

Irish Academy of Engineering

SUSTAINABLE TRANSPORT

Infrastructure 2035



April 2016
Ref. No. 02/02A/05.16

THE IRISH ACADEMY OF ENGINEERING

The Irish Academy of Engineering is an all-island body, concerned with long-term issues where the engineering profession can make a unique contribution to economic, social and technological development.

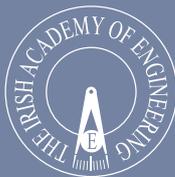
Its members are Irish Engineers of distinction, drawn from a wide range of disciplines, and membership currently stands at 145.

Drawing on the experience and knowledge of its distinguished members, the Academy works to facilitate communication and dialogue on engineering related matters. It regularly publishes reports and analyses, some jointly with other learned and professional bodies.

The Irish Academy of Engineering
22 Clyde Road, Ballsbridge, Dublin 4
Telephone: +353 1 665 1337
academy@engineersireland.ie
www.iae.ie

Taskforce Members

Jonathan Hegan (Chairman)
Fred Barry
Tim Brick
Don Cunningham
Gerry Duggan
Adrian Long
Donal McDaid
David Orr
Paddy Purcell
Michael Reidy
Brian Wylie



Disclaimer

The members of the Taskforce and the contributors participated in extensive discussions in the course of a series of meetings, and submitted comments on a series of draft reports. Its contents convey the general tone and direction of the discussion, but its recommendations do not necessarily reflect a common position reached by all members of the Taskforce, nor do they necessarily reflect the views of the organisations to which they belong.

CONTENTS

Foreword	2
Glossary Of Terms	3
Executive Summary	4
Chapter 1. Sustainable Transport - Definition, Vision & Key Planning Principles	9
Chapter 2: Transport Investment – A Strategic and Sustainable Driver	12
Chapter 3: Current Transport Strategy	19
Chapter 4: A Changing Landscape	24
Chapter 5 - Funding	29
Chapter 6: Transport Investment Recommendations for the Island of Ireland 2016–2035	34
Appendices	51

FOREWORD

The Irish Academy of Engineering (IAE) established a number of Working Groups to prepare the following series of complementary Policy Discussion Papers:

- ▲ Spatial Planning on the island of Ireland – Context and Challenges
- ▲ Dublin – Belfast Economic Corridor
- ▲ Atlantic City Regions - Development and Connectivity
- ▲ Sustainable Transport Infrastructure 2035 (this Paper)
- ▲ National Broadband Strategy for Ireland
- ▲ Critical Infrastructure – Adaptation for Climate Change: A Progress Report

These papers are to assist policy makers in both jurisdictions on the island in the ongoing development of spatial planning policy, and to inform planning and decision-making on associated major infrastructure development over the coming decades.

Transport has a major impact on every aspect of our lives, on the wider economy, and on our environment. Transport investment, which forms a significant and necessary part of government expenditure, is a vital driver of a strong economy, balanced regional development and a better quality of life for all. The Academy believes that this report, and its recommendations, will make a positive contribution to discussion on, and formation of, transport policy on the island of Ireland.

These Policy Discussion Papers have been prepared following research and wide-ranging discussions with senior executives from the public and private sectors in both Ireland and Northern Ireland. They are available on the Academy's website www.iae.ie.

GLOSSARY OF TERMS

TERM	DEFINITION
AIRO	The All-Island Research Observatory (AIRO) undertakes academic and applied mapping research and produces spatial datasets and specialist tools to aid in its analysis. Based at Maynooth University, AIRO is the leading spatial analysis and planning unit within the National Institute for Regional and Spatial Analysis (NIRSA).
ATP	Automatic Train Protection
BEV	Battery Electric Vehicle
BRT	Bus Rapid Transit. A high-quality integrated public transport mode, using buses on roadways, or dedicated lanes, to transport passengers quickly and efficiently to their destinations
CAWS	Continuous Automatic Warning System
COP21	United Nations Framework Convention on Climate Change held in Paris in 2015
DART Expansion Programme	The DART Expansion Programme describes the full scheme of proposed electrification, as well as fleet and depot facility expansion, of the DART network to create two interconnected, high capacity/frequency DART lines running initially from Maynooth to Bray/Greystones, and from Hazelhatch to Drogheda, of which the DART Underground Project is a key component. The lines will interchange at Pearse Station.
DART Underground Project	The DART Underground Project is the term used to describe the proposed city-centre, heavy rail DART Interconnector tunnel linking the Kildare rail line to the northern rail line.
ETS	European Union's Emissions Trading System This regulates greenhouse gas emissions from major sources in the EU viz. power stations, cement works etc. Smaller sources are included in the Non-ETS sector.
FCEV	Fuel Cell Electric Vehicle
GVA	Gross Value Added – The value of goods and services produced in an area, industry or sector of an economy
Ireland	The Republic of Ireland
KTC	Key Transport Corridor – Northern Ireland Strategic Transport Network
Motorways of the Sea	New intermodal maritime-based logistics chains in Europe
PHEV	Plug-in Hybrid Electric Vehicle
Prudent Funding Envelope	Funding envelope recommended by the Academy which is in line with OECD norms for inland transportation infrastructure investment.
Pull Factors	Aspects of travel which attract users
Sustainable Transport	The movement of people and goods in such a way that it develops the economy, protects the environment and strengthens society.
TEN-T	(TEN-T) is a planned set of road, rail, air and water transport networks in the European Union. TEN refers to Trans European Network.

EXECUTIVE SUMMARY

Introduction

The Irish Academy of Engineering has undertaken an all-island study of the Sustainable Transport Infrastructure that needs to be delivered over the next 20 years to support competitive economies on the island; enhance the social wellbeing of our people, and as a necessary prerequisite to underpin optimum spatial planning in both jurisdictions.

This report sets out the Academy's Sustainable Transportation Vision, to 2035 for land transport and recommends a priority infrastructure programme which, together with essential maintenance of existing road and rail assets, is affordable and will promote economic and social development on the island of Ireland, north and south.

The Academy's Vision for Sustainable Transport

By 2035, the Academy envisions the island of Ireland to have a smart, efficient and modern road and public transportation system that:

- ▲ supports a thriving economy and balanced regional development;
- ▲ provides citizens with safe, accessible and integrated transport;
- ▲ interconnects our cities and regions;
- ▲ enhances our natural environment; and
- ▲ ensures a sustainable future for all.

reducing transportation costs. It assists the movement of raw materials, goods and services; increases the catchment area of a skilled workforce; and attracts inward investment.

- ▲ It improves the quality of life for society by improving access to education, work and social activities, and by reducing the number and severity of transport-related accidents.
- ▲ Properly planned, it improves the environment and reduces pollution by encouraging a modal shift to public transport, through facilitating higher density development, walking, cycling and low-emission vehicles.

The Importance of Transport – a Sustainable and Strategic Driver

Transport has a major impact on every aspect of our lives, on the wider economy, and on our environment. While business and industry are the heartbeat of the economy, sustainable transport networks are the arteries. Efficient links within and between towns, cities and regions are critically important for our future development.

There is widespread international evidence¹ that transport investment is a vital driver of a strong economy, regional development, and a better quality of life.

Sustainable transport investment benefits the three sustainability pillars of Economy, Society and Environment:

- ▲ It drives economic growth and regional development by improving accessibility and

Current Status

Both jurisdictions have existing transportation strategies and plans for their regions and metropolitan areas. These will be significantly impacted by the obligations under the EU Directive to improve our Trans European Transport Networks (TEN-T) by 2030.

A European Commission Annual Report for Ireland this year² warns that Ireland's capital spending programme is inadequate for the country's needs. It highlights public transport as a key weakness, particularly in the car-dependent Dublin region.

Despite the island's relatively small population, its principal cities are amongst the most congested in Europe, due to underinvestment in public transport systems. TomTom, the Dutch global leader in navigation and mapping, reported in 2014 that Belfast and Dublin were, respectively, the third and fourth most congested cities in Europe.

1. Transport and the Economy, Standing Advisory Committee on Trunk Road Assessment (SACTRA), London 1999; The Eddington transport study: The case for action, Sir Rod Eddington, London, 2006.
2. EC Staff Annual Country Report Ireland 2016

Transport systems which service the needs of regions and rural communities on the island are inadequate and not up to European standards.

A Changing Landscape

Climate change poses particular new and ongoing challenges for the transport sector, which accounted for 19.5% of Ireland's total greenhouse gas emissions in 2014, and for 26.9% of emissions in the Non-ETS sector.

Given the pace of technological change, we live in a rapidly changing landscape:

- ▲ a radical reduction in transport emissions will be facilitated by rapid development of electric, hybrid and hydrogen-powered vehicles
- ▲ smart vehicles, autonomous vehicles, and shared-vehicles-on-demand will change the way we use private transport
- ▲ smart cities, with intelligent transport systems, will promote public and shared transport and interact with vehicles to reduce congestion and emissions, and improve safety
- ▲ Freight logistics will adapt to the rise in online shopping, with regional freight transport hubs/consolidation centres.

While the momentum of change is challenging, and the end goals uncertain, it would be a mistake to procrastinate. Extended lead-in periods mean that in order to have the infrastructure that the island deserves, and requires, by 2035, planning must start now.

Transport Infrastructure Funding

The OECD³ reports that nations with advanced economies typically devote 0.9% of GDP to investment on inland transport infrastructure.

On that basis, the Academy has calculated a funding envelope for transport investment in both jurisdictions. *Within that envelope we believe that maintenance and renewal of existing road and rail assets must take first priority.* But there remains more than sufficient funding for significant prudent investment in additional transport infrastructure over and above that already included in current transport plans.

Ireland and Northern Ireland have both the capacity, and need, to substantially increase investment in land transport infrastructure in the medium term.

Academy Recommendations to 2035

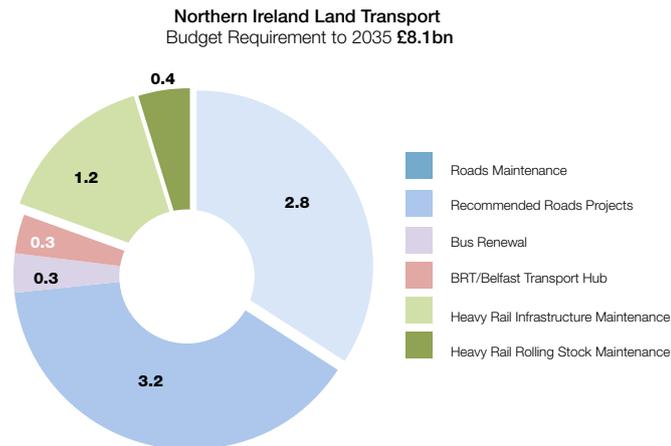
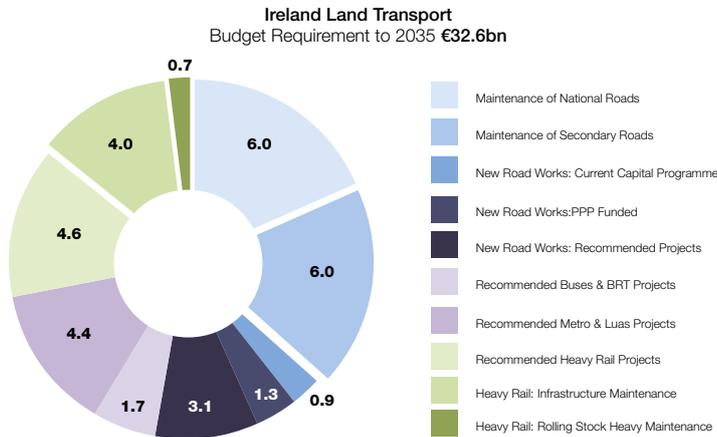
1. Commit to a prudent funding envelope in Ireland of 0.9% of GNP (a better measure of economic activity in Ireland) on land-based transport infrastructure over the period to 2035.
2. Because investment in land-based transport infrastructure in Northern Ireland has been significantly lower than 0.9% of GVA since the 1960s, commit to a prudent funding envelope of 1.15% of GVA in such infrastructure over the period to 2035. GVA is the nearest equivalent measure to GDP that is reported in Northern Ireland.
3. Prepare long term transport plans in both jurisdictions that are integrated modally and across both jurisdictions, with a time horizon to 2035, funded within the prudent funding envelopes recommended above. Ensure that the required long lead times, and the necessary early decisions and actions required of local and regional authorities, are included in these plans.
4. In Chapter 6 the Academy sets out in detail its recommendations for the highest priority projects, additional to current capital investment plans of the Ireland Government and the Northern Ireland Executive, which we believe to be affordable. These are focused on:
 - ▲ reducing urban congestion
 - ▲ facilitating balanced regional development by improving regional connectivity
 - ▲ improving safety
 - ▲ reducing emissions and noise
 - ▲ delivering the EU Ten-T Core Network

The Academy's recommends a funding requirement to 2035 totalling €32.6 billion for Ireland, and £8.1 billion for Northern Ireland. This includes currently planned capital

3. Spending on Transport Infrastructure OECD Analysis 1995-2011

programmes plus the Academy's additional priority projects.

The totals are well within the prudent funding envelopes described earlier, and the breakdown is given in the following pie charts.



The Academy's recommendations are less than the prudent funding envelope to the extent of €8.7bn for Ireland and £0.6bn in Northern Ireland. This allows headroom for other necessary transport expenditure over the period to 2035.

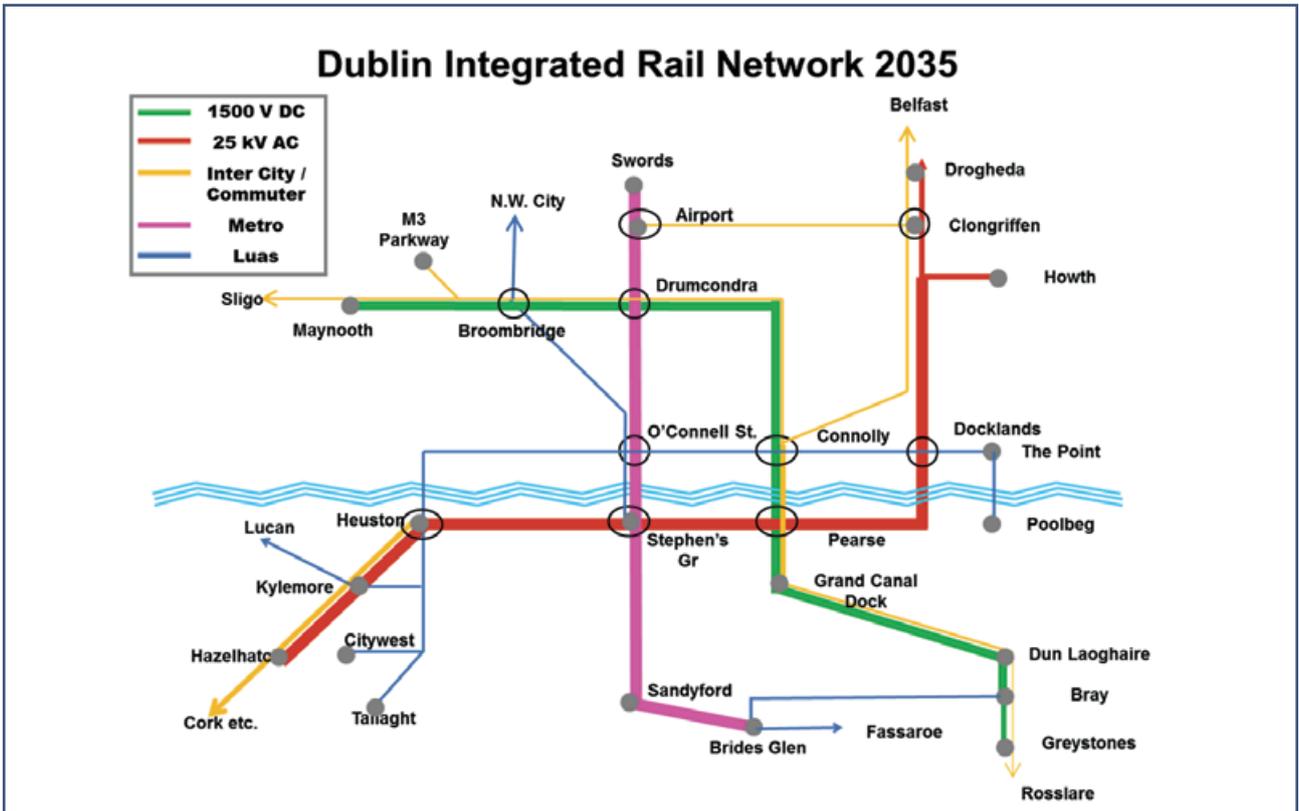
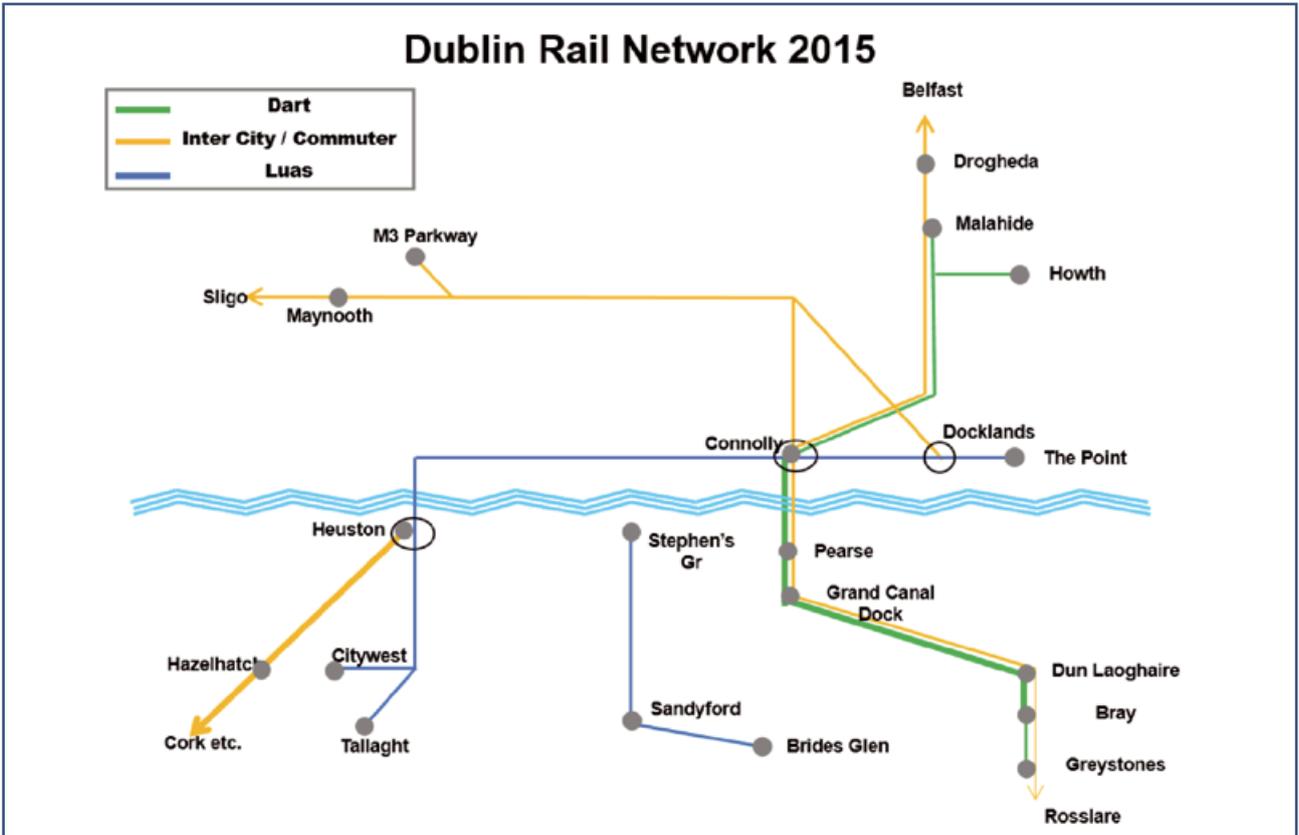
Some of the additional priority projects recommended by the Academy for each jurisdiction are represented diagrammatically in the following maps.

