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epa Research

Climate Change Adaptation: Risks and Opportunities for Irish Businesses

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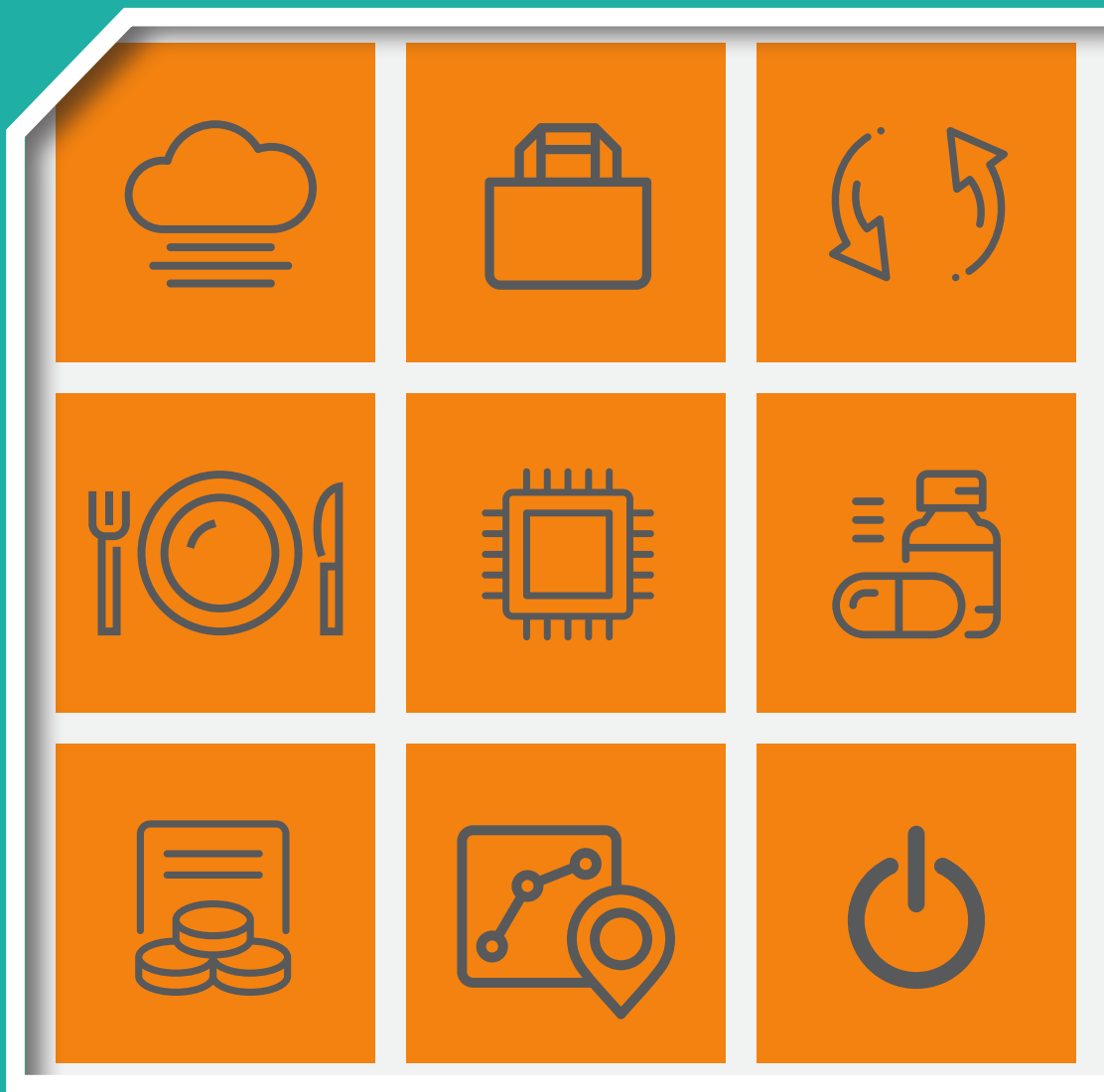

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Rialtas na hÉireann
Government of Ireland

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) is responsible for protecting and improving the environment as a valuable asset for the people of Ireland. We are committed to protecting people and the environment from the harmful effects of radiation and pollution.

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- Office of Environmental Sustainability
- Office of Environmental Enforcement
- Office of Evidence and Assessment
- Office of Radiation Protection and Environmental Monitoring
- Office of Communications and Corporate Services

The EPA is assisted by an Advisory Committee of twelve members who meet regularly to discuss issues of concern and provide advice to the Board.

EPA RESEARCH PROGRAMME 2021–2030

Climate Change Adaptation: Risks and Opportunities for Irish Businesses

(2019-CCRP-DS.24)

EPA Research Report

Prepared for the Environmental Protection Agency

by

SustainabilityWorks Ltd

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Representative organisations: Biopharmachem Ireland, Department of Enterprise Trade and Employment Retail Forum, ECR Ireland, Food Drink Ireland, Irish Manufacturing Research, Retail Ireland, Society of Actuaries in Ireland and Sustainable Travel Ireland.

Energy utilities: ESB Group and SSE plc.

DISCLAIMER

This report is based on research carried out from March 2020 to May 2021. More recent data may have become available since the research was completed.

The EPA Research Programme addresses the need for research in Ireland to inform policymakers and other stakeholders on a range of questions in relation to environmental protection. These reports are intended as contributions to the necessary debate on the protection of the environment.

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Executive Summary

This project identified key climate change risks and opportunities facing Ireland's private sector. In doing so it aimed to raise awareness of the need for businesses to adapt to the risks and seize the opportunities. It builds on the findings of previous research that summarised general climate adaptation issues for business and examined the integration of climate adaptation measures into sectoral policies.

The project took an in-depth look at five "core" business sectors that are important to Ireland's economy: (1) chemicals and pharmaceutical manufacturing; (2) computer and electronics manufacturing; (3) food and beverage manufacturing; (4) hospitality and tourism; and (5) retail. It also considered the role of two "enabling" sectors that will be crucial to enabling adaptation to climate change across the private sector, namely financial services and energy.

Using the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD), the project assessed the key risks and opportunities for each of the five core business sectors. The TCFD was found to be an effective framework to use at the sectoral level. The framework is based on the concept of financially material opportunities and risks, both physical and transition; it is fast becoming the gold standard for companies to use to identify, assess and report on climate-related impacts.

In addition to desk-based research, the project engaged directly with large and small businesses, trade bodies and relevant government agencies through interviews and workshops to inform and validate the research findings. Through this engagement, it was found that, other than large companies with significant internal resources, businesses have limited awareness of climate adaptation and tend to confuse it with climate mitigation. This reflects the lack of engagement and relevant information targeted at businesses on this topic. Most businesses do not yet seem to realise that adapting to climate change will have an impact on the bottom line. It was found that small and medium-sized enterprises (SMEs) tend to be focused on climate actions that will result in efficiencies and cost savings. One sector, the chemical and pharmaceutical manufacturing sector, was more advanced in its understanding, possibly reflecting the fact that this sector is adept at assessing and managing risks and incorporating them into long-term business strategies.

The financial services and energy sectors are equally advanced in their thinking and actions to support climate adaptation, with activities driven by a mix of regulation and acute awareness of the risks. Central banks and other supervisory authorities are now considering climate change as a risk to financial stability, and financial institutions are taking a sectoral approach to assessing the risks and opportunities of the business sectors they engage with. This will be a significant driver of business climate action in the coming years.

This research validated the hypothesis that considering climate adaptation by industry/economic sector is both practical and beneficial not only to businesses themselves, but also to policymakers and enabling sectors. It is recommended that this approach is replicated for other sectors and subsectors of the Irish economy. Climate change risk is complex and dynamic and is influenced by a wide range of factors, including the nature of production processes and supply chains, the location of the business and interdependencies with customers and enabling sectors. All five sectors assessed were found to be vulnerable to climate change risks related to supply chain disruptions, changing policy, and changing consumer demands. The food and beverage manufacturing and the hospitality and tourism sectors were found to be the most vulnerable to risks related to more extreme weather events.

The output from the research and engagement is a climate adaptation priorities matrix and a climate opportunities summary for each of the five "core" business sectors. These will be key tools in engaging these sectors on climate adaptation and demonstrating to businesses how to approach their own climate risk and opportunities assessment. The matrices have been published in a series of five short,

business-friendly sectoral guides. The intention of these guides is to make the research findings available and accessible to businesses, particularly SMEs. By translating climate impacts into business and financial risk, opportunity and commercial imperatives, it is hoped that businesses will be encouraged to take appropriate action to ensure that they remain resilient.

1 Introduction

1.1 Climate Adaptation and the Corporate Sustainability Agenda

Sustainability – the need to balance environmental, social and economic considerations – has moved rapidly up the business agenda in recent years. It is no longer "nice to have" but is an existential risk and is therefore a commercial imperative for any business looking to survive and thrive in the long term. Investors, lenders, customers, clients and employees are demanding higher standards and greater transparency, while policymakers at the global, EU and national levels are ramping up the pace of legislative change to support action.

The climate crisis and other environmental challenges are at the core of private sector sustainability concerns and the ambition level from business has taken a leap in recent times, with companies setting goals to be not only "net zero" but "carbon negative", "100% circular" and "forest positive" as well. These actions are largely focused on climate mitigation, i.e. efforts to reduce or prevent the emission of greenhouse gases.

In reality, climate change is already affecting businesses in various ways, and the magnitude of this impact will increase in the coming decades as global temperatures rise (IPCC, 2021). There are many physical impacts, such as sea level rise, that are already locked into the global climate system and are already costing lives and money (European Commission, 2021a). Furthermore, as efforts are made to reduce emissions, this gives rise to so-called transition risks. These are risks related to changing policy and legislation, changes in markets, and other shifts that stem from global and national efforts to mitigate climate change.

There will also be opportunities for businesses to respond to transition risks, for example through meeting the need for new products and services and by adapting business models to meet changing consumer sentiment and to address technological disruptions and new regulations and legislation. These costs and potential opportunities related to climate change are already unavoidable, meaning that adaptation to climate change is a "must do" for business, in conjunction with climate mitigation.

The European Environment Agency defines climate adaptation as:

> Anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise. (EEA, 2021a)

For the private sector, the climate crisis requires a disruption to business as usual. The crisis is activating a wave of innovation and creating new market opportunities for businesses that are ready to take advantage. Those businesses that understand the climate-related risks and opportunities relevant to their sector and which adapt their commercial strategy to respond to those impacts will be in a better position to gain competitive advantage and survive in our changing world.

1.2 The Economics of Climate Adaptation

Climate adaptation is not only an environmental and societal imperative, but also a global economic necessity. The total reported economic losses caused by weather and other climate-related extremes in Europe in the period 1980–2019 amounted to over €446 billion (EEA, 2021a), averaging at over €12 billion per year (European Commission, 2021a). Conservative, lower-bound estimates show that exposing today's EU economy to global warming of 3°C above pre-industrial levels would result in an annual loss of at least €170 billion, or 1.36% of EU gross domestic product (GDP) (European Commission, 2021a).

In 2019, research from the Global Centre on Adaptation found that, without adaptation, climate change could depress growth in global agriculture yields up to 30% by 2050, and that rising seas and greater storm surges could force hundreds of millions of people in coastal cities from their homes.

Conversely, investing US$1.8 trillion in adaptation from 2020 to 2030 could generate US$7.1 trillion in total net benefits (Global Commission on Adaptation, 2019).

In an Irish context, research in 2016 concluded that climate change impacts will cost the Irish economy billions of euros by 2050. The costs for agriculture alone have been estimated at between €1 billion and €2 billion per year, and damage from flooding could add another €1 billion per year, based on European-level projections. Analysis reveals potential substantial additional costs to the Irish economy that will probably arise from more adverse climatic conditions and which, to date, have not been sufficiently quantified, for example disruptions to transport infrastructure and other essential services, lost labour productivity and impacts on business activities (McDermott, 2016). Research published by the European Environment Agency indicates that there were €4617 million of losses and 71 fatalities in Ireland as a result of the impacts of extreme weather and climate-related events in the period 1980–2019 (EEA, 2021a). While this research does not quantify potential futures losses, it underpins the fact that the effects of climate change will have an impact on Ireland's economy.

Balancing the focus on cost, the Irish National Adaptation Framework (NAF) states that adaptation "offers an opportunity to adjust economic activity in vulnerable sectors and support sustainable development" (DECC, 2018, p. 19) and that "effective adaptation brings opportunities through green growth, innovation, jobs and ecosystem enhancement as well as co-benefits in areas such as water and air quality" (DECC, 2018, p. 24).

1.3 Climate Adaptation Policy and the Private Sector

Within the Paris Agreement (UNFCCC, 2015), the inclusion of a global adaptation goal was an important step forward for adaptation internationally. One of the key goals of the Paris Agreement is to foster the transition to climate resilience and low-emission development for all countries. As noted in *National Preparedness to Adapt to Climate Change: Analysis of State of Play* (Desmond, 2018), Ireland (alongside other signatories to the Paris Agreement) is:

> at the beginning of a long and challenging process of transitioning to a low-carbon, climate resilient and environmentally sustainable economy. The role of central government is to drive and support this agenda by creating an enabling environment in support of this transition at all levels and spheres of decision making. The role of society at large is to embrace these changes and work with government to make this transition as smooth as possible. The key to success will be the ability to effectively link and co-ordinate these spheres of activity in a manner that is fair, efficient and timely. (Desmond, 2018, p. viii)

As a key stakeholder group in "society", business will have a significant role to play in converting climate adaptation policy into action.

The European Commission adopted its new EU Strategy on Adaptation to Climate Change (European Commission, 2021a) in February 2021, building on the previous 2013 strategy and the European Green Deal. The new strategy sets out how the EU can adapt to the unavoidable impacts of climate change and become climate resilient by 2050. The strategy has four principal objectives: (1–3) to make adaptation smarter, swifter and more systemic than at present and (4) to step up international action on adaptation to climate change.

With regard to the role of business, the strategy recognises that "climate impacts pose destabilising risks to assets and to business" (European Commission, 2021a) and shifts the emphasis from planning to encouraging active participation from all sectors of society, including business, in implementing the strategy. In particular, the strategy states that it will:

> support the private sector to identify risks and steer investment towards action on adaptation and resilience (and avoid maladaptation). By offering solutions to help meet the rising awareness of climate impacts (such as the non-financial disclosure obligations, the EU taxonomy for sustainable activities and the Renewed Sustainable Finance Strategy), it will help large companies, SMEs [small and medium-sized enterprises], local administrations, social partners, and the public. It will also help correct the misperception that adaptation is solely

> a cost – it is an investment. (European Commission, 2021a, p. 4)

The strategy's four objectives are underpinned by 14 actions and the steps to be taken to deliver them. The Commission will discuss the strategy with the Member States in the Environmental Council. The Council agreed to council conclusions on the new strategy in June 2021.

The *UK Climate Change Risk Assessment 2017 Evidence Report* (UK Government, 2017) provides significant detail on risks and opportunities for UK business and industry. The stated audience is the government and related adaptation decision-makers, rather than individual companies, although it notes that companies may find the contents useful. Also relevant is the UK research on assessing climate risks across different businesses and industries (Surminski *et al.*, 2018).

The UK dedicates a chapter of its National Adaptation Programme to business and industry. The vision for the private sector is that "UK businesses are resilient to extreme weather and prepared for future risks and opportunities from climate change" (DEFRA, 2018, p. 6).

The importance of climate resilience in the private sector is well acknowledged in Ireland's national policy. The NAF notes the primary role for government in providing an enabling environment to ensure that individuals and businesses have the necessary information and incentives to respond appropriately. The NAF advises the private sector to "consider climate impacts in long-term strategic planning and investment decisions and to identify and assess climate change risks across their supply chains, assets and activities" (DECC, 2018, p. 78). It also recommends that each minister and agency "should seek to engage with private sector representatives for their respective sector/area in shaping and developing their adaptation plans" (DECC, 2018, p. 78). Furthermore, the NAF recognises the role of the insurance sector in "collecting and disseminating data on weather and catastrophe risk, financing risk assessments, and supporting the design and provision of insurance schemes" (DECC, 2018, p. 79).

In late 2019, sectoral adaptation plans were published for the 12 sectors identified in the NAF. However, the plans do not tend to provide detailed explanations for how businesses can develop and implement adaptation actions. The Agriculture, Forest and Seafood Climate Change Sectoral Adaptation Plan goes the furthest of any of the plans to engage the private sector, discussing impacts and adaptation options for the agri-food sector and setting out an action (Action 9) to "engage with industry to support the sector in building resilience in their systems and practices" (DAFM, 2018). However, the plan states that "there is little experience in terms of cross-sectoral adaptation policy" and describes the 12 sectoral adaptation plans as the "first round of plans … informing baseline information" (DAFM, 2018). This suggests that engagement with businesses is viewed as one of the next phases in the implementation of the plan.

Similarly, many of the adaptation strategies prepared by local authorities under the NAF do not yet provide guidance for business but are cognisant of the interconnectivity between local climate adaptation strategies and the ability of local businesses to respond to risk and opportunity. For example, the 2019 Dublin City Council Climate Change Action Plan "recognises the role of the business community in addressing climate change" and states that it "will engage with the business community and relevant bodies such as the Chamber of Commerce, Local Enterprise Office" (Dublin City Council, 2019, p. 23). However, the approach is not universal across local authorities.

1.4 Research Objectives

Typically, large Irish businesses understand climate-related impacts and are assessing their response and their climate resilience. Small to medium-sized enterprises (SMEs) may not be as well informed. They may be taking steps to reduce their energy use or increase recycling to improve efficiencies and reduce costs. However, many will not have considered risks in their supply chain, changing consumer preferences, and the likelihood or timing of policy action on carbon emissions; they will also not have explored potential climate-related opportunities.

