Adaptation to Climate Change: Issues for Business

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Forfás

A summary of this report can be found at www.forfas.ie

1 Introduction

1.1 Climate is changing

Credible international scientific evidence has confirmed that human activities have begun to modify our climate[1] and that such change will have significant social and economic implications. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) projects that, in the absence of policies to stabilise greenhouse gas emissions, global temperatures will increase by 3°C on average over the next century, with best-guess increases ranging from 1.8°C to 4°C . As a result, for example, rainfall patterns are expected to change and the frequency and intensity of extreme weather events are projected to increase in the 21st century.

1.2 Response to date has mainly been on mitigation measures…

International negotiations to secure a post 2012 global deal on climate change are ongoing (most recently at Copenhagen in December 2009). In the past, negotiations have primarily focused on efforts to mitigate, rather than adapt to, climate change. The United Nations Framework Convention on Climate Change (UNFCCC) meeting in Bali in 2007 put adaptation to climate change on a similar level with mitigation, reflecting the importance of this issue. Progress on climate change mitigation is essential to avoid the catastrophic impacts of climate change, i.e. achieve the objective of the UNFCCC and limit the negative impacts and therefore the need to adapt. The inertia of the global climate system and the long life times of the most important greenhouse gases ensures that, regardless of the success or otherwise of mitigation actions, the impacts of global warming and broader climate change will increasingly be felt and need to be addressed.

Mitigation needs to be distinguished from adaptation, as the former focuses on reducing the emission of greenhouse gases through energy efficiency measures, the Kyoto Protocol, regulation and control, etc. in attempting to reduce the rate of climate change. Adaptation focuses on ensuring that our society and economy are resilient to the realities of a changing climate. Adaptation measures are adjustments required in natural or human systems in response to actual or expected climate stimuli and their effects or impacts. Adaptation

[1] The difference between weather and climate is a measure of time. Weather refers to the conditions over a short period of time (i.e. days to weeks), while climate refers to average conditions over relatively long periods of time, such as 30 years or more. When we talk about climate change, we talk about changes in long-term averages of daily weather with changes in frequency and intensity of extreme events and the resources allocated for management of such events. The weather already significantly affects economic activity, as evidenced by huge increases in claims for flood damage following the floods of November 2009. As the climate changes, a range of sectors of Irish business will be faced with preparing for a range of new threats and opportunities.

moderates harmful impacts or exploits opportunities[2]. The European Commission has produced a White Paper on Climate Change Adaptation[3] which is in the first stage of implementation. A number of European Union Member States have already prepared and some are implementing national adaptation strategies.

1.3 …We now need to combine with adaptation measures to manage the unavoidable

An effective response to climate change must combine both mitigation - avoiding the unmanageable - with adaptation, managing the unavoidable. To date, the Irish policy approach – in line with that in the rest of the world - has been to focus on climate change mitigation. In recognition of Ireland's need to begin planning to adapt to the inevitable effects of climate change, the Department of Environment, Heritage and Local Government has committed to developing a National Adaptation Plan[4].

1.4 Forfás' work

The physical effects of climate change is having and will continue to have, a key influence on critical infrastructure and on important business decisions such as investment location. The purpose of this Forfás work is to develop an enterprise perspective on the opportunities and challenges for business in adapting to climate change. The draft Climate Change Bill, which is currently being developed, is expected to require the publication of a National Adaptation Plan within 12 months of enactment of the Bill. This Forfás work will feed into the development of the proposed National Adaptation Plan and is expected to form a key basis of the sectoral action plan for enterprise within it.

In preparing this work, Forfás has engaged with its sister agencies (IDA Ireland and Enterprise Ireland), a range of business interests (including an IBEC business workshop, one-to-one engagements with businesses, utility providers, industry representative organisations and the UK Carbon Disclosure Project) and policy stakeholders (including the Department of Environment, Heritage and Local Government, the Environmental Protection Agency, Sustainable Energy Authority of Ireland, Irish Academy of Engineering and the UK Climate Impacts Programme).

[2] Third Assessment Report of the Intergovernmental Panel on Climate Change, 2001 IPCC, Geneva, Switzerland.

[3] White Paper on Climate Change: Towards a European Frameworks for Actions. European Commission, Brussels, 2009.

[4] An initial framework document on the proposed National Adaptation Plan is expected to be published in Q3 2010.

2 How the climate is changing

A range of institutions (including the Environmental Protection Agency (EPA), Met Éireann, the C4I Project, University College Dublin and National University of Ireland Maynooth (NUIM)[5] in Ireland and the EU Ensembles Project at European Union level) are engaging in research on climate change impacts for Ireland. This research has shown conclusively that, in line with global patterns, Ireland's climate has changed over the past 100 years. Importantly, climate change and associated impacts are projected to increase in the coming decades and during the rest of this century. This change of climate is likely to bring resulting challenges to which Ireland's economy and society will have to adapt.

2.1 Some climate change is unavoidable for Ireland

The below tables list projected changes in Ireland's climate from established and peer reviewed research. The key findings are a summary of published reports from the EPA, UCD/ Met Éireann/ C4I and NUIM.[6] Some variations exist in scales of change and regional impacts due to uncertainty of models that project to the end of the century. Nonetheless, the overall message remains clear: the Irish climate is changing.

2.1.1 Temperatures: the Irish climate will continue to warm

Scale of increase	Timing	Regional Implications
1–3°C to 2100, compared to the 1961–2000 average (EPA Summary).	All seasons to be warmer	The greatest warming will occur in the south and east of the country. (UCD/ Met Éireann/ C4I).
3 - 4ºC towards the end of the century (UCD/ Met Éireann/ C4I).	More so in winter (EPA Summary).	
By the 2020s, average seasonal temperatures across Ireland will increase by between 0.75	Particularly in the summer and autumn seasons (UCD/ Met Éireann/ C4I). Greatest	

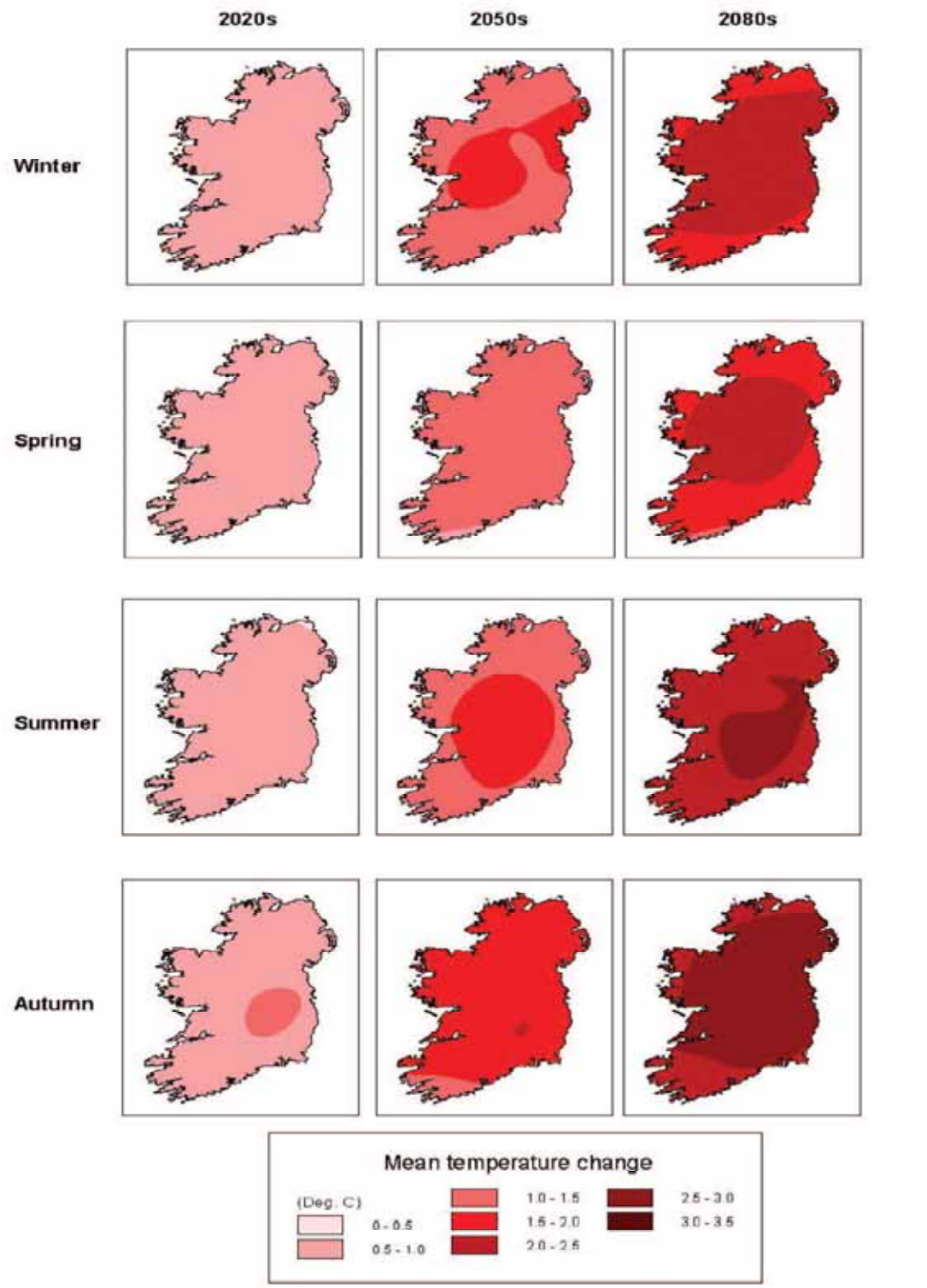
[5] Key pieces of research and weblinks on climate impacts for Ireland include:

- A Summary of the State of Knowledge on Climate Change Impacts for Ireland, Desmond M, O'Brian P., McGovern F., EPA, November 2009. http://www.epa.ie/downloads/pubs/research/climate/CCRP1(low).pdf
- Ireland in a Warmer World, UCD/ Met Eireann/ C4I, McGrath R. and Lynch P. (eds), June 2008 www.c4i.ie/docs/IrelandinaWarmerWorld.pdf
- Irish Climate Analysis and Research Units (ICARUS), National University of Ireland Maynooth (NUIM). www.icarus.nuim.ie
- Ensembles. http://ensembles-eu.metoffice.com/

[6] Ibid note 5.

and 1.0°C. By the 2050s, Irish temperatures are suggested to increase by 1.4– 1.8°C and by the 2080s, increases in the range 2.1–2.7°C are suggested (NUIM).	warming occurring during the autumn (NUIM).	
There is increased potential for frequency of heat waves. (EPA Summary).		
Changes in the climate may impede the recovery of the ozone layer; together with a warmer climate, there may be negative health consequences due to a greater exposure to UV radiation. (UCD/ Met Éireann/C4I).		

Figure 1: Mean seasonal temperature increases projected for the 2020s, 2050s & 2080s (Fealy & Sweeney).

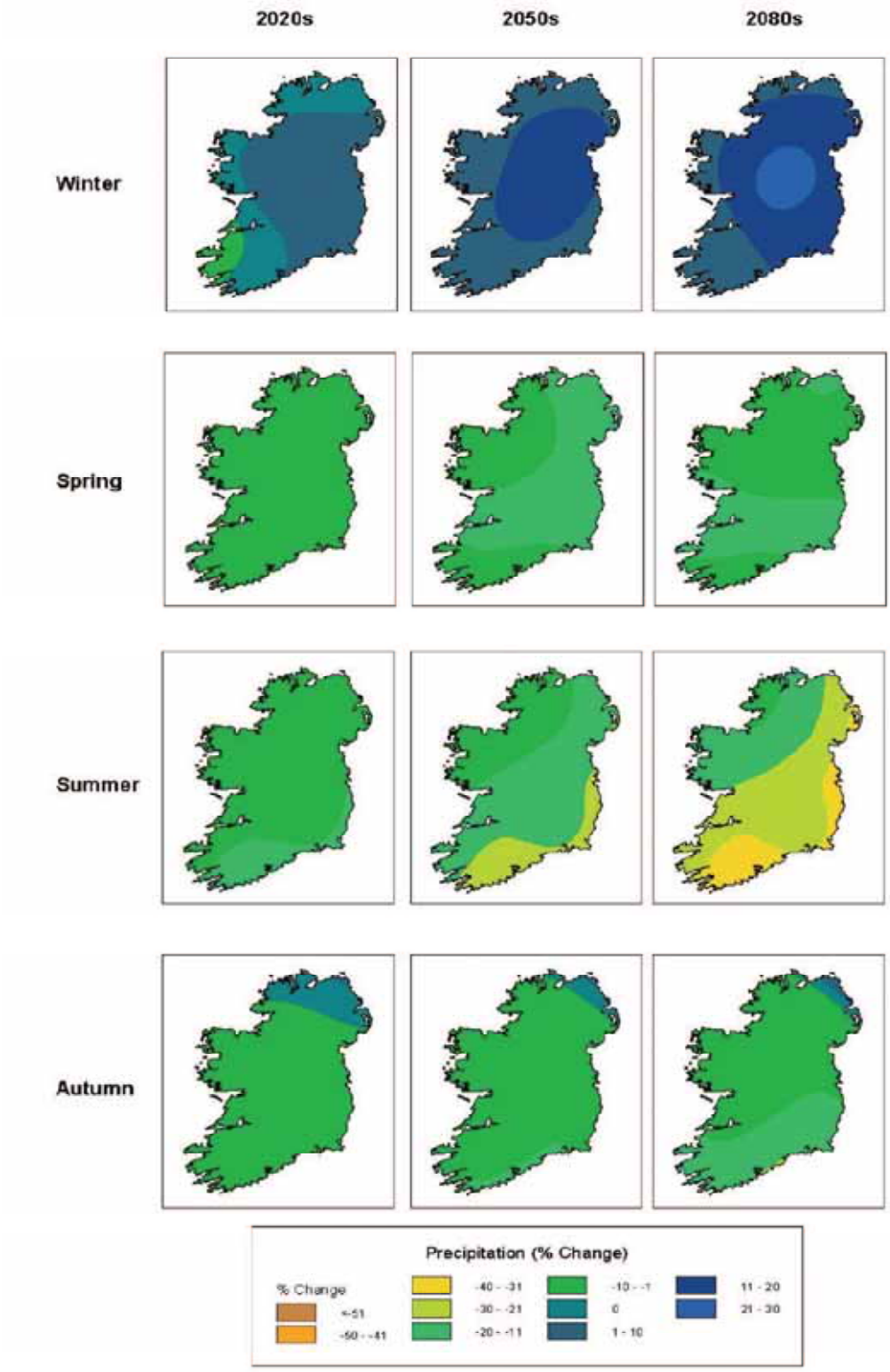


2.1.2 Rainfall: rainfall patterns are expected to change with wetter winters and drier summers

Scale of increase	Timing	Regional Implications
Increases in rainfall for autumn and winter in the range 15-25% towards the end of the century. Summers to be 10-18% drier towards the end of the century. (UCD/ Met Éireann C4I).	Autumn and winter seasons will become wetter. Summers will become drier (UCD/ Met Éireann C4I).	Regional details remain elusive, due to the large uncertainty in local projections. (UCD/ Met Éireann C4I).
	Winter precipitation is likely to increase marginally by the 2020s (~3%) with summer reductions of a similar order by 2050. Winter and summer during this time period experience the largest percentage changes in rainfall, ranging from 12% increases in winter to reductions of 12% in summer. These seasonal and spatial changes in precipitation are further enhanced by the 2080s, with winter increases of 13–18% and summer reductions of 14 -25%. (NUIM).	Wetter winters in the west. Drier summers in the south-east. (EPA Summary)
	Drier summers: 5-25% less rainfall in 2021 to 2060 compared to 1961 to 2000. (EPA Summary).	Reductions in precipitation in summer of 10-16% are suggested for regions along the southern and eastern coasts by the 2020s. By the 2050s, while increases are experienced along the east coast and midlands during winter, reductions of 20-28% are projected to occur along the southern and eastern coasts during the summer season. By the 2080s, the largest percentage increases in winter precipitation, of up to 20%, are projected to occur in the midlands, while the largest

		reductions during the summer months are again projected to occur along the southern and eastern coasts, which are likely to experience decreases of 30-40% during these months. (NUIM).

