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Fuel and drivetrain options for road transport
Impact on air pollution and external costs
Summary

Background

Air pollution is a major environmental contributor to public health problems worldwide.

The World Health Organization (WHO) estimates that every year, exposure to air pollution causes seven million premature deaths and results in the loss of millions more healthy years of life. Road transport is one of the major sources contributing to air pollution.

In a previous study for the European Public Health Alliance (EPHA), CE DELFT calculated the total costs of road traffic-related air pollution in the EU28. This study continues the search for health and social benefits by examining additional options to reduce diesel-related emissions from road transport.

Goal of this study

This study is an extension of a previous study and focuses on two main elements:

1. **Fuel and/or drivetrain scenarios**: the study analyses what the impact on emission levels would be if fuels/energy carriers such as electricity, CNG (compressed natural gas), LNG (liquid natural gas), LPG (liquefied petroleum gas), biofuels, and drivetrains such as plug-in hybrids and flex-fuel vehicles (which can run on high blends of fossil fuel substitutes) would replace diesel vehicles or diesel use.

2. **Broadened range of external costs**: In addition to external costs from NO_x and PM the study also assesses other external costs such as CO_2 emissions, noise, road safety, and congestion.

There are many different fuel and drivetrain combinations which potentially could replace diesel vehicles. The study examines the impacts of substitutes for diesel which may be promoted from the viewpoint of minimising air pollution and climate change. The scenarios aim to look at the impacts on air pollution and in particular on health when replacing diesel with alternatives.

It is important to realise the scenarios are hypothetical and constructed to reveal the maximum potential of diesel substitution: they do not reflect realistic fleet developments. Numbers may not add up due to rounding.

Impacts on air pollution emissions

The scenarios reveal the following impacts on NO_x and PM emissions:

— Replacing diesel vehicles with zero-emission (full-electric) vehicles is by far the most effective scenario to reduce NO_x and PM emissions (both tank-to-wheel and well-to-wheel).

— To a lesser extent, tank-to-wheel NO_x emissions can be reduced by replacing diesel vehicles with plug-in hybrid vehicles or vehicles running on natural gas (either CNG or LNG). Tank-to-wheel PM emissions are reduced far less with CNG and LNG. Apart from the most effective option, which is replacing them with zero-emission vehicles, PM emissions would also be reduced by replacing older diesel vehicles with the newest Euro 6 and Euro VI standard vehicles or plug-in hybrid vehicles.

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— The potential of liquid petroleum gas (LPG), ethanol (E85) and hydrotreated vegetable oil (HVO, a diesel substitute) to reduce well-to-tank NOx and PM emissions are limited and even lead to increased well-to-wheel emissions for the latter two.

Impacts on external costs

This study estimates that in 2030 for EU27 countries the costs that result from these emissions will amount to 14 billion euros, compared to 63.8 billion euros in 2016. This means that existing policies to reduce or modify diesel use will reduce the financial impact of diesel emissions but will not eliminate them (see Table 1). Over 90% of these costs are health costs.

External cost reductions are possible by replacing diesel use with alternative fuels and drivetrains. Replacing diesel vehicles with zero-emission (full-electric) vehicles would result in a reduction in costs from air pollution of 10.1 billion euros in 2030, which is a decrease of more than 70% compared to the baseline.

Replacing diesel use with compressed or liquid natural gas (CNG or LNG), plug-in hybrid vehicles or new diesel vehicles (Euro 6 and Euro VI) reduces external costs from air pollution by roughly 30 to 45% compared to the baseline. Diesel and petrol substitutes (hydrotreated vegetable oil and ethanol) do not result in a decrease in external costs.

Table 1 - Main results: costs for direct air pollution (TTW) from road transport in EU28 in 2016 and 2030 for various scenarios (costs in billion euros)

	Total costs	Reduction compared to 2030 baseline	Health costs	Health costs (% of total)
2016				
	63.8		58.5	91,7%
2030				
Baseline	14.0		12.8	91.4%
1. CNG/LNG	9.1	-35%	8.5	93.5%
2. LPG	12.2	-13%	11.3	92.2%
3. HVO	14.0	0%	12.8	91.4%
4. Plug-in hybrid	8.0	-43%	7.4	92.7%
5. E85 (bioethanol)	10.7	-23%	9.9	92.1%
6. Euro6/VI diesel	9.5	-32%	8.7	91.8%
7. Electricity	3.9	-72%	3.7	94.4%

The total level of external costs in 2016 increased from 64 billion to 721 billion euros when additional external impacts such as well-to-tank emissions, CO_2 emissions, congestion, noise, and traffic safety are also considered (see Table 2). Consequently, the fuel and drivetrain scenarios reveal larger external cost reductions ranging from 5 billion to 45 billion euros, whereas external costs from solely air pollution can be reduced by 0 to 10 billion euros.

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Table 2 – External costs of petrol and diesel transport in 2016 and 2030 for different scenarios (costs in billion euros)

	Tank-to-wheel air pollution	Well-to-tank air pollution	Well-to-tank CO_2	Tank-to-wheel CO_2	Accidents	Noise	Congestion 2016*	Total external costs	Reduction compared to 2030
2016									
	64	6	22	72	261	56	241	721	
2030									
Baseline	14	4	17	54	236	54	221	600	
1. CNG/LNG	9	2	10	46		54		578	3.6%
2. LPG	12	4	13	51		54		592	1.3%
3. HVO	14	6	10	18		54		559	6.8%
4. Plug-in hybrid	8	4	19	45		54		588	2.0%
5. E85 (bioethanol)	11	8	18	41		54		589	1.8%
6. Euro 6/VI diesel	9	4	17	53		54		595	0.9%
7. ZE vehicles	4	3	27	17		46		555	7.4%

Main conclusions

Substituting diesel road vehicles with full-electric vehicles is by far the most effective way to reduce tank-to-wheel emissions and associated external costs. It is roughly twice as effective as replacing diesel vehicles with plug-in hybrid vehicles, new (Euro 6/VI) diesel vehicles and CNG/LNG. This conclusion is still valid including well-to-tank emissions, i.e. the air pollution associated with the production of fuels/energy carriers.

Both hydrotreated vegetable oil (HVO) and ethanol (E85) have limited benefits in terms of replacing diesel use from a health perspective. For HVO this is because it can be used in the current vehicle fleet and the exhaust emissions remain practically the same whether regular diesel or HVO is used. Provided HVO is produced from truly renewable sources, it has substantial benefits in terms of reducing well-to-wheel emissions. In the more distant future when electricity production is expected to shift to higher shares of renewable production, the relative advantage of HVO will decrease.

Including additional external impacts in the external cost calculations such as noise pollution, congestion, and traffic safety, reveals a larger potential to reduce these costs when replacing diesel with alternative fuels and drivetrains. Further reductions in external costs are possible with non-technical policy interventions, like promoting active mobility (walking and cycling), leading to fewer motorised movements are very likely to lead to even greater reductions in external costs from road transport if this leads to fewer traffic accidents and less congestion.

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