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Strategic Public Infrastructure: Capacity and Demand Analysis

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Summary

An adequate and efficient level of infrastructure is a critical enabler of economic and social development across the key areas of the State. The Mid-Term Review of the Capital Plan provides a framework to consider progress in delivering investment projects and prioritisation in the context of the availability of additional capital expenditure.

The purpose of this paper is to provide an overview of the existing infrastructure and activity demand across the key areas of economic infrastructure. The paper contributes to the evidence base assembled through the Capital Review process and provides a number of findings including:

- On average over the period 1995-2015, Ireland's public GFCF as a share of GNP was 3.7% compared to the EU15 average of 3.0% of GDP. Following a decrease in line with the economic downturn, the level is expected to return to around the EU15 average in 2021.
- There are a variety of drivers which impact the use of infrastructure. Two critical drivers are demographics and economic growth, while spatial and climate impacts are important considerations.
- The sectoral analysis shows a number of trends including:
    - Transport demand is growing and would be expected to expand further in future years in line with forecast economic growth rates.
    - In the Health sector, a continued shift towards primary care can help meet the growing demands of an ageing population; further research is required to assess overall capacity needs.
    - In Education, the number of students set to attend third level will increase which may exert further pressure on capacity.
    - Significant pressure is evident in the housing sector. Commitments made under the Action Plan for Housing and Homelessness mean that €5.35 billion will be invested in 47,000 units across a range of delivery mechanisms. Furthermore, housing output delivered by the private sector is expected to pick up over the coming years.
    - Planned investment by Irish Water out to 2021 seeks to strike a balance between the demand for water infrastructure investment and the constraints that currently exist in terms of affordability, planning requirements and supply chain issues.

The identified sectoral demands and constraints highlight the need for a concerted focus on getting project selection right in order to ensure that the underlying problem is addressed and that value for money is achieved. In this regard, it is vital that individual projects are selected on transparent criteria and well-established methodologies as outlined in the Public Spending Code.

1. Introduction and Context

Infrastructure provides the fundamental basis for a modern functioning society and economy. It can contribute to resilience and strengthen economic growth by lowering costs, improving efficiency, increasing productivity and enhancing competitiveness. Infrastructure in the areas of housing, water, schools, hospitals and transport provides the social basis from which our society functions.

However, given the nature of infrastructure, there are numerous constraints surrounding the delivery of such capital investment. These constraints include: fiscal limitations and issues of affordability; the capacity of the construction sector to supply all the desired infrastructure at a given time; the administrative capacity of the planning system; climate change commitments and environmental constraints; and concerns relating to price inflation and value of investment. The nature of these limitations and how they can be managed are discussed in the macro-economic analysis of the Capital Review as well as previous IGEES papers[1]. Capacity constraints on the delivery of infrastructure in Ireland were also an important theme throughout previous studies by the ESRI in relation to Ireland's National Development Plans[2].

In light of these fundamental constraints, it is therefore necessary to make policy decisions as to what sectors and projects should be prioritised over the coming years. The Mid-Term Review of the Capital Plan provides a framework through which such constraints, along with demands, are considered. The review has involved the compilation of available evidence to support this process including macro-economic analysis, a public consultation, detailed submissions from Government Departments, as well as ongoing analysis by DPER.

Purpose and Scope of Paper

The purpose of this paper is to contribute to the Mid-Term Review's evidence base by detailing sectoral trends in activity, demand and existing infrastructure. As such, its main objectives are to:

- analyse primary areas of infrastructure in terms of historical investment and demand trends; and,
- provide clear and concise sectoral analysis to contribute to overall decision making in the context of the Mid-Term Review of the Capital Plan.

The focus of the paper is thus on providing a high level overview of investment levels, existing infrastructure and demand/activity across each of the primary areas of infrastructure. It is important to note a number of points in relation to the approach, scope and limitations of the paper from the outset. Firstly, the sectoral analysis is based on available data and as such the level of detail varies by sector. Secondly, the paper focuses on physical infrastructure across key sectors of the economy and it does not extend to all areas of Government capital expenditure. Most notably, consideration of capital grant schemes is excluded. Other sectors, not

[1] Dormer, E. and Ivory, K. (2015), Irish Government Economic and Evaluation Service, The Context for Public Capital Investment
[2] ESRI (2006), Edited by Edgar Morgenroth and John FitzGerald, Ex-Ante Evaluation of the Investment Priorities for the National Development Plan 2007-2013.

accounting for a significant share of overall public capital investment such as Justice, Defence, Sports, Arts and the OPW are not included in the high level analysis here but are considered in detail as part of the Mid-Term Review. Finally, the sectoral analysis provided through the paper should be read as a high level contribution to the evidence base for each area. The scope of this paper does not extend to assessing sector specific issues in further detail such as individual projects or issues.

In this introductory chapter, the rationale for investing in public infrastructure will be outlined along with an examination of the trends in capital investment in Ireland over the past twenty years. Looking to the future and the Capital Plan out to 2021, some of the primary drivers of demand for infrastructure will be discussed. Finally, this chapter will conclude by outlining some of the key principles of demand management and how it can be utilised in order to ensure the efficient use of existing infrastructure.

Infrastructure Investment and Government Intervention

Infrastructure is an essential element of a functioning modern society and economy. It can contribute to the general welfare of society, environmental sustainability and economic productivity. Targeted investment in infrastructure can improve the general welfare of citizens through the provision of basic social services such as health, education and housing, particularly in regions where the role of the private sector in the provision of such services could be weak or even non-existent. The primary economic benefit from infrastructure is derived from its long-term impact on productivity, thereby increasing the State's economic capacity. A recent meta-analysis carried out by Bonn and Ligthart (2014) found that doubling the stock of infrastructure increases GDP by approximately 10%[3]. Investment in infrastructure can increase competitiveness by reducing costs e.g. through improved transport and energy infrastructure, or through facilitating innovation e.g. through the delivery of broadband and education. Economic theory and research provides a clear justification for Government intervention in the provision of public infrastructure[4]. The primary reasons are due to:

1. market failure: as the benefits of public goods are often underestimated, the market will generally provide a sub-optimal level of public goods, therefore requiring public intervention.
2. redistribution: the State may also intervene and provide capital investment for redistributive objectives, to transfer resources to those on lower incomes, for example, through the provision of public health, education and social housing investment.

While there is a clear theoretical basis for public provision of infrastructure, it should also be noted that not all public investment will necessarily be efficient and not all infrastructure projects will provide the same returns. It is also possible to over provide infrastructure[5]. In order to ensure value for money in public

[3] Bonn, P. and J. Ligthart (2014), "What Have we Learned from Three Decades of Research on the Productivity of Public Capital?", Journal of Economic Surveys, Vol. 28, No. 5, 889-916.
[4] See Richard Cornes and Todd Sandler, (1996) The Theory of Externalities, Public Goods, and Club Goods, Cambridge University Press
[5] E.g. the Spanish airports, Castellón and Cuidad Real, which were built in 2011 and 2008 and lay empty for many years.

investment it is vital that individual projects are selected on transparent criteria and well-established methodologies. In Ireland, the Public Spending Code and the establishment of the Irish Government Economic and Evaluation Service (IGEES) play a crucial role in ensuring that this objective is met.

Historical Context of Public Investment in Ireland

Given the extended lifetime of capital infrastructure once it has been delivered[6], trends in public capital investment should preferably be examined over an extended time horizon in order to give a more accurate assessment of infrastructure investment in a country. The analysis provided here will focus on the period from 1995 onwards.

Gross Fixed Capital Formation (GFCF) is defined in the European System of Accounts[7] as tangible or intangible assets produced as outputs from production processes that are used repeatedly, or continuously, for more than one year. This includes: buildings and structures (including major improvements to land); machinery and equipment; weapons systems; cultivated biological resources, e.g. trees and livestock, etc. To be classified as public GFCF it must be recorded as being on the General Government balance sheet. The General Government Balance sheet includes both central and local government expenditure.

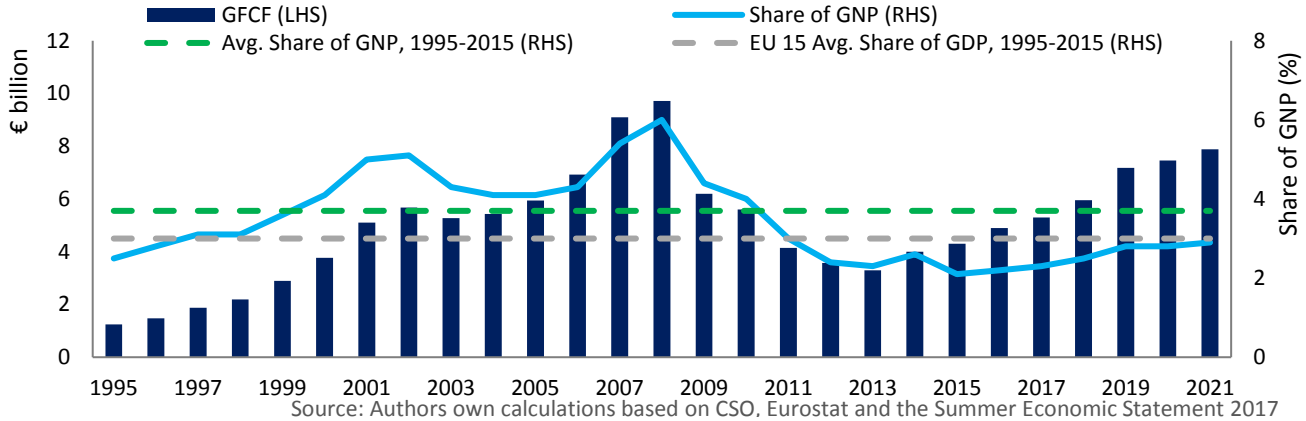
As the Irish Fiscal Advisory Council have noted, Ireland's public capital stock was above all the comparator countries, bar the UK, over the period 1998-2014[8]. On average over the period 1995 to 2015, Ireland's expenditure on public GFCF as a share of GNP was 3.7%. This is in comparison to the EU15 average over the same period of 3.0% of GDP[9]. This was at a time when Ireland was addressing major infrastructure deficits such as the motorway network. Capital expenditure grew rapidly over the period 1995 to 2008, increasing from 2.5% of GNP to an ultimately unsustainable level of 6% of GNP. The ESRI noted in its research at the time that the level of investment in physical infrastructure over the period 2000-2006 was ramped up too rapidly with significant inflationary consequences for construction as well as project management difficulties[10]. With the onset of the economic recession, capital spending was reduced from its peak in 2008, falling in each of the next five years from 2009 to 2013. In nominal terms, capital expenditure has increased every year since 2013 and will continue to do so in the coming years, (as shown in Figure 1.1) reaching an expected 2.9% of GNP by 2021.

In noting that the trend leading up to the period to 2008 represented an unprecedented level of public capital expenditure, Scott and Bedogni (2017)[11] also point to research calling into question the efficiency of this investment and whether value for money was achieved, stating that "*the magnitude of public capital spend in*

[6] See Part 2 of OECD (2009), Measuring Capital OECD Manual, Second Edition
[7] ESA 2010, page 73
[8] See Figure F.2, page 75, IFAC Fiscal Assessment Report, June 2017
[9] The EU 15 Average is used as the comparator here as these states are at a relatively similar stage of economic development to Ireland.
[10] ESRI (2006), Ex-Ante Evaluation of the Investment Priorities for the National Development Plan 2007-2013, Pg. 319
[11] http://igees.gov.ie/wp-content/uploads/2017/06/The-Irish-Experience-Fiscal-Consolidation-2008-2014.pdf

the period preceding the downturn, particularly given the overheating and price inflation in the construction sector, has led to concerns that the link between analysis and policy-making during this period, particularly in relation to capital expenditure, could have been improved to ensure more appropriate investment priorities [Morgenroth (2014); Ruane (2012)]." The message here is clear, sudden and significant increases in capital expenditure have previously resulted in poor value for money from that investment.

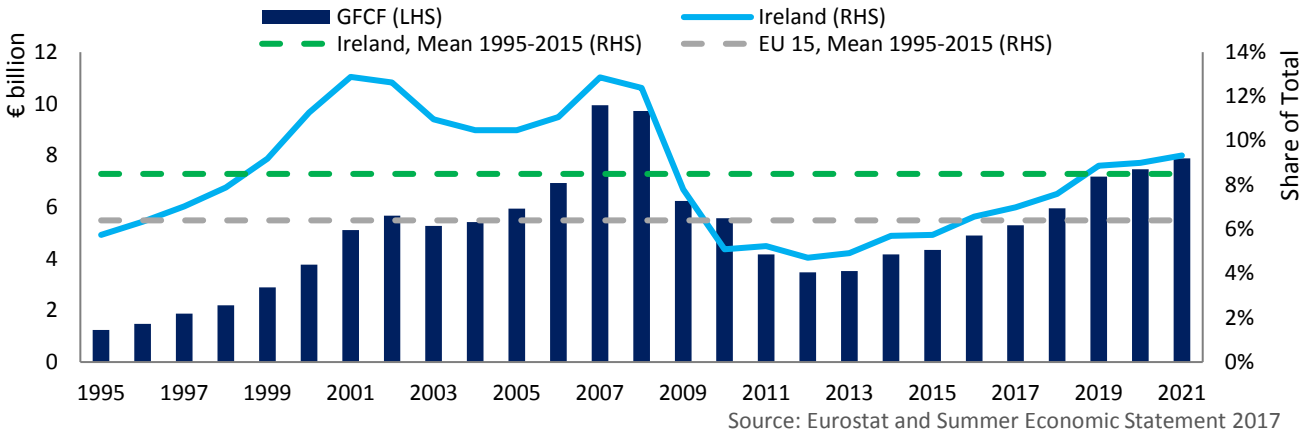
Figure 1.1: Ireland's Public GFCF as % of GNP, 1995-2021[12]



Source: Authors own calculations based on CSO, Eurostat and the Summer Economic Statement 2017

Ireland's public GFCF as a share of total General Government expenditure averaged 8.6% over the period 1995 to 2015, as demonstrated in Figure 1.2. This is above the EU15 average of 6.4% for the same period. In 2017, Ireland's public GFCF will be 7% of total General Government expenditure. By 2021, Ireland's public GFCF is currently projected to have increased to 9.3% of total General Government expenditure, above the long-term average and well above the euro area average as recently recognised by the European Commission in its 2017 Country Report for Ireland[13]. It should also be noted that Ireland is projected to have the lowest level of general government revenue to GDP and expenditure to GDP in the EU by 2021[14].

Figure 1.2: Ireland's Public GFCF as % of Total General Government Expenditure, 1995-2021



Source: Eurostat and Summer Economic Statement 2017

[12] If analysis was replicated using CSO's revised indicator (GNI*, see link), 2016 GFCF as proportion would be 2.6% rather than 2.2%.
[13] See page 45, https://ec.europa.eu/info/sites/info/files/2017-european-semester-country-report-ireland-en.pdf. Note that the European Commission Report was published before the additional capital was allocated in the Summer Economic Statement 2017.
[14] See page 113-114, IMF Fiscal Monitor: Achieving More with Less, April 2017

Figure 1.3 shows how Ireland has allocated its capital expenditure over the last twenty years in comparison to other European countries. Ireland has allocated more capital to Economic Affairs (primarily transport), Environment Protection and Housing than the EU15 average over the same period[15]. Ireland has allocated less capital to all other functions than the EU15 average, in particular Defence. Economic affairs (36%) and Housing (20%) comprised over 50% of General Government GFCF over the period while Education had the next biggest allocation of GFCF at 9.5%. It would be expected that the level of the existing infrastructure in a given sector would be a determinant of the level of investment witnessed, for example the lack of an extensive motorway network necessitated significant investment in the transport sector (included under economic affairs) over the period 1995-2015.

Figure 1.3: General Government Capital Expenditure by Function, Average 1995-2015

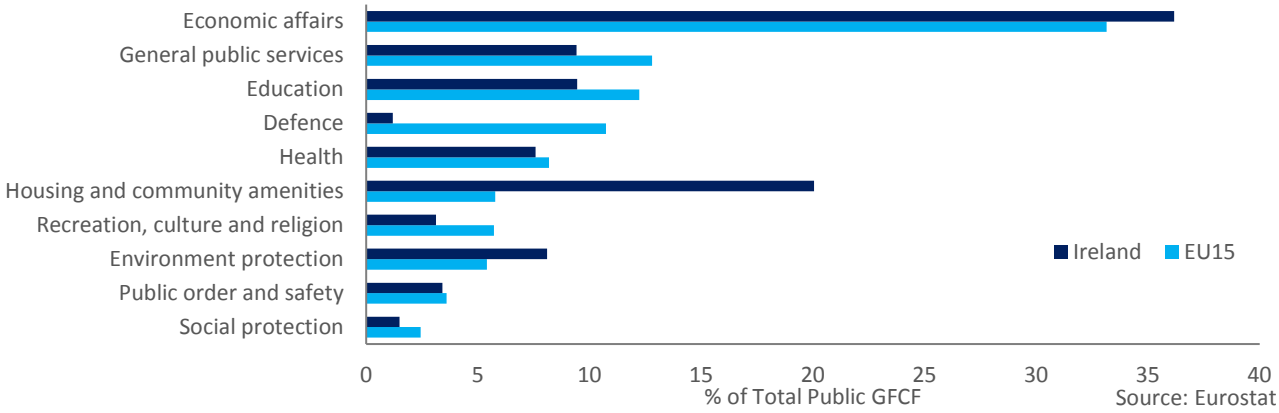
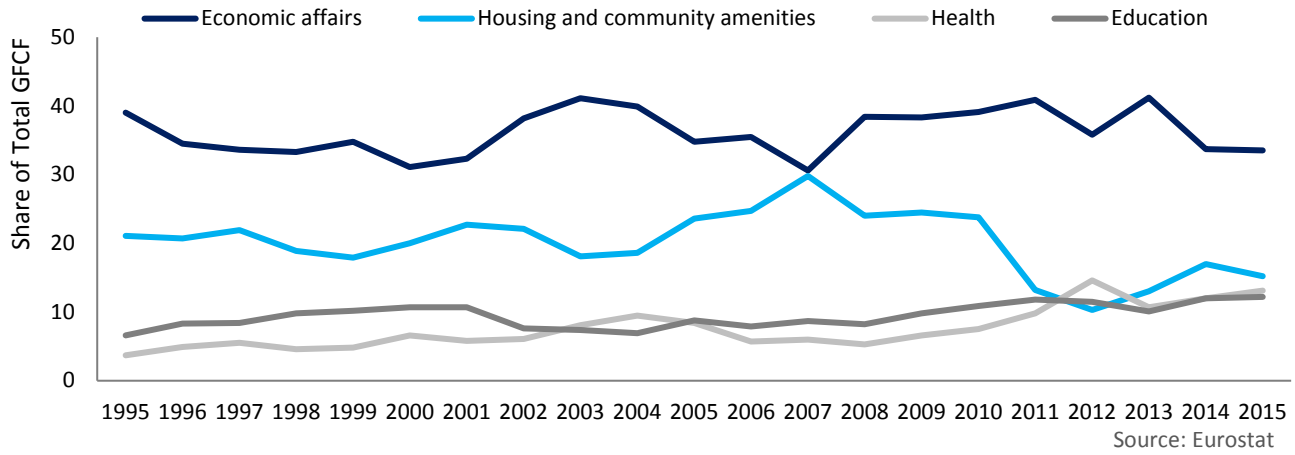


Figure 1.4 shows the trend in the share of four key areas of public GFCF investment from 1995 to 2015. Health and Education have both seen a general increase in their share of the total public capital spend over this time period. Housing's share peaked at almost 30% in 2007 with a sharp decline thereafter. Economic affairs has consistently held the largest share of capital expenditure over this period.

Figure 1.4: Trend in the Share of General Government GFCF for Key Functions, 1995-2015



[15] The Classification of the Functions of Government (COFOG) classifies expenditure into ten main categories. These divisions are further broken down into 'groups' (COFOG II level). For example, the groups for 'economic affairs' are: 'transport', 'communication', 'agriculture, forestry, fishing and hunting', 'fuel and energy', 'mining, manufacturing and construction', 'other industries', 'R&D economic affairs', 'economic affairs n.e.c.', 'general economic, commercial and labour affairs'.

In relation to trends in regional infrastructure investment, research has shown that all regions experienced significant increases in infrastructure expenditure over the period 1995-2009. On a per capita basis Dublin received less than the average level of investment[16].

Before moving on it is worth emphasising that much of the data referred to above is financial in nature (e.g. expenditure and capital stock) and as such should only be seen as indirect measures of Ireland's infrastructure. This data does not represent the infrastructure outputs delivered or the value for money achieved from the investment. Direct measures of infrastructure quality and output are discussed where relevant/possible in each of the sectoral chapters.

Drivers of Demand

There are many complex and interrelated factors which drive activity and demand, thus impacting the use and provision of infrastructure. While drivers of demand differ by sector, a number of the key primary drivers are discussed here at a high level. These factors will be vital considerations in the planning of Ireland's infrastructure over the coming years.

Table 1.1: Selected Drivers of Demand

Drivers of Demand	
Demographics	**Spatial Considerations**
Economic Growth	**Climate Change**
Technology	**Socio-Cultural Factors**
Geopolitical Developments (e.g. Brexit)	**Maintenance**

Economic Growth

Research has shown that as an economy grows there is generally an increased need for infrastructure[17]. For example, increases in industrial output tend to require increases in inputs such as energy consumption, broadband, transport of goods and people, increases in water and waste water etc. This increase in demand can be met through an increase in the supply of the required infrastructure or potentially by increasing the efficiency by which the existing infrastructure is utilised through demand management policies. Investment in infrastructure also has the potential to increase the short and long-term economic growth of an economy[18].

In terms of Ireland's economic growth over the coming period it is worth noting the following central forecasts:

- Average growth of GDP of 3.6% (GNP of 4%) over the period 2016-2021, declining to 2.5% by 2021 (GNP of 2.1%), based on the Department of Finance's medium term macro-economic projections in the 2017 Draft Stability Programme Update.

[16] For the 1995-2004 period see: Morgenroth, Edgar(2008)'Regional Dimension of Taxes and Public Expenditure in Ireland' ,Regional Studies,

[17] U.K. National Infrastructure Commission Report (2017), Economic Growth and Demand for Infrastructure Services.

[18] Fournier, J. (2016), "The Positive Effect of Public Investment on Potential Growth", OECD Economics Department Working Papers, No. 1347, OECD Publishing, Paris. http://dx.doi.org/10.1787/15e400d4-en

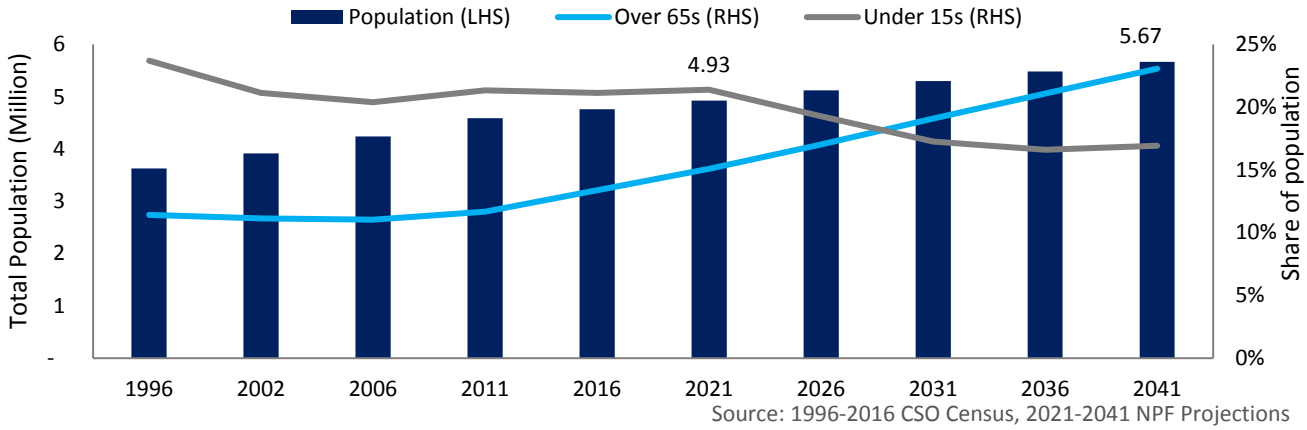
- Average growth of GDP of 3.2% (GNP of 3.3%) over the period 2020-2025, based on the ESRI macro-economic projections in the December 2016 publication, Ireland's Economic Outlook: Perspectives and Policy Challenges. [19]

Demographics

Changes in the demographics of a country have a direct impact on the demand for infrastructure. Increases in population can result in an increased demand for housing, education, health, transport services etc.[20]. Age is likely to have an impact on infrastructure demand, for example research suggests that older people are less likely to use peak-time transport[21] and energy services. Variation in household size[22] will have implications for infrastructure. In general, larger households use less energy and water per capita. A change in behaviour towards smaller sized household formation would also require a greater number of houses in order to provide for the same population.

The latest population projections from the CSO are based on the 2011 census. Updated projections based on the 2016 Census are not yet available. In order to ensure close alignment with the new National Planning Framework, this research as part of the Mid-Term Review of the Capital Plan has used the same population projections as prepared by the ESRI for the National Planning Framework. In addition to these projections, sector specific analysis of projected demographics where also used where relevant e.g. the education sector. As of April 2016, Ireland's population stood at 4,761,865. This was an increase of 3.8% or 173,613 people since the last census in 2011. Projections indicate that Ireland's population will increase by approximately 3.5%, or over 150,000 people, to reach approximately 4,927,922 by 2021.

Figure 1.5: Ireland's Population, 1996-2041



Source: 1996-2016 CSO Census, 2021-2041 NPF Projections

[19] Longer term forecasts are not produced by the Department of Finance or the ESRI, however the Directorate-General for Economic and Financial Affairs of the European Commission's 2015 Ageing Report projects average annual growth of GDP of 1.7% for Ireland over the period 2013-2060.

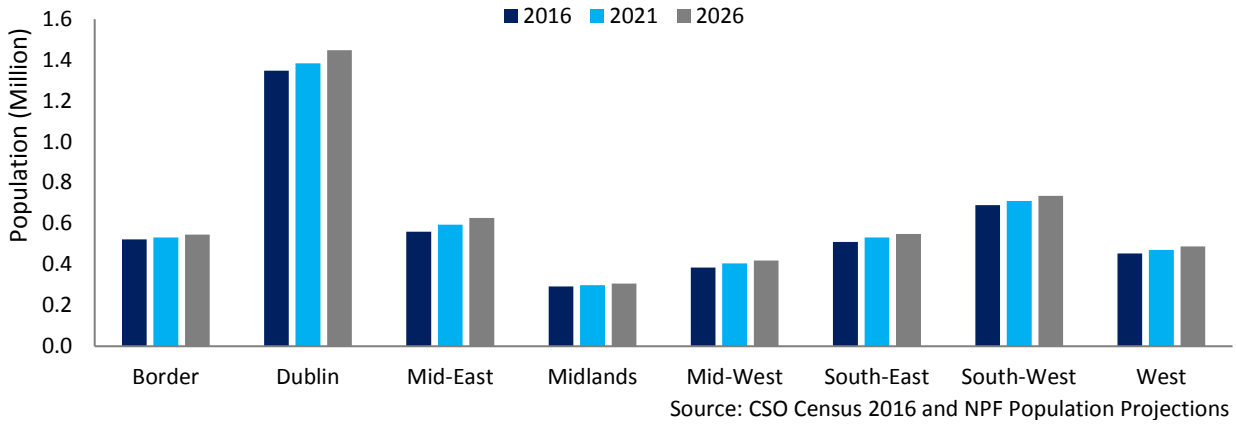
[20] U.K. National Infrastructure Commission(2016), The Impact of Population Change and Demography on Future Infrastructure Demand

[21] See page 40, Fiedler, M. (2007). Older people and public transport. Challenges and changes of an ageing society. Final report. http://www.emta.com/IMG/pdf/Final_Report_Older_People_protec.pdf

[22] Household size refers to the total number of people usually resident in a house.

The percentage of the population over the age of 65 will increase over the remaining period of the capital plan, from 13% of the population in 2016 to approximately 15% in 2021, an increase of over 100,000 people. This trend is projected to continue out to 2041. While the number of those aged under 15 is projected to increase by almost 50,000 over the remaining period of the plan to 2021, this cohort's share of the population is projected to remain constant at 21%. This age cohort is then projected to decrease as a share of the population to 17% over the following ten years out to 2031.

Figure 1.6: Projected Population by Region, 2016, 2021 and 2026



Source: CSO Census 2016 and NPF Population Projections

In the 2016 census Dublin accounted for 1,347,359 or 28% of the population. The South-West had the second largest population at 690,575 or 15% of the population. The Midlands had the lowest population at 292,301 or 6% of the population. Projections indicate that all regions will experience population growth over the period 2016 to 2021. Dublin and the Mid-East are projected to experience the largest population increases; Dublin's population increasing by approximately 36,000 and the Mid-East by 35,000. The Mid-East is also projected to experience the greatest proportional increase in its population over this period, increasing by 6%.

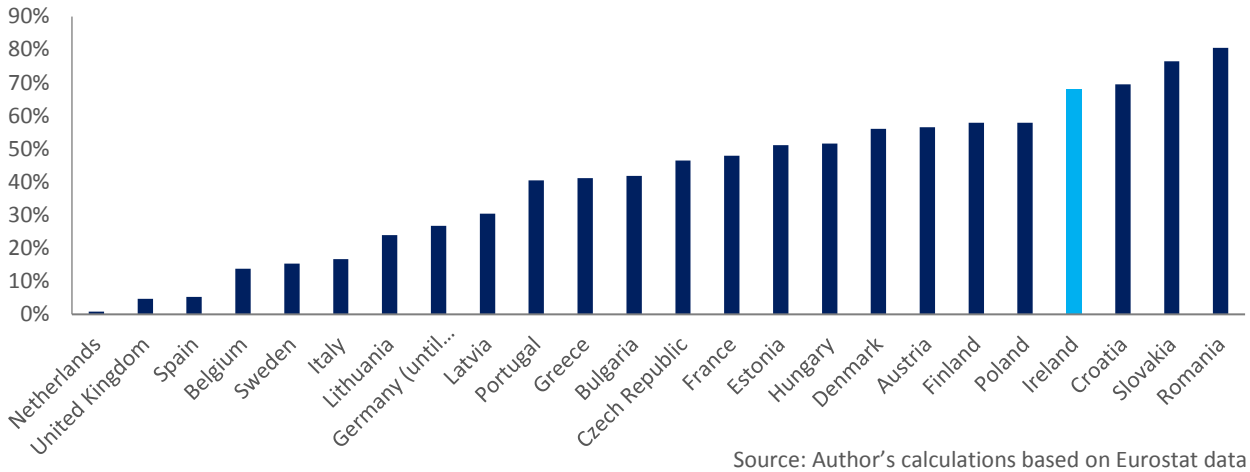
Spatial Pattern of Development

Given its physical nature, demand for infrastructure has an inherently spatial dimension to it. Infrastructure can be provided in areas where demand already exists or is predicted to increase. Alternatively, infrastructure can also be provided in strategic areas in order to encourage further development. At present a new National Planning Framework (NPF) is being drafted which will inform such decisions on infrastructure investments over the next twenty years.

This theme has emerged from the consultation for the new NPF. Submissions to the NPF suggested that it should inform strategic national infrastructure investment to better influence patterns of development and contribute to wider national objectives in areas such as transport, water resource management, waste management, climate action, communications and energy network roll-out and social infrastructure development in areas such as health, education and community facilities.

The consultation also highlighted that a more strategic and plan-led approach to infrastructure investment will assist in addressing an increasing pattern of dispersed development, mainly outside established urban areas, that has challenged the capacity of services. This dispersion and has also led to requirements for new infrastructure, facilities and services, whereas in other urban areas, existing services and infrastructure have become underutilised or redundant, serving declining and ageing populations. Figure 1.7 shows that Ireland has a high share of its population living in rural areas in comparison to most other EU countries.

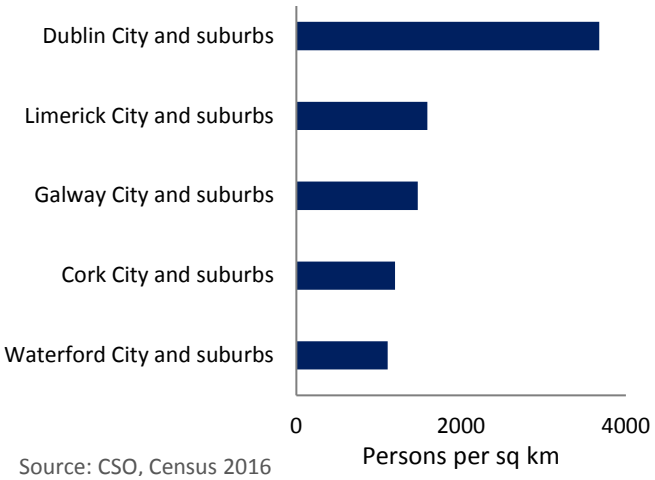
Figure 1.7: Percentage of Population Living in Rural Area, 2015



Source: Author's calculations based on Eurostat data

In this context, and in relation to demand and the provision of infrastructure, it is important to note that the higher the density of the population in an area the easier it is to spread the fixed costs of a piece of infrastructure. This is an important factor in whether the delivery of a piece of infrastructure is viable or not. For example, due to the high level of fixed costs associated with public rail transport systems, such infrastructure is more viable when operating in or between high density urban areas where there are sufficient numbers of users to meet an acceptable level of the fixed costs[23].For example, research suggest that densities of 3,400 persons per square kilometre are required for light rail systems to be viable[24]. Figure 1.8 details the population density of Ireland's five largest cities based on the results of the 2016 census. While this gives some detail on density in Ireland's cities, the density in and around the nodes along a particular transport corridor is of greater importance. Together, the long-term Capital Plan

Figure 1.8: Population Density of Ireland's Five Largest Cities, 2016



Source: CSO, Census 2016

[23] Cervero, R., & Guerra, E. (2011), Urban Densities and Transit: A Multi-Dimensional Perspective. Berkley Institute of Transportation Studies.

[24] Statement by Aisling Reynolds-Feighan (Professor of Transport Economics, UCD School of Economics) Submitted to the Oireachtas Joint Committee on Transport. October 17th 2016.

and the NPF will provide both a spatial planning and infrastructure investment context to address these matters and any emerging inter-linked themes.

Climate and Environment

There is unequivocal scientific evidence that human activity has been the dominant cause of the observed climate change since the mid-20th century[25]. Infrastructure must be designed with climate change in mind, and be flexible enough to be easily adapted to assist with the mitigation of[26] and/or adaption to[27] climate change impacts[28]. It may also be necessary to constrain the supply of certain infrastructure investments which could contribute to climate change, e.g. investing in certain unsustainable forms of transport which would lock in high carbon technologies.

A proposal on the non-ETS targets for individual Member States, the Effort Sharing Regulation (ESR), was published by the European Commission in July 2016. The ESR proposal suggests a 39% greenhouse gas emissions reduction target for Ireland, based on GDP per capita, for the period 2021 to 2030. This target has been adjusted downward for cost-effectiveness by 9 percentage points to give a headline target of 30%. While this target is not yet agreed, it is clear that the 2030 target will present an enormous challenge for Ireland, particularly given that at this point in time Ireland's non-ETS sector emissions are projected to be 4% - 6% below 2005 levels by 2020 (compared to the 20% target). Under the Renewable Energy Directive 2009/28/EC, Ireland is legally bound to deliver 16% of its final energy requirements from renewable sources by 2020. Ireland has committed to meeting this overall renewable target by achieving 40% renewable electricity, 12% renewable heat and 10% renewable transport by 2020[29]. The public service is to take an exemplar role in energy efficiency, with a savings target of 33% by 2020[30].

The Climate Action and Low Carbon Development Act 2015 contains the statutory basis for the production of National Mitigation Plans and National Adaption Frameworks at least once every five years. It also provides for the establishment of the Climate Change Advisory Council. Ireland's first statutory National Mitigation Plan provides a whole-of-Government approach to tackling greenhouse gas emissions, particularly in the key sectors - Electricity Generation, the Built Environment, Transport and Agriculture. The plan was published in

[25] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp, doi:10.1017/CBO9781107415324.

[26] Infrastructure which will help reduce greenhouse gas emissions

[27] Dealing with the mostly negative consequences of climate change e.g. flooding, rises in sea level etc.

[28] U.K. National Infrastructure Commission report (2017), The impact of the environment and climate change on future infrastructure supply and demand

[29] The 16% represents a binding legal target as does the 10% target in respect of renewable transport

[30] http://www.seai.ie/Energy-Data-Portal/Frequently-Asked-Questions/Energy_Targets_FAQ/#What_are_Irelands_1

July 2017[31]. Similarly, Ireland's National Adaptation Framework will set out Ireland's statutory strategy for the application of adaptation measures in different Government sectors, including the Local Authority sector to reduce the vulnerability of the State to the negative effects of climate change but also to avail of any positive effects that may occur. This is due to be published in 2017. Implementing these plans and meeting Ireland's greenhouse gas and renewable energy targets will require a "whole of Government" approach including capital and current expenditure, taxation policies, regulation etc. Ireland's infrastructure investment will be both driven and constrained by these challenges[32].

Other Drivers of Demand

The primary drivers of demand discussed above have informed the analysis that has been carried out in each of the following chapters. There are numerous other drivers of demand for infrastructure. For example changes in technology can have an impact on demand for high speed communication infrastructure and energy use[33]. Brexit may have a varied impact on demand for infrastructure over the remaining period of the Capital Plan. It may reduce demand if it results in a reduction in economic growth. At the same time Brexit may increase demand for specific infrastructure that is required for international trade such as ports and airports, reflecting the need for Irish exporters to diversify their markets. Additional attention has been paid to specific drivers of demand across each of the sectors.

Demand Management

Demand management can be used in order to optimise the use of existing infrastructure. This can be done through measures which attempt to match the capacity of the current infrastructure to the demand that exists for such infrastructure[34]. This can help ensure that demand is met without the need for the potentially costly investment in additional infrastructure, thereby freeing up funding and capacity for alternative higher priority infrastructure projects to be delivered instead.

Demand management may be used to increase, decrease, smooth or maintain demand. It may also be used to change the level of demand over a time period, rather than change the overall level of demand, for example smoothing out peaks in demand for transport infrastructure or electricity over the course of a day. It may be used for a variety of reasons, such as:

[31]http://www.dccae.gov.ie/en-ie/climate-action/topics/mitigation-reducing-ireland's-greenhouse-gas-emissions/national-mitigation-plan/Pages/default.aspx

[32] Note: As well as providing the statutory basis for the development of NMPs and NAFs, the Climate Action and Low Carbon Development Act 2015 (section 9 (12)) requires that: "A Minister of the Government shall, in the performance of his or her functions, have regard to a national mitigation plan approved by the Government under this section"

[33] U.K. National Infrastructure Commission Report (2017), The impact of technological change on future infrastructure supply and demand

[34] New Zealand National Infrastructure Unit (2014), Demand Management – A Discussion Document.
See also Chapter 11 – Accompanying Measures, ESRI (2006), Edited by Edgar Morgenroth and John FitzGerald, Ex-Ante Evaluation of the Investment Priorities for the National Development Plan 2007-2013.

- increasing demand for a service deemed beneficial to society (e.g. childhood education or preventative healthcare);
- increasing demand for a service deemed beneficial to the economy (e.g. faster connectivity);
- managing demand at the most efficient level for value for money of an asset (e.g. capacity on public transport);
- smoothing demand over time to avoid peaks and troughs (e.g. energy usage);
- redirecting demand to a substitute (e.g. teleconferencing instead of travel);
- decreasing demand where continuing rises will outstrip supply (e.g. road pricing); and,
- decreasing demand in the short term (e.g. water restrictions during a drought).

Creating a best fit between the demand and supply of infrastructure can result in a fairer distribution which is based on meeting need rather than historical norms of access to such infrastructure. The savings made from such an approach can also help address alternative infrastructure needs which cannot be met through demand management and which require the provision of additional well planned infrastructure.

Summary

While Ireland's public investment in GFCF as a percentage of GNP, and as a percentage of total Government expenditure, has been above the EU15 average in previous years, Ireland was below both of these long-term EU15 averages in 2016. However, indicators which use GNP/GDP as the denominator should be interpreted with caution given the large fluctuations in these measurements in recent years. Over the remaining period of the Capital Plan, Ireland's public GFCF is projected to reach 8.6% of total General Government expenditure, above the long-term average and well above the euro area average.

While there are many complex drivers of demand for infrastructure, two of the primary drivers examined here, economic growth and demographics, indicate an increase in demand for infrastructure over the coming years. Two of the other factors discussed, spatial considerations and climate change, will place demands as well as certain constraints on infrastructure investments in the future.

These challenges highlight the need for a coherent approach to investment planning between frameworks such as the Capital Plan and the National Planning Framework. Furthermore, the Capital Plan will also have to be highly cognisant of the National Climate Mitigation Plan published by the Department of Communications, Climate Action & Environment given the outlined interlinkages[35].

[35] E.g. DPER requested that all submissions to the current review of the Capital Plan, from both Government Departments and the Public, examine all potential impacts - both positive and negative – of capital proposals in the context of meeting Ireland's existing and forthcoming Climate and Energy goals.