According to the Central Statistics Office (CSO), SMEs accounted for 99.8% of the total population of *c.*250,000 Irish enterprises in 2016 (CSO, 2016). Addressing climate adaptation risks and opportunities for these individual enterprises may be challenging

because of limited in-house specialist knowledge, time/resource constraints and the tendency to focus mainly on near-term risks without paying adequate attention to risks that may arise in the medium to longer term. These businesses need support, guidance, shortcuts and tools to develop their climate resilience (Skouloudis *et al.*, 2020).

The objective of this research was to conduct a detailed analysis that would support Irish businesses – both larger corporates and SMEs – to develop their climate resilience through:

- developing or adapting an appropriate framework to identify, assess and manage/exploit climate risks and opportunities;
- developing detailed knowledge on climate-related risks and opportunities on a sectoral basis, focusing on those sectors of the economy that have not yet been the subject of much national research/policy supports;
- engaging directly with the private sector and communicating in its language, i.e. translating climate impacts into business and financial risk and opportunity and commercial imperatives;
- exploring whether existing channels could be used to reach sectors on a collective basis, e.g. through industry associations and other channels that businesses look to for updates, trends and information.

The outcome will be simple sectoral climate adaptation guidance for business on how to identify, assess, prioritise and respond to climate-related risks and opportunities, i.e. how to develop climate resilience, with a view to supporting the national policy objective of climate resilience by 2050. The process of developing the research will also involve extensive stakeholder engagement, which should result in raising awareness of climate risks and opportunities in the Irish private sector.

2 Project Research Methodology

The project followed a six-stage methodology, with each stage informing the next. A summary of the stages is outlined in Table 2.1, with further detail provided in the following sections.

2.1 Identify a Suitable Climate Adaptation Methodology/ Framework

An in-depth review of international research reports and publications on climate adaptation and the private sector was conducted. Based on this research, the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD) were identified as the most relevant framework for guiding the research. The TCFD recommendations are increasingly recognised as the gold standard framework for companies to use to identify, assess and report on climate-related impacts. As the concepts, definitions and approaches outlined by the TCFD are core to this project's research methodology, they warrant some further elaboration (TCFD, 2017).

2.1.1 The TCFD recommendations

The TCFD was established in December of 2015 by the Financial Stability Board (FSB). It was tasked with developing recommendations for more effective climate-related disclosures that could promote more informed investment, credit and insurance underwriting decisions and, in turn, enable stakeholders to better understand the financial system's exposures to

Table 2.1. Project research methodology

Stage	Description	Output
1 – Identify a suitable methodology/ framework for assessing climate risks and opportunities	A review of the international and national literature to identify projected climate hazards in Ireland, and of frameworks, approaches and tools that can be used to support private sector assessment of risks and opportunities related to climate adaptation	TCFD identified as most appropriate and useful framework
2 – Select sectors for detailed research	A step-by-step approach to selecting sectors to be researched as part of the project	A list of five "core" business sectors, and two "enabling" sectors identified for inclusion in the research project
3 – Identify climate risks and opportunities per sector	Desk-based research to understand physical climate risks for Ireland and to gain a high-level overview of each sector's economic characteristics and value chain to support identification of climate-related risks and opportunities using the TCFD framework	Sector-specific climate-related risk and opportunities identified
4 – Prioritise the most financially material risks and opportunities for each sector	Assessment of each sector's vulnerability to climate risks and their adaptive capacity; identification of potential opportunities linked to climate adaptation	Created climate adaptation priorities matrix for each sector and summarised key climate-related opportunities
5 – Validate prioritisation with sector representatives	Interviews with companies, trade bodies and other stakeholders; sector-specific workshops to gather further insights	Finalised climate adaptation priorities matrix and final climate opportunities summary for each sector
6 – Develop business-friendly sectoral guidance	Preparation of business-friendly guidance for each sector on the key climate risks and opportunities that need to be addressed to adapt to climate change	Produced short business-friendly guide for each sector summarising key climate risks and opportunities

TCFD, Task Force on Climate-related Financial Disclosures.

climate-related risks. The TCFD believes that better information will allow companies to incorporate climate-related risks and opportunities into their risk management and strategic planning processes.

The recommendations of the TCFD, published in 2017, request that companies provide disclosures structured around four thematic areas that represent core elements of how organisations operate: (1) governance, (2) strategy, (3) risk management and (4) metrics and targets. These thematic areas are intended to interlink and inform each other. They can also be used by businesses to assist them in identifying, managing and reporting on the risks and opportunities they face as a result of climate change. While currently voluntary, several governments and financial regulators around the world have expressed support for the recommendations and are integrating them into their guidance and policy frameworks (TCFD, 2017).

2.1.2 The TCFD recommendations: relevance to this project

The Task Force divided climate-related risks into two major categories: (1) risks related to the transition to a lower-carbon economy ("transition risks") and (2) risks related to the physical impacts of climate ("physical risks"). Recognising that the flip side of risk is opportunity, the Task Force also identified relevant climate-related opportunities.

Although the TCFD recommendations are primarily targeted at large corporations, the guidance is helpful in two important ways when communicating about climate adaptation with businesses of any size.

1. It provides a structured framework for identifying climate risks and opportunities, split between transition risks, physical risks and climate-related opportunities.
2. It makes a direct link between the climate-related impact and the financial impact on a business, which is important when making the business case for climate adaptation to both large corporates and time- and resource-strapped SMEs.

2.2 Select Sectors for Detailed Research

Although climate change affects nearly all economic sectors, the level and type of exposure and the impact of climate-related risks differ by sector, industry, geography and organisation (TCFD, 2017). It is generally accepted international best practice to adopt a sectoral approach to determining corporate exposure to environmental, social and governance (ESG) factors, including climate-related impacts. The sectoral approach also reflects the approach taken in Ireland's Climate Action and Low Carbon Development (Amendment) Act 2021 (DECC, 2021), which requires the Climate Change Advisory Council to produce carbon budgets covering 5-year periods. Following presentation of the budgets to the Oireachtas and approval by the Irish government, the government will then set sectoral emissions ceilings determining how each sector of the economy will contribute to the achievement of the budgets.

Given that this was a relatively short research project (1 year), the project team and the EPA steering committee recognised the need to focus the research on a small number of key sectors. European NACE (Nomenclature of Economic Activities) codes were used as the basis for sector selection. NACE codes are the EU standard for the statistical classification of economic activities. There are 21 NACE codes, representing 21 sectors and 615 subsectors. From this a list, a five-step selection process was followed:

1. Sectors dominated by the public sector, such as public administration, defence and education, were excluded, as this project focuses on private sector resilience.
2. Sectors that already had a national sectoral climate adaptation plan (e.g. agriculture) or that were already the focus of an EPA research project on adaptation (e.g. construction) were excluded. These two steps produced a shortlist of 11 NACE sectors.
3. A proxy measure of each sector's importance to the Irish economy was developed. Using the latest business demography data from the CSO (2017), the number of "persons engaged" was added to the number of active enterprises in the sector, to give a measure of "economic reach". This identified the seven NACE sectors with the greatest economic reach:
   (a) wholesale and retail trade, repair of motor vehicles and motorcycles;
   (b) electricity, gas, steam and air conditioning supply;

(c) manufacturing;

(d) accommodation and food service activities;

(e) professional, scientific and technical activities;

(f) administration and support service activities;

(g) financial and insurance activities.

4. These seven sectors were assessed for their expected vulnerability to current and future climate risks, based on a high-level assessment of possible climate impacts across the sector's value chain. Service-based sectors such as "professional, scientific and technical activities" and "administration and support service activities" were excluded, as, being mostly service based, they are less likely to be vulnerable to climate change risks. However, one subsector in the administration and support service activities was included for its relevance to the tourism sector. This was N-79,"travel agency, tour operator and other reservation service and related activities". This elimination left four sectors.

5. Subsectors were then analysed for their size and economic reach. For example, of the wholesale and retail trade sector, retail is by far the largest subsector in terms of economic reach. Thus, the retail subsector was selected for analysis in this project and the other subsectors were not included. This subsector analysis provided the final list of sectors. Sectors were renamed, where appropriate, for simplicity and were divided into "core" and "enabling" sectors. Financial services and energy were identified as the "enabling" sectors on the basis that they will be crucial to enabling adaptation to climate change across the private sector and have clear linkages with each of the core sectors that are the focus of the research.

The above process resulted in the selection of a final set of five "core" sectors and two "enabling" sectors to be included in the research. The five core sectors were: (1) chemicals and pharmaceutical manufacturing; (2) computer and electronics manufacturing; (3) food and beverage manufacturing; (4) hospitality and tourism; and (5) retail. The two enabling sectors were financial services and energy. Table 2.2 shows the economic reach of the five core sectors.

Table 2.2. Economic reach by NACE subsector of the core sectors

Sector	No. of active enterprises	No. of people engaged	Economic reach
Chemicals and pharmaceuticals manufacturing sector [Chemicals and pharmaceuticals (C20, C21)][a]	568	29,123	29,691
Computer and electronics manufacturing sector [Computer, electronic, optical and electrical equipment (C26, C27)][a]	693	25,418	26,111
Food and beverage manufacturing sector [Food products, beverages and tobacco (C10–C12)][a]	2067	52,434	54,501
Hospitality and tourism sector [Various hospitality and tourism subsectors (I55, I56, N79)][a]	20,384	195,361	215,745
Retail sector [Various retail subsectors (G471–G479)][a]	24,860	225,293	250,153
Total of core sectors	48,572	527,629	576,201
Total of all Irish sectors	271,166	1,555,799	
Percentage of all Irish sectors (%)	17.9	33.9	

[a]The NACE subsectors and codes are given in brackets.

Source: CSO business demography data (2017).

2.3 Identify Climate Risks and Opportunities

The purpose of this stage of the research was to identify climate-related risks and opportunities in line with the TCFD definitions of physical risks, transition risks and climate-related opportunities.

The Intergovernmental Panel on Climate Change (IPCC) defines climate risks as potential adverse consequences for human or ecological systems caused by climate extremes and climate change (IPCC, 2014a). IPCC further states that climate risks are the result of "the interaction of hazards linked to climate change and the vulnerability of exposed societies and systems" (IPCC, 2014b, p. 1043). In this project, the systems in question are business sectors. For the purposes of this report, given the intended business audience and the definitions in the TCFD recommendations, the terms climate hazard and physical climate risk should be treated as interchangeable.

In-depth research was conducted to gain a deep understanding of physical climate risks for Ireland; the information has been extensively and carefully researched in numerous other scientific research reports. Information was also gathered on each sector's economic characteristics and main activities/processes to identify transition risks and climate-related opportunities.

2.3.1 Identification of climate-related risks

Current and expected changes in Ireland's climate are in line with global trends. A summary of climate hazards was provided in the 2017 report *A Summary of the State of Knowledge on Climate Change Impacts for Ireland* (Desmond *et al*., 2017). More recent regional climate modelling has assessed the impacts of increased temperatures on the climate of Ireland in the 21st century, specifically the period 2041–2060 (Nolan and Flanagan, 2020).

A register of expected physical and transition risks was prepared, focusing on those risks that are likely to occur in Ireland at the national scale. The register drew on the above-mentioned research, the NAF, Irish sectoral and local climate adaptation plans, information from www.climateIreland.ie and Met Éireann, and EPA resarch (see Table 2.3).

It is noted that there will be considerable regional variability in climate changes in Ireland; for example, the east of Ireland is expected to suffer more from droughts, whereas the west is likely to experience increases in rainfall. However, this project aimed to provide guidance to businesses located in all parts of the country and therefore physical risks were considered at the national scale. Individual businesses can develop a more accurate and relevant picture of their exposure to regional climate change when conducting their own climate risk assessments.

Climate change impacts in other countries were not considered individually, as such an analysis was beyond the scope of this project. All global climate changes, from increased hurricanes in the USA to wildfires in Australia, were considered under the transition risk entitled "disruptions to global supply chains". In other words, global climate change impacts were considered from the perspective of an Irish business. This was on the basis that, regardless of the nature of the climate impact in the partner country, the end risk for Irish businesses would be a disruption to their global supply chain.

Transition risks were further identified and refined using the categories specified in the TCFD and through interviews with private sector leaders.

Relevant time horizons were noted where possible; for example, the research of Nolan and Flanagan (2020) refers to climate impacts in Ireland by mid-century (2041–2060). Time horizons for transition risks, such as stricter climate regulations, are less certain. Even where policy plans have been announced, such as the European Green Deal and national policy strategies, the degree and specifics of implementation will depend on a range of factors, including economic, scientific and political ones. For this reason, the timeframe of 2020–2050 was assigned to all transition risks.

A Climate-related Risk Register**,** which consolidates the available evidence from published research to indicate the likelihood of a physical or transition risk occurring, and a high-level overview of the expected impact of the physical and transition climate risks on business and the resulting financial implications are available here: https://drive.google.com/file/d/1ycOUy-PAvLCviJSxnDMpJQ1XK1eoD-xw/view. These risks will be low, medium or high priority, depending on the business sector. Therefore, the degree of impact and financial implication will vary.

Table 2.3. Register of climate risks

Risk category	Risk[a]
Physical risks	
Increased temperatures	Increased temperatures
	Increase in the intensity and duration of heatwaves
	Wildfires
	Increased length of growing season
	Decrease in frost and ice days
	Increased incidence of invasive species
	Increased incidence of pests and crop diseases
	Biodiversity loss
	Water-borne diseases
	Air-borne diseases
	Increased surface water temperature
	Increased ocean temperature
	Sea level rise
Increased CO_2 in atmosphere	Ocean acidification
Changes in frequency and intensity of storms	Sea surges
	Coastal flooding
	Coastal erosion
	Increased intensity of storms
Changes in wind speeds	Increase in “driving rain” events in winter
	Reduced availability of wind energy
Changes in precipitation	Droughts and dry periods
	Decreased rainfall in summer
	Decreased snowfall
	Heavy rainfall events
	Flooding
	Landslides
	Decreased water quality
	Increased humidity
Transition risks	
Policy and legal risk	Stricter climate regulations
	Sustainable finance regulations
	Litigation risk
Technology risk	Technology change
Market risk	Changes in consumer preferences/demand
	Disruptions to global supply chains
	Increased cost of insurance
Reputation risk	Reputation risk

[a]The timeframe for all physical risks is mid-century (2041–2060), with the exceptions of increased ocean temperature (2080–2099 timeframe), sea level rise (2080–2100 timeframe) and ocean acidification (by 2100). All transition risks have a 2020–2050 timeframe.

Table 2.4. Types of climate-related opportunity

Category of opportunity	Description	Examples	Potential financial impacts
Resource efficiency	Businesses can reduce operating costs and improve resilience by improving resource efficiency across their production and distribution processes, buildings, machinery/appliances and transport/mobility. Resources include energy, water and waste Resource-efficient businesses may be better prepared for climate change impacts, as they require fewer resources to operate. For example, a highly water-efficient business may be more resilient to droughts	Efficient heating Circular economy solutions LED lighting Industrial motor technology Retrofitting buildings Water usage and treatment solutions More efficient modes of transport (e.g. electric vehicles)	Reduced operating costs (e.g. through efficiency gains and cost reductions) Increased production capacity, resulting in increased revenues Increased value of fixed assets (e.g. highly rated energy-efficient buildings) Benefits to workforce management and planning (e.g. improved health and safety, employee satisfaction), resulting in lower costs
Energy source	Businesses can reduce energy costs and improve resilience by transitioning to lower-emission sources of energy such as wind, solar and wave energy. This can improve resilience by reducing exposure to future fossil fuel price increases and changes in the price of carbon. This is relevant in Ireland, as the government recently committed to increasing the carbon tax from €33.50 per tonne of CO_2e in 2021 to €100 by 2030 The SEAI estimates that the average SME could reduce its energy bill by up to 30% by implementing energy efficiency measures, and that some 10% of savings can be achieved with little or no capital cost. Some investment may be required to get the remaining 20% but, generally, payback takes only around 1.5 years	Use of lower-emission sources of energy Use of policy incentives and supports Use of new technologies Participation in carbon markets Shift towards decentralised energy generation	Reduced operational costs Reduced exposure to future fossil fuel price increases and changes in the cost of carbon Returns on investment in low-emission technologies Increased capital availability (e.g. as more investors favour lower-emission producers) Reputational benefits resulting in increased demand for goods/ services
Products and services	Climate change is likely to change consumer demand for goods and services. Organisations that innovate and develop new products and services to respond to climate change may improve their competitive position and capitalise by shifting consumer and producer preferences	Development and/or expansion of climate-friendly goods and services Development of climate adaptation solutions Development of new products or services through R&D and innovation Diversification of business activities	Increased revenue through demand for climate-friendly products and services Better competitive position as a result of responding to shifting consumer preferences, resulting in increased revenues
Markets	Opportunities exist for organisations to access new markets and better position themselves for the transition to a low-carbon economy by forming partnerships, e.g. collaborating with governments, entrepreneurs and community groups	Access to new markets Use of public sector incentives	Increased revenues through access to new markets (e.g. partnerships with governments, community groups)
Resilience	Adapting to climate change allows businesses to better respond to the risks and seize the opportunities associated with climate change. Opportunities related to resilience may be especially relevant for organisations with long-lived fixed assets or extensive supply or distribution networks, those that depend critically on utility and infrastructure networks or natural resources in their value chain, and those that may require longer-term financing and investment	Participation in renewable energy programmes and adoption of energy efficiency measures Resource substitutes/ diversification	Increased market valuation through resilience planning (e.g. infrastructure, land, buildings) Increased reliability of supply chain and ability to operate under various conditions Increased revenue through new products and services related to ensuring resilience

R&D, research and development; SEAI, Sustainable Energy Authority of Ireland.

2.3.2 *Identification of climate-related opportunities*

The TCFD recommendations note that climate-related opportunities will vary depending on the region, market and industry in which an organisation operates. The recommendations identify five broad areas of opportunity. Our research was also guided by the report *Advancing TCFD Guidance on Physical Climate Risks and Opportunities* (Mazzacurati *et al*., 2018).