The Academy also recommends;

- Promote a radical shift from private car to other transport modes – our cities simply do not have the space to accommodate further growth in private car traffic without exacerbating existing congestion levels.
- Commit to significant investment in public transport – rail, rapid transit, and bus.

- Recognise the role of other measures to promote modal shift, including bus priority lanes, park-and-ride, car-sharing, walking and cycling.
- When the 'pull' factors have been exhausted, give serious consideration to charging for workplace car-parking and introducing congestion / road use charges
- Recognise that roads will continue to play a vital role for buses, freight and cars, and require significant improvements to relieve congestion at urban pinch-points, and to ensure inter-regional connectivity.

The Academy commends these recommendations to the Government of Ireland and to the Northern Ireland Executive, urging them to plan now for a sustainable road and public transportation system that supports a thriving economy; provides citizens with safe and convenient accessibility; and enhances our natural environment, thereby contributing to a sustainable future for all.





CHAPTER 1. SUSTAINABLE TRANSPORT - DEFINITION, VISION & KEY PLANNING PRINCIPLES

Definition of Sustainable Transport

1. There is no universally accepted definition of Sustainable Transport. The European Union Council of Ministers of Transport defines a sustainable transportation system as one that:
 - ▲ Allows the basic access and development needs of individuals, companies and society to be met safely, and in a manner consistent with human and ecosystem health, and promotes equity within, and between, successive generations (Social dimension);
 - ▲ Is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development (Economic dimension);
 - ▲ Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimising the impact on the use of land and the generation of noise (Environmental dimension).
2. In summary, Sustainable Transport is the movement of people and goods in a way that develops the economy, protects the environment, and strengthens society.

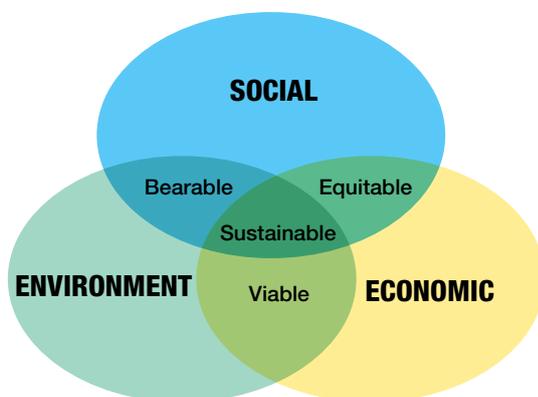


Figure 1.1 Sustainable Transport Dimensions and Interactions

Sustainable Transport Vision: Key Objectives

3. Transportation is the backbone of any economy and society as it allows the matching of goods and employment opportunities, as well as amenities and services, with potential customers. A competitive economy requires a reliable and efficient transport system that is affordable, and accessible, to all potential network users. When transport systems are efficient, they provide economic and social opportunities, and benefits, that impact throughout the economy. When transport systems are deficient, they can have an economic cost in terms of reduced or missed opportunities. Transport also has important social and environmental dimensions, which cannot be neglected.
4. A United Nations Resolution - 66/288 'The Future We Want' - adopted by the UN General Assembly on the 27th July 2012⁴ affirms:

'We note that transportation and mobility are central to sustainable development. Sustainable transportation can enhance economic growth and improve accessibility. Sustainable transport achieves better integration of the economy while respecting the environment. We recognise the importance of the efficient movement of people and goods, and access to environmentally sound, safe and affordable transportation as a means to improve social equity, health, resilience of cities, urban-rural linkages and productivity of rural areas. In this regard, we take into account road safety as part of our efforts to achieve sustainable development.'

'We support the development of sustainable transport systems, including energy efficient multi-modal transport systems, notably public mass transportation systems, clean fuels and vehicles, as well as improved transportation systems in rural areas. We recognise the need to promote an integrated approach to policymaking at the national, regional and local levels for transport services and systems to promote sustainable development.'

4. The Future We Want, UN Resolution 66/288 July 2012

5. The Academy strongly supports UN Resolution 66/288 as the basis for a sustainable transport system for Ireland and Northern Ireland by 2035.
6. The Academy's Sustainable Transportation Vision for 2035 envisions the island having a smart, efficient and modern road and public transportation system that supports a thriving economy and balanced regional development; with citizens who are mobile in a safe, accessible and integrated transportation system; and with inter-connected cities and regions that enhance our natural environment to ensure a sustainable future for all.
7. This Vision clearly recognises, in line with international best practice, that sustainable transportation is about more than just mobility. It includes a number of goals that fall under the three key pillars of Economy, Society and the Environment identified in the European Council of Ministers of Transport definition of sustainable transport, and previously outlined.
8. The Academy considers that sustainable transportation infrastructure should meet the following key objectives to deliver the Vision:
 - ▲ Ensure the efficient transportation of people and goods;
 - ▲ Facilitate long-term economic welfare and balanced regional development;
 - ▲ Maintain competitiveness;
 - ▲ Improve quality of life;
 - ▲ Contribute to a more low-carbon economy; and
 - ▲ Provide equality of access to all citizens

How can Transport deliver on the Sustainability Principles of Economy, Society and the Environment?

9. The Centre for Sustainable Transport in Canada⁵ sets out clear views on this important question as follows:



With respect to the Economy, sustainable transport infrastructure should:

- ▶ provide cost-effective service and delivery
- ▶ be financially affordable
- ▶ support vibrant, sustainable economic activity



With respect to Society, sustainable transport infrastructure should:

- ▶ meet basic human needs for health, comfort and convenience in ways that do not stress the social fabric
- ▶ allow and support development at a human level, and provide for a reasonable choice of transport modes, types of housing and community, and living styles
- ▶ be safe for people and property



With respect to the Environment, sustainable transport infrastructure should:

- ▶ make use of land in a way that has little or no impact on the integrity of ecosystems
- ▶ use sparingly energy sources that are essentially not renewable or inexhaustible
- ▶ reuse and recycle other resources
- ▶ produce no more emissions and waste than can be accommodated by the planet's restorative ability

5. Definition & Vision of Sustainable Transportation, Centre for Sustainable Transport Canada

Key Planning Principles

10. The Academy considers that the Sustainable Transport Vision it proposes for Ireland and Northern Ireland by 2035 requires a co-ordinated and integrated planning approach that involves moving people and goods in ways that reduce the impact on the environment, develop the economy, and strengthens society. It includes using more energy-efficient transport modes, improving transport choices, using cleaner fuels and technologies, applying information technology, and adopting progressive urban and regional planning approaches to reduce or replace the need to travel.
11. The challenges facing the achievement of the Academy's Vision for Sustainable Transport are stark. The All Island Research Observatory (AIRO)⁷ has published one of the most comprehensive analysis of Census data available covering both jurisdictions. The Atlas of Ireland report⁷ acknowledges that, despite the best intentions of stated transportation / spatial development policy in both jurisdictions, these policies have 'completely failed'. The report also states that dispersed patterns of spatial development have now effectively 'locked-in acute car dependency'. Such findings clearly highlight the scale of the challenge to achieve a sustainable transport balance by 2035, and point strongly to the need to pursue a future strategy that combines balanced investment across the modes and complementary transportation/spatial development policies.
12. Car-parking supply and pricing in urban areas, and in our cities in particular, also requires careful consideration and management given that it has such a predominant influence on the overall rationale to commute by car⁸. A report prepared by the Dublin Institute of Technology estimates that there are in the region of 390,000 public parking spaces under management in Ireland⁹. This figure excludes workplace and residential parking. The report suggests that revenue from car parking charges generates around €115m annually to Local Authorities in Ireland, and that private car parks generate in the region of €80m annually from charges. Clearly, management of both the supply and pricing of car parking, as a potential demand management measure to curb ever increasing levels of car-based commuting to our cities, will be a significant challenge.
13. It is also recognised, and acknowledged, by the Academy that the softer modes of transport (cycling and walking), have, and will continue to have, an important role to play in achieving sustainable modal shift from the private car, particularly in an urban context. Between 2006 and 2014 the number of cyclists entering Dublin city centre increased by about 10% annually, and this trend is growing. The number of cyclists increased by 14% in 2014, while the number of pedestrians increased by 6% annually from 2009 to 2014 according to Dublin City Centre / NTA statistics¹⁰. The Department of Regional Development in Northern Ireland also reports that there has been a 6% annual increase in cyclists and a 4% annual increase in the number of pedestrians, entering Belfast city centre between 2011 and 2013, following a range of new sustainable transport initiatives contained in the 'Belfast On the Move' Transport Masterplan for Belfast City Centre¹¹. While outside the remit of this particular study, the Academy fully supports and encourages continued investment in, and promotion of, measures which continue to grow the soft mode transport market. Such measures and investment are considered highly complementary to the overall objectives of this report.
14. The National Sustainability Summit, entitled 'Securing Ireland's Future', held in Dublin in November 2015, strongly emphasised the need to create a sustainable Ireland. The decarbonisation of the transport sector, including policy instruments required to deliver this, was a key objective highlighted at the Summit.

6. The All-Island Research Observatory (AIRO) undertakes academic and applied mapping research and produces spatial datasets and specialist tools to aid in their analysis. Based at Maynooth University, AIRO is the leading spatial analysis and planning unit within the National Institute for Regional and Spatial Analysis (NIRSA).

7. Atlas of Ireland (AIRO 2015)

8. Government and Government-owned bodies control a very significant number of parking spaces in both jurisdictions which are provided free to employees. This militates against a modal shift from car to public transport.

9. Car Parking Market Sector Report 2010, Dublin Institute of Technology

10. Report on Trends in Mode Share of People and Vehicles Crossing the Canal Cordon 2006 - 2013 (NTA/DCC)

11. Belfast on the Move Transport Plan Post Implementation Study DRDNI 2014

CHAPTER 2: TRANSPORT INVESTMENT – A STRATEGIC AND SUSTAINABLE DRIVER

Introduction

1. Based on evidence published in Ireland and Northern Ireland, and more widely in Europe, the Academy finds widespread international agreement that transport investment is a vital driver of a strong economy, regional development and a better quality of life.

2. Sustainable transport investment benefits all three sustainability pillars, provided it is properly targeted:

- ▲ It drives economic growth and regional development.
- ▲ It improves the environment and reduces pollution.
- ▲ It improves the quality of life for society.

3. To quote from the EC Transport White Paper¹²

‘Transport is fundamental to our economy and society. Mobility is vital for the internal market and for the quality of life of citizens as they enjoy their freedom to travel.’

‘Transport enables economic growth and job creation: it must be sustainable in the light of the new challenges we face.’

‘The future prosperity of our continent will depend on the ability of all of its regions to remain fully and competitively integrated in the world economy. Efficient transport is vital in making this happen.’

‘Curbing mobility is not an option.’

4. The European Commission 2016 Annual Country Report for Ireland¹³ states that:

‘Transport Infrastructure is critically important for spatial planning and economic development’.

5. These imperatives are reflected in national policy and strategy documents in both jurisdictions

a. The Investment Strategy for Northern Ireland¹⁴ explains that:

‘Good transport links are essential ‘must haves’ to encourage investment and to help local businesses to grow and compete in an increasingly global marketplace.’

‘High quality transport, communication and energy networks are the vital arteries of today’s most successful economies – powering competitive advantage in business, reducing social isolation, and linking people to an expanding world of information, services and opportunity.’

‘Investing in efficient reliable competitive and sustainable networks is critical if we are to deliver our top priority of growing a dynamic and innovative economy.’

b. And, in Ireland, the Department of Transport Tourism and Sport’s Strategic Framework ‘Investing in our Transport Future’¹⁵ contends that:

‘Transport is fundamental to how we live and work. A well-performing transport system is essential to the functioning of society and the economy as a whole. Failure to facilitate efficient transport creates costs for society, and acts as a barrier to economic growth.’

‘Transport investment provides a good return and has yielded efficiency and productivity gains for Ireland. Ireland’s transport infrastructure competitiveness ranking has improved, although it remains poor compared to well-developed economies with whom we compete for investment.’

12. Towards a competitive and resource efficient transport system, White Paper, European Commission, Brussels 2011

13. EC Staff Annual Country Report Ireland 2016

14. Investment Strategy for Northern Ireland 2011-2021, Northern Ireland Executive, Belfast 2011

15. Investing in our Transport Future – A strategic framework for land transport, Department of Transport, Tourism and Sport, Dublin, 2014

Economy

6. History has demonstrated a compelling link between transport systems and economic prosperity, with better transport connections enabling new economic relationships to be forged.

7. There is widespread international agreement on the economic benefits of transport investment. Studies such as the DTTaS strategic framework, the SACTRA report¹⁶ and the Eddington report¹⁷ identify the following ways in which economic growth and regional development is stimulated by properly-targeted transport investment:

- ▲ reduced costs for the transport of people, materials, goods and services (through reduction in urban congestion and faster inter-urban journey times) have a direct relationship with economic growth, by lowering production costs and increasing output and productivity;
- ▲ new products and services can be opened up through better access;
- ▲ the catchment area for labour is increased, impacting on labour costs and providing economic benefits throughout the expanded area;
- ▲ the development of economic clusters has positive agglomeration impacts – in other words, growth is stimulated by economies of scale¹⁸;
- ▲ inward investment is stimulated;
- ▲ the resulting growth in turn stimulates further growth.

8. The DTTaS Strategic Framework states the following:

‘Our analysis of the literature suggests national output increasing by up to 0.2% for every 1% increase in transport capital. Such returns obviously depend on prudent project choices that can increase productivity and achieve competitiveness gains.’

‘Failure to invest in our transport network to meet the needs of enterprise and society as a whole will lead to long-term costs through reduced competitiveness and productivity.’

9. The Eddington Report concluded that transport investment offers remarkable economic returns, with many schemes offering benefits several times their costs, even after environmental costs have been factored in.

10. The Academy’s report **Infrastructure for an island population of 8 million**¹⁹

made the case that the quality of transport infrastructure governs the accessibility of Ireland’s and Northern Ireland’s eight city regions, which is a key determinant of economic competitiveness.

11. In summary, the Academy believes there is compelling international evidence demonstrating that properly targeted transport investment delivers significant and sustainable economic growth and regional development.

Environment

12. The transport sector²⁰ accounted for 19.5% of Ireland’s total greenhouse gas emissions in 2014, and for 26.9% of emissions in the Non-ETS sector²¹. Evidence indicates that, to date, there has been a direct relationship between economic growth and transport-related emissions, and this link can only be broken if there is substantial investment in low emission transport systems. In addition, reductions can be made over the longer term by improved spatial planning to build up sustainable communities, limit transport demands arising from dispersed locations, and reduced commuting time and costs for people.

13. Some of the most significant reductions in emissions will arise from a shift in transport modes away from the private car to public transport, both for commuting and longer-distance, inter-urban journeys.

16. Transport and the Economy, Standing Advisory Committee on Trunk Road Assessment (SACTRA), London 1999

17. The Eddington transport study: The case for action, Sir Rod Eddington, London, 2006

18. Firms that locate in dense urban areas provide spill-over benefits to other firms in their locality. They have higher productivity and lower costs than those in more rural settings, other things being equal. The scale of a firm’s “locality” is in part determined by accessibility. If transport system improvements bring geographic areas closer together through accessibility enhancements, then the “effective density” of that area is raised.

19. Infrastructure for an island population of 8 million, The Irish Academy of Engineering and Engineers Ireland, Dublin, 2010

20. The EPA defines transport as road, rail, navigation, domestic aviation, pipeline gas transport.

21. Ireland’s Provisional Greenhouse Gas Emissions in 2014, EPA, Dublin

14. In urban areas this requires properly targeted investment in bus, rail and rapid-transit to improve catchment accessibility and increase capacity, coupled with measures to make public transport more attractive and convenient such as park-and-ride; bus / rapid transit priority; real time arrival information; and smart payment systems (which are on the brink of a step-change with the growing popularity of contactless cash payment systems²²). A shift to active travel modes (walking and cycling), while providing important health benefits, has less

impact on emissions because of the much shorter distances involved.

15. On longer inter-urban journeys there is also potential to encourage a switch to public transport, but the key drivers are reasonable frequency; reduced and reliable journey times that can compete with the private car, and cost.

Rail can make an important contribution in delivering sustainable objectives. As the graphic below indicates, in the UK rail remains one of the most sustainable forms of transport environmentally²³.

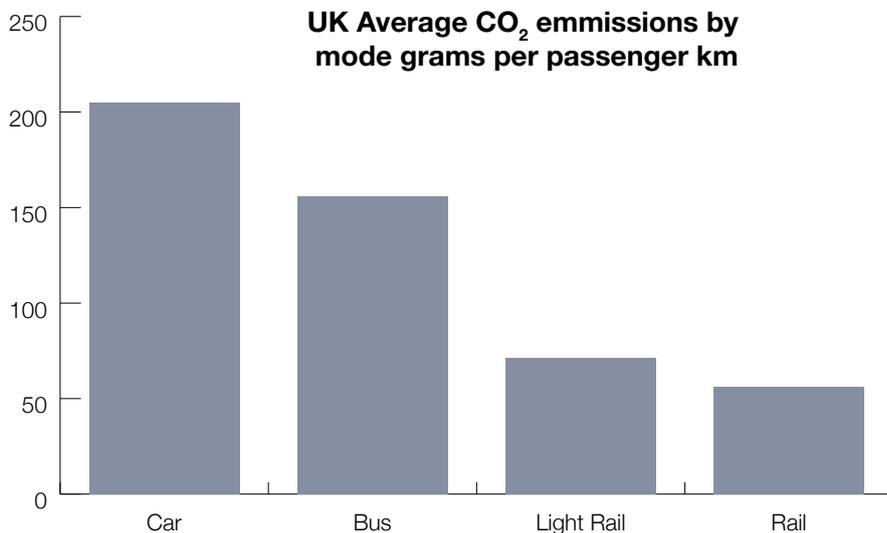


Figure 2.1 Average CO₂ emissions by mode grams per passenger km (UK)

The Community of European Railway and Infrastructure Companies (CER) recommends that the sustainability objectives of the EU Transport White Paper can be achieved by:

- ▲ prioritising infrastructure development
- ▲ creating a level playing field between transport modes
- ▲ setting up a transport pillar for EU climate & energy policies
- ▲ ensuring that there is solid, sufficient and predictable long-term funding for improvements in rail infrastructure quality and capacity to

enable the provision of reliable and sustainable rail passenger and freight operations

16. Investment in measures to make public transport more attractive may not be sufficient. It may also be necessary to promote a shift by considering congestion / road-user charging, and workplace car-park charges, to ensure that private car users pay the full costs of their modal choice and to manage demand. Such systems are mentioned both in the EU Transport White Paper, and in the DTTaS Strategy Framework, but these will require considerable political leadership.

