Life Cycle Assessment of LDVs and HDVs

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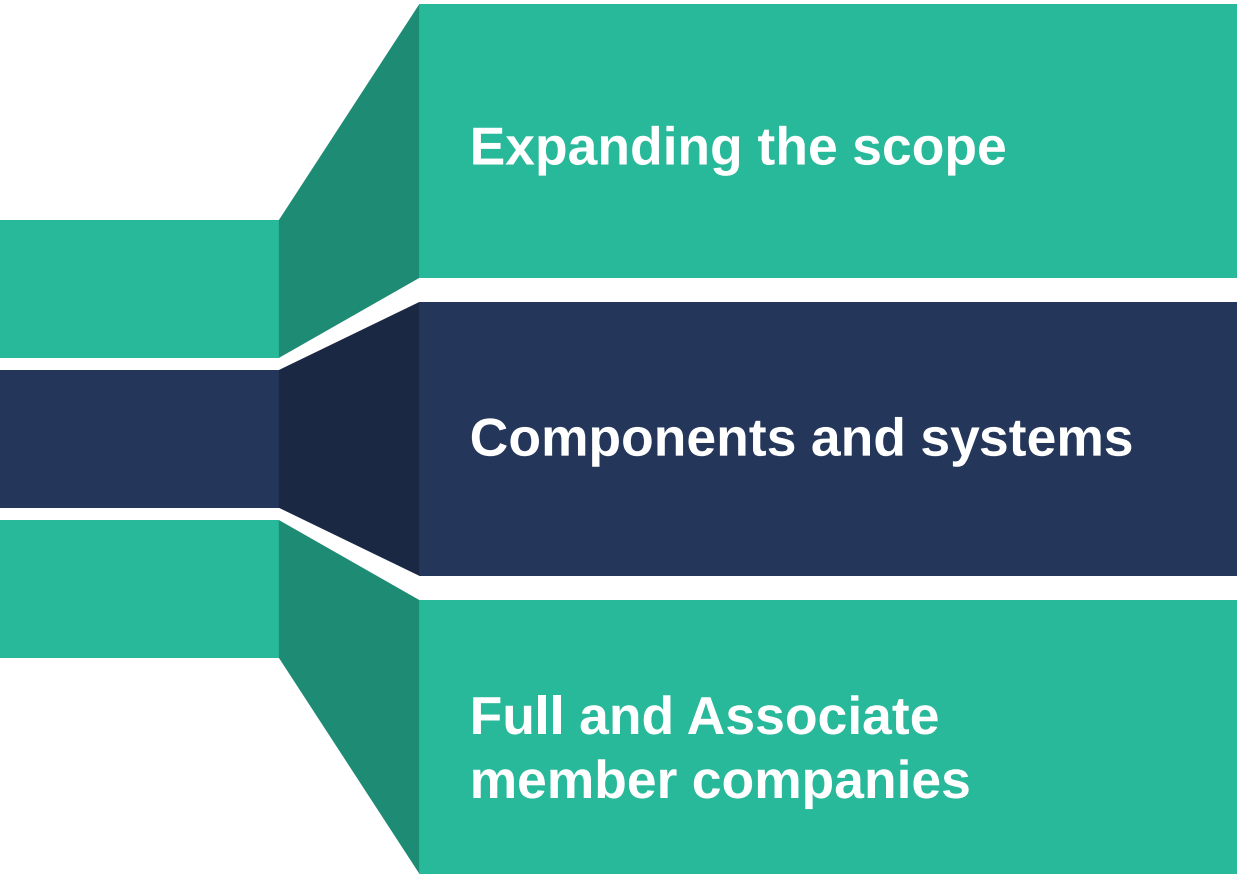
With the support of

AECC is now the Association for Emissions Control and Climate



- Air quality and **Climate** requirements
- Mobile and **Stationary** emissions sources
- Sustainable **components and systems**

