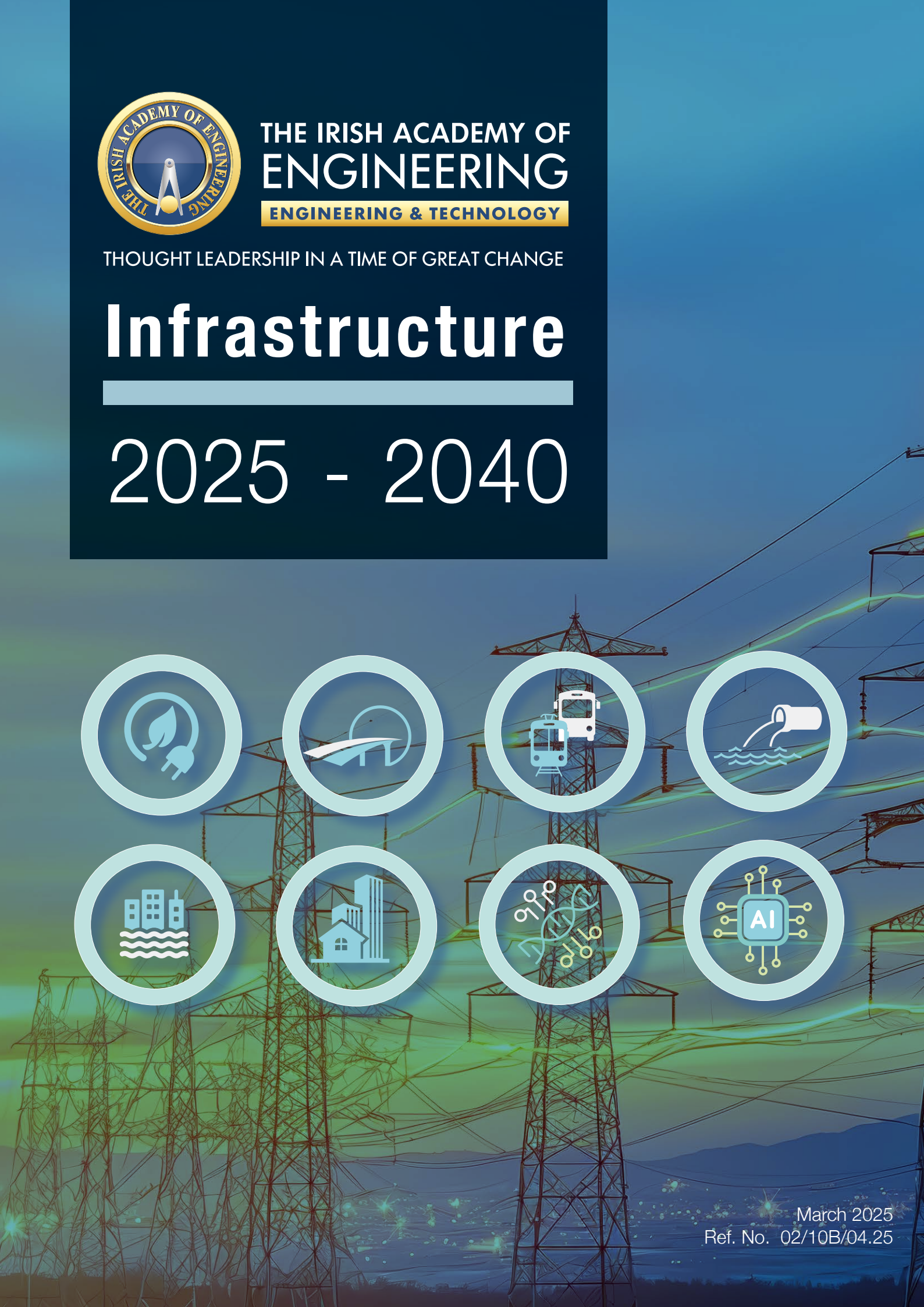
THE IRISH ACADEMY OF ENGINEERING

ENGINEERING & TECHNOLOGY

THOUGHT LEADERSHIP IN A TIME OF GREAT CHANGE

Infrastructure

2025 - 2040



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THE IRISH ACADEMY OF ENGINEERING

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INTRODUCTION TO INFRASTRUCTURE 2025-2040

This report identifies planned infrastructure investments needed over the next 15 years. While it identifies specific sectoral investment the report emphasises that cross sectoral challenges such as housing require water, wastewater, electricity and broadband infrastructure to deliver new housing supported by transport, schools and other services.

The report identifies individual capital investment funded from the public purse and also identifies examples of the private sector investment in medical technology leveraged off this investment, giving both employment and delivery of goods and services supporting the people on the island of Ireland.

Topics covered in detail include

Chapter 1	Power Infrastructure - Transmission, Wind, Solar PV and Storage
Chapter 2	Water, Wastewater and Flooding infrastructure
Chapter 3	Roads and Transportation infrastructure
Chapter 4	The Medical Technology Industry
Chapter 5	The Biopharmaceutical Industry
Chapter 6	Construction Innovation and Regulation
Chapter 7	Artificial Intelligence (AI) – Future opportunities

This report was prepared by Fellows of the Academy and over a dozen members of the Academy gave generously of their time pro-bono and contributed several hundred hours of time and effort to deliver on our mission of providing thought leadership in a time of great change. We particularly thank our Patrons for actively supporting the work of the Academy.

Academy leadership team

CHAPTER 1 POWER INFRASTRUCTURE - TRANSMISSION, WIND, SOLAR PV AND STORAGE

Introduction

Ireland has a target to become climate neutral by 2050. Climate neutrality requires that the energy sector is decarbonised and this, in turn, is dependent on decarbonising the electricity sector. Achieving this depends on a number of factors, including:

- The availability of the required technologies
- The implementation of a large programme of energy infrastructure projects on the supply side in a relatively short period of just 25 years
- Electrification of energy services on the demand side

The table below gives an indication of the scale of the programme of projects that need to be completed on the supply side. It is based on proven technologies already deployed at scale. New and emerging technologies including offshore floating wind, hydrogen and geothermal may, in the future, form part of the infrastructure mix.

The estimates of the number and scale of individual projects are high level and are only intended to give a sense of the scale of the implementation challenge.

Importantly, in addition to the 352 projects identified, there are hundreds of smaller transmission and distribution system projects that also need to be completed to deliver the overall supply side capacity required for the energy transition.

Category	Assumptions	# projects
Transmission lines	1,150 km of transmission lines at 25 km per line	46
Onshore wind	4,270 MW at 60 MW per windfarm	71
Fixed bottom offshore wind	20,149 MW at 700 MW per windfarm	29
Solar	5,452 MW at 40 MW per project	136
Storage	2,000 MW / 50 GWH at 50 MW per project	40
Interconnectors	6,113 MW at 600 MW per project	10
Back-up generation	6,000 MW at 300 MW per project	20
Total		**352**

Indicative scale of the programme of Energy Transition projects needed in the electricity sector

In this chapter we give an estimation of the infrastructure required in the main categories of projects shown above under 4 headings:

- Transmission grid
- Onshore and offshore wind
- Solar PV
- Storage

1.1 Transmission grid

The transmission grid comprises hundreds of circuits with thousands of kilometres of high voltage lines and cables as summarised in the following table.

	Length	No. circuits	Average length
400 kV	439 km	4	110 km
220 kV	2,130 km	71	30 km
110 kV	5,708 km	350	16 km
Ireland	**8,277 km**	**425**	**19 km**
275 kV	926 km	19	49 km
110 kV	1,865 km	89	21 km
Northern Ireland	**2,791 km**	**108**	**70 km**
275 kV	150 km	21	75 km
110 kV	50 km	2	25 km
Cross-border	200 km	4	50 km
Total	**11,268 km**	**537**	**21 km**

Analysis of transmission circuits in Ireland and Northern Ireland

As power demand grows, increasing capacity at the 400 kV and 220 kV levels will be essential. The last major new 220 kV transmission line constructed in Ireland was the 55 km Flagford - Srananagh line completed in 2012. In the 13 years since 2012, peak power demand has increased 20% from 5,000 MW to 6,000 MW.

The key enabler to facilitate the decarbonisation of the energy sector over the next 25 years (during which time peak electricity demand will increase to in the order of 12,000 MW) is an increase of grid capacity, particularly at these higher voltage levels.

Whereas additional capacity has been and continues to be provided by upgrading existing infrastructure (through, for example, reconductoring and dynamic rating), new additional infrastructure will, inevitably, also be required.

EirGrid's ten-year Transmission Development Plan 2024 identifies 223 projects at various stages of progress. Only one of these projects –the 137 km North-South Interconnector - will deliver new build transmission line capacity.

EirGrid's Grid25 plan (published in 2008) provides a benchmark to get some sense of the scale of new transmission line development that might be required by 2050.

In 2008 – when peak demand had grown to 4,900 MW - EirGrid published Grid25 showing how the transmission grid would be developed in the years to 2025. The overall development programme was costed at €4 billion (at 2008 prices) and included the development of 1,150 km of new transmission lines as shown in the following table.

Voltage	New lines	Upgraded lines	Total
220 kV / 400 kV	800 km	1,100 km	1,900 km
110 kV	350 km	1,200 km	1,550 km
Totals	**1,150 km**	**2,300 km**	**3,450 km**

Summary of transmission network development in Grid25

Taking a conservative view, and assuming that the new capacity envisaged in Grid25 would suffice for the power levels in 2050 (12,000 MW), the table below estimates that at least 46 sizable new transmission line projects might have to be completed over the next 25 years.

	Length	Average length	No. projects
400 kV / 220 kV	800 Km	34 Km	24
110 kV	350 Km	16 Km	22
Total	**1,150 Km**	**25 Km**	**46**

Estimate of new transmission lines required in Ireland by 2050 based on Grid25

1.2 Onshore and offshore wind

Ireland has a large and growing capacity of onshore wind and total capacity increased from 117 MW in 2000 to 4,730 MW in 2023 with a policy target to reach 9,000 MW by 2030. The onshore wind sector has, however, faced considerable delays in planning due to a combination of slowness in updating the *Wind Energy Development Guidelines 2006* and the dezoning of land in local authority development plans. The imminent publication of revised *Wind Energy Development Guidelines* as a *National Planning Statement* will, hopefully, resolve these issues.

The increased capacity of 4,270 MW required to meet the 9,000 MW target is equivalent to 71 projects, each with a capacity of 60 MW.

Six fixed-bottom offshore wind projects – with an aggregate capacity of 4,249 MW – are currently in planning and the next phase of offshore development has commenced with the creation of the South Coast DMAP comprising four separate areas to a total of 1,315 km^2.

An ORESS auction is due to take place in 2025 for 900 MW located in one of the four areas (Area A or Tonne Nua). Beyond that, the South Coast DMAP has the potential for a further 5,000 MW of offshore wind projects.

The ultimate scale of the possible development of fixed bottom projects beyond the South Coast DMAP area will be determined by the creation of further DMAPs around the Irish coast and subsequent ORESS auctions. If a further 10,000 MW could be developed in other DMAPs, fixed-bottom offshore wind with a total capacity of 20,149 MW might be achievable as shown below.

Assumption	MW
Six ORESS1 projects proceed	4,249
Tonn Nua	900
Balance of South Coast DMAP	5,000
Assumed future DMAPs	10,000
Total fixed bottom offshore wind	**20,149**

Summary of fixed bottom offshore wind potential by 2050

If the average size of offshore wind project was 700 MW, then a capacity of 20,149 MW would suggest the need for 29 projects.

1.3 Solar PV

The solar PV sector is not as long established as onshore wind and the installed capacity of solar in Ireland is reported to be 1,185 MW (*Scale of Solar Report, 2024*, Irish Solar Energy Association). As of August 2024, there were seven grid connected solar farms with a total capacity of 537 MW, the largest having a capacity of 119 MW.

Solar projects with a total capacity of 3,788 MW have been successful at RESS auctions since 2010 suggesting that there is a large pipeline of future solar projects.

Date	# projects	MW	
RESS1	Sep-2020	63	796 MW
RESS2	Jun-2020	66	1,534 MW
RESS3	Oct-2023	20	498 MW
RESS4	Sep-2024	23	960 MW
Totals		**172**	**3,788 MW**

Summary of RESS auction results for solar

Government has set a target to increase the capacity of solar to 8,000 MW by 2030.

Assuming 80% of the balance of the capacity required (from today's capacity of 1,185 MW) to meet the 8,000 MW target comes from utility scale projects and assuming further that each solar project has a capacity of 40 MW, then 136 projects would need to be completed to reach the 2030 target.

1.4 Storage

Grid scale lithium-ion battery technology (typically providing up to two hours output at maximum power) is widely deployed internationally and in Ireland to provide short-duration dispatchable power or to provide grid resilience. As of April 2024, there was 588 MW / 474 MWh of transmission connected battery capacity in Ireland.

Longer duration (100 hour) iron-air battery technology is beginning to be deployed in the US and a planning application for a 10 MW / 1,000 MWh battery has been approved (subject to appeal) in Donegal.

In addition to batteries, storage is provided by Turlough Hill (292 MW / 1,752 MWh) and, if the project to build a second pumped storage facility at Silvermines proceeds, it would add another 296 MW / 2,175 MWh.

More battery storage capacity over the coming years will primarily serve to increase the penetration of renewables by better matching supply and demand over periods of hours or days.

EirGrid published a *Call for Evidence on the Market Procurement Options for Long Duration Energy Storage (LDES)* in October 2023 and, in this, listed four benefits for LDES as follows:

- Increasing the penetration of renewables
- Reduces Carbon Emissions
- Reduces the level of renewables dispatch down
- Reduces All Island Generation Cost

EirGrid subsequently published a Response to the *Call for Evidence on Long Duration Energy Storage (LDES)* in March 2024.

In parallel with EirGrid's consultation, The Climate Change Advisory Council published a working paper *(Review of Deployment of Long Duration Energy Storage in the Electricity Sector in Ireland)* in May 2024.

These two initiatives by EirGrid and CCAC serve to highlight the uncertainty around what LDES technologies might become available over the next 25 years.

Notwithstanding this high level of uncertainty, the table below shows an indicative figure of 3,176 MW / 54 GWh of storage being available by 2050. This includes a speculative capacity of 2,000 MW of battery storage with an average storage duration capacity of 25 hours. At 50 MW per project, there could be a total of 40 large solar PV projects required by 2050.

	MW	Duration	MWh
Turlough Hill	292	6.0 hours	1,752
Batteries	588	0.8 hours	474
Existing	***880***	***2.5 hours***	***2,226***
Silvermines	296	7.3 hours	2,175
LDES	2,000	25.0 hours	50,000
Additional	***2,296***	***22.7 hours***	***52,175***
Total by 2050	**3,176**	**17.1 hours**	**54,401**

Indicative development of storage capacity to 2050

CHAPTER 2 WATER, WASTEWATER AND FLOODING INFRASTRUCTURE

2.1 Setting the context

2.1.1 Population

The 2022 ROI census identified a population of 5,149,139 with 28% located in Dublin. Adding the nearby Counties of Kildare, Meath and Wicklow gave a total population in the greater Dublin commuting area of 40%.

Cork had a population of 11%, Galway 5% and Limerick 4%.

In total 60% of the ROI population resided in the four main urban centres.

The corresponding population in NI was 1,910,500 giving an all -island population of 7 million people.

National Water Resources Planning

The Uisce Éireann National Water Resources Plan (NWRP) is a plan to identify how to provide a safe, sustainable, secure and reliable water supply to customers for now and into the future whilst safeguarding the environment.

The NWRP sets out how Uisce Éireann will balance the supply and demand for drinking water over the short, medium and long term. It is a 25-year strategy to ensure we have a safe, sustainable, secure and reliable drinking water supply for everyone.

Water supply in Ireland

Irish Water (Uisce Éireann) was created in 2013;

- Serves 4.2 million people;
- Delivers water services to approximately 87% of the population (the remainder receive water from private supplies or Group Water Schemes)
- Currently manages 539 individual water supplies in Ireland;
- Produces over 1.7 billion litres of drinking water every day, and takes wastewater away for treatment before it is returned to our rivers and seas.

Thousands of assets are operated and maintained to provide these services, including:

- 749 water treatment plants, which deliver water through over 65,000km of pipelines;
- an estimated 25,000km of sewer network through which they collect wastewater for treatment in over 1,000 wastewater treatment plants, with associated pumping stations and sludge treatment centres.

Water is currently abstracted from approximately 1,090 individual sources and treated in 749 Water Treatment Plants (WTPs). The size of these WTPs varies significantly across the country, with the largest 72 producing 73% of the water supplied, and the smallest 500 producing on average about 6% or 0.2Ml/d of the total supply.

Climate

Ireland has a temperate climate with relatively high annual average rainfall, so while it is easy to assume that there is plenty of water available for supply, this is not always the case. Rainfall is unevenly distributed across the country, with more falling in the west than the east. The areas with lowest rainfall have the greatest population density, meaning resources in our most populated areas can become stressed. Records show that in the last 150 years the total volume of rainfall in the east of the Country has not significantly changed but the pattern of rainfall has changed dramatically with bursts of intense rain coupled with increased periods of low rainfall and drought.

