



Life-Cycle Assessment of Different Powertrain Technologies for Light- and Heavy-Duty Vehicles

Dirk Bosteels • 16th Int. ECT Conference • 7-8 October 2025

AECC is now the Association for Emissions Control and Climate

Expanding the scope

Components and systems

Full and Associate
member companies

- Air quality and **Climate** requirements
 - Mobile and **Stationary** emissions sources
 - Sustainable **components and systems**
-
- Catalysts
 - Filters
 - Adsorbers
 - Fuel cells
 - Electrolysers
 - System integration

EMITEC
TECHNOLOGIES

JM Johnson
Matthey

NGK

umicore

Albonair

BASF
We create chemistry

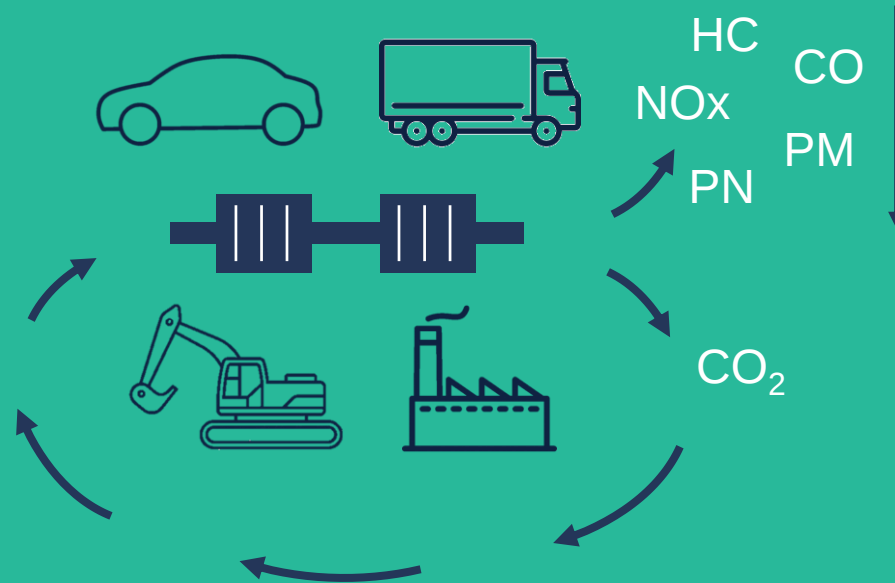
GORE
Creative Technologies
Worldwide

EU Transparency Register #78711786419-61, consultative status with the UN Economic and Social Council (ECOSOC)

AECC works in partnership with EU policymakers to target

**Zero-impact
pollutant
emissions**

**Net-zero
Greenhouse
gas emissions**



AECC member emission control systems ensure there's **no measurable negative impact** of these gases on the **environment** or on **public health**

AECC member emission control systems are compatible with **CO₂-neutral fuels** for a closed carbon cycle

LCA and LDV/HDV CO₂ reviews are a key AECC activity

On-road vehicles



Non-Road Mobile Machinery



Industrial Emissions



H₂ production and utilisation

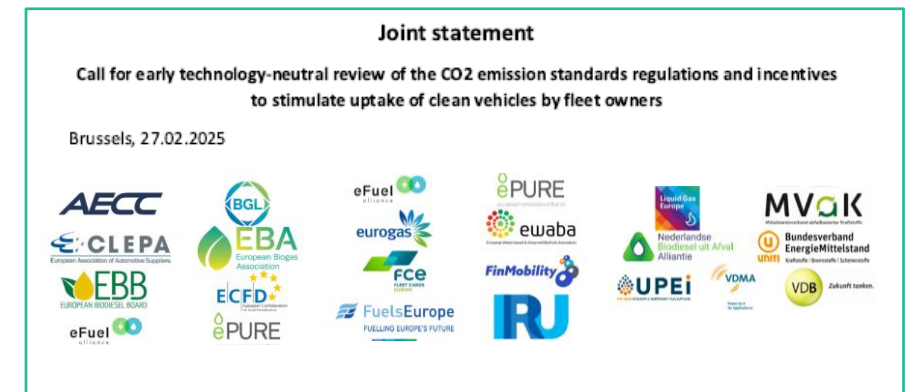


Life cycle assessment and circular economy



AECC is member of EU road-vehicle industry working groups

- Working group on Monitoring Methodologies (also known as ‘Stuttgart group’)
 - Evaluates all mechanical and digital solutions for **monitoring the use of CO₂-neutral fuels**
 - Published first [report](#) on 11 December 2024
- Network for Sustainable Mobility
 - Informal group of EU associations
 - Discussion of **ad-hoc joint statements** on topics related to the use of sustainable renewable fuels



