Rialtas na hÉireann
Government of Ireland

Urban Transport Related Air Pollution
(UTRAP Group)
Interim Report- March 2021

Contents

Report Details

This document is the interim UTRAP report prepared as part of the work of the UTRAP group which is co-chaired by the Department of the Environment, Climate and Communications and the Department of Transport.

The report was published on the 26th of March, 2021.

List of Acronyms

AQIH	Air Quality Index for Health
BC	Black Carbon
BEV	Battery Electric Vehicle
CARO	Climate Action Regional Office
CAS	Clean Air Strategy
CSO	Central Statistics Office
DCC	Dublin City Council
DECC	Department of the Environment, Climate and Communications
DFIN	Department of Finance
DHLGH	Department of Housing, Local Government and Heritage
DMS	Demand Management Study
DoH	Department of Health
DPER	Department of Public Expenditure and Reform
DPF	Diesel Particulate Filter
DoT	Department of Transport
EEA	European Environment Agency
EPA	Environmental Protection Agency
EU	European Union
EV	Electric Vehicle
GDA	Greater Dublin Area
HDV	Heavy Duty Vehicle
HGV	Heavy Goods Vehicle
HSA	Health and Safety Authority

HSE	Health Service Executive
LA	Local Authority
LEV	Low Emission Vehicle
LEZ	Low Emission Zone
NECP	National Energy and Climate Plan
NMVOC	Non-Methane Volatile Organic Compounds
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxide(s)
NTA	National Transport Authority
O_3	Ozone
OELV	Occupational Exposure Limit Value
PHEV	Plug-in Hybrid Electric Vehicle
PM	Particulate Matter
PSO	Public Service Obligation
RSA	Road Safety Authority
SDCC	South Dublin County Council
SDG	Sustainable Development Goal
SDZ	Strategic Development Zone
SEAI	Sustainable Energy Authority of Ireland
SO_x	Sulphur Oxide(s)
TII	Transport Infrastructure Ireland
UTRAP	Urban Transport Related Air Pollution Group
WHO	World Health Organisation

1. Introduction

1.1. Establishment of UTRAP

The Urban Transport-Related Air Pollution Working Group (UTRAP) was formed in autumn 2019, to consider and address rising concerns about the level of transport-generated air pollution in certain areas.

Concern had been mounting that levels of NO_2 were approaching EU limit values in certain areas of Dublin. Work carried out by the EPA, including the Urban Environmental Indicators Report, served as an early warning of potential exceedances in EU limit values for NOx. While air pollutant emissions levels in Ireland were generally below EU limits in 2018[1], concerns remained regarding rising levels of transport-related air pollution in urban areas. The Urban Environmental Indicators report suggested that on certain heavily trafficked streets in Dublin, nitrogen dioxide (NO_2) levels were higher than previously indicated. NO_2 is an air pollutant that is strongly associated with traffic emissions and with older diesel vehicles in particular. The report indicated that at some locations (in Dublin city centre, on the M50 motorway and at the entrance and exit to the Port Tunnel), levels of NO_2 may exceed EU limit values.

The UTRAP Working Group was tasked with addressing the findings of the report as they related to transport-related air pollution. Its primary aims were to examine transport-related air pollution in urban areas and to develop an evidence-based national policy framework within which local authorities could address the projected exceedance and any future exceedances.

A Steering Group and Working Group were established. They included representatives from government departments and agencies and additional key stakeholders. A list of the members of both groups and an outline of the overall UTRAP work programme are provided in Appendix A.

[1] EPA (2019) *Air quality in Ireland 2018* pp. 4, 12, 20.

1.2 Overview of the EPA Urban Environmental Indicators Report

The EPA Urban Environmental Indicators Report highlighted three areas within Dublin as having particularly high recorded NO_2 levels that approached, and in some instances may have exceeded EU limit values. These were:

- certain city centre streets
- the M50 motorway
- the entrance to and exit from the Dublin Port Tunnel

Of these three areas, the first is an area of dense urban fabric with concentrated levels of traffic, while the two others are major instalments of the national transport infrastructure which accommodate high traffic levels and, in the case of the Dublin Port Tunnel, also handle approximately 50% of national freight activities. Within the city centre area, while NO_2 levels were elevated along particular carriageways (relative to lower levels in adjacent suburban areas), concentration levels in exceedance of EU limit levels were recorded by NO_2 diffusion tubes at three geographical hotspots. These hotspots formed clusters that were broadly centred on:

- Gardiner Street/Amiens Street and North Wall Quay in the north-east;
- Pearse Street in the south-east; and
- Victoria Quay/Wolfe Tone Quay/Dr Steven's Hospital in the south-west.

All three clusters are situated in the vicinity of Dublin's major urban rail stations (Connolly Station, Heuston Station and Pearse Station), which act as transport hubs where heavy rail, small public service vehicles such as taxis, bus and passenger car networks intersect.

In light of the elevated levels of NO_2 in these areas, the UTRAP Group work programme included a review of existing air pollution data and any mitigation measures put in place to address traffic-related air pollution at the M50 and Port Tunnel and Dublin's major railway stations. This review was undertaken on the understanding that, while at the time the potential NO_2 exceedance and the high NO_2 concentrations in these areas are Dublin-specific, an examination of lessons learned and an identification of potential data gaps associated with the management of air quality in and around these major Dublin transport infrastructure nodes could feed into ongoing programmes of air quality improvement in other Irish cities.

1.3 Objectives of the Group

The UTRAP Working Group was established to achieve six objectives. These are reflected in the Terms of Reference which were established for the group and which are summarised as follows:

1. Enhance awareness of clean air legislation and its requirements generally, and specifically in relation to NO_2 and other transport related air pollutants, amongst relevant stakeholder organisations
2. Provide a forum to enhance understanding of the causes and the health and environmental impacts of NO_2 air pollution and other transport related air pollutants in conurbations
3. Identify developments that may impact on NO_2 levels and other transport-related air pollutants in conurbations, e.g. evolving technical standards, and quantify the impact under likely future scenarios
4. Identify examples of best practice in combatting NO_2 air pollution and other transport-related air pollutants in conurbations, particularly road traffic-related air pollution, assess applicability and any barriers to their implementation in an Irish context
5. Consider a range of options for potential measures and any associated actions and supports required to facilitate their effective uptake to address NO_2 and other air pollution; identify measures most suitable to Ireland and appropriate implementation bodies
6. Present the final UTRAP recommendations to the Minister for consideration by Government

1.4 Purpose and Structure of the Interim Report

This report was developed to capture the first stage of work completed by the UTRAP group. A final report will be published when the Demand Management study has been completed and the group has had the opportunity to review and consider if there are additional recommendations from that study which should be incorporated into a final report. This interim report demonstrates the work to date, sets out the initial recommendations for actions and enables the implementation of these actions to begin.

The structure of this report broadly follows the work programme of the UTRAP Group as outlined in the Terms of Reference and as developed through the thematic structure of the

Group's meetings. The report comprises a review of the evidence base for transport-derived air pollution in Irish cities, including national data collection and modelling networks; an assessment of existing measures and policies for combating and reducing emissions from transport in urban contexts; and recommendations regarding additional measures and strategies that could reduce urban transport-derived emissions and assist local urban authorities in addressing any pollutant emission exceedances.

In addition to this introductory section:

Section 2 presents an overview of the public health impacts of air pollution, addresses the legislative and regulatory framework within which transport-related air pollution, and outlines the role of local authorities in addressing air quality issues.

Section 3 comprises an overview of the current profile of the Irish vehicle fleet operating in Irish cities, and outlines transport movements around key road infrastructure, in Dublin namely the M50 and the Dublin Port Tunnel.

Section 4 comprises an overview of the current evidence base and monitoring networks for assessing and identifying air pollution levels and the emissions attributable to traffic and the transport fleet. It also provides an overview of research in this area.

Section 5 outlines the "Avoid, Shift, Improve" principle which underpins the emissions reduction efforts which have taken place to date. It consists of a discussion of vehicle standards, taxation and the public transport fleet transition away from conventional fossil fuels to alternative fuel technologies, as well as measures taken at critical national infrastructure assets to assess and reduce emissions.

Section 6 provides an overview of the ongoing DoT Five Cities Traffic Demand Management Study.

Section 7 lists the recommendations arising from the work of the UTRAP Group to address urban transport-related air pollution in Ireland's cities and to provide a robust policy framework within which any potential future air pollution exceedances can be addressed.

2. An Overview of Air Quality in Ireland

Key to addressing transport-related air pollution is gaining a better understanding how air quality and urban transport currently intersect. This section includes (a) an overview of the public health impacts associated with air pollution in general, and with transport-derived pollution in particular; (b) the legislative and regulatory frameworks for air pollution monitoring and compliance in Ireland; and (c) an outline of air quality work ongoing in the Dublin region. To inform discussion, information was presented by the Health Service Executive (HSE), the EPA, DCC, DECC and DoT.

2.1 The Public Health Impacts of Air Pollution

The potential for poor air quality to cause adverse health effects and other environmental costs have been well documented, and, as noted by the European Environment Agency (EEA), the 'scale of policy actions undertaken in Europe to specifically address transport-related air pollution has increased over recent years, reflecting the important contribution that transport still makes to reducing air quality'[2]. Air pollution as a whole has been implicated in cancer, asthma, cardiovascular disease, diabetes, obesity and dementia, and poor air quality has been identified by the WHO[3] as 'a global health emergency'. Since the 1990s, better scientific understanding of the links between air quality and public health has led to an increased awareness of links between air pollution and both short and long-term health impacts, and of the need to reduce air pollution from all sectors. Currently, EU air quality standards provide for a minimum level of health protection, but evidence from the World Health Organisation indicates that human health impacts occur at air pollution levels below the current EU ambient air quality limits.

In the case of transport, the air pollutant most directly associated with traffic in high-density urban contexts is nitrogen dioxide (NO_2). NO_2 exists in the environment as a gas and is formed by a reaction between ozone, other radicals, and nitrogen oxide (NO), which is emitted during combustion processes. Sources of NO include the burning of fossil fuel in vehicle engines and by stationary combustion sources, such as industry and home-heating[4]. In towns and cities, where people are often close to traffic, vehicles are responsible for a

[2] Emissions of air pollutants from transport — European Environment Agency (europa.eu)
[3] https://www.who.int/health-topics/air-pollution#tab=tab_1
[4] EU CION (1997) *Position paper on air quality: nitrogen dioxide*, p. 7; see also WHO (2000) *Air Quality Guidelines – Second edition*, Chapter 7.1, pp. 1-2.

significant portion of localised NO_2 levels. As NO_2 is a precursor to the formation of other pollutants, such as ground-level ozone (O_3) and secondary $PM_{2.5}$, vehicles also contribute to overall ambient levels of these pollutants. Vehicle engines also emit $PM_{2.5}$ directly, and brake and tyre wear also contribute to levels of PM_{10} in the air. Medical studies have shown a link between higher concentrations of NO_2 and short and long-term impacts on breathing and the lungs, and a potential link between NO_2 and increased susceptibility to bacterial and viral infections[5].

2.2 Transport-Related Air Pollution

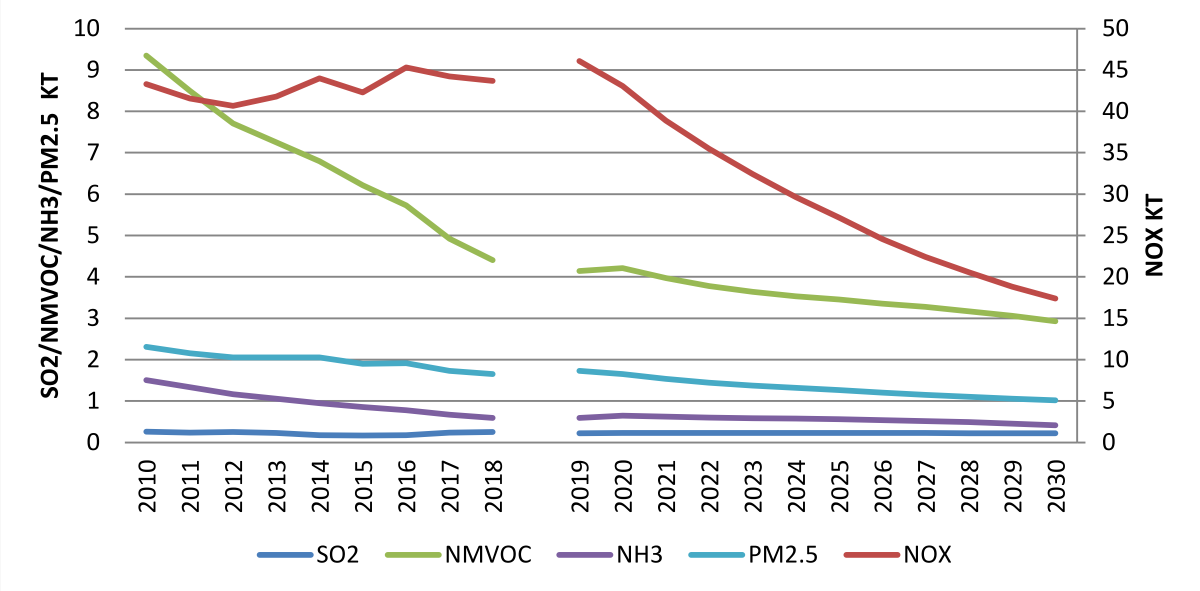
According to the European Environment Agency[6], levels of transport-derived air pollutant emissions significantly decreased between 1990 and 2017. In this period, levels of carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) emissions from transport reduced by up to 87% across the EU. Transport-derived sulphur oxides (SO_x) also reduced by c. 66%, during this period, while the levels of NO_x emitted by transport dropped by 40%. Since 2000, a reduction in particulate matter emissions from transport has also been recorded (44 % for $PM_{2.5}$ and 35 % for PM_{10}).

Figure 1 demonstrates the changing levels in the five pollutants in relation to the transport sector between 2010 and 2018 and the projected levels from 2019 to 2030. Overall reported emissions have decreased to date and are expected to decline even further over the next ten years.

NO_X levels have followed a similar pattern to the EU trend where between 1990 and 2018 levels reduced by c. 35%.[7] However Figure 1 demonstrates that these levels have changed little between 2010 and 2018. The impacts of existing policies and measures and those set out in the climate action plan are expected to have a significant impact on overall NO_x emission levels over the coming decade. The projected future decline is primarily attributed to a significant electrification of the national fleet.

[5] WHO (2000) *Air Quality Guidelines – Second edition*, Chapter 7.1., pp. 3-4..
[6] https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-air-pollutants-8/transport-emissions-of-air-pollutants-8
[7] http://www.epa.ie/pubs/reports/air/airemissions/ghg/nir2020/, see Chapter 2 'Trends'

Figure 1: Changing levels in the five pollutants in the transport sector 2010 and 2018 and projected levels 2019 to 2030



The reductions observed to date can be linked to improved vehicle standards, particulate matter abatement technologies and Fuel Quality Directives, plus localised transport policies aimed at improving air quality.

These decreases occurred in tandem with a rise in transport demand. This has meant that while the amount of pollutants emitted by individual vehicles has declined, emissions from transport have decreased less than was anticipated over the last two decades as more vehicles are on Ireland's roads. Rising traffic levels also mean that it is becoming increasingly challenging to maintain high standards of air quality in Ireland.

2.3 The EPA Air Quality Index for Health (AQIH)

In Ireland, pollution does not, in general, rise to levels at which people need to make significant changes to their habits to avoid exposure. Additionally, we have seen the beneficial impacts of reducing air pollution, for example as a result of the introduction and recent extension of the 'Low Smoke Zones'[8].

However, as the EPA's Urban Indicators Nitrogen Dioxide Report indicates, local conditions (including climatological events and proximity to emissions sources) can lead to relatively high ambient air pollution levels in some areas that may result in negative public health

[8] https://www.gov.ie/en/collection/77db4-low-smoke-zone-maps/

impacts. To provide members of the public with information on air quality in their local areas, the EPA has developed the Air Quality Index for Health[9] (AQIH). The AQIH provides real-time information on the quality of air at a number of locations in Ireland (currently 84), indicates whether or not this might have an effect on human health, and suggests actions that can be taken to avoid potential negative effects.

The AQIH does not distinguish between air pollutants or emission sources but it does map local air quality using a relative scale from 1 to 10 (where 1 is good and 10 is very poor).

A recent HSE and EPA study explored the relationship between the short-term Air Quality Index for Health and the acute hospitalisation for specific cardiovascular system and respiratory system diseases in Dublin city and county.[10] This study showed no correlation between cardiovascular admissions and air quality but noted a correlation between higher rates of admission to hospital due to respiratory disease and periods of fair to poor air quality as reported by the AQIH.

2.4 Air Quality Legislative and Regulatory Framework in Ireland

The main national legislative provisions to address air pollution in Ireland were introduced under the Air Pollution Act 1987 and it remains the primary basis for national legislation in this country. This Act sets out the statutory definition of air pollution and contains a general obligation to prohibit pollution along with powers to prevent it.

Over the years, the EU Commission has introduced legislation to ensure reduced emissions of air pollutants into the atmosphere and to limit maximum concentrations for pollutants in the ambient air that we breathe. These have been transposed into Irish legislation through a number of statutory instruments.

The Environment Protection Agency (EPA) is the designated competent authority for monitoring and assessing air quality in Ireland.

