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1.0 Abstract

This seminar paper focuses on the comparison between two engines of similar design but with different capacities, establishing whether it is better for the environment to remain with a larger engine in production vehicles, or to lower the engine capacity. There are claims that using a smaller capacity engine would lower the amount of emissions produced, therefore being better for the environment. However, there has been tests on the smaller engine which discovered that some of the gases produced are much higher, however the other emissions appear to be lowered. There will be practical tests in the near future to validate the emission outputs of the two different engines, therefore creating an understanding of the benefits and disadvantages from both engines. The aims for this dissertation include the emissions testing for both engines, followed by a conclusion of the most beneficial engine for the future, research and testing to prove the concept of a 50mph speed zone to lower the emissions by comparing the vehicle emissions at speeds of 50mph and 70mph. In order to lower the emissions from an engine, some vehicle manufacturers have resorted to completely removing the engine from their cars, replacing it with an electrical powered system.

The reason for this chosen area of study is to prioritise the future, this is by lowering the amount of vehicle emissions to reduce the carbon footprint produced by our vehicles. On top of this, there will be a confirmation of whether or not the vehicle manufacturers are taking the right direction by downsizing or removing the engine.

2.0 Technical Abstract

Because of the constant reduction in vehicle emissions introduced by each of the euro emissions standards, it is becoming increasingly difficult to follow these limits so vehicle manufacturers have resorted to different methods of following these guidelines. Engine downsizing is becoming a popular method of reducing the emissions, or resorting to the removal of an engine to replace with an electrical powered system, removing the emissions altogether. However, there are a lot of people who are sceptical about this decision based on the amount of time the vehicle battery would take to charge, creating a disadvantage over the internal combustion engine only taking a few minutes to fill with fuel before the driver can continue the journey.

The reason for this chosen area of study is to develop an understanding of engine downsizing, to test if the engine emissions are lower by dropping the engine capacity and increasing the volumetric efficiency via a forced induction method such as a turbocharger or supercharger. This has been proven to reduce most of the emissions, however it appears to produce much more NO_x (Nitrogen Oxide) which can be dangerous at a certain level, therefore there may need to be an introduction of new technology to the system in order to reduce the amount of NO_x produced, or the development of a current system to assist in this. These could include the introduction of an EGR system (Exhaust Gas Recirculation), this is where the exhaust gases would be put back through the system to reduce the amount of NO_x gas produced. There are also other methods to reduce the emissions, such as additives to the fuel or exhaust gases, known as AdBlue.

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<u>3.0 Table of Figures</u> NOx: Nitrogen Oxide EGR: Exhaust Gas Recirculation DPF: Diesel Particulate Filter SCR: Selective Catalytic Reduction ECU: Electronic Control Unit	CO: Carbon Monoxide HC: Hydrocarbons PM: Particulate Matter RDE: Real Driving Emissions
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4.0 Introduction

3.1: Dissertation Overview - The aims of this seminar paper are to discuss the plans and objectives to be carried out in the future, to prepare for the final dissertation paper. There will be many relevant questions that need to be researched and verified, followed by testing of some sort in order to prove this research to either be correct or incorrect.

The world is currently facing a lot of difficulties with emissions and greenhouse gases effecting the planet, this has resulted in a large amount of different methods being implemented in order to reduce or remove the amount of emissions being released into the atmosphere and increasing the greenhouse gases.

A very big method of doing this is by reducing the impact from the automotive world, which is forever reducing the amount of emissions that can be produced in this area. There are different regulations and guidelines that the vehicle manufacturers must follow when developing a new vehicle in order for it to be allowed on the public roads, in which these regulations and guidelines are getting stricter with the newer cars being released.

There are euro emissions standards which need to be followed by the vehicle manufacturers, this limits the emissions which can be produced by the engine and each new standard that gets released will lower these

emissions each time, resorting in some vehicle manufacturers changing to other alternatives. These include the development of a hybrid system, switching to a fully electric system, or using different methods to lower the emissions such as engine downsizing which is becoming more popular with vehicle manufacturers such as ford.

4.2: Aims –

- Investigate the real-world problems revolving around the vehicle emissions produced, and the methods implemented in order to reduce this output.
- Research the euro emissions standards (Euro 5 and 6) to discover the differences between each.
- Provide any reasons for the implementation of a permanent speed zone in certain areas, and whether the speed zone passing Port Talbot actually makes a difference to the air pollution around the Port Talbot area.

- Conduct a series of tests on a vehicle via a rolling road to gather data on the emissions output, then compare it to a similar vehicle with a different engine capacity to develop an understanding of the benefits or disadvantages with engine downsizing.

regulations and guidelines to be suitable for road driving, they would do this by ensuring that the correct testing methods and guidelines are followed to avoid any methods of 'cheating' during the test. Before any vehicle is allowed on public roads, it first needs to comply with all of the guidelines given by the Euro Emissions Standards.

