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GHG Comparison of Low Carbon Propulsion Alternatives for Heavy Duty Long Haulage

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Conclusions

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- The availability of electricity produced by low- and zero carbon emission technologies is very important for the sustainable development of heavy road transport since the GHG performance of BEV, ERS, FCEV and electrofuels are strongly dependent on this
- Biofuels can contribute to significant reductions of GHG emissions from heavy transport. The biofuel production is not as dependent as the other alternatives on the availability of renewable electricity.
- The GHG emissions from battery production give a significant contribution to the overall emissions of the BEV and ERS alternatives
- Adding a CO_{2e}-cost based on the fuel WtW CO_{2e} emissions will make several of the biofuel alternatives and electrified alternatives (BEV and ERS) cheaper than diesel.
- The relative mobility costs are very sensitive to carbon-based policy instruments related to the GHG intensity of the energy carriers.

Project background

Based upon project within the collaborative research programme ***Renewable transportation fuels and systems*** financed by the Swedish Energy Agency and f3 Swedish knowledge centre for renewable transportation fuels.
www.f3centre.se/samverkansprogram

Final report in Swedish, with summary in English is available here:

https://f3centre.se/en/research/knoga-cost-and-risk-distribution-among-key-actors-for-defossilized-long-haulage-freight-transports-on-road/

Energimyndigheten

SVENSKT KUNSKAPSCENTRUM
FÖR FÖRNYBARA DRIVMEDEL

Objective

- To compare the GHG emissions in a WtW perspective for different propulsion alternatives for heavy duty long haulage vehicles

- To illustrate the potential impact of a CO_2 cost based on the WtW emissions of the energy carrier on the relative mobility costs

The GHG emission comparison includes emissions related to the energy/fuel consumption for propulsion and considers the upstream emissions from producing the fuels/energy carriers and combustion emissions as well as battery production for electrified alternatives.

Studied system

The GHG emission comparison includes:

- emissions related to the energy/fuel consumption for propulsion and the upstream emissions from producing the fuels/energy carriers and combustion emissions as well as emissions related to battery production for electrified alternatives.

Analysed alternatives

Fossil reference

Fossil fuels
In internal combustion engines
(diesel or LNG/CNG)

Low carbon alternatives

Biofuels
(liquid or gaseous)

Electrofuels
(liquid or gaseous)

Electric road systems
(conductive or inductive)

Battery electric

Fuel cell
(hydrogen and fuel cells)