[9] https://www.epa.ie/air/quality/index/

[10] For an overview of this study, see Quintyne, K.I. (2019) 'Air quality and health: an Irish perspective', slide presentation made at the National Air Event 2019, link here.

To comply with EU regulatory requirements, air quality is assessed by two distinct but complementary methodologies: (1) compilation of national emission inventories and (2) monitoring of ambient air quality.

- **Emissions** are the overall atmospheric pollutants emitted from various sources across the economy, e.g. transport, agriculture, industry, power stations, waste and residential/commercial.
- **Ambient air quality** is the air in outdoor environments. Poor ambient air quality occurs when pollutants reach sufficiently high concentrations in a specific location to affect human health and/or the environment.

This report and the work of the UTRAP Group is primarily focused on those pollutant emissions that are associated with land transport in and around Irish cities, specifically those emitted by vehicular traffic and also by urban trains, which have a direct impact on our ambient air quality. The Group initially planned to include port-related shipping emissions in the work programme but due to the COVID-19 pandemic this was dropped. This is addressed later in the Report.

2.4.1 National Emissions Regulations

Annual emissions of atmospheric pollutants are primarily regulated under the National Emissions Ceiling Directive (2016/2284/EU) (NECD). This puts an annual permitted cap or 'ceiling' on total annual emissions of five key pollutants:

- Nitrogen Oxides (NO_x)
- Sulphur Dioxide (SO_2)
- Volatile Organic Compounds (VOCs)
- Ammonia (NH_3)
- Fine Particular Matter ($PM_{2.5}$)

The NEC Directive also sets national reduction commitments for the five pollutants listed above. Of these pollutants, those most closely associated with urban transport are NO_x, particularly NO_2, and primary Particulate Matter ($PM_{2.5}$).Transport emissions also contribute to overall NMVOC levels and to a small percentage of national NH_3 emissions, although the bulk of both of these pollutants and of urban $PM_{2.5}$ emissions come from other sectors (e.g.

industry, agriculture and home heating). A National Inventory Report is published each year by the EPA[11] and gives a detailed account of all emissions.

The NEC Directive set emission reduction commitments for Ireland for 2020 and 2030 for NO_x, SO_2, NMVOC, NH_3, and $PM_{2.5}$, and these are shown in the table below (Table 1).At a national level, recent analysis suggests that while ammonia and NMVOC targets will be very challenging to achieve, the 2030 NO_x reduction target will be met subject to the full implementation of Climate Action Plan targets, including electric vehicle targets[12].

Table 1: Emission Reduction Commitments under the NEC Directive

Pollutant	SO_2	NO_X	NH_3	NMVOC	$PM_{2.5}$
2020	65%	49%	1%	25%	18%
2030	85%	69%	5%	32%	41%

2.4.2 Ambient Air Quality Regulations

Ambient Air Quality legislation deals with the concentration of a pollutant at a specific place, at a specific time or over a specific period of time. The levels of pollution in ambient air are a result of the accumulation of emissions released from multiple and various sources such as vehicle emissions or emissions that result from the burning of fossil fuels in particular solid fuels such as coal, peat and wood in the home. Limits for ambient air quality are regulated under the Cleaner Air for Europe (CAFE) Directive (2008/50/EC).

Under the CAFE Directive the annual mean limits are set for several pollutants as demonstrated in Table 2 below. In addition, the World Health Organisation (WHO) guidelines also set non-binding guideline values which are similar or more stringent (Table 3).

---

[11] http://www.epa.ie/pubs/reports/air/airemissions/ghg/nir2020/
[12] EPA (2020) *Ireland's air pollutant emissions 2018 (1990-2030)*, p. 2, p.6, p. 23.

Table 2: Annual Limits for Ambient Air Pollution under CAFE Directive and WHO Guidelines

EU Air Quality Directive				WHO Guidelines	
Pollutant	Averaging Period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	Hourly			25 µg/m³	99th percentile (3 days/year)
$PM_{2.5}$	Annual	Limit value, 25 µg/m³		10 µg/m³	
PM_{10}	Hourly	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year	50 µg/m³	99th percentile (3 days/year)
PM_{10}	Annual	Limit value, 40 µg/m³		20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m³	
NO_2	Hourly	Limit value, 200 µg/m³	Not to be exceeded on more than 18 times a calendar year	200 µg/m³	
NO_2	Annual	Limit value, 40 µg/m³		40 µg/m³	

In Ireland, the annual average limit for Nitrogen Dioxide (NO_2) is 40µg/m^3. An hourly mean limit of 200µg/m^3 is also in place, which should not be exceeded more than 18 times a year in any specific location.

The EPA Air Quality in Ireland 2019[13] report published in September 2020 noted that there was an exceedance of the EU air quality limit value for NO_2 in Dublin. The exceedance was at the St. John's Road West station. An annual average concentration of 43µg/m^3 was measured in 2019; this is most likely as a result of the heavy traffic passing this monitoring station.

2.4.3 National Clean Air Strategy

The DECC is currently finalising Ireland's first National Clean Air Strategy. The Strategy will provide the policy framework necessary to identify and promote the integrated measures and actions across Government that are required to reduce air pollution and promote cleaner air, while delivering on wider national objectives.

There are a number of national policy frameworks already in place which will also help to reduce pollutant emissions and improve air quality, and the recommendations from the UTRAP group will play a part in delivering improvements in our transport related ambient air pollution. It is important that the synergies are maximised between this work and the Clean Air Strategy, with a view to achieving lasting reductions in the health and environmental impacts of air pollution in the most effective manner.

---

[13] https://www.epa.ie/pubs/reports/air/quality/epaairqualityreport2019.html

2.3 Local Authorities and transport related Ambient Air Quality

Under the Air Pollution Act, 1987[14] local authorities are required to take the best practicable means to prevent or limit air pollution that could negatively impact on the environment and human health within their jurisdictions. This means that, within the national legal air quality framework as outlined above, local authorities monitor and review air pollutant emissions arising from a range of air pollutant sources including machinery, plant, equipment, appliances, apparatus, buildings and other structures within the authority areas.

In the context of transport-related air pollutants, local authorities monitor NOx in partnership with the EPA, as is currently the case in Dublin and Cork. In Ireland, under the provisions of the CAFE Directive, if a breach of the EU limit values for pollutants occurs, the local authority with responsibility for the area within which the breach occurs is legally required to prepare an Air Quality Action Plan. In such plans, authorities are required to set out measures to be implemented in order to address the causes of exceedance, and to ensure compliance with EU limit values within as short a timeframe as possible[15].

In the case of Dublin, following a 2009 NO_2 EU limit level exceedance, the four local city and county authorities compiled and submitted an Air Quality Action Plan to the EPA in 2011[16]. The site of the exceedance in that year was on Winetavern Street in the city centre, where recent monitoring activities have also identified high NO_2 concentrations that are probably associated with high adjacent traffic levels. In that report, the participation of key transport stakeholders was seen as vital to the success of efforts to resolve the exceedance. It was also noted that NO_2 levels on Winetavern Street had increased at a time when overall traffic levels in the area had decreased, and it was suggested that the influence of localised climatic conditions or events may have been a significant factor in the exceedance[17]. Proposed measures to address the NO_2 exceedance included implementation of national spatial planning and land-use strategies; public transport expansion and fleet replacement;

---

[14] http://www.irishstatutebook.ie/eli/1987/act/6/enacted/en/print

[15] EEA (2019) *Europe's urban air quality: re-assessing implementation challenges in cities*, EEA Report No. 24/2018, p. 8.

[16] https://www.dlrcoco.ie/sites/default/files/atoms/files/media7432en.pdf

[17] Dublin Local Authorities (2011) *Dublin regional air quality management plan for improvement in levels of nitrogen dioxide in ambient air quality*, p. 4.

and the implementation of fiscal and other policies to reduce congestion and encourage modal shift away from car use and towards active and sustainable travel[18].

In 2013, Dublin was one of 12 European cities that participated in the joint EEA and European Commission Air Implementation Pilot project, which was undertaken as part of the EU's strategic efforts to improve the implementation and enforcement of EU environment legislation and which resulted in the publication of several international reports and communications[19]. A further aim of the project was to explore an enhanced role for the EEA in supporting that implementation. The Air Quality Implementation pilot examined five themes in air quality implementation, looking at: local emission inventories; computer modelling of urban air pollutant dispersal patterns; urban monitoring networks; city management practices; and the public availability of urban air quality information.

Despite the differences between the 12 participating cities, common themes emerged from the pilot. These included the challenges that cities faced during the implementation of quality improvement measures related to communicating air quality information. Other challenges identified included the difficulty of achieving coherent governance across various administrative levels, particularly in terms of analysing the co-benefits of measures implemented in the areas of climate change, noise, urban planning, and air quality[20]. In the case of Dublin, the postponement of major transport infrastructure projects in Dublin during the recession between 2007 and 2013 was also referenced during the pilot, as delays to these projects were identified as having a negative impact on the implementation of some air quality improvement measures in the city[21].

The four Dublin local authorities have also collectively joined the WHO, UN and World Bank-supported Breathe Life network. The network links 70 cities and regions, which have joined to demonstrate their commitment to bring air quality to safe levels by 2030, and to collaborate and share information on the clean air solutions that will help to achieve this goal as quickly as possible[22]. Sustainable transportation has been identified as a key plank of a

---

[18] Dublin Local Authorities (2011) *Dublin regional air quality management plan for improvement in levels of nitrogen dioxide in ambient air quality*, pp. 13-18.
[19] https://www.eea.europa.eu/themes/air/activities/the-air-implementation-pilot-project#:~:text=The%20Air%20Implementation%20Pilot%20was,EEA%20and%20the%20European%20Commission.&text=Both%20projects%20sought%20to%20explore,the%20European%20Union's%20environment%20policy.
[20] EEA (2019) *Europe's urban air quality: re-assessing implementation challenges in cities*, EEA Report No. 24/2018, pp. 4-5
[21] *Ibid*., p. 12.
[22] https://breathelife2030.org/about/

Dublin-wide approach to air quality, and strategies adopted in this regard include the trialling of car-free shopping streets[23] as part of Dublin City Council's Covid-19 Mobility Strategy.

Key options for local authorities include

- Creation of Low Emission Zone (LEZ);
- Improvement of public transport;
- Promotion of cycling;
- Management of traffic flow;
- Change of speed limits;
- Investment in technology to reduce emissions from public transport.

Recommendation	
1	UTRAP Group to determine most appropriate ways to support the development of the Air Quality Action Plan for Dublin Agglomeration (Zone A).

[23] https://breathelife2030.org/news/dublin-trials-car-free-streets-part-covid-19-recovery/

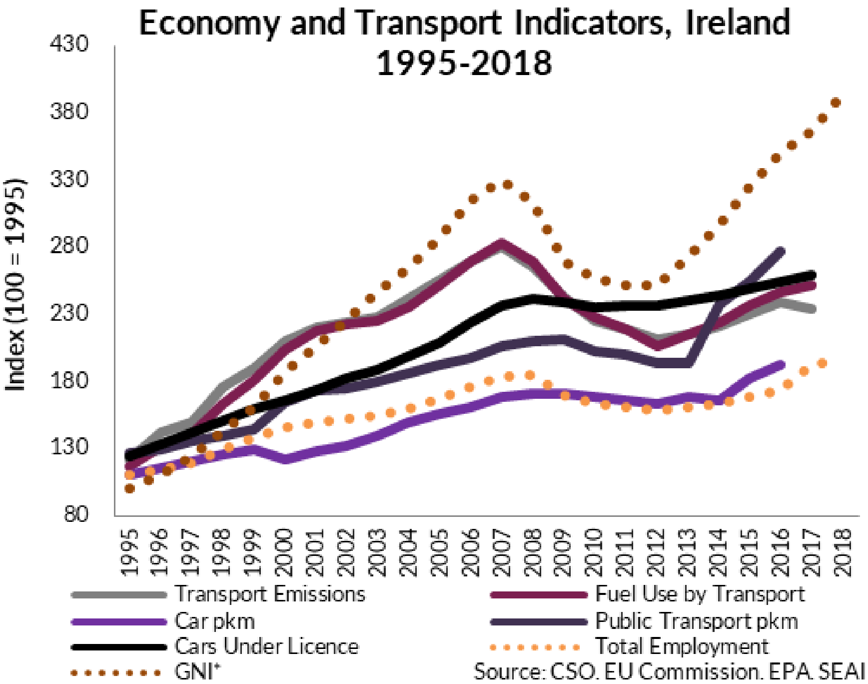
3. An Overview of Transport in Ireland

In Ireland, due to our historically dispersed settlement pattern, low population densities and dependence on fossil fuels[24], the transport sector as a whole has a significant impact on national emission levels. For example, in 2018, Ireland's vehicle fleets accounted for 20.1% of the country's total CO_2 emissions[25] but for approximately 41% of Irish nitrogen oxide (NO_X) emissions in the same year[26]. Diesel-fuelled engines and older diesel engines in particular, while emitting lower levels of GHG, emit more NO_2 than their petrol equivalents[27], although both types of engine are a source of NO_2 and other NO_x.

3.1. Profile of the Irish vehicle fleet

The make-up of the Irish vehicle fleet plays a significant role in determining local ambient air pollution levels. Nationally, over 2.8 million vehicles were registered and taxed in Ireland at the end of December 2019, representing an increase of more than 88,000 from December

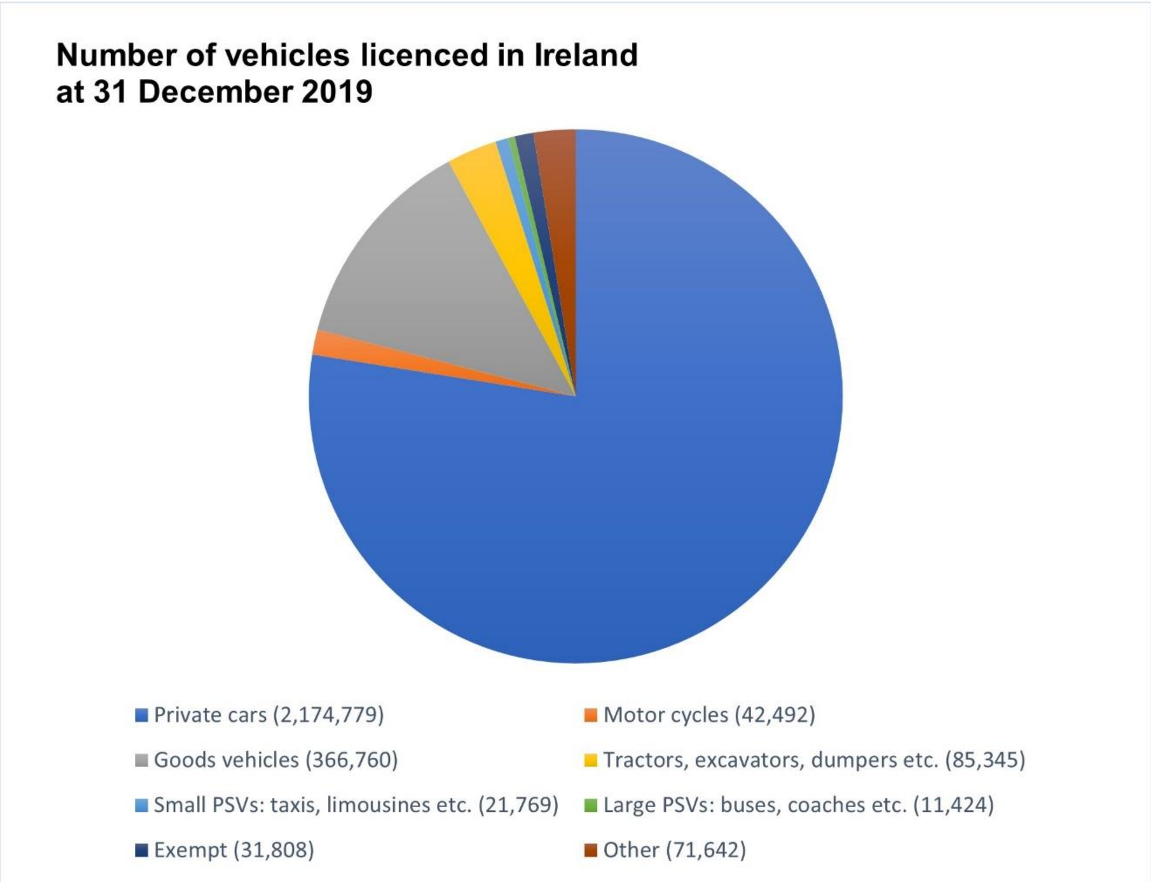
Figure 2: Economy and Transport Indicators for Ireland (1995-2018)



[24] See Government of Ireland (2019) *Climate Action Plan 2019 to tackle climate breakdown*, p. 85; see also DTTAS (2019) *Sustainable Mobility Policy Review Background Paper 3: Climate change challenge*, p. 13.
[25] EPA (2020) *Ireland's final greenhouse gas emissions 1990-2018*, p. 3.
[26] EPA (2020) *Ireland's Informative Inventory Report 1990-2018*,
[27] EEA (2017) Explaining road transport emissions: a non technical guide, pp.

2018[28]. Since 2014, there has been an annual rise in the numbers of vehicle registered and on the road[29], driven by and coinciding with economic recovery from the effects of the recession, and linked to the rise in NOx emissions. Initial reports show that this trend continued in 2020 despite a 25% drop in new car registrations due to the COVID-19 pandemic. A positive trend is that new electric vehicle (EV) registrations have bucked the general downward trend in registration and more new EVs were bought in 2020 than in 2019.[30] The relationship between trends in the economy and transportation is demonstrated in Figure 2 above.

