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Briefing

Future vehicles: quieter AND more fuel efficient

Context

The European Parliament's Environment, Public Health and Food Safety Committee (ENVI) is currently considering a Commission proposal [COM (2011) 856] for a Regulation on the sound levels of motor vehicles. The proposal, if adopted, will replace the existing vehicle noise directive (70/157/EEC), including enforcing tighter noise emission limits for cars, vans, lorries and buses and updating the testing method. Parliament is also considering how, on average, new cars should achieve a CO_2 limit of 95g/km as stipulated in Regulation (EC) No 443/2009. Concerns have been raised that making vehicles quieter is in conflict with making them more fuel efficient and lowering CO_2 emissions. This briefing paper outlines the evidence based upon a study by TNO, independent experts that advise the Commission on both noise and CO_2 regulations.[i] Results show that synergies between making cars more fuel efficient and quieter outweigh any conflict generated.

What's at stake?

Traffic noise is the most widespread cause of environmental health problems in Europe. Some 210 million EU citizens, over 44% of the EU population, are regularly exposed to road traffic noise over the level the World Health Organisation (WHO) is considered to pose a serious risk to health.[ii] In cities the number of people exposed to road noise is at least 5 times greater than all other sources (railways, airports, industry) put together.[iii] Reducing noise from vehicles is therefore a public health imperative. It is also far cheaper than the cost of noise walls, insulation and quiet surfaces, which are on average between 8 and 120 times greater per person protected compared to making vehicles quieter.[iv]

The benefits of reducing vehicle noise in better health and quality of life and higher property prices outweigh the costs by a factor of thirty![v]

Where does vehicle noise come from?

Vehicles' exterior noise, at the low speeds generally encountered in cities, mainly comes from the powertrain. This includes the engine (and a turbocharger, if present), air intake and exhaust, cooling system and the transmission (gearbox and drive axles). Only at high speeds do tyre noise and to a lesser extent aerodynamic noise become more important. The proposed new noise limits for vehicles are principally focused on reducing noise from the powertrain as other regulations limit tyre noise.

Vehicle noise standards have not been updated for 20 years and nearly a quarter of cars and a third of light trucks tested over the past 5 years already meet the strictest standards proposed by the European Commission. The costs of reducing car noise are small, just €20 per car per decibel reduction.[vi]

Although making vehicles quieter is essential, it is equally important to reduce CO_2 and air pollution emissions. For vehicles with an engine, CO_2 emissions are directly related to their fuel efficiency so low carbon vehicles are also more fuel efficient and cheaper to run. Fortunately most measures designed to make vehicles more fuel-efficient also make them quieter.

How does making vehicles more fuel-efficient also affect noise?

There are many ways vehicle manufacturers are making cars more efficient to achieve their 2020 CO_2 limits, the most common ways being:

1. Downsizing the engine and using a turbocharger to maintain the performance of the vehicle while reducing fuel consumption and CO_2 emissions;
2. Introducing advanced direct injection (DI) for petrol engines (DI is already widespread in diesel engines);
3. Reducing friction and mechanical losses in the engine and transmission;
4. Using stop-start technology to switch off the engine when the vehicle is stationery;
5. Deploying hybrid technology, capturing energy during breaking and storing this in batteries to power auxiliary equipment; or, in some cases, the entire vehicle;
6. Improving the aerodynamics and rolling resistance of the tyres;
7. Improving the efficiency of auxiliary equipment.

Most manufacturers will also begin to deploy battery-electric vehicles that are silent; or range extended electric vehicles that will operate with a much smaller engine that are inherently much quieter.

The following sections consider the implications for vehicle noise of measures to improve fuel efficiency. They also consider the extent to which any additional noise insulation will affect the weight and efficiency of the vehicle.

There are clear synergies between improving fuel efficiency and reducing noise.

What is the effect of advanced fuel-efficient engines on noise?

Engine noise is principally generated by the combustion of fuel in the cylinders and radiated through the air intake and exhaust where silencers and mufflers reduce external levels. Mechanical noise (caused by friction and vibration of the engine block) and from the cooling fan also contribute. Developments in engine and powertrain technologies designed to improve the efficiency of cars and vans are benefiting noise.