Water and life

Directly or indirectly, water affects all facets of life. Without it, there would be no vegetation on land, no oxygen for animals to breathe and the planet would look entirely different from how it does today. Water is necessary to keep people's bodies and the environment healthy and should be valued and protected as the precious resource it is.

The water cycle involves the continuous circulation of water in the earth atmosphere system. There are many processes involved in the water cycle, the most important are evaporation, transpiration, condensation, precipitation, and runoff. The total amount of water within the cycle remains essentially constant, however its distribution among the various processes is continually changing.

Clean drinking water and safe disposal of wastewater are essential to public health. The "modern" systems for the collection, purification and distribution of drinking water, and the collection, treatment of wastewater and returning to the aquatic environment, were mainly developed worldwide between 1830 and 1900 and have progressed thereafter to their current state.

2.1.2 Water Resource management

Ireland (ROI) is part of the European Union(EU), which is based on the rule of law. Everything the EU does is founded on treaties, voluntarily and democratically agreed upon by its member countries. Law and justice are upheld by an independent judiciary. EU countries have granted final jurisdiction to the European Court of Justice, whose judgments have to be respected by all.

Protection of the Environment is central to EU policy and is implemented through Directives, Regulation and supporting actions required of Member States to deliver the policy outcomes.

Citizens, nature and industry all rely upon healthy rivers and lakes, groundwater and bathing waters. The *Water Framework Directive* (WFD) focuses on ensuring good qualitative and quantitative health, reducing and removing pollution while ensuring that there is enough water to support wildlife at the same time as human needs.

Since 2000, the WFD has been the primary legislation for water protection in Europe. It applies to *inland, transitional and coastal surface waters* as well as *groundwater*. It ensures an integrated approach to water management, respecting the integrity of entire ecosystems, including by regulating individual pollutants and establishing corresponding regulatory standards. It is based on a river basin district approach to ensure that neighbouring countries cooperate in managing shared rivers and other bodies of water.

Water Framework Directive Objectives

The key objectives of the WFD are set out in Article 4 of the Directive. It requires Member States to use their River Basin Management Plans (RBMPs) and Programmes of Measures (PoMs) to protect and, where necessary, restore water bodies in order to reach good status, and to prevent deterioration. Good status means both good chemical and good ecological status.

Legislation

The *Water Framework Directive* (WFD) is the primary legislation for water management in the EU. It is supported by two so-called "daughter directives" on the quality and quantity of groundwater and on the quality of surface water. The WFD includes provisions regarding the deadlines for meeting the objectives of the Directive, as well as provisions for exemptions. The annexes to the WFD specify details including, for example, monitoring requirements, the criteria for assessing water body status, and the contents of the RBMPs.

At present, the WFD includes in its Annex X the list of priority substances that Member States must monitor in surface waters However, the standards for them are set in the *Environmental Quality Standards Directive* (EQSD) and must be met to achieve good surface water chemical status, as outlined in WFD Article 4 and Annex V

point 1.4.3. The WFD also requires Member States to set and meet *Environmental Quality Standards* (EQS) for substances of national concern, i.e. river basin specific pollutants; the monitoring of which currently contributes to the assessment of ecological status. This list of priority substances must be reviewed, and updated, if necessary, every 6 years.

Similarly, the list of pollutants and standards of EU-wide concern in Annex I to the *Groundwater Directive* (GWD) must also be reviewed every 6 years; these contribute to the assessment of chemical status in groundwater. That Directive also complements the WFD by including requirements relating to pollutant trends and quantitative status.

Groundwater

Groundwater sources provide 20-25% of drinking water supplies in Ireland. In some counties this figure can be as high as 50%. In rural areas not served by the public water network groundwater from wells and springs is the only source of drinking water. In certain counties, particularly in the Midlands, the proportion is much greater, e.g. Roscommon 86%, Laois 54%, Kilkenny 52% and Wexford 40%. UÉ sources some 18% of its supply from groundwater.

As with surface water bodies, groundwater is susceptible to pollution from land-use practices, distributed pollution sources, e.g. farming, and point sources such as the discharge from under-performing wastewater treatment plants or septic tanks. There are over 440,000 septic tanks in Ireland and almost 50% fail annual inspections carried out by Local Authorities.

A Groundwater Protection Scheme published jointly in 1999 by the then Department of the Environment and Local Government, the Environmental Protection Agency, and the Geological Survey of Ireland provides guidelines for the planning and licensing authorities in carrying out their functions and a framework to assist in decision-making on the location, nature and control of developments and activities in order to protect groundwater. The Scheme seeks to ensure that due regard is taken within the planning and licensing processes of the need to protect and maintain the beneficial use of groundwater.

The Geological Survey Ireland (GSI) provides information on groundwater vulnerability and quality.

The Institution of Geologists of Ireland (IGI), provides Guidelines on the safe construction and installation of water wells.

The EPA is responsible for monitoring groundwater quality. For the purposes of water management, groundwater in Ireland is assigned, assessed and managed within 514 groundwater bodies, which range in size from under 1 km^2 to 1,887 km^2.

The EPA's national monitoring network is made up of approximately 330 groundwater monitoring stations.

The EPA is also responsible for the regulation of groundwater abstraction. By law, if a body abstracts 25m^3/day (25,000 litres) of water or more per day, one must register this abstraction with the EPA. Abstractions already registered with the EPA under the 2018 Regulations are deemed to be registered under the Act. 25m^3 is equivalent to about 150 bathtubs of water. A farmer abstracting water for 200 dairy cows, or a group water scheme abstracting water for 42 households, would use around 25m^3/day. A well supplying a single household typically abstracts less than 1m3 of water per day and do not need to be registered.

Industries, especially rural food processing industries, such as creameries and meat factories have their own water supply often from groundwater. Groundwater abstractions are estimated as 105,000,000 m^3/yr. In rural areas not served by public or group schemes, groundwater is usually the only source of supply. The utilisation of groundwater in Ireland is far less than other E.C. Countries where groundwater supplies account for 60% to 99% of drinking water in Belgium, Denmark, France, Germany, Italy, Luxemburg, Netherlands and Portugal.

Wastewater

The 2024 EU Directive concerning Urban Wastewater Treatment includes requirements for:

- Additional provisions for Nitrogen and Phosphorus removal.
- Quaternary treatment for the removal of micropollutants - initially for treatment plants serving more than 150,000 PE.
- Extended Producer Responsibility (EPR). Whilst the Directive will shift a portion (80%) of the financial burden of quaternary treatment to producers, the implementation and administration of EPR schemes will inevitably involve additional costs and management efforts for UE.
- Energy Neutrality. Achieving energy neutrality in wastewater treatment plants (by 2045) will require investments in renewable energy technologies and energy-efficient processes. There is a phased introduction of the requirements with the total annual energy from 20% of treatment plants treating a load of 10 000 PE and above to be generated on-site or off-site by the end of 2030. (40% by the end of 2035).

WFD Review

In December 2019, a *Fitness Check*, which is a comprehensive policy evaluation by the EU Commission assesses whether the Directives are fit for purpose by examining their performance against the five criteria set out in the Commission's Better Regulation agenda: relevance, effectiveness, efficiency, coherence and EU added value, concluded that the water legislation is broadly fit for purpose, with room for improvement related to investments, implementation, integrating water into other policies, chemical pollution, administrative simplification and digitalisation. The key findings show that the directives have led to a higher level of protection for water bodies and flood risk management than could have been achieved without them. The objectives of the directives are as relevant now as they were at the time of their adoption, if not more so. They contribute to achieving a range of sustainable development goals.

2.1.3 Ireland (ROI) responsible Departments and Agencies

The responsibility for complying with EU legislation rests with the Irish Government through its relevant Government Departments and supporting agencies.

For this chapter the relevant key Departments and agencies are:

Department of Housing, Local Government and Heritage (DHLGH) supported by:

Local Authorities – Responsible for spatial planning and water quality in rivers, lakes and coastal waters, as well as implementing the WFD in conjunction with other Government Departments e.g. Agriculture. Local authorities are also responsible for stormwater systems and management. Under the National framework for emergency management (www.mem.ie) there are 3 Principal Response Agencies (PRA) viz. (Local Authorities, HSE, Garda Siochana) supported by their respective Principal Emergency Services (PES) –(Local Authority Fire Service, HSE Ambulance service and Garda operational service). Depending on the type of emergency there are prenominated lead agencies. The Local Authorities are responsible for taking the lead in managing flood emergencies.

Uisce Éireann – Responsible for drinking water from point of abstraction through treatment, storage, distribution to collection and treatment of wastewater to the point of returning to the aquatic environment.

Environmental Protection Agency (EPA)

The EPA is an independent public body established under the Environmental Protection Agency Act, 1992. The other main instruments from which it derives its mandate are the Waste Management Act, 1996, and the Protection of the Environment Act, 2003 and the Radiological Protection (Miscellaneous Provisions) Act 2014.

The EPA's purpose is to protect, improve and restore our environment through regulation, scientific knowledge and working with others. The EPA vision for Ireland is that we live sustainably in a healthy environment that is valued and protected by all.

The EPA purpose reflects its three core roles – as an environmental regulator, as a key source of trusted scientific evidence and knowledge, and as a voice for the environment through leadership and advocacy and a commitment to collaborating and partnering with others to deliver better environmental outcomes.

Commission for Regulation of Utilities (CRU)

The CRU was established in 1999 and has responsibility for economic regulation and customer protection in the energy and water sectors and regulation of energy safety.

Department of Public Expenditure, NDP delivery and Reform supported by OPW

The Office of Public Works (OPW) is an Irish government office whose primary function is to support the implementation of government policy. The OPW advises the Minister for Public Expenditure, NDP delivery and Reform and the Minister of State at that department, principally in the disciplines of property (including heritage properties) and flood risk management.

2.1.4 Flood Risk Management

Flooding is a temporary covering by water of land not normally covered by water, and is a natural process that can happen at any time in a wide variety of locations.

- Flooding can occur from a range of sources, individually or combined, including:
- Coastal flooding (from the sea or estuaries)
- Fluvial flooding (from rivers or streams)
- Pluvial flooding (from intense rainfall events and overland flow)
- Groundwater flooding (typically from turloughs in Ireland)
- Other sources (such as from blocked drains or pipes)

Flooding Policy development

The OPW has responsibility, for leading and co-ordinating the implementation of the National Flood Policy which involves the development of a planned programme of feasible works, with a greater emphasis on non-structural flood risk management measures.

Historically, flood risk management focused on arterial drainage for the benefit of agricultural improvement. With increasing urbanisation, the Arterial Drainage Act, 1945, was amended in 1995 to permit the OPW to implement localised flood relief schemes to provide flood protection for cities, towns and villages.

In 2004, an Inter-Departmental Review Group, led by the Minister of State at the Department of Finance with special responsibility for the OPW, published a review of national flood policy.

The 2004 Report of the Flood Policy Review Group established the following:

- The OPW is responsible for leading and co-ordinating the implementation of national flood risk management policy.
- Structural (i.e. engineered) flood relief measures would continue to play an important role in flood management but with increased emphasis to be placed on non-structural measures (e.g. flood forecasting, planning guidelines etc.).

- The OPW with input from other relevant State bodies, where necessary, to develop a programme to implement the detailed recommendations of the report.

This led to the development and implementation by the OPW, of the National Catchment- Flood Risk Assessment and Management (CFRAM) Programme, which was designed to:

- Focus on managing flood risk, rather than relying only on flood protection measures aimed at reducing flooding.
- Take a catchment-based approach to assessing and managing risks within the whole-catchment context.
- Be proactive in assessing and managing flood risks, including the preparation of flood maps and Flood Risk Management Plans.

The Office of Public Works (OPW) has completed production of a national catchment flood risk assessment and management (CFRAM) programme which includes predictive flood risk maps for rivers, the output of which is available to local authorities, infrastructure owners and other interested parties. The challenge now is for planning authorities to strictly enforce planning guidelines (The Planning System and Flood Risk Management) and to ensure that further inappropriate development does not take place in flood plains, repeating past mistakes.

However, despite the significant benefits of CFRAM, it must be recognised that with Pluvial flooding all areas can be at risk, and designs should cater for the potential for more intense rainfall events in any part of the island. There will be need to consider new flood mitigation approaches such as proactively delineating certain areas as flood basins to accommodate flood waters; recognition that certain areas and properties cannot practically be protected from flooding; increase in appropriate forestry in certain areas to slow runoff etc.

Predictive flood risk maps for the country's coastal areas are included in the OPW's CFRAM programme. However coastal erosion is likely to be exacerbated by climate change. This is particularly important for coastal towns and cities. There is need to develop, across the relevant government departments, comprehensive coastal zone management programmes to address this risk and to protect against coastal flooding where this is practical. However, it must also be recognised that in some instances coastal protection measures may not be technically, environmentally or economically feasible.

A new more comprehensive weather modelling and forecasting system is due to be developed by MET Eireann. The output from this new weather forecasting system combined with more comprehensive river flow and tide gauge information, should enable more timely and accurate information be provided to all stakeholders including the general public, on the probability, timing and extent of flood events. This information should be provided publicly on line in a transparent and easily understood manner.

2.1.5 EU Floods Directive

The European Commission describes on its website the objectives of the *Floods Directive*

> *to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity.*

Under the Floods Directive (*Directive 2007/60/EC* on the assessment and management of flood risks), all EU countries are required to

- assess all areas where significant floods could take place
- map the flood extent and assets and humans at risk in these areas
- take adequate and coordinated measures to reduce this flood risk

The rights of the public to access this information and to have a say in the planning process are also important elements of the Directive.

The CFRAM Programme was designed also, to meet the requirements of the 2007 EU 'Floods' Directive (2007/60/EC) which was transposed into Irish Law under Statutory Instrument No. 122 of 2010, as amended by Statutory Instrument No. 495 of 2015.

Flood Risk Management Measures

As stated above the aim of the FRM Policy is to reduce to an acceptable the risk of inundation and damage to homes and businesses. A suite of measures are being developed which include avoidance of the risk, protection against potential damage through constructed engineering defences preparedness for emergencies and recovery following an event.

Avoiding or removing a flood risk in the first instance, in areas areas prone to flooding though, for example, improved planning & Development controls is fundamental to the long-term avoidance of damage.

Sustainable Planning and Development Management

In November 2009, the Guidelines on the Planning System and Flood Risk Management, jointly developed by the Department of Environment, Community and Local Government (DECLG) and the OPW, were published under Section 28 of the Planning Acts. These Guidelines provide a systematic and transparent framework for the consideration of flood risk in the planning and development management processes.

The development of a suite of flood risk mapping as part of the CFRAM output will inform Planning Authorities of flood risk in areas being considered for development.

Flood Protection

Flood risk protection is aimed at reducing the likelihood and/or severity of flood events. These measures, typically requiring physical works, can reduce risk in a range of ways, such as by defending areas at risk against flooding, by reducing or diverting the peak flood flows, or by reducing flood levels.

These measures include:

Major Flood Defence Schemes

Solid structures built between the source of flood waters (rivers, estuaries or the sea) and an area vulnerable to flooding (people, properties, land and other assets) can prevent flooding up to the Standard of Protection of the structure, hence reducing the flood risk in the area being protected by the structure. Such structures typically include walls (generally in urban areas with limited space) or embankments (generally in rural areas and in urban areas where space is available, such as parks), but can also include other built or natural structures, such as sand dunes.

Flood relief works are designed to protect an area up to a certain 'Standard of Protection' and, depending on the type of protection measure, may reduce the severity of flooding above this Standard.

OPW major flood relief schemes are typically designed and built to a minimum standard that protects areas against a 1 in 100-year fluvial flood (flooding from rivers and streams), and coastal areas against a 1 in 200-year flood event, where it is feasible to do so. Schemes are also designed to be cost beneficial, have regard for environmental factors, take account of climate change, and ensure they do not worsen a flood risk upstream or downstream of the protected area.

Minor Works Programme

The Minor Flood Mitigation Works and Coastal Protection Scheme (the "Minor Works Scheme") is operated by the OPW to support the Local Authorities through funding of up to €750,000 to address qualifying local flood problems with local solutions.

Arterial Drainage Schemes

The implementation of Arterial Drainage Schemes began in the late-1940s and continued into the early-1990s. The OPW's annual arterial drainage maintenance works programme protects 260,000 hectares (650,000 acres) of agricultural lands and comprises 11,500km (7,150 miles) of river channel and approximately 800km (500 miles) of embankments.

Drainage Districts

Drainage Districts are areas where drainage schemes to improve land for agricultural purposes were constructed under the Arterial Drainage Acts from 1842 up to 1943. Of the 293 schemes carried out, 170 remain covering 4,600km (2,860 miles) of channel, and these are maintained by the relevant Local Authorities.

Maintenance of Channels not part of a Scheme

Outside of the Arterial Drainage and Drainage District Schemes, landowners who have watercourses on their lands have a responsibility for their maintenance.

Local Authorities can also advance their own flood defence schemes.

In particular they can avail of the Local Authority (works) Act 1949 and when coupled with the planning procedure as set out in Part 8 of the Planning and Development Regulations 2001 (as amended) give Local Government a powerful legislative mandate to progress flood protection schemes.

2.1.6 Local Authority Case study - Dublin Flood Initiative (DFI) created in 2002

Dublin City Council, supported by the OPW and by EU INTERREG funding has taken a leading role in implementing urban flood management in the Dublin City region.