AECC understanding of the EU CO₂ emissions review schedule

- LD CO₂ emissions
 - Commission proposal amending Reg. (EU) 2017/1151
 - Adding vehicle category running exclusively on CO₂-neutral fuels
 - Discussions in TCMV on Euro 6 stopped, *expected to reconvene for Euro 7 following CO₂ review*
 - Regulation (EU) 2023/851
 - Article 7a – [life cycle assessment methodology](#) by 31 December 2025
 - Article 14a – Progress report by 31 December 2025
 - Article 15 – Review of effectiveness and impact by Q2/2026
- HD CO₂ emissions
 - Regulation (EU) 2024/1610 – Article 15
 - Assessment of sustainable renewable fuels by 31 December 2025
 - Review of effectiveness and impact by 31 December 2027, including
 - Role of carbon correction factor
 - [Life cycle assessment methodology](#)
 - Methodology for registering vehicles running exclusively on CO₂-neutral fuels

Life-Cycle Assessment method development

- European Commission, DG-CLIMA
 - Work supported by a consortium of Ricardo, Öko-Institut, TU Graz and IVL Sweden
 - Build on existing EU legislative references and UNECE A-LCA IWG
 - Scope
 - All LDV vehicle technologies and powertrains in the EU according to cradle-to-grave method
 - HDV in second step
 - Initial goal: voluntary OEM reporting, feeding into the bi-annual EC progress report
- UNECE A-LCA
 - Timeline for drafting until GRPE adoption (WP.29 adoption to follow)



AECC and IPA LCA study

- Objectives
 - Extending the Well-to-Wheel CO₂ emissions of AECC-IPA LDV/HDV demonstrators on CO₂-neutral fuels
 - Understand impact of LCA methodology choices under consideration by UNECE and EU
- Conducted by Joanneum Research



J. Demuynck, et al.; *Life Cycle Assessment (LCA) of Light- and Heavy-duty Vehicles*, SIA Powertrain Conference 2025

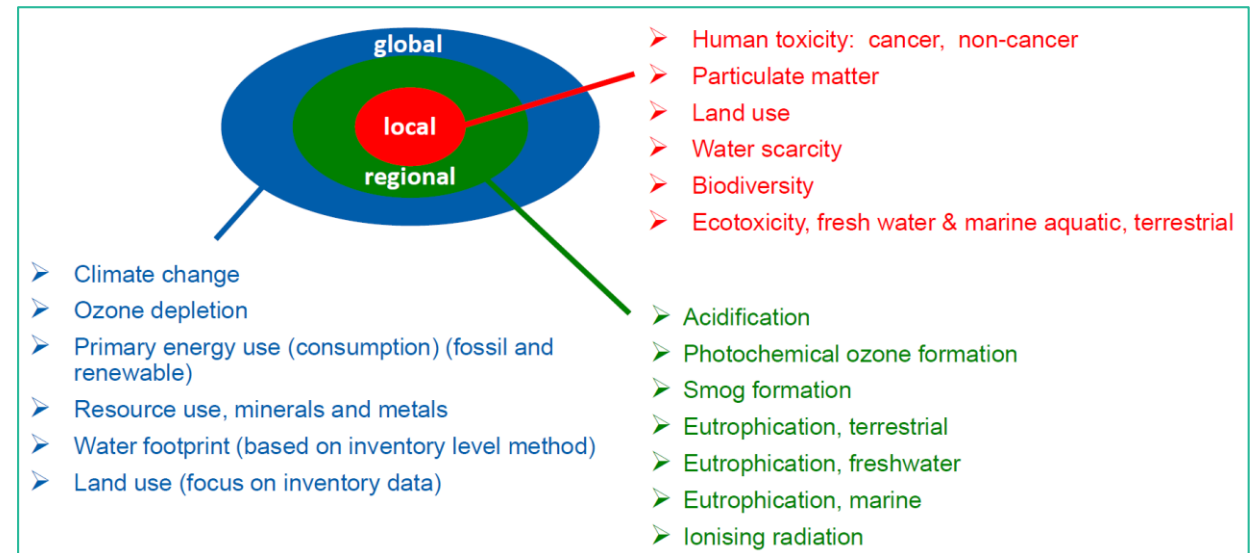
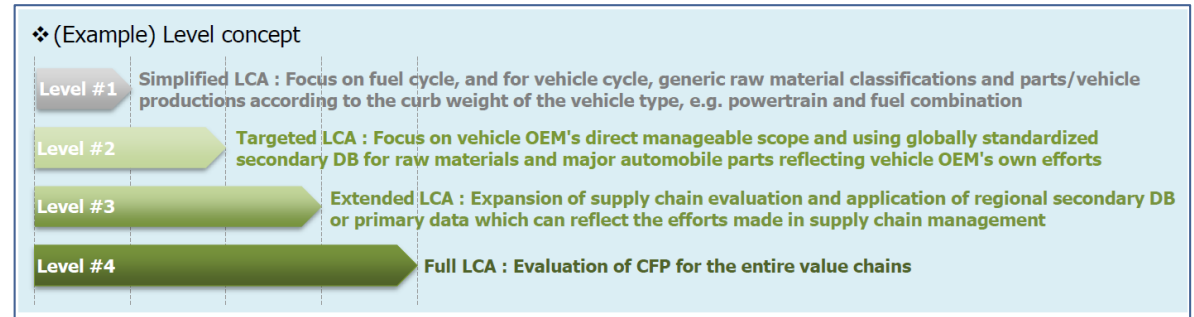
AECC and IPA LCA study

