn (£1.6bn).[87]

Occasionally, extreme weather events may lead not just to a hit to a company's finances, but to full-scale bankruptcy.

Case study

PG&E

In what has been described as 'the first climate-change bankruptcy, probably not the last',[88] in January 2019, the US power supplier PG&E filed for voluntary Chapter 11 bankruptcy protection, as a result of liabilities stemming from wildfires in Northern California in 2017 and 2018. It claimed that it faced an estimated US$30bn (£21.6bn) liability for damages from the two years of wildfires, a sum that would exceed its insurance and assets.

Whereas physical risks stem primarily from inaction on climate change, there are also climate risks and trade-offs associated with action – the so-called **transitional risks** – as the world shifts towards a low-carbon economy. As the Bank of England explains:

> *"Such transitions could mean that some sectors of the economy face big shifts in asset values or higher costs of doing business. It's not that policies stemming from deals like the Paris Climate Agreement are bad for our economy – in fact, the risk of delaying action altogether would be far worse. Rather, it's about the speed of transition to a greener economy – and how this affects certain sectors and financial stability.*
>
> *One example is energy companies. If government policies were to change in line with the Paris Agreement, then two thirds of the world's known fossil fuel reserves could not be burned. This could lead to changes in the value of investments held by banks and insurance companies in sectors like coal, oil and gas. The move towards a greener economy could also impact companies that produce cars, ships and planes, or use a lot of energy to make raw materials like steel and cement."*[86]

Transition risks are multiple in nature, including:

- **policy risks** – such as increased emissions regulation and environmental standards (see **Section 3**);
- **legal risks** – such as lawsuits claiming damages from entities (corporations or sovereign states) believed to be liable for their contribution to climate change; and
- **technology risks** – such as low-carbon innovations disrupting established industries.

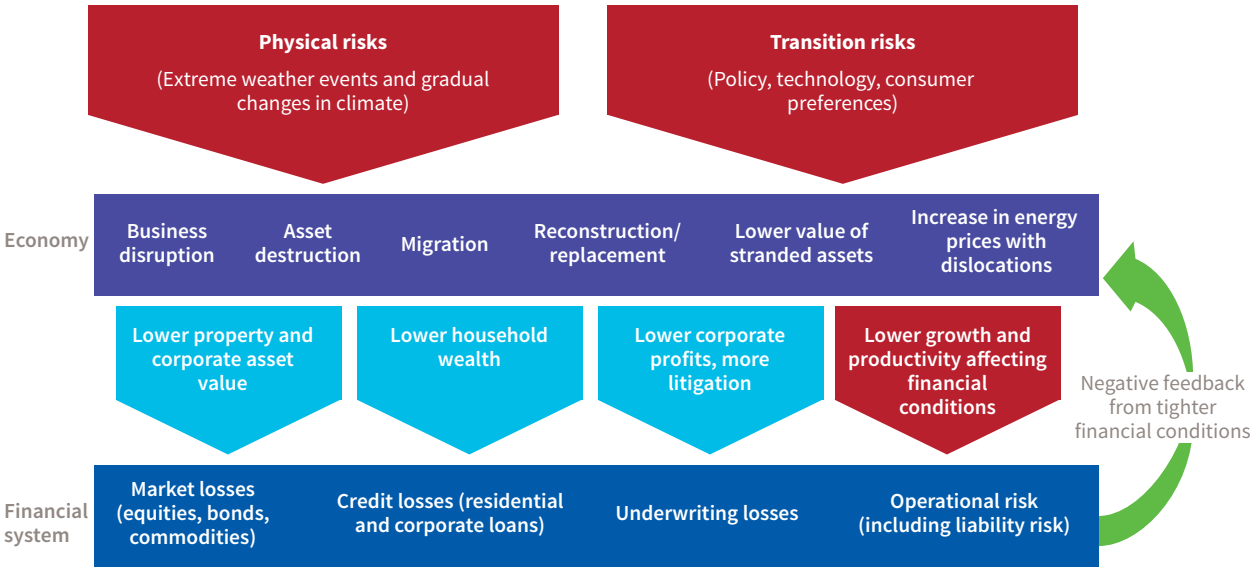
These risks are interlocking in nature and potentially have far-reaching impacts, which underscore their systemic relationship to business and financial activities. For example, a 2017 study from the London School of Economics found that more than half of corporate bond purchases by the Bank of England and European Central Bank (ECB) went to carbon-intensive sectors.[89] Such dependencies are increasingly being scrutinised by regulators, with the Bank of International Settlements – the 'bank for central banks' – warning that climate change could 'be the cause of the next systemic financial crisis".[90]

Figure 3.7 summarises the main physical and transitional risks.

Figure 3.7 RISKS TO FINANCIAL STABILITY DUE TO CLIMATE-RELATED PHYSICAL AND TRANSITION RISKS

Physical and transition risks

The risks from climate change to the economy have two basic channels, but many potentional impacts



Source: IMF.[91]

The relationship between natural resources and business

In general, businesses and investment activities impact and depend on natural resources and ecosystem services in both direct and indirect ways.

The *Global Reporting Initiative (GRI)*, which is a global sustainability reporting framework, explains the causes of direct and indirect impacts and dependencies of businesses on biodiversity resources.[92]

- A **direct impact**: an organisation's activities directly affecting biodiversity. For example, when:
  - degraded land is converted for the benefit of production activities;
  - surface water is used for irrigation purposes;
  - toxic materials are released; or
  - local species are disturbed through the noise and light produced at a processing site.
- An **indirect impact**: the impact is caused by parties in an organisation's supply chain(s). For example, when an organisation imports fruits and vegetables, produces cotton shirts, sells construction materials or publishes books, the production of the inputs for these goods will have indirect impacts on biodiversity.

  Indirect impacts can also include those from activities that have been triggered by the operations of the organisation. For example, a road constructed to transport products from a forestry operation can have the indirect effect of stimulating the migration of workers to an unsettled region and encouraging new commercial development along the road.

  Indirect impacts may be relatively difficult to predict and manage, but they can be as significant as direct impacts and can easily affect an organisation. Impacts on biodiversity can be either:

- **negative** (degrading the quality or quantity of biodiversity); or
- **positive** (creating a net contribution to the quality or quantity of biodiversity).

Examples of sectors that rely significantly on natural resources and ecosystem services, with the potential to negatively affect biodiversity, include:

- agriculture, aquaculture, fisheries and food production;
- extractives, infrastructure and activities or projects involving large-scale construction work;
- fast-moving consumer goods (FMCG) companies – primarily through the sourcing of raw materials in products;
- forestry;
- pharmaceutical (in some cases);
- tourism and hospitality (in some cases); and
- utilities, including those involved in hydropower or open-cycle power plants generating significant thermal discharges.

Supply, operational and resource management issues

Companies need to measure, manage and disclose the environmental impact (both positive and negative) from their direct operations. Investors need to assess the extent to which companies understand the impact of their operations and manage resources, which are material to their business.

Environmental impacts from direct operations can include:

- toxic waste;
- water pollution;
- loss of biodiversity;
- deforestation;
- long-term damage to ecosystems;
- water scarcity;
- hazardous air emissions and high GHG emissions; and
- energy use.

Failure to address these challenges will expose businesses to additional risks, while working on solutions presents a business opportunity to develop climate-resilient business strategies. The circular economy described in **Section 1** is a useful model for companies to assess and manage their operations and resource management.

The UK Government updated its *Environmental Reporting Guidelines* in March 2019, providing guidelines for businesses to measure and report their environmental impacts, including GHG emissions.[93] The guide emphasises the use of environmental key performance indicators (KPIs) to capture the link between environmental and financial performance.

In March 2019, the EU Commission adopted an ambitious *Circular Economy Action Plan* to address the challenges of climate change and pressures on natural resources as well as ecosystems.[94] This was followed by EU guidelines under the *Non-Financial Reporting Directive* which introduced the concept of 'double materiality' – in other words, asking companies to report both the impact of climate change on their activities as well as, conversely, the impact of a company's activities on climate change and the environment, stipulating that 'companies should consider their whole value chain, both upstream in the supply-chain and downstream'.[95]

Case study

Global mining and metals sector

The global mining and metals sector has a considerable impact on the environment and the community in which it operates. In January 2019, Brazil's iron ore producer, Vale, experienced a deadly dam disaster, which resulted in the deaths of more than 250 people. The share price fell, wiping out 71.34 billion reals (£12.7bn) in market value.[96]

The disaster followed a similar incident in 2015, with the industry's use of a particular structure for the storage of waste – tailings dams – being thrown into the spotlight. Credit (and ESG) ratings agencies downgraded Vale, with a number of funds selling out of the company, including from the world's largest sovereign wealth fund.[97]

Recognising the lack of transparency over the location and safety of such dams, a coalition of investors now representing over US$13tn (£9.3tn) in assets, has written to over 700 extractive companies to call on investigations and reporting into this issue, with a view to the development of a global safety standard.

Environmental (and social) scrutiny of the mining and metals sector has been increasing; many of the world's largest mining companies 'have some of the worst scores on sustainability ratings compiled by fund managers […] as well as external consultants'.[98] This reinforces the role of adequate management of supply chain and operational impact.

Supply chain transparency and traceability

Supply chain sustainability is the management of ESG impacts and practices beyond the factory gates, looking at the broader lifecycle of goods and services, particularly with regards to the sourcing of raw materials and components.[99] Supply chains are complex to understand due to the fact that they are heavily interdependent. As such, the relationships between products and services and environmental risk factors are intertwined across sectors and throughout every level of the supply chain. Companies are increasingly expected to understand, manage and disclose their exposure to supply chain ESG risks or be left exposed to reputational, operational and financial risks. As such, it is becoming increasingly important for investors to factor into their due diligence and active stewardship a stronger understanding of the supply chain management of their portfolio companies.

Addressing emissions in industry and the food system presents a particularly complex challenge. In industry, a growing demand for materials, coupled with a slow adoption rate of renewable electricity and incremental process improvements, make it especially difficult to bring emissions down to net-zero by 2050. In the food system, significantly reducing emissions will also be challenging and will require changing the consumption habits of billions of people, changing the production habits of hundreds of millions of producers, and decarbonising long and complex food supply chains.

Traceability is a useful practice to identify and trace the history, distribution, location and application of products, parts and materials. This ensures the reliability of sustainability claims in the areas of human rights, labour (including health and safety), the environment and anti-corruption.[100]

In the context of environmental factors, GHG emissions in supply chains are, estimated to be, on average, over five times as high as those from direct operations.[101]

Examples of sectors with particularly complex and/or high-risk supply chains include:

- oil and gas;
- mining;
- beef;

- cocoa;
- cotton;
- fisheries;
- leather;
- palm oil;
- agriculture; and
- forestry.

It is therefore important for investors to understand key areas of environmental risks as a result of supply chain factors. Some of the main environmental risks in the supply chain include:

- material toxicity and chemicals;
- raw material use;
- recyclability and end-of-life products;
- GHG emissions;
- energy use;
- water use and wastewater treatment;
- air pollution;
- biodiversity; and
- deforestation.

Case study

Forest-risk commodities

Commodity production – mostly beef, palm oil, soy and timber or pulp – is the leading cause of deforestation around the world, with significant amounts of financing devoted to these 'forest-risk commodities'. Trase Finance estimate that circa US$1tn (£0.7tn) of investments are linked to deforestation, which are facing increased scrutiny from governments and civil society, bolstered by new data and tools (such as satellite monitoring). In 2020, the UK Government announced companies may face fines if they cannot demonstrate their supply chains are free from illegal deforestation.

Investors have increased their engagement with relevant actors, and begun to take action to address these risks. The Norwegian sovereign wealth fund has divested from over 30 palm oil companies, and a coalition of over 30 investors with over US$4tn (£2.9tn) in assets under management has threatened divestment from commodity producers – and even government bonds – due to their impact in accelerating deforestation in the Amazon.[102]

Yet, much remains to be done. The results from Global Canopy's latest annual survey of the 500 most influential companies and financial institutions in forest supply chains shows that 43% do not have deforestation commitments for any of the forest-risk commodities they are exposed to (63% among financial institutions) and US$2.7tn (£1.9tn) of financing into the most influential high-risk companies comes from Forest 500 financial institutions with no deforestation policy.[103] The think-tank, Planet Tracker, estimates the deforestation risks are rising in exchange-traded funds (ETFs), according to its 2020 report *Exchange Traded Deforestation*.[104]

Measurement, frameworks and investor expectations around supply chains keep evolving. For example, in terms of GHG emissions, the initial focus has been on direct emissions from core operations ('Scope 1' emissions) and purchased energy ('Scope 2'). However, there is increasing focus on how to measure and incorporate indirect emissions from the whole value chain, including those produced by suppliers and customers ('Scope 3' emissions).

Case study

Scope 3 in the spotlight

For companies in certain industries, the highest contribution to their overall carbon footprint comes from outside 'the factory gates'. In the case of the fossil fuel industry, for example, most emissions do not come from the extraction and processing of coal, oil and gas, but from the use of such products by consumers in vehicles, power plants and steel mills around the world. Whilst, to some degree, the emissions associated with suppliers or consumers (Scope 3) are not under a company's complete control, they nonetheless represent a source of potential business risk: a low-cost oil producer that captured all the emissions from its operations may nevertheless find the market for its main product shrinking or even vanishing as consumers shift to electric vehicles, for example. To address this issue, there has been growing investor pressure for companies to tackle emissions along the value chain that may lie outside 'the factory gates'.

A growing number of companies are now setting targets to also reduce 'Scope 3' emissions – associated with the burning of fossil fuels by customers (for miners such as BHP, Glencore or Vale), with the production of parts and raw materials by suppliers (in the case of Volkswagen), or with indirect emissions associated with food production including land-use changes (in the case of Danone).

→ *For more information on classification of corporate emissions, see Section 5 on carbon footprinting.*

Investors should assess whether a company in their portfolio has policies and systems in place which:

(i) clearly explain the environmental (and social) requirements that suppliers are expected to meet via a procurement policy (such as a supplier code of conduct); and

(ii) enable it to assess environmental (and social) risks throughout its supply chain and discuss whether it has a mechanism in place to improve poor practices.

Achieving full transparency and traceability across all stages in a supply chain in order to undertake a complete assessment of a company's environmental risks is often complex. This is a result of multiple actors involved with different systems and requirements in a supply chain that are required to produce an end-product, often across international borders.

Despite these challenges, attempting to conduct this full value chain analysis is important for investors to obtain an accurate picture of investee companies, and for companies to ensure that their own policies are not undermined by actions taken elsewhere in their supply chain. For example, CDP estimates that whilst 71% of its partner companies have zero deforestation targets, only 27% of their suppliers had policies to match this ambition. Conversely, corporate buyers polled by CDP stated that suppliers showing environmental leadership were more competitive over the long term.[105] As such, investors should continue to collaborate with, and demand greater transparency from, both companies and governments.

Case study

Measurement frameworks and tools

Not-for-profit organisations offer measurement frameworks and tools that can help trace critical sustainability issues in company supply chains. These include:

- The Sustainability Consortium (TSC), which has built a set of performance indicators and a reporting system that highlights sustainability hotspots for more than 110 consumer-product categories, covering 80–90% of the impact of consumer products.
- The WWF offers more than 50 performance indicators for measuring the supply-chain risks associated with the production of a range of commodities, as well as the probability and severity of those risks.
- CDP and the GRI have created standards and metrics for comparing different types of sustainability impact.
- The Sustainability Accounting Standards Board (SASB) has developed standards that help public companies across eleven sectors, including consumer goods, to give investors material information about corporate sustainability performance along the value chain.
- The EU Taxonomy for Sustainable Activities and the Climate Bonds Sector Criteria provide sector-specific metrics and indicators to assess if assets, projects and activities across energy, transport, buildings, industry, agriculture and forestry, water and waste management, etc., are compliant with the goals of the Paris Agreement.
- The Transparency for Sustainable Economies tool (TRASE), a partnership between the Stockholm Environment Institute and Global Canopy.
- The Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE) tool, an initiative of the UN Environmental Program World Conservation Monitoring Center (WCMC), UNEP Finance Initiative and Global Canopy
- The Terra Carta (Earth Charter), an initiative under the patronage of the Prince of Wales, providing a roadmap for business action on climate change and biodiversity.

Companies and stakeholders in industries with complex supply chains, such as the agricultural and retail industry, have joined forces to build global multi-stakeholder initiatives in order to trace commodities collaboratively. Examples of global traceability schemes include:

- the **Forest Stewardship Council (FSC)**;
- the **Marine Stewardship Council (MSC)**;
- **Roundtable for Sustainable Palm Oil (RSPO)**; and
- the **Fairtrade Labelling Organizations International (FLO)**.

3 KEY "MEGATRENDS" AND DRIVERS INFLUENCING ENVIRONMENTAL CHANGE IN TERMS OF POTENTIAL IMPACT ON COMPANIES AND THEIR ENVIRONMENTAL PRACTICES

3.1.4 Assess key "megatrends" influencing environmental change in terms of potential impact on companies and their environmental practices: growth of environmental and climate policies; international climate and environmental agreements and conventions; international, regional and country-level policy and initiatives; carbon pricing.

Growth of environmental and climate policies

There has been a considerable number and adoption of environmental and climate policies in the last decade, with the majority coming from Europe. The London School of Economics (LSE) undertook a global review and found that in 2017 there were approximately 1,400 climate change-relevant laws globally, a twenty-fold increase over twenty years.[106] Since then, their number has only continued to increase: in January 2021, the LSE database counted a total of 2,092 climate laws and policies in countries across the globe.[107]

International climate and environmental agreements and conventions

International climate and environmental policy is particularly important in times of increasing globalisation as many environmental problems, particularly climate change and loss of biodiversity, extend beyond national borders and can only be solved through international cooperation.

Kyoto Protocol (2005)

The **Kyoto Protocol** was adopted in 1997 and became effective in 2005. It was the first international convention to set targets for emissions of the main GHGs, namely:

1. CO_2;
2. methane (CH_4);
3. nitrous oxide (N_2O);
4. hydrofluorocarbons (HFCs);
5. perfluorocarbons (PFCs);
6. sulphur hexafluoride (SF_6); and
7. nitrogen trifluoride (NF_3).[108]

It established top-down, binding targets, but only for developed nations, recognising the historical links between industrialisation, economic development and GHG emissions. The protocol's first commitment period began in 2008 and ended in 2012, but was subsequently extended to 2020. Negotiations on the measures to be taken after the second commitment period ends in 2020 resulted in the adoption of the *Paris Agreement*.

Paris Agreement (2015)

At the 21st Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) in Paris in 2015 (COP21), a landmark agreement was reached to mobilise a global response to the threat of climate change in the form of the **Paris Agreement**.