On 1st February 2002 Dublin was hit by a coastal flooding event. It arrived around the middle of the day, there was no severe weather and the "normal" high spring tide just kept on rising until it was 1 metre higher than forecast.

Clontarf was badly flooded as was the lower Dodder around Ringsend where the river banks were overtopped and houses were flooded up to the first -floor level and also flooding closed the Liffey quays near Heuston Station.

That was the day climate change arrived in Dublin City.

There were lots of questions and not many answers as to the cause of the flooding event with no rainfall.

It was initially assessed that this was at least a 1 in 100- year event and possibly a one in a one in a thousand -year event. In a hindcast analysis the DCC team computed that it was actually a one in 68- year event caused by a very low -pressure depression several hundred Km. off the NW coast of Ireland and quite remote from the flooding in Dublin City.

Dublin City created the **Dublin Flood Initiative (DFI)**.

It set the objectives as both simple and very challenging to answer the questions:

1. **What** flood risks was Dublin City exposed to?
2. **Where** were those risks highest?
3. **When** were those risks highest?
4. **What** needed to be done to reduce/mitigate those flood risks?
5. **What** needed to be done to respond to flood emergencies?

It also created a DCC flood defence unit (FDU) to answer those 5 "simple" questions and to deliver the necessary flood defences in a timely manner.

In parallel it answered all the other questions posed to the DFI as follows:

1. What flood risks was Dublin City exposed to?

There were **5 main flood risks for Dublin** (and combinations thereof)

A. River Flooding - Particularly in Europe but also in Ireland the history of flooding is usually associated with River flooding. In European rivers the high- water marks (Hochwasser) are usually marked with the year on buildings near the riverbank. Historically many flood events in previous centuries were not directly associated with rainfall but resulted from ice flows breaking loose and blocking bridges.

B. Tidal Flooding - The challenge is not to deal with sea level rise. That is very slow. The issue is the surge on top of this caused by atmospheric pressure. Often several hundred Km, remote from Dublin.

1012 HPa. is effectively the balance point. Pressure higher than this (e.g. 1035 Hpa.) results in surge lower than forecast tides and lower pressure (e.g. 930 Hpa.) results in tides higher than forecast. Dublin delivered a tidal surge early warning system for Dublin that predicted flood tides to +/- 50 mm. a previously unheard-of accuracy which triggered appropriate emergency management procedures. The DFI was strongly supported by the OPW and the EU

C. Dam break flooding - Dams can fail and if so, can cause devastating flooding but they also protect a city. Dublin has major dams (two ESB managed dams on the River Liffey) and Dams operated by DCC on the Rivers Dodder and Vartry in Wicklow. The DCC dams were re-evaluated following Hurricane Charley in 1986 and their dam crests were raised with crest walls to cater for a new probable maximum flood. I was involved directly in this work.

The carrying capacity of the River Liffey in the centre of Dublin was about 150 M3/sec (150 tonnes of water per second for the layperson). Anything above this will wash away bridges. The estimated flood without these dams was 450 M3/Sec (450 tonnes of water per second).

The Dam at Blessington can handle a 1/1000- year flood but after heavy rainfall the water has to pass through Kildare to create space for the next rainfall event. Some houses in Kildare are built in close proximity to the historical flood plain of the River Liffey.

One notable issue that should be mentioned in the context of dam safety is the absence in Ireland(ROI) of a legal framework for ensuring reservoir safety. Reservoirs in England and Wales are regulated under the **Reservoirs Act 1975, as amended by the Flood and Water Management Act 2010**, and this is enforced by the Environment Agency in England. The regulation of reservoir safety in Northern Ireland is provided for by the Reservoirs Act (Northern Ireland) 2015 which will introduce regular inspection, supervision, maintenance, and repair of reservoirs.

Mostly large reservoirs and owned and managed by the ESB or Uisce Eireann/Local Authorities, and were examined as part of the PRFA stage of the Floods Directive by the owners, where assurance of regular appropriate maintenance and operation was assured, the legislative lacuna should be addressed particularly in the light of an increasing risk from climate change impact on rainfall intensities and frequencies.

D. Infrastructure failure - This can be anything from a collapsed main sewer to a burst on a trunk watermain.

E. Pluvial flooding- In other words from rainfall. But not just any type of rain. Dublin City christened this a "monster rain" to distinguish it from heavy rain. With global temperature rise every 1% increase results in clouds carrying 7% more water and when these result in rain the intensity is monsoon like and exceeds the design capacity of every pipe.

2. Where were those risks highest?

Dublin mapped all the flood risk areas for each of the 5 known risks. This included 3D modelling for the entire city for pluvial flooding. It was difficult to explain that areas remote from rivers at high elevation were at high risk. It is not possible to control where rain falls or the intensity but using swales locally could direct where flooding might be stored during a major event.

3. When were those risks highest?

Through close working with MET Eireann, OPW and the DCC tidal surge model could mobilise to respond in the short term. The DCC tidal surge model delivered predicted tide levels 72 hours in advance with an accuracy of +/- 50 mm which were tracked every 12 hours before an event as better data became available.

4. What needed to be done to reduce/mitigate those flood risks?

Collectively Dublin City spent over €100 M. to include Flood works on the River Dodder, a new €10m. tidal gate near the Conference centre to protect Ringsend which was often below sea level. New flood defences on the river Liffey including tidal flood gates on the boardwalk and cycle paths, which were flood defences on the Liffey near Pearse Street. A long list of other accomplishments.

5. What needed to be done to respond to flood emergencies?

5. Item 5 was addressed first through a collaboration with EU partners funded through the EU INTERREG programme. It proposed the name **SAFER** project.

Strategies and **A**ctions for **F**lood **E**mergency **R**esponse management.

The follow up EU funded project Flood Resilient Cities(FRC) provided the fully detailed risk analysis and a City Pluvial Flood risk computation.

Project 2030/2050.

The DFI concluded in 2009 that after 2030 Dublin would start to be exposed to tidal surge flooding on a more regular basis and by 2050 no matter how high coastal flood walls were they could be overtopped.

This project analysed the scenarios and confirmed that a tidal barrier would be feasible, and the city would not flood from rain while the barrier was closed.

There was a very interesting natural development with a south bull island naturally building northward from Merrion Gates. By 2050 it could be close to the Liffey estuary. With man- made intervention this could result in a natural coastal defence with a new wetland behind it.

Equally offshore there are natural sandbanks close to the water surface, which could also provide a natural defence leaving the length of tidal barrier to be much shorter and not dissimilar to the London Barrage.

The DFI had international experts to assess this including Brendan Harley who built the Marina Barrage in Singapore.

2.1.7 Ireland (NI) responsible Departments and Agencies

Department for Infrastructure (Northern Ireland) (DfI) is responsible for a wide variety of services including (relevant to this chapter):

- **Water and sewerage services -** Policy in relation to the water and sewerage industry and for discharging the Department's statutory and other duties
- **Rivers and flooding -** Reducing the risk to life and damage to property from flooding from rivers and the sea, undertaking watercourse and coastal flood management in a sustainable manner. As well as major multi-million-pound projects to provide flood protection to residential and commercial properties the DfI Rivers also maintains sea defences and drainage structures.

NI Water

Key statistics

- 920,000 household and business customers
- 24 Water treatment works
- 27,000 Km. of water mains
- Delivers 605 million litres of drinking water/day
- 750,000 wastewater customers
- 16,500 Km. of sewers
- 1027 Wastewater treatment works
- Treats 306 m. Litres of wastewater/day

2023/24 was the third year of our six-year PC21 Business Plan (2021-27). Our PC21 plan, endorsed by the Utility Regulator, was ambitious and set out the step change in investment required to improve water and sewerage infrastructure, facilitate economic growth and protect the environment. The plan also challenged NI Water to deliver further performance improvements for our customers while continuing to drive down costs and embrace innovation.

Northern Ireland Authority for Utility Regulation

Northern Ireland's utility regulator has a vital role to play in ensuring the delivery of important strategic agendas at a time of profound challenges for the energy and water sectors, as they each address the impact of climate change.

'Protecting Consumers on the way to Net Zero' is the new corporate strategy from 2024-2029 which was published in April 2024. This new strategy is a clear statement of intent to meet head on the challenge of decarbonisation and balancing this with a Just Transition. Just Transition seeks to ensure that the benefits of net zero are shared widely, while also supporting those who stand to lose economically. This Just Transition must be fair to all and must ensure the protection of both current and future consumers.

Flood risk in NI is managed by a number of organisations, many of which come under the umbrella of the DfI.

Second Cycle NORTHERN IRELAND FLOOD RISK MANAGEMENT PLAN 2021–2027

This second cycle Flood Risk Management Plan, which is the culmination of several years of work by staff in DfI in cooperation with a wide range of stakeholders and consultees both inside and outside of government. The Plan is a requirement under The Water Environment (Floods Directive) Regulations (Northern Ireland) 2009.

This second cycle Plan differs from the first cycle Plans in that there is now a single Plan covering the three River Basin Districts (RBD) for the six years from 2021 until 2027.

Surface water flooding has been given greater emphasis due to the predominance of flooding from this source in recent years, and because the NIFRA 2018 indicated that potential damages from surface water flooding could be greater than the damages from the other main sources.

In preparing this Plan DfI has worked in partnership with NI Water, the Department of Agriculture, Environment and Rural Affairs (DAERA) and the Department for the Economy (DfE), to develop a shared understanding of flood risk and to consider and agree roles and responsibilities in managing this risk.

The Plan is based on the same River Basin Districts as the River Basin Management Plan, produced under the Water Framework Directive by DAERA and presents opportunities to further develop the synergies between these plans by both mitigating flooding and improving the water environment.

While this Plan focuses on the 12 Areas of Potential Significant Flood Risk (APSFR), with specific measures tailored to manage flood risk in particular locations, the Plan also sets out a series of Regional Measures which apply across all of Northern Ireland, supporting the sustainable management of flood risk for both APSFR and the wider River Basin Districts. It is hoped that this approach will continue to provide improvements in the delivery of flood risk management activities that will benefit citizens across the whole of Northern Ireland.

In terms of managing flood risk in NI from rivers and the sea at least £30m per year of capital investment is needed.

The Northwestern and Neagh-Bann are shared IRBDs with the Republic of Ireland. In addition, a small area of the Shannon IRBD covers NI, although there is no history of flooding and there are no APSFR within the Shannon IRBD in NI. The DfI continues to work closely with the Office of Public Works (OPW) in the Republic of Ireland (RoI) to ensure that measures undertaken in either jurisdiction do not increase flood risk and are mutually beneficial. Arrangements for cooperation and coordination in the implementation of the Floods Directive between the two Competent Authorities are in place.

Links to the NIW and UR annual reports and the FRMP.

Annual Report

Second Cycle Northern Ireland Flood Risk Management Plan 2021-2027

NIAUR 23-24 Annual Report and Accounts Final version.pdf

2.2 Progress on Delivery of strategic infrastructure Projects.

2.2.1 National Development Plan (NDP) – Water, Wastewater and flooding.

Project Ireland 2040 is the government's long-term overarching strategy to make Ireland a better country for all. By 2040, there will be approximately one million additional people living in Ireland. This population growth requires significant investment in capital infrastructure and in a sustainable manner, as we transition to a low carbon and climate resilient society.

The National Planning Framework (NPF) and the National Development Plan 2021-2030 combine to form Project Ireland 2040. The NPF sets the vision and strategy for the development of our country to 2040, and the NDP provides the enabling public investment of €165 billion to implement that strategy.

In Q1 2023, the Department of Public Expenditure, NDP delivery and Reform announced a package of actions to enhance delivery of vital public projects. These actions included significant changes to reduce the administrative burden in delivering major capital projects including

- The Minister is now taking a direct role in overseeing delivery of the NDP through chairing the Project Ireland 2040 Delivery Board
- Additional reforms to the Capital Works Management Framework, which sets out the contracts used for public capital projects.

Prospects 2023/2024 sets out a clear pipeline for 50 of the largest individual projects that make up Project Ireland 2040. This pipeline spans projects which are currently at planning and appraisal to projects which are completing construction in 2023.

Prospects 2023/2024 | Ireland's Major Infrastructure Project Pipeline

The Prospects 2023/2024 report contains high level information on 50 of the largest projects, with a focus across key sectors, included in Project Ireland 2040 and signposts to other sources for more detailed information. References to 'Main Contractor Procurement' in the report refers to when the procurement process began/ will began (i.e. when tender documents were/will be issued to the market). The date of main contractor award is recorded, as appropriate, under 'Contract Awarded To' in the report.

When launched in 2018, Project Ireland included over 150 projects, each with a value in excess of €20 million. The pipeline of projects has continued to expand and evolve since then. There are now over 300 large projects at various stages of the project lifecycle. The latest Investment Projects and Programmes Tracker and interactive map provide details on capital projects under the NDP. As of Q1 2023, the Tracker focuses on almost 320 projects and 140 programmes, including almost 100 projects in excess of €50 million. It is important to acknowledge that the timelines provided in the NDP report are indicative and subject to change in terms of main contractor procurement and construction, especially for projects in the earlier stages of the project lifecycle.

Prospects 2023/2024 published in September 2023 set out a clear pipeline for 50 of the largest individual projects that make up Project Ireland 2040

Projects by Sector

Prospects 2023/2024 -NDP Projects by Sector High level information on 50 of the largest projects, with a focus across key sectors, included in Project Ireland 2040		
Table	**Sector**	**Number of Projects**
Table 1	Public Transport Projects	8
Table 2	Flood Relief Projects	4
Table 3	Road Projects	7
Table 4	Uisce Éireann	7
Table 5	Health Projects	7
Table 6	Higher Education Projects	5
Table 7	Housing Projects	8
Table 8	Other Projects	4
Total		**50**

Prospects 2023/2024 Table 2 Flood Relief Projects			
Name of Project	**Stage of Project Lifecycle**	**Construction Timeline**	**Cost Range**
Lower Lee(Cork City) Flood Relief Scheme	Pre-Tender – Detailed Project Brief and Procurement Strategy	2025-2030	€100m-€250m
King's Island Flood Relief Scheme	Pre-Tender – Detailed Project Brief and Procurement Strategy	2024-2026	€50m-€100m
Arklow Flood Relief Scheme	Pre-Tender – Detailed Project Brief and Procurement Strategy	2024-2026	€20m-€50m
Shannon Flood Relief Scheme	Strategic Assessment& Preliminary Business Case	2026-2029	€20-€50m

Prospects 2023/2024 Table 4 Uisce Éireann Projects			
Name of Project	**Stage of Project Lifecycle**	**Construction Timeline**	**Cost Range**
Water Supply Project – Eastern and Midlands Region	Strategic Assessment & Preliminary Business Case	2028-2032	€1 billion+
Greater Dublin Drainage	Pre-tender – Detailed Project Brief and Procurement Strategy	2028-2031	€500m-€1bn
Ringsend Wastewater Treatment Plant	Implementation	2018-2026	€500m-€1bn
Carlow Wastewater Treatment Plant	Pre-tender – Detailed Project Brief and Procurement Strategy	2026-2028	€50m-€100m
Regional Biosolids Storage Facility	Post-tender – Final Business case	2024-2026	€50m-€100m
Letterkenny WSZ Upgrade	Strategic Assessment & Preliminary Business Case	2027-2030	€50m-€100m
Midleton Wastewater Transfer Project	Pre-tender – Detailed Project Brief and Procurement Strategy	2024-2026	€20m-50m.

Project Ireland 2040 Prospects 2024/2025 published in November 2024 updates the top 50 projects.

Prospects 2024/2025 -NDP Projects by Sector High level information on 50 of the largest projects, with a focus across key sectors, included in Project Ireland 2040		
Table	**Sector**	**Number of Projects**
Table 1	Public Transport Projects	8
Table 2	Flood Relief Projects	3
Table 3	Road Projects	7
Table 4	Uisce Éireann	6
Table 5	Health Projects	6
Table 6	Higher Education Projects	5
Table 7	Housing Projects	7
Table 8	Other Projects	8
Total		**50**

Prospects 2024/2025 Table 2 Flood Relief Projects			
Name of Project	**Stage of Project Lifecycle**	**Construction Timeline**	**Cost Range**
Lower Lee(Cork City) Flood Relief Scheme	Strategic Assessment & Preliminary Business Case	2026-2030	€100m-€200m
Limerick flood relief scheme	Strategic Assessment & Preliminary Business Case	2028 – 2032	€20m - €50m
Blackpool flood relief scheme	Strategic Assessment & Preliminary Business Case	2026 – 2029	€20m - €50m

Prospects 2024/2025 Table 4 Uisce Éireann Projects			
Name of Project	**Stage of Project Lifecycle**	**Construction Timeline**	**Cost Range**
Water Supply Project – Eastern and Midlands Region	Pre-tender - Project Design, Planning and Procurement Strategy	2028-2032	€1 billion+
Greater Dublin Drainage	Pre-tender - Project Design, Planning and Procurement Strategy	2028-2032	€1 billion+
Ballina/Lough Talt WSZ Upgrade	Pre-tender - Project Design, Planning and Procurement Strategy	2027 - 2030	€100m - €200m
Nenagh Wastewater Treatment Plant Upgrade	Pre-tender - Project Design, Planning and Procurement Strategy	2025 - 2029	€50m - €100m
Bailieborough WWTP Upgrade	Pre-tender - Project Design, Planning and Procurement Strategy	2026 - 2029	€20m - €50m
Buncrana WWTP Upgrade	Pre-tender - Project Design, Planning and Procurement Strategy	2026 - 2028	€20m - €50m

Note - Omission from the top 50 report does not imply de-prioritisation by Government

2.2.2 Uisce Éireann capital investment programme

The key capital projects and themes can be summarised as follows:

Topic	Project name	Project details
Water	National Leakage Reduction Programme	Much of Ireland's drinking water is lost to leaks before it reaches our taps. To conserve this precious resource, we have invested over €500 million to upgrade the underground water network across the country through the delivery of the Leakage Reduction Programme. UE are investing a further €250 million every year up to the end of 2030 - fixing leaks and replacing pipes to provide a more reliable water supply. Significant leaks are identified on the private customer side also. A total of 880,000 meters have been installed on domestic premises and if a continuous flow greater than 6 L/S is measured the potential leak is flagged. A "first fix free" scheme will replace private side leaks supported by funding approved by the regulator.

