Fuel and drivetrain options for road transport

Impact on air pollution and external costs

CE Delft

Committed to the Environment

An extension of our 2018 study

- Previous study by CE Delft:
  - *Costs of road traffic-related air pollution in the EU28*
    - *between € 67 and 80 billion in 2016*
    - *between €19.5 – 25.6 billion in 2030*

- Follow-up research question:
  - What if diesel is replaced by alternative fuel and drive train technologies?
    - E.g. natural gas (CNG/LNG), LPG, full or semi-electric, biofuels
  - What are their environmental benefits, both Well-to-tank and Tank-to-wheel?
  - What are the broader external costs (noise, safety and congestion)?

Key elements

- Focus on road transport (cars, vans, heavy goods vehicles, buses, two-wheelers)
- Base year 2016, predicted changes for the year 2030
- EU27 and 9 individual Member States
- 7 fuel/technology scenarios
- Impacts:

Emissions		**External costs**	
Nitrous Oxides (NO_x)	Well to tank (WTT)	Health impacts	
	Tank to wheel (TTW)	Additonal external costs	Safety (accidents)
Particulate matter (PM)	Well to tank (WTT)		Congestion
	Tank to wheel (TTW)		Noise
			Well-to-tank emissions
			Climate costs (CO_2)

Seven technology scenarios

1. Natural gas (mix of Compressed, CNG, and Liquid, LNG)
2. LPG, liquid petroleum gas
3. HVO, Hydrotreated Vegetable Oil, a diesel substitute (‘drop in’ fuel)
4. Plug-in hybrid vehicles (mix of electricity and petrol/diesel)
5. E85, ethanol, a petrol substitute
6. ‘Clean diesel’, conventional diesel in new vehicles (Euro 6/VI)
7. Zero Emission (ZE) vehicles, 100% electricity

- They are ‘What-if’ scenarios: to illustrate the maximum potential of diesel replacement

Findings on emission impacts (1)

- NOx and PM emissions decrease by far the most by substituting diesel with full-electric vehicles
- Plug-in hybrid and natural gas (CNG/LNG) do the same to a lesser extent
  - Concerns on ultrafine particles and health impacts for natural gas
- Diesel substitutes (biodiesel) although effective for climate are counterproductive for air quality

	Baseline	1. CNG/LNG	2. LPG *	3. HVO (biodiesel)	4. Plug-in hybrid*	5. E85 (bioethanol)*	6. Euro 6/VI diesel	7. Electricity
EU27	100%	37%	74%	100%	37%	63%	57%	0%
Bulgaria	100%	23%	60%	100%	28%	53%	32%	0%
Estonia	100%	29%	77%	100%	44%	68%	43%	0%
France	100%	36%	65%	100%	30%	48%	59%	0%
Germany	100%	46%	79%	100%	40%	59%	70%	0%
Hungary	100%	39%	88%	100%	34%	69%	61%	0%
Poland	100%	42%	94%	100%	46%	88%	60%	0%
Romania	100%	41%	88%	100%	47%	78%	59%	0%
Slovenia	100%	40%	64%	100%	33%	49%	60%	0%
Spain	100%	35%	60%	100%	27%	43%	52%	0%

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Findings on emission impacts (2)

Residual emissions in the 7 scenarios (NOx, Well to tank)

	Baseline	1. CNG/LNG	2. LPG *	3. HVO (biodiesel)	4. Plug-in hybrid*	5. E85 (bioethanol)*	6. Euro 6/VI diesel	7. Electricity
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Findings on external costs (air pollution only)

Costs in million Euro		Total costs	Reduction compared to 2030 baseline
2016		63.8	
2030	Baseline	14.0	
	1. CNG_LNG	9.1	-35%
	2. LPG	12.2	-13%
	3. HVO	14.0	0%
	4. Plugin Hybrid	8.0	-43%
	5. E85 (bioethanol)	10.7	-23%
	6. Clean Diesel	9.5	-32%
	7. Electricity	3.9	-72%

- External costs drop from 63.8 bln euro to 14.0 bln euro with existing policies
- Technology scenarios reduce external costs further with 0% (HVO) to 70% (Electricity) compared to baseline
  - Equals reduction of 0 to 10 bln euros

Findings on external costs (extended scope)

Costs in billion Euro		Tank-to-wheel air pollution	Well-to-tank air pollution	Well to tank (incl. CO_2)	Tank to wheel CO_2	Accidents	Noise	Con-gestion	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. Clean Diesel	9	4	17	53		54		595	0.9%
	7. ZE vehicles	4	3	27	17		46		555	7.4%

Findings on external costs (extended scope)

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← Max reduction 10 bln euro (air pollution only)

Max reduction 45 bln euro → (extended scope)

Main conclusions

- Current policies will reduce external costs from air pollution substantially (almost 80%) between now and 2030. Alternative fuels and drive trains can add to that.
- Substituting diesel vehicles with Zero Emission vehicles is very effective to reduce the impact of air pollution and associated social costs.
- Plug-in hybrid and natural gas also have substantial potential to reduce air pollution-related social costs. Some concern over ultrafine particles from natural gas.
- Broadening the scope of external costs from road transport reveals a much larger potential for reduction and policy intervention.

CE Delft

- Independent research and consultancy since 1978
- Transport, energy and resources
- Know-how on economics, technology and policy issues
- 85 employees, based in Delft, the Netherlands
- Not-for-profit

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