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Aviva's Climate-Related Financial Disclosure 2019

| Retirement | Investments | Insurance | Health |

Foreword

Climate change and extreme weather trends have been recognised as key risks facing the insurance, savings and investment industry and many regard the climate crisis as the greatest risk currently facing humanity. Aviva believes that unmitigated climate-related risks present a systemic threat to societal and financial stability over the coming decades. As Maurice Tulloch our Group Chief Executive Officer has said *"The planet does not have time for excuses. Investors have a central role to play in moving the world to a low carbon future ... The cost of doing nothing is far greater than any costs incurred by taking action."*

Our responsibility as leaders is to ensure we understand the fast-changing world around us and we are taking actions today to identify, measure, manage, monitor and report climate-related risks and opportunities. We are eager to help build a long-term sustainable future for our customers and investors and we believe that our actions will contribute to climate risk mitigation. Aviva is an asset owner with assets under management to the value of £510bn, an insurer with IFRS gross written premiums of £31.2bn, and Aviva Investors has assets under management of £346bn.

Aviva is committed to supporting a low carbon economy that will improve the resilience of our economy, society and the financial system in line with the 2015 Paris Agreement target on climate change. We have already invested £6bn in green assets since 2015 (£3.8bn in low carbon infrastructure, £2.2bn in green and sustainable bonds). We welcome and fully endorse the recommendations of the Financial Stability Board's Taskforce on Climate-related Financial Disclosures (TCFD) and the increased regulatory focus on climate change from the Prudential Regulation Authority, Financial Conduct Authority, European Insurance and Occupational Pensions Authority and the Network for Greening the Financial System.

Aviva is working collaboratively with the United Nations Environment Programme Finance Initiative (UNEP FI), industry associations, sector peers, academics, professional bodies, external consultancies, regulators and international agencies, including the Net Zero Asset Owner Alliance, to build robust, comprehensive and effective tools and approaches. These will enable the potential business impacts of climate-related risks and opportunities to be assessed and promote more informed understanding of climate-related risks and opportunities by investors, lenders, insurance underwriters and others.

Matt Saker,
Group Chief Actuary

Kirsty Cooper,
Group General Counsel
and Company Secretary

UNEP FINANCE INITIATIVE

Background

Aviva provides 33 million customers around the world with insurance, savings and investment products. For our customers and our business, addressing climate change and supporting the transition to a low carbon future represents the largest combined health, life, liability and general insurance contract that the world could sign-up to. The risks and uncertainty resulting from us not doing so are immense. Aviva has reported on climate change in our Annual Report and Accounts since 2004.

This disclosure sets out how Aviva incorporates climate-related risks and opportunities into governance, strategy, risk management, metrics and targets (in line with the recommendations of the TCFD, published in June 2017) and how we are responding to new regulatory requirements. It builds on the summary Climate-related Financial Disclosure in the 2019 Annual Report and Accounts. These pages and our climate dashboard are available at www.aviva.com/TCFD.

The ways in which the insurance sector could be affected by the climate crisis[1] are diverse. This disclosure focuses on the transition, physical and litigation risk factors and related opportunities. These were described in the Prudential Regulation Authority (PRA) 2015 report "The impact of climate change on the UK insurance sector" and are defined by Aviva as follows:

- **Transition** risks and opportunities relate to the business impact resulting from the transition to a low carbon economy. This may entail extensive policy, legal, technology, and market changes designed to mitigate climate change. As a result, depending on the nature, speed and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organisations.
- **Physical** risks and opportunities relate to the business impact arising from acute, abrupt, disruptive impacts such as more frequent and intensive storms, extreme heat and cold, floods, droughts and fires, as well as chronic gradual impacts such as higher than average temperatures, rises in sea level and the spread of vector-borne diseases. The risk includes the effects directly resulting from events, such as damage to property, and those that may arise indirectly through subsequent events, such as disruption of global supply chains or resource scarcity.
- **Litigation** risks relate to the business impact that could arise from parties who have suffered loss and damage from climate change and seek to recover losses from others who they believe may have been responsible. Where such claims are successful, those parties against whom the claims are made may seek to pass on some or all of the cost to insurance firms under third-party contracts.

The materiality and horizons over which climate-related risks and opportunities affect our business depend on the specific insurance products, geographies and investments being considered. For example, our general insurance business considers risks in the underwriting and pricing processes and setting the reinsurance strategy based on a relatively short time horizon (one to three years). Aviva recognises that the increased severity and frequency of weather-related losses have the potential to negatively affect our profitability. Consequently, large catastrophic losses are already explicitly considered in our economic capital modelling to ensure resilience to such catastrophic scenarios.

In contrast, when developing our new product strategy and updating Aviva's overall business plan, the impact of these risks and opportunities should be considered over a medium time horizon (three to five years). With respect to life and pensions, in areas such as setting premium rates and reserves for annuities in payment as well as our investment strategy to back those liabilities, the impact of these risks and opportunities needs to be considered over a much longer time horizon (five years plus).

In general, transition risk is likely to materialise more rapidly than the most extreme physical impacts from climate change. Aviva can mitigate the transition risk and grasp opportunities by investing in the transition to a low carbon economy. Sectors or subsectors particularly exposed to transition risk are closely monitored and the risk to Aviva's individual company level investments is analysed. Conversely, the most extreme physical risks present a fundamental threat to the insurance business model. The physical effects of climate change will result in more risks and perils becoming either uninsurable or unaffordable.

It is important to note, however, that many commonly used climate scenarios assume a gradualist path, in which temperatures slowly rise and climate policy is ramped up with a fairly high degree of global coordination. This does not consider the transition risk in a more chaotic policy environment, where there is lack of global coordination and policy action is taken too late and is too sudden. See for example the European Systemic Risk Board Report - Too late, too sudden.

We continue to develop our tools and approaches as well as metrics to assess the potential business impacts of climate-related risks and opportunities over a range of different time horizons. In particular, we are enhancing our Climate Value-at-Risk (Climate VaR) measure. This measure enables the potential business impacts of climate-related risks and opportunities to be assessed taking into consideration different scenarios and assumptions regarding policies, technologies, demand and various other macroeconomic factors as well as extreme weather. This measure looks at the evolution of climate-related risks and opportunities over the next 15 years, but with the ability to consider shorter time periods (three to five years) where appropriate. Aviva was awarded the Climate Risk Initiative of the Year 2020 by InsuranceERM, because the "Climate value-at-risk (VaR) initiative shows the practical benefits that can be achieved when insurers focus resources, time and expertise on climate risk management, as well as collaborating with other knowledge partners".

1 Climate crisis is a term describing global warming and climate change, and their consequences. The term has been used to describe the threat of global warming to the planet, and to urge aggressive climate change mitigation. AIQ: The climate crisis, examines challenges posed by climate change and explores potential solutions.

Aviva invested £717.3m in low carbon infrastructure in 2019, this included £27m in wind turbine projects.
Credit: Unsplash

In 2019 we completed a 'first of its kind in the UK' solar carport installation at our office in Norwich which with the right weather conditions removes our reliance on the national grid's electricity and feeds surplus electricity back into the grid.
Credit: Aviva

Governance

Aviva has built a strong system of governance, with effective and robust controls. The system of governance is proportionate to the nature, scale and complexity of the operations across Aviva businesses. It allows the Board, relevant management committees and senior management to integrate climate-related risks and opportunities into decision-making and business processes.

In 2019, we updated the Senior Management Function's Statements of Responsibilities and developed an implementation plan, in line with the PRA's Supervisory Statement 3/19 "Enhancing bank's and insurers' approaches to managing the financial risks from climate change". As a result, the UK regulated entities' Chief Risk Officers (CROs) are responsible for:

- Ensuring that climate-related risks and opportunities are identified, monitored and managed through Aviva's risk management framework and in-line with our risk appetite.
- Advising the Board on our exposure to the financial risks arising from climate change (including how these risks impact our strategy and business model) and assisting the Board with addressing and overseeing these risks.
- Assisting the Board with developing and maintaining an appropriate approach to disclosure and regulatory reporting of the financial risks from climate change.

In addition, the Group CRO is responsible for:

- Overseeing at a Group level Aviva's approach to the embedding of climate-related risks and opportunities into governance, strategy, risk management and reporting processes.
- Scrutinising (and where necessary, challenging) Aviva's regulated businesses in relation to their management of climate-related risks and opportunities.
- Advising the Plc Board in relation to the above and related corporate and regulatory reporting requirements.

To support the CROs in meeting regulatory expectations, we have initiated a groupwide climate-related risks and opportunities project. The aim of this project is to integrate the assessment of these risks and opportunities into our strategy, decision-making, risk management and reporting frameworks.

In order to support this project, an inter-disciplinary team has been created with representation from across the business. The Group CRO is the executive sponsor of the project supported by a Steering Group. The project is managed day-to-day by a Working Group. An Expert Panel, with internal and external membership, is responsible for reviewing and challenging key expert judgements and outputs from the project. We have updated the relevant Group and UK Board Committees' Terms of Reference to ensure these committees are accountable with respect to potential shifts in the business landscape that may result from climate change. We have also updated our risk policies and the business planning instructions to ensure the assessment of climate-related risks and opportunities is integrated into governance, strategy, decision-making, risk management and reporting.

Aviva's Group Chief Actuary (on behalf of the Group CRO) and the Group General Counsel and Company Secretary are the executive sponsors overseeing this disclosure. Other Group executives and the management teams within our businesses are responsible for managing specific areas of the business which may affect or be affected by climate change.

The Board Risk Committee and the Board Customer Conduct and Reputation Committee (formerly the Board Governance Committee) oversee our management of climate-related risks and opportunities.

Figure 1: Aviva's climate governance structure. Source: Aviva.

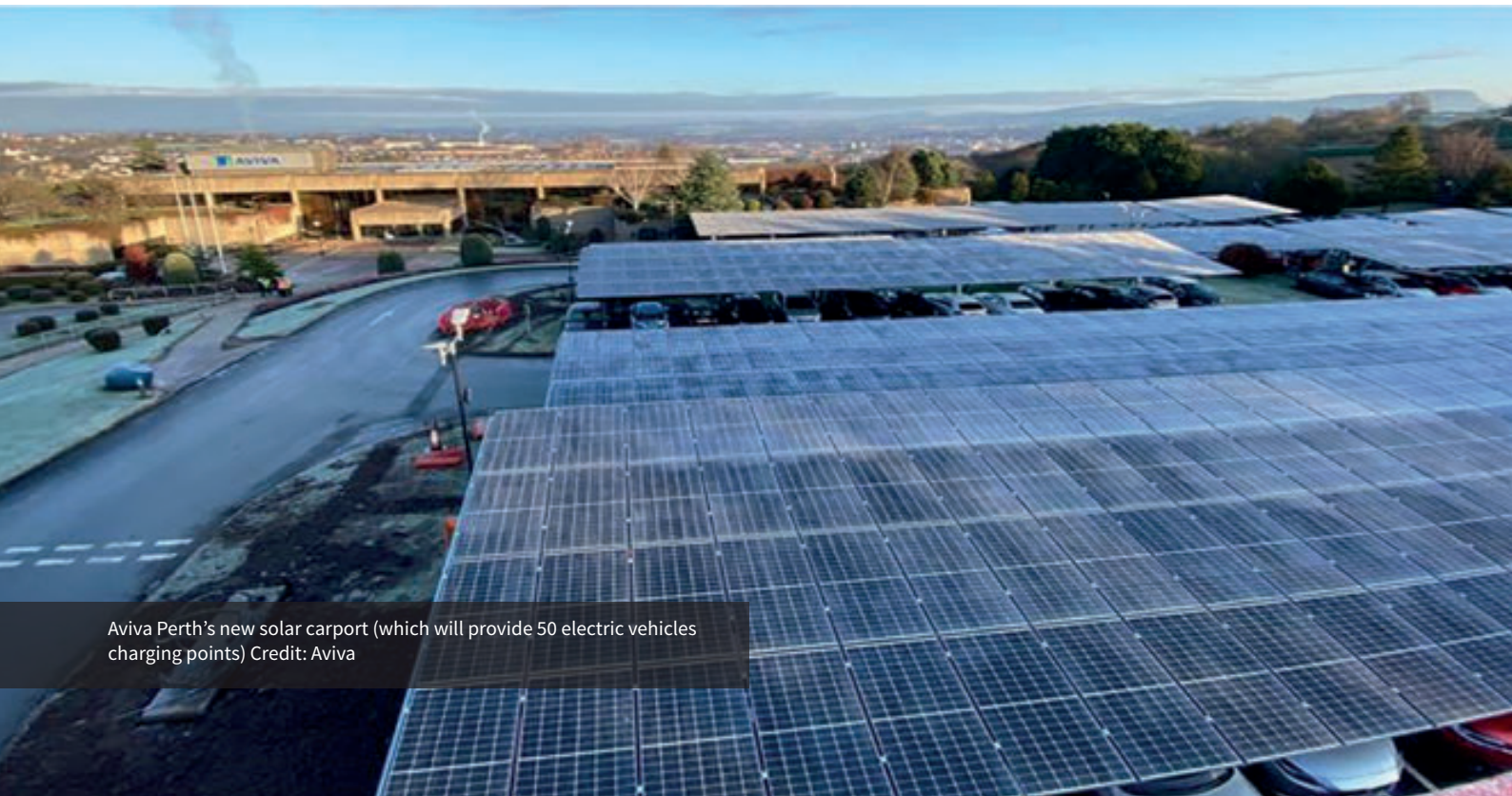
- The Board Risk Committee met six times in 2019 to review, manage and monitor all aspects of risk management and climate-related risks and opportunities were noted in four of those meetings. Climate change is classified as one of the most material long-term risks to our business model and is assessed for its proximity and significance to Aviva as part of our emerging risk processes.
- The Board Governance Committee met four times in 2019 to oversee how Aviva meets its corporate and societal obligations. This includes setting the guidance, direction and policies for Aviva's customer and corporate responsibility agenda, advising the Board and management on the assessment of the Group's exposure to climate-related risks and recommending to the Board management actions to mitigate these risks and grasp opportunities. This committee also approves the Group's Environment and Climate Change Business Standard and ensures alignment with the Group's strategy. This committee has now been replaced by the Board Customer Conduct and Reputation Committee.