One key development is the shift to smaller (downsized) engines with turbochargers fitted to the exhaust. Smaller engines are inherently quieter and have much more space to encapsulate the engine. The use of a turbocharger also tends to reduce exhaust noise since it maintains performance at a lower (and quieter) engine speed.

The introduction of advanced diesel engines using “common rail” fuel injection has also both improved fuel economy and reduced engine noise as a result of more efficient, smoother combustion in the cylinder. Advanced petrol engines using Direct Injection systems (such as the Ford Ecoboost engine[vii]) are now also being introduced and are much smaller, quieter and efficient than traditional (indirect injection) equivalents. Advanced engine lubrication is also enhancing efficiency and reducing noise.

Advanced engines are fuel efficient AND quiet

How do start-stop and hybrid systems affect vehicle noise?

Start-stop systems switch off the engine when it is idle (for example, when the gear is put into neutral). When a gear is selected, the engine starts automatically. In urban driving the engine can be idle for a significant time and the technology can deliver a significant fuel consumption benefit and virtually silent stationary vehicle.

In hybrid cars the engine is smaller and the powertrain optimised to run at lower (quieter) engine speeds and loads. These all have a beneficial effect on noise. The combustion engine is also used for a limited time, making the vehicle more fuel efficient and quieter.

What are the effects of improving aerodynamics and tyre rolling resistance?

Tyres are the dominant source of vehicle noise at constant speeds above 40 km/h but less important in urban environments with low speed driving. Contrary to popular myth there is no conflict between rolling resistance (fuel efficiency) and wet grip (safety) or noise.

In an urban environment aerodynamic noise from cars and (small) delivery vans makes only a minor contribution to traffic noise (although can be important for the interior noise level). In general aerodynamic enhancements improve fuel consumption and have a small noise benefit.

How effective is noise shielding and does it add much weight?

Noise shielding can reduce external noise by several decibels and can be designed to ensure engine cooling is still adequate. In some circumstances the improved encapsulation can increase fuel economy by reducing the number of times the car is driven with a cold engine. The additional weight of shielding is not significant especially as weight may be saved elsewhere on sound absorbing and damping materials. TNO suggests an additional 10 kg of shielding results in an additional emission of around 0.1 g of CO_2 per km – less than 0.1 % of the value for an average car.

What about trucks and buses?

The challenges of reducing CO_2 emissions from buses and trucks are different to those from cars and vans. Hybridisation of buses has proved to be an effective solution for urban buses and one with increasingly widespread take-up in some locations – notably London. These buses are also much quieter – leading to some residents in streets on bus routes actually asking transport operators to use hybrids on the route.[viii] Hybridisation may also become an option on vans and small urban delivery trucks with noise and CO_2 reduction benefits.

Noise encapsulation is likely to be a more widely adopted solution for reducing noise from trucks and buses. Encapsulation used to be widely employed but was reduced when quieter, more advanced “common rail” diesel engines were introduced. Noise encapsulation could be increased to meet tighter future noise standards, although there would need to be some adaptations to manage the insulation.

Trucks already cause half of the road noise burden across Europe and are a fast-growing share of the fleet. The additional costs of noise abatement technologies for trucks and buses are projected to be €250 per vehicle per decibel around a 1% increase in the purchase price for limits proposed by the Commission.[ix]

Simple noise encapsulation is cheap and effective in reducing noise from trucks and buses whilst adding minimal weight

Conclusions

In conclusion, there are widespread synergies, and relatively minor conflicts between measures to improve fuel economy, lower CO2 emissions and reduce noise. These synergies are summarised below:

Powertrain development	Effect on noise	Effect on CO_2
Downsized engine and turbocharger	√	√
Encapsulation	√	O
Reduced friction	√	√
Increased damping	√	O
Stop-start	√	√
Hybridisation	√	√
Electrification	√	√
Quiet & low rolling resistance tyres	√	√

Regulations that strengthen vehicles' noise limits have positive synergies with those improving fuel efficiency and lowering CO_2 emissions. Reducing vehicle noise is also the most cost-effective approach for reducing urban traffic noise and low cost for manufacturers to implement. There is no reason to weaken, or delay, the Commission's proposals.

Contact

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References

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[vi] Ibid 5
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[viii] Transport for London, 2011, Personal Communication
[ix] Ibid 5