The agreement's long-term goal is to keep the increase in global average temperature to well below 2°C (3.6°F) above pre-industrial levels, and to limit the increase to 1.5°C (2.7°F), since this would substantially reduce the risks and effects of climate change.[21]

Although the Paris Agreement is not legally binding under international law, it serves as a significant landmark in tackling climate change on a global scale.

Nationally determined contributions (NDCs) are at the heart of the agreement.[109] Instead of top-down imposed contributions, they capture voluntary efforts by each country to reduce national emissions and adapt to the impacts of climate change, and require every signatory (both developed and developing nations) to determine, plan and report on its NDCs, with updates to commitments every five years. While commitments vary, they tend to fall in the 25–30% range of GHG emissions relative to 2005 by 2030. Unfortunately, many countries are not on track to achieving their targets, with existing NDCs estimated to be aligned with a dangerous trajectory of around 3°C (5.4°F).[110]

The deal has been formally endorsed by 191 nations, with only six parties to the UNFCCC that were not signatories to the agreement by February 2021.[111] However, the implementation of certain elements of the agreement – such as the development of global carbon markets, and the delivery of a proposed yearly US$100bn (£71.9bn) in climate finance – remain the subject of further negotiations under the UNFCCC. The COP26 conference in Glasgow in 2021 will play a pivotal role in this process, as governments around the world are expected to announce their updated climate policies.

Other international agreements, which have impacted companies' environmental practices:

- The **UN SDGs** are a set of 17 global goals set in 2015 by the UN General Assembly seeking to address key global challenges such as poverty, inequality and climate change. Although primarily intended as a framework for government action, the SDGs are now regularly cited by corporate and investment actors as material to their business planning and operations. SDGs 7 (affordable and clean energy), 11 (sustainable cities and communities), 12 (responsible consumption and production), 13 (climate action), 14 (life below water) and 15 (life on land) are some of the most directly relevant to the environmental debate.
- The **Kigali Amendment to the Montreal Protocol** of 2016 is a global agreement to phase out the manufacture of hydrofluorocarbons (HFCs). These gases were used in an attempt to replace ozone-depleting chemicals, but have the downside of causing a potent warming effect on the planet.[112]
- The **International Maritime Organization (IMO) 2020 Regulation** caps the maximum sulphur content in the fuel oil used by ships. Limiting sulphur oxide emissions, which contribute to air pollution and acid rain is estimated to have a very positive impact on human health and the environment.[113]
- **'Corsia' (Carbon Offsetting and Reduction Scheme for International Aviation)** is a UN mechanism designed by the UN International Civil Aviation Organization (ICAO) designed to help the aviation industry reach its aspirational goal to make all growth in international flights after 2020 carbon neutral, with airlines required to offset their emissions. The scheme is important as domestic aviation emissions are covered by the *Paris Agreement*, but international flights – which are responsible for around two-thirds of the CO_2 emissions from aviation – are under the remit of ICAO.[114]

International, regional and country-level climate policy and initiatives

Over the last five years, there has been an acceleration in environmental and climate initiatives targeting the financial and business sector. The 2015 Paris Agreement has no doubt been the most instrumental driver in terms of bringing together all nations for a common cause to undertake ambitious efforts to combat climate change and adapt to its effects. It has also helped regulators and policy makers at national levels to take action.

Sustainable finance in the EU

In December 2019, the European Union (EU) announced the **European Green Deal**: a plan to make the EU economy climate-neutral by 2050 by boosting the efficient use of resources, restoring biodiversity and cutting pollution. As part of this programme, it has renewed its strategy focused on sustainable finance, whose main ambitions are:

- **to reorient capital flows** by:
  - establishing the following:
    - a classification system (taxonomy) for sustainable activities, and
    - standards and labels for green bonds, benchmarks and other financial products; and

» increasing EU funding for sustainable projects.

- **to mainstream sustainability into risk management** by efforts to incorporate sustainability into financial advice, credit ratings and market research, as well as more technical proposals on the treatment of 'green' assets in the capital requirements of banks and insurers (the so-called 'green supporting factor').
- **to foster transparency and long-term thinking** by strengthening the disclosure requirements relating to sustainability (on both the financial industry and companies more broadly).[115]

These developments are intended to embed sustainability across the entire investment chain – from the owners of capital (such as pension funds and insurance companies) to the beneficiaries of capital (such as investee companies), as well as key intermediaries (banks, asset managers, financial advisors and consultants, credit rating agencies).

EU taxonomy

One of the most heavily debated topics by the investment community has been the **EU taxonomy**. Approved by the EU Parliament in June 2020, it aims to significantly reduce (perhaps even remove altogether) the risk of green-washing financial products by providing a classification system to determine whether an economic activity is environmentally sustainable. Inclusion in the taxonomy is restricted to activities that contribute to at least one of the six environmental objectives:

1. climate change mitigation;
2. climate change adaptation;
3. sustainable use of protection of water and marine resources;
4. transition to a circular economy, waste prevention and recycling;
5. pollution prevention and control; and
6. protection of healthy ecosystems.

Under the taxonomy regulation, institutional investors and asset managers offering investment products as environmentally sustainable would need to explain whether and how they have used the taxonomy criteria. This forms a part of the growing disclosure requirements for investors relating to sustainability.

Sustainability disclosures

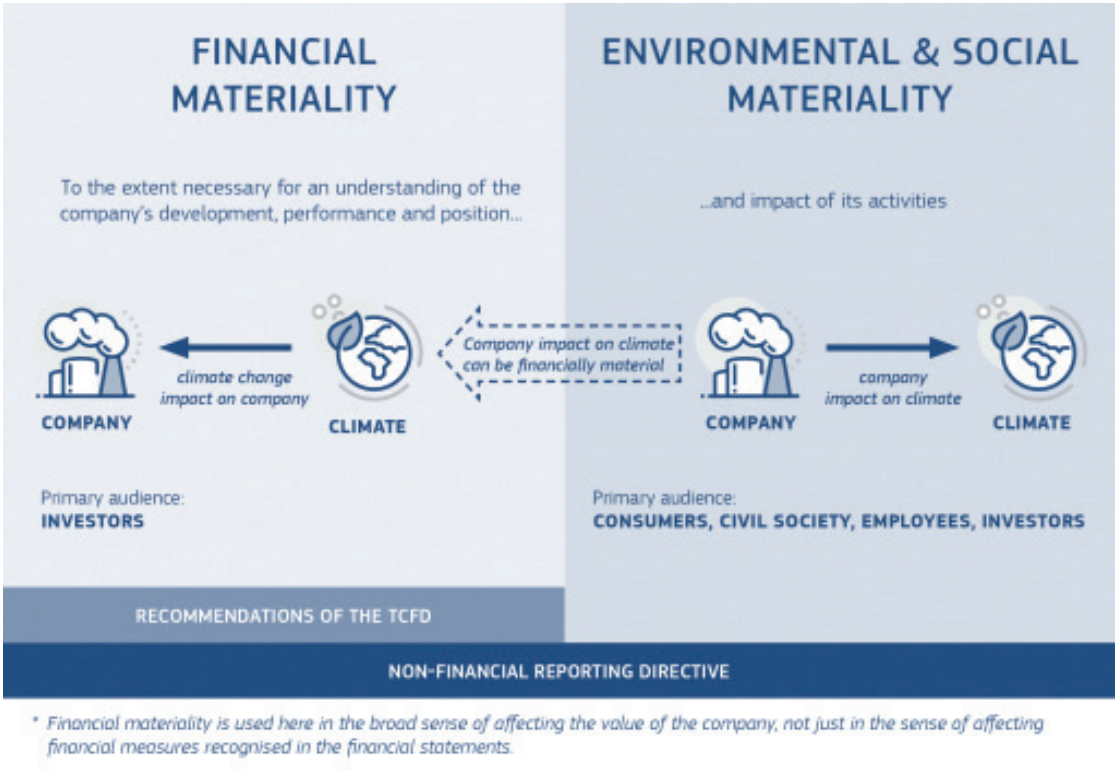
Two further significant EU developments include the **Sustainable Finance Disclosure Regulation (SFDR)** and the **Non-Financial Reporting Directive (NFRD)**.

Under SFDR, investors will be required to provide more transparency around:

- how the impacts of sustainability risks on their financial products are being systematically assessed (e.g. integrated into due diligence and research processes);
- how asset managers consider – and seek to address – the potentially negative implications of investment activities on sustainability factors; and
- products labelled with an explicit ESG focus.[116]

Under NFRD, companies, including corporates, insurers and banks, are expected to report on the policies they have in relation to environmental protection and a range of other social and governance factors. The original Directive is currently under review. In 2019, it was supplemented by guidelines on climate reporting which introduce the concept of 'double materiality', i.e. the two-way impacts between companies and climate change.

Figure 3.8: THE DOUBLE MATERIALITY PERSPECTIVE OF THE NFRD IN THE CONTEXT OF REPORTING CLIMATE-RELATED INFORMATION



Please note that TCFD recommendations are explained in the following section.

Source: European Commission.[117]

Climate benchmarks

Another area of EU activity is the creation of **climate benchmarks**. These play an important role in investments, serving – as their name suggests – as a comparator to measure the performance of investments (in the case of actively managed funds), or as a target for the construction of investment solutions, which aim to replicate (or 'track') the composition of certain widely used benchmarks (e.g. stock market indices like the FTSE 100 or S&P 500, in the case of so-called 'passive' or index funds).

However, the most widely used benchmarks are primarily based on company size (at least for equities) and thus do not directly reflect low-carbon considerations in their methodologies. This raises the possibility that a significant and, given the rising share of assets managed under index strategies, growing portion of the investment universe might be pursuing environmentally unsustainable investment strategies. In fact, some research suggests that "current benchmarks are likely to be more aligned with a 'business-as-usual' scenario, where temperature rises range from 4°C to 6°C (7.2°F to 10.8°F), leading to catastrophic damage to the Earth".[118]

Therefore, the EU have developed two types of climate benchmarks for equities and corporate bonds that aim to start with lower associated carbon emissions intensity relative to their investable universe, and then continually cut emissions thresholds each year by at least 7%, in line with IPCC estimates for annual reductions necessary for a 1.5°C (2.7°F) temperature scenario.

The two main categories of benchmarks are:

1. **EU Paris-Aligned Benchmarks (EU PABs)**, which must:
   - » reduce carbon emissions intensity by at least 50% in their starting year;
   - » have a four-to-one ratio of 'green' to 'brown' investments relative to the investable universe; and
   - » not invest in fossil fuels.

2. **EU Climate Transition Benchmarks (EU CTBs)**, which require a 30% intensity reduction in starting year and at least an equal 'green' to 'brown' ratio, but permit fossil fuel investments as part of a transition process.[119]

Further progress on developments from the EU Commission's *Sustainable Action Plan* will continue to play a pivotal role in the development of EU and global markets towards greater harmonisation through the International Platform on Sustainable Finance (IPSF), thereby influencing policy.[120]

Country-level policy and prudential actions

Countries and regions are leading the way in influencing the regulatory framework to promote the economic and financial mainstreaming of climate change and environmental factors.

France

France's *Energy Transition for Green Growth Law* took effect in January 2016, requiring mandatory disclosures from major institutional investors around their exposure to climate risks and efforts to mitigate climate change.[121] As the law explicitly targets institutional investors but not banks, it provided a control group for a kind of natural experiment; a 2021 report by the Banque de France found "evidence of a sharp relative decrease in holdings of fossil energy securities in the portfolios" of the investors affected by the law.[122]

The UK

In 2020, the UK Government announced a ten-point plan for a green industrial revolution that aims to:

- scale up low-carbon technologies and infrastructure;
- increase protections for biodiversity; and
- further the green finance agenda.[123]

An important element of the plan is a roadmap towards mandatory climate-related disclosures for UK companies, starting with large financial institutions and premium listed companies, and then gradually widening the scope to other UK-registered companies and financial actors.[124]

This follows a growing focus on sustainability from the main financial supervisors in the UK.

The Prudential Regulation Authority (PRA) and the Financial Conduct Authority (FCA) published separate consultations on climate change in 2018, which resulted in increased requirements on UK banks and insurers – notably the introduction of a climate change **stress-test** for their liabilities and investments to investigate the resilience of the financial system by testing the implications of high-impact climate change scenarios.[125]

This has elements of a precautionary approach, which focuses not on forecasts of plausibility, but on avoidance of worst case outcomes.

Case study

The precautionary principle

The precautionary principle states that "if an action or policy has a suspected risk of causing severe harm to the public domain (affecting general health or the environment globally), the action should not be taken in the absence of scientific near-certainty about its safety". It is intended to provide a safeguard "in cases where the absence of evidence and the incompleteness of scientific knowledge carries profound implications and in the presence of risks of 'black swans', unforeseen and unforeseeable events of extreme consequence."[126]

It is impossible to predict with full certainty the future evolution of the global climate system. But this does not mean it is impossible to state whether certain interventions are likely to increase, rather than decrease, climate risks. Moreover, by the time climate damages are confirmed, it may be too late, hence the importance of precaution.

Environmental standards in certain jurisdictions, such as the EU, already embody elements of the precautionary principle. However, it has been argued that financial authorities, too:

> *"need to move towards precautionary approaches to maintaining the safety and soundness of the financial system. Precautionary policy prioritises preventative action and a qualitative approach to managing risk above quantitative measurement and information disclosure. It aims to steer away from tipping points and build system resilience as a superior means of managing radical uncertainty."*[127]

One notable area where precaution is a legal requirement concerns the duties of pension fund trustees.[128] Bound to act in the best interest of their beneficiaries, in a number of jurisdictions trustees are expected to act 'as a prudent person acting in a like capacity would […] in the conduct of an enterprise of like character and aims'.[129] The implications of these duties with regards to, for example, the fossil fuel investments of pension funds, has been the subject of significant debate in recent years.

Regulation is also increasing on pension funds, with successive clarifications from the country's policy makers that ESG and climate considerations can have material financial impacts, and therefore are not 'to do with personal ethics, or optional extras',[130] but fall within the remit of the risks that must be monitored and addressed by pension trustees as part of their investment duties.

After the UK Government's Environmental Audit Committee (EAC) wrote to the largest 25 UK pension schemes on climate change risk, the UK Department for Work and Pensions (DWP) followed up in June 2018 with a proposal that corporate pension fund trustees should publish a fund statement of investment principles (SIP) by October 2019 that takes account of financially material ESG issues; climate change was singled out as a factor due to its 'systemic and cross-cutting nature'.[131]

The Pensions Regulator (TPR) in the UK has issued guidance to pension funds relating to ESG and climate change along similar lines. Since 1 October 2020, trustees of defined contribution (DC) pension schemes will be required to produce an implementation report setting out how they acted on the principles set out in the SIP. In February 2021, amendments to the **Pensions Schemes Act** required UK pension schemes, among increased climate requirements, to consider "the steps that might be taken for the purpose of achieving the Paris Agreement goal".[132]

USA

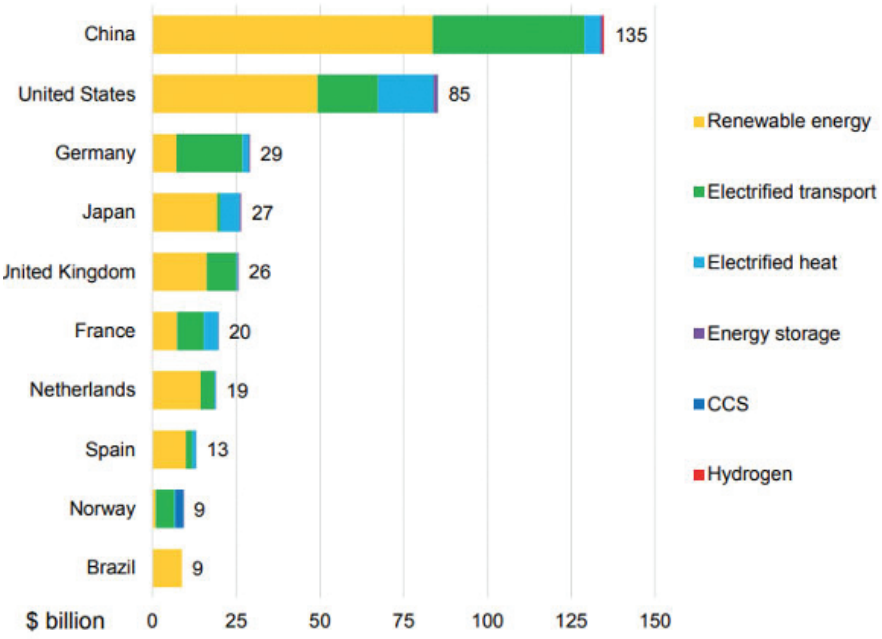
The USA has historically had a more conservative stance on this issue compared to the UK and the EU; with ongoing debate (and successive policy shifts) as to whether trustees may, may not or should consider ESG and climate factors in the management of their investments. Under the different administrations since 2015, the US Department of Labor's (DOL) guidance on the issue has varied, and is currently once more subject to review.

Much of the discussion focuses on the extent to which the incorporation of ESG issues can be interpreted as prioritising non-financial objectives (such as the pursuit of social and policy goals) over the long-term financial security of retirees. Recognising the evolution of ESG investing, feedback from market participants in response to a DOL consultation in 2019 overwhelmingly stressed the financial materiality of ESG factors.[133]

China

Reckoning with the climate costs associated with decades of explosive economic growth, the country's policymakers have begun combining its global leadership position on renewable energy with a greater desire for its financial system to address environmental issues. China is the world's largest manufacturer of solar cells, lithium-ion batteries and electric vehicles, and these are areas of clear policy priority.[134] In 2020 alone, China doubled its construction of new wind and solar power plants compared to the previous year.[135] It remains the country with the highest levels of investment in the low-carbon energy transition, and the highest absolute GHG emissions.

Figure 3.9: GLOBAL INVESTMENT IN ENERGY TRANSITION BY COUNTRY (2020)



Source: Bloomberg NEF.[136]

At the UN General Assembly in 2020, the country's policymakers committed to have its CO_2 emissions peak before the year 2030 and to achieve carbon neutrality before 2060, an objective that is set to inform the policy blueprint for the next five years and beyond. Efforts to further embed environmental considerations into the economy were already underway, with the roll-out of a national carbon market and China's seven ministerial agencies, including the central bank, having previously indicated their support for institutional investors to perform environmental stress-tests and for mandatory environmental disclosures for issuers of public debt and equity.[137]

The country's policymakers are increasingly engaging with international counterparts on issues pertaining to green finance and the green taxonomy. The country's green bonds market is now the world's largest, but it has faced barriers regarding investor access and lack of international harmonisation. In 2020, top regulators announced they will exclude fossil fuel projects from their green bonds taxonomy, bringing the country closer to international practice.[138]

India

The growing focus of financial regulators on environmental risks is reverberating in other Asian countries, too. The Securities and Exchange Board of India has introduced requirements for the 100 largest companies to report on sustainability and social aspects of their business practices. India's central bank published a study in 2020 arguing that climate change can exacerbate food price inflation, and the country also is host to one of the largest green bond markets among emerging markets.[139]

Japan

Japan has now pledged to enshrine into law a target for net zero GHG emissions by 2050,[140] and its regulator the Financial Services Agency is piloting climate 'stress-testing' for its largest banks.[141]

As the science on climate change and its impact on the environment continues to improve and become more sophisticated, it would be reasonable to expect these issues to increase the agenda of financial regulators and policymakers. These are likely to have important implications for economic, financial and business policies.

