Rialtas na hÉireann
Government of Ireland

Communications Sector

Climate Change Adaptation Plan

Prepared under the National Adaptation Framework

Prepared by the Department of Communications,
Climate Action and Environment

Table of Contents

Figures

Tables

Minister's Foreword

I am pleased to present the first Adaptation Plan for the Communications Sector, prepared under the National Adaptation Framework.

Our climate is changing and ensuring all parts of our society are ready to adapt to this change is a key priority for the Government. We must become fully engaged in confronting climate disruption, alter our behaviours and work collaboratively across all sectors to bring about the required transformation. As climate change continues and if, as predicted, it increases over the coming decades, the communications sector must prepare for, and adapt to, these new conditions in line with the Adaptation Framework.

Tackling climate change will take the effort of our entire society and the communications sector is no different. From our farming communities to tech start-ups and from our schools to our hospitals, almost all parts of our society are increasingly making use of new advances in digital technologies to enhance effectiveness, improve efficiencies and reduce their carbon footprint. This digital revolution promises to continue apace and provide real tangible benefits to all of our citizens. That is why it is ever more important to ensure the communications sector is as robust as possible in the face of climate change. By identifying areas of vulnerability now, steps can be taken and measures put in place to avoid or minimise future adverse impacts within the sector and to exploit opportunities.

The Climate Action Plan 2019 noted that the need for adaptation to address the current and future risks posed by a changing climate is both urgent and essential to successfully transition to a climate resilient economy and society by 2050. This Government will be taking the lead in developing a climate adaptation strategy for all of our key sectors across the board and this Adaptation Plan should be viewed as a first key first step on the journey towards reducing vulnerability and building resilience in the communications sector. My Department looks forward to continuing the work started by this Plan in the coming period and making sure the communications sector is as ready as possible for any challenges our changing climate may pose.

Richard Bruton T.D.

Minister for Communications, Climate Action and Environment

Preface

The communications sector is essential to the functioning of a modern economy and is a key enabler of numerous other economic activities. Disruptions to communications channels can have significant negative impacts on the economy and the citizen.

The communications sector is highly dynamic, with new technologies developing rapidly and with these new technologies, new elements are added to the critical infrastructure network. In addition, the communications sector, including access to broadband and mobile services, is becoming increasingly important for all citizens and businesses of all sizes. With the development of the Internet of Things (IoT) and the emergence of 5G over the coming years, the importance of secure and reliable communications networks will increase.

The Climate Action and Low Carbon Development Act, 2015 placed the development of National Climate Change Adaptation Frameworks and Sectoral Adaptation Plans on a statutory basis. As required under the Act, the first statutory National Climate Change Adaptation Framework was approved by Government in December 2017 and will be reviewed at least every 5 years after that.

Ireland's first statutory National Adaptation Framework (NAF) was published in January 2018. The NAF sets out the national strategy to reduce the vulnerability of the country to the negative effects of climate change and to avail of any positive impacts.

This statutory Climate Change Adaptation Plan for Communications Networks Sector is the first to be drafted under the new provisions set out in the Climate Action and Low Carbon Development Act 2015 and the National Adaptation Framework. The Communications Networks plan is considered under the Critical Infrastructure heading, alongside its sister plans for Electricity and Gas Networks and Transport Networks.

1. Introduction

Our climate is changing and the associated transformation could have critical implications for our planet and way of life. The impacts of climate change are now being observed across all continents and oceans and Ireland is already observing the impacts of climate change on natural and human systems (EPA, 2017). While there is still a degree of uncertainty about the level and extent of the likely impacts, an exacerbation of existing societal and systems vulnerabilities is to be expected.

Changes in Ireland's climate are in-line with global trends and observations show that temperatures have increased by about 0.8C° over the period 1900-2012, an average of about 0.07°C per decade. The overall trend is upwards and consistent with global patterns of change, however with a high degree of climate variability and associated uncertainties in relation to extreme events.

The science in relation to the warming of the climate system is unequivocal (EPA, 2017). Increasingly, there is a clearer understanding of how the risks of climate change can be reduced and managed through complementary strategies which focus on adaptation and mitigation (IPCC, 2014).

Climate change adaptation can be defined as the ability of a system to adjust to climate change (including climate variability and extremes), to minimise potential damage, to take advantage of opportunities, and to cope with the consequences.

By exploiting the opportunities and reducing the impacts posed by climate risks, successful adaptation can ultimately boost economic growth.

The critical infrastructure of the communications network plays an essential role in ensuring social and economic wellbeing. Risks to this infrastructure both from extreme weather events (such as flooding or extreme wind) and gradual climate change could have significant economic and social consequences and it is important therefore to future proof the efficient functioning of our communications networks.

All of the critical infrastructure networks are interdependent to various degrees. Communications networks are heavily dependent on the electricity and gas networks for their functioning. Disruption to the electricity and gas networks often results in knock on disruption to the communications networks. In addition, access to vital communications infrastructure is often contingent on the functioning of the transport networks. The preparation of this Adaptation Plan, and future iterations of the plan, helps identify these interdependencies and ensure that suitable adaptation measures are put in place.

1.1 Strategic Policy Focus

An overarching policy to build resilience to the impacts of climate change is being led by the EU Commission through an EU Adaptation Strategy which was adopted in April 2013 (http://ec.europa.eu/clima/publications/docs/eu_strategy_en.pdf). This Strategy supports action by promoting greater coordination and information-sharing between Member States with the aim of ensuring that adaptation considerations are addressed in all relevant EU policies. It sets out a framework and mechanisms for developing preparedness in respect of current and future climate impacts across the EU.

The Strategy is accompanied by a generic set of adaptation planning guidelines which have been used by the EPA to guide the roll-out of sectoral plans as well as the development of guidelines for local authorities in Ireland.

Aligned to the EU strategy is Ireland's National Climate Change Adaptation Framework (NCCAF)[1], referenced above, which was published by the Department of Environment, Community and Local Government in December 2012.

This Framework brings a strategic policy focus to climate change adaptation at local and national level through the development and implementation of sectoral and local adaptation action plans. The Framework identified the Department of Communications, Energy and Natural Resources (now the Department of Communications, Climate Action and Environment) as the lead Department charged with the development of a Sectoral Adaptation Plan for communications networks.

Subsequently, the Climate Action and Low Carbon Development Act, 2015 placed the development of National Climate Change Adaptation Frameworks and Sectoral Adaptation Plans on a statutory basis. As required under the Act, the first statutory National Climate Change Adaptation Framework was approved by Government in December 2017 and will be reviewed at least every 5 years after that. The Department of Communications, Climate Action and Environment (DCCAE) is responsible for developing the new framework.

Following approval of the statutory National Adaptation Framework, Section 6 of the Act requires the Government to request all relevant Government Ministers to prepare Sectoral Adaptation Plans covering the relevant sectors under their remit within a specified time period.

[1] http://www.environ.ie/en/Publications/Environment/ClimateChange/FileDownLoad,32076,en.pdf

The recently published Climate Action Plan[2] further iterates the importance of climate adaptation to the overall plan to tackle the effects of climate change. The requirement for the development of Sectoral Adaptation Plans and the implementation of this Plan is Action 181 of the new Climate Action Plan.[3]

In a broader sense, there are other international and national initiatives that are thematically relevant for the National Adaptation Framework as a whole. The Strategic Development Goals (SDGs) are a set of high-level strategic goals agreed by 193 Member States of the UN. The SDGs cover a broad suite of topics with the over-arching aims of ending poverty, protecting the planet and ensuring prosperity. Some of the SDGs are complementary to the production of the National Adaptation Plans, for example: *Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation* (Goal 9), *Make cities and human settlements inclusive, safe, resilient and sustainable* (Goal 11) and *Take urgent action to combat climate change and its impacts* (Goal 13).

On a national level, the urgent need to address climate change is reflected in its inclusion in the Government's National Risk Assessment, 2018[4]. This strategic document notes that "Many effects of climate change are now unavoidable… Future impacts of climate change are predicted to include sea level rise; more intense storms and rainfall; increased likelihood and magnitude of river and coastal flooding; water shortages in summer; and adverse impacts on water quality". The National Risk Assessment identifies the development of adaptation plans as one of the actions the Government must take to meet this challenge.

1.2 Communications Sector Approach

The communications sector, covering commercial telecommunications and broadcasting, is essential to the functioning of a modern economy and is a key enabler of numerous other economic activities. Disruptions to communications channels can have significant negative impacts on the economy and the citizen. The impacts of such disruptions will be highly dependent on scale and duration. As with many of the critical infrastructure sectors in Ireland, the functionality and security of the communications sector is at risk from climate

[2] https://www.dccae.gov.ie/documents/Climate%20Action%20Plan%202019.pdf

[3] https://www.dccae.gov.ie/documents/Climate%20Action%20Plan%202019%20-%20Annex%20of%20Actions.pdf

[4] https://assets.gov.ie/2405/261018155017-8828303ace924307816fda25dde8811c.pdf

change impacts. Adapting and future-proofing the efficient functioning of our communications networks to ensure that citizens and business still have access to this vital resource is therefore essential.

Climate change is a dual process, represented by both gradual changes (e.g. temperature) and recurring extreme events (such as storms or flooding), which bring with them both short and long-term impacts. Temperature changes may lead to increased energy demand over time (e.g. for heating and cooling); other gradual changes such as increased or more frequent rainfall may increase wear and tear on infrastructure. Extreme weather events may have immediate impacts, such as local or national electricity supply interruptions, with associated social and economic consequences. These impacts must be taken account of in how the communications network operates.

The statutory Climate Change Adaptation Plan for Communications Networks is the first to be drafted under the new provisions set out in the Climate Action and Low Carbon Development Act 2015 and the National Adaptation Framework. It aims to identify the potential impacts of climate change on communications networks, assess the associated risks and set out an action plan for adapting to those impacts.

1.3 Methodology

The approach to adaptation planning for communications networks has followed the six-step approach as outlined in the Sectoral Planning Guidelines for Climate Change Adaptation as published in May 2018. These Guidelines were developed to support the drafting of the 12 sectoral adaptation plans identified by the National Adaptation Framework. The Guidelines were developed to ensure they are flexible enough to be applied across all 12 sectors and provide a consistent and coherent approach for Government Departments and Agencies ensuring that appropriate adaptation plans are developed which will remain relevant until they need to be reviewed.

The Sectoral Planning Guidelines provides for a 6-step planning cycle as set out below.

Step 1: Preparing the Ground: In order to have an effective adaptation plan put in place it is essential to have the correct team in place. This includes establishing a Sectoral Adaptation Team (SAT) identifying stakeholders and their roles, and securing required human, technical and financial resources. The SAT oversees and undertakes the adaptation planning process. The SAT will be broken down into a Core Team which will co-ordinate and oversee the adaptation planning process and a Planning Team which will ensure a broad spectrum of relevant knowledge, know-how and technical expertise is considered in the development of the adaptation plan.