Figure 3: Number of vehicles licenced in Ireland at 31 December 2019 by vehicle type (from CSO figures)



Private passenger cars accounted for over three quarters of the vehicles on the road in 2019 (Figure 3), and for almost three quarters of the journeys that people made, either as drivers

[28]CSO Transport Omnibus 2019, Vehicle licencing and registrations.
[29]https://www.cso.ie/en/releasesandpublications/ep/p-tranom/transportomnibus2018/roadtrafficvolumes/
[30] https://www.simi.ie/en/news/2020-new-car-registrations-down-25

or as passengers[31]. Nearly 57% of the more than 2.17 million cars under taxation in that year ran on diesel[32]. While the number of cars registered in each county does not always reflect where each car is being driven, the greatest numbers of cars on the road were registered in counties with high urban populations.

Table 3: Number of private cars taxed by county on 31 December 2019[33]

County	Number of private cars taxed
Dublin	550,538
Cork	264,891
Galway	117,681
Rest of Ireland	1,241,669

3.1.1 Taxis and Small Public Service Vehicles

By the end of January 2020, the percentage of vehicles in the national taxi and Small Public Service Vehicle (SPSV) fleet running on diesel had reached over 82%. Statistics relating to the taxi fleet showed a similarly high concentration of vehicles in Dublin: two thirds of the 21,326 vehicles in the national taxi fleet were registered in the county. Although not all operate there, the high numbers of taxi drivers licenced and certified (as having passed the 'Area Knowledge Test') in Dublin suggests that the Greater Dublin Area (GDA) is the primary focus of taxi operations at a national scale.

3.1.2 Heavy Goods Vehicles

Post-recession, there has also been a steady increase in the number of Heavy Goods Vehicles in the national vehicle fleet, and greater levels of road freight activity have been registered. It is predicted that this trend will accelerate in the next decades, with future demand for freight expected to nearly double (*c.* 91%) in kilometre tonnes by 2050, surpassing the previous Celtic Tiger peak of freight activity in less than a decade. Vans and light trucks are currently by far the most numerous type of goods vehicle on the road. At the

[31] https://www.cso.ie/en/releasesandpublications/ep/p-nts/nationaltravelsurvey2019/howwetravelled/
[32] *Irish Bulletin of Vehicle and Driver Statistics 2010*, p. 25, Table 13.
[33] https://www.cso.ie/en/releasesandpublications/ep/p-tranom/transportomnibus2019/vehiclelicensingandregistrations/

end of 2019, they accounted for nearly three quarters (72.4%) of the goods vehicles registered in Ireland[34].

Despite being much more numerous on Ireland's roads, however, these lighter duty vehicles were responsible for just 2.4% of total freight activity. Most of the heavy hauling of goods is carried out by larger vehicles of over 10 tonnes unladen weight, with the heaviest trucks (over 12.5 tonnes unladen weight) responsible for nearly 65% of freight activity measured in tonne kilometres. This is despite the fact that these heaviest Heavy Duty Vehicles (HDVs) account for just under a twelfth (11.9%) of the total number of Irish goods vehicles.

3.1.3 Bus Fleet

Ireland's bus fleet shows a similar variability and diversity in terms of numbers, vehicle types and operating patterns. At the end of 2019, 11,424 miscellaneous minivans, buses and coaches were under taxation in Ireland and almost 100% of these were diesel-fuelled. A relatively small percentage of these (1,325 or 11.5%) were used to provide scheduled commercial bus services around the country, accounting for almost 9.3% of all public transport passenger journeys. As noted in a 2019 NTA bulletin:

> 'Commercial bus services cover large scale inter-city and interurban bus services which provide connections to and from the country's main towns, cities and airports; commuter services that bring passengers to employment and education; urban and suburban services; as well as rural services that generally link small towns and villages in rural areas[35].'

Once again, the GDA was a primary focus of operations, with almost 71% of these commercial bus services being offered in Dublin and adjoining counties.

By far the largest number of bus trips taken by passengers in Ireland is accommodated by transport services funded under the national Public Service Obligation (PSO) bus fleet. PSO services include Dublin Bus, Bus Éireann and Go-Ahead, among others. In 2018, 178 million

---

[34] CSO *Road Freight Transport Survey*, Quarter 4 and Year 2019, see section on 'Road freight tonnage increased by 6.3% in 2019' and Table 7.

[35] https://www.nationaltransport.ie/wp-content/uploads/2019/11/Commercial_Bus_Services_2019_V5.pdf, p. 9.

passenger journeys were made on bus services alone. Of these, approximately 140 million passenger journeys were made on Dublin Bus services, while approximately 22.9 million journeys were made on the Bus Éireann urban and regional fleets. The total urban bus fleet operating in the five largest cities at the end of 2018 consisted of 1,322 single and double-decker buses[36].

Table 4: Number of buses in each PSO Service

Service	Number of Buses 2018
Dublin Bus	987
Go-Ahead (Dublin)	125
Bus Éireann	210

Table 5: Locations of Bus Éireann PSO buses

Location	Number of Buses 2018
Cork	120
Galway	36
Limerick	30
Waterford	24

The age profile of the PSO buses varied from city to city but in all five listed above, at least half were the most recent EURO VI standard, rising to 79% EURO VI in Waterford and 90% EURO VI among Go Ahead's fleet of 125 Dublin PSO buses.

3.1.3 Irish Rail

Irish Rail has also seen continued growth in passenger numbers since 2013, primarily due to the expanding national economy. Data from the NTA indicates that heavy rail intercity passenger journeys increased by 23.5% between 2013 and 2018[37], with a 4.4% growth in

[36] DTTAS (2019) *Sustainable Mobility Policy Review Background Paper 5: Greener buses – alternative fuel options for the urban bus fleet*, p. 13
[37] NTA (2019) *Bus and rail statistics for Ireland – state funded services, Statistical bulletin 03/2019*, p. 11.

2019, bringing passenger journey numbers across the entire heavy and light rail network to 50.1 million in that year[38].

Services within the Greater Dublin Area (GDA), including the fully electric DART network as well as heavy-rail commuter services to Dublin are the core drivers of rail passenger numbers in Ireland. In 2017, 20.1m and 12.7m journeys were recorded on these services respectively. In 2019, 85% of the total number of rail trips made were within the GDA; passengers made 78,689 journeys a day on DART services, with the rail lines from Dundalk, Longford and Kildare together accommodating a further 71,983 daily passenger journeys[39]. In 2017 here was a 14% increase in daily journeys in the GDA alone bringing the number of trips per day to 141,000, with a further 8% increase between 2017 and 2018. This growth levelled off in 2019, with a slight decrease (c. 0.5%) in overall passenger numbers attributed to a 4.5% decrease in DART passenger journeys in 2019[40]. Despite this decrease, daily passenger trips on the network remained above the pre-recession peak of 2007.

Other mainline services accounted for a further 11.6m journeys in 2017 while the Enterprise service to Belfast had nearly 1.2m journeys. These numbers are projected to increase further with the implementation of the planned DART Expansion Programme, which has been identified a key element of the transport strategy for the GDA. When completed, the expanded DART network will see the provision of electrified rail services on the Dublin Commuter routes extending to Drogheda to the north, Maynooth and Celbridge to the west and Greystones to the south.

As discussed in Section 4, the exact impact trains have on air quality in urban areas is unclear. Given that the majority of intercity rail services are diesel-fuelled, it is possible that trains contribute to ambient NOx and air pollutant levels in urban areas adjacent to heavy rail infrastructure.

[38] NTA (2020) *Bus and rail statistics for Ireland – state funded services, Statistical bulletin 02/2020*, p. 6.
[39] NTA (2020) *National rail census report 2019, statistical bulletin: 01/2020*, p. 15, p. 9.
[40] NTA (2020) *National rail census report 2019, statistical bulletin: 01/2020*, p. 8.

3.2. Vehicle movements in and around Ireland's cities

As indicated by the registration and public transport configurations described above, transport patterns in Ireland as a whole are not uniform. They reflect not just differences in population densities, but also the proximity of people's homes to public transport systems and the numbers and types of vehicles travelling along different roads at different times. The general pattern that emerges is that a higher number of vehicles on the road lead to higher levels of congestion, longer journey times and higher levels of vehicle emissions. On average, in the GDA, while journey lengths were shorter than elsewhere in the country (9.5km per journey in 2019 as opposed to 15.3km in other regions) the journeys themselves took longer[41], reflecting the growing challenges posed by traffic congestion in the region as a whole[42]. Increased traffic congestion levels have also been recorded and addressed in recent years in other cities, notably in both Cork (particularly on the N40 Southern Ring Road[43]) and Galway[44], contrasting with relatively low congestion levels on the rural road network in both counties.

On a daily basis, traffic congestion patterns mirror the movements of large numbers of people during the working week and into the weekend, as they routinely enter cities and towns to work, shop, socialise and carry children to and from school. While patterns have altered due to the ongoing COVID crisis, in recent years, peak periods on the national road network have extended outwards due to pressures of increased demand and congestion. In the morning, the peak period lasts between 6.30am and 9.30am, while in in the evening, the peak covers the period between 3.30pm and 6.30pm[45]. Not all people moving through Ireland's cities use cars and other vehicles to get around, however, with significant numbers of people entering and circulating within cities on foot or by bicycle[46]. In urban areas 'there is a consistently greater modal share for active travel in densely populated areas where travel by foot or bicycle were 2.3% and 0.6% higher respectively than at aggregate level[47].

---

[41] CSO *National Transport Survey 2019*, 'Overview and key findings', Table 1.6.
[42] TII (2019) *National Roads Network Indicators 2018*, pp. 9-11, p. 23.
[43] TII (2020) *National Roads Network Indicators 2019*, p. 2, p. 15.
[44] For information on Cork city congestion, see Cork City Council website, 'Transport for Cork City', FAQs pages; for information on Galway city traffic congestion, see Galway City Council *et al*. (2016) *Galway Transport Strategy Executive Summary Report*, p. 7.
[45] TII (2020) *National Roads Network Indicators 2019*, p. 2.
[46] And see CSO National Travel Survey 2019, chapters on 'Walking' and 'Cycling' for an overview of national statistics relating to active travel.
[47] DTTAS (2019) *Sustainable Mobility Policy review Background Paper 2: Active Travel*, p. 20

In Irish cities, therefore, greater numbers of people share space for longer periods at higher densities. This has obvious implications both for the levels of vehicular air pollutants emitted and for the health of those exposed to those pollutants. For example, in 2019, the NTA's Canal Cordon count[48] indicated that over two mornings in November, at morning rush hour, an average of 46,388 cars, 4,292 taxis, 1,852 buses and 983 goods vehicles travelled inbound on some of the major arteries leading into Dublin city centre. During the same rush hour period, 24,691 people walked into the city, while a further 13,131 people cycled in. Of these figures, the number of buses travelling into the city is of particular interest as it represents a significant portion of the overall national and urban bus fleet. Buses overall account for only 3.4% of Ireland's CO_2 transport emissions, but as they are disproportionately highly represented on the streets of Irish cities, they represent a potentially significant source of urban air pollutant emissions.

Overall, the volume of goods vehicles crossing the cordon has remained relatively static between 2009 and 2019. Over the longer period from 2006 to 2019 however, the number of goods vehicles crossing the cordon has decreased by almost half. Most of that decrease (70%) occurred in the period 2006-2007 and coincided with the opening of the Dublin Port Tunnel in 2006 and the implementation of the HGV Management Strategy in 2007'[49]. This strategy involved banning 5+axle heavy duty trucks from driving within the city centre and was responsible for a welcome improvement in public safety and air quality in the city. The strategy demonstrated the effectiveness and co-benefits that can result from the use of targeted local measures to address interlinked air quality, congestion and other transport-related issues. The strategy also demonstrates the necessity for considering negative trade-offs in the design of emission reduction measures. Subsequent studies suggested that, after the introduction of the 5+axle ban in Dublin, trucks travelled longer journeys on average, resulting in an overall rise in NO_2 emissions in the wider city area[50].

[48] NTA (2020) *Canal cordon report 2019: report on trends in mode share of vehicles and people crossing the canal cordon*, p. 7.
[49] NTA (2020) *Canal cordon report 2019: report on trends in mode share of vehicles and people crossing the canal cordon*, p. 14.
[50] Yang et al. (2016) 'An evaluation of the impact of the Dublin Port Tunnel and HGV management strategy on air pollution emissions'.

3.3 The M50 and Dublin Port Tunnel

The M50 motorway is a 40km long C-shaped orbital motorway with 15 junctions that circles the northern, western and southern suburbs of Dublin, and that connects all of the national primary routes to the capital (Figure 4). It is a key national freight corridor, and it facilitates local, inter-urban and business as well as freight trips. It also performs several functions as a strategic national inter-urban corridor including direct linkage to Dublin Airport and Dublin Port through the Dublin Port Tunnel. In 2019, it was the most heavily trafficked length of road in the national network, with 'nearly 150,000 vehicles using several sections on an average day'[51].

Responsibility for the safe and efficient operation of the M50, and of the wider national road network, lies with Transport Infrastructure Ireland (TII). Through its commitment to ensuring that Ireland's national road and light rail infrastructure is safe, sustainable and resilient[52], and as part of its environmental sustainability activities, TII operates a network of NO_2 and noise pollution monitors along the M50 (see Section 4.1.4). The following information is based on analysis of traffic and emission patterns collated by TII from monitoring data and from traffic count numbers, and presented to the UTRAP group as part of its work programme.

3.3.1 Traffic movements on the M50

Some 44% of trips taken on the M50 involve journeys of less than 20km (equating to approximately one to two junctions) with only 4% of trips involving travel along the entire length of the motorway from end to end (M1 to M11)[53]. The average M50 trip length is c. 12km. On a daily basis, the M50 accommodates an average of 150,000 vehicles on its busiest segment, which extends between the junctions with the M4 and M7 routes to the west and southwest of the city. The numbers of vehicles travelling on each segment of the motorway between the 15 junctions varies on a daily basis, with the lowest overall average percentage of trips occurring in the southernmost section (Junction 16 to M11). This pattern correlates with higher numbers of journeys taken by trucks on the northern to southwestern portions of the M50 in part due to the use of the Port Tunnel by trucks travelling to and from Dublin Port. In 2019, approximately 24,000 vehicles per day used the tunnel, of which 39%

[51] TII (2020) *National Roads Network Indicators 2019*, p. 13.
[52] https://www.tii.ie/tii-library/statements-of-strategy/statement-of-strategy-2019-2023/TII-Statement-of-Strategy_Approved_May_2019.pdf
[53] TII (2020) *National Roads Network Indicators 2019*, p. 13.

were Heavy Goods Vehicles (HGVs). Commuter journeys make up most of the trips taken on the southern sections of the motorway.

While the annual traffic growth rate on the M50 averaged 5% per annum since 2013, the growth rate had reduced toward 2019. There were similar growth rates on the radial routes into Dublin. In the case of the Dublin Port Tunnel, traffic growth between 2017 and 2018 was 6%. The performance of the M50 is significantly impacted by the morning and evening commuting patterns on a typical working day, with peaks occurring between 6am to 10am and from 3pm to 6pm. This congestion has a consequential impact on vehicle performance and the levels of vehicle emissions. Analysis of key movements of M50 users (extracted from the National Transport Authority's Eastern Regional Model) shows an orbital pattern with very limited radial connections. This contrasts with the pattern of existing public transport trips and service routes, which predominantly extend radially from the city centre outwards.

Figure 4: Annual Average Daily Traffic (% Heavy Goods Vehicles) on M50 in 2019 (Source TII)

3.3.2 Dublin Port and Tunnel

Prior to the outbreak of COVID-19, it was originally intended that the UTRAP group would also consider information on other transport infrastructure. This would include preliminary data which was to be generated during the development of a proposed EPA/DoT co-funded study of the apportionment of air pollutant emissions from various sources (e.g. vehicular, maritime, industrial and other) in the vicinity of Dublin Port. However, due to COVID-19, this project was postponed.

4. Air quality monitoring, modelling and research

This chapter reviews existing national and local air quality monitoring and modelling networks. These networks provide the baseline evidence used to calculate ambient air pollutant levels across the county and at particular locations, and to assess the impact of measures introduced to reduce these levels. The close link between ambient NO_2 emissions and traffic means that tracking NO_2 as well as other traffic-related pollutants such as $PM_{2.5}$ is key to assessing the levels of emissions from the land transport sector, and disaggregating these from emissions from other sources and sectors (e.g. home-heating, industry and agriculture). Data from research on identifying the profile of emissions from vehicles as well as on identifying traffic-specific pollutant emissions and levels also form the backdrop against which the effectiveness of existing and proposed mitigating measures can be assessed.