The Board Risk Committee and the Board Customer Conduct and Reputation Committee reviewed the summary Climate-related Financial Disclosure in the 2019 Annual Report and Accounts before its approval by the Audit Committee. The Group Chief Actuary and the Group General Counsel and Company Secretary have reviewed and signed-off the content of this report. Our businesses are also taking actions to respond to local regulations (for example Article 173 in France and the PRA's climate change Insurance Stress Test in the UK).

In 2019 papers considering the impact of climate change on our business were presented to Board committees across the Group (for example the outcomes of the PRA's climate change Insurance Stress Test were presented to the UK Life and UK GI Risk committees and the outcomes of the Aviva Investors exploratory climate change stress scenario, to consider the impact of Accelerated Carbon Taxes on Aviva Investors 3-year plan 2020-2022, were presented to the Aviva Investors Holdings Limited Board). At the beginning of 2020, a global climate change paper was presented to the Group Board Risk Committee to highlight the ways in which climate change may affect our business and to invite the Risk Committee's views on the actions taken to date and planned.

As part of our regular Board training programme, during 2020 Aviva's climate-related risks and opportunities will be presented to the Group Board and cascaded to the local Boards as relevant. This training equips the Board to give appropriate direction to the company and ensures actions are taken to identify, measure, manage, monitor and report these risks and opportunities. We are committed to continue developing the skills of our Boards and our people in this area.

Aviva Investors was one of the first large asset managers to integrate Environmental, Social and Governance (ESG) factors as part of the pay criteria across the firm, including for its investment desk heads. Through its Global Reward Framework, all investment employees should support responsible investment and integrate ESG issues into their investment processes. The Global Responsible Investment Team undertakes an annual evaluation of investment professionals on the extent to which they supported ESG integration during the year. The results of the evaluation are subsequently shared with the heads of each investment function as well as with Aviva Investors' Head of Reward, which ensures that commitment to ESG is reflected in remuneration.



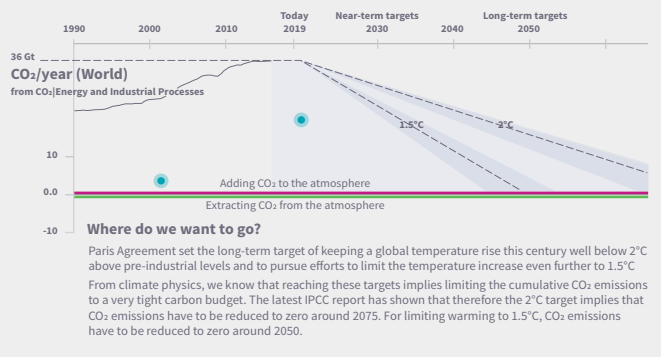
Aviva Perth's new solar carport (which will provide 50 electric vehicles charging points) Credit: Aviva

Strategy

Having achieved the targets set as part of our 2015 strategic response to climate change, this year our climate strategy took another important step forward. We are widening the scope from primarily focusing on investments, to create a broader, joined-up four-pillar approach covering investments, insurance, our operations and our influence. The revision of our strategy is based on the growing consensus that climate-related risks are more pressing and the window of opportunity to avert serious climate change is rapidly shrinking.

The Intergovernmental Panel on Climate Change's (IPCC) 1.5°C report highlights that if the Paris 1.5°C target is to be met, then "global net anthropogenic CO_2 emissions must decline by about 45% from 2010 levels by 2030, reaching net zero by around 2050". This report also indicates that the 2°C target implies that CO_2 emissions have to reduce to zero by around 2075.

Figure 2: Global net anthropogenic CO_2 emissions. Source: IPCC.



Our Climate change strategy

We commit to aligning our business to the 1.5°C Paris Agreement target[2]. We have focused our efforts through pragmatic, commercially smart actions and commit to be a net zero asset owner[3] by 2050. Our businesses will seek to develop and offer further climate-friendly products. We also commit to further cutting our operational carbon impact, as well as using our influence to help tackle climate change. This is aligned to our Company Purpose 'With you today for a better tomorrow'. Our climate change strategy will be implemented as part of the Group Business Strategy. It will be iterative and will be reviewed every two years, with the first formal review in 2022. This will ensure we are on target as well as able to take corrective action, accommodate new scientific thinking and data, and incorporate further findings from our TCFD work.

Investments

There are three ways in which Aviva is involved in investments i.e. as an asset owner, a long-term savings and pensions provider and as an asset manager.

As an asset owner, we are the decision maker about where the investment is made. We seek to align our investments with a pathway towards net zero carbon emissions and ensure consistency with the Paris Agreement target. We have signed up to key global commitments such as the Powering Past Coal Alliance Finance Principles in 2019[4] and the UN Net Zero Asset Owner Alliance in 2019. We are working with the industry to define methodologies and milestones with respect to these commitments and plan to increase our investment in low carbon infrastructure through to 2030; this is in addition to our £3.8 bn low carbon infrastructure investments over the last five years. We use our shareholder influence to encourage companies to transition to a low carbon economy and divest from highly carbon-intensive fossil fuel companies where we consider they are not making sufficient progress towards the engagement goals set.

For long-term savings and pensions products, we are investing policyholders' money and they are the decision maker as to where their funds are invested. To assist our customers, we integrate consideration of long-term climate-related issues into the products and services we offer (for example we continue to develop our customer Environmental, Social and Governance (ESG) strategy, both in terms of strengthening our climate engagement and voting and offering further climate friendly funds).

As an asset manager, we are investing clients' money and they are the decision maker as to where their funds are invested. Aviva Investors integrates consideration of ESG factors into the investment process to deliver long-term sustainable investment outcomes for clients whilst adhering to their mandate. Aviva Investors is developing a range of funds that support the climate change transition to a low carbon economy and is strengthening its climate engagement strategy[5].

Insurance

We seek to grasp opportunities to support the transition to a low carbon economy and promote activities that will secure a climate-resilient future for our customers and wider society. To meet these objectives, we will seek to ensure that consideration of climate-related risks and opportunities is part of our business development. We develop 'climate conscious' and innovative products across Aviva, which reward customers for environmentally responsible actions, provide an element of adaptation/resilience or additional cover for those customers at risk of the extreme weather impacts of climate change.

Operations

For over twenty years Aviva has focused on reducing the environmental impact of our business, becoming the first major insurer to be carbon neutral in 2006. Our ambition over time is that our business operations should have positive climate impact. We have already reduced our emissions by 66% since 2010 and have a long-term reduction target of 70% by 2030, which we are reviewing against our rising ambition. We are committed to using 100% renewable electricity by 2025 (aligned to the RE100 commitment[6]).

Influence

Aviva continues to provide strong and vocal support for capital market reform, to mobilise the trillions of pounds required to transition to a low carbon and climate-resilient economy and correct existing market failures with respect to climate change. We encourage policymakers and regulators to change the financial system, so markets reward sustainable investments and sustainable businesses. We will continue to champion thought leadership and promote policy and regulatory measures in this area.

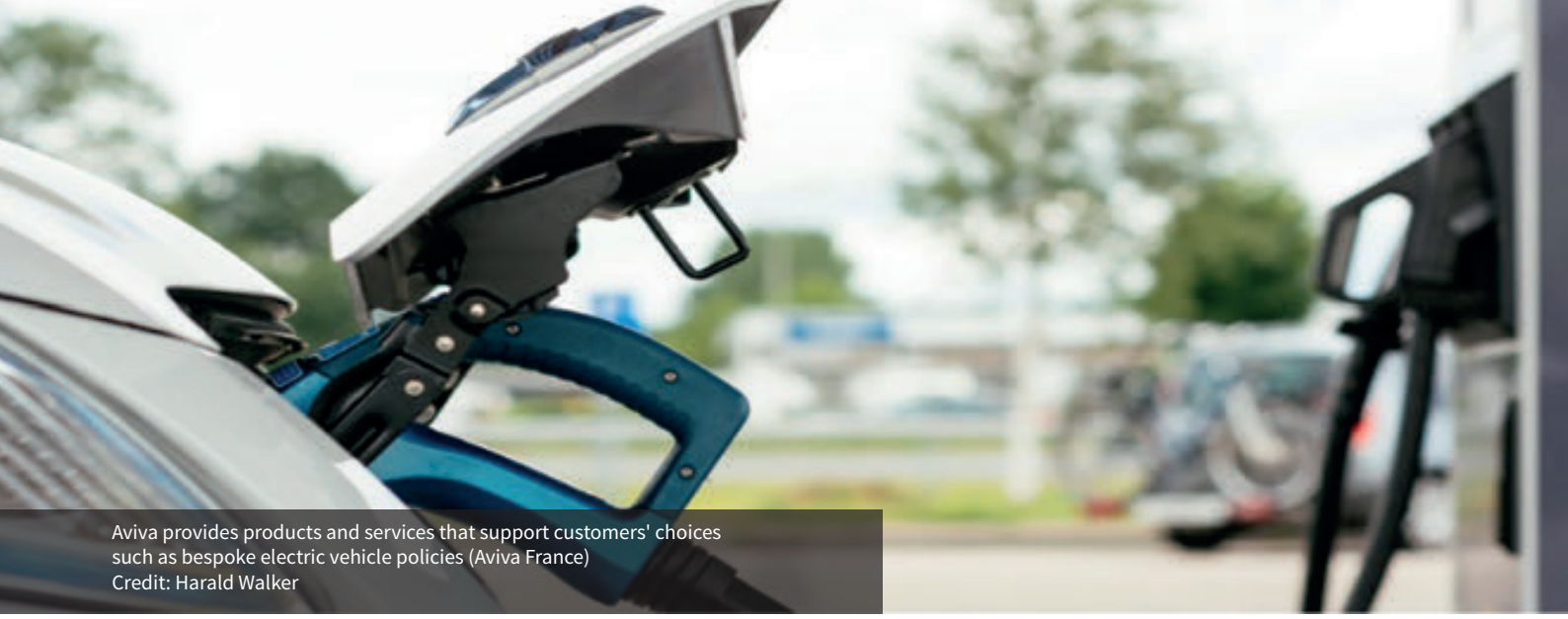
2 The 1.5°C target was set by the global Paris climate change deal in 2015 to limit the damage wreaked by acute events such as extreme weather and chronic events such as sea level rise.

3 Reduce the carbon equivalent emissions of our investment portfolio to net-zero.

4 The UK Government created a national commitment for countries to 'Power Past Coal' which was launched at the UN Climate Change Conference (COP23) in 2017. We have signed up to these principles to cease supporting thermal coal power investments and underwriting by 2030.

5 See "Why asset managers cannot be passive on climate change" FT article.

6 RE100's purpose is to accelerate change towards zero carbon grids, at global scale. Aviva has signed up to the commitment pledging to purchase or generate 100% of our global electricity from renewable sources by 2025.



Aviva provides products and services that support customers' choices such as bespoke electric vehicle policies (Aviva France)
Credit: Harald Walker

Embedding our Climate Change Strategy

Integrating Climate and other ESG risks in our investment considerations

Aviva recognises the benefit of integrating ESG factors including climate-related risks and opportunities into our decision-making processes as these factors provide an additional level of insight to make better decisions. When integrating the management of climate-related risks and opportunities into our liquid asset portfolios, Aviva Investors considers several layers: macro and sectoral analysis; risk management; investment decisions; climate change risk assessment and alignment as set out in figure 3.

Figure 3: Integrating climate-related risks and opportunities into investment considerations. Source: Aviva.

Climate change impact is considered in Aviva Investors' House View along with other macro-economic factors and is the foundation for strategic allocation decisions across all portfolios and multi-asset funds. The House View highlights the key trends that could affect our investment portfolio. Aviva Investors' analysts and responsible investing teams perform rolling deep dives by sector to establish the key climate-related risks and opportunities, where relevant to a sector.

On a monthly basis, Aviva Investors' portfolio risk team undertakes an analysis that includes a review of the Aviva Heatmap Algorithm (AHA) scores, and additional metrics (for example carbon emissions exposure, carbon emissions management, water stress exposure[7] and water management[8]), looking at any directional trends in the score as well as movements relative to the portfolio's benchmark. If a company is in a sector that has a high exposure to climate change then the weighting of climate change in the overall AHA score is increased to reflect such a risk.

Figure 4: Example of Aviva's AHA scores for two electric utility companies. Source: 2018 Aviva climate change stocktake.

	Company A	Company B
Average Final Voting Score	F	D
Latest Voting Score	F	D
Governance Rating Global	C	B
Governance Rating Home	C	B
ESG Rating	A	BBB
Controversies Overall Flag	Green	Yellow
Accounting Governance Risk Rating	B	C
Carbon emissions exposure	5.9	5
Carbon emissions management	5.7	5.8
Water stress exposure	3.9	3.5
Water management	3.4	1.4
AHA score	6.38	6.03

In the example above Company A has a higher overall score than Company B and is therefore performing better in terms of ESG considerations.

