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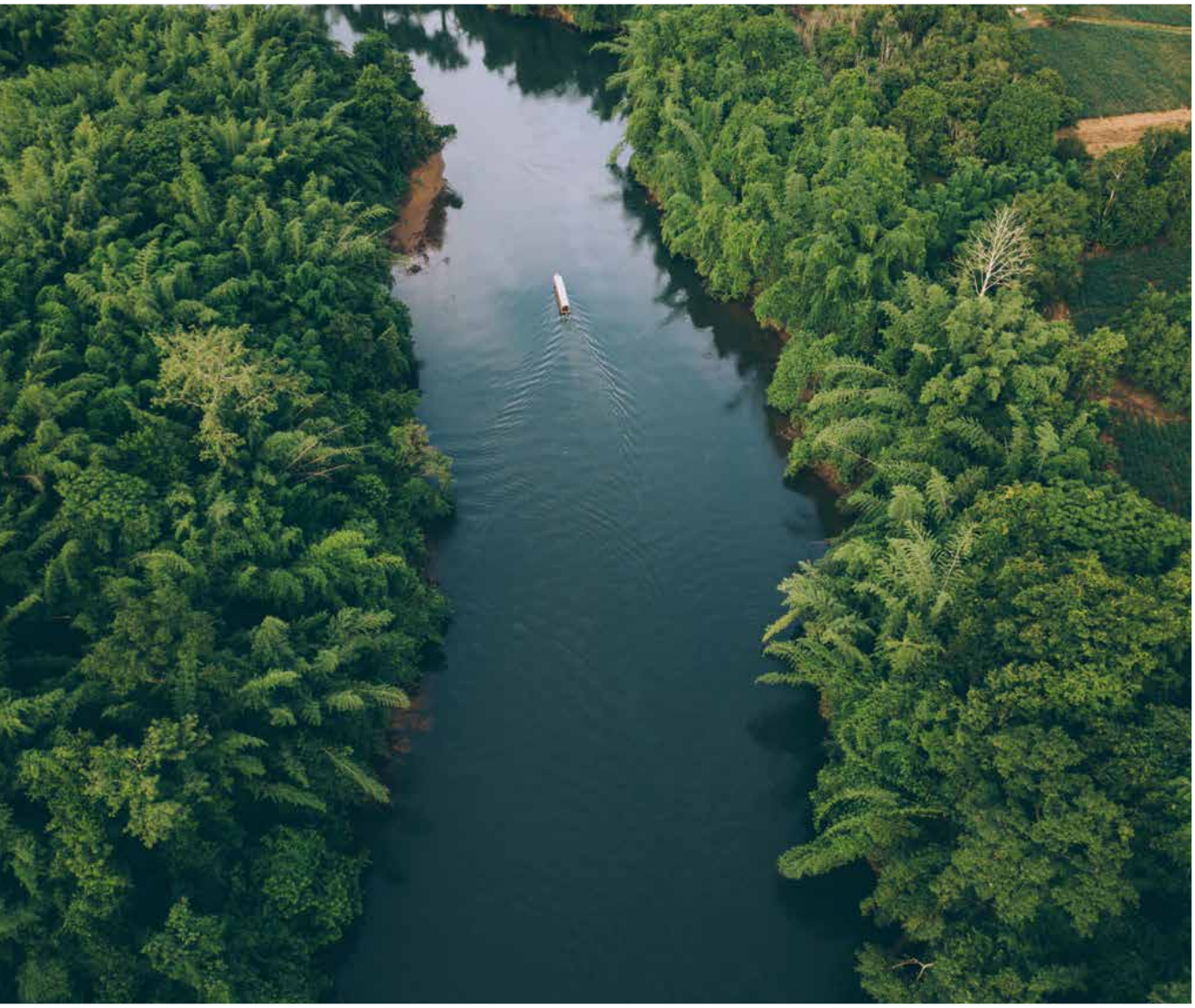

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How Climate Change Affects Insurance: A 2050 perspective

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A Introduction

The need to prevent climate change and the resulting sustainable transition of the economy have huge implications for insurance companies. Greenhouse gas emissions (GHG), in particular CO_2 emissions, have disrupted the mechanisms that stabilise the global climate leading to sea level rise and increasingly frequent extreme weather events. For the insurance sector, this implies an increase in both the frequency and amount of damages. The need for climate change prevention and mitigation measures is evident and many countries are starting a transition towards net zero. This transition, alongside other dynamic factors, particularly population and globalisation, will result in structural socioeconomic changes.

This paper examines what implications the changes in the socioeconomic environment caused by the transition to net zero will have for the insurance sector. Insurance companies play a big role in the sustainable transition of the economy both as underwriters and as asset owners. This paper focuses on insurers' role in non-life underwriting.[1] With regard to the time frame, the paper covers the period up to 2050. 2050 is a useful reference point to look at for several reasons: Firstly, the legally binding global climate change agreement of Paris has set the goal to limit global warming to well below 2 °C and pursue efforts to limit it to 1.5 °C by reducing green house gas emissions to net zero by 2050 (UNFCCC, 2016). Secondly, based on the Corporate Sustainability Reporting Directive (CSRD), which will enter into force gradually from 2025, companies are required to set net zero targets at a minimum by 2030, if possible also by 2050. In November 2024 the COP29, the 20th Conference of State Parties to the Convention will take place in Azerbaijan. Finally, 2050 is the benchmark used by the Intergovernmental Panel on Climate Change (IPCC) for its climate scenarios. Furthermore, the legally binding global climate change agreement of Paris includes the goal to limit global warming to well below 2 °C and pursue efforts to limit it to 1.5 °C (UNFCCC 2016). Based on this framework, greenhouse gas emissions need to reach net zero by 2050.

In this paper, the socioeconomic structural changes are examined through sector-specific scenario analysis. This suggests that the transition to net zero will favour key technologies such as green hydrogen, which will further stimulate the green economy. Agriculture, transport and building will be affected by changes in consumer preference and regulation in reaction to the climate crisis. The insurance sector will experience adjustment and possible growth in these sectors, as well as in more complex areas, such as pooled arrangements for electricity infrastructure performance risks. Furthermore, it has a key role to play in analysing the transition risks and supporting companies and communities in managing them. Climate change is already impacting the planet significantly and is likely to increase risks to human life in many vulnerable locations, including river valleys and coastal areas. In adjusting to the challenges and opportunities associated with climate change prevention, insurance will make a vital contribution by helping to manage risks and contributing to socioeconomic stability.

The insurance sector is directly affected by climate change in two ways. Firstly, there are increased risks for insured assets and related incomes, due to more frequent extreme weather events and to sea level rise causing inundation in some locations.[2] Measuring and anticipating these risks is challenging as extreme weather events are the result of complex changes occurring in global systems, especially ocean temperature effects, and the disruption of formerly stabilising mechanisms.

Secondly, as economies respond to climate change, there will be changing socioeconomic behaviours that affect insurance markets. In this paper we provide a classification of sectors covering a broad range of economic activities that could be affected. They include:

- Energy with implications for electricity and industry
- Agriculture (global food supply)
- IT and digital systems
- Buildings and constructions

[1] This paper does not consider Life & Health insurance or the impacts of climate-related events on insurance claims.

[2] The World Economic Forum estimates that Asian cities will be the worst affected by inundation in the short and medium term but cities in North America and Europe will also become affected (Muggah, 2019).

So far socioeconomic change has been slow with varying and increasingly polarised trends in public opinion.[3] The predominant scientific assessment is that we are in a global climate crisis which justifies radical government and corporate actions to reduce greenhouse-gas emissions and to adapt to the changing climate conditions. Recent studies come to the conclusion that climate "tipping points" are starting to occur, which will accelerate global warming and lead to irreversible changes.[4] For example, the dynamics of how the West Antarctic Ice layer will change will substantially affect global sea level projections. Research suggests that the threshold for irreversible loss of the ice layer will be triggered by an average global temperature rise of between 1.5 ˚C and 2 ˚C, as well as by changes in ocean temperatures and currents (Hulbe, 2020).

