An Roinn Iompair,
Turasóireachta agus Spóirt
Department of Transport,
Tourism and Sport

Irish traffic-related AQ projects

UTRAP Working Group Paper

Meeting 2

Contents

1. List of recent Ireland-specific traffic-related projects described in the paper

No.	Project name/acronym	Description/full name of project	Project Leader/ Lead Author	Institution /funding authority	Status
1.	**CON+Air Project**	Addressing **Con**flicts of Climate and **Air** Pollution	Eoin Ó Broin *et al.*	EPA	Completed. Published 2019.
2.	**DISTRACT**	Mo**D**al **S**hif**T** **R**educe **C**arbon in **T**ransport	Sheila Convery *et al.*	TCD/SEAI/DTTAS	Ongoing (end Jan 2020).
3.	**DTTaS Low Emission Bus Trial**	Low Emission Bus Trial to inform future urban bus procurements	Byrne Ó Cléirigh for DTTaS	DTTaS	Ongoing, final report under review.
4.	**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 /DTTAS	Ongoing (end date H2 2020).
5.	**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 (end date H1 2020).
6.	**Greening transport Project**	Greening transport	Brian Caulfield *et al.*	TCD/EPA	Ongoing, final report under review.
7.	**Impact of NO_2 on health**	Impact of NO_2 on health with particular emphasis on vulnerable groups	Margaret O'Mahony *et al.*	TCD/EPA	Ongoing (end date H2 2021).
8.	**MAP-HDV Project**	**M**itigation of **Air Pollution** impacts of Irish **HDV**s	Bidisha Ghosh *et al.*	TCD/SEAI/DTTAS	Ongoing (end 2020).

9.	**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/DTTAS	Ongoing (end 2020).
10.	**Particulate Matter from Diesel Vehicles**	Particulate matter from diesel vehicles: emissions & exposure	Meabh Gallagher *et al.*	TCD/EPA	Ongoing, final report under review.
11.	**REDMAP**	**R**oadside **E**missions in **D**ublin - **M**easurements **A**nd **P**rojections	Bidisha Ghosh *et al.*	TCD/EPA /DTTAS	Pending. March 2020 to March 2022.
12.	**TII Monitoring Network**	TII Monitoring Network adjacent to the M50 Dublin	Transport Infrastructure Ireland	TII	Ongoing monitoring programme (commenced June 2018).
13.	**Source Apportionment of Air Pollution in the Dublin Port Area**	TBD	TBC	EPA/ DTTAS	Pending approval.

2. Context and structure of the paper

This background paper has been prepared by the Department of Transport, Tourism and Sport (DTTAS) to inform stakeholder discussions at the second meeting of the Working Group on Urban Transport-Related Air Pollution (UTRAP) on 22 January 2020. The focus of the meeting is on air quality monitoring, modelling, forecasting and research. This paper brings together readily available information on future, ongoing and recently completed research projects that examine interactions between traffic-related pollutant emissions and air quality. The paper provides a broad overview of trends and focuses on Irish traffic-related air quality research but is not exhaustive; additional information on relevant projects not included in this paper may be brought to the attention of the UTRAP Group in the course of its deliberations and may feed into the Group's recommendations.

Sources of information used in compiling the paper include executive summaries published by project authors as well as information drawn from Department archives. Projects have been listed in alphabetical order according to their title.

This paper is not intended for publication and has been produced for reference purposes only.

3. Summary overview of projects

Information on 13 Ireland-specific traffic-related air quality projects is presented in this paper. Of these, four projects examine the impacts of transport-related pollutant emissions operating at a broad social scale:

- The **Greening Transport Project** is concerned with integrating technical emissions evaluation with the behavioural changes required to bring about emissions reductions across Irish society and operates within a timeframe structured around 2030 emissions targets;
- The **Impact of NO_2 on Health Project** is a multi-disciplinary study that seeks to model the impacts of NO_2 emissions, which largely derive from diesel-fuelled vehicles, on Irish public health, with a particular emphasis on impacts on vulnerable groups such as children, the elderly and the most socially disadvantaged;
- The **CON+AIR Project** models two counterfactual scenarios for emissions and concentrations of air pollutants in Ireland in the year 2030. The project focuses on air pollutant outcomes, with a particular emphasis on the pressures arising from certain climate-related policies and the effect that these can have on national air pollutant levels, associated health impacts and European Directive compliance; and
- The **DISTRACT Project** investigates the effectiveness of a limited number of behavioural change measures in bringing about reductions in transport emissions.