22. Transport for London has recently introduced contactless debit and credit card payments alongside its Oyster smartcard system.

23. Future Travel - Investigating Sustainable Travel UK

17. However, even with a successful modal shift, there will remain a significant level of goods vehicle and private car use. One of the key sources of emissions is congestion, and this can be alleviated by targeting road and junction improvements where congestion is high. The Centre for Economics and Business Research²⁴ has highlighted the significant contribution to carbon emissions and wasted energy arising from road congestion. So measures to reduce congestion have considerable environmental benefits.
 18. In addition, the growth of low emission vehicles (LEV) provides a significant opportunity. Ireland and Northern Ireland are to be commended for installing a good network of electric vehicle (EV) charging points, although take-up has been disappointing. But LEV technology continues to evolve rapidly and hybrid vehicles may be more attractive to road users as they eliminate range-anxiety. In the medium term, further international investment may be needed in emerging fuels, such as hydrogen, as well as greater user incentives to switch to low emission vehicles.
 19. The EU White Paper on Transport²⁵ advocates a switch from road freight to rail, but recognises this is generally not economic over short to medium distances below 300km. While there are challenges in this regard for Ireland, other countries have demonstrated that rail freight can play a significant role in improving access to key ports, when road capacity is limited, and some bulk freight opportunities may also merit consideration.
- ▲ improving activity levels and mental well-being in older people (which is why both jurisdictions provide free bus and rail travel to older people – over 66 in Ireland and over 60 in Northern Ireland);
21. In Ireland, the 2012 NTA Travel Survey found that inside the Greater Dublin Area (GDA) 71% of all trips are made for non-work purposes, with the figure rising to 80% for trips outside the GDA. This underlines the importance of transport for social activities that enhance quality of life.
 22. Of even greater significance, transport investment also delivers a step change in travel safety. Department of Transport (GB) figures²⁶ for 2012 indicate that motorway standard roads, with safety features such as dual carriageways, grade separation (flyover-type junctions), safety fencing and dynamic warning signs, are around eight times safer than normal A or N class roads.
 23. Significant improvements in road safety can also be delivered in both urban and rural areas by introducing engineering improvements, often at relatively low cost, to locations which have a particularly high cluster of injury accidents. Rail is an inherently safe mode; there has been no collision or derailment resulting in a fatality of rail passengers on the Iarnród Éireann network since 1983, and this can be attributed in part to a major, multi-annual railway safety investment programme.
 24. The Academy finds that transport investment brings significant improvements to the quality of life and social cohesion of our citizens, and dramatically improves road and rail safety, both on inter-urban routes and at locations with accident clusters.

Social

20. Properly targeted transport investment not only contributes to economic growth, regional development, improvement in the environment and benefits to tourism, but it also has a major impact in the quality of life of citizens by:
 - ▲ providing access to work and education opportunities within a larger travel-to-work area;
 - ▲ reducing commuting times;
 - ▲ providing access to health, leisure and social activities; and

Summary

25. On the basis of the evidence from the island as a whole, and internationally, it is unequivocal that transport investment is a vital driver of a strong economy, regional development and a better quality of life. This is illustrated by Case Studies 1 and 2 below. And the converse is also true: inadequate investment in transport can have an adverse impact on economic growth, social cohesion and quality of life as illustrated in Case Study 3.

24. The Economic and Environmental Costs of Gridlock, Centre for Economics and Business Research, London, 2014

25. Roadmap to a Single European Transport Area - Towards a Competitive and Resource Efficient Transport System, EU Commission 2011

26. Reported Road Casualties Great Britain, Department for Transport, London, 2013. Rural A-class roads had 4.7 ksi (killed or seriously injured) accidents per million km travelled, with the equivalent figure for motorway-standard roads 0.6 ksi/million km

Case Study 1 – Northern Ireland Railways



Class 3000 at Downhill Tunnel

In 2005, Northern Ireland Railways (NIR) introduced 23 modern diesel three-car sets, and in 2011 added a further 20 three-car sets. This represented a total investment by the company and its sponsor (the Department for Development) of £237m, which included platform lengthening and the upgrading of two existing stabling facilities into full-train care and maintenance depots.

The investment completely renewed and expanded NIR's passenger stock, allowing it to introduce more capacity and more frequent services on modern, attractive trains. This was supplemented by a comprehensive programme of park-and-ride facilities at stations; redeveloped stations including Newry, Portadown and Antrim; lengthening platforms to accommodate six-car sets, and real time passenger information.

The result has been dramatic – passenger journeys increased to 13.5m annually in 2014-15, approaching double the number prior to the introduction of the new trains in 2005 (7.4m), and the highest levels of patronage since the 1960s.

Case Study 2 – Impact of Improvements to Ireland's Strategic Road Network



Boyne Bridge

The first decade of the 21st century saw unprecedented development of Ireland's strategic road network, stimulated by the National Development Plan and Transport 21. The National Roads Authority (NRA) oversaw a significant programme in which the cities of Cork, Limerick, Galway, Waterford (and Belfast) were connected to Dublin by motorways, or high quality dual carriageways. In addition, Dublin has benefited from the upgrading of the M50 motorway, including implementation of Europe's first barrier-free tolling for all vehicle types (E-flow on the West Link toll bridge), and the Dublin Tunnel, while Cork has the Jack Lynch Tunnel and Limerick has a new tunnel under the Shannon River. The inter-urban routes cost €8 billion, with net present worth estimated to be €24 billion approximately.



Dublin Port Tunnel

According to a study undertaken for the NRA²⁷, a preliminary analysis shows that strategic road improvements in Ireland in the period 2006 to 2010 produced significant economic benefits, in addition to journey time saving and safety improvements. These included:

- ▲ an increase of effective density (where transport improvements expand the area enjoying spill-over benefits from industry in urban areas) of an average of 6.9%, with areas outside the Greater Dublin Area having most benefit;
- ▲ productivity increases of 0.35% of GDP (with current GDP over €200bn annually, the current benefit is approximately €700m annually);
- ▲ increase in reliability of journey times between major cities, ports and airports;
- ▲ significant reductions in journey times on strategic radial routes²⁸; and
- ▲ an increase of 6.9% in accessibility to employment, with areas where accessibility had been relatively low tending to gain most, provided there were significant radial road improvements that affected them. Some areas saw improvements in accessibility of 14% or more.

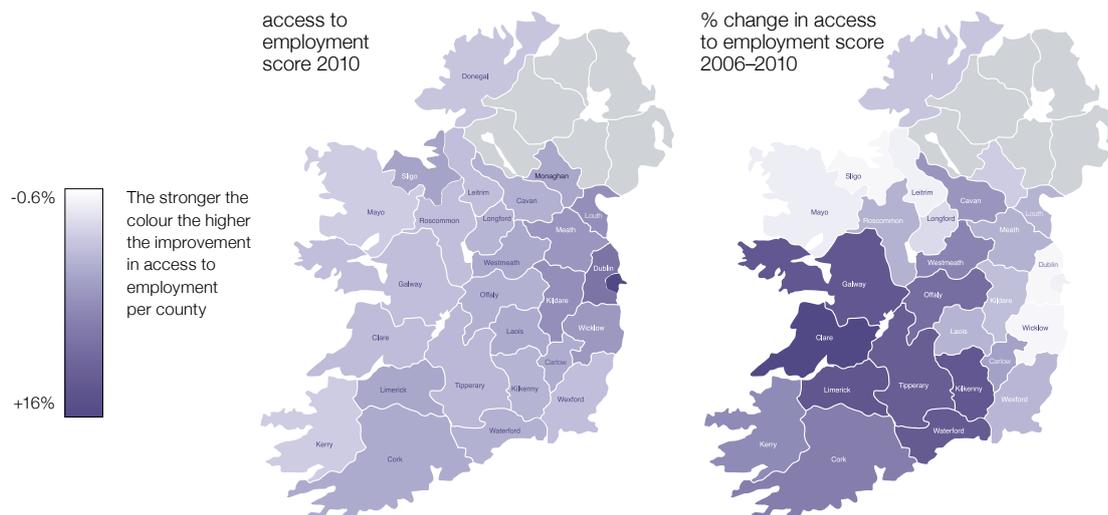


Figure 2.2 Access to Employment Scores

It is also estimated that road improvements over the period 2006–2010 are contributing an annual benefit in GDP terms of €525m.

27. Impact of Improvements in the Road Network on the Accessibility & Economic Potential of Counties, Urban Areas, Gateways & Hubs, Transport Research and Information Note, National Roads Authority, Dublin, 2012

28. For example: savings of 73 minutes (36%) between Dublin and Cork; and 31 minutes (39%) between Dublin and the border with Northern Ireland.

Case Study 3 – Adverse Impact of Inadequate Transport Investment on Housing Affordability and Economic Growth²⁹



Foreign Direct Investment (FDI) remains a key plank of economic development strategies in Ireland and Northern Ireland.

Low interest rates, low inflation, favourable tax regimes, growth in the demand for new bio-pharma and integrated circuit products, and ICT and financial services, have all contributed to a positive business environment. Employment is growing at an accelerating rate. However, markedly increased traffic congestion in our major cities is creating the real risk that infrastructure deficits within the cities may emerge as a serious constraint on economic growth.

For example, inadequate transportation networks in Dublin, coupled with the concentration of new ICT and financial services employment in the city centre, have indirectly contributed to a housing crisis that will impact on growth. Skill gaps can be filled with overseas recruitment, but recruitment will become progressively more challenging if educated migrants, or returning emigrants, cannot access affordable accommodation and schooling.

Families searching for affordable housing face a trade-off between locations with lower housing costs and longer commuting times. Housing costs tend to equalise over a wider areas in cities with efficient means of commuting. Distance to affordable housing for Dublin-based workers can extend as far as 80km from the city. The longer the combined time spent working and commuting, the higher the cost of childcare.

This is a matter of strategic importance. Access to affordable attractive housing is required to underpin the economic prosperity generated in the cities. The growing pent-up demand may persist for a decade, constraining the growth in employment in wealth generating companies.

29. Extract from a paper by John McGowan, President of the Academy, giving a personal insight into the dichotomy between housing affordability, ease of commuting, and reduced after-tax incomes.

CHAPTER 3: CURRENT TRANSPORT STRATEGY

European Strategies and Policies

1. The stated aim of the European Union's land transport policy is to promote efficient, safe, secure and environmentally-friendly mobility.
2. The EU Commission has produced a number of strategic policy documents relevant to land transport, the most important of which is the White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, adopted in 2011.
3. This document defined a long-term vision for a transport sector that should continue to serve the needs of the economy and of citizens, while meeting future constraints such as growing congestion and the need to cut CO₂ emissions. The vision was, to a substantial degree, based on better multi-modality of transport and new technologies that should lead to more optimised journeys.
4. The cost of congestion has been widely assessed internationally. The European Centre for Economic and Business Research (CEBR) was commissioned in 2014 to evaluate the direct and indirect economic and environmental cost to British, French and German households as a result of congestion on their roads³⁰²⁰. The study found that the impact on economies is enormous, with current road users spending on average 36 hours in gridlock every year in metropolitan areas. Based on comparative data from the CEBR report, the cost to Ireland of congestion, both direct and indirect, is in excess of more than €1bn per annum at present, and will significantly increase if appropriate measures are not implemented.
5. The general objective of the 2011 White Paper was to define a long-term strategy that would help the EU transport system achieve the overall goal of the Common Transport Policy, i.e. to provide current and future generations with access to safe, secure, reliable and affordable mobility resources to meet their own needs and aspirations, while minimising undesirable impacts such as congestion, accidents, air and noise pollution, and climate change effects.
6. Besides setting these objectives, the White Paper offered a vision of how the transport system should evolve in order to be capable of meeting these challenges. It needs to become a transport system with better integration between modes, fewer barriers to market entry, coherent infrastructure design, and wide deployment of new technologies for traffic management, travel planning and vehicle propulsion. These developments are deemed necessary to achieve the objectives without curbing mobility, which is vital for both social and economic growth.
7. In order to achieve these objectives the White Paper's strategy set four broad areas of intervention:
 - ▲ Internal market - elimination of the remaining internal market barriers;
 - ▲ Innovation - acceleration of the deployment of new vehicle and fuel technologies, and of IT solutions for traffic management;
 - ▲ Infrastructure - creation of a 'core' TEN-T network as a backbone of a truly multi-modal European network, and finding new sources of, and mechanisms for, funding, including greater recourse to user-pay and polluter-pays principles;
 - ▲ International - continuation of the efforts to open international markets, promote European technical standards, and defend with one voice EU global business in maritime and aviation areas.
8. There are many directives and policy documents relating to land transport, but the most significant for the purposes of considering investment priorities is probably the EU Directive Trans-European Transport Networks (TEN-T) Regulation (EU) No 1315/2013.
9. The Regulation identifies Core and Comprehensive transport networks. The Core network is intended to form the backbone for transportation in Europe's Single Market. By 2030, it is intended to remove bottlenecks, upgrade infrastructure, and streamline cross-border transport operations for

30. CEBR, 2014 The Future Economic and Environmental Costs of Gridlock in 2030 [http://ibttta.org/sites/default/files/documents/MAF/Costs-of-Congestion-INRIX-Cebr-Report%20\(3\).pdf](http://ibttta.org/sites/default/files/documents/MAF/Costs-of-Congestion-INRIX-Cebr-Report%20(3).pdf)

passengers and businesses throughout the EU. Its implementation is intended to be progressed by the setting up of nine major transport corridors that will bring together Member States and stakeholders.

10. The TEN-T Core network will be supported by a comprehensive network of routes, feeding into the Core network at regional and national level. The target for completion of the Core and Comprehensive networks is 2030, and 2050, respectively.
11. The aim is to ensure that, progressively, throughout the entire EU the existing patchwork of fragmented projects, and missing links, are replaced with a genuinely efficient and sustainable pan-European network. The TEN-T will contribute to enhancing internal markets, strengthening territorial, economic and social cohesion, and reducing greenhouse gas emissions³¹.

National Strategies and Policies - Ireland

12. There are a number of national strategies and policies relating to land transportation in Ireland.
13. Smarter Travel – A Sustainable Transport Future was published by the Department of Transport, Tourism and Sport (DTTaS) in 2008, and covers the period up to 2020. The main policy actions were to achieve a modal shift to 55% use of sustainable modes for all commuting trips; reduce the distances travelled by car; improve the alternatives to the car, and improve the fuel efficiency of all fleets, and to strengthen the institutional arrangement to deliver the policy document.
14. More recently, the DTTaS has published a Strategic Framework for Investment in Land Transport (SFILT). The SFILT report sets out the priorities and principles to guide future land transport decisions in the Republic. The study is intended to contribute to the development of a new multi-annual capital funding framework (2015-2019), and subsequent capital funding programmes. In addition, the SFILT report also considers investment requirements up to 2035.
15. The provision of public transport services in Ireland is managed by the National Transport Authority through contracted services provided, in the main, by Dublin Bus, Bus Éireann and Iarnród Éireann. The operation of the light rail network in Dublin is undertaken by Transport Infrastructure Ireland (TII) on behalf of the NTA.
16. The Academy acknowledges the strong role that bus and coach operators currently provide in the land transport sector, and the importance of continued investment in both new and well-maintained road infrastructure in supporting and enhancing this role in the future. The motorway network has improved the quality and speed of inter-city bus services and grown that market significantly. There is now an extensive network of inter-city and local bus services across the state. There are plans too for investment in bus priority measures, and other bus infrastructure, in the city regions across the state.
17. The NTA has finalised a Transport Strategy for the Greater Dublin Area (GDA) comprising the four Dublin local authority areas, and the Meath, Kildare and Wicklow County areas. The purpose of the Strategy, which has recently been formally approved, is to contribute to the economic, social and cultural progress of the GDA by providing effective, efficient and sustainable movement of people and goods.
18. The NTA is responsible for the provision of public transport infrastructure in the GDA and manages the investment programmes in the regional cities on behalf of DTTaS. The Authority has developed a number of regional transport models to assist decision-making in transport investment.
19. TII's responsibilities include the development and management of the national road network in Ireland. TII's strategy for the development of the roads infrastructure is influenced by the EU and national strategy documents noted above, particularly the Trans European Transport Network (TEN-T) Directive, but also by the Road Infrastructure Safety Management Directive, the Intelligent Transport Systems Directive, the Tunnels Directive, and the European Electronic Tolling Systems Directive.

31. European Commission, Mobility and Transport

20. Connectivity to ports plays a crucial, yet often overlooked role, in facilitating economic growth and prosperity. As an island economy we depend on the quality and efficiency of our port services to a much greater degree than many of our trading partners. This importance is highlighted in a new National Ports Policy framework issued by the DTTaS in 2013³². Most of Ireland's ports were originally located at railheads, although only Dublin and Waterford currently facilitate rail freight. The port of Shannon /

Foynes is also now designated as a port of national significance, along with the ports of Dublin and Cork. Ports of national significance (Tier 1 ports) are defined as ports that:

- ▶ are responsible for 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.