Governments are intervening through regulation and subsidies to encourage reduction in greenhouse gas emissions by companies. In this paper, expected regulatory changes are considered as part of transition risks in Chapter C. Furthermore, governments are investing in climate mitigation and adaptation, including alternative energy sources. They are also responding to related economic shocks, such as the currently high energy prices, to which drought is a contributing factor in some locations like China and the USA, leading to major reductions in hydro electricity supply (Murtaugh and Ding, 2022). Some research has suggested that European economies can adjust fairly easily.[5] However, the likelihood of significant structural and behavioural change is becoming more evident.[6]

Our analysis draws on research evidence, which we triangulate with other trend information referenced in this paper.

Predictions for 2050 are already numerous, with many researchers examining likely effects of the climate crisis,[7] including its economic impacts, and some forecasters highlighting other factors such as greater scarcity of food and water across large areas of the global south (Mukhi, 2020).

„What is the evidence base that is emerging and what is the prognosis for 2050?"

[3] For example, a 2018 European Social Survey of 44,000 responses found 40 percent or more respondents were very or extremely worried about climate change in just 3 of 23 countries and that there was greater concern about energy affordability (Poortinga et al., 2018). A 2022 global survey found that 40 percent of respondents were very concerned in just 6 of 31 European countries (Leiserowitz et al., 2022). A 2020 survey in Japan found that 56 percent of respondents wanted more government action on climate. The figure for India in the same survey was 37 percent (Funk et al., 2020).

[4] Armstrong McKay et al. evaluates nine global "core" tipping elements which contribute substantially to Earth system functioning and seven regional "impact" tipping elements which contribute substantially to human welfare.

[5] "A well-designed package, consisting of more extensive carbon pricing across EU countries and sectors, combined with cuts in distortionary taxes and targeted green investment support, would allow the EU to reach the emission goals with practically no effects on aggregate income" (Chen et al., 2020).

[6] The IMF refers to this as" the transformation of the global economy" although net effects on employment, for example, may be positive (Bergant et al., 2022).

[7] See for example (Figueres, 2020).

The IPCC examines changes in climate, including causal factors and likely impacts as well as adaptation and mitigation measures. One of the factors contributing to changes in economic activities is the falling unit cost of several low-emission technologies. Since 2010, unit costs of solar energy have decreased by 85%, of wind energy by 55%, and of lithium-ion batteries by 85%. The decreases in unit costs will probably be sustained, so that the continuous increases of deployment of low-emission technologies will have a large impact on mobility and transport, the energy sector and the buildings sector. The largest increase in deployment is currently seen in global investment and production of electric vehicles (EVs). Digital technologies will improve energy management in all sectors and will lead to a different energy system characterised by decentralised renewable energy (IPCC,2022b).

The IPCC also analyses related consequences for socioeconomic trends. The report "Climate Change 2022: Mitigation of Climate Change"[8] considers several scenarios. In this paper we reference three modelled ("C1") scenarios that assume global warming is limited to 1.5 °C by 2100. This is considered to be achievable with currently available technologies (IPCC, 2022b).

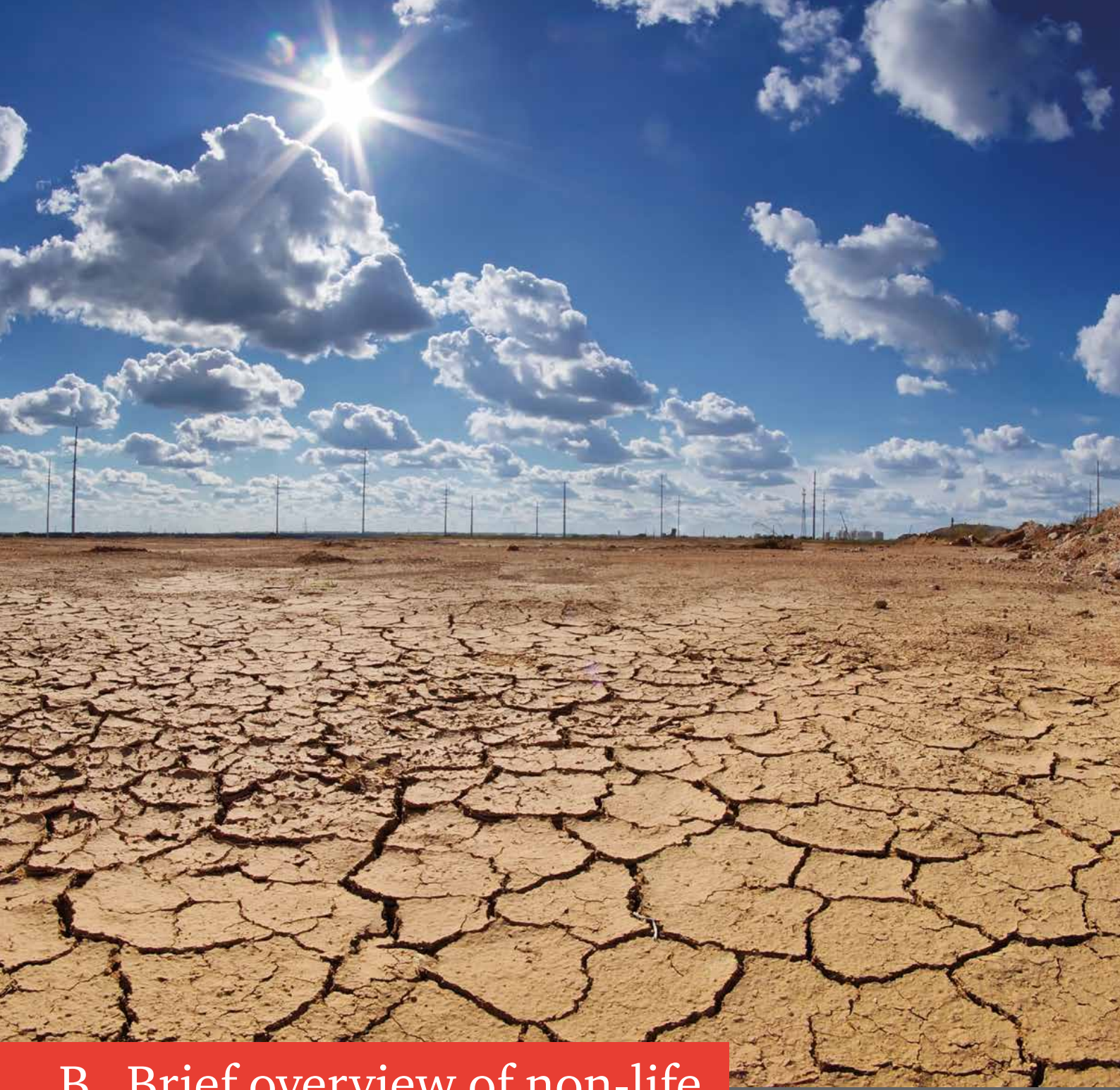
The IPCC's three C1 scenarios are a low energy demand scenario; a high renewables and electrification scenario; and a shifting development pathway scenario, giving greater priority to social welfare. All three scenarios involve significant socio-economic change as well as rapid and deep GHG emission reductions in all sectors (IPCC, 2022b). The technological and economic changes include transitioning from fossil fuels to very low- or zero-carbon energy sources, such as renewables or fossil fuels with carbon capture and storage (CCS), demand-side measures and improved efficiency. Compared to other sectors, the energy sector will require major transitions (reduction in fossil fuel use, use of low-emission energy sources, alternative energy carriers, and energy efficiency).[9]

Based on the evidence by the IPCC on the 2100 scenarios, what do we already know about 2050?