Fund managers take this scoring into account in their investment decisions. Fund managers, risk managers and Aviva's Chief Investment Officers have access to a growing suite of tools to assess climate change risks and opportunities at a portfolio level. This includes MSCI's ESG Ratings[9] and carbon foot-printing information, which is embedded in Aviva and Aviva Investors' risk systems, as well as analysis provided by MSCI (Carbon Delta)[10].

7 This metric assesses the water intensity of a company's operations and exposure to water stresses or scarce regions.

8 This metric provides an assessment of a company's water management strategy and performance.

9 MSCI ESG Ratings helps investors identify ESG risks and opportunities within their portfolio. Companies are rated on a 'AAA' to 'CCC' scale according to their exposure to industry-specific ESG risks and their ability to manage those risks relative to peers.

10 Carbon Delta is an environmental FinTech research firm that specialises in identifying and analysing the climate change resilience of publicly traded companies which recently became part of MSCI.

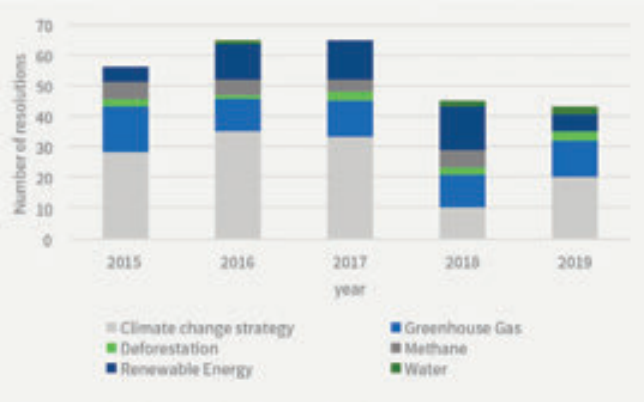
In July 2019, Aviva Investors launched the European Equity Climate Transition Fund, which excludes investments in companies with exposure to high carbon fossil fuels and invests in companies that provide solutions for climate mitigation/adaptation or are orientating their business models to be successful in adapting to a warmer world and supporting a low carbon economy (as identified using our T-Risk model[11]). Our insurance businesses are also engaged. For example, in 2019, Aviva France published its third ESG and Climate report in line with the requirements of the French law (Article 173) for energy transition and green growth. As part of this exercise, Aviva France demonstrated how, through its asset manager (Aviva Investors France), it incorporates ESG requirements into its investment process and manages climate-related risks and opportunities affecting its investments. The report also covers how Aviva France aims to accelerate its ambition to be aligned to the 1.5°C Paris Agreement target. Aviva France is now refining its approach to translate climate change considerations into targets using scenario analysis, green investments and carbon foot-printing information.

In 2020, Aviva Investors will further develop its climate risk assessment approach and the alignment with global or national targets on climate change.

Aviva's active stewardship on Climate and other ESG risks

Aviva Investors' Corporate Governance and Corporate Responsibility Voting Policy, expects companies to begin reporting climate-related risks, strategy, policies and performance against the TCFD's recommendations. This includes stress testing of business models and assets against various climate policy scenarios, see for example Royal Dutch Shell case study. Aviva Investors will begin voting against directors of companies in high- and medium-impact sectors that are climate laggards and against directors of companies in the Climate Action 100+ investor initiative that have not committed to science-based targets.

Figure 5: Active voting on resolutions related to climate issues (2015-2019) as at 31/10/2019. Source: Aviva.



In addition to our voting activities (as highlighted in figure 5), we also engage with companies both individually and collaboratively (members of Climate Action 100+, Institutional Investors Group on Climate Change, Transition Pathway Initiative etc.) on climate change related issues. Aviva Investors engage with businesses we lend to (via the debt markets), as well as those where we are shareholders, with a particular focus on in-depth engagement with companies strategically exposed to climate-related risks due to their significant carbon impact and exposure to transition risks.

The Aviva Staff Pension Scheme Board has revised its Statement of Investment Principles to take account of climate-related risks and opportunities as well as wider ESG issues. In this regard, they are fully engaged with Aviva Plc and the approach it takes as an asset owner. In 2019, Aviva UK launched the 'Stewardship lifestyle strategy' - a workplace pension default investment strategy that incorporates ethical and ESG considerations. This option means that scheme members can be reassured that ethical and ESG considerations are integrated all the way through to their selected retirement date. This results in the funds excluding companies that do not meet certain ethical standards or that harm society or the environment. These funds, along with the Aviva Investors Climate Transition fund and the Sustainable Income and Growth Fund (awarded the Sustainable and Responsible Investments (SRI) designation[12]), are now available to individual customers via our UK Life insurance business's Adviser platform. In 2020 we plan to have these funds available in an Individual Savings Accounts wrapper.

In 2018, our Robo Investment Subsidiary Wealthify launched an ethical investment option, focused on four ethical/SRI funds. Interest from customers has grown steadily with 25% of new customers selecting the ethical option. This now accounts for 13% of total assets under allocation for Wealthify and growing.

In September 2018, together with Index Initiative and the United Nations Foundation, we launched the World Benchmarking Alliance (WBA) on the eve of the General Debate of the 73rd session of the United Nations (UN) General Assembly. The WBA publishes free and transparent benchmarks ranking companies on contributions towards achieving the UN Sustainable Development Goals (SDGs). The aim is to increase transparency and accountability for businesses in relation to the SDGs as well as empower consumers, investors, governments and civil society organisations by providing them with free and publicly available data that shows a company's SDG performance, which they can use when deciding where to spend their money, allocate their investments or direct their policy and advocacy efforts. The WBA will develop a range of corporate benchmarks by 2023 to comprehensively assess the progress of 2,000 companies across major areas of transformation required to achieve the SDGs. The first set of benchmarks will be published in 2020 and will address food and agriculture, climate and energy, digital inclusion and gender equality and empowerment.

11 T-risk is a model using research inputs from in-house as well as academia, consultants, civil society and peers to rate the 159 GICS (Global Industry Classification System) sub-industries on their risk exposure to both physical and decarbonisation risks through their value chain. For the Climate Transition Fund, we combine this sub-industry assessment with a company's climate risk management score from CDP to decide if a company is investable or not.

12 Label backed by the French Ministry of Finance.

Decarbonising our portfolio

In 2015, we identified 40 companies with more than 30% of their business revenue associated with thermal coal mining or coal power generation and undertook focused engagement with them, including 51 in depth conversations. These meetings set out our expectations on their governance, business strategy, operational efficiency, responsible climate and energy policy advocacy. We also asked whether any of those companies have any plans for new investment in coal generating capacity, as we believe this would be inconsistent with the Paris Agreement's target of limiting the global temperature rise to well below 2°C.

We continue to engage with these companies to encourage them to transition. We believe it is better to be an engaged owner lobbying for change rather than divesting and walking away as these are the companies in need of the greatest challenge from their shareholders. Indeed, five companies we have engaged with have committed to Science Based Targets[13] to reduce greenhouse gas emissions in line with the level of decarbonisation required to keep the global temperature increase to 2°C or lower. Whilst others have signed no new coal pledges, or have diversified their operations away from thermal coal, where we do not see any prospect of movement then we will divest. To date, we have divested Aviva's own assets from 18 out of the 40 thermal coal mining and power generation companies and are prepared to add further companies to our investment Stoplist to limit our exposure to this, and other carbon intensive sectors.

Further to the groupwide stance, in 2019 Aviva France continued to monitor and improve the carbon intensity and ESG scores of their investments. In addition, they performed an impact analysis to implement the French Insurance Federation's (FFA) guidelines in terms of thermal coal. Since November 2019, Aviva France has committed to not invest in companies developing new coal mining projects or are planning a substantial increase of its annual (thermal) coal production volume; companies with 20% of their revenue coming from coal-related business (production/exploitation of coal mines or production of electricity from coal for energy producers) and companies where their annual coal production exceeds 10M tons and those whose coal-fired capacity exceeds 5000 MW. For the positions already held, engagement is underway with issuers that have coal-related businesses. This activity resulted in divestment from six thermal coal companies (during 2018 and 2019) with an aggregate value of €176m.

Aviva Investors Real Assets approach

Aviva Investors' £44bn Real Assets platform comprises equity and debt investments in both real estate and infrastructure, with a concentration of assets in Europe and a growing interest in developing countries. In equity, the platform is focused on creating opportunities for clients through long lease, refurbished and development in real estate, and has a diversified portfolio of low carbon, renewable and social infrastructure projects including onshore wind, solar and energy from waste. In debt, the platform has a range of interests in hospitals, schools and utilities as well as financing trade and the development of new roads and rail in developing countries.

The Real Assets platform is committed to reducing emissions as part of the broader Aviva Investors' and Aviva Plc's climate change strategy, as well as the ongoing drive to benefit clients and occupiers through investing in sustainable and resilient buildings. We are committed to the decarbonisation of the platform and developing low carbon and renewable energy generation capacity in infrastructure.

In 2020 the Real Assets platform will publish its net zero pathway, renewing carbon and energy targets and setting the platform on track to achieve net zero emissions by 2050. Considering the range of geographies and asset classes our platform is exposed to, climate-related transition risks and opportunities are relevant to all investments across the platform. Climate transition risks are assessed by our origination teams at the point of origination, where opportunities are sourced from the market and analysed for suitability for clients.

In Aviva Perth, we have a super-efficient heating pump, moving hot water around the building to heat it, which runs on reduced consumption and the speed can be varied subject to demand/load. Credit: Aviva

13 Science Based Targets is a joint initiative by CDP, the UN Global Compact, the World Resources Institute and World Wide Fund for Nature that raises the ambition of corporate mitigation efforts and drives bolder business solutions by identifying and promoting innovative approaches to corporate greenhouse gas target setting. Targets adopted by companies to reduce greenhouse gas emissions are considered "science-based" if they are in line with the level of decarbonisation required to keep global temperature increase to 1.5°C compared to pre-industrial temperatures, as described in the Assessment Report IPCC.

Through the origination process, the team assesses the asset, activity or counterparty involved in the transaction for exposure to climate transition risk, undertaking a detailed analysis of high-risk sectors such as chemicals, utilities and automotive. This could include assessing the risk of exposure to a commercial office occupier or a utility company seeking funding for investment in a power generation plant. Where transition risk is high, we may seek to mandate an environmental covenant in the transaction agreement or may choose to decline the transaction where transition risk cannot be mitigated. Exposure to legislative changes concerning Minimum Energy Efficiency Standards is assessed quarterly, where the volume of assets with non-compliant Energy Performance Certificate ratings are reported internally. We also consider where assets must be refurbished or redeveloped to meet modern energy efficiency standards and occupier expectations.

The Real Assets platform is committed to transparency and enters real estate funds and the infrastructure equity fund to the Global Real Estate Sustainability Benchmark (GRESB) annually. Aviva was a founding member of GRESB and continues to be an active participant and advisor to the benchmark.

For UK and European properties managed by Aviva Investors Real Estate on behalf of our clients, we are committed to an absolute reduction of Scope 1 and Scope 2[14] carbon emissions of 20%, from a 2015 baseline. The business has reached a 62% reduction against that baseline since 2015, meeting the commitment ahead of target. This is due to several reasons, including energy efficiency projects, procurement of renewable energy and a significant increase in the volume of renewables on the national grid. We are committed to increasing energy efficiency and have achieved a 5% reduction in energy use (electricity and gas consumption) year on year to end 2018. In 2019, energy efficiency projects across the real estate portfolio have contributed to over £660k of avoided energy costs for occupiers, with a further £1.5m of energy cost saving projects planned for initiation in 2020.

Offering climate conscious products

We develop 'climate conscious' and innovative products across Aviva, which reward customers for environmentally responsible actions, provide an element of adaptation/resilience or additional cover for those customers at risk of the extreme weather impacts of climate change. For example, we provide products and services that support customers' choices such as bespoke electric vehicle policies (Aviva France), reduce premiums for customers who opt to use public transport (Aviva France), support the sharing economy (Aviva Canada), encourage farmers to use bio-waste methanisation to generate green energy (Aviva France) and provide for whole lifecycle coverage for renewables (Specialty Risk). Last year, Aviva stopped underwriting fossil fuel power production worldwide and has recently expanded its renewable energy insurance products.

Our customer service information has been expanded over a number of years to educate customers on the risks of climate change in order to prevent, mitigate and build resilience to events. For example, event specific information has been placed in the media regarding what people should do to minimise the impact of particular weather events. In the UK, this has been personalised further with early warning emails for specific geographic areas and door to door visits prior to the event affecting the area. We have been working on building resilience to extreme weather through our products in a number of markets - for example the upgrade to commercial property insurance in Canada, which provides a 'build back better' element by using materials that are resilient to further weather events.

Through our claims' fulfilment process we have considered how to reduce environmental impact, through repair and restoration where possible, to minimise the amount of waste going to landfill or recycling. We also benefit the customer and the environment through the claims process by providing replacement A+ energy-rated white goods. Aviva UK owns a network of accident repair centres and as the transition from internal combustion engine vehicles to low carbon, electric and autonomous transport gathers pace, we are seeking the opportunity to support this. This year we are opening a state-of-the-art car bodyshop centre. Our repair team will be trained and equipped to respond to these advances and ensure we are able to continue delivering an exceptional customer experience while providing the highest quality of repair for electric and autonomous vehicles.