Task Force on Climate-related Financial Disclosures

The most influential international framework for disclosure of climate change risks and opportunities affecting companies and financial institutions is the framework from the **Task Force on Climate-related Financial Disclosures (TCFD)**.[142]

The TCFD was launched in 2015 following a request from the G20 countries' finance ministers and central bank governors for the Financial Stability Board – the organisation which coordinates the work of national financial supervisors and international standard setting bodies – to investigate the risks of climate change on the stability of the financial system and the appropriate response.

The TCFD set out to provide a set of recommendations and a framework for companies and financial institutions to provide better information to support investors, lenders, insurers and other financial stakeholders to identify, build and quantify climate-related risks and opportunities into their decisions. The TCFD also took the view that better information will help investors engage with companies on the resilience of their strategies and capital spending, including more efficient allocation of capital, which should help to promote a smooth transition to a more sustainable, low-carbon economy.

In July 2017, the TCFD published its final recommendations for how companies should report, structured around four thematic areas:

1. governance;
2. strategy;
3. risk management; and
4. metrics and targets.

Figure 3.10: TCFD CORE ELEMENTS OF CLIMATE-RELATED FINANCIAL DISCLOSURES

Governance
The organisation's governance around climate-related risks and opportunities.

Strategy
The actual and potential impacts of climate-related risks and opportunities on the organisation's businesses, strategy and financial planning.

Risk management
The processes used by the organisation to identify, assess and manage climate-related risks.

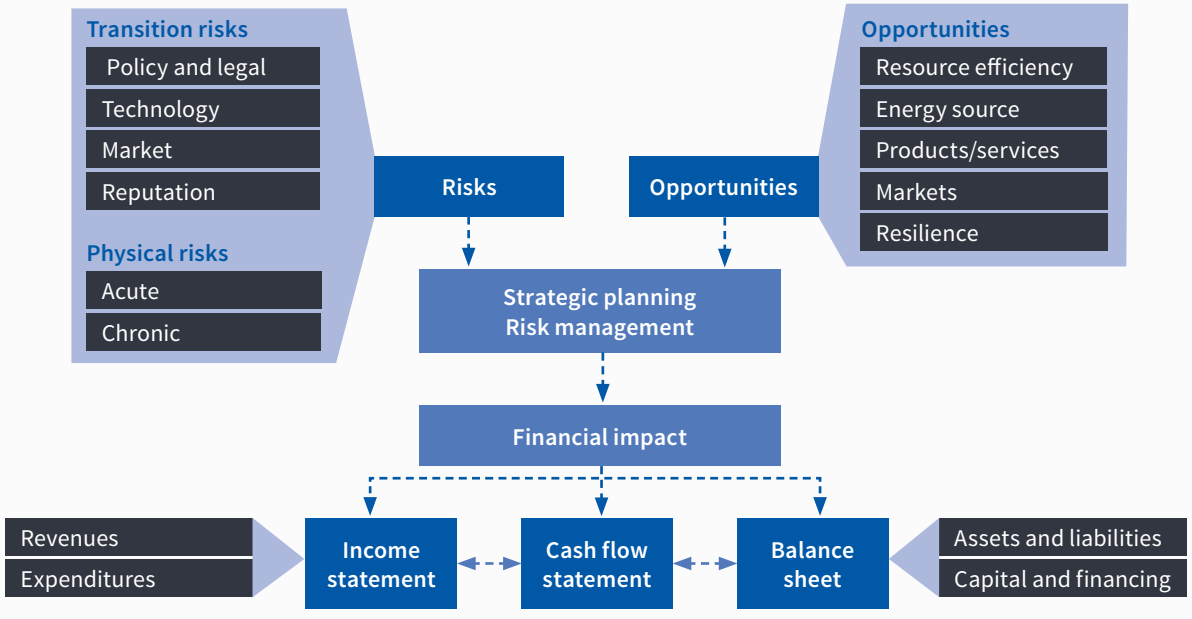
Metrics and targets
The metrics and targets used to assess and manage relevant climate-related risks and opportunities.

Source: TCFD.[143]

The work of the TCFD introduced the influential classification of climate-related risks into physical and transition risks, recommending that companies report on both of these dimensions. One notable recommendation was the use of climate scenario analysis (which will be considered in more detail in **Section 5**).

A growing number of public and private sector organisations are showing their support for the TCFD recommendations, including over 1,300 companies with a market capitalisation of US$12.6tn (£9.1tn) and financial institutions responsible for assets of US$150tn (£107.8tn). Whilst initially intended as guidelines for voluntary reporting, jurisdictions including the UK, the EU and New Zealand have announced policies requiring TCFD-aligned disclosures.[144]

Figure 3.11: CLIMATE-RELATED RISKS, OPPORTUNITIES AND FINANCIAL IMPACT ACCORDING TO TCFD



Source: TCFD.[143]

Network for Greening the Financial System

A related notable initiative is the **Network for Greening the Financial System (NGFS)**, comprising over 70 central banks and financial supervisors. It was set up to strengthen the global response required to meet the goals of the Paris Agreement, and to enhance the role of the financial system to manage risks and to mobilise capital for green and low-carbon investments in the broader context of environmentally sustainable development. The NGFS has developed technical guidance – including publishing a set of climate scenarios – for the regulatory supervision of climate risks.[145]

Carbon pricing

There is a growing consensus among governments, the financial community and businesses on the fundamental role of carbon pricing in the transition to a decarbonised economy. Putting a price on carbon emissions is viewed as one of the most effective methods of tackling climate change: this is often called the **polluter pays principle**.

There are many types of carbon pricing; the most common are the **emission trading system (ETS)** and **carbon taxes**, roughly corresponding to quotas and tariffs in international trade.

Emission trading system

An ETS is a system based on the exchange of per mits for emission units, where actors who exceed their emissions limits are required to buy permits from those that have emitted less. The overall quantity of emissions is fixed, and market mechanisms are used to set their price.

In theory, this creates an economic incentive for emissions reductions to occur at the point of least cost; rather than mandating similar levels of reductions for all actors, price discovery helps reward those that can afford to reduce more.

The effectiveness in practice, however, depends crucially on the design of the ETS. If the scheme is too restrictive, it may encourage the offshoring of industries into jurisdictions with fewer constraints (a phenomenon known as 'carbon leakage'), and thus fail to reduce emissions. As a result, free allocation of allowances (to give industry an initial 'buffer') has been a widely used feature of ETSs,[146] although in some cases, overallocation resulted in the price of an emissions unit being too low to properly incentivise decarbonisation.

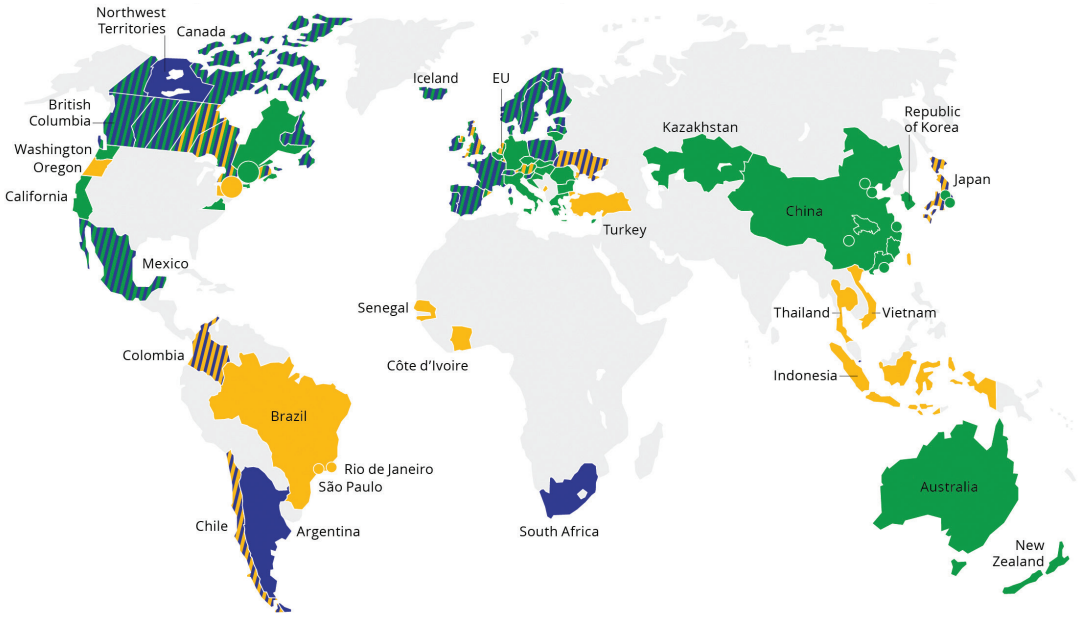
Carbon taxation

Carbon taxation takes a different approach by directly setting an explicit price on GHG emissions (e.g. per tonne of CO_2). This has the advantage of predictability, although the carbon tax rate, alongside the elasticity of demand for different products and the extent to which companies can pass on the carbon costs to their end consumers, will be key determinants of effectiveness. It has been estimated that an explicit global carbon price of US$40 to US$80 (£29 to £58) per tCO_2 in the 2020s, more than doubling to US$50 to US$100 (£36 to £72) per tCO_2 by 2030, is required to meet the goals of the Paris Agreement.[147] This is substantially higher than the current global average price, which the International Monetary Fund (IMF) estimates is US$2 (£1.4) per tCO_2.[148]

Carbon pricing and the trading of emissions trading certificates were initially trialled in the UK in the early 2000s, a process which contributed substantially to the swift displacement of coal in the UK's electricity mix (which provided less than 1% of electricity in 2020,[149] compared to 40% as recently as 2012).[150] The EU subsequently adopted emissions trading as one of its flagship climate policies with the establishment of the EU ETS in 2005. It covers the main energy and carbon-intensive industries, regulating about half the European economy with a carbon price.

The growth of national and international carbon markets since then has been steady, but sporadic, with regions, including the east and west coasts of the USA, New Zealand, South Korea and some Canadian provinces. Following the running of pilot schemes in some Chinese provinces, a fully-fledged national scheme is expected to launch in 2021. When it does, it will become the largest carbon market in the world, superseding the EU ETS. Overall, as of 2020, there are 61 carbon pricing initiatives implemented or scheduled – split roughly equally between carbon taxation (30) and ETS mechanisms (31). They cover circa 22% of global GHG emissions and are responsible for raising US$45bn (£32.4bn) in revenues.[148]

Figure 3.12: CARBON MARKETS AROUND THE WORLD



Source: World Bank.[148]

Over the last ten years, many companies – especially in energy-intensive sectors – have used the practice of shadow carbon pricing to guide their decision-making process. An internal or shadow price on carbon creates a theoretical or assumed cost per ton of carbon emissions. For example, the major oil company, BP, uses a price assu mption of a US$100 (£72) per tonne of CO_2 by 2030[151] to better understand the potential impact of future climate regulation on the profitability of a project, a new business model or an investment. Its use reveals hidden risks and enables businesses to build this factor into future valuations and estimates of capital expenditure. In addition, when emissions bear a cost in profit-and-loss statements, it helps to uncover inefficiencies and incentivise low carbon innovation within departments, cutting a company's energy use and carbon pollution.

Some governments are using internal carbon pricing as a tool in their procurement process, policy design and project assessments in relation to climate change impacts. More recently, financial institutions have also begun using internal carbon pricing to assess their project portfolio. In 2019, circa 1,600 companies – including more than 100 Fortune Global 500 companies with a total annual revenue of about US$7tn (£5tn) – reported that they are currently using an internal price on carbon or plan to do so in the next two years.[148]

4 ASSESSMENT OF MATERIALITY OF ENVIRONMENTAL ISSUES

3.1.5 Assess material impacts of environmental issues on potential investment opportunities, including the dangers of overlooking them: corporate and project finance; public finance initiatives; asset management.

Material environmental issues are factors that could have a significant impact – both positive and negative – on a company's business model and value drivers, such as operating and capital expenditure, revenue growth, margins and risk. Materiality is not static and it evolves in line with changes in the market, policies and consumer attitudes. For example, the surge in public concern over plastic pollution seen in recent years – and the subsequent regulatory clampdowns on single-use plastics – has been quoted by the oil company BP as having the potential to have a 'material impact' on the future oil demand.[152]

As such, efforts by investors to assess the material financial impacts caused by environmental risks have begun to increase in terms of their analytical scope and sophistication. This includes, for example, considering a wider

range of environmental factors, such as those from policy and technology responses (transition risks), as well as the impacts of environmental events and physical risks.

Investors need to undertake relevant research and materiality analysis to determine the environmental impact – both positive and negative. The type of analysis and approach will mostly be dependent on the type of assets being assessed – company, sector and geographic location, and on a portfolio level. Based on both quantitative and qualitative data, environmental analysis will potentially determine adjustments to forecasted financials and ratios, valuation-model variables, valuation multiples, credit assessments and portfolio allocation weightings.

Without sufficient consideration of materiality, investors may be exposed to changes in policy, technology and consumer sentiment, or forego investment opportunities.

However, the challenge is that environmental issues unfold in complex ways across time, regions and sectors, and there is significant variation in the definitions, classifications and measurement of these risks and opportunities.

Corporate and project finance

At a company or project level, investors looking to identify and measure a company's environmental impact or materiality would need to analyse both quantitative and qualitative environmental factors in order to make an informed evaluation of the environmental risks embedded within. A judgment is then made on how material the risks are and whether those risks are priced in or not. A scoring system is also typically used to benchmark the company against its peers. Materiality is also highly influenced by the industry or sector of the company, as well as its country and jurisdictions where projects are located. This is also particularly relevant in the financing and investments of infrastructure projects.

A useful starting point is analysing how a company or project use energy, water and waste:

- **Energy consumption** can be measured by the level of absolute emissions of GHGs from fossil fuel combustion and industrial processes, and is measured by the amount of CO_2e. This could also include savings in energy and performance relative to a benchmark year, and can be provided on an annualised or lifetime basis, based on estimates (particularly relevant for projects) or actual measurement (relevant to operational assets).
- **Water utilisation** can be calculated as the costs generated by water usage efficiency in operations taken directly from the ground, surface waters or purchased. Water and wastewater treatment can be assessed against indicators tracking reductions in pollutants and harmful substances in supply areas, as well as incident reports and sanctions.
- **Waste utilisation** is measured as the costs generated from the disposal of waste in operations such as through landfill, incinerated waste, or recycled or hazardous waste. Aspects that may need to be factored into the analysis include carbon capture and storage (e.g. for closed landfill, industrial operations), pollution control (soil, air, water), waste-to-energy facilities and waste-to-biofuel.

At a project finance level, when assessing project infrastructure initiatives, the International Finance Corporation's (IFC) *Equator Principles*, which are based on IFC's *Performance Standards,* have become a globally recognised risk management framework, and are adopted by financial institutions for determining, assessing and managing environmental and social risk in project finance. They set out performance standards that address environmental factors (such as resource efficiency, biodiversity and land resettlement) as well as other social-oriented standards. Examples of potential risks to be considered are presented in **Table 3.3**.

Table 3.3: IDENTIFICATION OF ENVIRONMENTAL RISKS AND IMPACTS AT COMPANY OR PROJECT LEVEL

RISKS		POTENTIAL IMPACTS
Release of air pollutants (air emissions)	→	Pollution of air, land and surface water
Release of liquid effluents or contaminated wastewater into local water bodies or improper wastewater treatment	→	Surface water pollution
Generation of large amounts of solid waste and improper waste management	→	Pollution of land, and ground and surface water
Improper management of hazardous substances	→	Contamination of adjacent land and water
Excessive energy use	→	Depletion of local energy sources and release of combustion residuals leading to air pollution
Excessive water use	→	Depletion of water resources
High or excessive noise levels	→	Negative effects on human health and disruption of local wildlife
Improper or excessive land use	→	Soil degradation and biodiversity loss

Source: IFC.[153]

Whilst considering the potential negative impacts of investments can illuminate important sources of material risk, considering the potential positive impact (for example, whether a given investment contributes to nature conservation or emissions reductions) can highlight opportunities.