- Catalysts
- Filters
- Adsorbers

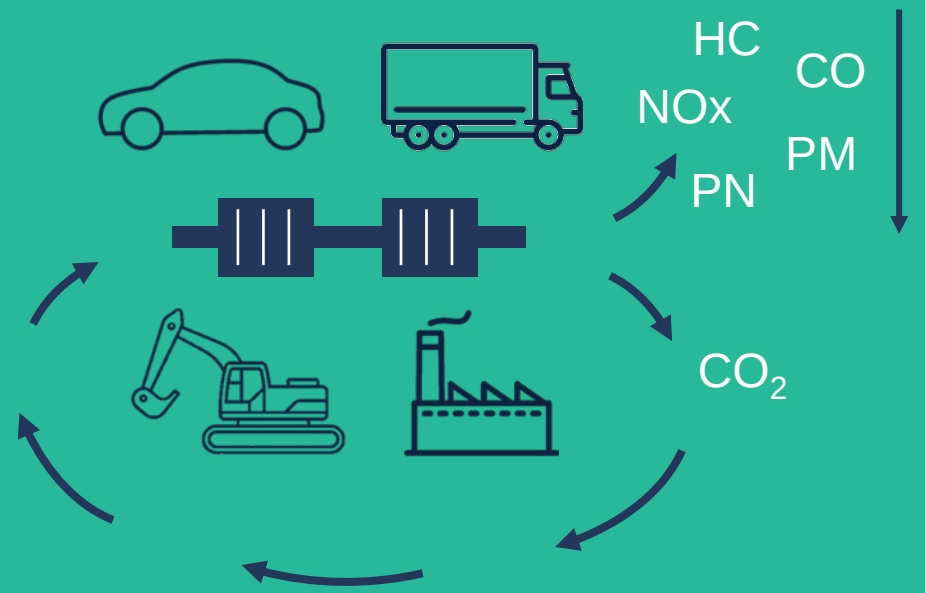
- Fuel cells
- Electrolysers

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

AECC works in partnership with EU policymakers to target

1: Zero-impact pollutant emissions

2: 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 **CO_2-neutral fuels** for a closed carbon cycle

LCA and LDV/HDV CO_2 reviews are a key AECC activity

On-road vehicles

Non-Road Mobile Machinery

Industrial Emissions

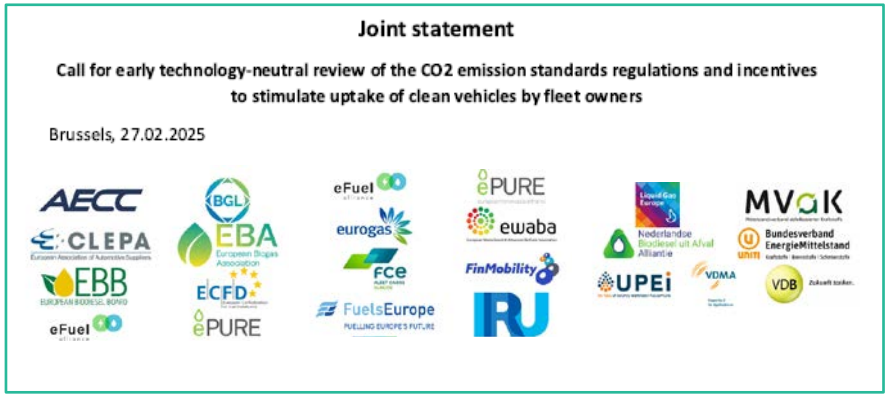
H_2 production and utilisation

Life cycle assessment and circular economy

Road-vehicle industry working groups AECC is member of

- Working group on Monitoring Methodologies (also known as ‘Stuttgart group’)
  - Evaluates all mechanical and digital solutions for monitoring the use of CO_2-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

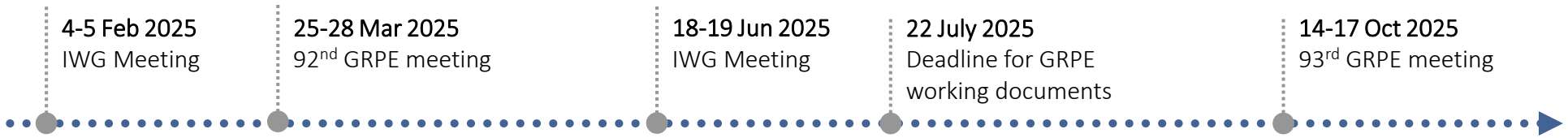


AECC understanding of the EU CO_2 emissions review schedule

- LD CO_2 emissions
  - Commission proposal amending Reg. (EU) 2017/1151
    - Adding vehicle category running exclusively on CO_2-neutral fuels
    - Discussions in TCMV on Euro 6 stopped, *expected to reconvene for Euro 7 following CO_2 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 in 2026 (*pulled forward to 2025 by Automotive Action Plan*)
- HD CO_2 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 CO_2-neutral fuels