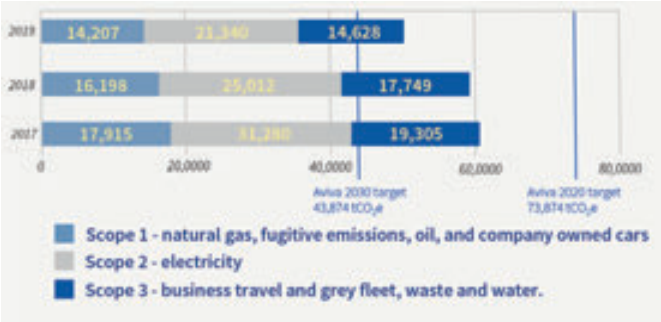
Climate change is expected to result in increased precipitation, coastal and river flooding. In the UK, Aviva provides extensive coverage for customers' homes and belongings when affected by these events. Credit: Unsplash

14 Scope 1: natural gas, fugitive emissions (leaks of greenhouse gases, e.g. from refrigeration and air-conditioning units. Refrigerant gases are generally extremely potent greenhouse gases, some of which are thousands of times more damaging than carbon dioxide), oil, and company owned cars. Scope 2: electricity. Scope 3: business travel and grey fleet waste and water. More details of this analysis can be found on www.aviva.com/social-purpose

Aviva's operational carbon emissions

We have measured our operational carbon emissions since 2004 and disclosed related metrics on an annual basis in our public filings. We report on the greenhouse gas emission sources on a carbon dioxide emissions equivalent basis. Aviva has been carbon neutral in our business operations since 2006 through the purchase and retirement of carbon offsets from the voluntary carbon market.

Figure 6: Absolute operational carbon emissions tCO_2e. Source: Aviva.



We have already achieved our 2020 operational target set in 2010 by reducing our carbon emissions by 66% and we have a long-term reduction target of 70% by 2030. Now, 67% of electricity used by our global operations is from renewable resources and we are committed to using 100% renewable electricity by 2025 (aligned to the RE100 commitment). Across the UK, more than 400 employees have signed up to our car share programme and there are 180 active car sharing groups. We have also introduced twenty electric vehicle charging points at eight UK office locations and moved 30% of our car fleet to hybrid. More details of this analysis can be found on www.aviva.com/social-purpose.

In 2015 we conducted a carbon footprinting exercise of our wider supply chain in the UK with the Carbon Trust. Approximately 73% of our spending is with professional services companies. The estimated associated emissions amounted to 780,000 tCO_2e. We do not believe these figures will have changed significantly since then, but we will regularly review them as part of our climate change strategy.

In 2019 we commissioned a 'first of its kind in the UK' solar carport installation at our office in Norwich which with the right weather conditions removes our reliance on the national grid's electricity and feeds surplus electricity back into the grid. By the end of 2019 our carport produced 40 GWh of electricity, of which 3.8 GWh was exported to the grid. We have identified two further locations for the installation of solar carports which will come on-stream in 2020. . We are seeking planning permission for a wind turbine at our Perth office which, through the combination of the existing and new solar carport (with 50 electric vehicles charging points), and battery storage, will take the location off-grid. We will seek further opportunities where our locations and type of building occupancy allows. Our workplaces are now free of single-use plastic containers in all our markets but one, which has a roadmap to do so in 2020, and our UK business continues to meet our zero to landfill target.

Our carbon management programme was recognised by the United Nations Framework Convention on Climate Change (UNFCCC) as a Momentum for Change 'Lighthouse Activity' (2017) and our reporting of emissions was awarded the Carbon Tick for comprehensive Scope 1 reporting. Whilst significant progress has been made in reducing Aviva's CO_2e emissions from air travel – reducing by 36% from 14,485tCO_2e in 2010 to 9,180tCO_2e in 2019 – it remains a challenge we continue to address.

Using our influence

Ensuring a smooth transition to a low carbon economy is key. The global economy has failed to recognise the potential impact of climate change and the transition to a low carbon economy in company valuations. Addressing this failure requires action throughout the capital markets system.

Aviva continues to support momentum towards implementing and tightening climate policy at national, regional and global levels. Aviva has supported multiple key studies and policy reports investigating the connection between climate change, sustainability and finance. We believe that our ideas will have the strongest impact through collaboration with others around the world – from the finance sector to national governments and multilateral institutions. We have therefore been instrumental in calling for and participating in a number of important cross-sector initiatives to encourage sustainable finance, for example the TCFD, the EU High Level Expert Group on Sustainable Finance and the UK Green Finance Taskforce). Aviva Investors has signed up to the UN Principles for Responsible Investment (PRI) Investor statement on deforestation and forest fires in the Amazon. This statement is endorsed by 230 investors representing approximately US$16.2 trillion in assets. We have been calling for the end to fossil fuel subsidies since 2015 in conjunction with the Overseas Development Institute. The International Energy Agency (IEA) estimates that fossil-fuel subsidies were around US$5.2 trillion in 2017. This amounts to 6.4% of global gross domestic product.

Aviva's CEO, Maurice Tulloch, spoke about climate at the UN High-level Dialogue on Financing for Development, which was convened by the UN General Assembly in September 2019. He highlighted the need for strategic asset allocation by governments and the private sector, the need for free public league tables such as the World Benchmarking Alliance, the need for subsidies to be in the right places and the responsibility of financial advisors to ask customers for their views on how their money is invested. During 2019, we launched our report "A Marshall Plan for the Planet", which develops these ideas.

To promote understanding, consistency, transparency and comparability, Aviva is working collaboratively with external parties. For example, we participated in the UNEP FI's recently published Investor and Real Estate Changing Course reports. We are a member of the UN Net Zero Asset Owner Alliance, UNEP FI's Insurance TCFD pilot, ClimateWise and the joint PRA Financial Conduct Authority Climate Financial Risk Forum (CFRF). Our UK Life CEO, Angela Darlington, chairs the CFRF Scenario Analysis Working Group and our Chief Investment Officer for Real Assets chairs the Investment Association's Sustainability and Responsible Investment Committee. We are also a member of the CRO Forum Carbon-footprinting working group and of the Geneva Association Climate Change and Emerging Environmental Topics Working Group.

Through 2020 and beyond, a core part of our climate strategy is to continue to leverage our leadership position and influence in this area, and to continue lobbying for a strong co-ordinated response to climate change.

Risk management, metrics and targets

Rigorous and consistent risk management is embedded across Aviva through our risk management framework, comprising our systems of governance and risk management processes. This framework sets out how Aviva identifies, measures, manages, monitors and reports on the risks to which it is, or could be, exposed (including climate-related risks). It defines the accountabilities of management, the risk function and internal audit with respect to enterprise-wide risk management.

In 2019 we continued to embed the assessment of climate-related risks and opportunities into our overall strategy, decision-making, risk management and reporting frameworks. In doing so, we have taken into consideration the fact that climate-related risks and opportunities do not always easily align with existing risk management processes.

We have updated our risk policies including our Risk Management Framework and Group ORSA (Own Risk and Solvency Assessment) policy as well as our business planning instructions to respond to the new climate-related regulatory requirements.

Aviva's process for identifying climate-related risks

We use our risk identification process to identify potential exposure to climate-related risks via the associated physical and transition transmission channels (for example new climate policies or increases in average temperatures). We then conduct exposure analysis to understand how these risks will impact our most material exposures.

Aviva's emerging risk spectrum (see figure 7) illustrates the significance of the impact and expected timescale for different external emerging risks. This is primarily a qualitative assessment informed by quantitative indicators. Aviva considers climate change to be one of the most material long-term risks to our business model, and a proximate risk[15], because its impacts are already being felt. We are therefore taking action now to mitigate and manage the effects of climate change both today and in the future. Through these actions, Aviva continues to build resilience to climate-related transition, physical and litigation risks including the risk of assets becoming stranded.

Figure 7: Aviva Group Emerging Risk Spectrum – August 2019. Source: Aviva.

Aviva supports the Gyapa project (this project is supported as part of our carbon off setting project), which promotes clean cooking in Ghana. An efficient cookstove which cooks food more quickly and requires 50% less fuel, meaning it not only cuts carbon emissions, but reduces exposure to toxic fumes as well. Cutting fuel requirements also saves families as much as US$100 annually and protects Ghana's dwindling forests. Credit: ClimateCare

15 Climate Change is a trend. While we can already observe some early impacts (physical and transition), we expect these to increase significantly over the longer-term. The potential size and nature of the risk and the time required to fully mitigate the risk as a business and wider society mean we need to take management action now. We therefore consider Climate Change to be a proximate risk.

Aviva's process for assessing, managing and monitoring climate-related risks and opportunities

As can be seen in the following table, we use a variety of metrics and tools to manage and monitor our alignment with global or national targets on climate change mitigation as well as the potential financial impact of climate-related risks and opportunities on our business.

Metric	Risk/Opportunity	Physical/ Transition	Measurement	Data Provider
Investment in Green Assets	Green bonds and low Carbon infrastructure	Transition	Measure Aviva's investment in Green Assets i.e. Infrastructure and Green Bonds and compare to target	Aviva
Carbon foot-printing	Equity and Credit	Transition	Use carbon foot-printing and weighted average carbon intensity data to assess the exposure of our assets.	Aviva/ MSCI
	Operational carbon emissions	Transition	Measure the operational carbon emissions tCO_2e and compare to target	Aviva
Portfolio Warming Potential	Equity, Credit, Real Estate, Sovereign and Green Assets	Transition	Measure the portfolio temperature pathways and alignment to Paris Agreement target.	Aviva/ MSCI (Carbon Delta)
Climate VaR	Equity, Credit, Sovereign, Real Estate and life and GI liabilities	Physical & Transition	Assess the potential business impacts of future climate-related risks and opportunities for each of the IPCC scenarios and in aggregate.	Aviva/ MSCI (Carbon Delta)
Notre Dame-Global Adaptation Index ND-GAIN	Sovereign holdings	Physical	Measure our exposure to countries highly or moderately vulnerable to climate change.	Aviva/ NDGAIN
Weather related losses	GI liabilities	Physical	Actual weather-related losses versus expected weather losses by year and business unit and Weather impact on COR – over/under long term average	Aviva

Whilst recognising the limitations of the metrics and tools used such as the scope of coverage, data availability and extended time horizons as well as the uncertainty associated with some of the underlying assumptions, we believe they are still valuable in supporting our climate-related governance, strategy and risk management.

During 2019 we have built on the analysis that we conducted for 2018 and we have also participated in the PRA's Insurance Stress Testing exercise, but we recognise that there is still more to do to further develop metrics and targets to support decision-making and our understanding of the impact of climate-related risks and opportunities on our business. We fully anticipate that these approaches will evolve over time and improve in the light of new research, data and emerging best practice.

Aviva's Climate VaR measure

Climate-related risks and opportunities have the potential to affect insurers' balance sheets as well as the long-term business model. Traditional approaches based largely on backward looking analysis may need to be refined or enhanced to capture these risks going forward. In order to address this challenge, Aviva has developed a Climate VaR measure, in conjunction with the UNEP FI investor pilot project and Carbon Delta as well as Elseware (a risk management and quantification expert consultancy). This measure enables the potential business impacts of future climate-related risks and opportunities to be assessed in each of the IPCC scenarios and in aggregate (see Appendix for more details of our Climate VaR methodology) as well as providing an indication of the resilience of our strategy.

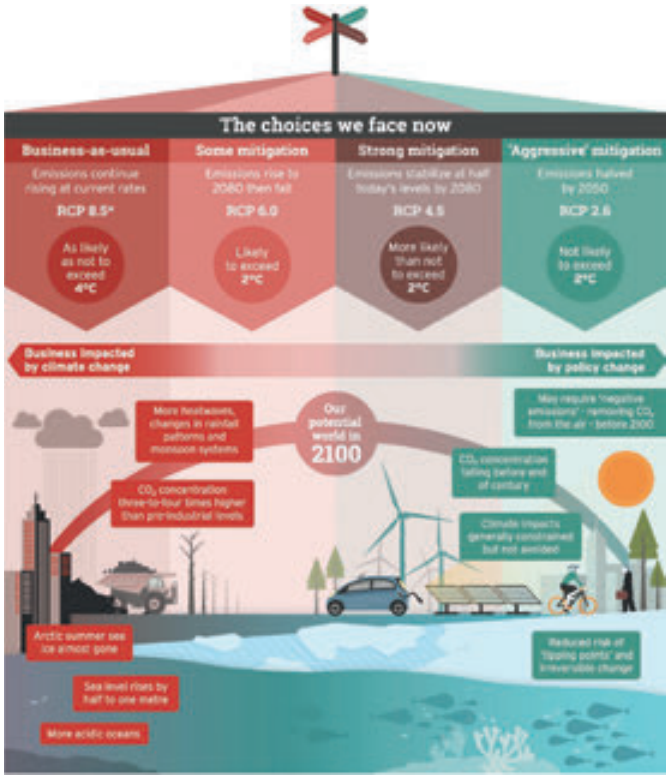
In order to support this initiative, an inter-disciplinary team has been created with representation from across the business and an expert panel has been set-up to review and challenge the main assumptions made in the selection, development and modelling of the scenarios. The panel includes internal experts as well as external experts – Dr Simon Dietz, Dr Nick Robins, Dr Swenja Surminski from the Grantham Research Institute on Climate Change and the Environment at the London School of Economics, Dr Paul Pritchard an Independent Sustainability Advisor and Dr Katharina Dittrich from Warwick Business School.

The IPCC has identified four potential future scenarios with respect to climate change[16]. Each scenario describes a potential trajectory for future levels of greenhouse gases and other air pollutants and can be mapped to potential temperature rises and levels of mitigation required: 1.5°C (aggressive mitigation), 2°C (strong mitigation), 3°C (some mitigation) and 4°C (business as usual).