- Scope

- Level 1-2 LCA study
(levels under consideration at UNECE A-LCA IWG)

- Impact categories investigated

- Global Warming Potential (GWP – CO₂eq/km)
 - Including impact of CO₂, CH₄ and N₂O
- Primary Energy Demand (PED – kWh/km)
- Several additional impact categories possible



AECC and IPA LCA study

- Scope

- Vehicles

- Passenger cars, based on GreenNCAP vehicles representative for AECC demonstrators
 - Trucks, based on IEA Task 46 vehicle representative for AECC demonstrator

- Powertrains

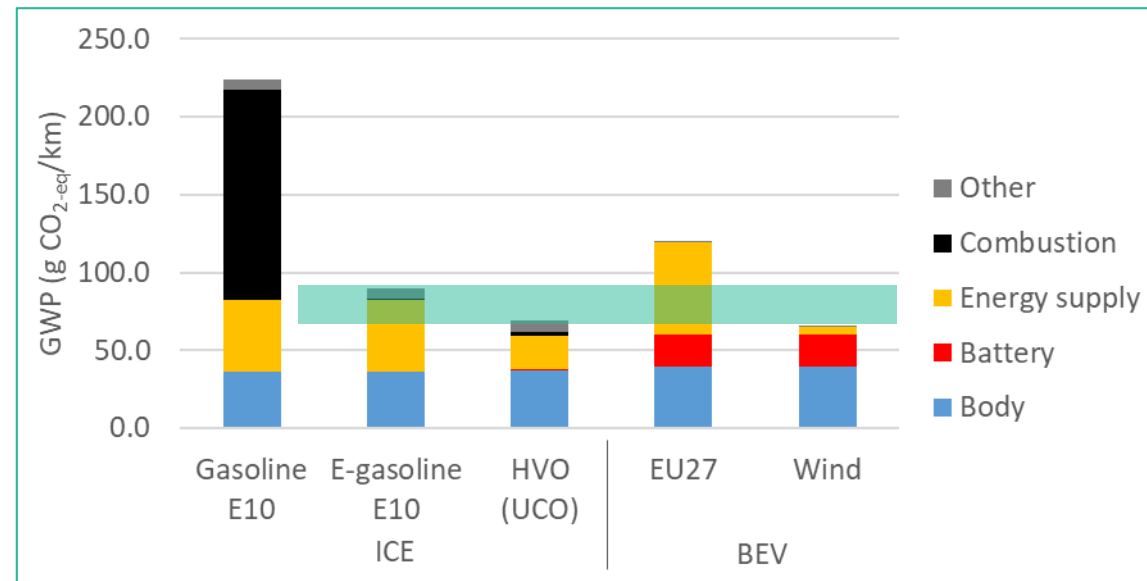
- Energy sources

- Variation in use phase only

Powertrain	Energy sources		Cars	Trucks
	Current	100% Renewable		
ICE	B7 diesel	HVO UCO (Used Cooking Oil) E-diesel (wind and Direct Air Capture)	X	X
ICE	Gasoline E10	E-gasoline E10 (wind and Direct Air Capture)	X	
