Reducing the environmental impacts of passenger cars: a comparison between electricity and biofuels

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INTRODUCTION

The exhaust emissions and life cycle impacts of a C-segment Euro 6d-TEMP GDI car, fed with four experimental blends of petrol and renewable fuels (Fuel A, B, C, D), were compared with those derived from:

- the same car fed with commercial reference petrol (Fuel A with fossil ETBE)
- an average C-segment battery electric vehicle (BEV)

Fuel	Unit	Fuel A	Fuel B	Fuel C	Fuel D
Petrol	% v/v	96.4	84.9	78.2	92.5
Bio-ETBE (ethyl tert-butyl ether)		3.6	-	21.8	-
Bionaphtha		-	7.0	-	-
Bio-EtOH (bioethanol)		-	8.1	-	4.8
Methanol or biomethanol or e-methanol		-	-	-	2.7

MATERIALS AND METHODS

Laboratory and on-the-road tests were carried out by driving the car following respectively the European homologation cold-start WLTC (Worldwide harmonized Light vehicles Test Cycle) and the RDE (Real Driving Emission) regulations. Results were compared and utilised within an LCA performed following the ISO standards 14040 and 14044 and the International Reference Life Cycle Data System (ILCD) guidelines.

Functional unit	1 km
System boundary	Production. use, and end-of-life of the cars, including capital goods (road, infrastructure, and equipment)
Modelling principle	Attributional
Geographic horizon	Europe
Impact assessment method	EF method 3.0
Data quality	Primary data only for the use phase of the petrol car

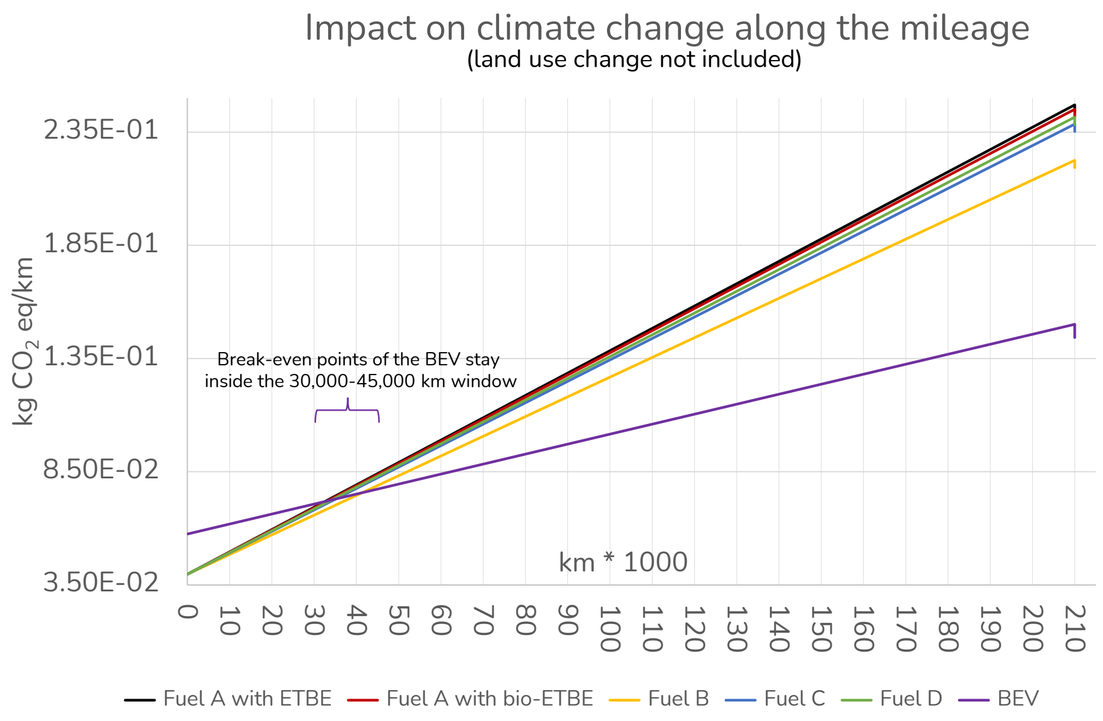
RESULTS: EXHAUST EMISSIONS

- Compliancy with Euro 6 standard (for WLTC) and Not-To-Exceed limits (for RDE)
- WLTC tests: 6.9% reduction in CO_2 emissions and 6.4% reduction in fuel consumption with Fuel B (versus Fuel A)
- RDE tests: 34%-43% increase in CO_2 emissions and fuel consumption, and 87%-200% increase in NOx emissions (versus WLTC tests)

RESULTS: LIFE CYCLE ASSESSMENT

Climate change:

- Fuel A with fossil ETBE (reference fuel of the study): highest impact (244 g CO_2 eq/km)
- Fuel A: 1% reduction
- Fuel B: 10% reduction
- Fuel C: 3.5% reduction
- Fuel D: 2% reduction
- BEV: 41% reduction



Use of fossil resources:

- Petrol cars: 1% - 11% reduction
- BEV: 25% reduction

Other 14 impact categories:

- Picture less straightforward
- Exhaust emissions are irrelevant when compared to the impacts of fuels and car production

	Climate change	Ozone depletion	Ionising radiation	Photochemical ozone formation	Particulate matter	Human toxicity, non-cancer	Human toxicity, cancer	Acidification	Eutrophication, freshwater	Eutrophication, marine	Eutrophication, terrestrial	Ecotoxicity, freshwater	Land use	Water use	Resource use, fossils	Resource use, minerals and metals
Fuel A beet ETBE	-0.8	0.0	0.0	-0.3	5.2	-0.8	0.0	10.6	-0.9	7.6	26.1	0.4	1.7	-4.2	-0.9	0.0
Fuel A straw ETBE	-0.8	0.3	0.1	-0.1	0.5	1.1	0.5	0.5	-0.7	4.0	1.5	1.3	0.9	0.6	-0.8	0.0
Fuel B beet EtOH	-10.1	-12.5	-8.9	2.8	30.9	-3.4	0.8	52.8	1.5	116.8	140.2	5.5	23.5	28.1	-11.1	1.3
Fuel B straw EtOH	-9.9	-11.0	-8.4	3.6	8.0	5.9	3.5	4.0	2.4	99.3	21.0	9.7	19.4	51.3	-10.6	1.4
Fuel C beet ETBE	-3.6	-5.3	-4.6	0.1	30.5	-4.5	0.0	61.8	0.2	48.2	159.4	2.0	9.8	-5.3	-5.1	0.7
Fuel C straw ETBE	-3.4	-3.5	-4.1	1.2	1.7	7.2	3.5	0.4	1.3	26.2	9.5	7.3	4.6	24.0	-4.5	0.8
Fuel D beet EtOH	-2.3	-3.3	-1.7	0.3	16.6	-1.8	0.4	33.3	-0.9	17.7	84.7	1.1	6.8	-4.4	-3.4	0.3
Fuel D straw EtOH	-2.2	-2.4	-1.4	0.8	2.3	4.0	2.1	2.8	-0.3	6.8	10.3	3.7	4.2	10.1	-3.1	0.4
BEV	-40.8	-69.6	131.7	-30.5	-10.9	3.7	3.5	-1.8	221.5	32.9	12.9	-61.6	4.5	108.5	-24.6	-57.3

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