Public finance initiatives

As governments continue to raise their climate targets in line with the Paris Agreement, resources are allocated and investments from the public sector are mobilised to implement these plans – including in partnership with private investors. For example, the **Helsinki Principles**, signed by a number of finance ministers around the world, encourage signatories to "take climate change into account in macroeconomic policy, fiscal planning, budgeting, public investment management, and procurement practices."[154]

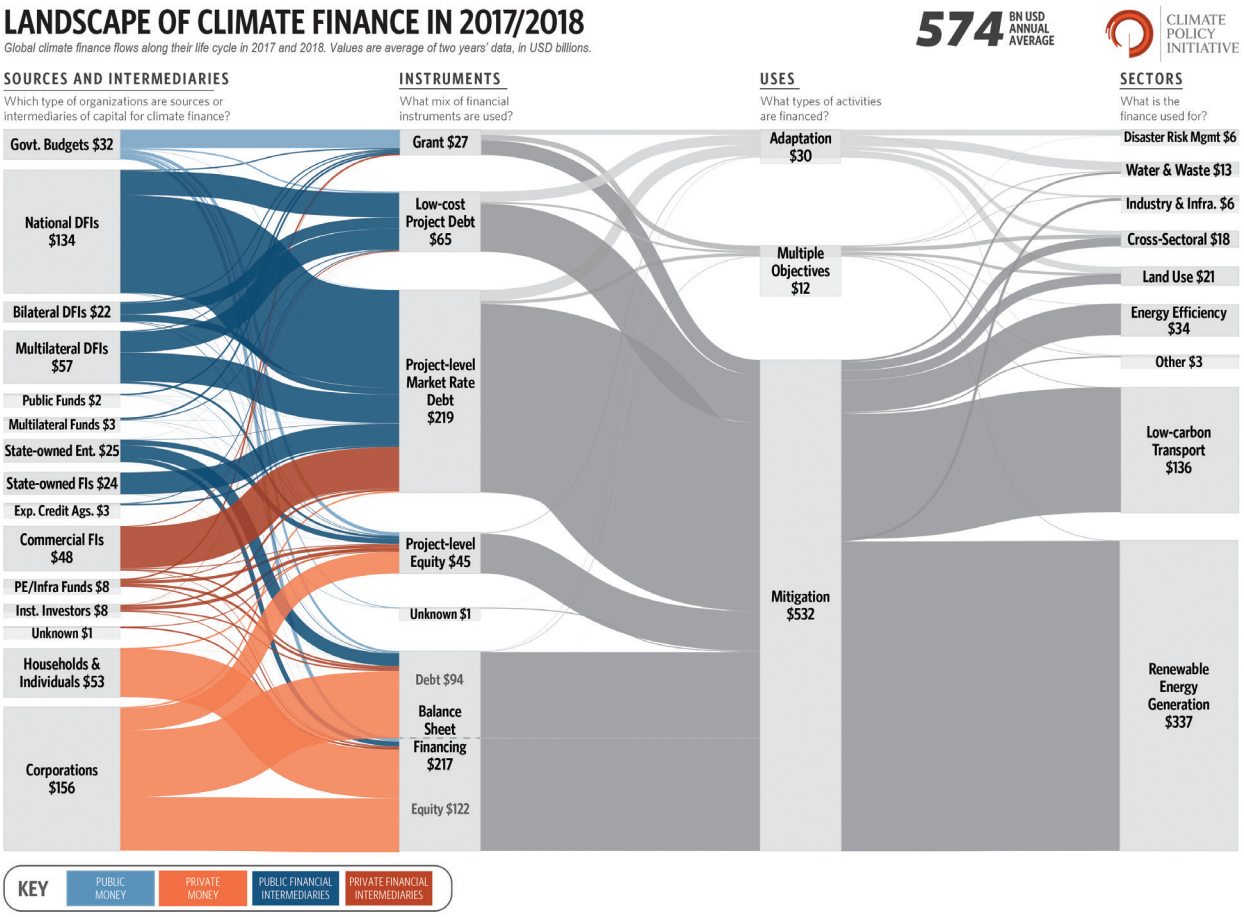
Public finance is a key policy instrument to both incentivise and enable the transition to green growth. Domestically, governments are a significant economic actor – commissioning new buildings, roads and other forms of infrastructure, for example – highlighting the importance of aligning public procurement and sustainability. Governments also contribute to international development, with public sector financing often blended with funding from multilateral development finance institutions in developing countries and disbursed through investment vehicles, such as:

- green infrastructure funds (e.g. the Association of Southeast Asian Nations (ASEAN) Catalytic Green Finance Facility under the ASEAN Infrastructure Fund);
- specialised banks (e.g. Asian Infrastructure Investment Bank); and
- funding platforms (e.g. the Tropical Landscapes Finance Facility).[155]

A variety of financing initiatives leveraging public sector and development finance for sustainable agriculture, biodiversity conservation and the blue economy are also emerging, particularly targeting more vulnerable and developing economies.[156]

The Climate Policy Initiative reported that the average annual public climate finance of around US$300bn (£216bn) in 2017/18, with the highest proportion dedicated to low-carbon transportation. Other areas of spending include adaptation and resilience, energy efficiency; land use; and infrastructure projects with cross-sectoral impacts.[157]

Figure 3.13: THE LANDSCAPE OF CLIMATE FINANCE IN 2017/18



Source: Climate Policy Initiative.[157]

Examples of the types of **public finance** include:

- export credit;
- development banks;
- concessionary lending to small and medium enterprises (SMEs);
- guarantees;
- research and development (R&D); and
- investment in infrastructure.

Initiatives that typically require **public (and private) sector funding** with high environmental impacts are:

- energy;
- water and waste;
- transport; and
- flood defences.

Asset management

As stewards of capital, asset managers play a key role in helping to steer capital towards sustainability. Whether directly (e.g. by deciding to fund a particular green infrastructure project or to buy the debt of a high-carbon company), or indirectly (e.g. by using investor rights to appoint and reward company directors, and through the related engagement with investee companies), the decisions made by asset managers can make positive or negative contributions to ESG factors such as the global emissions trajectory.

The environmental profiles of asset managers' portfolios have come under increased scrutiny from the media and civil society in recent years, often relating to campaigns for fossil fuel divestment. However, client mandates from asset owners may impose constraints on the options available to asset managers (particularly in the case of index-tracking funds). Exclusions remain only one of a range of potential strategies that asset managers can deploy to manage environmental risks, alongside positive screening or impact investing funds.

Historically, however, the majority of the world's assets under management do not fall under either of these two categories, but are invested in a variety of assets classes and strategies, which may not explicitly incorporate climate change or environmental objectives. This is changing, as both asset owners and asset managers are increasing their sustainability efforts. In December 2020, over 30 asset managers managing over US$9tn (£6.5tn) in assets joined the *Net Zero Asset Manager* initiative, pledging to support investing aligned with net zero emissions by 2050 or sooner.[158] This initiative mirrors the growing number of asset owners who are setting net zero emissions targets for their portfolios (e.g. the UN-convened *Net Zero Asset-Owner Alliance,* which gathers institutional investors with over US$5tn (£3.6tn) in assets).[159]

As a result of growing investor interest, asset managers are increasingly focused on the development of standardised frameworks and data points to be able to assess climate and environmental risks across multiple sectors, down to the level of individual companies or their securities. This recognises that:

1. companies within the same sector may face different levels of risk; and
2. these risks are likely to be complex, interlocking and affecting all sectors, not just those with high carbon emissions.

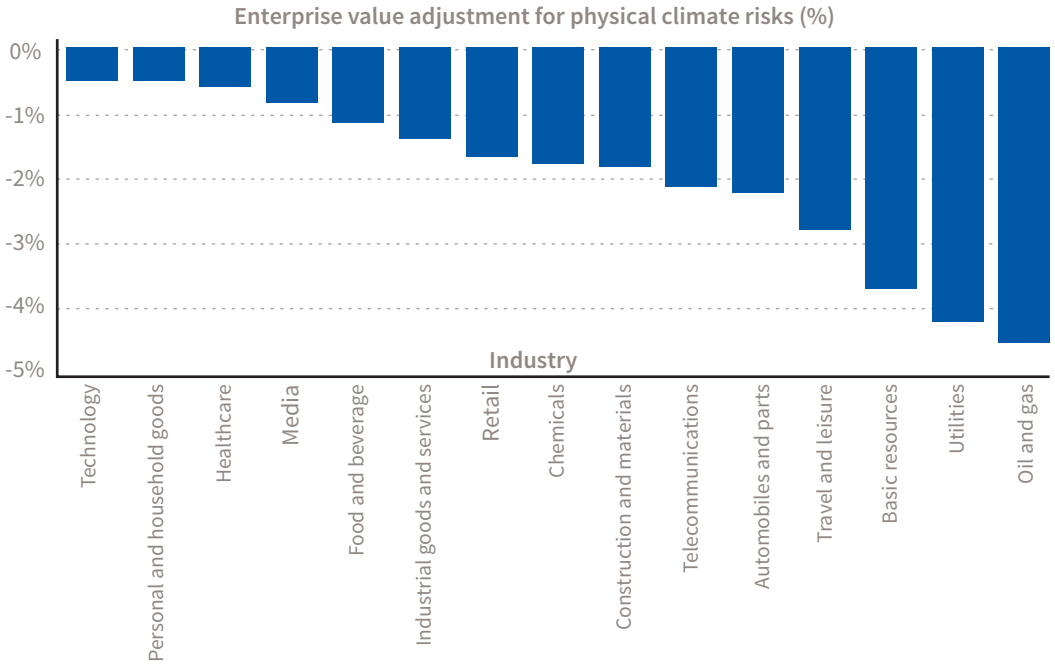
Such a framework, used by companies for reporting and disclosure and by investors in assessing the environmental (including social and governance) risks of companies, comes from the SASB, which was established in 2011 to develop and disseminate sustainability accounting standards. The standards identify financially material issues that are reasonably likely to impact the financial condition or operating performance of a company and therefore are most important to investors. SASB provides an interactive proprietary tool that identifies and compares disclosure topics across different industries and sectors, described as a 'materiality map'.[160] Environmental factors cover:

- GHG emissions;
- air quality;
- energy management;
- water and wastewater management;
- waste and hazardous materials management; and
- ecological impacts.

SASB's analysis reflects the varied nature of different sectors – GHG emissions are assessed to be material for more than 50% of industries in sectors such as extractives and minerals processing and transportation, but for less than 50% of industries in sectors such as healthcare or technology and communications – where the management of energy, waste and hazardous materials features more prominently.

An illustration of how environmental risk (in this case caused by physical climate change) affects different industries, is Schroders' analysis in **Figure 3.14** (based on their internal proprietary metrics). This shows the potential costs to some companies of insuring their assets against the impact of physical climate change. The sector exposures analysed tend to vary according to the capital intensity of the business.

Figure 3.14: ENTERPRISE VALUE ADJUSTMENT FOR PHYSICAL CLIMATE RISK BY INDUSTRY



Source: Schroders.[161]

However, there are different definitions of materiality and related reporting metrics under the multiple standards and frameworks used for sustainability reporting, including the GRI, the Climate Disclosure Standards Board (CDSB), Integrated Reporting and CDP. While SASB is focused on financial materiality, GRI has a much wider stakeholder and materiality lens, and CDP reporting zooms in on emissions and supply chains. The year 2020 saw concerted efforts by standard setters and accounting firms to work together towards comprehensive reporting to:

- align disclosures;
- identify key sustainability metrics to facilitate the creation and interpretation of disclosures; and
- scale up adoption of sustainability reporting, including under TCFD.[162]

Following the publication of guidelines in 2019 that set out an approach for determining financial materiality for climate-related and other emerging risks and opportunities, the IFRS ran a consultation in 2020 on the need for an international standard, whether to consider financial materiality only or dual materiality, and the role IFRS might play.[163] Standardised disclosure is important for investors to have access to reliable and comparable data. At the same time, many investors are incorporating this increasingly available climate and environmental data into their own proprietary investment frameworks, which reflect their house views on the climate and energy transition.

Whilst some environmental risks can be addressed quantitatively, others require a more qualitative approach – for example, through engagement with companies to align management incentives with sustainability goals. Asset managers have stepped up individual engagement efforts, but are also collaborating, to achieve this.

Case study

Investor collaboration on climate

Launched in 2017, Climate Action 100+ is an investor network with over 500 investors engaging the world's largest corporate emitters of GHGs.[164] Its members conduct joint company engagements and collaborate on shareholder proposals, and the initiative has been developing tools and benchmarks to be able to track company progress towards net zero emissions.

5 APPROACHES TO ACCOUNT FOR MATERIAL ENVIRONMENTAL ANALYSIS AND RISK MANAGEMENT STRATEGIES

3.1.6 Identify approaches to environmental analysis in both developed and emerging countries: company, project, sector, country and market level analysis; environmental risks including carbon footprinting and other carbon metrics, natural capital approach and climate scenario analysis.

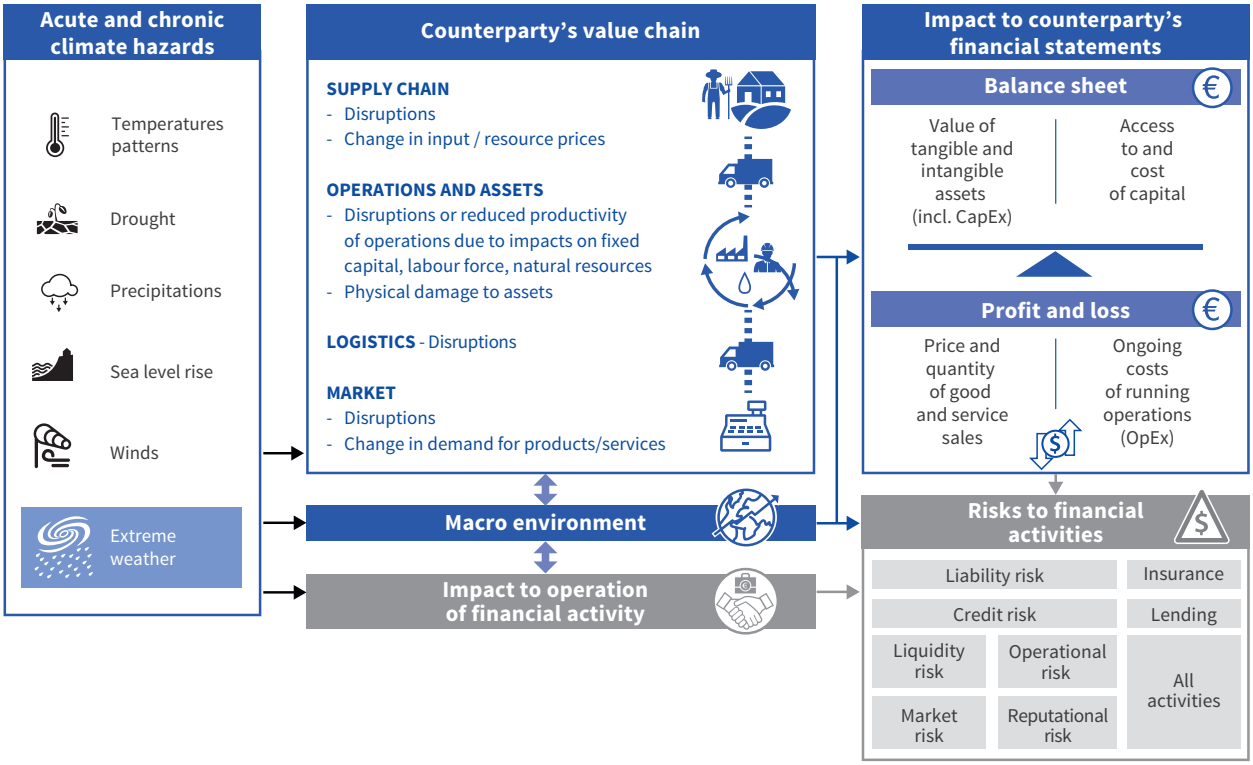
Environmental risks can be effectively integrated into company analysis and investment decision-making processes using various financial tools and models. According to a *G20 Green Finance Study*, financial institutions need to combine two types of approaches to assess environmental risks:

1. understanding environmental factors that may pose risks to financial assets and liabilities (for example, the wrong pricing of a pollution liability or natural disaster insurance policy could be a risk to liability, if the event probability is underestimated), and how such risks may evolve over time; and
2. translating environmental risk factors into quantitative measures of financial risk that can, in turn, inform firms' risk management and investment decisions.[165]

The types of risk analysis tools and associated metrics primarily depend upon the asset classes and risk types financial institutions are exposed to (for instance, a fixed income analyst may be most interested in credit risk). Similarly, the choice of approach depends on the type of direct or indirect exposure to an environmental risk factor. For example, the probability of physical risks from flooding will have to be incorporated differently than transition risks stemming from the transition to a low-carbon economy due to policy change. Depending on the investment strategy and objectives, different levels of analysis will likely be performed: at the individual asset level, portfolio level, and at the macroeconomic or systemic level.

It is important to analyse the extent to which environmental and climate-related impacts could affect a company's value chain – supply chain, operation and assets, logistics and market – which would have an impact on financial performance.

Figure 3.15: **SYSTEMIC RELATIONSHIP BETWEEN A COMPANY'S VALUE CHAIN AND THE IMPACT ON ITS FINANCIAL PERFORMANCE CAUSED BY CHANGES IN WEATHER CONDITIONS**



Source: Institute For Climate Economics (I4CE).[166]

Levels of environmental analysis

It is important to note that environmental risk assessments are conducted along with social and governance assessments at:

A. company or project level;
B. sector level;
C. country level, or
D. market level.

We will look at each of these in the following sub-sections.

A. Company or project level

At a company or project level, an assessment of material environmental risk factors will inform key financial metrics as monitored and disclosed in financial statements (such as profit and loss and balance sheet). For example, companies operating in water-scarce areas are exposed to higher risk than for those operating in areas where water availability is high. Therefore, it is important to undertake an analysis of how well the company is managing these risks (e.g. improvement in water efficiency over time.)

Often, analysts and portfolio managers will have their own internal environmental (social and governance) scoring system utilising a combination of external third-party data providers and internal analysis. Qualitative and quantitative assessments are then made to determine the materiality of environmental risks to a particular company; and how it will affect key efficiency or profitability ratios which might be used to value and compare across different companies. This could include a decision being made to adjust the target price-to-earning (PE) ratio, which reflects a company's competitiveness in comparison to its peers with higher or lower environmental standards. Cost assumptions can also be adjusted according to future capital expenditure in environmental (mitigation or adaptation) spending.

B. Sector level

Environmental and climate-related factors have varying degrees of impact on different sectors. Some sectors – whether through their higher carbon intensity or location of their assets – have higher exposure to:

- environmental risks such as:
  - chemicals;
  - energy;
  - steel and cement;
  - extractives;
  - food or beverages; and
  - transportation; or
- physical risk from natural disasters, for example, to:
  - buildings; or
  - urban infrastructure.

Companies in these sectors tend to be influenced by an environmental risk premium, which may affect the discount rate used. Hence, alongside the company level analysis above, these sector-wide considerations need to be considered and overlaid on the company analysis. Adjustments are made to remove any regional or sector biases that align with the manager's investment strategy and process.

C. Country level

A country's environmental regulations, emission targets and their enforcement may vary in emphasis across different jurisdictions. Often, investments may be multi-jurisdictional and hence, several country-specific considerations and regulations will need to be factored into the valuation of a company based on the country it is located or where its operations lie. Disclosure and transparency of environmental data will also vary by region – for example, companies in emerging markets tend to have fewer comprehensive disclosures.

Country analysis is relevant not just to corporate securities, but also to government bonds. Climate change, air quality, water stress, vulnerability to natural hazards and food security can have immediate and direct impact on a sovereign's ability or willingness to pay (credit risk), and/or ESG profile. For example, the consistent deterioration in a country's rating scores on food security and high vulnerability to climate change could lead an asset manager to reduce their position despite the bond's scarcity and attractive relative value, but – conversely – they can also hold an overweight position based on a view that starting with a relatively low environmental score is acceptable, when reforms and a green economy push from the government are expected to lead to ESG score improvements.[167]

D. Market level

Recognising the cross-cutting impacts of environmental risks, central banks and the Bank of International Settlements have warned of the potential systemic effects of both physical and transitional risks:

> *"In the worst case scenario, central banks may have to confront a situation where they are called upon by their local constituencies to intervene as climate rescuers of last resort."*[90]

Consideration of such market-wide impacts can influence investors' strategic asset allocation and long-term investment strategy, although research has sounded a note of caution with regards to the limits of some traditional risk mitigation strategies – such as diversification and hedging. In a report titled *Unhedgeable Risk,* the Cambridge Institute for Sustainability Leadership has warned that, in a scenario where investor sentiment changes away from high-carbon sectors, there may not be sufficient available assets – including low-carbon assets – for investors to successfully reallocate capital. It found that around half of the potential decline in the modelled equity and fixed income portfolios is 'unhedgeable', meaning investors and asset owners would be exposed unless some system-wide action is taken to address the risks.[168]

This reaffirms the need for predictable policy measures, which prioritise real-world emissions reductions and an orderly transition to the low-carbon economy. A growing number of investors (such as those under the Climate Action 100+ initiative) are advocating for this.