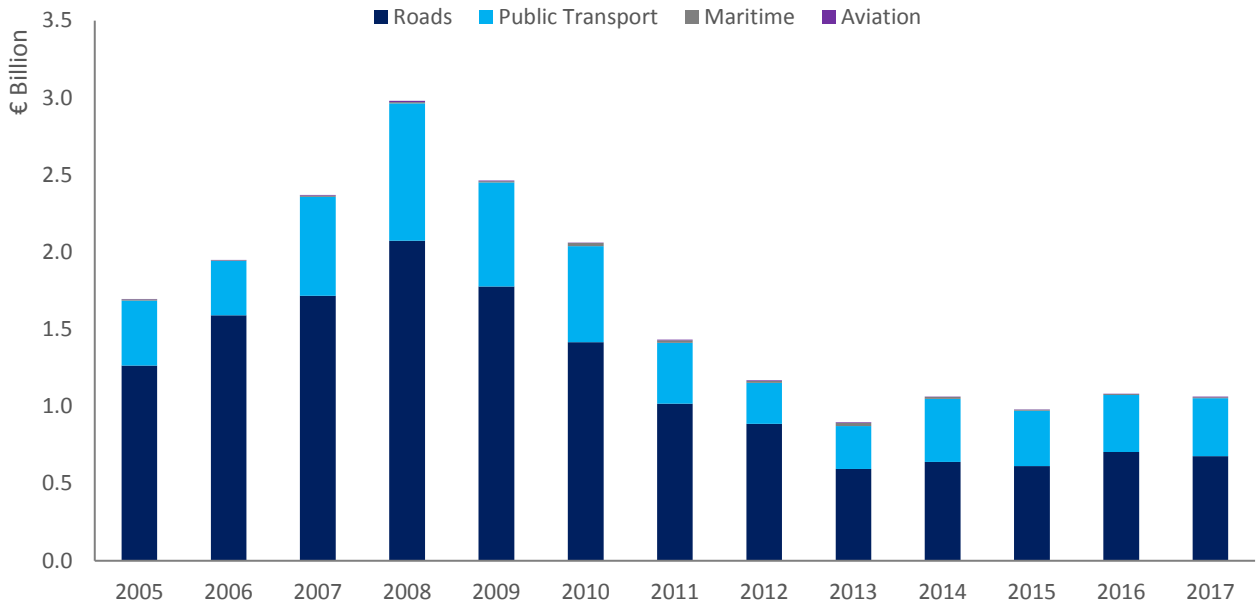
2. Transport

Transport infrastructure is a critical part of a country's overall infrastructure network. Roads, rail, ports, airports and public transport facilitate the movement of commuters, leisure trips, tourists, freight and goods. Transport infrastructure can thus enable economic growth if the network allows for efficient movement and transport. This section aims to set out the overall trends in transport investment, the stock of existing infrastructure and the level of demand being seen across the various elements of the network.

Previous Investment

The total level of investment in land transport grew substantially during the years between 1999 and 2011 (as set out in Box 2.1). This high level of investment resulted in a significant change in Ireland's transport network, most notably the construction of the country's motorway network and a number of public transport investments such as Luas. Capital expenditure by the Exchequer accounts for the vast majority of land transport capital formation in Ireland (trends in GFCF described in Box 2.1). As can be seen in Figure 2.1, gross Exchequer capital expenditure on transport peaked in 2008 at just under €3 billion. As of 2017, allocated capital expenditure stands at €1.06 billion.

Figure 2.1: Gross Exchequer Capital Expenditure on Transport, 2005-2017



Source: DPER. 2016 is provisional outturn and 2017 is allocation

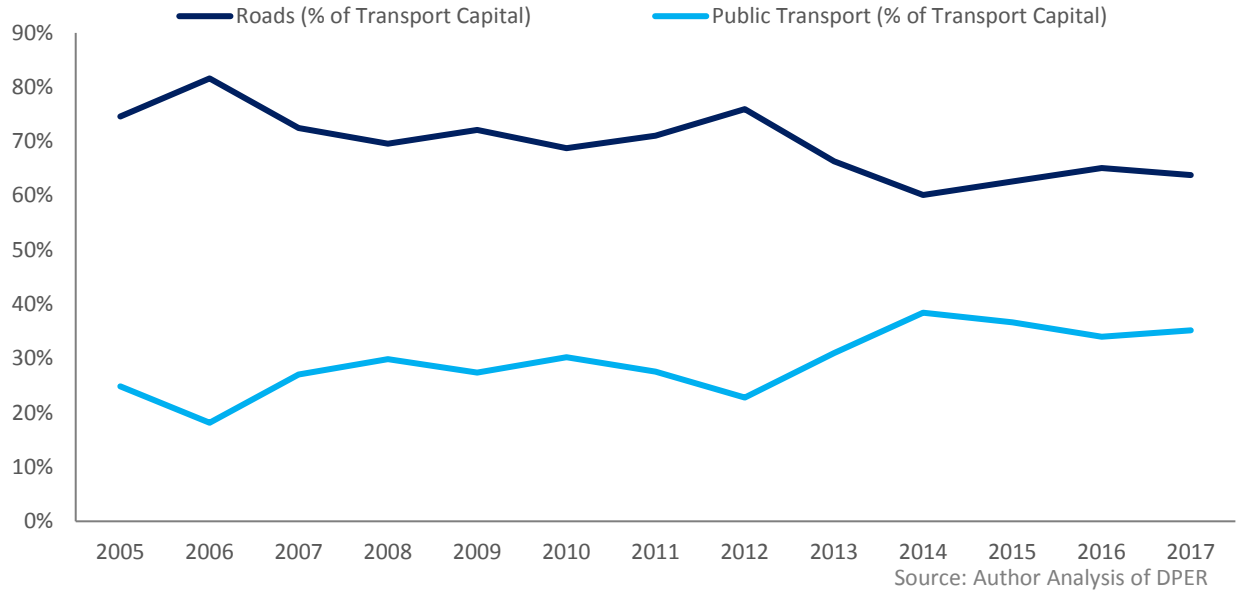
Box 2.1: Historical Transport Investment

Historically, Ireland has invested between 0.5% and 1.9% of GDP in land transport: road and rail. Between 1953 and 2012, the average level of investment annually was 1.13% of GDP. The average for the period 1953–1998 was 1.05%. After 1999 there was a very large increase in transport investment levels, averaging 1.44% of GDP in the period 1999–2011. Capital formation in transport had peaked in 2008 when the value of capital formed in land transport was €3.5 billion. This fell to €1.2 billion in 2012.

Source: Strategic Investment Framework for Land Transport (2015)

While the overall level of Exchequer investment is of interest, it is also necessary to consider the relative composition over time. Figure 2.2 sets out the proportion of total transport investment that has been held by roads and public transport respectively. As can be seen, investment in road infrastructure accounted for around 70% or more between 2005 and 2012. Since 2012, the relative share of roads investment has fallen to 64% as of 2017 while the relative share of public transport has increased to 35% from 30% in 2008.

Figure 2.2: Gross Exchequer Capital Expenditure on Transport, 2005-2017



Source: Author Analysis of DPER

As set out in Table 2.1, the existing Capital Plan sets out a seven year capital envelope for the Department of Transport, Tourism and Sport of just over €10 billion. €5.95 billion or 59% of the Department's total has been assigned for roads while €3.62 billion or 36% has been assigned for public transport. DTTaS's allocation to 2021 represents around one third of the total exchequer capital envelope set out in the Capital Plan.

Table 2.1: Seven Year Envelope for Transport, 2016-2022, € million

	2016	2017	2018	2019	2020	2021	2022	Total
Roads	591	622	743	832	996	1,082	1,082	**5,948**
Public Transport	348	321	368	358	533	845	845	**3,618**
Total DTTaS (Incl. Tourism and Sport)	**1,039**	**1,015**	**1,167**	**1,238**	**1,607**	**2,000**	**2,000**	**10,065**

Source: Building on Recovery: Infrastructure and Capital Investment 2016-2021

The Exchequer transport capital allocation is largely framed by the recommendations and priorities set out in the DTTaS's Strategic Investment Framework for Land Transport. These priorities are threefold: to maintain and renew the strategically important elements of the existing land transport system; to address urban

congestion; and to improve the efficiency and safety of existing transport networks. As set out in the Capital Plan, the outlined investment levels will enable a number of projects including:

Roads	Public Transport
N5 Westport to Turlough	Metro North
N22 Ballyvourney to Macroom	First phase of Dart Expansion Programme
N8/N25 Dunkettle Interchange	New and replacement buses
N4 Collooney to Castlebaldwin	Further upgrading of Quality Bus Corridors
M7 Naas to Newbridge Bypass Widening	Completion of the Luas Cross City project
N56 Dungloe to Glenties	Completion of the Dublin City Centre Resignalling programme
Sallins Bypass and Moycullen Bypass	The reopening of the Phoenix Park tunnel
N56 Mountcharles to Inver Road	The construction of a new Central Traffic Control centre for commuter and intercity rail.
N17/18 Gort to Tuam (PPP)	Ongoing maintenance to ensure the safety and efficiency of the rail network.
M11 Gorey to Enniscorthy (PPP)	**Sustainable Transport**
N25 New Ross By-Pass (PPP)	€100 million for smarter travel and carbon reduction measures (incl. Greenways)

It should be noted that Exchequer investment in the areas of aviation and maritime is relatively limited in comparison to land transport (roads, public transport, sustainable transport).

The National Ports Policy (2013) states that no further Exchequer funding will be provided for port infrastructure development, a position that has been adopted since the 2005 Ports Policy Statement. This position has been taken given the view that port infrastructure projects can attract private-sector finance due to the level of stable and strong cash flows. In the aviation sector, Exchequer support primarily relates to funding for the Regional Airports Programme referred to below. The State's primary aviation infrastructure comprises the airports in Dublin, Cork and Shannon which are operated in a commercial basis and do not receive Exchequer investment.

As such, apart from the Regional Airports Programme, investment in both the maritime and aviation sectors can be categorised in the Non-Exchequer category within the Capital Plan. There are a number of significant projects being undertaken in the time period of the plan. An example of this is the second parallel runway being constructed at Dublin Airport, a 3,110 metre runway which is expected to be delivered early in the next decade.

Infrastructure Overview

The following section sets out some high level analysis of existing infrastructure in the transport sector. The objective is to detail the extent and composition of infrastructure across the areas of roads, public transport, maritime and aviation.

Road Network

Table 2.2 details the extent of the road network by road type. As can be seen there are just under 100,000 kms of road in Ireland with 81% being local roads, 13% being regional roads and 5% being national roads. National roads are the primary inter-regional roads and are divided into National Primary roads and National Secondary roads. National Primary roads are the main long-distance routes that link Irish regions and a large portion of them are motorways (916 kms) and dual carriageways (293 kms). National Secondary roads make up the remaining amount of cross country links and are almost all single carriageways of medium length. The regional and local, or non-national, road network connects cities, towns and villages internally, to each other and to the national network.

Table 2.2: Composition and Size of Road Network

Road Type	Kms
National Roads	5,306
Regional Roads	13,120
Local Roads	80,472
Total	**98,898**

Source: DTTaS (2017) 'Transport Trends 2017'

As Figure 2.3 details the road network within Ireland has been transformed over time as the result of significant investment in the national motorway system. In 2003, there were 176 kilometres of motorway across the country while as of 2015 that has grown to 916 kms. In general, we can observe that the total length of the national road network has decreased slightly from 5,431 kms to 5,306 (primarily driven by road reclassification) but the composition has changed with a shift from 3% of national roads being motorway standard in 2003 to 17.3% being motorway standard in 2015. In addition to the detail on the length of the national road network it is also of note that there are approximately 2,700 bridges on national roads alone[36].

The regional composition and structure of the national road network can be observed in Figure 2.4. It can be seen that the national road network has a wide coverage across the country. In terms of motorway connections, the current system can be seen to serve the primary inter-city routes between Dublin and the rest of the country with direct links between Dublin and the cities of Waterford, Limerick, Cork and Galway.

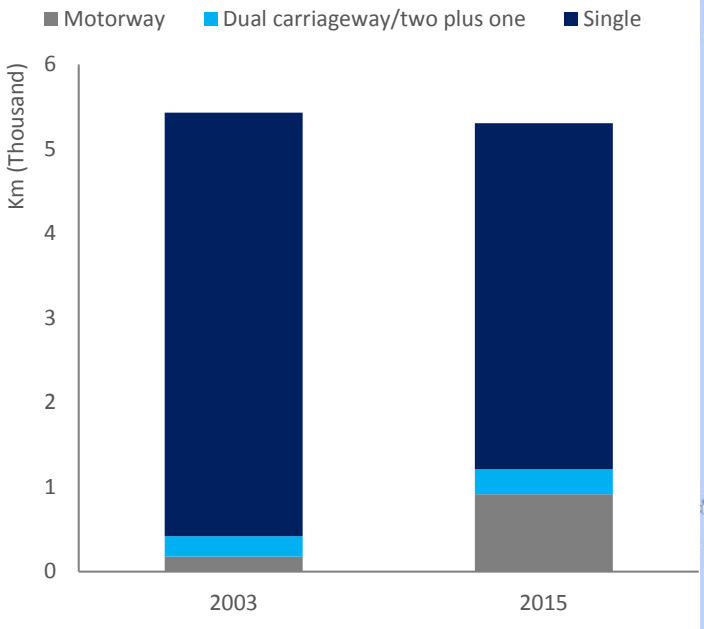
International comparisons of transport infrastructure are complex due to the myriad of interlinked factors such as population/employment density and geography. At a high level, we can observe that Ireland's road density is high by European comparison[37]. With 20.9 kms per 1000 inhabitants Ireland has the 5th highest

[36] TII (2016) 'National Road Network Indicators 2016'. Note, number of bridges on local and regional bridges unavailable.
[37] DTTaS (2017) Transport Trends 2017, http://www.dttas.ie/sites/default/files/publications/corporate/english/transport-trends/transport-trends-2017.pdf

density in the EU and is significantly above the EU28 average of 9.5kms. Ireland can also be seen to have over 3 times the level of the UK (6.5 kms per 1000 inhabitants). This is potentially driven by Ireland's low level of population density, amongst other factors.

While the structure and composition of the network is of interest in terms of this analysis, it is also important to consider the condition of the network. The three indicators used to assess the condition of the national road network are IRI, rut depth and LPV3[38]. In comparing 2012 scores on these measures for motorways/dual carriageways to 2016 we can observe that very good IRI and LPV3 levels have decreased from 70% to 67% and from 93% to 90% respectively while very good rut depth levels have actually increased from 72% to 74%[39]. While this will obviously be driven by levels of traffic, weather conditions, maintenance practices etc. it does give a general indication towards the condition of the network. The most recent survey of the regional road network indicated that (from best condition to worst condition) 22% of roads were in the category of routine maintenance, 39% were in the category of skid resistance, 24% were in the category of surface restoration while 15% were in the category of road reconstruction[40]. Work is ongoing to complete more regular road condition surveys for regional and local roads in terms of national reporting as highlighted by NOAC[41].

Figure 2.3: National Road Network, 2003 and 2015



Source: CSO Transport Omnibus

Figure 2.4: National Road Network, 2016

Source: TII

[38] IRI (International Roughness Index) which measures the response of vehicle to the pavement surface conditions. Rut Depth which measures the level of rutting/deformation on the pavement caused by heavy traffic. LPV3 (Longitudinal Profile Variance) which measures the level of bumps, potholes, sags etc. in the pavement

[39] TII (2013) National Road Network Indicators 2012 and TII (2017) National Road Network Indicators 2016.

[40] Feighan, K. and Murly, B. (2012) 'Assessing the Condition of the Irish Regional Road Network'. https://www.engineersireland.ie/EngineersIreland/media/SiteMedia/groups/societies/roads-tranport/Assessing-the-Condition-of-the-Irish-Regional-Road-Network-by-Kieran-Feighan-and-Brian-Mulry-28-11-2012.pdf?ext=.pdf

[41] NOAC (2016) Performance Indicators Report 2015. http://noac.ie/wp-content/uploads/2016/12/2015-PI-Report.pdf

Finally, it is worth noting that the current national road network, which accounts for 5% of all roads has been estimated to have a replacement value of €30 billion[42] highlighting both the overall value of the network as an asset and the requirement to maintain asset value.

Public Transport System

The public transport system in Ireland consists of a number of elements including heavy rail, light rail and bus. Services are in place to varying degrees and in different forms to facilitate inter-urban and city based services. The following section sets out some high level details of the existing level of infrastructure and service. In addition to describing headline infrastructure, it is also necessary to consider levels of service provision in the context of public transport.

For heavy rail, details related to the overall network are set out in Table 2.3. The rail network caters for three types of services. The DART network is an electric rail system which runs along the coast of the Irish Sea from Malahide or Howth in north County Dublin southwards as far as Greystones, Co Wicklow. Commuter services cater for services in the Greater Dublin Area (linking Dublin with areas such as Dundalk, Portlaoise, Longford and Gorey) and in Cork (linking Cork City with Mallow and Cobh/Middleton). Finally, inter-city services run between Ireland's major cities and towns. The overall length of lines within the network is 1,894 kms while there are 144 stations. The network has been slightly expanded since 2006. In service provision terms, the number of annual operated vehicle service kilometres has remained relatively unchanged since 2010 at 15.965 million while the number of operated vehicle seat kilometres is down by 13% from 7 billion to 6.1 billion. As such, available heavy rail services appear to be broadly similar to 2010 although capacity is at a lower level.

Table 2.3: Heavy Rail Infrastructure, 2006 and 2015

	2006	2015
Length of Lines (kms)	1,834	1,894
Length of Main Track (kms)	2,289	2,384
Length of Electrified Main Track (kms)	107.5	107.5
Number of Passenger Stations	135	144

Source: CSO, Transport Omnibus

Light rail services are present in Dublin through the operation of the Luas system, which was introduced in 2004. The Luas network, consists of the Red Line (20.8 kms) and the Green Line (16.4 kms) which amounts to 37.2 kms in total[43]. This represents an expansion on the initial system which amounted to 24kms in 2006[44]. The Luas Cross City project commenced construction in June 2013 and is scheduled to be in operation by the end of 2017. The completion of the project will see an additional 5.6 kms added to the network and a connection between the two existing lines. In terms of service provision, the total number of vehicle kms in 2015 was 3.9 million which is a 45% increase on 2006. This growth is likely driven by increased passenger demand and the aforementioned extensions to the Luas network.

[42] TII, Annual Report and Accounts for 2015
[43] CSO, Transport Omnibus 2015
[44] Expansions in the network undertaken to The Point, Bride's Glen and Saggart

The majority of public bus services can usefully be divided between Dublin based services (provided by Dublin Bus) and inter-city and regional services (provided by Bus Éireann). There are a number of other operators providing licenced bus services but publically supported bus services (PSO services) represent 87% of all licensed services and are primarily delivered by the two stated operators. Table 2.4 details the number of buses and the average age of those buses at Dublin Bus and Bus Éireann in 2010 and 2015. One can observe that the average age of buses has increased at both operators while the number of buses has grown at Bus Éireann and fallen at Dublin Bus. In terms of service provision, Bus Éireann have decreased the number of operated vehicle kms from 38.1 million in 2010 to 33.8 million in 2015 while Dublin Bus have decreased slightly from 56.5 million to 55.3 million.

Table 2.4: Number and Age of Buses, 2010 and 2016

	2010 Q4	2016 Q4
No. of Buses at Dublin Bus	1,023	967
Average Age of Buses at Dublin Bus	6.8 years	7.5 years
No. of Buses at Bus Éireann	400	517
Average Age of Buses at Bus Éireann	4.8 years	6.3 years

Source: NTA, Bus Statistics for Ireland: State Funded Services. Figures only include PSO Services. Age of BE Fleet is city fleet only.

In a similar fashion to roads, international comparisons of public transport are difficult given the variety of factors such as population density and geography which impact the provision and use of infrastructure. A further issue relates to the international comparability of data given varieties in definitions and methodology. Eurostat statistics[45] show that Ireland has a relatively low usage of trains at 2.9% of all passenger transport compared to the EU28 average of 7.6%. However, the use of buses and motorcoaches is 17.3%, well above the EU28 average of 9.1%. It should be noted that the comparability across countries is considerably restricted as concepts and methodologies are not harmonised at the EU level and as such the above should be seen as indicative only. Research by the European Commission[46] highlights that, based on their measurement, access to public transport is relatively low in Dublin compared to other European cities. Of the cities analysed[47], Dublin had the lowest share of population with a high level of access at 38% while the majority of other cities were above 60%. The report notes that Dublin's relatively low population density is a factor in explaining the lower access levels highlighting the significant challenge in comparing transport networks.

Maritime Infrastructure

Ireland's maritime sector plays an important role in connecting Ireland to international trade partners and facilitates and enables imports and exports. Furthermore, the sector also caters for inbound and outbound tourism and cruise ships. In terms of Ireland's maritime infrastructure it is useful to consider a brief overview of the existing port infrastructure. The National Ports Policy (2013)[48] sets out three tiers of ports within Ireland

[45] 2014 Eurostat statistics. Accessed at http://ec.europa.eu/eurostat/statistics-explained/index.php/Passenger_transport_statistics#Modal_split

[46] European Commission (2015) 'Measuring Access to Public Transport in European Cities' Accessed at: http://ec.europa.eu/regional_policy/sources/docgener/work/2015_01_publ_transp.pdf

[47] Amsterdam, Athens, Berlin, Brussels, Budapest, Copenhagen, Den Haag, Helsinki, Manchester, Marseille, Prague, Stockholm, Torino

[48] http://www.dttas.ie/sites/default/files/node/add/content-publication/National%20Ports%20Policy%202013.PDF

as described within Table 2.5. Ports of National Significance (Tier 1) are responsible for at least 15% to 20% of overall tonnage through Irish ports, and have clear potential to lead the development of future port capacity in the medium and long term, when and as required. Ports of National Significance (Tier 2) are responsible for at least 2.5% of overall tonnage through Irish ports; have the clear, demonstrable potential to handle higher volumes of unitised traffic, and have the existing transport links to serve a wider, national marketplace beyond their immediate region. Ports of Regional Significance are other ports which handle commercial traffic and function as important facilitators of trade for their regional and local hinterland.

Table 2.5: Port Infrastructure

Ports of National Significance (Tier 1)	Dublin, Cork, Shannon Foynes
Ports of National Significance (Tier 2)	Waterford, Rosslare
Ports of Regional Significance	Bantry Bay, Castletownbere, Drogheda, Dundalk, Dún Laoghaire, Galway, Greenore, Killybegs, Kinsale, New Ross, Sligo, Tralee Fenit, Wicklow, Youghal

Source: National Ports Policy, 2013

Aviation Infrastructure

Ireland's aviation infrastructure plays a critical role in international connectivity. The National Aviation Policy (2015)[49] sets out an overview of the State's aviation infrastructure and shows that there are 28 licenced aerodromes which include the three State-owned airports, 12 aerodromes licensed for public use and 13 aerodromes licensed for private use.

Table 2.6: Airport Infrastructure

State Airports	Dublin, Cork, Shannon
Regional Airports	Knock, Kerry, Donegal, Waterford
Other	Various small licenced aerodromes

Source: DTTaS

The primary aviation infrastructure in the State can be classed as State airports at Dublin, Shannon and Cork, which provide essential strategic transport infrastructure and services that support the economic and social activities of the State. The regional airports being supported by the Regional Airport Programme provide a level of international connectivity to the regions which they serve. The State airports at Dublin and Cork are owned and operated by daa plc while the State airport in Shannon is owned by Shannon Airport Authority Ltd, a subsidiary of Shannon Group plc. The airports which are supported through the Exchequer by the Regional Airports Programme are Donegal Airport, Ireland West Airport Knock, Kerry Airport and Waterford Airport.

[49] http://www.dttas.ie/sites/default/files/publications/aviation/english/national-aviation-policy-ireland/national-aviation-policy-ireland.pdf

Drivers of Demand

There are a variety of factors which contribute to transport demand across the various sectors of the network. However, in general transport can be described as a derived demand. Consumers of transport are doing so not for the sake of travelling but to enable another service or transaction. For example, commuters use transport services to access the labour market rather than travel having any distinct value in and of itself. As such, various studies have pointed towards economic growth as being correlated with transport demand over time. Increased employment, higher levels of trade and more leisure or tourist trips all increase the level of transport demand. While economic growth can be seen as a primary driver of transport demand there are a number of interrelated factors set out below that influence the demand for transport. Discussion of the various drivers of transport demand is well established across the literature including for example reports produced by the OECD ITF (2008)[50], EEA (2008)[51] and EU Commission (2009)[52].

Table 2.7: Selected Drivers of Demand

Driver	Example
Domestic Economic Conditions	Higher employment levels increases the number of people commuting each morning.
International Economic Conditions	Economic conditions in trading partner countries will affect the level of demand for freight and tourism transport at ports and airports.
Demographics	The level of population growth and the age composition of the population will influence overall transport demand.
Spatial Development	The regional distribution of employment and demographics will impact travel patterns and demand.
Socio-Cultural Changes	Changes in socio-cultural patterns can affect issues such as travel mode choice (e.g. use of public/sustainable transport v car)
Infrastructure	The supply of infrastructure and services can interact with demand. New transport infrastructure can play a role in inducing demand.
Technological Change	Technological change such as transport innovation or practices such as e-shopping/e-working can impact the level of transport demand.
Transport Costs/Energy Prices	The cost of travel affects the scale and composition of transport demand in terms of fuel and other costs by impacting affordability.

While acknowledging the various drivers of demand in the transport sector it is also pertinent to consider the area of demand management and the efficiency of infrastructure use. While the demand for travel can be externally driven and influenced it is also the case that policy interventions are available to manage the level of demand being seen such that the efficient use of the transport network is maximised. While not considered in detail here, it is worth noting that there are a variety of potential measures that can be used to manage the overall level of demand including fiscal measures (e.g. road tolling), traffic control/intelligent transport systems (e.g. variable speed limits), information provision/awareness campaigns and modal shift.

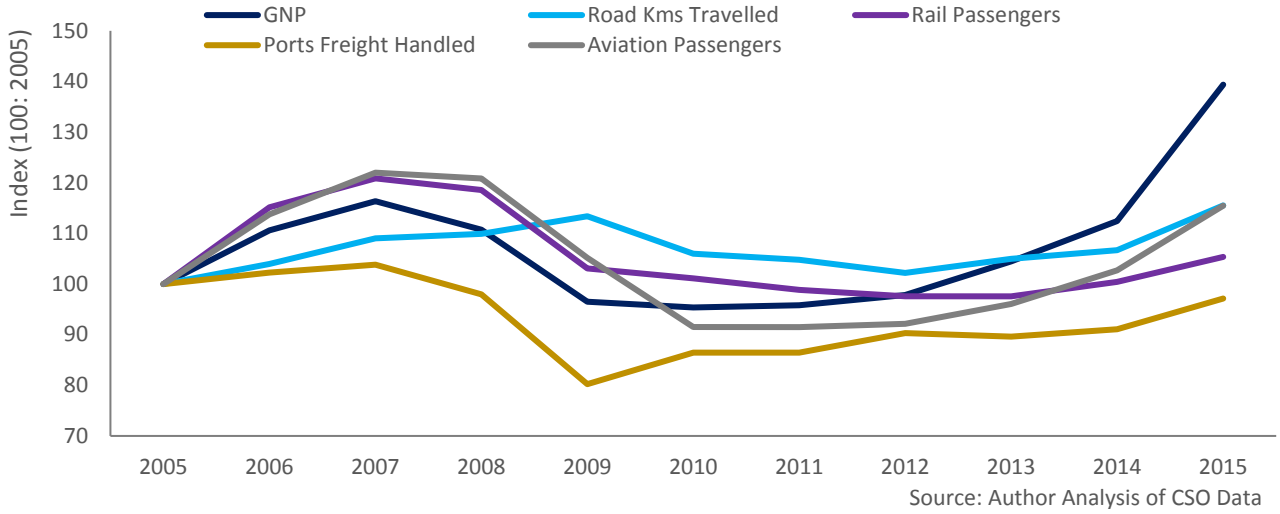
[50] OECD International Transport Forum (2008) 'Greenhouse Gas Reduction Strategies in the Transport Sector: Preliminary Report'
[51] EEA (2009) 'Beyond transport policy — exploring and managing the external drivers of transport demand'
[52] Sessa C and Enei R (2009) 'EU transport demand: Trends and Drivers'. European Commission Project

Furthermore, while the drivers and trends in activity demand are set out here, it should be noted that maintenance and renewal requirements are an important factor in determining overall investment needs. As with other sectors, public investment plays a role in protecting asset quality and value. Given the identified high level of previous investment in the sector, maintenance and renewal is an important consideration.

Trends in Demand Drivers

As set out previously, there are a variety of factors which influence the demand for transport services and infrastructure. This section will briefly consider the historical trend for transport demand in comparison to economic growth and will then review recent demand trends across the various sub-sectors within transport. As previously outlined, trends in transport demand are closely linked to the growth of the wider economy. This has been shown through a number of previous studies[53]. As the economy expands, the increased number of commuters and levels of trade translate into higher levels of transport demand and likewise when the economy is in a downturn the level of activity and demand on the network recedes. Figure 2.5 sets out the trend in transport demand across the relevant sectors in comparison to wider economic growth (as measured by GNP[54]) between 2005 and 2015. As can be observed, transport activity across the various sub-sectors has largely tracked developments in the wider economy over the last decade. When the economy contracted after 2007, activity on the roads, rail, ports and airports decreased also. Likewise, we can observe that between 2005 and 2007/2009 and between 2013 and 2015 transport activity has grown while the economy has grown. As highlighted in Section 1, economic growth in GDP terms is forecasted at an average of 3.6% between 2016 and 2021 and an average rate of 3.2% between 2020 and 2025. As such, one would expect that the level of demand on the transport network would increase if the economy grows as expected.

Figure 2.5: Economic Growth and Transport Demand, 2005-2015



Source: Author Analysis of CSO Data

[53] E.g. Eddington, R. (2006) 'The Eddington Transport Study'. Link . DTTaS (2014) 'Transport Infrastructure and Economic Growth: A Review of the Evidence'. Link.

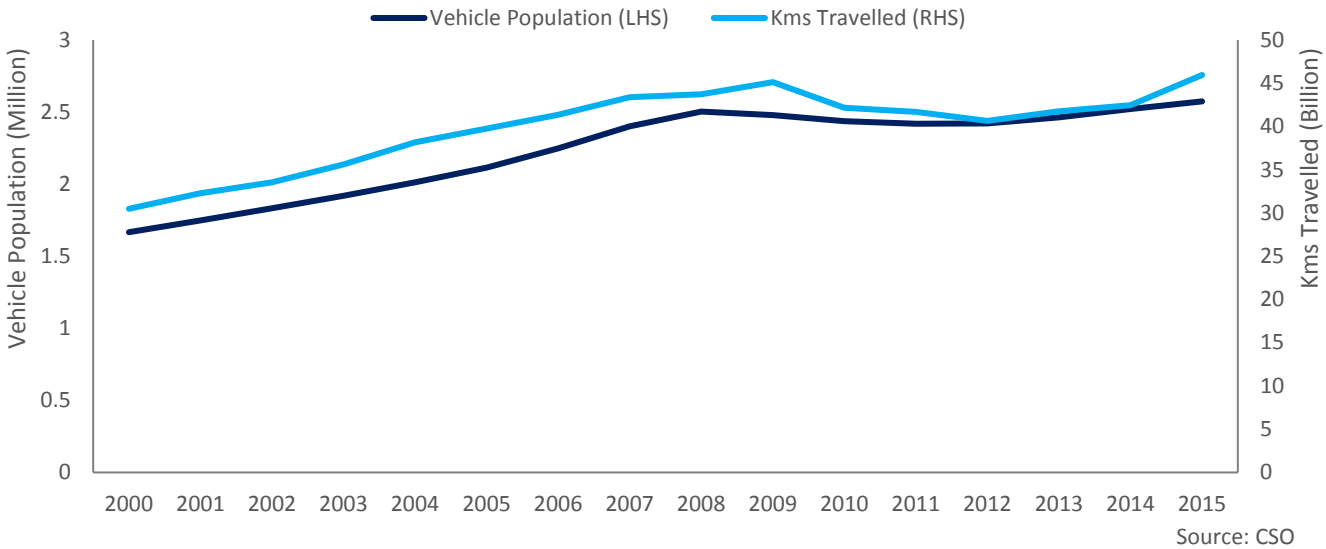
[54] Note: CSO have stated that step change in GDP/GNP in 2015 was largely due to asset/balance sheet relocations.

A number of estimates predict increased levels of transport demand in future years. DTTaS estimate that in 2041 the increase in travel demand arising from work trips will range between 35% and 57% depending on scenario[55]. The NTA have forecast that the total number of trips in 2035 in the AM peak in the Greater Dublin Area will increase by 28.5%[56]. Finally, Transport Infrastructure Ireland forecast that the total number of vehicle kms travelled will reach between 52 and 58.5 billion in 2050 from a current level of just over 40 billion[57]. While each of the modelling exercises employ a range of assumptions and methodologies, the general research in the area expects that transport demand will increase in the coming years in line with population and economic growth.

Trends in Road Demand

Specifically looking at trends in road demand we can observe that both the vehicle population and the number of kms driven increased significantly between 2000 and 2008. As Figure 2.6 describes, there was a 50% growth in the vehicle population over this time period and a 43% increase in the total number of kilometres driven. After 2008, the number of kms driven decreased and the vehicle population was largely stagnant. Since 2012, there has been renewed growth in both indicators with the vehicle population 3% greater than in 2008 while the total number of kms driven in 2015 was 5% higher than in 2008. It is also of note that there are some variances within the vehicle population with, for instance, goods vehicles remaining below the 2008 peak in terms of vehicle numbers (-7%) and kms driven (-8%).

Figure 2.6: Vehicle Population and Total Kms Travelled, 2000-2015



Source: CSO

In terms of understanding road demand in greater detail, it is necessary to consider some regional analysis of road use. Figure 2.7 sets out the level of service measured on the national road network in the average morning peak. As can be observed the majority of national roads (almost 90%) are operating in free flow

[55] DTTaS (2015) 'Strategic Framework for Investment in Land Transport'
[56] NTA (2016) 'Transport Strategy for the Greater Dublin Area 2016 – 2035'
[57] TII (2017) 'National Road Network Indicators 2016'

conditions (i.e. without any significant capacity issues). There are a small number of areas where the level of service experienced is either unstable or at breakdown. These indicators highlight that there are sections of the network which experience significant levels of congestion and thus provide poor levels of service. As highlighted below, these areas are primarily centred around the urban areas of Dublin, Galway and Cork.

Specific analysis of the M50 and the Cork Ring Road, two of the primary routes in those cities, shows that the level of service is a particular issue in these areas. The proportion of the M50 and Cork Ring Road operating at free or stable flow decreased by 10 percentage points and 5 percentage points respectively between 2015 and 2016[58]. In total, almost 50% of the M50 is at level of service D (approaching unstable flow or worse) and just over 10% is classed as either unstable flow or forced/breakdown flow.

These indicators show that road demand is particularly high around urban centres to the extent that significant elements of the infrastructure are providing low levels of service due to congestion. Growth rates on the national road network have been particularly strong in recent years as highlighted in Table 2.8.

Figure 2.7: Level of Service on National Roads, 2016

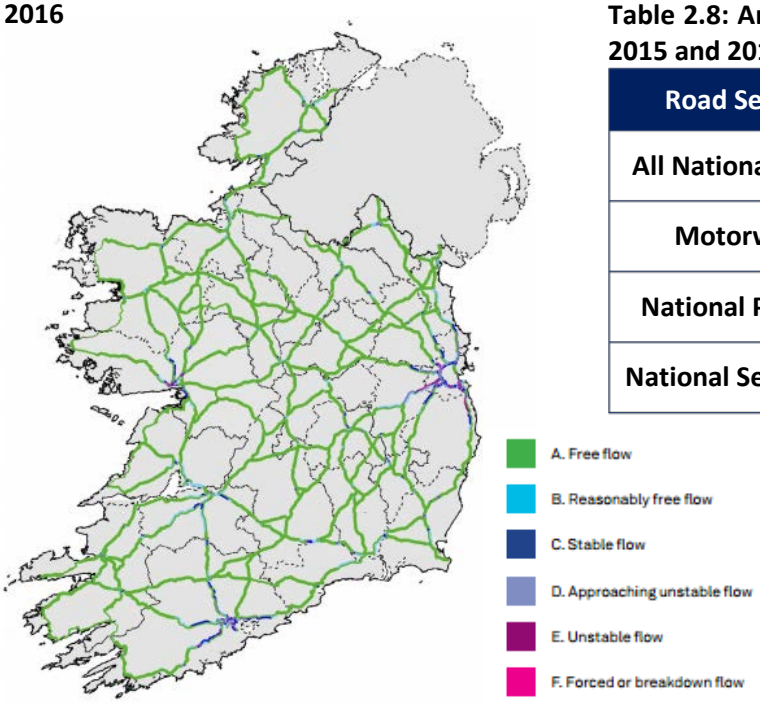


Table 2.8: Annual Traffic Growth Rate, National Roads 2015 and 2016 (All Vehicles)

Road Section	2015	2016
All National Roads	+4.1%	+4.6%
Motorways	+5.3%	+5.7%
National Primary	+3.5%	+4.2%
National Secondary	+2.9%	+2.9%

Source: TII

In terms of overall commuting trends, we can observe that the number of people driving to work, as measured by Census 2016[59], increased by 85,180 to 1,152,631 between 2011 and 2016 and this was the largest increase out of any of the transport modes. The number of commuters travelling to work as a car passenger increased by a smaller amount to 77,335 in 2016 from 69,164 in 2011. Travelling to work by car, either as a driver or as a passenger, represents 61% of all work commuting trips highlighting the importance of the car and roads as a modal choice. In summary, the level of road use has expanded in recent years following a downturn. Total

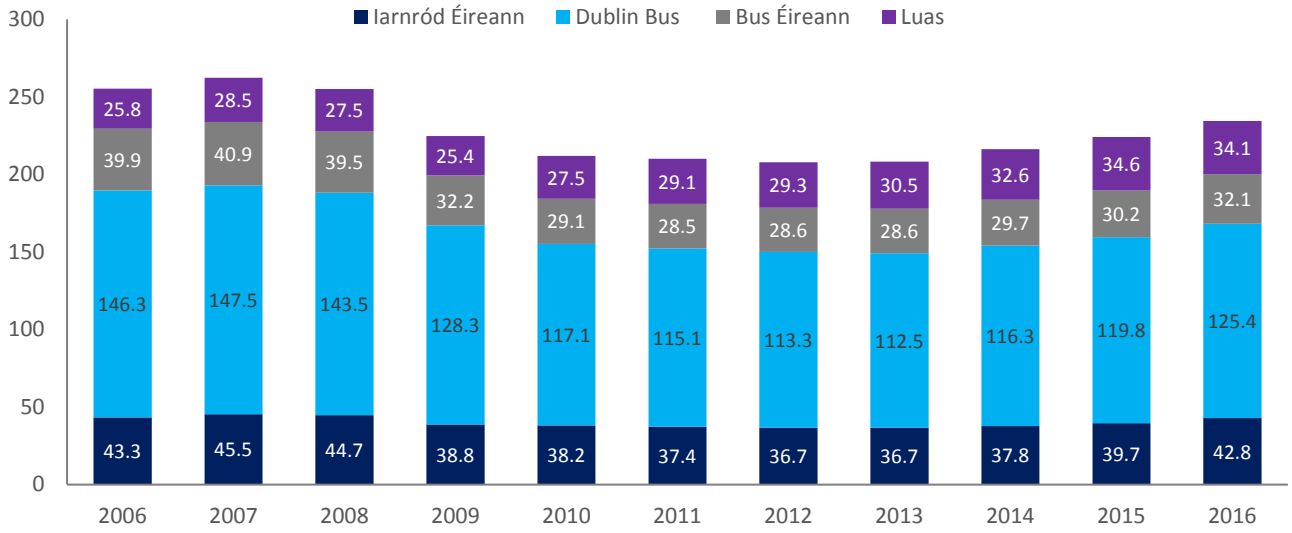
[58] http://www.tii.ie/tii-library/strategic-planning/nra-road-network-indicators/TII-National-Road-Network-Indicators-2016.pdf
[59] CSO, Census 2016. http://www.cso.ie/en/csolatestnews/presspages/2017/census2016summaryresults-part2/

kms driven are now higher than the peak in 2008 and issues in terms of congestion and levels of service are being seen in the primary urban areas.

Trends in Public Transport Demand

Figure 2.8 sets out the trend in public transport passenger numbers on primary services between 2006 and 2016. As can be observed, public transport passenger numbers at 234.4 million are 10.7% below the 2007 peak. In analysing each of the services we can see that passenger numbers on Dublin Bus and Bus Éireann are below their 2007 peak by 15% and 21% respectively. At Iarnród Éireann, passenger numbers are 6% below the 2007 peak. In contrast, the Luas has seen relatively consistent passenger growth over time given the roll out of extensions and use. Passenger numbers on the Luas in 2015 are 20% above their 2007 level. In summary, passenger numbers have resumed growth in recent years in line with wider economic growth but total annual passenger journeys are below their 2007 peak level.

Figure 2.8: Passenger Journeys on Primary Public Transport Services, 2006-2016



Source: CSO and NTA. Note: PSO Services Only

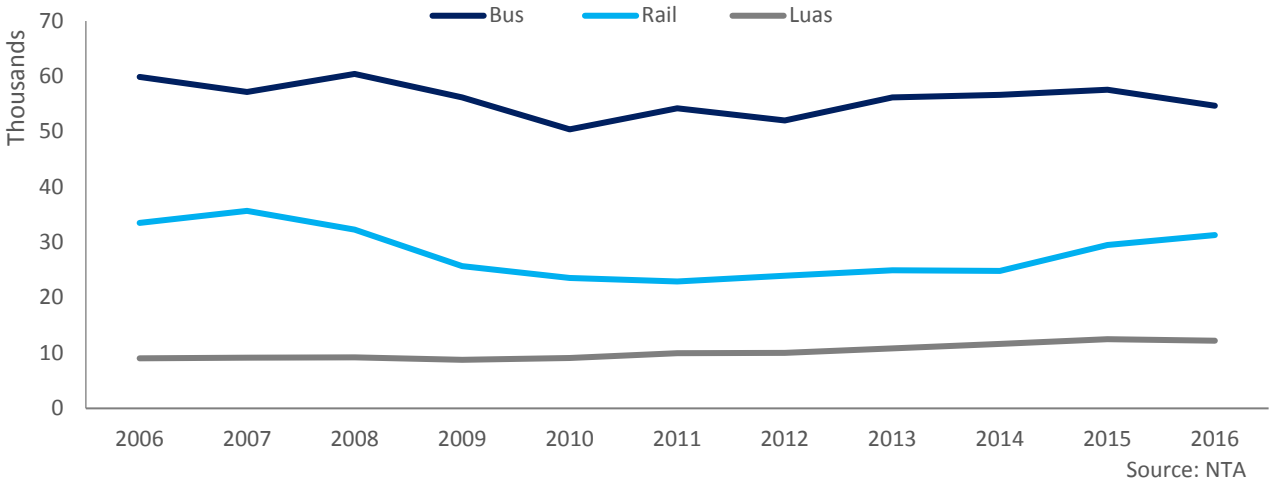
In line with the overall increase in the number of people commuting, the use of public transport to get to work or school increased by 30,144 between 2011 and 2016, bringing the total to 174,569 and representing 9.3% of total commuters[60]. This provides further evidence for the growth in public transport usage and demand over the time period.