Topic	Project name	Project details
Water	Water Supply Project Eastern and Midlands Region	This project is listed as one of the key 'Strategic Investment Priorities' of the National Development Plan. The project forms a key part of UE's long-term strategy to increase water supply resilience and levels of service in the region by creating a major new source of water to meet water supply demands of up to 50% of the State's population to 2050 and beyond. It will enable Ireland to meet the challenges of climate change and increasing demand by diversifying our water supplies. It will provide the greater area of Dublin, Meath, Kildare and Wicklow with a resilient, safe, secure water supply. Crucially it will also have capacity to serve communities along the route in Tipperary, Laois, Offaly and Westmeath.
Wastewater	Eliminating Raw sewage	Since 2014, UE have built new wastewater infrastructure for 34 towns and villages across the country, ending the discharge of raw sewage into the environment. In addition to the 34 completed sites, UE currently have 7 locations under construction across the country. This means 41 out of 50 locations either have brand new infrastructure in place or currently have projects under construction. There are plans for the rest, prioritising the areas where it can make the biggest impacts first.
Wastewater	Ringsend Wastewater treatment plant upgrade	A major upgrade is underway to the Ringsend Wastewater Treatment plant which will enable increasing volumes of wastewater arriving at the plant to be treated to the required standard, enabling future housing and commercial development. Wastewater from Dublin has been treated in Ringsend since 1906. Built in 2005, the current plant is the largest in Ireland and was designed to cater for an equivalent of 1.64 million people. The Ringsend Wastewater Treatment Plant (WwTP), which provides over 40% of Ireland's wastewater treatment capacity, is currently overloaded and is not in compliance with the EU's Urban Wastewater Treatment Directive.
Water and wastewater	Growth and development	Uisce Éireann's Growth and Development Programme is a national programme of targeted investment to increase the capacity of water and wastewater infrastructure to enable social and economic growth and development, including the delivery of essential housing. This programme is designed to support: Growth and development in key growth areas throughout the country, while protecting the environment and ensuring a continued supply of safe drinking water. National Policy Objectives and National Strategic Outcomes under the National Planning Framework, by ensuring that essential infrastructure is provided within each Local Authority area. Investment in accordance with County Development Plans. Customer funded projects to support social and economic development.

Topic	Project name	Project details
Wastewater	Athlone main drainage scheme	Uisce Éireann, working in partnership with Westmeath County Council, is progressing works to upgrade the Athlone sewer network. When completed, this project will reduce the risk of sewer flooding in Athlone and address non-compliant sewer overflows into the River Shannon. It will also improve the capacity of the sewer network allowing for current and future population growth. Currently, there are 18 storm water overflows within the Athlone Town main drainage system. There is frequent out of sewer flooding in the town due to insufficient capacity within the collection system. Additionally, the collection system has insufficient capacity to accommodate future population growth.
Wastewater	Arklow wastewater treatment plant	Arklow was identified by the Environmental Protection Agency (EPA), as an area where wastewater is discharged into the Avoca River without any treatment. This practice of discharging untreated wastewater to the river is no longer acceptable and Uisce Éireann is working in partnership with Wicklow County Council to address this. The provision of a new wastewater treatment plant in Arklow will bring benefits to the town and surrounding areas in terms of health, environmental protection and improved water quality for all.
Wastewater	Buncrana & Ballybofey, Stranorler sewerage schemes	Uisce Éireann, working in partnership with Donegal County Council, is progressing with works to upgrade the Buncrana and Ballybofey-Stranorlar Sewerage Schemes. The €31 million investment involves an upgrade to the wastewater network infrastructure in Buncrana and Ballybofey-Stranorlar, reducing the risk of sewer flooding and addressing non-compliant sewer overflows into Lough Swilly and the River Finn. It will also improve the capacity of the sewer network allowing for current and future population growth, and supporting the social and economic development of Buncrana, Ballybofey-Stranorlar and the surrounding area.

2.2.3 OPW Flood relief schemes

The OPW's *Catchment Flood Risk Assessment and Management (CFRAM) Programme* was undertaken by engineering consultants on behalf of the OPW working in partnership with the local authorities. The CFRAM Programme studied 80% of Ireland's primary flood risk and identified solutions that can protect over 95% of that risk.

These solutions are set out in a series of 29 Flood Risk Management Plans, launched in May 2018 and available on *www.floodinfo.ie*, and includes some 150 additional flood relief schemes. The Government has committed €1.3 billion to the delivery of these flood relief schemes over the lifetime of the National Development Plan to 2030 to protect approximately 23,000 properties in threatened communities from river and coastal flood risk. Since 2018, as part of a phased approach to scheme delivery this funding has allowed the OPW to treble the number of flood relief schemes at design, planning, and construction to some 100 schemes.

The following table shows flood relief scheme information for the whole country

Scheme category	Number of schemes
Ongoing schemes	95 entries (may include phases of the same scheme)
Completed schemes	55 entries
Future schemes	54 entries

OPW Minor Flood Mitigation Works and Coastal Protection Scheme

Under the scheme, applications are considered for projects that are estimated to cost not more than €750,000 in each instance. Funding of up to 90% of the cost is available for approved projects. Applications are assessed by the OPW having regard to the specific economic, technical social and environmental criteria of the scheme, including a cost benefit ratio.

Works that are normally the responsibility of the local authorities will generally not be considered for OPW funding. Where such works would also mitigate the risk of flooding to properties, partial funding may be considered by OPW. The Local Authorities must be satisfied that the works will not have a significant impact on flood risk elsewhere. The commencement and progression of any works for which funding is approved is a matter for each Local Authority concerned.

There are a total of 999 schemes listing the approved funding and the approval date.

2.3 The future

The new programme for Government 2025 Securing Irelands Future is committed to ensuring that Ireland is a leader in the digital economy and artificial intelligence. The Government recognises that delivery of essential infrastructure is a key driver in attracting and retaining investment in Ireland, growing our economy, fostering regional development, delivering on our housing targets and achieving our ambitious climate goals.

Delivery of large-scale projects vital for the economy and society in areas including energy, transport, water, flood defences and climate resilience can be subject to timing challenges. Issues include the planning process, legal challenges, inconsistent timelines in sponsoring agencies (government departments, state agencies, local authorities, higher education institutes or other state bodies) in completing appraisals and developing business cases as required under the Infrastructure Guidelines, and multi-annual funding requirements. Delays to project delivery result in higher costs and hamper our ability to provide the necessary infrastructure to service a modern society and economy. It also represents a real risk to our competitiveness and to our attractiveness as a location for foreign direct investment. Stable, long-term delivery of essential infrastructure is a priority for the Government.

To ensure projects are delivered as early as possible and within budget, this Government will:

- Prioritise early review of the National Development Plan which will be completed in July 2025.
- Review and reform the prioritisation process of capital projects in key agencies.
- Create a dedicated Infrastructure Division in a re-named Department of Public Expenditure, Infrastructure, Public Service Reform and Digitalisation. The Division will be led by a Deputy Secretary General.
- Task the new division to work with stakeholders to advise Government on strategic project selection and prioritisation, aligned with national priorities and making maximum use of resources.
- Ensure the division develops a sustainable pipeline of projects, allowing for continued investment over the medium to long-term to deliver upon the ambition of the National Development Plan.

- Create a Cabinet Committee on Infrastructure, chaired by the Taoiseach, to drive infrastructural delivery, accountability and value for money. Broaden the remit of the National Development Finance Agency (NDFA) in the National Treasury Management Agency (NTMA) to provide expert advice for major infrastructure delivery as required by sponsoring departments or agencies.

Mindful of the need to ensure projects represent value for money, the Infrastructure Division will:

- Work directly with sponsoring agencies including Government departments, the Office of Public Works and state agencies to expedite delivery of project assessments, appraisals, business cases and other stages of the approvals process with a view to aiding quicker decision making.
- Review the Infrastructure Guidelines and create a Public Investment Act, requiring sponsoring agencies to meet timelines on development of project appraisals and other evaluations so as to reduce delays in decision making and embed value for money across all capital projects.
- Assist sponsoring agencies in complying with local, national and EU environmental and development standards.
- Ensure relevant expertise in project management, procurement, planning, engineering and other disciplines is available within the Division to aid timely delivery.
- Work with stakeholders to develop mechanisms to reduce delays in obtaining sanction when directly employing relevant specialist expertise.
- Meet with sponsoring agencies regularly to review progress of projects.

Investment in Infrastructure related to water, wastewater and flooding is likely to accelerate in the next 5 years to build a platform for securing Ireland's future.

2.3.1 Housing

A key Government focus will be to address the housing need. Current plans envisage 300,000 new housing units to 2030.

This will require water and wastewater services, new roads and transport infrastructure, coupled with energy grid connections.

Uisce Eireann (UE) has published a capacity register showing where capacity is/is not available for water and wastewater services. To Increase capacity to c. 50,000 housing units/year will require an additional ring-fenced investment of the order of €1.7 Bn.

In addition, the Government should consider extending existing planning permissions which are close to their expiry date. Otherwise, existing "shovel ready" schemes will have to go through the Planning process again with time delays and no certainty of a successful outcome.

Amending the definition of that which constitutes "substantial completion" for existing Planning Permissions by Ministerial Order should also be considered.

CHAPTER 3 ROADS AND TRANSPORTATION

3.1 Introduction

This chapter describes the planned and potential projects that will likely be delivered in the island of Ireland in the period 2025 to 2040' It draws on information available from agency websites, north and south of the island. It is supplemented by information obtained in discussions with senior participants in the delivery of roads and other transportation projects. As there is a new government in the Republic of Ireland, priorities might change and funding available for transportation projects might decrease.

The chapter is laid out under agency headings:

- 3.2 Transport Infrastructure Ireland (TII)
- 3.3 National Transportation Authority (NTA)
- 3.4 Iarnród Eireann/Irish Rail
- 3.5 Dept of Infrastructure Northern Ireland

Many projects could be described under more than one heading, for example TII and NTA, but generally projects are described under one agency only.

3.2 Transport Infrastructure Ireland (TII)

3.2.1 Roads and Greenways

Introduction

TII published a report in December 2024 entitled *Major Roads and Greenways Projects Active List*.

https://www.tii.ie/media/x3jlql0p/major-active-projects_mar2023.pdf

3.2.2 Roads:

The report tabulates the roads and greenways projects grouped by development stage. For Roads Projects, the stages and numbers of projects are:

Stage	No. of Projects
Projects at Early Planning	7
Projects at Planning and Design	15
Projects Progressing to Construction	2
Projects at Construction	1
Projects Placed on Hold (Can be Progressed Subject to Funding)	7

It is notable that there is only one project "at Construction" which reflects the significantly reduced funding for roads under the previous Government. An article in the Irish Times on 15th January 2025 notes that "there will be an increase in funding for new roads, in addition to those in the current National Development Plan". It is hoped that a commitment to adequate funding will allow a consistent pipeline of projects to progress efficiently.

3.2.3 Greenways:

For Greenways projects, the stages and numbers of projects are:

Stage	No. of Projects
Greenways at Planning & Design	40
Greenways Progressing to Construction	5
Greenways at Construction	10
Other Greenways Projects (Phase 0)	12
Only projects currently receiving funding from TII are included	

3.2.4 Roads Projects:

Summary Sheets are provided in the TII report for Projects at the various stages (other than those on hold). These provide some descriptions as well as information on length, road type, and cost estimates. It is important to note that the cost estimates include some broad ranges which will be narrowed down only after further design as well as some noted as older costs without inflation or risk. Some have no cost estimates or simply say “greater than” a particular number. Also, some are missing “lengths” of scheme.

Notwithstanding the above, the following is an attempt to quantify total length and value of the schemes in a simplified way. It uses average cost where a range was given, conservatively uses the “particular number” where a “greater than” was given, guesstimates using approximate cost per km where no cost was given, and estimates length where none was provided. The following results therefore need to be treated with a level of caution:

Stage	No. of Projects	Total Length (km)	Cost Estimate €m
Projects at Early Planning	7	239	€3,010
Projects at Planning and Design	15	295.55	€5,019
Projects Progressing to Construction	2	45.5	€792
Projects at Construction	1	33.4	€462
Projects Placed on Hold (Can be Progressed Subject to Funding)	7	140	€1,960
Projects in planning yet to go to Construction	22	534.55	€8,029
Projects on hold subject to Funding	7	140	€1,960
TOTAL	**29**	**674.55**	**€9,989**

3.2.5 Additional Investment in Roads, announced Feb 2025

Minister for Transport Darragh O'Brien, Minister of State Seán Canney and Minister of State Jerry Buttimer have jointly announced an investment programme of €713m for regional and local roads in 2025. This represents an overall increase of over 8% in funding this year for road and safety improvements on the vast interconnected regional and local road network.

> *'The main priority of the investment is the ongoing maintenance and renewal of the regional and local road network, alongside strategic investment in developing and improving the road infrastructure network'*
>
> *In addition to maintaining our current road network, we are developing and upgrading this infrastructure through investing €70 million in vital strategic projects which are continuing to be progressed. These include those identified for development under the National Development Plan such as the Shannon Crossing and Killaloe Bypass project in Killaloe and Ballina, and the Coonagh to Knockalisheen Distributor Road in Limerick City."*

As part of the €70m investment, more than €20m is being allocated under the Specific Grant category for smaller-scale road improvements.

These grants will fund a variety of projects, including bridge repairs, junction reconfigurations and initiatives to reduce traffic congestion in towns. They will also aim to enhance access to educational institutions, businesses and public transport. Funded projects in 2025 include rehabilitation of Ballycorkey Bridge in County Westmeath and R595 Old Court, Skibbereen to Baltimore realignment in County Cork.

3.3 National Transport Authority (NTA)

3.3.1 Introduction

Part of the NTAs role is to develop integrated, accessible public transport

Within this the NTA:

- is responsible for developing and implementing strategies to provide high quality, accessible, sustainable transport across Ireland.
- has a statutory function to implement a transport strategy for the Greater Dublin Area and also leads the development of transport strategies in Cork, Galway, Limerick, and Waterford.
- plans, procures and oversees Public Service Obligation (PSO) public transport, ensuring that vital bus and rail services are available to communities across the country under the Transport for Ireland brand.
- is the licensing authority for the commercial bus sector and Small Public Service Vehicles (SPSVs).
- works with local authorities throughout Ireland to deliver active travel infrastructure that facilitates cycling, walking and wheelchair use.
- delivers the technologies and services that provide integrated information and methods of payment for public transport services.
- is a statutory non-commercial body, which operates under the aegis of the Department of Transport.

3.3.2 Infrastructure Projects

NTA provides information on 'Planning and Investment' and what projects are in development in the following link *https://www.nationaltransport.ie/planning-and-investment/*

3.3.2.1 MetroLink

The MetroLink project aims to develop a new high capacity high frequency segregated rail corridor from Charlemont to Swords, via Dublin Airport. The MetroLink Project integrates with Irish Rail, Dublin Bus and Luas services to provide a fully integrated public transport system in the Greater Dublin Area. The corridor is predominately in tunnel and includes 16 new stations, including 11 underground stations, and a park and ride facility.

Anticipated issue of construction tenders 2025

The official estimate of cost was between €7.16 and €12.25 Bn. at 2021 prices and excluding VAT. The Department of Transport clarified that officials are 95% confident that the final cost will be the same or less than €23.39Bn. (2025 P95 costs, less VAT)

3.3.2.2 BusConnects

BusConnects is the National Transport Authority's programme to improve bus services across the country. BusConnects aim is to deliver a bus service that's better for everybody; the people, the city and the environment.