Contributors to the work of the Group in this area included stakeholders responsible for national and traffic emissions monitoring and modelling networks, including the EPA, NTA and TII. The Group reviewed the existing national air pollutant monitoring and modelling framework with a particular emphasis on the monitoring of NO_2 and considered:

- how the national network intersects with transport-specific air pollutant monitoring networks what overlaps and gaps in information exist and how these intersect with on-going research projects
- how identified information gaps can be addressed
- how to leverage existing networks to strengthen the collection of transport-specific data
- areas of potential future action
- and how to increase stakeholder and public awareness of traffic-related pollution and its impacts

Presented here is a summary overview of current land transport-related air quality monitoring and modelling networks and activities as presented to the UTRAP Group. Also contained are the Group’s recommendations, which aim to address identified knowledge gaps and to strengthen future traffic-related emissions monitoring, modelling and research activities. The overall aim of these recommendations is to improve the identification and quantification of land-transport-derived emissions, and to strengthen the evidence base for assessing the effectiveness of existing and proposed measures to reduce these emissions.

4.1. Monitoring networks and activities

4.1.1 The national ambient air quality monitoring network

The EPA is responsible for overall air quality monitoring within the state and manages the National Ambient Air Quality Monitoring Network as well as the roll-out of the National Ambient Air Quality Monitoring Programme (AAQMP) 2017 - 2022[54]. The programme was built around three key pillars, namely:

- A greatly expanded national monitoring network, providing enhanced real-time information to the public;
- Modelling and forecasting capability, to provide an ongoing air quality forecast to the public;
- Encouraging greater understanding and involvement of the public in air quality issues utilising citizen engagement and citizen science initiatives.

This network of monitoring stations is currently undergoing a significant upgrade which will expand the number of stations from 29 in 2017 to 107 (by end of 2022). As of December 2020, 86 monitoring stations were operational across the country. The information collected at the stations is gathered in accordance with the requirements set out in EU air quality directives, which govern air quality standards in Ireland as outlined in Chapter 2. These directives also outline how ambient air quality is monitored, assessed and managed and they also require member states to designate "Zones" for the purpose of managing air quality.

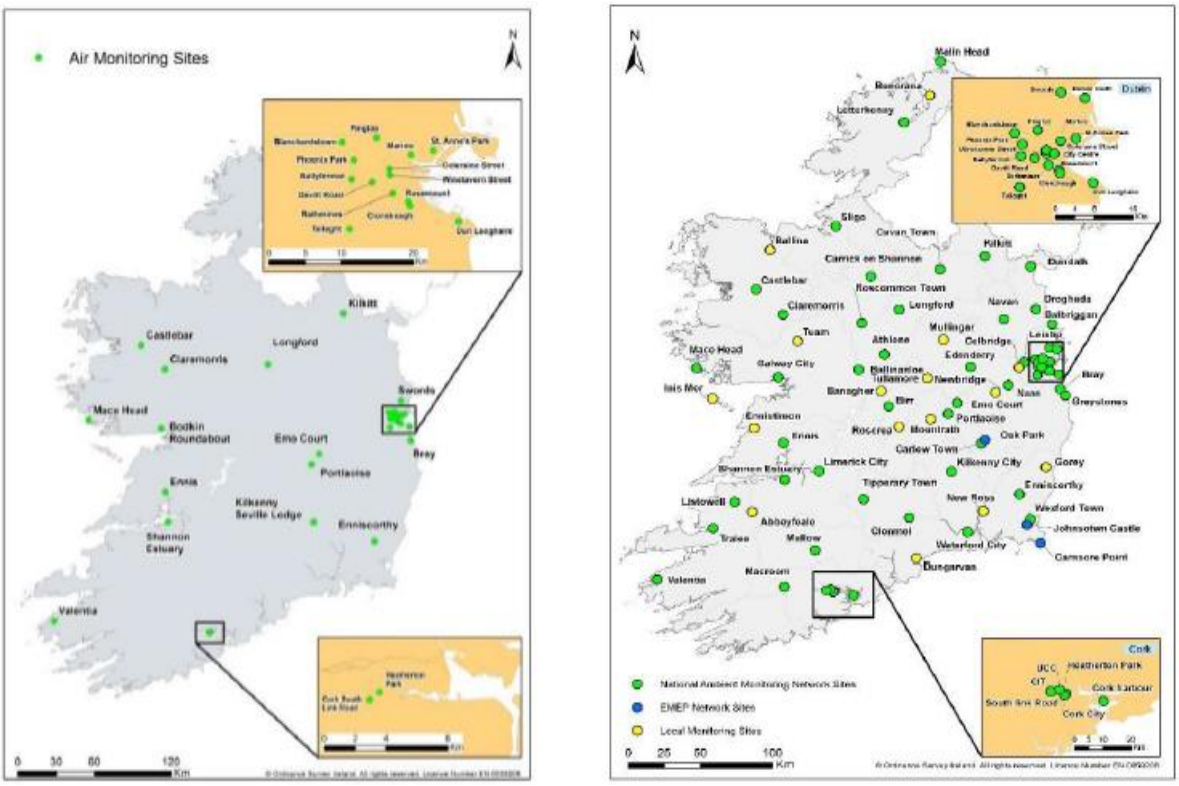
For Ireland, four zones were defined in the Air Quality Standards Regulations (2011)[55]. Three of these zones cover Ireland's larger cities, with Dublin designated as Zone A, Cork as Zone B, a range of other cities and larger towns collectively designated as Zone C, and the remainder of the State outside of the cities (i.e. 'Rural Ireland') designated as Zone D[56]. The maps below (Figure 5) show the total number of stations in Ireland in 2016, prior to the new AAMP getting underway. Figure 5 shows the location of stations once full roll-out of programme has been completed.

---

54 https://www.epa.ie/pubs/reports/air/quality/epanationalambientprogramme.html
55 http://www.irishstatutebook.ie/eli/2011/si/180/made/en/print#
56 https://www.epa.ie/air/quality/zones/

Once completed, significant clusters of monitors will be located in both Dublin and Cork, as well as in other Irish cities and towns. The programme also involves the upgrading of the original network of 29 stations to include real-time monitoring of PM under the provisions of the CAFE Directive. Additionally, in urban areas, 26 of the EPA operated national monitoring stations include NO_2 monitors situated at traffic orientation sites, which collect information on localised NO_2 levels at particular sites within Ireland's cities.

Figure 5: Monitoring Stations pre AAMP and Stations following full roll-out of AAMP



The EPA also gathered additional information on traffic-related urban air pollutant levels in conjunction with local authorities in the largest Irish cities. Under this programme, non-permanent localised networks of NO_2 diffusion tubes were established in urban areas over a set timeframe between 2016 and 2020. Whilst the diffusion tube method is useful for gathering information on localised NO_2 concentrations, the results that they produce are 'indicative' rather than definitive. This means that they only give an estimate of longer-term average NO_2 concentrations rather than definitive information on NO_2 levels at specific times.

The joint EPA/local authority diffusion tube monitoring programme, which was impacted by COVID-19 restrictions, involved the establishment of seven NO_2 diffusion tubes in Waterford in 2018; 15 were planned to be operation in Galway in conjunction with Galway City Council in 2020; 14 in Limerick in 2020; with a further 20 in Cork in 2019. Of the Cork diffusion tubes, four which were located at Glanmire Road with a fifth on Washington Street were left in place until March 2020. Four of the national networks monitoring stations installed across Cork City Council's functional area currently provide live, continuous air quality data, of which two collect information on NO_2 and O_3 levels[57]. Levels at these stations provide an indication of adjacent traffic-related air pollutant emissions levels, and broadly correlate with the volumes of traffic reported in the vicinity of the station.

While the indicative results of the NO_2 diffusion tubes provide a valuable picture of emissions levels in their vicinity over set periods of time, as CAFE Directive-compliant monitoring sites, the EPA fixed site network represents the most accurate data source for emissions. Data collected at these sites is also used to identify the occurrence of EU air pollutant level exceedances. In 2019, one exceedance of the EU annual limit value for NO_2 was recorded at St John's Road West in Dublin[58]. All other concentrations observed at the remaining monitors located at national traffic orientation sites that recorded NO_2 data in that period were below the annual average EU limit values of 40µg. It should be noted, however, that not all of these monitors are located in urban areas; for example, in 2019 there was no fixed EPA traffic orientation site gathering information on NO_2 in Galway city, although the expansion of the national monitoring network included the planned establishment of a traffic monitoring site as well as city centre NO_2 monitors in that city.

The ongoing expansion of the EPA's NO_2 monitoring programme through the national air quality monitoring network in Ireland's cities, as well as the roll-out of EPA-supported local indicative NO2 monitoring programmes, was therefore identified by the UTRAP group as being crucial to accurately gauging the extent of transport-related pollution. Results from these programmes together allow patterns of emissions to be established that can be related to data on national and urban vehicle fleet profiles. They also provide the baseline data through which the effectiveness of policy measures implemented to reduce urban transport-related air pollutant emissions can be assessed.

	Recommendation
2.	The EPA and relevant stakeholders to identify and support targeted indicative monitoring programmes at areas of recorded or suspected high transport-related air pollutant-emissions levels in urban areas, to feed into the development of policy measures and the expansion of air pollutant modelling activities.

[57] https://www.corkcity.ie/en/council-services/services/environment/air-quality/air-quality-monitoring-program.html

[58] EPA (2020) *Air Quality in Ireland 2019 report*, p. 18.

4.1.2 Localised traffic-related air quality monitoring networks and activities

In addition to the national ambient air quality monitoring network operated by the EPA, other state agencies and some local authorities also engage in transport-focused air quality monitoring activities, which represent an additional source of information on NO_2 levels at particular points on Ireland's road network. In the case of road infrastructure-related monitoring, the backdrop to these activities was the publication in 2011 of the National Road Authority's *Guidelines for the treatment of air quality during the planning and construction of National Road Schemes*[59]. These guidelines were underpinned by a three-year post EIA air quality study on major national roads. All new national roads are assessed in accordance with the guidelines and the 2011 Air Quality Standards Regulations. Of the standards set out in the Regulations, those for NO_x, PM_{10} and $PM_{2.5}$ are considered to be most relevant for the assessment of national road schemes.

Information on the following air quality monitoring programmes was presented to the UTRAP Group, and the added value that these activities brought to the national monitoring programme was discussed as part of the Group's work programme.

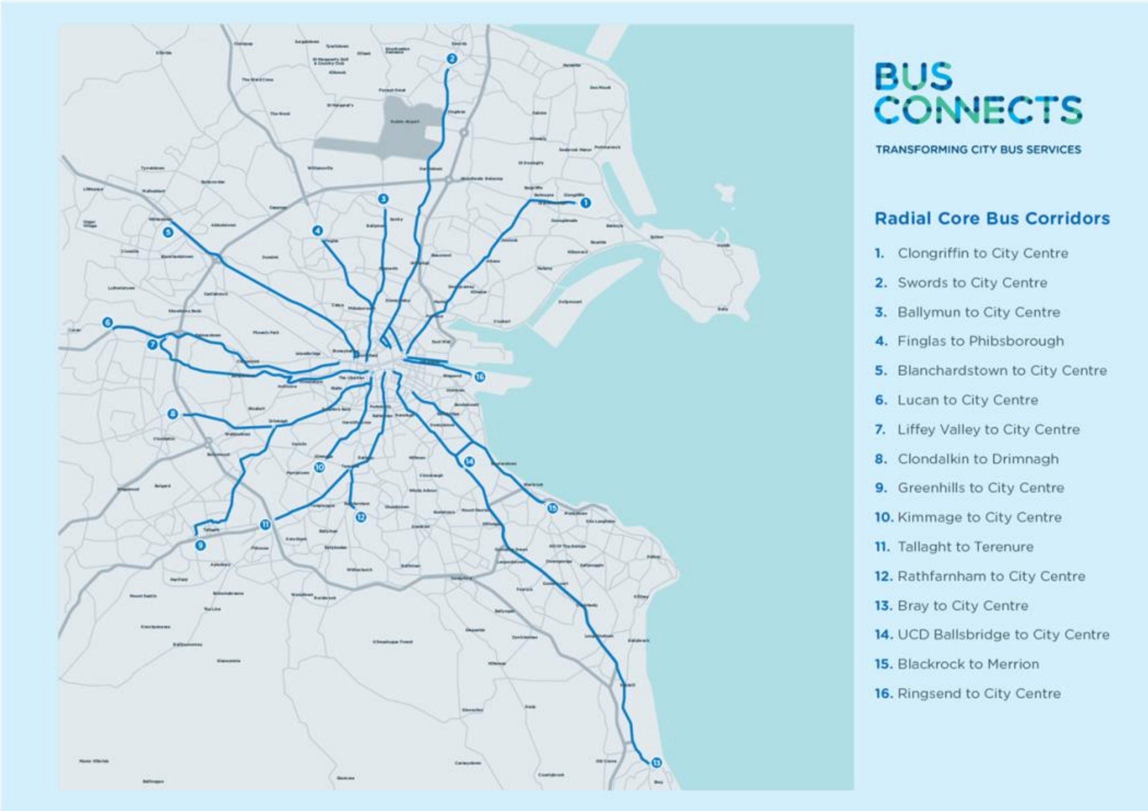
4.1.3 NTA air quality monitoring

In advance of the roll-out of the BusConnects[60] project, which will improve and expand bus services in all our major cities, the NTA is preparing an Environmental Impact Assessment Report (EIAR) for the sixteen radial Core Bus Corridors (CBCs) planned for the Greater Dublin Area. These corridors generally follow the line of the major traffic arteries leading from Dublin's hinterland into the city centre. As part of this assessment, it was proposed that a baseline model for the current air quality conditions along each corridor would be established. To develop this baseline, in November 2019 the NTA's Environmental Impact Assessment Report (EIAR) team set up approximately 120 air NO_2 diffusion tube stations along all 16 CBCs. The timeframe for the operation of these monitors was six months, with monitors to be removed in May 2020.

---

59 https://www.tii.ie/technical-services/environment/planning/Guidelines-for-the-Treatment-of-Air-Quality-during-the-Planning-and-Construction-of-National-Road-Schemes.pdf
60 https://busconnects.ie/media/1767/big-picture-map-a0-241019-fa-web.pdf

Figure 6: Bus Connects core corridors



Monitor locations were chosen in consultation with all four Dublin local authorities, with 83 diffusion tube sites being placed within the Dublin City authority area, 8 in Fingal, 23 in South County Dublin and 10 in Dún Laoghaire-Rathdown. Data generated by the monitoring programme will be combined with a range of other information in order to develop the air quality baselines. Information fed into the baselines is to include historic data generated through the AAMP and the maps of the Dublin Regional Air Quality Management Plan 2009-2012 and National Parks and Wildlife maps as well as the EPA's annual Air Quality Reports and National Ambient Air Quality Monitoring Data Archive.

As the second half of the NTA NO_2 monitoring programme coincided with the initial Covid-19 restriction period, the data generated by the CBC air quality programme is not entirely representative of 'typical' pre-restriction patterns and emissions levels. They do, however, represent a potentially valuable source of information on the impacts of traffic reduction levels on NO_2, and on traffic-related air pollutant levels on routes identified in the EPA *Urban Indicators* report as being NO_2 hotspots.

4.1.4 TII air quality monitoring (M50 motorway, Dublin)

Since 2014, monitoring of NO_2, PM_{10} and $PM_{2.5}$ has been undertaken on the M50 by TII in accordance with An Bord Pleanála's approval to upgrade the M50, and as part of TII's commitment to ensure that the air quality of communities alongside transport infrastructure are not negatively impacted. TII significantly extended its NO_2 monitoring network in June 2018 in advance of the introduction of Variable Speed Limits and the delivery of M50 Traffic Flow Optimisation (MTFO) Project. The expansion of the network involved the establishment of 34 new monitoring stations at residential and leisure facility locations adjacent to the M50. Like the NTA, air quality monitoring by TII involved recording Indicative NO_2 concentrations at the monitoring stations using passive diffusion tube samplers. In addition to recording indicative information on NO_2 levels, since 2014, TII also monitors PM at two locations on the M50 using real-time continuous nephelometers. These monitors were sited at the same locations as the two initial NO_2 monitoring stations at the eastern quadrant of the N4/M50 interchange and at the western quadrant of the Sandyford interchange.

TII reported to the UTRAP Group that in 2019, the average NO_2 concentrations measured at these 34 new monitoring stations ranged from 13.6 to 36.4µg/m^3 and all values recorded were below the annual average EU and WHO NO_2 limit value of 40µg/m^3. A comparison of NO_2 concentrations measured at the 34 new monitoring stations between June–December 2018 and June–December 2019 by TII showed a strong correlation between the measured concentrations for both monitoring periods.

4.1.5 Dublin City Council air quality monitoring

Dublin City Council monitors air quality at a number of locations around Dublin City and has also been involved in air monitoring activities on behalf of other local authorities in the Dublin area. This arrangement will be phased out in 2020 as these local authorities further engage in air quality monitoring in collaboration with the EPA, as described above. The Dublin City monitoring locations have over time been integrated into the EPA national monitoring network, and in some cases, DCC and EPA monitors have been sited at the same location, where complementary monitoring activities are carried out. In the latter half of 2019, in response to increasing public demand for air quality information, a number of additional stand-alone indicative particulate matter monitoring stations were also established by the authority. Currently, the DCC network comprises 16 air quality monitors, of which four monitor NO_2 on a continuous real-time basis in tandem with the EPA and the network is currently expanding[61]. Data from these monitors, all of which lie in city centre locations contributed to the EPA's Urban Indicators report, and facilitated the identification of the St John's Road NO_2 limit value exceedance in 2019. A further EPA study is planned for early in 2021 and DCC will assist in this work.