Step 2: Climate Impact Screening: Climate Impact Screening establishes a broad overview of sectoral vulnerability and consequences of current and future climate impacts using information that will allow for prioritisation of the most urgent climate impacts and vulnerabilities to be analysed further.

Step 3: Prioritisation: Having identified the most urgent climate impacts and vulnerabilities, prioritisation will highlight those changes and impacts that will have the greatest consequence within the sector. Prioritisation can be assessed using criteria such as timing of impact, magnitude of impact, and the relevance of the impact to activities within the sector and their priorities and objectives.

Step 4: Priority Impact Assessment: Once the potential climate impacts and vulnerabilities have been identified and prioritised, a more detailed exercise is carried out to assess possible outcomes (impacts and consequences) based on multiple time horizons and on multiple emission levels that can provide for identification and assessment of adaptation options.

Step 5: Develop your plan: After completing the priority impact assessment, the following will have been established: an understanding of vulnerabilities; the relative priorities of these vulnerabilities; the location and timing of focus for the sectoral adaptation efforts. The Plan will consist of establishing goals, sequencing objectives, and identifying and prioritising actions to implement the plan. The Plan will also include the risks, barriers and enablers to implementing the adaptation options.

Step 6: Implement, Evaluate and Review: The overall Plan and measures contained within will require on-going tracking and evaluation of progress to ensure effectiveness and efficiency. In the long term, there will be recurring National Adaptation Frameworks and sectoral plans as provided for in the Climate Action and Low Carbon Development Act 2015.

1.4 Planning Legislation

Planning legislation can offer resilience. The Planning and Development Act, 2000 sets out the detail for regional planning guidelines, development plans and local area plans as well as the basic framework for the development management and consent system. Among other things, it provides the statutory basis for protecting our natural and cultural heritage and carrying out Environmental Impact Assessments.

Environmental Impact Assessment (EIA) is the process by which the anticipated effects on the environment of a proposed development or project are measured. If the likely effects are significant, design measures and/or other relevant mitigation measures can be taken to

reduce or avoid those effects. In recent years, measures have been taken to integrate climate change, including adaptation, into the EIA.

In practical terms, changes may be required which allow the heights of critical assets to be increased so that they are mounted a metre or so above expected flood levels.

The EU Commission issued 'Guidance on Integrating Climate Change and Biodiversity into Environmental Impact Assessment' which aims to help Member States improve how climate change, both mitigation and adaptation, are integrated in Environmental Impact Assessments.

Guidance is available to support the planning system and documents which are particularly relevant to climate change adaptation include: The Planning System and Flood Risk Management – Guidelines for Planning Authorities (OPW-DEHLG, 2009).

The role sustainable planning guidelines can play in addressing climate adaptation is reflected in the recently published National Planning Framework, 2018. This policy document, part of the Ireland 2040 initiative, aims to establish a framework to guide public and private investment in the coming years in a manner that protects and enhances our environment (DHPLG, 2019)[5]. The Framework establishes a suite of National Policy Objectives to guide policy development in the area. National Policy Objective 54 denotes the synergies between planning policy and climate mitigation/adaptation: "reduce our carbon footprint by integrating climate action into the planning system in support of national targets for climate policy mitigation and adaptation objectives, as well as targets for greenhouse gas emissions reductions."

1.5 Government Emergency Planning

In 2001, a range of Government structures were put in place to support emergency planning in Ireland. A key objective was to improve co-ordination across the various existing national emergency plans.

The Government Task Force on Emergency Planning (GTFEP) directs and oversees the emergency planning activities of all Government departments and public authorities in Ireland. The Minister for Defence chairs the GTFEP, which includes Ministers, senior officials of Government departments, senior officers of the Defence Forces, An Garda

[5] Department of Housing, Planning and Local Government, http://npf.ie/wp-content/uploads/Project-Ireland-2040-NPF.pdf

Síochána and officials of other key public authorities which have a lead or support role in Government Emergency Planning.

The Office of Emergency Planning (OEP) provides a key support role to the GTFEP. Under the remit of the Minister for Defence, the OEP is responsible for the co-ordination and oversight of emergency planning. The OEP also chairs the various subgroups of the GTFEP, including the National Framework Subgroup. This Subgroup comprises officials representing all Government departments and public authorities with lead or principal support roles and responsibilities for the range of emergency/incident types. As part of the work of the GTFEP, a review of the existing national-level structures and processes was initiated and this has culminated in the production of the "Strategic Emergency Management (SEM): National Structures and Framework"[6] document. This framework sets out the national arrangements for the delivery of effective emergency management which outlines the structures for coordinating a "whole of Government" approach.

The SEM defines an emergency as follows: *An event which, usually with little or no warning, causes or threatens to cause death, serious injury, serious disruption to essential services, the economy or critical infrastructure, significant damage to property or the environment, and which requires the activation of national resources to ensure an effective coordinated response and recovery.*[7] In relation to emergencies involving severe weather, the Department of Housing, Planning and Local Government acts as the Lead Government Department (LGD) and has the mandate and responsibility to coordinate all national level activity for its assigned emergency types.

The LGD role includes risk assessment, planning and preparedness, prevention, mitigation, response, and recovery. Supporting roles are taken by numerous other Departments, including the Department of Communications, Climate Action and Environment. The LGD, working with the designated support Government Departments/Agencies, is responsible for the coordination of the 'whole of Government' approach to specified emergencies during the emergency management cycle.

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[6] https://www.emergencyplanning.ie/system/files/media/file-uploads/2018-06/Strategic%20Emergency%20Management%20National%20Structures%20and%20Framework_0.pdf

[7] Strategic Emergency Management: National Structures and Framework Page 2.

1.6 Emergency Planning – Critical infrastructure and Communications

Critical Infrastructure

A modern state depends on a complex infrastructure of services and utilities in order to facilitate the efficient functioning of its economy and the day-to-day lives of its citizens. This includes, but is not limited to, a wide range of infrastructure assets and systems such as: roads, bridges and railways; power stations, and power transmission lines; telecommunications networks and systems; hospitals and other public buildings; ports and airports; water treatment plants and supply networks etc. Infrastructure may be physical (e.g. sites, installations, pieces of equipment) or logical (e.g. information networks, systems).

Much of this infrastructure is interconnected and interdependent, and failure of one asset or system may affect the continued functioning of other assets and systems.

Within the sectors/sub-sectors there are certain critical infrastructure (CI) assets or systems, the loss or compromise of which would have a particularly detrimental impact on the availability or integrity of essential services, leading to severe economic, environmental or social consequences, or to loss of life.

EU Council Directive 2008/114/EC defines critical infrastructure as: '*an asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of failure to maintain those functions*.'

Citizens expect that CI will continue to function, and if disrupted, will be restored as quickly as possible. They also expect that any disruption will, as far as possible, be managed in an equitable manner to minimise the impact on society as a whole and in particular vulnerable people.

Across the EU there is considerable focus on the resilience of CI within Member States and how it could be improved. The objective is to assure service continuity in the aftermath of destructive events, especially where these cannot be predicted.

The European Commission has also highlighted the need to assess the criticality of individual CI assets, prioritising and protecting them with adequate risk management and security controls.

Critical infrastructure is vitally important in emergency planning. The GTFEP have established a Critical Infrastructure Sub-Group which aims at identifying measures to

improve the resilience of critical infrastructure networks nationally to ensure that citizens and government can be assured of their continued functioning during an emergency.

Communications

When severe weather events leads to the declaration of an emergency, the Department of Housing, Planning and Local Government convene a NECC. The Department of Communications, Climate Action and Environment attends the NECC and directly engages with the Communications Regulator, ComReg. The NECC then monitors the fall-out of the emergency in relation to various different sectors, for example, transport, energy and communications networks.

Updates from operators relating to the continued operation of the national communications networks are reported into the NECC, including information relating to whether they are experiencing outages or network disruption and if so, whether there is an estimated time for rectification for these issues. A standardised template for communications of this data has been developed and is in use. Operators are expected to report at scheduled times during the period of the emergency. Individual operators, via their nominated single points of contact, feed this standardised template data into ComReg.

ComReg then routes these Industry updates through DCCAE's designated point of contact. The DCCAE contact point then communicates the reports on the integrity of the networks to the NECC and provides updates as to the integrity of the network, as required.

Network Incidents

Both Ireland and the European Union place a high value on continued efficient functioning of the electronic communications networks. To this end, work has been done to ensure that Government and appropriate agencies are aware of any event that constitutes a "loss of integrity" in the network.

This is codified in 2009 *Framework Directive* (2009/140/EC) which updated and amended the 2002 *Framework Directive* (2002/21/EC). This Directive was transposed into Irish law as the Framework Regulations (S.I. No. 333/2011).

Regulation 23 (3 -6) sets out certain obligations imposed on Operators to ensure the security and integrity of their networks. Network Operators providing public communications networks or publicly available electronic communications services are required to notify the Communications Regulator, ComReg, in the event of a breach of security or loss of integrity

that has a significant impact on the operation of networks or services.[8] This can include a loss of network integrity that has resulted from a serious weather event.
Where ComReg receives such reports, it is required to inform the Minister of Communications, Climate Action and Environment and, where appropriate, the European Network and Information Security Agency (ENISA).[9]

Operators are the foremost parties responsible for ensuring the security and integrity of their network. Management of an incident is the responsibility of the Operator concerned, calling upon resources as appropriate to assist in the efficient handling of the issue. In some circumstances this may include a Network Operator requesting the support of ComReg, for example to assist in its coordination of the incident response with other parties such as other interconnected Network Operators.

In addition, Operators have a positive obligation to take steps to guarantee the integrity of their networks and to ensure that continuity of service is provided.[10]

These requirements under the Framework Regulations are further reinforced through the General Authorisation requirements on Operators. Under Section 4 (1) of the European Communities (Electronic Communications Networks and Services) (Authorisation) Regulations 2011[11], any person intending to provide an electronic communications network or service shall, before doing so, notify the Regulator of his intention to provide such a service. This is referred to as the General Authorisation procedure. Failure to do so is an offence.

Conditions are attached to the General Authorisation procedure, one of which is the maintenance of the integrity of public communications networks in accordance with the Access Regulations.[12] It is an offence to fail to comply with these conditions.[13]

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[8] 23(4)(a)

[9] 23(4)(b)

[10] 23(3)

[11] S.I. No. 335 of 2011

[12] 8(1)

[13] 8(7)

1.7 The Communications Sector: Industry Measures

Commercial communications network operators are already working to adapt to climate change. However, operators would not necessarily categorise their actions as climate adaptation measures but would consider them more broadly as business continuity management. These business continuity and emergency plans are built into everyday operations as well as future plans to ensure an effective response to a range of events. While these plans do not, of themselves, constitute climate change adaptation, there are strong linkages and overlap in these areas.