Figure 2: Mean seasonal precipitation changes projected for the 2020s, 2050s & 2080s (Fealy & Sweeney, 2007).



2.1.3 Floods: Flood events – both coastal and riverine – are likely to become more frequent

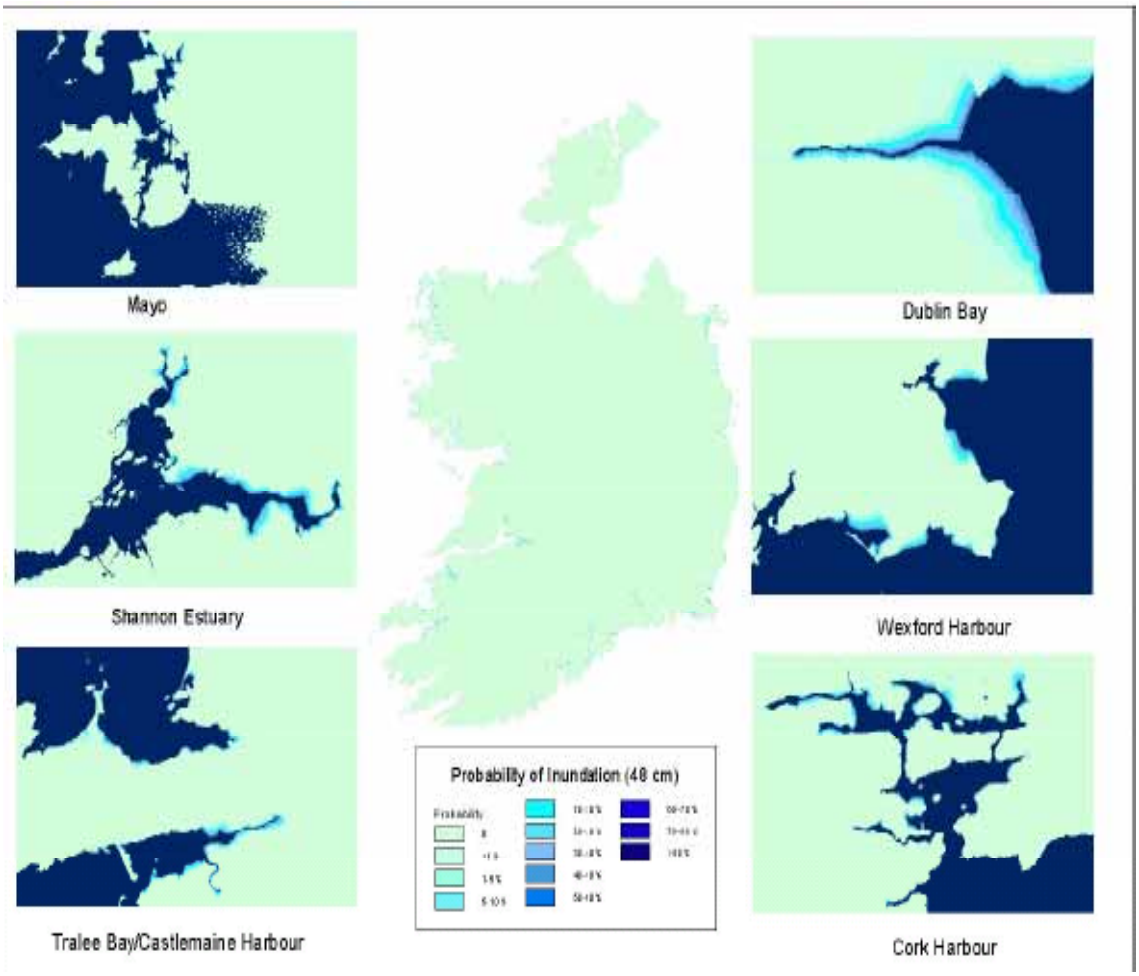
Coastal Flooding

- There is a medium scientific certainty of a rise of 60 cm to 2100. Changes in sea level are predicted to magnify impacts of changing storm surge and wave patterns in coastal areas. (EPA Summary).
- Sea levels are rising on average about 3.5 cm per decade around Ireland. This sustained trend would lead to sea level rises that are consistent with the IPCC (2007) global projections for the end of the century, although these estimates are probably conservative as they do not include current uncertainties in ice flow processes (melting glaciers, etc.). (UCD/ Met Éireann/ C4I).
- There will be an increased risk of coastal flooding due to storms/ surges. Higher waves are also expected to add to the intensity of surges and resulting coastal flooding. (EPA Summary).
- Ocean modelling results indicate an increase in the frequency of storm surge events around Irish coastal areas. There is also a significant increase in the height of extreme surges (in excess of 1m) along the west coasts, with most of the extreme surges occurring in wintertime. The impacts on wave heights are seasonally dependent: there is some evidence of significant increases (up to 30 cm) in some months. Extreme wave heights also show an increase - up to 10% around the northwest coast. (UCD/ Met Éireann/ C4I).

River Catchment Flooding

- Increased risk of river flooding. Increased flow to rivers in winter and less in summer. (EPA Mapping).
- Changes in precipitation and temperature are likely to lead to a rise in winter stream flows (increasing the risk of flooding), and a reduction in summer flows. (UCD/ Met Éireann C4I).

Figure 3: Probability of inundation associated with a sea level rise of 0.48m



Source: Fealy (2003)[7]

2.1.4 Storms: more frequent and severe stormy weather is predicted

- Modelling the sensitivity of the climate system to Atlantic sea surface temperatures suggests that there will be an increase in the frequency of very intense cyclones with maximum wind speeds of more than 30 metres/second; and increases in the extreme values of wind and precipitation associated with the cyclones. (UCD/ Met Éireann/C4I).
- Ocean modelling results indicate an increase in the frequency of storm surge events around Irish coastal areas; in the northwest the increase in surge heights between 50 and 100 cm is around 30% by mid century. Extreme wave heights are also likely to increase in most regions. (UCD/ Met Éireann/C4I).
- There will be slightly fewer storms, but storms will be of a more intense nature. It is predicted that a northward shift in storm tracks is likely. (EPA Summary).

[7] Fealy, R., (2003). The impacts of climate change on sea level and the Irish coast, in Sweeney, J. (ed.) Climate Change: Scenarios and Impacts for Ireland. Report prepared for the Environmental Protection Agency, Johnstown Castle, Wexford, 189-222.

- Changes in overall wind speeds are less certain. Some preliminary assessments on the impacts of climate change on wind speeds have shown increases of between 8-11% for winter. In contrast, modelling has indicated decreases of as much as 14-16% in wind speeds during summer months. (UCD/ Met Éireann/C4I).

2.2 What are the likelihoods of climate risks?

Likelihoods of events are key drivers in helping businesses make decisions on the extent to which they wish to adapt. Although significant improvements have been made in developing climate models, there will always be uncertainties associated with climate projections. The robustness of the most recent trends and projections in the main climate variables for Ireland have all been expressed as "medium" confidence levels. This translates to about 50% confidence in being correct in line with the definitions set out in the UNFCCC Fourth Assessment Report[8].

Table 1: Projected changes and current confidence projections

Climate Variable	Projected Changes	Degree of confidence in being correct
Air temperature	1–3°C to 2100, compared to the 1961–2000 average.	Medium (5 out of 10 chance)
Heat waves	Increased frequency of heat waves.	Medium (5 out of 10 chance)
Cold snaps/ frost days/ nights	Decreased frequency.	Medium (5 out of 10 chance)
Precipitation	Wetter winters in the west, Drier summers in the south-east.	Medium (5 out of 10 chance)
Extreme weather	Slightly fewer storms, but more intense. Northward shift in storm tracks.	Medium (5 out of 10 chance)
Ground- and surface-water runoff	Increased flow to rivers in winter and less in summer.	Medium (5 out of 10 chance)

Source: EPA Summary of the State of Knowledge on Climate Change Impacts for Ireland (2009)

[8] Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties, Intergovernmental Panel on Climate Change, July 2005. Available at http://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf

Some work has also been done in the UK on how often potential extremes will occur. The proximity of the UK may allow this work to shed some light on potential likelihoods of extreme temperature and precipitation events for Ireland.

Table 2: Likelihoods of extreme temperature and precipitation events for UK

How often will extremes occur?	Anomaly	Likelihood of years experiencing an extreme event (%)		
		2020s	2050s	2080s
Mean temperature				
A hot August	3 - 4°C warmer	1	20	63
A warm year	1 - 2°C warmer	28	73	100
Precipitation				
Drier summers	37 % drier	10	29	50
Wetter winters	66 % wetter	1	3	7

Source: UKCIP

Risk is the combination of the likelihood of occurrence and the magnitude of the consequence of a hazard. It is a useful concept for dealing with an uncertain future. The way in which climate change will translate into business consequences in Ireland is not certain. Nonetheless, decisions made today can increase or decrease vulnerability to future climate change. Infrastructure that business relies upon which is designed today will need to be able to resist climatic pressures and extremes in fifty or one hundred years from now. Decisions about where business locates will need to take account of future climate risks, including floods and coastal inundation.

2.3 Impacts vary globally, but Ireland is expected to be relatively less severely impacted than other areas

Changes in the global climate system during the 21st century are projected to include increased average global temperatures and changes in precipitation, sea level rise, extreme events such as hurricanes, droughts, wildfires and other effects[9]. It is important to note that

[9] Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, 2007:

the severity of the impacts of climate change is likely to vary by region and within regions[10]. While all countries are likely to be impacted in some way by climate change, Ireland stands to be less severely impacted relative to a number of other competitor countries/ trading partners in the short to medium term at least[11]. Indigenous firms can seek to realise opportunities from these expected comparative advantages. In marketing Ireland as a destination for inward investment, IDA Ireland can also point to the likelihood of Ireland remaining relatively temperate, avoiding extreme natural disasters (such as earthquakes) and - properly managed - being relatively "water-rich" when compared with other key competitors.

2.3.1 Europe

- Nearly all European regions are expected to be negatively affected by some future impacts of climate change. Southern Europe, the Mediterranean Basin, outermost regions and the Arctic are seen as the most vulnerable. Furthermore, mountain areas (in particular the Alps), islands, coastal and urban areas and densely populated floodplains are facing particular problems.
- Some northern countries are likely to experience overall increases in annual precipitation but to benefit from increased crop yields, forest productivity, and food supplies from the North Atlantic. By 2020, most areas of Europe are likely to see an increased flood risk.
- Central and Eastern European countries could face less summer rainfall, causing potential water shortages. Health risks due to heat waves are expected to increase. Forest productivity is expected to fall and the frequency of peatland fires to increase.
- Southern European countries are very likely to see reduced water supplies, lower crop production, more wildfires and health impacts from increased heatwaves.
- A decrease in snow season length and snow depth is expected over most of Europe.

2.3.2 North America[12][13]

- Coastal areas: Significant sea-level rise and storm surges will adversely affect coastal cities and ecosystems around the nation; low-lying and subsiding areas are most vulnerable. More spring runoff and warmer coastal waters will increase the seasonal reduction in oxygen resulting from excess nitrogen from agriculture. Rising sea levels, severe weather and storm surges, combined with population growth in coastal areas, are very likely to increase economic losses.
- Southwest America: Water supplies will become increasingly scarce, calling for tradeoffs among competing uses. Increasing temperatures, drought, wildfires, and

[10] Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007.

[11] Forfás is planning to undertake a more detailed assessment of the impacts of climate change on trade flows around the world. This work is expected to be finalised by the end of 2010.

[12] Global Climate Change Impacts in the United States, United States Global Research Program, Cambridge University Press, 2009. Available at http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf

[13] Impacts to Adaptation: Canada in a Changing Climate 2007, Natural Resources Canada, 2007.

invasive species will accelerate transformation of the landscape. Increased frequency and altered timing of flooding will increase risks to people, ecosystems, and infrastructure. Cities and agriculture face increasing risks from a changing climate.

- Midwest America: During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing insect and waterborne diseases. In the winter, warming will have mixed impacts. Significant reductions in Great Lakes water levels, which are projected under higher emissions scenarios, could lead to impacts on shipping, infrastructure, beaches and ecosystems. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer could lead to more periods of both floods and water deficits. While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects, and weeds will present increasing challenges to managing crops, livestock, and forests. Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.
- Northeast America: Extreme heat and declining air quality are likely to pose increasing problems for human health, especially in urban areas. Agricultural production including dairy, fruit, and maple syrup, are likely to be adversely affected as favourable climates shift. Severe flooding due to sea-level rise and heavy downpours is likely to occur more frequently. The projected reduction in snow cover will adversely affect winter recreation and the industries that rely upon it.
- Northwest America: Sea-level rise along vulnerable coastlines will result in increased erosion and the loss of land. Declining springtime snowpack leads to reduced summer stream flows, straining water supplies. Increased insect outbreaks, wildfires, and changing species composition in forests will pose challenges for ecosystems and the forest products industry.
- Southeast America: Projected increases in air and water temperatures will cause heat-related stresses for people, plants and animals. Decreased water availability is very likely to affect the region's economy as well as its natural systems. Sea-level rise and the likely increase in hurricane intensity and associated storm surge will be among the most serious consequences of climate change. Ecological thresholds are likely to be crossed throughout the region, causing major disruptions to ecosystems and to the benefits they provide to people. Quality of life will be affected by increasing heat stress, water scarcity, severe weather events, and reduced availability of insurance for at-risk properties.
- Northern Canada: Increased navigability of Arctic marine waters and expansion of land-based transportation networks will bring both opportunities for growth in a range of economic sectors and challenges associated with culture, security and the environment.
- Atlantic Canada: Water resources will come under increasing pressure as conditions shift and demands change in response to both climatic and non-climatic factors. Impacts on marine fisheries will include numerous aspects of fishery operations.
- Quebec: Some impacts could be beneficial for certain economic sectors, including hydroelectricity and forestry. There will likely be increased shoreline erosion where most of the region's social and economic activity is concentrated.