Further data on public transport use in Dublin is available from the NTA's annual canal cordon count. The count measures the number of vehicles, pedestrians and cyclists crossing into Dublin City Centre (inside the canals) on an average weekday morning. As can be seen in Figure 2.9, the number of people using both bus and rail to access the City Centre remains below the previous peak by 9% (v 2008 peak) and 12% (v 2007 peak) respectively. As previously outlined, the number utilising the Luas has continued to rise in line with the further

[60] CSO, Census 2016. http://www.cso.ie/en/csolatestnews/presspages/2017/census2016summaryresults-part2/

roll out of the infrastructure and is 33% higher than in 2008. Finally, the data also details that 27% of those entering the city do so by Bus, 15% do so by rail and 6% do so by Luas.

Figure 2.9: Number of People Crossing the Canal Cordon by Mode of Travel, 2006-2016

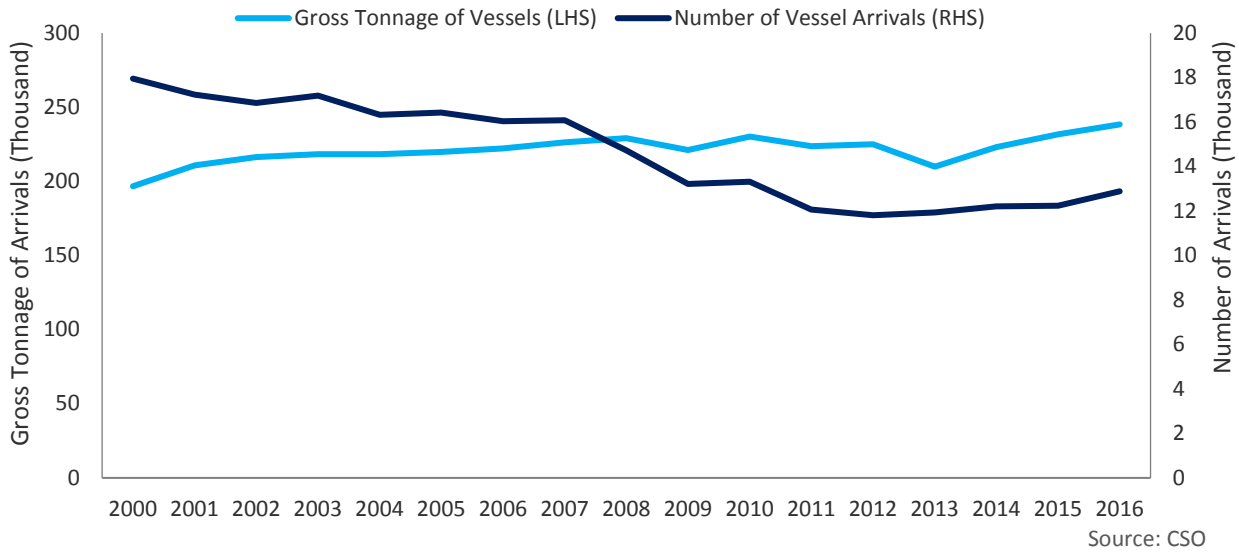


In summary, public transport numbers have returned to growth in recent years. However, overall activity remains below the previous peak.

Trends in Maritime Demand

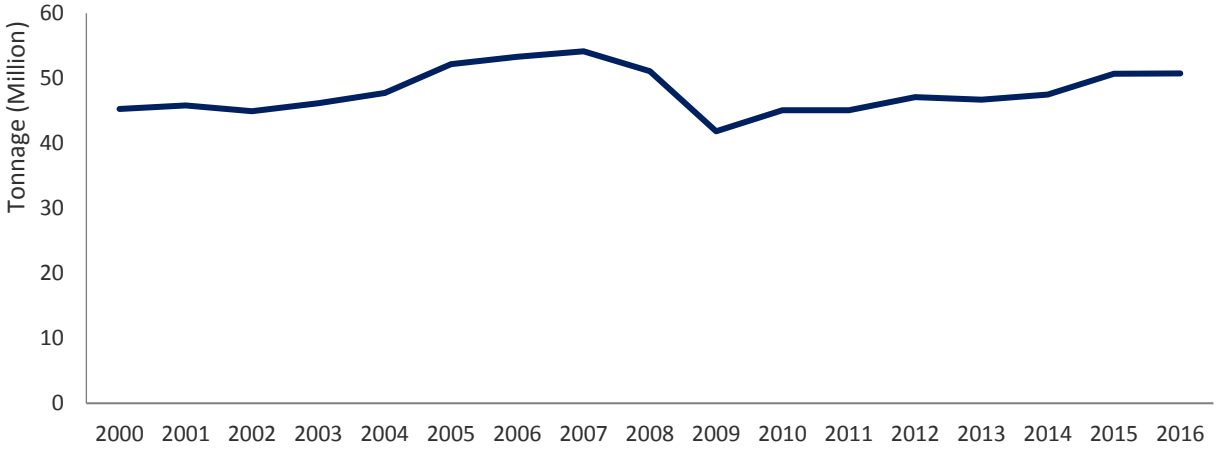
Through analysing the number of vessel arrivals and the gross tonnage of arrivals at Irish ports over time we can observe headline trends in demand across that element of the transport sector. One key trend that is evident from the data is that the size of vessel arrivals at Irish ports has increased over time. While the total number of vessels arriving in 2016 (12,880) is 20% lower than the 2007 level, the gross tonnage of all vessels has increased by 5%. Thus, in terms of demand, it is clear that the form of demand in this area in terms or the number of vessel arrivals has changed and the total tonnage of arrivals is above the 2007 level.

Figure 2.10: Number and Gross Tonnage of Vessel Arrivals at Irish Ports, 2000-2016



A second measure of demand and activity in the maritime sector is the total tonnage of goods that are handled at Irish ports. As can be observed, the total tonnage of goods handled increased between 2000 and 2007 and then dropped off in the 2008 and 2009 in line with the developments in the wider economy. The latest data, for 2016, indicates that the total amount of goods handled is 6% below the 2007 level at 50.7 million tonnes. As such, activity at Irish ports has resumed growth but remains below the previous peak level.

Figure 2.11: Gross Tonnage of Goods Handled at Irish Ports, 2000-2016

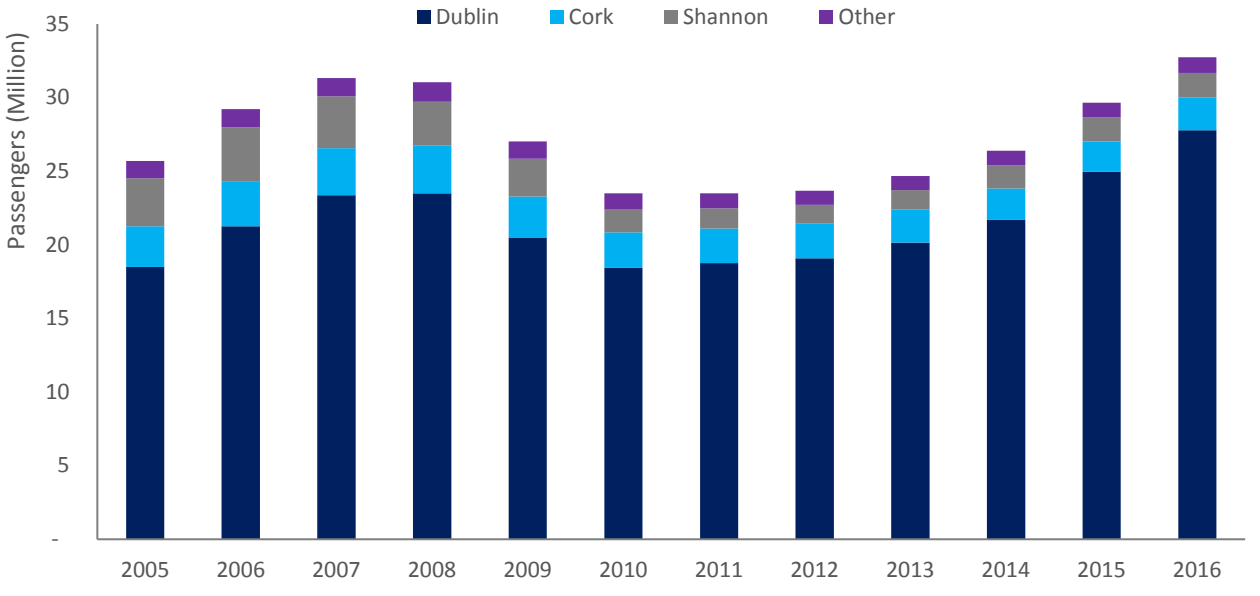


Source: CSO

Trends in Aviation Demand

Total passenger numbers at the primary Irish airports are 5% above the level in 2008 at 32.7 million. However, the details between airports reveal a different trend. Passenger numbers at Cork, Shannon and the other airports are down 32%, 43% and 20% respectively. Dublin Airport meanwhile has seen annual passenger numbers increase by 4.2 million or 18%. As such, growth in aviation demand and activity has been led by activity at Dublin airport and reflects a further increase in the share of passenger activity at the primary airport.

Figure 2.12: Annual Number of Passengers Handled by Airport, 2005-2016



Source: CSO

Summary

In summary, this high level overview of transport infrastructure and demand has made the following findings:

- Investment levels in the transport sector are lower than those seen before 2008. Previous high levels of investment saw the transformation of the national road network and investment in infrastructure such as the Luas. The Capital Plan outlines just over €10 billion of investment in the sector over a seven year time period
- Transport demand is closely linked to economic growth and the performance of the economy. As the economy expands, the number of commuters and the level of trade tends to increase.
- In terms of current demand levels, it is clear that:
    - Overall road usage is above its previous peak in 2008 and issues with regard to congestion and level of service are evident in urban regions.
    - Public transport use has grown significantly in recent years but remains below 2007 peak levels.
    - Data on maritime demand, as measured by the total tonnage of goods handled at ports, indicates that demand has increased but is still below the 2007 peak.
    - Aviation demand and activity is above its previous peak with record passenger numbers being driven by activity at Dublin Airport.

The Capital Plan states that the Exchequer transport capital allocation is largely framed by the recommendations and priorities set out in DTTaS's Strategic Investment Framework for Land Transport. These priorities are threefold: to maintain and renew the strategically important elements of the existing land transport system; to address urban congestion; and to improve the efficiency and safety of existing transport networks. As such, investment in this sector is also driven by maintenance and renewal requirements. As set out through this section, transport activity and demand is growing and would be expected to expand further in future years in line with forecast economic growth rates.

3. Health

Ireland has an extensive range of health sector infrastructure located throughout the country. The objective of this chapter is to examine the historic and planned investment in the sector, provide an overview of the existing infrastructure and its capacity, as well as examining the trends in the drivers of demand for that infrastructure.

This chapter will focus specifically on the *infrastructure* required to provide Ireland's health services. While providing the appropriate infrastructure is critical in order to enable the delivery of health services, other factors in terms of current expenditure such as staffing levels, operational costs etc. also play a major role in health service delivery and are not directly addressed in this paper.

There is a clear legislative basis for capital expenditure within the health sector. Specifically, Section 34 of the 2004 Act[61] sets out that the Minister for Health only needs to seek approval for projects from the Minister of Public Expenditure and Reform if spending is likely to exceed the allocated envelope. Outside of that, the Minister of Public Expenditure and Reform sets the annual capital envelope, the HSE develops a Capital Plan and the Minister for Health approves it, as set out in Section 33B of the 2014 Act[62].

While this chapter sets out past activity trends in Ireland's acute hospital sector, it also notes that other countries, with much older populations, are currently reducing their acute hospital capacity in favour of primary care. Further research which establishes the extent and structure of the existing infrastructure stock in Ireland will help clarify whether there is a need for additional capital resourcing to improve the quality of that stock while also reconfiguring existing services to the primary care milieu.

Policy Context

The last comprehensive statement of Government policy was set out in the 2012 *Future Health: A Strategic Framework for Reform of the Health Service 2012-2015*. A key feature of this policy is the aim to deliver an integrated system of primary and hospital care where the first point of contact for a person needing healthcare in the vast majority of cases would be primary care. The primary care model was first adopted as Government policy in 2001 with the *Primary Care: A New Direction* Health Strategy. Up until that point Ireland's health strategy had been primarily focused on the delivery of health services through acute hospitals.

There has been a shift in the primary care direction in recent years, as witnessed by the additional resources allocated to primary care. The 2017 HSE National Service Plan includes an allocation of €1,018m for the Primary Care Division, marking an increase of approximately €130m on the €887m[63] spent in 2013. This

[61] Health Act 2004, http://www.irishstatutebook.ie/eli/2004/act/42/enacted/en/pdf
[62] Health Service Executive (Financial Matters) Act 2014, http://health.gov.ie/wp-content/uploads/2014/08/Health-Service-Executive-Financial-Matters-Act-20141.pdf
[63] Includes multi-care group services.

investment represents a 14.8% increase over four years and is reflected in increased staffing levels, the number of whole-time equivalents working in Primary Care increasing from 10,072 at end-2013 to 10,540 at end-2016. The biggest increases have been witnessed in the nursing and health and social care professional staffing categories, which increased by 9.4% and 8.3% respectively across the period.

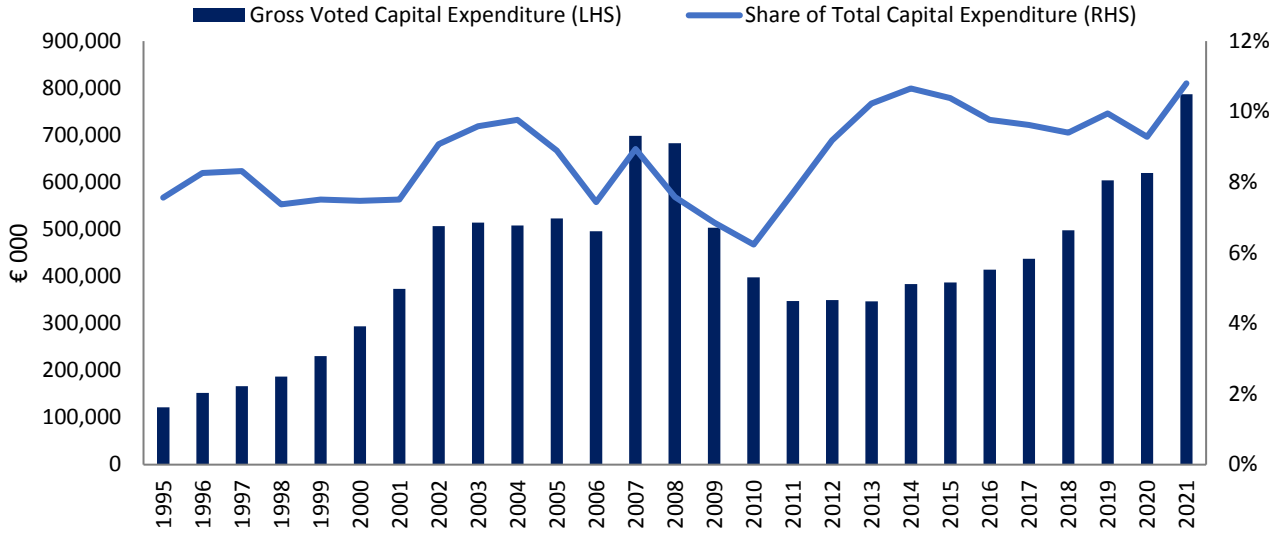
Previous and Planned Investment

There has been significant Government investment in the health sector since 1995, with a particularly high level of investment (over €4.5 billion) over the period 2000-2008 (see Figure 3.1). Expenditure in nominal terms peaked in 2007 at close to €700 million.

In 2017 the Department of Health received a gross voted capital allocation of over €454 million. This represents 3% of the total voted health allocation (€14.6 billion) and 9.6% of the Government's total gross voted capital allocation for 2017. Health's gross voted capital allocation will increase to 10.8% of the total gross voted capital allocation by 2021.

We also saw in the introductory chapter (Figure 1.4) that Health's share of General Government Gross Fixed Capital Formation (a broader definition of public capital which includes non-exchequer expenditure) has increased from 3.6% of the total in 1995 to 12.2% of the total in 2015. Both of these measures, GFCF and gross voted capital, demonstrate that Health's share of capital investment has increased over time. Health's capital allocation now accounts for a greater share of the total allocation than during the mid-2000s.

Figure 3.1: Gross Voted Capital Expenditure on Health



Sources: DPER Databank for 1995-2016, REV 2017 for 2017-2019, Capital Plan for 2020-2021, includes additional funding allocated to Children's Hospital as per Government Decision 00382-17: National Children's Hospital Memo.

The Capital Plan 2016-2021 includes over €3 billion for investment in health infrastructure, and the Department of Health has identified five main priority areas to begin a long term programme of transformation of health care facilities across the country.

Table 3.1: Health Infrastructure included in existing Capital Plan to 2021

Hospitals	Social Care
Children and Maternity	Primary Care Construction Programme (26 centres by mid-2018)
The new National Children's Hospital (at St. James's)	National Rehabilitation Hospital Redevelopment
The new National Maternity Hospital (at St. Vincent's)	Mercer Institute for Successful Aging
Mental Health	
The new National Forensic Mental Health Hospital (at Portrane)	
Cancer Care	**Equipment and ICT**
University College Hospital Galway Radiation Oncology Unit	ICT equipment (€412 million)
Cork University Hospital Radiation Oncology Unit	Equipment replacement programme (€190 million)

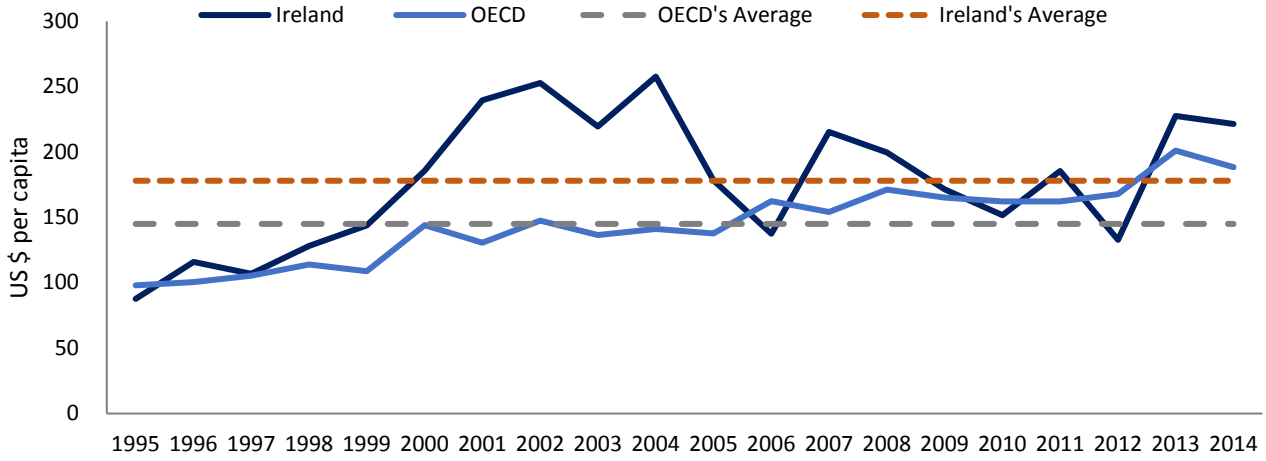
Source: information provided by Department of Health

Further details on the specific projects and programmes within the Capital Plan are contained in the Capital Projects Tracker published by the Department of Public Expenditure and Reform.

International Comparisons

Over the past twenty years there has been significant capital investment in the health sector (public and private). As shown in Figure 3.2, investment was particularly high over the period 2000-2008. The available data indicates that Ireland's capital investment in the health sector exceeded the OECD average over this period.

Figure 3.2: Total Gross Fixed Capital Formation in the Health Care System

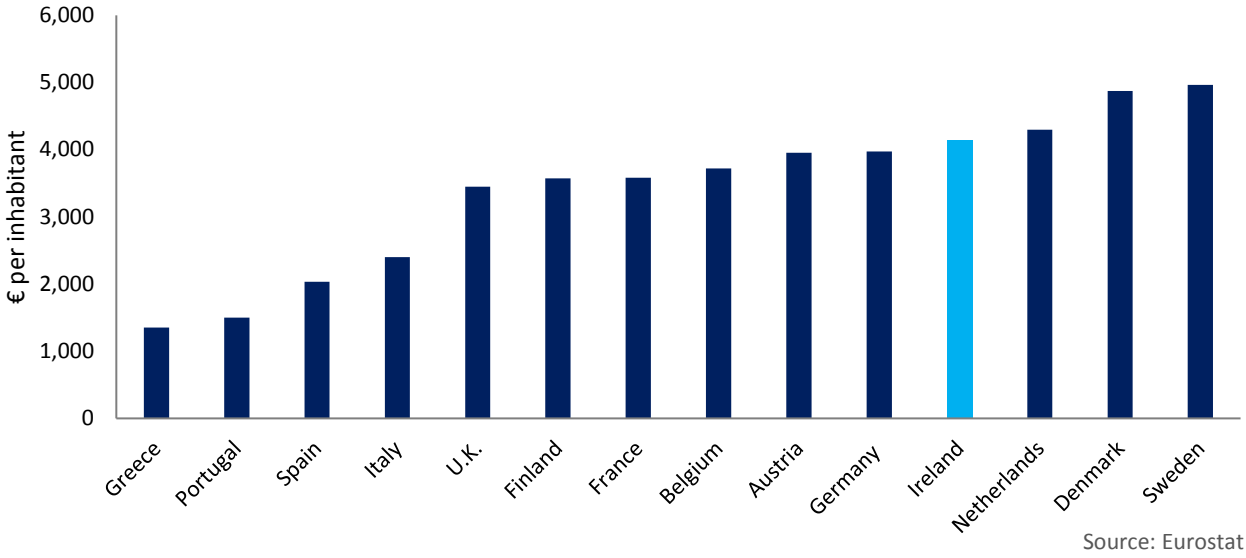


Source: Own calculations based on OECD, all domestic providers, per capita, constant prices, constant PPPs, OECD base year, US Dollar 2010

It is important to note that Ireland has a health system with both public and private components. In 2015 approximately 69% of Ireland's health expenditure was public expenditure. This is slightly below the OECD

average of 72% over the period 2000-2015. Eurostat data indicates that Ireland is one of the highest spenders on health care (all providers) in Europe, see Figure 3.3.

Figure 3.3: Health Care Expenditure (All Providers) 2014



Source: Eurostat

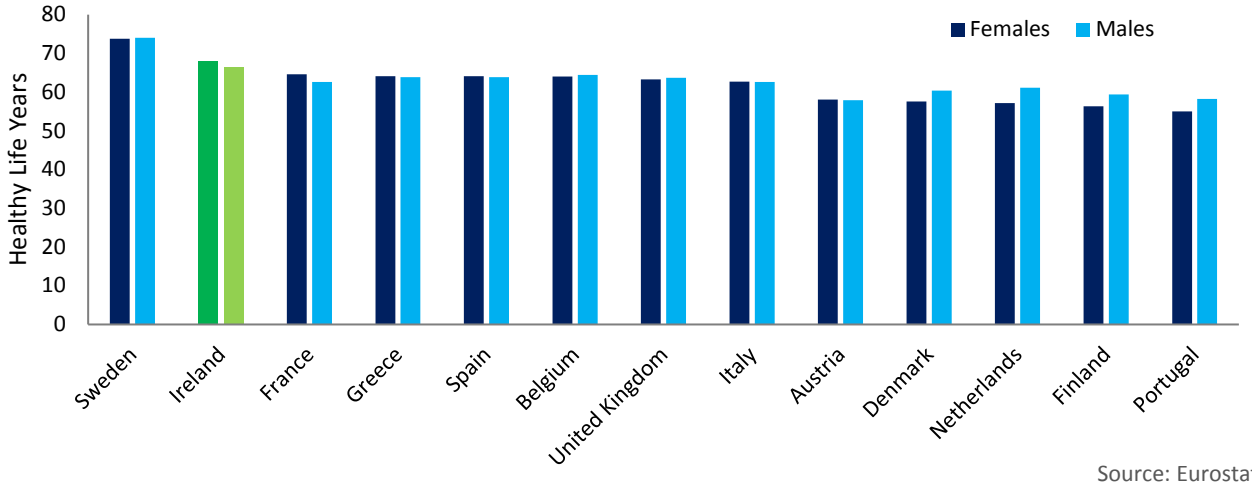
The majority of Ireland's health expenditure is directed to current expenditure. In 2014 approximately 3% is allocated to capital expenditure. This is similar to the EU27 average of approximately 2% of health spend on capital expenditure[64].

Before moving on, it is worth examining the outcomes in terms of the health status of Ireland's population following such significant levels of investment. As Figure 3.4 shows, Ireland has a relatively high level of healthy life years for both males and females in comparison to other similarly developed countries in Europe. The HSE's *Planning for Health 2017* report[65] outlines a number of positive health status indicators for Ireland. Life expectancy in Ireland has increased by almost two and a half years since 2004 and is now above the average for the EU. Mortality rates from circulatory system diseases have fallen by 32% between 2005 and 2014 and is now 9.2% lower than the EU28 average. Cancer deaths decreased by 8% between 2005 and 2014.

On the negative side the report notes that mortality from respiratory diseases (including cancer of trachea, bronchus and lung) was 42% higher than the EU 28 average in 2012.

[64] Own calculations based on Eurostat data
[65] Page 34, Planning For Health, Trends and Priorities to Inform Health Service Planning 2017

Figure 3.4: European Comparison of Healthy Life Years (2015)



Source: Eurostat

The data discussed above demonstrates that there has been a higher-than-average investment in Ireland's health infrastructure over the past twenty years, against a backdrop where Ireland has one of the youngest populations in Europe along with one of the highest levels of healthy life years. Given these findings, it might be expected that Ireland's existing health sector would have the required capacity to deliver the desired level of health services.

Infrastructure Overview and Capacity

In this section the outputs from Ireland's public capital investment in health sector will be outlined and the capacity of that infrastructure will be assessed. The HSE manages approximately 2,500 properties with an estimated value of €10 billion[66]. These include:

- 49 acute hospitals (split across 7 Hospital Groups)[67];
- 119 community nursing units;
- 628 community health centres;
- 92 Primary care centres;
- 795 mental health units;
- 372 disability service units;
- 96 ambulance bases; and,
- various offices and warehouses.

Table 3.2 outlines capital spend on HSE infrastructure projects due to be completed in 2017. Given the policy objective of moving to a primary care system as expressed in *Future Health*, it is worth noting that acute services still represent the largest proportion of this spend at 30%, rather than primary care which has the second largest allocation of 21%.

[66] Presentation by the HSE at the Infrastructure Ireland Conference, 27th September 2016
[67] The HSE's Management Data Report for December 2016

Table 3.2: Spend on Capital Infrastrucute Projects due to be Completed in 2017

	€ million	% of total
Acute Services	32.51	30%
Primary Care	22.87	21%
Social Care – Services for Older People	20.59	19%
Social Care – Disability Services	21.04	19%
Mental Health	5.03	5%
National Cancer Control Programme	4.37	4%
National Ambulance Service	2.5	2%

Source: Author calculations based on Appendix 4, HSE National Service Plan 2017

Ireland has a health system which relies heavily on the delivery of health services through the acute sector and this is reflected in the significant expenditure allocated to the acute sector, notwithstanding the stated policy to shift to a primary care model. Given this fact, along with lack of available data on the primary care sector, this analysis will focus on assessing the capacity of the acute sector to deliver the desired level of health services.

In 2015 there were 12,169 acute hospital beds available in Ireland. According to the HSE's Management Data Report for December 2016 there is an additional 119 beds due to be fully operational by 2018 with a significant number of replacement beds also planned[68]. These figures do not include private hospital beds.

Table 3.3: Available Hospital Beds in Ireland 2009-2016

	2009	2010	2011	2012	2013	2014	2015
Available beds in hospitals	**12,813**	**12,434**	**12,008**	**11,692**	**11,837**	**11,989**	**12,169**
Curative Care	11,755	11,417	11,116	10,885	11,005	11,241	11,370
Rehabilitative	126	129	129	132	140	161	159
Long-term	932	888	763	675	692	587	640

Source: Eurostat

In 2008 the HSE published a review of acute hospital bed capacity up to 2020. If a preferred health system was implemented, with a shift in health service delivery to the community, it was estimated that 8,008 public patient beds would be required in 2014. If a preferred health system wasn't implemented then the review predicted that 16,036 public patient beds would be required. Ireland's health services were delivered in 2014 with 11,989 beds, along with an increase in resources allocated to primary care.

Table 3.4: HSE's 2008 Estimates of Public Patient Bed Requirement to 2020

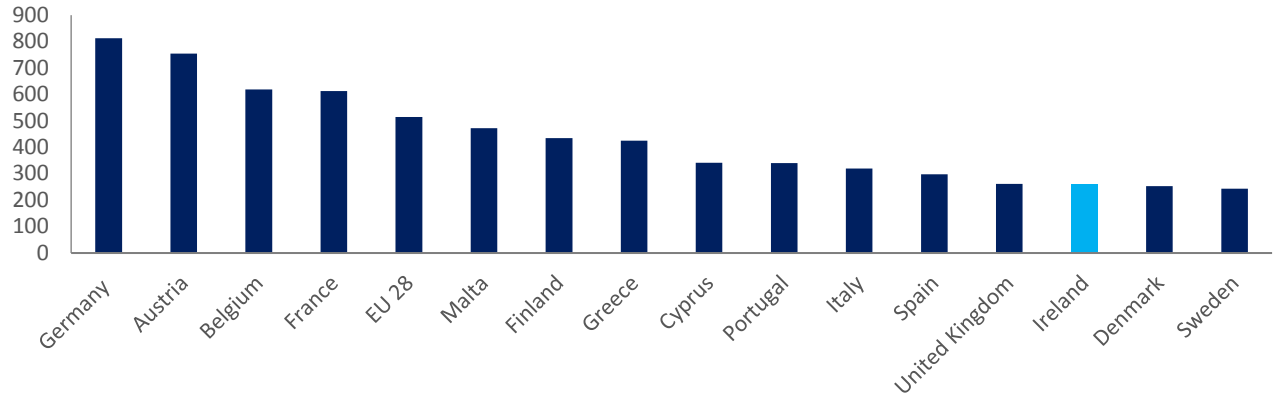
Beds Required	2014	2020
Based on preferred health system	8,008	8,834

Source: 2008 Acute Hospital Bed Capacity Review

[68] HSE National Service Plan 2017 (Appendix 4)

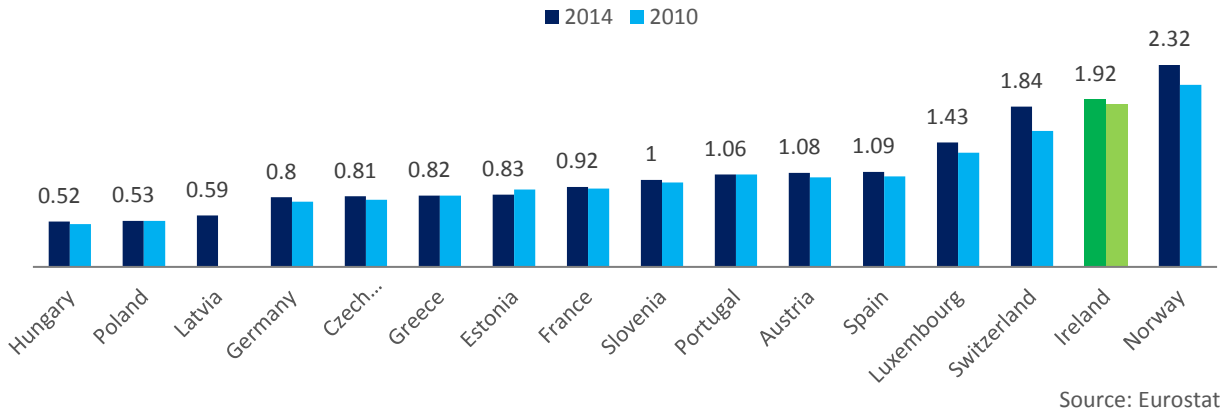
Bed projections which attempt to reconcile capacity with demand should be treated with caution given the fact that there appears to be a persistent overestimation bias when forecasting the needs for future beds, as demonstrated by the ability of the acute sector to increase discharges while bed numbers have stayed well below a number of previously projected requirements[69].

Figure 3.5: Hospital Beds per 100,000 of the Population, 2015



Source: Eurostat

Figure 3.6: Total Hospital Beds, Nurse-to-Bed Ratio (Head Counts), 2010 and 2014



Source: Eurostat

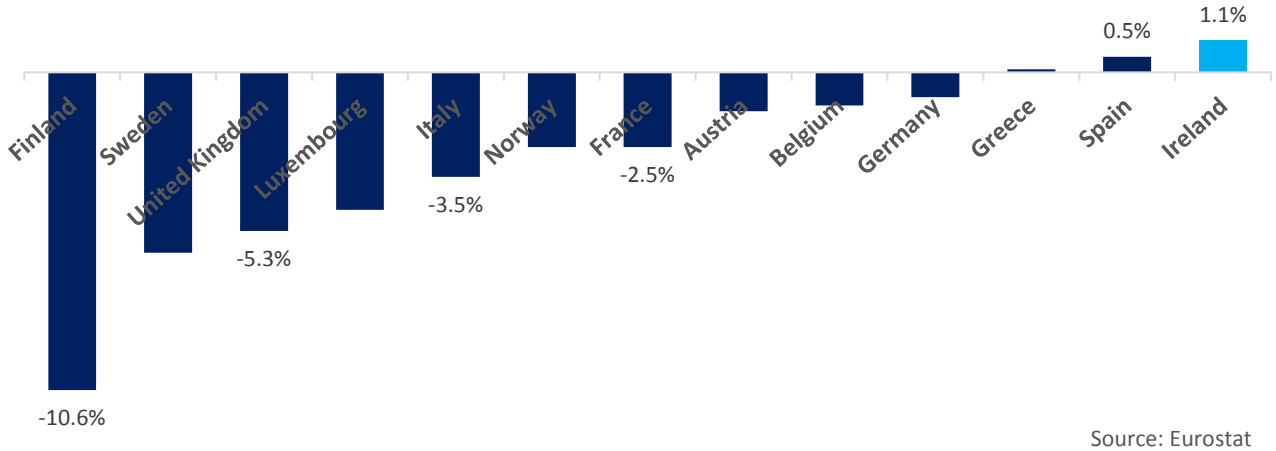
According to Eurostat data, in 2015 Ireland had 260 available hospitals beds per 100,000 inhabitants. Denmark, Sweden and the U.K. have similar levels of beds compared to Ireland and also generally score high on different health outcomes compared to other EU countries. It should also be taken into account that Denmark, Sweden and the U.K. have older populations than Ireland. Generally, older age cohorts require more hospital care than younger age cohorts. Figure 3.6 also indicates that Ireland has a relatively high ratio of nurses to hospital beds.

There has also been a clear international trend of decreasing hospital bed numbers in recent years. According to Eurostat data, between 2000 and 2015 every single country in the European Union (apart from Austria) has reduced its hospital bed numbers. This trend has been particularly clear in recent years as indicated in Figure 3.7. From 2013 to 2015, Ireland actually increased its hospital bed supply relative to its population by over

[69] For example, the ESRI's Ex-ante Evaluation of the Investment Priorities for the National Development Plan 2007-2013 found that 13,325 acute hospital beds would be required in 2013 (assuming 100% occupancy rate). As it transpired Ireland's health services were provided with 11,837 hospital beds in 2013.

1%[70]. In contrast, most EU countries decreased their hospital bed supply over this period. On average, availability of inpatient hospital beds in the EU decreased by 1.4%.

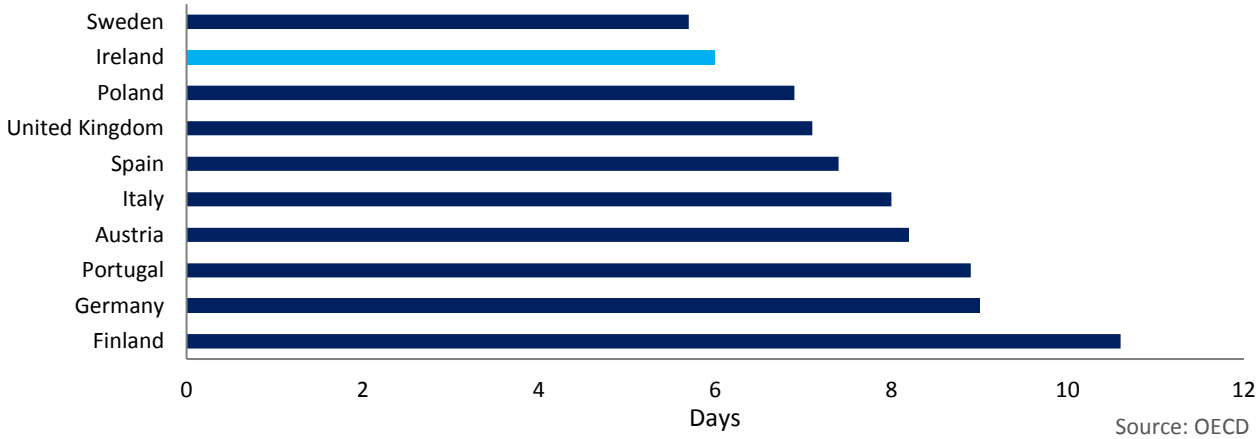
Figure 3.7: Change in the Number of Hospital Beds per 100,000 Population, 2015 on 2013



Source: Eurostat

The efficiency of acute hospital bed use in Ireland is often assessed using standard bed utilisation performance statistics as detailed below, including bed occupancy, beds per discharge and average length of stay. In 2014 Ireland had the highest rate of occupancy for acute care beds in the OECD at 94% of the available beds. This is in comparison to the OECD average of 77%[71]. Figure 3.8 shows that the average length of stay (ALOS) for inpatient care in Ireland is relatively low compared to other European countries. A low inpatient ALOS may be an indication that there is little scope for further improvement in bed management, or it may also indicate that hospitals are still carrying out too many relatively noncomplex short stay treatments as inpatients rather than day cases.

Figure 3.8: Inpatient Care Average Length of Stay, 2014



Source: OECD

The composition of hospital discharges also impacts on the demand for hospital beds. Generally speaking, the higher the proportion of day case discharges to inpatient discharges the less hospital beds will be required.

[71] OECD, Health Policy in Ireland, February 2016

The HSE's *Planning for Health 2017* report[72] notes that total inpatient and day case discharges have increased by almost 18% between 2009 and 2015. This increase has largely been facilitated through an increase in day case discharges, which were 58% of total discharges in 2009, increasing to 62% by 2015[73]. If possible, a further increase in the proportion of day case discharges could help increase the capacity of the system do deal with higher discharge numbers.

In emergency Departments the number of patients on trolleys increased from 230 per day in 2013 to 292 per day in 2015, and subsequently decreased slightly to 286 per day in 2016. It is possible that some of this demand for beds could be met by reducing the numbers of delayed discharges from acute hospital beds. The average number of delayed discharges per month has dropped from 692 per month for 2014 to 582 per month for 2016. December 2016 was also the first time the target of 500 or lower was achieved with 436 delayed discharges that month.

Reducing the number of delayed discharges through the provision of additional long-term care beds could possibly reduce the average length of stay for overnight inpatients aged 65 years and over. 90% of delayed discharges from May 2013 to December 2015 were over 65 years of age, with 35% of total delayed discharges going to a Nursing Home Support Scheme bed[74]. However, research also shows that Ireland already places in the middle of the ranking among EU countries for the number of beds in residential care facilities per 1,000 inhabitants over 65 years old. Furthermore, when taking into account the proportion of this cohort that is aged 80 or over, Ireland is placed more towards the higher end of the ranking[75].

Figure 3.9: Total Inpatient and Day Patient Discharges in 2009 and 2015

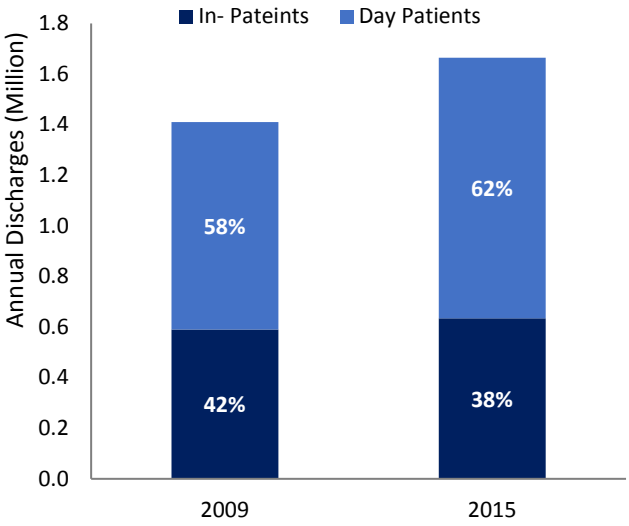
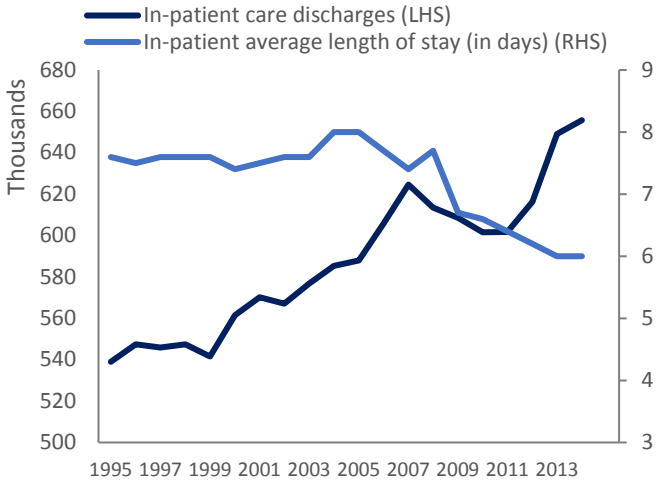


Figure 3.10: Trend in In-patient Activity in Irish Hospitals



Source: Eurostat

[72] Page 54, Planning For Health, Trends and Priorities to Inform Health Service Planning 2017
[73] Health Pricing Office, Activity in Acute Public Hospitals in Ireland, Annual Reports
[74] Planning For Health, Trends and Priorities to Inform Health Service Planning 2017
[75] IGEES Staff Paper (June 2017), Judith Meirmans, Long-Term Residential Care in an International Context

Before moving on it should be noted that continued investment in the health sector's Information and Communications Technology (ICT) has the potential to provide further improved outcomes for patients as well as enhancing the management and capacity of the existing health infrastructure. The *eHealth Strategy for Ireland* published in 2013 sets out the current policy in this area and it is worth noting that there is over €400 million included in the existing Capital Plan for investment in ICT. While the data outlined in this section reveals increased discharges from the acute sector and some pressures in terms of patients on trolleys, it is important to note the Government policy of shifting to a primary care model in order to address such pressures as well as the international trend of reducing hospital bed numbers in recent years, even in countries with older populations than Ireland.