This activity is complementary to their obligations under the Framework Regulation and Authorisation Regulations, discussed above.

1.8 Telecommunications: Broadband Operators, Fixed Line Providers and Mobile Operators

The electronic communications market in Ireland is fully liberalised, ensuring effective competition between operators with the regulatory regime enforced by the Communications Regulator, ComReg. This competitive market provides many benefits for consumers, including increased choice, better value and innovative solutions to industry problems.

However, it also results in a necessary level of commercial sensitivity between operators in the telecommunications sector. Any vulnerability that may exist in a commercial network could constitute extremely commercially sensitive information for an operator. Therefore, this plan does not attempt to identify specific areas where individual operators have discovered vulnerability, but will instead offer a general overview of the sector's work to date.

The electronic communications network is strategically designed to ensure that the highest value assets, the backhaul and core networks (core network, metro node, local exchange and radio base stations), are robust in the face of extreme weather events.

The backhaul and core networks systems are built with resilience in mind and are insulated from many events, whether they are directly meteorological or, more commonly, the result of a fault in power supply (which could itself be the result of extreme weather events). In respect of the latter, backhaul and core networks are often designed with more than one direct power supply. The circuits are designed to ensure that any faults in the power supply can be absorbed by the system.

The reason for this necessary resilience is that if any part of the backhaul and core network were to go offline, this would have catastrophic repercussions for the rest of the downstream

network that feeds off the backhaul and core network, impacting multiples of tens of thousands of customers.

As the network moves further downstream from the backhaul and core networks, the resilience of the network decreases proportionally to the potential impact of any network failure. This is based on a risk management strategy that maintains that investment in network resilience is best focused on high value assets and that the business case for ensuring full resilience throughout the network cannot be made on a financial basis.

The access network, the section of the network closest to the consumer, contains the most vulnerable sections of the network. The street cabinet is at the more robust end of the access network. Street cabinets are usually cuboid in shape and constructed of highly durable materials, such as powder coated galvanized steel. Street cabinets contain electronic communications infrastructure that needs to be protected from interference from weather or vandalism. In this sense, street cabinets themselves can be seen as part of climate adaptation in a holistic sense. They are able to withstand many types of weather conditions, including temperature fluctuations (within certain parameters), high winds and moderate precipitation. Fibre cables run from the backhaul and core networks to the street cabinet, at which point the connection to the end user is continued, usually via a copper sub-loop.

Connections to the premises, whether via fibre to the home or through the utilisation of copper wires, are the most vulnerable parts of a network. Fibre cables and copper wires are oftentimes dispersed on pole networks. This leaves this infrastructure vulnerable to high wind conditions, including vulnerability from falling trees. Electrical storms can also damage both the poles and the telecommunications infrastructure.

Operators carry out routine monitoring and maintenance on these poles. However, the risk of environmental damage to this relatively fragile, low-cost infrastructure, the consequent cost of repair and temporary loss of service to customers, is generally not considered dissuasive enough to encourage operators to move away from this method of service completely.

Fibre and copper cables can also be routed to the premises underground. While less vulnerable to adverse weather conditions than the utilisation of overhead cables, this method also presents challenges should excessive damage to roadways be done by adverse weather conditions.

The electronic communications sector is an ever-evolving industry in which new technologies are continually coming into use. 5G, a new form of mobile technology now in its infancy, promises to provide consumers with hitherto unimagined mobile download and

upload speeds and negligible amounts of latency. This is expected to bring about the advent of Internet of Things (IoT) technology and an era in which quantities of data are being transmitted at a heretofore unimaginable rate. For 5G to work, operators will need to deploy small cell wireless network infrastructure. These small cells will be placed short distances from each other throughout a 5G hotspot or city, oftentimes on the sides of buildings or at the top of poles. Their exposure to the adverse weather conditions associated with climate change will need to be considered and appropriate adaptation measures considered.

1.9 Broadcasting Sector

Unlike the telecommunications sector, the provision of national public service terrestrial broadcasting communications is provided exclusively by a semi-state body, 2RN. 2RN is a wholly owned subsidiary of RTÉ. It owns and operates national radio and TV terrestrial broadcast network infrastructure in Ireland. Coverage for both radio and TV is available to approximately 98% of all Irish households. 2RN infrastructure is also used to host regional and local radio stations, broadband/mobile services, and emergency services.

TV (Saorview) and national radio broadcasts are distributed to mountain top main transmission stations via microwave radio links and then broadcast throughout Ireland; either directly or via relay transmission stations.

The infrastructure owned and operated by 2RN is robust in nature and can therefore withstand various weather extreme weather conditions without suffering performance issues. The main vulnerability experienced by the network is its dependence on electrical power supplies. Events that can impact on power supply are mainly high winds.

2RN have worked to mitigate this vulnerability through the provision of generators at key sites that provide redundancy should there be any issues with power supply (provided there is sufficient supply on site to fuel the generator).

The nature of national broadcasting results in a certain amount of overlapping coverage areas from different transmission stations. This effective use of radio spectrum provides a level of redundancy for many radio listeners in the event that a transmission site is not broadcasting due to an extreme weather event and provides a level of backup for the distribution network in the event of a core network failure.

2. Preparing the Ground

A stakeholder team, led by the DCCAE and involving key communications network stakeholders was established to scope out and develop this Plan. The following organisations were represented on the team and/or made contributions to the development of the Plan:

- Department of Communications, Climate Action and Environment (DCCAE) www.dccae.gov.ie
- The Communications Regulator, ComReg www.comreg.ie
- TII, Telecommunications Infrastructure Ireland, https://www.ibectii.ie/
- ALTO, Alternative Operators in the Communications Market http://www.alto.ie/
- 2RN, https://www.2rn.ie/

In addition to establishing a group of relevant communications networks stakeholders with relevant experience and expertise, the communications division of DCCAE engaged with other sectors within DCCAE and local authorities currently involved in developing adaptive strategies, through representation on a National Climate Change Steering Group chaired by DCCAE. Such collaboration seeks to secure a cohesive approach to the multi-layered adaptive strategy for Ireland. Particular focus was put on engagement with other critical infrastructure policy owners, Electricity and Gas Networks and Transport Networks, to ensure that cross-sectoral issues were understood and addressed in the plan.

2.1 Climate Change Trends in Ireland

Climate change is happening in Ireland and Government has developed a plan to address the issue.[14] Changes in Ireland's climate are in line with, and similar to, relevant global trends (EPA, 2017)[15]. These changes are projected to continue and increase over the coming decades (Gleeson, 2013).

These include:

- Temperatures have increased by about 0.8°C over the period 1900-2012 - an average of about 0.07°C per decade;

[14] https://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/Climate-Action-Plan.aspx

    - Projections for mid-century indicate an increase of 1 – 1.6°C in mean annual temperatures, with the largest increases seen in the east of the country. The scientific confidence of this projection is deemed medium/high. (EPA, 2017).
    - All seasons are projected to be significantly warmer (0.9 – 1.7°C) by mid-century. The scientific confidence of this projection is deemed medium to high. (EPA, 2017).
- Changes in precipitation patterns – An increase in average annual national rainfall of approximately 60 mm or 5% in the period 1981 to 2010, compared with the 30-year period 1961 to 1990:
    - Significant projected decreases in mean annual, spring and summer precipitation amounts by midcentury. The projected decreases are largest for summer, with reductions ranging from 0% to 20%. The scientific confidence of this projection is deemed low/medium. (EPA, 2017)
    - Less snow. The scientific confidence of this projection is deemed medium to high. (EPA, 2017).
    - Increased flow to rivers in winter and less in summer. A 20% increase in the amount of water flowing through rivers is expected for the majority of catchments by mid-to late century, while for summer decreases of over 40% have been simulated for the end of the century. The scientific confidence of this projection is deemed medium. (EPA, 2017).
- Studies have shown that the intensity and frequency of extreme events are changing and will change further as a result of climate change (EPA, 2017);
- Ongoing sea-level rise:
    - Rise of c. 55–60 cm to 2100. Predicted changes in mean sea level will be the primary driver in magnifying the impacts of changing storm surge and wave patterns in coastal areas
- Changes in wind energy content.

A changing climate leads to changes in the frequency, intensity, spatial extent, duration and timing of extreme weather and climate events, and can result in unprecedented extreme weather and climate events (IPCC, 2012). Changes in weather extremes are projected to disrupt most natural and managed systems and regions.

In particular, extreme weather events which may lead to breakdown of infrastructure networks and critical services such as electricity, water supply, transport and health and emergency services are expected.

Research carried out as part of the CiVIC research programme has summarised the mid-century projections for Ireland's climate as follows:

Mid-century Climate Change Projections for Ireland.[16]	
Temperature	• Increase of 1–1.6°C in mean annual temperatures with the largest increases seen in the east of the country. • Hotter summers: increase by 0.7-2.6°C for the warmest 5% of daily maximum summer temperatures. • Warmer winters: increase by 1.1-3.1°C for the coldest 5% of night-time minimum winter temperatures. • Decrease in the average number of frost days (Tmin<0°C) over the whole country by over 50%. • Increase in the average length of the growing season of over 35 days by mid-century.
Precipitation	• Significant decreases in average precipitation amounts for the spring and summer months. • Drier summers: increases of 12-40% in dry periods. • Wetter winters and autumns: increase in the frequencies of heavy precipitation events.
Wind Energy	• Increase in extreme storm activity and number of extreme storm events in winter. • Decreases in the wind energy content for spring, summer and autumn seasons with no significant increase for winter.

[16] Hawchar, Lara & Ryan, Paraic & Naughton, Owen & Nolan, Paul. (2018). High-level Climate Change Vulnerability Assessment of Irish Critical Infrastructure.

Met Éireann and the national universities provide information on projected climate trends for Ireland. A summary of the state of knowledge was published by EPA in 2017 and was utilized in the writing of this Plan. Key reports may be accessed as follows:

(a) https://www.epa.ie/pubs/reports/research/climate/EPA%20RR%20223_web.pdf

(b) www.climateireland.ie and

(c) Ireland's Climate: The Road Ahead at http://www.met.ie/publications/IrelandsWeather-13092013.pdf

Despite the above, the data that is currently available in respect of climate trends is still at a high level and provides little data/information about local or regional area projections, which is critical for determining risks for communications networks.

Future modelling for the communications sector in relation to climate risk will be important as we progress to more focused actions in subsequent Adaptation Plans.

2.2 Communications Sector Profile

The Communications Sector in Ireland is comprised of certain separate components. The electronic communications sector relates to the provision of electronic communications networks or services and is often more commonly known as the telecommunications sector. This encompasses broadband, including via fixed and mobile technologies, and more traditional telephony services.

The communications sector also encompasses the broadcasting sector, both relating to television and radio broadcasting.

Both of these sectors will be discussed in turn.