These Euro Emissions Standards will vary on the year of production for the given vehicle, in which these standards get stricter each step by lowering the maximum values allowed from the engine as the standards increase.

For example, Euro 6 standards have a stricter emissions limit than the Euro 5 standards, whereas Euro 7 standards, to be released in the near future, will have a stricter emissions limit than the Euro 6 standards.

Each increase in the Euro Emissions Standards, will decrease the amount of emissions that can be produced by an engine. These constantly lowering values required for the emissions standards have started causing many difficulties within the manufacturing process of a vehicle, this is due to the restrictions becoming increasingly difficult to follow, therefore causing some manufacturers to start resorting to a number of different production methods in order to follow these restrictions. The popular Ford EcoBoost Engine has been found to produce a high amount of NO_x as shown in Figure 3.

Euro 5 is applicable for vehicles registered after 1st January 2011 but before 1st January 2015, brought the introduction of the DPF (Diesel Particulate Filter) which is capable of capturing 99% of diesel particulates.

5.0 Research

4.1: Emissions, Euro 5 and 6 –



Figure 1 – Vehicle Emissions. Smith, L (2017)

A popular problem with emissions is the fact there are so many variables to affect the output of a vehicle's emissions, when a vehicle is being emissions tested before a sale it will need to be verified by a governing body. The governing body will assess these tests in order to confirm that the vehicle follows all

Euro 5 emissions standards (petrol)

CO: 1.0g/km
THC: 0.10g/km
NMHC: 0.068g/km
NO_x: 0.06g/km
PM: 0.005g/km (direct injection only)

Euro 5 emissions standards (diesel)

CO: 0.50g/km
HC + NO_x: 0.23g/km
NO_x: 0.18g/km
PM: 0.005g/km
PN [# / km]: 6.0×10^{-11} / km

Figure 2 – Euro 5 Emissions, RAC (2019). In Appendices.

Euro 6 is applicable for vehicles registered after 1st September 2016 and is still the current emissions standards. This focused mainly on lowering the amount of NOx produced by a diesel engine, resorting in the development of an SCR system (Selective Catalytic Reduction). This injects a liquid into the exhaust through a catalyst, converting the NOx into less harmful Nitrogen and Water.

Euro 6 emissions standards (petrol)

CO: 1.0g/km
THC: 0.10g/km
NMHC: 0.068g/km
NOx: 0.06g/km
PM: 0.005g/km (direct injection only)
PN [# /km]: 6.0x10⁻¹¹/km (direct injection only)

Euro 6 emissions standards (diesel)

CO: 0.50g/km
HC + NOx: 0.17g/km
NOx: 0.08g/km
PM: 0.005g/km
PN [# /km]: 6.0x10⁻¹¹/km

Figure 3 – Euro 6 Emissions, RAC (2019). In Appendices.

To find these figures, the vehicle will need to be tested for RDE (Real Driving Emissions), where the vehicle is tested whilst driving on the road in realistic conditions.

4.2: Methods to Lower Emissions - Such manufacturing methods can include engine downsizing to help reduce the emissions or some manufacturers will try to 'cheat' during the certain tests as discovered in the past. This is achieved by allowing the vehicle to detect any test conditions, such as when the engine is running with the bonnet open, then the ECU would notice that the bonnet is open and switch to a different engine map to lower the emissions due to the possibility of it undergoing an emissions test, which will then be reverted back to the old engine map with increased emissions after the test had taken place.

Manufacturers such as Volkswagen and BMW have been discovered using this method in the past, which has resorted in extra tests coming into place to avoid this happening again in the future. A new test being implemented would include a live road test

where the vehicle is driven in realistic conditions on a road.

There can also be the introduction of currently developed technology such as and EGR system (Exhaust Gas Recirculation), this is where the exhaust gases are recirculated through the engine to reduce the amount of NOx produced. However, this can cause some of the other exhaust gases to increase by a small amount, but still beneficial when introduced to the system compared to the higher amounts of NOx. Another method of reducing the emissions will include the addition of an additive into either the fuel or exhaust system, known as AdBlue. This AdBlue contains urea which when added to the exhaust gases, it helps to convert some of the harmful gases in the system into less harmful gases. This AdBlue would be inserted into the fuel tank when refilling to mix with the fuel, therefore mixing with the fuel.

4.3: Speed Zones:



Figure 4 – Speed Cameras. Dron, W (2018)

Port Talbot 50mph speed zone was put into place on July 24th 2019, with the aims of being a temporary method of reducing the amount of emissions being released from cars passing on the M4 and busy built up areas such as Port Talbot, Newport, the A470, the A483 and the A494. However, these 50mph speed zones were instead made permanent by the welsh government to tackle the high amounts of emissions they were previously struggling to improve.

