



From 70mph to 50mph: What effect does lowering the speed limits on motorways have on the reduction of emissions and fuel consumption in diesel passenger cars?

Seminar Paper

Stephen Hutchings
BSc in Automotive Engineering

Contents Page

Abstract	Page 2
Technical abstract.....	Page 2
1.0 Introduction.....	Page 3
2.0 Review of literature.....	Page 3 -6
2.1 Government Documentation.....	Page 3-5
2.2 Literature from other countries.....	Page 5-6
Conclusion.....	Page 6
Reference list.....	Page 7-9

Abstract

The main purpose of this seminar paper is to explore secondary research that relates to the reduction of speed limits from 70mph to 50mph as a measure to reduce emissions in passenger cars. As this is a current emission reduction initiative for Wales, Welsh Government policies and reports that focus on this scheme were investigated. Research from other countries who already use this initiative was also explored. From secondary research it was found that this measure may not be sustainable and several factors such as traffic congestion, driver behaviour and vehicle maintenance can have an adverse effect on this proposal. It was also found that many studies collect their data from vehicle simulation programmes rather than real world driving conditions. It was established that diesel cars produce more emissions than petrol vehicles. Overall, it was concluded that more research that compared simulation data against real-world data needed to be conducted on diesel vehicles, it was also determined the factors that may have an effect on emissions need to be included in the research.

Technical Abstract

The main purpose of this seminar paper is to critically evaluate secondary research that is associated with the Welsh Governments measure, which focuses on reducing speed limits on motorways from 70mph to 50mph in a bid to reduce the amount of NO₂ and particulate matter(PM) emissions from passenger cars. This review established that 28.5% of NO₂ emissions originated from passenger vehicles, also NO₂ emissions in Wales exceeded the European PCM limits of 40µg/m³. From exploring research from other countries who have deployed this measure, it was found that simulation software such as VISSIM 9 is commonly used quantify data rather than real-road driving conditions. It was also discovered that factors such as European emissions standards, vehicle maintenance and driver behaviour had an adverse effect on the reduction of emissions. The review also established that diesel vehicles produced more NO₂ and PM than petrol vehicles. It was concluded that more primary research that focused on both simulation data and real-road driving conditions needed to be quantified. Also, it was decided that factors such as European emissions standards, driver behaviour and vehicle maintenance needed to be taken into consideration when evaluating this emission reduction measure.

1.0 Introduction

Currently the UK as a whole is failing to meet the limit values of nitrous dioxide (NO_2) set by the European Union (European Commission, 2017). NO_2 can cause adverse effects to public health and the environment, according to Public Health Wales (2018), 1108 deaths are caused by NO_2 exposure and 1604 deaths are caused by exposure to particulate matter (PM), however, it is unclear how they generated this data in the report. Nevertheless, this suggest that several measures need to be put in place in order to reduce the levels of nitrous dioxide in the environment.

According to the Welsh Government (2018) “the greatest impacts of NO_2 can be seen at roadside locations”. In a bid to meet the European limit values, several trunk roads and parts of the M4 motorway in Wales saw the reduction of speed limits from 70mph to 50mph in an attempt to decrease the high levels of NO_2 in these areas (Welsh Government, 2017). However, as data has not yet been gathered by the Welsh Government to quantify the effectiveness of measure after it has been put in place, it is not clear how sustainable this measure is for Wales. In addition to this, studies from other countries have found that similar measures do not significantly reduce NO_2 emissions (Keuken et al, 2010; Panis et al, 2010). Therefore, the main aim of this study will be to investigate the effect that lowering speed limits from 70mph to 50mph has on NO_2 and fuel consumption in diesel vehicles. The aim of this paper to explore current literature and Government policy that relates to the reduction of road speeds as a measure to reduce NO_2 .

2.0 Review of literature

2.1 Government documentation that relates to the reduction of emissions

According to the European Commission (2017) “Transport represents almost a quarter of Europe's greenhouse gas emissions and is the main cause of air pollution in cities.” This suggests that automotive vehicles largely contribute to pollution as a