Several research projects are concerned with mitigating air pollutant emissions associated with fuel use; there is a particular emphasis within the research on the Heavy Duty Vehicle (HDV) sector: the **HDV CO_2 and Air Pollutant Emissions Project**; the **MAP-HDV Project**; and the **Eco-HDV Project**. The remaining projects focus on measuring real-life vehicle emissions: the **Particulate Matter from Diesel Vehicles Study** focuses on $PM_{2.5}$ emissions from diesel traffic; it is anticipated that the **REDMA**P project will measures NO, NO_2, PM and ammonia emissions from in-use vehicles; the pending **Source Apportionment of Air Pollution in the Dublin Port Area** Project will likely consider a range of air pollutants from both vessels and vehicles in the area around the port; the **EFFORT Project** is concerned with emissions from non-road vehicles (such as agricultural and construction machinery); while the **DTTAS Low Emission Bus Trial** measured tail-pipe emissions from a range of different bus fuel technologies. Finally, the **TII Monitoring**

Network tracks NO_2 emissions across a network of recording sites that are situated adjacent to the M50 Motorway in Dublin.

4. Descriptions of Irish traffic-related air quality projects

4.1. CON+AIR Project[1]

The Environmental Protection Agency's (EPA) CON+AIR project presents two counterfactual scenarios for emissions and concentrations of air pollutants in Ireland in the year 2030. It focuses on air pollutant outcomes, with a particular emphasis on the pressures arising from certain climate-related policies (e.g. biomass combustion, indirect encouragement of use of diesel vehicles) and the effect that these can have on national air pollutant levels, associated health impacts and European Directive compliance. The CONAIR project highlights the sensitivity of national compliance to a clearly defined plausible alternative outlook – the "problematic pathway" scenario. This alternative outlook is driven by variables outside policy control (e.g. population and economic growth), as well as varied sectoral pathways (e.g. trends in residential solid fuel use) where policy and technology interventions can have a strong bearing on air pollutant outcomes. The project will offer insight into the issues of most relevance to air pollution emission outcomes in Ireland, and the menu of policies and actions required to address these challenges.

The project also develops and describes a "solution pathway", which is designed to counter the trends and emission outcomes that are detailed in the problematic pathway, and the project quantifies energy, emissions and air pollution concentration outcomes for both pathways. In addition to highlighting issues associated with fuel consumption and emissions in the home heating sector, and with land use planning, the project highlights the particular importance of electrification of the transport sector; capacity and levels of service improvement for the public transport sector in major cities; and substantial investment in non-motorised travel infrastructure. Among the outcomes of the CONAIR project are the first high-resolution spatial maps of air pollution emissions across Ireland.

4.2. DISTRACT Project[2]

The DISTRACT Project reviews the effectiveness of behavioural change measures in bringing about reductions in transport emissions. Four potential mitigation measures underwent in-depth analysis using survey and secondary data; the measures were:

i) Increasing availability of EV chargers in workplaces;

ii) Increasing levels of remote working;

iii) Increasing levels of online shopping and delivery in place of retail travel; and

[1] https://www.epa.ie/researchandeducation/research/researchpublications/researchreports/research286.html.

[2] https://www.tcd.ie/civileng/people/sconvery/.

iv) Influencing campaign to encourage monitoring of tyre pressure in private passenger vehicles.

The measures were analysed based on notional implementation models in Ireland and evaluated based on public acceptance; success in other countries; potential emissions savings; cost and potential for success. Proposed key outputs from the project include an evaluation framework (toolkit) and proposed modifications to the Common Appraisal Framework for low cost behaviour change programmes; a refined list of measures which could be considered for investment; and areas for further research and piloting will be highlighted.