The Electronic Communications Sector

The provision of electronic communications services in Ireland occurs within a fully liberalised market, offered by competing network and service providers. A wide range of services are available to customers over infrastructure, including fixed and mobile networks, voice, data and Internet services, cable television, developments in next generation networks and broadcast networks for radio and television.

The liberalisation of the Irish telecommunications market was completed in the late 1990's. Telecommunications services were originally provided by the Department of Posts and Telegraphs until the establishment of Bord Telecom Éireann in *The Postal and Telecommunications Services Act* of 1983.

In 1993, Esat became the first private company to be awarded a licence to operate and entered into the Irish telecommunications market. In 1998, the *European Communities (Full Competition in Telecommunications) Regulations* were signed resulting in the deregulation of the telecoms market in line with Ireland's European obligations. This Statutory Instrument (SI 85/1998) gave force to Directive 96/19/EC with regard to the implementation of full competition in telecommunications markets. In 1999, Telecom Éireann was fully privatised and floated on the Irish, London and New York Stock Exchanges. This was the biggest IPO in the history of the State.

Liberalisation of the Irish telecommunications market in the late 1990's led to a growth in competition in the sector and an increase in consumer choice. There are currently eight mobile operators in Ireland, with three operators, Eir, Vodafone and Three, operating their own mobile networks. There are also seven primary broadband providers operating in the State, in addition to a number of small providers specializing in providing broadband in certain rural areas.

In the period since the late 1990's, there have been rapid advances in the technologies used in the telecommunications sector. Where previously copper wires were the most prevalent infrastructure for use in the provision of broadband, fibre optic cabling is becoming increasingly common due to its superior capacity. There have also been major developments in the mobile sector since the 1990's, with 3G and 4G providing customers with ever increasing download speeds. 5G, currently in its infancy, promises to offer consumers considerably faster speeds with negligible amounts of latency which will allow for the proliferation of Internet of Things (IoT) technologies, such as Connected and Automated Vehicles (CAVs).

In addition, the telecommunications market has changed considerably, with increased customer demand for data, growth of so-called "Over the Top" (OTT) services and a decrease in traditional telephony services.

The Broadcasting Sector

Broadcasting relates to both audiovisual or television programme service and audio or sound broadcasting service (Radio).

Under Section 2 of the *Broadcasting Act 2009*, a 'public service broadcaster' (PSB) is defined as RTÉ, TG4, the Houses of the Oireachtas Channel and the Irish Film Channel.

Part 7 of the Act sets out the common provisions applicable to RTÉ and TG4. The objects of RTÉ and TG4 are set out in Sections 114 and 118 respectively. Both RTE and TG4 are regulated by the Broadcasting Authority of Ireland (BAI).

RTÉ is a statutory body and the national PSB of Ireland. It both produces and commissions programmes and broadcasts them on television and radio, as well as worldwide through its online website and the RTÉ Player.

TG4 is the National Irish language PSB, bringing Irish language programming content to audiences in Ireland on all platforms and worldwide on TG4 player. TG4 was established on 31 October 1996 and was initially operated as part of RTÉ. Teilifís na Gaeilge, trading as TG4, was established as an independent statutory body in 2007, in accordance with the Broadcasting Act, 2001 and is also regulated by the BAI.

Virgin Media Ireland, formerly TV3, is the only Irish commercial broadcaster. It has three free to air channels, Virgin Media One, Virgin Media Two and Virgin Media Three. The broadcaster is licenced under Section 70 of the Broadcasting Act 2009 by the BAI.

2rn is the communications network operator in Ireland, distributing the programme services of RTÉ Radio and Television, Virgin Media, TG4 and a number of local and regional radio broadcasters. 2rn also provides site services to mobile telephone and broadband operators, private communications companies and the emergency services.

2.3 Broadband Network

Broadband networks provide increased bandwidth over a traditional dial-up service enabling faster speeds for transmitting information. Within the Irish telecommunications market, eir is the largest wholesale operator providing wholesale telecommunication services to retail service providers (RSPs).

A broadband network is divided into two main parts: access and backhaul (and core) networks. The wholesale operator provides the access network and backhaul network to the RSP or access network only. In the latter case the RSP procures an alternative backhaul network.

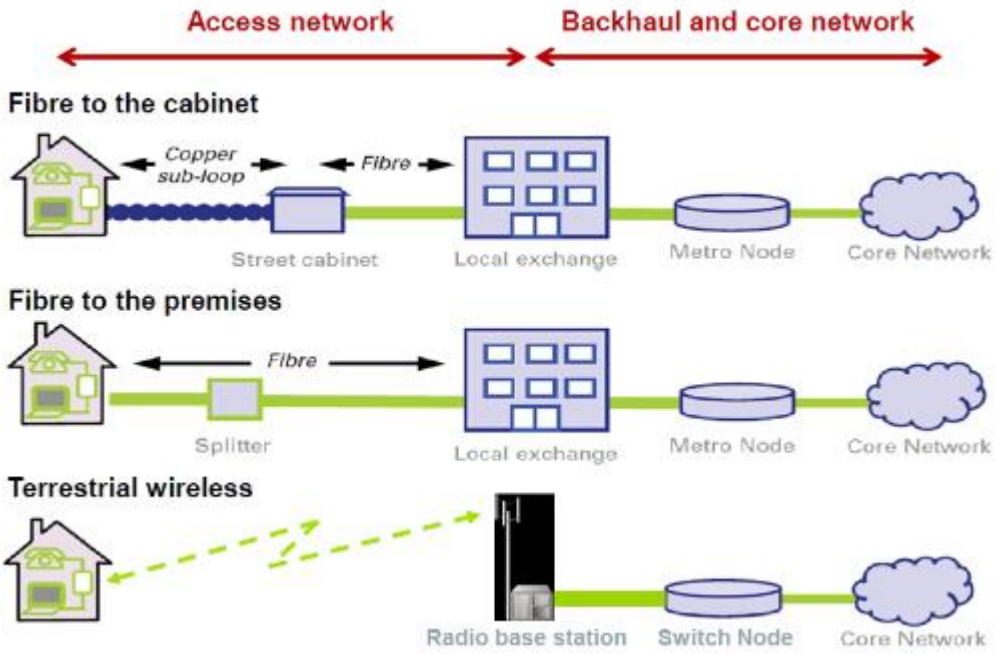

Figure 1: Infrastructure components in broadband networks

Access Network

The access network connects the service to the end-user. Broadband access can be provided by a wide range of different technologies, each with its own technical characteristics as well as economic costs and benefits. Figure 1 shows an example of the infrastructure components in broadband networks on three different technology platforms: fibre to the cabinet, fibre to the premises and terrestrial wireless. In access networks, resilience becomes less commercially viable and these networks are therefore more exposed during extreme weather events.

Fixed Line Network

Copper telephone lines (typically consisting of 'twisted pairs' of copper wire) have long been used to provide traditional telephone services. In the late 20th century, connections via the circuit-based public switched telephone network (PSTN) could be made to computer networks, but dial-up access was slow and meant that phone calls could not be made at the same time. At the turn of the century, Digital Subscriber Line (DSL or xDSL) technology became available using Internet Protocol packet-switching which supports faster broadband speeds and meant that broadband access can be provided with or alongside regular telephone service.

A decade later, very high-speed digital subscriber line (VDSL) in a fibre to the cabinet (FTTC) solution was deployed by Eir where an optical fibre backhaul connection to the local

exchange terminates in the street cabinet. Copper lines run from the cabinet and enter a user's premises via an overhead pole network or underground using a duct network.

Another solution using coaxial cable consists of copper wires that are shielded to protect them from interference. They are usually installed and owned by suppliers of cable television services e.g. Virgin Media in Ireland. Standards like DOCSIS 3.0 allow high-bandwidth data transfer over coaxial cable. The coaxial cables typically enter the user premises by overhead means which are predominantly installed in urban areas.

Optical fibre is a glass strand that uses laser light pulses to transmit signals over distances up to hundreds of kilometres. Optical fibre is impervious to electromagnetic interference, requires less signal boosting and has a much higher capacity than copper wires transmitting electrical signals. Optical cables are used extensively in the backhaul and core networks. In access networks, they are used in FTTC and FTTP solutions. Fibre access products are provided by a range of wholesale operators e.g. Eir, SIRO, Magnet, enet, BT and ESB.

Wireless Access

Terrestrial wireless is provided by a range of technologies that may extend over short or long distances and that use licensed or unlicensed radio spectrum. WiFi is a short-range technology using unlicensed bands of radio spectrum that is often used to provide privately managed wireless access within a home or office. However, public WiFi 'hotspots' can also provide fast access in public places such as cafés and airports or increasingly throughout a city. However, the rapid adoption of mobile phones, smartphones and tablets has meant that the newer generations of mobile telephone technologies (third generation '3G', fourth generation '4G' and soon to be released '5G' technologies) are increasingly used for broadband access. Mobile internet access can be bundled with a voice telephone subscription (e.g. using a smartphone) or available as a separate data subscription (e.g. using a separate modem or dongle).

Mobile phones rely on a network of base stations that send and receive calls and other mobile services such as video calling, wireless broadband and mobile TV. Base stations need to be located close to mobile phone users to provide good quality network coverage as shown in figure 2. The backhaul connection to the base station is provided by either a microwave link using a small dish antenna, or via optical fibre cable.

Base stations sites typically consist of a shelter containing digital electronic equipment, and antennas/radio unit mounted on a support structure such as a building, mast or tower.

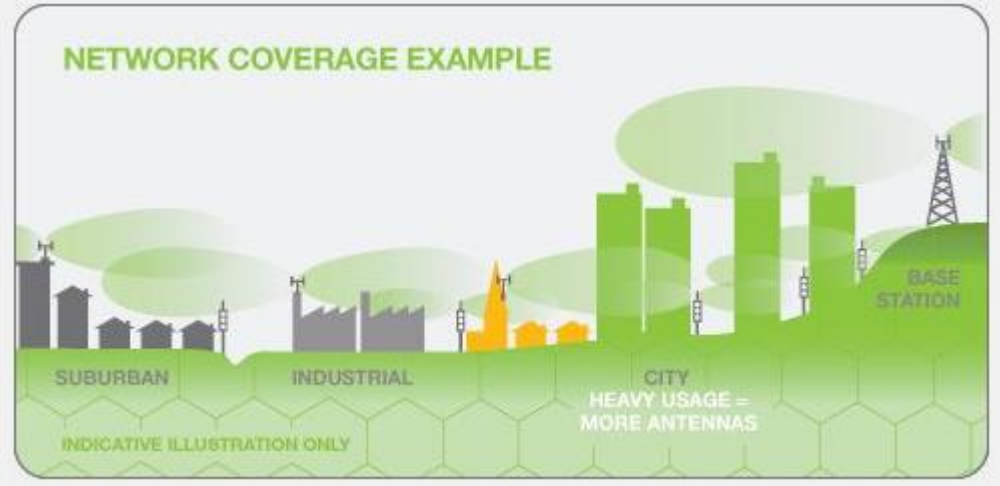

Figure 2: Typical mobile network coverage containing base stations

Fixed wireless access (FWA) is an alternative broadband service. FWA involves the user having a fixed antenna on their premises which then connects over the air to a nearby base station. FWA is a nomadic wireless solution in contrast to mobile wireless.