A welsh government spokesman had confirmed that the Nitrogen Dioxide levels being produced by the vehicles was over the legal limits so it needed to be reduced quickly, and these speed zones was found to be the quickest method of reducing these Nitrogen Dioxide levels to within the legal limits.

A Transport Minister, Ken Skates, stated that he hopes motorists would agree slowing down to reduce emissions is more important than saving a small amount of time driving along the road (Skates, 2019). This is due to the high amounts of air pollution reportedly having an effect on the life span of those living locally to the area, as expressed in the above quotation by Skates (2019).

However, many motorists believe that the speed zone has a very little effect on the air pollution around Port Talbot, or even no affect at all. This is due to the lower speeds implemented instead causing more congestion in this area, therefore increasing the amount of time spend in the area and polluting the area for a longer period.

6.0 Methodology

5.1: Research – In order to conduct the necessary research, there will need to be many different means of retrieving the information. This includes any online novels, literature available via the library and any personal knowledge which would need to be verified with research. This research will be compiled into a document to develop an understanding of the different areas, and it will need to be provided by a verified source to be included in an argumentative point.

5.2: Emissions testing – In order to retrieve the emissions data a vehicle will need to be brought into the university facility, and after being fitted with the testing equipment, it will be run on the rolling road through a drive cycle and then at three speed intervals covering the same distance for realistic emissions readings that can be easily

repeated for a comparison. In order to gather data about the speed zone passing Port Talbot, the duration of the speed zone will be timed in a personal vehicle in order to calculate the total amount of emissions produced by the vehicle over that duration. The emissions testing will be noted at a vehicle speed of 30mph to simulate a busy road, again at 50mph to simulate the speed zone, and lastly again at 70mph to simulate a motorway in which was the allowed speed before the 50mph speed zone was implemented. The test comparisons at 30mph would be used to decide which of the two vehicles would be the most beneficial to reduce the emissions on a busy road full of pedestrians and houses, the tests at different speeds of 50mph and 70mph would aim to discover the total amount of emissions produced by the vehicle throughout the speed zone, trying to prove the benefit of lowering the vehicle speed to 50mph or whether it's more beneficial to spend less time passing the speed zone.

7.0 Conclusion

The government and vehicle manufacturers are working together to lower the vehicle emissions and benefit the environment, there are many different methods being implemented from both sides in order to achieve these benefits.

The government has implemented speed zones and emissions regulations in order to set a maximum amount of emissions produced by the vehicles, these are very useful in busy areas such as cities and where the emissions would be harmful to those around the area, therefore the lower emissions would be very beneficial.

The vehicle manufacturers implement different methods in order to comply with these regulations provided by the government and these emissions regulations, this results in

the development of new technologies for reducing the emissions further. These technologies are constantly being developed due to the decreasing values allowed from the emissions, resulting in the addition of new technologies or some manufacturers resorting to fully electric systems. One of the methods used by the government to lower the emissions includes speed zones on busy

roads, it is claimed to lower the amount of emissions produced but some people believe that it causes congestion in these areas therefore increasing the amount of emissions being produced overall, this is due to there being more vehicles on the road and travelling on the road for a longer duration of time. So, a future test will be carried out to settle this argument and better the emissions.

8.0 Appendices

"I would hope most motorists would agree that helping to save people from illness or even death is more important than saving a minute or so on their journey." (Skates, K. 2019). retrieved from <https://www.bbc.co.uk/news/uk-wales-49938080>

Figure 2 – Euro 5 Emissions, RAC (2019)

"I am encouraged by these findings in the first year of these speed limits, but it is vital we continue to reduce emissions in order to save people from the risk of developing potentially serious health conditions." (Skates, K. 2019) retrieved from <https://www.itv.com/news/wales/2019-10-07/50mph-speed-limits-see-pollution-drop-at-welsh-traffic-hotspots/>

"It is vital urgent reductions in nitrogen dioxide emissions are achieved to meet legislative requirements and to support our ambitions for a healthier and more globally responsible Wales." (Griffiths, L. 2019). Retrieved from <https://www.bbc.co.uk/news/uk-wales-49938080>

Euro 5 emissions standards (petrol)

CO: 1.0g/km	CO: 1.0g/km
THC: 0.10g/km	THC: 0.10g/km
NMHC: 0.068g/k	NMHC: 0.068g/km
NOx: 0.06g/km	NOx: 0.06g/km
PM: 0.005g/km	PM: 0.005g/km (direct injection only)
	PN [# /km]: 6.0x10 ¹¹ /km (direct injection only)