In the following chapters we will examine how the climate crisis and transition to a low-carbon economy will affect the global insurance business.

[8] see also Synthesis Report, Climate Change 2023: Synthesis Report, https://www.ipcc.ch/assessment-report/ar6/

[9] There are six additional categories in addition to the three C1 scenarios: "Category C2 comprises modelled scenarios that limit warming to 1.5 °C in 2100 with a likelihood of more than 50%, and exceed warming of 1.5 °C during the 21st century with a likelihood of more than 67%. In this report, these scenarios are also referred to as scenarios that limit warming to 1.5 °C (>50%) after a high overshoot. High overshoot refers to temporarily exceeding 1.5 °C global warming by 0.1 °C–0.3 °C for up to several decades". "Category C3 comprises modelled scenarios that limit peak warming to 2 °C throughout the 21st century with a likelihood of greater than 67%. In this report, these scenarios are also referred to as scenarios that limit warming to 2 °C (>67%)". "Categories C4, C5, C6 and C7 comprise modelled scenarios that limit warming to 2 °C, 2.5 °C, 3 °C, 4 °C, respectively, throughout the 21st century with a likelihood of greater than 50%. In some scenarios in C4 and many scenarios in C5–C7, warming continues beyond the 21st century" (IPCC, 2022b).



B Brief overview of non-life insurance markets

The global insurance market has been estimated to total $US 3.860 trillion of nonlife premiums in 2021, almost half of which is comprised of health insurance (49%), with about one quarter made up of commercial insurance (24%) and the other quarter of personal insurance (27%). Motor vehicle insurance amounts to about 21% of this total (Swiss Re Institute, 2022).

Global insurance-estimate by Swiss Re Institute, 2022

	Premiums $US billion	Percentage	Percentage
Health	**1,880**		**49**
Commercial	**930**		**24**
Property	260	7	
Liability	250	6	
Motor vehicle	180	5	
Other	240	6	
Personal	**1,050**		**27**
Motor vehicle	630	16	
Property	240	6	
Other	180	5	
total	**3,860**		**100**

Non-life global insurance markets are growing, with one report suggesting substantial business growth over the next five years (Hay and Longworth, 2022). Another commentator suggests that tech-driven innovation in telematics, artificial intelligence, machine learning and automation have huge implications for the insurance value chain" (Irbeck and McElhaney, 2022).

EIOPA considers current risks in the EU insurance sector as stable and medium, however indicating that there are vulnerabilities and potential risks in the real estate sector (EIOPA Risk Dashboard, 2024). Inflation rates are decreasing and the period of ultra-low interest rates has come to an end which could help insurance companies increase their resilience in the medium term, although it is still important for them to strengthen their liquidity preparedness according to the ECB (ECB Financial Stability Review, 2024).

C Impact of socioeconomic factors resulting from climate change

In this chapter we outline how the socioeconomic transition resulting from climate change and related measures and consequences will impact the insurance industry over the next 30 years. We contrast current settings with those that we expect to see in 2050. Although direct climate change impacts of extreme weather events on insurable risks are already apparent, they are not considered in this paper. We assume that the indirect impacts from transitioning to net zero will ultimately be more profound for the insurance industry.

This transition includes both climate responsive policies implemented by governments, as well as business, and household responses to the climate crisis. The transition which is often described as the move to net zero also includes action on other greenhouse gases, such as methane produced in agriculture.

While some transitions are a direct government response to the heightened risks from climate change, such as accelerated investments in alternative energies, other more opportunistic changes will emerge, such as widespread changes in vehicle ownership structures stemming from the move to electric vehicles and car-sharing models as well as greater use of public transport.

New areas such as technological innovations and commercialisation in areas such as carbon capture and storage, renewable energy generation and electrification of transportation provide opportunities as they will require similar insurance coverages as carbon intensive sectors (Golnaraghi, 2021).

Transition risks in financial markets include difficulties in pricing, due to the uncertainty that characterises the introduction of policies to prevent or mitigate climate change (Dunz, 2020, Tyson and Kennedy, 2022). Transition pathways are diverging around the world, with profound changes in consumer preference ultimately affecting the value of insured assets. The meat industry - which was impacted by the rising popularity of plant-based diets - is an example of this. A study of the European financial sector found wide divergence in returns for the firms studied under different climate transition scenarios, and variation in the impacts on financial systems in different European countries (Ojea-Ferreiro et al., 2022).

1 A 2050 scenario for global population and economic diversification

Global population growth is forecast to slow.[10] Global inequalities will remain very large, and inequalities within countries will persist. However, inequalities between countries, particularly between the global North and South, may diminish as the numbers of middle-income countries continue to increase (Chacel et al., 2022). However, for much of the population of the global South, insurance will remain unattainable due to poverty.

> We examine transition risks through the lens of two “meta changes” which are identifiable over the coming three decades leading up to 2050. The first are the effects from changes in global population implying new generational influences on innovation, with potential implications for asset ownership and insurance. The second relates to transport systems and mobility.

[10] The UN Department of Economic and Social Affairs, Population Division growth estimate for 2021 is 0.93 percent which is considerably below estimates for previous years.

Populations will become older in most high- and middle-income countries[11], but more people will work for longer. Generational differences will become much more accentuated. There could be a new industrial revolution led by younger generations who already use information technology in all aspects of their lives. Generation Y (Millennials) and Generation Z (born 1995–2009) are reportedly more interested in entrepreneurialism and in activism. One report suggests that as many as two-thirds of this age group aspire to have their own business (Schwabel, 2014). An US survey indicates that they are politically active on addressing the climate crises (Tyson et al., 2021). More acutely aware of the climate crisis, generations Y and Z are already starting to use smart technology to access sustainable transport, energy, food and recreation. They exploit at least three factors combining together dynamically over the coming period:

1. A strong moral imperative to rapidly move to a net zero economy, with demand for a different mix of goods and services, particularly transport and food[12] (Edwards, n.d.). A net zero economy includes additional environmental aspects such as biodiversity and ecosystem protection and restoration measures as well as the promotion of a circular economy. Examples include Norway's 92% EV share of their vehicle fleet (Holland, 2022). Regulations to increase plastic packaging recycling rates and recycled content, and laws to reduce single-use plastic, are becoming politically popular. In addition to the reduction of single-use products, there is also a rise in incentives by insurers for circular economy, meaning more recycling and reuse, instead of renewal. For the increased use of recycled products adjustments in supply and production chains are necessary. Other examples, such as urban energy generation and urban farming, are also attracting investment from Gen Y and Gen Z. Such a change in energy sources also means the expansion of urban energy production, e.g. solar parks. Additionally, urban farming and the development of lab-grown meats and substitutes may also become a new market field, which remains as-yet unexplored. This would lead to a growing demand in insurance products and an overall bigger insurance market for any of these products. Nonetheless, there should be an awareness of not only possible opportunities, but also possible risks, e.g. uncertainty in regards to harmful substances and resulting damages caused by their production.
2. Active engagement in the dynamic global marketplace for ideas through the World Wide Web. IT and digital systems are enhancing the accessibility of the global marketplace. Current trends are enabling rapid increase in capabilities and falling IT unit costs (Corbo et al., 2022). Cloud infrastructure has become very reliable, and many businesses are re-platforming to the cloud. There is also a push towards better networks – 5G is being rolled out, and 6G is on the horizon, leading to even more power in phones, cars, and wearable devices. Growing computer power is enabling us to create smarter devices, including more intelligent robots that can work alongside humans to complete more tasks (Marr, 2021). These developments will facilitate the creation of new global market places and ecosystems.
3. Living in urban environments, with both flexible working and strong social interaction. Millennials seek easy travel and are prepared to pay a premium for walkability (Voegeli, 2020). Large cities have agglomeration advantages that lead to higher productivity and an innovative environment (Harris and Moffat, 2021). On the other hand it will be important to keep rural areas attractive, as dense urban areas also have negative sustainability impacts, e.g. higher construction costs.