Drivers of Demand

There are numerous complex and interrelated factors which influence the demand for infrastructure in the health sector. These include the structure of the underlying health system, demographics, trends in chronic illnesses, maintenance of existing infrastructure, advances in medical technologies as well as the changing expectations which citizens have for health services. The following section focuses on the first three of these drivers of demand due to their higher potential impact and propensity to change over time.

Table 3.5: Selected Drivers of Demand for Health Infrastructure

Driver of Demand	Example
Primary Drivers	
Structure of the Health System	The Government health policy of shifting to a primary care orientated health system will influence the demand for the relevant health infrastructure.
Demographics	The level of population growth and the age composition of the population will influence overall health demand. Older age cohorts generally require greater levels of care.
Chronic Illnesses	Trends in illnesses and diseases have an impact on the demand for health infrastructure. In particular, the incidence of chronic disease and multiple morbidities and consequences of ageing population will impact on demand.
Secondary Drivers	
Maintenance	**Developments in Medical Technology**
Changing Expectations	**Socio-Cultural Factors**

Trends in Demand Drivers

Structure of the Health System

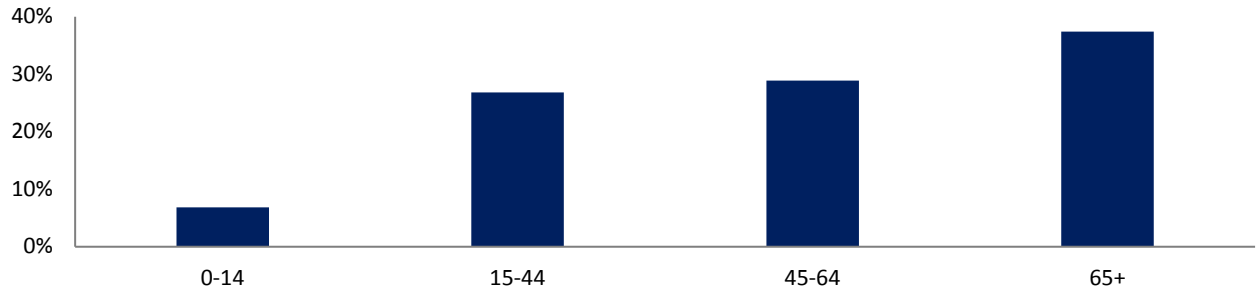
Based on the existing Government health policy of shifting to a primary care orientated health system, the structure of Ireland's health system is likely to continue to change over the coming years and therefore influence the demand for the relevant health infrastructure. Enhanced capacity in the primary care sector should relieve some of the capacity pressures in acute hospitals as previously detailed. Based on this policy it

would appear that increased use of primary care will play a fundamental role in managing the majority of care needs in the future.

Demographics

Demographics are one of the other key drivers of demand in the health sector. If that demand is to be met through an increased use of primary care then a shift of investment towards primary care infrastructure would be required. Despite only representing 13% of the population in 2015, those aged over 65 represented 37% of all hospital procedures in that year.

Figure 3.11: Proportion of Hospital Procedures by Age Group, 2015



Source: Health Pricing Office

The National Planning Framework projections suggest that Ireland's population will increase by at least 166,057 by 2021. The over 65s age cohort is projected to increase by approximately 106,476 by the year 2021. This represents an increase of 17% by 2021 of those aged over 65. This signifies a continued trend of ageing in the Irish population. These demographic pressures will likely result in an increased demand on Ireland's health services. While *Planning for Health 2017* projects an increase of adult bed days required between 2017 and 2022, it should be noted that these figures assume that hospital discharge rates, models of care and the ratio of in-patients to day cases remains stable over the period. A greater ratio of day cases and an increased shift towards primary care could reduce the number of bed days required.

Chronic Illnesses

Trends in illnesses and diseases have an impact on the demand for health infrastructure. In particular, the incidence of chronic disease and multiple morbidities and consequences of ageing population will impact on demand. Healthy Ireland, the Government's framework for improved health and well-being, identifies major risks to health from increases in adverse population trends related to obesity, diabetes, and physical activity. These have the potential to place significant additional burdens on health services. The recent OECD and European Commission report, *Health at a Glance: Europe 2016*, detailed the growing number of people living with chronic illnesses in Europe and noted that in order to meet the challenge of these demographic and epidemiological shifts, "EU health systems need to strengthen primary care systems to provide continuous, comprehensive, and co-ordinated care for their populations". Research has shown that primary care can

generally reduce the risk of complications and prevent the need for hospitalisation from conditions such as asthma, chronic obstructive pulmonary disease, congestive heart failure and diabetes[76].

Conclusions

The delivery of a high quality health system is dependent on many complex and inter-related factors. While physical infrastructure is clearly very important in its own right, capital expenditure constitutes less than one-twentieth of the total Exchequer Health budget.

Ireland's total health expenditure is amongst the highest in Europe. Over the past twenty years Ireland has invested significant levels of capital expenditure in health infrastructure. This is evident when comparing Ireland's capital expenditure levels to other OECD countries. The health sector's share of the capital budget has also increased over the past twenty years.

This investment has also coincided with the development of a health strategy which aims to ensure that a greater number of people are treated through primary care rather than in acute hospitals. Further to this, the existing Capital Plan includes a wide range of major infrastructure projects to be built over the coming years across both the acute and primary care sectors.

While increasing demand for health services seem likely over the remaining period of the Capital Plan based on demographics and Ireland's ageing population, an increased use of day case treatment along with a continued shift towards primary care can help meet these needs.

This analysis points to the importance of further research which should aim to bring greater clarity to the current level of provision. At present there is no comprehensive assessment of the existing stock of infrastructure. Once the current level of capacity is established, it will be possible to form a view on whether the composition of the existing stock needs to be changed in the face of changing needs and the policy objective of meeting 90/95% of care needs in the primary care setting.

[76] Purdy S. et al. (2012), "Interventions to Reduce Unplanned Hospital Admission: A Series of Systematic Reviews", *Research for Patient Benefit,* No. PB-PG-1208-18013, funded by the National Institute for Health Research.

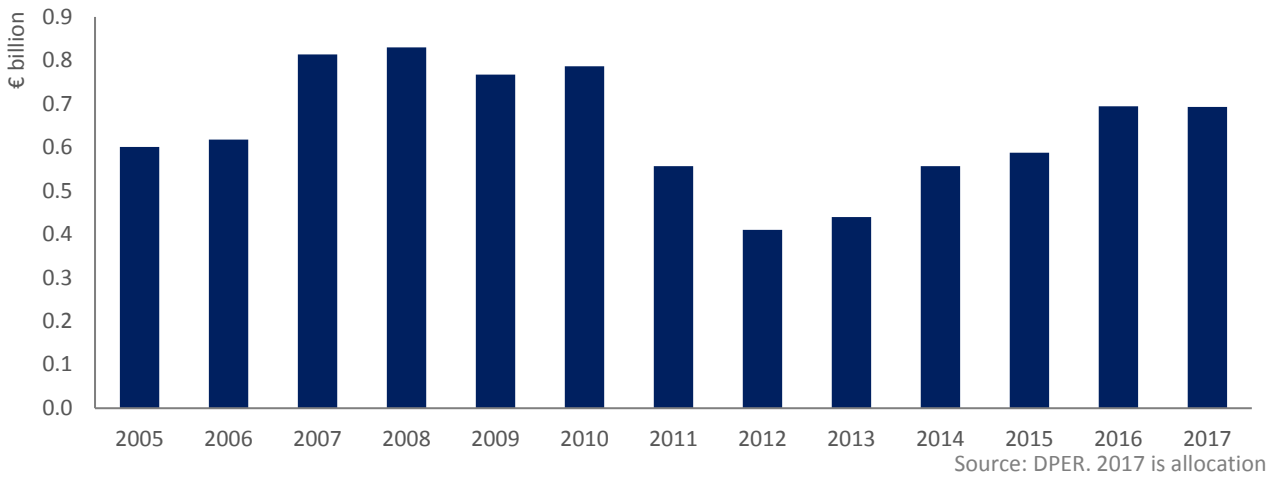
4. Education

Schools, higher education institutions and further education and training (FET) centres are critical elements of national infrastructure. Providing appropriate capacity to allow for the education system to function effectively and efficiently at primary, post-primary and tertiary level is of great importance and investment in this area by Government plays a key role in this. This section briefly outlines previous investment in this sector and discusses overall infrastructure levels, drivers of demand and trends in demand drivers.

Previous Investment

The total gross level of capital expenditure by the Exchequer in the education sector peaked in 2008 at €830 million. In line with the other elements of capital expenditure, investment in the education sector decreased significantly up until 2012 when it stood at €410 million. As of 2017, the capital allocation for the Department of Education is 69% higher than 2012 at €693 million. However, as demonstrated this is below previous investment levels. These trends are described in Figure 4.1.

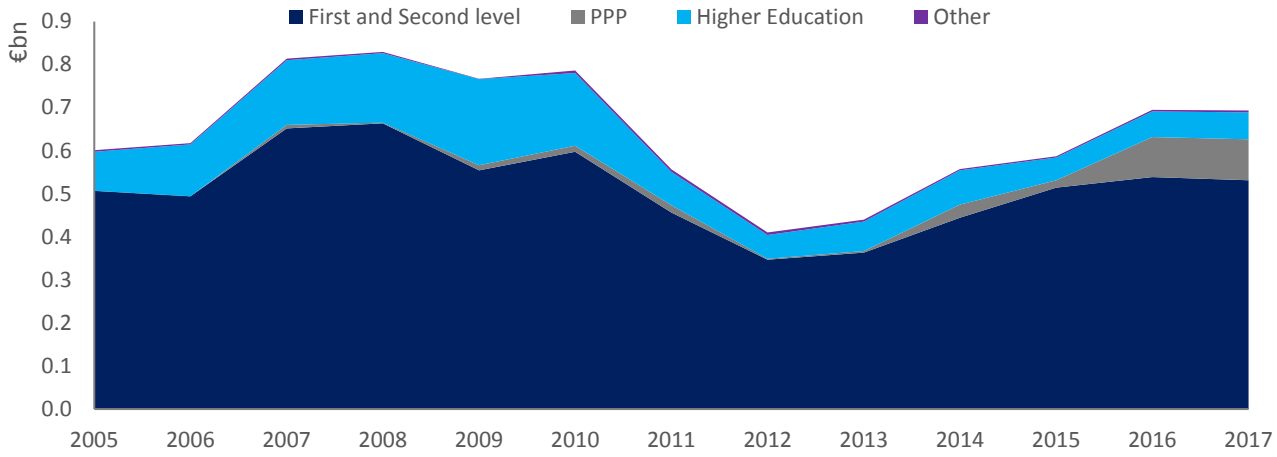
Figure 4.1: Gross Exchequer Capital Expenditure on Education (€bn), 2005-2017



Source: DPER. 2017 is allocation

Figure 4.2 focuses on the composition of expenditure over the time period. We can observe that capital expenditure in the primary and post-primary area in 2017 is 20% lower than the peak expenditure level in 2008. A much greater decrease can be seen in the area of higher education which saw a fall of 61% over the same time period. It is important to note that expenditure delivered under PPP arrangement, as classified in Figure 4.2, relates to investment across primary, secondary and tertiary level (not included in change figures listed above) and has increased substantially. While Exchequer capital investment decreased up to 2012 and now stands below the peak level, it is clear that reductions in higher education were greater than those in first and second level. In terms of the current composition of capital expenditure in 2017, we can observe that primary and post-primary level accounts for 77% of gross capital expenditure while PPPs account for 14% and higher education accounts for 9% (6% research activities and 3% infrastructure).

Figure 4.2: Gross Exchequer Capital Expenditure on Education by Area (€bn), 2005-2017



Source: DPER. Note: Expenditure under PPP arrangements contains primary, secondary and tertiary elements

Commitments and delivery through PPPs has been a feature of education investment in recent years. The total allocation for the PPP programme stands at €95 million in 2017. The submission to the Capital Review by DES indicates that to date, 25 post primary schools, two primary schools and two higher education projects have been delivered by PPP. Service commencement of these projects was achieved at various dates between January 2003 and May 2016.

It should be noted that the analysis presented in this report primarily focuses on institutions (schools and third level institutions) which are supported by DES. As such, there are elements of the overall education system which are not supported by the Exchequer (e.g. private education institutes). In addition, elements of the publically supported system collect funding from other sources (e.g. student fees and commercial revenue at tertiary level). However, public sources make up the majority of expenditure in the area. The OECD[77] estimates that in 2013 95% of total expenditure at primary, secondary and post-secondary non-tertiary levels is public (OECD average is 91%) and 78% of total expenditure at tertiary level is public (OECD average is 71%).

The Capital Plan provides €3.8 billion in Exchequer funding for investment in primary, secondary and third level education facilities; combining the upgrade and extension of existing educational infrastructure and the provision of new buildings. The profile of this expenditure between 2016 and 2021 is highlighted in Table 4.1. The key objective of this investment is to meet the demographic demand for school places which, as will be detailed later, will impact on the primary and post primary school sector during the period of the Plan and feed through to the further education and third level sectors thereafter.

Table 4.1: Six Year Envelope for Education (€m), 2016-2021

	2016	2017	2018	2019	2020	2021	Total
DES	545	599	623	654	700	700	**3,820**

Source: Building on Recovery: Infrastructure and Capital Investment 2016-2021

[77] OECD (2016) 'Education at a Glance 2016'

The previous Capital Plan and subsequent stimulus programmes prioritised investment in primary and post-primary schools, funding the delivery of 239 large scale projects – 141 new/replacement schools and 98 major extensions – in the period between 2012 and 2016. These 239 large scale projects provided 84,000 permanent school places over the five year period of which 62,600 were additional school places. The 239 large scale projects included 61 projects that were already under construction prior to 2012 and these reached completion in the period 2012 to 2014. The annual announcements in respect of large scale projects over the years 2012 to 2015 together with the stimulus projects announcement indicated that 275 large scale projects were to advance to tender and construction. By the end of 2016, a total of 175 such projects had reached substantial completion. The balance of 100 projects together with the 310 large scale projects announced in November 2015 remain to be delivered over the five years to 2021. Many smaller scale projects at school level, involving the addition of extra classrooms to meet immediate enrolment demands, were also funded. These smaller scale projects provided 39,600 additional permanent school places over the five year period.

The current Capital Plan targets the delivery of a further 19,000 additional primary school places required by 2018 and a further 43,000 additional post-primary school places required by 2022, the completion of large scale projects previously announced as well as a significant programme of replacing existing ageing pre-fab accommodation with permanent classrooms and facilities.

Phase 1 of the Prefab Replacement Initiative was launched in 2012, replacing 458 prefab units with permanent accommodation at 167 primary schools and 4 post-primary schools. Phase 2 of the Initiative was announced in June 2013 to allow 46 schools to replace 119 mainstream classrooms and 37 resource rooms. While this work is continuing, the next step in this initiative is to begin the process of replacing old purchased prefabs with permanent accommodation. The extension of the prefab replacement initiative will ensure that the use of prefab accommodation in schools will be brought to an end.

In addition, the allocation will also fund the cost of ongoing refurbishment projects across the school system, and support minor works, site acquisitions and emergency works. Complementing this building programme, the capital allocation will allow for investment of €210 million to upgrade school ICT infrastructure under the Government's Digital Strategy for Schools.

There will be an extra €110 million for facilities in the higher education sector. This is in addition to the €40 million previously committed to the Grangegorman DIT project. This will facilitate progress on a small number of projects, some of which are already underway, plus some essential works. Under PPPs, an extra €200 million worth of projects will be delivered in the third level sector. The Capital Plan will also fund higher education research activities.

Infrastructure Overview

The following section sets out a high level analysis of existing infrastructure in the education sector. The objective is to detail the level and composition of infrastructure across primary, post-primary and higher education sectors. It also briefly covers the area of further education and training (FET) and apprenticeships.

An important point to note from the outset of this analysis is the lack of a comprehensive database on capacity across primary and second level sectors. The Department of Education and Skills (DES) has indicated that there is no up to date database which provides detailed comprehensive information on the capacity, age and condition of the more than 4,000 school buildings across the State, the majority of which are not in the ownership of the State. Rather, the Department only has an indication of capacity, age and condition from the applications it receives from schools for schemes for essential works, etc. This also reflects the reality that the focus of the school building programme in recent years has been on additionality to cater for demographic growth rather than on refurbishment of existing schools. Thus, the analysis presented here focuses on high level trends in the number and size of schools and any conclusion related to capacity should be seen as indicative rather than definitive.

Primary Level

There are 3,115 primary schools in Ireland (mainstream classes only), down from 3,165 in 2010/2011. However, this decline masks significant changes in the composition of primary schools by size over the period.

Table 4.2: Number of Primary Schools by Size, 2010-2017

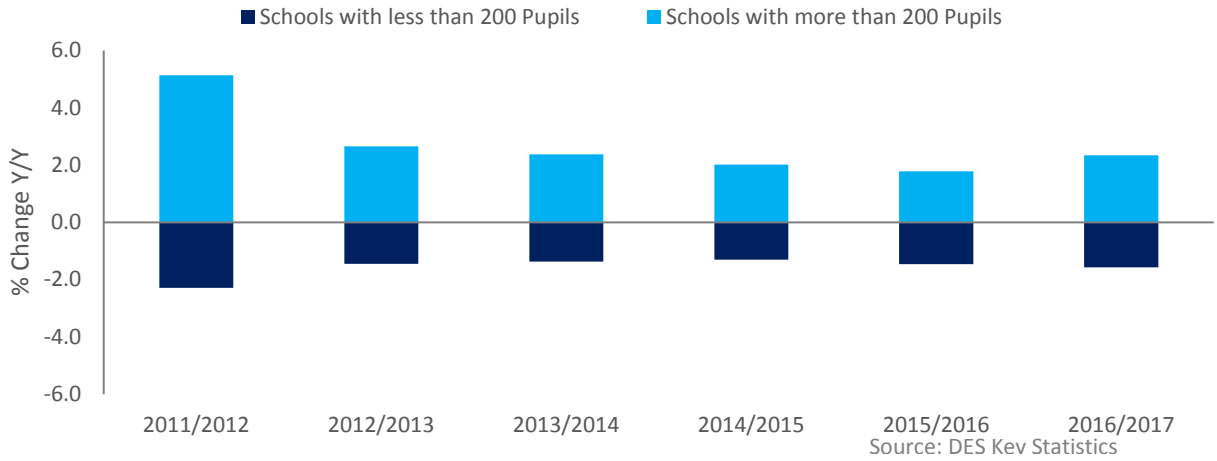
Enrolment Size – No. of Pupils	2010/ 2011	2011/ 2012	2012/ 2013	2013/ 2014	2014/ 2015	2015/ 2016	2016/ 2017	% Change since 10/11
Less than 50	618	599	598	600	603	588	583	-5.7
50 - 99	836	824	783	751	702	707	699	-16.4
100 - 199	816	795	805	805	823	802	782	-4.2
200 - 299	492	506	513	513	513	511	518	5.3
300 - 400	310	338	351	367	378	392	403	30
500+	93	97	102	109	118	124	130	39.8
Total	**3,165**	**3,159**	**3,152**	**3,145**	**3,137**	**3,124**	**3,115**	**-1.6**

Source: Dept. of Education and Skills: Education Statistics Database. Note: Mainstream Classes only

The chart below sets out two clear trends. The number of schools with more than 200 pupils increased by 17% since 2010/2011 while the number of schools with less than 200 pupils decreased by 9% over the same period. This trend reflects the Department of Education and Skills' (DES) Value for Money Review (VFMR) of Small Schools in 2013[78] which recommended the reorganisation and amalgamation of schools based on size, ethos and distance from other schools.

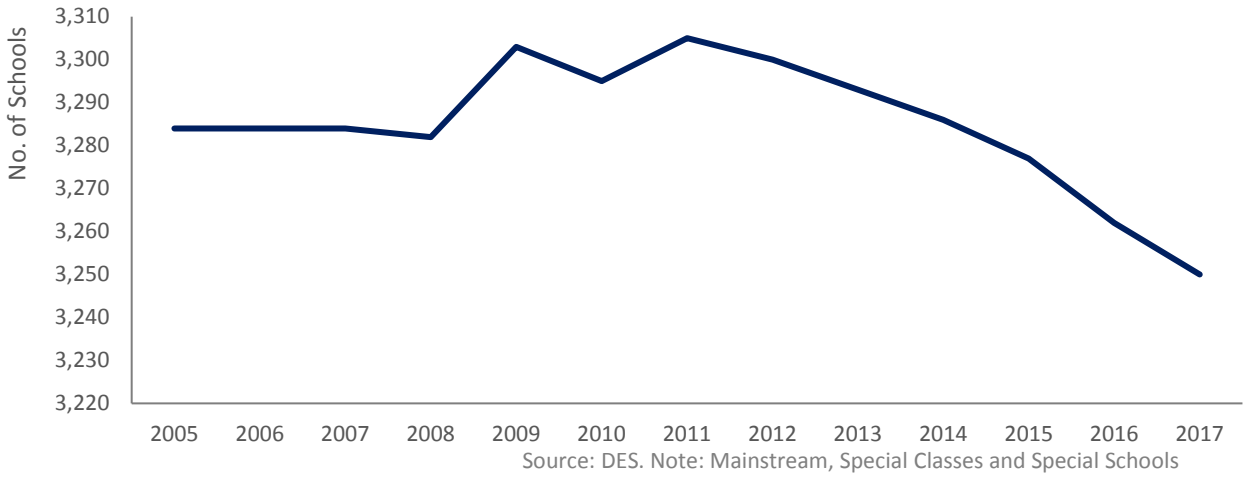
[78] https://www.education.ie/en/Publications/Value-For-Money-Reviews/Value-for-Money-Review-of-Small-Primary-Schools-2013.pdf

Figure 4.3: Percentage Change in the Number of Primary Schools by Size



Thus, while the number of schools has declined over time, this is not to say that overall capacity in the primary sector has also declined. This is because of the large increase in the number schools catering for over 200 pupils since 2010/2011. However, the lack of comprehensive data on overall capacity hinders any firm conclusion in this regard.

Figure 4.4: Total Number of Primary Schools in Ireland, 2005-2017



As displayed in Table 4.3, over 4 in 10 schools in Ireland are located in Leinster and since 2009 this is the only province that has seen a rise in the number of schools. Munster (-3.4%), Connaught (-3.5%) and Ulster (-1.6%) have all experienced reductions. However, it is worth noting again that this doesn't equate to a capacity reduction as data on specific school size and overall capacity is unavailable.

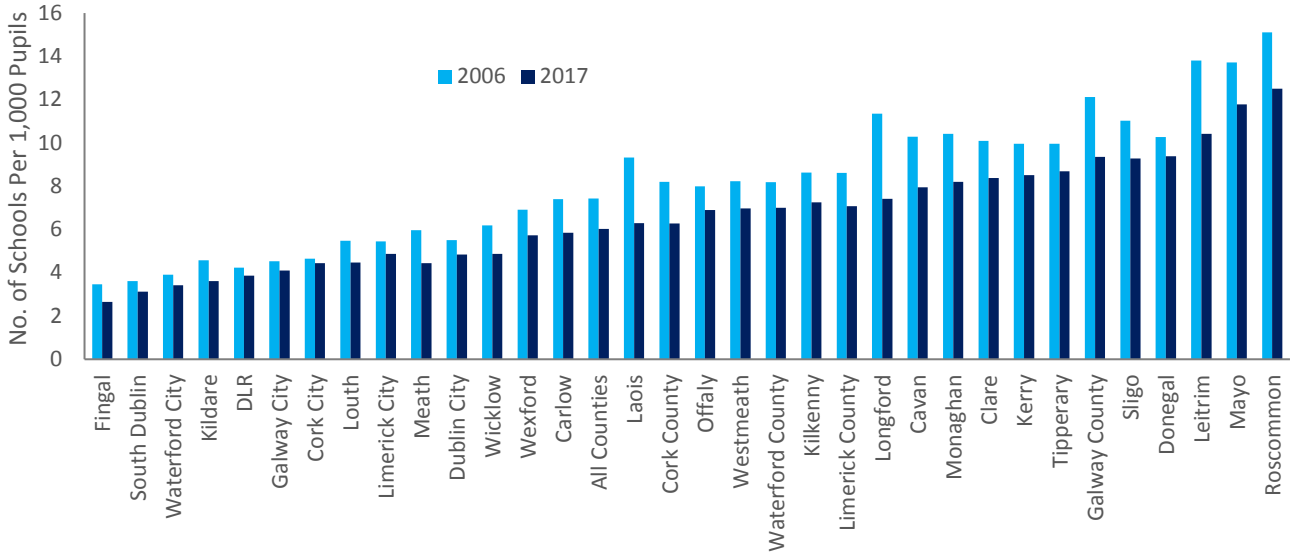
Table 4.3: Number of Primary Schools by Province and Year, 2009-2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Leinster	1,340	1,340	1,352	1,353	1,356	1,357	1,358	1,355	1,349
Munster	1,019	1,016	1,014	1,011	1,006	1,002	997	988	984
Connaught	624	620	621	618	614	610	606	604	602
Ulster	320	319	318	318	317	317	316	315	315
Total	**3,303**	**3,295**	**3,305**	**3,300**	**3,293**	**3,286**	**3,277**	**3,262**	**3,250**

Source: Dept. of Education and Skills: Education Statistics Database. Note: Mainstream, Special Classes and Special Schools

Despite having the largest number of schools, in terms of schools per 1,000 pupils, many counties in Leinster are towards the middle and bottom end of the scale as set out below. This is in part due to higher population density in these areas than for areas such as Mayo and Roscommon at the other end of the scale. In areas where population density is lower, one would expect to see a higher number of schools per 1,000 of population. In addition, the number of schools per 1,000 pupils has declined since 2006 as the rate of population growth has outstripped school building. This has been a consistent trends across all areas. With the urban population increasing at a faster rate than for rural areas (5% vs 2% from 2011 to 2016), the demand for primary school places may be more likely to come from our cities in the years ahead.

Figure 4.5: Number of Primary Schools Per 1,000 Pupils by County, 2006 and 2017



Source: Dept. of Education and Skills: Education Statistics

Most schools in Ireland, 86%, are ordinary primary schools. There are a further 427 ordinary national schools with pupils with special needs. This type of school has increased by 68% since 2012 while there has been a 4% fall in the number of special schools. This increase in the number of schools with pupils with special needs potentially reflects some mainstreaming of special needs education in the classroom. Again, and importantly, the data below does not reflect overall capacity given the lack of detail on school size.

Table 4.4: Number of National Schools by Type, 2012-2017

	2012	2013	2014	2015	2016	2017
Ordinary Primary Schools	3,159	3,152	3,145	3,137	3,124	3,115
Ordinary Primary Schools with Pupils with Special Needs	254	278	312	335	386	427
Special Schools	141	141	141	140	138	135

Source: Dept. of Education and Skills: Education Statistics Database. Note: Discontinuity in series pre-2012

In addition, DES maintains a detailed database of all temporary accommodation being rented at both primary and post-primary level. In early 2008, more than 870 schools were renting over 2,000 temporary prefab units. As of December 2016, that number has been reduced to 350 schools renting 950 prefab units.

Second Level

The composition of schools by size at post-primary level is significantly different from primary. Here, only 13 percent of schools have less than 200 pupils (versus 66% at primary) while 87% of schools have more than 200 pupils (versus 34% at primary).

Table 4.5: Number of DES Aided Post-Primary Institutions by Size, 2010-2017

Enrolment Size – No. of Pupils	2010 /2011	2011 /2012	2012 /2013	2013 /2014	2014 /2015	2015 /2016	2016 /2017	% Change 2010-2016
Less than 100	19	15	13	15	21	18	24	26.3
100 - 199	64	66	60	62	59	59	71	10.9
200 - 299	105	97	103	107	107	110	97	-7.6
300 - 499	218	212	207	184	185	177	179	-17.9
500+	322	332	338	355	360	371	340	5.6
Total	**728**	**722**	**721**	**723**	**732**	**735**	**711**	**-2.3**

Source: Dept. of Education and Skills: Education Statistics Database

There has been some change in terms of school size at second level over the last few years[79] with 12 more schools with less than 200 pupils and 29 fewer schools with more than 200 pupils since 2010/2011. As per Table 4.6, there is also a broadly similar composition of post-primary schools by province as is the case for primary schools with most being in Leinster. In fact, half of all post-primary schools are in Leinster. A further 28% of schools are in Munster, 14% in Connaught and 7% in Ulster.

Table 4.6: Number of DES Aided Second Level Institutions by Province and Year, 2009-2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Leinster	360	360	360	358	358	360	369	372	360
Munster	216	216	216	213	212	210	209	209	202
Connaught	106	104	103	102	101	103	103	103	99
Ulster	50	50	50	50	50	50	51	51	50
Total	**732**	**730**	**729**	**723**	**721**	**723**	**732**	**735**	**711**

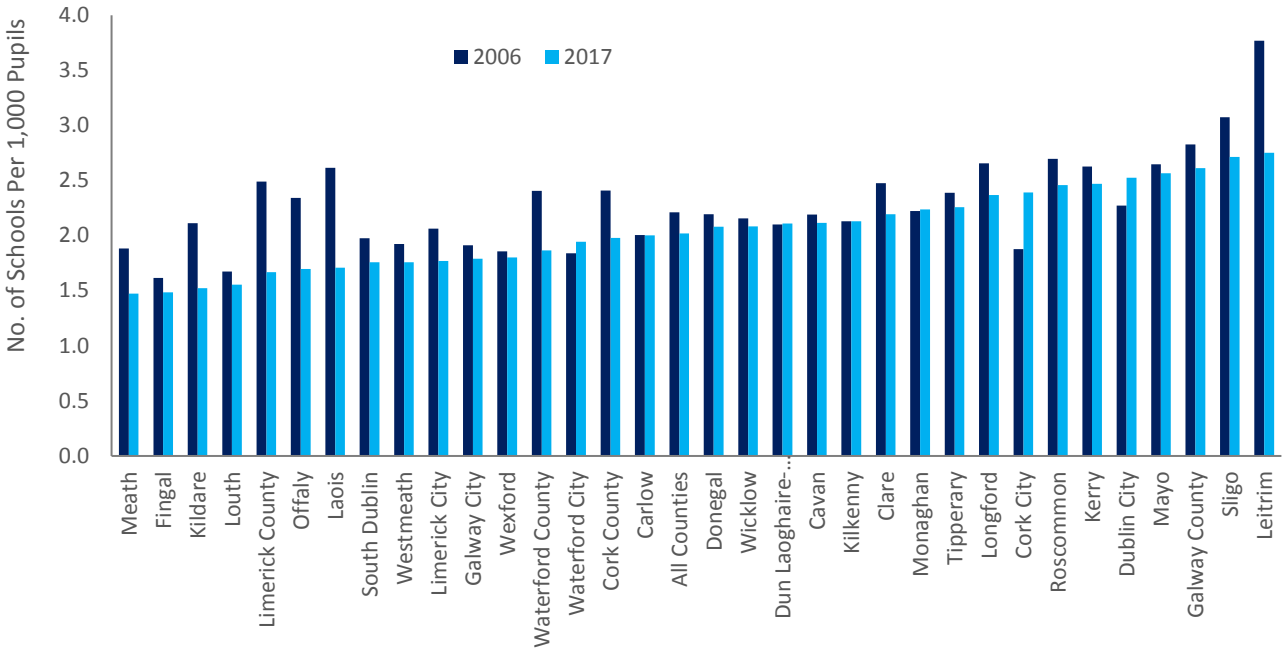
Source: Dept. of Education and Skills: Education Statistics Database

Looking at schools per 1,000 pupils by county in 2016[80] shows that, in comparison to primary level, there is less of a difference in school provision across the country. Meath is at the bottom end of the scale with 1.5 schools for every 1,000 pupils while conversely Leitrim has 2.8 post-primary schools for every 1,000 pupils. The national average is 2 schools per 1,000 pupils. Again, population density is reflected in this figure with commuter counties towards the lower end of the scale and more rural western and southern counties at the

[79] DES have stated that a reason for the decrease in total school numbers is due to reclassification of schools (e.g. PLC courses by SOLAS as colleges of further education).
[80] DES statistical database for 2017 lists schools vy LA area.

higher end. We would thus expect that there would be a higher number of schools in areas of the country with lower population densities. As with primary level, a distinctive trend in the chart is the general decline in the number of schools per 1,000 pupils since 2006, pointing to the increase in population over the period in question.

Figure 4.6: Number of DES Aided Post-Primary Institutions Per 1,000 Pupils by County, 2006 and 2017



Source: Dept. of Education and Skills: Education Statistics Database. Leitrim 2017 unavailable.

Secondary and vocational schools make up the large majority of schools in Ireland – nearly 90%. There are a further 82 community schools with 14 comprehensive schools.

Table 4.7: Number of DES Aided Post-Primary Institutions by Type, 2009-2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Secondary Schools	388	384	383	376	375	373	375	375	374
Vocational Schools	253	254	254	254	253	256	262	266	241
Community Schools	77	78	78	79	79	80	81	80	82
Comprehensive Schools	14	14	14	14	14	14	14	14	14

Source: Dept. of Education and Skills: Education Statistics Database

Tertiary Level

In comparison to primary and post-primary levels, at a high level there has been relatively little change in the composition of the third level sector in terms of infrastructure over the last number of years. The table below provides a broad profile of the sector which shows that there are seven Universities in Ireland, three in Dublin and four spread across Limerick, Galway, Cork and Maynooth. There are a further 14 Institutes of Technology (IOTs). Following from the recommendations of the 2012 Report on the Structure of Initial Teacher Education

Provision in Ireland (the Sahlberg Report) a programme of consolidation of teacher training colleges was implemented, including the incorporation of certain colleges with universities. It is anticipated that there will be 2 teacher training colleges by the end of this year. The reduction in the number of teacher training colleges has been one of the main changes in the composition of the third level sector in recent years. In infrastructure terms, the ongoing consolidation of the DIT Campus at Grangegorman is a very significant project.

Table 4.8: Number of 3rd Level Colleges Aided by DES, 2011-2016

Type	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016
Universities	7	7	7	7	7
Institutes of Technology	15	15	14	14	14
Teacher Training	7	7	5	6	5
Other	4	4	4	4	3
Total	**33**	**33**	**30**	**31**	**29**

Source: Dept. of Education and Skills: Education Statistics Database

As highlighted by the Expert Group on Future Funding for Higher Education[81], the higher education sector has a very significant asset base with buildings with an estimated insured value of €8 billion, in addition to equipment. The report also points to the conclusions from a 2010 Higher Education Authority (HEA) Space Survey on the current state of buildings which suggested that:

- The higher education sector has stretched itself significantly to accommodate an increasing student population at both third and fourth levels along with also increasing numbers of part-time students at all levels. This has been achieved largely on the strength of highly efficient space utilisation;
- Space provision within the sector is seriously inadequate. Around 39 per cent of the existing space is not of an appropriate standard—this is an average so the proportion is higher in a number of HEIs;
- A significant proportion of the sector's space is either rented or prefabricated.

Further to the findings of the 2010 survey, these issues have been exacerbated by the 26,000 additional enrolments between 2010/2011 – 2015/2016 across 21 institutions – Universities and Institutes of Technology. As a result the capacity of higher education institutions is under significant additional pressure when compared to the 2010 survey. More up to date data on capacity and condition is not available as the last space survey was 2010.

Further Education and Training (FET) and Apprenticeships

Up to the setting up of SOLAS in 2013, further education programmes were funded directly by the Department and delivered locally by 33 VECs. These 33 VECs were amalgamated and became 16 Education and Training Boards (ETBs) in 2014. These FE programmes included PLC, VTOS, Youthreach, BTEI, Adult Literacy and

[81]https://www.education.ie/en/Publications/Policy-Reports/Investing-in-National-Ambition-A-Strategy-for-Funding-Higher-Education.pdf

Community Education. During this period, training programmes were delivered by FÁS which was initially under the Department of Jobs, Enterprise and Innovation and transferred into the Department of Education in 2010. FÁS was dissolved and replaced by SOLAS in 2013. The Department integrated the further education and training areas, and SOLAS, the new agency, took over responsibility for the oversight and funding of further education and training (FET) in Ireland.

On the ground, FET is delivered through 16 Education and Training Boards (ETBs) across the country. Apprenticeships are also delivered in Higher Education Institutions (in particular IoTS). ETBs are constituted from the former Vocational and Education Committees (VECs), of which there were 33, and 19 FÁS Training Centres. Within these centres, there is widespread use of small, single purpose premises. As a result, it is the view of D/E&S that the sector does not currently have the capacity to respond to the changing needs of both learners and employers. In addition, the Department argues that the lack of a dedicated capital budget for further education has resulted in programmes being delivered in buildings that have not been refurbished over the years and in some cases are not fit for purpose.

However, it is difficult to robustly assess the extent of these issues due to the lack of a comprehensive database on the capacity in the FET sector including the age, size and quality of infrastructure. However, DES has stated that the list of capital funding requirements compiled by SOLAS on the basis of applications from ETBs, points to a significant infrastructural deficit.

In terms of previous investment, it is worth noting that in previous years there has not been a consistent dedicated capital budget provided for further education. In 2007 and 2008, capital allocations of €35 million and €25 million respectively were provided for the training centre network, a level of investment which built up the capacity of training centres and enabled the growth in registrations to date be met. In addition, a further annual allocation of €3 million has been made for SOLAS Headquarters and the upkeep and provision of equipment in the 19 training centres and 16 ETBs.

Drivers of Demand

This section provides a brief overview of the main factors that are likely to influence demand for education infrastructure in Ireland in the years ahead.

Table 4.9: Selected Drivers of Demand in Education

Driver	Example
Primary Driver	
Demographics	Population growth, the age composition of the population, migration patterns and the geographical dispersion of the population (urban and rural) are primary drivers of demand. In this regard, regional development and the National Planning Framework are also important considerations.
Secondary Drivers	
Participation Rates	Changes in participation rates will influence demand especially at third level.
Existing Stock and Prefab Replacements	The age of the existing stock of infrastructure will drive demand for investment as will the replacement of prefabs.
Technological Developments	Technology is one of the key drivers of change in the economy. Developments in ICT can drive demand for better broadband connectivity and improved infrastructure within education institutions, including wireless networking, digital learning tools, and equipment.
Special Needs Provision	Providing for students with special needs will impact on the demand for infrastructure.
The Pupil Teacher Ratio (PTR)	Changes in the PTR will impact on class sizes and by extension demand for space.
Skills Needs and Further Education	Policy choices on the mix of employment and training supports and the state of the labour market will influence demand in this area. Furthermore, general skills development policy is a driver across levels.

Demographic changes are the key driver of demand for education infrastructure. Within this, the birth rate and migration are important in terms of the number of school and college places. Moreover, demographic change is not evenly spread across the country – population growth is concentrated in urban and commuter areas, a trend that has been ongoing for many years. The geographical distribution of projected pupil population increases must be matched against the existing profile of schools to inform the prioritisation of future capital investment. Furthermore, school types[82] and composition of demand is an additional consideration. In addition to demographics, there are a number of other drivers of demand for education infrastructure, including:

- **Participation rate –** this is the proportion of the eligible population that participates in education at the various levels. Given that the rates of participation in Ireland are very high, especially for primary

[82] E.g. denominational, multi-denominational and non-denominational

and post-primary, this will be closely linked to demographics. This factor is particularly important at tertiary level where participation is not mandatory.

- **The existing stock of infrastructure –** this is another important driver of demand. The age and composition of the current stock of infrastructure, including prefabricated accommodation, will have an impact on the level of demand for the upgrading or replacement of buildings and other capital stock.
- **Technological developments** – ICT developments such as broadband will also have an impact on demand. For example, as online learning becomes more prevalent and initiatives in the area of Science, Technology, Engineering and Maths (STEM) are further developed in line with skill shortages, the demand for ICT infrastructure/equipment and broadband connectivity is likely to increase.
- **Special Needs Provision** – the demand of educational infrastructure will also be influenced by special needs provision, whether through the adaptation of existing infrastructure or within the development of new infrastructure.
- **Pupil Teacher Ratio (PTR)** – The PTR may also lead to changes in demand. In particular, decreases in the PTR may increase the demand for additional space.
- **Skills Needs and Further Education** – Trends in skills needs and subject mixes are an important factor across all levels of education. In particular, this is relevant to the area of FET which is a relatively complex sector. It is influenced by a number of factors including the state of the economy and labour market, the demand for training by employers and government policy in areas such as social inclusion and education supports. As such, the drivers of demand are more difficult to specify.

The above drivers of demand are broadly reflective of the whole sector but will vary across the different levels. For example, because participation rates are very high at primary and second level, this may not be an important additional consideration in addition to demographics. This is reflected by the fact that as of 2013, nearly 90% of persons in Ireland aged 20-24 years had completed second level. However, the participation rate will be more important for the FET and third level sectors where participation rates continue to rise. Over 45 per cent of the labour force now has a higher education qualification, and the participation rate of 18-20 year olds in higher education has grown from 20% in 1980 to a current level of 58%.