BusConnects Dublin

At present, planning consent applications for all 12 CBC schemes (122km), together with associated compulsory purchase orders, have been submitted to An Bord Pleanála. Planning consents have so far been granted for the nine schemes listed below, marking a significant milestone in the BusConnects Dublin Programme:

- Liffey Valley to City Centre;
- Clongriffin to City Centre
- Ballymun/Finglas to City Centre;
- Belfield/Blackrock to City Centre
- Swords to City Centre;
- Blanchardstown to City Centre
- Ringsend to City Centre;
- Lucan to City Centre
- Tallaght/Clondalkin to City Centre

Following receipt of planning consents for these schemes, the focus of activity has now moved to the construction stage for the first two schemes (noting that some schemes are subject to Judicial Review). The NTA are currently establishing a panel of contractors to build the schemes, with procurement of the first two schemes to commence in 2025. It is expected that the first two scheme construction contracts will be awarded in the first half of 2025, followed subsequently by the award of an additional two schemes for construction. Given the traffic management requirements during construction, it is considered that a maximum of four schemes can be built concurrently.

The Statutory Planning Application has been submitted to An Bord Planeala for the following three schemes

- Templeogue/Rathfarnham to City Centre;
- Kimmage to City Centre;
- Bray to City Centre

When completed in the early 2030s, it is anticipated that the bus fleet will be all electric.

Implementation costs could be €2,000m.

BusConnects Cork

The third round of public consultation on the preferred route options for eleven sustainable transport corridors as part of the BusConnects Cork programme took place from the 6th of November 2023 until 18 December 2023. The NTA will finalise the Preferred Route Options for all eleven corridors taking into account all submissions received during the 3rd round of public consultation. The scheme designs will be further developed and statutory consent applications to An Bord Pleanála will be prepared, inclusive of transport and environmental impact assessments. At this stage, as part of the formal planning application to ABP, there will be a statutory public consultation process

BusConnects Cork is a €600m programme of work that aims to transform the city's bus system, making public transport more accessible to more people. By delivering approximately 91kms of new bus lanes and bus priority and 98km of cycle facilities (one direction) delivering 49km of the cycle network, BusConnects Cork will make travel by bus, as well as active travel, a more attractive option while also reducing carbon emissions and congestion.

The eleven route corridors are

- Dunkettle to City;
- Mayfield to City
- Blackpool to City;
- Ballincollig to City
- Bishopstown to City;Togher to City
- Airport Road to City; Maryborough Hill to City
- Mahon to City; Kinsale Road to Douglas

It is anticipated that the Statutory Planning Application will be submitted to An Bord Planeála in 2025, and construction will commence on the first two corridors in 2028

BusConnects Limerick

The new bus network for Limerick consists of 14 routes, with branches, as follows

- UHL to Athlunkard/Shannon Banks/ Westbury
- Moylish/Coonagh Shopping Centre/Jetland Shopping Centre to UL North Campus
- Coonagh Shopping Centre to Georgian Village; St Nessans Church to UL
- Raheen Ind Estate/Mungret Park to Annacotty; UL to St Mary's Park
- Coonagh Shopping Centre to UL; Sarsfield Gardens to Prospect Hill
- TUS Moylish to Colbert Station; Colbert Station to Ardnacrusha via Corbally Rd
- Colbert Station to Ardnacrusha via Kileely Rd

The NTA anticipates putting the New Network into service starting in 2025. As part of BusConnects, the NTA are also advancing work on the Sustainable Transport Corridors which will improve travel times on the bus network and improve connections for pedestrians and cyclists.

BusConnects Galway

The new bus network for Galway consists of 12 routes, with branches, as follows

- Gateway to Parkmore Business Park; Gateway to Ballybrit
- Gateway to Merlin Park; Univ of Galway to City Centre
- Cappagh Rd to Castlegar; Knocknacarra to Parkmore Business Park
- Cappagh Rd to Parkmore Business Park
- Upper Ballymoneen Rd to Parkmore Business Park
- Taylors Hill Rd to Oranmore; Salthill to Oranmore
- Gateway to Oranmore; Ceannt Station to Barna

As part of BusConnects Galway, a Cross City Bus Priority link, Univ. Rd – Dublin Rd., is under consideration

The NTA anticipates putting the New Network into service starting in 2025. As part of BusConnects, the NTA are also advancing work on the Sustainable Transport Corridors which will improve travel times on the bus network and improve connections for pedestrians and cyclists.

BusConnects Waterford

As foreseen in the Waterford Metropolitan Area Transportation Strategy (WMATS0, BusConnects Waterford will deliver approximately 63 kms of bus lanes and bus priority measures alongside new cycling routes and greenways in urban Waterford and south Kilkenny The new bus network will incorporate the relocation of Plunkett Station toa new site in the North Quays, and the availability pedestrian and cycling connections over the new active-travel bridge. Finally, BusConnects will increase the quantity and quality of bus service, as planned in WMATS, and will deploy 75 new zero emission buses

The proposed new bus network for Waterford consists of 7 routes, with branches, as follows

- SETU to UH/ Woodlands Hotel/Ardkeen; UH to Rockshire Rd
- The Quays to Inner Ring Rd/Balltruckle and Airport Rds
- Outer Ring Rd/SETU Arena/Whitfied Hospital/Slieverue to Ferrybank/Slieverue/Belview Port; The Quays to Ballybeg Drive /Lacken Rd/SETU
- The Quays to SETU

With the public consultation complete, all submissions will now be reviewed by the NTA design team. Public feedback will help shape the Final New Network with the redesign being finalised in the coming months. The new network will then be rolled out from 2026.

3.3.2.3 Luas in Greater Dublin Area (GDA)

The Greater Dublin Area Transport Strategy 2022-2042 proposes the delivery of new Luas/ LRT projects as follows *(https://www.nationaltransport.ie/wp-content/uploads/2023/01/Greater-Dublin-Area-Transport-Strategy-2022-42-1.pdf)*

2022 – 2042

- LRT 1 Metrolink, Swords – Dublin, described elsewhere in this document
- LRT 3 Luas Finglas, extension from Broomsbridge
- LRT 4 Luas Lucan, Lucan – city centre

- LRT 5 Luas Bray, extension from Brides Glen, the current terminus of the Green Line
- LRT 6 Luas Poolbeg, depending on rate of development in Poolbeg

Note: LRT 2 is titled Further Metro Development and will depend on a review and update of the Transport Strategy.

Based on studies carried out by NTA, there is sufficient demand for these 4 Luas lines and Metrolink and it is anticipated that they will progress sooner than previously thought.

Additional Luas Lines post 2042

Analysis undertaken for the Transport Strategy indicates that a number of corridors in the GDA will, in the longer term, generate travel demand above that which can be catered for by higher capacity bus systems and are likely to require upgrading to light rail in the period after 2042

The NTA is of the view that it is prudent to identify these corridors in this Transport Strategy in order to set out a long term framework for transport investment in the GDA and to ensure that planning and design work can commence during the strategy period.

The detailed alignments and locations to be served will be subject to these assessments. It is likely, however, that due to capacity constraints on the existing Luas lines, a reconfiguration of both lines will be required to meet additional demand arising from development in locations such as the Naas Road, Cherrywood, and sites to the west of the N/M11.

The NTA will undertake detailed appraisal planning and design work for the following Luas lines. With a view to their delivery in the period after 2042

1. City Centre to Clongriffin;
2. City Centre to Beaumont and Balgriffin;
3. Green Line Extension to Tyrrelstown;
4. City Centre to Blanchardstown;
5. Red Line Reconfiguration to provide the following lines*:
    - Clondalkin-City Centre; and
    - Tallaght-Kimmage-City Centre.
6. Tallaght to City Centre via Knocklyon*;
7. Green Line Reconfiguration to provide the following lines*:
    - City Centre to Bray via UCD and Sandyford; and
    - Sandyford to City Centre

* Subject to Measure LRT2

However, depending on projected travel demand, some or all of these projects could be expedited and commence construction before 2042.

3.3.2.4 Light Rail in Cork

The Cork Metropolitan Area Transport Strategy 2040 proposes an East West light rail tram system extending from Mahon through the city centre to Ballincollig. Indicatively, the route will be 17Kkm long with 23 stops and the project has an estimated construction cost of €1bn. Initially it is anticipated that a high capacity bus service will commence along the corridor to be followed by construction of the light rail tram project. It is anticipated to commence construction before 2040

3.3.2.5 Light rail in Galway

As part of the process of updating the Galway Transport Stra the NTA identified the requirement for a Light rail feasibility study to better understand the general feasibility for light rail in the Greater Metropolitan Area (GMA) and to investigate potential indicative alignment of a preferred alignments.

The light rail Feasibility Study is not intended to specifically identify of a light rail corridor in the city: instead the final report explores key issues and potential feasibility Route options will need to be explored in more detail during any subsequent process of options assessment and development. The indicative corridor for Galway LRT is east west through the city centre. An indicative length is 12km, potentially delivered in phases.

https://www.nationaltransport.ie/publications/light-rail-feasibility-study-for-galway/

3.4 Iarnrod Eireann

3.4.1 Introduction

This section presents programmed heavy rail projects which are anticipated to be delivered by Iarnrod Eireann in the period 2025 – 2040. It also describes heavy rail projects that are being evaluated and might progress in that period.

3.4.2 DART+West

This project is designed to increase the capacity of the existing rail services, from Maynooth and M3 Parkway to Connolly and Docklands, from six services per hour, with a capacity of 5k passengers/hour/direction, to twelve services, with a potential capacity of 13.2k passengers/hour/direction. This project had a Base cost of €700m, at 2019 values, and a Budget Amount of €1.4Bn, inclusive of Contingency, Inflation and VAT. A RWO for the project has been granted by ABP.

This project involves the

- Construction of a new station at Docklands and a new entrance to Connolly St.
- Electrification of the existing rail lines from Connolly to Maynooth, Docklands to Glasnevin Jct. and Clonsilla Jct to M3 Parkway
- Extension of twin tracking and electrification from Maynooth to a major new maintenance and stabling depot located just east of Kilcock. This element was not approved by ABP, when granting the DART+West Railway Order, because of flood risk issues considered by the ABP Inspector. No such issues were raised at the Oral Hearing.
- The closure of level crossings at Ashtown, Coolmine, Porterstown Rd, Clonsilla, Barberstown and Blakestown.
- Provision of new road overbridges at Ashtown and Barberstown, replacement of the existing rail bridge at Leixlip Confey and raising the existing bridges at Broombridge, Castleknock Rd. and Leixlip Louisa Bridge.
- Provision of new pedestrian/cycle overbridges at Ashtown, Coolmine, Porterstown and Clonsilla.

- Buildings for ESB substations and rectification equipment at Glasnevin, Ashtown, Castleknock, Leixlip Confey, Blakestown, Maynooth, Hansfield, Dunboyne and M3 Parkway.
- A new station at Docklands, at a cost of €70m, is under consideration.

Approval will be required for a major new maintenance and tabling depot to support the project.

3.4.3 DART+SouthWest

This project is designed to increase commuter capacity on the existing rail line to Portlaoise, by providing increased capacity and improved travel times from Portlaoise to Heuston and Newbridge to Grand Canal Dock, via the Phoenix Park Tunnel. The Base cost of the project was estimated to be €400m, at 2019 values and now has a Budget Value of €900m, incl. Contingency, Inflation and VAT. A Railway Works Order for the project was recently granted by ABP.

The project involves the

- Extension of four tracking from Cherry Orchard to Heuston Stn.
- Construction of a new station at Heuston West, on the line to Grand Canal Dock
- Electrification of the Commuter rail lines from Hazelhatch to Heuston and Glasnevin Jct., where it will join DART+West
- Construction of replacement overbridges at Le Fanu Rd and Kylemore Rd. and the widening of the existing underbridge at Sarsfield Rd.
- Buildings for ESB substations and rectification equipment at Hazelhatch, Adamstown, Kishoge, Parkwest and South Circular Rd.
- Slabtracking of the rail formation through the Phoenix Park Tunnel, to permit higher travel speeds.

Completion of this project would facilitate the later development of the DART Interconnector project, for which a Railway Works Order was previously obtained, as one section of the proposed track works in Heuston Stn. Railyard could be directly connected to the DART Interconnector Green Line Alignment Option, proposed by Parsons Brinckerhoff in their 2003 report for Iarnród Éireann.

That alignment provided for underground stations at Heuston, predominantly built under Guinness lands alongside Victoria Quay, Digital Hub, St. Stephens Green North, Pearse Stn. and Docklands where it would be located under the new Docklands Stn., proposed by the NTA. This alignment has a total length of 6.9km from tunnel portal to tunnel portal. The DART Interconnector project might proceed later in the period 2025-2040

3.4.4 DART+Coastal North

This project is to extend electrification of the DART from Malahide to Drogheda, initially by using hybrid rolling stock, which would operate on battery power from Malahide to Drogheda. The Howth Branch would be operated as a shuttle service, from Howth to Howth Jct.

The project includes modifications to Howth Jct. station, to improve passenger security, the provision of an additional line at Clongriffen Stn., to provide a passing loop on the up line, one is already provided on the down line and a turnback facility north of Malahide Stn. Additional platform, stabling and maintenance facilities are to be provided at Drogheda, including battery charging facilities.

The Base costs are estimated at €300m, at 2019 values and the Budget Amount is now €600m, inclusive of Contingency, Inflation and VAT. A RWO has been sought for this development.

3.4.5 DART+Coastal South

This proposal is designed to increase the service frequency that can be achieved between Grand Canal Dock and Bray, by closing some of the five level crossings between Grand Canal Dock and Booterstown Stations. Extending more frequent commuter services from Wicklow station is being evaluated

3.4.6 Limerick-Foynes Freight Line

The 42km rail line from Limerick to Foynes is currently being restored, for freight traffic, at an estimated cost of €150m. The track works are now substantially complete. In addition, three new overbridges are being built and the River Maigue viaduct was removed refurbished and has now been reinstated.

3.4.7 Cork-Midleton Line

Work has commenced on the twin tracking of the rail line from Cobh Jct. to Midleton, a distance of 10.5km. This line was originally constructed as single track but, in common with many other single track rail lines, the overbridges were constructed to accommodate twin tracking at a later date. The civil engineering contract for this work is valued at €30m.

When complete this work and associated work at Kent Stn. and in Victoria Tunnel, together the re-signalling of the Mallow-Midleton rail line will permit Cork commuter services to operate at 10min frequencies.

The services will be operated by new battery powered rolling stock.

3.4.8 Four tracking north of Connolly Station

The current tracks accommodate DART stopping services to Malahide and to Howth, intercity services to Belfast and outer commuter service to Dundalk. However, the current tracks present constraints on train paths and slows the longer distance services.

Iarnrod Eireann are currently evaluating upgrading the corridor to three or four tracks to accommodate more train paths, possibly including a heavy rail service to Dublin Airport. Given the proximity of existing development to the rail corridor, any major projects will be technically challenging and expensive.

3.4.9 Portarlington to Galway Line

An evaluation of upgrading the single-track line will commence in 2025. Currently the line is generally single track with double tracks at main stations, where trains can pass each other travelling in opposite direction. This constrains the current service of one train every two hours in each direction, Dublin -Galway. It is planned to increase the service to one train /hour and the study will assess the rail infrastructure needed to support this service level. This infrastructure could involve double tracking, additional special trackwork, upgrading of stations and rail structures such a bridges and signalling.

3.4.10 Reopening of the Western Rail Line from Athenry to Tuam and Manulla Jct.

The reopening of the Western Rail Line (Corridor) has local and political support for passenger and freight rail use. The Tuam- Athenry section could continue to Galway as a commuter passenger service although it is not a direct route. The full length (Athenry to Manulla Jct) is seen as a potential final link in a freight line, West of Ireland to southern ports.

Further evaluation will be required before a project progresses to planning design and construction

3.4.11 Twin Tracking the Rail line from Killonan. Jct. to Limerick Jct.

The rail line from Limerick to Killonan Jct (where the line to Nenagh, Roscrea and Ballybrophy diverges) is already twin tracked. Iarnród Éireann has proposed that the remaining 27km from there to Limerick Jct. should also be twin tracked. Like the Cobh Jct. to Midleton rail line the overbridges have been designed for twin tracking and the terrain along the route is flat. Thus, the costs involved should be similar/km to those for the Midleton Line.

3.4.12 New stations, upgraded stations in GDA

The NTA, in conjunction with Irish Rail, will develop new rail stations at Cabra, Glasnevin, Heuston West,Kylemore, Woodbrook, west of Sallins, west of LouisaBridge and west of Maynooth. Kishoge station will also open in the short term as development of the ClonburrisSDZ is realised. Other stations will be considered where development patterns support such provisions. Many stations in the GDA are in need of investment in order to make them more comfortable for passengers and more attractive.

The NTA and Irish Rail will continue to invest in rail station buildings and supporting infrastructure. In addition, a major upgrade of Tara Station will be undertaken to facilitate enhanced interchange between MetroLink and the DART network.