4.1.6 Dublin Port air quality monitoring

In addition to these monitors, Dublin City Council briefed the UTRAP Group on a CAFE Directive-compliant air quality monitoring station on Tolka Quay Road on the north side of Dublin Port. This monitor is operated by the Council in collaboration with the Dublin Port Company. The Council also signalled its interest in establishing an analogous monitoring station on the southern side of Dublin Bay.

Currently, while PM monitoring at various locations across Dublin suggest the spread of sea-derived emissions such as sea salt across the city, the contribution of shipping to the overall air pollutant emissions profile of the city and wider port area is poorly understood. International research has indicated, however, that air pollutant emissions from shipping can have a significant impact on the air quality of coastal cities. At an international level, this has led to the implementation of international policies by the EU and International Maritime Organisation (IMO) to reduce pollutants associated with shipping fuels, particularly sulphur[62].

At a national level, the Tolka Quay Road monitor was established to capture data relating to overall air pollutant emissions levels in and around Dublin Port, where a significant knowledge gap exists. Given the high volumes of vehicular and maritime traffic in and around the port (which in 2019 catered for 9.4m gross tonnes of exports, nearly 2 million passengers and 158 cruise ships[63]), it is possible that port-related emissions are contributing to the elevated levels of NO_2 that have been recorded in the wider Amiens Street area.

Although the Tolka Road air quality station feeds data on NO_2 and sulphur dioxide (SO_2) into EPA bulletins[64], it was noted in the course of the UTRAP meeting that the ambient air quality monitors in the national and local networks do not distinguish between specific sources of air pollutant emissions (e.g. what percentage of identified emissions have been emitted by

---

[61] An up to date overview of network can be found at http://dublincityairandnoise.ie/

[62] https://ec.europa.eu/environment/air/sources/maritime.htm
[63] https://www.dublinport.ie/
[64] epa.ie/air/quality/data/dp/no2/

freight vehicles as opposed to berthed ships or other port-side transport infrastructure). There is a similar lack of information about the emissions profiles of Ireland's other ports, most of which lie in proximity to urban centres and towns. Prior to the Covid-19 crisis, a proposal had been made for an EPA/Department of Transport co-funded air pollutant emissions source-apportionment study to be carried out at Dublin Port. As proposed, the aim of the study was to establish the profile and also the sources of transport-related air pollutant emissions in the port area. With the onset of Covid-19 restrictions, the commissioning of this study was postponed.

Given the valuable information that such a study could provide on a potentially significant but poorly understood source of transport-related emissions at Dublin Port in particular and at other Irish ports, the UTRAP group recommends that this study be commissioned and carried out.

Recommendation	
3.	The EPA and DoT to progress the postponed Dublin Port transport-related air pollutant emissions source apportionment study.

4.1.7 PurpleAir PM monitoring, Cork City Council

The UTRAP work programme also included a brief overview of the pilot PM air quality research study carried out in Cork city by Cork City Council and the Centre for Research into Atmospheric Chemistry (CRAC) research group at University College Cork (UCC). The project involved the deployment of a number of air quality sensors from the PurpleAir Company, which use laser particle counters to provide real time measurement of $PM_{1.0}$, $PM_{2.5}$ and PM_{10}. Data from the air quality sensors is hosted by PurpleAir and provides live indicative air quality data to the public that can be accessed from the PurpleAir website[65]. While this study provided information on PM levels adjacent to the monitors, it did not allow the different emissions sources to be identified.

[65] https://www.corkcity.ie/en/council-services/services/environment/air-quality/air-quality-monitoring-program.html

The data from these low-cost sensors must be interpreted with caution. The European Environment Agency in its report on using citizen science for assessing air quality[66] had noted that the results from these types of monitors obtained are only robust when humidity is in the range of 20-50 % and particulate matter (PM10) mass concentrations are below 20µg/m^3.They further noted that when humidity is very high, for example when it is foggy, the sensors can deliver incorrect values. The average humidity in Ireland is much higher than most other countries (typically 75-85%) and thus the PurpleAir maps can therefore give only a general indication of the geographical patterns of air quality in the city.

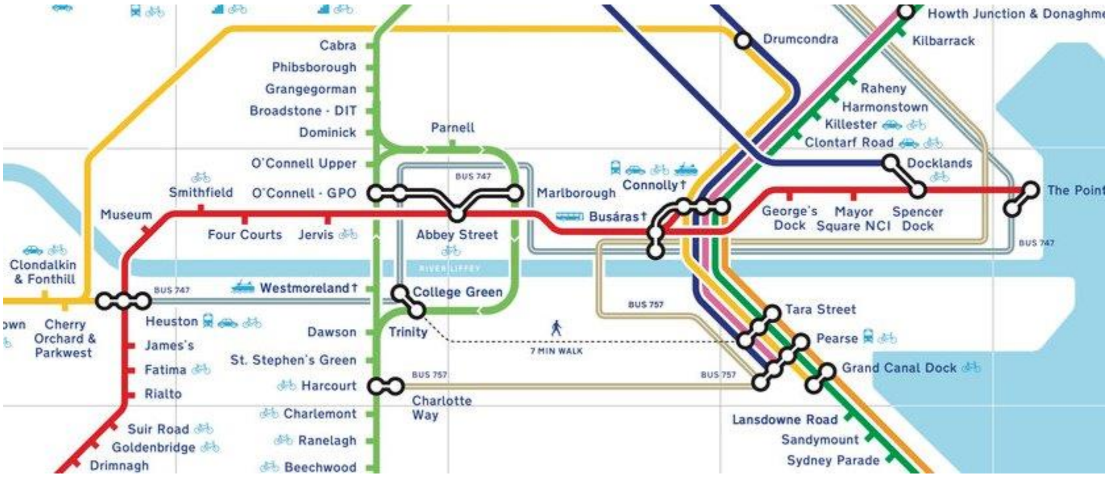
4.1.8 Air quality monitoring activities at Dublin terminal railway stations

As noted in Section 1.2, several locations in Dublin were identified in the 2019 EPA Urban Indicators Report as NO_2 air pollution hotspots, with emissions levels approaching or potentially exceeding EU limit values. One of the observations to emerge from the UTRAP Work Programme was the fact that three of the highest NO_2 concentration clusters identified in Dublin were broadly centred in the wider area of Dublin's three major urban terminal railway stations[67] which are highlighted in Figure 7. All three stations (Connolly Station, Heuston Station and Pearse Station) are among the most frequented heavy rail stations in the country, and were the three busiest rail stations in Ireland in terms of passenger boarding and alighting numbers in 2017 and 2018[68].

---

[66] https://www.eea.europa.eu/publications/assessing-air-quality-through-citizen-science
[67] CERC (2019) *Urban air quality modelling of Dublin – Final Report*, report prepared for the EPA, p. 8, Table 3.4.; EPA (2019) *Nitrogen dioxide diffusion tube survey in Dublin: 2016-2017*, pp. 10-12.
[68] NTA (2019) *National Heavy Rail Census Report 2018*, Statistical Bulletin 01/2019, p. 19.

Figure 7: Map of Urban Terminal Railway Stations



All three are also significant transport hubs, where heavy rail, public service vehicles such as taxis and buses, and passenger car networks intersect. As noted in UTRAP Meeting 4, studies in other European cities[69] have shown similarly high concentrations in the vicinity of rail stations.

In Ireland, the direct contribution of heavy rail train emissions to ambient air pollutant levels is generally poorly understood. The potential role of operational practices relating to the movement of trains within and around urban terminal rail stations is also poorly understood. Additionally, although significant work and progress have been made over the last two decades by CIÉ and Iarnród Éireann to reduce emissions through fuel efficiency, maintenance and fleet replacement practices, the impact of these interventions has not been quantified in terms their impact on ambient air quality. This lack of information represents a significant gap in understanding of the extent to which trains contribute to the build-up of transport-related air pollutants in Ireland's towns and cities.

To date, as described to the UTRAP Group, air quality programmes implemented by Iarnród Éireann/Irish Rail within Dublin's major terminal rail stations have been undertaken from an occupational health viewpoint. Their primary aim has been to assess and mitigate the potential exposure of station employees and rail passengers to air pollutant emissions within station buildings. For that reason, the results of the studies carried out to date within the

[69] Notably Sheffield in the United Kingdom, and see Munir et al. (2019) 'Structuring an integrated air quality monitoring network in large urban areas – Discussing the purpose, criteria and deployment strategy', *Atmospheric environment* 2, April, link here, accessed 03-11-20.

stations are not directly comparable with national and local ambient air pollutant emission monitoring activities carried out by the EPA. The studies do, however, provide a general indication of the potential contribution of heavy rail to ambient NO_2 and PM levels in and around the terminal stations. The studies were also undertaken to address public concerns arising from visible air emissions build-up in the stations at peak times associated with the running of trains.

Three investigations were carried out at Connolly Station and two at Heuston Station between August 2018 and December 2019. The results of four of the five studies indicated that Occupational Exposure Limit Values for NO_2 and PM within both the stations were below the legally permitted thresholds. However, the NO_2 and PM study carried out at Connolly Station between August and October 2018 indicated that mean value exceedances for NO_2 were recorded within the station building on two of the platform walkways and at the entrance to the station concourse. On Amiens Street, the test showed mean average values below the annual limit value.

From the Group discussion of the results of the Connolly Station study, as well as the identification of the knowledge gaps referenced above, the Group suggested that collaboration and information sharing between rail and air quality stakeholders would be of benefit in identifying and quantifying the contribution of heavy rail to overall transport-related air pollutant emissions levels. While the focus of activities to date has been on the larger Dublin terminal stations, information derived from these stations may also have relevance for the operation of other urban terminal stations, such as those in Cork, Galway and Limerick.

Recommendations	
4.	CIÉ, Iarnród Éireann and the EPA to examine how best to share information, including on rail operation patterns in urban terminal stations and available traffic data, to determine the contribution of heavy rail to ambient air pollutant emissions and for possible inclusion in air quality models.
5.	CIÉ, Iarnród Éireann and the DoT to commission a feasibility study on the potential installation of platform-side shore power electricity in terminal rail stations to eliminate engine idling by trains.
6.	The DoT to provide funding for the rollout of EV charging infrastructure at train stations, and other transport hubs, nationally with funding provided by the Carbon Tax Fund.

4.2 Modelling Ambient Air Quality

While not currently a requirement under the CAFE Directive, modelling of ambient air quality allows the provision of information for locations between monitoring stations and supports the identification of the sources of poor quality air. In their presentation to the UTRAP Group, the EPA noted that it is currently developing this capability under the National Ambient Air Monitoring Programme 2017– 2021 (AAMP). To date, as part of the modelling pillar of the AAMP (see Section 4.1.1), the EPA in conjunction with Cambridge Environmental Research Consultants Ltd (CERC) carried out a modelled urban air quality assessment of Dublin City for 2015 and 2017. This assessment included the modelling of NO_2, PM_{10} and $PM_{2.5}$ concentrations. The outputs of this model in relation to NO_2 were published in the Urban Environmental Indicators report for Dublin.

The model used by CERC was the ADMS-Urban air pollution modelling tool, which has been developed to provide high resolution calculations of pollution concentrations for all sizes of study area relevant to the urban environment. The model can be used to look at concentrations near a single road junction or over a region extending across the whole of a major city. ADMS-Urban has been extensively used for the review and assessment of air quality carried out by Local Authorities in the UK and for a wide range of planning and policy studies across the world.

As the report from 2019 was the first time such a detailed study using a dispersion model was completed, the EPA noted that it had spent a considerable amount of time assembling and processing the raw data to be fed into the model. Terrain data was sourced for the Dublin area through the OPW. Traffic data incorporated into the model was provided by Dublin City Council through the Canal Cordon Count[70] and the City's SCATS traffic management system, which charts hourly traffic counts, speeds and percentage HGV for each road. Other sources of data factored into the model included the UK Government's Traffic Emission Factor Toolkit; traffic speeds; annual average daily traffic (AADT) values; industrial emissions data; the MapEire national emission mapping model; meteorological information; surface roughness parameters and urban canopy flow profiles; and background (national) concentrations of NO_2, O_3, PM_{10} and $PM_{2.5}$ and SO_2.

---

[70] https://data.gov.ie/dataset/traffic-volumes

4.2.1 EPA Modelling: future potential outputs of the ADMS-Urban model

As part of the UTRAP work programme, the EPA outlined the potential future information that the ADMS-Urban model was capable of capturing, and described potential future model runs. It was noted that a model could be run for the entire city for one year, with support from model application providers to ensure that the model set up is consistent. Also discussed was the potential modelling of specific streets, which could be completed within a relatively tight timeframe by the EPA, subject to the availability of resources and accurate input data. Discussion at the meeting also centred on the possibility of the EPA carrying out source apportionment studies for NO_2 using other models, such as the SHERPA emissions source app developed by the EU Joint Research Centre (JRC) and the EU Commission. Such studies could be completed internally by EPA, with the proviso that accurate traffic configuration information would be required in order to reflect the scenario being assessed. The EPA further reported that additional modelling assessments using newly developed air quality modelling tools and verification methodologies could also be used in conjunction with the existing local information where applicable.

A common thread that emerged from the UTRAP discussion of the value of future potential modelling runs to the identification of air pollutant emissions and the development of mitigation measures was the value of leveraging existing traffic-related databases and information sources. The robust nature of the AMDS-Urban modelling tool and its capacity to meaningfully process multiple variables means that a range of transport-related monitoring data as well as more general information on vehicular traffic, emissions profiles and fleet breakdown can be fed into the model. One of the most strongly proposed recommendations that emerged from the work of the Group in this area was that all stakeholders should collaborate to identify and feed relevant information to the EPA for inclusion in any future modelling runs.

Recommendations	
7.	Examine and improve the pathways by which central government departments and their agencies supply the EPA with traffic-related data for inclusion in urban ambient air quality models.
8.	Ensure that air quality considerations, including the collection of data on transport-related air pollutant emissions, continue to be mainstreamed into broader transport-related research and emissions projects co-funded by central government departments and agencies, such as the DoT, and the EPA.

4.2.2 Modelling of other Irish cities

In its discussions, the UTRAP group also noted that the majority of projects relating to urban transport-related emissions monitoring and modelling focus on Dublin city and the Greater Dublin Area. A further strong recommendation to emerge from the group was that modelling for air pollutants be extended to other urban areas, outside of Dublin. This was proposed by the EPA as being of particular importance, given the increasing levels of traffic congestion recorded in a number of cities in Ireland. The EPA also noted the potential role that extended modelling activities could play in informing policy direction in this area, and in assessing the potential impact of any proposed policy changes regarding transport demand measures.

Recommendation	
9.	DECC, EPA and relevant stakeholders to develop the capacity to perform modelling on an ongoing basis across the five cities in Ireland.

4.2.3 EU LIFE Emerald project

In addition to examining the potential expansion of modelling to Irish cities other than Dublin, the UTRAP Group also discussed the EPA's forthcoming work on the EU LIFE Emerald (Emissions ModElling and FoRecasting of Air in IreLanD) project which has recently been approved for funding.

Among the proposed outcomes of the LIFE Emerald project proposal were a number of key products that will support the ongoing work in relation to reduce urban transport emissions, such as:

- a customised air quality dashboard
- an operational 3-day ambient air quality forecasting system
- near real time (NRT) air quality maps to provide finer granularity in the information being disseminated to the public
- annual average high-resolution air pollutant maps providing detailed air pollution assessment, reliable health impacts, and meeting current/future (e-)reporting needs

From a national policy perspective, the Group noted the potential value of annual average air pollution maps, which could be used to provide baseline snapshots of emissions at particular points in time. As other European countries have implemented similar models, the existence of a similar Irish mapping capacity could facilitate more direct comparisons of the impacts of air pollutant measures introduced in other jurisdictions.

Recommendation	
10.	The EPA, DECC, DoT and relevant stakeholders to support the implementation of the LIFE Emerald project through the provision of data and any other necessary resources.

4.2.4 Communication of information on transport-related air pollution to the public

A further broad theme that emerged from the work of the UTRAP Group on modelling and monitoring was the critical importance of raising public awareness of the nature and sources of air pollutant emissions. This importance related not solely to the significant negative health impacts of transport-related air pollution, but also to encouraging the inhabitants of Irish cities to move away from the use of private cars and towards more sustainable transport, such as walking and public transport. It was noted that many of the monitoring projects presented to the Group had public information components, with the EPA[71], TII[72], Dublin City Council[73] and Cork City Council[74] all operating online air quality resources, such as maps or dashboards that are accessible to members of the public.

Through its Citizen Science programmes, the EPA also noted its status as a participant in a joint European Environment Agency (EEA) 'Cleanair@schools' project[75]. This project resulted in the installation of NO_2 diffusion tubes at the gates of 54 schools across the State in Autumn 2019. The aim of the project was to encourage children and their parents to build an awareness of air pollutant emissions from cars and other vehicles, and to track changes in emissions levels, particularly at drop-off and collection times.

Local authorities and An Taisce have active Schools initiatives in operation which are proven to be a readymade framework for promoting a wide range of environmental initiatives including air quality.

Local authority and EPA representatives in particular noted the existence of keen interest in air quality-related issues among sectors of the Irish public, and the increasing presence of

[71] https://airquality.ie/
[72] https://tii.sonitussystems.com/monitors
[73] https://dublincityairandnoise.ie/
[74] https://www.corkcity.ie/en/council-services/services/environment/air-quality/air-quality-monitoring-program.html
[75] https://www.epa.ie/irelandsenvironment/getinvolved/citizenscience/epacitizenscienceinitiatives/

informal air quality monitoring activities by individual citizens. The role of such initiatives in supporting wider policy measures aimed at improving air quality and at promoting behavioural shift was discussed. From these discussions, the Group recommends examining how best to support the communication of accurate and effective information on transport-related air pollutant emissions to the wider public.