Satellites can also send and receive data through high-speed Internet connections directly to end users. However, end users of satellite services must install satellite dishes; installation costs and the overall costs of satellite broadband are on average above those of other access technologies. Satellite is therefore a solution of last resort typically used in remote rural areas where no other service is available.

Backhaul and Core Network

The backhaul network connects the access network to the core network for enablement of upstream applications and services e.g. the internet. A fit-for-purpose backhaul/core network is essential for providing effective broadband services. Core networks and their backhaul links are designed with resilience in mind and multiple routes are made available in the case of an outage. The backhaul and core networks are therefore the most robust part of the communications infrastructure in the case of extreme weather events.

Broadband Technologies

The layered architecture of broadband technologies is shown in figure 3. The three layers are passive infrastructure, active infrastructure and applications & services. Each layer's availability relies on the underlying layer. The bottom two layers are the physical infrastructure layers which have the potential to be affected by climate change and extreme weather events.

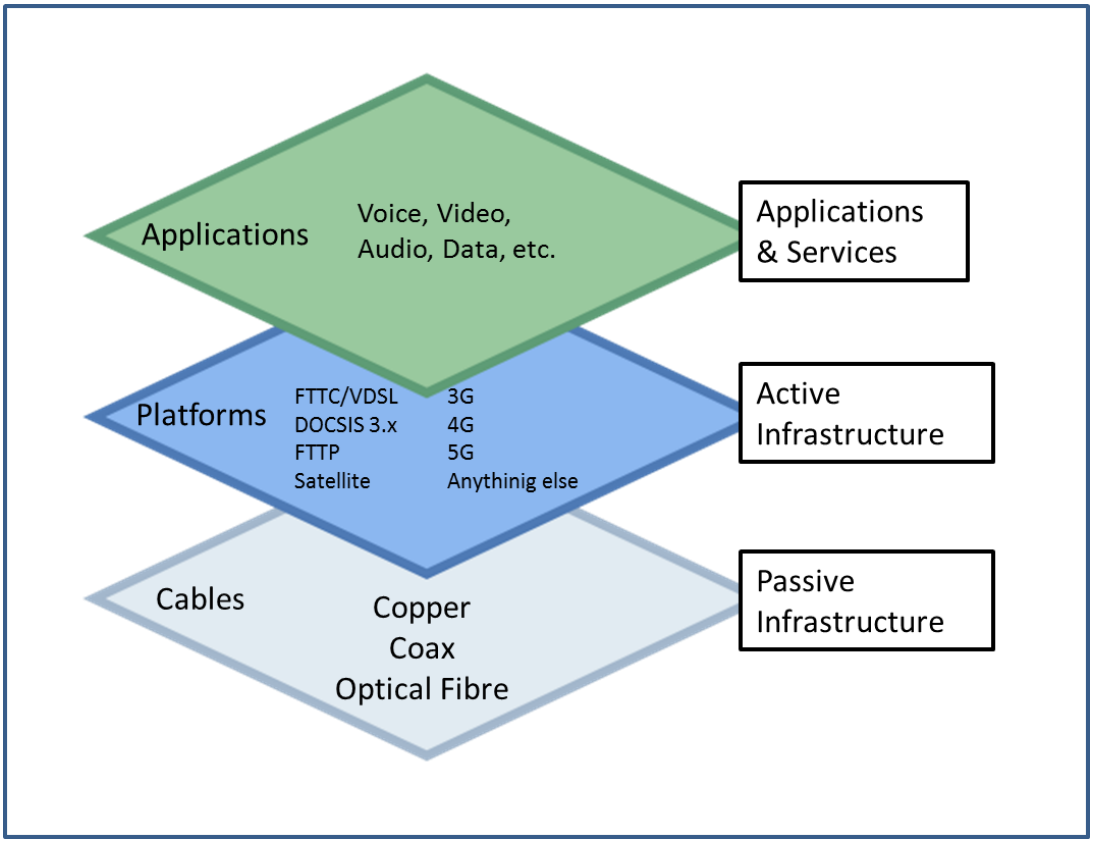

Figure 3: Layered architecture of broadband technologies

Passive Infrastructure (Non-Electronic Equipment)

The passive infrastructure is non-electronic equipment including the following:

- Cables (copper, coaxial, optical fibre)
- Buildings
- Telecom local exchanges
- Antennas
- Poles
- Masts/Towers
- Ducts
- Cabinets
- Power supplies, rectifiers and batteries
- Diesel generators

Active Infrastructure (Electronic Telecom Equipment)

The active equipment is dependent on the technology platform (DOCSIS, VDSL, FTTP etc.) that is used. Examples include:

- Optical line terminals (OLTs)
- Telephone exchange equipment
- Transmission equipment
- Radio base station equipment such as digital baseband and radio units.

2.4 Broadcasting Network

Broadcast Network

2RN is a wholly owned subsidiary of RTÉ. It owns and operates national radio and TV terrestrial broadcast network infrastructure in Ireland. Coverage for both radio and TV is available to approximately 98% of all Irish households. 2RN infrastructure is also used to host regional and local radio stations, broadband/mobile services, and emergency services.

TV (Saorview) and national radio broadcasts are distributed to mountain-top Main transmission stations via microwave radio links and then broadcast throughout Ireland; either directly or via Relay transmission stations.

To maximise service coverage, radio and TV transmission masts and towers must operate from mountain top, or relatively high, locations. None of 2RN's transmissions sites are therefore at risk of flooding. All network infrastructure has been designed to operate at the high wind speeds and low temperatures found at their locations and altitudes, typically with layers of redundancy to prevent service outages during periods when the transmission sites are inaccessible to 2RN engineers.

The largest weather/climate related risk to service continuity is electricity supply. All key main stations have on-site generator back-up power supplies to minimise vulnerability to electricity supply problems. Physical access to remote mountain top sites is also challenging and access routes are at risk of disruption and damage from severe weather events.

Map Key:

Red: Main Transmission Stations

Green: Relay Transmission Stations

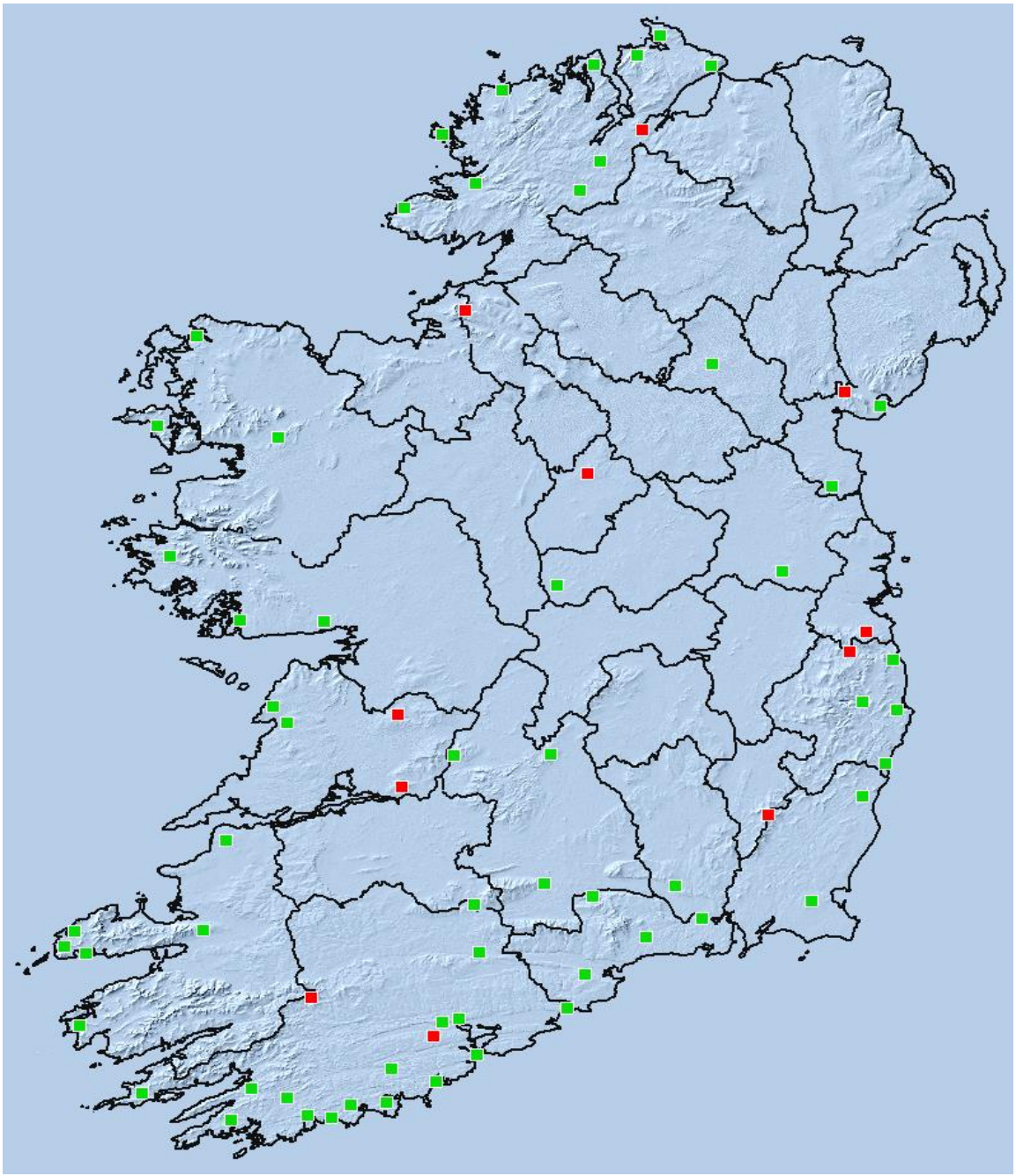

Figure 4: National Transmission Station Map

2.5 Cross Sector Interdependencies

The communications sector is heavily reliant on the other sectors to operate. This is especially true of the other critical infrastructure sectors: electricity and energy, and transport.

The NAF lists twelve sectors for which adaptation plans are required and proposes a themed approach to adaptation planning to allow for cross-sectoral identification of synergies and conflicts. Under this themed planning approach, significant interdependencies have been identified between transport infrastructure and the national information and communication technologies (ICT) network and gas and electricity networks, collectively designated *critical infrastructure*.

Table 2.2: Sectors and lead departments in the NAF. **Source:** NAF: DCCAE, 2018.