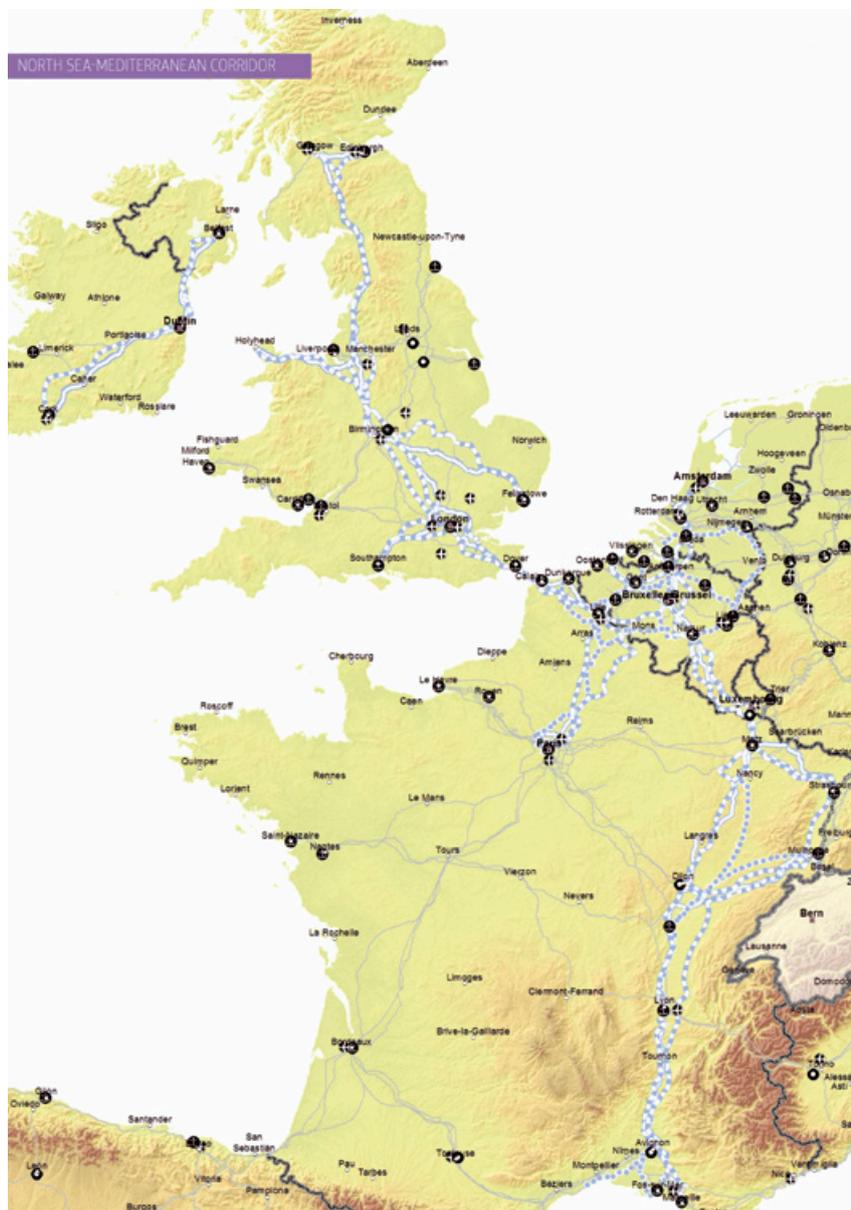


Figure 3.1 North Sea-Mediterranean Corridor

32. National Ports Policy 2013 DTTaS National Ports Policy 2013

National Strategies and Policies – Northern Ireland

21. In Northern Ireland, transport strategy is set out in the Regional Development Strategy (RDS) 2035³³, which is the overarching spatial strategy for Northern Ireland, and in A New Approach to Regional Transportation³⁴, which sets out policy prioritisation principles for future transport investment.
22. The RDS is the Northern Ireland Executive's overarching spatial planning strategy, and includes strategic planning guidance, which promotes greater consideration of where people live and work. It aims to reduce car dependency, and the need to travel by people living or working in town and city centres. It also supports the development of technologies, such as broadband, which would allow more people to work from home.
23. The New Approach to Regional Transportation complements the RDS and aims to achieve the transportation vision “to have a modern, sustainable, safe transportation system which benefits society, the economy and the environment, and which actively contributes to social inclusion and everyone’s quality of life”. The New Approach seeks to provide the infrastructure and services that will ensure that travel and transport are as sustainable as possible.
24. In relation to roads, the RDS defines a Regional Strategic Transport Network where five Key Transport Corridors, supported by four Link Corridors and the rest of the Trunk Network, connect: the Belfast Metropolitan Area; the North West Region centred on Derry~Londonderry; Hubs (the regional towns and cities); and Gateways (including the air and sea ports and cross border gateways).
25. The five Key Transport Corridors are illustrated in the following diagram:

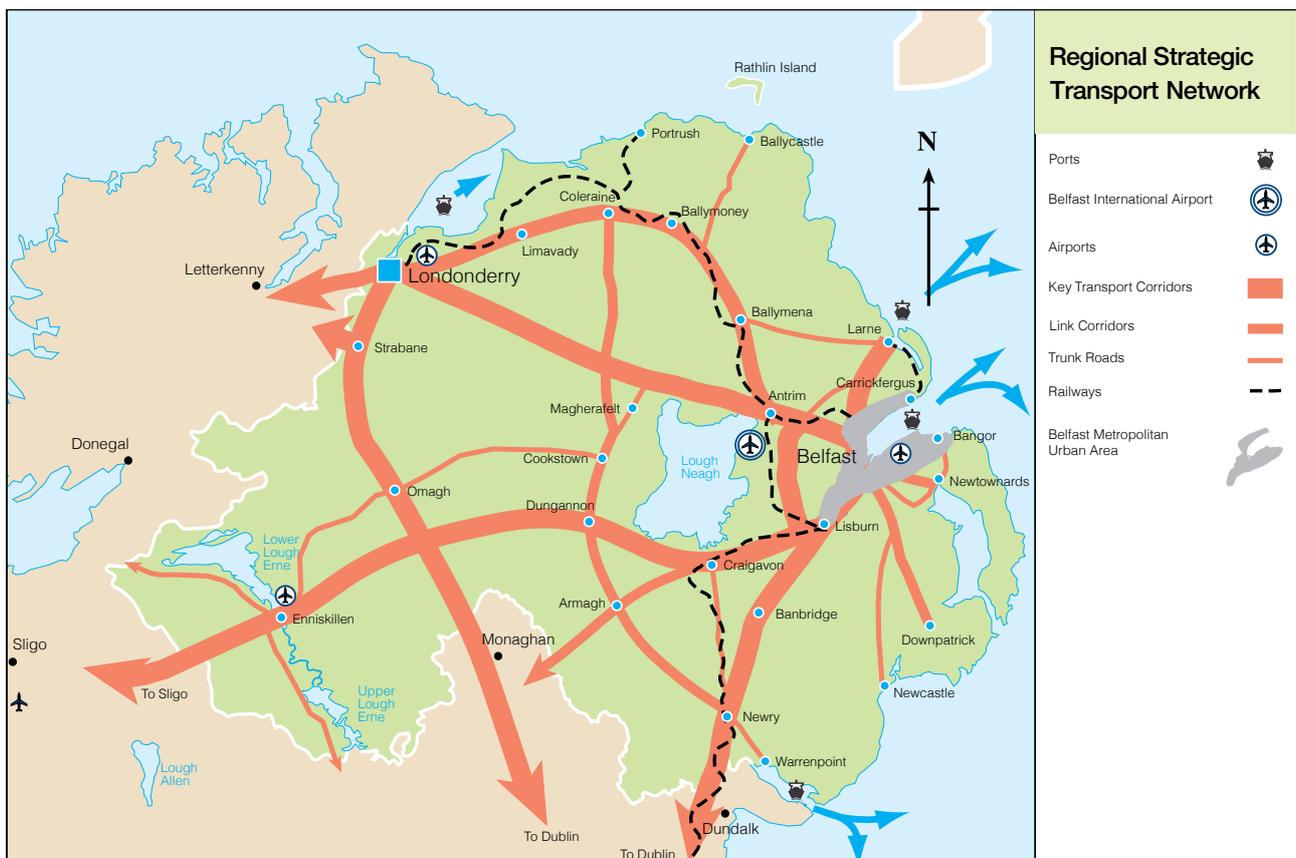


Figure 3.2 Northern Ireland Regional Strategic Transport Network

33. Regional Development Strategy 2035, Department for Regional Development, Belfast, 2010

34. A New Approach to Regional Transportation, Department for Regional Development, Belfast 2012

26. There are subsidiary transportation plans for the Belfast Metropolitan Area and a Sub-Regional Transportation Plan.
27. Operation of public transport within Northern Ireland is the responsibility of the Northern Ireland Transport Holding Company (NITHC), which is a public corporation. NITHC operates under the trading name Translink and has three operating companies: NI Railways, Ulsterbus and Citybus (operating as Metro). Whilst rail services in Northern Ireland are limited to servicing the north coast, and the main towns and cities in the east of the province, there is also a network of publicly operated inter-urban coach services (Goldline, operated by Ulsterbus), connecting the towns within the remainder of Northern Ireland.
28. NI Railways is approaching the point where a number of key routes are becoming congested at peak periods, which may shortly lead to the constraining of further growth. There is a continued need for capital investment to renew aging command-and-control systems, as well as maintaining in a serviceable condition what is essentially a 100 year old asset.

CHAPTER 4: A CHANGING LANDSCAPE

Changing Landscape

1. One of the greatest challenges facing the engineering community, and society at large, is to substantially reduce CO₂ emissions from the transport sector, while not suppressing economic activity. This is because the transport sector is now overwhelmingly dependent on the excellent energy storage characteristics of liquid hydrocarbons and the capability to use those in a variety of engine types, and the contribution that transport now makes to overall emissions, especially emissions in the Non-ETS sector.
2. In Ireland the problem of reducing transport-related CO₂ emissions from historic levels appears particularly acute given the CSO's findings³⁵, based in part on the 2011 Census, and subsequent research, which concluded:

- ▲ The number of people at work increased from just under 1.1 m in 1986 to just under 2.1m in 2008, before falling back to just under 1.8m in 2010, and recovering to almost 2m in Q4 2015. At the same time the number of commuters who drove a car to work increased from 0.43m in 1986, 37% of the total, to 1.07m in 2011, which was 60% of the total. A notable feature was the increase in the number of female drivers in the period, and a corresponding decline in their numbers travelling as car passengers. Indeed, in 2011 the number of females driving a car to work exceeded the number of males for the first time.
- ▲ The percentage of commuters travelling by bus in the same period declined from 8.6% to 5.2%, whereas the percentage travelling by rail increased from 1.5% to 3.0%, in part because of the introduction of the LUAS light rail network.
- ▲ Even in Dublin city and suburbs, 55% of commuters drove to work; in many cases, presumably, because of the availability of free parking spaces, reflecting the high proportion of public sector workers with that facility.

▲ While employment is increasingly concentrated in the larger urban areas, much of Ireland's population continues to live in 'one off' housing in the countryside, and is increasingly dependent on private motoring for access to employment, shopping, services or education. Indeed the number of persons working from home has declined significantly in the period due to:

- ▶ The continuing decline in the number of full-time farmers
- ▶ A fall in construction-related employment, particularly in rural areas
- ▶ A continuing fall in the number of families 'Living Above the Shop'
- ▶ The absence of sufficient high bandwidth fibre broadband

The numbers in full-time education increased at a slower rate than those in employment in the period, from 911,000 in 1981 to 1,038,000 in 2011. But the proportion of students being driven, or indeed driving a car to school or college, in the period 1981- 2011 increased from 26% to 61% at primary level; 11.5% to 42% at secondary level, and 13% to 37.8% at third level

The total number at primary school declined by 56,000, or 10%, during the period and those walking to school declined by 143,000, whereas the number being driven to school increased by 163,000. The number of pupils being driven to secondary school increased by 89,000 during the period; indeed more second level students now drive themselves to school than cycle. The number of third level students driving to college increased from less than 2,000 in 1986 to 53,600 in 2011.

Thus, the overall number of students travelling to school or college by car increased by almost 325,000, between 1986 and 2011. This, no doubt, contributed to the very considerable increase in childhood obesity in the same period, as well as adding very significantly to the general level of traffic congestion, associated with the 'School Run'.

35. Census 2011 Profile10 – Door to door

3. The impact of these trends is illustrated in Appendix 1 which shows estimated Road/Rail Passenger Movements in 2012/2013. This shows that approximately 88.6% of all passenger km were undertaken in private cars, with 7.5% undertaken in bus or taxi, and the remaining 3.75 % by rail.
4. Thus, reducing emissions associated with personal transport in Ireland will prove to be extremely challenging, and will require major advances in low or no-emission motor cars; a very substantial investment in public transport and associated infrastructure; a massive return to walking and cycling to work, school or college, and the necessary investment in facilities to encourage that; the regulation of road traffic to ensure that walking or cycling are both safe and convenient, and a significant change in public attitudes to personal mobility.
5. On the freight side the problems are equally challenging. The reported overall freight tonne-km increased from 5.1 billion in 1990, to 19.15 billion in 2007 (as indicated in Appendix 2), before falling back to 9.8 billion in 2014. Half of the decline in the period since 2007 was associated with the collapse in construction activity, with the balanced related to the overall decline in the economy and, in particular, the decline in consumer expenditure.
6. A notable feature of the period was that rail's share of overall tonne-km declined from 10.3% in 1990 to just 0.5% in 2007, though recovering slightly to 1.0% in 2013, due to the decline in overall volumes rather than any increase in rail freight activity. Indeed the tonnage carried by rail declined from 3.3m tonnes in 1990 to 0.6m tonnes in 2014. Thus, if rail freight, and particularly electrified rail freight, is to play a significant role in reducing CO₂ emissions in the longer term, it will require a very determined effort and significant investment to reverse the switch to road freight.
7. Furthermore, with economic recovery, it is clear that traffic volumes are again rising, particularly goods traffic. As a result, road transport fuel use increased by 4.2% in 2015. Thus, even stabilising Ireland's transport-related emissions will be a challenge, not to mind achieving the reduction required from 2005 levels to meet the targets now being envisaged at EU level.

Meeting the Challenge

8. The Academy's earlier Policy Advisory Towards Low-Carbon Transport in Ireland (July 2014) set out various measures designed to ensure that transport-related CO₂ emissions in Ireland could be maintained at close to 2012 levels in the period to 2020. Since that paper was drafted, economic growth has been much faster than the 2.5% p.a. growth in GNP forecast in 2013 by the ESRI for the period 2012-2020. Indeed based on current expectations, overall GNP in 2016 should match that projected for 2020.
9. In addition, there have been a number of features of automotive development which raise questions about the efficiency improvement assumptions made in the 2014 report.

It is now widely recognised that the gap between European test and real-life auto fuel consumption for new car models has continued to diverge, and that test figures for 2015 models now understate real-life performance by approximately 40%, which is significantly higher than the 20% assumed in our earlier report. This raises significant issues in relation to the motor taxation regime's dependence on such test figures.

It has recently emerged that auto makers are finding it increasingly difficult to simultaneously meet increasingly stringent NO_x, particulate and fuel efficiency standards for smaller diesel cars, where cost is more a factor.

Thus, stabilising transport related CO₂ emissions at 2012 levels will prove even more challenging, and will require a more expansive suite of measures, than previously envisaged.

10. The roll out of Battery Electric Vehicles (BEVs) has proved extremely slow, but is in line with the Academy's earlier expectations. However, considerable advances continue to be made in extending the range of BEVs and in reducing battery costs/kWh. This is being helped by the increasing cost-effectiveness of solar photo-voltaic electricity in parts of the world, and a consequent interest in using high-capacity batteries to provide complimentary electricity storage. This trend is expected to accelerate, to aid the roll-out of BEVs, and help overcome the barrier created by much reduced fuel costs. Plug-in Hybrid Electric Vehicles (PHEVs) are

rapidly gaining market share and are likely to be the dominant technology in Europe in the future, driven by the EU's 95g/km target.

11. Some major manufacturers favour hydrogen-powered Fuel Cell Electric Vehicles (FCEVs) as the route to zero emission vehicles. Clearly this requires the development of a hydrogen distribution infrastructure as well as new technology. It is not evident at this stage which, if any, zero-emission technology will gain a mass market.
12. But while the roll-out of zero-emission vehicles is much slower than envisaged by some governments, their wide-scale adoption may well be driven by local, rather than global, environmental/health concerns, including:
 - ▲ California's adoption of a Zero Emission Vehicle Programme
 - ▲ The mayors of Paris and London's separate proposals to restrict the use of diesel cars in the city area, or to require the use of zero emission taxis
 - ▲ China's need to substantially improve air quality in urban areas
13. But perhaps the most dramatic technology now emerging is the concept of the 'driverless vehicle' which is being developed by traditional auto industry players, and by companies whose origins are very far removed from the auto industry. At this stage it appears that technological development will outstrip the necessary institutional, societal and legal changes necessary to permit the operation of such vehicles on the public highway. Their impact, should the concept gain acceptance, is difficult to judge at this stage. But given that it is accepted that the average car is only being driven for a small fraction of the time, it seems probable that the successful introduction of the 'driverless car' would result in a substantial increase in shared ownership, with fewer cars being driven longer distances each year, thus favouring the adoption of higher-cost electric vehicles. A key advantage of the concept is that, in addition to freeing the occupants to do other tasks, it would reduce the requirement for parking spaces,

particularly in cities. Thus 'driverless cars' may also tend to reduce the requirement for public transport, and add to, rather than reduce, CO₂ emissions, unless they are predominantly electrically propelled.

Potential of High Speed Broadband to Reduce Transport Related CO₂ Emissions

14. As noted earlier, some of the key factors driving auto use in Ireland and Northern Ireland are our dispersed residential settlement patterns and the decline in the numbers working from home. The extension of high-speed broadband to rural Ireland offers, perhaps, the only way of overcoming this problem and, at the same time helping to reverse the evident decline in our towns and villages. Experience in other jurisdictions has clearly shown that the availability of high speed broadband can attract workers reliant on that technology to live and work in rural areas, which are currently devoid of employment opportunities, but otherwise offer a high quality of life. This trend is particularly pronounced when urban housing costs are perceived as unaffordable.

Technological Developments

15. Our world and society is changing rapidly. The last 20 years have seen a social revolution through the widespread use of the internet, email, and mobile phones. The last five years have seen a convergence of technologies in the application-driven smartphone, driving the relatively new phenomenon of online social networking.
16. Smart technology is already having a notable and beneficial impact on the way we access and use the transport network. Smart cards, such as the Leap card, offer convenient pay-as-you-go access to public transport, with the dual user and operator benefit of eliminating the need to carry and process cash. Real Time Passenger Information has increased the attractiveness, general punctuality and utility of the public transport system.

Technology and data can provide us not only with information on customers' usage and habits, but also on their preferences, which can help operators to better adapt and integrate services. This is improving the

offer, enhancing service quality by reducing crowding, and securing a better funding mix for public transport. Variable pricing mechanisms, often referred to as 'yield management', are increasingly being considered in the public transport sector as technology develops to support this management tool. The benefits of technology are not just confined to operators and end-users, but also allow transport authorities to introduce measures to control and manage demand, particularly during periods of peak demand.

17. In producing this report the Academy has been mindful of the changes that will impact on transportation in the short to medium term, of which the following may be the most significant:

- ▲ The continued increase in technologically advanced and internet-connected vehicles. We will see adaptive cruise-control and proximity-sensing technologies introduced across all vehicles, with significant safety benefits. Internet-connected vehicles will be able to avoid congestion and be guided by smart routing engines. Vehicles may be able to travel in convoy, more closely spaced, with resulting increases in capacity.
- ▲ The increase in shared (and perhaps driverless) vehicles on demand. The dramatic inroads made by Uber and Hailo to challenge the traditional taxi industry may be a precursor of a similar challenge to public transport. Will people take a bus if they can get a driverless car (alone or shared service) to provide door-to-door convenience for the price of a Metro ticket?
- ▲ Smart city developments, which can promote public and shared transport by making it more comfortable and convenient, and can interact with vehicles to reduce congestion and improve safety.
- ▲ Regional freight transport hubs which, through collaboration and use of consolidation centres, will reduce freight traffic in city centres, and bring lower logistics costs for the benefit of both suppliers and customers in an age where online shopping will continue to increase.

- ▲ The Intelligent Transport Systems (ITS) Directive will set the need to use technology to enhance transport across the EU including the need to provide information to road users.
- ▲ The rapid roll-out of enhanced vehicle technology; e.g. GPS and internet connectivity, will facilitate the introduction of congestion charging, or road user charging (variable by time of day, location and distance travelled). This measure will be available to policy makers if other levers do not achieve sufficient shift from the car to more efficient transport modes.