4.3. DTTAS Low Emission Bus Trial[3]

Under the National Development Plan, Ireland committed to cease buying diesel-only urban buses from July 2019 onwards. In December 2018, DTTAS launched a low emission bus trial to inform future Public Service Obligation bus fleet purchasing decisions. The trial assessed full electric, diesel-electric hybrid, compressed natural gas, and retro-fitted buses under real-driving conditions on selected routes in both Dublin and Cork. Each of the fuels and technologies underwent testing and were compared against a Euro VI diesel baseline. The trials considered CO_2 and air pollutant emissions, the contribution potential towards renewable energy targets as well as other criteria such as costs, fuel economy, availability and infrastructural requirements for each technology.

Real-life driving conditions and journeys were simulated, including operation in real traffic situations and timed stops at or near bus stops with opening and closing doors. Additionally, the independent drivers appointed in the trial provided qualitative data by completing surveys on the operational experience of driving each alternatively fueled bus. The final report on the findings of the bus trial will be published by DTTAS in the near future.

4.4. Eco-HDV Project[4]

The Eco-HDV desk-top-based project, funded by the EPA and carried out by a team at Trinity College, Dublin, aims to evaluate the impacts of adaptation of eco-driving programs in the Irish Heavy Duty Vehicle (HDV) fleet, including the freight sector. The project addresses the fact that, although eco-driving and related practises have been shown to improve fuel efficiency and to reduce vehicular emissions in HDV fleet internationally, little research has been carried out on the impacts of eco-driving across the Irish HDV fleet. The Eco-HDV project focuses on identifying best practises, analysing the immediate and long-term impacts of adaptation of eco-driving programs for Irish HDVs and developing simulation models to estimate future policy implications. The project will generate guidelines for adaptation and evaluation of eco-driving programs to reduce vehicular emissions from the Irish HDV fleet.

[3] https://www.gov.ie/en/policy-information/b72548-transport-and-climate-change/.
[4] https://www.researchgate.net/project/ECO-HDV.

4.5. EFFORT Project[5]

This project examines emissions from fuel consumed by Non-Road Mobile Machinery (NRMM), which was defined as any mobile machine, transportable equipment or vehicle with or without bodywork or wheels, not intended for the transport of passengers or goods on roads, and including machinery installed on the chassis of vehicles intended for the transport of passengers or goods on roads. Although contributions from NRMM could negatively impact on the quality of air, to date, fuel usage, air pollution, and greenhouse gas emissions associated with off road machine sources in Ireland are not fully understood. The EFFORT project, led by Technological University Dublin, aims to provide estimations on NRMM use within Ireland in order to develop more accurate emission inventories for both air quality pollutants and greenhouse gases associated with the use of NRMMs within an Irish context. The overall fuel consumption associated with NRMM will also be examined. The project will ultimately provide an assessment of potential environmental and human health risks associated with NRMM emissions and inform future policy and NRMM regulation.

4.6. Greening Transport Project[6]

The main vision of the EPA-funded Greening Transport project undertaken by Trinity College was to merge the technical evaluation of emissions from transport, and improvements in their calculation, with the behavioural changes needed to realise reductions in emissions. Past attempts to measure the "low hanging fruit" in terms of emissions reductions from transport have failed to fully merge these two disciplines. The project team stated its belief that in order for the EPA to have a holistic picture of the potential emission reductions that are possible in Ireland by 2030 (and beyond), it is vital not to ignore the behavioural constraints in which transport analysis is framed. The team further asserted that, while it is possible to predict targets for take up using assumptions, to ignore human behaviour is to not fully grasp the problem at hand.

With this in mind the work packages for this project were designed to tackle the interaction between technical emissions and transport models, and the ways in which behavioural constraints impacted the models. Project outcomes included a projection of emission reductions based on the integration of environmental and transport modelling methods with smart travel options and changes in the profile of Ireland's private car and public bus fleets. The project also measured the impacts of fiscal changes implemented in order to promote sustainable car use.

[5] For additional information, please contact the EPA.
[6] http://www.greeningtransport.ie/.

4.7. Impact of NO_2 on health with particular emphasis on vulnerable groups[7]

This EPA-funded project involves collaboration between a team of engineers, hospital consultants and environmental scientists from Trinity College, Dublin to examine the impacts of NO_2 on health in Ireland, with particular emphasis on vulnerable groups including children, the elderly and the socio-economically disadvantaged. Using currently available air pollution measurements, and recent research results on the influence of meteorological and source parameters (including transport vehicle and population mobility demands), they will identify a set of characteristics for the locations in Ireland that are at most risk of experiencing high levels of NO_2.