Theme	Sector Level	Lead Department for Sectoral Adaptation Plans
Critical Infrastructure	Transport Infrastructure	Department of Transport, Tourism and Sport
	Electricity and Gas Networks	Department of Communications, Climate Action and the Environment
	Communications Networks	

Critical infrastructure supports and underpins the effective functioning and overall resilience of all other sectors of the economy.

In respect of the electricity and energy sector, no piece of active communications sector equipment can operate in the absence of a power supply. The efficient functioning of the electricity and gas sectors is key to the functioning of much of Ireland's critical infrastructure and the overall resilience of many sectors of the economy (powering industry, agriculture, transport, communications, enabling heating and cooling, food production, etc.). Decisions taken at energy sectoral level may potentially also affect communications networks indirectly.

In addition, weather events are unlikely to affect one sector in isolation. Critical infrastructure is often clustered in close proximity, which can concentrate impacts and, on occasion, impede contingency plans and responses to extreme events. The co-location of telecommunications equipment on overhead energy networks e.g. fibre on ESB lines, or

telecommunications in transmission and distribution stations, are examples of where one event could disrupt both power and telecommunications.

Industry often reports that the single biggest threat to their operations staying online is the sudden failure of the power supply. Certain contingencies are put in place by industry to respond to these issues, such as the use of battery and/or diesel-powered generators. However, these contingencies are themselves not fool proof, as this report will detail later.

Connectivity is becoming ever more integral to a multitude of sectors and oftentimes can be a vital tool in increasing overall sectoral efficiencies, thus contributing to climate mitigation in particular instances.

The National Broadband Plan will deliver High Speed Broadband services to over 1.1 million people in areas where there is no existing or planned commercial network. The Intervention Area includes 540,000 premises, including 56,000 farms and 44,000 businesses. It will ensure that households and business in rural parts of Ireland will have a similar level of connectivity as households and businesses in urban areas. For each new remote worker, an estimated average net saving of up to 10 kWh per day will be achieved, reducing commuter transport energy use and carbon emissions. Availability of better online conferencing and collaboration tools will reduce the need for business travel and the associated carbon emissions. High Speed Broadband also increases the creation of local employment opportunities, which allows more people to work closer to their homes, reducing the emissions associated with longer commuter journeys. 'Smart Homes' technologies will allow the remote management of domestic energy consumption through smart metering, heating and lighting systems, and enable consumer autonomy over their domestic energy consumption. This will play an important contributory role in decarbonising the residential sector.

In the energy sector 'Smarter' energy grids may depend on a robust telecoms system. Any disruption to the telecommunications network that supports the Smart grid could result in large scale disruption.

The transport sector is reliant on efficient telecommunications to facilitate the safe and timely transfer of domestic and international tourism and freight, to coordinate public transport provision and to communicate safety and traffic management information to transport users. In addition, "Smart" transport solutions for our cities that aim to build efficiencies into the transport sector, often associated with an increased prevalence of Internet of Things technologies and Smart Cities, will rely on access to strong telecommunications services.

The agriculture sector in Ireland is increasingly utilising "smart" applications that display cutting edge technology, such as Internet of Things and Artificial Intelligence amongst

others. These technologies can greatly contribute to the overall efficiency of farms, contributing to climate adaptation measures in the sector. However, these applications rely on consistent and robust connectivity. Disruption to the telecommunications network can therefore have consequent impacts on the agricultural sector.

Climate change adaptation options must therefore be considered in the context of such interdependencies. A holistic/coordinated approach to climate adaptation is required to identify instances where multiple potential points of failure exist and to take steps to prevent these failures from occurring.

2.6 The Regulation of Communications Networks

The Communications Regulator, ComReg

The provision of electronic communications services in Ireland occurs within a fully commercial and liberalised market, offered by competing network and service providers.

The Commission for Communications Regulation (ComReg) is the statutory body responsible for the regulation of the electronic communications sector – which includes telecommunications, radio communications, broadcasting transmission and premium rate services – as well as the postal sector.

ComReg was established by the Communications Regulation Act 2002. Its objectives in relation to the electronic communications sector are to:

- promote competition;
- promote consumer interests;
- contribute to the development of the EU internal market; and
- ensure the efficient management and use of the radio frequency spectrum and the national number scheme; and
- protect the interests of end users of premium rate services.

Its objectives in relation to its role as regulator of the postal sector are to promote the development of the postal sector, promote the interests of postal service users, and to facilitate the development of competition.

The 2002 Act also provides that ComReg is funded by an industry levy and fees, with provision for the Minister to direct ComReg to transfer any surplus to the Exchequer.

Statutory Independence

While the Minister for Communications has responsibility for policy in the sector, the 2002 Act provides that ComReg is statutorily independent in the exercise of its functions.

The Broadcasting Authority of Ireland

The Broadcasting Authority of Ireland (BAI) is the independent regulator of the broadcasting industry. It formulates broadcasting codes, licences radio and television beyond the public service broadcasters and also has a role in media mergers. Section 24 of the Broadcasting Act 2009 sets out that the BAI shall be independent in the performance of its duties.

3. Climate Impact Screening

Climate change impacts will vary depending on communications network in question, whether for broadcasting, fixed line, mobile or backhaul *et cetera,* and their associated infrastructure, and impacts may also vary depending on location.

It may be difficult to determine the precise extent to which climate change will impact on the networks in the coming years but this plan has attempted to research the visible impacts of the extreme weather events in the period between 2016 and 2019 in order to gauge the possible effects the changing climate could have on the networks. While this is not an extensive timeline by which to gauge trends, it does however, form an important basis upon which informed discussions can begin.

Through consultation with the stakeholder team a range of impacts from observed and projected changes in key climate parameters and extreme weather events was identified.

The key climate impacts for the energy sector are:

- Flooding / change in precipitation / extreme events
- Temperature rise
- Sea level rise
- Changes in wind energy content

The following key infrastructure types were identified as being particularly vulnerable to the climate change impacts identified: overhead fibre and copper lines, underground cables, street cabinets and base stations, with secondary impacts on other infrastructure, staff, customers and the economy.

Communications Networks Vulnerability Assessment

The following sets out the impacts on communications networks from observed recent weather events and the likely impacts from projected climate change variables.

3.1 Vulnerability of Electronic Communications Services Distribution Access Networks

The access networks of electronic communications systems have been demonstrated to be the most vulnerable part of the network. As this report has previously highlighted, the access network is the most exposed to adverse weather conditions and for reasons of business planning is oftentimes not built to be as robust as the core or backhaul of the network.

Overhead Copper and Fibre Lines

Overhead copper and fibre lines suspended on poles are the most exposed section of the electronic communications network. Researchers have noted that, in respect of the energy sector "the transmission and distribution networks are more vulnerable to climate change than the electricity generation sector as they embody a considerable quantity of overhead assets (i.e. cables, towers and poles) that cover all the Irish territory."[17] The communications sector utilises infrastructure that is closely similar to the energy sector, and in some instances shares the same infrastructure. We can therefore draw parallels between the experiences in the telecommunications sector and the energy sector in this respect.

Increased wind energy content can have both a direct and an indirect impact on this infrastructure, whether as a result of the poles themselves succumbing to wind pressure and toppling, or trees or branches falling due to the severe wind and damaging the fibre or copper cables.

These overhead fibre or copper cables are similarly vulnerable to increased electrical storms for many of the same reasons that they are vulnerable to increases in wind energy content. Electrical storms risk damaging both the poles themselves, thus bringing down the cables, or alternatively nearby trees or branches which themselves can bring down over head cabling.

While the impact of these events for electronic communications service customers is limited, with each overhead line usually impacting a relatively small number of premises, the exposure of the infrastructure itself could pose a risk to the general public. This risk is compounded by the fact that many overhead copper or fibre cable systems share their infrastructure with overhead electricity lines.

There are also higher-capacity backhaul and core links, such as fibre cables, sharing overhead electricity poles and pylons. Such infrastructure may be adversely affected by high winds. This could be in the form of temporary service degradation or loss that returns to normal when the weather calms. More serious events can cause lasting damage that requires equipment or infrastructure to be repaired or replaced before service can be restored.

For wireless networks, wind can create large forces on the antennas used for transmitting and receiving signals. If average or peak wind speed levels increase, these forces could potentially put antennas out of alignment or mean that masts need to be stronger.

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[17] Hawchar, Lara & Ryan, Paraic & Naughton, Owen & Nolan, Paul. (2018). High-level Climate Change Vulnerability Assessment of Irish Critical Infrastructure

During extreme red status wind events, such as hurricanes, operators can find themselves unable to deploy engineering teams to assess or rectify damage to the network. This can cause delays to the return of full service to end users.

Underground Fibre Cabling

While considerably more protected than overhead copper or fibre lines, underground fibre cabling can experience vulnerability to the effects of changing climate. Of particular concern in this respect would be the effects of increased instances of flooding, due to extreme precipitation events, a rise in sea levels or a combination of these factors.

Operators have expressed their concern about underground infrastructure in the context of the challenge of flooding and this report understands that flooding has caused damage to underground cabling in certain parts of the country that are more susceptible to flood risk and are expected to see increased instances of flooding in the coming years. Longer term planning will be required to assess where the intersection exists between flood plains and underground fibre networks and how to properly insulate this important infrastructure from these extreme weather events.

Street Cabinets

The purpose of street cabinets is to ensure the protection of valuable electronic communications equipment from a multitude of impacts, including impact relating to everyday weather events such as precipitation, wind and exposure to the sun. In this context, the cabinets themselves could be classified as measures which could contribute to a climate adaptation strategy in the sector.

However, the cabinets could themselves be vulnerable to changing weather events, specifically temperature rise. Increases in mean temperature could in turn increase the operating temperature of street cabinets that are currently passively cooled and therefore dependent on the external environment maintaining temperatures within a certain range. It will be important to assess the maximum temperature at which street cabinets can function without requiring artificial cooling methods as would be required in hotter climates but which, up to now, have not been required in Ireland.

3.2 Access to Remote Infrastructure and Possible Impacts on Wider Networks

Radio base stations, used for the provision of wireless broadband, transmission stations, used to convey broadcasting signals, and local exchanges, a key component of the fixed line broadband network, are all required to be dispersed throughout the country, often in remote

areas. This is particularly the case for base and transmission stations which are commonly found on higher ground to ensure effective conveyance of wireless signals.

During extreme weather events that result in heavy snowfall many such sites can become unreachable.

The electronic communications infrastructure held at such sites is not itself usually affected by snow or the associated weather conditions, however, the main concern relates to interruptions to the power supplies at these sites. Base and transmission stations, as well as local exchanges, are high value parts of the infrastructure network in terms of the number of end users potentially affected by outages at the sites. To mitigate this risk, these sites usually contain either diesel or battery-operated generators to ensure continuity of service should power be interrupted. These generators usually have an average operating capacity of 2 days before they are required to be refueled or recharged.