18. There are also other rapid and non-linear developments in transportation:

- ▲ IBM has launched a smart city initiative with Dublin City Council, and many cities in the EU and US are on the same path;
- ▲ many young urban dwellers prefer car-sharing to car-ownership.

19. The scale and momentum of change is unprecedented. But it would be a mistake simply to sit back and await developments. These technological advances are all opportunities, not threats. The UK government has focussed on transport research, funded in part through the Innovate UK Transport Catapult. This includes regulatory permissions to conduct research into drone-based goods delivery, autonomous cars, underground urban freight delivery, etc.³⁶. Ireland could benefit from a similar emphasis on transport R&D

Walking, Cycling, Promotion of Public Transport and Road User Charging

20. As a nation's prosperity increases, so too does the desire to travel by private transport for reasons of comfort, convenience and personal security. But inevitably this means that major cities become congested, with the demands of the private car community outstripping the road capacity that is reasonably available within the city limits.

36. www.bbc.co.uk/news/uk-england-northamptonshire-32331451r

Every effort should be made to improve the attractiveness of:

- ▲ walking – emphasising the health benefits;
- ▲ cycling – which really only becomes a viable and safe alternative when dedicated and grade segregated cycle lanes are provided that are regularly swept and well maintained;
- ▲ public transport – investment in reliable, frequent and affordable services needs to be supplemented by measures such as convenient park-and-ride facilities, bus lanes, bus-lane enforcement, and real-time information systems; and
- ▲ travelling to school using modes other than the private car – it is a salutary fact that more pupils drive themselves to school than cycle. Vigorous

efforts must be made to encourage walking and cycling to school, using innovative measures such as encouraging primary school children to use push scooters accompanied by their parents.

Once all of the “pull” factors have been exhausted, and there is the political appetite and leadership to deal with continuing congestion, consideration has to be given to some form of road-user charging. This will include, in increasing order:

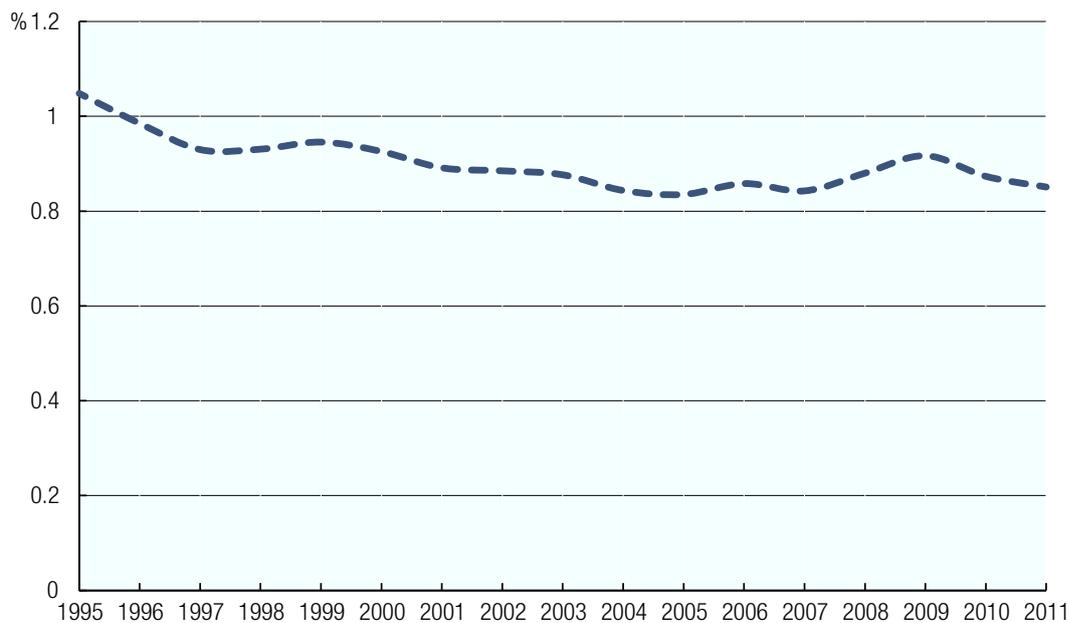
- ▲ workplace parking: restrictions on the provision of new workplace parking in the city centre, and charging or tax liability for those who utilise existing spaces free of charge;
- ▲ congestion charging: where vehicles entering a city centre are subject to a charge, which can be varied according to the type of vehicle, its environmental footprint, and the time of day.

CHAPTER 5 - FUNDING

1. As stated earlier, properly targeted investment in inland transport infrastructure produces a significant economic multiplier. However, in making proposals for investment, or in seeking to determine priorities, it is essential to recognise that capital availability for such investments is necessarily limited. Thus it is appropriate to examine what the potential availability of funding may be in each jurisdiction.

Internationally advanced economies typically devote 0.9 % of GDP to investment on inland transport infrastructure, based on the OECD's analysis³⁷, as may be seen from Figure 5.1 below. Countries with rapidly growing populations devote somewhat more. But for the purposes of this analysis 0.9% will be used as a reference point. As it is generally recognised that Ireland's reported GDP overstates real economic activity, because of the impact of transfer pricing by multinationals, GNP, which eliminates these effects, is used here as the basis for evaluating what could reasonably be afforded. Regional GDP figures are not generally produced for Regions in the UK, and therefore Gross Value Added, which is calculated on a regional basis, will be used to determine potential investment levels in Northern Ireland.

Figure 5.1 Investment in inland transport infrastructure in the OECD 1995-2011 (as a percentage of GDP, at current prices and exchange rates)



Source: International Transport Forum at the OECD estimate.

Ireland

2. In Ireland, the recently published Capital Program for the period 2015-2022 is assumed to give the upper limit on what is potentially available for inland transport infrastructure investment in the short term. However, leading economists now predict that Ireland's Debt/GDP ratio will fall to below 60% by 2020, which is significantly below the EU average at present. Thus Ireland will have both the capacity, and definitely the need, to substantially increase investment in land transport infrastructure in the medium term, particularly on public transport in urban areas, above that allowed for in the Government's Capital Program.
3. Therefore, it is essential that the necessary planning and engineering to enable such an expansion to occur is undertaken now, to ensure maximum capital efficiency.
4. Beyond that, the amounts available are calculated on the basis of the most recent ESRI economic projections for 2015 and 2016, which now appear

37. Spending on Transport Infrastructure OECD Analysis 1995-2011

understated, and the assumption that GNP growth in Ireland will average a conservative 2.0% p.a. in the period 2016-2035. On the basis of these assumptions

the sum available for investment in inland transport infrastructure in Ireland in the period 2016-2035 is as follows:

Table 5.1

IRELAND	
GNP 2016	€189.1 bn
Assumed Annual Growth Rate 2017-2035	2%
Cumulative GNP 2016-2035	€4595 bn
Available for Investment on Inland Transport Infrastructure	0.9%
Prudent Inland Transport Investment Envelope 2016-2035	€41.35 bn

5. The proposed investment envelope of over €40 billion may appear large, but it must be borne in mind that the land transport sector contributes substantially more to the Exchequer than the Exchequer allocates to that sector, for both capital and current expenditure. Indeed the proposed Prudent Investment Envelope is likely to be no more than 30% of the projected tax take from the sector in

the period 2016-2035. The following table from the Department of Transport Tourism and Sport's SFILT Report shows how total Exchequer receipts from the land transport sector, including Vehicle Registration Tax, Road Tax, Excise Duty on Transport Fuels, Carbon Taxes and VAT, compared with Exchequer expenditure on land transport, over the period 1997-2012.

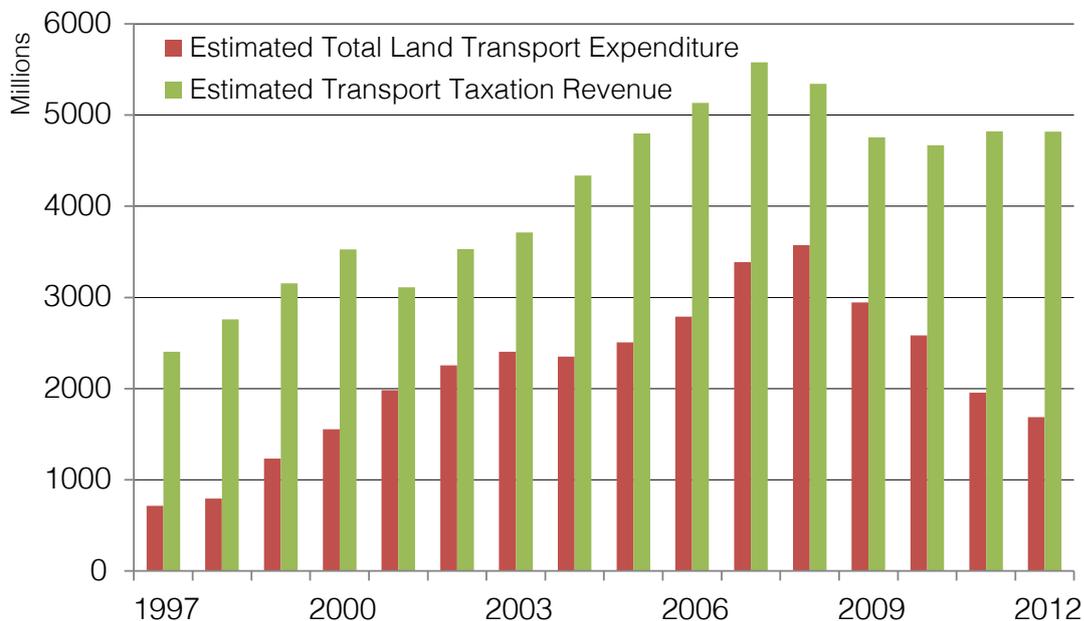


Figure 5.2 Estimated land transport expenditure and taxation 1997 - 2012

6. For 2015 it now appears that the tax take from the land transport sector will again have reached €5.5bn, whereas the Exchequer's provision for expenditure on land transport was only €1.285bn in 2015; i.e. less than 25% of projected receipts from the sector.
7. The Irish Government's Capital Programme for Land Transport, with the funding requirement to maintain the existing road and rail infrastructure, and the projected capital cost of the various projects
- ▲ listed in the Governments Capital Program, and
 - ▲ already approved for development, are compared in Table 1 of Appendix 3. From this it is evident that:
 - ▲ The funding envelope for road infrastructure for the period to 2022 appears sufficient to fund both ongoing maintenance requirements and the various road projects listed in the Capital Programme, with the exception of the three projects listed for development as PPP projects. However, the squeeze on capital investment was envisaged as continuing through to 2018. Thus all of the non-PPP road projects, listed in the capital programme, are effectively on hold, until funding becomes available.
8. The funding requirements for land transport in Ireland to 2035, covering
- ▲ The position in relation to public transport infrastructure provision is clearly far more difficult. It is evident from Table 1 of Appendix 3 that the funding envelope in the period to 2019 is inadequate to fund the projects currently under way, and the level of maintenance investment considered necessary by Iarnrod Eireann, to deliver a safe and reliable rail service.
 - ▲ Given that this maintenance funding requirement constitutes 20% of the total capital investment envelope envisaged for the period 2016-2022, it raises very serious issues as to whether the existing rail network can continue to be operated as at present.
 - ▲ ongoing maintenance expenditure on both roads and rail infrastructure and rolling stock (which the Academy considers essential to maintain existing inland transport capacity)
 - ▲ capital items, included in the Current Capital Programme, and
 - ▲ new works, considered as priority investment projects by the Academy and detailed in Tables 6.1-6.4 of Chapter 6, are summarised in the following graphic.

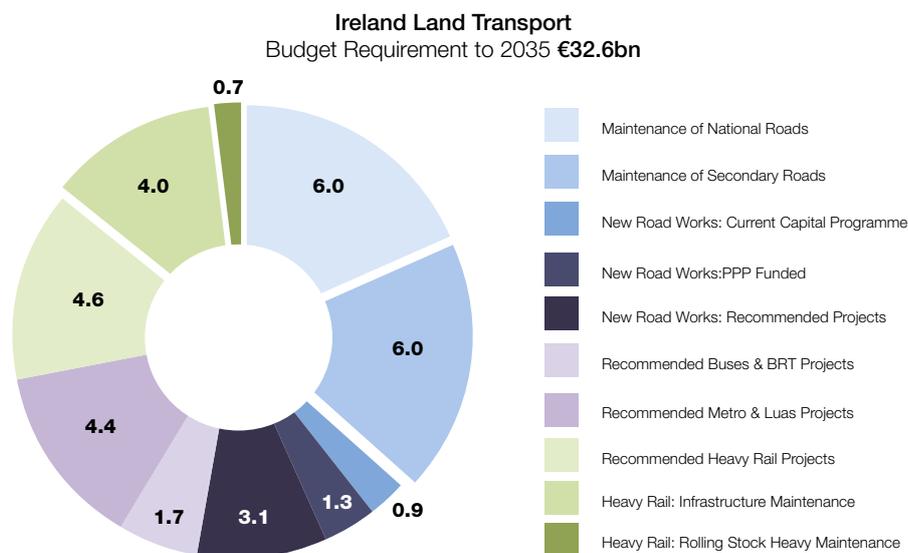


Figure 5.3 Ireland Land Transport Budget Requirement to 2035

From a comparison of Table 5.1 and Figure 5.3 above it can be seen that the overall funding requirement of €32.6bn is almost €8.7bn below the Prudent Investment Envelope, i.e. what would be considered the norm in OECD countries and is believed to be eminently affordable, given the relatively conservative economic assumptions made.

- ▲ Over 35% of the total budget is allocated to maintaining the existing road network.
- ▲ Given that road transport accounts for over 95 % of passenger km's, and over 99% of freight tonne km's, this allocation appears wholly appropriate. Indeed it could be argued that a higher figure would be more appropriate given the very poor quality of many of our roads and the very high yield from road transport taxes.
- ▲ Additional expenditure in this area would both improve safety and reduce emissions, as improved pavement quality would reduce the rolling resistance of motor vehicles. In addition the present very poor pavement quality on many of our secondary roads is also a barrier to increased public transport uptake as the ride quality on city and stage carriage services is considerably poorer than would be experienced in a private car, as the suspension systems on the buses employed on these services are not designed to cope with the very poor pavement quality which is very much the norm in Ireland.
- ▲ This poor pavement quality is also a barrier to further accelerating the re-adoption of cycling as a regular mode of transport as it both increases the effort required and significantly adds to cyclist's risk of serious injury, as they swerve to avoid potholes.
- ▲ Almost 15% of the total budget is allocated to rail infrastructure and rolling stock heavy maintenance.
- ▲ The latter is justified by the very long life of these assets, up to forty years if an appropriate maintenance regime is in place, compared with the approximate seven-year life of a bus in front-line service. But there is a need for a focused

targeting of investment for the railway network in the context of the wider policy objectives, including sustainable development and climate change, documented in this report, and ongoing funding constraints. The primary investment focus for the railway should be on delivering value for money by targeting the commuter belts and the higher volume inter-city routes, which also incorporate outer commuter services for the Greater Dublin Area, and developing new business opportunities and more cost effective systems.

- ▲ This focus, along with a critical value-for-money review of the under-used lines in the context of other public transport options, and a greater emphasis on delivering modal shift to the railway through a range of measures, should inform the terms of reference for a strategic rail review as recommended in SFILT. It should be noted that the ongoing deferral of essential infrastructure, and fleet maintenance and renewal investment, may have safety and operational consequences, including longer journey times and that it will ultimately add to the avoidable long-term cost of supporting the network of services.

Northern Ireland

9. For Northern Ireland the potential investment envelope is computed on the basis of the Office of National Statistics calculation of GVA in 2013, and an assumption that the GVA in Northern Ireland will increase at 1.5% p.a. in the period to 2035. This is based on the belief that the rebalancing of the economy, away from public sector employment, will continue. Because investment in transport infrastructure in Northern Ireland was inadequate in the period since the 1960s, it is considered that an accelerated level of investment is required in the period to 2035 to facilitate catch-up. Thus the Academy recommends the adoption of 1.15% of GVA as the appropriate investment target for the period to 2035. The potential investment envelope is computed in the following table.

Table 5.2

Northern Ireland	
GVA 2012	£32.84 bn
Assumed Annual Growth Rate 2013-2035	1.5%
GVA 2016	£34.85 bn
Cumulative GVA 2016-2035	£759.4 bn
Available for Investment on Inland Transport Infrastructure	1.15%
Prudent Inland Transport Investment Envelope 2016-2035	£8.7 bn

10. The currently planned investment in inland transport infrastructure in Northern Ireland is shown in Table 2 of Appendix 3.

11. The funding requirements for land transport in Northern Ireland to 2035, covering

- ▶ ongoing maintenance expenditure on both roads and rail infrastructure and rolling stock, which the Academy considers

as essential to maintain existing inland transport capacity

- ▶ capital items, included in the Current Capital Programme

- ▶ new works, considered as priority investment projects by the Academy and detailed in Table 6.2 of Chapter 6, are summarised in the following graphic.

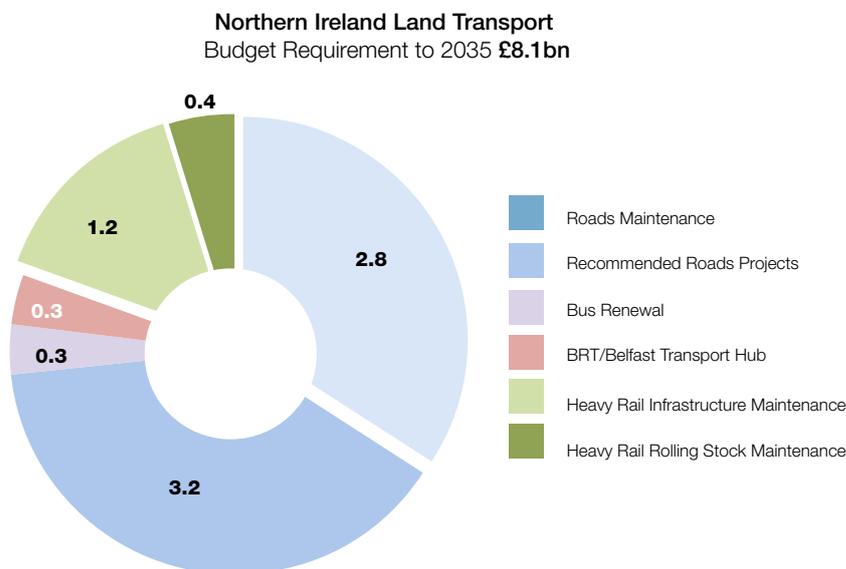


Figure 5.4 Northern Ireland Land Transport Budget Requirement to 2035

From a comparison of Table 5.2 and Fig 5.4 above, it can be seen that the overall funding requirement of £8.1 bn is below the £8.7bn sum considered appropriate as the prudent investment envelope for Northern Ireland's inland transport infrastructure, in the period to 2035.

In addition to the capital expenditure items identified above, it is essential that substantially increased provision is made in both jurisdictions for the improvement of walking and cycling facilities to reduce congestion and transport-related emissions, and to improve public health.