Recommendation	
11.	Examine initiatives to strengthen and expand the communication of accurate transport-related air pollutant information to the public (as per the Aarhus Convention), with the cross-cutting aims of encouraging behavioural shift towards low emission and active travel modes, improving public health, and reducing air pollutant emissions.

4.3 Transport-related air pollutant research projects

The UTRAP work programme also included a brief overview by the Department of Transport of ongoing and recently completed traffic-related air quality projects. These projects were carried out under the auspices of a range of Irish research institutions and were funded by a range of sponsors, including the EPA and the Department of Transport. Eleven Ireland-specific research projects were referenced, of which four (Nos 1-4 in Table X) examined the impacts of transport-related pollutant emissions operating at a broad social scale. Of the remaining research projects, three are concerned with mitigating air pollutant emissions associated with fuel use with a particular emphasis on the Heavy Duty Vehicle (HDV) sector (Nos 5-7 in Table 6). The remaining projects (Nos 8-11 in Table 6) focus on measuring real-life emissions from a range of vehicles, including contributions from non-road vehicles. Also referenced was the ongoing Department of Transport Five Cities Demand Management Study, the significance of which is briefly discussed in Chapter 6. The results of all of the research projects listed in Table X below will add to the evidence base upon which the Department of Transport and associated agencies will develop emissions reductions policy and measures. It should be noted that this isn't an exhaustive list and it is recognised that other research has been done in this area.

Table 6: Summary of recent and on-going Irish transport-emissions-focussed research[76] projects

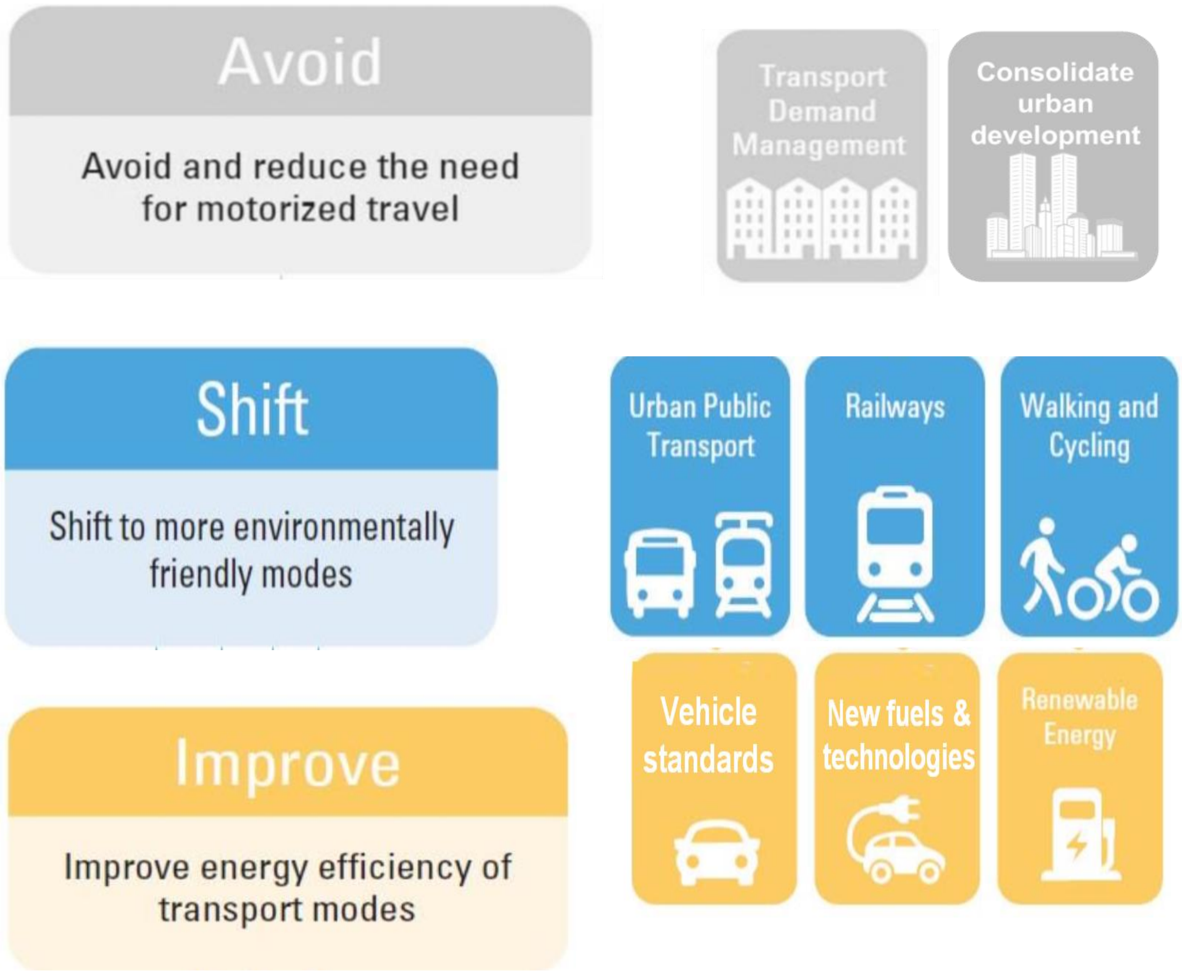
No.	Project name/ Acronym	Description/Full name of project	Project Leader/ Lead Author	Institution/ Funding authority	Status/ Weblink
1	Greening Transport Project	Greening transport	Brian Caulfield et al.	TCD/EPA	Ongoing, final report under review.
2	Impact of NO_2 on Health Project	Impact of NO_2 on health with particular emphasis on vulnerable groups	Margaret O'Mahony et al.	TCD/EPA	Ongoing (end date H2 2021).
3	CON+AIR Project	Addressing **Con**flicts of Climate and **Air** Pollution	Eoin Ó Broin et al.	EPA	Completed. Published 2019.
4	DISTRACT Project	Mo**D**al **S**hif**T** **R**educe **C**arbon in **T**ransport	Sheila Convery et al.	TCD/SEAI/DoT	Ongoing
5	Mitigation of Irish HDV CO_2 and/or air pollutant emissions	Desktop study to assess potential mitigation measures that would reduce CO_2 and/or air pollutant emissions from the existing Irish HDV fleet	Brian Ó Gallchóir	UCC/SEAI/DoT	Ongoing
6	MAP-HDV Project	**M**itigation of **Air Pollution** impacts of Irish **HDV**s	Bidisha Ghosh et al.	TCD/SEAI/DoT	Ongoing .
7	Eco-HDV Project	Evaluating the impacts of adaptation of **eco**-driving training programmes in the Irish Heavy Duty Vehicles (**HDV)** fleet, including the freight sector	Brian Caulfield (Bidisha Ghosh)	TCD/EPA/DoT	Ongoing.
8	Particulate Matter from Diesel Vehicles Study	Particulate matter from diesel vehicles: emissions & exposure	Meabh Gallagher et al.	TCD/EPA	Ongoing, final report under review.
9	REDMAP	**R**oadside **E**missions in **D**ublin - **M**easurements **A**nd **P**rojections	Bidisha Ghosh et al.	TCD/EPA/DoT	Pending. March 2020 to March 2022.
10	EFFORT Project	**E**missions **F**rom **F**uel consumption associated with **O**ff **R**oad vehicles and o**t**her machinery	Eoin McGillicuddy	TU Dublin/EPA	Ongoing.
11	Low Emission Bus Trial	Low Emission Bus Trial to inform future urban bus procurements	Byrne Ó Cléirigh for DTransport	DoT	First phase completed, trial extended to include hydrogen bus technology, results in c. Q.1, 2021.

[76] It is noted that this is not a comprehensive list of all transport related air pollution research projects

5. Reducing Emissions

In recent years, several measures have been implemented in Ireland and across Europe to reduce emissions from transport. While not all of these measures have been specific to air quality, they have had the added benefit of reducing transport-related air pollution. There are several ways to reduce emissions from transport and they can be broadly summarised by the "Avoid, Shift, Improve" model.

Figure 8: Overview of transport transition model



The work of the Group aimed to evaluate what has been done to date, identify gaps that exist and identify opportunities to reduce transport-related emissions. Areas considered included:

- Vehicle Standards
- Taxation
- The Transition of the PSO Fleet
- Critical Infrastructure
- The Role of Demand Management

This involved participation by a number of key transport actors engaged in work in this area to fully inform the discussions the Group invited the Road Safety Division of the Department of Transport, the Road Safety Authority (RSA), Córas Iompair Éireann (CIÉ) and Systra to the meetings.

Understanding that the Climate Action Plan has charted a pathway for Irish transport[77] which in the long run will greatly reduce transport-related emissions in Irish towns and cities, the work of the Group focussed on what can be done in the short to medium-term to address the issues of transport-related air quality in urban areas.

5.1. Vehicle standards

5.1.1 Euro Vehicle Emissions Standards

Emissions testing for vehicles form an important part of roadworthiness testing which aims primarily to enhance road safety. In 1992, the first EU-wide emissions standards for vehicles – known as Euro 1 – were introduced. Since the introduction of Euro 1, the EU has continued to strengthen emissions standards for new vehicles to improve air quality. While the emissions standards apply to all internal combustion engine vehicles, different pollutant levels apply depending on whether the vehicle is petrol or diesel-powered, an important point to note when considering the dieselisation of the Irish fleet. These standards set lower emissions limits, now known as Euro 5 and Euro 6 for atmospheric pollutants such as particulates and nitrogen oxides. The EU implemented an equivalent system for large commercial vehicles known as Euro I-VI.

Euro 5 emissions limits came into effect for new vehicle types from September 2009 (and new vehicles from 1 January 2011), while Euro 6 emissions limits came into effect for new vehicles types from September 2014 (and new vehicles from September 2015). The main effect of Euro 5 was to reduce the emission of particulate matter from diesel cars from 25mg/km to 5mg/km, and accordingly the introduction of particle filters for diesel cars became widespread. Euro 6 limits mainly reduce the emissions of nitrogen oxide from diesel cars further, from 180mg/km to 80mg/km.

Regulation (EC) No 715/2007 also sets the requirements for unrestricted access to vehicle repair information and in particular to information relating to on-board diagnostic (OBD)

[77] https://assets.gov.ie/10207/c8f59b1734af460fa310ddbe20e01388.pdf

systems and their interaction with other vehicle systems. OBD systems play an important role in the control of vehicle emissions.

5.1.2 Ensuring Emission Standards

In September 2015 the United States Environmental Protection Agency (US EPA) formally reported that Volkswagen (VW) violated US emissions standards. They reported that VW had installed illegal “defeat devices” in hundreds of thousands of engines in the United States since 2009. In Turbocharged Direct Injection (TDI) diesel vehicles, software was installed to allow emissions control to activate during laboratory testing. This had the effect of lowering the nitrogen oxide (NO_x) output to meet the required standards during type approval testing. Real driving emissions (RDE) were found to be up to 40 times the amount measured in the laboratory. The vehicles had engine control units that could switch from good fuel economy with high NO_x emissions to low-emission compliant mode when the vehicles system detected an emission test was being undertaken. This software was reported to be deployed in approximately eleven million diesel vehicles worldwide between 2009 and 2015. This is commonly referred to as the ‘Dieselgate scandal’.

This has resulted in several improvements to the EU test process:

- The New European Driving Cycle was replaced by the Worldwide Harmonised Light Vehicle Test Procedure (WLTP), a more rigorous test for measuring pollutant levels, in September 2017;
- For light-duty vehicles, portable emission measurement systems (PEMS) equipment has now become an element of on-road testing under the Real-Driving Emissions (RDE) procedure; and
- Conformity factors, which provided a range within which emissions were considered acceptable, were introduced.

Recommendation	
12.	The DoT and the RSA to organise a pilot study to assess the emissions profile of ICE vehicles as they age.

5.1.3 Diesel Particulate Filters (DPFs)

A DPF is a filter placed within the exhaust system of a diesel vehicle to remove particulate matter or remove soot from exhaust gases in the case of diesel vehicles. DPFs can become blocked by trapped soot and need to be emptied regularly to prevent blockage. Long journeys and correct fuel usage help to prevent DPF blockages. However, now that there are more people using diesel vehicles for short, urban journeys there is a worry that DPF issues are becoming more common. As a result, there is a worry that DPF removal, which is illegal[78], is becoming more commonplace. There is no evidence of widespread DPF removal and all of the discussion to date has been anecdotal.

Recommendation	
13.	DoT and the RSA to organise a pilot study to assess the rate of DPF removal in the Irish fleet.

5.2 The Tax System in Ireland as a tool for addressing vehicle emissions

5.2.1. Background

The tax system, particularly taxes on fuels, can play a complementary role to regulation and wider public policies that support clean transport in addressing negative environmental impacts from road transport. Taxes on road vehicles can also support these wider environmental and public health objectives.

Ireland's VRT regime for cars is an emissions-based tax which is levied as a percentage of the open market selling price (OMSP) of a vehicle entering the State for the first time. The higher the CO_2 emissions of the vehicle, the higher the charge will be. Vehicle taxes which are solely CO_2-based have been criticised for their failure to recognise the specific contribution of other emissions such as NO_x and PM to air pollution and their impacts on public health and the environment. The introduction of CO_2-based VRT and motor tax regimes in 2008 initiated the dieselisation of the Irish car fleet. This is illustrated in the Figures 9 and 10 below[79].

[78] http://www.irishstatutebook.ie/eli/1963/si/190/made/en/print
[79] Data source: CSO Road Traffic Volumes, Tables THA12 and THA17.