The IPCC Global Warming of 1.5°C report, published in October 2018, indicates the need to take dramatic action now to keep warming below 1.5°C and the potential severe consequences if this is not achieved.

The scale of change needed to meet the 1.5°C target is unprecedented; industry will have to slash their CO_2 emissions by 65% to 90% by 2050 and investments in low carbon energy technology and energy efficiency will need to increase 5-fold by 2050 versus 2015 levels. Buildings and transport will also need to shift heavily towards green electricity and tools to remove CO_2 emissions from the atmosphere, such as carbon capture and storage (unproven at scale), will be needed to store 100 to 1,000 gigatons of CO_2 over the century.

Figure 8: The choice we face now. Source: TCFD.



In the IPCC's 4°C scenario, which corresponds to emissions continuing to rise at current rates, the transition risk is clearly more limited, but the potential physical risks are significant, and the likelihood of tipping points being reached is much higher. In particular, one can expect increased precipitation, coastal and river flooding, periods of extreme heat and cold, wildfires and droughts. In addition, sea levels could rise significantly resulting in major displacement of populations as well as spread of diseases, currently typical only in tropical areas, to more temperate areas.

Finally, particularly in the more extreme warming scenarios it is also important to consider whether climate may trigger changes in social

16 The IPCC Fifth Assessment Report (AR5) provides an overview of the state of knowledge concerning the science of climate change.

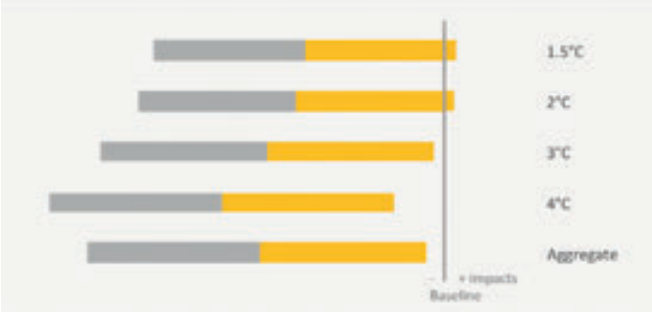
attitudes which result in increased litigation against companies for failing to reduce emissions or to disclose climate-related risks transparently.

Calculated on a like for like basis the YE18 and YE19 Climate VaRs are similar, indicating that Aviva's overall exposure to climate-related risks and opportunities remains broadly unchanged. However, we have made a number of methodology improvements that have led to an increase in the central estimate of the aggregate results. In particular:

- We have participated in the UNEP-FI Changing Course Real Estate Pilot which resulted in enhancements being made to the MSCI (Carbon Delta) real estate methodology.
- We have made allowances for gaps in the coverage of the underlying constituents within the MSCI (Carbon Delta) data.
- We have extended both the geographical exposure and range of perils modelled for GI risk.

Figure 9 compares a plausible range of outcomes (5th to 95th percentile) from our Climate VaR analysis for the different scenarios considered. Consistent with last year, Aviva is most exposed to the business-as-usual (BAU) 4°C scenario where physical risk dominates, negatively impacting long-term investment returns on equities, corporate bonds, real estate, real estate loans and sovereign exposures. The aggressive mitigation 1.5°C and 2°C scenarios are the only scenarios with potential upside. Physical risk impacts are more limited but there is still downside risk on long-term investment returns from carbon intensive sectors (for example utilities) as a result of transition policy actions. This is offset partially by revenues on new technologies from some sectors (for example automotives).

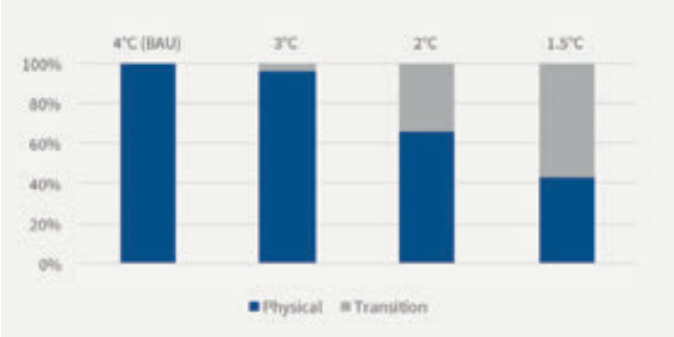
Figure 9: Aviva's Climate VaR output by scenario for shareholder funds as at 30/11/2019. Source: Aviva.



The grey bars represent the range of outputs between the 5th percentile and the central estimate for each scenario and the orange bars represent the range between the central estimate and the 95th percentile.

When aggregated together to determine an overall impact of climate-related risks and opportunities across all scenarios, the plausible range is dominated by the results of the 3°C and 4°C scenarios, reflecting that neither existing nor planned policy actions are sufficiently ambitious to meet the 1.5°C Paris Agreement target. In the 1.5°C scenario transition risk is larger than physical risk (see figure 10) even after taking into account mitigating technology opportunities. In the 2°C scenario, transition and physical risks are somewhat balanced, whereas in the 3°C and 4°C scenarios physical risk dominates.

Figure 10: Physical versus transition risks by scenario for Aviva's shareholder funds as at 30/11/2019. Source: Aviva.



Similar to last year, in all scenarios the impact on insurance liabilities is more limited than on investment returns. However, there is potential for some impact on life and pensions business as a result of changes in mortality rates in different scenarios either from physical effects such as more extreme hot and cold weather or transition effects related to changes in pollution levels. The impact on general insurance liabilities is relatively limited because of the short-term nature of the business and the ability to re-price annually and mitigation provided by our reinsurance programme. However, the physical effects of climate change will result in more risks and perils becoming either uninsurable or unaffordable over the longer term.

We will continue to develop and incorporate Climate VaR into our overall strategy, risk management and reporting frameworks. In particular, we will further refine and improve our Climate VaR approach in the light of new research and data as well as emerging best practice including using output from the UNEP FI Insurance TCFD pilot. In addition, litigation risk could be explicitly modelled as could transition risk for sovereign bonds or physical risk modelling extended to cover wider factors such the supply chain, demand for products or services and access to capital. We could also consider how adaptation measures could be incorporated.

PRA Insurance Stress Testing

As part of an effort to embed climate-related risks and opportunities within the insurance industry, the PRA specified three exploratory stress scenarios which our Aviva UK life and general insurance entities have run as part of the 2019 Insurance Stress Tests. These scenarios covered both physical and transition risks.

The scenarios are described below:

Scenario A: A sudden transition, ensuing from rapid global action and policies and materialising over the medium-term business planning horizon that results in achieving a temperature increase being kept below 2°C (relative to pre-industrial levels) but only following a disorderly transition. In this scenario, transition risk is maximised.

Scenario B: A long-term orderly transition scenario that is broadly in line with the Paris Agreement target. This involves a maximum temperature increase being kept well below 2°C (relative to pre-industrial levels) with the economy transitioning in the next three decades to achieve carbon neutrality by 2050 and greenhouse-gas neutrality in the decades thereafter.

Scenario C: A scenario with failed future improvements in climate policy, reaching a temperature increase in excess of 4°C (relative to pre-industrial levels) by 2100 assuming no transition and a continuation of current policy trends. Physical climate change is high under this scenario, with climate impacts for these emissions reflecting the riskier (high) end of current estimates.

As well as the quantitative scenarios, the PRA also requested qualitative information on firms' own internal approach to assessing climate-related risks and opportunities.

We have compared the results of this exercise to Aviva's internal approach to modelling climate-related risks and opportunities used in the climate-related financial disclosure for 2018. In absolute terms, the impact of the PRA stresses is about half that of those produced by Aviva's internal approach. This is due to scoping differences as the Climate VaR covers the whole group and not just the UK. However, the two approaches rank the impact of scenarios similarly, and are based on much of the same academic literature.

Other Stress Scenario Testing (SST) exercises

The regulatory and business risks and opportunities of ESG and climate-related risks are monitored on the Aviva Investors Emerging Risk Register and reported internally to the Aviva Investors Risk Management Committee on a quarterly basis.

Within the annual SST exercise, an exploratory climate change scenario was conducted in 2019 to assess the potential financial impacts on Aviva Investors. This scenario comprised of accelerated carbon taxes affecting our liquid funds under management, and accelerated implementation of energy policy, leading to increasingly stringent regulation in real estate causing downward pressure on real estate valuations. The stress scenario was run against the Aviva Investors three-year plan and reported to the Board as part of the wider SST report. Although the impacts of the stress test were mild compared to other scenarios, the climate change scenario will be retained over the coming years and reassessed in order to capture new risks as they materialise. This will allow Aviva Investors to monitor the impact of climate risk within each asset class and also the resilience of the business plan to the long-term structural risks associated with climate change and international policy responses.

Other metrics and targets

In addition to Climate VaR, and SST, Aviva uses a variety of other metrics to manage, monitor and report its alignment with global, national or internal targets on climate change mitigation and the associated potential financial impact on our business.

Transition risks and opportunities

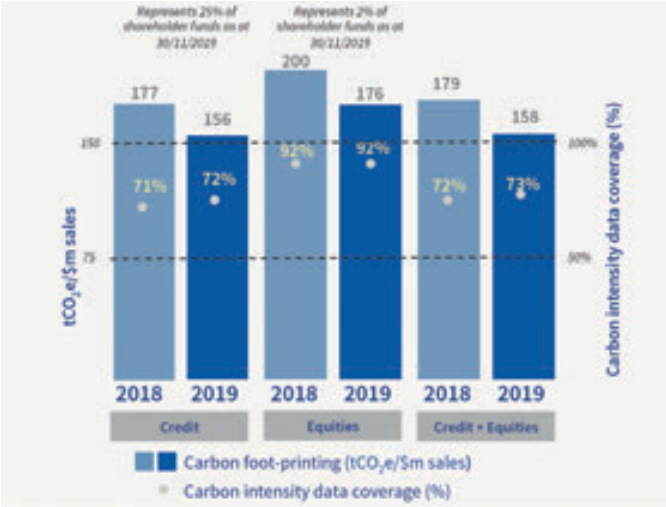
For transition risks and opportunities, the metrics and tools used include:

- Carbon foot-printing of investments
- Portfolio Warming Potential
- Investment in Green Assets

Carbon foot-printing of investments

In line with the TCFD guidelines, we monitor the carbon footprint of our credit and equity portfolio on a regular basis. We use carbon foot-printing and weighted average carbon intensity data (tCO_2e[17]/$m sales) to assess our exposure to a potential increase in carbon prices in shareholder funds.

Figure 11: Weighted average carbon intensity (tCO_2e/$m sales) of credit and equities in Aviva's shareholder funds as at 30/11/2019 compared to YE18[18]. Source: Aviva/MSCI.



Generally, our carbon foot printing intensity has reduced compared to last year. This is due to proactive investing by Aviva into less carbon intensive industries as well as companies reducing their carbon intensity. Our objective is to reduce over time the carbon intensity of our investment portfolio in order to reduce its sensitivity to an increase in carbon prices. This could be achieved through reducing our exposure to the most carbon intensive sectors such as utilities, oil and gas, and building materials.

Figure 12: Aviva's exposure to carbon intensive sectors in Aviva's shareholder funds (credit and equities) as at 30/11/2019. Source: Aviva.

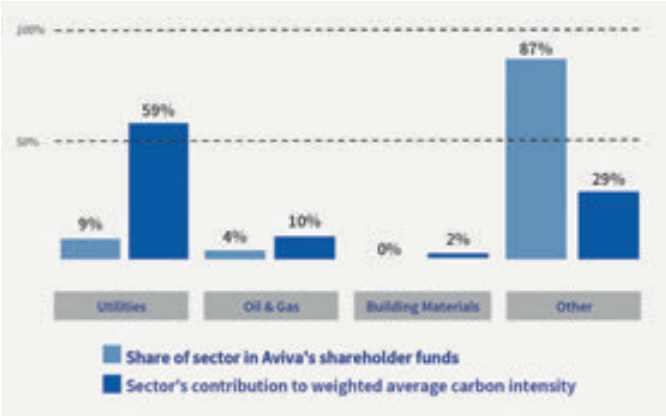


Figure 12 shows that these carbon intensive sectors represent 13% of our corporate credit and equities shareholder funds but contribute 71% of the weighted average carbon intensity. The utilities sector is the largest single contributor representing 9% of the portfolio but contributing to 59% of the weighted average carbon intensity.

17 Scope 1 and Scope 2 emissions

18 For 2018 TCFD we reported Aviva's shareholder and participating funds for some metrics. This year we have focused on Shareholder funds to ensure consistency (except for figure 15 where we allow for both Shareholder and Participating funds). Where we refer to Shareholder funds this represents shareholder funds and the shareholder component of participating funds. Where we refer to Shareholder and participating funds this represents shareholder funds and all participating funds. In both cases the data has been taken at 30/11/2019 from our internal risk system used to monitor credit risk limits and as a source for Solvency II disclosures.