Considering a truck of maximum total weight of 40 tonnes, HGV40

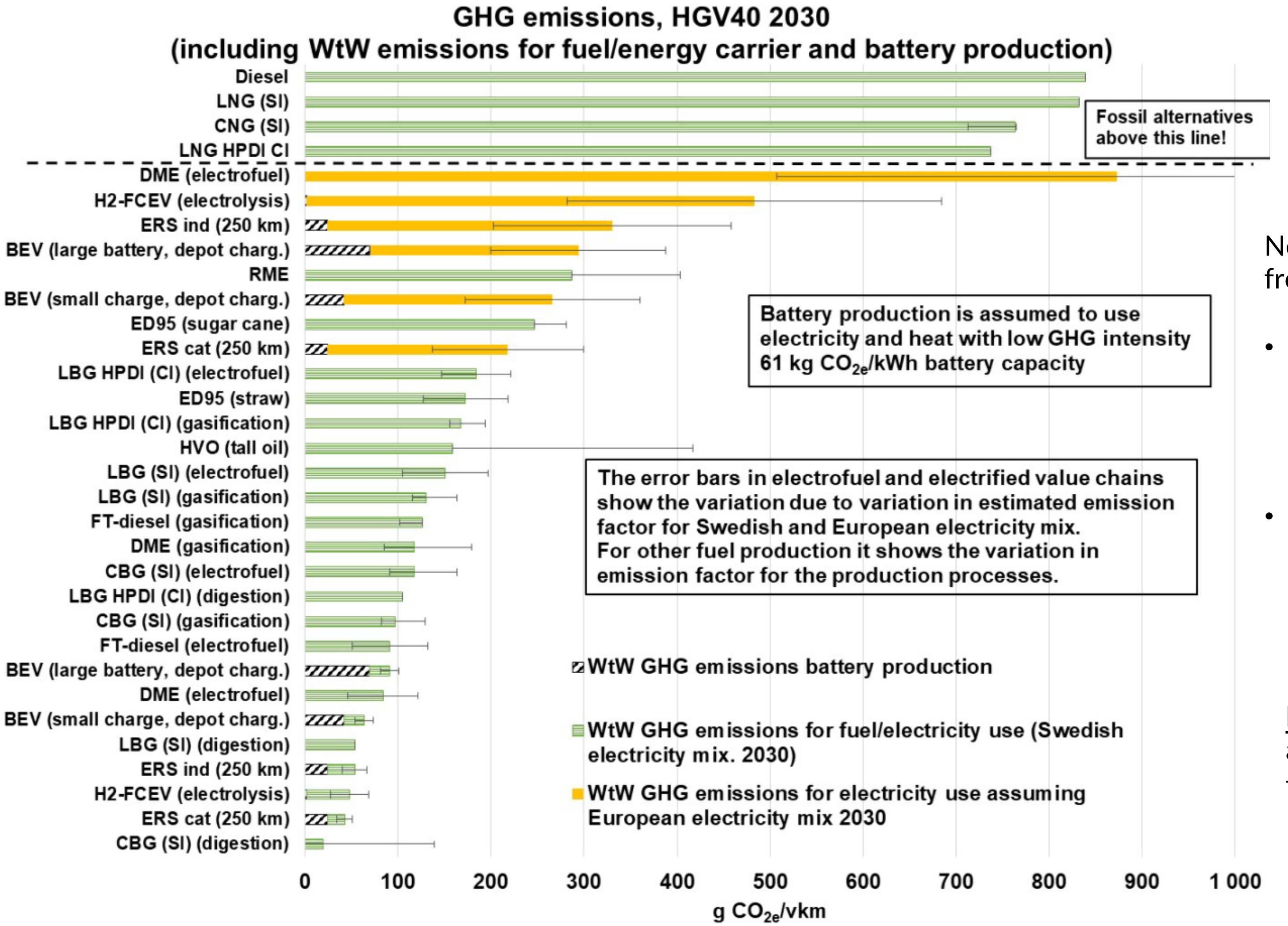
- Energy consumption extrapolated from JRC/JEC 5th WtW study (Röck et al. 2018)
- All alternatives have a range of at least ~ 640 km (long haulage)

Method

Data was gathered from literature (mostly grey) and official documents, updated with estimated developments and aligned with input from industry experts

GHG emissions	References/data sources
Vehicle performance data, fuel consumption etc.	Mainly based on Röck et al. (2018) (part of JEC 5th WTW study) Energy efficiency extrapolated from Röck et al. (2018), level in 2025 to 2030
GHG emissions of fuel production	RED II typical values for biofuels and fossil references, Furusjö & Lundgren (2017) gasification-based fuels, Prussi et al. (2020) (JRC 5th WtW study) and EEA (2020) , GHG intensity of electricity production, Bokinge et al. (2020) (electricity demand for electrofuels), Hagos & Ahlgren (2018) (distribution of gaseous fuels).
Battery production	Emilsson & Dahllöf (2019)