Many stations in the GDA are in need of investment in order to make them more comfortable for passengers and more attractive. The NTA and Irish Rail will continue to invest in rail station buildings and supporting infrastructure. In addition, a major upgrade of Tara Station will be undertaken to facilitate enhanced interchange between MetroLink and the DART network

3.4.13 New stations in Cork Metropolitan Area

Planned new stations include:

- Midleton/Cobh - Cork: Tivoli, Dunkettle, Water Rock, Ballynoe, Carrigtwohill West.
- Mallow – Cork; Blackpool/Kilbarry, Monard, Blarney/Stoneview

3.4.14 New stations in Limerick Shannon Metropolitan Area

New stations are being considered at Moyross, Ballysimon (with P&R) and on the Limerick Foynes line, under construction for freight services

3.4.15 New stations in Galway Metropolitan Area

A second platform is being provided at Oranmore station to support commuter services to Galway city. There could be an opportunity to provide a P&R station on the twin track section of the Oranmore – Galway line

3.4.16 Plunkett Station, Waterford

As described in the Waterford Metropolitan Area Transport Strategy, Plunkett Station is the terminal for rail services in Waterford City, located just north of the River Suir approximately 15-minutes' walk from the City Centre. This station is served by Intercity rail and some city bus services, offering opportunities for interchange. The station building is proposed to be relocated to the North Quays Innovation District to create a more direct access to Waterford city centre, through the creation of a Sustainable Transport Bridge from The Mall to Ferrybank. The Strategy supports the relocation of the train station to the North Quays SDZ, which will provide opportunities for interchange with city bus services via the new Sustainable Transport Bridge

3.5 Dept of Infrastructure Northern Ireland (DfI)

3.5.1 Introduction

The DfI published a major roads prioritisation programme in August 2023. The priority projects are presented in section 3.5.2 together with an update on progress during 2024

A similar list for rail projects appears not to be available. The Belfast Grand Central Station and associated track work was opened recently. Further rail projects appear to be at evaluation stage as described in section 3.5.3

3.5.2 Roads Projects

- A1 Junctions Phase 2. 25.2km £95-115m PQQ for D&B contract released
- A5 Western Transport Corridor. 85km, £1.7bn. Section 2 to proceed. Other sections subject to further consideration of Inspector's report..
- A6 Derry / Dungiven Phase 2 7.1km £170-200m. resolving waste site issue before it can commence
- Belfast Rapid Transit 2 (BRT2) £142-145m. Current funding gap of, potentially, £90m. possible opening 2030, depending on funding
- Lagan Pedestrian & Cycle Bridge £23m. Currently at PQ
- A2 Newry Southern Relief Road 3km.£85-100m. Current funding gap and will need from from DfI. Earliest possible construction start is 2028
- A4 Enniskillen Southern Bypass. 2.1km + improvement to existing A509. Currently out to tenderA29 Cookstown Bypass 4km, £65-75m. Possibly 2026 for procurement of D&B contractor.

There is a list of smaller projects generally of lesser priority, Another list describes other projects which are paused due to lack of funding.

3.5.3 Rail Projects

- Suburban rail upgrades are progressing. For example, Lisburn West halt is happening (with a Park & Ride) and there have been a number of ongoing asset upgrades at various stations to address asset or access issues.
- Feasibility studies include
  - Bleach Green to Antrim (and onwards to Ballymena) is being considered as part of the overall Derry~Londonderry Line programme. but at this moment still up in the air.
  - A feasibility study of infrastructure to improve service frequencies between Coleraine and Derry~Londonderry.
  - A feasibility study of reopening Portadown to Armagh line.
  - A feasibility study of reopening the line from Portadown to Dungannon, Strabane, Omagh and Derry~Londonderry, a major project if it progresses
  - A feasibility study of reopening Lisburn – Antrim line

Belfast-Border electrification is at feasibility stage. This will tie into Irish Rail's proposals south of the border including integration with Dart+ North which will bring electrification of the DART route north from Malahide to Drogheda.

CHAPTER 4 THE MEDICAL TECHNOLOGY INDUSTRY

Introduction

This report focusses on the public sector investment in infrastructure. In this chapter we focus on the private sector investment in the medical technology industry which leverages off the public sector investment.

4.1 Dismantling trade barriers

In 1958, the Department of Finance published the First Programme for Economic Expansion. This began the change of converting Ireland's economy from a closed insular model with a restrictive industrial policy to an open trading economy. This was accompanied by a major reform of the education system.

4.2 From small beginnings

When the IDA was incorporated as a state-sponsored body in 1969, it developed a focus on specific industrial sectors. One sector in which Ireland has enjoyed spectacular success is the Medical Technology sector.

In the early 1970s companies such as Baxter Healthcare, Becton Dickinson (BD) and Howmedica (now Stryker) set up manufacturing facilities with major assistance from the IDA.

4.3 Overview of the Irish Medical Technology Industry today

The sector now includes more than 400 companies. Ireland is now home to 14 of the top 15 med tech companies spanning multiple sites across the country and the sector now employs in excess of 50,000 people, of which more than 60% are graduates in engineering and science. Exports now exceed €15 billion per annum, approximately 8% of Ireland's exports.

The country offers these key attributes which make it an attractive location for an industry which is largely driven by corporate entities which are American owned.

- A low-cost manufacturing base
- English speaking (now the only English-speaking EU country post Brexit)
- Politically stable-EU access
- Low corporate tax regime
- High standard of education

This industrial sector has had almost continuous expansion in Ireland over a 50 -year time frame. This has led to the creation of a large suite of high-quality educational offerings across almost all of the Irish Higher Education Institutions (HEIs). As a result, many of the advanced level courses and PhD and Masters level are now attracting high quality international students, many of whom remain in Ireland as key members of the steadily growing Med Tech sector.

4.4 Overview of the Medical Technology Industry Today

The IMDA Strategy for 2022-25 has identified five key game changers as follows

4.4.1 Health Trends

1. Global population growth and ageing demographics are putting increasing pressure on healthcare provision
2. Rising Spend placing cost pressure on the industry
3. A greater focus is being placed on healthcare outcomes
4. Supply chain resiliencies being enhanced
5. The industry is being obliged to adapt to improve its environmental footprint, e.g. packaging materials and recyclability of components is now on the agenda at all levels

4.4.2 Customer Trends

1. Consumer Technology and patient knowledge of personal data is leading to greater integration of smart devices into the Med Tech mix and leading to greater use of preventative approaches
2. Greater levels of personalised medicine including individualisation of device manufacture are changing the profile of the supply chain
3. The younger demographic is paying increased attention to prevention of disease through improved monitoring approached and dietary approaches.

4.4.3 Health tech Trends (Health tech encompasses industries which intersect with Medtech, namely Nanotech, Pharma, Tech and Microelectronics)

1. Increasing capability in technology and integration of sensing technology into the diagnostic and therapeutic space is creating a blend of physical and virtual solutions
2. Data is now becoming more valuable and improvements in data analysis may leader to new approaches to health care decision making and interventions.
3. New skills in data handling and analysis will be required at a variety of levels in the eco system.
4. Data security will place new demands on the health care providers and the eco-system in general.

4.4.4 Response to Convergence

1. There is a dramatic increase in convergence in the Medical Technology industry, with indications that large tech companies are considering moving into the MedTech arena (e.g. Apple Watch) and industry observers have noted closer collaboration between large MedTech companies and semiconductor and chip manufacturers and designers.

4.4.5 International Trends

1. A suite of international trends across Global Taxation, Regulatory Controls, US retention of R&D activity and the increasing capability of Asian centres all pose challenges to the Irish position in this sector.

4.5 Looking to the future

Both the IMDA and IDA Strategies identify multiple key elements as follows.

Ireland needs to embrace a new approach to maintain its competitive position in

4.5.1 Innovation

There is a range of supports available in Ireland at every stage of MedTech activity, from early-stage research through to near-commercial activity. These include incentives for building in-company capacity, sourcing skills, and collaboration opportunities.

Continue to provide feasibility and research grants, and maintain the current tax credit of 25% for R&D activity

Ensure that the Irish ecosystem continues to maintain a high- quality network of connectivity for people, ideas and technology

4.5.2 Collaboration

Ireland's MedTech ecosystem provides multiple opportunities for collaboration, asset sharing, supplier relationships and co-investment. Its mature, integrated medical technology community spans cutting-edge industry, academic and clinical research groups and government agencies.

In the evolving Med Tech space, the Irish eco system needs to facilitate interaction with leading names in software, engineering and industrial technology, cybersecurity and more

The existing world-class research centres which focus on medical devices, advanced materials, smart manufacturing, data analytics need to be further supported.

4.5.3 Competitiveness

Benchmark Ireland's current personal tax, tax credits and other incentives and state aid, and collate recommendations on how best to enhance Ireland's value proposition.

Monitor the evolving Global Tax Reform agenda and foster open discussions on its implications for current and future Irish business operations to minimise any adverse effects.

4.5.4 Talent

- See earlier comments re Higher Education
- There are over 50,000+ people employed in Ireland's MedTech industry. This makes Ireland the largest employer of MedTech professionals in Europe per capita.
- A deep pool of highly trained technical and managerial MedTech talent
- Fast-track support for employment permits for skilled international labour

4.6 Future developments in new device therapies and eHealth

Advances in robotic surgery are occurring at pace and the industry is seeing intense competition amongst the leading companies for market advantages.

New approaches for treatment of Atrial Fibrillation are being developed by a number of market leaders which use pulsed filed ablation and the technique has been shown to be less traumatic for the patients than previous techniques. This has given rise to a rapid expansion of treatment for this clinical condition and opened up new markets for the leading companies, all of whom have facilities in Ireland although they currently do not manufacture these devices in Ireland.

New technologies using biologics are emerging into clinical use and these approaches will need more sophisticated manufacturing facilities than the current plants. Such changes will need to be factored into future developments in the Irish Medical technology space.

4.7 Manufacturing Technology

The leading companies in Medical Technology space continue to enhance their manufacturing capability in Ireland on an ongoing basis.

For example, world leaders in 3D metal printing for medical devices, Stryker, have built a state-of-the-art manufacturing facility in Cork and continue to enhance their leading position in the industry through further expansion of its instrument manufacturing facility also in Cork.

Edwards Lifesciences have recently completed construction of a state-of-the-art facility for heart valve manufacture in Limerick and expect to grow the business further to meet demand for its leading-edge products.

4.8 Sustainability

The Medical Technology industry is committed to

- Support the industry to meet new sustainability, and environmental requirements, and create the necessary competitive advantage to attract investment and talent and build a differentiated customer offering.
- Develop a cross industry strategy for how Medtech can unlock the value from Ireland's future renewable energy supplies.
- Seek and lobby for private and public investment in innovation through incubators, academies, science parks, technology clusters to foster innovation from early stages.
- Support and lobby for development of national infrastructure that enables connectivity to enable businesses to compete internationally.
- Enhance Ireland's existing expertise, resource and investment in cybersecurity and establish Ireland as a best-in-class ecosystem that protects data and enables the ethical use of data

4.9 Major investment

Many of the major Medical Technology companies have already committed to fresh large scale capital investment. These include **Stryker, Boston Scientific, Medtronic, Dexcom, Johnson and Johnson, Edwards Lifesciences, Zimmer Biomet, Aerogen, BD and Integer**

4.10 Indigenous Medical Technology companies and start-ups

Galway has established itself as the 5th Medical Technology hub in the world and this has given rise to a steady increase in company locations in and around the city.

Furthermore, the University of Galway has established the Ian Quinn Centre for Medical Technology Innovation on the campus in 2024. This facility coupled with the CURAM Research Centre for medical technology funded by Research Ireland is expected to lead to a large growth in corporate and academic research, development and innovation both locally, nationally and internationally. Already, major research funding partnerships with Medtronic are in place and more are expected to follow.

Aerogen, an Irish owned large medical technology player has announced a €300m investment in new facilities in Galway and Shannon in recent days reflecting the strength of the west of Ireland as a location for medical technology companies.

Irish Medtech Strategy 2022-25 Irish Medical Devices Association,IBEC 2024

CHAPTER 5 THE BIOPHARMACEUTICAL INDUSTRY

5.1 Dismantling trade barriers

In 1958, a paper on economic development featured the state of industrial development in Ireland. The article highlighted our lack of industrial development, underdeveloped management skills, and shortage of capital to set up businesses. Ireland then had substantial trade barriers, including protective barriers and import quotas. Industries, such as car assembly, were protected by these tariffs. It mentioned that the pharmaceutical industry was almost non-existent.

People such as Sean Lemass and Dr TK Whittaker played an essential role in changing the restrictive industrial policy at the time. In 1958, the Department of Finance published the First Programme for Economic Expansion. It was 1963 before the measures recommended in the publication were implemented.

Sean Lemass, ministers Donagh O'Malley, and later Patrick Hillary led the reform of our education system. This reform shifted from a restrictive curriculum to a more modern approach, promoting increased adoption of technological methods.

5.2 From small beginnings

A 1958 report prepared before the implementation of free trade indicated that fewer than 20 pharmaceutical companies were operating in Ireland. Of these, thirteen were functioning under licensing agreements with foreign firms. Pharmaceutical exports from Ireland totalled £300,000, while imports were approximately £3 million. The industry employed 800 individuals and generated a turnover of £1.3 million.

George Fasenfeld, a German national, visited Ireland in 1933. His father had built a successful business buying cattle from Ireland for their operations in Germany. Fasenfeld played a key role in establishing Roscrea Meats alongside Irish partners the following year. As managing director, he expanded the business and began diversifying into producing medicines derived from animal products to treat diabetes and pernicious anaemia. In 1946, he founded Antigen and established a manufacturing facility to produce water for injection for the National Health Service in the United Kingdom. The venture proved highly successful, and in 1958, a new modern sterile facility was inaugurated by Sean Lemass, leading to an increase in employment to 120 individuals.

In 1959, another German national established a pharmaceutical plant in Bantry, County Cork. Rowa, a small yet successful pharmaceutical manufacturer in Germany, sought additional manufacturing capacity. To this day, their primary focus is on producing finished dosage pharmaceuticals and providing contract manufacturing services for other pharmaceutical companies.

Leo Laboratories, a subsidiary of a prominent Danish company with origins dating back to 1620, established a pharmaceutical manufacturing facility in Crumlin, Dublin. Initially, this facility produced finished products for their European sales force. Over time, the plant was expanded to include manufacturing bulk penicillin. Leo later established a subsidiary in County Cork to produce heparin in a newly built facility.

The 1960s was a decade of dramatic change for industrial expansion in Ireland. The shift from our insular thinking and trade protectionism was now reaping benefits.

Dr William Schuller, a brilliant and innovative chemist, established Loftus Bryan in County Wicklow. The facility was a large-scale, modern synthetic plant with excellent research and development facilities.

The first U.S. pharmaceutical multinationals began establishing manufacturing facilities in Ireland, with Pfizer opening its operation in County Cork and Squibb in County Dublin. Over the years, the Squibb plant significantly expanded its manufacturing capabilities. Similarly, the Pfizer site in County Cork has seen considerable growth,

including creating one of the largest fermentation units for citric acid production, primarily catering to the food and beverage industry. Today, Pfizer is one of the largest employers in Ireland, operating multiple manufacturing facilities and providing back-office support for various operations beyond our borders.

Since the 1960s, the impact of foreign direct investment from pharmaceutical companies has been remarkable. Thanks to the vision and foresight of dedicated politicians and public servants, the industry has become the state's leading generator of export revenues.

5.3 Overview of the Irish pharmaceutical industry today

Since the very modest beginning of the industry in Ireland, it has undergone remarkable growth.

The industry is now the world's third-largest exporter of pharmaceuticals, including MedTech and goods, with a value of over €110 billion. This accounts for approximately 65% of all exports.

Over 85,000 people are employed in well-paid jobs, and many more indirectly service the needs of the various companies. The industry is the largest employer of PhD's in numerous companies, helping improve process efficiencies here and in overseas affiliated companies.

19 top pharmaceutical companies operate in Ireland, including the top 10 global biopharmaceutical companies. Twelve of the top-selling global medicines are manufactured in Irish plants. Currently, approximately 90 pharmaceutical companies operate in Ireland.

In the past five years, these companies have invested over €10 billion in their facilities and plan to invest a further €10 billion in the next ten years.

The industry is expected to continue expanding by introducing novel products currently being developed. Last year, the IDA announced an additional €1.5 billion in new investments by their client companies. These investments are located across the country, with many new sites.

Most companies produce active pharmaceutical ingredients (APIs) or fill-and-finish operations, including sterile and non-sterile formulations, to serve the pharmacy market. In recent years, there has been a significant shift towards biological products that utilise cell biology for their development. Many of these products are classified as monoclonal antibodies (MABs) and conjugated monoclonal antibodies, which are used to treat numerous medical conditions that were previously considered untreatable.

Of importance, most of these companies are approved by the FDA to supply the US market. Ireland's reputation for compliance with the stringent Federal Code of Regulations is second to none.

5.4 The global pharmaceutical industry today

The past decade has seen unprecedented progress in the global pharmaceutical industry. Many would agree that in the developed world, we are witnessing a golden age of pharmaceutical innovation driven by a combination of scientific, technological and regulatory factors accelerating drug discovery. Diseases that once were not treatable some time ago are now being controlled or cured by an array of new novel therapeutic agents.

The industry has grown to over one trillion dollars.

The US Food and Drug Administration has approved approximately 900 medicines since 2000, many life-saving drugs. For example, the industry reacted rapidly to the onset of COVID-19 by developing vaccines that saved over 2 million lives. There have also been remarkable advances in the treatment of cancer.

Currently, 12,000 new clinical medicines are under trial, many of which will profoundly benefit patients in the future. Many of these novel products are in biologics, a fast-developing area of pharmaceutical research.

5.5 Looking to the future

Analysts believe that the industry will continue to expand through the discovery of new compounds and their introduction to global markets, which should lead to a compound growth rate of USD 240 billion by 2033.