Analysing environmental risks

It is not possible to outline all the available approaches for investors to assess environmental risks because there is no one common standard. However, based on a combination of independent third-party research and data along with useful frameworks, practitioners are able to map out and analyse the environmental risks and costs across different types of asset classes by company and sector in order to make their own quantitative and qualitative risk assessments. The following outlines some of the approaches that are used by investors to assess material environmental risks (and opportunities):

A. carbon footprinting and other carbon metrics;

B. natural capital approach; and

C. climate scenario analysis.

We will look at each of these approaches in further detail in the following sub-sections.

A. Carbon footprinting and other carbon metrics

Carbon footprinting is one of the most common approaches used by companies and investors. A portfolio carbon footprint effectively measures carbon emissions and intensity associated with operations of the companies in a portfolio. Measuring the carbon footprint of a portfolio means that an investor can:

- compare it to global benchmarks;
- identify priority areas and actions for reducing emissions; and
- track progress in making those reductions.

The use of carbon footprinting applies the international accounting tool of the *GHG Protocol Standards*. While Scopes 1 and 2 cover direct emissions sources (such as the fuel used in company vehicles and purchased electricity), Scope 3 emissions cover all indirect emissions arising from the activities of an organisation. These include emissions from both suppliers and consumers, as shown in **Table 3.4.**

Table 3.4: GHG PROTOCOL STANDARDS – EXAMPLES OF DIRECT AND INDIRECT EMISSIONS

SCOPE 1	SCOPE 2	SCOPE 3
• Fuel combustion. • Company vehicles. • Fugitive emissions .	• Purchased electricity, heat and steam.	• Purchased goods and services. • Business travel. • Employee commuting. • Waste disposal. • Use of sold products. • Transportation and distribution (up- and downstream). • Investments. • Leased assets and franchises.

Source: GHG Protocol standards.[169]

The benefits of carbon footprinting include the potential to aggregate emissions across industries and value chains, for countries and portfolios, enabling comparisons between companies or portfolios, across sectors and geographies, and to focus the analysis on emissions intensity. However, the analysis has its limitations and challenges as a risk measure, and is increasingly seen as too backward-looking or static.

Some of the main challenges of carbon footprinting include:

- the lack of disclosure for unlisted or private assets;
- Scope 3 emissions are rarely being included, thus failing to capture companies' full value chain;
- 'double-counting' (a metallurgical coal miners' Scope 3 emissions can be a steel-makers' Scope 1 emissions);
- the use of different estimation methodologies; and
- it does not measure potential investment risks related to the physical impacts of climate change.

Depending on objectives, carbon footprinting can be an absolute or relative metric. It can be used to assess, for example, the **total carbon emissions** associated with a given investee company or portfolio. This recognises that investments that may be seen to have a disproportionately high contribution to global emissions may have a higher exposure to future policy interventions on carbon emissions.

Equation 3.1: TOTAL CARBON EMISSIONS

Total carbon emissions: $\sum_{n}^{i} \frac{\text{current value of investment}_i}{\text{issuer's market capitalisation}_i} \times \text{issuer's Scope 1 and 2 emissions}_i$

Source: TCFD.[170]

Alternatively, investors may wish to track carbon emissions **intensity** (e.g. emissions scaled in relation to a particular metric such as a company's revenues). The TCFD recommends that asset owners and managers report the weighted average carbon intensity associated with their investments.[170]

Equation 3.2: WEIGHTED CARBON EMISSIONS

Weighted average carbon intensity: $\sum_{n}^{i} \frac{\text{current value of investment}_i}{\text{current portfolio value}} \times \frac{\text{issuer's Scope 1 and 2 emissons}_i}{\text{issuer's US\$m of revenue}_i}$

Source: TCFD.[170]

This can provide a measure of how carbon-efficient companies are, allowing for an element of comparability between companies of different sizes, and recognising that high levels of carbon emissions are not a perfect proxy for high climate risks. A coal-burning power plant and a coal-burning steel plant may have very similar levels of emissions. But renewable energy can much more easily – and, for two-thirds of the world's population, more cheaply[171] – replace the use of coal for generating electricity, whereas cleaner and economic alternatives to coal for steelmaking are not as widespread. As such, the policy focus and future profitability profile of the two plants may look radically different. A useful starting point is to consider companies' announced emissions targets and related environmental ambitions, also in relation to carbon pricing in different climate scenarios.

Net zero/ Science-based targets

As mentioned in **Section 1**, companies are increasingly adopting **net zero targets**. However, there is significant variation among these targets, as they can:

- be absolute or relative targets;
- cover different scopes of emissions (just operational (Scope 1 and 2) or include some or all of the value chain (Scope 3) and different types of emissions (just carbon dioxide or all GHGs);
- focus on differing or multiple timeframes; or
- rely on offsets.

This can make it difficult for investors to accurately measure and benchmark their carbon emission reduction objectives.

One element of standardisation comes from **Science-based targets (SBT)**: targets underpinned by the latest climate science and evaluated by the Science-Based Target initiative (SBTi), a partnership between several environmental institutions, which provides independent certifications of the strength of companies' targets. It has produced decarbonisation guidance in different sectors, including power, apparel and footwear, and information and communication technology, and more recently for the financial sector. Over 1,000 companies have set targets through the SBTi.[172]

Public companies' and their commitments are only one – albeit an important – part of investors' portfolios. Methodologies to assess the environmental profile of private companies, sub- and supra-national debt, or other asset classes are still evolving. The UN Principles for Responsible Investment (PRI), UNEP Finance Initiative and the Institutional Investor Group on Climate Change are developing frameworks to help benchmark investors' transition to net zero.[173]

Emissions trajectories

Emissions trajectories can be used to assess the required reductions to reach a stated goal (for example, net zero carbon by 2050) and compare the pathways implied by corporate commitments, policies or individual assets (for example, proposed refurbishments to a building to improve its energy efficiency). For instance, the *Transition Pathway Initiative* is an asset-owner-led collaboration, which has developed a publicly available tool that aims to assess companies' preparedness for the low-carbon transition.[174]

Temperature alignment

Another approach are measures of **temperature alignment**. This seeks to compare the climate profiles of companies, sectors or portfolios against a benchmark of global temperature. As global 'carbon budgets' impose constraints on the amount of emissions that are compatible with maintaining a reasonable chance of global temperatures not exceeding certain levels, this allows a degree of quantification of the implied future temperature levels associated with a company or portfolio. For example, Japan's Government Pension Investment Fund (GPIF), the world's largest pension fund, estimates its portfolio of equities and bonds are aligned with a warming trajectory of around 3°C (5.4°F).[175]

As an illustration, Legal & General Investment Management analysed the emissions intensity trajectory of circa 2000 companies against different climate change scenarios and found that the majority were not aligned with the goals of the Paris Agreement. This raised "concerns that some institutional portfolios may be aligned with temperature outcomes of greater than three degrees (3°C)", leaving them exposed to tightening climate policies.[176]

While intuitively easy to understand the aim of these measures and seemingly easy to compare temperatures, there is significant variation in the market around such metrics. They:

- go under different names (e.g. 'implied temperature rise', 'global warming potential' or 'temperature alignment');
- use different inputs for climate performance (including carbon footprint, share of investments in 'green' technologies, proportion of investee companies with (science-based) emissions targets); and
- result in a different quantification of output – a binary statement (aligned or not), a score, a percentage of misalignment or a temperature number).

Lastly but importantly, different methodologies can offer significantly different alignment results.[177]

Temperature alignment tools

The Paris Agreement Capital Transition Assessment (PACTA) is a public tool developed by 2° Investing Initiative, with backing from the UN PRI, which aims to measure the alignment of financial portfolios with climate scenarios. The analysis incorporates the business and capital expenditure plans of companies for the next five years. The tool compares portfolios to the trajectory required to meet the goals of the Paris Agreement. There are two versions:

one for publicly listed securities (equity and fixed income); and

an open source data and modelling suite for private portfolios (such as bank loan books).[178]

CDP and right. based on science have also developed temperature rating tools.[179,180] However, there is a wide range of analytical products.

Capital expenditures, 'green' revenues and research and development

A different approach looks in more detail at companies' level of **'green' capital expenditures, revenue streams and R&D** to gauge the direction of travel for their business models.

For the oil and gas sector, the Carbon Tracker Initiative have created a framework to assess companies' potential **capital expenditures** on new oil and gas projects, compared against their cost of production, associated emissions and demand levels in different climate scenarios.[181]

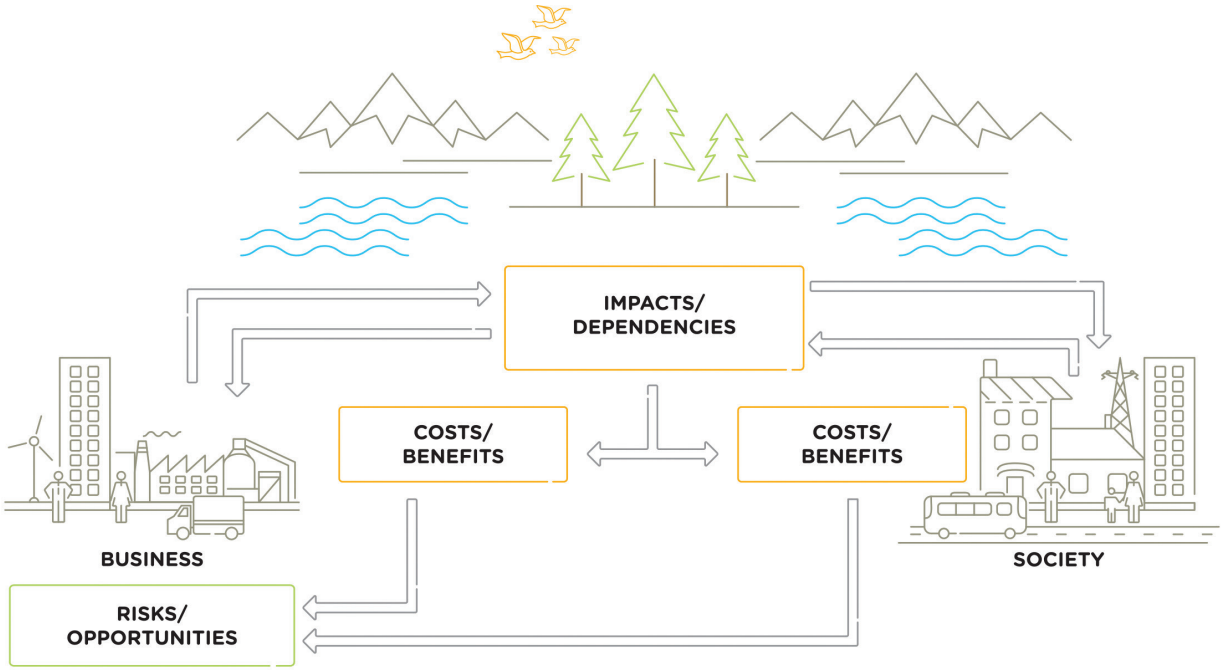
An alternative is to consider **existing revenues**. Data providers including FTSE Russell and HSBC have compiled proprietary databases to assess the sales companies generate from over 100 low-carbon products and services.[182]

Several data providers have constructed methodologies to analyse the **patents** for low-carbon technologies filed by companies. R&D is a potentially useful indicator; however, the mere accumulation of patents need not imply strategic commitment – for example, Kodak engineers invented and patented the digital camera that would eventually render its company's main business obsolete.[183]

B. Natural capital approach

A term often used to describe the relationship between nature and measuring and valuing nature's role in decision-making is **natural capital**. Natural capital helps businesses identify, measure, value and prioritise their impacts and dependencies on biodiversity and the ecosystem, which ultimately give businesses new insight into their risks and opportunities.[184] Understanding the value of both natural capital impacts and dependencies helps business and financial decision-makers assess the significance of these issues to their institution, and therefore make more informed decisions.

Figure 3.16: THE NATURAL CAPITAL APPROACH EXPLAINS THE COMPLEX WAYS IN WHICH NATURAL, SOCIAL AND ECONOMIC SYSTEMS INTERACT, IMPACT AND DEPEND UPON ONE ANOTHER



Source: Capitals Coalition.[184]

Assessing environmental factors using the *Natural Capital Protocol (NCP)*, a decision-making framework, enables organisations to identify, measure and value the direct and indirect impacts and dependencies of companies on natural capital. It currently provides guidance for the apparel sector, food and beverage sector and forest products sector.

The protocol aims to allow companies to measure, value and integrate natural capital impacts and dependencies into existing business processes such as risk mitigation, sourcing, supply chain management and product design.[184]

Recognising the need for increased consideration of natural capital issues by financial decision-makers, an initiative to establish a **Task Force on Nature-related Financial Disclosures (TNFD)** was announced in mid-2020, a collaboration between UN-affiliated institutions, Global Canopy and WWF, supported by financial institutions and governments.[185]

Natural resource risk assessment tools for investors and policymakers

Integrated Biodiversity Assessment Tool (IBAT) for Business, developed by the International Union for Conservation of Nature (IUCN), is a central global biodiversity database, which includes key biodiversity areas and legally protected areas. Through an interactive mapping tool, decision-makers can easily access and use this up-to-date information to identify biodiversity risks and opportunities within a project boundary.[186]

Enabling a Natural Capital Approach (ENCA) is a policy tool and guidance developed by the UK Department for Environment, Food & Rural Affairs.[187]

CERES and WWF have developed water risk assessment tools, targeted at investors, lenders and policymakers:

- *CERES Aqua Gauge: A Comprehensive Assessment Tool for Evaluating Corporate Management or Water Risk.* Developed by CERES and CDP.[188]
- *WWF Water Risk Filter.*[189]

C. Climate scenario analysis

Scenario analysis is an approach for the forward-looking assessment of risks and opportunities. Scenario analysis describes a process of evaluating how an organisation, sector, country or portfolio might perform in different future states, in order to understand its key drivers and possible outcomes.

Climate-related risk has been identified as one of the most complex macro-existential risks, which is least understood and hardest to quantify. The TCFD recommends that companies and financial institutions:

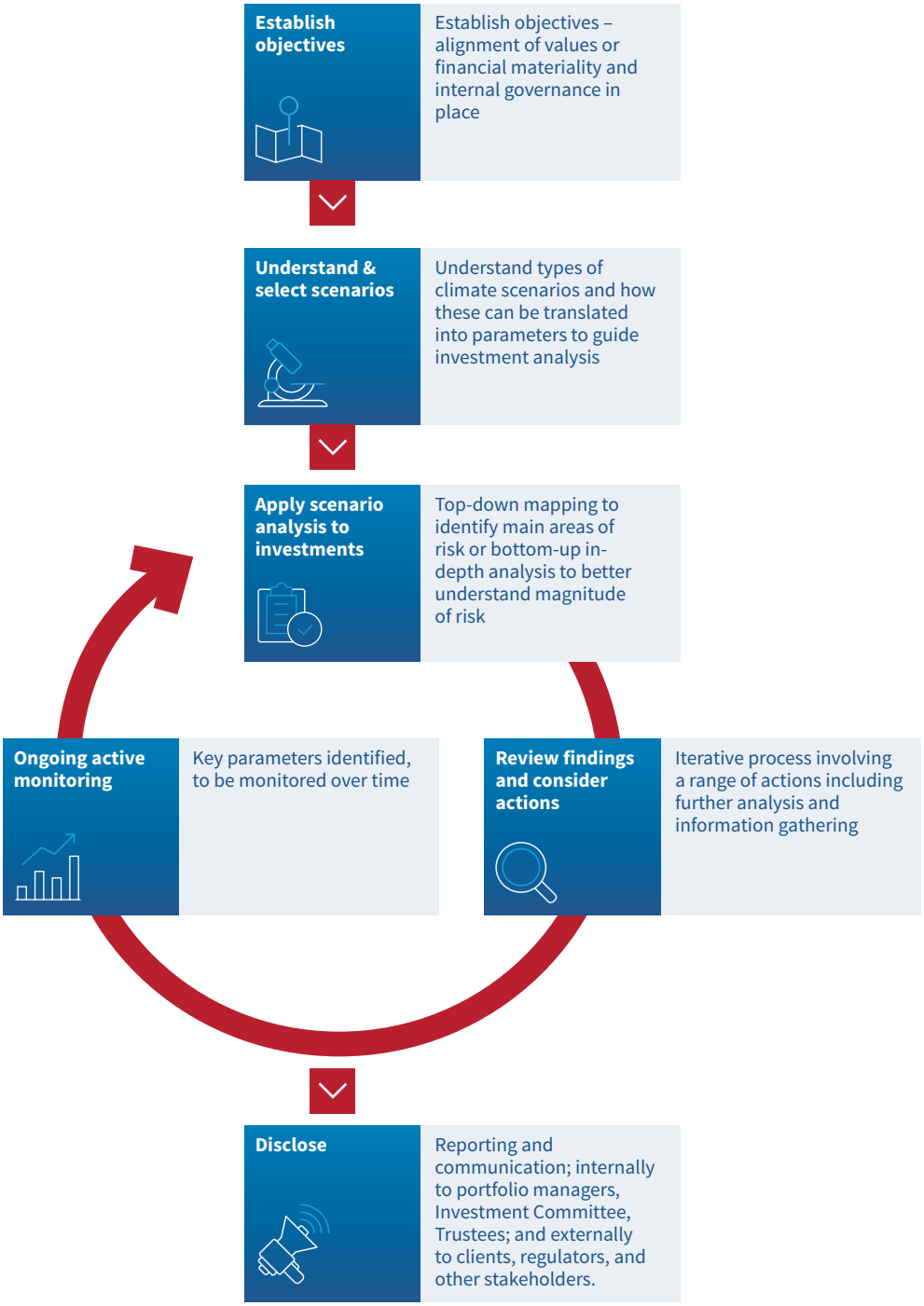
> *"Describe the resilience of the organisation's strategy, taking into consideration different climate-related scenarios, including a 2°C (3.6°F) or lower scenario and, where relevant to the organisation, scenarios consistent with increased physical climate-related risks."*[190]

In the current landscape, there is no common set of scenario analysis methodology used by investors. Instead, the types of approaches and models will depend largely on the objectives and scope of the work.

The **Institutional Investors Group on Climate Change (IIGCC)** published a practical investor guide, which provides a useful framework (see **Figure 3.17**) in which to approach climate-related scenario analysis.[191] The guide sets out two objectives of undertaking scenario analysis:

1. **Financial impact**: the use of scenario analysis enables the assessment and pricing of climate-related risks and opportunities.
2. **Alignment**: aligning the portfolio(s) with a 2°C (3.6°F) or lower future. This is typically driven by a set of investment beliefs.