The Project will also examine the HSE-Primary Care Reimbursement Service (PCRS) prescribing database to establish much needed baseline data linking NO_2 levels with the prescription of drugs used to treat asthma and chronic obstructive airways disease with the intention to consider methodologies to facilitate the collection of prospective data in the future. Other databases, such as the Growing up in Ireland (GUI) and the Irish Longitudinal Study on Ageing (TILDA) will be explored to investigate if relationships between prevalence of respiratory symptoms in vulnerable groups and NO_2 levels exist. Finally, the team will review policies and strategies being implemented by other countries to bring NO_2 within compliance levels and to identify a set of effective and efficient solutions to reduce and mitigate the impact of the transport sector on NO_2 levels in Ireland, given its predominance in the output of NO_2 emissions.

4.8. MAP-HDV Project[8]

The MAP-HDV project is funded by the SEAI and DTTAS, and is being carried out by a team from Trinity College, Dublin. Its goals are to explore and establish the environmental, economic and health impacts of the vehicular emissions generated by the Irish HDV fleet; and to develop an appropriate tool-kit to monitor and calculate future energy consumption and related vehicular emissions from the fleet, using the most advanced simulation tools. In addition, the research focuses on exploring and evaluating a set of fleet and demand management tools derived from international and European best practices, and aims to develop a scenario-based modelling approach to mitigate vehicular emissions including CO_2. By evaluating the potential environmental and economic impacts and long-term sustainability of a range of measures, a suite of the most suitable of these will be recommended for possible implementation following consultation with expert stakeholders.

[7] https://www.tcd.ie/transport-research/research/projects-current/NO2-Health.php.

[8] https://www.researchgate.net/project/Mitigation-of-Air-Pollution-Impacts-of-Irish-Heavy-Duty-Vehicles-MAP-HDV.

4.9. Mitigation of Irish HDV CO_2 and/or air pollutant emissions[9]

A multitude of options are available to aid in the decarbonisation of heavy goods vehicles (HGVs), including measures focusing on increasing technical efficiency, improving the logistics and operations of transport, and encouraging the switch to alternative fuel technologies. This SEAI-funded study will review international best practice and benchmark the Irish HGV fleet against other comparator countries, followed by the quantitative assessment of select policies and measures with generic (LEAP, TIMES) and bespoke simulation and optimization-based transport modelling tools for emissions and air quality impacts. Consultation with industry and stakeholders in terms of their practices, preferences and behaviours will inform the quantitative assessments and will provide qualitative information that will feed into the selection of measures. The process of identifying least cost options for decarbonisation and reduction of pollutant emissions from the heavy goods vehicles sector in Ireland will also be informed by a review of international best practice, model-based assessment and consultation.

4.10. Particulate Matter from Diesel Vehicles Project[10]

This project was conducted in Dublin over a two year period (2016-2018) to assess the contribution of diesel vehicle emissions to the concentrations of $PM_{2.5}$ experienced by the city's population. The project was conducted as a collaboration between the Department of Civil, Structural & Environmental Engineering and the Department of Geology at Trinity College Dublin. $PM_{2.5}$ was monitored for over one year at two locations in Dublin. Source apportionment of emissions at the two sites was carried out using Laser Ablation Inductively Coupled Plasma Mass Spectrometry. This new technique enabled a large number of chemical species to be determined at greatly reduced cost and time, and with lower limits of detection. Positive Matrix Factorisation (PMF) modelling and Chemical Mass Balance modelling were also used for contextualisation and comparative purposes. Project outcomes also included the use of advanced land use regression (LUR) modelling to develop a spatial air quality model for Dublin, which integrated project data with available fixed site and mobile $PM_{2.5}$ data recorded by the EPA and Transport Infrastructure Ireland (TII). A new weighted support vector regression (SVR) model was developed that was used to model the health impact of $PM_{2.5}$ in Dublin generally, and as a result of diesel emissions. Expected death rates and disability adjusted life years (DALY) lost were also quantified.