CHAPTER 6: TRANSPORT INVESTMENT RECOMMENDATIONS FOR THE ISLAND OF IRELAND 2016–2035

Introduction

This section considers the emerging needs for transport infrastructure on the island of Ireland and recommends additional improvements, in addition to current capital investment plans, that the Academy believes will be required by 2035. In doing so, it takes full account of the role of transport as a strategic and sustainable driver of economic and social development, the changing landscape, and the Academy's recommendations for key planning principles as set out in previous sections. It also includes significant transportation measures proposed in the Academy's Submission on a new Transport Strategy for the Greater Dublin Area³⁸.

In making its recommendations, the Academy is aware that transportation is subject to rapid and far-reaching technological development. The scale and momentum of change is almost unprecedented. But it would be a mistake to procrastinate. Transportation infrastructure has shown itself to be inherently adaptable to change, and the implementation of our infrastructure recommendations must take emerging developments into account over the extended lead-in periods. However, those lead-in periods mean that, in order to have the infrastructure that the island requires by 2035, planning must start now.

All Island Recommendations

1. An essential element of transport planning and funding is increased support for walking, cycling and public transport modes including demand management measures.
2. Adequately funded annual infrastructure maintenance and renewal programmes to:
 - ▲ improve the cost and operational efficiency of the rail network;
 - ▲ maintain reliability and safety standards; and
 - ▲ ensure the long term viability of the railway as an attractive and sustainable option
 - ▲ Obsolescence is a key issue with many aspects of railway technology (signalling, IT, communications, train control etc.). It is absolutely critical that these systems are modernised / replaced in line with their design life, rather than relying on a replacement programme subject to severe funding constraints. Many of these systems are in urgent need of replacement. There is a particular need for new train control and command systems.
3. Improved customer information and ticketing is required to encourage the use of public transport through real-time customer information and service availability updates. Island-wide integrated ticketing systems, which embrace technology advances, are vital to provide customers with easy-to-use options, simple integration of services, and best value ticketing. The aviation industry has clearly demonstrated how load factors can be maximised through yield management, and maximising load factors is the key to minimising emissions/passenger km. An expanded programme of station car-parking and feeder bus services will further improve the attractiveness of rail transport for commuters.
4. The Belfast to Dublin rail corridor is a key route on the TEN-T Core network. The Academy recommends that it should have a modern, electrified service on the existing alignment, with one hour frequency and 1½ hour journey time.
5. There is little value in developing the Island's road networks unless existing roads are properly

38. Submission on a new Transport Strategy for the Greater Dublin Area, Response to NTA Consultation on a New Transport Strategy for the Greater Dublin Area, 2015-2035, Irish Academy of Engineering, Dublin, 2015

maintained. Currently road maintenance is seriously underfunded.

6. The Dublin - Derry~Londonderry – Donegal Road Corridor is the critical link to the North West and within the North West. It is the policy of administrations in Ireland and Northern Ireland that this road corridor is upgraded to an acceptable standard, a policy the Academy supports.

Ireland Recommendations

7. In addition to the projects listed in the Government's capital programme, there are almost an equal number of road projects at the planning stage, many of which are of great national importance, but are not included in the current programme.
8. Equally it is clear that a very significant level of investment is now required in developing new public transport infrastructure, and to provide commuters with
 - ▲ access to affordable housing
 - ▲ acceptable travel times,
9. Overall, an additional €13.5bn of capital investment in inland transport infrastructure will be required to maintain transport in Ireland on a sustainable footing in the future. But this can be funded, while at the same time adequately providing for ongoing maintenance of Ireland's road and rail infrastructure, provided that investment in inland transport infrastructure, as a percentage of national income, is kept at levels considered the norm in other OECD

countries, and economic growth in Ireland matches the relatively conservative assumptions made in this report.

Northern Ireland Recommendations

10. The Academy is very clear in its view that investment in transport infrastructure, and particularly road transport infrastructure, in Northern Ireland has fallen well behind requirements in the past fifty years. Thus significant investment is now required to reduce travel times in Northern Ireland and improve its connectivity with the rest of the island.

Key Transport Investment Recommendations

11. The Academy's key recommendations for transport infrastructure measures in the period to 2035 are summarised below in Tables 6.1-6.4, and explained in more detail later. They are evaluated on the basis of their contribution to:
 - ▲ reducing urban congestion
 - ▲ improving regional connectivity (to promote balanced regional development)
 - ▲ improving safety
 - ▲ reducing emissions and noise
 - ▲ the EU TEN-T Core Network

Table 6.1 Projects Recommended by the Academy in Ireland

Notes to Tables

1. Basis of Estimating:
Costs are estimated at 2015 prices and include works, land, fees, risk, contingencies and VAT.
2. Timescales are indicative
Short Term 2016-2020, Medium Term 2021-2030, Longer Term, 2031-2035
3. Projects for which cost estimates are available and which are additional to those already included in current capital investment plans

Ref	Projects	Cost €m	Mode	Period	Priority Indicators				
					Reduce Urban Congestion	Regional connectivity	Safety	Emissions & noise reduced	EU Ten-T Core
Rail									
1	Train Control and Protection	170	Heavy Rail	Short Term			✓		✓
2	Four Track Cherry Orchard – Heuston	95	Heavy Rail	Short Term	✓	✓	✓	✓	✓
3	Metro North –South, Swords-Ranelagh	2,750	Rapid Transit	Medium Term	✓	✓	✓	✓	
4	Upgrade Ranelagh-Cherrywood for 80m trams	110	Rapid Transit	Medium Term	✓	✓	✓	✓	
5	Additional trams for 80m operation	190	Rapid Transit	Medium Term	✓	✓	✓	✓	
6	DART Expansion Programme	3,500 ³⁹	Heavy Rail	Medium Term	✓	✓	✓	✓	✓
7	DART to Dublin Airport	260	Heavy Rail	Medium Term	✓	✓	✓	✓	✓
8	Intercity Route Corridor Upgrades	255	Heavy Rail	Medium Term		✓	✓	✓	✓
9	Luas Cherrywood-Bray	280	Rapid Transit	Medium Term	✓		✓	✓	
10	Luas Red Line Extension to Lucan	630	Rapid Transit	Longer Term	✓		✓	✓	
11	Luas Red Line Extension to Poolbeg	170	Rapid Transit	Longer Term	✓		✓	✓	
Total Rail (Ire)		8,410							

39. Further to Government and National Transport Authority announcement on 22nd September 2015, DART Underground will now conduct a design review process with a view to producing a lower cost technical solution, whilst retaining the required rail connectivity

Ref	Projects	Cost €m	Mode	Period	Priority Indicators				
					Reduce Urban Congestion	Regional connectivity	Safety	Emissions & noise reduced	EU Ten-T Core
	Road								
12	M28/N28 Cork-Ringaskiddy	160-200	Road	Medium Term		✓	✓	✓	✓
13	Cork-Limerick	500-1000	Road	Medium Term		✓	✓	✓	✓
14	Limerick-Newcastle West	200	Road	Medium Term		✓	✓	✓	✓
15	N6 Galway Bypass	400-600	Road	Medium Term	✓	✓	✓	✓	
	(M50 Relief)								
16	N3-N81 Outer Link	200-400	Road	Medium Term	✓		✓	✓	
17	Local Road Upgrades	200-400	Road	Medium Term	✓		✓	✓	
18	N7 to Naas, Improve to Motorway Standard	200	Road	Medium Term	✓	✓	✓	✓	✓
19	Downstream Liffey Bridge	300	Road	Medium Term	✓		✓		✓
	Total Road (Ire), mean of cost of estimates	2,730							
	Bus / BRT								
20	Bus Fleet Renewal	1,100	Bus	Full Term	✓	✓	✓		
21	Blanchardstown-UCD BRT	290	BRT	Short Term	✓		✓	✓	
22	Clongriffin-Tallaght BRT	270	BRT	Medium Term	✓		✓	✓	
	Total Bus/BRT (Ire)	1,660							
	Total (All Projects Ire)	12,800							

Table 6.2 Projects Recommended by the Academy in Northern Ireland

Notes to Tables

1. Basis of Estimating:
Costs are estimated at 2015 prices and include works, land, fees, risk, contingencies and VAT.
2. Timescales are indicative
Short Term 2016-2020, Medium Term 2021-2030, Longer Term, 2031-2035
3. Projects for which cost estimates are available and which are additional to those already included in current capital investment plans

Ref	Projects	Cost £m	Mode	Period	Priority Indicators				
					Reduce Urban Congestion	Regional connectivity	Safety	Emissions & noise reduced	EU Ten-T Core
Road									
23	Eastern Seaboard KTC, Grade Separated Junctions York St., Sprucefield-Beech Hill	400	Road	Short Medium Term		✓	✓	✓	
24	North Western KTC Derry-Londonderry – M22 Randalstown	950	Road	Medium Term		✓	✓	✓	
25	Northern KTC Dromore-Moira-Templepatrick, via Belfast International Airport	600	Road	Medium Term	✓	✓	✓	✓	✓
Total Road (N.I.)		1,950							
Bus/BRT									
26	Bus Replacement	300	Bus	Short Term	✓		✓	✓	
	Belfast BRT	120	BRT	Short Term	✓		✓	✓	
27	Belfast Transport Hub	200	Hub	Short Term		✓			✓
Total Bus/BRT (N.I.)		620							
Total (N.I.)		2,570							

Table 6.3 All-Island Projects recommended by the Academy

Notes to Tables

1. Basis of Estimating:
Costs are estimated at 2015 prices and include works, land, fees, risk, contingencies and VAT.
2. Timescales are indicative
Short Term 2016-2020, Medium Term 2021-2030, Longer Term, 2031-2035
3. Projects for which cost estimates are available and which are additional to those already included in current capital investment plans

Ref	Projects	Cost	Mode	Period	Priority Indicators				
					Reduce Urban Congestion	Regional connectivity	Safety	Emissions & noise reduced	EU Ten-T Core
Rail									
28	Customer Service Improvements	€70m	Heavy Rail	Short Term	✓	✓		✓	
29	Belfast – Dublin Rail Corridor Upgrade	€225m	Heavy Rail	Medium Term		✓	✓	✓	✓
Dublin to Derry~Londonderry to Donegal road upgrade									
30	N2/N13/N14 Upgrade	€400m	Road	Medium to Longer Term		✓	✓		
31	Derry~Londonderry to Aughnacloy	£1200m	Road	Medium to Longer Term		✓	✓		

Table 6.4 Other Projects recommended by the Academy for further consideration (cost estimates not currently available)

Ref	Projects	Cost	Mode	Period	Priority Indicators				
					Reduce Urban Congestion	Regional connectivity	Safety	Emissions & noise reduced	EU Ten-T Core
32	Bus Priority Measures (Dub/Gal/Lim/Cork)	n/a	Bus		✓	✓		✓	
33	Kishoge Inland Container Port	n/a	Heavy Rail		✓	✓	✓	✓	✓
34	Rail Freight Line to Foynes	n/a	Heavy Rail			✓	✓	✓	✓

PROJECTS RECOMMENDED BY THE ACADEMY

Projects in Ireland

Rail

Heavy rail is a key transport mode, both for inter-city journeys, where demand is sufficient to justify the investment, and for commuting to main city centres. No alternative transport system is capable of providing the same capacity, given the restrictions of creating new roads in urban areas, and the fact that even four-lane motorways provide only one-third the passenger carrying capacity of a twin-track, commuter rail system. It thus has a key role to play in encouraging modal shift and reducing carbon emissions.

The following are the recommended priority investments for rail in Ireland up to 2035:

Short Term Projects

1. Train Control and Protection

The additional capacity, frequency and journey time improvements, recommended for the rail network, need to be supported by the replacement / upgrading of existing constrained and obsolete train-control and protection systems. There needs to be a reduction in the requirements for human interventions in safety-critical tasks. There is a particular need in this respect for a modern Central Traffic Control (CTC) facility, and for the network-wide roll-out of a replacement train protection system for the existing limited CAWS and ATP systems. Iarnród Éireann is currently rolling out two complementary systems - GSM-R (an adaptation of standard mobile phone technology for use in rail systems) and a train protection system. It should be noted that as an 'isolated networks' with a unique non-standard EU gauge, both networks (Iarnród Éireann and NIR) are exempt (EU REGULATION 1315/2013) from full deployment of the European rail traffic management system (ERTMS) to meet inter-operability requirements.

2. Four Track Cherry Orchard-Heuston

The extension of four tracking on the Kildare line from Cherry Orchard to Heuston, a distance of approximately 4km, would allow a very significant increase in commuter services on a line with considerable potential for housing development, and also provide a substantial improvement in connectivity between East Leinster and the Docklands area, which is critical in ensuring that development in that area is not stifled by the lack of affordable housing. In addition it would facilitate the subsequent development of the critically important DART Expansion project.

Medium Term Projects:

High Capacity Public Transport Projects in the GDA

The Academy considers that it is now imperative that the two major rail projects in the GDA, namely the DART Expansion Programme, incorporating the DART Underground project,⁴⁰ and the Metro project, for which Railway Works Orders were obtained following an extensive and costly planning process, be immediately reactivated. It is essential that high capacity, public transport links be developed as quickly as possible, if congestion is to be limited and those working in the GDA are to have access to

- ▲ Acceptable travel times, and
- ▲ Affordable housing

However, the Academy considers that each of those schemes, for which Railway Works Orders were obtained but have now lapsed, should be modified, in line with the Academy's submission to the NTA on the development of a Transport Strategy for the GDA.

- ▲ Thus the Academy supports the decision to extend four-tracking on the Kildare line from Cherry Orchard to Heuston, and recommend that it be completed as quickly as possible,

40. The DART Underground Project is the term used to describe the proposed city centre, heavy rail DART Interconnector tunnel linking the Kildare rail line to the northern rail line. The DART Expansion Programme describes the full wider scheme of proposed electrification, fleet and depot facility expansion of the DART network to create two separate and integrated high capacity/frequency DART lines running initially from Maynooth to Bray/Greystones, and from Hazelhatch to Drogheda, of which the DART Underground Project is a key component. The lines will interchange at Pearse Station.

and that the Dart Underground tunnel should subsequently be developed from Docklands to Heuston, rather than Inchicore, as previously proposed.

- ▲ The Academy also supports the recent decision that Metro North be extended underground, from St. Stephens Green to Ranelagh, thus allowing the creation of a Metro North/South, running from Swords to Sandyford and on to Cherrywood, and the use of 80 meter trams. This would provide the essential high-capacity N/S public transport link that is so desperately needed in Dublin. It would relieve congestion on the M50, as well as providing a rail-link from Swords (the largest town in the state without a rail link) to the airport, the city centre and south city, and to the rapidly expanding Sandyford business quarter. It would also provide the essential public transport capacity to permit extensive and rapid development of the Cherrywood area, and provide the necessary connection capacity to permit the development of the proposed Cherrywood - Bray Luas link.

3-5. Metro North-South

The most critical missing element in Dublin's transport is the lack of a high capacity North to South route through the city. The development of Luas Cross City will not provide this, because of capacity limitations and its potentially adverse impact on cross-city bus capacity. Thus the development of a virtually fully segregated metro line from Swords to Sandyford, utilising 80m trams is recommended, as previously outlined.

The Academy's analysis indicates that development of Metro N/S could be delivered at a cost of no more than 20% above the more recent cost estimates for Metro North, including the cost of extending its capacity from 55 meter trams, as envisaged, to 80 meter trams, and provide for the additional rolling stock required. But this would require the adoption of an alternative routing through the north city. However this alternative routing would facilitate significantly higher density housing development on the 50 hectares of currently undeveloped land immediately adjoining the alternative alignment, most of which is in public ownership

6. DART Expansion Programme

This will be the single most important transport infrastructure investment in Ireland, alleviating congestion in the Greater Dublin Area and enabling a modal shift from private to public transport. The key element of the programme involves the construction of a city centre tunnel (DART Underground), with additional underground stations in the city centre, to link the northern and Kildare commuter lines with a major interchange at Pearse. This would relieve congestion in the Dublin city centre and facilitate the operation of two twinned high-capacity / frequency grade-separated DART corridors: one linking Drogheda with the Kildare line via the DART underground, and the other linking Maynooth with the Wicklow line via the existing Loop Line Bridge. It will also require further electrification of the Dublin commuter rail network to Drogheda, Maynooth, and Hazelhatch (on the Kildare line), with potential further electrification to Portlaoise. In addition to the ongoing major city centre re-signalling project, further re-signalling along the Maynooth line, coupled with the removal of level crossings to Maynooth, will be required. The programme will also require expansion of fleet and depot facilities, as well as additional four-racking on the Kildare line (between Heuston and Park West / Cherry Orchard) to facilitate higher frequencies and more competitive journey times.

7. DART to Dublin Airport

The Academy recommends that Iarnród Éireann's proposal for a rail connection from Clongriffin Station to the Airport (7.5km spur across largely undeveloped lands) should be seriously considered, and it is essential that the required route corridor is incorporated in Fingal County Council's Development Plan. This would be a mainly surface-level link across undeveloped lands, although some undergrounding may be needed near the airport. It would link Dublin Airport:

- ▲ to the existing DART network, providing a direct service to key central locations and to the national rail network at Heuston, via the DART Underground
- ▲ to the Dublin – Belfast economic corridor, with Clongriffin Station acting as a key interchange point for the Enterprise service and the northern outer commuter services

9-11 Luas Extensions

The Academy fully supports measures to improve the attractiveness of public transport, thereby reducing commuting and other trips by private car. The best opportunities for doing so are in the major cities, where rail and rapid transit systems with modern attractive vehicles can operate frequent and reliable services.

The Academy recommends the following Rapid Transit Improvements:

- ▲ The extension of the Luas Red line to Lucan is recommended, following the completion of the Cherry Orchard to Heuston four-tracking and the development of a Luas / Heavy Rail interchange station at Kylemore. There are 40,000 people living in the Lucan area and the extension of the Luas Red line to there has been planned for some time. However if the extension is not co-ordinated with upgraded rail capacity, the existing Luas Red Line would be severely capacity constrained nearer the city
- ▲ The extension of the Luas Red Line to Poolbeg is recommended following the completion of a downstream road bridge across the Liffey. This would facilitate high density residential development on the Poolbeg Peninsula, which is otherwise effectively landlocked because of the very limited road capacity in the Irishtown / Sandymount area.
- ▲ The development of a Luas line from Bray to Cherrywood, where it would connect with the Metro is recommended, following the development of Metro North-South to Cherrywood

The benefit of the considerable investment level identified above on public transport integration and capacity in the GDA is illustrated in Figs 6.1 & 6.2, where the thicknesses of the lines indicate route capacity.

It is also evident from the above that public transport infrastructural investment in the GDA will need to increase more than fivefold in coming years, to over €8.5bn in total, if the area is to continue to grow, and if Dublin is to compete as a European capital city. It must be recognised that while this appears a very large sum, the bulk of land transport capital investment in the period 1995-2005 was spent on the national motorway network, and 45% of

Ireland's population live in the GDA and the commuting counties of Louth, Laois and Wexford.