- Ontario: Climate-related disruptions to critical infrastructure, including water treatment and distribution systems, energy generation and transmission, and transportation are likely to become increasingly frequent in future. Water shortages in southern regions are projected to become more frequent as summer temperatures and evaporation rates increase.
- Canadian Prairies: The Prairies could lose some advantages of a cold winter which limit pests and diseases, facilitate winter operations in the forestry and energy sectors, and provide access to remote communities through the use of winter roads. Drought, which can have associated economic impacts of billions of dollars, wildfire and severe floods are projected to occur more frequently in future.
- British Columbia: Many regions and sectors of British Columbia will experience increasing water shortages and increasing competition among water uses (e.g. hydroelectricity, irrigation, communities, recreation and in-stream flow needs), with implications for trans-border agreements. British Columbia's forest industry is particularly vulnerable to climate-related risks, including pest infestations and fire. Climate change will exacerbate existing stresses on British Columbia's fisheries. British Columbia's agricultural sector faces both positive and negative impacts from climate change, with more frequent and sustained drought being the greatest risk.

2.3.3 Asia

- Increased frequency, intensity, and duration of heat waves are likely in East Asia and Korea.
- Glacier melting in the Himalayas is expected to disrupt water supplies within the next 20 to 30 years. Increased winter precipitation, floods and rock avalanches are expected, particularly in northern Asia and the Tibetan Plateau.
- Heavily-populated coastal regions, including the deltas of rivers such as the Ganges and Mekong, are likely to be at risk of increased flooding.
- Economic development is likely to be impacted by the combination of climatic change, urbanisation, and rapid economic and population growth.
- Forecast changes in temperature and rainfall are likely to reduce crop yields overall, increasing the risk of hunger.
- The presence of lethal diarrhoeal diseases associated with floods and droughts is expected to rise in East, South and Southeast Asia and rises in coastal water temperature could exacerbate cholera in South Asia.

2.3.4 South America

- Sea level rise is very likely to bring flooding to low-lying regions such as the coast of El Salvador, Guyana and the Rio de la Plata estuary. Increasing sea temperatures are likely to impact coral reefs and south-east Pacific fish stocks.
- Changes in rainfall patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation.

- Increasing temperatures and decreases in soil water in the eastern Amazon region would lead to replacement of tropical forest by savannah. Species extinctions are likely.
- Drier areas are likely to see salinisation and desertification of agricultural land, with falling crop yields and livestock productivity reducing food security. However, some crop yields (such as soybeans) are likely to increase in temperate zones.

2.3.5 Australia and New Zealand

- The length and frequency of dry spells over Australia and New Zealand is expected to increase, with increased seasonable droughts over many mid-latitude continental interiors.
- Ongoing water shortages, notably in southern and eastern Australia, are likely to get worse by 2030.
- Some coastal communities are very likely to see an increased risk of coastal storms and flooding.
- Temperature rises of 1ºC-2ºC are likely to bring benefits to cooler areas, such as New Zealand, in the form of longer growing seasons and reduced energy demand. Greater warming is likely to bring a net negative impact - such as increased risk of drought and fire.
- Increased wildfires in arid and semi-arid areas such as Australia.

2.3.6 Middle East and North Africa

- The Middle East and North Africa (MENA) region is particularly vulnerable to climate change. It is one of the world's most water-scarce and dry regions with a high dependency on climate-sensitive agriculture and a large share of its population and economic activity in flood-prone urban coastal zones.
- According to the latest IPCC assessment, the climate is predicted to become even hotter and drier in most of the MENA region. Higher temperatures and reduced precipitation will increase the occurrence of droughts, an effect that is already materialising.
- It is further estimated that an additional 80–100 million people will be exposed by 2025 to water stress, which is likely to result in increased pressure on groundwater resources, which are currently being extracted in most areas beyond the aquifers' recharge potential.
- Agriculture yields, especially in rain fed areas, are expected to fluctuate more widely, ultimately falling to a significantly lower long-term average. In urban areas in North Africa, a temperature increase of 1-3 degrees could expose 6–25 million people to coastal flooding. In addition, heat waves, an increased "heat island effect," water scarcity, decreasing water quality, worsening air quality, and ground ozone formation are likely to affect public health, and more generally lead to challenging living conditions.

2.3.7 Russia[14]

- A warming climate holds the possibility of milder and shorter heating seasons, which in turn may lead to reduced Russian energy demand. Increased water availability—particularly along those Siberian rivers that are used for hydroelectric power—should result in increased power production in certain parts of the country. However, existing and future energy infrastructure for the petroleum industry will experience more pronounced challenges: structural subsidence, risks associated with river crossings, and construction difficulties as permafrost thaws earlier and deeper, impeding the construction of vital new production areas.
- Many parts of Russia's massive territory will experience increases in the availability of water, including much of Siberia, the Far North, and northwestern Russia. This change will bring certain positive impacts—including for hydroelectric generation (as noted above). However, managing the increased flows will pose other problems, especially when these increased flows coincide with extreme weather events such as downpours, or springtime ice-clogged floods.
- As growing seasons become longer and precipitation patterns change, using lands for agricultural purposes that previously would have been too far north—too cold for too much of the year—will become possible.

[14] Russia: Impact of Climate Change to 2030, Joint Global Change Research Institute and Battelle Memorial Institute, Pacific Northwest Division, April 2009.

3 Implications for businesses in Ireland

In spite of research indicating that Ireland will be less severely impacted relative to a number of other countries, Ireland is expected to remain exposed to a number of climate risks. This section will attempt to look at climate impacts which are expected to be felt across a range of business areas. It will also demonstrate that there are likely to be opportunities as well as threats for businesses but that such opportunities will only be realised if these risks are managed in a systematic way.

3.1 Physical Impacts

There is a complex relationship between business growth and physical changes in climate: climate change can affect growth by increasing the depreciation of capital (such as buildings) or by affecting productivity, output, sales and reputation. In turn, these can have knock-on implications for the rate of investment and the investment available for research and development and new technologies. From the research available for Ireland, the below lists how predicted physical changes in Ireland's climate could impact on Irish businesses[15]:

3.1.1 Markets: climate change could change demand for goods and services

Potential risks

Climate change may create changes in customer demand. There may be decreased or disappearing demand for the present range of goods and/or services or a competitor's position may be enhanced by climate change.

Potential business responses

In some cases, this may require modifications to existing products and services; in other cases, potential may exist to diversify and deliver entirely new products or services to meet the emerging sustainability demands of consumers and other stakeholders.

3.1.2 Logistics: climate change could increase vulnerability of supply chain, utilities (in particular energy and water) and transport arrangements

Potential risks

Some key business sectors (such as Information and Communications Technologies (ICTs) and Life Sciences) with extensive supply chains which are heavily reliant on transport/infrastructure are particularly vulnerable to climate risks. In addition, the supply and quality of water to businesses could be impacted by changes to the seasonal cycle of rainfall and impact on business water supply management and water quality. Increased winter flows, coupled with the predicted increase in extreme precipitation events lead to an

[15] The UK Climate Impacts Programme Business Areas Climate Impacts Assessment Tool (BACLIAT) tool has been used as the basis of this framework. http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=82&Itemid=195.

elevated risk of flooding. This is particularly significant in the southwest of the country, and those catchments with fast response times[16]. The decrease in summer precipitation will reduce stream flow and aquifer recharge and will thus negatively impact on water availability and on water quality for industry. Critical energy and telecommunications transmission infrastructure may be exposed to increased risks of storms and flooding.

Potential business responses

There may be a need to understand the potential impacts on operations and the company's supply chain and how these can best be managed. In particular, an understanding of the vulnerability of critical suppliers and product distributors may be important. Companies with global supply chains could assess the potential for geographic diversification of supply chains.

3.1.3 Premises: climate change could impact on building design, construction, maintenance and facilities management

Potential risks

Potential climate risks such as flooding, stormy weather, coastal erosion, landslides and even forest/peatland fires could translate into an increased risk of damage for vulnerable business sites, coastal cities and for critical infrastructure required by business.

Potential business responses

Businesses will need to locate and design facilities for increased resilience to extreme weather events and reduce vulnerability by locating in areas of reduced risk. In particular, for all future site construction, vulnerability to flooding, sea level rise, access to water, subsidence and drainage will be key considerations.

3.1.4 Finance: climate change could have implications for investments, insurance and stakeholder reputation

Potential risks

Failure to make business climate resilient may create difficulties in securing investment and/or insurance cover. Potential liabilities may arise if climate change is not factored into long term decisions about the future.

Potential business responses

- Business climate risk management strategies should incorporate a risk screening for assets and investments.
- Reputational concerns may arise as a result of climate risks. A proactive stance on dealing with climate change could enhance the reputation of individual firms and that of their sector.

[16] The flooding of November 2009 resulted in a number of contamination risks to water supplies in areas such as Cork and Galway where water treatment plants or reservoirs were flooded.

- Businesses could assess the implications of increased insurance costs and ways to keep such costs down.

3.1.5 People: climate change could have implications for workforce, customers and changing lifestyles

Potential risks

- Climate change may impact on working conditions of staff or ability of staff and customers to travel. Sectors relying on outdoor workers (such as agriculture and construction) may also be impacted.

Potential business responses

- Assigning someone within the company with responsibility for work on adapting to climate change and providing them with the necessary support can assist in driving forward the climate impacts and adaptation agenda throughout the company.
- It is important that all parts of a large organisation will have some basic understanding of the issues and planned responses. Providing staff with access to sufficient information to prepare for climate change can help company responsiveness. Training and incentives to effectively market and sell sustainability products and services may also be required.
- Businesses could consider climate impacts from health and safety perspective of staff and customers.

3.1.6 Processes: climate change could have impacts on production processes and service delivery

Potential risks

Higher temperatures may impact on key business processes (such as refrigeration, data centre cooling and precision engineering processes).

Potential business responses

- Companies can plan to reduce key resources such as water and energy which stand to be impacted by climate change. Active water and energy conservation policy and monitoring processes can help understand and manage this risk. Proactive investments and policies should be developed to address key risks (water efficiency and rain water harvesting, etc.).
- Companies should have well developed and tested business continuity plans to deal with extreme events.
- Companies should design operational processes to be flexible and resilient so they can adapt to changing demand or risk in very short time scales.
- Proactive R&D actions against possible business risks and opportunities could enable technological and business model innovations which could contribute to the company's competitive edge.

- Adaptation to a changing climate needs to be complemented by strategies for reducing greenhouse gas emissions (mitigation). Any adaptation strategies for production processes must avoid increasing greenhouse gas emissions.

3.2 Depending on the location, there are potentially costs for businesses and the economy from a changing climate

Information on the costs and benefits of adaptation remains limited and this is an area which will need to be focused on as research in Ireland develops. Some evidence is available of rising economic losses associated with extreme weather events. For example, a recent study by the European Central Bank[17] has estimated that the budgetary impact of extreme weather events ranges between 0.23% and 1.1% of GDP annually depending on the country group with higher impacts on developing countries, countries with already warm climates and countries nearer the equator. A very crude application of the lower ECB estimate would put the budgetary impact of extreme weather events for Ireland at €368 million per year[18].

Policymakers in Ireland have yet to identify adaptation options and to undertake cost-benefit analyses on these options to inform decision making. As an initial indication of what potential vulnerabilities to climate change might be, figures from the Irish Insurance Federation (IIF) show that the combined insured property cost of the November 2009 floods and the January 2010 freeze stood at €541 million. To compare with historical claims, the insured cost of these two weather events has exceeded the total cost (€358 million) of all serious weather events that have occurred in the last decade (although it should be recognised that the value of property at risk increased significantly over this time). In line with the expected impacts of climate change, the greatest impact of these floods, the cost for which totalled €244m, was very localised with the three counties worst hit (Cork, Galway and Clare) resulting in property insurance claims between commercial and household property of over €141m, €23m and €16m respectively. Beyond property damage, the floods also impacted the economy through inability of workers to access work, water shortages, impacts on water quality and power-outs. Such losses of sectoral output and infrastructure damage on an increased basis can have persistent negative impacts on economic growth[19].

[17] European Central Bank, The Impact of Extreme Weather Events on Budget Balances and Implications for Fiscal Policy, Working Paper Series No. 1055, May 2009. Available at http://www.ecb.int/pub/pdf/scpwps/ecbwp1055.pdf

[18] Based on Ireland's projected GDP for 2010 as set out in the Central Bank 2010 Forecasts, Central Bank, Quarterly Bulletin 02, April 2010.

[19] Fankhauser, Samuel and Tol, Richard S.J. (2005) On Climate change and Economic Growth. Resource and Energy Economics, 27 (1). pp. 1-17.

Table 3: Insured Property Cost of Weather Events (2000 – 2010)

Year	Event	Insured Property Cost
January 2010	Freeze	€297m
November 2009	Floods	€244m
January 2009	Storm	€16m
January 2009	Freeze	€40m
August 2008	Flood	€96m
October 2004	Flood	€38m
November 2002	Flood	€50m
February 2002	Flood	€37m
December 2001	Freeze	€30m
November 2000	Flood	€51m

Source: Irish Insurance Federation

In addition, it is recognised that, as well as meeting the costs of its domestic adaptation needs, Ireland will also have to contribute to meeting the costs of adaptation in developing countries (as per the principle of 'Common but Differentiated Responsibilities and Respective Capacities' enshrined in the UNFCCC). This money will have to come from public finances and may have an impact on business costs and competitiveness if further taxes or levies are to be imposed on the business sector. The overall potential impact of adaptation on business costs is as yet unclear but it is expected that the private sector will be a key implementer of adaptation actions using primarily their own resources.

3.3 Early adaptation measures can reduce these costs

Although adaptation is only one part of the response to (and therefore the costs of) climate change, successful adaptation policies and planning will reduce the negative impacts caused and are central to enhancing growth in the long run. Adaptation measures range from soft responses (policy, planning and integration) to hard (engineering) responses, with varying degrees of cost implications. For example, business adaptation measures with no or minimum cost implications could include changing crop planting times, more careful location section planning to avoid the risk of flooding, moving sensitive equipment (servers) to a higher floor, etc. Similarly, early consideration of the need to adapt to climate change within the policy

system – particularly through planning measures and spatial policies - can ensure that risks are minimised at least cost or that measures are cost-effective over the lifetime of the decision/policy.

At the same time, it is expected that certain levels of investment will be required (in areas such as the water supply network or flood protection infrastructure) to ensure that key parts of Ireland's current and future infrastructure are climate resilient. It is not clear what proportion of expected damage could be avoided by such investment but research from Munich Re and the Confederation of British Insurers estimate that additional investment of 5 to 20 per cent of its cost would be needed in 2030 to adapt new infrastructure vulnerable to climate change[20]. Linking in to this research, first estimates from the UNFCCC concluded that $49 – 171 billion per annum would be needed globally in investment to 2030 to cover the costs of adaptation to climate change for key areas such as agriculture, water, human health, coastal protection and infrastructure[21].