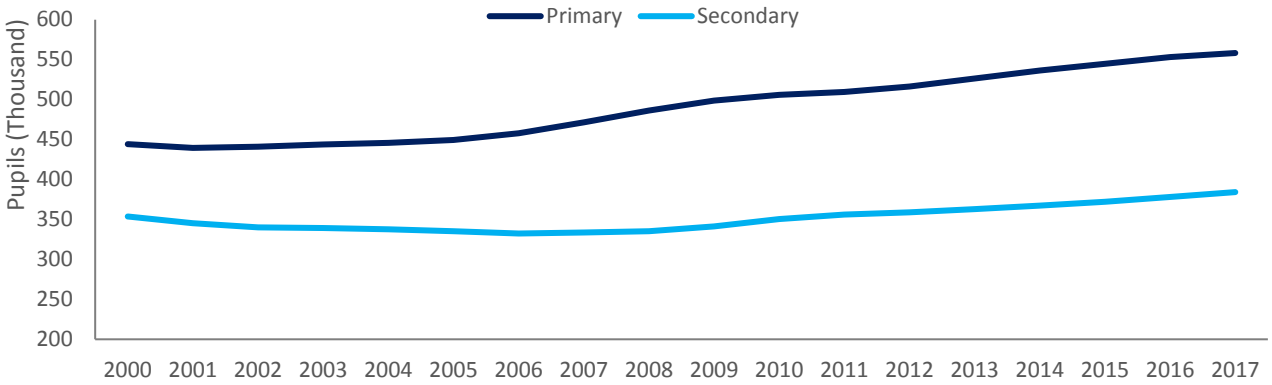
Other factors such as ICT will also have various implications for different sectors. For example, given that the higher education sector is predominantly urban based, issues related to broadband access may be less acute here than for the primary and secondary sectors which have a broader regional composition. However, how course choices impact on the composition of infrastructure may be more important. For example, increased demand for, and policy initiatives to promote, STEM courses may have implications for the type of infrastructure and technological equipment (e.g. laboratory equipment) that will be required. These, and other related issues, will need to be considered in the context of future educational infrastructure.

Trends in Demand Drivers

As detailed, demographics are the primary driver of demand in the education system. Education is mandatory for those between the ages of six to sixteen or until students have completed three years of second-level education. Dynamics within the child cohort of the population have a direct impact on capacity requirements at primary and post-primary level. Likewise, the size of the cohort completing second level has an impact on the demand for access to third level. The purpose of this section is to review trends in the drivers of demand for the education sector. As such, high level analysis of previous demand levels and forecast trends are provided here.

In terms of the total number of pupils at primary and post-primary level, we can observe that there has been significant growth since 2005 at both levels. As of 2017, the number of pupils enrolled at primary level has grown by 24% since 2005, from just under 450,000 to over 558,000. Over the same time period, pupil numbers at second level have increased from just over 335,000 to over 384,000, a rise of 15%. It is thus clear that demographic change has been a significant driver of demand up to 2016. The high level of recent increase at primary level will have a knock on effect at secondary level in future years as will be detailed.

Figure 4.7: Number of Pupils at Primary and Post-Primary Level, 2000-2017



Source: D/E&S. Note: Refers to all schools aided by D/E&S at both primary and secondary

In terms of understanding the effect of this growth on capacity and infrastructure it is important to consider a number of issues including the pupil teacher ratio and the regional composition of demand. Table 4.10 displays the pupil teacher ratio (PTR) at both primary and post-primary level between 2007 and 2017. It is evident that the ratio of pupils to teachers at primary level has remained relatively constant since 2007 with a slight increase between 2011 and 2013 before a decrease to 2017. In contrast at post-primary level we can observe that the PTR is higher in 2017 than in 2007 although this has fallen since 2013 by 0.4.An alternative measure of pupil density at primary level is the average class size[83]. Analysing this data shows that the average size increased from 23.9 in 2011 to 24.7 in 2017. While not possible to draw firm conclusions from this high level analysis it is possible that the increased class size at primary level and the higher PTR at second level may

[83] PTR at primary level includes part time teachers and as such average class size is a useful additional metric.

have had an impact in terms of reducing demographic pressure on infrastructure due to increased density of students. As such, it is evident that policy decisions related to the PTR and class sizes can have an influence on capacity.

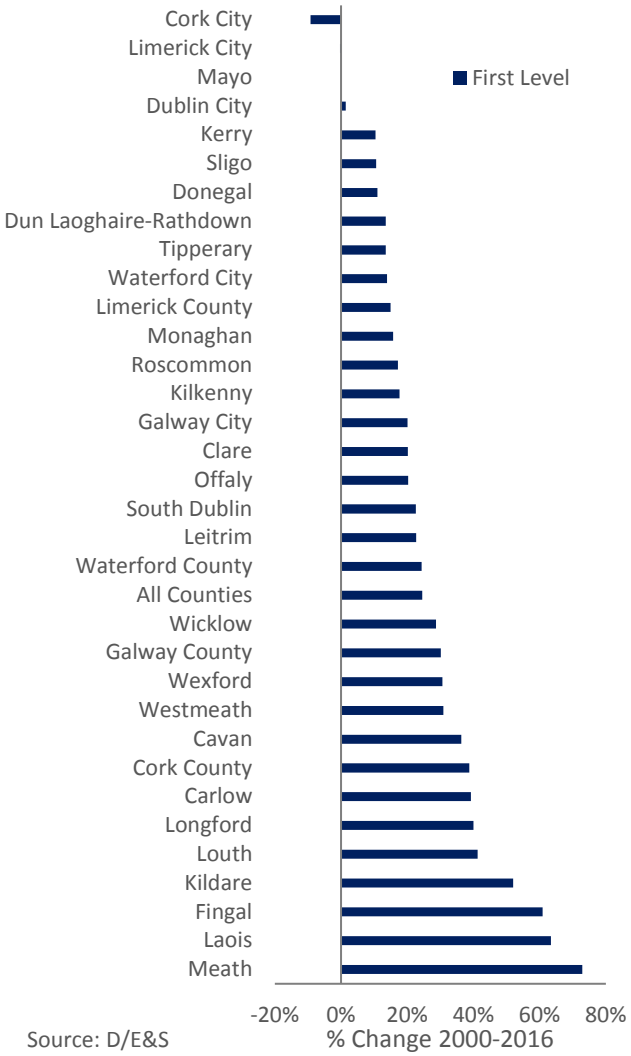
Table 4.10: Pupil Teacher Ratio (PTR) at Primary and Post-Primary Level, 2007-2017

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Primary	16	16	15.9	16	15.7	16.2	16.4	16.3	16.2	16	16
Post-Primary	13.1	12.9	13	13.6	13.6	13.9	14.3	14.3	14.2	14.1	14.1

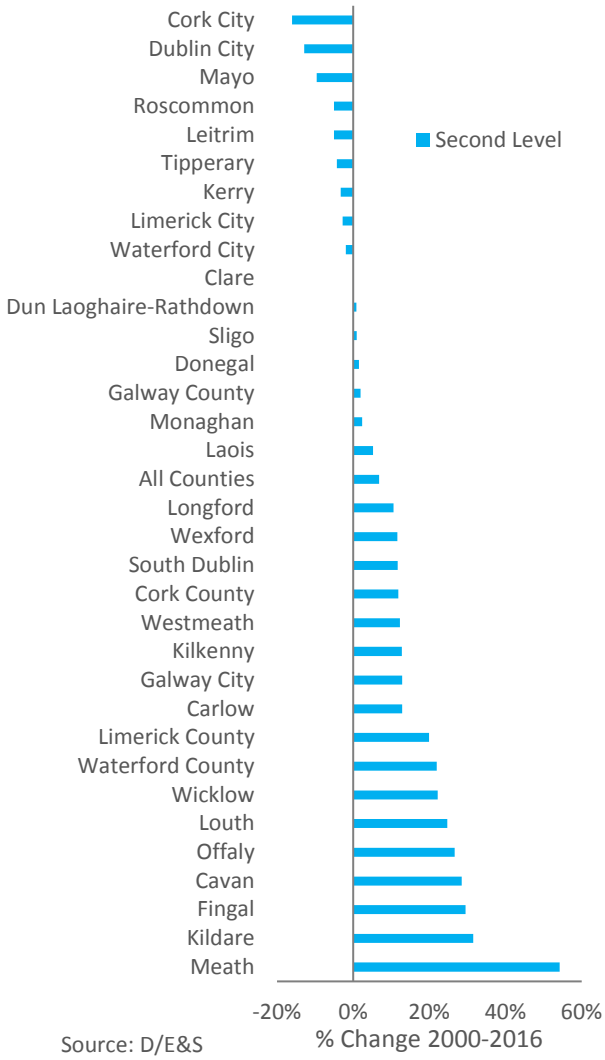
Source: D/E&S. Note: Year refers to school year end

Finally, it is useful to consider the geographic dimension in relation to both primary and post-primary demand. Figures 4.9 and 4.10 present the change in total enrolments at primary and second level by area between 2000 and 2016. As can be seen the largest increases in enrolments at both levels were in Meath, Kildare and Fingal while decreases or stagnation can be observed in the cities of Cork, Dublin and Limerick as well as Mayo. This analysis in indicative of the regional variation that has been seen in education demand in recent years.

Figures 4.8 and 4.9: % Change in Total Pupil Numbers at First and Second Level, 2000-2016



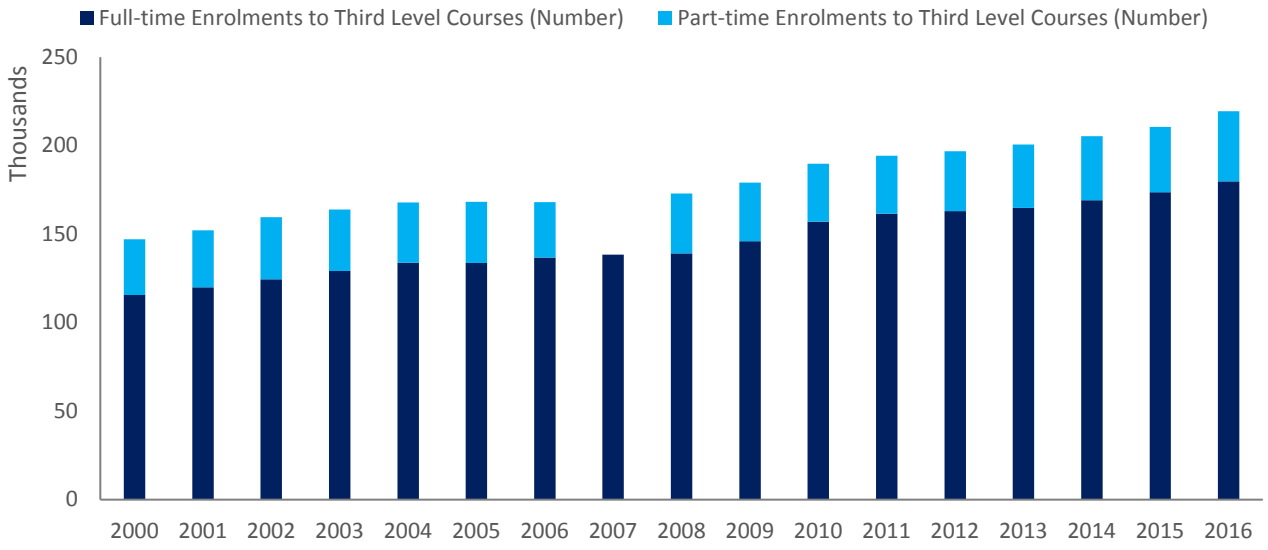
Source: D/E&S



Source: D/E&S

At third level, we can observe that the total number of enrolments has increased consistently over time as demonstrated in Figure 4.11. The total number of students enrolled at third level has increased by 49% between 2000 and 2016. Growth in full time and part time enrolments over the time period has been 55% and 26% respectively. As such, it is clear that the number of students accessing third level education has increased over time. In terms of the composition of total enrolments in 2016, 82% of students at third level are full time while 18% are part time.

Figure 4.10: Full-Time and Part-Time Enrolments to Third Level Courses, 2000-2016



Source: D/E&S. Note: 2007 part-time unavailable. Only includes institutions aided by D/E&S

It is also of use to consider the composition of student enrolments at third level institutions aided by D/E&S by type of institution. As Table 4.11 displays, 53% of students at third level in 2016 are in universities while 40% are in Institutes of Technologies (IOTs). In terms of trends over time, total student numbers at universities have grown by 20% since 2009 while student numbers at IOTs has increased by 27%. Recent years have thus been marked by growth in student numbers across third level with a relatively higher level of growth at IOTs.

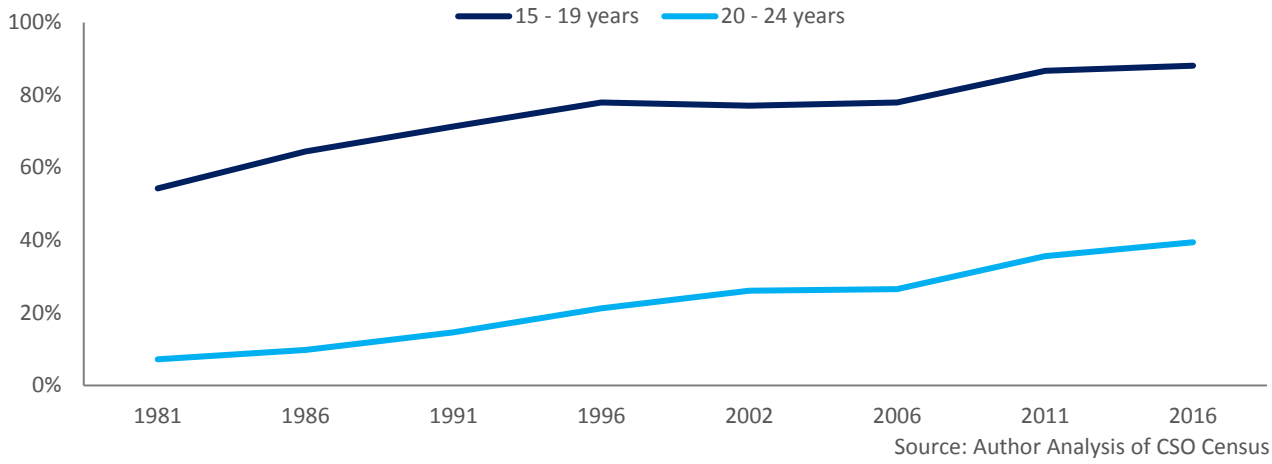
Table 4.11: Total Enrolments at Third Level by Type, 2009-2016

	2009	2010	2011	2012	2013	2014	2015	2016
University Sector	97,001	101,559	103,188	105,695	107,175	108,570	110,775	116,367
Technology Sector	69,489	75,282	78,380	78,924	80,905	83,775	86,221	87,907
Teacher Training	8,329	8,273	8,175	7,668	7,829	8,044	8,375	8,347
Other 3rd Level	4,276	4,665	4,526	4,559	4,732	5,018	5,253	6,861
Total	**179,095**	**189,779**	**194,269**	**196,846**	**200,641**	**205,407**	**210,624**	**219,482**

Source: D/E&S. Only includes institutions aided by D/E&S

The increasing demand in the area of third level education can be further exemplified and explored by analysing the proportion of the population in the age cohorts associated with attending third level education who are classified as being a student/pupil as per Census data. As Figure 4.12 displays, the % of those aged between 15 and 19 who are students increased from 54% in 1981 to 88% in 2016 while the proportion of those in the 20-24 age cohort in education increased from 7% to 39% over the same time period. As such, while demographic trends have increased demand in the third level sector over time, higher participation rates among the population have also played a role in increasing third level student numbers.

Figure 4.11: Proportion of Age Cohort Classified as Student/Pupil, 1981-2016



Source: Author Analysis of CSO Census

The remainder of this section will focus on forecasted levels of future demand across the education sector. The data and analysis used in the section come from the latest DES pupil projections for both primary/post-primary[84] and third level[85]. In producing the projections the DES make a number of assumptions for specific variables to produce different scenarios of demand. At primary and post-primary level these assumptions primarily relate to fertility and migration assumptions. At third level, the estimates are based on assumptions around the transfer rate from second level to third level and also assumptions on the number of mature and international students. Finally, an estimate of the rate of undergraduate turnover (a measure of the number of continuing third level students) is included. Using these assumptions a number of projected scenarios are produced. Full details of the methodology utilised is detailed in the relevant publication linked in footnotes 82 and 83 below. It should be noted that the projections for higher education were produced in 2015 and as such are based on data available then while the projections for primary and post-primary level have only recently been published.

[84] DES (2017) Projections of Full Time Enrolment Primary and Second Level, 2017-2035, http://www.education.ie/en/Publications/Statistics/Statistical-Reports/Projections-full-time-enrolment-Primary-and-Second-Level-2017-2035.pdf

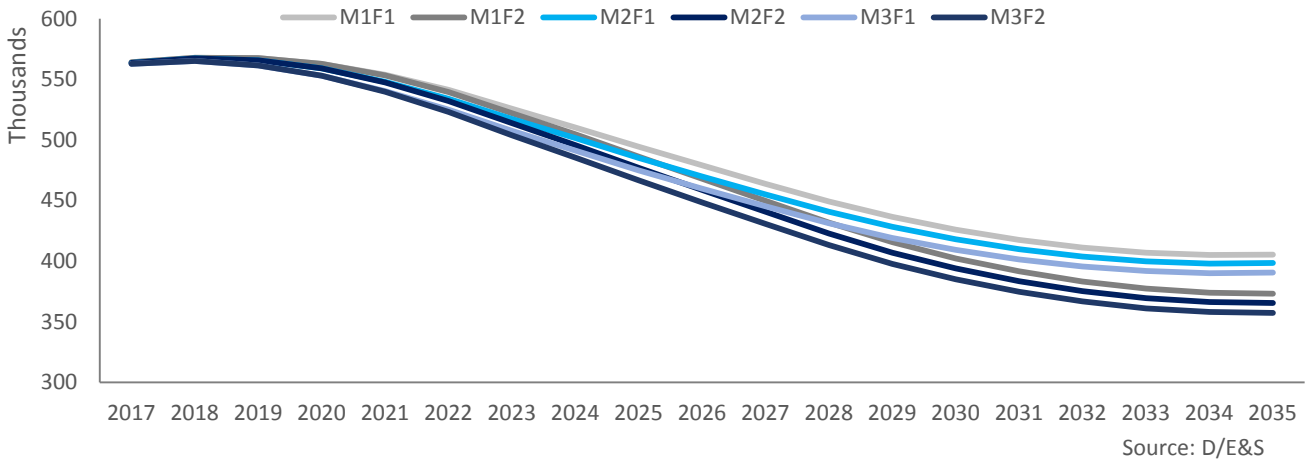
[85] DES (2016) Projections of Demand for Full Time Third Level Education, 2015-2029, https://www.education.ie/en/Publications/Statistics/Statistical-Reports/Projections-of-demand-for-full-time-Third-Level-Education-2015-2029.pdf

Primary Level Projections

Figure 4.13 displays the various projection scenarios produced by DES for primary level between 2017 and 2035. As can be seen, it is estimated that the number of primary students will peak in 2018 with an average across the scenarios of almost 567,000. Under the M2F1 scenario, which DES consider as the most likely scenario, the total student population at primary level will rise by 0.6% between 2017 and 2018. After the peak of 2018, the total student cohort at that level according to the M2F1 scenario will decrease by an average of 2.1% per year. The total cohort projected for 2035, at 398,419, is 30% lower than the projected 2018 peak. Under the most optimistic scenario (M1F1), demand is still predicted to be 29% lower in 2035 than the peak in 2018.

Thus, while total pressures for primary demand will continue until 2018, beyond that year it is projected that demand will begin to decrease. It should be noted that this high level analysis of total student projections does not account for regional dynamics and as such specific capacity issues at primary level could be more or less prevalent in different locations.

Figure 4.12: Projected Enrolments at Primary Level, 2017-2035



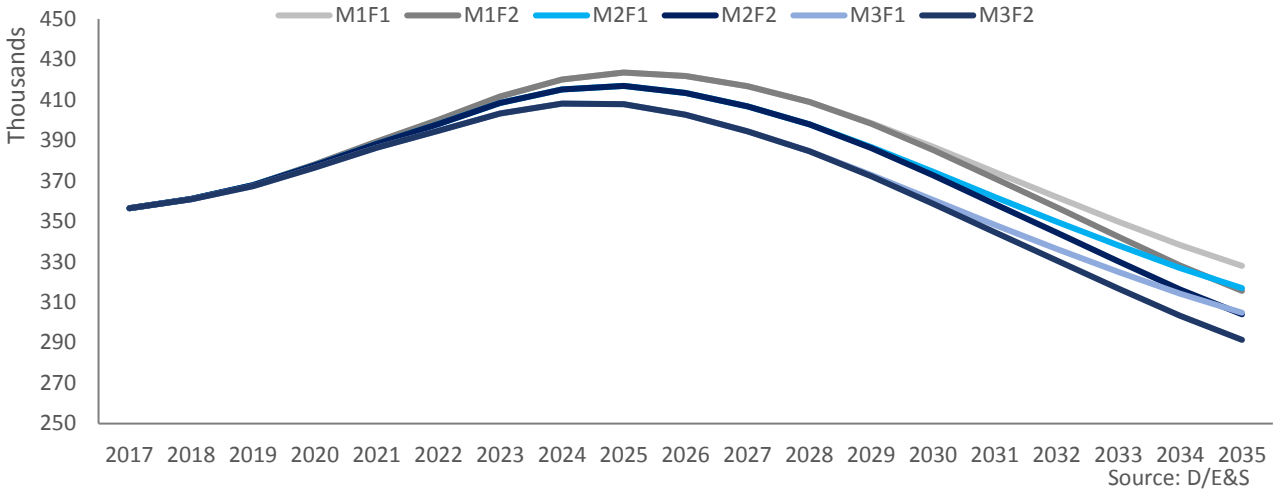
Post-Primary Level Projections

While demand at primary level is expected to peak in 2018, the peak level of demand at post-primary level is expected in 2025 as the peak cohort at primary level moves through the education system. Across the scenarios produced by DES, the average level of enrolments is over 416,000 at post-primary level in 2025. Focusing on the M2F1 scenario, which DES consider as the most likely scenario, the projected level of enrolments in 2025 is 17% higher than the 2017 level. After the peak year of 2025, enrolments are projected to decrease by an average level of 2.7% between 2025 and 2035.

Thus, total demand at post-primary level is expected to peak in 2025, a number of years after the primary sector has peaked. As such, at a high level we can observe that demand is expected to increase by an average of 2% per year to 2025 before decreasing out to 2035. It should be noted that this high level analysis of total

student projections does not account for regional dynamics and as such specific capacity issues at primary level could be more or less prevalent in different locations.

Figure 4.13: Projected Enrolments at Post-Primary Level, 2017-2035

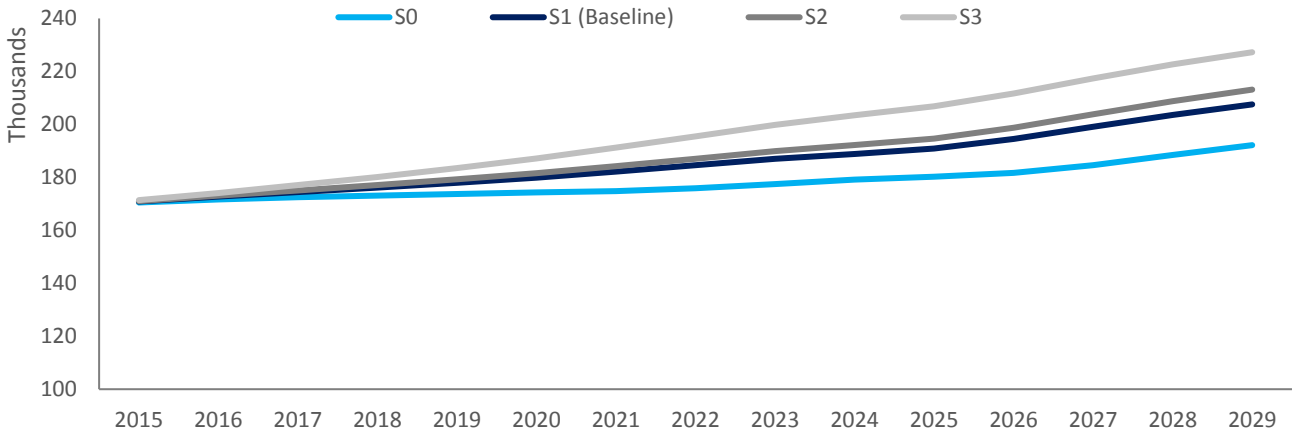


Third Level Projections

Projections produced in the area of third level education have a number of factors to account for other than demographics as education is not compulsorily at that level and there are other dynamics such as international students and mature students. Figure 4.15 highlights the scenarios for third level demand produced by DES. As can be observed, the baseline projection estimates that demand will grow by an average of 1% per annum between 2015 and 2020, 1.2% per annum between 2021 and 2025 and then 2.1% per annum between 2026 and 2029. As such, demand is expected to increase consistently with higher growth rates in later years. The total projected level of demand under the baseline scenario in 2029 is 207,544 which is 21% higher than the 2015 level. In summary, the available projections anticipate significant increase in demand for third level education out to 2029.

However, it should be noted that there are a number of factors which differentiate the implications of demand at third level to that seen at primary and post-primary. Firstly, and as previously stated, in policy terms the provision of primary and post-primary education is more closely linked to demographics. The interaction between demand and the overall policy framework for third level education is an important consideration. Secondly, the nature of demand at tertiary level is of much greater importance than primary and post-primary. The composition of demand and provision in terms of course and subject type will have implications for capacity levels. For instance, a growth in demand for, or a policy choice to invest in, a particular area such as STEM courses may necessitate further specific capacity changes. Finally, the extent to which the overall provision of third level education is funded by the Exchequer may have implications for the level of necessary Exchequer investment. For example, changes in the level of other revenue raised by the sector may impact the extent to which Exchequer support is required.

Figure 4.14: Projections of Full Time Demand for Education in DES-Aided Third Level Institutions, 2015-2029



Source: D/E&S

Further Education and Training (FET) and Apprenticeships

At present, the FET sector is catering for over 300,000 beneficiaries each year. However, it is difficult to estimate the number of people that will be catered for in the FET sector going forward due to both the broad variety of provision within the sector and the multitude of factors that drive demand for FET places. These include the state of the economy and labour market, the demand for training by employers and the policy environment related to education supports, social inclusion, etc. In addition, given the heterogeneous nature of the sector, there may also be other factors influencing demand which will make estimating the volume and composition future demand, and by extension future infrastructure needs, very difficult. Having said that, the D/E&S does have relevant targets for apprenticeship and traineeship places. This relates to the Programme for a Partnership Government commitment to deliver 50,000 apprenticeship and traineeship registrations in the period to 2020. This may impact on capital demands in the years ahead with DES estimating that approximately 20% of school leavers will be catered for through this stream.

Table 4.12: Expected Number of Apprenticeship and Traineeship Registrations, 2016-2020

	2016	2017	2018	2019	2020
Apprentice Registrations	3,472	4,947	6,197	7,384	9,000
Traineeship Registrations	2,500	2,600	3,900	5,000	5,000

Source: D/E&S.

Ultimately, the degree to which developments in the FET sector will impact on the demand for infrastructure in the years ahead is unclear. While the sector is catering for a significant number of people, it is difficult to predict how these numbers will trend over time due to a number of factors as set out above. The lack of a comprehensive database on overall capacity within the sector also adds to the uncertainty on future demand. In order to gain a clearer picture of this, more data will need to be collected and collated with a view to projecting the volume and composition of FET participation. This information should then be considered in any decisions related to capital allocations in this area.

Conclusions and Findings

This analysis contained within this section has shown the high level trends in relation to capital investment and infrastructure. As detailed, capital investment by the Exchequer in the Education sector decreased significantly between 2008 and 2012 while investment levels have since picked up. In terms of composition it is clear than third level had a higher proportional decrease in Exchequer capital expenditure. The Capital Plan has allocated €3.8 billion to the education sector between 2016 and 2021. This allocation is in place to fund significant enhancements across primary, post-primary and tertiary education.

As set out through this analysis, demographic changes are the most important driver of demand in the education sector. Demand and access to education has increased significantly in previous years. Based on evidence of future demand pressures the following high level conclusions are of note:

- At primary level, student numbers are projected to peak in 2018, thereafter declining each year by around 2% on average, although some specific growth areas may continue to experience increasing demand. The existing Capital Plan targets the delivery of 19,000 additional primary school places in response to this demand pressure.
- At post-primary level, the peak in student numbers will be in 2025 beyond which demand is expected to decrease. The existing Capital Plan targets the delivery of 43,000 additional post-primary places required for demographic growth to 2022. Additional resources may be required to account for any increase in demand thereafter.
- The demand for access to third level education is expected to increase which will exert further pressure on capacity. Investment levels required at third level are impacted by a number of considerations including responsiveness to skills needs in the economy, the relevant sources of overall funding and the overall policy framework for third level education.
- The degree to which developments in the FET sector will impact on the demand for infrastructure in the years ahead is unclear. While the sector is catering for a significant number of people, it is difficult to predict how these numbers will trend over time due to a number of factors and a constraint in terms of comprehensive and collated data on current capacity.

Finally, as noted throughout this section there are a number of factors that are not included here. In particular, an analysis of the current condition of education infrastructure and consideration of the extent to which investment in renewal may be necessary is absent given data constraints. Furthermore, consideration of the nature and composition of demand is excluded. This is particularly pertinent in the area of regional demand projections at primary and post-primary level which will have implications for capacity issues. It is also pertinent across the education sector, and in particular in the case of higher education and FET, where changes to subject mixes and educational delivery will influence specific areas of capacity need.

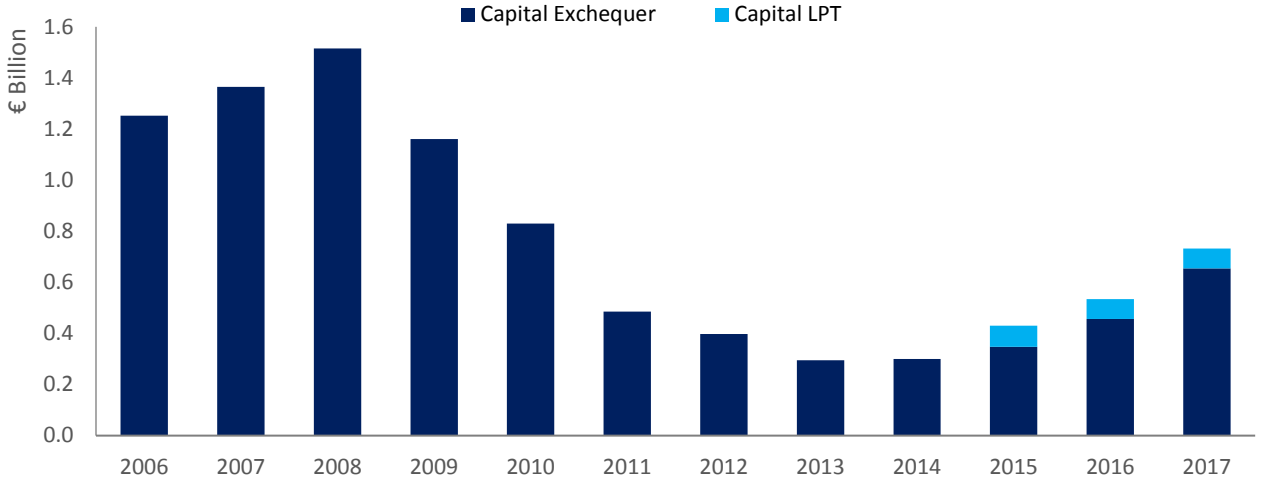
5. Housing

The housing market and sector is a fundamental part of the economy and a large element of national infrastructure. The overall market can be usefully distilled into three segments: privately owned/rented accommodation, publically owned accommodation and publically supported accommodation. Government intervenes to provide support to those who cannot provide for their own accommodation needs through a variety of mechanisms including the construction and acquisition of social housing stock via capital expenditure and a number of current expenditure programmes which provide support through income supplement, direct rental support and leasing units from the private market. This section sets out a high level assessment of investment in the housing sector, the stock of housing and the demand for housing. In doing so, the analysis looks at both the overall housing market and social housing.

Previous Investment

Capital expenditure in the area of housing follows a similar trend to other elements of the capital budget. Between the early 2000's and 2008 expenditure increased substantially to €1.5 billion in 2008 before a large decrease post-2008 in line with the trend in the overall expenditure. The total level of investment allocated for 2017 by the Exchequer is €655 million. When the second stream of public funding is included, retained Local Property Tax recipients by Local Authorities, total investment in 2017 is €732 million. This is 70% higher than capital investment (through both the Exchequer and the LPT) in 2015 but substantially lower than 2008.

Figure 5.1: Public Capital Expenditure on Housing, 2006-2017



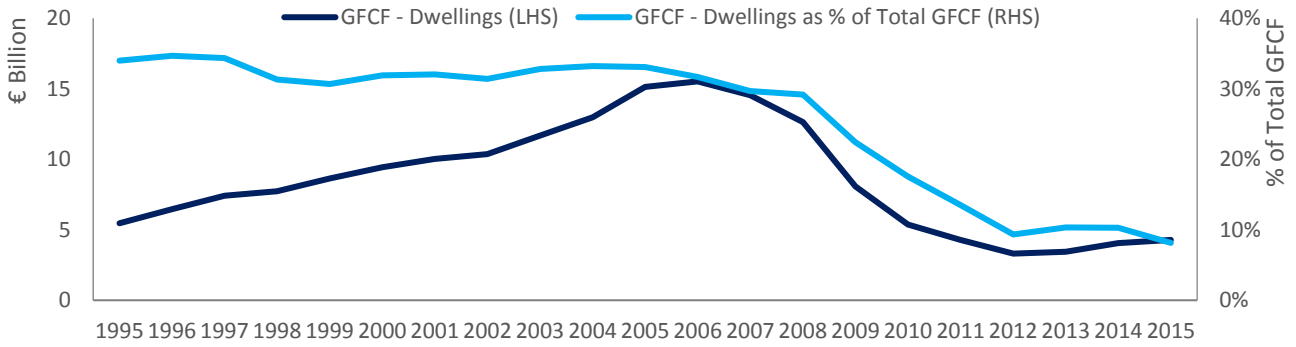
Source: DPER. 2016 is Provisional Outturn. Updated 2016 capital expenditure from DHPCLG. 2017 is allocation. Additional LPT funding provided by DHPCLG. 2017 self-funding is funding requirement.

The majority of Government expenditure in the area of housing is targeted at social housing and assisting those who cannot provide for their own means in the private market. It should be noted that while capital expenditure has decreased since 2017, the level of expenditure on housing supports provided through current expenditure (such as the Housing Assistance Payment, Leasing Schemes, Rental Accommodation Scheme etc.) has grown to cater for demand to some extent. In total, €624 million is allocated in 2017 for the four main

support schemes[86]. As such, while considering the level of capital investment is important in terms of understanding developments in housing infrastructure, it is important to note that current expenditure on supporting households has increased significantly in recent years to assist households in the private housing market through a combination of income support, direct rental payments and leasing schemes.

In terms of a wider understanding of the sector, it is important to briefly consider the total level of investment from both private and public sources. Figure 5.2 sets out the level of investment, measured in Gross Fixed Capital Formation terms, between 1995 and 2015. As we can observe, total GFCF in the sector increased rapidly between 1995 and 2006 reaching a peak of €15.5 billion (constant prices). However, over this time period the share of total GFCF that was accounted for by dwellings remained relatively constant at between 30-35%. After 2007, the level of investment decreased rapidly to a trough in 2012. The level of GFCF as a proportion of the total shows a similar decrease indicating that investment in this area fell to a large extent even relative to total GFCF. To further highlight this, GFCF in dwellings remains below 2006 levels by just over 72% while total GFCF is 7% higher than the 2006 level. It is evident that investment in the sector has started to increase in recent years with a growth of 29% evident between 2012 and 2015. Research by the Central Bank[87] shows that the level of investment in housing across Europe was relatively stable over time with the exception of Ireland, Greece and Spain where investment as a % of GDP grew substantially in the years to 2007 and then fell significantly.

Figure 5.2: Gross Fixed Physical Capital Formation on Dwellings (Constant Prices), 1995-2015



Source: Author Analysis of CSO. All Constant Prices

The existing Capital Plan sets out the allocation to the area of housing between 2016 and 2021 with a total of €2.9 billion allocated to this area at that time. To support the Government's Action Plan on Housing and Homelessness, Rebuilding Ireland, €2.2 billion of additional capital expenditure has already been pre-committed to the area of housing, while Budget 2017 saw the allocation of additional capital funding for 2017, which has carry-over implications for 2018 and 2019. Rebuilding Ireland, which was published on 19th July 2016, is currently being reviewed by the Department of Housing, Planning and Local Government (DHPLG) in consultation with DPER and the Department of Finance.

[86] Housing Assistance Payment, Rent Supplement, Rental Accommodation Scheme, LA and AHB Leasing
[87] https://www.centralbank.ie/docs/default-source/publications/economic-letters/economic-letter-vol-2016-no-12.pdf?sfvrsn=6

As the current Action Plan for Housing and Homelessness sets out there are a number of measures which have been put in place to both increase supply directly and enable/encourage additional output. Under the Action Plan the committed funding of €5.35 billion will support the delivery of 47,000 units of social housing over the period 2016-2021. Within this target of 47,000, it is anticipated that 26,000 will be constructed; 11,000 will be acquired from the market; and around 10,000 will be secured under long-term lease arrangements. In addition, €226 million has been allocated under the Local Infrastructure Housing Activation Fund. The targeted investment aims to stimulate the early supply of 23,000 new dwellings by 2021 with a stated potential for up to 69,000 units in the longer term, as the sites are fully built out. Funds are being provided to local authorities to build roads, bridges and public amenities such as parks through a public procurement process.

Delivery will be contingent on the capacity of local authorities, Approved Housing Bodies (AHBs) and a functioning and productive private residential construction sector. The Action Plan contains a range of specific actions to drive and support this capacity development. Furthermore, there a number of other delivery mechanisms which are not delivered through capital expenditure, most notably the Housing Assistance Payment. Under the plan, 83,000 households will have their housing needs met by HAP over the period.

Infrastructure Overview

In terms, of total housing stock we can observe that there was a large increase between 1991 and 2011 from 1.16 million to just under 2 million. Between 2011 and 2016, there has been a slight increase of 0.4% indicating a restricted level of additional supply. This trend is described in Figure 5.3.

Figure 5.3: Total Housing Stock, 1991-2016

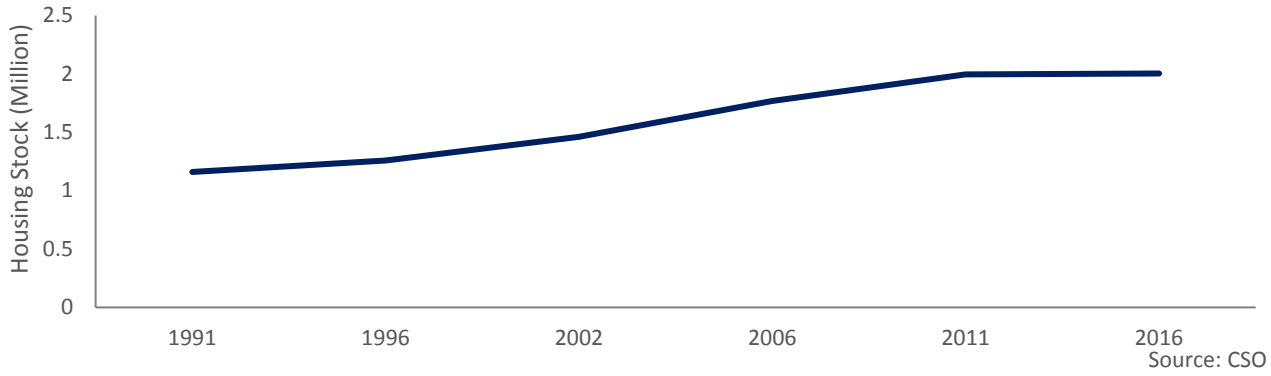
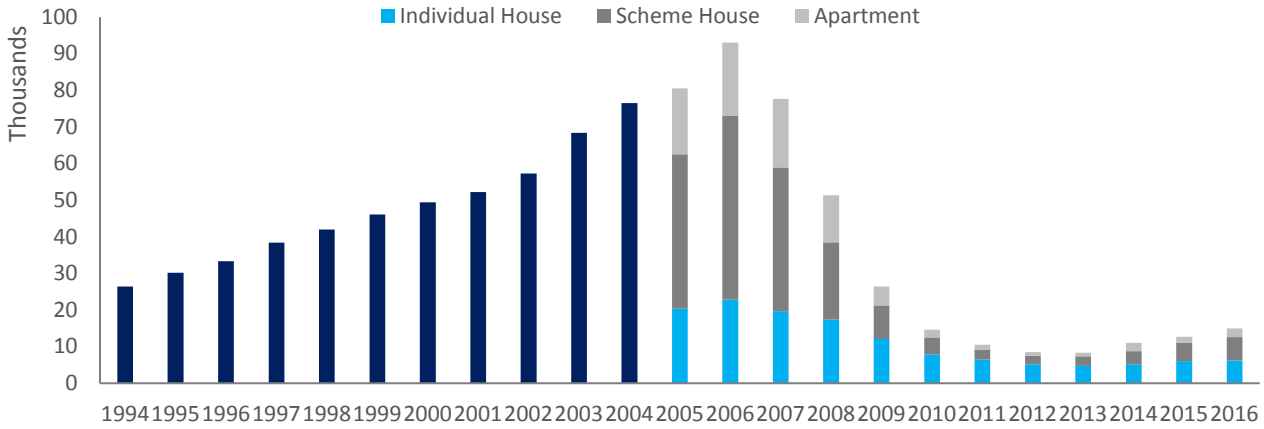


Figure 5.4 displays DHPLG data on housing connections which is compiled from ESB data and is used as a proxy for homes that become occupied including completed dwellings. While the data does not represent a comprehensive measure of housing completions, it provides an indication of the overall trend over time. Further indicators of supply and activity are detailed elsewhere[88]. As we can observe the level of output increased markedly between the early 1990's and 2007. In line with the wider downturn in the economy,

[88] E.g. Department of Finance 'Housing and Property Sector Chart pack: August 2017. http://www.finance.gov.ie/wp-content/uploads/2017/08/170817-Housing-and-Property-Sector-Chartpack-August-2017-Online-version.pdf

output decreased significantly and remains constrained at just under 15,000 in 2016. This was primarily driven by relatively larger decreases in scheme houses and apartments while individual or one-off housing reduced by a smaller amount thus increasing as a share of total completions (from 25% in 2005 to 62% in 2011).