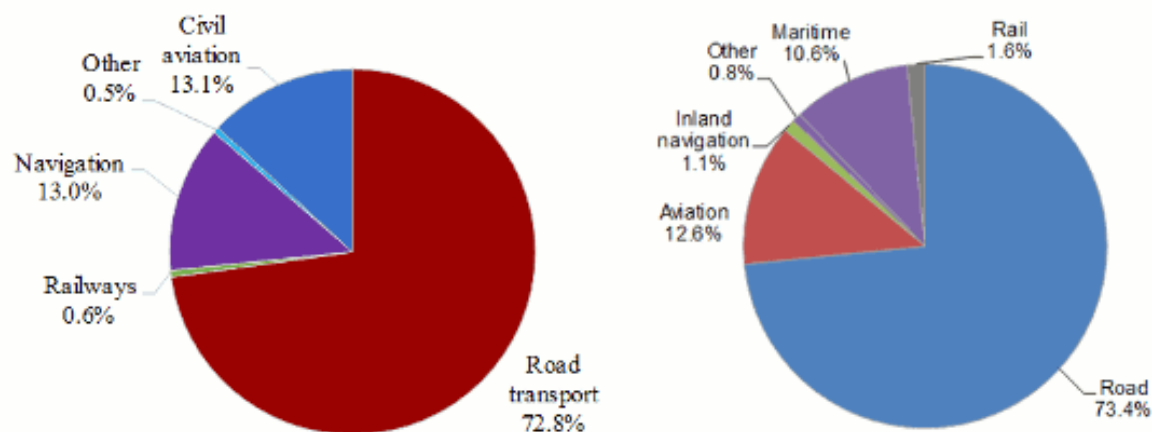


Figure 1: Pollutants from automotive vehicles European Commission (2017)

whole. However, it is important to note that this figure includes international aviation statistics (European Commission, 2017). Nevertheless, it can be seen from figure 1 that pollutants from road transport are much higher than other methods of transportation. As 72.8% of transport pollution derives from road transport it is clear that radical measures need taken in order to successfully reduce Europe's greenhouse gas emissions. In a bid to reduce the amount of air pollutants, legally binding limits are set by the Council Directive on ambient air quality and cleaner air for Europe (DEFRA, 2015). However, the UK as a whole is failing to meet the Nitrous Oxide limits set by the council. Therefore, an Air Quality Plan that specifically focused on the reduction of NO₂ was published by the UK Government in 2017 (DEFRA, 2017). In addition to this, the Welsh Government, who adheres to Council Directive by implementing Air Quality Standards Regulations (2010) have created their own set of policies in order to reduce emissions in Wales.

In Wales, 28.5% of NO₂ emissions originate from road transport (Welsh Government, 2018). From figure 2 it can be seen that passenger cars contribute to this figure more than other road vehicles, also this statistic is slightly higher than the UK's average. Consequently, this suggests that several measures need to be put in place to effectively reduce the amount of NO₂ pollutants in Wales. Amongst other measures used to effectively decrease NO₂, DEFRA (2017) proposed that speed limits should be reduced on Motorways where the air quality is poor. This measure was implemented by the Welsh Government in 2017 when temporary speed limits were put in place on five roads in Wales, two of these roads were part of the M4 motorway (BBC News, 2018). The measures were specifically put in place on these roads as the PCM limits (pollution climate mapping) of 40µg/m³ of NO₂ were exceeded on these road stretches (Welsh Government, 2018).

Metric	Wales	UK
Proportion of Emissions of NO _x from Road Transport	28.5%	33.7%
Proportion of Emissions of NO _x from Road Transport from Heavy Duty Vehicles (including buses)	18.3%	22.6%
Proportion of Emissions of NO _x from Road Transport from Light Duty Vehicles (excluding cars)	31.8%	29.8%
Proportion of Emissions of NO _x from Road Transport from Passenger Cars	49.5%	47.4%
Proportion of Emissions of NO _x from Road Transport from Motorcycles/Mopeds	0.3%	0.3%

Table 1: Emissions on Roads in Wales and the UK Welsh Government (2017)

When considering the statistical data from the emission reducing measures it can be seen that several factors

such as the volume and speed of traffic were taken into account in order to determine the amount of NO₂ pollutants likely to be emitted over time. Trafficmaster data was used to average vehicle speeds and annual average daily flows were obtained from the Department for Transport (Welsh Government, 2018). When

looking further into the statistical data it appears that the measures taken were quantified using the VISSIM 9 traffic simulation software. It appears that this traffic simulation is commonly used in studies as it gives a realistic simulation of traffic patterns (Barcelo, 2011). This suggests that it is a reliable piece of software to use. However, Jolovic et al (2016) state that there are several limitations to using simulation software, the main being that the software is not a true reflection on driver behaviour because it is a prediction of behaviour and therefore may not give a true representation of drivers from that particular geographic area. Therefore, this could mean that the analysis of emissions by the Welsh Government will not be a truly accurate account.