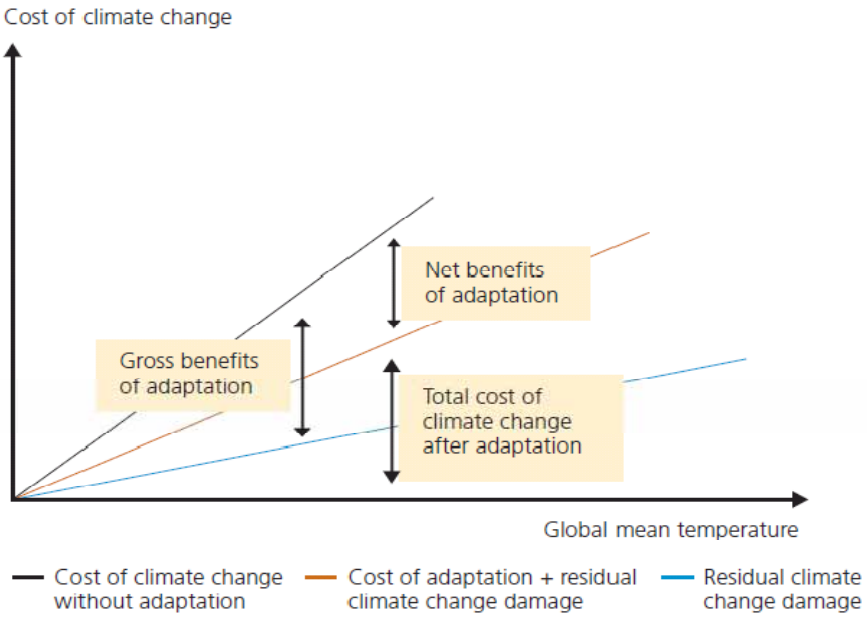
Although the additional investment and financial flows needed for adaptation described above are significant, the value of the climate change impacts that those expenditures would avoid could be larger. Several sources already indicate that the costs of taking action to address climate change (including mitigation and adaptation measures) will be much lower than the costs of inaction over the medium to long term[22].

[20] Association of British Insurers, The Financial Risks of Climate Change, ABI Research Paper No 19, November 2009, Munich Reinsurance Company (2007) Topics: Natural Disasters. Annual Review of Natural Disasters 2006. Munich, Munich Reinsurance Group.

[21] Investment and Financial Flows to Address Climate Change, UNFCC (2007), UNFCCC Climate Change Secretariat, Bonn.

[22] Economic Aspects of Adaptation to Climate Change (OECD, 2008) and The Stern Review on the Economics of Climate Change, (HM Treasury, 2006).

Figure 4: Adaptation and costs of climate change



Source: Stern (2006)

Thus, it is recognised that failure to prepare or invest in adaptation may leave an economy or a business poorly prepared to cope with adverse changes and increases the probability of severe consequences. Starting now will bring significant benefits.

3.4 There will be opportunities as well as risks for business

A key point is that given the likely scale of global investment in climate change adaptation, businesses will be presented with commercial opportunities as well as threats. Incorporating climate change into business planning and ensuring that the policy framework for business is as facilitative as possible will help businesses in Ireland to realise these commercial opportunities.

While all businesses will not be equally impacted by climate change, below is an assessment of some of the potential opportunities and risks for businesses generally under the following headings:

- Markets: changing demand for goods and services
- Logistics: vulnerability of supply chain, utilities and transport arrangements
- Premises: impacts on location, materials, building design, construction, maintenance and facilities management
- Finance: implications for investments, insurance and stakeholder reputation
- People: implications for workforce, customers, human behaviour and changing lifestyles

- Processes: impacts on production processes and service delivery

3.4.1 Markets: changing demand for goods and services

Opportunities	Risks
New products or modifications to existing products to respond to a changing market, e.g. flood management technologies, ventilation and cooling, consultancy, measuring and monitoring equipment, climate resilient building materials.	Potential impacts of markets shrinking for present range of goods and/or services caused by climate change disasters or extreme weather.
Advantages for early movers in response to changed markets and lifestyles.	Competitors' position enhanced by changing climate.
Increased passing trade in some sectors during longer summers.	Quality issues relating to how products perform in the new climate e.g. in agriculture, overheating of grain.
Increasing demand for some products and services.	Access of customers to products or services could be undermined by extreme weather.
More extreme events means opportunities, e.g. repair, maintenance and clean up services, domestic tourism, summer foods, sport, leisure, al-fresco eating facilities.	Difficulties in marketing existing assets, e.g. buildings, that become increasingly unsuited to the climate.

3.4.2 Logistics: vulnerability of supply chain, utilities and transport arrangements

Opportunities	Risks
Competitive advantages for companies with redundancy or flexibility built into delivery systems and supply chains or those undertaking business continuity planning.	Global climate change could affect availability of some goods and services (e.g. raw materials, components) and commodity prices. Suppliers and third party manufacturers may also be exposed to physical risks from climate change. Interruptions or shortage of raw materials supply.
Supplying local markets creates an opportunity for marketing approaches based on regional distinctiveness or reduced product miles.	Disruption to utilities, especially electricity supply, water supply and sewerage, which can be affected by extreme weather.
	Disruption of transport and delivery systems for goods and services in and out – Just-In-Time - systems are especially vulnerable.

	Businesses that rely on abstracting water could be faced with reduced supply or changing licence conditions during droughts, e.g. pharmaceuticals, food and drink.

3.4.3 Premises: impacts on building design, construction, maintenance and facilities management

Opportunities	Risks
Maintaining thermal comfort in winter months is less of a challenge.	Vulnerability due to proximity to potential river, coastal or urban flooding.
Opportunities for high thermal mass building solutions, which can reduce air-conditioning requirements.	Existing buildings not designed with the future climate in mind. Building fabric and structure could be vulnerable to rain, storms and subsidence.
Opportunities for those in built environment industries to develop expertise and reputation in climate-related building issues.	Refurbishing to low carbon, climate-resilient standard represents a significant challenge.
Opportunities to exploit external spaces to accommodate outdoor living.	Internal environment: challenge of coping with increased summer temperatures (without adding to greenhouse gases). Potential future regulation in this area.
	Increased risk of flooding leading to clean up costs and loss of business continuity if premises are inaccessible to staff and customers.
	Pest damage to buildings, e.g. termites overwintering in mild winters.

3.4.4 Finance: implications for investments, insurance and stakeholder reputation

Opportunities	Risks
Good risk management will appeal to financiers, insurers and other stakeholders, leading to security for investment and opportunity for reduced insurance premiums.	Failure to adapt creates difficulties in securing investment and/or insurance cover at reasonable cost.
Potential risks reduced and liabilities diminished through pro-active risk assessment	Potential liabilities are associated with previous actions which future changes in climate may

and implementation of climate change adaptation strategies.	reveal as vulnerable.
Clients and customers attracted to businesses that can show they are resilient to climate change.	Potential liabilities if climate change is not factored into long-term decisions about the future.
	Investment in equipment could tie business into climate-sensitive process or activity.
	Limit of global financial markets to absorb risk could be reached.

3.4.5 People: implications for workforce, customers and changing lifestyles

Opportunities	**Risks**
Greater comfort and lower fuel bills in winter.	Threat to working conditions and travel arrangements for staff from extreme weather.
Opportunities for the introduction of early warning systems providing warnings and rules of conduct for certain times and areas, communication of information about climate change, its potential health impacts, and response strategies.	Possibility of contaminated waters and service disruptions to the health service.
Reputational opportunities of responding effectively as a good employer can help recruitment and retention of high quality staff.	Failure to attract or retain staff through reputation as a poor employer (e.g. business not climate resilient, no training on impacts and adaptation).
Opportunity to improve work/ life balance by responding to climate change risks with flexible working hours and increased home-working.	External workforce exposed to increased sunlight and temperatures in summer. Increased employee and customer exposure to temperature rises and increased dust/pollens (air quality, respiratory diseases).
Generally more outdoor activity creates opportunities for some industries, e.g. tourism, leisure, urban design.	Internal environment uncomfortable as a result of increased summer temperature.
	Training and skills implications e.g. for farming, engineering, building or insuring in the new climate.

3.4.6 Processes: impacts on production processes and service delivery

Opportunities	Risks
Some aspects of a production process or service delivery made easier as a result of changing climate.	Reduced productivity or disruption to climate sensitive processes or activities.

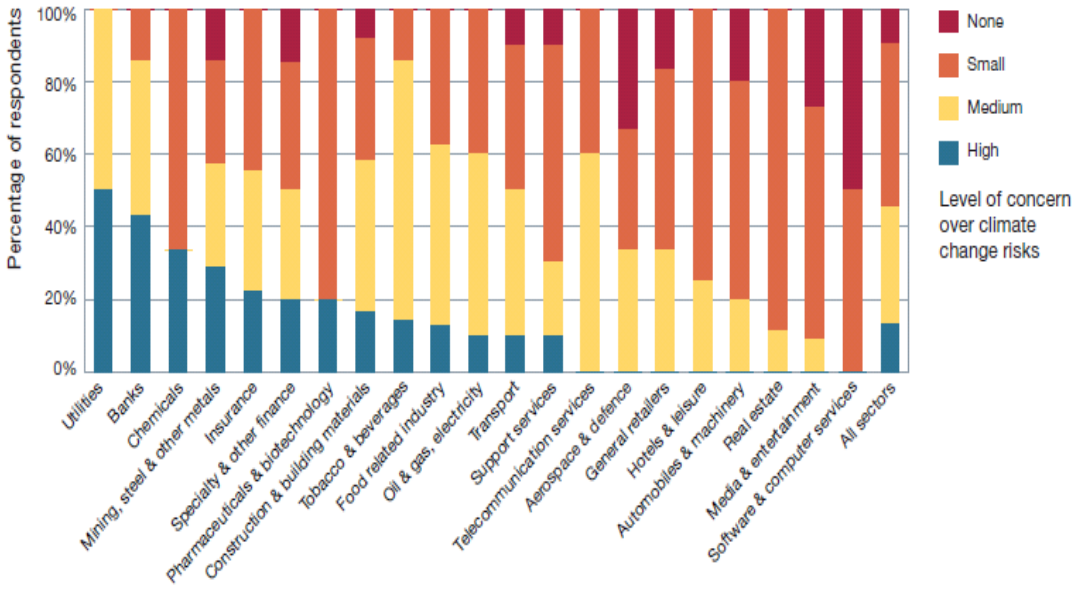
4 Assessment of Climate Risks and Opportunities for Key Sectors of the Irish Economy

4.1 Some business sectors will be more exposed than others

It's clear that not all businesses and business sectors will be equally exposed to climate risks. Some of the firms and sectors that are expected to be most exposed to the impacts of climate change include:

- Sectors currently affected by weather events (e.g. food and drink, construction);
- Sectors making long-term investment decisions (e.g. utilities, pharmaceuticals);
- Sectors heavily reliant on transport/ infrastructure in (global) supply and demand chains (e.g. ICT/ pharmaceuticals);
- Sectors which are global in nature and which are particularly exposed to adaptation internationally (e.g. financial services); and
- Sectors that need a lot of high quality water such as pharmaceuticals, ICT (wafer manufacturing), food and drink.

Figure 5: Sectoral concern over risks posed to companies by the impacts of climate change in UK



Source: Carbon Disclosure Project UK

4.2 Climate risks and opportunities for key sectors of the Irish economy

Based on the literature review undertaken, a business workshop organised through IBEC, engagement with the UK Climate Impacts Programme (UKCIP) and the Carbon Disclosure Project as well as other business consultations, the below is an assessment of some of the potential risks and opportunities from climate change for key sectors of the Irish economy[23]. Blank spaces point to no specific opportunity or risk emerging from the research and consultation for the sector but generic opportunities or risks which have been identified in the previous section (section three which looked at implications for all businesses) may still apply. It is important to note that some of the risks may be generic risks which companies in other countries may also be exposed to. Thus, in certain areas (in particular risks associated with temperature rises which are expected to be relatively less extreme in Ireland), Irish companies may be in a stronger position to manage these risks compared to international competitors.

4.2.1 Food and Drink

Size	The food and drink industry is Ireland's largest indigenous sector. It has a gross output of over €18 billion and total exports exceed €8.2 billion.	
	Opportunities	**Risks**
Markets	Due to global changes, export demand for foodstuffs may increase as the food production of regions suffering from drought will continue to weaken. Ireland's relatively low temperatures may mean lower impacts on grass-based meat and dairy production when compared with other countries. There are also opportunities to leverage research in food production by research bodies such as Teagasc.	Growth in markets may bring increasing challenges to reduce greenhouse emissions, such as pressures to reduce meat consumption.
Logistics	Climate change will probably result in qualitative changes in the raw materials of the food industry as the cultivation zones of different plants move and the preconditions for primary production change. The changes may also have long-term impacts on the location of industrial	Extreme weather events can impact on transportation and delivery of the products and supplies, community infrastructure where company facilities are located, and product consumption. In particular, the transportation and refrigeration of raw materials, such as milk, may become more difficult due to the weakened condition of

[23] Where possible, sectoral statistics have been sourced from the NCC's Statement on Sectoral Competitiveness, 2009, Forfás. The UK CIP BACLIAT framework has been applied to each sector.

	facilities. Properly managed, Ireland can remain relatively ‘water rich’ which should support the competitiveness of our food and drinks sector vis-à-vis ‘water poor’ regions.	the road network and effects of storms on shipping lanes sensitivity to disruptions, which would make deliveries less reliable.
Premises	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.3.	Increased winter precipitation and rising water levels will in some places cause flooding or such high ground water levels that agricultural exploitation may be difficult to maintain.
Finance	Food related businesses are not considered as 'negative' or 'highly responsible' in terms of global warming. By retaining this image, shifts in consumer attitude and demand for "eco" products and services will give opportunities to food businesses.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.4.
People	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.5.	Extreme weather events can have negative impacts on outdoor agricultural workers.
Processes	A longer growing season, shorter growing times and warmer summer temperatures provides opportunities for Ireland to improve agricultural productivity and to produce an extended range of goods. Retailers and restaurants may thus find it easier to find local sources of some products.	The sector is heavily reliant on natural raw materials which will be more exposed to extreme weather events such as flooding, drought, and severe storms can disrupt supply and impact raw product quality. Water availability is one of the vulnerable 'natural services' given by the ecosystems. Interruption of water availability will immediately jeopardize agriculture, and could eventually affect operations. Water quality is central to a number of processes, and summer droughts or floods can impact quality levels. Waste water and warm water discharges may be increasingly regulated. In addition, higher water temperatures and increased storm frequencies could also present risks to the shellfisheries and marine aquaculture industries. Changes in temperature variation could also impact raw product supply and could increase the costs of refrigeration.