Figure 5.4: Housing Connections/Completions[89], 1994-2016



Source: DHPCLG. Note: Consistent type breakdown unavailable pre-2005. Direct comparisons with 2006 not possible due to completions lag. Direct comparisons pre and post 2010 not possible due to previous inclusions of voids.

In terms of understanding the stock of housing infrastructure in more detail it is useful to consider the age of the stock, the regional composition and the vacancy rate related to the stock. Firstly, in terms of the overall age of the stock it is clear that 27% of private houses have been construction since 2001 with 37% being constructed between 1971 and 2000 and 28% before 1970.

Table 5.1: Private Households in Permanent Housing Units by Period in which Built, 2016

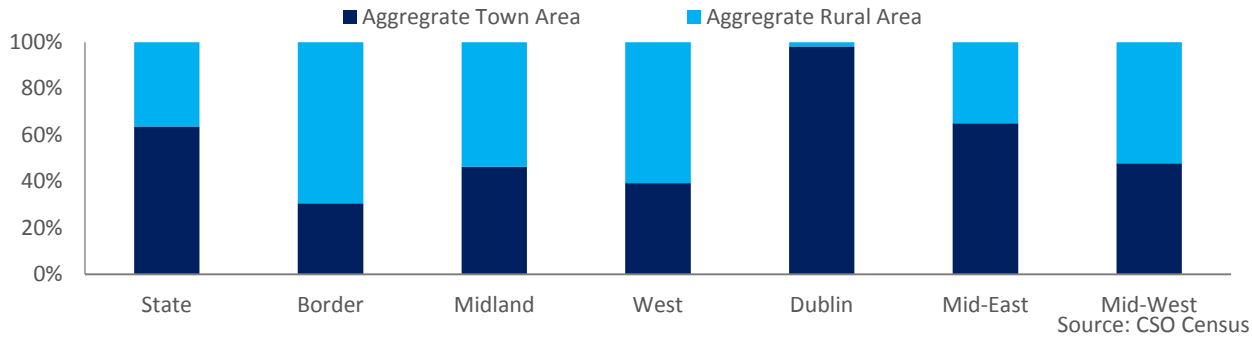
Period of Build	2016	% of Total
All years	1,697,665	
Before 1919	141,200	8%
1919 to 1945	109,668	6%
1946 to 1960	126,107	7%
1961 to 1970	116,041	7%
1971 to 1980	213,473	13%
1981 to 1990	171,044	10%
1991 to 2000	240,811	14%
2001 to 2010	431,763	25%
2011 or later	33,436	2%
Not stated	114,122	7%

Source: CSO Census 2016

In terms of the regional distribution of the housing stock, it is useful to consider the proportion of households distributed by rural and urban areas[90]. As Figure 5.5 details 64% of all private households are in aggregate town areas while 36% are in aggregate rural areas. Furthermore, there is a variance between regions in terms of the urban and rural balance reflecting population distributions across the State.

[89] It should be noted that the measure is not a precise indicator of additional supply given a number of methodological issues outlined elsewhere including reconnections and delayed housing completions.
[90] Aggregate Urban Area: towns > 1,500 population. Aggregate Rural Area: population outside urban areas and < 1,500.

Figure 5.5: Private Households in Permanent Housing Units by Aggregate Town/Rural Area, 2016



Source: CSO Census

Finally, an important consideration in terms of the housing stock and overall housing supply is the vacancy rate. According to Census 2016 data the vacancy rate measures the proportion of the overall housing stock which is assessed as unoccupied. The overall vacancy rate for the State (excluding holiday homes) is 9.2% and this has reduced from 11.5% in 2011. We can also observe that at a high level there is a large variation between areas with a low of 3.6% in South Dublin and a high of 19.9% in Leitrim. However, further detailed analysis would be required to understand housing vacancy, and in particular potential usage, in more detail.

Having detailed trends in overall housing stock it is worth considering the stock of social housing given the primary role of public expenditure in this area. In terms of the overall stock of supported households/units, LA owned social housing stands at just under 130,000 with an additional 30,000 owned by Approved Housing Bodies[91]. Housing delivered through HAP, RAS and Leasing amounts to just under 45,000 while Rent Supplement has 48,000 recipients[92].

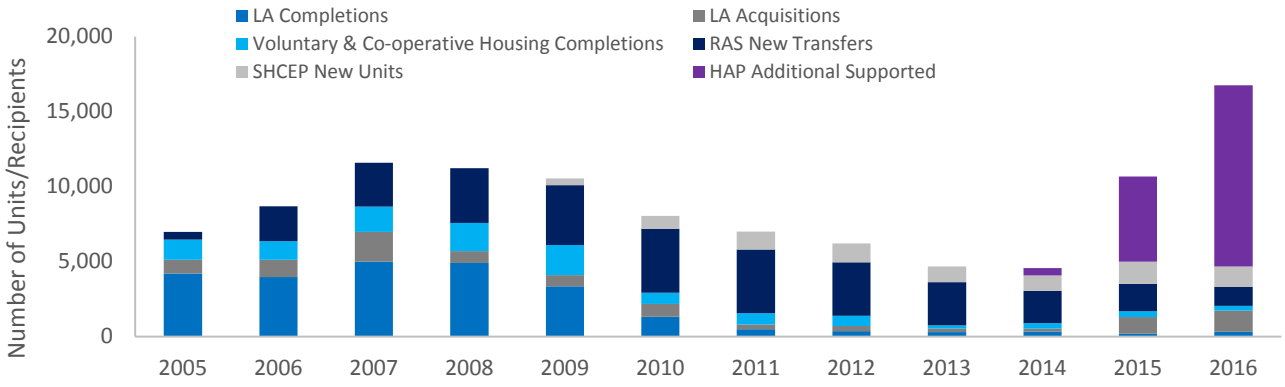
It is also evident that the level of social housing output mirrors the trend in Exchequer expenditure. As previously detailed, the level of capital expenditure decreased significantly after 2008 and the corresponding level of output can be seen in Figure 5.6. The total number of completions (constructed houses) or purchases (buying second hand properties to use for social housing) by LAs and AHBs (voluntary and cooperative housing in Figure 5.6) fell from 8,673 in 2007 to 889 in 2014. This has since increased to 2,058 in 2016 and is targeted to increase further in the future under the Action Plan for Housing and Homelessness. Meanwhile, the number of units delivered through current expenditure (such as Housing Assistance Payment, Rental Accommodation Scheme and leasing) increased to 14,689 in 2016 from 3,680 in 2014. However, it should be noted that while HAP is included in social housing output as it is a social housing support a large number of recipients would have been previously in receipt of support in the form of Rent Supplement.

The mechanism for delivery has shifted with 88% of 2016's output being provided through HAP, RAS and leasing while these schemes accounted for just 25% in 2007. In terms of total output this is now above 2007

[91] NOAC 2015 Performance Indicators and Housing Agency Annual Report on Regulation of Approved Housing Bodies in Ireland, 2015
[92] HAP, RAS and Leasing: DHPCLG. Rent Supplement: DSP

levels due to the expansion of the HAP scheme. The total number of completions or acquisitions (new permanent social housing stock) remains below the 2007 level by 76%.

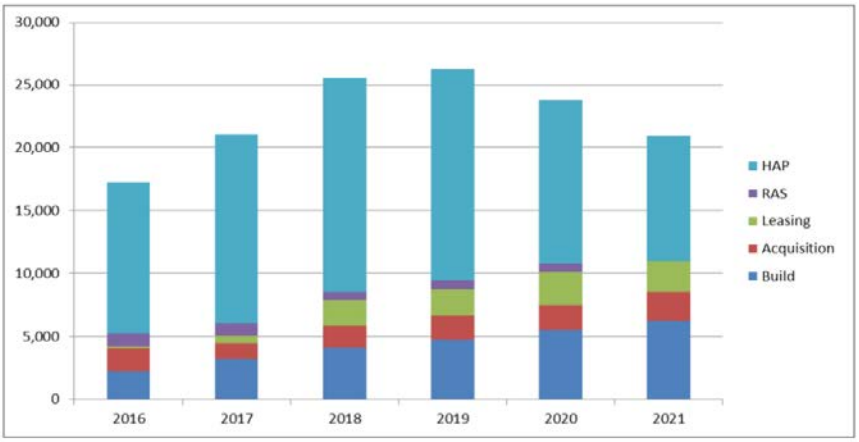
Figure 5.6: Social Housing Output[93], 2005-2016



Source: 2005-2013 from DHPCLG Website. Updated 2014-2016 data provided by DHPCLG.

In terms of projected future levels of delivery, the Action Plan sets out the forecast level of social housing provision. Under the Action Plan, targeted social housing supply is being increased by 47,000 units over the period 2016-2021. Within this target of 47,000, it is anticipated that 26,000 will be constructed; 11,000 will be acquired from the market; and around 10,000 will be secured under long-term lease arrangements. Figure 5.7 details the plan's proposed social housing delivery over the time period which includes the 47,000 units stated above as well as the forecast level of HAP delivery. In total over period of the Action Plan, around 83,000 households will be supported by HAP. As such, while social housing output delivered through capital investment has been constrained in recent years it is forecast to increase as a result of Government commitments under the Action Plan for Housing and Homelessness and the associated funding commitment. Furthermore, the plan contains a number of specific actions in a variety of areas including homelessness, the private rented market and utilising the existing housing stock.

Figure 5.7: Social Housing Provision Forecast under Action Plan for Housing and Homelessness, 2016-2021



*This new social housing stock includes units and tenancies delivered through the HAP and RAS schemes on an annual basis. It should be noted that HAP is a demand-led scheme and it is envisaged that the transfer of those on rent supplement to HAP will be complete by 2020.

[93] It should be noted that the Figure excludes units entering the stock through the Voids programme. The number of such units was 2,333, 2,696 and 2,308 for 2014, 2015 and 2016 respectively. Note: Voluntary & co-operative housing consists of housing provided under the capital loan & subsidy and capital assistance schemes and includes units acquired under Part V, Planning and Development Acts 2000-2015 for rental purposes. RAS new transfers is defined as the number of households which have moved from Rent Supplement to RAS in that specific year. It includes households who remained in their existing accommodation and those for whom the LA had to source new properties. HAP new households supported refers to the number of qualified households with an established housing need who are being accommodated under the HAP scheme for that year. LA and AHB Leasing (SHCEP) end year output may differ from new units operational in that year due to the timing of the recoupment process in a given period.

Drivers of Demand

There are a number of interlinked drivers that impact the level of housing demand at any given time. A number of these high level drivers are set out in Table 5.2.

Table 5.2: Selected Drivers of Demand for Housing

Drivers of Demand	
Demographics	**Household Formation**
Economic Growth	**Tenure Choice**
Income	**Socio-Cultural Factors**
Wealth	**Government Policy/Intervention**
Access to Credit	**Spatial Development**

The drivers of demand in the housing sector can be viewed from a number of perspectives given the complexity of the sector and market. At a high level, the primary drivers of demand in terms of the total number of households requiring accommodation are demographics and household formation rates. The level of population growth and the age composition of the population will have an impact and the average size and formation rate of households translates the total population into the number of households requiring accommodation. Demographic growth and migration thus have a significant impact on the demand for housing. The regional distribution of demographic trends will impact on the number of households which require housing. Factors such as the average size of households and the age at which people form or create households has a clear effect on the overall number of households and is an important factor across the literature.

There are a variety of other factors which impact the level of demand, and indeed the previous factor of household formation, including the level of economic growth, income and wealth which determines elements such as housing affordability and interacts dynamically with house prices. Access to credit is an important factor particularly in terms of house purchases which are typically funded through mortgages. Tenure choice is also an important factor in terms of the nature of demand. The proportion of households which choose to rent versus purchase impacts the market and, like many of the other factors, is influenced by supply trends and wider socio-cultural factors. The structure and nature of any Government intervention can play a role in influencing demand in terms of composition etc. Finally, the spatial distribution of employment and economic activity can have a key role in influencing the nature and composition of demand.

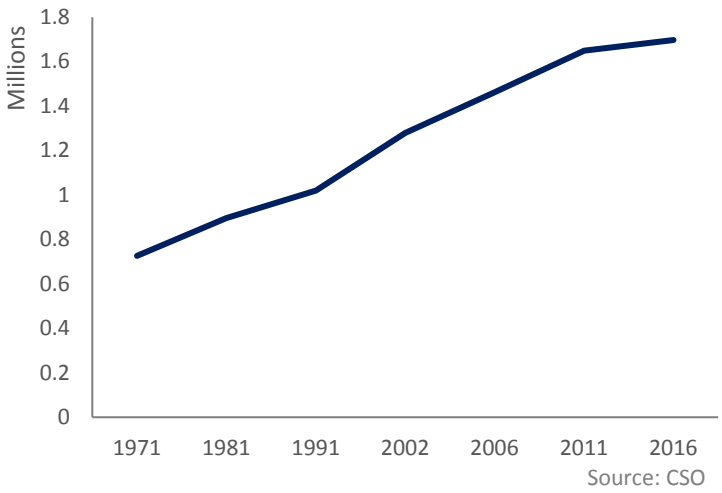
Box 5.1: Housing Demand and Housing Need

A distinction can be made between housing demand and housing need. Housing demand is termed to capture the willingness of households to pay for a particular dwelling within the existing stock. Housing need includes a measure of existing deficit and looks at the number of households that do not have access to accommodation with certain normative standards. Housing demand can be seen as an objective measure based on current supply/stock while housing need is a subjective measure requiring consideration of a number of elements including housing quality, housing cost, location of housing, and the longevity of housing need.

Trends in Demand Drivers

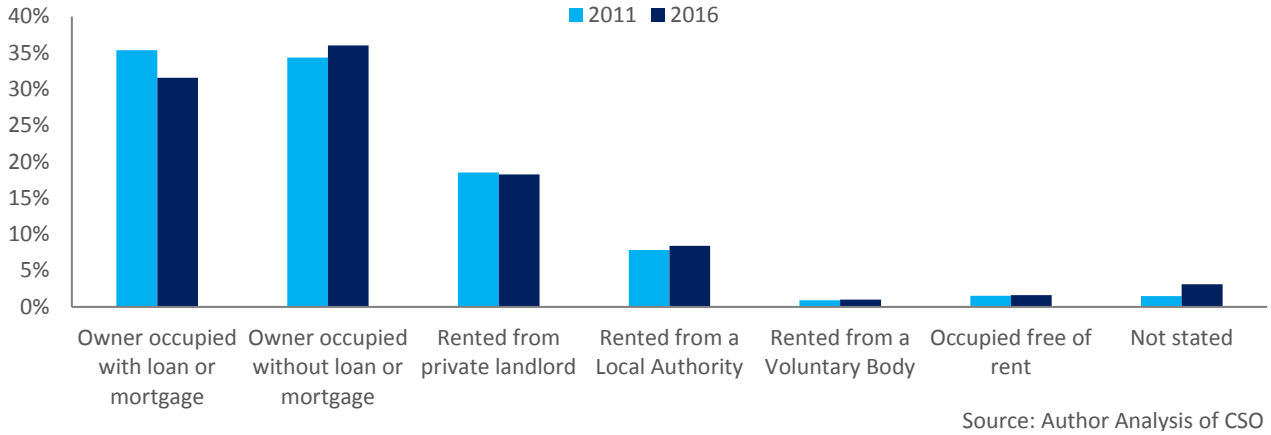
The total number of households has increased in line with both overall demographic growth and the reduction in average household size as will be detailed through this section. The number of households has more than doubled since 1971 and has seen a 16% increase since 2006 at a total of 1.7 million as detailed in Figure 5.8. While the total number of households is of clear interest in terms of overall demand, as discussed in the previous section, there are a number of trends within this development which are important to understand including the nature of occupancy and household formation. In terms of the occupancy of households, we can observe that about two thirds of households are owner occupiers. 36% of households are owner occupiers with a loan or mortgage while 32% are owner occupiers without a loan or mortgage as displayed in Figure 5.9. In terms of other occupancy types, 18% are rented from a private landlord[94] while 8% are rented from a Local Authority. The vast majority of households are catered for in the private market, either through ownership or renting, while 11% are listed as renting from an LA, an AHB or as paying no rent.

Figure 5.8: Number of Households in Ireland, 1971-2016



Source: CSO

Figure 5.9: Proportion of Households by Nature of Occupancy, 2011-2016



Source: Author Analysis of CSO

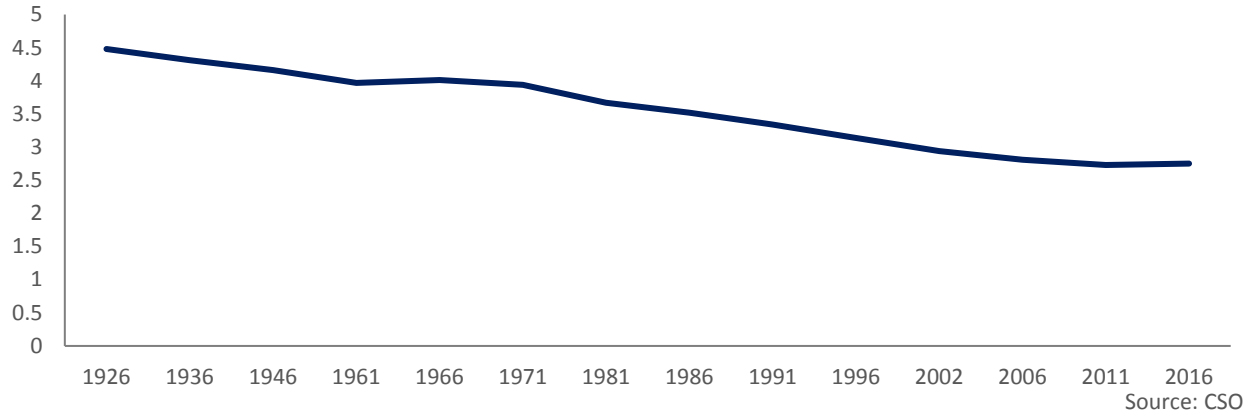
There are two main areas that we can analyse to further understand the development in the total number of households and the level of housing demand: average family size and headship rates.

The composition of the population and families is an important factor in the overall dynamics of housing demand. As can be seen in Figure 5.10, the average number of people per household in Ireland has fallen

[94] A proportion of this cohort are in receipt of state support to assist renting. E.g. Rent Supplement and Housing Assistance Payment.

consistently over time. At 2.75 as of 2016, the level is now 18% lower than the 1991 level. While there are a number of factors behind this trend including birth rates and the age composition of the population, it is an important factor in the type, trend and nature of housing demand. A smaller number of people per household can thus increase the overall number of households and change the nature of overall demand in terms of the type of accommodation needed.

Figure 5.10: Average Number of Persons per Private Household, 1926-2016



Source: CSO

Headship rates are measured by the proportion within each age group identified as head of household or household reference person. By looking at trends in these rates, and assessing dynamics by gender, it Is possible to observe trends related to household formation across the population distribution. Research undertaken by the ESRI shows that the total headship rate in the State has increased from 28.9% in 1991 to 36.1% in 2011. Analysis of 2016 data indicates that the total headship rate has decreased slightly between 2011 and 2016 to 35.7%. The analysis by the ESRI shows that the primary area of growth in terms of headship rates has been within female cohorts suggesting that, while this may in part be driven by an increase in the number of females completing the Census form, there is an increasing number of households being formed by females.

Housing Market Dynamics

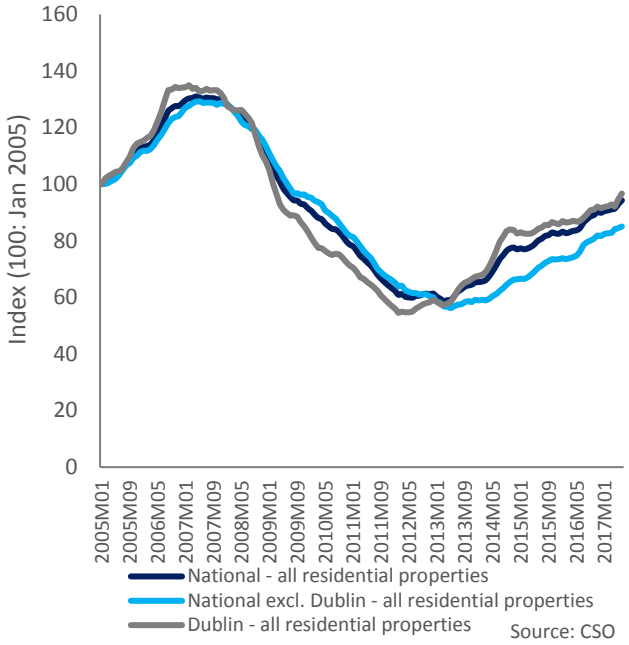
Having considered analysis on supply and drivers of demand, it is necessary to set out trends in relation to house price and rental price dynamics. As set out in Figures 5.11 and 5.12, there has been significant growth in both residential property prices and in rental prices in recent years.

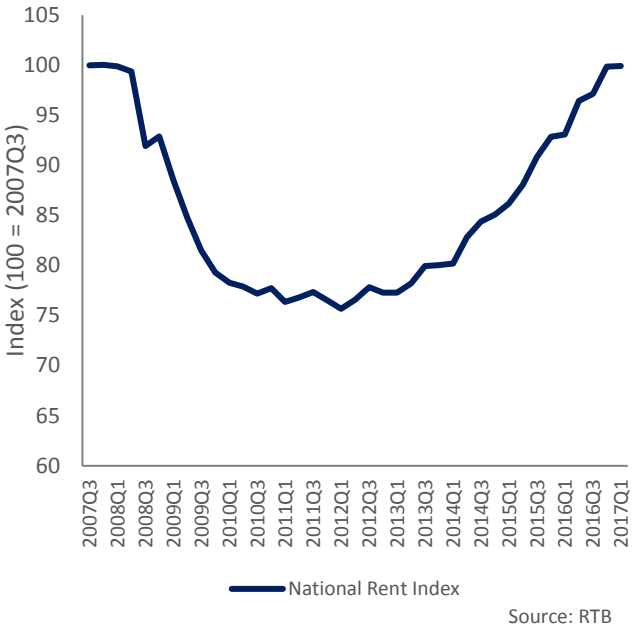
From the low point in early 2013, prices have increased nationally by 58% with higher increases in Dublin (74%) than in the rest of Ireland (50%). However, this has occurred in the context of a large fall in residential property prices after 2007. Prices nationally remain 29% lower than the peak in 2007. Prices outside Dublin are 35% lower than the peak in May 2007 while residential property prices in Dublin are 30% below the peak February 2007 level. As such it is clear that significant price growth has occurred in recent years with higher levels of growth evident in Dublin indicating the level of pressure in that section of the market.

In terms of rental prices, a similar trend is evident with a large decline after 2007 in line with the wider economy before significant growth in recent years. The RTB's rent index[95] shows that rent prices nationally have now largely recovered to peak levels seen in 2007. Their analysis of the Dublin market indicates that rental prices in the capital are now 11.5% ahead of Q3 2007 levels again highlighting the significant pressure in the market. It should be noted that analysis undertaken by daft.ie[96] utilising a different data source indicates that rents nationally are above their previous 2008 peak (+13%) with pressure evident in the cities of Dublin (+18%), Cork City (+11%) and Galway City (+21%).

As such, while market dynamics are not analysed in detail here, it is clear that there has been a significant increase in both residential property prices and rental prices. Further analysis of a range of relevant metrics such as affordability, market transactions and mortgage market activity is available elsewhere[97].

Figure 5.11: Residential Property Price Index, 2005-2017 and Figure 5.12: National Rent Index, 2007Q3-2017Q1





Future Demand Trends

A number of studies have assessed the potential future level of housing demand[98] from a variety of angles. The majority of studies focus on the two main drivers of demand: demographic growth and headship rates. By using these two variables, and making a number of assumptions, it is possible to forecast the future level of housing demand. Firstly, research carried out for the Housing Agency on projected demand for housing in

[95] http://www.rtb.ie/docs/default-source/default-document-library/rtb-rent-index-2017-q1-(3).pdf?sfvrsn=2
[96] https://www.daft.ie/report/2017-Q2-rentalprice-daft-report.pdf
[97] E.g. Department of Finance 'Housing and Property Sector Chart pack: August 2017. http://www.finance.gov.ie/wp-content/uploads/2017/08/170817-Housing-and-Property-Sector-Chartpack-August-2017-Online-version.pdf
[98] As opposed to the concept of housing need. See Box 5.1.

urban settlements (500 people or more) resulted in an estimate of a minimum requirement of 81,118 homes between 2016 and 2020[99]. As the analysis sets out the majority of the demand is likely to be in urban settings with 55% of the estimate being based in the five major urban areas. It is important to note that this demand assessment is based on population growth and migration and does not take account of pent-up demand or cyclical issues. The report estimates the following requirements at the city level between 2016 and 2020:

- 33,109 homes for Dublin City and Suburbs alone (which incorporates Dún Laoghaire and parts of South Dublin and Fingal);
- 5,328 homes for Cork City and Suburbs account;
- 3,436 homes for Limerick City and Suburbs;
- 2,316 homes for Galway City and Suburbs; and
- 713 homes for Waterford City and Suburbs.

Secondly, research undertaken by the ESRI[100] analyses future demand and supply in the housing sector. The research estimates that the household formation rate, a key driver in housing demand, will rise to approximately 32,000 by 2024 from a present level of approximately 16,000. Furthermore the report notes that in 2015 housing activity was quite low historically with around 12,600 units being built and that the underlying requirement for housing in the economy is approximately 23,000 units. Rebuilding Ireland targets an annual output across the housing market of 25,000 units.

The paper then forecasts the level of housing activity and estimates that the market could reach a point where housing activity meets structural demand of about 27,000 units in 2018 and that from 2018 onwards demand increases at a steady rate before reaching just over 30,000 units per annum by 2024. However, it is important to note a number of points. Firstly, the analysis focuses on structural demand only and does not take account of cyclical aspects or pent-up demand. Secondly, the paper also notes that there are potential issues in terms of available finance to deliver necessary supply levels. The report suggests that in the future the traditional deposit base will be unable to fund the level of credit required to meet the housing demands of the economy and this will necessitate significant changes in the domestic financial sector.

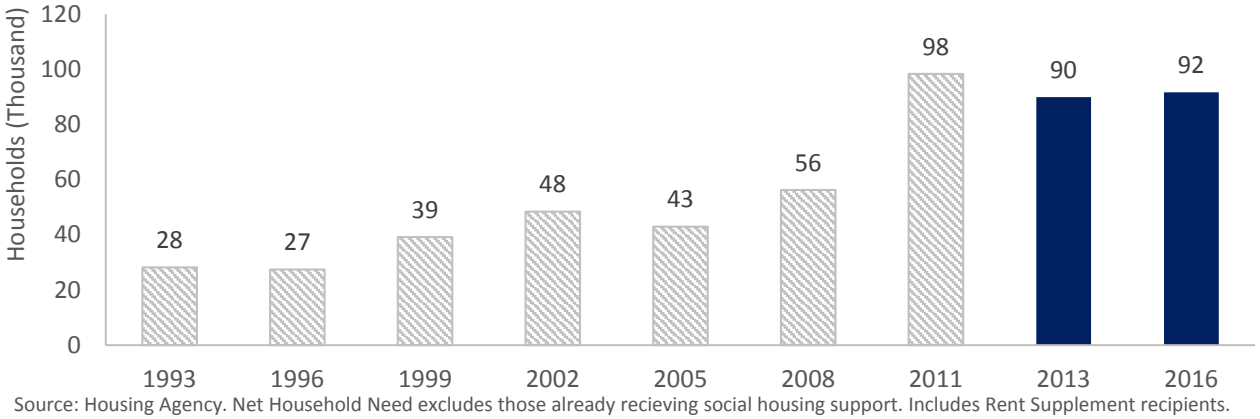
Social Housing Demand

Public expenditure in the area of housing is primarily focused in the area of social housing and providing accommodation for those who are in need but cannot provide for their own means through the private market. As such, in terms of tracking demand in this sector relevant to Exchequer capital expenditure it is necessary to understand the demand for social housing support.

[99] Future Analytics (2017) Housing Supply Requirements in Ireland's Urban Settlements 2016 – 2020: A Preliminary Update'.
[100] Duffy, D. et al (2016) "Demographic Change, Long-Run Housing Demand and the Related Challenges for the Irish Banking Sector" in Ireland's Economic Outlook: Perspectives and Policy Challenges.

The latest estimate of social housing demand puts the total net household need at 91,600 as of 21st September 2016. 'Net Household Need' is defined as the total number of households qualifying for social housing support whose social housing need is not being met. Households must be eligible and in need of social housing support. Households currently living in local authority rented accommodation, voluntary/ co-operative accommodation, or accommodation provided under current expenditure programmes (such as HAP, RAS etc.) are not included in the total number. It is important to note that households that are in receipt of Rent Supplement are included in the figure as this is not classified as a social housing support (33,819 or 37% in private rented accommodation with Rent Supplement). It is not possible to reliably track the total level of net need over time due to variations in how the data has been collected in previous iterations. Summaries carried out before 2013 were not done under a standardised assessment regime. As such, some discrepancies emerge such as the fact that those on Rental Accommodation Scheme were previously included as in need and the 2011 exercise didn't involve a reassessment of household eligibility. As can be seen, net household need has slightly increased between 2013 and 2016 by 1.9% or 1,728 households.

Figure 5.13: Net Household Need, 1926-2016



Source: Housing Agency. Net Household Need excludes those already recieving social housing support. Includes Rent Supplement recipients.

This data collated by the Housing Agency also shows that:

- For the majority of households the age of the main applicant is between 30-39 (33%) or 40-49 (23%).
- In terms of the primary income for the main applicant, the majority of households are unemployed and in receipt of benefits (60%). 20% of households are in employment of some form.
- The vast majority (74%) of households in need of social housing are single adult households either with children (30%) or without (44%).
- 68% are living in the private rented market (37% with Rent Supplement and 31% without).

In terms of estimates of the future requirements for social housing output, the Housing Agency's National Statement of Housing Supply and Demand 2016 highlights the aforementioned estimate of total net household need as the main evidence around future requirements for social housing. In summary, there is significant demand for housing support as highlighted through the measure of net household need.

Conclusion

In summary, this high level analysis of existing infrastructure and demand in the housing sector has highlighted the following key findings:

- Pressure is evident across the housing market with significant increases in both residential property purchase prices and average rents in recent years following large decreases after 2007.
- The level of housing output, both public and private, in recent years has been constrained following a period of rapid expansion in 2007 and 2008.
- In terms of the demand and supply of social housing, it is clear that there is a significant number of households that have been deemed as eligible for support but are not currently in receipt of such support while additional permanent stock (delivered through construction or acquisition) has been limited in line with decreased levels of capital expenditure. However, housing supports delivered through current expenditure (e.g. HAP, Leasing) have played a role in providing necessary assistance.
- Under the Action Plan for Housing and Homelessness, which is currently in the process of being reviewed, €5.35 billion has been committed with the target of 47,000 units for delivery. Of this 47,000, it is anticipated that 26,000 will be constructed; 11,000 will be acquired from the market; and around 10,000 will be secured under long-term lease arrangements. The Plan also targets reaching overall supply levels of 25,000 by 2020.
- The demand for housing is forecast to increase in the short term due to demographics and household formation rates from 23,000 to 30,000 by 2024. The ESRI's research has highlighted the potential for the level of housing activity to increase significantly in future years but also highlights the that the availability of sufficient finance will be a challenge to delivering necessary supply. In addition to total structural demand there are a number of other considerations such as pent-up demand, regional composition and cyclical issues.

In summary, the State's role in providing social housing has faced significant constraints in recent years while demand remains high. However, €5.35 billion is planned for investment in supporting the delivery of 47,000 units across a range of delivery mechanisms in the coming years as committed through the Action Plan for Housing and Homelessness. The Action Plan, which is currently being reviewed, also has specific targets and measures across a range of areas such as homelessness, the private rental market and utilising the existing housing stock. Furthermore, housing output delivered by the private sector is expected to pick up over the next couple of years. However, it is noted that the area of housing is highly complex with a large number of interrelated drivers and factors and delivery capacity across the sector is a key enabler.

6. Water and Waste Water

Water infrastructure in Ireland can be split between infrastructure for drinking water and infrastructure to deal with waste water or sewage. The purpose of this infrastructure is to 1) provide high quality and clean drinking water to the population and industry, and 2) adequately treat any waste water in order to protect the natural environment and avoid raw sewage being discharged.

The focus of this paper is on the public water infrastructure which accounts for over 80% of Ireland's water infrastructure[101]. In the past, water infrastructure in Ireland was delivered in a very fragmented manner through 34 Local Authorities. Incorporated in July, 2013 as a company under the Water Services Act 2013, Irish Water brings the water and wastewater services of the 31 (previously 34) local authorities together under one national service provider. Irish Water is therefore responsible for capital investment and the general operation of all public water and wastewater services in Ireland since 1st January 2014. A comprehensive register of water infrastructure assets does not currently exist, however, Irish Water estimates that it manages the following asset base[102]:

Water

- 918 Water Treatment Plants
- 63,000km of water mains
- This infrastructure delivers 1,670 million litres of water to 1.5 million domestic and 200 thousand commercial/industrial people daily[103].

Waste Water

- 1,102 Waste Water Treatment Plants
- 32,000km of sewers
- This infrastructure facilitates the recovery, treatment and discharge of 1,600 million litres of wastewater daily[104].

Irish Water is a State-owned entity in public ownership, with a statutory mandate and governance requirements are set out in the Water Services Acts. Irish Water is accountable to its shareholders including the Minister for Housing, Planning, Community and Local Government, the Minister for Finance and Ervia. Irish Water is economically regulated by the Commission for Energy Regulation and environmentally regulated by the Environmental Protection Agency as well as being obliged to consult with the Health Services Executive (HSE) on matters relating to public health.

[101] According to the Environmental Protection Agency Report, Focus on Private Water Supplies, less than 20% of people in Ireland get their drinking water from private water supplies such as group water schemes or private wells, usually located in rural areas.
[102] Presentation by Ervia to the Joint Oireachtas Committee on Future Funding of Domestic Water Services, 12th January 2017
[103] According to its website, Scottish Water delivers 1.37 billion litres of water a day to 5 million customers in 2.49 million households. http://www.scottishwater.co.uk/about-us/freedom-of-information/key-facts
[104] According to its website, Scottish Water treats 921 million litres of waste water every day.

In April 2017 the Oireachtas Joint Committee on the Future Funding of Domestic Water Services published a report which made a number of recommendations to the Government. Among the key recommendations are that "domestic water use should be funded through general taxation", and "ensure that the wastage, excess use or wilful abuse of water can adequately be addressed…levies and other measures proposed in this report will address excess use of water in order to dissuade users from wastage of water thereby demonstrating that Ireland is compliant with all relevant EU water directives". Previous to this, domestic water charges had been introduced in 2015 before being suspended in 2016. Irish Water continues to charge non-domestic customers. In particular reference to investment in water infrastructure, the report recommended that "there must be funding certainty and long term stability for the water utility so that it can plan and deliver the requisite level of operational and infrastructure projects, in line with the commitments made in its business plan up to 2021, which in turn is based upon Ireland's EU obligations under the Water Framework Directive (WFD)."

The Water Services Strategic Plan[105] (approved by the Minister in October 2015) sets out the strategic objectives for the delivery of water services by Irish Water over the 25 year period up to 2040. It provides for a long-term view of water services investment at a national level, to ensure that investment is strategically targeted towards priority needs and to put in place an asset management approach towards investment in water services that gives the optimum balance between capital and operational spend to ensure the required service delivery, and at least cost.

In light of the Oireachtas adoption of the Joint Committee on the Future Funding of Domestic Water Services Report (April 2017), the Government has approved the priority drafting of the Water Services Bill 2017. In addition, there is currently a Working Group examining future funding arrangements for Irish Water.

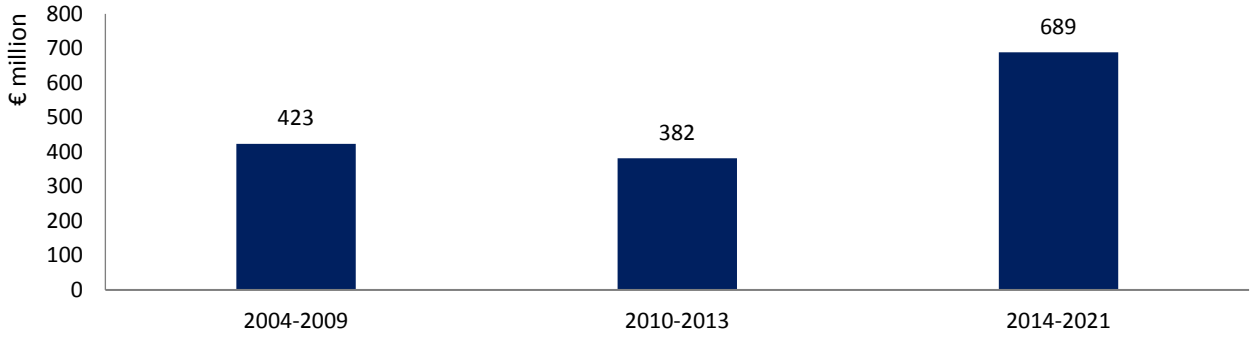
Previous Investment and Planned

It is generally accepted that there has been a historical under investment in Ireland's water and waste water infrastructure. This is evident from the 49% of treated drinking water being lost through leakages from the existing infrastructure as well as the breaches of environmental directives which have taken place in recent years and which are discussed in further detail below.

Over the period 2004 to 2009 the annual average capital expenditure in Ireland's water and waste water sector was €423 million. During the recent recession this decreased to an annual average of €382 million over 2010 to 2013.

[105] Statutory requirement under section 33 of the Water Services (No 2) Act 2013

Figure 6.1: Annual Average Capital Expenditure in Ireland's Water and Waste Water Sector



Source: Irish Water Business Plan, Transforming Water Services in Ireland to 2021

However that is not to say that there has been no improvement in the sector's infrastructure over time. The Department's Report on the Value for Money (VFM) Review of the Water Services Investment Programme 2007-2009 found that the 2007-2009 WSIP had been effective in meeting its objectives while acknowledging the improvements made in developing future programmes to enhance effectiveness. It also recognised that the significant expansion in the capacity of the water services infrastructure ensured that infrastructure kept reasonable pace with the demands of very rapid demographic and economic growth experienced in the early to mid-2000s. Subsequently, the Water Sector Reform Programme giving rise to the establishment of Irish Water superseded many of the VFM report recommendations.

The Price Waterhouse Coopers Report (November 2011) also highlighted that there has been a substantial and historic under-investment in water and wastewater services in Ireland and while there has been significant investment in the last decade (drawing on the Department's VFM Report) highlighting that there is still a substantial backlog of capital investment. Both these reports highlight that the large number of local authorities providing water services gave rise to a high degree of fragmentation in the provision of the services which inhibits the achievement of benefits of scale and the introduction of the kinds of standardisation of technology and procedures which can drive efficiency.

In relation to waste water treatment, capital investment since the turn of the century has resulted in improvements in a number of aspects according to the Environmental Protection Agency[106]. Under the Water Services Investment Programme there was on average approximately €270 million of capital expenditure per annum on waste water infrastructure between the years 2000 and 2011. This resulted in:

- A reduction of waste water receiving little or no treatment nationally from 30% in 2001 to approximately 4% in 2015.
- An increase of waste water receiving secondary (biological) treatment nationally from 29% in 2001 to over 94% in 2015.

[106] Environmental Protection Agency Report, Urban Waste Water Treatment in 2015

Similarly, in relation to drinking water the EPA[107] has found that there has been considerable improvements in the quality of Ireland's drinking water supplies in recent years and suggest that continued and increased investment should prioritise supplies subject to boil water or water restriction notices.

Irish Water's latest capital investment plan stretches over the period 2017-2021 and amounts to a total of €3.6 billion of capital expenditure[108]. The plan details capital investment in 2017 of €516 million, peaking at €824 million in 2020. This investment is almost evenly split between waste water and drinking water investment.

Table 6.1: Irish Water Capital Investment Plan 2017-2021

Category	2017-2021 (€ m)	Overall Share
National Programmes	**963**	**27%**
Water National Programmes	591	-
Wastewater National Programmes	320	-
Other infrastructure – National Labs, Inventory Management, Depots etc.	51	-
Capital Maintenance	**551**	**15%**
Projects	**2,074**	**58%**
Water Projects	841	-
Wastewater Projects	1,233	-
Total	**3,588**	**100%**

Source: CER Irish Water Second Revenue Control 2017-2018 & Irish Water Investment Plan 2017-2021

Irish Water's capital investment plan has a number of outcomes which it aims to deliver by 2021 including:

- the elimination of drinking water contamination risk which currently affects 940,000 people;
- the lifting of all current boil water notices;
- the reduction of leakage in the water network, by over 10 percentage points, to less than 38%;
- the implementation of a national lead strategy benefiting at least 180,000 homes[109];
- The elimination of wastewater discharge without treatment.

Over the next twenty years Irish Water has estimated that it will require a minimum of €13 billion in capital expenditure in order to meet its objectives[110] based on the known deficits. This amounts to an average of €650 million per year. Irish Water plans to spend an average of approximately €700 million per year on infrastructure over the period 2017-2021. Irish Water has indicated to the Commission for Energy Regulation (CER) that it is satisfied that its capital investment plan can be delivered[111]. In accordance with section 34 of the Water Services (No.2) 2013 Act, Irish Water's Investment Plan was approved by the CER subject to a number of caveats, including an efficiency challenge of €132 million over the period 2017-2018.