Figure 3.17: INVESTOR FRAMEWORK FOR CLIMATE-RELATED SCENARIO ANALYSIS



Source: IIGCC.[191]

At the over-arching level, however, there is no 'one size fits all' methodology that investors can use to determine materiality and they consequently use financial modelling and concepts, such as financial ratio analysis. The EU's NFRD (covered in **Section 3**), which helps analysts and investors to evaluate the non-financial performance of large companies, sums up the most effective and recommended approach. This involves:

- taking a set of transparent and credible data sources and assumptions, which can be quantitative or qualitative;

- applying recognisable, accepted methodologies, which will probably have the backing of an industry body, government department or multilateral institution;
- focusing on materiality – looking in particular at business models, operations and financial performance; and
- generating a set of outputs which can be measured in terms of key performance indicators.[192]

In order for the financial system to achieve a better appreciation of climate change risks (and opportunities), there is a need for more data, greater disclosure, better analytical toolkits, advanced scenario analysis and new risk management techniques.[84]

6 APPLY MATERIAL ENVIRONMENTAL FACTORS TO FINANCIAL MODELLING, RATIO ANALYSIS AND RISK ASSESSMENT

3.1.7	Apply material environmental factors to financial modelling, ratio analysis and risk assessment.

The following case study is based on a WWF and *Cadmus survey* (2018) of more than 20 infrastructure investors and related stakeholders and looks at how investors evaluate the sustainability of infrastructure assets. It can, however, be adapted for evaluating individual companies.

It demonstrates how and where to integrate the results of a comprehensive ESG assessment as input into the key financial ratios and variables of a financial model – such as the forecasting of revenues, operating costs and capital expenditures which form the basis of discounted cash flow (DCF) analysis.

Note that this example focuses only on the environmental impacts. In reality, the social and governance factors need to be considered in parallel for a full ESG materiality assessment.

Case study

ESG review – environmental factors and materiality

Over the lifetime of an infrastructure project – from development to construction, to operation, and all the way through to the decommissioning phase – infrastructure assets face all kinds of ESG issues. These vary depending on asset type, sector, size, geographic location and stage in the life cycle.

Some of the environmental issues may originate outside the asset but could impact its technical ability to operate or impact its profitability (for instance, temperature rise and increased water scarcity). Other issues may be caused by the asset itself and impact its surrounding environment and communities (such as water effluence and the quality of life of the communities around it). In this latter case, these are called 'externalities', which can (and will) increasingly impact the asset's financial performance via various feedback loops (including protests of the surrounding community). It is thus important to realise that both directions of potential environmental impact (impact ON the asset, and impact FROM the asset) may have financial consequences for the investors.

For the purpose of arriving at a shortlist of environmental factors for which the potential impact of environmental risk on infrastructure financials can be demonstrated, a two-step process was followed:

1. A longlist of widely recognised environmental factors was derived. The longlist was reduced to a shortlist of environmental factors that are typically among those considered key to an environmental assessment in the context of infrastructure.

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Case study

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2. If, and to what extent, any of the selected environmental factors has a material impact on the infrastructure asset will be revealed by the asset-specific ESG due diligence process.

Environmental factors material to infrastructure projects:

TYPICAL ENVIRONMENTAL FACTORS	MATERIAL ENVIRONMENTAL FACTORS FOR INFRASTRUCTURE
Degradation and pollution • Air (climate) – GHG emissions. • Air (health) – other pollution. • Water. • Ground or contamination. • Noise and light. • Biodiversity.	**A) Quantifiable** Degradation and pollution 1. Air (health) & water pollution 2. Air (climate) – GHG emissions *Resource efficiency – sourcing, use, treatment* 3. Energy (E) 4. Water (E) 5. Solid waste (E) 6. (Raw) Materials and supply chain (E/S)
Resource efficiency sourcing, use or treatment: • (Raw) materials including supply chain. • Energy. • Water. • Waste.	**B) Difficult-to-quantify** 7. Biodiversity and habitat (E) 8. Physical climate change impacts (E)
Physical risk – impact on asset, such as flooding.	

Approach to assess the implications of environmental risk on financial ratios and models

The approach utilised in this case study, which uses surveys input across a range of infrastructure project simplifies the TCFD classification of risks introduced in **Section 3**, on the one hand, whilst broadening it to ESG, not just climate, themes.

The following table helps to show how the selected environmental factors may impact the financial performance of infrastructure organisations. It elaborates on the potential impact pathways from the selected environmental factors to specific financial ratios or inputs into financial models.

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Case study

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ENVIRONMENTAL FACTOR	RISKS CONSIDERED	FINANCIAL RATIO OR FACTOR IMPACT	IMPACT OF THE RISK
Air pollution or water pollution	Tightening regulations	Asset write-off / capital expenditure (CapEx)	Write-offs, asset impairment or early retirement of existing assets may result from the tightening of regulation.
		Provisions	Provisions may be needed to cover potential fines in case of non-compliance with new regulations. They may also need to be made for potential lawsuits or other legal proceedings.
	Costs for obtaining relevant permit increase	Operating expenditure (OpEx)	The overall production cost will increase due to an additional discharge cost.
	Imposition of new environmental tax	Tax	Taxes will increase.
	Enhanced disclosure requirements	OpEx	Monitoring, reporting and auditing costs will increase.
	Reputational	Provisions	Reputational damage may lead to loss of revenues.
		Financing costs	Additional interest paid due to higher interest rate or lower credit rating.
GHG emissions	Client demand for lower-carbon products and services (e.g. cleaner electricity in the case of a utility company).	Revenues	Decrease in revenues from high-carbon activities.
	Introduction or increase of price for GHG emissions, implementation of a carbon tax, loss of subsidies for high GHG-intensity energy sources.	OpEx/Tax/CapEx	Production cost increases (OpEx, Tax). Preventive investment (CapEx) in measures of technology to reduce GHG emissions per unit of output or to reduce energy intensity of processes.

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Case study

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ENVIRONMENTAL FACTOR	RISKS CONSIDERED	FINANCIAL RATIO OR FACTOR IMPACT	IMPACT OF THE RISK
Energy	Physical: rising temperatures	OpEx	Higher temperatures may influence the functioning of equipment and lead to an increase of fuel consumption or lower performance levels (OpEx).
Water	Physical: increased water scarcity	Revenue/OpEx	Insufficient supply for water-reliant assets, such as hydro-power plants or district heating networks, leads to loss of revenues due to loss of energy production (hydro-power plant), or increase of operating costs because of the rise in water prices.
	Reputational: conflicts with the surrounding community on water withdrawal	Revenues/ provisions/OpEx	Conflicts with community may lead to project delays which in turn may lead to loss of revenues or fines for late completion. Increase of operating expenses due to additional community engagement and marketing measures.
	Regulatory: implementation of more stringent regulation regarding water withdrawal	CapEx /OpEx	Investments in water-saving measures may become necessary but may reduce water usage going forward. Implementation of new production processes, which substitute water with more expensive resources leads to higher OpEx.
Solid waste	Regulatory: Tightened regulation on waste disposal and land restoration	Provisions	Potentially stricter regulation for waste disposal, recycling or land restoration during the decommissioning phase.
(Raw) materials supply chain	Reputational: Environmental, social or governance issues may be found in the supply chain	Provisions	Dealing with reputational issues is time-consuming and costly and provisions may need to be made to cover for such cases.

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Case study

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ENVIRONMENTAL FACTOR	RISKS CONSIDERED	FINANCIAL RATIO OR FACTOR IMPACT	IMPACT OF THE RISK
Biodiversity and habitat	Regulatory/ legal: tightening of regulations or other operating requirements regarding the protection of critical species or habitats	Revenues/CapEx/ OpEx	Potential operating restrictions on certain days of the year or on certain times of the day leading to a reduction in sales (revenues). Investments into alterations to existing structures, such as implementation of sound curtains for offshore wind turbines, may be necessary. Adherence to stipulations may lead to increased monitoring and reporting cost.
Climate change impacts (E)	Physical: extreme weather (storms and floods) can lead to disruptions	Revenues	Periodic loss of energy production (windfarms) due to shutdown.
	Physical: extreme weather may destroy the asset partially or fully.	Asset book value/ revenues/CapEx/ OpEx	A write-down or write-off of the assets and a loss of revenues may be the immediate result. Investments will be needed to repair or even rebuild the damaged asset. If the probability of extreme weather increases, the probability of damage or destruction increases, therefore insurance policies are likely to increase.

Source: Adapted from WWF and B Capital AG guidance note.[193]

7 OPPORTUNITIES RELATING TO CLIMATE CHANGE AND ENVIRONMENTAL ISSUES

3.1.8 Explain how companies and the investment industry can benefit from opportunities relating to climate change and environmental issues: circular economy; clean and technological innovation; green and ESG-related products; blue economy.

Previous sections have covered the risks of neglecting the implications of key environmental factors from companies as a result of direct and/or indirect business activities. The increased awareness of climate change and environmental impact has resulted in an accelerating search for viable societal and economic solutions to enable a transition to a less carbon intensive economy. Estimates for this transition reach trillions of dollars and the magnitude of change required will be pervasive, across all aspects of life as we understand it today.

A study by the Global Commission on the Economy and Climate found that the world is expected to invest about US$90tn (£64.7tn) in infrastructure over the next 15 years, requiring an urgent shift to ensure that this capital is spent on low-carbon, energy-efficient projects. The report further describes that "transformative change is needed now in how we build our cities, produce and use energy, transport people and goods, and manage our landscapes".[194] It is therefore no surprise that there is an increasing number of investment strategies that focus primarily on the opportunities of the low-carbon transition and green finance. Investing in sectors such as technology and resource efficiency, waste management, circular economy and sustainable agriculture and forestry are just some of the investment opportunities available relating to climate change and environmental issues.

Already, the investment opportunities are becoming visible – FTSE Russell estimate the green economy (the total market capitalisation of the companies generating revenues from activities providing environmental benefits) in 2020 is 'equivalent to 5% of the total listed equity market. It has grown faster than the overall equity market since 2009 and is estimated to have overtaken the size of the oil and gas sector'.[195]

This section provides an overview of some of these opportunities as they relate to:

A. the circular economy;
B. clean and technological innovation;
C. green and ESG-related products; and
D. the blue economy.

It also highlights how clean technology and innovation will play a critical role and investment opportunity in mitigating and adapting to the impacts of climate change and environmental degradation. This section also covers some of the financial products most prevalent in supporting environmental (green) considerations in investments.

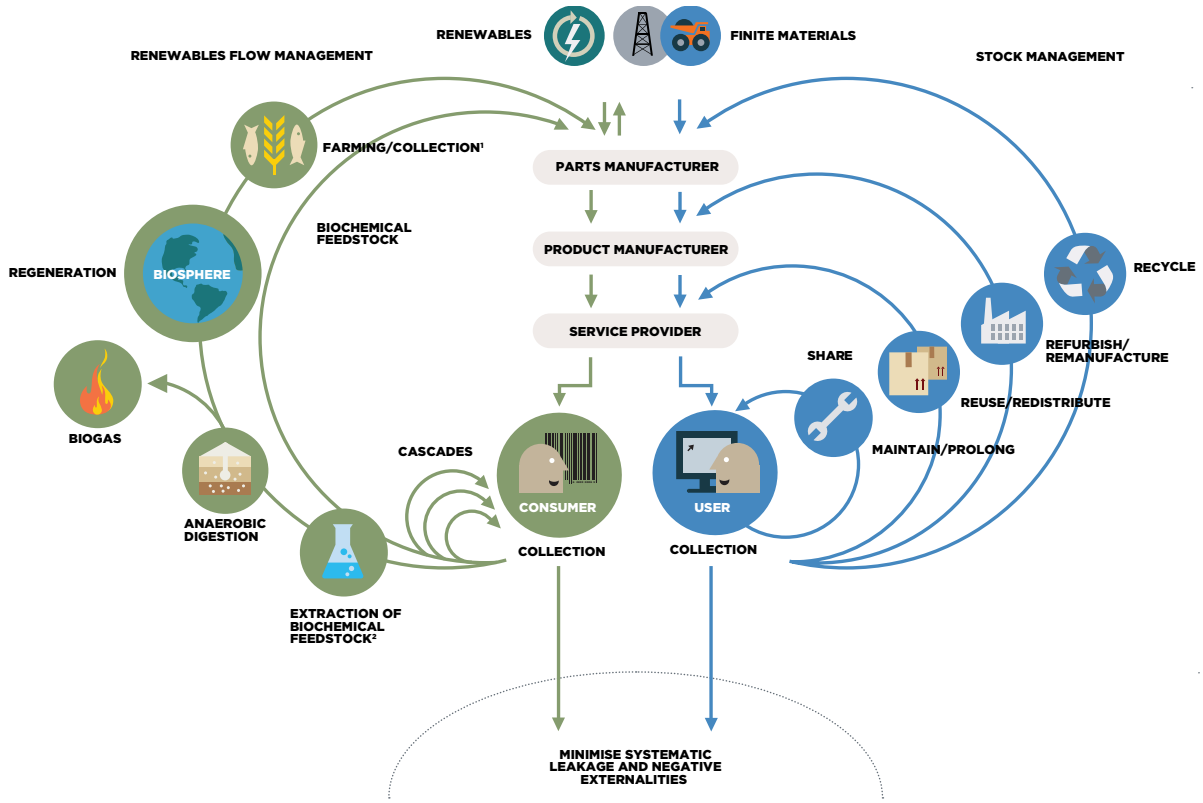
A. Circular economy

With only a fraction of material inputs being currently recycled (less than 12% in the EU in 2019, for example),[196] there are significant investment opportunities from innovations to encourage a shift towards a **circular economy**. This shift is already underway: by September 2020, assets managed through public equity funds with the circular economy as their sole or partial focus were estimated to have increased sixfold compared to the beginning of the year, from US$0.3bn to US$2bn (£0.2bn to £1.4bn), with the number of such funds almost doubling.[197]

Companies that factor in circularity in their business model are able to play a major role in safeguarding natural resources and transform the way we currently use natural resources and support a transition to a low-carbon economy (see **Figure 3.18**).

In a circular economy, products and materials are repaired, reused and recycled rather than thrown away, ensuring that waste from one industrial process becomes a valued input into another. The circular economy concept is now a core component of both the EU's *2050 Long-Term Strategy* to achieve a climate-neutral Europe and of China's five-year plans.

Figure 3.18: CIRCULAR ECONOMY SYSTEM



Source: Ellen MacArthur Foundation.[198]

Due to the expanding market of investible opportunities, both in the private and public markets, companies are working to bring circularity closer to the heart of their business models.

Case studies

Jurong Island

Singapore's Jurong Island is one of the world's top 10 chemical parks. The close proximity of industries on the island "provides an ecosystem where one company's product can become the feedstock of another. For example, waste from some companies is burnt to generate steam for industrial use. Similarly, wastewater is recovered and recycled for industrial use."[199] Industrial developer JTC Corporation is partnering with local companies and regulators to explore further avenues for circularity, by mapping water, energy and waste flows.

Heineken

As part of their Zero Waste Programme, 102 of their 165 production units sent zero waste to landfill in 2018. The waste from these sites was instead recycled into animal feed, material loops, compost or used for energy recovery.[200]

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Case studies

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Schneider Electric

The company specialises in energy management and automation. It uses recycled content and recyclable materials in its products, prolongs product lifespan through leasing and pay-per-use and has introduced take-back schemes into its supply chain. Circular activities now account for 12% of its revenues and will save 100,000 metric tons of primary resources between 2018–2020.[201]

Stora Enso

The company provides renewable solutions in packaging, biomaterials, wooden constructions and paper. Reducing waste operates at the heart of the "bioeconomy and contributes to a circular economy".[202]

In 2019, the European Investment Bank launched an investment fund to support the circular bioeconomy.[203]

Close the Loop

This Australian company works to turn old printer cartridges and soft plastics into roads by mixing them with asphalt and recycled glass, resulting in a road surface that is estimated to be up to 65% more durable than traditional asphalt. For a kilometre of road, the equivalent of 530,000 plastic bags, 168,000 glass bottles and the waste toner from 12,500 printer cartridges is used.[204]

B. Clean and technological innovation

Technological innovation and the development of new business ventures associated with the environment have been around for some time. However, the term **cleantech** as an umbrella term "encompassing the investment asset class, technology, and business sectors which include clean energy, environmental, and sustainable or green, products and services" became increasingly popular approximately 20 years ago.[205]

As with many other technological innovations – such as the Internet or GPS – state support and a favourable policy and regulatory environment have been instrumental in driving the early growth of technologies, such as wind and solar energy. However, as the technologies have matured, unsubsidised solar and wind have become the cheapest source of new electricity in most regions around the world; it is cheaper to build new wind and solar capacity than to operate 60% of the operating coal power plants in 2020.[206]

As a result, there is increased interest from private investors into this area. Over the past seven years – a period of intense digitalisation and research into automation – it has been estimated that venture capital investment into cleantech grew three times faster than similar investments into artificial intelligence.[207]

In the following, we discuss some of the technologies that can play a role in decarbonising sectors, which contribute substantially to global emissions.

Energy as the 'prime mover' of the economy, reducing the emissions associated with energy production has knock-on effects across all sectors. The production of low-carbon **electricity** has been at the forefront of these developments, from sources such as solar photovoltaics, onshore and offshore wind, hydroelectricity, nuclear energy, tidal and geothermal energy. Fuels derived from biomass (e.g. 'biofuels' such as bioethanol) may also be considered as a renewable energy source – although this depends on the sustainability of the source, with significant debates around the environmental impacts of large-scale biofuel cultivation.[208]

Albeit very important, electricity is only one component of energy. The challenge is harder when it comes to decarbonising **heat and cooling**. For residential and commercial properties, ground and air source heat pumps, combined heat and power (CHP), as well as district heating are some of the potential heating solutions. More difficult is the decarbonisation of high-temperature processes. The use of renewable energy

to produce hydrogen – which can burn at high temperatures – is increasingly the focus of governments' and investors' strategies, although the deployment of supportive hydrogen infrastructure is currently lacking. Other speculative technologies include research into nuclear fusion, and next-generation battery storage.

The electrification of **industrial processes** – from clean sources – is an essential lever for the decarbonisation of industry. In steel-making – which has a substantial carbon footprint – the use of electric arc furnaces coupled with increased steel recycling and alternative reductants (e.g. hydrogen or gas instead of coal) are important avenues. In the chemicals industry, the use of green hydrogen, synthetic fuels, new catalysts and alternative feedstocks (including use of biogenic materials), as well as the development of lightweight materials and plastic alternatives, can contribute.