[11] World Bank reporting for example shows China as an upper middle-income country.
[12] In the US only 2.5 percent of Americans over the age of 50 consider themselves vegetarian, 7.5 percent of Millennials and Gen Z have given up meat (Statista, 2022). In Comparison in France 10 percent of Gen Z are vegetarians (Trenda, 2022).

Impacts on Insurance

The virtual industrial revolution provides insurers with metadata and very rapid IT analysis to understand specific customer behaviours and needs. Insurance businesses will use AI to price and sell products. Enhanced information about client behaviour and risk will help insurance companies manage costs and offset some of the additional costs associated with rising business-disruption claims in the lead up to 2050 (C40 Cities, n.d.). In addition, significantly improved data in the future will offer both opportunities and risks. The trend towards individual insurance policies and premiums based on the actual behaviour of customers (stronger pricing according to life circumstances e.g. climate friendly lifestyle or driving behaviour) will increase and offer new opportunities. However, the trend to increased individualisation will have to be balanced with the benefits of a certain degree of collectivisation of risks, as otherwise some individuals or areas might become uninsurable due to climate risks. On the other hand, there is the possibility that costs and effort associated with developing new products for specific circumstances as demanded by younger generations will increase in connection with data processing and the acquisition of know-how for the use of new technologies and new types of cooperation e.g. with device manufacturers.

There are not only opportunities and risks arising from the virtual industrial revolution in regards to existing products, but also products or even entire markets emerging from this change in societies and economies. This can be seen in different levels of intensity, starting from existing technologies like cloud-based implementation of data management, which already plays a big role in most companies and also society. Despite this, development and expansion continue, leading to potentially new insurance needs and products. However, entirely new technology is also emerging with no existing knowledge on the subject whatsoever. The biggest trend concerning this is AI (artificial intelligence) with a huge variety of use cases. Technologies like this will pose a big challenge for insurers, with no reliable data on possible damages, claims or even the possibilities of insuring new technologies being available.

A second impact is that new business collaborations will form much more rapidly, thus making it more difficult for insurance to strictly define the scope of business being insured with a business client. Nevertheless, insurance undertakings need to understand the business models and, in particular, the growing dependencies and interconnections of the insured businesses in order to expand underwriting practices (incl. technical know-how) and appropriate pricing accordingly.

Thirdly, the mix of personal insurance business will evolve with a low carbon economy, including different asset ownership preferences of younger generations. Private property which is well insulated and has solar cells to supply electricity to the grid, will be in high demand, but insured at a premium due to its complexity - at least this is what we are facing today. It may take time to build up consumer acceptance of this greater variability of insurance premiums in what some might choose to see as the same market. In the near future it is conceivable that some insurers will take this trend as an opportunity and respond with innovative solutions, e.g. premium discounts instead, in order to fulfill customer expectations and remain attractive to the market.

Summary

The population scenario analysis shows some underlying changes that involve generation-specific attitudes and values. Public attitudes influence the cost of the transition. This is because the speed and extent with which measures are introduced will affect emission levels and resulting climatic impacts. The population scenario suggests that by 2050 (i) the way we produce, transport and trade goods will change in order to reach climate neutrality, (ii) the modalities and the location of trade will change to dynamic virtual global market places and (iii) the living conditions and social interactions will change, e.g. climate-friendly housing and transport.

2 A 2050 scenario for transport and mobility

By 2050 most jurisdictions will likely have regulations in place to discourage the purchase of petrol and diesel-powered vehicles. These regulations are designed to change behaviour quickly, and in some areas, radically. This is because transport is an area where government interventions can directly make a substantial difference to reducing greenhouse gas emissions. Because of this, many carmakers have plans to electrify their fleets which go further than policy targets.

The success of EVs is being driven by multiple factors. Sustained policy support is the main pillar. Public spending on subsidies and incentives for EVs nearly doubled in 2021 to about $30 billion. Nearly 10% of global car sales were electric in 2021, four times the market share in 2019. The increase in EV sales in 2021 was primarily led by the People's Republic of China ("China"), which accounted for half of the growth. In China, electric cars are typically smaller than in other markets. This, alongside lower development and manufacturing costs, has contributed to decreasing the price gap with conventional cars. In 2021, the sales-weighted median price of EVs in China was only 10% more than that of conventional offerings, compared with 45% to 50% on average in other major markets (International Energy Agency, 2022).

Globally EV car numbers will reach 30% of the total car fleet by 2050, according to estimates by the US Energy Information Administration (Wiklund, 2022). Across the EU, battery electric cars and plug-in hybrids are, on average, currently just 0.5% and 0.6% of the fleet (ACEA, 2022). Sales in the EU are forecast to double in the next five years (Statista, n.d.).

Change will initially be slow, due to the importance of private car ownership for many people. A percentage of the public will buy electric cars or electric bikes, while others will make the switch to public transport[13]. But it is not only private households that are switching to electric cars; the share of battery-electric public transport buses across Europe also increased from 14.8% in 2020 to 21.7% in 2021 (Mathey et al., 2022). China accounts for 95% of new registrations of electric two- and three-wheeler vehicles, and 90% of new electric bus and truck registrations worldwide. Electric two- and three-wheeler vehicles now account for half of China's sales. The speed of charging infrastructure roll-out in China is faster than in most other regions (International Energy Agency, 2022). Switching to bicycles and public transport will in time lead to a significant reduction in private car ownership, which is a large component of the insurance market.

By 2050, hydrogen and other new fuels will be used to power at least some part of the fleet of trucks, buses, possibly planes, and ships. So far hydrogen energy has been proven as a viable fuel source in some situations. Currently 50 U.S. fuel stations provide hydrogen to support the more than 12,000 hydrogen fuel cell-powered vehicles and nearly 70 buses on the road (Office of Energy Efficiency & Renewable Energy, 2022). The EU is encouraging the introduction of hydrogen powered vessels on inland waterways (European Commission, 2022).
There is clearly some growing flexibility in transport and mobility systems. IEA reports that CO_2 emissions from the global transport sector fell by over 10% in 2020, during the height of the pandemic. They estimate that to achieve net zero by 2050, scenario transport sector emissions will need to fall by 20%.

[13] Extensive mass transportation networks have proven essential (Verma, 2021).

Another key trend affecting mobility is that by 2050, roughly 68% of the global population will live in urban centres[14]. That amounts to 6.6 billion people, or an increase of 2.2 billion from today, i.e., almost all of the population growth between now and 2050 will happen in cities. Therefore, urban communities have a dominant influence on markets, savings, and investment including transport. Generations Z and Alpha will work at a computer screen and choose to live in urban areas but will expect considerable social interaction in public spaces such as cafes. (Williams, 2021). People in cities in some jurisdictions will see advantages in car-sharing, short-term renting and bike hire programmes, as well as largely relying on public transport. Car sharing in 2022 accounted for around €3 billion and is steadily growing (Heineke at al., 2022). Additionally, working from home, within walking and cycling distance of amenities, will become commonplace. This will mean substantially fewer cars in cities and lower rates of ownership.

Impacts on Insurance

One impact on insurance is the sinking demand for fossil fuels due to an increased environmental awareness of customers which will lead to a smaller demand for insurances of fossil fuel companies. If extraction, storage, transport or usage of facilities for fossil fuels becomes limited due to government intervention, this will lead to extreme losses in insurance volume. Whether gradually or abruptly, a shift towards sustainable energy production will take place.

The surge of sustainable energy and transportation will also lead to a sinking demand for insurance for privately-owned cars. Increasing use in public transport and sharing models will lead to increasing insurance rates for the private transport sector, since there is less diversification in these products. On the other hand, demand for public insurance will rise and local governments will take on more at-risk assets requiring insurance (Rogers, 2020).