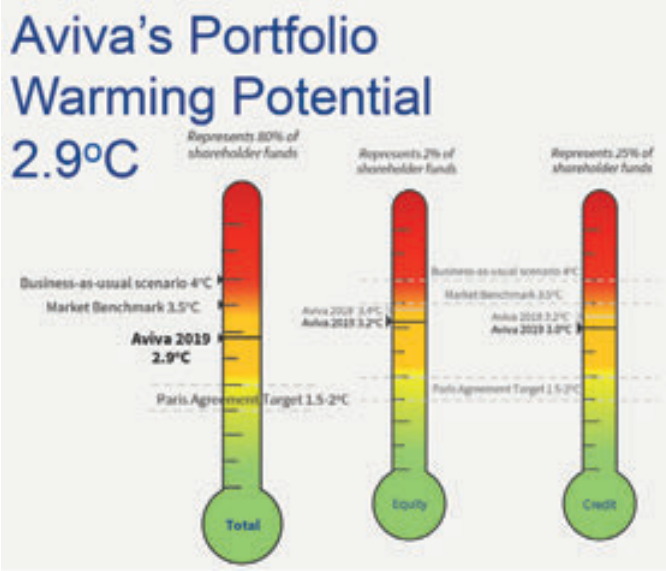
Portfolio Warming Potential

Aviva is exploring the uses of a number of different emerging metrics designed to help analyse the alignment of investment portfolios to the Paris Agreement's target of limiting the global temperature rise to well below 2°C. However, we fully anticipate that these approaches will evolve over time and be improved in the light of new research, data and emerging best practice.

Aviva uses a portfolio warming potential metric from MSCI (Carbon Delta) to assess our corporate credit, equities and real estate shareholder funds' alignment with the Paris Agreement's target.

The "Portfolio Warming Potential" is calculated as a weighted average of individual issuers' warming potential. This is based on the alignment of each company within the portfolio to the sectoral greenhouse gas emission intensity needed for each sector to make its contribution to reach the global well below 2°C target. This warming potential methodology captures the Scope 1[19] emissions of investments as well as investments in low carbon technology to provide a forward-looking perspective.

Figure 13: Warming potential (in °C) for Aviva's shareholder funds as at 30/11/2019. Source: Aviva/MSCI (Carbon Delta).



This year we extended this analysis to cover 80% of our shareholder funds by including real estate, sovereign bonds and green assets in the analysis. We have derived portfolio warming potentials for our most material sovereign exposures based on analysis of individual government's climate action and how it compares against the Paris Agreement's target, taking into account independent analysis conducted by organisations such as Climate Action Tracker[20].

The actions we are taking to reduce our investment exposure to carbon intensive sectors over time should lead to a reduction in the warming potential of Aviva's shareholder funds. The analysis found that Carbon Delta's warming potential of our shareholder funds equity portfolio at 3.2°C was 0.2°C below last year's results. The warming potential of our shareholder funds corporate credit portfolio at 3.0°C was also 0.2°C below last year's results. Overall, this analysis estimates the total warming potential of our shareholder funds at 2.9°C. Whilst clearly still above the Paris Agreement's target, this represents year on year progress, is lower than the warming potential of the market benchmark portfolio[21] (3.5°C) and significantly lower than the portfolio warming potential of the business-as-usual scenario (4°C).

We have also used the Paris Agreement Capital Transition Assessment (PACTA) model (developed by 2 Degrees Investing Initiative (2°ii)) to analyse alignment, over the next five years, of our investment portfolio to the International Energy Agency's 2°C scenario[22] as well as how our investment portfolio compares to the market[23]. This analysis focuses on the most carbon intensive sectors for which energy transition risk can be estimated. We have fed this analysis into investment strategy reviews of our businesses. Our £3.8bn unlisted infrastructure investments in renewables are not captured in this analysis.

Figure 14: PACTA analysis as at 30/11/2019 for Aviva's shareholder funds invested in the utilities sector. Source:PACTA.

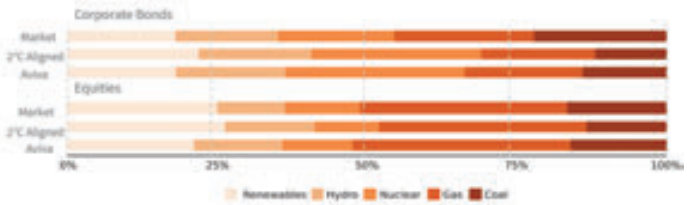
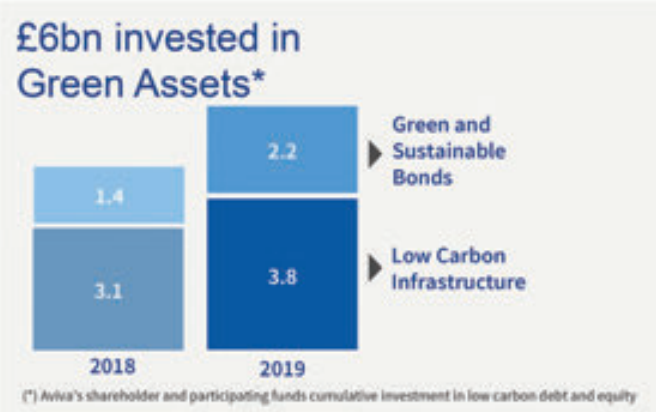


Figure 14 provides insight into the transition risk by looking through to the mix of energy sources (for example coal, gas, nuclear, hydro and renewables) used by the utility issuers of the corporate bonds and equity securities that we hold. This analysis demonstrates that our current investment portfolio of utilities is not fully aligned to the 2°C scenario, but it is generally better or aligned with the market as a whole.

Investment in Green Assets

Figure 15: Investments in Green Assets. Source: Aviva.



Increasing our investment in low carbon and renewable energy generation capacity is a significant opportunity. In July 2015, we announced an investment target of £500m annually for the next five years in low carbon infrastructure (i.e. investing £2.5bn in low carbon infrastructure by 2020). We have already achieved our 2020 target. Aviva has invested £6bn in green assets since 2015, £3.8bn in low carbon infrastructure, £2.2bn in green and sustainable bonds.

In 2019, we invested £717.3m into wind, solar, energy from waste and energy efficiency projects. This level of investment in renewable and low carbon energy generation supports the transition to net zero and will create more than 159,000 tCO_2e savings.

19 Scope 1 – All direct emissions from the activities of an organisation or under their control. Including fuel combustion on site such as gas boilers, fleet vehicles and air-conditioning leaks.

20 The Climate Action Tracker is an independent scientific analysis tracking government climate action since 2009.

21 The MSCI (Carbon delta) "Full Universe" of 9,800 companies.

22 The Sustainable Development Scenario (SDS).

23 The equity market is represented by all securities from publicly listed companies and the corporate bond market by all companies with outstanding debt from Bloomberg at the end of 2018.

Physical risks and opportunities

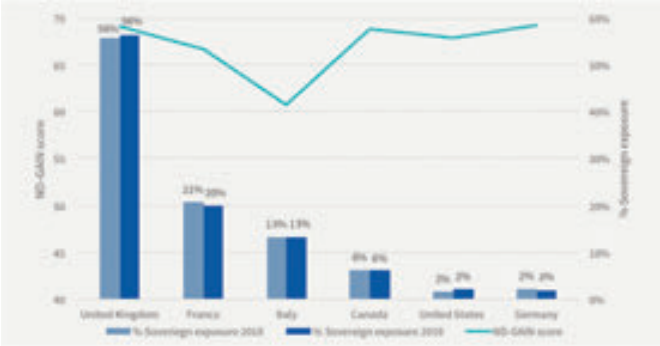
For physical risks and opportunities, the metrics and tools used include:

- Monitoring of sovereign risk
- Weather-related losses

Monitoring of sovereign risk

Aviva uses Notre-Dame University's Notre Dame-Global Adaptation Index (ND-GAIN) to measure our sovereign holdings exposure to climate-related risks (see figure 16). ND-GAIN measures a country's vulnerability to the physical effects of climate change and its overall readiness (by considering economic, governance and social readiness). In addition to our risk monitoring, we engage around the world with finance ministries on climate change mitigation and adaptation/ resilience and will continue to increase our profile in this regard.

Figure 16: Aviva's top sovereign holdings shareholder funds versus ND-GAIN (ND-Gain index 0-100 Higher is Better) as at 30/11/2019 compared to YE18. Source: Aviva/ND-GAIN 2017.



For sovereign bonds, Aviva is predominantly exposed to sovereigns from developed markets. Aviva has no significant exposure to countries highly vulnerable to the physical effects of climate change and our exposure to moderately exposed countries is captured as part of our risk management and monitoring of sovereign risk. Aviva has also no material exposure to sovereigns whose credit quality is reliant on oil and gas production.

Weather-related losses

Aviva is dedicated to help our customers protect their home. For many years, we have carried out cost neutral repairs following a flood. We have also played a key role in the launch of a new Code of Practice – a series of industry-backed guidelines – created to give homeowners the knowledge to stay flood resilient. In addition, we have trained our field claims teams as well as our surveyors to advise on property flood resilient measures.

We recognise that weather-related events may become more frequent, severe, clustered and persistent. The speed of this change and the ability of society to adopt mitigation strategies may impact our ability to profitably provide products for our customers at affordable levels over the longer term. This has driven a focus on explicitly considering the impact of extreme weather events in financial planning and pricing, using catastrophe model results supplemented by in-house disaster scenarios.

Our general insurance business exposure is limited by being predominantly in Northern Europe and Canada. We require our general insurance businesses to protect against all large, single catastrophe events by purchasing reinsurance in line with local regulatory requirements or, where none exist, to at least a 1-in-250-year event. The catastrophe reinsurance programmes limit Aviva's losses depending on territory from a relatively low retention level (£150m on a per occurrence basis and £175m on an annual aggregate basis) up to at least a 1-in-250-year event. Factors determining these decisions include capital efficiency, appetite for general insurance earnings volatility and reinsurance market competitiveness. Aviva Canada is moving to requiring reinsurance cover up to at least the 1-in-500-year level, in line with government requirements.

In the medium to longer term, there is potential for the premiums we need to charge to cover our risk exposure to increase in line with intensity and frequency of extreme weather. Looking across all of our property insurance portfolios, the proportion of property insurance premiums attributable to weather-related losses is currently quite small, so the impact on premiums would be correspondingly low. Naturally there are areas at higher risk, which would see disproportionate increases in premiums. In those cases, we consider that the continued presence of industry wide initiatives like Flood Re in the UK and development of risk mitigation techniques would be vital in ensuring widespread access to insurance for all.

Figure 17: Actual weather-related losses versus expected weather losses by year and business unit (net of reinsurance). Source: Aviva.

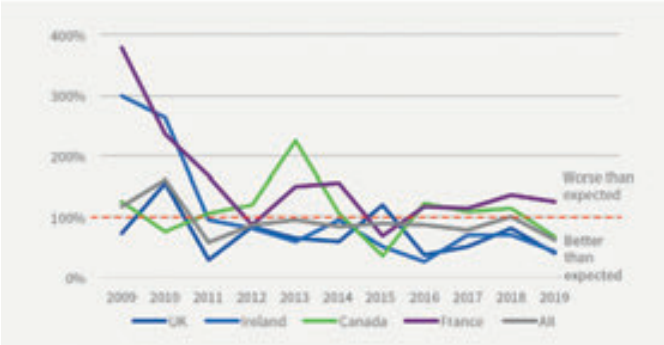
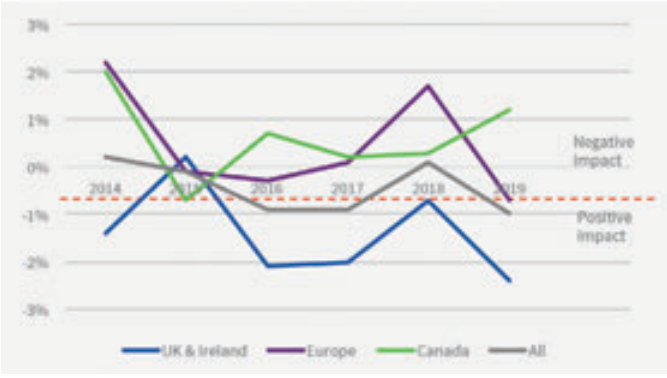


Figure 18: Weather impact on Aviva's Combined Operating Ratio (COR) (net of reinsurance). Source: Aviva.



A change in climate can also mean that disease may spread to new and expanded geographic areas. Aviva uses external reinsurance for its life business to manage its exposure to life insurance risks and to manage capital in an efficient manner in line with the Aviva Group's risk appetite.

In Real Assets, physical climate-related risks are assessed at the point of origination through technical analysis and due diligence. Our origination teams use flood risk modelling programmes to assess the level of risk to an asset or location as part of the underwriting process for all transactions or use technical advisors to undertake surveys. Where a building or infrastructure asset is shown to have high levels of flood risk, the transaction is referred to the Aviva Investors Global Responsible Investment team for additional due diligence. In addition to assessing historical flood risk in each transaction, the Real Assets team work closely with climate specialists in the broader Aviva business, undertaking forward looking assessments of the flood risks for the transaction and the portfolio. These assessments supplement the assessment of the climate-related risks to the portfolio on an annual basis which covers the flood modelling and the chronic climate-related risks such as sea-level rise and heatwaves. In 2018 this study analysed risk exposure in commercial mortgages, and in 2019 was extended to include all managed real estate.

Litigation

Climate change litigation is increasingly viewed as a tool to influence policy outcomes and corporate behaviour and could encourage some companies and investors to give greater consideration to climate risk. Yet there is currently insufficient evidence of the impacts of climate change litigation on corporate behaviour (see Global Trends in climate change litigation, 2019 snapshot, Setzer and Byrnes). Aviva monitors its potential exposure to climate-related litigation in a number of ways alongside other climate change-related risks.

There are two direct litigation trends that could affect Aviva. The first is litigation which seeks to get companies to increase their disclosure on climate change (physical and transition risks). In addition, this could extend to the climate-related risk of the assets in which the company invests, the impact of projects, and companies that the company finances.