The **buildings** sector contributes up to 40% of total GHGs as a result of the whole life carbon of the building – the embodied carbon and the carbon associated with operation (energy used to heat, cool and light). Embodied carbon is associated with the construction materials, the building process, the fixtures and fittings inside, as well as from deconstruction and disposal at the end of its lifetime.

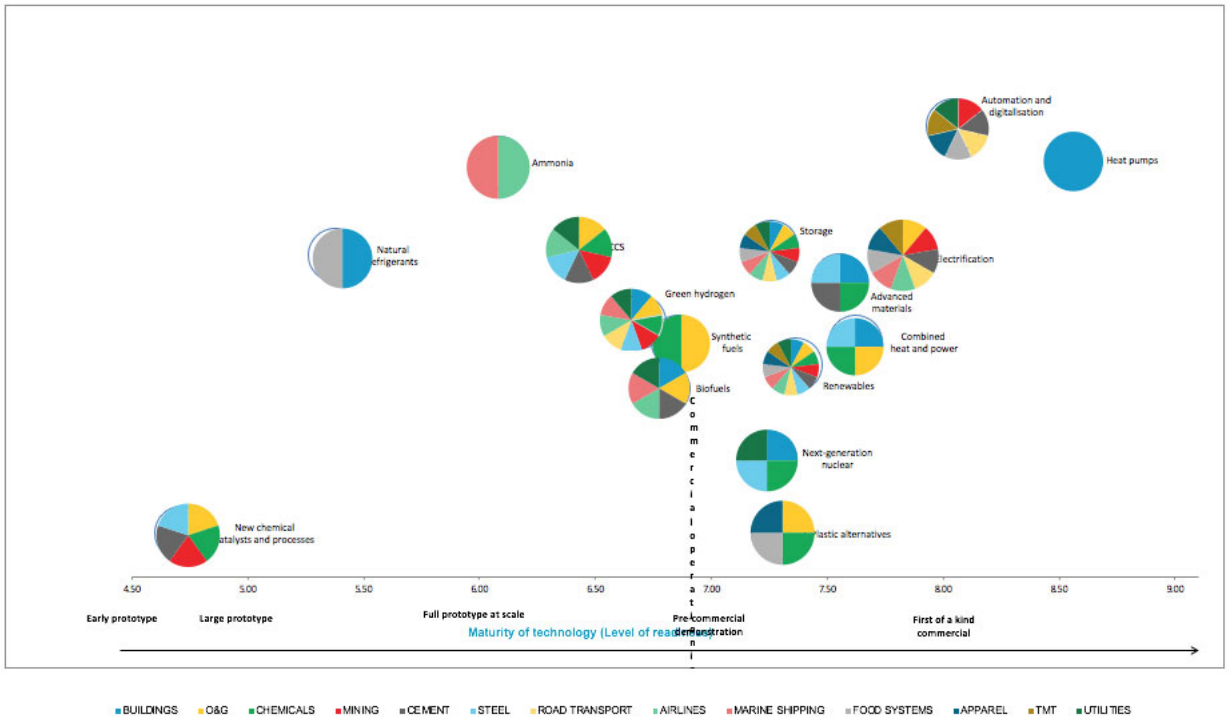
In terms of technology drivers in this sector, CO_2 is an inevitable by-product of the chemical reaction used to create the most widely used form of cement. Developing alternatives to 'clinkers' (one of cement's major components) will play a key role. Several large cement producers have already begun to develop breakthrough technologies in producing cement with lower emissions and higher energy efficiency.

In the **transport** industry, many of the world's large automobile makers have begun to shift their business models towards battery electric vehicles (BEVs), with global sales of electric cars rising by 43% in 2020.[209] The extent to which batteries and electrification will play a substantial role in the decarbonisation of heavy-duty transport, or whether other fuel sources (such as ammonia, hydrogen fuel cells or biofuels) may be used to power trucks, planes and ships – remains an open question, and subject to intense research and investment.

Given the substantial emissions associated with food production, packaging and consumption, innovation will be needed in the **food** industry. The development of protein alternatives (whether plant-based or laboratory-grown meat, for example) is a fast growing market. Further innovation in agricultural techniques – e.g. around precision and regenerative agriculture or the development of less toxic fertilisers – will also be needed.

Given the interdependencies in the global economic system, it is often the case, as illustrated in **Figure 3.19**, that technologies have the potential to be used across multiple sectors.

Figure 3.19: CLEAN ENERGY TECHNOLOGIES' LEVEL OF READINESSAND APPLICABILITY ACROSS DIFFERENT SECTORS.



Abbreviations:
O&G = oil and gas;
CCS = carbon capture and storage;
TMT = technology, media and telecommunications.

Source: LGIM, International Energy Agency.[210]

As noted earlier, the development of cleantech often works in tandem with standard-setting by governments. One notable example of this is in the case of our built environment.

Case studies

Environmental standards in real estate

The real estate sector is currently undergoing significant change, with major property developers and managers stepping up their sustainability practices in their role to tackle climate change.

In the UK, the Better Buildings Partnership (BBP), a coalition of some of the largest commercial property owners, have committed to achieving net zero carbon by 2050. This is a bold ambition and one which will require significant changes in the current practices throughout the life cycle of a building. The BBP believes that the UK energy efficiency standard and regulations, which are intended to achieve better energy performance, are actually not 'fit-for-purpose' and will certainly not support the BBP's net zero carbon goal. These standards are focused on design intent rather than on how a building actually performs in-use, hence creating a 'performance gap'.

As such, the BBP have embarked on an initiative, *Design for Performance (DfP)*, which is based on the *National Australian Built Environmental Rating System (NABERS)* that measures and rates the operational efficiency of its commercial offices. NABERS has proven to be very successful as it focuses on target ratings, outcomes and transparency, and so, they recently published the *NABERS UK Guide to Design for Performance* aimed at the UK market.

In the near future, we can expect to see other governments that have made commitments to achieve carbon neutrality by 2050 start to strengthen their existing energy performance standards and regulations in the real estate sector, and adopt best practice approaches such as this.[211]

According to Bloomberg New Energy Finance (BNEF), in 2020, total investment in the low-carbon energy transition worldwide was US$501bn (£360bn), with China as the largest investor, followed by the USA.[212] The largest area of funding in 2020 was renewable energy, followed by electrified transport and heat.

There has also been increasing activity in corporate venturing and investments by incumbent fossil-fuel based corporations into clean and renewable technologies. These private sector efforts have been complemented by greater supra-national and public sector support, for example the European Institute of Innovation and Technology (EIT) **InnoEnergy**, which was established to invest in and accelerate sustainable energy innovations. Another initiative, still in concept phase is the World Economic Forum's **Sustainable Energy Innovation Fund (SEIF)**, which matches up private funding with public investment.

C. Green and ESG-related products

The risks and opportunities associated with environmental sustainability and mitigating climate change necessitates a re-alignment of financial products and services in order to facilitate the transition to a low-carbon economy. There have been several developments in this area, along with expectations for rapid expansion of the breadth and depth of these green products and services, over the next few years.

Some specific financial products that have emerged include:

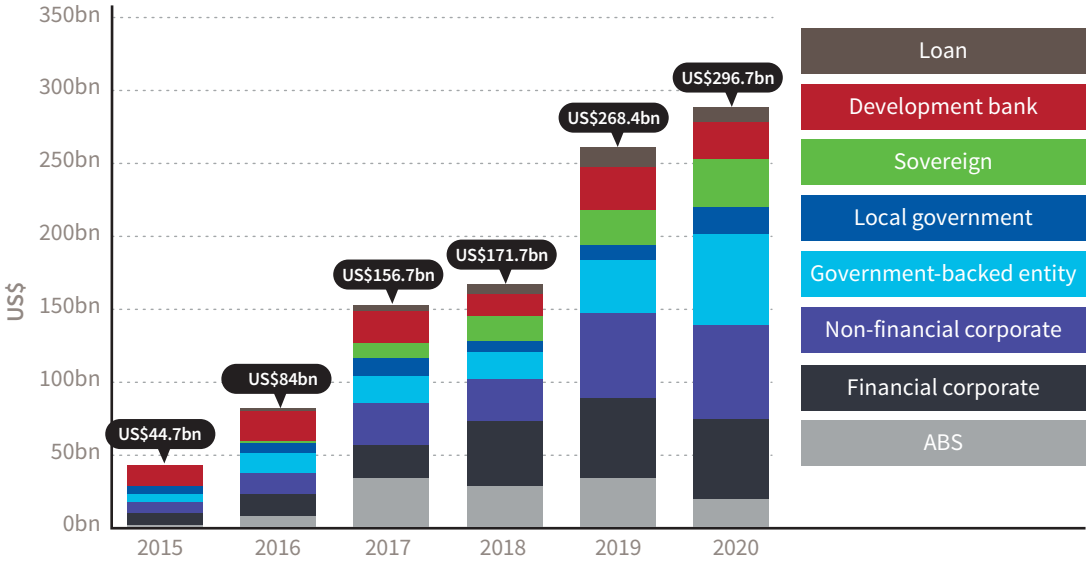
- a range of green, sustainability and ESG indices;
- green bonds and loans, sustainability funds and ETFs;
- retail and institutional deposit or savings products; and
- crowdfunding investments.[213]

Green bonds, loans and other labelled ESG-related products

The first green bond issuance was announced in 2007 by the European Investment Bank to raise funding for climate-related projects. Green bonds were created to fund projects that have positive environmental and/or climate benefits. The majority are green 'use of proceeds' or asset-linked bonds (**Figure 3.20**).

Green bond issuances by banks and corporates have accelerated in recent years, with total cumulative issuance surpassing the US$1tn (£0.7tn) mark in late 2020.[214] From around US$44.5bn (£32bn) in 2015, annual issuance has risen five-fold in 2019/20.

Figure 3.20: GREEN BOND AND GREEN LOAN ISSUANCE VOLUME, 2015 TO 2020

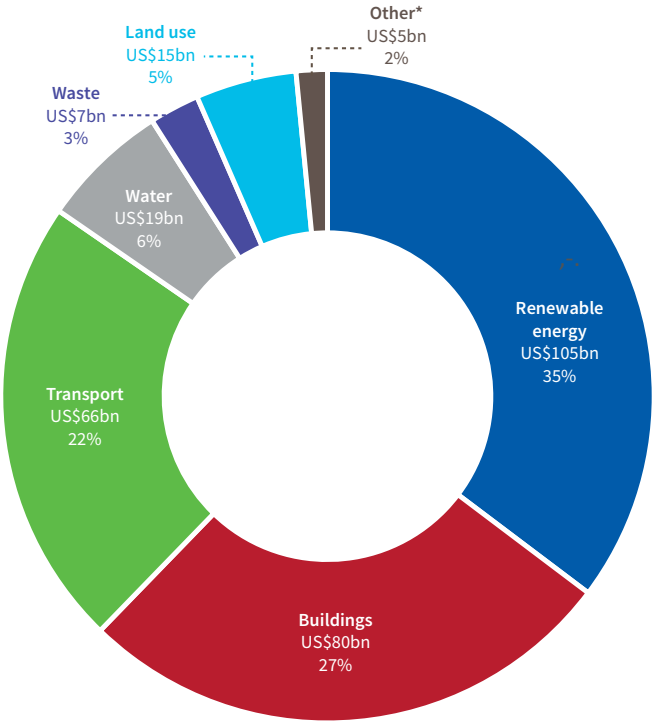


Note: Data is up to the end of 2020, as of 27 April 2021. All debt instruments have been screened in accordance with the Climate Bonds Green Bond Database Methodology[215] and Social & Sustainability Bond Database Methodology.[216] Definitions of green are derived from the Climate Bonds Taxonomy,[217] and issuer type classification follows Climate Bonds convention.

Source: Climate Bonds Initiative (2021).[218]

While clean energy and low-carbon building investment continues to dominate allocations, funding for low-carbon transport has increased dramatically and issuers from the information and communications technology (ICT) and manufacturing sectors have entered the green bond market.

Figure 3.21: USE OF GREEN BOND AND LOANS PROCEEDS 2020



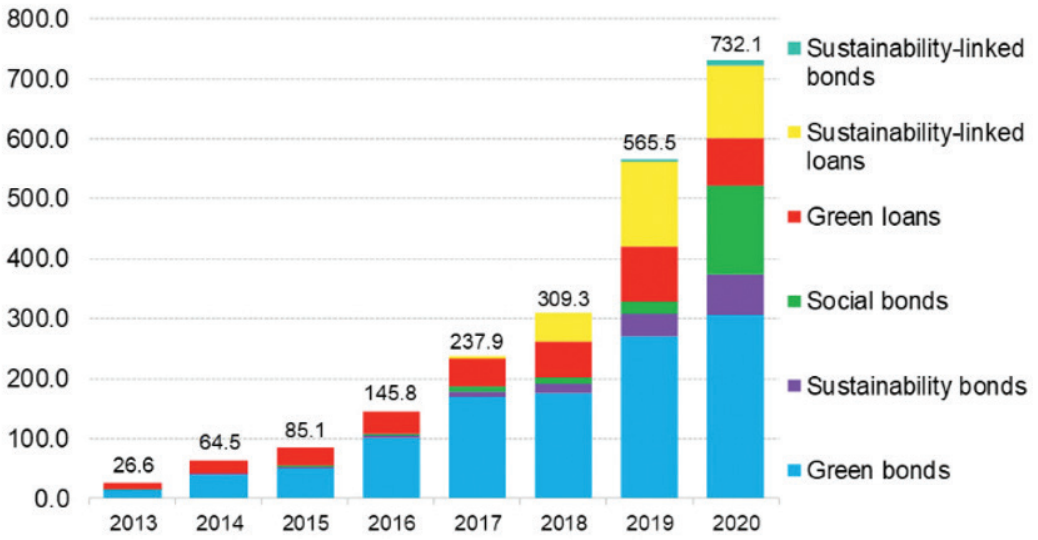
* Other includes industry (US$0.9bn, 0.3%), ICT (US$1.4bn, 0.5%) and adaptation and resilience financing not allocated to sectors (US$2.2bn, 0.7%).

Note: Data is up to the end of 2020, as of 27 April 2021. All debt instruments have been screened in accordance with the Climate Bonds Green Bond Database Methodology[215] and Social & Sustainability Bond Database Methodology.[216] Definitions of green are derived from the Climate Bonds Taxonomy,[217] and issuer type classification follows Climate Bonds convention.

Source: Climate Bonds Initiative (2020).[218]

In addition to green bonds, which focus closely on climate-change solutions, there has been increased issuance in other labelled debt, primarily green and sustainability loans, where the financing terms are linked to climate or environmental performance indicators (for example, investors may receive an increase in the bond's coupon if the company fails to meet certain targets).

Figure 3.22: GLOBAL SUSTAINABLE DEBT ISSUANCE, 2013 TO 2020 (US$BN)



Source: Bloomberg New Energy Finance.[219]

Table 3.5 shows examples of such transactions, ranging from green bonds to sustainability or SDG-linked bonds and loans.

Table 3.5: EXAMPLES OF SUSTAINABLE FINANCING TRANSACTIONS

ISSUER AND TYPE	USE OF PROCEEDS
Green bond issued by Louisiana Local Government Environmental Facilities and Community Development Authority (2018)	Coastal flood defenses.
Dutch sovereign green bond (2019)	Flood protection under its Delta Programme.
First dedicated resilience bond under the *Climate Resilience Principles* by European Bank for Reconstruction and Development (EBRD) (2019)[220]	Climate resilient infrastructure in Eastern Europe and North Africa.
Chile's sovereign green bond (2019 and 2020)	The first issue in 2019 was focused on financing solar, low carbon transport, low carbon building upgrades and water infrastructure. The 2020 issue was focused primarily on low carbon transport.
Rizal Commercial Banking Corporation (RCBC), one of the Philippines' largest banks, issued the first ASEAN sustainability bond (2019)[221]	RCBC applied its *Sustainability Finance Framework*, which includes seven eligible green categories (energy, buildings, transport, urban and industrial energy efficiency, waste, water and land use) and five eligible social categories (affordable basic infrastructure, access to essential services, employment generation, affordable housing and socioeconomic advancement and empowerment).

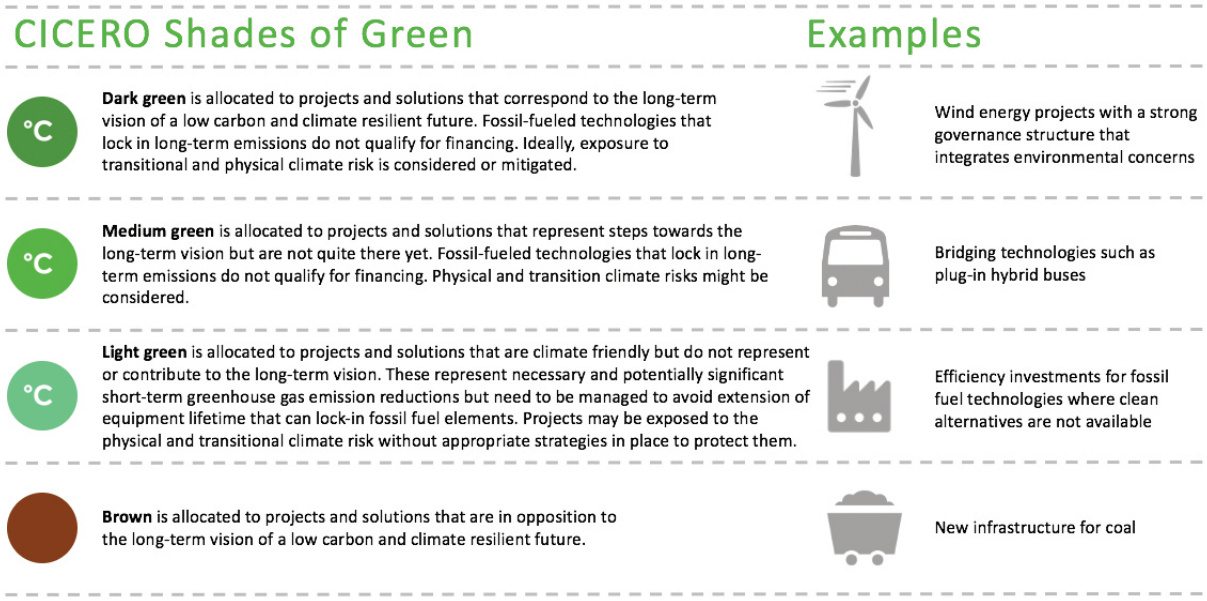
ISSUER AND TYPE	USE OF PROCEEDS
First SDG-linked bond, launched by the Italian energy producer Enel (2019)	Proceeds aimed at general corporate purposes. However, the new instrument requires Enel to measure its performance against several environmental and social KPIs, to which the coupon will be dependent.
First SDG-linked sovereign bond, launched by the government of Mexico[222]	Eligible categories need to meet two criteria: • geospatial (prioritising location of vulnerable populations); and • governance (involvement of a UN organisation).
Seychelles launching the world's first sovereign 'blue bond'[223]	Proceeds used to help finance the island's transition to sustainable fisheries and marine protection.
Starbucks issued a sustainability bond (2019), following its previous issues in 2016 and 2017	Eligible categories fall under socioeconomic advancement and empowerment and access to essential services and under green (green buildings).
Thames Water became the UK's first corporate to issue a £1.4bn sustainability linked revolving credit facility (2018)[224]	Interest payments are linked to its Global Real Estate Sustainability Benchmark (GRESB) infrastructure score.
Solvay, a Belgium chemical company issued a sustainability linked loan[225]	Linked to an ambitious GHG reduction target – in this case one million tonnes of CO_2 by 2025.
Luxembourg was the first European country to launch its own *Sustainability Bond Framework*, in line with the European taxonomy for green financing (2020)[226]	Combination of EU green projects and sustainability projects.