[107] Environmental Protection Agency, Drinking Water Report for Public Water Supplies 2015
[108] CER16345a Irish Water Investment Plan 2017-2021
[109] Total number based on age of properties per the Census although not all are served by public water supplies - some are served by group water schemes or private wells.
[110] Response by DHPCLG to the Joint Committee on the Future Funding of Domestic Water Services, 10 January 2017
[111] CER16345a Irish Water Investment Plan 2017-2021

Infrastructure Capacity

Ireland's water infrastructure should be capable of providing clean drinking water and collecting and safely disposing of the wastewater by all those connected to the public networks. Irish Water delivers approximately 1,670 million litres of water to 1.5 million domestic and 200 thousand commercial/industrial people daily. Irish Water also facilitates the recovery, treatment and discharge of 1,600 million litres of wastewater daily. There are a number of key metrics, see Table 6.2, which demonstrate the current capacity of Ireland's water infrastructure along with the aims of Irish Water over the period to 2021.

In relation to the quality of drinking water, there were over 23,000 customers on boil water notices in 2015 (i.e. greater than 200 days). In line with the EPA's recommendation to target the elimination of boil water notices, Irish Water expects to reduce the number of boil water notices to zero by 2021. As of December 2015 there had been a reduction of customers on boil water notices to 6,900 people[112].

In terms of drinking water capacity, almost half of the existing treatment plants do not meet the industry standard of headroom capacity of over 15%. Of particular concern is the limited headroom capacity in the Greater Dublin and Mid-Eastern region. Since 2015, the CER has noted that headroom capacity in the greater Dublin area has increased to 8% which indicates positive progress towards the final target. Irish Water reports that from 2025, the region will require a major new water source, with the Midlands and Eastern Water Supply Project involving the transfer and treatment of water from the River Shannon identified for planning application in 2018. According to Irish Water, approximately 49% of treated drinking water is lost through network leakage. This is often due to ageing pipes that are rusting and leaking. The CER noted in their decision paper that over 500km of existing poor quality water mains has been replaced by Irish Water and 27 million litres per day of drinking water has been saved in the first eight months of operation of the First Fix Leak Repair Scheme which addresses private side leakage[113].

However, it is worth noting that the target in Irish Water's business plan of <38% of network leakage by 2021 would still be relatively high in comparison to water networks in the U.K., where England and Wales have 22% leakage, Northern Ireland Water has 28% leakage and Scottish Water has 34% leakage. However, these UK figures were achieved after 25 years of sustained investment in leakage management and network improvements. In the first 3 years, Irish Water has been upgrading the District Meter Infrastructure and has replaced over 850km of the worst performing water mains. In terms of wastewater quality and capacity, Table 6.2 shows that in 2015 there were 158 plants that were overloaded and 51 cases of wastewater discharge with no treatment or only preliminary treatment. Since then, major upgrades have taken place to wastewater treatment plants throughout the country including upgrades to large population centres such as Galway,

[112] See page 15, CER 16342 decision paper on Irish Water's Second Revenue Control 2017-2018
[113] See page 51, CER 16342 decision paper on Irish Water's Second Revenue Control 2017-2018

Leixlip, Swords, Clonakilty and Naas. Again, it is worth noting that even if Irish Water reaches its targets there could still be 80 plants which are overloaded in 2021.

Table 6.2: Irish Water's Key Infrastrucutre Capacity Metrics and Targets

	Metric	2015	2021 (Expected Outcome)
Drinking Water Quality	Schemes on EPA remedial action list	121	0
	No. of people on boil water notices (i.e. greater than 200 days)	23,279	0
	Lead shared service pipes	40,000 (circa)	<22,000
	Individual lead pipes	140,000 (circa)	<117,000
Drinking Water Capacity	Headroom Capacity in Greater Dublin & Mid Eastern Region	2%	>15%
	Plants with Head Room Capacity <15%	45-49%	30%
Infrastructure	Network Leakage	49%	<38%
Wastewater Quality	Discharge with no treatment or preliminary treatment only	44	0
	Discharge with no treatment or preliminary treatment only from large urban areas	7	0
	Agglomerations not meeting requirements on secondary treatment of discharges (EPA 2013 List)	43	0
	Larger Agglomerations not meeting requirements on more stringent treatment of discharges (EPA 2013 List)	10	0
Wastewater Capacity	Plants overloaded > 2,000 PE (EPA 2013 List)	45	6
	Plants overloaded < 2,000 PE (EPA 2013 List)	113	74

Source: Irish Water Business Plan - Transforming Water Services in Ireland to 2021, Irish Water Investment Plan 2017-2021

Drivers of Demand

There are two main drivers of demand for water and wastewater infrastructure which will be focused on here. Firstly, as the population and economy grows it is generally expected that an increased volume of drinking water would be required and an increased volume of wastewater would also need to be treated. Secondly, there are a number of EU Directives which set the standards for drinking water quality and the treatment of waste water. Meeting the standards set by these directives is a key driver of infrastructure demand. While not addressed directly here, climate change can also have an impact on the demand for both drinking and waste water infrastructure in the medium to long-term due to changes in rainfall volumes, as well as spatial and temporal distribution of rainfall. Other factors which can impact the demand for water and water infrastructure include pricing[114] and changes in consumption behaviour.

Table 6.3: Selected Drivers of Demand for Water

Drivers of Demand	
Population	**EU Directives**
Economic Growth	**Consumer Behaviour**
Pricing	**Spatial Development**

[114] Albeit in the absence of domestic water charges, this is only applicable to the commercial and industrial sectors.

Trends in Demand Drivers

Population and Economic Activity

Irish Water state in their Capital Investment Plan that they expect water and wastewater demand to increase over 2017-2021, driven by economic and population growth. Ireland's population is projected to increase by approximately 200,000, by 2021. This is an increase in the population of approximately 4.5%. Similarly, economic growth is forecast to continue to grow over the coming years, averaging 4% of GNP over the period 2016 to 2021. This will lead to an increase in demand for drinking water as well as increased levels of waste water which will need to be treated.

In Appendix D of its Capital Investment Plan 2017-2021 submitted to the CER, Irish Water details its approach to this growth and how it will accommodate these projected increases in population and economic activity. While the population projections used by Irish Water were commissioned from the ESRI in June 2013, the plan also states that "new population projections and targets resulting from the National Planning Framework and Regional Spatial and Economic Strategies", will inform any subsequent analysis at project stage following the approval of Irish Water's capital plan by the CER.

In particular, the regional distribution of any population growth targets in the National Planning Framework, for example in designated urban centres, will need to be a key consideration in Irish Water's prioritisation of investments in the medium to long-term. Irish Water has strengthened provisions for growth in response to the Government's housing policy initiatives[115], including the provision of water services infrastructure to serve Strategic Development Zones (SDZs), with the most recent investment plan allocating additional funding to Network Extension Programmes for Water (€13m) and Wastewater (€38m) and wastewater treatment reserve list (€10m) to support large scale housing delivery working in conjunction with planning authorities.

EU Directives

Environmental policy and compliance standards for water and wastewater management are set by the European Commission. In Ireland, it is the Environmental Protection Agency's role to monitor and report on drinking water quality as well as to authorise wastewater discharges from treatment plants. The three key directives are discussed below.

The Drinking Water Directive sets the standard of the quality of water for human consumption across Member States. According to the EPA, the compliance rate in 2015 for public water supplies, was 99.92 % for Microbiological parameters, 99.39 % for Chemical parameters and 99.05 % for Indicator parameters. However, during 2015 there were 35 Boil Notices and 9 Water Restriction Notices active in 17 counties affecting 47,271 people. Since 2008 the EPA has prepared a Remedial Action List of public water supplies in need of remedial

[115] See page 24 of CER16345a Irish Water Investment Plan 2017-2021

action. The number of these water supplies in need of remedial action has decreased from 339 in 2008 to 99 at the end of 2016. The EPA also issued 31 legally binding Directions to Irish Water during 2015, 14 of which were for inadequate progress with Remedial Action Programmes. In May 2015, the EU Commission initiated pilot infringement proceedings against Ireland due to THM exceedances in approximately 70 public water supply zones (impacting around 480,000 people) operated by Irish Water. THMs (Trihalomethanes) are by-products of the chlorination process and studies suggest that long-term exposure to high levels of THMs may be linked to increased risk of some types of cancer in humans. Ireland's response to the Pilot Infringement has been rejected by the Commission therefore this case is now expected to escalate to a Letter of Formal Notice.

The Urban Waste Water Treatment Directive (UWWTD) sets out the standard on the protection of the water environment from the adverse impacts of the release of treated and untreated sewerage and other industrial outflows. In 2015, according to the EPA, over 94% of waste water received at least secondary treatment, which is a biological treatment process that significantly reduces the risk of pollution by organic matter. Of the 171 urban areas which are subject to the EPA's waste water discharge licensing programme and had a population equivalent above the size thresholds specified in the Directive, 143 areas complied. This was an increase from 74% of areas in compliance in 2011 to 84% in 2015. However the EPA highlight that this is below the EU compliance rate of 91%.

The European Commission commenced an infringement process against Ireland regarding its implementation of the directive in September 2013, with the case being referred to the Court of Justice of the European Union in February 2017. The European Commission has identified compliance concerns regarding a total 43 agglomerations. Irish Water estimates that to address these concerns would cost roughly €1.7 billion. Approximately €1.4 billion is included for such measures in the current plan out to 2021, with an additional €286 million required thereafter[116].

The Water Framework Directive sets out the standard in relation to the protection and improvement of the overall water environment. Its objective is to ensure that Member States deliver plans to clean-up polluted water environments and to ensure that clean water environments are kept clean. In its 2015 report, Water Quality in Ireland 2010-2012, the EPA found that "53% of rivers, 43% of lakes, 45% of transitional waters, 93% of coastal waters and 99% of groundwater were satisfactory at good or high status". The report also stated that "the target of 13.6% improvement in ecological status for surface waters from the 2009 baseline by 2015 included in the first cycle river basin management plans is unlikely to be achieved."

The Water Framework Directive is implemented through River Basin Management Plans (RBMPs). The second cycle RBMPs takes a very different approach to river basin management planning to that adopted during the first cycle plans. It now takes a single river basin district approach to plan preparation with a much improved

[116] Reply to Parliamentary Question by Minister of State Damien English 24807/17

evidence base to underpin decision making, at both national and local level. The draft RBMP sets out a range of actions aimed at moving towards the objectives of the Water Framework Directive. The planned actions are diverse, involving multiple stakeholders and will be implemented taking account of available resources. Planned actions range from high level national measures implemented by national authorities (such as the Irish Water Capital Investment Plan and the Nitrates Action Programme), through to sub-catchment management and water body specific measures that need to be refined and implemented at a local level. A new cycle of these plans will be completed in 2017 and may require additional funding in the future.

Existing Research

The ESRI examined capital investment in the Water and Waste Water sector in its 2006 Ex-ante Evaluation of the Investment Priorities for the National Development Plan 2007-2013. This research outlined a rationale for increased public investment in the sector based on population growth, economic growth, EU Directives and global warming. The research found that there had been very good progress towards meeting the targets of the different EU Directives, although there was a question raised as to whether there had been a similar increase in environmental benefits as one might expect.

Increased scrutiny in relation to spatial planning was recommended by the report. It was suggested that concentrating the expansion of water infrastructure in the gateways and hubs of the National Spatial Strategy should be prioritised in order to support the development of critical mass. This principle is still relevant for water infrastructure investment today and into the future. It will be essential for future investments in water infrastructure to be closely aligned with the upcoming National Planning Framework. In its latest business plan Irish Water has already stated its intention to deliver capital infrastructure for residential and commercial development across the country in line with the Government's 2020 Housing Strategy. As acknowledged by Irish Water, the new National Planning Framework will also need to be taken into account once it has been published. The ESRI's 2006 report also recommended a number of accompanying measures to the investment in the Water sector including the introduction of a proper pricing mechanism for domestic water and waste water, which it suggested could result in a reduction in water consumption of around 10%.

The Commission for Energy Regulation (CER) was appointed as the independent economic regulator for the water sector in 2013. Part of the CER's role is to ensure that Irish Water's capital and operational expenditure are appropriate. In its 2016 decision paper[117] on Irish Water's Second Revenue Control 2017-2018, the CER stated that Irish Water had adopted an appropriate approach to the development of its Capital Investment Plan. It was noted that however that no funding was included for non-network capital investment beyond

[117] CER 16342 decision paper on Irish Water's Second Revenue Control 2017-2018

2017-2018 and that expenditure for the Greater Dublin Drainage project (GDD) and Water Supply Project – Eastern and Midlands Region (WSP) had been re-profiled to the period 2022-2024.

In approving the plan, the CER found that Irish Water's plan was *"risk-based, seeks to objectively optimise for defined constraints, such as cost, and incorporates customers' preferences as surveyed".* At the same time, the CER suggested that Irish Water should be challenged to deliver the outputs and outcomes of its proposed investment plan more efficiently.

A report published by the Environmental Protection Agency (EPA) in 2016, *Urban Waste Water Treatment in 2015*, found that while there had been improvements in Ireland's waste water infrastructure since the year 2000, the existing levels of investment were not sufficient to in order to protect Ireland's rivers, lakes and coastal areas from the adverse effects of urban waste water discharges. The report also highlighted delays in a number of planned investments by Irish Water. However it is important to note that the report did not examine Irish Water's future investment plans out to 2021 which aim to address many of the concerns raised by the EPA. The EPA also pointed out that improving waste water quality does not always require significant investment. Improvements can be delivered through the better management of the existing assets, for example through a standardised best practice approach to operations of treatment plants and networks.

Conclusions

There has been a historical underinvestment in Ireland's water infrastructure which has resulted in a system which is not fully capable of providing the required level of high quality drinking water or adequately treating the waste water which our society produces. Following the onset of the recent economic recession investment in water infrastructure was reduced over the period 2010 – 2013 to an annual average of €382 million. This under investment was compounded by the fragmented delivery of water infrastructure through 34 different local authorities, leading to a lack of coordination in planning, diseconomies of scale, and inconsistencies in the operation and maintenance of infrastructure. However, in spite of these challenges research from the ESRI and the EPA has shown that the quality of Ireland's drinking water and wastewater has improved since the turn of the century, even if it has yet to reach an acceptable standard.

At present Ireland's drinking water infrastructure is not meeting demand in terms of quality and capacity as demonstrated for example by the estimated 4,000 people on boil water notices at the end of 2016 and the limited amount of headroom capacity in so many treatment plants, particularly in the Greater Dublin area[118]. The existing wastewater infrastructure is also failing to meet the existing demand as demonstrated by the 44 agglomerations discharging wastewater with either no treatment or only preliminary treatment and the resulting infringement proceedings which have been initiated against Ireland by the European Commission.

[118] See page 4, CER 16345c IP2 Investment Portfolio Outcomes Explanatory Note

Irish Water's establishment in 2013 brought the responsibility for the delivery of water infrastructure under one single entity. Since its establishment Irish Water has been able to bring greater clarity to the composition of the existing asset base and its current state, which in turn has enabled more informed decisions to be made in relation to the efficient allocation and prioritisation of investments in Ireland's water infrastructure. Irish Water provides a high level strategic planning approach to water infrastructure, taking a national rather than local perspective and looking at a long term time frame as well as considering priorities for short term investment. This framework for strategic planning of public water infrastructure together with its implementation programme of plans and projects should enable the delivery of the required water standard of quality and reliability, in a manner that protects the natural environment, which is critical to the country's economic and social development.

In the short term, Irish Water's Capital Investment Plan 2017-2021 aims to address many of the pressing capacity and quality issues through the investment of approximately €3.6 billion out to 2021. As required by law, the first two years of this plan have been approved by the Commission for Energy Regulation. While Irish Water acknowledged in its plan that it would not meet all the demands that existed[119], Irish Water also stated that it would not be possible to deliver all of the investments required to address these demands in the next four years due to a number of issues such as planning requirements and other supply chain capacity issues. Examples of projects which Irish Water is suggesting will be required in the period 2022-2026 include a major new water source for Dublin and a major new north Dublin drainage scheme. As noted earlier, Irish Water estimates that a minimum of €13 billion will be required over the next 20 years in order to meet its objectives. That is €650 million a year on average, a level which the current investment plan out to 2021 surpasses.

Substantial investment is currently planned for Ireland's water infrastructure for the period out to 2021. The planned investment as outlined by Irish Water seeks to strike a balance between the demand for water infrastructure investment and the constraints that currently exist in terms of affordability, planning requirements and supply chain issues. Delivery on the key performance metrics which have been set by Irish Water should be closely monitored over the coming period. The actual level of capital investment will be determined through the regulatory process. The next revenue control period, for which Irish Water must submit plans for approval to the CER, commences in 2019 provides a suitable opportunity to assess the planned investment levels in Ireland's water infrastructure set out in Irish Water's Capital Investment Plan on the basis of the risk-based approach adopted in that Plan to addressing critical issues such as drinking water quality, compliance with the EU Urban Waste Water Treatment Directive and reduction in leakage levels.

[119] See pages 17-18 of the Irish Water – Investment Plan 2017 - 2021

7. Energy

Reliable and secure energy systems are of vital importance to the functioning of modern advanced economies. In addition, the source and composition of energy is an important consideration in light of climate related targets and the overall transition to low carbon energy. The primary energy infrastructures which exist in Ireland are the electricity network and the natural gas network. This section provides a high level overview of key physical electricity and natural gas infrastructure and demand/consumption patterns.

Irish and EU Policy

Climate and energy policy are inextricably linked. A new Energy White Paper – Ireland's Transition to a Low Carbon Energy Future 2015-2030 – was published in December 2015. It sets out a framework to guide Irish energy policy in the period up to 2030 which reiterates the fundamental pillars of energy policy – competitiveness, security of supply and sustainability. It also sets out a vision for a profound transformation of Irelands' energy systems, moving to lower emissions fuels and ultimately towards a lower reliance on fossil fuels, significantly increasing renewable generation, achieving a step change in energy efficiency performance, implementing smart and interconnected energy systems, strong regulatory structures and markets to underpin these changes, and repositioning energy consumers to have a more active role within the energy sector. In 2015, the European Commission adopted its strategy for a European Energy Union. This strategy builds further on the 2030 Framework for Climate and Energy and the European Energy Security Strategy. The Energy Union is made up of five closely related and mutually reinforcing dimensions:

- **security, solidarity and trust:** diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries
- **a fully integrated internal energy market:** enabling the free flow of energy through the EU through adequate infrastructure and without technical or regulatory barriers
- **energy efficiency:** improved energy efficiency will reduce dependence on energy imports, lower emissions, and drive jobs and growth
- **decarbonising the economy:** the EU is committed to the Paris Agreement and to retaining its leadership in the area of renewable energy
- **research, innovation and competitiveness:** supporting breakthroughs in low-carbon and clean energy technologies by prioritising research and innovation to drive the energy transition and improve competitiveness.

The Commission's 'Clean Energy for All Europeans' package, which was published in November 2016, includes a proposal for a Regulation on Energy Union Governance. This regulation will be fundamental to delivering on the Energy Union's objectives and ensuring sufficient action is taken to meet the EU's 2030 targets for climate and energy.

Previous Investment and Infrastructure Overview

In detailing investment in energy infrastructure it is necessary to make a distinction between Exchequer investment and non-Exchequer investment. The vast majority of investment in energy infrastructure in Ireland is non-Exchequer based. State companies hold the responsibility for the development and maintenance of the electricity grid (EirGrid and ESB Networks) and the natural gas network (Gas Networks Ireland). As such, investment in these services is financed primarily through revenue generated by the companies, rather than through the Exchequer. The current Capital Plan includes €14.5 billion in non-Exchequer investment out to 2021 with energy accounting for 40% of this. This investment in energy features a number of key projects including:

- North-South Interconnector – to add a second high-capacity electricity interconnector between Ireland and Northern Ireland;
- Smart Metering – to upgrade energy meters to allow consumers to better monitor their energy use and benefit by changing when they consume electricity.

Exchequer capital investment in the area of energy is focused on energy efficiency and renewable energy initiatives with the existing Capital Plan committing €444 million in these areas over the course of the plan. While the overall level of capacity and demand in the energy sector is of interest, the composition of energy generation and use is also an important factor given the commitments which Ireland has with regards to climate change and the use of renewable energy. There are a range of potential Government interventions available in the general policy area including expenditure, regulation, taxation and behavioural change. The stated Exchequer investment levels thus assist, in conjunction with non-Exchequer investment and other policy measures, in the State's efforts to transition to a low carbon economy and meet various commitments and targets. Further detail in relation to overall policy in this regard is contained within the 2015 Energy White Paper 'Ireland's Transition to a Low Carbon Energy Future: 2015-2030'[120]. The focus of this section, in line with the rest of the paper, is on physical infrastructure and as such it sets out some high level analysis related to physical energy infrastructure in terms of both previous investment and scale/composition.

Electricity

Significant investment has been made in the electricity system over the last two decades. This has included investment in the generation and transmission systems and through the better interconnection of the Irish transmission system with Great Britain. Projects such as the proposed North-South Interconnector, further connecting the electricity networks of Ireland and Northern Ireland, and the East-West interconnector, connecting Ireland and Wales, enhance the security and efficiency of the system as a whole. Capital investment is detailed within the Commission for Energy Regulation's price reviews which contain information

[120] http://www.dccae.gov.ie/documents/Energy%20White%20Paper%20-%20Dec%202015.pdf

on transmission and distribution system operators' capital and operating expenditures as well the charges that can be levied (transmission and distribution use of service charges).

The capacity of the transmission system has been enhanced in response to both increasing levels of demand from households and business, and the necessity of expanding capacity to accommodate renewable electricity generation. Figure 7.1 sets out the increase in generation capacity from combustible fuels and wind between 1990 and 2015. Furthermore, data from EirGrid indicates that the level of dispatchable generation capacity has increased from 6,585 MW in 2012 to 7,617 MW in 2016 and the level of partial/non-dispatchable capacity has increased from 1,586 MW to 2,991 MW over the same time period[121]. The peak demand on the system to date occurred in 2010 at a level of just over 5,100 MW[122].

All populated areas of the country are serviced by the electricity grid[123]. In their 2016 report, Engineers Ireland noted that "continued investment has ensured that Ireland's electricity network is benchmarked internationally as among the most advanced in the world[124]". Generation plants provide electricity through a range of sources including burning natural gas, peat and coal, and harnessing wind and hydro and pumped storage electricity generation. While a large share of electricity generation currently comes from non-renewable sources, continued investment in renewable energy and a range of other measures will contribute to Ireland's efforts in relation to climate change targets.

In terms of renewable generation, significant investment has been made in this area. Much of the progress has been in the area of wind energy. For example, the installed capacity for wind energy is over 2,600 MW[125] indicating the level of investment in the sector since 2000 when the level of wind energy capacity was minimal. This is demonstrated further in Figure 7.1. Between 2003 and 2016, approximately 190 wind farms were installed across 24 counties[126] which provided for the enhanced level of capacity. EirGrid's infrastructure analysis estimates that the capacity of renewable generation in Ireland will increase substantially in future years with 3,480 MW of additional capacity already planned.

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121 Eirgrid, 2012 and 2016 Generation Capacity Statement

122 All Island Generation Capacity Statement 2017-26. Eirgrid.

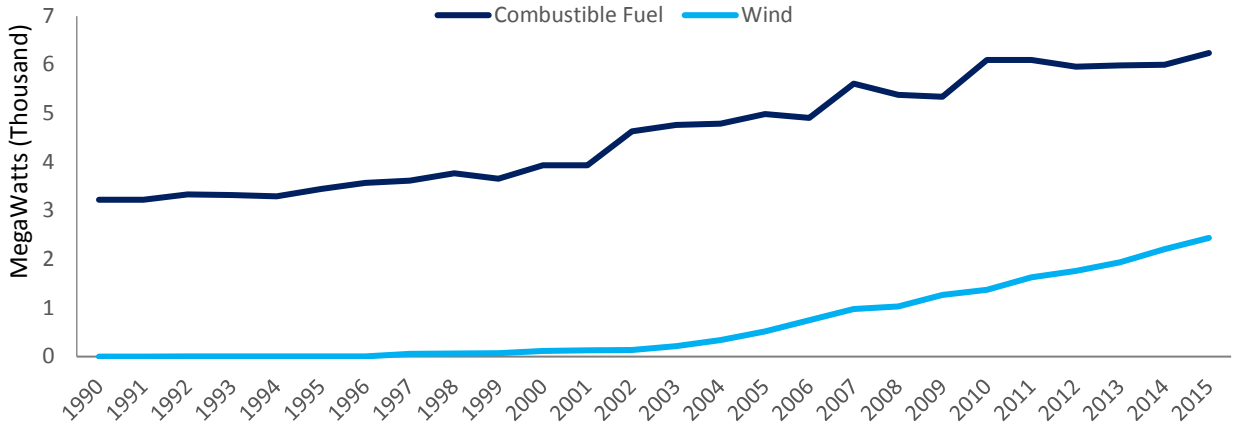
123 For a geographic illustration of the Irish transmission and production systems, see the Eirgrid Transmission System Map

124 Engineers Ireland (2016) 'The State of Ireland 2016: A Review of Infrastructure in Ireland'. https://www.engineersireland.ie/EngineersIreland/media/SiteMedia/communications/publications/engineers-ireland-state-of-ireland-2016.pdf?ext=.pdf

125 http://www.eirgridgroup.com/site-files/library/EirGrid/4289_EirGrid_GenCapStatement_v9_web.pdf and https://www.gasnetworks.ie/corporate/company/our-network/GNI_NetworkDevPlan_2016.pdf

126 https://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/Ireland%E2%80%99s-Energy-Targets-Progress-Ambition-and-Impacts.pdf

Figure 7.1: Electrical Capacity in Ireland from Combustible Fuels and Wind, 1990-2015



Source: Eurostat. Note: Main Activity Producers Only

Gas

Capital investment in gas networks has focused on enhancing the coverage and quality of the network throughout the island. The network has increased from 31km of transmission pipeline in 1978 to 2,433 km of transmission and 11,339 km of distribution pipelines[127]. Development projects have included the construction of new pipelines, pressure regulating stations, and upgrading boilers among other things. The development of the interconnectors with the UK transmission system in Scotland, in 1993 and 2001 respectively, represented significant investment and secures consistent access to gas into the future. In the present Price Control period (PC3) – spanning October 2012 to September 2017 - GNI were permitted €387 million for investment in the distribution and transmission systems.

The gas distribution network can currently be accessed by around 640,000 households and 25,000 businesses on the island. It has good coverage across the State with the exception of the South-West and North-West/Border areas. As previously stated, the network consists of 13,685 km of pipelines as well as Above Ground Installations, District Regulating Installations and compressor stations at entry points in Ireland and Scotland. Indigenous production facilities exist at the Corrib gas field, off the coast of Mayo. The transmission network includes the interconnectors to Great Britain; the interconnector system between Ireland and Great Britain is made up of two sub-sea interconnectors. There is also a gas interconnector from Great Britain to Northern Ireland and a gas interconnecting pipeline between Ireland and Northern Ireland. The compressor stations in Scotland at Beattock and Brighouse Bay as well as 10km of onshore pipeline between Brighouse Bay and Moffat make up the off shore elements of the Irish transmission system. The interconnector system links directly into Great Britain's National Transmission System, which also supplies gas to the Northern Irish market at Twynholm. Ireland's onshore part of the system consists primarily of a ring-main system with spur lines serving various network configurations and a compressor station located in Midleton Co. Cork.

[127] Gas Network Ireland https://www.gasnetworks.ie/corporate/company/our-network/18048_GNI_GasNetwork_ReliabilityCapacity_Doc_Update.pdf

Drivers of Demand

The demand for energy is driven by a number of interrelated factors some of which are briefly discussed below.

Table 7.1: Selected Drivers of Demand for Energy

Drivers of Demand	Examples
Consumption Trends	The extent to which both residential and commercial activity requires energy is an obvious driver of demand. For example, the level of energy consumption per household or per business will reflect trends in individual consumption patterns. Changes in consumption levels and the efficiency of usage will have an impact on the level of necessary supply.
Economic Cycle	Trends in other areas such as wider economic growth, incomes and price dynamics will also be a factor in influencing demand. For instance, higher levels of economic growth or a decrease in energy prices may facilitate higher levels of energy consumption.
Demographics and Spatial Development	Similarly to other sectors the level of demand is also influenced by trends in the size and composition of the population and also the spatial distribution of activity.
Composition of Demand	The composition of demand is an important factor in this sector. For example, demand for generation via renewable sources versus non-renewable sources can play a role.
Technological Change and New Industry Demands	Changes in technological developments and in demands from industry can also have a significant impact on demand. For example, construction of data centres (e.g. Apple in Athenry Co. Galway) necessitate access to significant power loads.

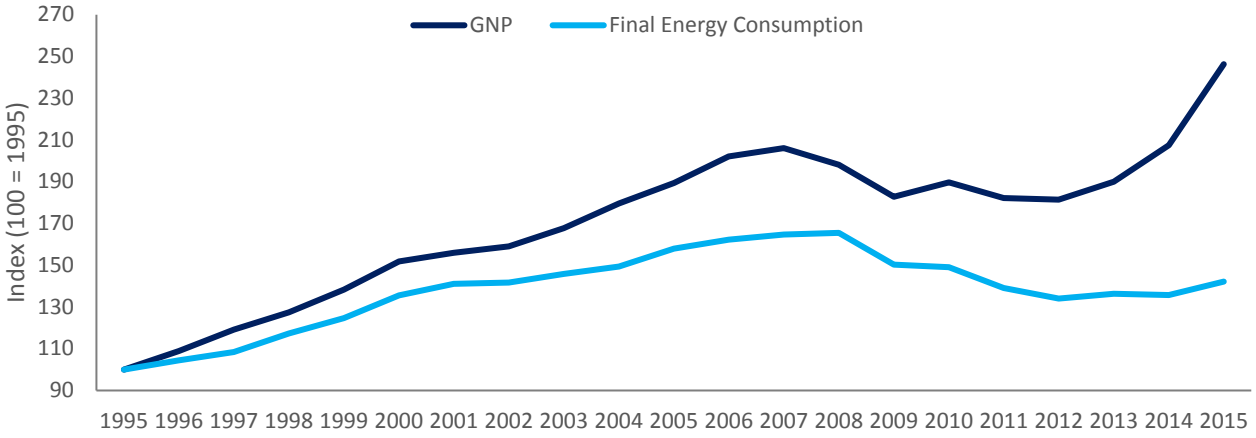
While the factors above relate to the general drivers of demand for energy consumption, it is important to briefly set out the details of Ireland's targets for energy efficiency and renewable energy use given the importance of the composition of energy generation and consumption relevant targets. Ireland's target under the Directive 2009/28/EC is a 16% share of energy consumption from renewable sources by 2020. The Directive required Ireland to establish a national renewable energy action plan setting out Ireland's national targets for the share of energy from renewable sources consumed in transport, electricity and heat to deliver on the overall renewable energy target. Ireland's 2020 national renewable energy targets are 40% of electricity consumption from renewable sources, 10% of transport energy consumption from renewable sources and 12% heat and cooling energy consumption from renewable sources.

In addition, Ireland has a non-binding target of 20% energy efficiency savings by 2020. This is a nationally set target adopted by Government in response to the EU Energy Efficiency Directive. The legally binding renewables target was set on the assumption that 20% energy efficiency would be achieved. Therefore, while there is a binding target and a non-binding one, there is a critical interdependence between the two. Thus, while it is clear that there are a number of interrelated factors that drive demand for energy it is also important to consider the composition of demand and supply in terms of generation source in the context of Ireland's various energy and climate commitments.

Trends in Demand Drivers

At an overview level it is important to first consider the total level of energy demand and use. As can be seen in Figure 7.2, total energy consumption grew significantly between 1995 and 2008 before falling in line with the wider economic downturn. In 2015, Ireland's overall energy consumption increased by just under 5% but remains below previous peak levels.

Figure 7.2: Final Energy Consumption and GNP, 1990-2015

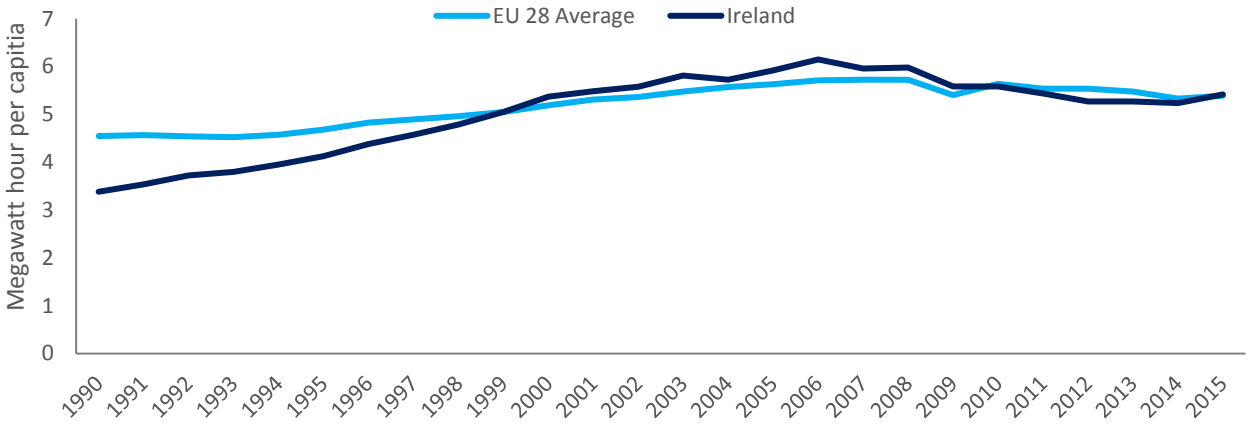


Source: Author Analysis of CSO and SEAI. Note: GNP is constant 2014 prices

Electricity

Over the period between the early 1990's and now, electrical consumption per capita, as measured through final energy consumption, has increased significantly. Part of this increase was a convergence with the EU average during the economic development which took place during the 1990's and early 2000's. Around 1999, average consumption surpassed that of the EU28 average though has since levelled off and is now roughly on the same trajectory.

Figure 7.3: Final Electricity Consumption per Capita, Ireland and EU 28 Average, 1990-2015

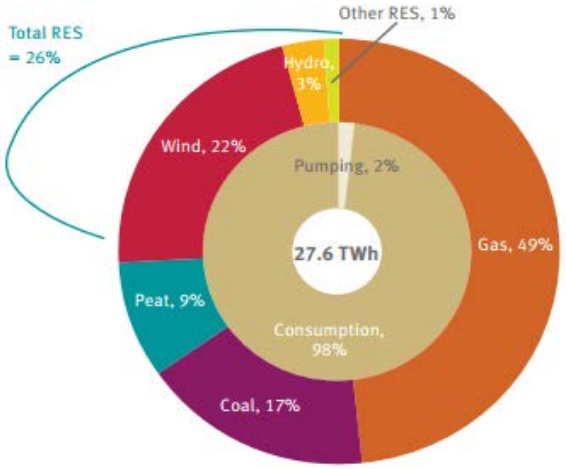


Source: Author Analysis of Eurostat. Electricity consumption is final energy consumption

There are several energy sources which provide Ireland's electricity. At present the largest source is natural gas which is produced domestically and imported from the UK. Due to the need to reduce greenhouse gas emissions there is a corresponding need to reduce the quantities of fossil fuels which are used to produce

electricity, particularly the more carbon intensive forms such as coal and peat. Ireland has set a target of 40% of electricity consumption to come from renewable sources by 2020. Significant progress has been made on the decarbonisation of Ireland's fuel mix. In 2015, electricity consumption from renewable sources stood at around 26%, a significant increase from the 4.9% in 1990[128] but still below the targeted levels.

Figure 7.4: Generated Electricity by Fuel Source, 2015



Source: Eirgrid All-Island Generation Capacity Statement 2017-2026

In terms of future demand, EirGrid's demand modelling estimates that total electricity demand in Ireland over the next ten years will grow by between 15% and 36% depending on the scenario. Under EirGrid's median demand scenario (the central scenario upon which the supply scenario is modelled), the network will have sufficient capacity out to the end of the forecast period in 2026. It should be noted that the projections assume that the proposed North South Interconnector is delivered. In the absence of the proposed North South Interconnector in the median scenario Ireland is in large surplus in the short term up to 2020. By 2021, enough plant is projected to have been decommissioned so that there is a balance between supply and demand out to 2026. However under a high demand scenario the system is projected to face deficits of almost 500 MW. However, the TSOs note that *"in practice, the Capacity Market should react to a rising demand by revising the forecast each year and by securing more capacity"* [129].

It is clear that the potential construction of data centres may drive significant growth in electricity demand in the coming years. Given their large size, encouraging the strategic location of data centres in areas where the grid is strongest will minimise network reinforcement requirements and therefore the network costs borne by all electricity consumers. Data centres will also be able to avail of short connection times at such locations. A challenge exists in that several data centres are seeking to ensure that their demand is met by 100% renewable generation (either on site or imported from the grid). EirGrid in its annual generation capacity statement projects energy demand to continue to increase mainly driven by new large users such as data centres. EirGrid expects a significant proportion of this extra data centre load will materialise in the Dublin region and state *"given the lead times associated with transmission reinforcements, generation capacity or equivalent may need to be available in the Dublin region to accommodate this additional demand in the short-term"* [130].

[128] http://www.seai.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy-in-Ireland-1990-2015.pdf
[129] http://www.eirgridgroup.com/site-files/library/EirGrid/4289_EirGrid_GenCapStatement_v9_web.pdf
[130] Ibid

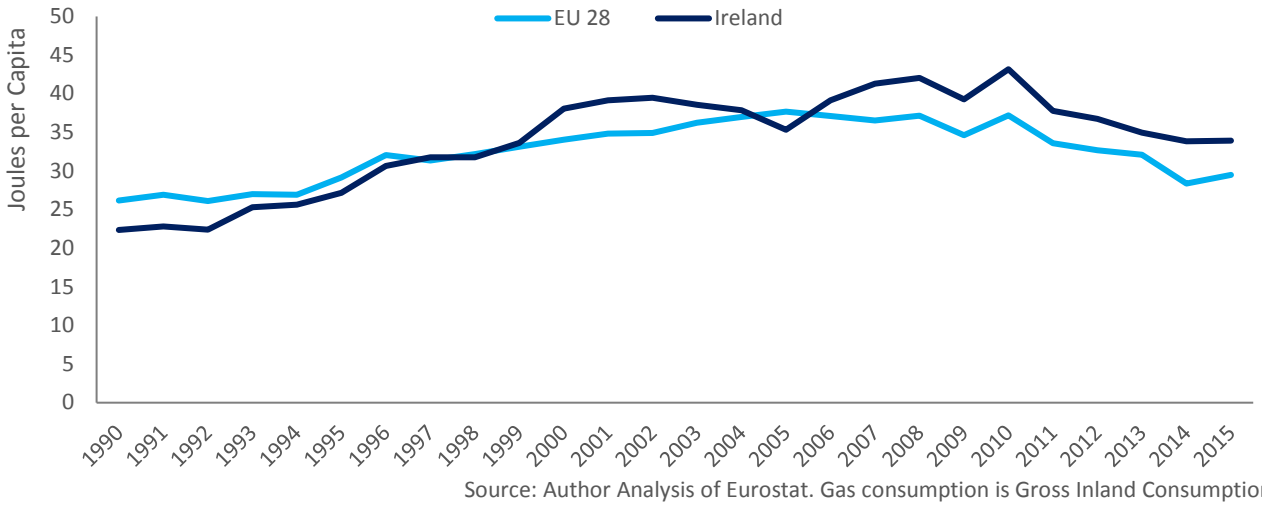
While overall electricity generation is expected to be sufficient to meet demand, it is crucial to note that to meet relevant targets and renewable energy generation additional investment will be required. For example, it is estimated that the necessary wind capacity in 2020 is between 3,900 and 4,300 MW and reaching this level of capacity would require an estimated installation of 340 MW additional wind capacity per year[131].

Gas

Irish gas consumption per capita, as measured through gross inland consumption, grew between 1990 and the mid-2000's before levelling off in line with the downturn in the economy. As with the European average, peak usage occurred in 2010 and has since reduced. While at an individual or household level gas consumption is primarily used for heating purposes, the high reliance on gas in electricity production mean that gas consumption will be highly correlated with electricity consumption. As can be seen in Figures 7.3 and 7.5, gas consumption follows a similar trajectory. As stated, consumption of energy overall, and thus electricity and gas, is in part linked to the economic cycle with a gradual increase over the late 1990's/early 2000's followed by a decrease following the crisis.

The need to reduce reliance on fossil fuels for electricity generation will likely have an impact on network expansion over coming years with any expansion projects relatively limited in scope. However, this transition may also have a positive impact on gas demand in the medium term as it may be used as a substitute for other more carbon intensive fossil fuels in electricity generation while further renewable capacity is introduced.

Figure 7.5: Gross Inland Gas Consumption per Capita, 1990-2015



Source: Author Analysis of Eurostat. Gas consumption is Gross Inland Consumption

The capacity and demand analysis undertaken by Gas Networks Ireland indicates that Ireland's transmission system will have sufficient capacity to meet future gas flow requirements in the short to medium term. The forecast increase in demand between 2015/16 and 2024/25 is between 14% and 44% depending on the scenario and it is anticipated that the network will be able to cater for this.

[131] http://www.eirgridgroup.com/site-files/library/EirGrid/4289_EirGrid_GenCapStatement_v9_web.pdf

Energy Transition and Climate Targets

As previously stated, the need to reduce emissions from energy generation is the primary driver in demand for investment in energy infrastructure. While continued investment in the existing energy networks has created a viable and secure energy system, aiding the transition to renewable energy, it will be necessary over coming years to make additional investment in a variety of areas, in order to meet Ireland's emission commitments.

The analysis contained here has looked at physical infrastructure within the energy sector (generation and transmission) only. Exchequer investment has been committed through the current Capital Plan to initiatives such as energy efficiency which aim to assist in overall efforts to meet targets. It should be noted that there are many avenues of intervention which could facilitate a transition to low carbon energy system and progress in relation to achieving relevant targets. Consideration of the range of options is ongoing (e.g. National Mitigation Plan[132]) and the optimal balance of measures in terms of efficiency and effectiveness is to be determined. There are a range of possible measures and interventions which are available including expenditure, fiscal, regulatory and behavioural change.