Figure 9: No. of Licensed Cars 2008-2018

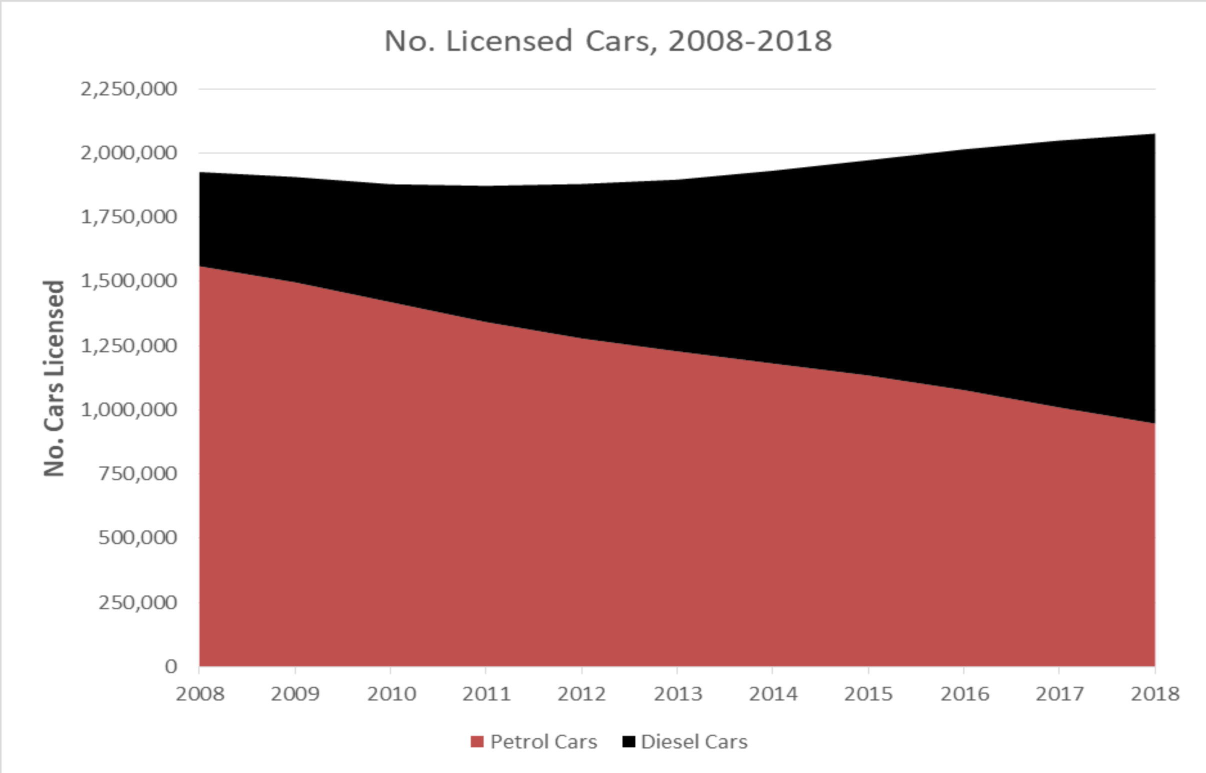
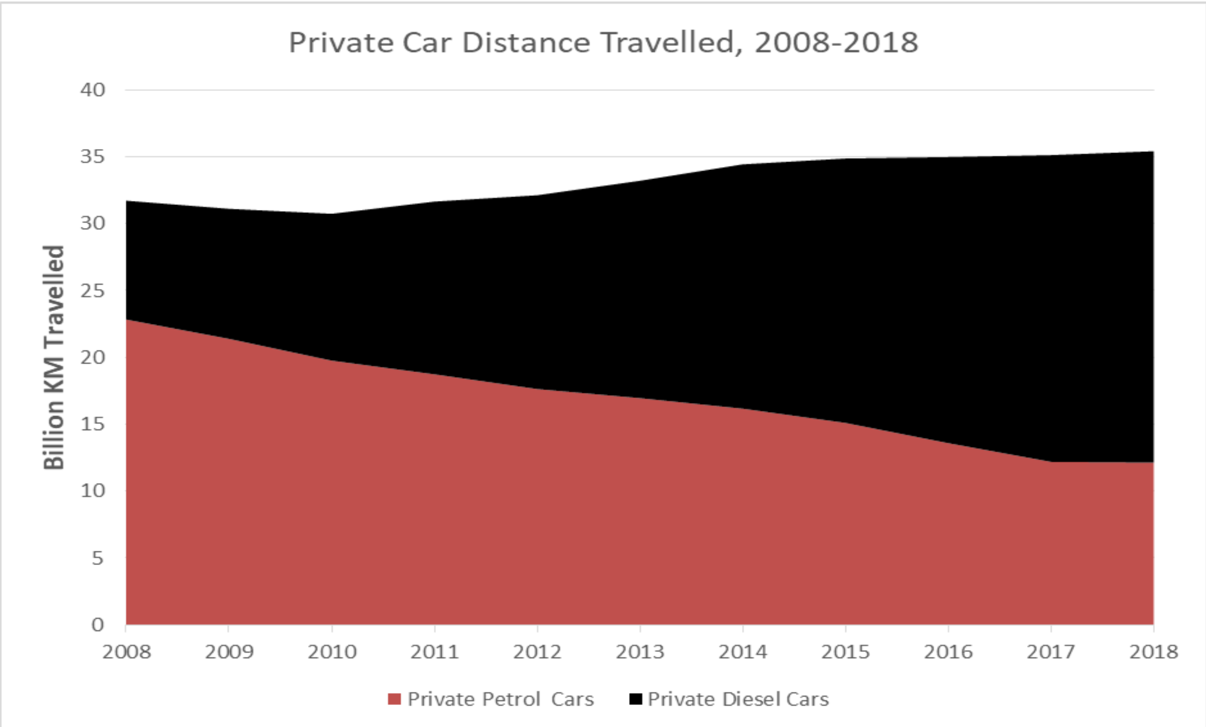
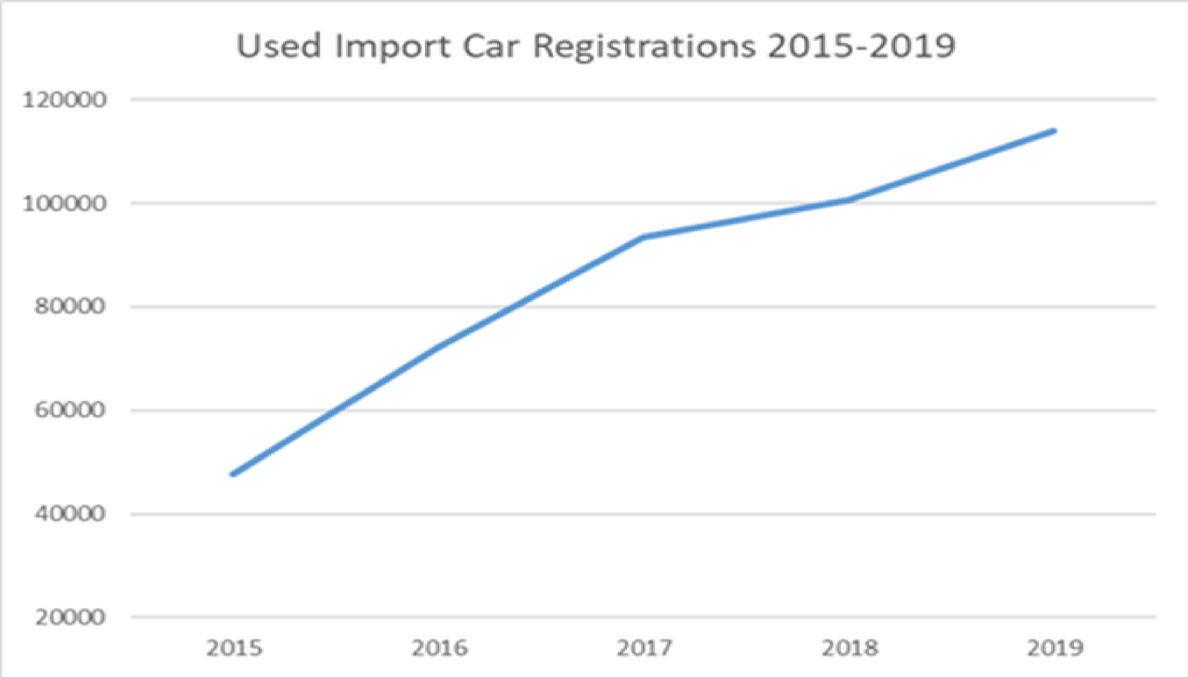


Figure 10: Distance Travelled by Private Cars 2008-2018



The increase in the share of diesel cars registrations between 2008 and 2011 was highly significant, and in more recent years the high volume of diesel car registrations has been sustained due to a sharp increase in used car imports as shown in Figure 11, about 70-75% of which were diesel.

Figure 11: Used Import Car Registrations 2015-2019



5.2.2. Fiscal measures implemented to address vehicle emissions

In recognition of the environmental health costs caused by pollutants emitted in particularly high quantities by diesel vehicles, Budget 2019 saw an introduction of a 1% surcharge on all diesel vehicles. Due to the car value component of the VRT charging formula, this surcharge resulted in newer diesel cars paying more than cheaper imports even though the older imports were likely to emit higher levels of pollutants.

Budget 2020 replaced the 1% surcharge with a surcharge tied to NO_x emissions levels based on the "polluter-pays" principle, where the greater the level of NO_x a car emits, the higher the surcharge. Budget 2021 adjusted the structure of the NOx surcharge, with the effect of adding €200 to high emission vehicles. The surcharge structure is set out on the Revenue website[80].

[80] https://www.revenue.ie/en/importing-vehicles-duty-free-allowances/guide-to-vrt/calculating-vrt/calculating-the-nox-charge.aspx

5.2.3 Impacts of fiscal measures taken

The surcharge is structured to levy a modest charge on the newest vehicles complying with the latest vehicle standards. Most new petrol and well performing diesel cars will have typical NOx emissions below 40mg/km and therefore are subject to a NOx charge of less than €200.Levels of NO_x emissions tend to be much higher among older cars, particularly diesel, which were not subject to more stringent Euro standard thresholds. As such, for an older diesel with 85 mg/km NO_x, the surcharge added to the regular VRT will be €925. In general, the impact will be less severe on petrol-fuelled cars, as petrol engines are typically associated with lower NO_x emissions.

The introduction of the NO_x surcharge is designed to correct an imbalance in VRT where the focus was purely on CO_2 emissions. The environmental and public health impacts of other pollutants such as NO_x are now recognised in the tax code and duly charged. It is envisaged this will have a positive impact on incentivising cars which are less harmful to our environment and in reversing recent trends in the proliferation of used diesels imported from the UK.

The surcharge only commenced on 1 January 2020 and therefore it will take some time before its impact can be properly assessed. . Furthermore, it is difficult to conclusively separate the impact of both the NOx surcharge and COVID on the profile of used cars registering in 2020. However, there is evidence that the surcharge is having an effect. In the year to end July, used imports are down 50% versus the same period last year, while used diesels aged 6 to 9 years are down 83%. This suggests the NOx charge can act as a successful deterrent to high NOx emission vehicles.

Recommendation	
14.	Review the impact of the NO_x surcharge once more data is available to give an accurate reflection of its efficacy.

5.3 Transition of the Public Transport Fleet

5.3.1 Background to public fleet transition

The National Transport Authority (NTA) is responsible for the procurement of all Public Service Obligation (PSO) bus services and the rail fleet. In early 2019, the NTA decided to cease the procurement of diesel-only buses. This was in line with Priority 3 of the NTA Statement of Strategy 2018-2022 which was to "acquire 300 low emission buses for the operation of subsidised bus service". However, as the technology and markets for alternatively fuelled buses is still developing, particularly for double deck electric buses, the NTA has decided to purchase diesel electric hybrids as an interim solution. Given the above, it was necessary to set out a pathway to determine the future technology of the public bus fleet.

This was in line with Action 85 of the Government's Climate Action Plan which requires the "Adoption of Medium Term Fleet Technology Pathway for the Public Bus Fleet" by the end of 2019. In addition to governmental policy on LEVs, the European Commission published Directive (EU) 2019/1161 – also known as the Clean Vehicles Directive – which aimed to promote clean and energy-efficient road transport. The Directive sets out binding minimum targets for the procurement of clean and zero-emission vehicles procured by state bodies. The targets for buses are set out below.

Table 7: Targets for buses

	From 2 August 2021 – 31 December 2025	From 1 January 2026 to 31 December 2030
Clean Vehicles	45% of bus fleet procured during this period	65% of bus fleet procured during this period
Zero Emission Vehicles	One quarter of the 45% of Clean Vehicles	One half of the 65% of Clean Vehicles

5.3.1.1 Proposed Technology Pathway

Given the uncertainty surrounding future technology, the NTA felt it unwise to determine the long-term strategy at this point. The following roadmap will be followed in keeping abreast of evolving technologies for buses.

Based on both national and European policy, 11.25% of all buses procured by the NTA by the end of 2025 must be zero emission buses. With this in mind, the NTA must consider alternatives to diesel-electric hybrid vehicles for procurement over the next five years.

The following sets out the key actions necessary to achieve the required targets for clean and zero emission buses:

- Ensure that the diesel-electric hybrid buses purchased from 2020 onwards comply with the definition of Clean Vehicles;
- Undertake pilot studies in 2020/2021 on zero emission buses, both electric and hydrogen, to assess technology readiness level;
- Assess infrastructure requirements for charging/refuelling at depot locations and determine lead-in times for bringing zero emission vehicles into full service;
- Procure single deck electric buses for town services and commence operations in 2021, potentially in Athlone and Carlow as initial towns. These procurements will count towards the 11.25% target for zero emission vehicles;
- Continue to monitor developments in new technologies and develop pilots and trials as appropriate to determine technology readiness levels;
- Following the above trials and pilots, decide in 2022 on the type of zero emission double deck bus fleet to be procured, providing sufficient time to meet minimum target requirements by 2025;
- Procure zero emission double deck bus fleet starting in 2023; and
- Deliver fuelling/charging infrastructure at depots.

5.3.1.2. Current Status of the Transition of the Public Bus Fleet

In December 2019, the NTA entered into a framework agreement with Alexander Dennis Limited (ADL) to supply up to 600 double deck hybrid buses. An initial order of 100 buses has been placed with delivery of the first vehicle scheduled for the end of February 2021. An additional 180 buses have been ordered with delivery expected by the end of 2021. The ADL hybrid buses (Enviro400ER) represent the latest technology for hybrid vehicles. Some facts and features of the new buses are:

- Series-hybrid double deck bus with plug-in charging facility;
- Meets the relevant definition of a “clean vehicle” under the EU’s Clean Vehicles Directive;
- Well-to-wheel greenhouse gas emissions 30% less than a Euro VI diesel bus of equivalent passenger capacity;
- Certified for continuous zero tailpipe emission operation over a distance of two and a half kilometres, with sufficient battery capacity (32kWh) to cater for operation over a distance in excess of five kilometres;

- Geofencing capability enables automatic shutdown of the onboard generator so that the bus operates within defined geographical areas in zero tailpipe emissions mode; and
- Ability to recover energy from the braking system.

The buses are due to enter passenger service once all acceptance, commissioning and training activities have been completed by the relevant operator. At present, it is planned 74 buses will go to Dublin Bus and 26 will go to Bus Éireann.

5.3.1.3 Purchase of Single Deck Electric Buses

The NTA has identified opportunities to transition a number of town and suburban local services within the cities to single deck electric bus. They are currently preparing a framework agreement for the supply of the single deck electric buses. At present, available technologies can facilitate daily duties of approximately 200km based on an overnight charge. It should be noted that for some existing bus services operating in Europe this charge can only be achieved where heating and cooling of passenger areas are powered by biofuels.

A framework agreement for up to 200 buses is currently being procured, with the right to order more or less than this number. An initial order of 45 buses is expected to be placed in May 2021, with Athlone and Carlow town services seen as potential destinations for these buses. In addition, a full analysis of the revised Dublin Area bus network is being undertaken to determine which routes could be transitioned to electric in the short-term.

5.3.1.4 Purchase of Double Deck Electric Buses

A framework agreement is currently being procured for up to 800 double deck electric buses, with the right to order more or less than this number. The prequalification questionnaire process begun in December 2020 and it is expected that an initial order will be placed by December 2021, with initial buses to be delivered by the end of 2022.

5.3.1.5 Pilot of Hydrogen Double Deck Buses

The NTA has entered into an agreement with Wright Bus to purchase three double deck hydrogen buses. These are scheduled to be delivered in Q1 2021. A pilot scheme is being developed that will see the buses move from trial running to passenger service. The vehicle technology will be the same as those operated by Translink Belfast.

Recommendation	
15.	To ensure that we are up-to-date on alternatively fuelled vehicles, continue to trial alternative fuel technologies where possible to inform the "Technology Pathway" of the NTA.

5.3.2 Transition of the Public Rail Fleet

5.3.2.1 DART Expansion

The DART Expansion Programme is a key element of the transport strategy for the GDA. The initial elements of the programme comprise the provision of high frequency electrified rail services on the Dublin Commuter routes extending to Drogheda to the north, Maynooth and Celbridge to the west, and Greystones to the south.

Initial plans laid out in Project Ireland 2040: National Development Plan included the purchase of Diesel Electric Multiple Units (DEMU) to facilitate increased frequency of rail services in advance of electrification of the existing lines. Following an extensive fleet strategy study, and given that it will take time to fully electrify the network, it has been determined that the appropriate fleet is a mixture Battery Electric Multiple Units (BEMU) and Electric Multiple Units (EMU).

Iarnrod Éireann has completed a pre-qualification process for a framework agreement for up to 600 BEMU/EMU units, progress on this procurement process is expected in 2021. Iarnrod Éireann has also commenced a pilot study with MTU Solutions to replace the existing diesel power train with a hybrid electric power train on their InterCity Railcars (ICRs). These hybrid power trains have the potential to reduce fuel consumption by up to 33% with associated reductions in emissions. The pilot is likely to be completed in 2021 and decisions on the wider rollout will be informed by the pilot, however it should be noted that it generally takes between two to three years for the delivery of intercity rail cars

5.3.2.2 Air Pollutant Emissions associated with Rail Stations

As previously mentioned, a 2018 report showed exceedances for NO_2 within Connolly Station. In order to address and reduce air pollutant emissions in the stations, several recommendations were made to Iarnród Éireann by the study consultants. These broadly fell into two areas, involving making changes to:

- the maintenance and the profile of the train fleet as a whole (primarily involving a reduction in the amount of fuel burned by diesel-fuelled trains through fuel efficiency measures and the replacement of diesel engines); and
- site-specific practices, such as curtailing stationary engine idling by diesel trains (particularly in proximity to staff members) and ensuring adequate station ventilation.

The first set of recommendations accords with national policies regarding the transition of the rail fleet away from diesel and with established organisational energy efficiency practices within Iarnród Éireann. The second set of recommendations is being addressed by Iarnród

Éireann through ongoing reviews of driver practices and driver training (as part of Continuing Professional Development), and through analyses of the feasibility of ventilation options for the historic station structures.

Recommendation	
16.	Support CIÉ and the SEAI in running a trial of behavioural interventions to improve air quality and fuel economy.

As can be seen from this review of air quality studies of Dublin rail stations, several significant data gaps remain in terms of knowledge of the overall contribution of rail-derived air pollutant emissions to local ambient air pollution levels. In Dublin, this is particularly the case for Pearse Station, which stands at the centre of one of the three NO_2 hotspots for Dublin, and which is in relative proximity to the EPA's fixed NO_2 monitor, where exceedances of EU limit values have been recorded[81]. Given the role of urban railway stations as nodes where multiple transport systems intersect (particularly in Cork and Galway), it is also possible that ambient air pollutant levels in the vicinity of rail stations in other Irish cities are higher than average, and contribute to localised air pollution.

Recommendations	
17.	In tandem with DoT and the EPA, examine the evidence basis for operational activities relating to major urban railway stations, collate available data and establish a framework within which this information might be supplied to the EPA for inclusion in ambient air quality models.
18.	In tandem with DoT and relevant local authority stakeholders, the EPA and Iarnród Éireann to develop and implement air quality studies and associated monitoring programmes to address the current knowledge gap relating to the impact of heavy rail air pollutant emissions within and in the vicinity of Ireland's urban terminal railway stations (including Pearse Station, Dublin).

[81] For example see EPA data on NO_2 exceedances from 01 January to 29 June 2020, https://www.epa.ie/air/quality/reports/no2/#d.en.68425.

5.4 Traffic and demand management of the M50 and Dublin Port Tunnel

In the National Roads Traffic Management Study (2011) some key measures were identified for the management of traffic on the M50 e.g., Variable Speed Limits (VSLs) and fiscal intervention (multi-point tolling). In the absence of fiscal intervention it was recommended that a Public Transport Freight Toll, i.e. extension of the Dublin Port arrangements to the wider M50, be considered. Within the M50 Demand Management Study (2014)[82], proposals identified include:

- Fiscal Measures in the form of multi-point distance-based variable time tolling;
- Intelligent Transport Systems (ITS) / Traffic Control Measures in the form of VSL and Incident management.
- Traffic Control Centre.