At the global level, some analysis of climate opportunities for business is available. In 2018, environmental non-profit organisation CDP analysed over 6700 companies globally and found that, of the five opportunity types identified by the TCFD, products and services is the leading category (CDP, 2019a).

Table 2.4 describes the five categories of climate opportunity. It was informed by the report from Mazzacurati *et al*. (2018) and the TCFD.

2.4 Perform Climate Risk Assessment and Prioritise Risks

As part of its ongoing guidance and support to companies seeking to implement the TCFD recommendations, the Task Force published guidance in October 2020 to support companies seeking to integrate climate-related risks into their existing risk management processes (TCFD, 2020). Key elements of the 2020 TCFD guidance that informed our research methodology and approach include:

- integrating climate-related risks into risk management;
- expanding prioritisation criteria for risks beyond likelihood and impact to include vulnerability and speed of onset.

We also factored in the adaptive capacity of the sector to respond to the risks and, through plotting vulnerability against adaptive capacity, we developed the output for this stage, namely a climate adaptation priorities matrix by sector.

2.4.1 *Assess likelihood*

In assessing the likelihood or probability of the physical or transition risk occurring, relevant climate research was considered, and each risk was assigned a likelihood rating of low, medium or high, based on the descriptions in Table 2.5.

Likelihood scores for physical climate risks were assigned based on the descriptions, projections and scenarios set out in published research. Given the scope of the project, the likelihood assessment did not include the severity of the climate risk under different scenarios. This follows the approach taken in the NAF, which states that “the general trends observed to date in climate projections are likely to remain the same even as the levels of uncertainty about these projections falls” (DECC, 2018). From the business perspective, it is expected that the impact of a given climate will be broadly similar, even under different scenarios (DECC, 2018).

Given the uncertainty around transition risks (e.g. announced policies vs actual policy implementation), all transition risks were assigned a likelihood of medium, except for disruptions to global supply chains, which was considered to be of high likelihood, given the increasing frequency of climate impacts globally. Likelihood scores for transition risks were assigned based on published research and a qualitative assessment by the project team.

2.4.2 *Assess impact*

Taking each physical climate hazard and transition risk in turn, the project team conducted a qualitative assessment of the potential impact of the risk on each part of the sector’s value chain. Key questions discussed to inform this view included those outlined in Table 2.6. Four sections of the value chain were considered: supply chain, production/operations, logistics and sales. The assessment of potential impacts considered both exposure and sensitivity where possible.

Table 2.5. Descriptions of likelihood scores

Rating	Description
Low	The climate risk will probably never happen (rare) or is not expected to happen, but it is possible (unlikely)
Medium	The climate risk may occasionally happen (possible) or it will probably happen but is not persistent (likely)
High	The climate risk will most probably happen, possibly frequently

Table 2.6. Questions to inform the assessment of climate impacts on sectors

Part of business	Question for consideration
Asset	Will the climate hazard have an impact on sector assets, such as buildings, facilities, owned land and infrastructure?
Revenue	Will the climate hazard affect sales and revenues, e.g. by putting off customers?
Expenditure	Will it be costly to protect/repair?
People	Will it lead to injury/loss of productivity/loss of life?

Each risk was then assigned a qualitative impact rating of low, medium or high, based on the descriptions in Table 2.7. Where a risk was not relevant to a sector, such as the risk of an "increased incidence of invasive species" to the computer and electronics manufacturing sector, it was marked as not applicable (N/A).

2.4.3 Assess vulnerability

Based on the ratings from the likelihood and impact assessment, the sector's overall vulnerability to each risk was determined using the formula outlined in Table 2.8. This follows standard practice in risk assessments. In each case, the vulnerability score was the lowest common denominator between the likelihood and impact scores. This is true for all cases, except medium likelihood and high impact, because this combination, owing to the high impact categorisation, would warrant the sector's attention.

Table 2.8. Vulnerability assessment formula

Likelihood	×	Impact	=	Vulnerability
H	×	H	=	H
H	×	M	=	M
H	×	L	=	L
M	×	H	=	H
M	×	M	=	M
M	×	L	=	L
L	×	H	=	M
L	×	M	=	L
L	×	L	=	L

H, high; L, low; M, medium.

2.4.4 Assess adaptive capacity

In considering adaptive capacity, the following definition was applied:

> The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. (IPCC, 2014a)

Table 2.7. Descriptions guiding low, medium and high impact ratings

Impact score	Description	Supply chain	Production	Logistics	Sales
Low	If the climate hazard occurs, it will have little or no impact on business/sector activities across the supply chain, production, logistics or sales. If there is an impact, business activity can continue at an acceptable level	Performance of supply chain is acceptable and meets all KPIs	No disruption to normal production and operation procedures	Logistics meet all KPIs	Sales meet all KPIs
Medium	If the climate hazard occurs, it will have a moderate impact on business/sector activities across the supply chain, production, logistics or sales. If there is an impact, business/sector activity can continue but certain KPIs will be affected	Performance is somewhat disrupted and some KPIs are affected	Normal production and operation procedures are somewhat affected, including some KPIs	Logistics are somewhat affected, including some KPIs	Sales are somewhat affected, including some KPIs
High	If the climate hazard occurs, it will have a significant impact on a business/sector, preventing it from achieving desired results to the extent that one/more of its goals will not be achieved	Performance is significantly disrupted and critical KPIs are affected	Normal production and operation procedures are significantly disrupted and critical KPIs are affected	Logistics are significantly disrupted and critical KPIs are affected	Sales are significantly disrupted and critical KPIs are affected

KPI, key performance indicator.

The following questions guided the adaptive capacity assessment:

- Cost: is there a significant cost to adapt to the hazard? Does the sector tend to have capital available to respond to unexpected situations or does cash flow tend to be restricted?
- Control: is adaptation to the hazard within the sector's control?
- Business agility: can the sector easily change suppliers or location to respond to the hazard?
- Preparedness: are long-term planning and scenario analysis common within the sector? For example, do businesses in the sector typically have business continuity plans in place?

For each risk, the sector was assigned a qualitative adaptive capacity rating of low, medium or high, based on the definitions in Table 2.9.

2.4.5 Prioritise risks

The vulnerability rating for each risk was then plotted against the adaptive capacity rating to determine an overall prioritisation of high, medium or low. This resulted in the production of a climate adaptation priorities matrix for each sector, as shown in Chapter 3. The matrix allows each sector to consider and prioritise climate risks based on those to which they are most vulnerable and least able to adapt.

2.5 Validate Risks and Opportunities with Sector Experts

A total of 26 interviews were conducted with businesses representing the sectors under review, with 15 interviews pertaining to the five core sectors and eight to the enabling sectors. Three further interviews were conducted with relevant stakeholders such as Met Éireann and the climate action regional offices. Table 2.10 provides an overview of interviews per sector. The purpose of the interviews was to discuss and validate the desk research undertaken, and to review and validate the climate adaptation priorities matrices. There was also a discussion on the climate-related opportunities identified.

A sectoral workshop for each of the five core business sectors was also held virtually. The workshops were widely advertised and well received. Overall, 302 people registered and 162 attended, a 53% conversion rate. To optimise schedules, Biopharmachem Ireland facilitated a workshop with the chemical and pharmaceutical sector, which also had a high level of engagement.

A series of polls were conducted during the workshops to validate the climate risk priority matrix for the sector. Participants were also invited to vote on whether or not the priority ranking of any risks should change. These recommendations were reviewed by the project team and weighed against scientific evidence to determine whether or not any changes should be made.
Six hazards changed priority as a result of this review:

- In food and beverage manufacturing, disruptions to global supply chains moved from medium to high priority and litigation risk moved from low to medium priority.
- In hospitality and tourism, changes in consumer demand, biodiversity loss and heavy rainfall events each moved from medium to high priority.
- In computer and electronics manufacturing, technology change moved from medium to high priority.

Table 2.9. Definitions of each adaptive capacity score

Rating	Descriptor
Low	Sector is not ready or is not in a position to adjust to potential damage, to take advantage of opportunities or to respond to consequences
Medium	Sector is somewhat ready or has moderate ability to adjust to potential damage, to take advantage of opportunities or to respond to consequences
High	Sector is highly ready or has the ability to adjust to potential damage, to take advantage of opportunities or to respond to consequences

Table 2.10. Number of interviews by sector

Sector	Number of interviews
Chemical and pharmaceutical manufacturing	1
Computer and electronics manufacturing	4
Energy	2
Finance	6
Food and beverage manufacturing	3
Hospitality and tourism	3
Retail	4
Other	3
Total	26

For completeness, it is noted that no changes were made for either retail or the chemicals and pharmaceutical manufacturing sectors.

2.6 Develop Business-friendly Sectoral Guidance

To communicate the research findings to a wide audience, a set of business-friendly, sector-specific guides were produced – one guide for each of the five sectors included in this research. These short publications summarise, in simple, non-technical language, the key climate risks and opportunities for the sector. They also provide step-by-step guidance on how businesses can conduct their own climate risk assessment, using a simplified version of the TCFD framework and following the same methodology that was used in this research project. These guides will be disseminated to trade bodies, businesses and relevant government departments and agencies.

3 Findings

These findings draw on insights from the desk-based research, interviews and workshops. Results from all sectors are presented, followed by a discussion of high-priority risks and opportunities for each sector. Finally, interlinkages with the two enabling sectors – energy and finance – are discussed.

3.1 Overview

3.1.1 Overall level of awareness and engagement on climate adaptation

The Forfás report on climate adaptation by business was published over 11 years ago (Forfás, 2010). Although awareness of climate change has increased over this period, research for this project found that, overall, business preparedness for the impact of climate change remains low.

To date, businesses have tended to focus most of their efforts on climate mitigation, often stemming from a focus on efficiency and cost saving. They have focused less on how they will adapt to the disruptions that a changing climate will bring. There is a perception that climate change impacts in Ireland will not be as severe as those experienced in other countries (e.g. hurricanes and wildfires in the USA). While this is true to some degree, the fact remains that Irish businesses are currently not prepared for the changes that are likely to occur.

Engagement with businesses on the topic of climate adaptation has to date primarily focused on national adaptation plans for sectors to provide critical infrastructure that is likely to be significantly affected by extreme weather events, e.g. energy or transport infrastructure. There has been little engagement with business sectors such as the ones this research focuses on.

The industry interviews conducted as part of this project revealed confusion between different sustainability topics. For example, interviewees and workshop participants raised issues such as the circular economy, sectoral decarbonisation, packaging and single-use plastics. These issues are somewhat relevant to the topic of climate adaptation and business preparedness, but are more aligned with climate mitigation. The confusion between these different topics reflects the close interconnectedness of climate adaptation and mitigation and the synergies between them. Indeed, the IPCC notes the benefit of taking an integrated response to climate change that links “mitigation, adaptation and the pursuit of other societal objectives” (IPCC, 2014b, p. 112). The “merging” of sustainability topics and climate change responses may also reflect the fact that, in many businesses, one person or team deals with all aspects of this broad agenda, as well as the general “noise” and confusion around the terms sustainability, climate mitigation and climate adaptation.

Several interviewees raised the point that there is a lack of business-relevant information available on climate adaptation and on climate risks and opportunities. It was noted that trade bodies and industry associations regularly provide their business members with detailed information on topics such as Brexit and future skills needs, but lack actionable information on climate risks and opportunities at present. In addition, most businesses do not yet seem to realise that adapting to climate change will have an impact on the bottom line. There are likely to be costs associated with managing the risks and possible financial upsides from responding proactively to the opportunities.

3.1.2 Heat map of climate adaptation priorities by sector

The heat map in Figure 3.1 summarises the findings of the materiality assessment for each sector, which assessed 28 physical risks and eight transition risks. Each of the 36 risks is assigned a high, medium or low priority ranking. This approach is inspired by guidance in the Sustainability Accounting Standards Board *Climate Risk Technical Bulletin* (SASB, 2021).

It is clear from the heat map that transition risks have a similar priority level across sectors. In particular, the risks of stricter climate regulations, changes in consumer preferences/demand, disruptions to global

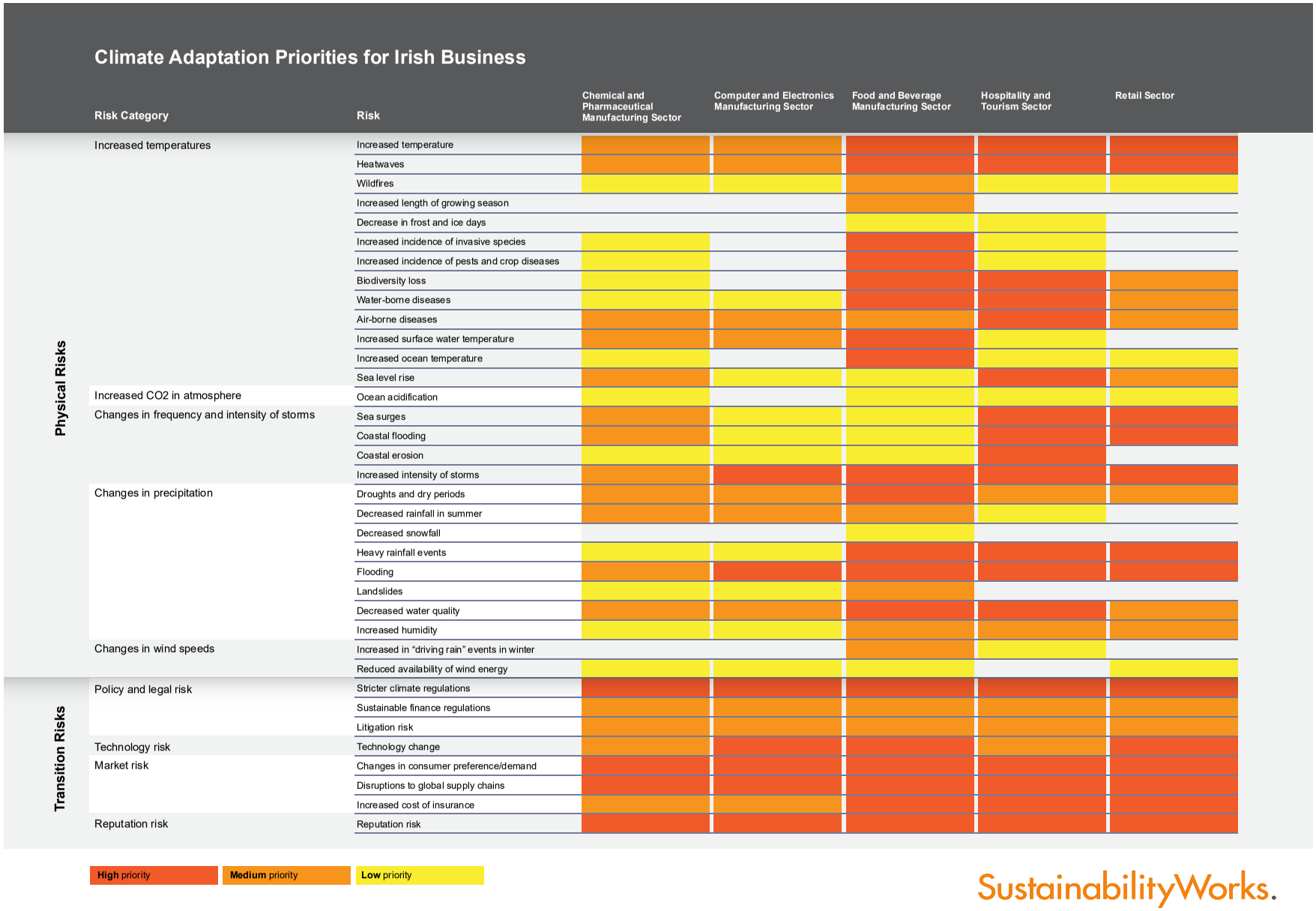

Figure 3.1. Climate adaptation priorities for Irish business.

supply chains and reputation risk are marked as high priority across all five sectors.

The prioritisation of physical risks is more varied across sectors, and, indeed, each business will have a different risk profile according to the location of its operations and supply chains. Food and beverage manufacturing and hospitality and tourism are the sectors most exposed to physical risks. Each has 13 out of 28 physical risks designated as high priority.

In the sections that follow, a general discussion of climate risks is provided, followed by sector-specific discussions along with a climate adaptation priorities matrix for each sector. Risks are grouped and discussed under the overall risk category heading, as shown in Figure 3.1.

3.1.3 General findings on climate-related opportunities

The TCFD recognises that "efforts to mitigate and adapt to climate change also produce opportunities" (TCFD, 2017). The types of opportunities that the TCFD describes are outlined in Table 2.4. Similarly, the EU Strategy on Adaptation to Climate Change captures the opportunity side of climate adaptation, referring to the fact that "the green transformation is an opportunity and that failure to act has a huge cost". Indeed, Europe has founded the European Green Deal on this basis. The European Green Deal – a framework to facilitate at least €1 trillion of investment over the next decade – likens climate-related opportunities to a "third industrial revolution". The opportunities it describes are aligned with those identified by the TCFD; for example, both describe resource efficiency actions such as retrofitting buildings or switching to low-emission energy sources as adaptation-related opportunities.

In an Irish context, the NAF recognises climate-related opportunities and it states that:

> A potential economic opportunity for Ireland is the adaptation economy. This is related to the concept of climate services and involves the transfer of specific adaptation knowledge and developing a comparative advantage and expertise in adaptation to particular forms of climate hazard e.g. flooding. (DECC, 2018, p. 79)

A notable finding from this project is that understanding of the climate-related opportunities linked to adaptation is at an early stage among Irish businesses. Although companies tend to be familiar with potential cost savings from climate mitigation activities, such as implementing energy efficiency measures, they are less aware of the potential upsides and opportunities related to adaptation.