Following initial, largely unsuccessful cases that were primarily about public nuisance, some have referred to an emerging "second wave" of climate litigation that focusses on alleged breaches of corporate law, misleading conduct, fraud, human rights and breaches of disclosure rules in listing and other corporate regimes. Shareholders, consumers and regulators around the world are showing an increased willingness to challenge companies that are perceived to have failed to take meaningful action in respect of climate change or have misrepresented the risks to which they are exposed and the action that they are taking. Aviva's best mitigation against the risk of such claims is the robust governance, due diligence and disclosure framework that it has put in place around its risk exposures to climate change as set out elsewhere in this document.

The second trend is litigation that targets asset owners, such as UK Life and General Insurance, or asset managers, such as Aviva Investors, in relation to the climate impact of their investments. The direct impact from legal challenges and any associated fines are likely to be limited to specific companies and the risk should be mitigated by diversification within our portfolio.

Aviva recognises the growing trend in climate-related litigation and has assessed its potential exposure to litigation risks accordingly. For example, the climate-related litigation risk posed to Aviva through the underwriting of directors and officers liability insurance has been assessed and considered to be low.

Aviva sponsors city bicycles in Lithuania
Credit: Sarah Regh

Conclusion

We will continue to integrate the assessment of climate-related risks and opportunities into our strategy, decision-making, risk management and reporting frameworks. In particular:

- Our updated climate change strategy will be launched this summer. We fully intend for this strategy to be an interactive process. It will be implemented as part of the Group Business Strategy and will be reviewed every two years, with the first formal review in 2022. These reviews will ensure we are on target as well as able to take corrective action, accommodate new scientific thinking and data, and incorporate further findings from our TCFD work.
- We will further develop the skills of our Boards and our people in this area across Aviva.
- We will develop our tools and approaches as well as metrics to assess the potential business impacts of climate-related risks and opportunities over a range of different time horizons. We fully anticipate that these approaches will evolve over time and improve in the light of new research, data and emerging best practice.
- We will work collaboratively with the UNEP FI, industry associations, sector peers, academics, professional bodies, external consultancies, regulators and international agencies including the Net Zero Asset Owner Alliance. Through these collaborations, we hope to promote use of comprehensive and effective tools and approaches that enhance both the quantity and quality of disclosures to make them as comparable and as decision useful as possible.
- We support and will participate in the PRA's 2021 Biennial Exploratory Scenario (BES). We believe this exercise will improve understanding of the resilience of the financial sector to climate risk.

Ahead of the 26th UN Climate Change Conference of the Parties (COP26) to be held in Glasgow, 9-20 November 2020, we will also be calling for the establishment of a finance-focused equivalent to the IPCC, which will help UN member states ensure that their public and private finance flows become consistent with the Paris Agreement's target as well as for TCFD climate-related financial disclosures to be made mandatory.

Aviva will provide over £200m of debt-financing towards new rolling stock for the West Coast Partnership rail franchise. This fleet of Hitachi trains will comprise of 135 vehicles and is based on bullet train technology, will be quieter and greener than the rolling stock they replace and are expected to reduce carbon dioxide emissions by 61% across the franchise.
Credit: Hitachi (Artistic Impression)

Appendix: Climate VaR Modelling Approach

Aviva developed a Climate VaR measure that enables the potential business impacts of future climate-related risks and opportunities to be assessed in each of the IPCC scenarios and in aggregate[24] .

Climate scenarios considered

The IPCC scenarios aim to measure the effect on the energy balance of the global climate system due to changes in the composition of the atmosphere from sources like greenhouse gas emissions, other air pollutants[25] and changes in land use. The four IPCC scenarios represent different Representative Concentration Pathways (RCPs) which describe the composition of the atmosphere at the end of the 21st century. Figure 19 summarises the link between the RCPs, potential temperature rises by 2100 and the level of mitigation required, which we will use to describe the scenarios in this report.

Figure 19: Mapping for RCPs, potential temperature rises and levels of mitigations. Source: TCFD.

RCP	Temperature rise	Description
RCP2.6	1.5°C	Aggressive mitigation
RCP4.5	2°C	Strong mitigation
RCP6.0	3°C	Some mitigation
RCP8.5	4°C	Business as usual (BAU)

Figure 8 also sets out implications for greenhouse gas emissions and potential temperature rise by 2100 for each scenario. Aggressive mitigation is the only scenario where it is more likely than not that the temperature change in 2100 will be less than 2°C.

Aviva developed this Climate VaR measure in conjunction with the UNEP FI investor pilot project, which developed models and scenario analysis tools to assess the potential impact on corporate assets and real estate of the four IPCC scenarios in conjunction with MSCI (Carbon Delta).

MSCI (Carbon Delta) is using the AIM/CGE model[26] from the Japanese National Institute for Environmental Studies (NIES)[27]. Whilst the scenarios reflect current scientific research and the Paris Agreement, there clearly remains significant uncertainty regarding future climate trajectories as well as political risk with respect to implementation of the Paris Agreement and Nationally Determined Contributions (NDCs)[28]. It is also important to note that the four scenarios all assume a gradual path, in which temperatures slowly rise but climate policy is ramped up at varying speeds with a fairly high degree of global coordination. They do not consider the transition risk in a more chaotic policy environment, where there is lack of global coordination and policy action is taken too late and too suddenly. This may result in an understatement of transition risk.

The MSCI (Carbon Delta) model and scenario analysis tools also allow consideration of the five Shared Socioeconomic Pathways (SSPs). These consider socio-economic characteristics including things such as population, economic growth, education, urbanisation and the rate of technological development. Within SSPs, scenarios can also be selected that represent early policy action or late policy action. The timing of climate action can represent orderly and disorderly transition pathways.

Time horizon considered for each scenario

In conjunction with the UNEP FI investor pilot project, it was agreed to use a single 15-year time horizon for the Climate VaR measure to analyse the impact of the different scenarios on our business but with the capability to consider transition effects over shorter time horizons depending on the business decision being considered. Consideration was given as to whether a longer time horizon was needed to capture the worst physical impacts of climate change, as these are not likely to manifest themselves until the second half of the century (see figure 20).

To address this point in a decision-useful way and ensure consistency with the 15-year time horizon for transition risk, it was agreed to look at a higher, 95th percentile of physical risks as well as the expected outcome in the BAU scenario over the 15-year horizon. Figure 21 shows large dispersion around the mean from the impact of climate change on coastal flooding over the next 15 years.

24 Aviva was awarded the Climate Risk Initiative of the Year 2020 by InsuranceERM

25 Daniel Vallero, in Fundamentals of Air Pollution (Fifth Edition), 2014.

26 The AIM/CGE model is a multi-regional, multi-sectoral, computable general equilibrium (CGE) model.

27 The National Institute for Environmental Studies (NIES) is a Japanese research institute that undertakes a broad range of environmental research in an interdisciplinary and comprehensive manner.

28 Intended Nationally Determined Contributions is a term used under the UN Framework Convention on Climate Change for reductions in greenhouse gas emissions that all countries that signed the UNFCCC were asked to publish in the lead-up to COP21.

Figure 20: Global average surface temperature change. Source: IPCC.

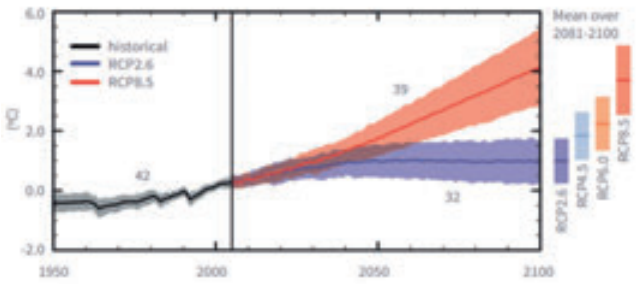
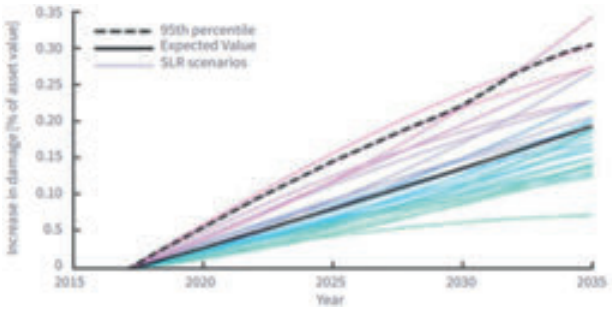


Figure 21: Example of coastal flooding. Source: MSCI (Carbon Delta).



Risks and opportunities covered

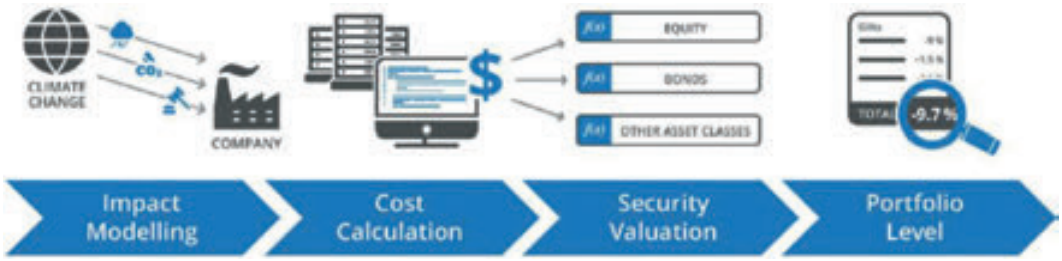
The modelling of transition and physical risks and opportunities specifically covers the projected costs of policy action related to limiting greenhouse gas emissions as well as projected profits from green revenues arising from developing new technologies and patents. In addition, it captures acute weather impacts such as coastal flooding and tropical cyclones as well as chronic impacts from gradual changes in extreme heat and cold, heavy precipitation and snowfall or wind gusts. Regional sea level rise is an important input to the risk model and constitutes a key driver of coastal flooding impacts. It is important to note that the changes in acute and chronic impacts can also have a positive as well as negative effect on individual companies or instruments (see figure 22).

Figure 22: Risks and opportunities covered. Source: MSCI (Carbon Delta).

Building Block Approach

To assess these risks and opportunities, a building block approach has been adopted (see figure 23).

Figure 23: Building Block Approach. Source: MSCI (Carbon Delta).



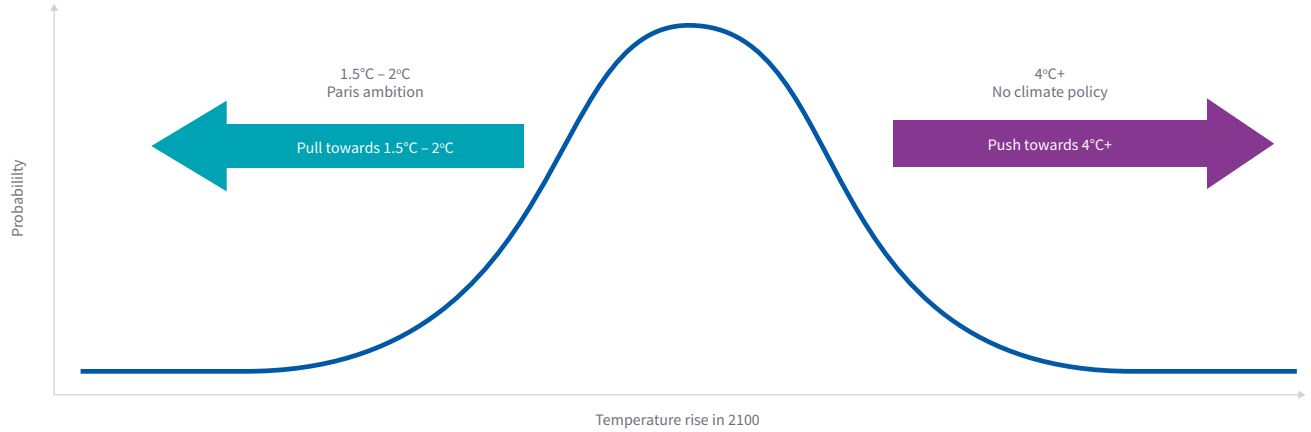
When assessing the impact of climate-related risks and opportunities associated with each scenario, different financial indicators need to be used and assumptions made. To assess the impact on market value of investments and the impact on reserves or premiums, for example, the following assumptions need to be considered:

1. The extent to which asset valuations, reserves and premiums already take account of the climate-related risks and opportunities in each scenario;
2. The likely timing of future changes to asset valuations, where not all of these climate-related risks and opportunities are currently considered;
3. Changes in our asset portfolio over time and the timing of such changes relative to the timing of any future market corrections to take account of these climate-related risks and opportunities;

4. The extent to which changes in costs over the next 15 years will be passed on to policyholders and/or sales volumes could reduce or increase for specific lines of business; and
5. The impact on reinsurance market capacity and pricing, as well as the creditworthiness of reinsurers, and the implications for our reinsurance strategy.

Finally, to assess the overall impact of climate-related risks and opportunities across all scenarios, the relative likelihoods or probabilities of each scenario need to be assigned. To do this Aviva considered amongst other things the current scientific analysis of the likely trajectory of emissions as well as policy commitments made by countries to reduce emissions (see figure 24).