Euro 5 emissions standards (diesel)

CO: 0.50g/km	CO: 0.50g/km
HC + NOx: 0.23g	HC + NOx: 0.17g/km
NOx: 0.18g/km	NOx: 0.08g/km
PM: 0.005g/km	PM: 0.005g/km
PN [# /km]: 6.0x1	PN [# /km]: 6.0x10 ¹¹ /km

Figure 3 – Euro 6 Emissions, RAC (2019)

 Aq  AIR QUALITY Petrol and Hybrid Euro 6									
Manufacturer	Model	Fuel type	Model year	Engine size litres	Power bhp	Driven wheels	Transmission	Regulatory stage	EQUA Aq Index
Audi	A1	Petrol	2015	1.4	123	2	Manual	Euro 6	A
Audi	A3	Petrol	2015	1.4	148	2	Automatic	Euro 6	A
Audi	A4	Petrol	2016	2.0	187	2	Automatic	Euro 6	A
Audi	R53	Petrol	2016	2.5	362	4	Automatic	Euro 6	A
BMW	1 Series	Petrol	2015	1.5	134	2	Manual	Euro 6	A
BMW	X5	Petrol	2015	4.4	575	4	Automatic	Euro 6	A
Hyundai	i20	Petrol	2015	1.4	99	2	Manual	Euro 6	A
Hyundai	i30	Petrol	2015	1.6	183	2	Manual	Euro 6	A
Infiniti	Q30	Petrol	2016	1.6	120	2	Manual	Euro 6	A
Kia	Sportage	Petrol	2016	1.6	174	4	Manual	Euro 6	A
Mercedes-Benz	CLA	Petrol	2014	1.6	120	2	Manual	Euro 6	A
Mini	Convertible	Petrol	2016	1.5	134	2	Manual	Euro 6	A
Mini	Hatch	Petrol	2014	2.0	189	2	Manual	Euro 6	A
Porsche	Cayenne	Petrol Plug-in Hybrid	2016	3.0	410	4	Automatic	Euro 6	A
Seat	Ibiza	Petrol	2016	1.2	108	2	Manual	Euro 6	A
Seat	Ibiza	Petrol	2016	1.4	148	2	Manual	Euro 6	A
Seat	Leon	Petrol	2016	1.4	148	2	Manual	Euro 6	A
Seat	Leon	Petrol	2016	2.0	286	2	Manual	Euro 6	A
Smart	ForFour	Petrol	2015	0.9	89	2	Manual	Euro 6	A
Suzuki	Celerio	Petrol	2015	1.0	67	2	Manual	Euro 6	A
Toyota	Prius	Petrol Hybrid	2016	1.8	134	2	CVT	Euro 6	A
Toyota	Yaris	Petrol Hybrid	2015	1.5	100	2	CVT	Euro 6	A
Toyota	Yaris	Petrol Hybrid	2016	1.5	100	2	CVT	Euro 6	A
Vauxhall	Astra	Petrol	2016	1.4	148	2	Manual	Euro 6	A
Vauxhall	Astra	Petrol	2016	1.6	197	2	Manual	Euro 6	A
Vauxhall	Corsa	Petrol	2015	1.2	69	2	Manual	Euro 6	A
Vauxhall	Corsa	Petrol	2015	1.6	202	2	Manual	Euro 6	A
Vauxhall	Corsa	Petrol	2016	1.4	148	2	Manual	Euro 6	A
Vauxhall	Viva	Petrol	2015	1.0	75	2	Manual	Euro 6	A
Volkswagen	Caddy	Petrol	2016	1.4	123	2	Automatic	Euro 6	A
Volkswagen	Golf	Petrol	2013	1.4	138	2	Manual	Euro 6	A
Volkswagen	Golf	Petrol Plug-in Hybrid	2015	1.4	201	2	Automatic	Euro 6	A
Volkswagen	Golf	Petrol	2015	2.0	296	4	Manual	Euro 6	A
Volkswagen	Golf	Petrol	2015	2.0	296	4	Automatic	Euro 6	A
Volkswagen	Golf	Petrol	2016	1.0	115	2	Manual	Euro 6	A
Volkswagen	Polo	Petrol	2015	1.2	89	2	Manual	Euro 6	A
Volvo	V40	Petrol	2015	2.0	242	2	Automatic	Euro 6	A
DS	3	Petrol	2015	1.2	128	2	Manual	Euro 6	B
Mercedes-Benz	S-Class	Petrol	2014	4.7	449	2	Automatic	Euro 6	B
Mini	Hatch	Petrol	2014	1.5	134	2	Manual	Euro 6	C
Ford	Focus	Petrol	2015	1.0	123	2	Manual	Euro 6	E

Figure 5 – NOx Emissions. Evans, J (2016)

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