2.2 Global perspectives of the measure

In order to establish whether this measure is sustainable for Wales, literature from other countries where similar measures have been put in place was reviewed. From this literature it can be seen that reducing motorway speeds in order to tackle pollution is common practice in countries such as the Netherlands and Switzerland. From these studies it can also be seen that there is little use of real road data and research methodology is focused on simulation drive cycles (Janssen et al, 2001; Keller et al, 2008; Keuken et al, 2010). One study that has compared the difference between simulated and real world data is that of Andre et al (2005), the findings of this study found that there is a significant difference in data, especially when looking at vehicles that have recent European emissions standards. Therefore, it would be beneficial in this study if the differences between real road data and simulation data of different European emissions standard were compared.

Another study that has looked at real world data when evaluating the sustainability of reducing road speeds is that of Panis et al (2010), they found that CO₂ emissions decrease on motorways but NO₂ and PM increase. This is also similar to the findings from Keuken et al (2010) who found that traffic congestion caused by the reduction of speed limit caused emissions to increase. Therefore, it would be imperative to replicate real road conditions such as traffic congestion into the current study so that an accurate data is obtained. In this study two diesel and one petrol vehicle were used as this gave a true representation of car sales in Europe. However, it was found that petrol vehicles produced much lower amounts of NO₂ and PM than diesel vehicles, therefore this suggests that petrol vehicles do not contribute to the high levels of NO₂ emitted by passenger cars, this is also supported by Childs and Stobart (2005). As a result of this and because of the increasing amount of diesel vehicles on the roads, this current study will only focus on data from diesel vehicles only.

It appears that there are several factors that affect the ability to reduce emissions by decreasing motorway speeds; these include driving patterns and frequency of speeding (European Environmental Agency, 2011). Consequently, it would be advantageous to determine the driver behaviour of individuals who travel regularly on the stretches of motorways with the reduced speed limit to establish whether they stick to the speed limit and their driver behaviours on regular journeys. In addition to

this, the European Environmental Agency (2011) state that smooth driving conditions would reduce emissions by approximately 12-18% whereas realistic driving conditions which took into consideration the previously discussed factors would only reduce emissions by 2-3%. Therefore, this means that reducing motorway speeds in Wales may not be sustainable. Also, it would be valuable in this study if smooth driving conditions and driving conditions which took into consideration the above factors were compared. All the above studies have used vehicles that are Euro 4 emissions standard, however, as the average age of a car in the UK was 8.1 years old in 2017 (Statista, 2017) using a Vehicle which is Euro 5 emissions standard would give more of an accurate representation of vehicles used on today's roads. Nevertheless, as older vehicles with earlier emissions standards produce more emissions than newer vehicles it would be beneficial in this study to determine how the reduction of speed on motorways affects both old and new vehicles.

Another factor that may impact on the reduction of emissions by capping motorway speeds to 50 mph could be the overall maintenance of a vehicle. According to Nasir et al (2014), vehicles that poorly maintained emit more emissions and consume more fuel in comparison to vehicles that are serviced regularly. In addition to this, Fontaras et al (2017) states that incorrect tyre pressure could also increase the emissions produced by a vehicle. However, when looking at studies relating to the reduction of speed limits and emissions there is a clear lack of literature that looks at the effect of poor maintenance on emissions. Therefore, this is an important factor to consider in the current study.

Not many of the studies mentioned previously have focussed on the effects that the measure would have on fuel consumption. Having said this, one study conducted by the European Environment Agency (2011) demonstrated that a reduction of speed limit can lower the fuel consumption of a vehicle. In opposition of this, as a reduced speed limit can cause traffic congestion (Keuken et al, 2010), this means that the vehicle is not driving smoothly and the driver would be using the more fuel when operating up and down the gears (Treiber et al, 2012). Therefore, this measure may be costly to road users. As there is limited research on the effects of speed reduction on both emissions and fuel consumption, this will be a factor that is measured in this study.

3.0 Conclusion

Action needs to be taken in order for the Welsh Government to reduce the current amount of NO₂ emissions in order to meet PCM limits. However, having read several government reviews and research papers from other countries that already have reduced speed limits on motorways in a bid to tackle pollution, it is still unclear if this measure is as effective as a sustainable one. As many studies, including Welsh Government reviews, have used data gathered from laboratories rather than real-world data, this means that data gathered may not be a true representation of the actual measure. Therefore, in this study the sustainability of the measure will be analysed by comparing real world emissions data against laboratory data on two diesel vehicles. Furthermore, studies in this report have shown that it is important to

take into consideration other factors that may affect the amount of emissions being produced such as traffic congestion, driver behaviour, emissions standards and vehicle maintenance. As a result of this, the emissions and fuel consumption of vehicles that have been serviced in comparison to those that have not will be compared. Also, the emissions of a Euro standard 3 passenger car will be compared against a Euro standard 5 passenger 5 to determine whether the measure of reducing speed limits affects one vehicle more than the other. Lastly, the driver behaviour of individuals who use these particular stretches of roads will be sought and analysed to determine whether this is a factor that could have a negative effect on the measure. Therefore, the further actions needed to address the research question are:

- To analyse the sustainability of reducing motorway speeds through the comparison of real world emissions data and laboratory data of two diesel vehicles (one Euro standards 3 and the other Euro standards 5).
- To compare the NO₂ emissions and fuel consumption of the two diesel vehicles before and after a full vehicle service.
- To gather and evaluate the driver behaviour of drives who regularly use the affected stretch of road.