During extreme weather events involving heavy snowfall, operators have reported that access to these remote sites has been interrupted for extended periods of time. When adverse weather conditions, resulting in electricity network failures, are combined with difficult road conditions, leading to a lack of access, electricity interruptions can be long-lasting, resulting in outages in the communications and electricity networks. In such circumstances, engineers are unable to ensure the continuity of service if they are unable to access these remote sites. This has the potential to have major impacts on end users.

Table 1: Communications Networks Vulnerability Assessment

Priority Climate Impact	Sector	Infrastructure	Observed / Projected Impacts
Temperature	Telecommunications	Street Cabinets	Increases in mean temperature could in turn increase the operating temperature of street cabinets that are currently passively cooled and therefore dependent on the external environment maintaining temperatures within a certain range.

Precipitation / Extreme Events	Telecommunications	Base Stations	Inability to access remote sites to replenish diesel for petrol generators or attend to malfunctioning apparatus, leading to power interruptions at the site.
		Underground Fibre Networks	Flooding due to extreme precipitation events can damage underground fibre networks, leading to interruptions in service.
	Broadcast Networks	Transmission Stations	Inability to access remote sites to replenish diesel for petrol generators or attend to malfunctioning apparatus, leading to power interruptions at the site.
Changes in Wind Energy	Telecommunications	Small cell infrastructure	Small cell infrastructure has the potential to suffer damage due to increases in wind energy due to its usual positioning atop buildings/electricity poles etc.
		Overhead wiring	Increases in wind energy can result in branches and trees being felled. This can have a knock-on

			effect of damaging overhead wiring, should the falling tree collide with the overhead wiring.

4. Prioritisation

The future climatic conditions to which the communications network will have to adapt have been projected with various levels of confidence by a number of research groups nationally. These include:

- An increase of 1-1.6°C in mean annual temperatures with the largest increases seen in the east of the country. This will include hotter summers and warmer winters.
- A decrease in the average number of frost days (Tmin<0°C) over the whole country by over 50%.
- An increase in the average length of the growing season of over 35 days by mid-century.
- Drier summers: increases of 12-40% in dry periods and wetter winters and autumns: increase in the frequencies of heavy precipitation events.
- An increase in extreme storm activity and number of extreme storm events in winter.
- Decreases in the wind energy content for spring, summer and autumn seasons with no significant increase for winter.
- Temperature: Average temperatures will rise by about 1.5 degrees Celsius by mid-century
- Precipitation: wetter winters and drier summers
- Extreme Events: increased frequency of heavy rainfall
- Sea level rise: a rise of 50cm by 2100 is predicted
- Energy content of wind: increased energy content in winter and a decrease in summer months.

Understanding potential future impacts is essential for informing and developing adaptation strategies and actions. While the information available is, in the main, at a high level and not local area specific, this report has, based on input from industry, considered these projected climatic conditions and table 2 sets out how these elements might impact on the various communications network components.

Table 2: Future Climate Change Impacts on Communications Sector

Impact of Climate on Communications Infrastructure	Overhead Lines	Underground Cables	Street Cabinets	Local Exchanges	Core Network	Radio Base Station	Transmission Stations	Small mobile infrastructure (e.g. small cells)
Climate Risk								
Increased			X					
Summer Drought		X						
Prolonged Growing Season	X							
Increased Sea Level		X						
Coastal Erosion		X						
Increased Lightning	X							X
Increased Rainfall / Flooding	X	X	X					
Increased Wind	X							X
Increased Snowfall	X					X	X	

5. Priority Impact Assessment

Climate change adaptation can be defined as the ability of a system to adjust to climate change (including climate variability and extremes), to minimise potential damage, to take advantage of opportunities, and to cope with the consequences.

The adaptation actions detailed in this report should therefore function to reduce the impact of climate change on the communications sector, exploit any opportunities that arise as a result of climate change and facilitate the communications sector in coping with the consequences of climate change.

Generally, actions can be grouped under three headings: Technological or Engineering (Grey), Environmental (Green) and Policy/Behavioural (Soft) actions.

- Technological or engineering solutions to climate impacts may include for example construction of sea walls in response to sea level rises. Actions of this nature are usually easy to quantify but can be very costly.
- Environmental actions are usually responses of an ecological nature, for example efforts to reinstate dune systems to act as buffers against coastal storm damage; Sustainable Drainage Systems (SUDS), wetland creation, planting in flood zones, better planning. These options can have very long lead times.
- Policy (soft) actions, including Government actions and changes in human behaviour. These options can be relatively inexpensive to progress but they require a lot of commitment and on-going support. They can also include the provision of information, mainstreaming, capacity building, etc.

Sections five and six outline communications network climate vulnerabilities and put measures in place to mitigate against negative impacts, while section seven aims to set out potential future risks and challenges. This section now aims to set out potential additional / future adaptation options to address climate change impacts.

The challenge is to identify additional worthwhile and economic improvements which make business sense for operators to implement. While it is understood that many, if not all, operators appreciate the risk that extreme weather events can have on the functionality of their networks, many may feel that the economic case is not met to ensure the network is completely insulated from the effects of these ever more extreme weather events. The increased frequency with which these extreme weather events are occurring, in conjunction with the consumers' increasing demand for uninterrupted communications network services, may encourage network operators to develop increasingly resilient networks in the coming years.

If the cost of adaptation can be proven to offer an increase in overall revenue for the operators, this will assist them in making the business case for the extra investment required to improve the resilience of their networks. This can be utilized in conjunction with the mainstreaming of climate adaptation awareness throughout the sector and beyond what would more generally be thought of as contingency planning for emergency weather events.

The communications sector must be assisted during this transition to a climate adaptation culture through increased dialogue between government departments, agencies, state bodies and the sector to ensure that the sector has an up to date understanding of the potential impacts of climate change in order to facilitate the sector making informed decisions about investments and maintenance. This is an example of one low-cost technique, based upon an improved understanding of risks and potential costs that can be deployed to continue the process of building resilience into our communications networks sector, and to predict the likely impact of imminent weather events.

In the long term, the communications network companies need to optimise or put systems in place as part of network planning to monitor and assess emerging financial requirements, to specifically target the adaptation of communications networks to climate change. This will necessarily involve the climate change adaptation becoming a consideration of the operators when they are determining long term investment decisions. This could be integrated into existing business case development plans.

Tackling the challenge of climate change impacts on the communications sector can be enhanced through collective efforts and cooperation between all stakeholders. The following represents a suite of general adaptation options available to the communications sector:

- Collaborative research across stakeholder bodies e.g. EPA research on Critical Infrastructure Vulnerability to Climate Change
- Auditing communications network infrastructure to identify vulnerabilities and implement optimum adaptation measures
- Effective cooperation and communication between Departments, agencies, state bodies and other key stakeholders to ensure that communications network infrastructure is prepared for changes to climate; this should include the sharing of information that will assist with adaptation such as climatic data. This should include the facilitation of increased dialogue between operators and local authorities, who have a vital role to play in climate adaptation nationwide
- Mainstream climate change adaptation into all communications policies
- Climate change to be incorporated into engineering management practices

- Communications infrastructure planners and designers to take climate change projections and impacts into account
- Increased sharing of best practice in respect of both long term climate adaptation planning and emergency management between network operators
- Instigation of dialogue between communications network operators and other critical infrastructure providers to take account of cross-sector interdependencies during the climate adaptation planning process
- Development of an increased awareness amongst government departments with responsibility for policy relating to critical infrastructure networks of the interdependencies between the sectors
- Establishment of the critical infrastructure specific working group consisting of representatives of Department of Communications, Climate Action and Environment and Department of Transport, Tourism and Sport.
- Perform a midterm review of the statutory critical infrastructure adaptation plans with potential input from relevant actors such as local authorities and the County and City Management Association (CCMA)

Building on adaptation measures already in place, the following outlines some system specific options for the communications sector.

5.1 Telecommunications Sector

- Further consideration of weather events and climate change trends in the planning and design of new infrastructure. For example, site selection would take account of the possibility of flooding.
- Operators should be informed of the possibility of utilising the National Catchment Flood Risk Assessment and Management (CFRAM) Programme developed by the OPW where appropriate.
- Where underground network infrastructure is required to be constructed within flood plains, particular consideration should be given to mitigating any potential damage caused by flooding to the network.
- More detailed identification of vulnerable areas where existing critical transmission and distribution infrastructure is located, carried out in conjunction with operators.
- More detailed risk assessment of existing critical transmission and distribution networks for impacts from climate change.

- More detailed consideration of climate change impacts on asset management and in respect of maintenance approaches and policies.
- Further detailed contingency planning, in collaboration with local authorities and other critical providers, to ensure ease of access to critical base stations during extreme weather events.
- Continued monitoring and inventory of overhead telecommunications lines to minimise potential damage caused by falling debris during extreme weather events.
- Continued monitoring of street cabinets during periods of increased temperature to ensure adequate levels of cooling maintained.

5.2 Broadcasting Sector

- Further consideration of weather events and climate change trends in the planning and design of new infrastructure.
- More detailed consideration of climate change impacts on asset management and maintenance approaches and policies.
- Further detailed contingency planning, in collaboration with local authorities and other critical providers, to ensure ease of access to critical base stations during extreme weather events.

6. Develop Your Plan

The following actions, when taken together, represent the Adaptation Implementation Plan for the Communications Sector to 2050. This first statutory sector plan for the Communications Sector will be reviewed and updated as appropriate and in compliance with 0.19 the obligations set down in the Climate Action and Low Carbon Development Act, 2015.

Table 3: Actions representing the Adaption Implementation Plan for the Communications Sector

Objective	Potential Action	Related SDG
1. Continue to build on adaptation measures already in place	Identify measures that are working well in other jurisdictions and assess whether they can also be deployed in Ireland.	