PHEV	Gasoline E10	E-gasoline E10 (wind and Direct Air Capture)	X	
BEV	EU27	Wind	X	X
H ₂ ICE	-	Wind electrolysis		X
H ₂ FCEV	-	Wind electrolysis		X

All LDV powertrains have similarly low GHG emissions

- When operated on renewable electricity/fuel
- ICE and BEV have similar emissions for production of vehicle body
 - Emissions of battery production are additionally significant for BEV
- Remaining ICE emissions are mainly from fuel supply and combustion
 - Combustion becomes net-zero in case of e-fuel or HVO (UCO)
- Remaining BEV emissions are from electricity supply

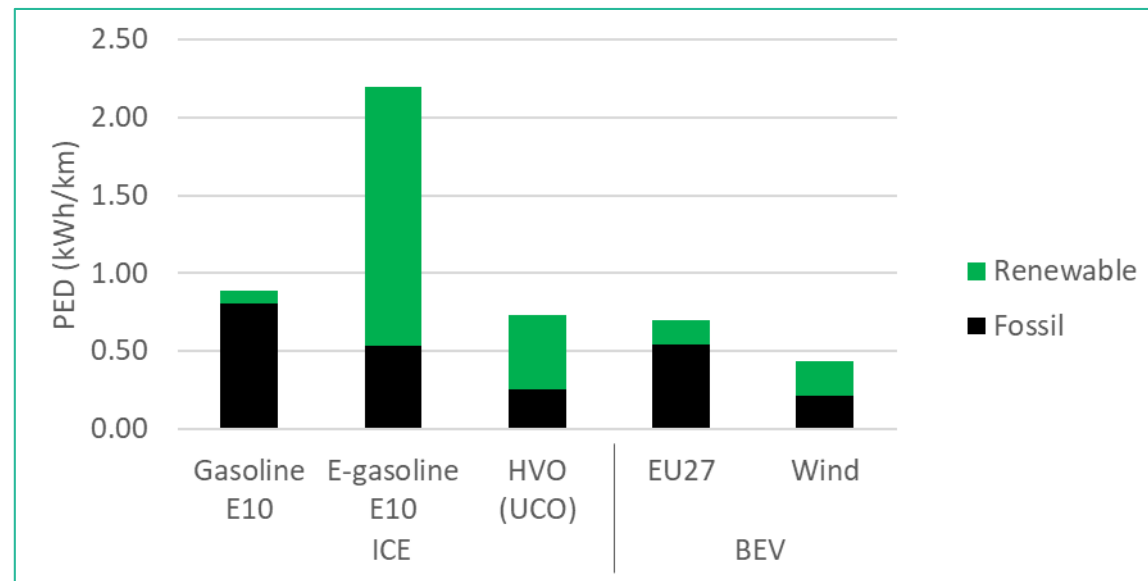


Key assumptions

- GreenNCAP LCA methodology
- C-segment vehicle
- Production: 2024 global average
- Fuel/energy varied only in use phase
- Lifetime: 240k km, 16 years
- E-gasoline from wind & DAC
- HVO from Used Cooking Oil
- CO_{2eq} incl. CO₂, CH₄ and N₂O