		Warmer weather may also support new diseases, insects and competing plants. This could impact on Ireland's livestock, bring about an increased and altered need for plant protection based on altered disease and insect patterns and an increased need for fertiliser and the consequent risk of runoff into the water. Current production methods and market standards (e.g. supermarket washed produce) are water and energy intensive, and will become increasingly expensive.

4.2.2 Chemicals, Pharmaceuticals and Medical Technologies

Size	13 of the world's top 15 pharmaceutical companies have manufacturing operations in Ireland. There are 25,000 people employed within chemical and pharmaceutical firms assisted by the IDA and Enterprise Ireland. There are also currently over 140 medical technology companies in Ireland, exporting €6.2 billion annually and employing 24,000 people.	
	Opportunities	**Risks**
Markets	Companies in this sector may have opportunities to address global healthcare issues that arise as a result of climate change. For example, demand for pharmaceutical products may increase, according to probable difficulties in lives or infectious disease outbreak due to global warming.	There are considerable regulatory risks to consider, as handling, transmission and storage safety standards may be compromised.
Logistics	Where the raw materials used to manufacture products are not derived from biological species, potential opportunities may arise if climate change impacts flora in a region. Pharmaceutical companies using synthetic materials to produce their products may have opportunities over those using natural materials of which there may be less.	The vulnerability of supply chains to weather events may lead to shorter supply chains, increased transportation costs and additional materials storage capacity requirements. Sea-level rises and abnormal weather might cause physical distribution difficulties.
Premises	No sector sector-specific opportunities emerged from	Many chemical and pharmaceutical industries are based on the coast,

	research/ consultation. See section 3.4.3.	particularly in Cork Harbour and the Shannon Estuary.
Finance	Strong existing commercial reputations of companies in this sector may be an opportunity on which to capitalise.	Spread of disease might result in the short supply of medicines, and it might lead to the downfall of trust in pharmaceutical markets.
People	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.5.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.5.
Processes	Ambient air temperatures, water quality and the availability of cooling water are all key inputs into chemical and biological processes. Properly managed, Ireland can exploit its relative lower temperatures and potential 'water richness'. Opportunities may arise from new production techniques and products to help other industries reduce emissions (e.g. carbon capture and storage and advanced processes for hydrocarbon refining).	Rising ambient air temperatures, variations in water quality, and the availability of cooling water will all have an effect on chemical processes. Lower river flows could lead to restrictions on water abstractions, with consequences for cooling processes. Restrictions on the volume of high-temperature water that companies are allowed to discharge and lower abilities to dilute pollutants, could lead to tightened restrictions on effluent discharge. The availability of fresh water is essential for operations in the biotechnology sector, as vaccine manufacturing operates under strict norms that require fresh water. Climate change may cause water scarcity or flooding, all of which may affect sanitation and clear water supplies. In particular, lower river flows could lead to restrictions on water abstractions, with consequences for cooling processes and restrictions on the volume of high temperature water that companies are allowed to discharge and lower abilities to dilute pollutants, leading to tightened restrictions on effluent discharge.

4.2.3 Information and Communication Technology (ICT) Manufacturing and Services

Size	ICT manufacturing accounts for 26,000 full-time jobs within development agency-assisted firms and 11 percent of total merchandise exports by value. ICT services account for 60,000 full-time positions within agency-assisted firms and 35 percent of

	total services exports.	
	Opportunities	**Risks**
Markets	ICT hardware and software offers huge potential to support climate change adaptation. Examples include videoconferencing; sensor networks; improving energy use, power distribution and transmission (smart grids and metering); making buildings more climate resilient (smart buildings); business support (business recovery, continuity, and back-up products); solutions helping industries optimise motors, transport routes and logistics; and flood monitoring. The potential exists for Ireland to act as a test centre for adaptive engineering solutions related to ICT could be developed. Compared to more extreme projected impacts on competitor countries with more extreme climates, Ireland's relatively temperate climate may mean that Ireland becomes more attractive for inward investment in the ICT sector.	As more people use more ICT equipment, the contribution of ICT equipment to greenhouse gas emissions is likely to rise. The corollary opportunity is to re-engineer equipment and telecommunication networks to significantly reduce the power consumption requirements of devices, networks, and data servers, etc.
Logistics	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.2.	Like all high technology and engineering industries, the software and computer services sector is vulnerable to any disruption in supply chain or manufacturing processes. Both incremental changes and extremes of climate can interrupt engineering operations. Just-in-time manufacturing and delivery systems can add to the complexity of supply chain and operational risks. High-tech companies potentially will face increasing upstream supply chain risks in areas related to water conservation, agricultural commodities and chemicals.
Premises	Key international competitors for investment in ICT such as the western United States, Israel, and	ICT companies face potential operational risk from climate change, which may include business interruption or physical damage to

	Central Europe are all significantly warmer than Ireland. Lower temperature increases in Ireland relative to other countries may mean that Ireland retains a competitive advantage in locating data centres.	assets due to an increased likelihood of natural disasters caused by climate change. Climate change will increase the risk of subsidence damage to communications masts and possible increased storm damage to overhead cables, disrupting operations and processes. Any increase in downtime from loss of energy supply or telecommunications could have significant cost implications.
Finance	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.3.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.3.
People	Ireland has already made some progress in certain research and development areas. There may be other opportunities to establish world class R&D in areas which need to adapt to climate change, such as efficient motors, electricity generation/distribution, etc.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.5.
Processes	Opportunities exist for electrically powered heat pumps which fulfil both heating and cooling requirements. Opportunities also exist for power generation and co-generation with combined heat and power.	For air temperatures, a risk is linked to abnormal temperature rise during the summer. Electricity demand during winter time loading is expected to decrease, while demand for cooling will increase summer time electricity. While this is expected to flatten the seasonality curves (probably resulting in a lower overall instantaneous generation capacity requirement) there is potentially an increased overall requirement. The vast majority of all cooling and refrigeration in Ireland is electrically generated using vapour compression cycle equipment and such increases in electricity demand may place strains on the grid. Increases in electricity demand for cooling is likely to be a global phenomenon which will increase business pressures for Ireland to have competitively priced and secure energy supplies. Air cooling equipment for clean rooms could reach capacity limit. Impact would be investment to adapt cooling capacity. Higher indoor temperatures can compromise high

		technology and precision engineering processes. This can have knock-on impacts on performance conditions and quality standards. As high users of energy, software and computer services industries are vulnerable to any damage to infrastructure or energy supply. Temperature sensitive equipment may be compromised and require an increased need for cooling. One potential future consequence of climate change is the availability of water for ICT data centres. Hydropower and the water needs for cooling data centres may be compromised if the availability of water declines. In addition, power outages resulting from rising sea levels, increased storm activity, hurricanes, droughts, flooding and wildfires and health risks due to the spread of diseases. Rising energy costs and potential brown outs pose a risk to data centres.

4.2.4 Financial Services

Size	According to the most recent CSO data, there were 103,500 people employed in financial, insurance and real estate in Q1 2010. Employment in (agency assisted) international financial services firms has more than doubled between 2000 and 2008, with the number of full time jobs increasing from 8,000 to 20,000. In 2008, international financial services accounted for 23 percent of services exports.	
	Opportunities	**Risks**
Markets	Risk management of potential climate change impacts, coupled with the implementation of regulatory regimes for greenhouse gas emission mitigation, provide significant business opportunities (e.g. carbon auditing and trading, consultancy on infrastructure vulnerability/ risk management; insurance-related opportunities; banking opportunities due to capital investment expenditure, etc.) as well as the development of specialist financial instruments like catastrophe bonds and weather-related derivatives on	The financial services sector is a truly global industry, and as such will be affected by both domestic and global extreme events. The insurance sector is highly sensitive to weather and climate risks as shown by recent spikes in pay outs caused by recent floods and freezes in Ireland. Insurance risks include claims associated with short-term extreme events like flash flooding, and longer term events such as hot, dry spells which can lead to increased subsidence. Typically, weather damage accounts for one-quarter of total property

	international trading markets. Significant funding will be required by other industries looking to take advantage of adaptation opportunities.	insurance claims, but this may rise to between one-third and one-half of total claims in extreme event years. Research from the Association of British Insurers has shown that the annual average insured losses from inland flooding in Great Britain will rise by 6% and the losses from an extreme event by 18% as a result of a 2°C increase in temperatures[24]. These higher losses will feed through into higher insurance premiums and restrict the availability of capital. There are potential negative implications for reputation if property insurance cannot be provided in areas of increasing risk, e.g. high flood risk, high subsidence risk. Reduced market for insurers and lenders in climate-sensitive locations/sectors.
Logistics	For the insurance industry, more weather-related claims can improve efficiencies per claim and allow for specialised claims handlers for climate-sensitive claims.	Prolonged periods of poor weather make it harder for insurers to deal with high volumes of claims. Insurers' and lenders' operations (including IT systems) could be vulnerable to impacts of stormy conditions, unpredictable electricity supply etc. In addition, physical risks from climate change may affect the creditworthiness of clients (e.g. through damage to physical property, disruption of transports, yield losses) and therewith indirectly impact financial services businesses.
Premises	The relatively new stock of buildings in the IFSC and the spread of locations away from the river may reduce the need to retro-fit buildings to cope with floods and higher temperatures. Some of the newer builds in the IFSC have incorporated climate change considerations to a degree in incorporated into the building design.	As financial services companies are office-based, climate change stands to impact on building design, construction, maintenance and facilities management. The typical new build in the financial services sector is air conditioned to some degree with high density office accommodation in glass walled buildings. There is often little in the way of thermal mass so they react quickly to warmer days. This has implications for the operational aspects of the buildings which will need more

[24] The Financial Risks of Climate Change, Association of British Insurers, November 2009.

		sophisticated energy management than is currently in place. Physical effects stemming from climate change may also affect energy demand and supply. As financial services companies rely heavily on data processing systems and global communications networks, if any of these systems does not operate properly or are disabled, financial losses, disruption of businesses or reputational damage could ensue. A key physical risk for the financial services sector in Ireland is the location of the IFSC in the Dublin docklands and its potential vulnerability to rising sea levels which could cause damage to office buildings and infrastructure and make daily business more difficult.
Finance	Investment funds risk levels may increase (equities, corporate and government debt) if investments are made in assets that are vulnerable to climate change. Climate risk increases the need for risk-transfer mechanisms. Alternative Risk Transfer mechanisms could be developed through other parts of the financial sector – e.g. catastrophe bonds and weather derivatives.	Climate change stands to have implications for investment, insurance and stakeholder reputation. Balancing responses is seen to be important for the financial services sector – there are risks associated with no action to possible risks, over reaction to risks, and ignoring climate change in the short-term in an attempt to get better returns on investment. For the specialty finance sector the threat of business failure rises when companies cannot maintain sufficient financial capacity to deal with climate risks. Climate change may challenge limits of capacity of global financial markets to absorb risk, in particular with regards to reinsurance capacity.
People	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.5.	Portions of financial services operations require significant human interaction and anytime weather events disturb the ability for staff to get to facilities or impact the facility itself, these operations could be impacted. Business risks from decreased employee productivity in buildings that are not designed to cope with higher temperatures.

		For the insurance sector, individual householders may not understand or respond to potential impacts of climate change. There may also be a risk of dissatisfied customers/occupants with 'buildings that are not fit for purpose' (e.g. experiencing flooding, inadequate drainage, lack of solar control and cooling, problems with air tightness, driving rain and winds).
Processes	For the insurance sector, it will be possible to develop new kinds of products to insure premises against damage from extreme weather events or to assure businesses against losses due to changes in climatic conditions (e.g. in agriculture, tourism).	Rapid increases in volumes of claims may become unmanageable. Insurance underwriting may become more difficult as traditionally it is based on historic information of previous patterns of claims.

4.2.5 Tourism

Size	Foreign earnings from tourism amounted to €4.8 billion in 2008. 123,700 people are employed directly in accommodation and food service activities. The sector employs thousands of others in entertainment, cultural, transport and related services.	
	Opportunities	**Risks**
Markets	A warmer, more reliable summer season in Ireland could support an extension of the peak tourist season into April and October. The relative attractiveness of other regions may also weaken; e.g. the Mediterranean will experience hotter summers, increased water problems and the potential loss of beaches through coastal erosion. There is potential to build on the "green" brand of Ireland and additional sustainability perceptions (which are already a key element of Tourism Ireland's overseas marketing of the island of Ireland).	The sector will have to cope with more extremes in weather (with implications for travel) and potential changes to tourist products (e.g. changes in marine ecosystems, hiking, golf, etc.) arising from climate change. Pitches, parks, golf courses are vulnerable to drought.
Logistics	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.2.	Potential disturbances of travel routes from extreme weather events. Further risks to aviation industry and threats to

		budget flights. Extreme weather events and infrastructure failure could affect Ireland's image through negative feedback from visitors.
Premises	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.3.	Loss of blue flag beaches or key types of flora and fauna. Heavy rainfall, floods and drought could result in conservation challenges for our built and cultural heritage (in particular those located in coastal areas).
Finance	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.4.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.4.
People	Staff may need to have training and awareness to prepare – this could be an opportunity to raise awareness of climate change in corporate planning.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.5.
Processes	Increased attractiveness of water-based holidays, water recreation and boat ownership.	Water activities likely to be impacted by climate change through both high and low flow situations and impacts on water quality. Beach use may be restricted by coastal erosion. Potential for increased competition between leisure activities and commercial shipping in ports.

4.2.6 Construction and Building Materials

Size	From CSO data, there were 129,100 people working in construction in Q1 2010. Recent forecasts have estimated that the value of output of the sector will be €12 billion by the end of 2010[25].	
	Opportunities	**Risks**
Markets	Opportunities for design of new builds, development of climate-proof materials and concrete in situations where high thermal mass is appropriate, especially by recycling	Delays to construction and maintenance programmes, poor internal environment and mould growth, slope instability, damage to building fabric and cladding, and structural damage from wind and

[25] Source: Construction Industry Federation and Department of Environment Heritage and Local Government/ DKM Review of the Construction Industry 2008 and Outlook 2009-2011.

	waste materials from other industries, thereby reducing use of virgin materials. There is expected to be increased demand for hard structural solutions such as stronger flood and coastal defences and softer solutions (e.g. landscaping, architecture) to make allowances for projected changes in river flows and sea level will grow. Consumers and regulatory bodies may require better performance from buildings as climatic conditions change, providing an opportunity for early movers to gain competitive advantage.	precipitation events. Unless these risks are managed this sector may be vulnerable to reputational, litigation and regulatory risks in the future. Building fabric is generally vulnerable to increased temperatures, driving rain and other extreme events; existing buildings not well-adapted to new climate, especially in hot summer conditions, leading to reduced value of existing buildings if they are not resilient to climate change.
Logistics	Opportunities for specific building solutions where production is close to point of use, including pre-fabricated buildings and components.	Flooding, especially flash flooding, will disrupt transport for site deliveries; site work more difficult leading to more prefabrication and longer delivery lines for materials/components which will be vulnerable to extreme events, and generate more carbon dioxide emissions; utilities (energy distribution, drainage infrastructure) vulnerable to extreme weather events.
Premises	Clients will require increased maintenance of existing buildings. Opportunities for high thermal mass building solutions which can reduce air-conditioning requirements Opportunities to develop expertise and reputation in climate-related building issues.	Risk of flooding to properties and building sites, provision of cooling through installation of air-conditioning will increase capital costs, running costs and emissions of greenhouse gases; poor working conditions on site including on-site huts particularly in higher summer temperatures.
Finance	Clients attracted to designers and contractors with evidence of climate future-proofing in building projects; good risk management will appeal to financiers and insurers and provides opportunity to market risk management expertise; good reputation attracts good staff, customers, and investors.	In order to secure increased investment, the construction industry will need clarification of design standards in the face of changing climate and performance indicators of well-adapted buildings. Implications for insurance (of buildings, professional indemnity, employer's liability) for existing buildings, new buildings and during the construction process.