It is important to note the distinction between opportunities associated with climate change in general and those associated with climate adaptation specifically. Climate change has sometimes been painted as an opportunity for Irish businesses, especially if climate impacts are less severe for Ireland than for competing regions. For example, the Forfás report mentions "increased passing trade in some sectors during longer summers" and the creation of opportunities for some industries as outdoor activities increase, e.g. tourism, leisure and urban design (Forfás, 2010). Galway County Council's Climate Adaptation Strategy projects that "drier and warmer weather will see an increase in beach tourism and marine activities enhancing the blue economy" and states that "Ireland's temperate climate should be capable of absorbing the predicted changes in climate over the next one hundred years without resulting in unacceptable comfort levels for visitors or taking away from the reasons that people choose to come to Galway" (Galway County Council, 2019). Meanwhile, the NAF discusses potential improvements to Ireland's ability to hire specialist skilled workers because of the country's moderate climate impacts relative to other countries (DECC, 2018).

However, these opportunities cannot be realised without proper business planning and preparedness, and there is a risk that, by over-emphasising them, the message that "climate change is good for business" gets unintentionally communicated. Furthermore, discussing such opportunities can be controversial, as businesses may be concerned about being seen as insensitive to the risks and damages that others face. It must be acknowledged that "identifying these opportunities by no means implies that an altering climate should be seen as a positive development" (Mazzacurati *et al*., 2018, p. 29).

Conversely, there has been less emphasis on the business benefits of adapting to climate change. Adaptation brings opportunity through green growth,

innovation, jobs and ecosystem enhancement, as well as improvements in areas such as water and air quality (DECC, 2018). Table 2.4 identifies climate-related opportunities based on TCFD opportunity categories. Specific examples relevant for each sector are provided in the following sections.

3.2 Climate Adaptation and the Chemical and Pharmaceutical Manufacturing Sector

3.2.1 Sector overview

Table 3.1 provides an overview of the characteristics of the chemical and pharmaceutical sector in Ireland.

3.2.2 Discussion of high-priority risks

Physical risks

No physical risks were identified as high priority for the chemicals and pharmaceutical manufacturing sector (see Figure 3.2). This reflects that, although many pharmaceutical companies have operations in Ireland, supply chains are global. Furthermore, as business continuity planning (e.g. planning for disruptions to energy or water supply) is commonplace within the sector, adaptive capacity is relatively higher than in other sectors.

Transition risks

Disruptions to global supply chains is a high-priority risk for the chemicals and pharmaceutical manufacturing sector companies, as the sector is heavily reliant on a functioning global supply chain. The sector sources most of its raw materials and active ingredients from countries outside Ireland. The European Fine Chemicals Group estimates that the European medicines supply chain sources more than 74% of its supplies from Asia (EFCG, 2021). Climate impacts in other countries could lead to disruptions or delays. The transportation of goods could also be affected; for example, increased frequency and intensity of storms globally could affect shipping routes/channels and cause delays to deliveries to Ireland.

General climate regulations will affect the chemicals and pharmaceutical manufacturing sector, as well as sector-specific regulations, such as the recently published EU Pharmaceutical Strategy for Europe. The strategy provides for the establishment of a structured dialogue to identify potential vulnerabilities in pharma supply chains and strengthen resilience (European Commission, 2020a). The Commission also aims to "engage with Member States and stakeholders in developing best practices for decarbonising value chains" (European Commission, 2020a).

Although the energy and agriculture sectors account for most of Ireland's greenhouse gas emissions, emissions from industrial processes and product use accounted for 5.3% of total emissions in 2019 (EPA, 2019). From a reputational perspective, chemicals and pharmaceutical manufacturing sector companies may come under increased scrutiny regarding their contribution to climate change and actions to adapt in the context of Ireland's Climate Action and Low Carbon Development (Amendment) Act 2021 (DECC, 2021) and associated sectoral carbon reduction targets.

Table 3.1. Chemical and pharmaceutical manufacturing sector in Ireland overview

Characteristic	Details
NACE codes	C20 and C21
Main activities/ processes, economic characteristics	Activities include the manufacture of chemicals and chemical products, agrochemicals, pesticides, soaps and detergents, pharmaceutical products and rubber and plastic products. The sector is of high value to the Irish economy. In 2020, the domestic biopharmaceutical and chemical sector had an export value of €106 billion, representing 67% of total goods exported (IBEC, 2021). The sector is heavily weighted towards pharmaceutical manufacturing, with all of the top 10 global pharmaceutical companies operational in Ireland
Number of active enterprises	568
Number of persons engaged	29,123
Relevant trade bodies/industry associations	Biopharmachem Ireland; Irish Cosmetics & Detergents Association; Irish Association of Chemicals & Ingredients; Irish Pharmaceutical Healthcare Association Ltd; European Federation of Pharmaceutical Industries and Associations

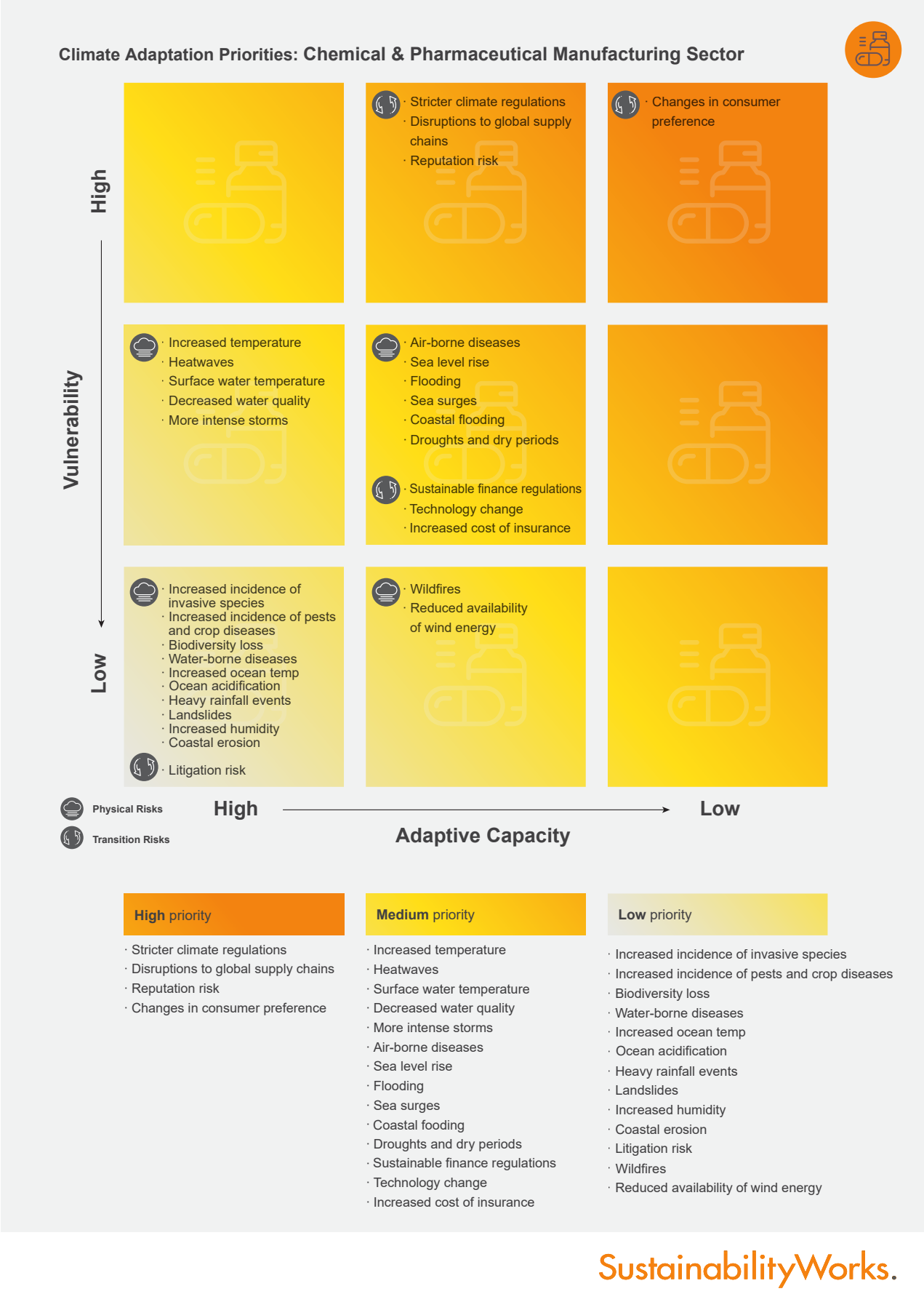

Figure 3.2. Climate adaptation priorities matrix for the chemical and pharmaceutical manufacturing sector. Source: SustainabilityWorks Ltd.

Rising temperatures as a result of climate change will change disease patterns and distributions, which is likely to change consumer demand for certain chemical and pharmaceutical products. The sector was considered to have low adaptive capacity to respond to these changes, as decision-makers in the chemicals and pharmaceutical manufacturing sector tend to be located in headquarters outside Ireland; Irish operations may therefore not be authorised to make decisions to meet changes in consumer demand.

3.2.3 Climate opportunities summary

Many chemical and pharmaceutical companies have already invested in resource efficiency in areas such as energy, but more can be achieved. In addition to cost saving, improving resource efficiency may improve companies' competitive advantage. Some support is available to businesses; for example, Irish Water runs a Water Stewardship Programme for businesses to reduce their water use and save on costs.

Switching to renewable energy sources can improve business resilience to the rising costs of energy and the development of carbon pricing schemes. In its response to CDP's 2019 climate programme, Novartis reports that "decarbonizing our products may also make them more attractive to companies like Kaiser Permanente, who have pledged to decarbonize their supply chain" (CDP, 2019b). Roche reports that it is implementing a pilot project in the UK to convert suppliers to 100% renewable energy by sharing Roche's electricity rate, which is obtained through a corporate power purchase agreement for offshore wind turbine energy (Roche, 2020).

Chemical and pharmaceutical manufacturing sector companies can gain competitive advantage by growing their sustainable product base in response to changing consumer and customer demands for sustainable products. Sales of these new products present an opportunity for the sector, but only if companies are prepared. The sector can engage its customers, invest in research and development (R&D) and form partnerships to create economies of scale. For example, in its response to the CDP's 2019 climate programme, Shire Pharmaceutical stated that "[their] commercial team must increasingly respond to customer inquiries about Shire's environmental impacts and mitigation strategies when responding to tenders" (CDP, 2019c). They can also reduce their reliance on natural raw materials (CDP, 2019c). The 2010 Forfás report stated that "Pharma companies using synthetic materials to produce their products may have opportunities over those using natural materials of which there may be less" (Forfás, 2010, p. 12). Roche aims to reduce Scope 3 greenhouse gas emissions in the supply chain by 15% between 2020 and 2025. Roche has also set a divisional goal to increase the number of "green suppliers" by 50% between 2020 and 2025 (Roche, 2020).

3.3 Climate Adaptation and the Computer and Electronic Manufacturing Sector

3.3.1 Sector overview

Table 3.2 provides an overview of the characteristics of the computer and electronic manufacturing sector in Ireland.

Table 3.2. Computer and electronic manufacturing sector in Ireland overview

Characteristic	Details
NACE codes	C26 and C27
Main activities/ process, economic processes	Activities include the manufacture of consumer electronics, electric motors, generators, transformers and electricity distribution and control apparatus. Products include electromedical equipment, optical instruments, electric lighting equipment, batteries and domestic appliances
Number of active enterprises	693
Number of persons engaged	25,418
Relevant trade bodies/industry associations	Irish Manufacturing Research (IMR); Microelectronics Ireland; Power Electronics Research Centre (National University of Ireland, Galway); Cobotics Skillnet; Institute of Electrical and Electronics Engineers (IEEE)

3.3.2 Discussion of high priority risks

Physical risks

The chemical and electronics manufacturing sector was considered to have medium vulnerability and low adaptive capacity to increased intensity of storms and flooding (see Figure 3.3). Manufacturing sites tend to be fixed assets that cannot easily be relocated or diversified. Thus, if a site is located in an area vulnerable to flooding and/or storms, it may suffer damage, which can be costly to remediate. However, establishing policies and protocols to deal with these risks can help to mitigate effects. Storms and floods could also prevent staff from getting to offices or factories. One interviewee from this sector explained that they have a rapid communication system whereby when a storm or flood is expected within a few hours, staff can be quickly advised not to come into the office and the head office in the USA can also be notified.

Transition risks

The chemical and electronics manufacturing sector is heavily reliant on a functioning global supply chain and is therefore vulnerable to climate-induced disruptions to global supply chains. Manufacturing is concentrated in Asia, and climate impacts or supply chain shocks have caused significant disruptions to the sector in the past. For example, the 2011 floods in Thailand forced major factories such as Sony, Western Digital and Honda Motors to close, and caused supply chain disruptions for Toyota and Nissan (BBC, 2011). The transport of goods could also be affected; for example, increased frequency and intensity of storms globally could affect shipping routes and cause delays to deliveries to Ireland. One interviewee from the sector explained that, when disruptions like that happen, they are forced to switch from shipping to aviation to fulfil deliveries, and that this increases their carbon footprint.

Changes in consumer preferences or demand are a strategic risk for businesses in the chemical and electronics manufacturing sector. As customers become more aware of the dangers of climate change, they will increasingly seek products that either address or do not contribute to climate change. Failure to update products and innovate to create more efficient and circular products will make companies less attractive than their competitors. This is reflected in the climate disclosures from major multinationals in the sector, as shown in the following quote from Intel's 2019 response to the CDP Climate Change programme:

> We face market risk due to intense competition across our broad product portfolio from other companies. If Intel does not proactively respond to customer needs and expectations for increasing energy efficiency with increased compute power, Intel risks losing market share in this highly competitive technology environment. (CDP, 2019a)

The sector has medium capacity to adapt to this risk, as it can respond by engaging with its customers to understand their needs, investing in R&D, and forming partnerships to create economies of scale. There will be some cost, but there is also the opportunity to increase sales.

Businesses in this sector are expected to have a medium capacity to adapt to stricter climate regulations. Relevant climate regulations include the EU's circular economy action plan, which will promote a longer lifetime of products through designing for energy efficiency and durability, repairability, upgradability, maintenance, reuse and recycling (European Commission, 2020b). The European Environment Agency has found that extending the lifetime of electronics can significantly reduce the environmental and carbon impacts of those products (EEA, 2020). Responding to regulatory changes will carry a cost for businesses, but those that take proactive measures will have time to investigate the best options for their business. Taking a reactive or last-minute approach may be more expensive and disruptive.

Furthermore, companies in this sector are often consumer facing, so loss of reputation may become an issue if they are not managing climate risk appropriately. The sector's adaptive capacity to this reputational risk was considered to be medium, as companies can probably avoid reputational damage by transitioning to low-carbon business models and preparing for climate change.

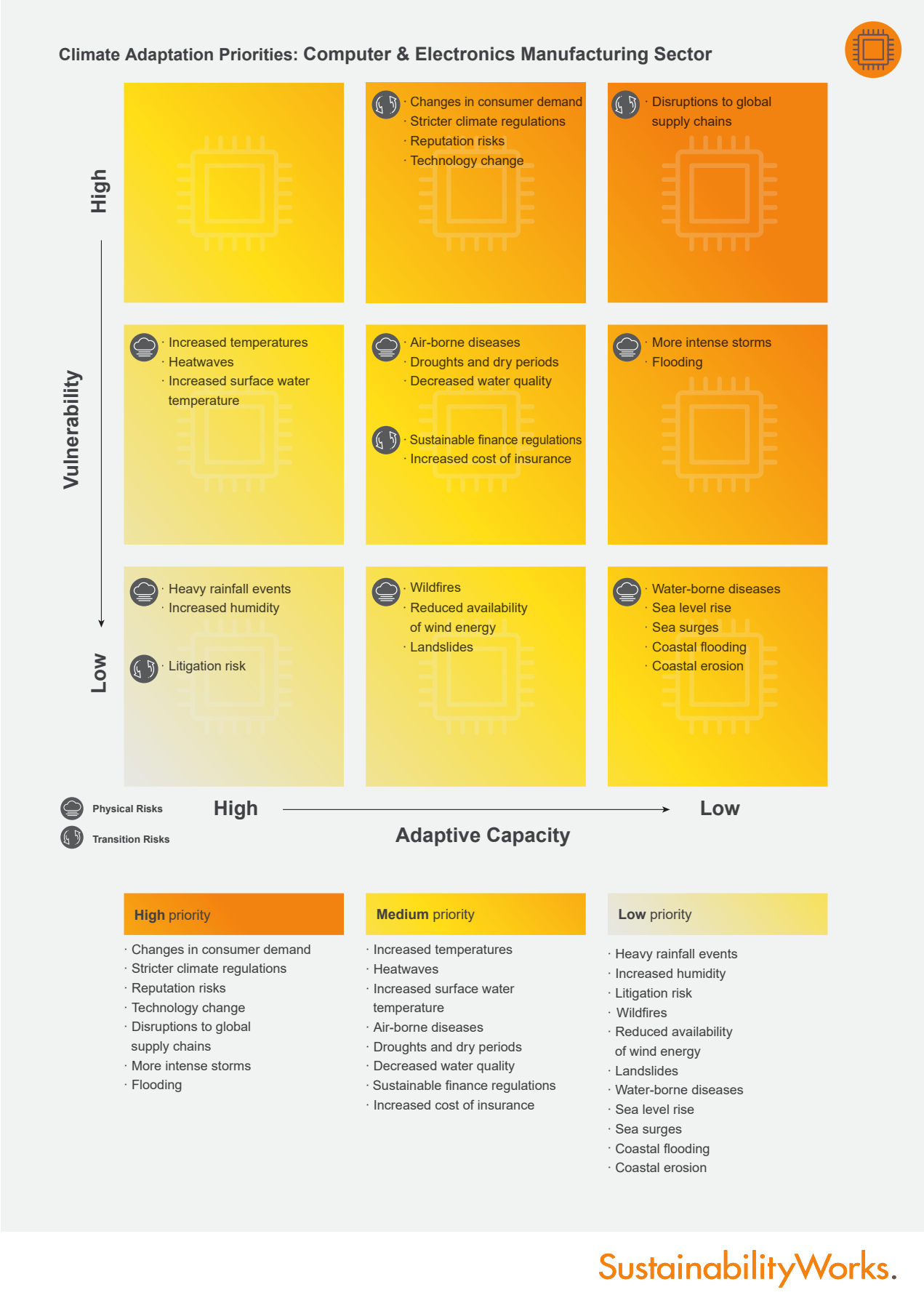

Figure 3.3. Climate adaptation priorities matrix for the computer and electronics manufacturing sector. Source: SustainabilityWorks Ltd.