In the case of the Dublin Port Tunnel, while no capacity issues have been identified within the tunnel itself, congestion can be experienced on the surrounding road network on the city side, which has the potential to negatively impact ambient air quality in the city. When such congestion occurs, vehicle access to the tunnel can be temporarily withdrawn as vehicle queueing in the tunnel is not permitted for safety reasons. Withdrawal of access shifts the standing traffic to the northside of the tunnel and further north and around the M50 depending on the severity of the incident. The impact of Brexit in relation to congestion in the environs of the Port will be assessed in due course.

As noted above, approximately 60% of the traffic travelling through the tunnel consists of passenger cars and private vehicles, with 40% consisting of HGVs. When designed, it was intended that the tunnel would primarily operate as a dedicated route for HGVs between the Port and the greater road network via the Coolock Lane Interchange (M50)[83] as part of a wider strategy to shift HGV traffic away from Dublin City Centre[84]. Through the provisions of the Dublin Tunnel Bye-Laws, TII does not have any means to prioritise trucks and buses other than to discourage tunnel use by non-exempt vehicles by raising the applicable toll.

[82] AECOM (2014) *M50 Demand Management Report*, report compiled on behalf of National roads Authority.
[83] https://www.dublintunnel.ie/about.
[84] http://www.dublincity.ie/hgv

Currently, non-exempt vehicles are subject to a €10 charge southbound during the morning peak and northbound during the evening peak while the charge is €3 at other times.

5.4.1. Variable Speed Limits – M50 Traffic Flow Optimisation (MTFO)

Following the M50 Demand Management Study, TII is progressing the implementation of Variable Speed Limits (VSLs) on the M50. TII established the M50 Traffic Flow Optimisation (MTFO) Project to implement a variable speed limit regime on the M50 which will improve the operational efficiency of the motorway by smoothing traffic flow, improving journey time reliability and reducing the number of traffic collisions. This will be achieved through the setting of mandatory reduced speed limits which are most appropriate to the prevailing traffic conditions, and using electronic speed limit signs displayed overhead each lane. MTFO is a part of the wider enhancing Motorway Operation Services (eMOS) project. The first phase of this project will be implemented in 2021.

The consequent smoother traffic flows that will result from the VSL regime will reduce the number of shockwaves and breakdowns in traffic flows that occur, thereby reducing increases in vehicle emissions. Speed management has in places (e.g. The Netherlands) been complemented by 'eco-driving' campaigns which educate the public on fuel-efficient forms of driving. In advance of implementing MVSL, TII is undertaking a comprehensive assessment of baseline concentrations of NO_2 at a range of residential sites in close proximity to the M50.

	Recommendation
19.	Support the introduction of Variable Speed Limits across Ireland's national motorway infrastructure in accordance with national plans and support the implementation of the MTFO.

5.4.2 Park & Ride Strategy

The Government's Climate Action Plan 2019[85], the National Mitigation Plan[86] and the NTA's Transport Strategy for the Greater Dublin Area[87] all highlight the need to reduce emissions from the transport sector via a range of measures including the development of a Park & Ride Strategy and eventual provision of associated facilities. . In the Greater Dublin Area, Park & Ride has potential in terms of serving National Roads user and also reducing, or slowing, the growth in demand for car travel on both the radial corridors (M1, M2, M3, M4, M7, M11) and the M50 but is part of a wider strategic demand management process.

In line with the Action 89 of the Climate Action Plan the NTA established a Park and Ride Development Office in February 2020. The Park and Ride Development Office is currently developing a more detailed strategy, which in the GDA will inform the review of the Transport Strategy, while also developing feasibility studies and detailed proposals for Park & Ride sites. The Park and Ride Strategy is an evidence based assessment considering the demand for Park and Ride and the appropriate points at which to intercept traffic.

	Recommendation
20.	Develop a Park & Ride Strategy and support the delivery of park and ride sites

5.4.3 Air pollution barriers

Environmental noise barriers have effects on air quality without this being their original purpose. These barriers tend to lead to decreased pollution behind the barrier. Therefore, the 39km of environmental noise barrier along the M50 may also be considered to have air quality improvement capabilities. Trees and vegetation, in general, have been shown to have positive impacts on air quality. Leaves are capable of filtering out certain pollutants such as NO_2 and PM. While data is not currently available, it is anticipated that the significant planting along the M50 may play a role in mitigating air quality impacts from vehicle emissions.

In addition to the beneficial effects of certain types of physical barriers, technologies have also been developed that seek to remove road traffic pollution from the air. However, these remain unproven. For example, substances which react with NO_2 have been applied to

[85] Government of Ireland (2019) *Climate Action Plan to tackle climate breakdown*, pp. 91 and 96.
[86] DECC (2017) *National Mitigation Plan*, p. 113.
[87] NTA (2016) Transport Strategy for the Greater Dublin Area 2016-2035, pp. 85-86, and also p. 54.

surfaces (e.g. noise barriers) in several countries including The Netherlands and the UK. However, the results of these initiatives remain inconclusive and everyday wear and tear can limit their effectiveness. The key difficulty with these initiatives is that only a small fraction of air ever comes into contact with the applied substances, meaning that the overall impact on air quality is often negligible.

Recommendation	
21.	Keep abreast of international best practice for air pollution barriers.

6. Demand Management Study

Given the critical role played by traffic congestion, commuter patterns and urban fleet profiles in determining concentrations of transport-related air pollutant emissions in cities and towns, the UTRAP work programme also included an outline review of traffic demand management in Ireland's five major cities, Dublin, Cork, Galway, Limerick and Waterford.

As noted above, the Dublin city air pollution hotspots coincide with locations at which various modes of urban traffic intersect. The EPA air quality modelling (as distinct from air pollutant monitoring) also indicated elevated levels of traffic on heavily-trafficked urban streets with large numbers of vehicles, dense urban fabric in these locations can prevent the dispersal of pollutants[88]. In recent years, increased travel demand has led to an increased number of vehicles on the streets of several cities, with the result that urban traffic congestion is increasingly recognised as a problem in Ireland. This problem is not specific to Irish cities, as traffic congestion is a problem globally and has been estimated to cost local and national economies in the EU in the region of €100 billion (or 1% of the EU's GDP), annually[89]. Traffic congestion is also associated with increased air pollutant emissions from vehicles[90], as increased numbers of cars on the roads taking longer to reach their destinations burn more fuel , are constantly accelerating/decelerating and idle for longer along particular routes.

In cities, congestion and its associated problems are generally addressed using traffic demand management measures. These involve taking a multi-faceted approach to identify a

[88] https://www.epa.ie/pubs/reports/air/quality/Urban_Environmental_Indicators_2019.pdf, pp. 11-13.
[89] https://ec.europa.eu/transport/themes/urban/urban_mobility_en
[90] E.g. DoT EFEU (2017) *The costs of congestion: an analysis of the Greater Dublin Area*, pp. 2-3, p. 5, p. 19..

suite of options that are best suited to the particular needs of specific locations. Traffic demand measures may include enhanced public transport provision; embracing home/remote working; and enhancing walking and cycling facilities and connectivity within the urban areas. These broader measures may exist alongside complementary measures in particular cities including road pricing strategies, supports for low emission small public service vehicles (SPSVs), and parking provisions and controls within city centres and suburban locations.

In 2019, the Department of Transport, Tourism and Sport commissioned a study to consider the potential roles of congestion pricing, low-emission zones, parking policies and other demand management measures in reducing greenhouse gas emissions and improving air quality in five Irish cities. The study was commissioned in response to Action 81 of the Climate Action Plan[91], which required the Department to:

'Develop a regulatory framework in low emission zones and parking pricing policies, and provide local authorities with the power to restrict access to certain parts of a city or town to zero-emission vehicles only. Examine the role of demand management measures in Irish cities, including low emission zones and parking pricing policies.'

The ongoing study will consider key demand management drivers in each city (e.g. congestion, air quality, climate considerations), each of which will be given equal weight; review international best practice on various demand management measures, and will recommend the most appropriate responses for Dublin, Cork, Galway, Limerick and Waterford. Overall transport strategies for each city will also be taken into account along with a national roadmap for delivery. Representatives from the relevant local authorities and Climate Action Regional Offices (CAROs) sit on the Steering Group for this study. Consequently, there is an overlap between the Study Steering Group and UTRAP Group membership, which will maximise the alignment of the work carried out by both groups.

The study will also support all other actions in the Climate Action Plan relevant to helping to deliver cleaner air, reducing congestion, and increasing levels of active and sustainable travel mode share. Also integrated into this approach is consideration of how to minimise any negative impacts on the local economy, and to avoid exacerbating any transport-related inequalities on vulnerable groups.

[91] https://assets.gov.ie/25419/c97cdecddf8c49ab976e773d4e11e515.pdf, p. 95.

The study methodology includes the collection and analysis of data from a range of sources to establish the current make-up of vehicle fleets travelling into the centres of the five cities. It also includes modelling the impact of a range of potential measures on both congestion and emissions levels in each city. The collection of baseline Automatic Number Plate Recognition (ANPR) data on the vehicle fleet profiles of each city was completed in February 2020 prior to the imposition of COVID-19 travel restrictions. Where possible, ANPR monitors were placed close to existing EPA air quality monitors. Analysis has also been undertaken to establish local traffic flow patterns as well as establishing the specific local profile of each city's vehicle fleet. Preliminary analysis has also been carried out to examine potential Low Emission Vehicle (LEV) use patterns in Irish cities, as well as the profile of vehicles using critical infrastructure (such as the Dublin Port Tunnel). Initial analysis and recommendations arising from the study are expected later this year.

Recommendation	
22.	UTRAP Group to reconvene and review the findings and 'Road map' of the Five Cities Traffic Demand Management Study to support local authorities in implementing suitable traffic demand management measures identified for specific cities.

7. Implementation and Oversight

The members of the UTRAP group have agreed to continue to meet on a regular basis to ensure implementation of the recommendations listed in the report. In addition to this, UTRAP will continue to act as a forum for sharing of knowledge and best practice amongst stakeholders, and if the need arise will explore new and emerging issues concerning transport-related air pollution in our towns and cities.

Recommendation	
23.	UTRAP Group to continue to meet at least bi-annually to monitor the implementation of the recommendations until completed.

8. Recommendations

	Recommendations	Lead
1	UTRAP Group to determine most appropriate ways to support the development of the Air Quality Action Plan for Dublin Agglomeration (Zone A).	DECC
2.	The EPA and relevant stakeholders to identify and support targeted indicative monitoring programmes at areas of recorded or suspected high transport-related air pollutant-emissions levels in urban areas, to feed into the development of policy measures and the expansion of air pollutant modelling activities.	EPA
3.	The EPA and DoT to progress the postponed Dublin Port transport-related air pollutant emissions source apportionment study.	DoT/EPA
4.	CIÉ, Iarnród Éireann and the EPA to examine how best to share information, including on rail operation patterns in urban terminal stations and available traffic data, to determine the contribution of heavy rail to ambient air pollutant emissions and for possible inclusion in air quality models.	DoT/DECC/ CIÉ/EPA
5.	CIÉ, Iarnród Éireann and the DoT to commission a feasibility study on the potential installation of platform-side shore power electricity in terminal rail stations to eliminate engine idling by trains.	DoT
6.	The DoT to provide funding for the rollout of EV charging infrastructure at train stations, and other transport hubs, nationally with funding provided by the Carbon Tax Fund.	DoT
7.	Examine and improve the pathways by which central government departments and their agencies supply the EPA with traffic-related data for inclusion in urban ambient air quality models.	DECC
8.	Ensure that air quality considerations, including the collection of data on transport-related air pollutant emissions, continue to be mainstreamed into broader transport-related research and emissions projects co-funded by central government departments and agencies, such as the DoT, and the EPA.	DoT
9.	DECC, EPA and relevant stakeholders to develop the capacity to perform modelling on an ongoing basis across the five cities in Ireland.	DECC
10.	The EPA, DECC, DoT and relevant stakeholders to support the implementation of the LIFE Emerald project through the provision of data and any other necessary resources.	DECC/DoT/ EPA
11.	Examine initiatives to strengthen and expand the communication of accurate transport-related air pollutant information to the public (as per the Aarhus Convention), with the cross-cutting aims of encouraging behavioural shift towards low emission and active travel modes, improving public health, and reducing air pollutant emissions.	DECC
12.	The DoT and the RSA to organise a pilot study to assess the emissions profile of ICE vehicles as they age.	DoT/RSA
13.	DoT and the RSA to organise a pilot study to assess the rate of DPF removal in the Irish fleet.	DoT/RSA

14.	Review the impact of the NO_x surcharge once more data is available to give an accurate reflection of its efficacy.	D/Finance
15.	To ensure that we are up-to-date on alternatively fuelled vehicles, continue to trial alternative fuel technologies where possible to inform the "Technology Pathway" of the NTA.	DoT
16.	Support CIÉ and the SEAI in running a trial of behavioural interventions to improve air quality and fuel economy.	DoT/DECC
17.	In tandem with DoT and the EPA, examine the evidence basis for operational activities relating to major urban railway stations, collate available data and establish a framework within which this information might be supplied to the EPA for inclusion in ambient air quality models.	DoT/DECC/ EPA/CIÉ
18.	In tandem with DoT and relevant local authority stakeholders, the EPA and Iarnród Éireann to develop and implement air quality studies and associated monitoring programmes to address the current knowledge gap relating to the impact of heavy rail air pollutant emissions within and in the vicinity of Ireland's urban terminal railway stations (including Pearse Station, Dublin).	DoT/DECC/ EPA/CIÉ
19.	Support the introduction of Variable Speed Limits across Ireland's national motorway infrastructure in accordance with national plans and support the implementation of the MTFO.	TII
20.	Develop a Park & Ride Strategy and support the delivery of park and ride sites	NTA
21.	Keep abreast of international best practice for air pollution barriers.	TII/UTRAP Group
22.	UTRAP Group to reconvene and review the findings and 'Road map' of the Five Cities Traffic Demand Management Study to support local authorities in implementing suitable traffic demand management measures identified for specific cities.	DECC/DoT
23.	UTRAP Group to continue to meet at least bi-annually to monitor the implementation of the recommendations until completed.	DECC/DoT to continue co-chair

Appendix A

UTRAP Group Members

- Department of the Environment, Climate and Communications
- Department of Transport
- Department of Finance
- Department of Health
- Department of Public Expenditure and Reform
- National Transport Authority
- Transport Infrastructure Ireland
- Environmental Protection Agency
- Dublin City Council
- Bus Éireann
- Dublin Bus
- Dublin Climate Action Regional Office
- South Dublin County Council (inc. Fingal and Dun Laoghaire Rathdown)
- Road Safety Authority

Terms of Reference

- Enhance awareness of clean air legislation and its requirements generally, and specifically in relation to NO_2 and other transport related air pollutants, amongst relevant stakeholder organisations;
- Provide a forum to enhance understanding of the causes and the health and environmental impacts of NO_2 air pollution and other transport related air pollutants in conurbations;
- Identify developments that may impact on NO_2 levels and other transport related air pollutants in conurbations, e.g. evolving technical standards, and quantify the impact under likely future scenarios;
- Identify examples of best practice in combatting NO_2 air pollution and other transport related air pollutants in conurbations, particularly road traffic-related air pollution, assess applicability and any barriers to their implementation in an Irish context;
- Consider a range of options for potential measures and any associated actions and supports required to facilitate their effective uptake to address NO_2 and other air pollution; identify measures most suitable to Ireland and appropriate implementation bodies; and

- Present the final UTRAP recommendations to both Ministers for consideration by Government.

Topics Covered

Meeting One (11/12/2019) – Scene Setting

1. Air Quality in Ireland, Context and Legislation – Andrew Caldicott, DCCAE.
2. Urban Air Quality Monitoring of Dublin – Kevin Delaney, EPA
3. Overview of the Transport Sector – Máirín Ní Cheallaigh, DTTAS.
4. Meeting the Challenges of Air Quality Management – A Local Authority Perspective – Martin Fitzpatrick, DCC.
5. Air Quality and Human Health – Keith Ian Quintyne, HSE.

Meeting Two (22/01/2020) – Research and Air Quality Modelling

1. Irish Traffic-Related Air Quality projects – Máirín Ní Cheallaigh, DTTAS.
2. Air Quality monitoring – Pat Kenny, EPA
3. Air Quality modelling – Pat Kenny, EPA

Meeting Three (27/02/2020) - Transition of the Transport Fleet

1. Vehicle standards and technology – Maria Holmes, RSA.
2. Overview of car stock model – David Crowe, DTTAS.
3. The NOx tax component of the VRT – Niall O'Sullivan, DoF
4. The transition of the public transport fleets to low emission technologies – Eoin Gillard, NTA.

Meeting Four (23/06/2020) - Critical Infrastructure and Transport Demand Management

1. M50 and Port Tunnel updates and initiatives – Derek Brady, TII and Vincent O'Malley TII.
2. Rail Fleet Transition and Air Quality Monitoring – Heidi Hopper Duffy, Irish Rail.
3. Potential Role of Demand Management – Study and Measures – David Connolly, Systra