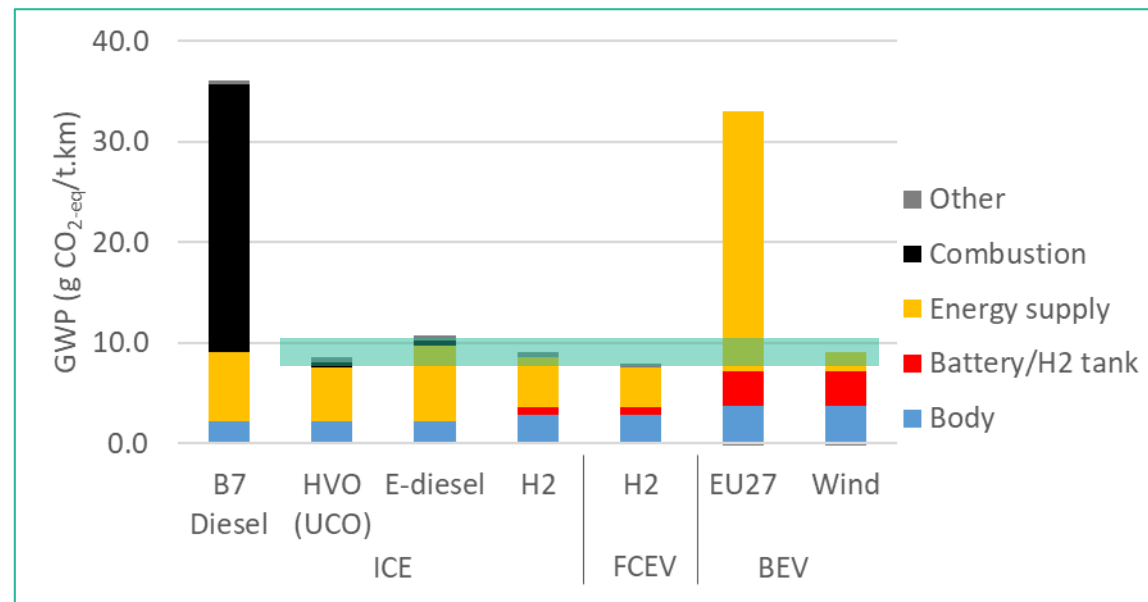
Mixed picture for Primary Energy Demand

- Primary Energy Demand (PED) represents the amount of energy needed to drive a km
- BEV on wind and ICE on HVO (UCO) have the lowest PED from those powertrain options that are relying on renewables sources
- ICE on e-gasoline has higher PED
 - Requiring a higher amount of renewable energy sources
 - But fuel can be energy carrier of renewable energy sources elsewhere in the world



All HDV powertrains have similarly low GHG emissions

- When operated on renewable electricity/ fuel
- ICE, FCEV and BEV have similar emissions for production of vehicle body
 - Emissions of battery production or H₂ tank are additionally significant for ICE, FCEV and BEV
- Remaining ICE emissions are mainly from fuel supply and combustion
 - Combustion becomes net-zero in case of e-fuel, H₂ or HVO (UCO)
- Remaining FCEV and BEV emissions are from H₂ or electricity supply