3.3.3 Climate opportunities summary

The chemical and electronics manufacturing sector can play an important role in the transition to a low-carbon economy. The 2010 Forfás report stated that:

> ICT hardware and software offers huge potential to support climate change adaptation in areas such as sensor networks, more efficient power distribution and transmission, making buildings more climate resilient, [and] business support (continuity and back-up recovery). (Forfás, 2010, p. 13)

The sector manufactures the component parts and final products for a range of technologies that will support adaptation to and mitigation of climate change, including energy-saving light sensors, air conditioning units and water treatment technologies. Printed circuit boards are increasingly used in renewable energy products and environmental monitoring equipment. The sector has the opportunity to grow its production of these products and enhance its reputation as contributing to the transition to a low-carbon economy.

The chemical and electronics manufacturing sector has a track record of adaptability and agility in the face of rapid technological change. This may allow it to embrace new technologies more quickly than other sectors and gain competitive advantage.

3.4 Climate Adaptation and the Food and Beverage Manufacturing Sector

3.4.1 Sector overview

Table 3.3 provides an overview of the characteristics of the food and beverage manufacturing sector in Ireland.

3.4.2 Discussion of high-priority risks

Physical risks

Increased temperatures and heatwaves may affect the supply of ingredients for the food and beverage manufacturing sector (see Figure 3.4), as higher temperatures can damage crops and pose a danger to livestock. There will probably be increased costs to cool facilities and, if temperatures are extreme, there could be health risks for staff, such as heatstroke. For example, extreme warm weather in 2018 increased production costs, such as fuel and labour, in the Irish horticulture sector. Growing crops had to be irrigated to maintain yield and quality and additional energy was required to chill crops after harvest and to maintain temperatures at acceptable levels in glasshouses and mushroom tunnels (DAFM, 2018). In terms of logistics, there may be increased cooling costs during transport and distribution and greater potential for spoilage of goods, such as milk. The sector is considered to have medium adaptive capacity to these risks, as

Table 3.3. Food and beverage manufacturing sector in Ireland overview

Characteristic	Details
NACE codes	C10–C12
Main activities/processes, economic characteristics	Activities include the manufacture of food products and beverages. The agricultural sector is a crucial supplier of raw ingredients to the food and beverage manufacturing sector, but it is not a part of the actual sector under the NACE classification system. Teagasc has found that agri-food companies source 74% of raw materials and services from Irish suppliers, compared with 43% for all manufacturing companies, suggesting that the impacts of climate change in this country will be significant for this sector. However, the sector has strong links to other markets; in 2018, the sector exported €12.1 billion in goods to over 180 countries, with 37% of products exported to the UK, 34% to Europe and the remaining share to the rest of the world (Food Drink Ireland, 2021)
Number of active enterprises	2067
Number of persons engaged	52,434
Relevant trade bodies/industry associations	Drinks Ireland; Dairy Industry Ireland; Food Drink Ireland; Meat Industry Ireland; Prepared Consumer Foods Council; Food Services Network; Bord Bia; The Drinks Industry Group of Ireland

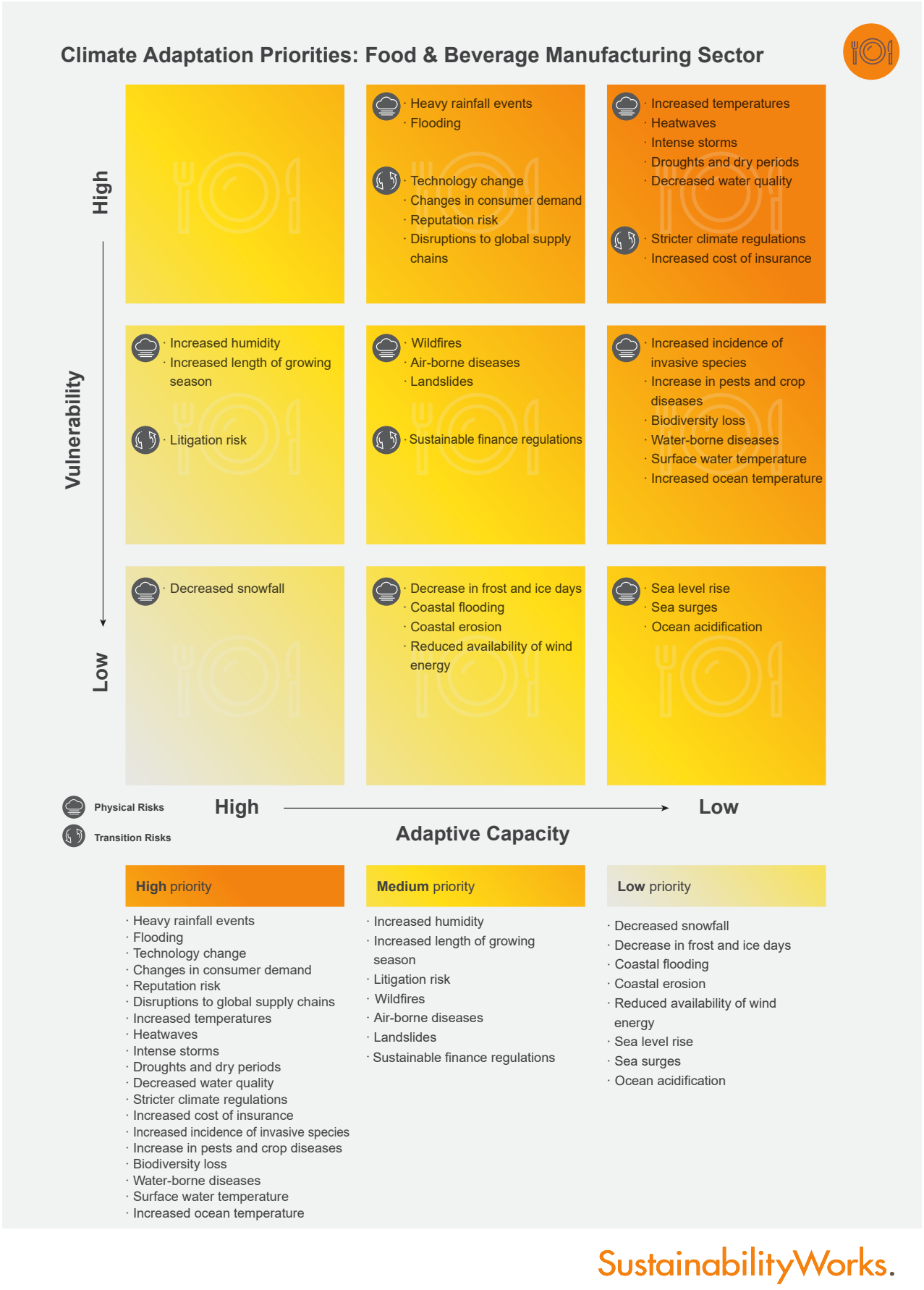

Figure 3.4. Climate adaptation priorities matrix for the food and beverage manufacturing sector. Source: SustainabilityWorks Ltd.

the sector can invest in tools to help deal with higher temperatures, e.g. air conditioning systems. However, increased use of air conditioning systems will increase the energy costs and carbon footprints of companies.

Increased temperatures will probably lead to an increase in the number of non-native species, pests and crop diseases arriving in Ireland. These hazards can have an impact on wildlife and ecosystems (e.g. riverbank stability) and can act as a pest for crops (EPA, 2017). Invasive Species Ireland estimated the direct annual cost of invasive species to Ireland's economy in 2013 to be over €200 million (DTCAGSM, 2017). Controlling invasive species and pests once they are established can be costly. The supply of ingredients to food and beverage manufacturers could be disrupted by these issues, primarily affecting the availability of raw materials. There may also be reputational impacts if businesses are not seen to take action on the issue of biodiversity loss.

Storms, flooding and heavy rainfall can affect the supply of ingredients to food and beverage manufacturers. On land, heavy rainfall and poorly drained soils can lead to extensive floods in rural areas, which can affect agricultural activity. Research shows that, even after flood waters recede, the underlying soils can remain saturated for several weeks, with the result that crops can be affected for significant periods (Teagasc, 2019). Furthermore, flooding can affect farmers' winter fodder stores (Teagasc, 2019). During Storm Emma, in 2018, farmers struggled to get supplies to supermarkets, and growers in the soft fruit and nursery stock sectors suffered the collapse of tunnels and glasshouses as a result of the heavy snowfall (Met Éireann, 2019).

Storms also pose a risk to fishing fleets and can damage harbour and aquaculture infrastructure (DAFM, 2018). On the operations side of the food and beverage manufacturing sector, storms and floods can damage buildings and products, and prevent staff from getting to offices or factories. Logistics can also be disrupted; for example, deliveries by road can be disrupted as a result of fallen trees or poor driving conditions.

The following risks are grouped together under "water impacts": water-borne diseases, increased surface water temperature, increased ocean temperature, droughts and dry periods, and decreased water quality. As flooding increases with climate change, more pollutants can reach water systems. Conversely, droughts can lead to low water levels and less dilution of contaminants, also causing water quality issues. For the food and beverage sector, water quality issues could disrupt the supply of ingredients; for example, plants and leafy greens are vulnerable to microbiological contamination from poor-quality water. Dry, cracked soil could mean that pesticides reach groundwater.

For companies that use fish products, increased ocean temperature can mean changes in the distribution of fish stocks; for example, fish may migrate northwards to access colder waters. This can lead to increased fuel costs for fishermen, which may be passed on to food and beverage manufacturers.

The sector's capacity to adapt to these water-related impacts was considered to be low. Such impacts are largely outside the sector's control, given that companies are largely dependent on Irish Water for their supply.

Transition risks

Climate regulations are changing rapidly, at both EU and national levels. The EU Farm to Fork Strategy aims to accelerate the transition to a sustainable food system that should have a neutral or positive environmental impact and help to mitigate climate change and adapt to its impacts (European Commission, 2020c). Targets relating to the reduced use of pesticides and fertilisers will change the way suppliers to the food and beverage manufacturing sector operate, potentially increasing costs for companies in the sector.

Other regulations, such as the disclosure of environmental information, as set out in the Non-Financial Reporting Directive, are likely to become stricter, and companies that fail to assess the risks posed by climate change and adapt accordingly may be penalised by investors. Both of these impacts will probably affect larger corporates first but will have knock-on effects on SMEs as suppliers to larger corporates. For example, interviewees explained that food and beverage retailers have begun including questions about sustainability and climate practices as part of their responsible sourcing due diligence.

The insurance industry will be an increasingly important partner for the food and beverage manufacturing sector in managing the impacts of climate change, such as crop failure leading to ingredient (commodity) shortages. However, insurance is not the panacea for solving food security issues, as these must be addressed in a holistic way.

In the food and beverage manufacturing sector, adapting to climate change will require investment in new technologies. Companies are considering technologies to improve efficiency in factories and processes, low-carbon technologies in logistics, such as the use of electric vehicles and route optimisation, and technologies such as blockchain to respond to increased consumer demand for full traceability of products.

Changes in consumer preferences or demand are a strategic risk for business in the food and beverage manufacturing sector. As customers become more aware of the dangers of climate change, they will increasingly seek products that either address or do not contribute to climate change. Failure to update products and innovate to create more efficient and circular products will make companies less attractive than their competitors.

Companies in this sector are often consumer facing and loss of reputation may become an issue if companies are not managing climate risk appropriately. Although aviation and oil and gas companies often suffer the worst reputational damage in relation to climate change, agri-food companies – particularly in Ireland – have come under increased scrutiny regarding their contribution to climate change.

The issue of plastic waste offers an example of how environmental issues can quickly capture the public imagination and lead to consumer demand for rapid change from companies. The sector's adaptive capacity to this reputational risk was considered to be medium, as companies can probably avoid reputational damage by transitioning to low-carbon business models and preparing for climate change.

Although the food and beverage manufacturing sector sources most of its raw materials and services from Irish suppliers, an important part of the supply chain is located in other countries. For example, Ireland imported €7.7 billion worth of food and beverages, which is an increase of almost €500 million relative to 2016 and an increase of €1.5 billion, or 24%, relative to 2012 (CSO, 2017). Some of these products will be sold directly by the retail sector, but others are used as ingredients in the food and beverage manufacturing sector. It is recognised that Europe is largely self-sufficient in terms of cereals and grains but is dependent on imported tropical products and commodities for animal feed and processing, for example. The supply of these tropical products is considered vulnerable because of climate change and the limited number of countries producing the raw material (EEA, 2021b). Climate impacts in these trading partner countries could lead to disruptions or delays in the import of these products. For example, over 93,000 tonnes of bananas were imported in 2017, with over 70% coming from Costa Rica (39,000 tonnes) or Belize (27,000 tonnes). If these countries suffer from physical climate hazards such as droughts, supplies may be disrupted, leading to financial impacts for Irish businesses. Businesses may be able to change suppliers to hedge against these climate risks, but this can be costly and is not always feasible, especially if all suppliers in an important export region are affected by the same climate issue (CSO, 2017).

3.4.3 Climate opportunities summary

The Irish food and beverage manufacturing sector has the opportunity to respond to changing consumer preferences relating to climate change. Bord Bia market research of over 18,500 people from nine countries found that 65% are making more of an effort to be more aware of the environment around them and 27% are willing to pay more for food that is sustainably produced. Beyond this, consumers are also seeking new products, such as plant-based foods, alternative proteins (e.g. meatless meats) and food that has high nutritional value.

Adapting their processes to become more resource efficient will deliver real cost savings for food and beverage manufacturers. Many are already doing this, but as technology advances there will be opportunities to make further savings. The sector has a unique opportunity to adopt circular economy principles in how it manages and values its waste streams. Indeed, it is one of the sectors with the most potential for circular transformation.

3.5 Climate Adaptation and the Hospitality and Tourism Sector

3.5.1 Sector overview

Table 3.4 provides an overview of the characteristics of the hospitality and tourism sector in Ireland.

3.5.2 Discussion of high priority risks

Physical risks

The hospitality and tourism sector is highly exposed to physical climate risks, given its dependence on the weather and the natural environment (landscapes and seascapes) (see Figure 3.5). The risks listed below emerged as high priorities for the sector. Certain risks are grouped and discussed together, as they will probably have an impact on the sector in similar ways, including:

- sea level rise, sea surges, coastal flooding and coastal erosion;
- increased temperatures and heatwaves;
- heavy rainfall events, flooding and increased intensity of storms;
- water- and air-borne diseases and decreased water quality;
- biodiversity loss.

Many of the losses due to climate change are likely to occur at the coast. Coastal risks, including sea level rise, sea surges, coastal flooding and coastal erosion, are closely interrelated, and each could disrupt the supply of key goods and services, damage buildings and infrastructure, and affect tourist activities. These findings are reflected in the Transport Sector Climate Change Sectoral Adaptation Plan, which states that "sea level rise, increasing ocean acidification and coastal erosion threaten Ireland's coastal tourism infrastructure and natural attractions" (DoT, 2019, p. 34). As noted in the Built Heritage Adaptation Plan, low-lying or geologically soft areas are particularly vulnerable to damage from sea surges, coastal flooding and coastal erosion. Coastal heritage sites, such as castles, Martello towers, harbours, promontory forts, historic houses and a variety of archaeological sites, including shipwrecks on the seabed, will also be affected. Saline intrusion can affect these historic structures and archaeology through physical and chemical reactions. Even areas set back from the coast could be affected, as tidal influences begin to move upstream in rivers, leading to flooding in places that were not previously exposed, such as historic urban centres. In this way, climate change could erode the foundation of Ireland's tourism industry, namely the amenities visited by tourists, such as coasts, beaches and castles. Adaptation options for the sector are limited and/or costly. For example, assets such as coastal hotels cannot easily be relocated, and flood defences can be costly and outside the control of individual businesses (DTCAGSM, 2019a).