2. Mainstream climate change adaptation into general communications policy, and strategic objectives to 2050	Assess level of climate change adaptation in communications policy and make recommendations, as appropriate Submit regular Adaptation Plans to Government	
3. Enhance cooperation and communication between Departments, agencies, state bodies and other stakeholders on a national and international level to ensure that communications infrastructure and services are resilient to the impacts of climate change	Identify areas of additional cooperation and any missing communication channels. This should include information / data sharing to assist with adaptation measures.	
4. Communications network companies to continue to ensure climate change is taken into account in planning and design standards and engineering management practices	Inventory of existing specific standards and practices Elaboration of climate change related amendments Full integration of climate-change related amendments into standards and practices	
5. Identification of areas vulnerable to impacts of climate change	Communications network companies to continue to identify vulnerable areas where assets are located	
6. Identify measures required to adapt to climate change impacts on vulnerable infrastructure. These	• It will be important that communications service providers assess their	

measures should be tailored to the particular utilities infrastructure.	own networks and tailor their climate adaptation measures as appropriate. This can include, but should not be limited to: • Increased monitoring, especially in areas deemed most vulnerable to the effects of climate change; • Enhanced maintenance which utilizes the most up to date information about network vulnerabilities to the impacts of climate change to better assess maintenance requirements; • Improved synergies between network refurbishment / upgrades and climate adaptation measures; • Integration of flood plain mapping to infrastructure maintenance, refurbishment and location planning; • Relocation of network infrastructure that experiences sever and	

	frequent interruptions due to extreme weather events.	
7. Continue to develop and improve timely communications to customers during weather events including information provision to users on status of infrastructure, how they will be affected and when normality will be restored. Increase public awareness of measures being taken to ensure resilience to ensure public support for the benefits being provided by climate adaptation actions.	Assess existing communications procedures; identify gaps and make recommendations as appropriate	
8. Increased sharing of best practice in respect of both long term climate adaptation planning and emergency management between network operators	Facilitating increased dialogue between operators in respect of long-term planning for climate adaptation and emergency management, while respecting commercial sensitivity between operators.	
9. Increased dialogue between communications network operators and key stakeholders, such as local authorities, to ensure operators are able to access key sites as	Better communication between operators and key stakeholders, such as local authorities, to ensure that the location of key sites is known by the relevant stakeholders and adequate contingency planning can be	

promptly as possible during extreme weather events.	developed by all parties.	
10. Initiating and maintaining engagement between communication network operators and state bodies, such as Climate Ireland and Met Éireann, to ensure that the Communications Sector remains aware of developments in our understanding of potential climate change impacts and can integrate this into their business planning appropriately.	Developing a repository of key contacts within these state bodies that can be utilized by communications sector operators to ensure the sector remains abreast of developments in the climate adaptation sector. Ensuring that communications sector operators are aware of all available online resources for climate adaptation planning.	
11. Development of an increased awareness amongst government Departments with responsibility for policy relating to critical infrastructure networks of the interdependencies between the sectors.	Establishment of an Inter-Departmental Group for Critical Infrastructure Climate Adaptation to be attended by officials from relevant Government Departments. The purpose of the IDG CICA will be to develop a deeper understanding of the interdependencies between each critical infrastructure sector and how climate change impacts can pose challenges to these interconnected networks. Commence review of the effectiveness of current quantitative data collection procedures for the impacts of	

	extreme weather events and longer-term climate change with a view to developing a cross-sectoral reporting mechanism Commission a study to identify common criteria to define critical assets within the transport, communications and energy sectors Perform a midterm review of the statutory critical infrastructure adaptation plans with potential input from relevant actors, such as local authorities and the CCMA.	

7. Implement Evaluate and Review

This Adaptation Plan represents a high-level approach to climate change adaptation planning for the communications networks (telecommunications and broadcasting) sector. It is a first step to set the communications sector on a pathway to robust climate change adaptation planning. It will lead to improved understanding of how best to adapt the sector to climate variability, which is essential given the communications sector's vital important to the social and economic fabric of the country.

As part of the process to establish a robust plan, it will be important to establish a system for monitoring, reporting and evaluating the measures identified in the Plan.

Performance indicators will be used to establish whether adaptation measures are being achieved and if they are considered to have value in terms of improving the future outcomes of an adaptation action.

It is also even more important to identify where climate adaptation measures will be needed in the future based on the risks and consequences associated with climate change effects in that location, so that the process is forward looking.

Monitoring will inform requirements for additional adaptation measures under subsequent plans. The monitoring system will also help to support communication and learning and to indicate progress towards the goals of adaptation.

Continued engagement between DCCAE, other Government Departments, public bodies and industry stakeholders will be required over the coming months to ensure that the actions suggested by this plan are carried forward and the deliverables are realized. Looking forward, the following indicators may help to demonstrate progress towards an ultimate goal of building resilience into the energy networks system against the impacts of climate change:

- Baseline monitoring
- Recognition of adaptation needs within sectoral work programmes (mainstreaming)
- Launch of adaptation measures
- Cooperation with other sectors/sub national levels is planned/happening
- Periodic reviews /evaluations are planned

As required under the Climate Action and Low Carbon Development Act, 2015, a subsequent sectoral adaptation plan will be developed in due course as appropriate.

Table 4: Adaption Implementation Plan for the Communications Sector

Action	Deliverable	Lead Authority	Stakeholders	Timeframe
1. Continue to build on adaptation measures already in place	Identify measures that are working well in other jurisdictions and assess whether they can also be deployed in Ireland.	Communications network operators and industry representative bodies	DCCAE, ComReg	Short term
2. Mainstream climate change adaptation into general communications policy, and strategic objectives to 2050	Assess level of climate change adaptation in communications policy and make recommendations, as appropriate Submit regular Adaptation Plans to Government	DCCAE DCCAE	Communications network operators Communications network operators, ComReg	Short – medium term Every 5 Years
3. Enhance cooperation and communication between Departments, agencies, state bodies and other stakeholders on a national and international level to ensure that communications infrastructure and services are resilient to the impacts of climate change	Identify areas of additional cooperation and any missing communication channels. This should include information / data sharing to assist with adaptation measures.	DCCAE, Communications network operators, industry representative bodies, ComReg	Interdepartmental Steering Group on Climate Change Adaptation, Government Taskforce on Emergency Planning, Climate Ireland	On-going

4. Communications network companies to continue to ensure climate change is taken into account in planning and design standards and engineering management practices	Inventory of existing specific standards and practices Elaboration of climate change related amendments Full integration of climate-change related amendments into standards and practices	Communications network operators and industry representative bodies	ComReg, DCCAE	On going
5. Identification of areas vulnerable to impacts of climate change	Communications network companies to continue to identify vulnerable areas where assets are located	Communications network operators	DCCAE, ComReg	On going
6. Identify measures required to adapt to climate change impacts on vulnerable infrastructure. These measures should be tailored to the particular utilities infrastructure.	It will be important that communications service providers assess their own networks and tailor their climate adaptation measures as appropriate. This can include, but should not be limited to: • Increased monitoring, especially in areas deemed most vulnerable to the effects of climate change; • Enhanced maintenance which utilizes the most up to date information about network vulnerabilities to the impacts of climate change to better assess maintenance requirements; • Improved synergies between network refurbishment / upgrades and climate adaptation measures; • Integration of flood plain mapping to infrastructure maintenance, refurbishment and location	Communications network operators	DCCAE, ComReg	On going

	planning; • Relocation of network infrastructure that experiences sever and frequent interruptions due to extreme weather events.			
7. Continue to develop and improve timely communications to customers during weather events including information provision to users on status of infrastructure, how they will be affected and when normality will be restored. Increase public awareness of measures being taken to ensure resilience to ensure public support for the benefits being provided by Climate adaptation actions.	Assess existing communications procedures; identify gaps and make recommendations as appropriate	Communications network operators, ComReg, DCCAE, Government Taskforce on Emergency Planning	Consumer groups, communications sector dependent businesses / industries / services	On going
8. Increased sharing of best practice in respect of both long term climate adaptation planning and emergency management between network operators	Facilitating increased dialogue between operators in respect of long-term planning for climate adaptation and emergency management, while respecting commercial sensitivity between operators.	Communications network operators	ComReg, DCCAE, Government Taskforce on Emergency Planning	Short – medium term
9. Increased dialogue between communications network operators and key stakeholders, such as local authorities, to ensure operators are able to	Better communication between operators and key stakeholders, such as local authorities, to ensure that the location of key sites is known by the relevant	Communications network operators, local authorities,	ComReg, DCCAE, Government Taskforce on Emergency	Short – medium term

access key sites as promptly as possible during extreme weather events.	stakeholders and adequate contingency planning can be developed by all parties.	CCMA	Planning	
10. Initiating and maintaining engagement between communication network operators and state bodies, such as Climate Ireland and Met Éireann, to ensure that the Communications Sector remains aware of developments in our understanding of potential climate change impacts and can integrate this into their business planning appropriately.	Developing a repository of key contacts within these state bodies that can be utilized by communications sector operators to ensure the sector remains abreast of developments in the climate adaptation sector. Ensuring that communications sector operators are aware of all available online resources for climate adaptation planning.	DCCAE	Communications network operators, Met Éireann, Climate Ireland	Short – medium term
11. Development of an increased awareness amongst government Departments with responsibility for policy relating to critical infrastructure networks of the interdependencies between the sectors.	Establishment of an Inter-Departmental Group for Critical Infrastructure Climate Adaptation to be attended by officials from relevant Government Departments. The purpose of the IDG CICA will be to develop a deeper understanding of the interdependencies between each critical infrastructure sector and how climate change impacts can pose challenges to these interconnected networks. Commence review of the effectiveness of current quantitative data collection procedures for the impacts of extreme weather events and longer-term climate	DCCAE, DTTAS	Communications network operators, Climate Ireland, Interdepartmental Steering Group on Climate Change Adaptation	On going

	change with a view to developing a cross-sectoral reporting mechanism. Commission a study to identify common criteria to define critical assets within the transport; communications and energy sectors. Perform a midterm review of the statutory critical infrastructure adaptation plans with potential input from relevant actors such as local authorities and the CCMA			

8. Conclusion

This first Adaptation Plan has examined the impacts of climate change and weather related events, both past and projected, on the communications sector (telecommunications and broadcasting). As these changes continue and if, as predicted, increase over the coming decades, the communications sector must prepare for, and adapt to, these new conditions. By identifying areas of vulnerability now, steps can be taken and measures put in place to avoid or minimise future adverse impacts within the sector and to exploit opportunities.

Ultimately, this Adaptation Plan should be viewed as a first step towards reducing vulnerability and building resilience in the sector. Beginning the discussion of climate adaptation within the communications sector has been one of the primary outputs of this Plan. It is hoped that further consideration of climate adaptation can be progressed over the coming period, both between the communications sector and the Department of Communications, Climate Action and Environment and between the communications sector and a wider group of interested stakeholders working in the climate adaptation sector.

Exploring the cross-sectoral interdependencies between multiple sectors has also been a key benefit of this process. The Department of Communications, Climate Action and Environment and the Department of Transport, Tourism and Sport have both committed to continuing to work closely on issues pertinent to the critical infrastructure sectors (energy, communications and transport) in the coming period. The Plan has also been useful in stimulating discussion and thinking from the public and a broader suite of interested stakeholders on the very important area of climate change adaptation in the communications networks sector. As sectors of all kinds increasingly make use of connectivity, from “smart farming” to an increase in e-working options, it will become ever more important for the communications sector to insulate itself from disruption. This Plan may assist in future work to ensure that communications networks finally remain robust in the face of climate change, a sector of vital importance for citizens and industry in Ireland.

It is hoped that this Plan will act as useful first step in the development of future Climate Adaptation Plans for the Communications Sector.