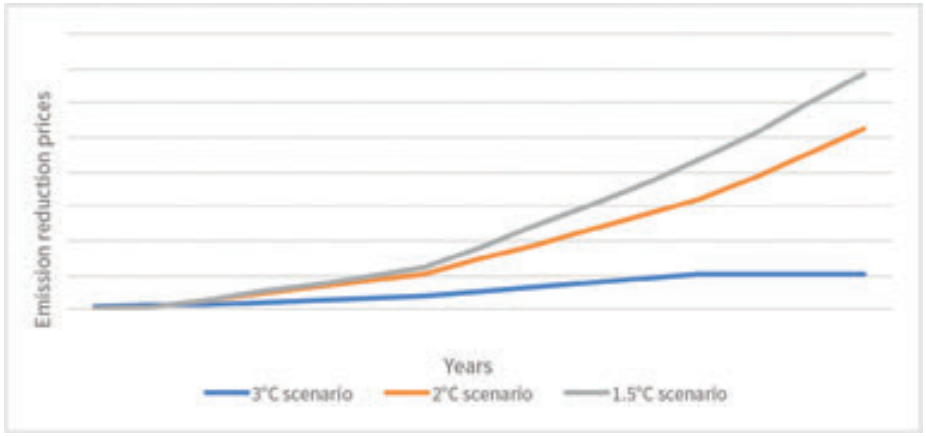
Figure 24: Most Likely outcome based on where we are. Source: Aviva.



Transition risks and opportunities

The financial impact of transition risks and opportunities are calculated relative to the BAU scenario (i.e. there are assumed to be no transition costs or opportunities in the BAU scenario, where current emissions are presumed to continue to rise at the current rate). The calculation covers both emission reduction prices (see figure 25) and revenues from new technologies.

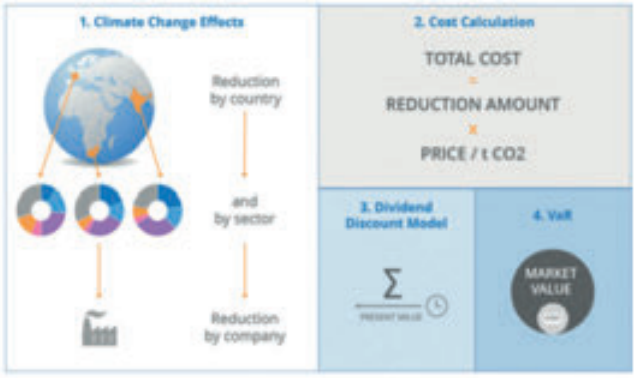
Figure 25: Emission Reduction Prices (2010 US$/tCO₂e). Source: MSCI (Carbon Delta).



Investments

The following high-level methodology is used to assess the potential downside risk from different transition scenarios on our investments (see figure 26).

Figure 26: High level methodology overview. Source: MSCI (Carbon Delta).



For both corporate bonds and equity securities the difference between the market value and the adjusted value after factoring in future climate change costs and/or revenues is measured (i.e. the impact relative to current climate conditions and emissions trajectory). To estimate the impact in a consistent way when a company has issued both shares and bonds, the Merton model[29] is used. This model enables the impact on a business as a whole to be translated into a change in value of its corporate bonds and equity securities. As both costs and opportunities are covered, the Climate VaR can be either negative or positive depending on the balance of future anticipated carbon-related costs and revenues for individual companies or instruments.

Carbon Delta has also developed a methodology for estimating the transition exposure of property assets which we have used for both direct real estate and real-estate-linked debt holdings. For infrastructure assets, Aviva plans to use the ClimateWise Transition Risk Framework to identify the key risk exposures across our portfolio of assets, taking into account how transition risk and opportunities vary by geography, sector and sub-sector to assess the potential impact in different climate scenarios. For example, a recent review of transport infrastructure highlighted strong potential opportunities.

Insurance liabilities

Aviva has assessed the impact on life insurance reserves from the potential reduction in mortality rates resulting from less air pollution in the aggressive and strong mitigation scenarios. This reflects an anticipated reduction in carbon emissions and an increase in electric vehicles replacing vehicles with internal combustion engines. For each transition scenario, there is potential for fewer deaths relating to air pollution. Although we note that this is very much dependent on the fuel mix generating electrical power for the grid. Whilst waste-to-energy plants have similar particulate outputs to gas-fired power stations, biomass plants such as wood pellet fired facilities, for their many positives, produce significantly more particulates than gas-fired power stations for example[30].

On the general insurance side, transition risks and opportunities may also arise. For example, the wider adoption of electric vehicles and the rise of car-sharing and automated cars might decrease the pool of vehicles to be insured leading to a decrease in claims frequencies but also premiums. However, these effects have not been included to date. We plan to extend our modelling to cover general insurance transition risks and opportunities over time.

Physical risks and opportunities

The financial impact of physical risks and opportunities is based on an assessment of both the expected costs in the BAU scenario and the costs at a higher 95th percentile arising from hazards such as: extreme heat and cold, heavy precipitation and snow, coastal flooding, wind gusts and tropical cyclones. We use the expected costs and the costs at a higher percentile to define a distribution of physical risk outcomes for each scenario and thus capture some of the more extreme potential physical effects of climate change whilst using a consistent 15-year time horizon as that used for transition risk.

Investments

The physical risks on investments are generally going to be driven by the exposure of the facilities (buildings, plant, infrastructure) owned or used by the company who has issued the financial instrument, their "facilities", and the supply chain they rely on for producing their end product. We use the following high-level methodology to assess the potential physical risk from different scenarios on our investments in this regard.

29 Analysts and investors utilise the Merton model to understand how capable a company is at meeting financial obligations, servicing its debt, and weighing the general possibility that it will go into credit default.

30 Shakoor Hajat and others, in Climate change effects on human health projections of temperature-related mortality for the UK during 2020s, 2050s and 2080s, February 2014.

Figure 27: Impact modelling and expected cost estimate. Source: MSCI (Carbon Delta).

The cost (in figure 27) is built up by mapping the facilities onto a world map, with measures that define the facility's exposure to different extreme weather hazards, and then combining this with a vulnerability function that converts the exposure and an assessment of the physical hazard impact in each scenario into an estimated monetary cost, per facility.

For both corporate bonds and equity shares, the difference between the market value and the adjusted value after factoring in aggregated facility costs and/or revenues is measured. The costs and/or revenues to a business are measured relative to an assessment of physical risks under current conditions as these are assumed to be already factored into the market value. This business impact is then translated into a change in the value of its corporate bonds and equity securities using the Merton model.

Aviva recognises that the current approach does not capture the impact on companies' supply chains nor necessarily demand for its products and services or potential mitigating impact of insurance. For example, in the case of a major car manufacturer their real assets will mainly include their factories and machinery and possibly their dealerships. Their supply chain will be broad, complex and potentially geographically diverse and if disrupted it could adversely impact companies' costs and/or revenues. We will continue to work internally and with external partners to develop best practice in this area. For directly held real estate assets, real estate loans and infrastructure assets, we use the same approach described above. For directly held real estate the impact is carried directly against the property valuation. For real estate loans, we assess the physical climate change risk impact by running the stressed property value through our debt valuation models.

For sovereign bonds, the impact on the market value of a security is measured by assessing how a sovereign's rating could change as a result of the occurrence of different extreme weather hazards in each scenario. The following climate-related factors may impact sovereign debt: exposure and vulnerability to climate change; readiness and adaptation; ability to raise money for mitigation and post-disaster repair; ability to raise money via taxation and debt; reliance on foreign aid and support of the International Monetary Fund and other supra-national bodies. To assess a sovereign's vulnerability to climate change and readiness, the Notre-Dame University's Notre Dame-Global Adaptation Index (ND-GAIN) measure for country climate change risk has been used. We note that the assessment of sovereign debt is difficult because sovereigns are exposed to climate change via several vectors: government buildings and government owned infrastructure, cost of emergency relief to areas effected by climate-related disasters, aid and rebuilding costs and the cost of acting as insurer of last resort. So, the ND-GAIN data has been used to help support expert judgements about the appropriate stresses to apply to different sovereign bonds in our modelling at this stage. We will continue to work internally and with external partners to develop best practice in this area.

Insurance liabilities

The Climate VaR for life insurance risks calculates the impact on reserves of a change in mortality rates as a result of the occurrence of different extreme weather hazards in each scenario based on a review of academic literature linking climate change to potential changes in mortality rates[31]. For higher temperature scenarios, where climate change has dramatically taken hold, the picture is complicated. For example, it is possible that both summers and winters will be warmer or that seasons will in fact be more extreme. The latter is more likely to have an adverse impact and for the UK could plausibly result from the Gulf Stream changing its path and missing the UK.

On the general insurance side, the Climate VaR calculates the impact on premiums as a result of the occurrence of different extreme weather hazards in each scenario. The impact on premiums is then used to determine the impact on our business, considering the impact on pricing, sales volumes and our reinsurance strategy. During 2019 we have extended the scope of physical risks covered to different regions (UK, Canada and France) and various perils (flood, freeze, subsidence, wildfire, winter storm, hail and severe convective storm) noting that the precise list of perils is region dependent. We have worked with internal and external experts to consider how climate change could change the frequency and severity of UK flood and leveraged our existing catastrophe modelling capability to assess the impact of this on premiums.

31 Antonio Gasparrini and others, in The Lancet Planetary Health, Volume 1, Issue 9, Projections of temperature-related excess mortality under climate change scenarios, Pages e360-e367 December 2017.
Every breath we take: The lifelong impact of air pollution, Royal College of Physicians, 23rd February 2016.
Martin William and others, in The Lancet Countdown on health benefits from the UK Climate Change Act: a modelling study for Great Britain, The Lancet, May 2018.
Jessica Elkin and others, in Hot and Bothered report, Club Vita, 4th July 2018.

Aggregation of climate-related risks and opportunities

In conjunction with Elseware, a risk management and quantification expert consultancy, we have used a Bayesian Network[32] methodology to aggregate all the component parts of our exposure to derive an aggregate view of the impact of climate-related risks and opportunities. The attraction of this approach is that we can combine a set of beliefs, expert judgements, internal data and external data to assess the potential impact of these risks, on an aggregated basis. We can then determine an overall Climate VaR for each scenario (see figure 28).

The impact distributions of each climate scenario are then combined to give a fully aggregated result across all four scenarios. This final step of aggregation uses the assigned likelihood given to each scenario taking into consideration amongst other things the current scientific analysis of the likely trajectory of emissions as well as policy commitments made by countries to reduce emissions (see figure 29).

Figure 28: Aviva's aggregation process for each scenario. Source: Aviva.

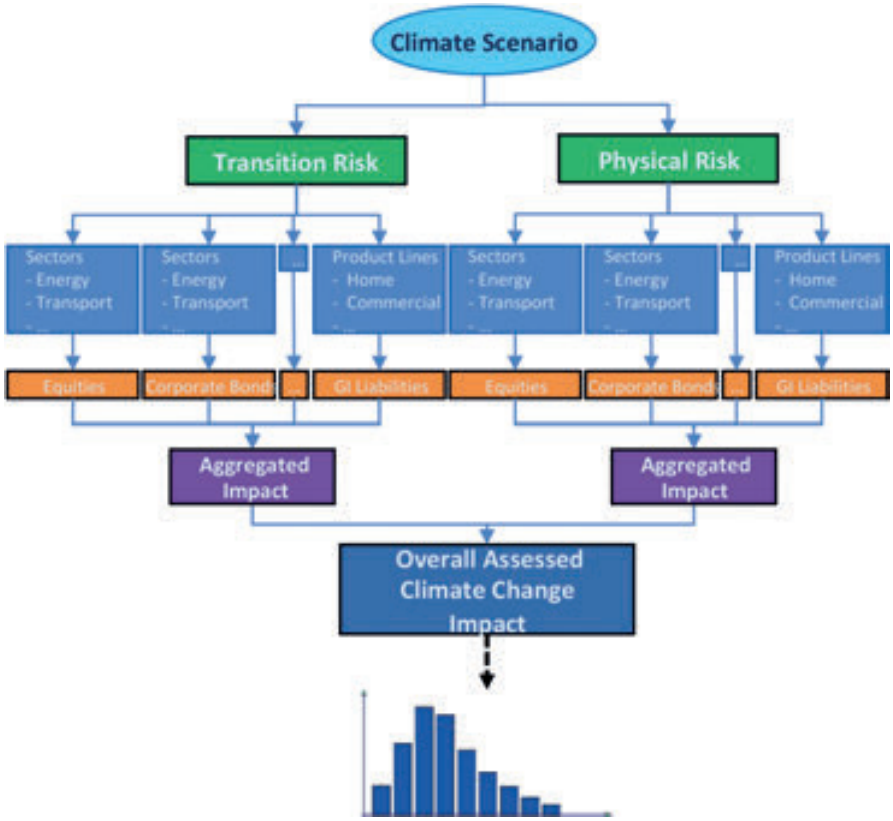
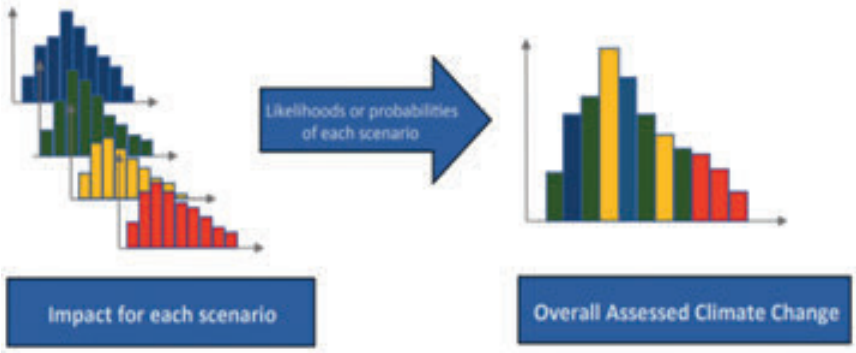


Figure 29: Overall assessed climate change impact. Source: Aviva.



32 Probabilistic graphical model that represents a set of variables and their conditional dependencies via a directed acyclic graph.

If you have any questions, please contact
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