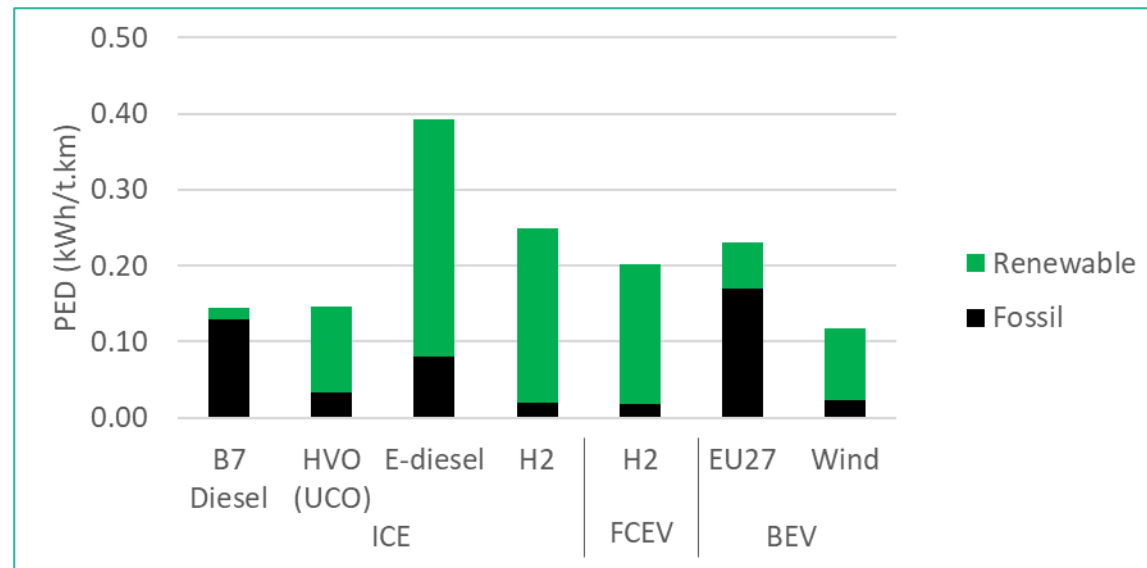


Key assumptions

- GreenNCAP LCA methodology
- N3 truck IEA Task 46
- Production: 2024 global average
- Fuel/energy varied only in use phase
- Lifetime: 1.2m km, 12 years
- E-diesel from wind & DAC
- HVO from Used Cooking Oil
- CO_{2eq} incl. CO₂, CH₄ and N₂O

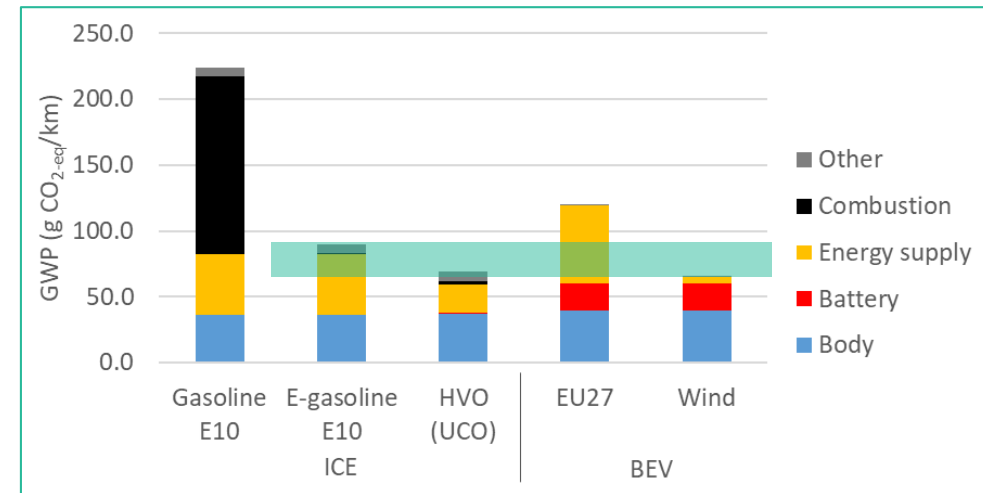
Mixed picture for Primary Energy Demand

- BEV on wind and ICE on HVO (UCO) have the lowest PED from those powertrain options that are relying on renewables sources
- H₂ ICE and FCEV have higher PED, requiring higher amount of renewable sources
- ICE on e-diesel has highest PED, requiring highest amount of renewable sources
- H₂ and e-diesel can be energy carriers for renewable energy sources elsewhere in the world



Summary and outlook

- LCA results
 - Only 2 out of many impact categories investigated
 - Results show no “Zero-GHG emissions” vehicle, but all powertrains show similarly low GHG emissions when further developing technologies for biofuels, e-fuels, renewable electricity and hydrogen
 - ICE on ‘HVO from UCO’ and BEV on ‘wind’ have lowest Primary Energy Demand
 - ICE on H₂/e-fuels and FCEV have higher Primary Energy Demand, but can be energy carriers for renewable energy sources elsewhere in the world
- LCA methodologies
 - Transparent reporting is needed for base characteristics of
 - Vehicle
 - Powertrain
 - Energy and fuels



THANK YOU!

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Methodologies investigated

- Levelling concept 1 - 4
- Additional GHG species (next to CO₂, CH₄ and N₂O)
 - Focus on global warming potential of H₂
 - Gaseous storage and transportation
 - Liquid storage and transportation
- Allocation of emissions in case of co-products, e.g. biofuels
 - System expansion
 - Energy allocation
- End-of-Life modelling
 - Substitution of primary material
 - Circular Footprint Formula
- Relevance of infrastructure

Need for transparent reporting

- Most significant methodology impact is from base characteristics
 - Powertrain energy consumption
 - Vehicle mileage (km) definition
 - Others
 - Vehicle weight
 - Powertrain battery capacity
 - Energy/fuel emission factors