Storms can affect all parts of the hospitality and tourism value chain, from tourists' ability to arrive in and leave Ireland, to building damage, staff and customer disruption, and the cancellation of bookings

Table 3.4. Hospitality and tourism sector in Ireland overview

Characteristic	Details
NACE codes	I55, I56, N79
Main activities/processes, economic characteristics	The sector comprises accommodation, food and beverage service activities, and travel agencies and tour operators. Accommodation covers hotels, holiday accommodation, campsites and trailer parks, while food and beverage service activities covers restaurants, bars and pubs, and event catering. The subsectors are strongly interlinked and the sector has many touchpoints with other sectors, such as food, infrastructure and construction. All subsectors depend on international and domestic tourists being able to travel freely throughout the country. Temperate climatic conditions can facilitate the smooth operation of the sector, while adverse climactic conditions can disrupt operations
Number of active enterprises	20,384
Number of persons engaged	195,361
Relevant trade bodies/ industry associations	Travel, Leisure and Hospitality Network; Irish Tour Operators Association; Ireland's Association for Adventure Tourism; Fáilte Ireland; Association of Visitor Experiences & Attractions; Irish Tourism Industry Confederation; European Tourism Association (ETOA); Restaurants Association of Ireland; Licensed Vintners Association; Vintners' Federation Ireland; International Tourism Partnership – a programme of Business in the Community

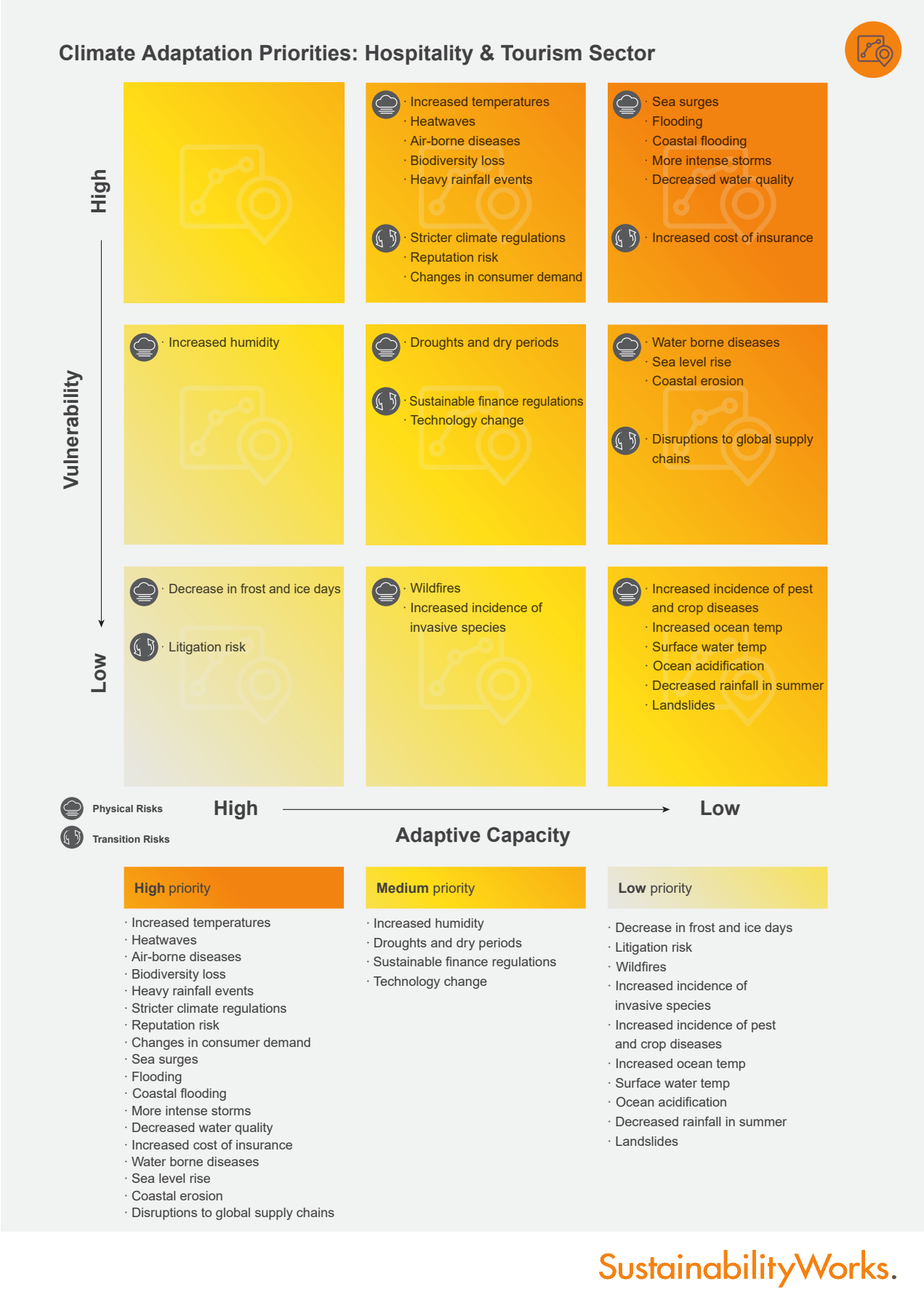

Figure 3.5. Climate adaptation priorities matrix for the hospitality and tourism sector.
Source: SustainabilityWorks Ltd.

and tour activities. For example, one interviewee described the impact of Storm Ophelia in 2018; all their tours had to be cancelled when a red weather warning was issued. As storms increase wave heights off the coast, certain activities, such as surf schools, may no longer be suitable for beginners. A large hotel chain explained how Storm Emma caused mass cancellations and the cancellation of a large awards function, which was a significant loss of revenue.

Heavy rainfall events and flooding already have a significant impact on the sector, such as flooding in Bantry as a result of Storm Francis in the summer of 2020 and Storm Emma in 2018. The sector was considered to have low adaptive capacity to flooding and medium adaptive capacity to heavy rainfall events. This reflects the difference in the duration of the events and the cost of responding to them – heavy rainfall is generally short-lived and may not cause long-lasting damage, whereas flooding can persist over days and the damage to buildings and operations can take weeks or even months to repair.

Increased temperatures and more frequent heatwaves are often thought of as an opportunity for the sector; however, there are downsides too. Long, dry summers with lowered water tables can damage the foundations of older buildings (DTCAGSM, 2019a). One interviewee explained that many smaller, local, older hotels do not currently have air conditioning and described an incident during the heatwave in summer 2018 when "even the Australians were finding it too hot!" Higher temperatures could also cause health risks for staff and tourists (e.g. heatstroke) and there is likely to be increased pressure on tourist amenities such as beaches. Some tours and activities may not go ahead if temperatures are too high and there will also be impacts on passenger comfort on trains and buses (Desmond *et al*., 2017). The sector was considered to have medium adaptive capacity to these risks, as companies can invest in tools to help deal with higher temperatures such as air conditioning systems and outdoor seating for pubs and restaurants. They can also establish health and safety protocols for staff and customers engaged in hospitality and tour activities in higher temperatures.

As flooding increases with climate change, there is a greater chance of pollutants reaching water systems. Conversely, higher temperatures, heatwaves and droughts lead to lower water levels, which reduce the dilution of contaminants, also causing water quality issues. For the hospitality and tourism sector, this could disrupt the supply of ingredients to hotels, pubs and restaurants and disrupt normal operation if drinking water is unavailable or cannot be provided to guests. Swimming bans could affect coastal hospitality and tourism, and water-based sports and activities. The sector's capacity to adapt to these risks was ranked as low, given that businesses generally rely on Irish Water for their supply of clean water and, therefore, quality issues are largely outside the sector's control. Providing bottled water is an additional cost for businesses.

Higher temperatures increase the viability of pathogens. Air- and water-borne diseases could have a similar impact, disrupting the ability of staff to work and reducing footfall where there is a fear of infection. The COVID-19 pandemic has illustrated the significant impact that disease can have on the normal operation of the hospitality and tourism sector.

Many people travel to Ireland for its scenery, natural attractions and unspoilt environment, and any threats to this image as a result of biodiversity loss could make Ireland a less attractive travel destination (Conghaile, 2016). As noted in the Sustainable Tourism Working Group Report:

> Ireland's tourism sector derives a unique advantage from the nation's natural beauty. Sustaining and nurturing the nation's natural assets (including coasts, mountains, rivers and lakes) through the adoption of sustainable tourism practices is recognized as a fundamental underpinning for Ireland's future sustainable tourism growth. (DTCAGSM, 2019b)

Biodiversity is declining in Ireland. This gradual loss is unlikely to have a sudden effect on the day-to-day operations of hospitality and tourism sector businesses, but it may have an incremental impact on tourism. For example, nature-related tours, such as bird and whale watching, could suffer if species appear less frequently. Adaptive capacity is considered to be medium, as, although the sector can take action to help reverse these trends, halting biodiversity loss will require cross-sector action and collaboration between public and private organisations. Thus, the resolution of the issue is not entirely within the sector's control.

Transition risks

For this sector, "disruptions to global supply chains" refer to any disruptions to the inflow of international tourists to Ireland's tourism sector as a result of climate-related impacts in other countries. Climate impacts in other countries can include storms, hurricanes, heatwaves and disease outbreaks. This framing was considered appropriate, as Ireland's hospitality and tourism sector is not heavily dependent on global supply chains for goods and services. However, the hospitality and tourism sector is heavily dependent on the movement of people into the country from abroad.

Using this framing, disruptions to global supply chains are considered a high priority for the sector. For example, the Irish Hotels Federation said that disruption caused by the ash cloud from the eruption of an Icelandic volcano in 2010 cost its members between €17 million and €20 million in lost revenue and the sector suffered widespread cancellations (Doyle, 2010). One interviewee – from a large hotel chain – described how business in their Dublin Airport hotels was severely affected by the closure of the airport during Storm Emma. The sector is considered to have low adaptive capacity, as these climate impacts are generally outside the sector's control. The sector has the option to grow the domestic tourist market, but this is smaller than the international market. It is expected that disruptions from the COVID-19 pandemic will have a more significant and long-term impact on the sector.

The increased frequency and severity of physical climate risks in Ireland may drive up insurance premiums, as more businesses than anticipated claim for the cost of storm and flood damage, lost revenues, etc. For example, one interviewee explained that insurance will not cover tour vehicles during a storm. The sector was considered to have low adaptive capacity, as the process by which insurers set premiums is based on models outside the sector's control. Insurers use certain data, such as flood risk maps, to determine the risk to business. A business located in a high-risk zone of such a map may pay a higher insurance premium than a business outside this zone, and interviews with the insurance sector indicate that insurers do not yet account for whether or not the business has taken steps to control climate risk.

Climate regulations affecting the hospitality and tourism sector are changing rapidly, at both the EU and national levels. In March 2021, the European Parliament passed a resolution on establishing a new EU strategy for sustainable tourism, and Ireland is also accelerating its work in this area (European Commission, 2020d). In October 2020, Ireland's Tourism Recovery Taskforce report was published and, in addition to addressing the COVID-19 crisis, it acknowledged that sustainability should be at the heart of the sector's recovery, if it is to have long-term resilience (Tourism Recovery Taskforce, 2020). Furthermore, countries may begin to apply a form of carbon tax on air travel, which could make flying more expensive and would affect Ireland, as an island nation.

Consumer demands in the hospitality and tourism sector are changing. Changes are coming from both tourists and participants in the hospitality and tourism sector. For example, one interviewee reported that corporate clients are including sustainability considerations on their requests for proposals from hotel groups. Meanwhile, a report from the Cambridge Institute for Sustainability Leadership found that there is "considerable uncertainty" about how tourists will respond to the effects of climate change. A survey by Swiss bank UBS found that "flight shame" could halve growth in air traffic globally (BBC, 2019).

The sector's adaptive capacity to this reputational risk is medium, as companies can probably avoid reputational damage by transitioning to low-carbon business models and preparing for climate change.

3.5.3 Climate opportunities summary

Hotel and restaurant businesses can avoid and reduce costs by using resources efficiently. There are various programmes that support and enable them to do this.

Galway County Council's Climate Adaptation Strategy identifies an opportunity to enhance the tourism offering and increase the sector's resilience by developing and implementing beach management plans and integrated coastal zone management, as well as sustainable hospitality programmes (Galway County Council, 2019).

There are opportunities for new products and services, for example to grow the nature and adventure tourism markets on account of changing consumer

preferences towards recreation in nature. Adventure tourists spend 45% more than other tourists on a typical stay in Ireland and the global adventure tourism market is expected to grow at a compounded average growth rate (CAGR) of nearly 46% during the period 2018–2022 (BDO, 2019).

In the restaurant and hospitality sector, there is an opportunity to respond to changing dietary preferences as demand increases for vegetarian, vegan, local and sustainably sourced food and drink.

3.6 Climate Adaptation and the Retail Sector

3.6.1 Sector overview

Table 3.5 provides an overview of the characteristics of the retail sector in Ireland.

3.6.2 Discussion of high priority risks

Physical risks

In its 2019 response to the CDP's climate programme, US retailer Walmart noted that the costs of physical climate risks "can include costs of maintenance and repair of damaged buildings, loss of sales from store closures, inventory loss from damage and spoiled food during power outages, and increased transportation costs to meet store needs during storms" (Walmart, 2020). More intense storms, heavy rainfall and more frequent flooding (including coastal flooding and sea surges) in Ireland are grouped together (see Figure 3.6), as such acute weather-driven events are likely to have an impact on the sector in similar ways. These were assigned high priority, as all parts of the sector's value chain are likely to be affected (Walmart, 2020).

Storms, flooding and heavy rainfall can cause logistics delays, for example delays to road deliveries from ports to retail outlets or warehouses if conditions on roads are affected or unsafe. Storms and flooding could affect the supply of ingredients to food and beverage retailers, for example if crops are damaged. On the operations side, storms, floods and heavy rainfall could damage not only buildings of companies in the retail sector but also their products, and prevent staff from getting to offices or factories. One interviewee from the insurance sector mentioned the large costs when underground car parks, such as the one in Dundrum Town Centre in Dublin, are flooded. Retailers located on the coast will be affected by coastal flooding and sea surges.

Regarding sales and demand, the uncertainty and unpredictability of storms and floods can create sudden changes in demand from customers. Consumers may be less likely to shop in store in periods of storms and floods. For example, Retail Ireland's Retail Monitor report notes that Storm Emma, in 2018, caused widespread disruption and closures over four key trading days (i.e. Thursday to Sunday). The storm also resulted in longer-term supply chain and consumer disruption, which ran into a full week and led to losses exceeding 30% for some businesses (Retail Ireland, 2018). These changes in sales and demand can be an opportunity for the sector – for example, demand for essentials such as bread, toilet paper and canned goods often increases during storms – but preparation is needed for the sector to respond quickly to these changes.

The sector's capacity to prepare and adapt to these risks is limited owing to the difficulty in predicting

Table 3.5. Retail sector in Ireland overview

Characteristic	Details
NACE codes	G471–G478
Main activities/processes, economic characteristics	This sector includes the sale of goods (e.g. clothes, household appliances) and groceries (e.g. from supermarkets, smaller newsagents and petrol stations). The sector is heavily dependent on international supply chains. The wholesale/retail sector was the biggest importer of goods from the UK, importing €12.8 billion of goods from the UK in 2017, or 57% of Ireland's total UK imports (CSO, 2021)
Number of active enterprises	24,860
Number of persons engaged	225,293
Relevant trade bodies/industry associations	Retail Ireland; Retail Excellence Ireland; Retail Grocery Dairy & Allied Trades Association (RGDATA); Efficient Consumer Response Ireland (ECR Ireland)

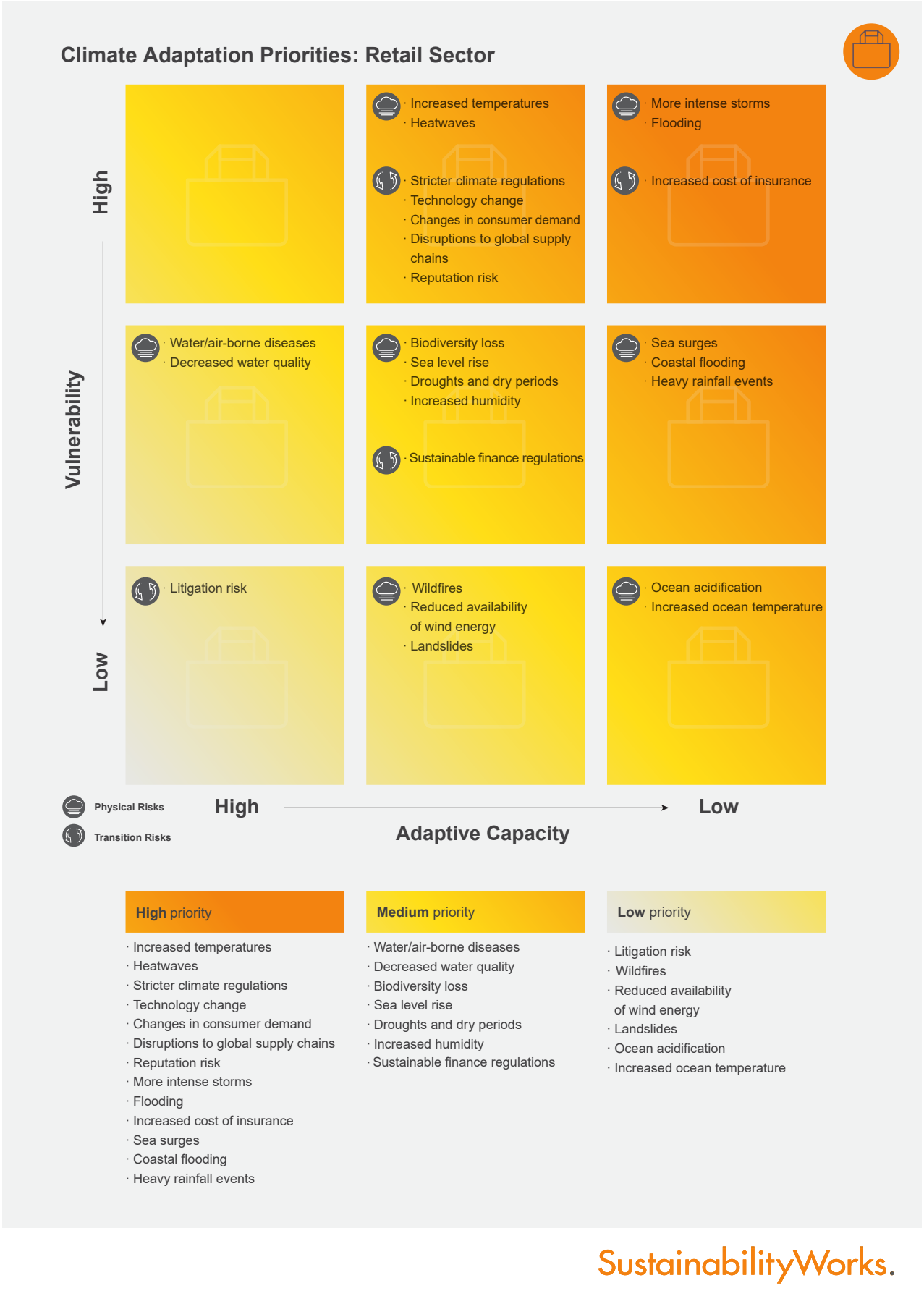

Figure 3.6. Climate adaptation priorities matrix for the retail sector. Source: SustainabilityWorks Ltd.

the timing and severity of storms and flooding. Furthermore, the cost of cleaning up flood and storm damage can be high and create a knock-on impact on the cost of insurance for businesses in the sector.