The expectation is that drugs produced by chemical synthesis (API) will continue to be the dominant manufacturing area, but the production of biologicals will continue to expand rapidly.

Some of the recent launches of new products in novel therapeutic areas are generating considerable interest. One such area is the treatment of obesity and diabetes, which has been revolutionised by introducing **GLP-1 agonists**. With treatment, patients can lose considerable weight, and many who were suffering from diabetes have seen remarkable reductions in their blood glucose levels.

This category of drug is being used to explore the treatment of other major disease areas such as sleep apnea, addiction and Alzheimer's.

Sales of **GLP-1** drugs have recently reached $18 billion, and expectations are that this will grow to $105 billion by 2029.

A quiet revolution is underway in pharmaceutical research, with considerable work using **cell gene technology, Crisp-R and advanced therapeutic**s. Understanding how our body reacts to disease challenges and how our immune system responds is an exceptionally novel area of medical science.

Hepatitis C patients can now receive a treatment with a 95% cure rate. Last year, a treatment for a disease for which no treatment was available was approved for human use.

Figures show impressive progress in the treatment of cancer in the US. Since 1991, the death rate there has declined by 30%. Novel technologies are achieving further improvement.

This area of medicine is highly innovative and presents numerous challenges. Despite these difficulties, over 700 active research projects are currently underway. While there have been some setbacks in bringing these products to market, there have also been notable successes. Many large pharmaceutical companies are investing in these potential products. Venture capital investments are funding some smaller companies to develop discoveries from universities. Increasingly, major pharmaceutical companies use these avenues of research to source new products.

Micro RNA regulates disruptive and disorderly genes. Two US scientists, Victor Ambros and Gary Ruvkun, were awarded the 2024 Nobel Prize in Medicine for their ground-breaking work in this field. This area of genetic research is generating considerable interest within the scientific and pharmaceutical communities.

Areas such as Drug Conjugates and Crisp-R are also exciting developments. Last summer, a treatment for sickle cell disease was approved for human use, the first of its kind.

5.6 Future developments in new therapies

The output from drug research and development has never been so active.

Overall, there are over 12,000 new products in clinical development.

2,500 projects are using monoclonal antibodies to develop new therapies.

Approximately 900 new cell and gene-modification products are expected to be developed.

Over 200 products are being developed using RNA or DNA technologies.

Given our strong track record in Ireland, we are well-positioned to become significant players in the products emerging from these areas, requiring companies to upskill their workers.

However, these treatments are developing rapidly, and we must develop the necessary skills to attract investments in these novel areas.

5.7 Manufacturing Technology

Pharmaceutical companies take a long-term view of business planning. Some major companies have announced significant capital investment programmes to establish new manufacturing units in the US.

Lilly is building a new $4 billion fill-finish and R&D facility in Indiana.

Novo Nordisk has purchased a pharmaceutical company for $16 billion to augment its manufacturing capacity. It is also building a $4 billion new facility in North Carolina to produce its GLP-1 product, Ozempic.

The cost of medicines is very high, and companies are using modern technology to reduce the cost of goods.

Much of the investment goes into biological plants, where most new products will be produced.

Tools such as data analytics, AI, automated plants, and robotics are improving process efficiencies and reducing costs. AI, in particular, is seen as a tool to improve manufacturing systems. Machine learning is still in its infancy and is being explored to support better decision-making in plant optimisation, improve safety, and help with complex biological processes.

5.8 Sustainability

In the early days of the nascent pharmaceutical industry in Ireland, the industry had a negative image with the general public, particularly in the Cork Harbour area.

The industry is now considered a leader in environmental protection and continues to exemplify best ecological practices.

Many companies have advanced wastewater treatment plants, catalytic air scrubbers, and solvent recovery facilities, making considerable efforts to reduce their energy and water usage.

In Kerry, a plant has been using sustainable wood to fire its boilers, significantly reducing carbon emissions. It recently announced it is building a new plant in Tralee and will once again install wood-burning boilers.

Many companies have installed photovoltaic panels on their lands to reduce their electrical demand, and some have even installed wind turbines.

5.9 Major investment

The pipeline of foreign investment in Irish pharmaceutical plants remains strong and resilient despite the volatility of global conditions.

BMS is constructing a $400 million sterile drug facility in Blanchardstown, which will augment its supply chain for global medical products.

Alexion, in recent times, has spent over 1 billion euro on new facilities in Dublin and Athlone.

Eli Lilly announced last September an additional $1 billion investment in a new facility in Limerick, in addition to expanding their existing facility in County Cork. This new state-of-the-art facility will expand the production capacity of biological active ingredients for Lilly's treatment of Alzheimer's disease.

Cara and Partners in Co Cork are investing an additional €130 million in their site in County Cork.

Astellas, a Japanese pharmaceutical company with plants in Blanchardstown and Killorglin, has started constructing a $330 million fill-finish sterile plant in Tralee.

Bio-Marin, based in County Cork, is expanding its facilities with a $63 million expansion of its existing facilities.

West Pharmaceutical in Blanchardstown has acquired an additional site to expand its contract packaging of finished pharmaceuticals for client companies.

Merck recently announced purchasing and expanding an ultramodern biopharmaceutical plant in Dundalk. This will ensure the company can produce new products and clinical trial materials.

Aerogen, initially a small start-up Irish company, now has plants in Galway, Shannon and the US producing nebulisers for severe lung disease disorders. It recently announced it is branching into biological manufacturing to provide drug doses for its delivery technology. Employment will be increased to 1000 employees.

Many other API plants, such as BK BioPharma in Swords, Astellas in Blanchardstown, PTC Therapeutics, and many others, are also upgrading and expanding their manufacturing facilities.

The other significant factor in the global pharma industry is the ongoing annual investment in existing facilities committed by multinational companies. The combined annual budgets for relatively small upgrade projects would run into hundreds of millions of dollars.

Globally, there is an average capital investment of between $1 billion and $2 billion, and in some years when mega projects are in progress, that would easily surpass $3bn.

5.10 The supply chain to the pharmaceutical industry

Locally, many successful engineering companies, construction contractors, material manufacturers and suppliers have grown into significant operations from small beginnings due to the level of capital investment in the pharmaceutical industry.

Ireland has witnessed a growing number of design engineering firms engaging in creating complex facilities both domestically and internationally. A considerable number of these each employ more than 1000 professionals in Ireland with many more working in international markets. Most of these plants demand advanced and sophisticated designs to guarantee safe and efficient operations while adhering to the stringent standards set by regulatory bodies, such as the US Food and Drug Administration.

Many of these companies provide detailed engineering services, from basic design and planning applications to local authorities to the construction and commissioning of complex facilities. Their expertise in this high-tech industry is such that some of them now rank among the top design companies in the world in terms of pharmaceutical plant design capacity and capability. The leading Irish companies in this area are PM Group and DPS, while foreign-owned companies such as Arup and Jacobs Engineering also have a very strong presence in Ireland with significant experience and involvement in the Pharma Sector

In summary, engineering design is fundamental to the pharmaceutical industry. It ensures high-quality products, regulatory compliance, operational efficiency, and innovation. Its integration into all drug development and production stages supports the ultimate goal of delivering safe and effective medicines to patients.

A considerable number of contractors in the construction industry have also grown significantly on the back of this ongoing level of capital investment, particularly mechanical, electrical, and instrumentation contractors. They have also taken that expertise overseas to continue growing their businesses. The best examples are Mercury Engineering, Jones Engineering (H.A. O'Neill), Kirby Electrical, and Suir Electric.

Equipment manufacturers and material suppliers have also benefited significantly, with companies such as vessel manufacturers in particular growing to an international scale.

All of this ensures that a very strong supply chain is in place to support continued investment in Ireland by these companies

The success of the Irish pharmaceutical industry stems from **the quality of our graduates** and strong collaborations between third-level colleges and industry, with Science Foundation Ireland driving research and innovation.

Also, some of the remarkable **spin-offs from academia** include:

APC and VLE Therapeutics are great examples of our many successful spin-offs. Two talented academics, Professors Brian Glennon and Mark Barrett, both from UCD, set up these companies. They now employ 250 people, 90% of whom are PhD's. They plan to grow the company to 600 people in the next few years. They are the largest employers in the industry employing PhD's. They are working on over 100 medicines for most of the top 10 pharmaceutical companies.

Twenty-five years ago, two dynamic scientists, John Climax and Ronan Lambe established Icon to provide advanced clinical trial services to global pharmaceutical companies. The company is now a world leader in clinical trials and other areas and employs over 40,000 staff.

5.11 And finally

Multinational pharmaceutical companies, particularly those with their European headquarters in Ireland, have operated in Ireland for many years, drawn by factors such as favourable corporate tax rates, our entry into the European Union, the availability of English-speaking professionals, and a highly skilled workforce. As the competition for foreign investment has increased, numerous countries have begun offering tax incentives to attract such investments. Nevertheless, Ireland continues to excel in various dimensions. Our education system has proven effective in producing a well-prepared workforce, with many individuals holding PhDs in science and engineering. These companies have become integrated into the supply chains of their parent organisations, with numerous operations overseeing other plants and facilities throughout Europe and the Middle East.

Many companies offer essential services in quality control, regulatory quality assurance, health and safety, environmental management, process improvement, supply chain management, and analytical development for both local and international operations of parent multinational corporations. Additionally, some of these companies are developing automation systems for plant control using advanced information technology and artificial intelligence.

The pharmaceutical industry is a complex field that requires a highly skilled workforce. For many talented individuals, it presents an exciting and rewarding career path, offering opportunities for both practical and academic skill development. This appeal has attracted a significant number of highly educated professionals from abroad to Ireland. It is estimated that up to 18% of the pharmaceutical workforce consists of individuals who have moved to Ireland for work in this sector, and academia also continues to attract many well-qualified individuals.

In recent years, the IDA has supported the establishment of the National Institute of Biological Research and Training (NIBRT) to bolster the emerging biopharmaceutical industry. Last year, NIBRT successfully trained over 4,500 individuals across diverse training programs, ensuring a skilled workforce to drive the growth of this vital sector within pharmaceuticals. Recently, the IDA has also provided additional funding for NIBRT to expand its facilities, including training in Advanced Therapeutics, focusing on critical areas such as microbial cell lines and biological materials.

In an article in the pharmaceutical publication Pharmaphorum in 2023, the author summarised the industry's success in Ireland.

What is clear from speaking to various companies and organisations that have played a role in the development of Ireland's biopharma base is that future growth and investment has sprung from a long-term strategy. The Irish government, industry associations, and the pharma industry itself helped build a solid foundation, which has culminated in Ireland becoming one of the centres of the industry in Europe, and the world.

CHAPTER 6 CONSTRUCTION INNOVATION AND REGULATION

6.1 Introduction

The Irish construction sector is a major driver of economic activity. The industry is responsible for providing the social, economic and productive infrastructure required to sustain economic growth and competitiveness and attract foreign direct investment.

With National Development Plan 2021-2030 costing €165billion to deliver and to tackle the housing and climate challenges, the industry needs to move away from manual processes and traditional forms of construction to smarter, more efficient and more sustainable ways of construction.

6.2 The Story So Far.....

The Construction Sector Group (CSG) was set up by Government in early 2018 consisting of 50:50 Government departments and the construction industry. This coincided with the Government initiating Project Ireland 2040 at the same time to ensure that the essential housing and infrastructure would be built by 2040 to cater for another 1 million people living on our island. Since then, the CSG has become a powerful mechanism to ensure that that government and industry have remained in step with each other as the industry has recovered from the deepest of recessions brought about from the 2008 – 2013 banking collapse and subsequent bailout.

In September 2020, The Construction Sector Group (CSG) Subgroup for Innovation and Digital Adoption was set up as a first attempt to modernise the Irish Construction industry. In June 2020, the KPMG Report on Productivity in the Irish Construction Sector was delivered to the Department of Public Expenditure and Reform.

The key issues were identified and concentrated on the elements of change which would have the best and more immediate impact. These were the areas which could impact particularly on productivity and sustainability. The productivity of the construction workforce had been assessed by KPMG as being half that of the best performing Benelux and Nordic countries. It emerged that the relatively high productivity in these Northern European Countries, was due to their widespread use of digital systems or Building Information Modelling (BIM) on their major projects.

The Construction Sector Group facilitated the invaluable opportunity to adopt the learnings and most modern policies and techniques from across Europe and further afield to realise a brand new industry to compete both nationally and internationally.

From the KPMG Report, the seven most urgent tasks to modernise our industry were adopted which has stepped up in terms of digital adoption (BIM) for design and Modern Methods of Construction for construction of the National Development Plan 2021 – 2030. Not only has approach been favoured by industry to increase productivity but also in sustainability terms to meet the exacting new climate and carbon emission targets set out in Climate Action Plan 2023.

Now, as 2030 approaches, we are increasingly adopting the concept of the Circular Economy in construction where handling waste is no longer a cost on projects but an opportunity to conserve and recycle recoverable resources whenever we can.

6.3 Construction Sector Group

The CSG Subgroup has now been streamlined to match the ambition of the 2020 KPMG Report on productivity in the Irish construction sector. Since the formation in 2020, the Subgroup has availed of the expert knowledge and skills of some hundreds of our industry colleagues under seven Priority Actions/Leaders as follows:

6.3.1 Undertake Construction Research with industry working collaboratively with government to solve 'real life/ on site' problems and challenges (now integrated into Action 3.4 below).

6.3.2 Import sustainability into all of our projects to include circular economy approaches and thus to 'design out waste' in projects led by the Royal Institute of Architects of Ireland.

In collaboration with the Department of Environment, Climate and Communications, a detailed study was undertaken by the CSG Sustainability and Climate Action Group leading to a Circular Economy Roadmap to comply with the Circular Economy Act 2022.

This examined the impact of Construction and Demolition Waste, which was found to be responsible for 37% of all Greenhouse Gas Emissions, 50% of all mineral extraction, 33% of potable water usage and 50% of total waste in Ireland according to the Irish Green Building Council. In terms of Irish construction, it requires an increasingly measurable transition from linear to circular economy practice through reuse, repair, recycling, remanufacture, maintenance and refurbishment and calls for innovation, critical thinking and adoption of best practice in Ireland.

In a circular economy system less raw materials are used and products are designed for long-life and recyclability. Products are shared, and we use them for longer and reuse and repair them before we recycle and before we throw them away. Embracing circular principles means resources are kept in use as long as possible, creating a closed-loop system that minimises waste and maximises the value of resources so that future construction and infrastructure activities and materials we choose are re-usable, repairable and recyclable.

6.3.3 Set up systems for offsite construction to build momentum on Modern Methods of Construction (MMC) to replace the once widespread use of 'bricks and mortar' – roadmap published by Department of Enterprise Trade and Employment with National Standards Authority of Ireland (NSAI) to ensure certification of products.

This requires transition to Modern Methods of Construction (MMC) through the greater use of 'modular build' practice. Also termed 'Off Site Construction' (OSC) as this form of construction is normally carried out in large factories where staff and operational plant are protected from the impacts of weather. Potential benefits of MMC include faster construction where time savings can range from 20% to 60%, depending on the circumstances. There can be up to 70% reduction in the onsite labour and savings in cost in the range of 20% to 40% while overall, greater programme certainty should be achieved.

A number of large contractors tend to use MMC as part of their main activities of being a 'main contractor'. Thus MMC systems use sub-assemblies, panelised systems in 2D and 3D, volumetric or modular systems and bathrooms/kitchen pods.

There are however significant upfront financing challenges with MCC and additional risks in architectural design and manufacturing processes.

In a recent survey, the perceived future importance of MMC was stronger amongst larger firms, with 86% of larger firms highlighting the importance of MMC to the future of the industry. With an average of potentially 50,000

homes required each year, MMC can help address the housing shortage supply shortfall more speedily, while also delivering well-designed and high-quality buildings, cost savings and higher productivity.

6.3.4 Enterprise Ireland to set up a Construction Technology Centre in 2022 which became the National Construction Technology Centre now rebranded 'Construct Innovate' hosted in one of our universities to become a 'dedicated research engine', now based in the University of Galway together with support from UCD, TCD, UCC, Irish Green Building Council and TU Dublin.

Enterprise Ireland undertook a Detailed Description of Needs to ascertain what type of Construction Technology Centre was required through extensive consultations with industry. It was known that Ireland's adoption rate of MMC is low though it is widely accepted that it has the potential to improve the speed of construction by 30% with considerable reduction also in delivery times, onsite labour by up to 70% and greater programme certainty.

Three important lessons that emerge for the establishment of a Construction Technology Centre are Communication, Collaboration and Commercialisation.

'Construct Innovate' works as a research engine where industry and Enterprise Ireland share the cost of undertaking projects. The projects are identified based on real life construction challenges which require a solution. Priority was given to housing type projects in the early years to accelerate housing in particular but also infrastructure. Much emphasis is placed on low carbon solutions and ways of lowering the embedded carbon footprint of projects. Investigations are also seeking to identify innovative materials in modular design projects. Buildings and their construction account for 39% of all carbon emissions with operational carbon accounting for 28% and embodied carbon the remaining 11%.

When deciding the mix of funding required, consideration should be given to the fact that in the region of 6 government departments who are the promotors of major building and infrastructure projects in the National Development Plan, Project Ireland 2040, Housing for All Plan and the Climate Action Plan.