Additionally, the demand for energy of any sort will redistribute with consumers having the ability to produce the energy they need by using privately owned photovoltaic systems. There could even be an overproduction of privately produced energy, which can be put back into the energy network, powering facilities outside of private households. Insurance companies will need to adapt to these changes accordingly, with a higher demand for private energy production. As further discussed in Chapter D.1, there is also a growing demand in alternative and sustainable investments in energy production by governments. Both of these factors will drive the interest of insurers to demand newer and better energy efficiency standards in order for them to supply insurance products to customers.

Summary

The scenario for transport implies that mobility will become more strongly dominated by public transport supported by EVs and scooters. In this scenario, the size of the insurance market for vehicles will be smaller than at present. New ownership structures will emerge in sectors such as transport and energy. In transport, shared ownership and shared use of vehicles will become common. These changes will have an impact on insurance industries, such as an increased need for insuring local government assets, as well as a plateau and decline in private car insurance. In addition, the risk profile of some asset classes will be novel, for example in transport, there will be many self-drive EVs.

[14] Extensive mass transportation networks have proven essential (Verma, 2021).

D Sector-specific climate change effects

In this section we examine sector-specific effects of climate change and their implications for insurance by mapping key trends by 2050. We focus on the four sectors which are most relevant for the reduction of greenhouse gas emissions: global food supply, energy with implications for electricity and the industrial sector, IT and digital systems, as well as buildings and construction.

1 2050 trends for energy with implications for electricity and industry

2050 trends for energy

Key Drivers

- Major shift in energy generation from fossil fuels towards renewable and low-carbon sources, but regional differences will be significant
- Energy generation, transmission and storage will be more decentralized and digitalized (e.g. smart grids) in order to cope with fluctuations in supply
- Significant government and private sector investments in energy infrastructure (energy generation, efficiency)
- Governments will have a greater investment and guarantor role to reduce risk (e.g. nuclear energy plants)
- In the Net Zero Emissions by 2050 (NZE) Scenario, electrification advances more rapidly, enhancing the efficiency of the energy system and resulting in a decline of 1.2% per year in primary energy consumption until 2030 (IEA World Energy Outlook, 2023)
- Further investments in material efficiency, recycling and additional decarbonization through carbon capture and storage (CCS) and utilization (CCU) and green hydrogen

Impacts on Insurance

- Substantial increase in stranded assets due to transition risks (e.g. diesel vehicles)
- Liability, such as product design and climate change liabilities, will be a major issue for the insurance sector and will come with an increase in litigation activities
- Significant growth opportunities for insurers as there will be new energy suppliers and new markets (e.g. energy storage)
- Supervisory authorities will closely monitor the risk management capabilities of insurers, in particular for climate and environmental risks. Closer monitoring means a necessary adjustment of risk management policies for insurance companies

The trend for energy and electricity points to major changes in energy supply and demand. A centrepiece will be a rapid expansion of renewable energy generation, transmission and storage. The transition of the sector will involve extensive investments, with pricing determined through the electricity supply network. Another priority will be material efficiency, recycling and additional decarbonisation through carbon capture, storage (CCS) and utilization (CCU) as well as hydrogen. The analysis highlights the importance of green hydrogen to transition high carbon energy user industries such as steel. Storage and sequestration by large companies will incentivise investments by small energy suppliers. Innovations and scaled-up energy storage will reduce demand while the global population will grow. Government intervention and private investment will go hand in hand to stay on track on the net zero pathway until 2050.

Key Drivers

Both energy supply and demand will have changed substantially by 2050. The energy sector is currently the source of around three-quarters of greenhouse gas emissions, and more rapid action to reduce use of coal in the energy sector will be crucial to averting the worst effects of climate change (IEA, 2021). However, the US Energy Information Administration forecasts that oil and gas will continue to be the dominant energy source in the US until 2050 and beyond, but renewables will grow rapidly (EIA, 2022). A milestone towards the long-term net zero target in 2050 is the year 2030, where the world economy is predicted to be some 40% larger than today but uses 7% less energy. In order to reach the 2050 net zero target, the IEA therefore calls for scaling up solar and wind rapidly this decade, reaching annual additions of 630 gigawatts (GW) of solar photovoltaics (PV) and 390 GW of wind by 2030, four-times the record levels set in 2020 (IEA, 2021). For solar PV, this is equivalent to installing the world's current largest solar park roughly every day. Hydropower and nuclear, the two largest sources of low-carbon electricity today, provide an essential foundation for the transition.

Across Europe, distributed energy generated by private industry will be a major source by 2050. This will be helped by artificial Intelligence (AI) that leverages decentralised renewable generation sources. Such AI is already in the market (Lagarrigue, 2021). Electricity grids will be denser, will make extensive use of information technologies[15] and will be more internationally connected[16], to help manage fluctuations in supply. As the electricity sector becomes cleaner, electrification emerges as a crucial economy-wide tool for reducing emissions. Electric vehicles (EVs) go from around 5% of global car sales to more than 60% by 2030 (IEA, 2021).

On the demand side, industry will have responded to higher energy costs through innovations in production technologies, while also being influenced by investments in green energy as an accelerator. In the IEA net zero emissions pathway presented above, global energy demand in 2050 is around 8% smaller than today, but it serves an economy more than twice as big and a population with 2 billion more people (IEA, 2021). Both industry and government will invest in energy storage to help address the supply fluctuation problem. The economic transition means that most governments[17] will have a greater investment and guarantor role in some important areas of insurance, the energy and electricity sectors being a prime example. Increased occurrence of extreme climatic events causing economic disruption will prompt some governments to intervene to help reduce risks. For instance, in 2021 the British government announced a major new nuclear energy plant with government support, including government indemnity as "insurer of last resort" (World Nuclear News, 2021).

As many governments will invest heavily in alternative energy sources, they also look to the private sector to similarly invest (IEA, 2021). Market research shows that globally, private investment in renewables has grown significantly over the past decade to be the largest subsector of investment in 2020. Since 2010, it has more than doubled its share of private investment in infrastructure, from 21% to 47% (Global Infrastructure Hub 2022). In addition to energy generation,

[15] IT and digital use includes "public EV charging infrastructure, transmission and distribution automation, networking and communications, analytics (asset performance management, power quality and grid operations), smart meters, advanced distribution management systems, energy management systems, transmission line sensors, vegetation management, dynamic line rating and digitalisation of power transformers and substations" (IEA, 2022).
[16] Such connectivity is described as "large-scale interconnectors".
[17] This is not the situation in Japan where businesses carry substantial self-insurance (Takami, 2016).

companies will also invest substantial sums to reduce energy costs and emissions. This includes investing in an emerging "energy efficiency and use" sector, such as investments in building efficiencies (IEA, 2022).

The steel industry will invest heavily in the production of green hydrogen and blue hydrogen as energy sources, as a report from the World Economic Forum highlights. One European steelmaker recently said it will invest up to $40 billion to make this transition (World Economic Forum, 2022). Changes will be incentivised by innovation and consumer preference for products made with green steel. There may also be UN anti-pollutant agreements, similar to the Montreal Protocol. The EU Carbon Border Adjustment Mechanism is a possible precursor to this type of agreement.

Coal is the largest source of electricity generation, the second-largest source of primary energy (after gas) and the largest source of energy-related CO_2 emissions (IEA, 2022). By one estimate, coal energy use will have fallen to about 2% of total energy final consumption, and oil to 4%, by 2050. Oil and coal will be largely superseded by electricity systems powered by natural gas, nuclear power and by alternative energies. Use of natural gas will be offset by carbon storage in sequestration. Hydrogen energy will contribute about 12% of total energy consumption (IRENA, 2021).