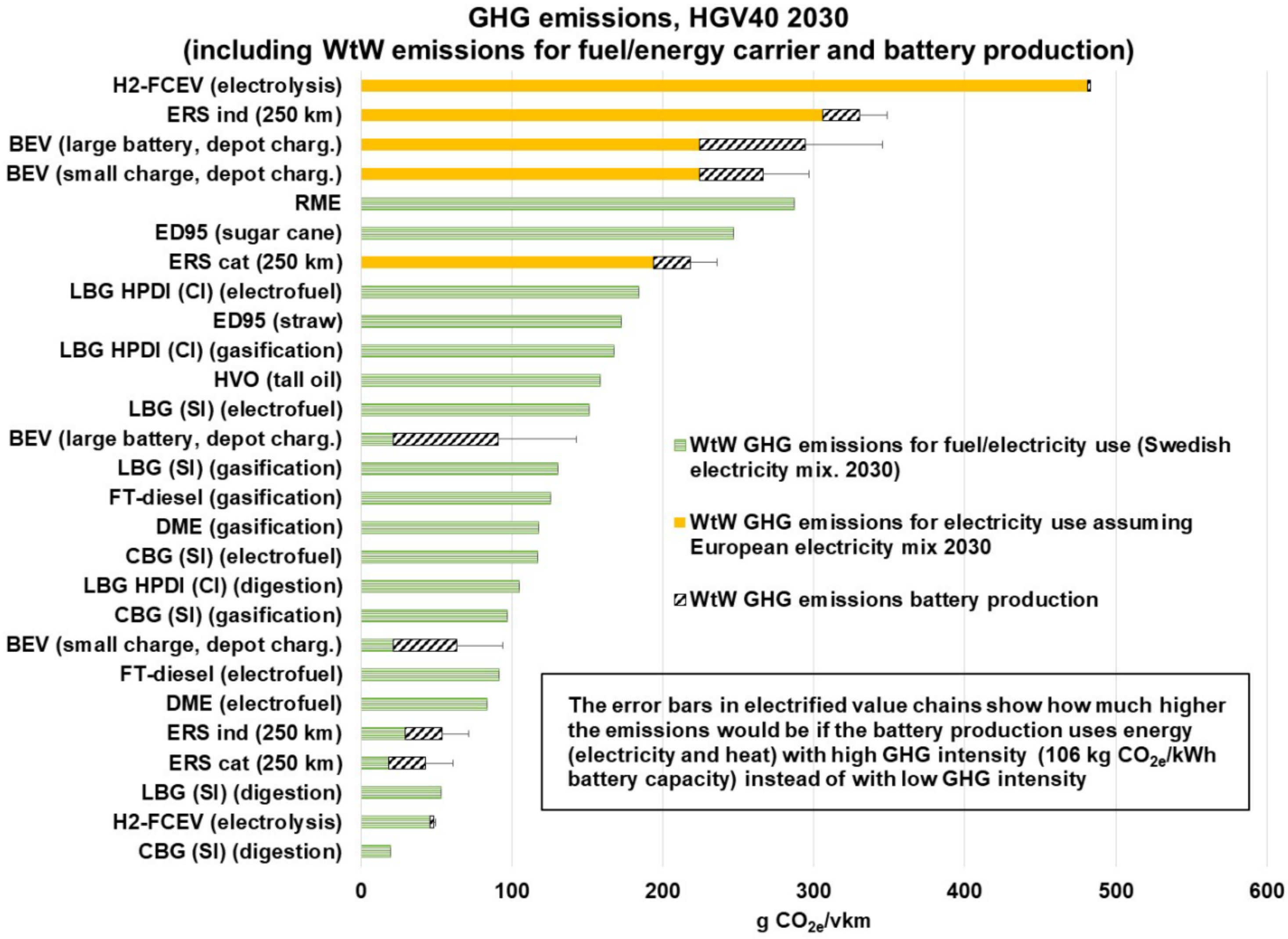
For cost data, see the Holmgren et al. (2021a) and Holmgren et al. (2021b)



Not considering the GHG from battery production:

- The CBG (digestion) has the lowest emissions followed by ERS, BEV and the LBG (digestion)
- FCEV has only slightly higher GHG impact, but very dependent on carbon intensity of electricity mix

NOTE: Error bars for CBG and LBG digestion extends to negative values



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Considering also GHG emissions from battery production:

- Alters the ranking making both BEVs (small and large battery) showing higher GHG intensity than FCEV and, DME (electrofuels) has lower GHG intensity then BEV (large battery)
- The GHG emissions from battery production is significant for BEV and ERS cases
- For BEVs, in the case of Swedish electricity mix, the emissions from battery production is more significant than the electricity used.