People	Training staff on climate change issues, including design, on-site activities etc.	Potential discomfort in summertime in all building types; on-site workforce exposed to increased ultraviolet rays and temperatures; dissatisfied occupants of buildings that are not fit for purpose: e.g. building occupiers experiencing flooding, inadequate drainage, lack of solar control and cooling, problems with air tightness, driving rain and winds.
Processes	Fewer frosts reducing interruptions to on-site processes. Opportunities arising from expertise and technology in water management and drainage, design of well adapted buildings and managing construction processes in response to climate change. Opportunities exist for timber production (as more carbon dioxide helps growth) for use where 'lightweight construction' is appropriate.	Excessive heat in summer will affect on-site construction processes; need to damp down on-site dust in dry summer conditions; extreme rainfall events make muddy site conditions and restrict on-site days; partly-completed structures more vulnerable to wind and storm damage.

4.2.7 Environmental Goods and Services (EGS)[26]

Size	Although difficult to define, the EGS sector in Ireland was conservatively estimated to be worth some €2.8 billion in 2008. A best estimate suggests that (excluding eco-construction) there were more than 6,500 people directly employed in EGS companies in Ireland in 2008[27].	
	Opportunities	**Risks**
Markets	Increased demand and rapidly growing	Weak buy-in from enterprise sector

[26] According to the agreed OECD/ Eurostat definition, the environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco systems. This includes cleaner technologies, products and services that reduce environmental risk and minimise pollution and resource use. Key sectors which are considered within EGS include: water and wastewater treatment, waste management, renewable energies, environmental consulting and services, clean technologies.

[27] Source: Environmental Goods and Services on the island of Ireland, Forfás/ InterTrade Ireland, October 2008. This figure does not include the market for environmental goods and services in building and construction materials and is therefore likely to underestimate the value of the sector to the economy.

	global market for “adaptation” products and services.	regarding climate change adaptation. Lack of clear policy or investment which promotes adaptation for certain sectors such as waste, water wind energy and energy service companies (ESCOs).
Logistics	The use of ICT to monitor and adapt to climate change will drive demand for services.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.2.
Premises	Businesses that prepare for flooding can save significantly on the cost of lost stock and moveable equipment.	Climate risks (such as flash flooding or lower river water levels) could impact the operation and reputations of key EGS sectors such as water and waste treatment if services are disrupted or curtailed.
Finance	Advanced preparation may reduce business regulatory liability and make it easier to obtain insurance. Potential business opportunities generated though green public procurement plans which incorporate adaptation.	Risk-averse public procurement could embed non climate resilient technology.
People	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.5.	Poor knowledge base in key sectors such as energy.
Processes	Potential synergies between EGS and other sectors (e.g. ICT and sensors). Increased demand for water-saving technologies and services. Emerging opportunities in hard and soft engineering solutions for flood protection. Acceleration of shift from solid fuels to electricity to reduce carbon footprint, supported by innovation in energy end use. Ireland’s theoretical hydropower potential could increase with increased seasonal precipitation.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.6.

4.2.8 Retail, Wholesale and Distribution

Size	From last available CSO data 266,800 people are employed in retail and wholesale operations in Ireland and 92,800 are employed in transport and storage.	
	Opportunities	**Risks**
Markets	Retailers are less exposed than other sectors but face knock-on impacts in terms of supply chains and distribution, premises, and changing structures of market demand. New product and service opportunities. Increased passing trade in some sectors during longer warmer summers, e.g. retail.	Potential loss of competitiveness due to lack of responsiveness to changes in consumption patterns.
Logistics	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.2.	Supply chain interruption and inefficiency of the distribution network. Damage to products during transport and warehousing.
Premises	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.3.	No sector sector-specific risks emerged from research/ consultation. See section 3.4.3.
Finance	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.4.	Increased costs associated with health and comfort of workforce.
People	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.5.	Consumer goods companies will need to educate consumers on the benefits of products that can mitigate climate change impact.
Processes	No sector sector-specific opportunities emerged from research/ consultation. See section 3.4.6.	Rising sea levels might interrupt the predictable flow of materials from overseas suppliers.

4.2.9 Other Internationally Traded Services

Other internationally trading services include a diverse range of activities across a number of sub-sectors such as business services and international education. Services, some of which are already dealt with in previous sections (such as ICT and medical technologies) are hugely important to Ireland's economy and Ireland has clearly established itself as one of the world's leading service economies. In per capita terms, Ireland is by far the biggest exporter of services in the world.

As workers in these sectors are usually highly office-based, business risks from decreased employee productivity in buildings that are not designed to cope with higher temperatures are possible. All businesses make use of premises, transport systems and utilities, all of which are vulnerable to weather-related events like floods, storms and subsidence. Disruption to electricity supplies, water supplies and sewerage as a result of extreme events may impact on businesses. Premises affected by flooding can severely damage business profitability through costly refurbishment, temporary lack of access, and disruption to trading. Transport and delivery systems for goods and services may also be vulnerable to climate risks.

5 Business Adaptation

5.1 Awareness of the need for Irish businesses to adapt varies

Adaptation for business is often difficult. Potential future impacts on business are longer term and often unclear; businesses often lack information or awareness of climate impacts; some businesses lack the ability to respond to climate change because of financial or other constraints (such as organisational and cultural or institutional constraints); and the transactions costs of adapting may be high. These difficulties may be reflected in the reluctance of certain businesses to prioritise adaptation measures.

Much of the business response at present in Ireland appears to continue to focus on mitigation measures. The Carbon Disclosure Project (CDP) is an organisation which works with large corporations to disclose their greenhouse gas emissions and climate change strategies, including adaptation measures. The CDP Global 500 report is an annual questionnaire which targets the 500 largest global corporations in the FTSE Global Equity Index Series. From the Global 500 report, it appears that a number of multinationals which operate in Ireland are factoring physical impacts of climate change into their global business planning. At the same time, the Carbon Disclosure Project has also begun publishing an Ireland report which focuses on the largest Irish companies. The CDP Ireland report 2009 showed that the majority of Irish companies appear less concerned with the physical effects of climate change when compared with other risks, particularly the risks associated with regulations and higher energy prices resulting from mitigation efforts. An additional point about the Ireland report was the low response rate of 33% from Irish corporations compared with the Global 500 response rate of 81%[28].

Table 4: Percentage of companies seeing physical risks and opportunities

Sample: geography/ number of companies	% of responders seeing physical risks	% of responders seeing physical opportunities
Global 500 companies	78	63
Ireland 43 companies	64	43

Source: Carbon Disclosure Project Global 500 (2009)

In spite of these responses, it is clear that climate change adaptation is likely to have a cost for business and this cost is expected to rise more than proportionately with the extent of global warming. Businesses that assess the risks and opportunities associated with the physical effects of climate change and incorporate these risks and opportunities into their

[28] 14 out of 43 Irish corporations invited to participate in the Irish CDP responded.

business planning can thus realise competitive advantages over competitor companies that do not.

5.2 Greater awareness among businesses encourages autonomous adaptation

Businesses often lack information or awareness of climate impacts. Without a proper understanding about their current vulnerabilities and the likely consequences of climate change, it is difficult for businesses to manage the risks and opportunities of adaptation. Providing information about the likely consequences of climate change can help resolve some of the uncertainty around future benefits and help provide business decision makers with a more robust and reliable evidence base. Some specific responses that could develop business awareness of the need to plan for adaptation could include:

- Climate change research that is being undertaken in Ireland should be developed and tailored for businesses through an information campaign aimed at businesses and consulting services. In particular, the proposed EPA Climate Change Information System should have a well developed business section providing easy access to the latest information on what climate change means for business in Ireland and should be developed to provide appropriate tools and links on measures businesses can take to minimise risks and maximise opportunities. Enterprise development agencies and business representative bodies should play an important role in promoting this information to business.
- Geographic maps and warning systems also have a key role to play in ensuring that future development of business sites is resilient to climate change. Programmes such as the OPW's Flood Maps website and the Geographical Survey of Ireland's database of past landslide events should continue to be supported and promoted to business by business representative bodies and enterprise development agencies.
- There is potential for business representative bodies to raise business awareness of specific climate change adaptation issues through seminars (or inclusion of adaptation in other business events), guest speakers, local fora, etc.

5.3 Developing business capacity to deal with adaptation

Some businesses may lack the ability to respond to climate change because of financial or organisational and institutional/cultural constraints. Some specific responses that could develop business capacity to deal with adaptation could include:

- There is a need to develop and apply tools to help business adaptation. The process of adopting climate change adaptation measures can be quite complicated and tools which provide examples of how the business decision process can be structured, how calculations can be made, etc. can help businesses incorporate climate risks and opportunities into business planning. A number of specific business tools, such as the UK Climate Impacts Programme Business Areas Climate Impacts Assessment Tool (BACLIAT) or Adaptation Wizard[29] are open source and can be readily promoted to

[29] The BACLIAT tool provides business with a checklist for assessing the potential impacts of climate change http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=82&Itemid=195.

Irish companies by business representative bodies, trade associations and enterprise development agencies. Work is also being done in National University of Ireland Maynooth on tools for Co-ordination, Communication and Adaptation for Climate Change in Ireland (Cocoadapt) which could incorporate business planning tools. Such business tools should also be considered for inclusion in the EPA's proposed Climate Change Information System. In addition, given that some businesses stand to be more affected by climate change than others, the development of a qualitative screening process for business vulnerability – possibly as a tool on the proposed EPA proposed Climate Change Information System - would be of benefit. This could assess whether a business is likely to be vulnerable to the physical risks associated with climate change, and whether a more detailed risk assessment is warranted. If necessary, a business could then decide whether to undertake a more detailed financial risk assessment, and then, if indicated, take action.

- Sector organisations (business representative associations and professional bodies) are also key in creating, gathering and sharing sector-specific information on adaptation as well as developing appropriate training, accreditation and support programmes. Much successful adaptation involves working in partnership for example with suppliers, contractors, regulators etc. The forthcoming development of the EPA Climate Change Information System is an important opportunity for business representative associations to input business adaptation issues. The involvement of sector organisation bodies in such developments encourages the mainstreaming of climate change into existing business management culture (by using risk management, business continuity, health and safety messages and processes), sharing of costs and information and also extending the sphere of influence over the complex web of interactions that influence weather and climate impacts on business.
- Adapting to the physical effects of climate change will require improved skills and multi-disciplinary working, for example in areas such as the planning and refurbishment of existing buildings and infrastructure. Ensuring that both new and existing professionals have developed the skills necessary to respond to climate change and keep pace with policy and technology advancements will be an important policy response. The Expert Group on Future Skills Needs is currently undertaking work on actions required to ensure that the supply of skills in the environmental goods and services sector will be sufficient to meet the future skills needs of enterprise. As this work is looking at key adaptation areas such as ICT applications/ software, environmental consultancy and eco-construction, implementation of the impending recommendations from this work are likely to be an important step in assisting successful business adaptation.
- The Stern Review identified financial constraints as one of the main barriers to successful business adaptation. As access to finance continues to be a big issue for business, this holds true for longer-term investments such as future-proofing/climate-proofing/adaptation investment. Forfás would contend that current business supports and capital allowances could be assessed to understand their potential to support business adaptation. Consideration could also be given to the role of specialised market based instruments play in business adaptation. The possibility of using revenue generated from auctioning allowances under the Community greenhouse gas emission

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The Wizard tool is a high level, process based tool to take people through the adaptation process www.ukcip.org.uk\wizard

allowance trading system (the EU ETS) for business adaptation purposes could also be utilised.

- The enterprise development agencies (and IDA Ireland in particular) should continue to incorporate climate change adaptation research and considerations (in particular avoiding purchase of sites on flood plains) in their expansion of greenfield developments and future industrial estates/ business parks.

6 Adapting business infrastructure and the policy framework

6.1 Ensuring that critical pieces of business infrastructure are climate resilient

A range of infrastructures are essential for the efficient functioning of a society and an economy. Well-developed infrastructure can improve the flow of people, goods, services and finance, as well as increasing productivity and reducing costs. This not only affects existing firms, but also a country's attractiveness as an investment location and the overall quality of life it can provide.

Infrastructures have long pay-back periods, in some cases over generations, and also take a long time to build, so that bringing about improvements in infrastructures requires long-range thinking and vision. It is thus vitally important that investments are resilient to climate change in order to support economic development. While many infrastructure investments already have significant experience in dealing with weather events, the proposed National Adaptation Plan will be essential to ensuring that an overall policy position on climate change adaptation is taken with regards to infrastructure plans and critical infrastructures.

As part of Forfás' work, a high level assessment of the physical implications of climate change on critical pieces of infrastructure for enterprise has been undertaken. While some of the following pieces of infrastructure have been considered in more detail in other parts of the proposed National Adaptation Plan framework, the sections below provide business considerations regarding:

- Water Supply and Quality;
- Flood Protection;
- Energy Infrastructure;
- Transport and Communications; and
- Waste Infrastructure.

6.1.1 Water Supply and Quality

Water is the natural resource that stands to be most critically affected by climate change and has recently been identified by the World Economic Forum as a key concern for global business over the next 20 years.[30] A number of key sectors of Ireland's enterprise base rely

[30] Of all the water on earth, which is c.97% of the total amount of surface water, only 2.59% is freshwater. Of this 2.59% another percentage is trapped in ice caps and glaciers, which is about 2% (and as climate change advances this is melting at an accelerating rate and mixing with salt water). This leaves less than1% of all global water available for all human use. 70% of all water use is in agriculture which leaves the smaller fraction of water supply divided between industrial activity and

heavily on access to secure and competitively priced water supplies, at appropriate quality levels. Ireland is fortunate that it is well endowed with water resources, having one of the highest rates of water availability in Europe. Unfortunately, the places where water availability is greatest and where water is most needed tend to be at opposite ends of the country. Changing rainfall patterns, temperature increases, an aging water infrastructure and probable future population shifts towards the east and other major cities are expected to aggravate this. The increasingly frequent disruption in recent years to water supplies through lack of availability and impairment of quality, for example in the flooding in November 2009, raises key concerns from an enterprise perspective about the ability of Ireland's water infrastructure to cope with climate risks which are expected to increase in the medium term.