Impacts on Insurance

First, major transition risks – such as policy changes or carbon-pricing – will have an impact on all sectors, but energy stands out. There will be substantial stranded assets in the energy sector as it moves from use of carbon-based fuels to sustainable sources, including solar and wind. Noteworthy examples for climate-related stranded assets, which will impact the insurance business, are industry plants, gas or diesel vehicles, and aircraft (CRO Forum, 2022). This almost complete wipeout of fossil-based industries leaves companies in these sectors with no other choice than transitioning their business to future-oriented methods of producing energy, also presenting insurers new opportunities for coverage of these newly emerged industries.

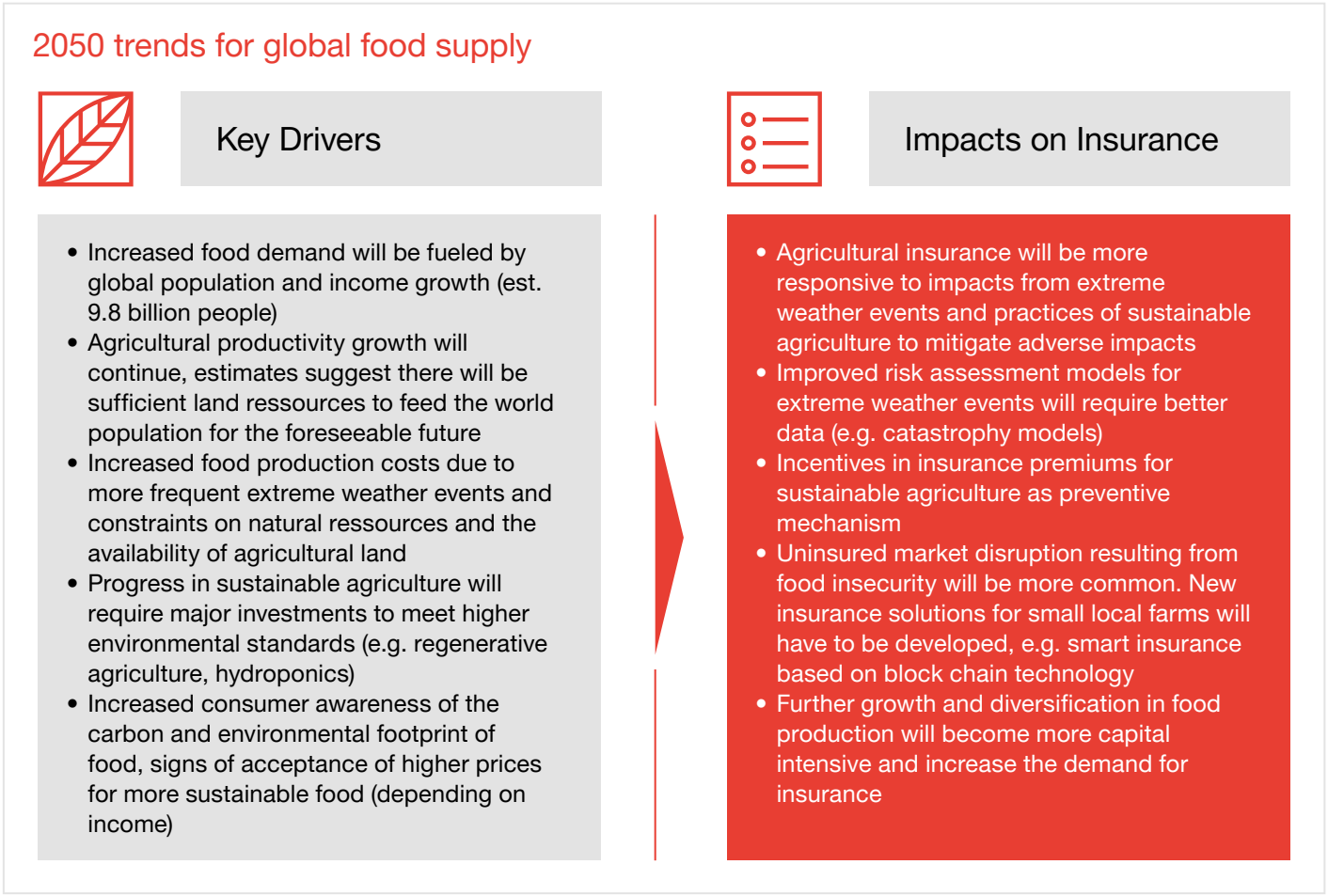
Second, the CRO Forum highlighted the liability implications for the insurance sector, which centre around product design and emerging climate change liabilities (CRO Forum, 2022). Litigation activities will likely increase and lead to substantial losses in connection to environmental liability, product liability and D&O/professional liability.

Climate protection and sustainability itself is already a huge cost factor, which will only get more excessive as regulations are made even stricter. This has to be taken into account by insurers, especially with regards to D&O and liability insurance. Liability risks need to be counted in by insurers in order to tackle this new risk field.

Third, there will be insurance growth opportunities in the energy sector due to a larger number of smaller suppliers (with the exception of CCS companies), more diverse capacity, and a broadening of the sector to include energy storage. For underwriting, this could require new scoring models to improve the calculation of customer risks.

Fourth, as governments will be more interventionist with regulations covering the use of greenhouse gases and alternative fuels, there will be close monitoring of the insurance industry's capabilities for managing risk from climate change impacts and for stimulating the transition to more sustainable technologies. Thus, an adjustment of risk management policies will be key for insurers.

2 2050 trends for global food supply



The trend for food production envisages greater capital intensity responding to sustained real price rises, a shift to plant-based food, products and extensive use of IT. As the analysis shows, in 2050 food supply will likely satisfy the rising demand but require substantial capital investment as production methods intensify. High levels of urbanisation, including mega cities, plus changes in consumer choice will affect the production and supply systems. Agriculture and the food sector will need to prepare for much higher levels of climatic uncertainties due to climate change.

Key Drivers

Food production will have rapidly diversified by 2050 in response to more frequent extreme weather events and increasing demand. The world has been successful in producing more food per person on average, primarily because of agricultural productivity growth (Fukase at al., 2017). The FAO estimates that there are still sufficient land resources to feed the world population for the foreseeable future, provided that the investments required to develop these resources are made and that the neglect of recent decades in agricultural research and development is reversed (HLC-2050, 2009). However, this is quite an optimistic scenario, and if current food supply systems become constrained by agricultural land availability, then clearly prices will rise, and consumers may be incentivised to switch to more plant-based diets.

According to a World Economic Forum article, global food prices are currently affected by more frequent extreme climatic events, energy price rises and other factors (Smith, 2021). Population and income growth have increased demand, but agriculture is increasingly affected by drought, heat and flood events. These extreme weather events have led to increased production costs, including water, fertiliser, and energy costs. Fisheries production is adversely affected by the rise in sea temperatures and changing currents. In addition, there will be more constraints on natural resources, mainly water availability and tighter regulation of pollution from nutrients. Rising temperatures will reduce crop yields growth and hectare productivity (Schlenker and Roberts, 2009; Schauberger et al., 2017).

Agricultural investment and farmers are at the heart of the shift to sustainable food production and will reshape farming. Moving away from conventional agriculture requires major investment and acceptance of additional costs to meet environmental standards. For instance, regenerative agriculture and urban farming using hydroponics are becoming more common. Urban farming using hydroponics is increasing. A report by the WRI and others estimates that by 2050, the world will need to increase food production by about 70% to meet the caloric needs of a global population of 9.8 billion – 68% of whom are projected to live in urban areas (Searchinger et al., 2019). By keeping crop production in an IT controlled environment, such as a repurposed urban building, the supply of water, nutrients, and light can be optimised (Boyan, 2020).