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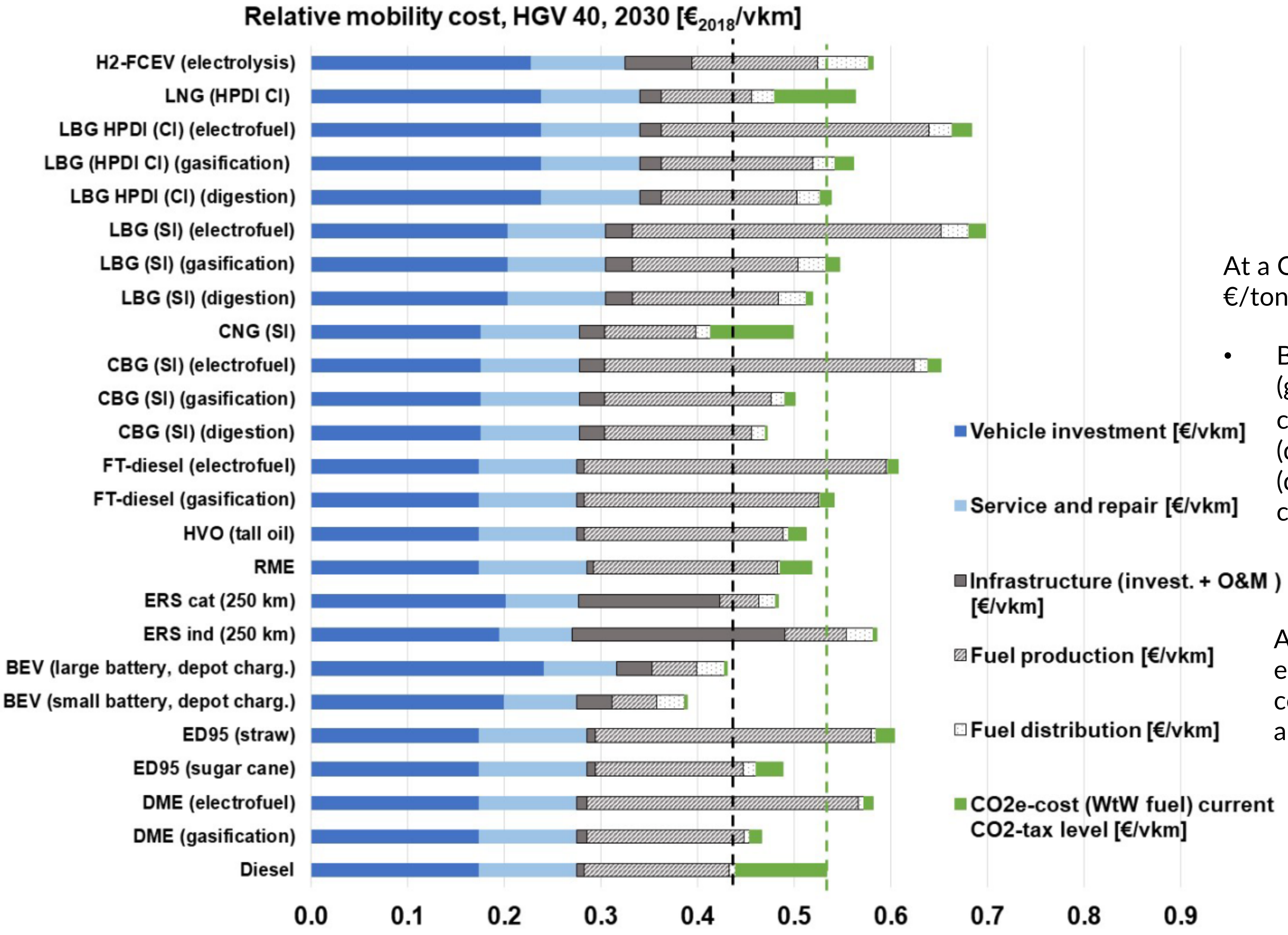

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At a CO_{2e}- cost level of 113 €/tonnes:

- BEV, ERS (cond.), DME (gasification), ethanol (sugar cane), RME, HVO, CBG (digestion and gasification), LBG (digestion based) have lower cost than diesel

Adding a CO_{2e}-cost for the energy carrier impacts the cost ranking of the alternatives significantly

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Conclusions

- The availability of electricity produced by low- and zero carbon emission technologies is very important for the sustainable development of heavy road transport since the GHG performance of BEV, ERS, FCEV and electrofuels are strongly dependent on this
- Biofuels can contribute to significant reductions of GHG emissions from heavy transport. The biofuel production is not as dependent as the other alternatives on the availability of renewable electricity.
- The GHG emissions from battery production give a significant contribution to the overall emissions of the BEV and ERS alternatives
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Thank you for the attention!