Increased temperatures and heatwaves are sometimes thought of as an opportunity for the retail sector (see section 3.6.3), but there are downsides too. Increased temperatures and heatwaves can affect the supply of food and beverage products, and in logistics there may be increased cooling costs during transport and distribution, and greater potential for spoilage of goods. In operations, high or extreme temperatures could lead to a loss of staff productivity and increased running costs to cool stores and chilled or frozen products.

Transition risks

The increased frequency and severity of physical climate risks in Ireland discussed previously may drive up insurance premiums, as more businesses claim for the cost of storm and flood damage, lost revenues, etc. The sector has low adaptive capacity, as insurers set premiums based on models and probabilities, and insurers do not yet take into account whether or not a business has taken steps to control climate risk. Thus, the process is outside the control of the sector. Some large companies can self-insure but there is a risk that SMEs in the sector will lose insurability.

Technology change will have a significant impact on the retail sector in the coming years. Low-carbon technologies, blockchain, automation, e-commerce, click and collect, the use of electric vehicles for logistics, route optimisation and supply chain optimisation will bring not only opportunities but also risks, for example if a business invests in a technology that is quickly superseded. There are costs to implementing these new technologies, but companies in the sector risk losing out if they do not keep pace with technology changes.

The retail sector is heavily reliant on a functioning global supply chain; it therefore experiences climate-induced disruptions to global supply chains. In an analysis of agricultural commodities, the European Environment Agency acknowledges that climate change will affect agriculture in Europe and globally, which, in turn, will affect the availability of products available to retailers. It recognises that Europe is self-sufficient in many products, but that it is reliant on imported tropical products, such as cocoa beans or palm oil, which are vulnerable to climate risks (EEA, 2021b). One interviewee from the retail sector explained that they source from different hemispheres at different times of the year, and that any changes to that timeline as a result of climate impacts would have a significant effect on their business. Businesses may change suppliers to hedge against climate risk, but this can be costly and is not always feasible. For example, if a drought affects an entire primary coffee-growing region, retailers dependent on this region cannot quickly and easily diversify to another supplier plantation, as all plantations in the region would be affected. In this example it is likely that the retailer could source coffee from an alternative region, and this should be a consideration in a responsible sourcing strategy.

Changes in consumer preferences and reputation risk are also strategic risks for business in the retail sector. As customers become more aware of the dangers of climate change, they may increasingly seek products that either address or do not contribute to climate change. There may also be an increased expectation for transparency on the provenance of products. In food retail, companies have noted a change in dietary preferences towards flexitarian, vegetarian, vegan and organic, while there is a growing backlash against “fast fashion” in fashion retail. Failure to update the product offering will make companies less attractive than their competitors, whereas companies that adapt to these changes will take a bigger market share.

As companies in this sector are often consumer facing, they may suffer reputational damage if they are not seen to take sufficient and effective action on climate change. The sector’s adaptive capacity to this reputational risk was considered medium, as companies can probably avoid reputational damage by transitioning to low-carbon business models and preparing for climate change.

Climate regulations are changing rapidly, at both the EU and national levels. With the increase in climate regulation, for example carbon tax, retail businesses will have to fundamentally rethink aspects of their operation and supply chain, such as logistics and product sourcing. They will also be part of the infrastructure to “take back” packaging and products

such as consumer electronics, and will therefore need to facilitate this.

3.6.3 Climate opportunities summary

The retail sector can increase its resilience by preparing for climate impacts. Interviews with sector representatives demonstrated that the sector has proven itself to be adaptable to new challenges. For instance, retailers have met the challenge of the "death of the high street" over the past decade by incorporating technology into their business, for example through click and collect, and have developed new offerings such as food courts at service stations along motorways.

When it comes to consumer preferences, retailers are the frontline in terms of direct engagement with consumers. There is an opportunity for the retail sector to play a part in educating consumers on climate-smart choices and behaviours.

Adapting to climate change also represents a major opportunity for the retail sector in terms of new products and services. A 2019 PricewaterhouseCoopers survey highlighted that 41% of Irish consumers are prepared to pay a premium for sustainable products. The report also showed that this trend is likely to continue to grow with greater awareness of climate change, resource depletion and the implementation of carbon taxes (PwC, 2019).

Finally, retailers that implement resource-efficient practices around energy, materials and water will benefit from cost savings.

3.7 Linkages with the Finance Sector

3.7.1 Overview

The financial sector is increasingly aware that climate change is fundamentally about financial risk and opportunity. The former Governor of the Bank of England and initiator of the TCFD, Mark Carney, has said that "achieving net zero will require a whole economy transition – every company, every bank, every insurer and investor will have to adjust their business models" (Carney, 2020). Carney also stated that climate change could be the greatest commercial opportunity of our time.

As outlined in previous sections, physical and transition climate risks will affect businesses across Ireland, both large and small, including beyond the five core sectors covered in this project. Banks, insurers and investors that are lending to, insuring or investing in Irish businesses will, therefore, be indirectly affected by climate change. This is because the financial sector depends on the resilience and readiness of real economy businesses.[1] The following sections provide an overview of climate-related financial impacts from the perspective of key financial sector stakeholders. It is based on findings from desk research and interviews with banks, insurers, investors, financial regulators and policymakers.

3.7.2 Financial policymakers

Sustainable finance policy has been a focus of policymaker attention since 2015, triggered by the Paris Agreement and the signing of the United Nations Sustainable Development Goals. This focus has only heightened as governments are discussing how to rebuild their economies in the wake of the COVID-19 pandemic. There is a growing consensus that economic recovery strategies must be sustainable and inclusive and deliver reforms that enable a more just and fair society.

Policymakers' focus on sustainable finance is driven by the need to mobilise private capital to deliver on policy objectives relating to climate and sustainability, the systemic risk that climate change poses for financial stability and the need to secure sustainable economic growth as the world transitions to a low-carbon, resource-efficient and circular future.

The European Commission includes sustainable finance as a core pillar of its broader sustainability policy framework and has developed a comprehensive sustainable finance workstream to deliver on the European Green Deal aims, with its second strategy announced in July 2021 (European Commission, 2021b). The backbone of the first EU sustainable finance strategy launched in 2018 (European Commission, 2018) is the EU taxonomy,

1 A real economy business is one that is involved in the production, purchase and flow of goods and services within an economy; it is different to the financial economy, which is involved in the transaction of money and financial services.

a classification system for environmentally sustainable economic activities that provides common definitions for companies, investors and policymakers alike. The taxonomy is expected to create security for investors, protect private investors from greenwashing, help companies to plan their transition to the "green" future, mitigate market fragmentation and eventually help shift investments to where they are most needed.

All this European legislation and regulation is now starting to directly affect Irish financial sector institutions, further raising awareness of the financial relevance of ESG factors broadly and climate-related impacts in particular. The Irish government's international financial services strategy, Ireland for Finance Strategy to 2025, identifies sustainable finance as a horizontal priority for Ireland's international financial services offering. This strategy is now supported by the first Irish Sustainable Finance Roadmap (Sustainable Finance Ireland, 2021).

3.7.3 Financial regulators

Central banks and regulatory authorities globally are increasingly concerned about the risks that climate change poses for financial stability, and many have begun integrating climate risks into their activities. For example, the European Central Bank published the results of an economy-wide climate stress test in September 2021 (ECB, 2021). The exercise tested the impact of climate change on more than 4 million firms worldwide and 1600 banks in areas using the euro under three different climate policy scenarios. The results show that both firms and banks clearly benefit from adopting green policies early on to foster the transition to a zero-carbon economy. The exercise also reveals that the impact of climate risk is concentrated in certain regions and sectors of the euro area. Firms located in regions most exposed to physical risk could face very severe and frequent natural disasters, which would in turn affect their creditworthiness.

In Ireland, the Central Bank has established the new Climate Change Unit to meet the growing challenges to its mandate from climate change, with the Governor of the Central Bank stating in March 2021 that:

> Our goal is to ensure that climate change is a strategic priority for the financial system, and that the financial system is resilient to the risks posed by climate change and capable of supporting the transition to a lower-carbon world. (CBI, 2021a)

3.7.4 Banking

As the backbone of the financial system, banks are at the heart of the global economy and are integral to its stability. In an Irish context, 76% of SMEs raise most of their debt from their bank (CBI, 2018). Compared with other financial sector stakeholders, banks are more exposed to the risk of customers failing to adapt to climate change. Although investors can easily shift their capital from one place to another and insurers can decide not to renew a policy, banks are dependent on ongoing lending to their customers. In terms of opportunity, banks can play a role in channelling capital towards low-carbon activities (as defined under the EU taxonomy) and can develop products and services that will support and incentivise their customers to make the transition to low-carbon activities.

In recognition of the complexity of the task of assessing climate-related risk and opportunities, at the global level, banks are aligning with the TCFD recommendations. They are collaborating to develop their responses to this challenge, with extensive guidance being published by the United Nations Environment Programme (UNEP) Financial Initiative TCFD banking pilot projects (UNEP FI, 2021). From a European perspective, the European Central Bank has issued guidance on how it expects EU-based banks to prudently manage and transparently disclose climate-related and environmental risks (ECB, 2020). Its guidance is also aligned with the approach of the TCFD.

3.7.5 Insurance

Of all financial sector stakeholders, the insurance sector has had the earliest and most tangible links with climate change, with the earliest reports appearing in the 1970s. Climate change alters the risk landscape for insurance companies, presenting not only diverse, interconnected and complex risks, but also new opportunities. The sector is particularly exposed to physical climate hazards because of its role in insuring physical assets such as real estate, infrastructure

and transport. As a result, insurers have been pricing these risks for some time and often have considerable expertise in areas such as natural disaster catastrophe modelling. However, affordability is likely to become a concern over time, as certain risks may ultimately become unaffordable to insure, e.g. certain coastal properties. In more extreme warming scenarios, many risks may simply be uninsurable, which has a profound impact on both the economy and society.

The latest EU Adaptation Strategy highlights the climate protection gap – the share of non-insured economic losses caused by climate-related disasters. On average, only 35% of climate-related economic losses are insured and the figure is sometimes 5% or lower in some parts of Europe (European Commission, 2021a). According to the German reinsurance company Munich RE, US$5200 billion has been lost since 1980 as a result of natural disasters. This gap appears to be widening because of slow adaptation action and more frequent extreme weather events in the absence of higher climate insurance penetration rates (Munich RE, 2020).

In the national context, there are a number of actions worth noting:

- The Department of Finance held a public consultation on climate change and insurance in 2019, targeted on the impacts of flooding (DoF, 2019).
- The NAF recognises the role of the insurance sector in collecting and disseminating data and calls for better information sharing between insurers, agencies such as the Office of Public Works (OPW), and local authorities facilitating improved risk modelling and the charging of premiums that more accurately reflect risk levels (DECC, 2018, p. 79).
- More recently, the Central Bank of Ireland issued a climate and emerging risk survey to assess awareness understanding and management of these risks across the Irish insurance sector (CBI, 2021b).

One other point of note is that, although it uses sophisticated modelling to price its policies, the insurance sector lacks good-quality, consistent data when it comes to predicting physical risks associated with climate change. With climate change, the past is no longer a good predictor of the future, and this poses an ongoing challenge for the insurance sector. To date, many insurers have used proprietary data to inform their models, but one interviewee emphasised that the sector is moving towards greater collaboration and transparency, for example through the Oasis Platform for Catastrophe and Climate Change Risk Assessment and Adaptation, and the Insurance Development Forum (Oasis Hub, 2021).

Like banks, the insurance industry has started to use the TCFD as a framework through which to consider climate-related risk and opportunity systematically (UNEP FI PSI, 2021). The European Insurance and Occupational Pensions Authority (EIOPA) has clarified its supervisory expectations in this regard in a statement to national supervisory authorities (including the Central Bank of Ireland), namely that it expects insurers to implement the TCFD recommendations on conducting climate-related scenario analysis (EIOPA, 2021). Furthermore, large EU-based insurers will be facing increasing disclosure requirements around climate impacts under increasing non-financial reporting requirements under the current Non-Financial Reporting Directive and the announced Corporate Sustainability Reporting Directive.

3.7.6 Investors

Investors rely on the existence of resilient, profitable companies in which they can invest. In recognition of financially material climate-related impacts, there are a number of large institutional investor initiatives that highlight the importance of integrating climate change into portfolio analysis and decision-making, including Climate Action 100+, the Investor Agenda and the Net-Zero Asset Owner Alliance.

Large investors and asset managers are also aligning with the TCFD recommendations. In addition, and to enable their own TCFD reporting, these stakeholders are requesting TCFD alignment and reporting from the companies they invest in. For example, in 2020, Larry Fink of BlackRock, the largest asset manager globally with assets under management of US$9.5 trillion, asked all companies they invest in to report alignment with the TCFD recommendations (Fink, 2021).

For Irish SMEs seeking to access funding from private equity and/or venture capital investors, these firms may raise funds, in turn, from large institutional

investors such as BlackRock, so requests for climate risk information are likely to increase.

3.7.7 Summary of findings for the financial sector

Although the sectoral workshops conducted as part of this project were primarily targeted at businesses and trade bodies, approximately 20% of attendees were from the financial sector, suggesting an interest in climate change adaptation among this enabling sector.

The key findings from the research and interviews with financial sector stakeholders are:

1. The financial sector is facing increasing pressure from multiple sources, including financial regulators, policymakers, shareholders, customers and employees, to take action on climate change and to consider financially material climate-related risks and opportunities to their business.
2. Banks, investors and insurers serving the Irish market are aligning with the TCFD recommendations and often publicly report in line with same. This may be because of either the intrinsic realisation of the usefulness of the recommendations, or external pressures from shareholders, policymakers or financial regulators.
3. Irish businesses should prepare to provide more information on their climate adaptation capacity to access finance and insurance.
4. Businesses that are climate resilient should be in a better position to access finance and take advantage of preferential rates/supports available for greener or more climate-resilient economic activities.

3.8 Linkages with the Energy Sector

All businesses are wholly dependent on energy companies for the power supply that enables them to carry out their activities. As the climate changes, businesses depend on the energy sector to manage its exposure to climate risks so that disruptions to power supply are minimised. Businesses also depend on the energy sector decarbonising, so that they (businesses) can manage transition risks related to climate policy and regulatory changes in pursuit of decarbonisation. Given these considerations, the energy sector was identified as an enabling sector for climate adaptation. Some larger businesses may be able to reduce their dependence on the energy sector by installing on-site energy and storage, but smaller businesses will, for the most part, remain dependent.

Several assessments of climate risk have been published for the energy sector, including the adaptation plan for the electricity and gas network sector (2018 and updated in 2019) (DECC, 2019a) and the recent EPA project *CIViC: Critical Infrastructure Vulnerability to Climate Change* (Ryan *et al*., 2021). The latter project explored the vulnerability of energy sector infrastructure to climate threats, finding that the projected change in extreme winds is likely to be the major challenge for energy infrastructure. For example, power outages caused by Storm Ophelia in 2017 resulted in cascading failures affecting the wastewater treatment, water treatment and telecommunications sectors. The *Electricity and Gas Networks Sectoral Adaptation Plan* (DECC, 2019a) also notes that critical infrastructure is often clustered in close proximity, for example telecommunications equipment on overhead energy networks, such as fibre on electricity lines, or telecommunications in transmission and distribution stations. Furthermore, smart grid development may mean that grid operation increasingly relies on a robust telecommunications system. These features can mean that one event can disrupt both power and telecommunications.

Climate change poses threats to physical energy infrastructure through extreme weather events, but it could also affect the normal operation of renewable energy infrastructure. For example, climate change is expected to increase the energy generated in winter and decrease the energy generated in summer months. As noted previously, businesses in all sectors depend on the energy sector's ability to respond and adapt to these risks.

The energy sector also faces transition risks, which will have a knock-on effect for other sectors of the Irish economy. Emissions from energy accounted for 58.9% of total national greenhouse gas emissions in 2019 and emissions from public electricity and heat production accounted for some 25% of energy sector emissions (EPA, 2019). Under the European Green Deal and the new Climate Action and Low Carbon Development (Amendment) Act 2021 (DECC, 2021), the energy sector is subject to strict decarbonisation

targets. The degree of progress against these targets will affect other sectors' ability to decarbonise. For example, sectors analysed in this project, such as retail, may seek to reduce their carbon emissions through the use of electric vehicles. Ireland's Climate Action Plan sets a target of almost 1 million electric vehicles on the road by 2030. This will depend on a functioning public recharging network, most of which is currently operated by ESB.

Ireland missed its binding EU target of 16% of total gross final consumption from renewable energy sources by 2020 (SEAI, 2020). The imperative to "catch up" may mean that changes to the energy system will come rapidly in Ireland over the next decades, potentially causing disruption for other sectors.

It was found that the energy sector is mature in its consideration of climate risks and opportunities. In interviews, energy sector representatives were more advanced in their assessment of climate risks and opportunities, with both companies interviewed already applying the TCFD framework and reporting the results.

It was also found that the energy sector is experienced in business continuity planning, owing to its status as critical infrastructure and the need to avoid outages and interruptions. Many companies in the energy sector own assets across Ireland and, as a result, are directly exposed to physical climate risks. This contrasts with the financial sector, which generally has indirect exposure to asset risk through the companies that it lends to. One company explained that the COVID-19 pandemic helped to strengthen some of its business continuity protocols, for example by ensuring that knowledge is spread across different teams so that if one team is affected by infection, know-how is not lost and operations are not disrupted.