A report by the World Resources Institute suggests that sustainable agriculture could become more effective and cost-efficient through innovations in technologies, subsequent changes in farming practices and through organisational change (Searchinger et al., 2019). However, the acceptance of these innovations by consumers and society will be crucial. The observed progress in agricultural sustainability will thus likely continue in the future, although environmental pressures might remain high in certain regions (ibid.). Percentage change in agriculture's negative impacts on the environment has at least not exceeded percentage change in productivity gains.

Consumers are becoming more aware of food's carbon and environmental footprint. Many consumers have changed their eating habits and buy less carbon intensive food. For instance, there is a growing demand for plant-based products. A study from the Good Food Institute shows that the sales increase in the US alone was 31% between 2019 and 2021 (Ignaszewski et al., 2023). This trend will most likely continue and accelerate. In addition, information technology informs buyers about their food. Various apps already allow consumers to scan bar codes of products and show information about the sustainability of products and their supply chain. There are also signs that consumers in Europe are willing to pay higher prices for sustainable food, as surveys show (Corteva Agriscience, 2019).

Impacts on Insurance

First, agricultural insurance will be much more responsive to impacts from extreme weather events. Practices of sustainable agriculture that can mitigate the impact of climate change will thus play a key role for insurance. These need to be defined and factored into contract designs. In this context, the insurance sector is currently working on acquiring better data in a number of areas. For example, following heavy losses from natural disasters in the early 1990s, the US insurance sector adapted its catastrophe models with five-year plus data on hurricanes and similar events to try to address what was acknowledged as ''pervasive underestimations of risk" (Gray, 2021). The current contractual mechanisms for compensation are based on historical yield losses, where it can take months to determine and settle, during which time losses rise further. Thus, this will need to be addressed by new digital insurance techniques such as the use of distributed ledger technologies (Schwartze and Sushchenko, 2022). A driver for this form of data usage will be the digitalisation of agriculture, gathering data that was not available for risk mitigation in the past. Another example could be the rise of applications for metadata analysis to better quantify individual customer risks. This additional work and the demands on insurance will continue to grow. In addition to conventional agriculture, the new segment of lab-grown plants and meat will create a demand for new and innovative insurance products, as already mentioned in Chapter C. Insurers need to take new pollutants and the resulting damages into consideration when planning for possible future insurance claims.

Second, uninsured market disruption resulting from food insecurity will probably be more common by 2050. An estimated 205 million people in 53 countries currently experience acute food insecurity at "crisis or worse levels" (Food Security Information Network, 2022).

Third, similar to other sectors, further growth and diversification in food production will become more capital intensive and increase the demand for insurance (Searchinger et al., 2019; Gallin, 2022).

3 2050 trends for the use of IT and digital systems

2050 trends for IT and digital systems

Key Drivers

- Digital technology will contribute substantially to reducing low-carbon emissions and transitioning to a low-carbon economy
- ITC solutions will drive changes and innovations in many sectors (e.g. production processes, transport, robotics & logistics)
- Investments in digital platforms and technologies will grow further, driven by digital adaptation by businesses, consumer demands and fintech

Impacts on Insurance

- The insurance services landscape will become a highly sophisticated digital-enabled marketplace
- In 2050, customers will demand more personalization, more access, more security and more options; hence insurance willl need partnerships to provide a seamless product offering that supports changing customer needs
- Insurers will reshape to become more like high-tech companies with a mindset shift in the industry and a new attitude about data, partnerships, service and success
- IT insurances will become a large share of the market and financial services will be integrated into IT services
- Regulators will focus on risk management capabilities of insurers, in particular for climate and environmental risks
- Insurers will need to follow and understand current trends in order to keep up with their capability to assess and mitigate risks

The trend for IT and digital systems shows a continuous expansion into smart homes, robotic businesses, and self-driven vehicles, including public transport, all of which will substantially contribute to the zero-carbon transition. In manufacturing, factory assets will be a component of an IT-integrated process supplying product lifecycle services.[18]

Key Drivers

Digital technology will likely help reduce global emissions by about 15%, according to Ekholm and Rockström (Ekholm et al., 2019). The study argues this will be achieved through smart driverless buses and cars, through enhanced online communications reducing the need to travel, and through smart electricity reticulation systems allowing maximum use of alternative energy sources. On the other hand, corporate IT infrastructure alone contributes between 13–17 megatons of CO_2 emissions in Germany. However, technological advancements are enhancing efficiency, and can contribute to lower CO_2 emissions in the future (Becker et al., 2022).

[18] This is currently the situation in some industries such as aircraft engines.

Investment in digital platforms will continue to grow, driven by fintech, digital adoption by businesses and by the rise of the digital urban consumer. Digital technologies will change many production processes in nearly every sector of the economy and often offer an opportunity for integrating low emission solutions. For example, the global cloud computing market is essential to power the digital economy, and is expected to grow from around $US 500 billion in 2021 to almost $US 1 trillion by 2026 (Strunsani, 2022).

A range of ICT (information and communications technology) solutions such as smart motors and industrial process-management in industry, traffic-flow management, efficient engines for transport, smart logistics and smart energy systems will contribute to the transition to a global low-carbon economy. The global market for ICT is rapidly increasing and this growth will be sustained (Bitkom, 2022). Subsectors such as robotics are growing rapidly (robotics by an estimated 10% per annum (Research and Markets, 2022)). Changes in manufacturing processes that are a response to the transition to a zero-carbon economy will contribute to some of this IT investment. The growth of digital multinationals is monitored by the UNCTAD who note in their World Investment Report, 2022 that IT multinationals are increasingly decentralised, with specialised professional services, R&D centres, and internet infrastructure support around the world.

Impacts on Insurance

First, new value networks will transform the industry from a reactive and incidental consumer relationship toward an intensively proactive relationship. In 2050, customers will demand more personalisation, more access, more security and more options. Insurers will not be able to provide this on their own. Therefore, they'll need to partner with other industries, start-ups and service providers to offer a seamless product offering that supports changing customer needs. As a consequence, insurance companies themselves will reshape to become more like high-tech companies. This will require a mindset shift in the industry, and a new attitude about data, partnerships, service and success.

Second, IT insurance policies become a large share of the market, including insurance on critical infrastructure such as smart electricity systems and robotic manufacturing. Financial services will be largely integrated into IT services. On the one hand, this will likely lead to a rise of cyber risks. On the other hand, these trends also bear a great growth potential for insurance. For both scenarios, insurers have no choice but to build up topic-specific know-how and to follow and understand digital trends in order to consider these for the price setting in their underwriting process.

Third, insurers will work closely with both regulators and government to fulfill expectations for the management of climate and environmental risks. For this, insurers will be required to use new digital skill sets to evaluate emerging risks relating to climate. As mentioned above, this will require closer collaboration with IT companies.

4 2050 trends for buildings and construction

2050 trends for buildings and construction

Key Drivers

- Increased market value for real estate with regional differences due to severe climate and biodiversity risks posed to cities and housing settlements
- Higher demand for new renovated eco-friendly buildings rather than existing building stock
- Demand for housing in growing urban areas will stay high, strong increases in small, one-person households
- Due to higher building costs from rising material prices and climate-friendly regulations, the existing building stock will require substantial investments
- Increased diversity of use of buildings in urban areas (e.g. shared offices, small homes, public spaces)

Impacts on Insurance

- High demand of capital investment to improve the climate and energy performance of new buildings and existing building stock
- Growing market for property Insurance due to larger number of households in urban areas with new business opportunities emerging
- Higher insurance premiums for housing in areas with high climate-related risks (e.g. coastal regions), potentially even not insurable buildings in particular cases
- Higher material prices, also for increased use of technology, and circularity approaches will enable new types of insurances such as life-cycle product insurance
- Increased forced governmental ownership in order to cover for risk areas prone to extreme weather events

Buildings and construction, which are a significant source of GHG emissions, will produce a strong discrimination between modern, zero-carbon constructions and existing buildings. Changing consumer choice for size of home, cost of energy and smart devices will lead to a two-tier market. Integrated use of urban buildings containing everything from apartments to vertical farms to 3D printing plants will be common. The analysis indicates a high demand of capital investment to improve the performance of new and existing buildings. Zero-carbon buildings will include efficient HVAC (Heating, Ventilation, and air Conditioning), especially heat pumps, building management, efficient appliances, on-site renewables backed up with demand flexibility and digitalisation measures. Buildings located on sites which become uninsurable will offer a stark reminder to the public of the limitations of insurance.