In order to realise any competitive advantages arising from Ireland's water resources, planning for the optimum collection, storage and transmission of the island's water resources to ensure that sufficient water of appropriate quality continues to be available to all businesses – particularly in key centres where deficits are forecast – is essential.

Business risks

- Hotter, dryer summer conditions in Ireland will create water supply problems when business demand is highest.
- As reduced river flows are more affected by pollutants and as critical pieces of water supply infrastructure come under increased threat of flooding, water quality for key business sectors may also be impacted.
- Industrial users are likely to face increasing pressure to conserve water, and potential arises for conflict and risks to license to operate.
- Flooding of water supply works in riverbank locations may lead to supply disruption while pipe systems may be more prone to cracking due to greater soil movement.
- There may already be issues around water quality arising from the contamination of ground water by existing infrastructure (Ireland has a heavy dependence on septic tanks associated with one-off housing) that would be exacerbated by climate change.

Required responses

- A long term strategic approach to water services policy and planning which takes into account the needs of current and future enterprise development is required at national level. A well-resourced single National Water Authority should be introduced with overall responsibility for system planning, delivery and maintenance. Consideration could be given to the allocation of this role to the National Roads Authority which already has much of the project management, financial, administrative and engineering competences required to successfully undertake the role. Key considerations of the single National Water Authority from a business perspective include:

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drinking water. Growing urban populations, increasing temperature, pollution and reducing natural water reserves (aquifers and glaciers) is creating competition between industrial demand and drinking water demand in many regions of the world.

  - Ensuring that water infrastructure (such as treatment plants, reservoirs and distribution networks) across the State are assessed and protected from events such as flooding and future climate change.
  - Planning for competing national demands (in the context of increased supply in the west of Ireland and increased demand in the east). Assessing and incorporating changing precipitation patterns into water management planning and ensuring that water infrastructure continues to facilitate enterprise development. Key business priorities are the development of water distribution interconnection through national pipelines and the upgrading of sewerage networks.
  - Completing risk assessments for water quality and planning for pollution events.
  - Adapting infrastructure planning to ensure sufficient water storage in reservoirs, aquifers and bankside storage.
- Additional capital investment will be required in particular for additional water storage capacity; to transmit water from areas rich in water (i.e. the west), to areas not able to meet demand (i.e. the east); and to interconnect the country's water networks. There is thus a need to continue to prioritise water and waste water investment programmes in key regional centres, particularly those facing capacity shortages in the next five years (Dublin, Athlone, Galway, Letterkenny, Mallow and Wexford) to ensure that these locations can accommodate future enterprise development needs.
- Water pricing is a key incentive in promoting adaptation behaviour. The introduction of volumetric treated water charges for domestic users and more transparent, fully reflective charges for non domestic consumers would create incentives to use water more efficiently and thereby create a market for water efficiency goods and services with future export potential. Continuing to enhance awareness of the need for water conservation is also an important adaptation response.
- As noted previously, water of sufficient quality is essential to the functioning of a number of key business sectors in Ireland. Climate changes will bring challenges for water quality and careful management of these challenges will be essential. There is a need to improve real time monitoring of water quality and implement the Water Framework Directive, the Water Services Investment Programme 2010-12 and the Rural Water Programme.
- Rainwater harvesting represents an opportunity to reduce demand for produced water nationally while giving enterprises greater independence in case of water shortages. Measures to encourage rainwater harvesting and the re-use of grey water should be encouraged.

6.1.2 Flood Protection

The damage flooding can cause to businesses and infrastructure, such as transport or utilities like electricity and water supply, can have significant detrimental impacts on local and regional economies. The long-term closure of businesses, for example, can lead to job losses and other economic impacts.

The Office of Public Works (OPW) has responsibility for flood management in Ireland. Some of the OPW's work on flood assessment is being driven by requirements of the EU Floods

Directive to undertake a Preliminary Flood Risk Assessment (PFRA) to determine areas of existing or potential future "significant risk". This work is ongoing and is expected to be finalised in mid-2011. This OPW is also engaged in more detailed Catchment Flood Risk Assessment and Management Studies (CFRAM Studies) which are producing Catchment Flood Risk Management Plans (CFRMPs). The CFRAM studies have begun with pilot studies on the River Lee, the River Dodder, the River Suir and the Fingal-East Meath area while the River Lee and River Dodder have recently been completed[31]. The OPW has also developed a National Flood Hazard Mapping website which provides mapped flood data and is currently developing a Flood Asset Database which will enable the planning of more effective and targeted monitoring and maintenance of flood defences[32]. As well as flood assessment, the OPW is also responsible for flood risk management and is working to incorporate design measures which can improve defences both now and in the future.

Business risks

- Climate change will increase the risks of flooding and the vulnerability of low-lying coastal areas to sea-level rise, particularly through storm surges and higher wave heights. Ireland's cities, critical business infrastructure as well as many key business sites are located on estuaries and are exposed to these risks to a greater or lesser degree. Many important infrastructural assets for business are located on the coast, close to jetties for import of raw materials and close to cooling water and to centres of population.
- Flash flooding and combined sewer overflows may increase with greater rainfall event intensity and frequency, leading to greater property damage and associated infrastructure upgrade costs.

Required responses

- To help businesses prepare and plan for flood risks, business decision makers need to have access to information on the risk of flooding from rivers or the sea. The outputs of the OPW's work on flooding (such as www.floodmaps.ie, CFRAM studies and the forthcoming Flood Asset Database) should continue to be supported and promoted to businesses through business representative bodies, enterprise development agencies and trade associations. Such inventories will need to continue to include business sites which suffer the most from floods and should include general plans for businesses on how to manage flood risks.
- All local authorities should continue to recognise the need to minimise business development on flood plains. Continuing to enforce and mainstream draft guidelines on "The Planning System and Flood Risk Management" which have been developed by the OPW to ensure that risks of flooding into the future are integrated into the planning process - particularly in business location decisions - will be necessary.
- Continuing to prioritise investment in OPW programmes which reinforce existing protective facilities and drainage for key business sites. Such investment can also create employment opportunities in the emerging environmental goods and services

[31] Details on the Lee project are available at www.leecframs.ie.

[32] National Flood Hazard Mapping website is available at http://www.floodmaps.ie/View/Default.aspx.

sector. In the context of the current state of public finances, soft engineering solutions which were recommended by the Flood Policy Review Group[33] (such as the creation of retention areas or flood-adapted methods of construction) which have lower costs can play a valuable role in sustainable flood management. New methodologies for designing and flood-proofing infrastructure will also need to be considered.

- Owners of critical pieces of infrastructure for business (energy, water, transport, communications and waste) should be required to undertake an asset risk assessment of potential flood risks.
- There is need to implement an island-wide and integrated coastal zone management policy, the objective of which should be to establish sustainable levels of social and economic activities while still protecting the coastal environment. Coastal protection plans should be produced for cities, towns and critical infrastructure deemed at risk, to support implementation of coastal zone management policy.

6.1.3 Energy Infrastructure

A reliable and competitively priced supply of electricity remains as important as ever for enterprise development and is a vital ingredient in Ireland's international competitiveness and long term economic development. Although climate changes will evolve gradually and offer the potential for energy infrastructure to be adapted to emerging problems, without appropriate planning, changes in climate could impact on the security of supply of energy for business in Ireland.

Business risks

- Interruption of transmission networks and overhead cables due to extreme weather events could cause business interruptions and failure to meet contractual obligations. Intensive storms may require that new or existing transmission equipment are designed or retrofitted to a higher standard. Large scale storm related disturbances in power distribution could cause interruptions also in other technical systems, such as water and heat distribution, wastewater services and telecommunications.
- There are expected to be changes in seasonal demands for electricity with lower winter demand and higher summer demand. The vast majority of all cooling and refrigeration in Ireland is electrically generated using vapour compression cycle equipment and such increases in electricity demand may place strains on the grid. In addition, increased summer loads will affect the maintenance of transmission equipment which are currently designed on the basis of low summer demand and allow for all maintenance outages to be scheduled in this period.
- Coastal protection is also a concern as some of Ireland's coal, oil and gas power stations are located in areas exposed to flooding and erosion risks due to sea level rises and increased storm-surge height. Oil reserve storage facilities are also located on the coast - most are on reclaimed land. In addition, as with all business premises, increased wear and tear of buildings and generation sites due to more violent weather

[33] Report of the Flood Policy Review Group, OPW, 2004.

conditions could lead to higher maintenance/repair costs, and shorter replacement times for equipment.

- Renewable power plants will be impacted by changes in the average wind speed, river flow and wave height. For example, increased wind speed could lead to greater wind electricity production, but may mean turbines have to be shut down to avoid storm damage if they are not made resilient to climate change. Extensive wave and tidal plants are planned and are under test at present off the coast.
- There is the potential for interruptions in fuel supply due to extreme weather and related events along the supply chain.
- There may be an inability to meet peak load due to combinations of rising demand and reduced plant and system capacity during extreme weather events. Output from many forms of electricity generation, particularly gas-fired could also be lower in hot weather due to reduced turbine efficiency.
- Reduced availability of water during dry periods could impact the output from pumped storage hydro plants and/or thermal plant cooling systems, resulting in reduced plant output, flexibility and/or need to modify the system.
- Energy production is highly water intensive - some coal and gas-fired power stations in Ireland are cooled by river water. Hot dry summers and decreased stream flow increase the risk that river water volumes will be insufficient to dilute cooling water effluent. In these cases power stations may be forced to reduce output in order to meet regulatory pollution control standards. Significantly, these episodes usually coincide with peak demand for energy for cooling.
- In the absence of forward-looking policies on the part of generators addressing climate change, energy producers could face reputational risks from being seen as a contributor to climate change.

Required responses

- Adaptation to climate change will need to be incorporated in the long-term planning of the main actors involved in Ireland's all-island energy sector. An important starting point would be for the Commission on Energy Regulation to require owners of energy infrastructure to carry out a climate risk assessment for critical energy infrastructure and transmission assets. Such an assessment could incorporate:
  - Identifying frequency of exposure to a hazard, resilience to exposure, the consequences of asset's failure/ maintenance and mitigation measures which could be applied;
  - Evaluation of the effects of the projected climate change scenarios over energy production systems depending on water resources and air cooling systems;
  - A cost-benefit analysis of climate proofing critical pieces of new or existing energy infrastructure; and
  - Approaches to integrating the impacts of climate change in the design of energy infrastructure.

- Continuing to ensure that energy providers have robust contingency plans in place to minimise the impact of possible energy supply disruptions for business, especially electricity, in extreme weather conditions is also a key consideration.
- Continuing to develop research which monitors climate change trends and impacts of existing infrastructure. Key areas of required research that have been identified as priorities by the ESB include[34]:
  - Socio-economic models and methodologies for integrating adaptation in future demand.
  - The impact climate change will have on renewable energy generation and the preparation of wind and wave atlases for future scenarios to ensure the system can sustain potential variations.
  - Need for identification of climate parameters that will impact efficiency and capacity factors of energy conversion and storage.
  - Need for adaptation in Codes and Standards for design of structures, power plants, electricity and gas network substations, oil storage and dam safety based on predictions of extreme rainfall, wind, wave and surge - standards that are higher than in most design situations.
  - Analysis of the so-called "Water-Energy Nexus", the complex linkage between energy for water/wastewater and water for energy, with changes in rainfall, evaporation, river flows, sea level and surge.
  - Coastal protection measures at reserve oil storage, pipelines, power generating stations, network substations and seabed cables.
  - Bio Energy Action Plan measures accounting for seasonal changes in temperature and the water cycle.
- Higher average temperatures are expected to reduce the need for heating in winter and increase the need for cooling in summer. In district cooling, the energy in district heating water is used to produce comfort cooling[35]. In this way surplus heat from electricity production at combined heat and power plants in summer can be used as an energy source to produce cooling as an alternative to electrically operated air conditioning. The establishment of district cooling is at present not directly included in the National Energy Efficiency Action Plan. As the technology and uptake develops, the use of district heating systems to produce district cooling could be considered by Department of Communications, Energy and Natural Resources/ Sustainable Energy Authority of Ireland for industrial estates where the loads are sufficiently large and consistent.

[34] Critical Infrastructure Adaptation for Climate Change, Energy Infrastructure, Report of ESBI, Irish Academy of Engineering Adaptation Workshop Dublin April 2009.

[35] District heating is a system for distributing surplus heat generated from electricity production, fuel and biofuel-refining and from other different industrial processes in a centralised location for residential and commercial heating requirements. As with district heating, district cooling aims to use centralised local resources that otherwise would be wasted or difficult to use as an alternative to conventional electricity or gas-driven air conditioning systems. Strategic resources include natural cooling from deep sea, lakes and rivers or conversion of surplus heat from industry, Combined Heat & Power and waste incineration.

6.1.4 Transport and Communications

Infrastructure for transport and communications are vulnerable to climate risks, and therefore businesses that use these infrastructures are also at risk. In light of Ireland's geographic location and our dependence on export markets, planning for climate risks of Ireland's transport and communications infrastructure are vital to the competitiveness of the productive sector of the economy and to the country's prosperity.

Business risks

- Transport infrastructure (road, rail, ports and airports) which is essential to the transport of goods domestically and internationally is vulnerable to climate change which can cause severe disruption to services and require frequent repair.
- Flooding can block key transport arteries and roads and railways along the coast may be vulnerable to storm surges, high tides and cliff instability, while tunnels may be vulnerable to flooding. Port and harbour facilities will need to be able to cope with changing sea levels, wind speeds and storm surges which already impact on the reliability of shipping from Ireland. Air freight is becoming increasingly important for high value exporting sectors like ICT and pharmaceuticals while higher temperatures will increase the need for longer airport runways or payloads restrictions. Rough seas enhance the attractiveness of air freight for high-value goods.
- The substantial fixed assets managed by the telecommunications sector are vulnerable to climate change. Extreme events present a significant risk (storm damage to overhead cables, subsidence of masts, poles, etc.), but steady incremental changes in temperature, precipitation and sea levels will also present an increasing challenge to the operations and distribution of services (e.g. the impact of higher indoor temperatures on the operation of high-tech equipment or increase the risk of subsidence damage to communications masts). All other business sectors are reliant on the telecommunications services and infrastructure. Any negative impacts in this sector increase the risks in every other industry and could present significant cost implications.

Required responses

- Adaptation will require that impacts of climate change are incorporated into the long term planning and investment of all actors in the transport and communications sector. As it stands, key pieces of policy in the transport and telecommunications sector focus more on mitigation measures than on adaptation[36] and future iterations should incorporate the need to adapt to a changing climate. New transport and communications infrastructure should be made resilient to climate change from the early design phase. The maintenance of this infrastructure should be actively managed to test their resilience and flexibility to climatic conditions over their lifetimes. Contingency plans should be adjusted in anticipation of more frequent use for more extreme impacts.