8. Intercity Route Corridor Upgrade

The inter-city rail network has been placed at a competitive disadvantage in terms of journey times by the completion of the major inter-urban motorway network in 2010, along with the upgrading of the M50 in Dublin. It will be necessary to address this by significant infrastructure enhancements, the delivery of more competitive journey times and, in some cases, higher frequencies on existing lines. An investment programme for the delivery of more competitive journey times along the major rail corridors, as a counterbalance to road developments, is crucial for the railway to play its part in a sustainable and more balanced transportation system.

- ▲ The target for inter-city routes to be delivered by fleet and infrastructure enhancements should be:

Dublin to Cork:	2 hours
Dublin to other provincial cities:	less than 2 hours

Road

While considerable and very worthwhile investment was made on the radial routes from Dublin in the period to 2007, there remains a requirement to improve a number of routes to promote balanced regional development.

12. M28/N28 Cork-Ringaskiddy

Ringaskiddy port is on the TEN-T Core Network and, following An Bord Pleanála's decision to approve its development as a Lo-Lo port, and the associated decision to relocate much of the Port of Cork's activities from the city quays to Ringaskiddy, it is essential that the required road infrastructure is completed to facilitate this development, and free up large areas of Cork City for redevelopment.

13. Cork-Limerick

The completion of the motorway connection from Cork to Limerick (and Galway) is essential to ensure balanced regional development in the country, as none of the three cities, on their own, are of a scale to provide an effective counterweight to Dublin. But if their industries, commercial centres, and third level institutions, were within one or two hours of each other, by road, it would facilitate co-ordinated development and facilitate balanced regional development. There are a number of alternative route options that need to be evaluated, with significantly different cost implications.

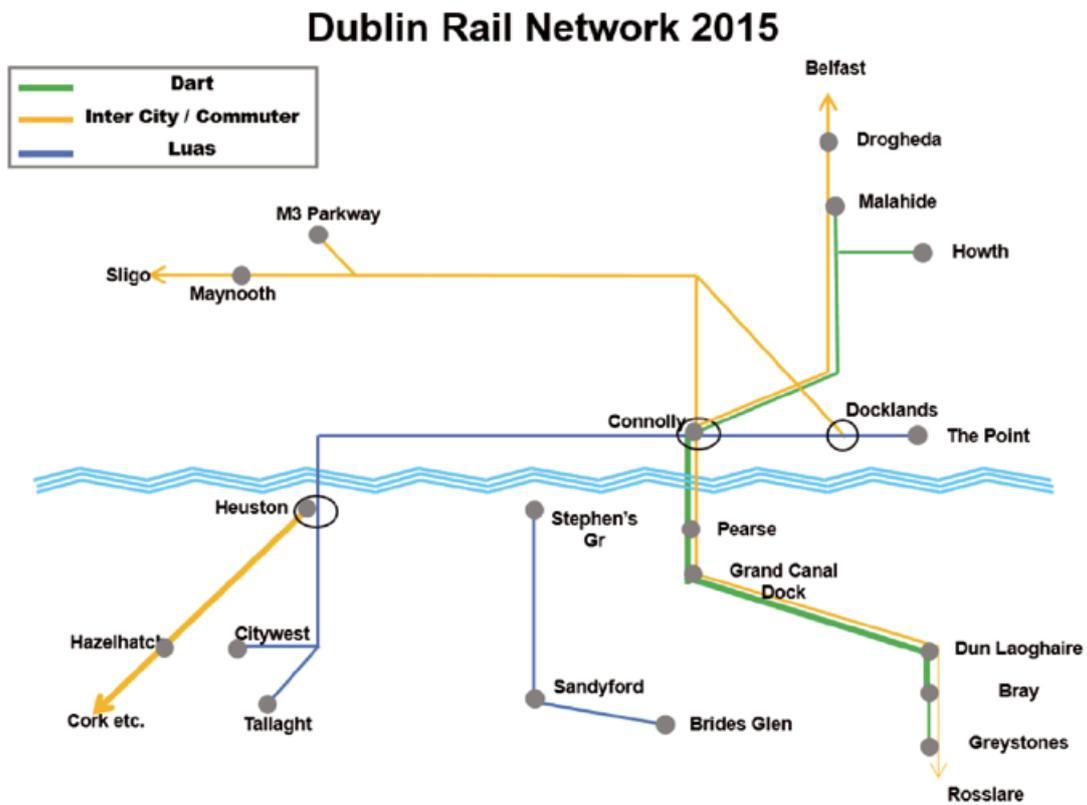


Figure 6.1 Dublin Rail Network 2015

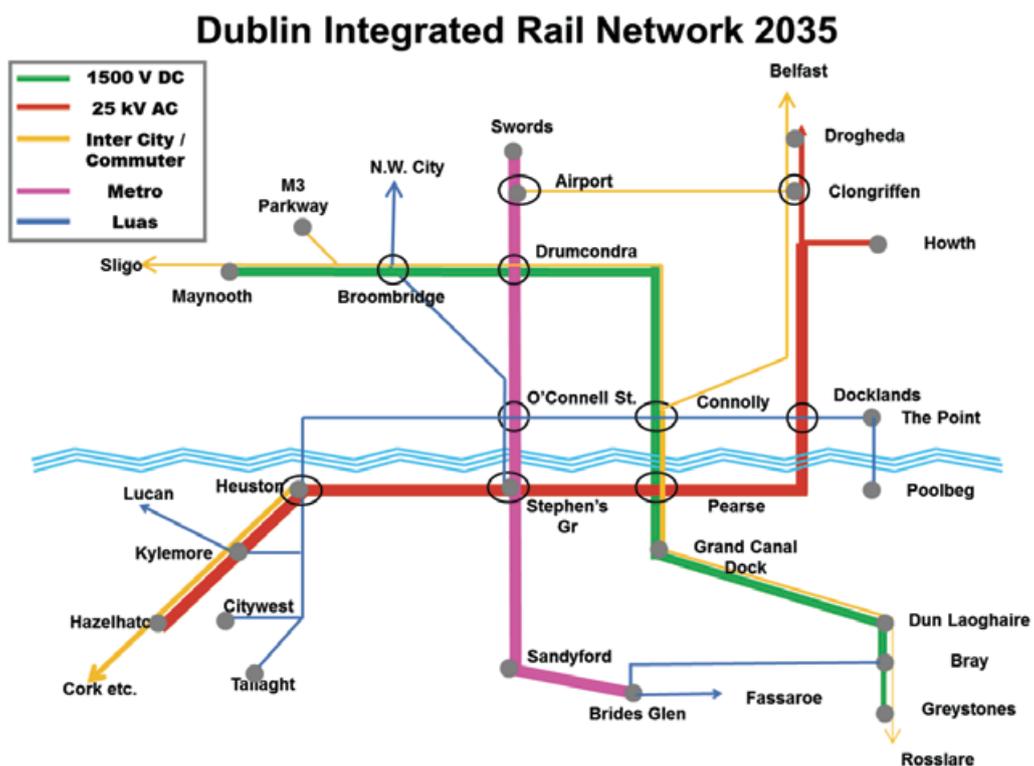


Figure 6.2 Dublin Rail Network 2035

The considerable commuter traffic from Mallow to Cork could be most sustainably catered for by developing the Mallow-Cork rail line as a suburban rail service, with additional stations between Mallow and Cork, with increased service frequency, and with fares in line with suburban services in Dublin.

14. Limerick – Newcastle West

At present Adare, on the N21, is probably the worst traffic choke-point in the country. It is essential to develop a new road alignment from Limerick to Newcastle West which would relieve the congestion at Adare, and significantly reduce travel times to Kerry.

15. N6 Galway Bypass

Galway has been one of the fastest growing, and economically and culturally successful, urban centres in Ireland over the past fifty years. But the growth of the city and its hinterland has not been matched by a corresponding improvement of its transport infrastructure. Given its medieval core, it is not possible to develop a proper public transport system for the city unless through-traffic is removed. Thus the completion of the proposed bypass is essential.

16-19. M50 Relief Projects

The M50 is now the most important piece of inland transport infrastructure in Ireland, and is again rapidly approaching congestion levels at peak hours. Furthermore it has become very apparent in recent times that a single incident on the M50 can have repercussions all over the GDA. Yet the Current Capital Programme contains no measures to address these problems.

Therefore the Academy proposes the development of an Outer Link road, from the N3 to the N81, paralleling the most heavily trafficked sections of the M50, and providing road connections to the Academy's proposed inland container port at Kishoge. The proposed route would use

- ▲ the existing R 136 from Kishoge to the N81
- ▲ the existing or planned road alignment from the N3 to west of Adamstown
- ▲ the Academy's proposed road alignment running parallel to the rail line from Adamstown to Kishoge

The proposed route is shown in Fig 6.3

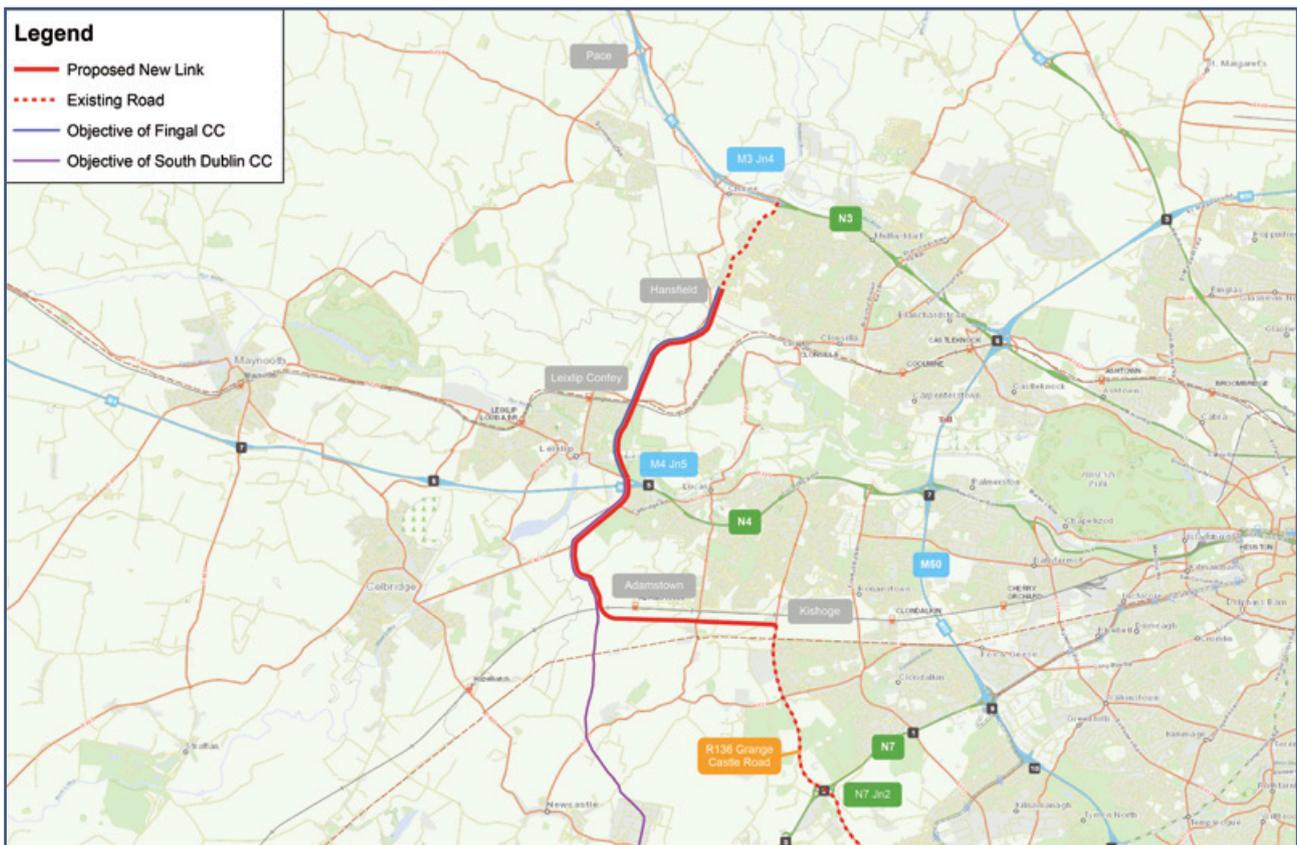


Figure 6.3 Proposed Outer Link Road

In addition, the Academy supports proposals by the NTA and TII to develop a number of link routes inside the M50 that would provide alternatives for traffic now using the M50 for local journeys.

The Academy believes that commitment to the above proposals is essential to getting public acceptance for multi-point tolling of the M50.

But in the Academy's view the key short term relief measures are support for:

- ▲ ride-sharing initiatives, utilising modern communications technology and the removal of any legal or institutional barriers to their adoption
- ▲ point-to-point bus services along, or paralleling, the M50

Bus

20-22. Bus/BRT

The Academy recognises that buses provide by far the dominant mode of public transport, in terms of passenger journeys, and even in terms of passenger km. Thus the continuing development of, and investment in, bus services is essential if emissions and indeed urban congestion are to be avoided. The Academy recommends a programme of investment in bus fleet renewal to replenish the aging bus fleet and to keep the average age of the fleet within accepted industry norms.

However the Academy also recognises that constrained road capacity does place a limit on the role buses can play in urban areas, whereas the development of the inter-urban motorway network has given coach operators a significant competitive advantage for many inter-urban journeys.

In all cities throughout the island bus-based rapid transit can make a significant contribution, particularly those with wider thoroughfares and which are not based on medieval street patterns.

Where the road network permits, or alternative alignments can be found, the development of Bus Rapid Transit system has proved to offer medium capacity routes at a much lower capital cost than rail based systems. Thus, given the relatively low population density in many of our urban areas, the possibility of utilising a Bus/BRT solution must be considered before more expensive systems are proposed. Indeed continuing investment in bus systems is essential.

The Academy supports the NTA's proposal to create two high-capacity BRT routes from Blanchardstown to UCD, and from Clongriffin to Tallaght.

In addition the Academy recommends that increased emphasis be placed on developing very limited stop-bus services along the M50.

Projects in Northern Ireland

Public Transport

26. Bus Fleet Renewal / Belfast Rapid Transit

The Academy recommends a programme of investment in bus fleet renewal to replenish the aging bus fleet and to keep the average age of the fleet within accepted industry norms.

Early implementation of the three currently planned bus-based Belfast Rapid Transit (BRT) routes (EWAY, WWAY, and CITI) is recommended. Early planning should start on other key corridors including:

- ▲ NWAY: Belfast centre to a park and ride sites / feeder interchanges at Sandyknowes, passing the Ulster University campus in York Street.
- ▲ SWAY: Belfast Centre to a park-and-ride site / feeder interchange at Newtownbreda.
- ▲ Other radial routes in the city.

It is important to discourage through traffic (which has neither an origin nor destination in the city centre) from using key streets in central Belfast, leaving these available for rapid transit vehicles and bus priority. Schemes such as the Westlink/M2/M2 junction will assist this aim as well as the proposed new road from Templepatrick to Moira to Dromore.

The Belfast Rapid Transit (BRT) system will:

- ▲ use high-quality articulated buses carrying around 100 passengers, with fuel efficient hybrid engines (in November 2015, the Department for Regional Development awarded a £19m contract for the first 30 vehicles to Van Hool);
- ▲ run on dedicated running lanes and mixed traffic lanes on existing roads, and will receive priority at traffic lights;

- ▲ stop at high-quality halts, placed at least 400m apart, providing shelter, security and real time travel information; and
- ▲ be fed by re-organised conventional bus services, and park-and-ride sites.

While BRT will provide an interim solution, it is likely that planning of a Light Rapid Transit (i.e. tram) network will need to be undertaken for implementation towards the end of the period of this report.

27. Belfast Transport Hub

This will provide a new public transport interchange located on the site of the Europa Buscentre and Great Victoria Street Train Station in Belfast, integrating rail services with the inter-urban coach network and local bus services.

The new Hub will bring the cross-border Enterprise trains into the heart of the city, underlining Belfast's role as a confident, vibrant and progressive capital city. Eliminating the need for the Enterprise to take the current, circuitous route to Central Station will reduce journey times by up to 10 minutes. The Hub will also offer additional platform and bus stand capacity in Belfast to support passenger growth.



One of the options for the Belfast Transport Hub

By kind permission of Translink

Roads

The Academy recommends the proposals for road improvements on Northern Ireland's Key Transport Corridors (KTCs) that are illustrated in Figure 6.4 and described below:

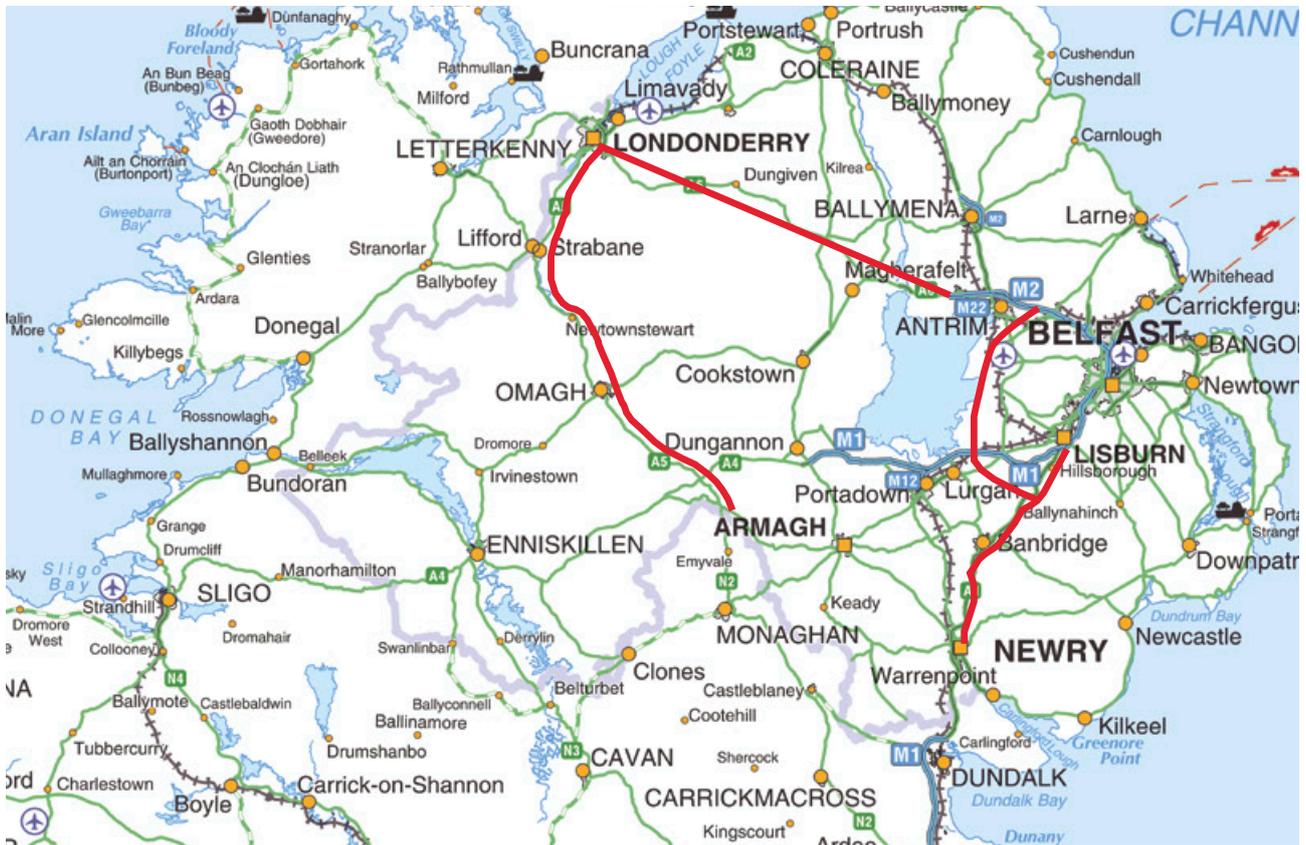


Figure 6.4 Roads Proposals for Northern Ireland

23. Eastern Seaboard KTC Belfast - Dublin

This KTC is part of the EU TEN-T core network. The last ten years have seen significant improvements, which mean that the sections from Larne to Belfast to Sprucefield, as well as Beech Hill (north of Newry) to the border, are either to motorway or high standard (grade-separated) dual carriageway.