Variation between the results recorded at both sites indicated that local conditions played a significant role in the apportionment of PM particles. At one of the two sites (Site A), solid fuel burning contributed 46%-50% of the total mass recorded, followed by diesel vehicle emissions (22%) and by road dust (19%). Overall percentages of diesel (9%) and road dust (8%) emissions

[9] SEAI Research, Development & Demonstration Funding Programme Call for submission of Applications 2018, p. 12 Topic 3, see https://www.seai.ie/grants/research-funding/research-development-and-demonstration-fund/SEAI-RDD-2018-Call-Document.pdf.

[10] https://www.tcd.ie/civileng/people/research-staff/meabh-gallagher.php

were considerably lower at the second of the two sites (Site B). Other sources of emissions recorded at both sites included soil (20% at Site B), sea spray (14% at Site B) and petrol emissions.

4.11. REDMAP Project[11]

The REDMAP project aims to measure, model and project real vehicular emission levels of key pollutants (including NO, NO_2, PM and Ammonia) from in-use vehicles in Dublin. Emissions from real-world driving are often higher than estimated emission levels presented in the national inventory based on Euro emissions standards and type-approval tests; consequently the air quality in cities has not improved as originally anticipated from fleet renewal and stringent emission regulations. To address this discrepancy, this project will measure real world emissions using remote sensing and portable emission monitoring systems. The real-world emission contribution of different vehicles considering Euro standard, fuel type, make, and categories and vehicle modifications will be utilised to improve the existing emission inventory, which has been generated using literature values. A new traffic-emission model and a paired air quality model that estimates pollutant concentrations will be formulated based on real-world emission factors (RDEF). The modelling framework will illustrate the potential environmental, economic and health impacts of real driving resulting from policy changes and future growth, considering scenario-based modelling. The project will generate guidelines on measures and opportunities to reduce actual vehicular emission on roads in Dublin.

4.12. TII Monitoring Network adjacent to the M50 Dublin[12]

Transport Infrastructure Ireland (TII) currently operate a network of 43 monitoring sites, which are located along the course of the M50 motorway in Dublin. Of the 43 monitors, 9 monitor noise levels, while the remaining sites monitor air quality, specifically ambient NO_2 levels. Since June 2018, the air quality monitoring sites have been used to produce an indicative estimate of longer-term average NO_2 concentrations along the motorway. Readings from the monitors have been collated to feed into an associated online map and a dashboard that allows members of the public and stakeholders to view bi-monthly and bi-annual NO_2 reports from each monitoring site. The monitoring programme was undertaken as part of the TII's commitment to ensure that air quality for communities adjoining national infrastructural projects is not significantly impacted. It also dovetails with TII's aim to provide a road network that will allow a more flexible approach to the adoption of Ultra Low Emission Vehicles and new emerging vehicle technologies. The design of the network accords with the revised guidelines for the treatment of air quality during the planning and construction of National Road Schemes, which were produced by the National Transport Authority in 2011.

[11] Project pending, online information to be published in due course.
[12] https://tii.sonitussystems.com/.

4.13. Source Apportionment of Air Pollution in the Dublin Port Area[13]

Ship emissions contain sulphur oxides, nitrogen oxides and PM that can impact on human health and the environment. The aim of this project is to assess, for the first time, the contribution of shipping emissions to air pollution in Dublin. The research will use an innovative combination of continuous air monitoring, intensive field campaigns and source apportionment modelling. Continuous monitoring will focus on the following key air pollutants; PM, heavy metals, black carbon, sulphur dioxide, nitrogen oxides and ozone. Highly detailed chemical and physical characterisation of ship emissions will also be achieved using state-of-the-art mass spectrometers operating in real-time. This chemical composition data will be used in source apportionment models to provide quantitative estimates of all major source contributions to PM, including shipping and other port-related emissions, road traffic, domestic solid fuel burning, construction and industry. The results will be used to inform policy on air pollution reduction strategies and provide recommendations and mitigation options for reducing emissions from ships in the Dublin Port area.

This project is pending approval by the EPA Board; co-funding from DTTAS is allocated if approved by the EPA.

[13] Project pending, online information to be published in due course.