[36] For example, it is unclear if transport initiatives (such as the completion of the inter-urban motorway network, expansion of Luas/ DART lines or new Metro lines) as part of the Government's Transport 21 Initiative have incorporated climate risk considerations.

- As a starting point, owners/ regulators of critical pieces of infrastructure should be required to assess the risks, disturbances and structural impacts caused by climate change in each form of transportation (road transportation, sea traffic, railways, air traffic) and the communications network. Such an assessment could consider aspects such as:
  - The proximity of transport and communications infrastructure to potential flood areas;
  - Technical measures needed to make infrastructure resilient to extreme events, such as floods, landslide and mudslide protection;
  - Assessment and revision of the design standards and instructions for transport and communications infrastructure; and
  - Technical adjustments to transportation infrastructure with new climate resilient materials.
- The general principle of flood-sensitive areas avoidance into planning of road and rail networks should be introduced. Investment should be prioritised in win-win options or environmental resources with adaptive value.

6.1.5 Waste Infrastructure

The provision of integrated and cost effective waste management treatment options is both an important competitiveness challenge and a key environmental consideration for Ireland. As the timescales for key pieces of waste management infrastructure (such as landfills and waste-to-energy plants) are likely to be long, there is significant potential for climate change to impact waste management processes and operations. It is vitally important from a business perspective that waste management infrastructure is resilient to climate change to ensure that the waste management requirements of the enterprise base continue to be met.

Business risks

- Increased disruption to supporting infrastructure from increased flooding (surface water, ground water and drainage systems). This could also affect some on-site facilities such as weighbridges and gas and leachate systems.
- Changes in site hydrology and temperature could in turn affect waste management processes, e.g. landfill degradation rates, leachate production and composition.
- Increased risk of damage to site buildings from storms.
- Increased disruption to transport infrastructure due to flooding hence delivery of waste.
- Increased health risks to workers from increased sunshine, exposure to UV radiation and increased pathogen and vermin activity.
- Reduced worker comfort, with negative impacts on productivity due to higher indoor and outdoor temperatures.
- Increased site disamenity from odour, dust, litter and vermin.
- Increased risk of subsidence and slope instability from drying out soils followed by rapid wetting due to heavy rainfall.

- Inundation and/or erosion of low lying coastal facilities (in particular two of the new or planned waste-to-energy plants are at coastal locations).

Required responses

- Waste management policy makers and regulators should continue the process of building a shared understanding of the potential impacts of climate change on waste management policy and practices. This will require increased engagement with climate change research.
- A new waste and resource management Bill and a policy statement on waste are expected to be published by the Department of Environment, Heritage and Local Government in 2010. Policy makers and regulators should ensure that such policies and regulatory activities incorporate the need to respond to climate change risks that may affect waste management.
- As climate change could impact their business, waste management companies should ensure that they also have a good understanding of potential climate change impacts and how they could affect their operations. This will aid effective planning. Waste management industry representative bodies will have a key role to play in facilitating this process.
- Waste collection and disposal authorities should be made aware of any issues arising from the potential impacts of climate change that could influence their service delivery responsibilities and contractual commitments.

6.2 Adapting business infrastructure and the policy framework

Mainstreaming policies and measures that address climate change into development planning and ongoing sectoral decision-making is the overarching aim of any national adaptation plan. Ensuring that such a plan is consistent with existing policy criteria, development objectives and management structures is central to this. The benefit of mainstreaming would be to ensure the long-term sustainability of investments as well as to reduce the sensitivity of development activities to the current and future climate.

A clear policy framework is necessary to provide certainty for business adaptation planning. Ensuring that the policy framework allows for flexible and quick responses within Government as the impact of climate change becomes clearer is also an important consideration. A number of key policy areas which impact on enterprise are likely to be considered in Ireland's proposed National Adaptation Plan. From a business perspective, the following are seen as priority policy areas which can help business reduce the risks and maximise the opportunities of climate change.

6.2.1 Spatial policies

Spatial policies are an essential means of reducing the negative socioeconomic consequences of climate change and should always reflect and adapt to the risks and possibilities brought on by climate change. Given Ireland's low population density, significant scope exists to develop an overall approach to spatial policy in Ireland which minimises the impact of climate change. Until recently, the key pieces of Ireland's spatial planning policy (the National Spatial

Strategy, Regional Planning Guidelines, City and County Development Plans and Local Area Plans) did not take adaptation considerations into account. There is scope for future iterations of these plans to inform business (and broader constituencies) about the potential implications of climate change.

There is clearly a strong role for local and regional authorities to play in spatial policy as it is impacted by climate change. Building on the Development Plan Guidelines of 2007 and the Sustainable Residential Development Guidelines of 2008, flood risk management considerations have been included in Flood Risk Management Guidelines for Planning Authorities which were published by the OPW in 2009[37]. Planning authorities and An Bord Pleanála are legally required to have regard to the principles and procedures of these guidelines in carrying out their functions. The Planning and Development (Amendment) Bill 2009 has also included the need to address the necessity of adaptation to climate change in planning and development decisions. In order to limit business building and construction in high-risk areas (and to avoid costs for flood damage such as dike construction, infrastructure protection or water pumping) these guidelines will have to be enforced effectively and communicated to businesses. In addition, it would seem that planning authorities in particular, having access to centralised data on flood plains, river basins, coastal risks etc. could form part of an efficient information dissemination process which could be of assistance to businesses.

Given the timescale of some of Ireland's strategic planning framework (for example the Regional Planning Guidelines (RPGs) have recently been renewed and are set to apply until 2022), planning authorities will need to continuously evaluate whether there is a requirement for a follow-up with further restrictions on new building in risk areas. Socio-economic analyses should be included as a part of the basis for decisions.

6.2.2 Built environment

Changes in rainfall patterns, potential increases in windiness and storm winds and excess heat caused by increased temperatures can impact on critical business infrastructure and business premises and cause operational interruptions, reputational and infrastructure damage, forgone revenue and remediation costs. To mitigate these risks, such changing stress circumstances caused by climate change will need to be taken into consideration in the planning of new or the retrofitting of existing business buildings.

The need to incorporate climate change, including extreme phenomena, into long-term planning, standards and regulations (such as the Building Regulations) concerning existing buildings and the use of building materials is thus seen as an important consideration from a business risk mitigation perspective. It is also a potential significant opportunity for the domestic construction sector. Further research is needed to understand the costs and benefits of different adaptive measures to improve the robustness of new buildings (e.g. materials, design, etc.) and options for retrofitting. Further industry guidance and design criteria are needed which incorporate climate change allowances in design, for example in areas such as

[37] The Planning System and Flood Risk Management, Guidelines for Planning Authorities, Office of Public Works, November 2009.

building design to minimise heating and cooling needs. Cocoadapt in NUIM are currently undertaking work on potential impacts on construction and building standards. Adaptive responses which will be recommended from this and other research will need to be considered and, where appropriate, incorporated into legislation as soon as possible. Business representative organisations and enterprise development agencies will need to ensure that this research is adequately communicated to businesses who can avail of opportunities.

6.2.3 Insurance

Weather and climate effects are core insurance business areas. Insurance can play a dual role with respect to business adaptation. Access to insurance payouts can lessen the net adverse impact of climatic events on business policy holders. At the same time, insurance is also an instrument for incentivising business adaptations aimed at reducing climate risks. Thus, as insurance can play a prominent role in any business adaptation plan, the benefits of covering climate risks will need to continue to be promoted to business.

As climate changes and historical weather records become less useful, the insurance sector will have to develop new ways of assessing risk and spreading it away from those affected, while encouraging those at risk to adapt to the new environment. The big problem for the insurance industry – and for policymakers – lies mainly not in the huge uncertainty of the effects of climate change itself, but in the balance between properly assessing and pricing current risks and ensuring that those in the most exposed areas can afford cover for their property. Though the public insurance option is not viable in many respects, Government policy which systematically addresses the risks of climate change through measures such as the use of spatial planning to avoid development flood-prone land and investment in flood defences can go some way to reducing this uncertainty.

At the same time, little is known about the insurance-related impacts of climate change for businesses and other property owners in Ireland. Internationally, on the other hand, there has been increasing awareness in recent years of the insurance-related problems stemming from climate change[38] even if this work has led to only a few practical initiatives[39]. To develop a knowledge base of potential insurance implications of climate change for business, Irish insurance companies could develop risk assessment research for business insurance in Ireland according to different climate change scenarios. There is scope for insurers and Government to continue to co-operate to ensure that insurable risks are kept to a manageable level and that coverage remains wide.

6.2.4 Regulations

[38] Studies by the Association of British Insurers and the European reinsurers Swiss Re and Munich Re report that climate change has already caused a significant increase in losses for insurers in the past two decades.

[39] For example, Insurance Scheme AquaPol in the Netherlands, which offers insurance coverage against damage caused by "rain storms".

Regulations to mitigate climate change have increased significantly in recent years (e.g. the Kyoto Protocol and the introduction of the EU Emissions Trading Scheme). In response to climate change, it is possible that new or existing regulations which incorporate adaptation considerations will increase in number and influence in areas such as building quality standards, use of water, health and safety, etc. Any proposed new measures would be likely to impact on business competitiveness (through increased business costs, requirements for new business processes and skills for compliance management) and as such should be well justified in terms of the risk probability. It is equally important that upon introduction of such measures, businesses are enabled to meet new regulations in a manner that minimises costs and that information on what is required of companies to comply is strongly promoted by business representative bodies and enterprise development agencies.

In an effort to reduce costs and administrative burdens for business, there appears to be merit in extending existing regulatory instruments and environmental planning tools such as Strategic Environmental Assessments, Environmental Impact Assessments and Regulatory Impact Assessments, to incorporate adaptation concerns. These pieces of regulation which already apply to industrial activity, would allow for adaptation risks, opportunities and capacity to be assessed in industrial and commercial practices as an extra aspect of an environmental assessment without creating an extra layer of administration.

At the same time, certain regulations can also be a potential driver for opportunities for companies in the environmental goods and services sector. Although research to date on some of the key regulatory areas appears to be quite limited in Ireland (although, as noted above, Cocoadapt in NUIM are currently undertaking work on potential impacts on construction and building standards), emerging research and regulations will need to involve and be communicated to companies who can avail of potential opportunities.

6.2.5 Institutional

To ensure that Ireland adapts to climate change, action is required by an array of sectors and actors and at local, regional and national levels. A strong institutional framework is central to the mainstreaming and co-ordination of climate change adaptation policy measures across government departments, critical infrastructure providers and a range of stakeholders. The draft Climate Change Bill is attempting to put in place such a structure through its proposed Expert Advisory Body and sub-committees. It is vital that these bodies have the structures to properly implement policies and measures on a cross-sectoral and cross-departmental level and in a manner which adequately takes into account business risks and opportunities and national competitiveness concerns. To provide confidence and visibility for the enterprise sector, at least one member of the Advisory Body should possess strong business and competitiveness expertise.

In addition, climate change adaptation can be expected to have North – South implications in certain areas that may impact on business. Key areas may include water management where water catchment areas are on both sides of the border, energy transmission in an all-island energy market and cross border co-operation in key sectors (such as agri-food) which may help mitigate risks and realise opportunities resulting from climate change. There will be a

need to ensure that North-South responses are aligned in addressing some of these challenges.

6.2.6 Research and information

The need for updated information on climate developments and relevant risk analyses to be promoted to businesses is dealt with in section 5.2. The proposed EPA Climate Change Information System is seen as crucial in this respect. Research being developed through the EPA Climate Change Research Programme (CCRP) is improving the understanding of climate change risks, reducing information failures, and helping Government define adaptation priorities and should continue to be supported. A structured and co-ordinated approach involving business stakeholders should continue to be undertaken to identify and agree adaptation research priorities; how research should be funded and carried out; monitoring its implementation and how best to disseminate research on climate change adaptation to key adaptation actors (including businesses). Continuing to focus research on costs and likelihoods of climate risks is also of key importance to business and further engaging the business community (for example through workshops or seminars) on costs and benefits will be an important starting point.

Beyond information provision, the development of research and development and technology transfer will be key considerations in meeting the adaptation challenge. A significant proportion of the climate change research undertaken in the short-to-medium term should address the needs of those designing, planning and producing policy for new infrastructure in general and for critical infrastructure in particular (in areas such as adaptation technologies, design standards, building materials and techniques etc.). Research bodies in other areas, such as food production, may also have a role to play in developing business opportunities or reducing barriers arising from climate change adaptation. Continuing interaction between relevant research bodies and businesses will be important.

6.2.7 Procurement

Annual expenditure on goods and services by the Irish Government amounts to circa €10 billion with a further €7 billion on works. Decisions about public infrastructure will have significant, long-term consequences for resilience to climate change. Such infrastructure is essential for business competitiveness and economic growth.

The incorporation of endorsed environmental criteria into public authority contracts for procurement of goods and services is imperative. In the construction sector for example specification and award criteria could be incorporated into contracts for water saving installations, building materials and energy performance. The technical capacity of contractors to ensure specified building standards are met could also be included. Climate change risks could be taken into account in public procurement performance standards. By doing so, the State can safeguard key pieces of infrastructure in particular in relation to buildings and infrastructure for future climate impacts, create business opportunities in the emerging environmental goods and services sector while maintaining transparency and ensuring value for money. The work currently being undertaken by Department of

Environment, Heritage and Local Government to develop a Green Public Procurement Action Plan could incorporate climate change adaptation into public procurement.

7 Conclusions

There is recognition that the global climate will continue to change and that as a result, economies and societies will have to adapt to manage the unavoidable. This work has attempted to identify some of the issues for businesses and the business environment in Ireland that may arise from future changes in climate. In doing so, the following key messages have emerged.

For businesses

- Climate impacts are likely to be felt across a wide range of business areas, not just the more apparent ones;
- Changes in climate will bring business opportunities as well as threats;
- Planning ahead by businesses can reduce costs and help realise opportunities; and
- Existing systems are in place (such as research and business planning tools) which can be used to help businesses incorporate climate risks.

For the enterprise development agencies

- Climate change adaption can create a range of new market opportunities for client companies;
- The development agencies can build on potential competitive advantages for indigenous firms and market the fact that the impact of climate change on Ireland will be limited relative to that in competitor countries – thus reducing risks for investors; and
- Properly managed, Ireland can remain relatively 'water rich', thus providing a strong competitive advantage to a range of sectors.

For critical infrastructure for business

A number of pieces of critical infrastructure which are essential to the functioning of Ireland's business environment may be affected by climate change. Early planning and incorporation of climate risks by the owners of critical infrastructures or public authorities that manage them is essential to ensure that these pieces of infrastructure are climate resilient.

For policy

A clear policy framework is necessary to provide certainty for business adaptation planning. Ensuring that the policy and regulatory environment minimises risks for business and allows businesses to avail of opportunities are key policy objectives.

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