4 Conclusions and Recommendations

4.1 Conclusions

4.1.1 Awareness levels and appetite among Irish businesses

To date, much of the focus for business action on climate change has been on climate mitigation – reducing greenhouse gas emissions to limit global warming to 1.5°C, in line with the Paris Agreement. There has been a lot less focus on adaptation – adapting to the physical and transition risks and the inevitable disruptions they will bring to business operations, services and supply chains.

Current levels of awareness among Irish businesses of the need for climate adaptation are low. However, based on the interactions with companies and trade associations during this project, there is evidence of a genuine appetite to better understand adaptation risks and opportunities. This is both encouraging and essential because it does not make sense for companies to think about mitigation and adaptation separately. They are inextricably linked and need to be considered as part of a comprehensive climate action approach.

4.1.2 TCFD as a climate risk and opportunity assessment framework

The use of TCFD as a framework for assessing climate risks and opportunities was found to be highly effective. The concept of financially material physical risks, transition risks and opportunities resonated with companies and trade bodies as a useful way of conceptualising climate impacts and the potential business response. The research team found the framework to be applicable when taking a sector-level approach to climate risk and opportunity assessment.

When it comes to carrying out a climate risk and opportunity assessment at the business level, those businesses with a strong existing approach to continuity planning and enterprise risk management should be able to quickly integrate a TCFD-style assessment into their approach. Those that are less advanced in these areas will have more of a learning curve ahead of them; however, doing a simplified TCFD-style assessment is likely to deliver benefits regarding not only climate risk management, but also general risk management and business model resilience.

4.1.3 Drivers for climate adaptation action

The need to understand and disclose information on climate risk will soon become increasingly important for all businesses. Larger corporates will be driven by multiple factors, including requirements under the Non-Financial Reporting Directive and its impending replacement, the Corporate Sustainability Reporting Directive, and pressures from investors and insurers. However, all businesses, both large and small, will soon be required to provide climate-related information to their bank when seeking a new loan. This is the result of banks needing to “green” their portfolios and make their loan books climate resilient. The same banks will probably offer services and support to help their clients adapt to climate change. In this way, the financial sector will be both a key driver and a key enabler of business action on climate.

Supply chains are also driving positive climate action. Anecdotal evidence from this project shows that Irish SMEs are increasingly being questioned about the climate impacts of their products, services and business model by the larger corporates they supply, particularly global multinationals, which are looking to their suppliers to help them deliver on their climate goals.

On the policy side, there was genuine interest from policymakers who engaged in this project and who clearly recognise the vital role of government in supporting businesses to adapt to the realities of climate change. This will require significant investment, not only in the form of information and training for businesses, but also in the form of infrastructure that enables systemic change (e.g. infrastructure to collect or reprocess goods and materials).

4.1.4 Barriers to action

There are several barriers to action, including a lack of:

- awareness of the urgent need for climate adaptation;
- information on what the practical impacts on businesses will be;
- coordination within the sectors and their supply chains to leverage advocacy or funding opportunities.

It is hoped that this project will go some way towards addressing these barriers.

4.1.5 Seizing the opportunity

A recent publication by the CDP found that there are "climate business opportunities calculated at US$2.1 trillion, nearly all of which are highly likely or virtually certain" (CDP, 2019a). Indeed, this project identified financially material opportunities for each of the five core business sectors included in the research. Businesses that seize these opportunities stand to gain competitive advantage and will be well placed to weather the disruptions that climate change brings. Taking advantage of the opportunities will require businesses across and within sectors to work in partnership. SMEs that embrace this and which proactively partner with the larger corporates they supply will see their position as preferred suppliers strengthened.

4.2 Recommendations

4.2.1 Further research

It is strongly recommended that further research be undertaken on the topic of climate risks and opportunities for the Irish private sector. This is especially important in the context of the Climate Action and Low Carbon Development (Amendment) Act (2021), which will see the introduction of carbon budgets for a range of industry sectors in 2021.

The approach taken for this project can and should be replicated for multiple other sectors, such as construction and technology. Further research can also be undertaken at the subsector level, as subsectors may face different risks and opportunities. For example, the food, fashion, pharmacy and forecourt retail subsectors of the retail sector merit distinct analysis, as do the dairy and beef subsectors of the food and beverage manufacturing sector. Support for such research may be available from financial sector stakeholders, particularly banks, that are engaging with these issues presently and also adapting a sectoral, TCFD-aligned approach.

Moreover, individual businesses should be encouraged to conduct their own climate risk and opportunity assessments applying the same approach to their own operations and value chains. Business-level assessments can use more granular data, such as geographical variations in climate hazards, and company-specific data, such as the location and prioritisation of sites, relevant risk timeframes, existing corporate policies (e.g. storm or flooding protocols) and availability of funds for adaptation projects. This would allow businesses to better determine their exposure and vulnerability to physical hazards and define their adaptive capacity to them. Businesses could also make their climate risk and opportunity assessments publicly available to enable peer-to-peer learning and knowledge-sharing within sectors.

As noted in Chapter 3 of this project, the financial services sector and the energy sector are quite advanced in using the TCFD approach to conduct climate risk assessments. These sectors could share their experience of climate risk assessment and business continuity planning with other sectors.

4.2.2 Availability of data and information

Businesses must be able to access clear, actionable information to conduct an assessment of climate risks and opportunities. At the moment, there is no standardised way to conduct these assessments, with some companies relying on external consultants to manage the process for them, while others with in-house sustainability teams are opting to manage the process themselves. The data required include a comprehensive list of physical climate risks projected to affect Ireland, the expected timeframe for these impacts and the possible effects.

The outputs from this research project could provide the foundation for a comprehensive, Irish-specific, sector-specific climate risk and opportunity database. It is recommended that such a database be created

and added to/expanded over time (read more on this in section 4.2.3).

4.2.3 Recommendations to policymakers

Given the need for accurate, business-friendly information on climate adaptation, it is recommended that policymakers, potentially supported by financial services stakeholders and business representative groups, develop a one-stop shop for Irish-specific, sector-specific data and information. The existing Climate Ireland website is an excellent repository of climate information; however, it is not currently targeted at a business audience, so it may or may not be the appropriate platform. Either a business-focused section on Climate Ireland could be developed or a new online platform could be created that can be regularly updated as new data come to light.

The heat map shown in Figure 3.1 of this report, which is inspired by the Sustainability Accounting Standards Board *Climate Risk Technical Bulletin* (SASB, 2021), could provide a simple structure for presenting the information. If turned into an online interactive tool, users could click on their sector or subsector, click into each risk category or individual risk and find relevant information and data on which to base their climate risk and opportunity assessment.

The current Programme for Government addresses climate adaptation, but primarily from a broad societal perspective. The only business sector it acknowledges as being exposed to climate risk is the agri-food and seafood sector. The Climate Change Advisory Council has also flagged a limited consideration for adaptation in policymaking. Future government policy needs to address the fact that all businesses will be exposed to both risk and opportunity arising from climate change, and initiatives should be put in place to enable adaptation by all sectors. The new EU Adaptation Strategy calls for policymaking to systematically take climate adaptation into account to avoid inadvertently undermining it. It states that "Data on climate-related risk and losses are crucial to improve the accuracy of climate risk assessment" and *"*to avoid 'climate-blind' decisions, data from both the private and public sector should be recorded, collected and shared in a comprehensive and harmonised way*"* (European Commission, 2021a).

Finally, policymakers should consider innovative mechanisms for the public and private sector to work together to address the adaptation finance gap. This gap between the need for climate adaptation projects and the funding available for them has been recognised by Adaptation Scotland, which recently launched a programme offering economic and financial advisory support services for climate adaptation projects and/or business cases (Adaptation Scotland, 2021). Ireland could consider developing a similar approach.

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Abbreviations

CSO	Central Statistics Office
ESG	Environmental Social and Governance
IPCC	Intergovernmental Panel on Climate Change
NACE	Nomenclature of Economic Activities
NAF	National Adaptation Framework
R&D	Research and development
SME	Small and medium-sized enterprise
TCFD	Task Force on Climate-related Financial Disclosures

AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL
Tá an Ghníomhaireacht um Chaomhnú Comhshaoil (GCC) freagrach as an gcomhshaol a chaomhnú agus a fheabhsú mar shócmhainn luachmhar do mhuintir na hÉireann. Táimid tiomanta do dhaoine agus don chomhshaol a chosaint ó éifeachtaí díobhálacha na radaíochta agus an truaillithe.

Is féidir obair na Gníomhaireachta a roinnt ina trí phríomhréimse:

Rialú: *Déanaimid córais éifeachtacha rialaithe agus comhlíonta comhshaoil a chur i bhfeidhm chun torthaí maithe comhshaoil a sholáthar agus chun díriú orthu siúd nach gcloíonn leis na córais sin.*

Eolas: *Soláthraímid sonraí, faisnéis agus measúnú comhshaoil atá ar ardchaighdeán, spriocdhírithe agus tráthúil chun bonn eolais a chur faoin gcinnteoireacht ar gach leibhéal.*

Tacaíocht: *Bímid ag saothrú i gcomhar le grúpaí eile chun tacú le comhshaol atá glan, táirgiúil agus cosanta go maith, agus le hiompar a chuirfidh le comhshaol inbhuanaithe.*

Ár bhFreagrachtaí

Ceadúnú
Déanaimid na gníomhaíochtaí seo a leanas a rialú ionas nach ndéanann siad dochar do shláinte an phobail ná don chomhshaol:
- saoráidí dramhaíola *(m.sh. láithreáin líonta talún, loisceoirí, stáisiúin aistrithe dramhaíola)*;
- gníomhaíochtaí tionsclaíocha ar scála mór *(m.sh. déantúsaíocht cógaisíochta, déantúsaíocht stroighne, stáisiúin chumhachta)*;
- an diantalmhaíocht *(m.sh. muca, éanlaith)*;
- úsáid shrianta agus scaoileadh rialaithe Orgánach Géinmhodhnaithe *(OGM)*;
- foinsí radaíochta ianúcháin *(m.sh. trealamh x-gha agus radaiteiripe, foinsí tionsclaíocha)*;
- áiseanna móra stórála peitril;
- scardadh dramhuisce;
- gníomhaíochtaí dumpála ar farraige.

Forfheidhmiú Náisiúnta i leith Cúrsaí Comhshaoil
- Clár náisiúnta iniúchtaí agus cigireachtaí a dhéanamh gach bliain ar shaoráidí a bhfuil ceadúnas ón nGníomhaireacht acu.
- Maoirseacht a dhéanamh ar fhreagrachtaí cosanta comhshaoil na n-údarás áitiúil.
- Caighdeán an uisce óil, arna sholáthar ag soláthraithe uisce phoiblí, a mhaoirsiú.
- Obair le húdaráis áitiúla agus le gníomhaireachtaí eile chun dul i ngleic le coireanna comhshaoil trí chomhordú a dhéanamh ar líonra forfheidhmiúcháin náisiúnta, trí dhíriú ar chiontóirí, agus trí mhaoirsiú a dhéanamh ar leasúchán.
- Cur i bhfeidhm rialachán ar nós na Rialachán um Dhramhthrealamh Leictreach agus Leictreonach (DTLL), um Shrian ar Shubstaintí Guaiseacha agus na Rialachán um rialú ar shubstaintí a ídíonn an ciseal ózóin.
- An dlí a chur orthu siúd a bhriseann dlí an chomhshaoil agus a dhéanann dochar don chomhshaol.

Bainistíocht Uisce
- Monatóireacht agus tuairisciú a dhéanamh ar cháilíocht aibhneacha, lochanna, uiscí idirchriosacha agus cósta na hÉireann, agus screamhuiscí; leibhéil uisce agus sruthanna aibhneacha a thomhas.
- Comhordú náisiúnta agus maoirsiú a dhéanamh ar an gCreat-Treoir Uisce.
- Monatóireacht agus tuairisciú a dhéanamh ar Cháilíocht an Uisce Snámha.

Monatóireacht, Anailís agus Tuairisciú ar an gComhshaol
- Monatóireacht a dhéanamh ar cháilíocht an aeir agus Treoir an AE maidir le hAer Glan don Eoraip (CAFÉ) a chur chun feidhme.
- Tuairisciú neamhspleách le cabhrú le cinnteoireacht an rialtais náisiúnta agus na n-údarás áitiúil *(m.sh. tuairisciú tréimhsiúil ar staid Chomhshaol na hÉireann agus Tuarascálacha ar Tháscairí)*.

Rialú Astaíochtaí na nGás Ceaptha Teasa in Éirinn
- Fardail agus réamh-mheastacháin na hÉireann maidir le gáis cheaptha teasa a ullmhú.
- An Treoir maidir le Trádáil Astaíochtaí a chur chun feidhme i gcomhair breis agus 100 de na táirgeoirí dé-ocsaíde carbóin is mó in Éirinn.

Taighde agus Forbairt Comhshaoil
- Taighde comhshaoil a chistiú chun brúnna a shainaithint, bonn eolais a chur faoi bheartais, agus réitigh a sholáthar i réimsí na haeráide, an uisce agus na hinbhuanaitheachta.

Measúnacht Straitéiseach Timpeallachta
- Measúnacht a dhéanamh ar thionchar pleananna agus clár beartaithe ar an gcomhshaol in Éirinn *(m.sh. mórphleananna forbartha)*.

Cosaint Raideolaíoch
- Monatóireacht a dhéanamh ar leibhéil radaíochta, measúnacht a dhéanamh ar nochtadh mhuintir na hÉireann don radaíocht ianúcháin.
- Cabhrú le pleananna náisiúnta a fhorbairt le haghaidh éigeandálaí ag eascairt as taismí núicléacha.
- Monatóireacht a dhéanamh ar fhorbairtí thar lear a bhaineann le saoráidí núicléacha agus leis an tsábháilteacht raideolaíochta.
- Sainseirbhísí cosanta ar an radaíocht a sholáthar, nó maoirsiú a dhéanamh ar sholáthar na seirbhísí sin.

Treoir, Faisnéis Inrochtana agus Oideachas
- Comhairle agus treoir a chur ar fáil d'earnáil na tionsclaíochta agus don phobal maidir le hábhair a bhaineann le caomhnú an chomhshaoil agus leis an gcosaint raideolaíoch.
- Faisnéis thráthúil ar an gcomhshaol ar a bhfuil fáil éasca a chur ar fáil chun rannpháirtíocht an phobail a spreagadh sa chinnteoireacht i ndáil leis an gcomhshaol *(m.sh. Timpeall an Tí, léarscáileanna radóin)*.
- Comhairle a chur ar fáil don Rialtas maidir le hábhair a bhaineann leis an tsábháilteacht raideolaíoch agus le cúrsaí práinnfhreagartha.
- Plean Náisiúnta Bainistíochta Dramhaíola Guaisí a fhorbairt chun dramhaíl ghuaiseach a chosc agus a bhainistiú.

Múscailt Feasachta agus Athrú Iompraíochta
- Feasacht chomhshaoil níos fearr a ghiniúint agus dul i bhfeidhm ar athrú iompraíochta dearfach trí thacú le gnóthais, le pobail agus le teaghlaigh a bheith níos éifeachtúla ar acmhainní.
- Tástáil le haghaidh radóin a chur chun cinn i dtithe agus in ionaid oibre, agus gníomhartha leasúcháin a spreagadh nuair is gá.

Bainistíocht agus struchtúr na Gníomhaireachta um Chaomhnú Comhshaoil
Tá an ghníomhaíocht á bainistiú ag Bord lánaimseartha, ar a bhfuil Ard-Stiúrthóir agus cúigear Stiúrthóirí. Déantar an obair ar fud cúig cinn d'Oifigí:
- An Oifig um Inmharthanacht Comhshaoil
- An Oifig Forfheidhmithe i leith cúrsaí Comhshaoil
- An Oifig um Fianaise is Measúnú
- Oifig um Chosaint Radaíochta agus Monatóireachta Comhshaoil
- An Oifig Cumarsáide agus Seirbhísí Corparáideacha

Tá Coiste Comhairleach ag an nGníomhaireacht le cabhrú léi. Tá dáréag comhaltaí air agus tagann siad le chéile go rialta le plé a dhéanamh ar ábhair imní agus le comhairle a chur ar an mBord.

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Climate Change Adaptation: Risks and Opportunities for Irish Businesses

Authors: Karen Deignan, Aideen O'Hora, Orlaith Delargy, Laura Heuston and Conor Morrow

Identifying Pressures

Climate change is already affecting Irish businesses and these impacts are likely to increase in severity. Our research identified material climate risks (pressures) for Ireland's private sector. Many businesses focus on climate mitigation; they may be taking steps to reduce their energy use or increase recycling to improve efficiencies and reduce costs. However, awareness and understanding of climate adaptation is low. Mobilising action is challenging because of limited in-house specialist knowledge, time/resource constraints and the tendency to focus mainly on near-term risks. The direct engagement approach taken in this project aimed to create greater awareness among businesses of the financial impact of climate change, obtain feedback on the challenges that sectors face and discuss practices or regulation that would enable each sector to do more on climate adaptation.

Informing Policy

The National Adaptation Framework notes that "the Government acknowledges the importance of complementary private sector action to address the impacts of climate change." It furthermore states that "Each Minister and Agency, where appropriate, should seek to engage with private sector representatives for their respective sector/area in shaping and developing their adaptation plans." This project has identified climate risks and opportunities at the sectoral level, and the work can inform policies to engage these sectors further to develop solutions and seize opportunities. For example, Enterprise Ireland and Industrial Development Agency Ireland (IDA Ireland) can use the findings to guide their sectoral policies.

Developing Solutions

By raising awareness of climate risks and opportunities, this research can help the private sector identify and develop solutions to address the environmental and economic challenges that they face. Some solutions, e.g. controlling flood risk, may need to be developed with the public sector. This project can also inform the development of solutions to develop business-level (rather than sector-level) resilience and adaptation plans. One potential solution is a practical, scalable workshop-based solution that can be rolled out nationally across the Irish private sector.

Furthermore, the examples highlighted in this project can inspire other businesses to develop solutions.

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