Key Drivers

Building stock in all jurisdictions will have increased in market value and diversity of use. There will be regional differences due to risks posed by climate change to cities and settlements. The IPCC points out, that such risks "will rise rapidly in the mid to long term with further global warming, especially in places already exposed to high temperatures, along coastlines, or with high vulnerabilities." (IPCCa, 2022). New housing construction methods will involve much less use of carbon, as a study about net zero in residential building systems suggests (Karlsson et al., 2021). According to that, new building costs will be higher due to regulations for carbon neutrality and carbon taxes on cement. The residential buildings sector accounted for 22% of global final energy consumption in 2018 (IEA, 2019). Direct CO_2 emissions, those related to building homes, accounted for 6% of total global energy-related CO_2 emissions. Yet, buildings consume more than 55% of global electricity use (IEA, 2019). When these indirect emissions are considered, the total carbon footprint of the residential buildings sector rises to 17%.

Demand for new buildings may be higher than for existing stock, thus effectively creating a specific market of ecofriendly buildings with a distinct risk profile (Cournède, 2020; Mao et al., 2020). The higher costs of new building materials will enable existing housing stock to retain value and become more resistant to replacement. However, existing buildings will be subject to required investment to improve their energy efficiency. Accelerated deep-energy renovation is necessary because half of the buildings that will be standing in 2050 are already standing today (Cournède, 2020). This includes insulation and smart technologies to optimise energy use. Many houses will become 'smart homes', but mainly for those who can afford them (Mao et al., 2020).

Building occupancy will have changed, with shared offices the norm and some manufacturing such as 3D printing able to use the same space. Housing supply, demand for better quality (due to climate change) and rapid urbanisation will result in people shifting to smaller homes. In many countries, the expected increases in house prices will outpace income growth, which negatively affects housing affordability (Cournède, 2020). Projected rapid increases in one-person households will increase demands for smaller housing units and favour adaptive reuse of existing housing units through conversion (Pitken and Myers, 2008). Large homes (houses and apartments) will be unusual, with many people considering their home as a commodity. Urban centres will include intensified accommodation with more and more diverse public spaces. These changes will be driven by higher energy costs and changes in consumer preference. Generations Y and Z have a strong preference for public spaces where they can socialise and will place less importance on home ownership.

Impacts on Insurance

First, the trends for the housing and buildings sector indicate a high demand of capital investment for improving the climate and energy performance of new and existing buildings. (IEA, 2019; Karlsson et al., 2021).

Second, with a larger number of smaller homes, the market for property insurance may substantially increase and new business opportunities will emerge (Researchdive, 2021). According to a Swiss Re analysis, property insurance was estimated to be about 7% of the global insurance market (Gallin, 2022). Property in areas affected by higher climate-related risks, such as coastal regions, will likely require higher insurance premiums by customers; some buildings in high-risk areas could be difficult to insure at all. Moreover, the higher material prices and circularity approaches will enable new types of insurance such as life-cycle product insurance, including for some types of housing. For instance, a report by PwC highlights the opportunities for developing new products or expanding existing insurance products in a fluid climate change risk landscape (PwC, 2021).

Third, for infrastructure and buildings at risk from extreme flooding and weather events, governments will be forced to cover risk through increased government ownership, but businesses will find this problematic. Consequently, developing markets will become more conscious of the need for insurance (Thyme, 2021; Nobanee et al., 2021). Addressing the question how the effects of climate change can be taken into account in actuarial modelling will be key, in particular to ensure the risk-bearing capacity of insurance undertaking.

E Conclusions

This publication suggests that there will be significant socioeconomic changes caused by the climate crisis as well as enhanced climate risks for underwriting by 2050. Greenhouse gas emissions (GHG) have disrupted the mechanisms that stabilise global climate. These will contribute to sea level rise and increasingly frequent extreme weather events. Under the Paris Agreement GHG emissions should be reduced as soon as possible and reach net zero by 2050. The transition towards net zero will result in some major changes in the business environment, including structural changes, e.g. urbanisation and agricultural transformation. Key changes will include sector-specific structural changes with a transformed energy sector, an increased role of government in some areas and increased regulation of carbon and other GHG emissions. Growth will be stimulated by radical innovations, contributing green investments and job creation. The industrial sector will introduce higher energy and materials efficiency, circular material flows, abatement technologies in production processes or new production processes using low and zero GHG electricity, hydrogen, and fuels. GHG emissions by cities and urban areas are projected to rise by 2050. Cities will increase resource efficiency and limit the rise of GHG emissions through the systemic transition of infrastructure towards high-levels of electrification and improved energy and material efficiency. Most GHG emissions savings will be achieved by improving the building stock and supporting non-motorised mobility (walking, cycling) and public transport. These changes will be driven by sector-specific dynamics and transition results.

The direct impacts of climate change, together with the impacts from the transition to a low carbon economy, are adding complexity to insurance markets.

The insurance sector is currently working on assessing better data in a number of areas. For example, following heavy losses from natural disasters in the early 1990s, the US insurance sector adapted its catastrophe models with five-year plus data on hurricanes and similar events to try to address what was acknowledged as "pervasive underestimations of risk" (Gray, 2021). This additional work and demands on insurance will continue to grow.

However, the transition towards net zero also opens some interesting new areas of business for the sector. For example, new technologies such as carbon capture and sequestration, and enhanced battery storage capabilities will require insurance models. Insurers can harness their risk advisory capacity to help accelerate the testing and deployment of carbon-friendly technologies (Bouchard and Kousky, 2022).

Insurers are enhancing their research and analytical capabilities to better understand the additional transition risks. New actuarial modelling and analysis is being undertaken to fully include climate risk analysis. These additional capabilities will come under scrutiny by the regulatory agencies, and this might contribute to a lively debate about what is an adequate response (Kehnscherper, 2022). Insurance regulators are already expecting more information from the sector on climate and transition risk management. In the USA, the Financial Stability Oversight Council proposes that insurers will need to routinely report on this (National Association of Insurance Commissioners, 2022).

The areas of insurance business that will need climate risk management, will continue to evolve. This will require judgement calls, as insurers gain better information on their exposure to climate change and transition risk.

Summary of important, overarching implications on insurance

- Insurance has a lead role in the transition in helping businesses and communities manage emerging risks, including in areas where the performance record has been problematic. For example, pooled arrangements for insurance cover of the public safety of nuclear power generation will be vital to energy transition in some countries over the coming decades.
- The insurance services landscape will become a highly sophisticated digital-enabled marketplace, steered by smart and adaptive technologies. Customers will more frequently switch insurers with the benefit of enhanced customer information due to digitalisation.
- IT insurance policies capture a large share of the market, including insurance on critical infrastructure such as smart electricity systems and robotic manufacturing.
- Insurance services for new business models and value chains created through the circular economy (e.g. use of recycled products) and other sustainability products.
- Increased incentives for preventive measures, e.g. flood protection, sustainable agriculture, fire protection.
- In business, carbon budgets and balance sheets will become fully integrated into company valuations. Stress testing in EIOPA risk management will be commonly used.
- Litigation risks may rise due to failure of directors in their duty to meet climate pledges, disclose climate-related information or adequately respond to climate risks.

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