6.3.5 Establish a Construction led Skillnet to identify the future skills required for the building of the National Development Plan (CIF together with Department of Further and Higher Education, Research, Innovation and Science).

6.3.6 Digitise the current planning permission applications system from the current paper-based system (Local Government Management Agency and local authorities, now almost fully implemented)

There are 31 local authorities with responsibility for Planning Permissions in Ireland. In each local authority area prior to the setting up of the CSG in Autumn 2020, each planning application was a 'paper based exercise' whereby each applicant wishing to apply for planning permission was required to submit 4 hard copies of each application running to thousands of pages to the local authority.

Commencing in 2021, steady progress was achieved to bring 27 local authorities onto a new national planning portal. Cork County Council, Cork City Council and Wexford County Council are planning to join the portal in Q2 of 2025. Already most counties are using the portal which was designed by the Local Government Management Agency (LGMA).

In most counties and cities, most (over 80%) applications from residents and their agents report that their applications are now accepted on line on the national portal with no requirement for any hard or paper copies.

6.3.7 Establish and fund a Build Digital Project across Ireland by the Department of Public Expenditure and Reform for BIM and digital adoption, now led with TU Dublin and Grangegorman Development Authority (GDA) together with MTU, ATU, UCD, TCD and Irish Green Building Council.

The Build Digital Project was awarded to TU Dublin and their technological university partners initially in partnership with CitA which was subsequently changed to a partnership with the Grangegorman Development Authority. The project is currently in year 4 of a 5 year grant agreement funded by the Department of Public Expenditure and Reform.

The immediate priority is to service the Building Information Model (BIM) requirements for the major public projects in the National Development Plan e.g. Metrolink a new underground rail link between Dublin City Centre and Dublin Airport/Swords in North County Dublin and many of the principal new hospitals, schools and universities in the Dublin Area. Major projects are also being designed using BIM to realise the Bus Connects projects in Dublin, Cork, Limerick and Galway.

A BIM Mandate was introduced in 2024 by the Department of Public Expenditure and Reform requiring all major public projects to be designed on BIM in order to expedite projects costing in excess of €20millions. The requirements to improve the productivity and sustainability of future buildings in Ireland will require the use of BIM to accelerate construction and ensure that construction processes are made more efficient and sustainable.

The use of 2- and 3-BIM will ensure that future construction is well managed in terms of technical accuracy and sustainable materials while 4D BIM requires that projects are completed on time, 5D ensures that the project is within budget, 6D measures the carbon footprint and 7D processes will control the delivery of the built asset. It is estimated that 80% of the overall building cost is in the running and maintenance costs while the design/ construction normally account for remained 20%.

In addition to the CSG Subgroup's work, a further significant government initiative took place in the refresh of the Project Ireland 2040 Delivery Board in early 2024. This is the board which meets regularly to ensure effective leadership of the implementation of both the National Planning Framework and the National Development Plan. In January 2024, the membership of this board was changed to include five independent external members and the Minister for Public Expenditure and Reform became the Chair of the new board. He then became the Minister for Public Expenditure NDP Delivery and Reform. With Government approval, the Minister's title now includes 'NDP Delivery' to emphasise the importance of infrastructure such as water, power and transport in addition to housing.

The new board reporting directly to the Minister as Chair has also now taken responsibility for the seven Priority Actions of the CSG Subgroup. This change of governance greatly strengthened the 'innovation and digital adoption' remit of the CSG Subgroup.

To summarise, construction in Ireland is currently being transformed to meet the challenges posed by the need to deliver the ambitious National Development Plan with greatly increased productivity and sustainability, also to enable meeting the ambitious challenges of the Climate Action Plan. This innovation can only be achieved through real day to day collaboration between government and industry as has happened with the setting up and ongoing involvement of the Construction Sector Group since 2018 and its Innovation Subgroup since 2020.

The priority of the CSG is to enable the construction sector to sustain viable companies in order to produce high quality construction output, thereby delivering better value for money and key national priorities as detailed in Project Ireland 2040. Specific helpful policy objectives of the CSG include communication to support industry confidence, securing the skills pipeline, drive growth and productivity, improve value for money and to encourage a sustainable and resilient industry.

6.4 Building Regulations and Compliance

The Irish Building Regulations under the control of Department of Housing, Local Government and Heritage provide for the safety and welfare of people in and about buildings. They also apply to the design and construction of a new building or an extension of an existing building. The minimum performance requirements that a building must achieve are set out in the second schedule to the building regulations. These requirements are set out in 12 parts (classified as Parts A to M).

Under Housing for All, the Government's housing plan to 2030, a Building Regulations Advisory Body consisting of key construction industry stakeholders across private and public sectors will be established to advise the Minister on matters relating to the Building Regulations. Existing Building Regulations will be reviewed on an ongoing basis.

Technical Guidance Documents demonstrate how the requirements of each part of the Building Regulations can be satisfied.

The Building Control Documents require Owners, builders, and registered construction professionals to demonstrate through the statutory Buildings Control Management System (BCMS) that the works or building have been designed and constructed in compliance with the Building Regulations.

The Building Control (Amendment) Regulations 2014 known as BCAR set out the roles of Design Certifier and Assigned Certifier. These roles can be carried out only by Registered Architects, Chartered Engineers and Chartered Building Surveyors. The Assigned Certifier is appointed by the Building Owner to develop an inspection plan, inspect and coordinate inspections of the professional design team and certify the compliance of the building or works with the Building Regulations. Professionals acting as Assigned Certifiers are bound by the Code of Ethics and professional best practice.

In the case of MMC , to ensure compliance on new or novel materials such as modular panels, they have to comply with Agreement Certificates issued by the National Standards Authority of Ireland (NSAI).

CHAPTER 7 ARTIFICIAL INTELLIGENCE [AI] – FUTURE OPPORTUNITIES

7.1 Introduction - What is AI?

AI is a set of technologies that enable computers to perform a variety of advanced functions, including the ability to see, understand and translate spoken and written language, analyse data, make recommendations, and more.

AI makes it possible for machines to learn from experience, adjust to new inputs and perform human like tasks. Most AI examples that you hear about today – from chess-playing computers to self-driving cars – rely heavily on deep learning and natural language processing.

Artificial intelligence is a specific branch of computer science concerned with replicating the thought process and decision-making ability of humans through computer algorithms.

AI is now being used in almost every business sector. Examples include:

- Transportation
- Healthcare
- Banking
- Retail
- Entertainment
- E- Commerce
- Manufacturing
- Smart Cities

7.2 Important technology definitions associated with AI

Machine Learning (ML)

AI systems capable of self-improvement through experience, without direct programming. They concentrate on creating software that can independently learn by accessing and utilizing data.

Deep Learning

A subset of ML involving many layers of neural networks. It is used for learning from large amounts of data and is the technology behind voice control in consumer devices, image recognition, and many other applications.

Natural Language Processing (NLP)

This AI technology enables machines to understand and interpret human language. It's used in chatbots, translation services and sentiment analysis applications.

Large Language Models (LLMs):

LLMs are a specific type of machine learning model designed to understand, generate, and process human language. These models are usually based on deep learning techniques, particularly transformer architecture, and are trained on vast amounts of text data.

Robotics

This field involves designing, constructing, operating, and using robots and computer systems for controlling them, sensory feedback, and information processing.

Computer Vision

This technology allows machines to interpret the world visually, and it's used in various applications such as medical image analysis, surveillance, and manufacturing.

Expert Systems

These AI systems answer questions and solve problems in a specific domain of expertise using rule-based systems

7.3 History and Background to AI

The history of Artificial Intelligence (AI) spans several decades and involves key milestones and breakthroughs. In 1936, British mathematician Alan Turing proposed the **Turing Machine**, a theoretical device that became foundational to the idea of computation and algorithms. In 1956, John McCarthy coined the term **"Artificial Intelligence"** at the Dartmouth Conference, where the field was officially born. In 1950, Turing also proposed the **Turing Test**, a measure of a machine's ability to exhibit intelligent behaviour. Due to overhyped expectations and slow progress in 1970s and 1980s, funding and interest in AI research decreased, leading to periods known as "AI winters."

7.3.1 Rise of Machine Learning (1990s-2000s):

- AI research shifted towards **machine learning** and **neural networks**, where computers could learn patterns from data rather than relying solely on programmed rules.
- In 1997, IBM's **Deep Blue** defeated world chess champion Garry Kasparov, marking a significant achievement for AI.
- In the 2000s, AI applications began to emerge in areas like search engines, language translation, and recommendation systems.

7.3.2 Deep Learning and Modern AI (2010s-Present):

The development of **deep learning** algorithms, particularly neural networks with many layers, led to significant advances in areas such as image recognition, natural language processing, and autonomous vehicles.

AI technologies are now used in numerous industries, from healthcare to finance, and continue to evolve rapidly, with ethical concerns and the impact on jobs being central to ongoing discussions.

7.4 Generative AI - what is it ?

Generative AI or gen AI is a type of AI that can create new content and ideas, like images and videos. It can also reuse what it knows to solve new problems.

The recent explosion of AI is down to advances in machine learning algorithms and increased computer power in terms faster central processing units [CPU] and the extensive use of Graphic Processing Units [GPU]

With investment from Industry and increasing public awareness, these factors have driven speedy advancements in the AI field.

7.4.1 ChatGPT

ChatGPT is an advanced AI language model created by OpenAI. It is designed to understand and generate human-like text based on the prompts it receives. Using vast amounts of text data, ChatGPT can engage in a wide range of conversations, answer questions, provide information, assist with creative tasks, and much more.

7.5 Data and AI

AI and data are closely interconnected, as data is essential for training and improving AI models.

Training AI: AI systems, particularly machine learning models, rely heavily on large amounts of data to "learn." This data is used to identify patterns, make predictions, or understand various aspects of the world.

Big Data: AI is often associated with the use of "big data," which refers to vast volumes of structured and unstructured data that are processed at high speed. AI algorithms, especially those used in deep learning, are designed to handle and extract useful information from these large datasets.

Data Privacy and Ethics: The use of data in AI also raises concerns regarding privacy, consent, and ethics. Data used to train AI should be obtained and used responsibly, ensuring compliance with laws like GDPR and focusing on transparency and fairness.

7.6 Data Centres and AI

AI models, especially deep learning models, require vast amounts of computational resources to process and analyse data. Training these models involves running complex mathematical operations on large datasets, which necessitates powerful computing hardware. Data centres house the high-performance servers and specialized hardware, such as Graphics Processing Units (GPUs) and Tensor Processing Units (TPUs), which are optimized for AI tasks.

Data centres play a critical role in the functioning of AI systems. As AI technology continues to advance, the demand for processing power, storage, and high-speed networking increases.

Interestingly, AI is also being used to optimize data centres themselves. AI-powered systems are used to manage energy consumption, monitor performance, detect potential issues, and even predict hardware failures. This leads to more efficient and sustainable data centre operations.

- **Predictive Maintenance:** AI models can analyse historical data to predict when hardware components (such as servers or cooling systems) might fail, allowing data centres to conduct proactive maintenance.
- **Energy Efficiency:** AI is being used to optimize cooling and power systems in data centres, reducing costs and environmental impact

7.7 Jobs and Skills

AI is reshaping the job landscape, offering both challenges and opportunities. While some jobs or, elements of them may be displaced, new roles will emerge, particularly in tech and AI-centric industries. AI and automation are especially effective at handling repetitive tasks in sectors like manufacturing, logistics, and customer service.

As AI continues to evolve, demand for roles in AI development, machine learning, data science, and software engineering grows.

The need to upskill and reskill with AI has become more critical in today's rapidly evolving job market. As artificial intelligence continues to transform industries, it's reshaping how work is done, the types of jobs available, and the skills required to succeed.

7.8 Manufacturing: AI Case Study

AI is increasingly playing a transformative role in the manufacturing industry by enhancing efficiency, productivity, and quality. Here are some of the ways AI is being used in manufacturing:

Robotics and Automation

Collaborative robots (cobots) powered by AI can work alongside human operators, handling repetitive tasks with precision. AI also enhances fully automated manufacturing systems by enabling robots to adapt to variations in the production process.

Energy Management

AI is used to optimize energy consumption in manufacturing processes. By analysing energy usage patterns and adjusting operations accordingly, manufacturers can reduce costs and improve sustainability.

Process Optimization

AI algorithms can analyse manufacturing processes in real-time, identifying inefficiencies or bottlenecks. By optimizing these processes, manufacturers can improve throughput, reduce waste, and lower production costs.

Advanced Simulation

AI is used in simulations to model manufacturing processes, allowing for the testing of different scenarios before physical implementation. This helps optimize designs, production lines, and workflows, minimizing trial-and-error in real-world environments.

7.9 What will AI be like in 2025 and beyond.

The future of AI will likely evolve in several key directions, driven by advancements in technology, ethics, and societal needs. AI systems will become even better at understanding and mimicking human behaviour. Voice assistants, chatbots, and digital companions will feel more natural and emotionally intelligent, with the ability to recognize nuances in tone, sentiment, and context. They might even develop the ability to hold more meaningful, long-form conversations.

As AI becomes more powerful, the development of ethical guidelines and regulatory frameworks will be crucial to ensure that these systems are used responsibly. Topics like privacy, fairness, bias reduction, and transparency will take centre stage in AI research and policy-making.

AI will increasingly be used as a tool for creative industries, including art, music, writing, and film. We'll see collaborations between human artists and AI systems to produce new, innovative works, and AI might even generate content autonomously in some cases.

We may see breakthroughs in interfaces that allow people to interact with AI more seamlessly, such as brain-computer interfaces, advanced augmented reality (AR), and virtual reality (VR) technologies. These interfaces could allow more intuitive ways of controlling and interacting with AI systems.

Some relevant links

Link to European Parliament website on AI
https://www.europarl.europa.eu/topics/en/article/20200827STO85804/what-is-artificial-intelligence-and-how-is-it-used

National AI Strategy Refresh 2024
https://enterprise.gov.ie/en/publications/national-ai-strategy-refresh-2024.html

Over the next 15 years, Ireland is likely to see significant developments driven by advancements in AI and related technologies. Some key areas of growth could include:

7.10 AI-Driven Industries and Startups

AI in Pharmaceuticals & Biotech: Ireland is already a hub for the pharmaceutical and biotech industries. With the integration of AI in drug discovery, personalized medicine, and clinical trials, we may see new biotech companies that leverage AI for faster and more efficient drug development.

AI-Enhanced Manufacturing: Companies could use AI for predictive maintenance, automation, and process optimization in manufacturing, especially in high-tech sectors like electronics, medical devices, and automotive.

7.10.1 Green Tech and Sustainability

AI in Renewable Energy: Ireland has strong renewable energy potential, particularly from wind power. AI could be employed in managing and optimizing the grid, forecasting energy production, and improving energy storage solutions.

Smart Agriculture: With AI-driven solutions for precision farming, Ireland may lead in sustainable agriculture, optimizing crop yields while minimizing resource usage and reducing carbon footprints.

7.10.2 Smart Infrastructure and Urban Planning

AI in Urban Development: AI could revolutionize how cities in Ireland are planned and developed. Smart infrastructure, traffic management, and predictive maintenance for public services (like water, waste management, and transportation) could transform urban living.

Autonomous Vehicles: Ireland may witness developments in self-driving cars, especially with rural connectivity and urban transport systems. AI could also be used to manage transportation networks, reducing congestion and enhancing safety.

7.10.3 Digital Economy and AI Products

AI-Powered Software and Platforms: The rise of AI-driven platforms across various industries (e.g., finance, insurance, retail) may lead to new products developed by Irish companies in sectors like fintech, e-commerce, and data analytics.

AI in Cybersecurity: As cybersecurity threats evolve, AI-based solutions will be crucial. Ireland may become a leader in developing AI solutions to combat cyber threats and safeguard critical infrastructure.

7.10.4 Education and Talent Development

AI in Education: The education sector in Ireland may see a transformation with AI-powered learning platforms, personalized curricula, and intelligent tutoring systems. The demand for AI-related skills will continue to drive innovations in training and education programs.

AI Research & Development: Given Ireland's strong focus on research and development, we can expect continued investment in AI research. New AI algorithms, models, and tools may emerge from both academic institutions and startups.

7.11 Regulatory and Ethical Frameworks

AI Governance: Ireland may play a key role in shaping AI regulations and ethical frameworks at both the European Union and global levels. This could involve the development of policies around data privacy, AI transparency, fairness, and accountability.

7.11.1 Talent Attraction & Retention

AI Talent Hubs: With companies like Google, Facebook, and Microsoft already having a presence in Ireland, there could be an even greater influx of AI talent and research, making Ireland a centre of excellence for AI development and innovation.

7.12 Conclusion

AI will likely be a driving force behind many transformative developments in Ireland's economy and society. The integration of AI across industries, from healthcare and manufacturing to energy and transportation, will create new opportunities for businesses and citizens alike.

Disclaimer

The members of the Taskforce and the contributors participated in extensive discussions in the course of a series of meetings, and submitted comments on a series of draft reports. This report represents the collective view of the Academy , and its recommendations do not necessarily reflect a common position reached by all members of the Taskforce and do not necessarily reflect the views of individual members of the Taskforce, nor do they necessarily reflect the views of the organisations to which they belong.

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