Energy Security

A further consideration in terms of Ireland's future energy infrastructure is that of energy security. Ireland's energy import dependency was 88% in 2015[133]. Half of all oil product imports and all of Ireland's natural gas imports come from the UK. As outlined in this section, Ireland has a number of international connections with the UK in the energy sector. The State's natural gas infrastructure is interconnected to the UK through Moffat in Scotland while the electricity grid is also interconnected with the UK through the East-West Interconnector. Furthermore, there is a Single Electricity Market in operation across the Island of Ireland since 2007 which is being developed into the Integrated Single Electricity Market (I-SEM) by May 2018. Other connection projects are being considered including the Celtic Interconnector, a proposed energy link between Ireland and France. These connections provide for the transfer of energy across jurisdictions and enhance the security of Ireland's energy supply. The high dependence on energy imports highlights the importance of the continued consideration of overall energy security as an important element of infrastructure planning.

Energy Sector Links to the UK

Given the outlined links between Ireland and the UK in the energy sector, such as through both gas and electricity interconnection, it is clear that the ongoing process of the UK leaving the EU may have implications within this policy area. The precise implications of this change will depend on a number of factors including

[132] http://www.dccae.gov.ie/documents/National%20Mitigation%20Plan%20April%202017.pdf
[133] SEAI (2016) 'Energy in Ireland 1990-2015'. http://www.seai.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy-in-Ireland-1990-2015.pdf

the UK's future relationship with Europe in terms of energy markets and infrastructure and their overall future energy policy. As such, Ireland's policy and infrastructure development in this sector will thus be informed by any emerging implications of the Brexit process. Ireland's priorities[134] for Brexit negotiations in the energy sector are:

- To maintain the trade in secure supplies of energy between European Union Member States and the United Kingdom.
- To maintain the Single Electricity Market across the island of Ireland.
- To accommodate Ireland's ability to meet European Union obligations.
- To ensure appropriate energy infrastructure.

Summary

In general, energy infrastructure in Ireland is in a good position to continue meeting overall demand. The key energy infrastructure development is the North-South Interconnector providing a second high-capacity link between Ireland and Northern Ireland.

The vast majority of investment in the sector is non-Exchequer based. At a high level, it is expected that both the natural gas and electricity networks will be broadly sufficient to meet anticipated future flow requirements into the medium term.

While overall demand is expected to be catered for, the composition of generation and usage is an important consideration in the energy sector. In particular, commitments in the areas of climate change, energy efficiency and renewable energy present a significant challenge to the sector, and means that continued investment beyond maintenance will be necessary for the coming period. The existing Capital Plan has committed €444 million to 2021 in the area of Energy Efficiency and Renewable Energy and significant additional investment will be carried out by State companies with the total level of physical generation capacity (primarily renewable/wind) anticipated to expand over the coming years. Another important area within the sector is that of energy security given Ireland's high energy import dependency. Ireland's energy system also has close linkages to the UK and as such the process of the UK leaving the EU will be an important consideration in future policy and planning, although precise impacts are unclear at this point.

[134] DCCAE (2017) 'The All-Island Brexit Civic Dialogue on Energy – Report of Meeting on 6 February 2017'. http://www.dccae.gov.ie/documents/Brexit%20Civic%20Dialogue%20on%20Energy%20Report.pdf

8. Broadband

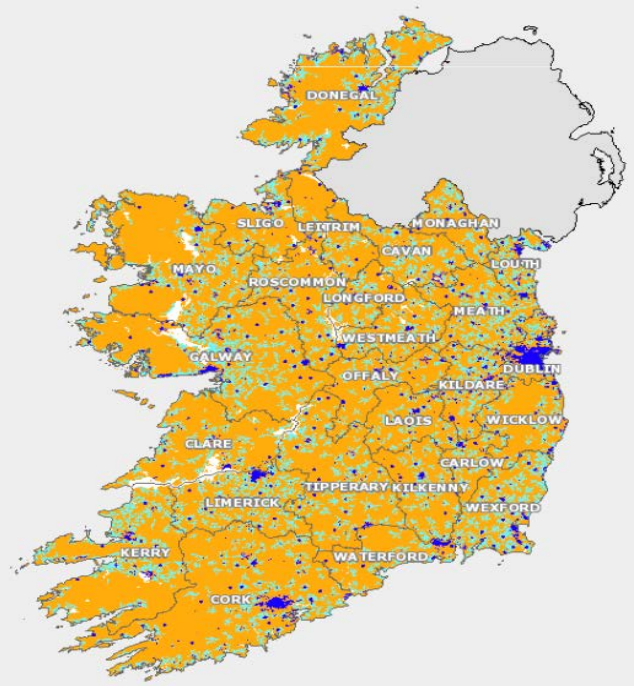
Access to high speed internet is considered to be an essential utility in the 21st Century with broadband infrastructure being seen as key enabler. The digital economy is of particular importance in Ireland, representing 6% of GDP and employing almost 116,000 people directly and indirectly[135], with these figures anticipated to grow further over the coming years. This section includes an overview of the National Broadband Plan, a description of Ireland's broadband infrastructure, and an analysis of drivers of demand.

Investment and the National Broadband Plan

The National Broadband Plan aims to deliver high speed broadband services to all businesses and households in Ireland through a combination of public and commercial investment. The strategy aims to ensure the development of an open access and wholesale network which will be part subsidised by the State through the commercial stimulus/gap funded model. The details of the plan have been updated since the commencement of the plan[136], and the National Broadband Plan currently remains at the procurement stage. The precise cost of the plan is subject to the outcome of this process. The current Capital Plan states that an initial allocation of €275 million of Exchequer funding has been provided for the NBP however the precise funding profile will only be apparent after the competitive tendering process. It is anticipated that the cost of the publicly funded element of the Plan will be spread over the 25 year life cycle of the project with some front loading at the initial construction phase.

The objectives of the plan include delivering the intervention as quickly as possible, allowing each home and business to access high speed broadband and ensuring that the network can meet current and future demand. The stated minimum technical standards in terms of speed are a minimum of 30Mbps download and a minimum of 6Mbps upload or twice the maximum upload speed of existing broadband in the intervention area, whichever is greater. In April 2017 the National Broadband Plan was updated with Eir announcing that an additional 300,000 premises across Ireland will gain

Figure 8.1: National Broadband Plan Map



Dark Blue; areas where commercial operators either already or have committed to deliver high speed broadband
Light Blue; rural areas in which providers have committed to deliver high speed broadband by 2018.
Amber; target areas for State intervention under the National Broadband Plan.

[135] http://www.dccae.gov.ie/en-ie/news-and-media/press-releases/Pages/Trading-Online-Enterprise-Impact-Reports.aspx
[136] April 2014: http://www.dccae.gov.ie/en-ie/news-and-media/press-releases/Pages/Major-fibre-build-out-to-rural-Ireland-will-be-cornerstone-of-Government-strategy.aspx
April 2017: http://www.dccae.gov.ie/documents/Press%20Release%2004%20Apr%202017.pdf

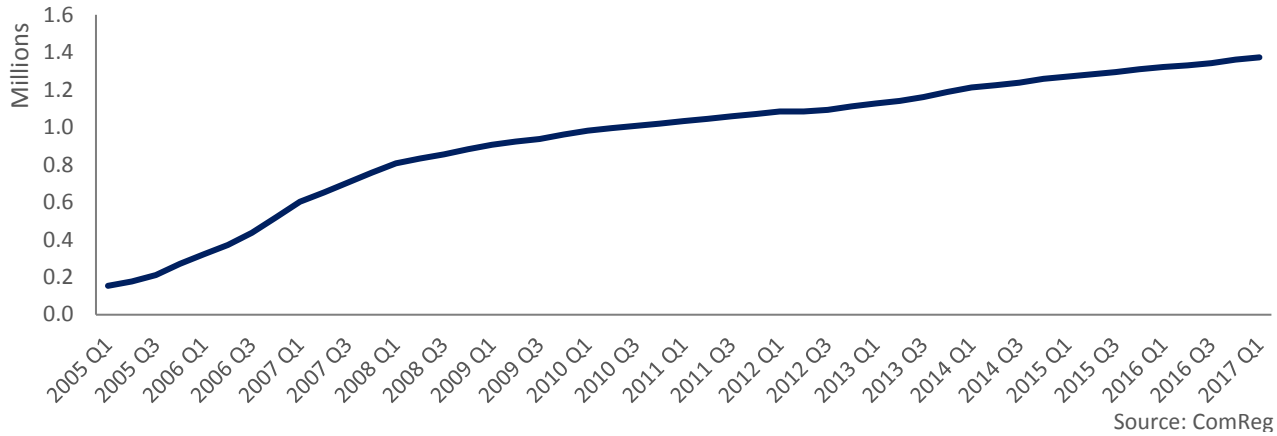
access high speed broadband by the end of 2018 as a result of €200 million investment over 2 years. A further 84,500 premises were added to the state intervention area because they are in areas where planned commercial investment is unlikely to materialise.

The intervention area of the National Broadband Plan covers 21% of the national population, 542,000 postal addresses and 47,000 SMEs (primarily micro). Figure 8.1 illustrates the intervention areas of the National Broadband Plan. Areas in blue indicate areas in which commercial providers either already, or have plans to roll out broadband services in this area, while the amber areas are the target areas of the National Broadband Plan. Since the National Broadband Plan was published in 2012 the intervention area has been reduced as commercial providers expand their services, with €2.5 billion invested by commercial providers in upgrading the telecom networks over the past 4 years[137], reflecting the dynamic nature of the sector. The rationale for the National Broadband Plan is to provide broadband to those areas where commercial provision is not forthcoming (e.g. due to low population density or high per capita investment cost). Given the dynamic nature of the sector, with different strategies and technologies for delivering broadband constantly being developed, the level and type of state intervention that is required can change over time.

Infrastructure Overview

The following high level analysis looks at Ireland's existing broadband infrastructure. In particular it considers how it has developed over time, looks at the regional dynamics, and looks at Ireland's infrastructure in an international context. In recent years Ireland has made considerable progress in developing its broadband infrastructure. This is illustrated in Figure 8.2 in which we can see an upward trend in the number of fixed broadband subscriptions. Fixed broadband subscriptions increased by 0.9% in Q1 2017 and were up by 3.9% compared to Q1 2016. The estimated fixed broadband household penetration rate at the end of Q1 2017 was 70.4%[138]. It is further illustrated by results from the Census which indicate that the number of households with broadband access has increased from 20% in 2006 to 71% in 2016.

Figure 8.2: Total Fixed Broadband Subscriptions, 2005- 2017

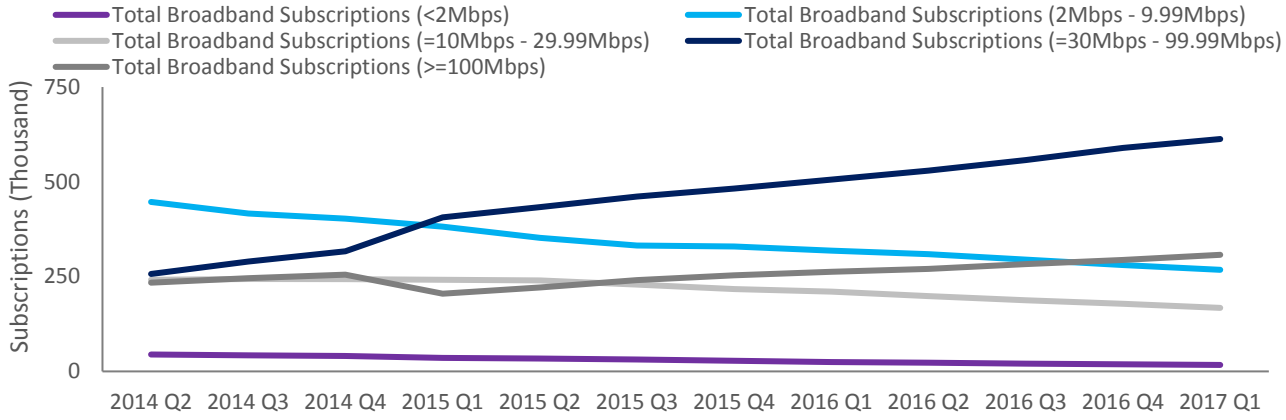


Source: ComReg

[137]http://www.dccae.gov.ie/en-ie/news-and-media/press-releases/Pages/Naughten-finalizes-the-Broadband-Intervention-Map-.aspx
[138] Commission for Communications Regulation (ComReg), Quarterly Key Data Report 2017 Q1.

In addition to the improved situation in terms of broadband subscriptions, improvements have also been made in terms of the speeds available. In Q1 2017, approximately 79% of all fixed broadband subscriptions were equal to or greater than 10Mbps up from 74% in Q1 2016. 67% of all fixed broadband subscriptions were greater than or equal to 30Mbps, up from 58% in Q1 2016[139]. Figure 8.3 below shows broadband subscription by speed and shows that the number of subscriptions with an advertised speed of between 30Mbps and 99.99Mbps has experienced a large increase in recent years while the number of subscriptions offering slower speeds has fallen.

Figure 8.3: Broadband Subscription by Speed, 2014-2017

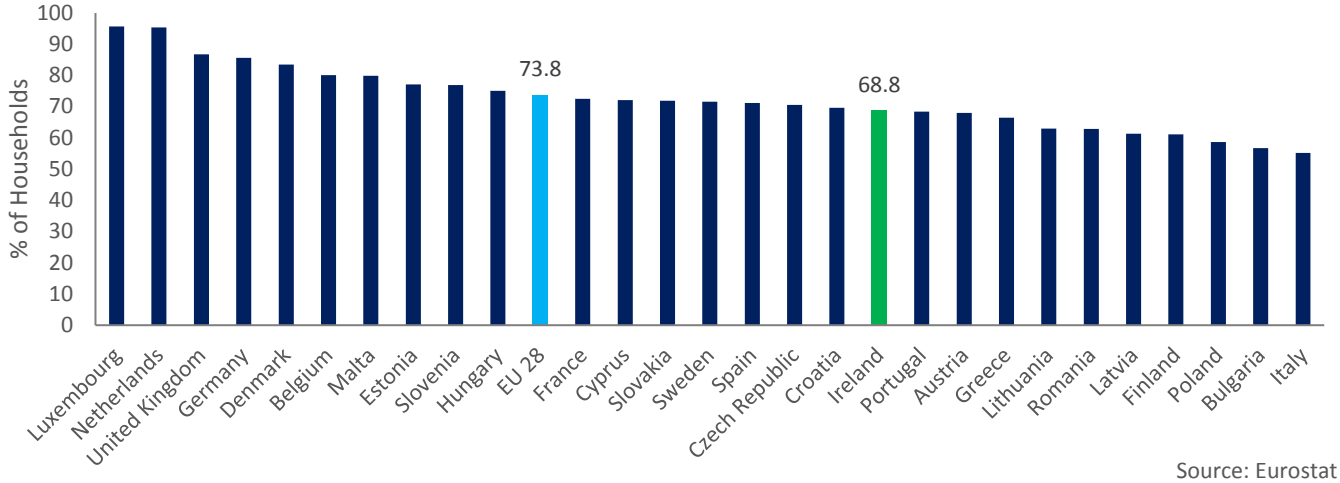


Source: ComReg Report

International Comparison

Despite ranking 8th overall in the EU's Digital Economy and Society Index (DESI)[140], Ireland's connectivity remains below the EU average. Ireland has improved its position relative to its European counterparts in terms of access to broadband, having previously lagged behind. Figure 8.4 shows Ireland's fixed broadband penetration rate as well as that of other EU member states.

Figure 8.4: Proportion of Households with Fixed Broadband Connection, 2016



Source: Eurostat

[139] Commission for Communications Regulation (ComReg), Quarterly Key Data Report 2017 Q1.

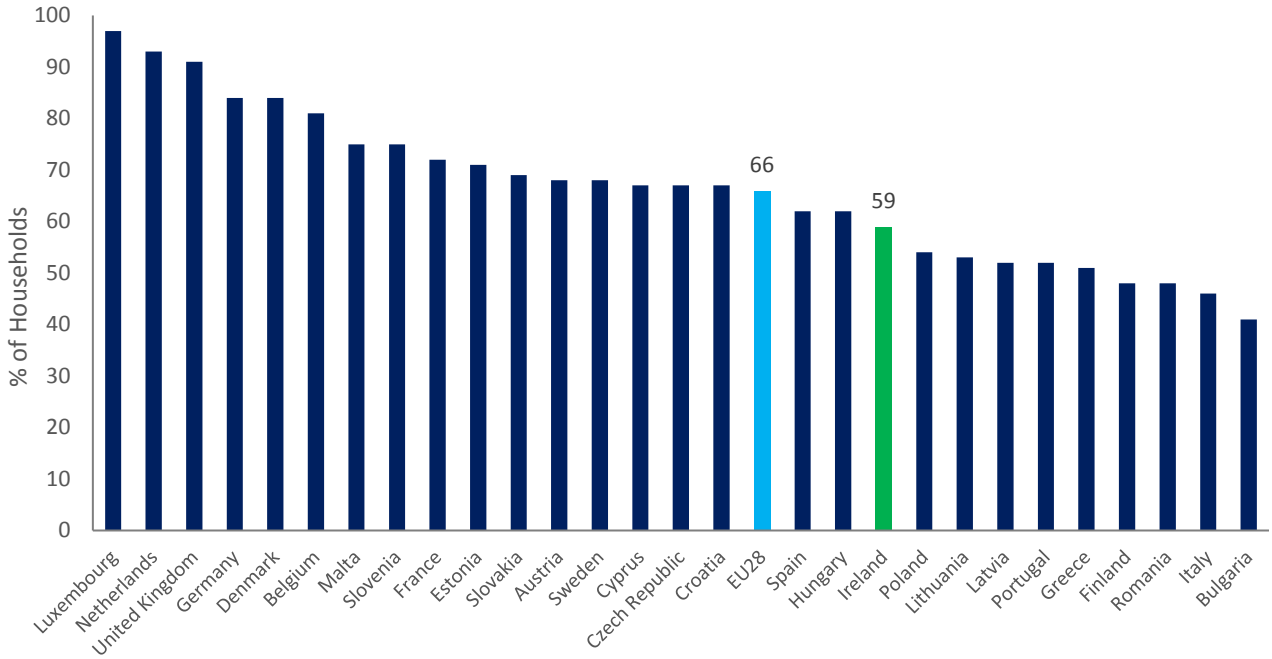
[140] The Digital Economy Society Index (DESI) is a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU Member States in digital competitiveness. https://ec.europa.eu/digital-single-market/en/scoreboard/ireland

Regional Comparison

While progress has been made in terms of the availability of broadband in Ireland, disparities persist between the rural and urban areas. 24.9% of households in rural areas can subscribe to broadband speeds of 30Mbps or more[141], while 7% of rural homes still have no access even to basic fixed broadband. One of the principal factors driving this discrepancy is the low population density of many of Ireland's rural areas. Ireland has one of the lowest population densities in Europe with only 67 people per km^2, while in some counties this can be as low as 19 people per km^2. Low population density and the thinly distributed rural population makes the deployment of high speed broadband network infrastructure costly, and is a factor in inhibiting commercial provision of services.

2016 Census data published by the CSO[142] shows that 71% of households in the State had broadband internet access. 86% of households had broadband internet access in Dún Laoghaire–Rathdown, the highest rate in the country, while the lowest level was in Leitrim where only 58% of households have broadband internet access. This provides an indication of the regional disparity in access levels. Figure 8.5 below shows the percentage of households in areas with less than 100 inhabitants per km^2 with a fixed broadband connection across the EU. Ireland falls below the EU average, however this figure has increased by 23 percentage points since 2012.

Figure 8.5: Proportion of Households in Sparsely Populated Areas (less than 100 inhabitants per km^2) with Fixed Broadband Connection, 2016



Source: Eurostat

[141] Study on National Broadband Plans in the EU-28, European Commission
[142] Census 2016 Summary Results Part 1- CSO

Drivers of Demand

The level of demand for access to high speed internet is, and will in the future be, influenced by a number of factors. Clearly, the supply of adequate infrastructure is a key factor in determining access to broadband services. It is possible to identify a number of high level factors which impact the overall level of demand. The following table identifies some of the principal factors that drive demand for broadband services.

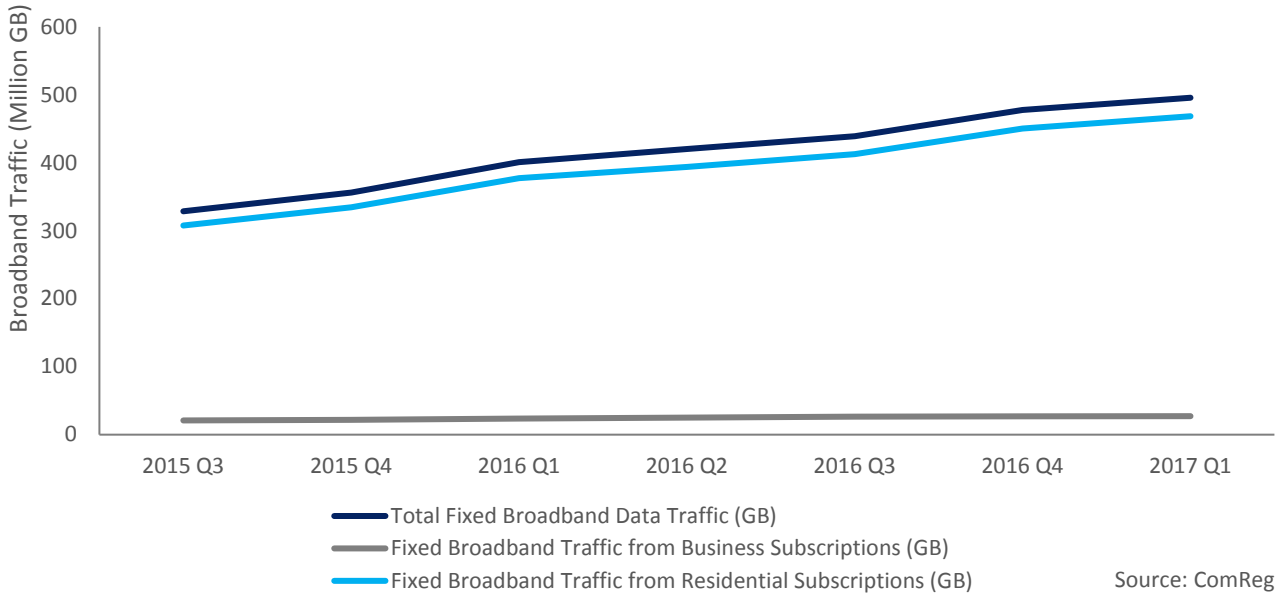
Table 8.1: Selected Drivers of Demand for Broadband

Drivers of Demand	Examples
Consumption Trends	Changes in consumption patterns and types will also affect the demand for broadband access. For instance, higher individual or commercial consumption or a change in the type of data consumed (e.g. larger file types) will increase the overall level of demand.
Cultural Changes and Technological Use	Technological development and cultural change are important factors in determining overall demand for broadband access. The extent to which access to high speed internet becomes more important to a variety of both residential and commercial services is clearly an important factor in determining overall demand.
Demographics and Spatial Development	The level of demographic growth and the spatial distribution of both settlements, employment and business are important factors in determining the composition of demand. This is a particular factor in terms of the split between urban and rural demand and the delivery of relevant infrastructure to support this.

Trends in Demand Drivers

Figure 8.6 below shows that broadband traffic in Ireland has increased substantially over the last couple of years and has been driven by residential subscriptions. The trend that can be seen in the below figure is indicative of the trend in demand that is predicted for the coming years. This increase in total traffic is due to a combination of factors including the drivers stated above.

Figure 8.6: Fixed Broadband Traffic (GB), 2015 Q3- 2017 Q1



Source: ComReg

Socio-economic indicators showed that internet services are an important aspect of the everyday lives of Irish citizens. Data from the CSO[143] indicates that the proportion of people who have used the internet within the last three months has increased from 58% in 2007 to 82% in 2016 highlighting the growing level of demand in previous years. Furthermore, the number of people who use the internet everyday has increased from 32% to 70% over the same time period.

Furthermore, Ireland ranks highly when it comes to the integration of digital technologies by businesses, with Irish SMEs making the most use of online opportunities[144]. Estimates from March 2016 suggest that Irish consumers spent around €850,000 an hour online, with this figure anticipated to grow by a further 25% over the next 3-5 years[145]. These trends suggest that internet and broadband services are of great importance to Irish society and the economy, which is likely to further increase the demand for broadband services.

As detailed earlier in the paper, the population is anticipated to expand in the coming years. According to the CSO's population forecasts (based on Census 2011 data), the largest increase in population will be in Dublin and the Mid-East while populations in the West, Mid-West and Midlands, and Border are expected to grow to a lesser extent. This suggests that the trend over the coming years will be for the population in urban areas to grow at a faster rate than rural areas. As such, increases in the number of people and households in the state may increase demand for broadband in the future while this is anticipated to be relatively more focused on urban areas.

Summary

Access to high quality internet is of growing importance in today's digital age, and the foregoing analysis showed that this trend is likely to continue for the foreseeable future. While Ireland has made progress in terms of improving its broadband infrastructure, differences persist in terms of the availability of broadband in urban and rural areas of the country, an issue which the National Broadband Plan aims to address through a combination of state intervention and commercial investment. The current Capital Plan sets out the level of initial Exchequer funding for the state intervention element of the National Broadband Plan but precise costs will not be available until the current tendering process is complete.

[143] http://www.cso.ie/en/releasesandpublications/er/isshh/informationsocietystatistics-households2016/
[144] https://ec.europa.eu/digital-single-market/en/scoreboard/ireland
[145] http://www.dccae.gov.ie/en-ie/communications/publications/Documents/58/1.%20FINAL%20Assessment%20of%20Macro%20Impacts%20of%20Internet-Digital%20-%20Indecon%20Report%20-%20March%202016.pdf

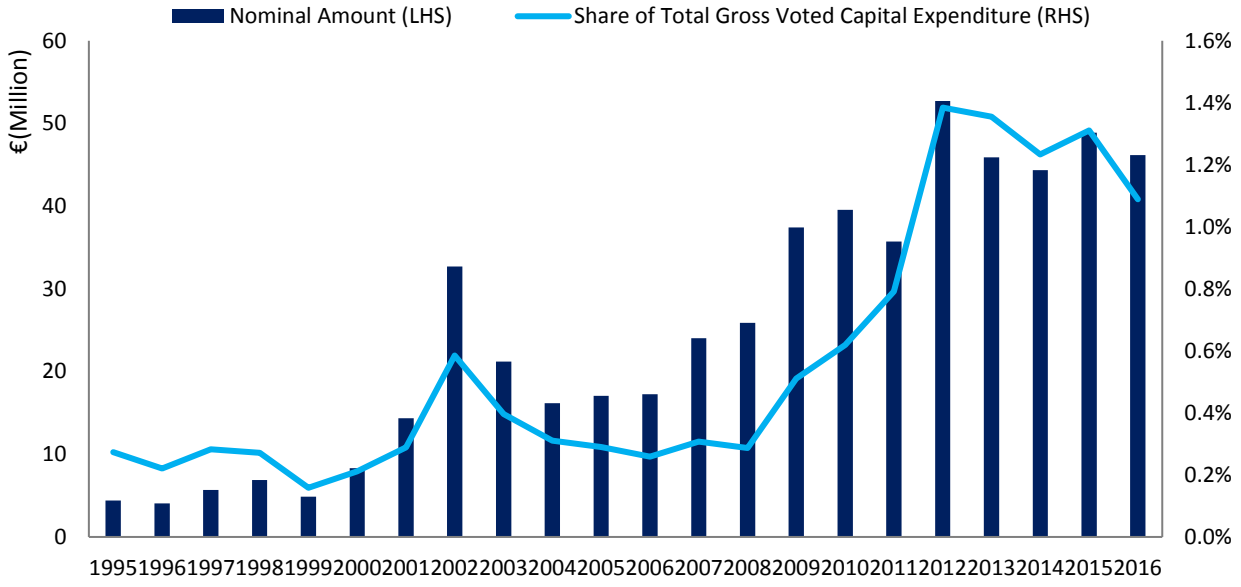
9. Flood Defences

Flood risk management aims to minimise the extent of coastal and river flooding and its social, economic and environmental impacts through the implementation of effective protection and mitigation measures for at-risk areas. This requires both capital infrastructure and non-infrastructure measures. The Office of Public Works (OPW) is the lead agency in managing Ireland's response to flood risks and it does so in cooperation with the Local Authorities. The focus here is on capital investment in flood defences.

Previous and Planned Investment

Exchequer capital investment in flood risk management has grown in both nominal terms and as a proportion of the total capital budget over the past twenty years, as shown by Figure 9.1. In 2017, €45 million gross voted capital expenditure was allocated to flood risk management[146]. This represented approximately 1% of the total Gross Voted Capital Budget for 2017.

Figure 9.1: Gross Voted Capital Expenditure on Flood Risk Management



Source: DPER Databank

The Capital Plan has allocated €430 million for flood mitigation initiatives to protect threatened localities from river and costal flood risk. A number of major projects included in the Capital Plan are listed below:

- The Lower Lee (Cork City) Flood Relief Scheme;
- The Bray Flood Relief Scheme;
- The Skibbereen Flood Relief Scheme;
- The Enniscorthy Flood Relief Scheme; and,
- The Bandon Flood Relief scheme.

[146] Revised Estimates for Public Services 2017

Further to these major projects, there is an extensive Catchment-based Flood Risk Assessment and Management (CFRAM) Programme which includes circa 125 smaller projects.

Infrastructure Overview

Between 1995 and Q3 2017 the OPW has completed construction on 39 major flood defence schemes[147]. Some of the major schemes completed since 2009 include:

- Waterford City Phase 1, 2, 3 and 4;
- River Dodder (Tidal), Dublin;
- Clonmel, Co. Tipperary;
- Mallow, Co. Cork; and;
- Fermoy, Co. Cork.

Further to these projects, there are an additional 11 major flood defence schemes at construction and 23 schemes at planning.

Drivers of Demand

Climate change could potentially have a very significant effect on the demand for flood defences in the longer term. In the short term, the EU Directive on the assessment and management of flood risks [2007/60/EC] , often referred to as the 'Floods' Directive, came into force late in 2007. The OPW is producing Flood Risk Management Plans (FRMPs), in line with National Flood Policy and the requirements of the EU 'Floods' Directive. Other drivers include development and property price increases.

Table 9.1: Selected Drivers of Demand for Flood Defences

Drivers of Demand	Examples
Climate and environment	Climate change could potentially have a very significant effect on the demand for flood defences in the longer term e.g. sea level rises, increased number of heavy rainfall days and wetter winters.
EU Directives	The EU Directive on the assessment and management of flood risks [2007/60/EC] , often referred to as the 'Floods' Directive, came into force late in 2007. The OPW is producing Flood Risk Management Plans (FRMPs), in line with National Flood Policy and the requirements of the EU 'Floods' Directive.
Development and Property Price Increases	Increasing risk over the past decades has also been driven in part by development (including some in flood prone areas) and increases in property and asset values.

[147] http://opw.ie/en/media/Overall%20view%20of%20Schemes%20(website)_20170420-2.pdf

Trends in Demand Drivers

Climate and Environment

As outlined by the OPW[148], there are three primary manifestations of climate change which increase the demand for flood defences:

- Sea level rise is already being observed and is projected to continue to rise into the future, increasing risk to our coastal communities and assets.
- It is projected that the number of heavy rainfall days per year may increase, which could lead to an increase in both fluvial and pluvial (urban storm water) flood risk.
- The projected wetter winters, particularly in the West of the country, could give rise to increased groundwater flood risk associated with turloughs.

EU Directives

The Flood Risk Management Plans (FRMPs) are currently being finalised by the OPW and its partners under the Catchment-based Flood Risk Assessment and Management (CFRAM) Programme. The FRMPs set out a range of proposed measures and actions, including capital flood relief schemes, to manage and reduce flood risk within the catchments and coastal reaches covered by each Plan, focussing on the 300 areas of potentially significant flood risk around Ireland that were previously identified under the Preliminary Flood Risk Assessment (PFRA).

Conclusions

Exchequer capital investment in flood risk management has increased significantly over the past twenty years. The OPW has completed construction on 39 major flood defence schemes in this time. The drivers of demand for flood defences, namely climate change and EU Directives, are likely to increase the need for flood defence infrastructure over the coming years. In order to meet this demand, and following an extensive process, the OPW is producing a set of comprehensive Flood Risk Management Plans in line with EU Directives. In its submission as part of the Review of the Capital Plan the OPW has stated that the €430 million allocated to flood defence schemes over the lifetime of the existing Capital Plan is largely sufficient to meet the demands of this sector.

[148] http://www.opw.ie/en/climatechange/

10. Summary and Conclusions

Public investment in strategic infrastructure is crucial in order for a society and economy to reach its full potential. The provision of an adequate and efficient level of infrastructure is a key enabler for economic growth.

The first chapter of this paper detailed the significant public capital investment in Ireland's infrastructure over the last twenty years. While Ireland's public capital investment is currently below the long-term average, it is planned to increase steadily over the remaining years of the Capital Plan to 2021. By 2021, Ireland's public Gross Fixed Capital Formation is currently projected to have increased to 9.3% of total General Government expenditure, above the long-term average and well above the EU15 average.

Even with such increases, however, the level of demand for additional capital projects will nearly always exceed the ability to supply all the desired infrastructure at the same time. Supply side constraints can include the capacity of the construction industry and planning system, environmental and regulatory requirements, as well as fiscal constraints. It is therefore necessary to prioritise public capital investment.

The objectives of this paper were therefore to:

- analyse primary areas of infrastructure in terms of historical investment and demand trends; and,
- provide a clear and concise assessment of available sectoral evidence to contribute to overall decision making in the context of the Mid-Term Review of the Capital Plan.

There are many complex drivers of activity demand which has implications for the use and necessary provision of infrastructure. Two of the primary drivers examined in this paper, economic growth and demographics, indicate an increase in demand in certain sectors and areas over the coming years. Two of the other factors discussed, spatial considerations and climate change, will place both demands and certain constraints on infrastructure investments in the future. The introductory chapter also briefly discussed the benefits of demand management in maximising the efficient use of existing infrastructure and the principles related to this. A summary of the findings relating to the sectoral analyses, particularly the demand trends, are outlined below.

Transport

Transport demand is closely linked to economic growth and the performance of the economy. As the economy expands the number of commuters and the level of trade increases. In terms of current demand levels, it is clear that:

- Road use is above its previous peak in 2008 and issues with regard to congestion and level of service are evident in urban regions.
- Public transport use has grown in recent years but remains below 2007 peak levels.

- Data on maritime demand, as measured by the total tonnage of goods handled at ports, indicates that demand is still below the 2007 peak.
- Aviation demand and activity is above its previous peak with record passenger numbers being driven by activity at Dublin Airport.

As has been highlighted in the sectoral analysis, transport demand is growing and would be expected to expand further in future years in line with forecast economic growth rates.

Health

While increasing demand for health services seem likely over the remaining period of the Capital Plan based on demographics and Ireland's ageing population, an increased use of day case treatment along with a continued shift towards primary can may help meet these needs.

Further research should aim to bring greater clarity to the current level of provision. At present there is no comprehensive assessment of the existing stock of infrastructure. Once the current level of capacity is established, it will be possible to form a view on whether the composition of the existing stock needs to be changed in the face of changing needs and the policy objective of meeting 90/95% of care needs in the primary care setting.

Education

The analysis contained within this section highlighted that demographic changes are the most important driver of demand in the education sector. Demand and access to education has increased significantly in previous years.

At primary level, student numbers are projected to peak in 2018, thereafter declining each year by around 2% on average, although some specific growth areas may continue to experience increasing demand. The existing Capital Plan targets the delivery of 19,000 additional primary school places in response to this demand pressure.

At post-primary level, the peak in student numbers will be in 2025 beyond which demand is expected to decrease. The existing Capital Plan targets the delivery of 43,000 additional post-primary places required for demographic growth to 2022. Additional resources may be required to account for any increase in demand thereafter.

The demand for access to third level education is expected to increase which will exert further pressure on capacity. Investment levels required at third level are impacted by a number of considerations including responsiveness to skills needs in the economy, the relevant sources of overall funding and the overall policy framework for third level education.

Housing

The level of housing output, both public and private, in recent years has been constrained following a period of rapid expansion in 2007 and 2008.

In terms of the demand and supply of social housing, it is clear that there is a significant number of households that have been deemed as eligible for support but are not currently in receipt of such support (91,600) while additional permanent stock (delivered through construction or acquisition) has been limited in line with decreased levels of capital expenditure. However, housing supports delivered through current expenditure (e.g. HAP, Leasing) have played a role in providing necessary assistance.

Under the Action Plan for Housing and Homelessness, €5.35 billion has been committed with the target of 47,000 units for delivery. Of this 47,000, it is anticipated that 26,000 will be constructed; 11,000 will be acquired from the market; and around 10,000 will be secured under long-term lease arrangements.

The demand for housing is forecast to increase in the short term due to demographics and household formation rates. The ESRI have forecast that the level of housing activity may be in line with structural housing demand by 2018 and will reach approximately 30,000 units per annum by 2024. However, this doesn't account for pent-up demand and regional composition and the report does raise concerns that the necessary level of finance will not be in place to provide necessary housing investment.

In summary, the State's role in providing social housing has faced significant constraints in recent years while demand remains high. However, the commitments made under the Action Plan for Housing and Homelessness mean that €5.35 billion will be invested in 47,000 units across a range of delivery mechanisms in the coming years. Furthermore, housing output delivered by the private sector is expected to pick up over the next couple of years. However, the sector is complex and delivery capacity is an important enabler of supply.

Water

There has been a historical underinvestment in Ireland's water infrastructure which has resulted in a system which is not fully capable of providing the required level of high quality drinking water or adequately treating the waste water which our society produces.

Irish Water's establishment in 2013 brought the responsibility for the delivery of water infrastructure under one single entity. Since its establishment Irish Water has been able to bring greater clarity to the composition of the existing asset base and its current state, which in turn has enabled more informed decisions to be made in relation to the efficient allocation and prioritisation of investments in Ireland's water infrastructure. Irish Water provides a high level strategic planning approach to water infrastructure, taking a national rather than local perspective and looking at a long term time frame as well as considering priorities for short term investment. This framework for strategic planning of public water infrastructure together with its

implementation programme of plans and projects should enable the delivery of the required water standard of quality and reliability, in a manner that protects the natural environment, which is critical to the country's economic and social development.

Substantial investment is currently planned for Ireland's water infrastructure for the period out to 2021. The planned investment as outlined by Irish Water seeks to strike a balance between the demand for water infrastructure investment and the constraints that currently exist in terms of affordability, planning requirements and supply chain issues. Delivery on the key performance metrics which have been set by Irish Water should be closely monitored over the coming period. The actual level of capital investment will be determined through the regulatory process. The next revenue control period, for which Irish Water must submit plans for approval to the CER, commences in 2019 provides a suitable opportunity to assess the planned investment levels in Ireland's water infrastructure set out in Irish Water's Capital Investment Plan on the basis of the risk-based approach adopted in that Plan to addressing critical issues such as drinking water quality, compliance with the EU Urban Waste Water Treatment Directive and reduction in leakage levels.

Energy

In general, overall energy infrastructure in Ireland is in a good position to continue meeting overall demand well into the medium term. At a high level, it is expected that current capacity in both gas and electricity networks is broadly sufficient to meet anticipated future flow requirements for the next ten years. Investment in this sector is largely non-Exchequer based.

While overall demand is expected to be catered for, the composition of generation is an important consideration in the energy sector. In particular, commitments in the areas of climate change, energy efficiency and renewable energy present a significant challenge to the sector, and means that continued investment beyond maintenance will be necessary for the coming period.

Broadband

Access to high quality internet is of growing importance in today's digital age with this trend is likely to continue for the foreseeable future. While Ireland has made progress in terms of improving its broadband infrastructure, differences persist in terms of the availability of broadband in urban and rural areas of the country, an issue which the National Broadband Plan aims to address through a combination of state intervention and commercial investment. The current Capital Plan sets out the level of initial Exchequer funding for the state intervention element of the National Broadband Plan but precise costs will not be available until the current tendering process is complete.

Flooding

Exchequer capital investment in flood risk management has increased significantly over the past twenty years. The OPW has completed construction on 39 major flood defence schemes in this time. The drivers of demand for flood defences, namely climate change and EU Directives, are likely to increase the need for flood defence infrastructure over the coming years. In order to meet this demand, and following an extensive process, the OPW is producing a set of comprehensive Flood Risk Management Plans in line with EU Directives. In its submission as part of the Review of the Capital Plan the OPW has stated that the €430 million allocated to flood defence schemes over the lifetime of the existing Capital Plan is largely sufficient to meet the demands of this sector.

Conclusions

This paper, and the sectoral analyses within it, has sought to examine past investment in Ireland's public infrastructure and establish the extent of the existing stock resulting from that investment.

The paper has detailed both the nature of the existing and planned infrastructure. It has also looked at projected trends in demand and given a high level overview of which sectors are likely to face increased demand pressures in the future. The analysis indicates that a number of sectors have a generally appropriate level of infrastructure planned out to 2021 e.g. flood defences. In some sectors, such as health, further research is required in order to gain a greater understanding of the existing and required infrastructure. In other areas, it is evident that demand is increasing in line with wider economic growth e.g. transport.

This analysis forms part of a broad evidence base which is intended to help inform decision making in the context of the Mid-Term Review of the Capital Plan. The evidence base also consists of a macro-economic analysis of capital investment, submissions made by Government Departments, submissions from a public consultation, as well as additional analysis carried out by the Department of Public Expenditure and Reform.

While the analysis collated here shows relevant trends across sectors, the detailed constraints and demands highlight the requirement to place an increased emphasis on project selection, appraisal and evaluation. In addressing any identified infrastructure needs a concerted focus is required on getting project selection right in order to ensure that the underlying problem is addressed and that value for money is achieved. As such, it is vital that individual projects are selected on transparent criteria and well-established methodologies as outlined in the Public Spending Code.