Glossary of Terms

PCM – Pollution Climate Mapping

Traffic Master – GPS sourced data of GPS links broken down into 15 second intervals.

VISSIM – Traffic Analysis and forecast software

Reference List

Andre,M.,Jourmard,R.,Vidon.R.,Tassel,P. and Perret,P. (2006) Real-world European driving cycles, for measuring emissions from high and low powered cars. *Journal of Atmospheric Environment*. Vol 40 (31), pp5944-5953

Barcello, J. (2011) *Fundamentals of Traffic Simulation*. Springer: London

DEFRA (2015) Annual report of air pollution in the UK. (online) available from: https://uk-air.defra.gov.uk/assets/documents/annualreport/air_pollution_uk_2015_issue_1.pdf [last accessed 25/10/2018]

DEFRA (2017) UK Plan for tackling roadside nitrogen oxide concentrations. (online)available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/633269/air-quality-plan-overview.pdf [last accessed on 29/10/2018]

European Commission (2017) A European strategy for low-emission mobility. (online) available from: <https://ec.europa.eu/clima/policies/tr> [last accessed 23/10/2018]

Fontaras, G.,Zacharof,N. and Ciuffo,B. (2017) Fuel consumption and co2 emissions from passenger cars in Europe- Laboratory versus real-world emissions. *Progress in Energy and Combustion Science*. Vol 60. Pp97-131

Janssen, N., Vliet, P.,Aarts,F., Harseema, H. and Brunekeef, B (2001)Assessment of the exposure to traffic related air pollution of children attending schools near motorways. *Journal of Atmospheric Environment*. Vol 35 (22), pp3875-3883

Jolovc, D.,Salgado, D.,Martin, P.and Aldrete,R. (2017) Traffic microsimulation models assessment-A case study of international port of entry. *Procedia Computer Science*. Vol 83. Pp441-448

Keller, J., Tinguely, M.,Flemming,J., Heldstab, H., Keller,M. and Prevot, A. (2008) The impact of reducing the maximum speed limit on motorways in Switzerland on emissions and peak o zone. *Environmental Modelling and Software*. Vol 23(3). PP322-332

Keuken, M.,Jonkers, S., Wilmink,I. and Wesseling, J. (2010) *Science of the total environment*. Vol 408 (12), pp 2517 – 2526

Nasir,M., Noor,F.,Kalam, M. and Masum, B. (2014) Reduction of fuel consumption and exhaust pollutant using intelligent transport systems. *The Scientific World Journal*. Pp63-78

Panis, L.,Beckx., Broek,S.,Vlieger,L.,Schrooten,L. and Pelkmans,L. (2011) PM, Nox and CO2 emission reduction from speed management policies in Europe. *Transport Policy*. Vol 18 (1), pp32-37

Public Health Wales (2018) Making a Difference: Reducing Health Risks Associated with Road Traffic Pollution in Wales. (online) available from: <https://www.wales.nhs.uk/sitesplus/documents/888/PHW%20Air%20pollution%20report%20%28final%20English%29.pdf> [last accessed 01/11/2018]

Welsh Government (2018) *Clean Air Zone Framework for Wales*. (online) available from: <https://beta.gov.wales/sites/default/files/consultations/2018-04/180424-clean-air-zone-framework-en.pdf> [last accessed 27/10/2018]

Welsh Government (2018) Effectiveness review : Consideration of interventions on the Welsh Government trunk road and motorway network for nitrogen oxide reduction. (online) available from: <https://beta.gov.wales/sites/default/files/consultations/2018-04/180425-no2-effectiveness-review-report-en.pdf> [last accessed on 27/10/2018]

Welsh Government (2018) WELTAG Stage 3, impact assessment report: Consideration of interventions on the Welsh Government trunk road and motorway network for nitrogen oxide reduction. (online) available from: https://beta.gov.wales/sites/default/files/consultations/2018-09/weltag-stage-three-impact-assessment-report_1.pdf [last accessed 23/10/2018]