From an investment perspective, as the supply of green or ESG-related products continues to grow, it is important to note that what may be considered to be green or sustainable for one investor may not be so for another. Therefore, investors need to have a clear framework by which to assess these assets. The following are some of the considerations:

- the eligibility of assets and criteria to meeting their green, ESG or SDG-related objectives;
- the use of proceeds effectively allocated to eligible projects;
- the transparency and reporting requirements and key measures of impacts; and
- the issuer or borrower has a clear sustainability and ESG strategy.

Figure 3.23 shows an example of the 'shades of green' methodology developed by the Center for International Climate Research (CICERO) to provide second party opinions that determine how a green or sustainability bond aligns with a low-carbon resilient future.

Figure 3.23 : EXAMPLE OF THE 'SHADES OF GREEN'



Source: CICERO.[227]

At the intersection of 'brown' and 'green' in **Figure 3.23**, the term 'transition bonds' has been coined for bonds issued by high-emission companies to finance their reduction in GHG emissions. Some of these products finance measures that may not be considered 'green enough', but still aim to address climate change.

There will continue to be a proliferation of 'green' financial products in the marketplace. The important consideration to note is that the quality and transparency of environmental and climate-related data and disclosure will need to improve in order to avoid 'greenwashing'. Efforts by the EU to harmonise and create a common language will be a significant development for green financial products.

Case study

What is 'green'?

The International Capital Markets Association (ICMA) sets out voluntary guidelines called the **Green Bond Principles (GBP)**, which were established in 2014 by a consortium of investment banks to promote the integrity of the green bond market by recommending transparency, disclosure and reporting.[228] As part of ensuring the integrity of the use of proceeds, external review is obtained through a second party opinion provider who will track and report on whether proceeds are used as promised.

The **Climate Bonds Initiative** has regular information about the state of the green bond market. The Climate Bonds Taxonomy and sector-specific criteria have been scientifically developed to meet the object of the Paris Agreement of keeping global warming under 2°C (3.6°F), and the range of sector criteria keeps expanding. More recently, the NGO has started focusing on transition and published a framework for delineating green and transition finance.[229]

In 2018, the **Green Loan Principles (GLP)** were established by the UK and Asia Pacific Loan Market Association (APLMA). The four pillars of the GLP are:

1. There is clear green use of loan proceeds.
2. The project's sustainability objectives have been clearly evaluated and communicated to lenders.
3. Loan proceeds are strictly managed through project accounts.

cont'd. ..

Case study

...

4. Detailed and strict reporting is mandated.[230]

Further to the GLP, in 2019, the UK, APLMA and the US Loan Syndications and Trading Association launched the **Sustainability-linked Loan Principles (SLLP)**.[231]

In addition to labelled debt, green and sustainable finance includes debt from companies that operate in such sectors. Climate Bonds Initiative's **Bonds and Climate Change: State of the Market 2018** provides information on the scale of the unlabelled climate bond market relative to the green bond market.[232] Climate-aligned issuers are entities that generate 75% or more of their revenues from green business lines. According to Climate Bonds Initiative, as of 30 September 2020, the aligned outstanding bond volume from climate aligned issuers was US$913bn (£656bn), up from US$811bn (£583bn) as of 30 June 2018.[v] LGX, the Luxembourg Green Exchange, launched a climate-aligned issuer segment to complement its existing green bond, sustainability and social bond segment.[233]

D. Blue economy

The World Bank defines **blue economy** as the "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem".[234] All other definitions of the term essentially relate to a broader perspective on sustainable economic and social activity associated with the world's oceans and coastal areas.

Examples of ocean-based industries representing the blue economy are shown in **Table 3.6**.

Table 3.6: EXAMPLES OF OCEAN-BASED INDUSTRIES REPRESENTING THE BLUE ECONOMY

• Aquaculture.	• Maritime transport.
• Fisheries.	• Desalination.
• Fish processing industry.	• Blue bioeconomy and biotechnology.
• Ports and warehousing.	• Coastal and environmental protection.
• Shipbuilding and repair.	• Offshore wind energy.
• Coastal tourism.	• Ocean energy.
• Marine extraction.	• Deep water source cooling.

The blue economy has more recently begun to gather more attention and has climbed the policy agenda. As covered in the previous section on oceans as a natural resource, it is clear that the ocean is already under stress from over-exploitation, pollution, declining biodiversity and climate change.

Investors and policymakers are now beginning to recognise:

- the growth prospects for the ocean economy;
- its capacity for future employment creation and innovation; and
- its role in addressing global challenges.[235]

v 2020 data provided by Climate Bonds Initiative in response to a data request by CFA UK.

There is growing scope for science and technology to manage the economic development of our seas and ocean responsibly. Marine ecosystems lie at the heart of many of the world's global challenges, providing food and medicines, new sources of clean energy and natural cooling systems, climate regulation, job creation and inclusive growth. But safeguards are required to improve the health of these ecosystems to support an ever-growing use of marine resources. As we have seen in the section on biodiversity, the issue of accounting for natural capital remains a promising, but underdeveloped area; this is also true in the case of the blue economy. The World Ocean Initiative has suggested the inclusion of **ocean accounting** – adding ocean-related services and assets – to national balance sheets.[236]

Based on a study by OECD, three priority areas for action are presented:

1. approaches that produce win–win outcomes for ocean business and the ocean environment across a range of marine and maritime applications;
2. the creation of ocean-economy innovation networks; and
3. initiatives to improve the measurement of the ocean economy via satellite accounts of national accounting systems.

The OECD suggests that many ocean-based industries have the potential to outperform the growth of the global economy as a whole, both in terms of value added and employment. Projections suggest that the ocean economy could more than double its contribution to global value added to over US$3tn (£2.2tn), in addition to huge potential in employment growth by 2030.

Case study

Blue Economy Development Framework

The World Bank and the European Commission have launched the *Blue Economy Development Framework (BEDF)*, which is a new step in the area of international ocean governance.[237] It helps (developing) coastal states transition to diverse and sustainable blue economies while building resilience to climate change.

The BEDF aims to create a roadmap that assists governments to:

- prepare policy, fiscal, and administrative reforms;
- identify value creation opportunities from blue economy sectors; and
- identify strategic financial investments.

The BEDF intends to help coastal countries and regions to develop evidence-based investment and policy reform plans for its coastal and ocean resources.

KEY FACTS

1. The range of environmental factors that have a material impact on investments are broad and far-reaching. These include, but are not limited to:

   a. climate change;

   b. natural resources (including water, biodiversity, land use and forestry and marine resources); and

   c. pollution, waste and circular economy

2. Driven by the emissions of greenhouse gases (GHGs) into the atmosphere, accelerating climate change carries significant risks to human health, economies and ecosystems. Effective responses will involve a combination of climate mitigation and adaptation measures.

3. The *Paris Agreement* of 2015 was reached to mobilise a global response to the threat of climate change, amid growing concern reported by scientific experts. The agreement's long-term goal is to keep the increase in global average temperature well below 2°C (3.6°F) above pre-industrial levels, and to limit the increase to 1.5°C (2.7°F).

4. Since the Paris Agreement was signed, a global consensus is emerging that reaching net zero carbon dioxide emissions around 2050 is required to turn its goals into reality. Governments, companies and investors are increasingly adopting net zero targets as a result.

5. Putting a price on carbon emissions is seen by many economists as one of the most effective methods of tackling climate change. Carbon markets have steadily grown around the world, but current levels of carbon pricing remain low.

6. Policy-makers and investors must navigate both:

   - the physical risks of climate change (associated with climate inaction); and
   - the transition risks of climate change (associated with climate action).

   Rising carbon costs carry financial risks of their own, as they can affect the value of high-carbon assets, with potential knock-on effects across sectors. This reinforces the need for an orderly and just transition to the low-carbon economy.

7. Environmental degradation, the depletion of natural resources and the associated losses in biodiversity are presenting multiple, interrelated challenges for both governments and businesses. Issues such as water scarcity, deforestation and unsustainable agricultural practices, waste and pollution are increasingly impacting business and investment activities. To help alleviate some of these pressures, the model of the circular economy promotes a more efficient use of raw materials, coupled with increased reuse, recycling and waste management.

8. Material environmental issues are factors that could have a significant impact – both positive and negative – on a company's business model and value drivers, such as operating and capital expenditure, revenue growth, margins and risk. The material factors differ from one sector to another.

9. Environmental risks can be effectively integrated into company analysis and investment decision-making processes, using various financial tools and models. The types of risk analysis tools and associated metrics primarily depend upon the asset classes and risk types financial institutions are exposed to. Similarly, the choice of approach depends on the type of direct and/or indirect exposure to an environmental risk factor. Investors have developed a combination of metrics, from carbon footprinting to forward-looking climate scenario analysis.

10. There is an increasing number of policy initiatives at both country and regional level to promote the economic and financial mainstreaming of climate change and environmental factors, in jurisdictions across the world. Requirements for climate-related disclosures (both mandatory and voluntary) are increasing across different parts of the entire investment chain, from the owners of capital (pension funds and insurance companies) through to the beneficiaries (investee companies).

11. Coupled with regulatory tailwinds, technological innovation is giving rise to increasing investment opportunities from the provision of climate and environmental solutions, in areas including clean energy and mobility, sustainable buildings and advanced materials. There is a growing number of specialised investment products – including low-carbon (active and index) funds, sustainability-linked debt and others – that aim to capture this opportunity set.

CHAPTER 3

SELF-ASSESSMENT

These self-assessment questions are provided only to enable you to test your understanding of the chapter content. They are not indicative of the types and standard of questions you may see in the examination.

Questions

1. In relation to shadow carbon pricing, which of the following is incorrect?

(a) Shadow carbon pricing is used to understand the potential impact of external prices on the profitability of a project.

(b) Shadow carbon pricing is used to reduce a business's carbon footprint.

(c) Shadow carbon pricing is used to reveal hidden risks and to factor these into future valuations and estimates of capital expenditure.

(d) Shadow carbon pricing is used to create a theoretical cost per tonne of carbon emissions by establishing a business's internal price on carbon.

2. Which of the following would be considered a climate change adaptation strategy?

(a) Releasing sunlight-reflecting aerosols into the atmosphere to reduce temperatures.

(b) Retrofitting buildings to become more energy efficient.

(c) Developing clean cooling systems.

(d) Protecting coastlines from erosion.

3. What is "natural capital"?

(a) Natural resources (such as oil, gas or timber), which can be sold for a profit in a capitalist economy.

(b) The stock of natural assets, which include geology, soil, air, water and all living things.

(c) An international collaboration to increase the proportion of natural spaces in capital cities.

(d) The sum-total of monetary benefits that are directly dependent on nature.

4. Scope 3 of the GHG Protocol standards covers which of the following emission sources?

(a) Company vehicles.

(b) Company facilities.

(c) Purchased electricity.

(d) Purchased goods and services.

5. Which of the following is not a Task Force on Climate-related Financial Disclosures (TCFD) core element of climate-related disclosures?

(a) Governance.

(b) Impact.

(c) Risk management.

(d) Strategy.

6. Which of the following is not an explicit UN Sustainable Development Goal (SDG)?

(a) Ending poverty in all its forms everywhere.

(b) Access to affordable, clean nuclear energy.

(c) Ensuring healthy lives and promoting well being for all ages.

(d) Taking urgent action to combat climate change and its impacts.

7. Which of the following is not an example of a proposed planetary boundary?

(a) Freshwater use.

(b) Loss of coral reefs.

(c) Ocean acidification.

(d) Stratospheric ozone depletion.

8. Which of the following represents a transition risk?

(a) Policy change to encourage low carbon technologies.

(b) Occurrence of extreme weather events.

(c) Break downs in business supply chains.

(d) Long term rises in global temperatures.

9. What is the most common method of waste management globally?

(a) Recycling.

(b) Incineration.

(c) Landfill.

(d) Treatment.

10. Which of the following best describes the principles of a circular economy?

(a) Extracting natural resources for products that are then used and eventually discarded.

(b) Designing out waste and pollution, keeping materials in use and regenerating natural systems.

(c) Ensuring that all products are returned to the manufacturers to reuse component parts.

(d) Producing goods only for consumption by customers in the manufacturer's domestic market.

11. Which of the following is not a requirement for a bond or a loan to be considered 'green' under frameworks such as the Green Bond Principles (GBP) or Green Loan Principles (GLP)?

(a) A description of the environmental benefits associated with the use of proceeds.

(b) Minimum of 10 tonnes of certified emissions reductions per every US$1 (£0.7) of debt.

(c) A clear process for the evaluation and selection of eligible projects.

(d) Detailed and regular reporting.

12. The long term goal of the Paris Agreement (2015) is to keep the increase in the global average temperature above pre-industrial levels to well below what level?

(a) 1.0°C (1.8°F).

(b) 1.5°C (2.7°F).

(c) 2.0°C (3.6°F).

(d) 2.5°C (4.5°F).

13. For a reasonable chance of limiting global average temperature rise to 1.5°C (2.7°F), the Intergovernmental Panel on Climate Change (IPCC) recommends that global emissions of CO_2 must reach 'net zero' around:

(a) 2050.

(b) 2030.

(c) 2100.

(d) 2075.

14. What is the blue economy?

(a) Industrial activities which generate pollution of oceans and inland waterways.

(b) The global network of shipping which transports people and manufactured goods.

(c) Products and processes used to clean up water based environmental pollution.

(d) Sustainable economic and social activity related to oceans and coastal areas.

15. What is the primary objective of the EU Taxonomy?

(a) Clear labelling of the use of proceeds for green bonds.

(b) An EU-wide classification system of sustainable activities.

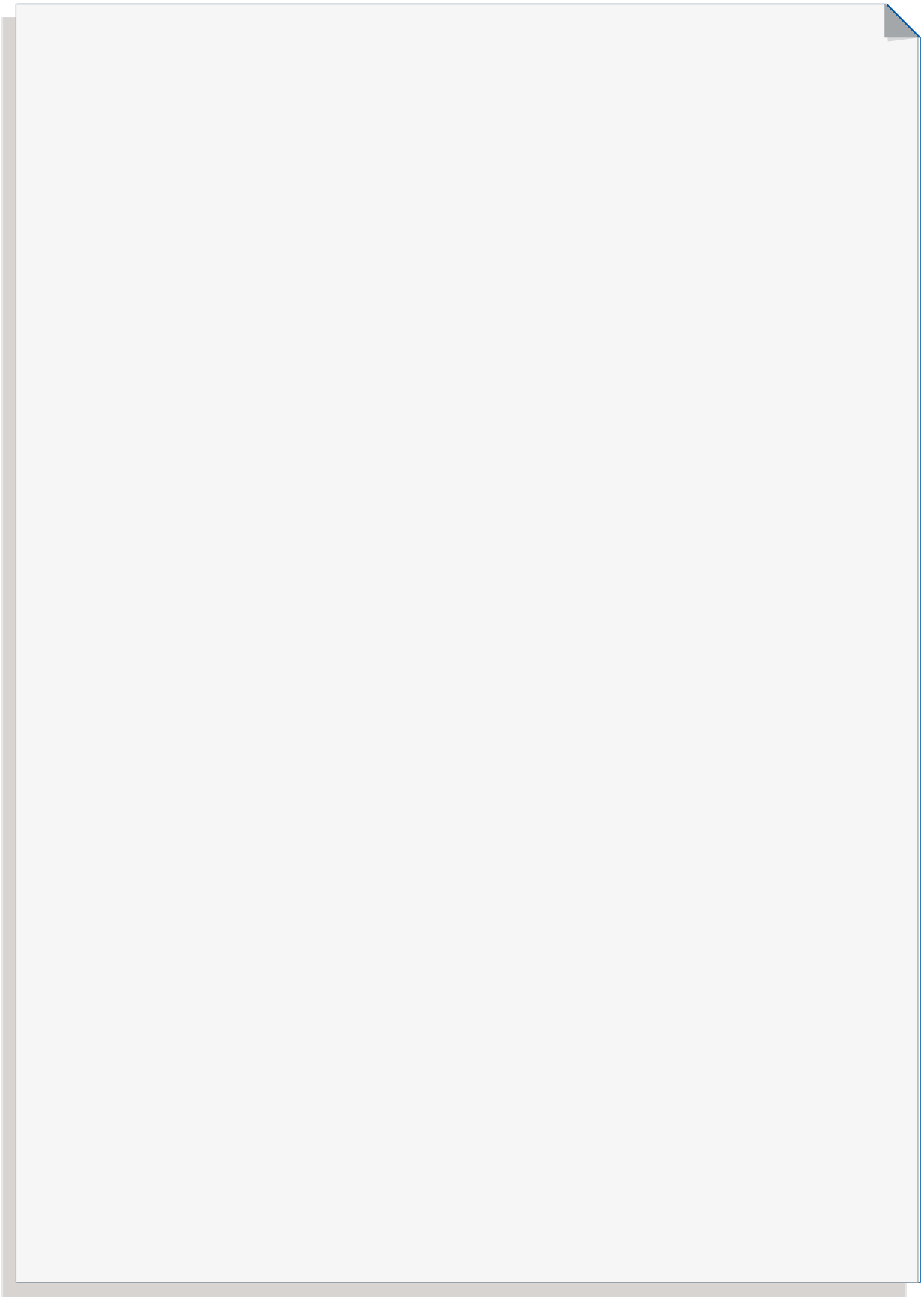
(c) A classification of what 'green' activities states can finance domestically without breaching competition rules.

(d) A classification system of the Scope 1, 2, and 3 emissions associated with the activities of EU companies.

CHAPTER 3

SELF-ASSESSMENT **ANSWERS**

1. **b.**
2. **d.**
3. **b.**
4. **d.**
5. **b.**
6. **b.**
7. **b.**
8. **a.**
9. **c.**
10. **b.**
11. **b.**
12. **c.**
13. **a.**
14. **d.**
15. **b.**



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