Completion of this route to the necessary standard will require:

- ▲ improvement of the existing dual carriageway between Sprucefield and Beech Hill, by providing grade-separated junctions to eliminate hazardous cross movements; and
- ▲ major grade-separated interchanges to eliminate bottlenecks at the M2 / M3 / Westlink junction at York Street, Belfast (a £165m scheme is in preparation), and the A1 / M1 junction at Sprucefield including Hillsborough Roundabout.

These improvement works are urgently required, both for better safety, and to complete a continuous, uninterrupted motorway, or high standard dual carriageway, on Euroroute 01 from Larne to Rosslare.



Figure 6.4 Roads Proposals for Northern Ireland York Street Interchange (clockwise from top left: M2 / M3 / Westlink) *By kind permission of Transport NI*

24. North Western KTC (Belfast to Derry~Londonderry)

A high-standard dual carriageway is required between Randalstown and Derry~Londonderry, thus completing the route between Northern Ireland's two largest cities. It will not only facilitate freight and car journeys, but will also provide significant enhancement to public transport services between Derry~Londonderry and Belfast. On this route, express buses are scheduled at 15 minute frequencies during peak commute times, and are so fully loaded that services are often worked by two or three buses. The upgrade to high standard dual carriageway (at an investment of £950m) will improve express bus service journey times from 2 hours to around 1 hour 20 minutes at peak times.

25. Northern KTC (Dromore - Moira - Templepatrick, via Belfast International Airport)

The Academy proposes a new, high-standard dual carriageway on this route which has the following benefits:

- ▲ It provides an alternative route, avoiding Belfast, for traffic between Larne Port and the south. Belfast is reported, by TomTom, to be the third most congested city in Europe, and removing through traffic from the Westlink corridor will reduce traffic congestion.
- ▲ It provides an alternative route between Derry~Londonderry and Dublin, and one which may well be more attractive than the Western KTC / N2 corridor since it would be entirely full motorway, or high standard dual carriageway standard;
- ▲ It provides a high standard dual carriageway link between Belfast International Airport and Belfast, as well as Craigavon / Banbridge / Newry and Dublin.

Further Improvements

Further improvements to Northern Ireland's strategic road network will also be required by 2035 on the:

- ▲ Northern KTC (on the A26 between Ballymena and Coleraine (part of this scheme between Glarryford Cross and the Ballycastle Fork is on site);
- ▲ A2 between Coleraine and Derry City Airport; and
- ▲ the South Western KTC between Ballygawley and Enniskillen including a Southern Bypass of Enniskillen.

All Island Projects

28. Customer Service Improvements

Improved customer information and ticketing is required to encourage the use of public transport through real-time customer information and service availability updates. Island-wide integrated ticketing systems, which embrace technology advances, are vital to provide customers with easy-to-use options, simple integration of services, and best value ticketing. The aviation industry has clearly demonstrated how load factors can be maximised through yield management and maximising load factors is the key to minimising emissions/passenger km. An expanded programme of station car parking and feeder bus services will further improve the attractiveness of rail transport for commuters.

29. Belfast – Dublin Rail Corridor

The Belfast to Dublin rail corridor is a key route on the TEN-T Core network. The Academy recommends that it should have a modern, electrified service on the existing alignment, with one hour frequency and 1½ hour journey time.

The route infrastructure needs to be upgraded to deliver a consistent journey speed of 100mph (160kms). This will require investment in track infrastructure, including improvements to the ballast and sub-ballast layers, along with alignment improvements. In order to maintain the 100mph level of service, the delivery of an adequately

funded, steady-state maintenance and renewal investment programme is critically important.

30-31. Dublin –Derry~Londonderry – Donegal Road Corridor

Improving this road corridor is recognised as being very important for the economic development of the North-West of the Island. But achieving this objective requires a series of costly road infrastructure improvements, namely:

▲ Dublin – Border

The N2 is now the poorest quality national road radiating from Dublin with particular problems between Ashbourne and Ardee. The options for resolving this problem are varied and include incentivising traffic, particularly HGV traffic, to use the M1 to Dunleer and then the excellent Dunleer–Ardee road.

▲ Western KTC Derry~Londonderry - Aughnacloy

Significant improvement is required to this key route in order to bring the advantages of better transport links to the peripheral areas in the north west of the island.

It provides a link from Co. Donegal and Derry~Londonderry to Dublin, via the A5 to the border at Aughnacloy, and onwards via the N2 / M2. But, just as importantly, it provides better connectivity between Omagh and Strabane to Belfast and Derry~Londonderry, the two largest cities in Northern Ireland. A high standard dual carriageway has been planned, but has been stalled due to legal challenges and funding constraints⁴¹. Work to address these is ongoing.

To complete the entire route will require a very significant investment of some £1.2 billion and, for reasons of affordability and to satisfy value for money requirements, it will need to be undertaken in stages, extending to the end of the period covered by this report (2035).

▲ N13 & N14 in Donegal

Additional investment is required to upgrade the quality of these roads

41. In the November 2015 Stormont Agreement, the Northern Ireland Executive and the Irish Government agreed that construction on the first section of the A5 scheme (Newbuildings to north of Strabane) will commence in 2017 with a view to completion by 2019. The Irish Government committed an additional £25m of funding to this project, bringing its total committed contribution to £75m. expansion of the DART network to create two separate and integrated high capacity/frequency DART lines running initially from Maynooth to Bray/Greystones, and from Hazelhatch to Drogheda, of which the DART Underground Project is a key component. The lines will interchange at Pearse Station.

Other Projects for consideration in Ireland

Note: The following projects are included separately as cost estimates are not available to the Academy.

32. Bus Priority Measures Dublin/Cork/Limerick/Galway

Given the very important role that buses play in providing public transport in urban areas, it is essential that continuing investment is made in reducing travel times for those travelling by bus and that road space allocation adequately reflects their importance.

33. Kishoge Inland Container Port

The Academy proposes development of an inland “port” at Kishoge in West Dublin, with containers transported by rail from Dublin Port for subsequent transfer by road to the many distribution facilities located between the N2 and the N81. Returned empty containers could then be returned to Kishoge, rather than Dublin Port for storage and repair. The empty containers could then be railed to the South of Ireland, where there is an ongoing shortage of containers, particularly for the export of agricultural products. Finally, containers could, if required be railed from the south to Dublin Port. This would significantly reduce HGV traffic on the M50.

It would also free up considerable space in the docklands area and facilitate the development of housing in the south docks area, in line with Dublin City’s plans.

34. Rail Freight to Foynes

The rail line from Limerick to Foynes has the potential to be upgraded significantly to enable freight operations to the port of Foynes. However this will require the automation of some of the highest risk level-crossings in the country. Shannon/Foynes Port is the largest bulk port in Ireland and handles around 20% of all seaborne trade. There is also significant potential for future rail shipment of biomass and animal feeds, as well as zinc ore from the Pallas mine in Limerick through the port of Foynes.

Although this port is not directly on the TEN-T North South Mediterranean Corridor, which includes a corridor connecting Belfast – Dublin – Cork (see below), it is a core port, and therefore plays an important role in the interconnections with both rail and “Motorways of the Sea”.

Analysis of the Capacity to Fund the Maintenance and New Works Expenditure Proposed by the Academy in the Time-frame Proposed

The ability to execute the new works proposals made by the Academy, in the timeframe proposed, while continuing to invest in essential maintenance, is examined in Appendix 4.

It demonstrates that the Academy’s proposed programme can be delivered in both jurisdictions in the timeframe proposed and within the funding model proposed.

Appendix 1 Road/Rail Passenger Traffic in Ireland 2012/2013

Mode		No of Passengers Reported M	Avg. Length of Journey Calculated km	Passenger km Reported M	Seat km Reported M	Passenger km M	%
Heavy Rail	DART	15.747	10.0	156.9			
	Dublin Suburban	9.934	30.8	305.6			
	Mainline & Other	10.35	106.8	1105.8			
	Total					1568	3.4
LUAS	Red Line	17.2	4.3	74.0			
	Green Line	13.3	5.7	75.8			
	Total					150	0.33
Bus			Estimated	Calculated			
Dublin Bus		112.5	7.5	843.8	3343	843.8	
Bus Eireann	City Services	17.9	3.5	62.65			
	Stage Carriage	11.8	10.0	118.0			
	Total PSO			180.7	2255		
	Schools	41.1	15.0	616.5			
	Total			797.2		797.2	
Licenced GDA		12.9	15.0	193.5			
Licenced ex-GDA		7.2	100.0	720.0			
				913.5		913.5	
Total Bus						2555	5.7
	Vehicle km reported M	Occupants / vehicle estimated					
Private Car	33700	1.2				40440	88.6
Small PSV	860	0.5				430	1.0
Total						45143	

Appendix 2 Road/Rail Freight Activity Ireland 1990-2014

Year	Road Freight						Rail Freight			
	Minerals Tonne km M	Building Material Tonnes Carried M	Other Goods Tonne km M	Other Goods Tonnes Carried M	Total Tonne km M	Total Tonnes Carried M	Tonne km M	Tonnes M	Tonne km %	Tonnes Carried %
1990	950	34	4180	47	5130	81	589	3.3	10.3	3.9
1991	859	30	4279	50	5138	80	603	3.3	10.5	4.0
1992	826	31	4324	53	5150	84	633	3.3	10.9	3.8
1993	931	30	4164	51	5095	81	575	3.1	10.1	3.7
1994	1045	34	4213	51	5258	85	569	3.0	9.8	3.4
1995	864	34	4629	51	5493	85	602	3.2	9.9	3.6
1996	913	32	5403	56	6316	88	570	3.1	8.3	3.4
1997	1212	43	5786	61	6998	104	522	2.9	6.9	2.7
1998	1810	69	6393	74	8203	143	466	2.8	5.4	1.9
1999	2131	80	8144	84	10275	164	526	2.9	4.9	1.7
2000	2855	104	9493	90	12348	194	491	2.7	3.8	1.4
2001	3174	112	11753	92	14927	204	516	2.6	3.3	1.3
2002	3549	125	10899	106	14448	231	426	2.2	2.9	0.9
2003	4116	145	11782	114	15898	259	398	2.3	2.4	0.9
2004	4876	166	12412	117	17288	283	399	2.1	2.3	0.7
2005	5256	188	12896	116	18152	304	303	1.8	1.6	0.6
2006	5402	195	12285	118	17687	313	207	1.2	1.2	0.4
2007	5545	192	13601	123	19146	315	103	0.8	0.5	0.3
2008	4226	140	13063	106	17289	246	79	0.7	0.5	0.3
2009	2283	69	9786	79	12069	148	92	0.6	0.8	0.4
2010	1852	47	9072	79	10924	126	105	0.6	1.0	0.5
2011	1477	38	8464	72	9941	110	91	0.6	0.9	0.5
2012	1410	36	8485	72	9895	108	99	0.6	1.0	0.6
2013					9138	109	99	0.6	1.1	0.5
2014	1138	39	8634	73	9772	112	100	0.6	1.0	0.5

Appendix 3

Table 1: Investment in Transport Infrastructure in Ireland: Seven Year Envelope, €m

Road Investment Envelope	2016	2017	2018	2019	2020	2021	2022	Total	
	591	622	743	832	996	1082	1082	5948	
Maintenance Requirement National Roads Note 1	300	309	318	328	338	348	358	2299	
Maintenance Requirement Secondary Roads Note 1	300	309	318	328	338	348	358	2299	
Available for New Works	-9	4	106	176	321	386	366	1360	
Note 1: Assuming 3% p.a. Annual Cost Inflation									
Projects to be Directly Funded by Exchequer, Listed in The Governments Capital Programme and now on hold									
N5 Westport Turlough								180-220	
N22 Macroom- Ballyvourney								160-180	
N8/N25 Dunkettle Interchange								80-100	
N4 Colloney-Castlebaldwin								120-140	
M7 Naas-Newbridge Widening								70-80	
N56 Dungloe -Glenties								25-35	
Sallins Bypass								100	
Moycullen Bypass								35	
N56 Mountcharles-Inver								40	
Garavogue River Bridge								25-30	
Total of Mean of Cost Estimates								897.5	
Funds Potentially Available for Other Projects								462	
Projects to be Funded by PPP									
M18 Gort-Tuam, under way									550
M11 Gorey- Enniscorthy									350-400
N25 New Ross Bypass									350-400
Total of Mean of Cost Estimates									1300
Public Transport Investment Envelope									
	348	321	368	358	533	845	845	3618	
Rail Infrastructure Maintenance Requirement Note 1	240	240	240	240	240	240	240	1680	
Rolling Stock Heavy Maintenance	35	35	35	35	35	35	35	245	
Available for New Investment	73	46	93	83	258	570	570	1693	
Note 1: Assuming €43m p.a. from Track Charges									
Projects Directly Funded by Exchequer and Listed in Governments Capital Programme									
Luas Cross City	100	100	50					250	
Green Line Capacity Improvement, for 55m Trams			55					55	
Phoenix Park Tunnel Reopening	7							7	
City Centre Re-Signalling	16							16	
Bus Fleet Renewal	55	55	55	55	55	55	55	385	
Total	178	155	160	55	55	55	55	713	
Public Transport Funding Deficit/Surplus	-105	-109	-67	28	203	515	515	980	
Funds Potentially Available for Other Projects								980	

Appendix 3

Table 2: Planned Transport Investments in Northern Ireland 2016-2021

	2016-17	2017-18	2018-19	2019-20	2020-21	Planned Total
Road Projects						
A5 Derry ~ Londonderry – Aughnacloy part of route	13	40	53	55	68	229
A6 Derry ~ Londonderry - M22	21	57	60	60	60	258
Public Transport Investment						
Rail Infrastructure Maintenance Requirement	10	20	78	78	78	264
Bus Fleet Renewal	15	15	15	15	15	75
Public Transport Projects						
Belfast Transport Hub	6	16	40	60	78	200
Belfast BRT	17	9	20	13	61	120

Appendix 4: Land Transport Funding Capacity, in constant 2016 money

Table 4.1 Ireland: Land Transport Funding Capacity

Year	GNP €bn Note 1	Period GNP €bn	Period GNP €bn	Funding Capacity €bn Note 2	Period Maintenance Requirement € bn Note 3	PPP Roads €bn Note 4	Available for New Works €bn	Roads €bn Notes	Bus €bn Note 8	BRT €bn Note 9	Luas €bn Note 10	Heavy Rail €bn Note 11	Balance €bn	Metro N/S €bn	DART Expansion €bn	Luas €bn Note 12	Uncommitted €bn
2016	189.1	2016-20	984	8.9	4.2	1.3	3.4	0.9	5	0.28	0.29	0.360	1.3	1.3			0.0
2021	208.8	2021-25	1086	9.8	4.2		5.6	1.57	6	0.28	0.27	0.255	3.2	1.45	1.79		0.0
2026	230.5	2026-30	1199	10.8	4.2		6.6	1.57	7	0.28		0.260	4.65	0.3	1.71	0.28	2.2
2031	254.4	2031-35	1324	11.9	4.2		7.7			0.28		0.225	7.2			0.77	6.5
Total			4594	41.3	16.7	1.3	23.3	4.0		1.10	0.56	1.10	16.3	3.05	3.50	1.05	8.7

Note 1 Assumed Annual GNP Growth 2% p.a.

Note 2 Taken as 0.9 % of GNP

Note 3 Annual: National Roads €300m , Secondary Roads €300m, Rail Infrastructure€200m, Rail Rolling Stock Heavy Maintenance €35m

Note 4 M18 €550m, M11 €375m, N25 €375m

Note 5 Projects Listed in Governments Current Capital Programme

Note 6 50% of Costs of Projects Recommended by Academy or otherwise at Planning Stage

Note 7 Ditto

Note 8 €55m p.a.

Note 9 Blanchardstown - UCD €290m, Clongriffin-Tallaght, €220m

Note 10 Luas Cross City

Note 11 Customer Service System Improvements €70m, New Rail CTC and ATP €200m, 4 Track Cherry Orchard- Heuston €95m, Kishoge Container Terminal €13m, Limerick-Foynes €88m, Dart to Dublin Airport €260m, Intercity Line Upgrades €255, Dublin-Belfast Upgrade €225m

Note 12 Luas Cherrywood-Bray €280m, Red Line to Lucan €630m, Red Line to Poolbeg €140m

Table 4.2 Northern Ireland: Land Transport Funding Capacity

Year	GVA £bn Note 13	Period	Period GVA £bn	Funding Capac- ity £m Note 14	Period Maintenance Requirement £m Note 15	Available for New Works £m	Bus £m	BRT £m	BTC £m	Balance £m	Road Works £m	Uncommitted £m
2016	32.84	2016-20	169.2	1946	1090	856	75	120	200	461	461	0
2021	35.38	2021-25	182.3	2096	1090	1006	75			931	931	0
2026	38.11	2026-30	196.4	2258	1090	1168	75			1093	1093	0
2031	41.06	2031-35	211.6	2433	1090	1343	75			1268	665	603
Total			759.4	8733	4360	4373	300	120	200	3753	3150	603

Note 13 Assumed Annual GVA Growth 1.5% p.a.

Note 14 Taken as 1.15% of GVA

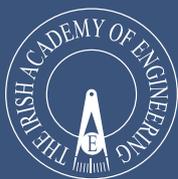
Note 15 Annual Roads £140m, Rail Infrastructure £58m, Rail Rolling Stock £20m

Note 16 Current Program A5 £229m, A6 £232m,

Note 17 Eastern Seaboard KTC £400m, North Western KTC Derry~Londonderry - Randalstown £531m

Note 18 North Western KTC £187m, Northern KTC Dromore-Templepatrick £600m, Western KTC Derry~Londonderry - Aughnacloy £306m

Note 19 Western KTC £665m



The Irish Academy of Engineering
22 Clyde Road, Ballsbridge, Dublin 4
Telephone: +353 1 665 1337
academy@engineersireland.ie
www.iae.ie

Published by: the Irish Academy of Engineering
ISBN: 978-0-9935995-3-8