Life-Cycle Assessment method development

- European Commission, DG-CLIMA
  - Information from stakeholder workshop on 11 December 2024
    - 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
  - Supported by a consortium of Ricardo, Öko-Institut, TU Graz and IVL Sweden
- UNECE A-LCA
  - Timeline for drafting until GRPE adoption (WP.29 adoption to follow)



AECC and IPA LCA study

- Conducted by Joanneum Research
- Objective
  - Extending the Well-to-Wheel CO_2 emissions of AECC-IPA LDV/HDV demonstrators on CO_2-neutral fuels
  - Understand impact of LCA methodology choices under consideration by UNECE and EU

IPA IAV Concawe

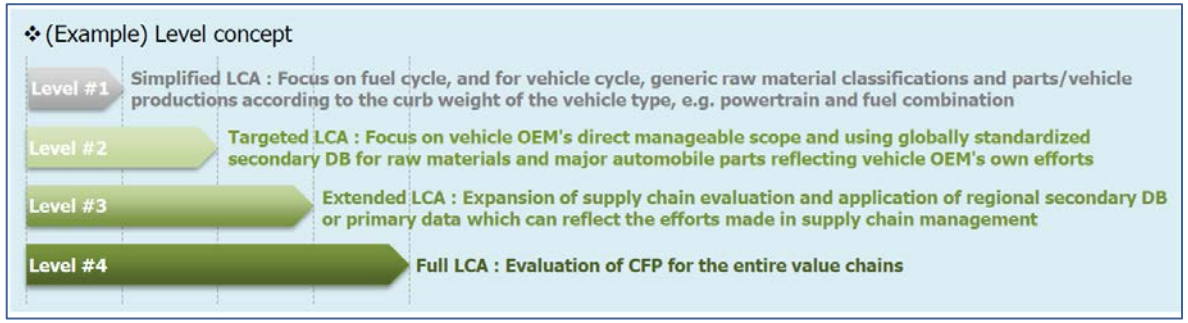
IPA IAV DENSO CATALER BOSCH aramco PORSCHE

IPA FEV BASF CORNING cefic NESTE aramco

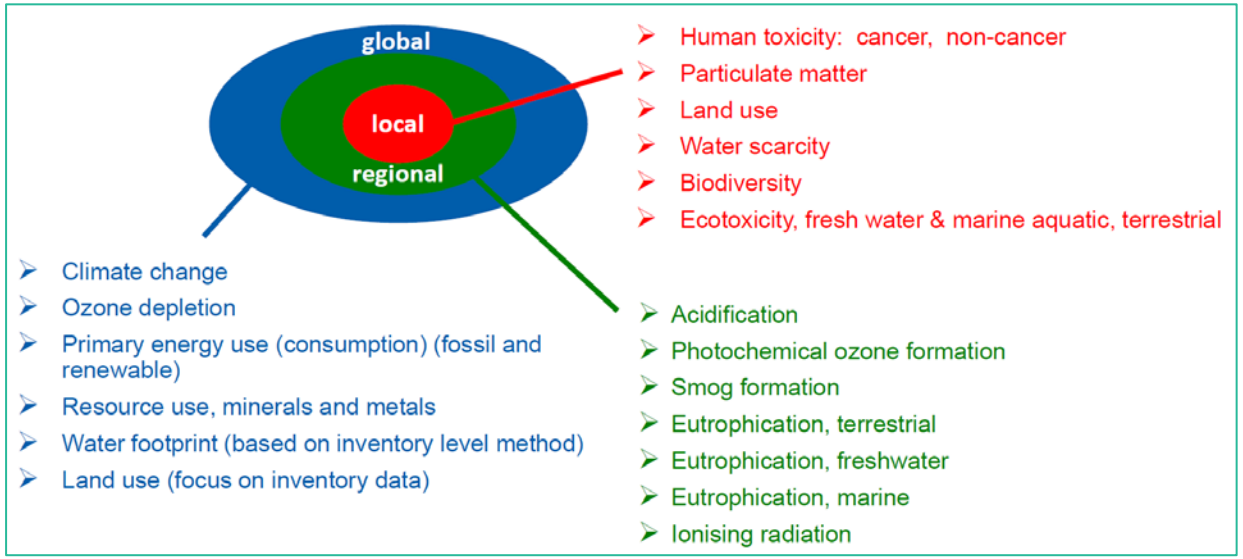
AGU Sector Group

AECC and IPA LCA study

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



  - Impact categories investigated
    - Global Warming Potential (GWP – CO_2eq/km)
      - Including impact of CO_2, CH_4 and N_2O
    - Primary Energy Demand (PED – kWh/km)
    - Several additional impact categories possible



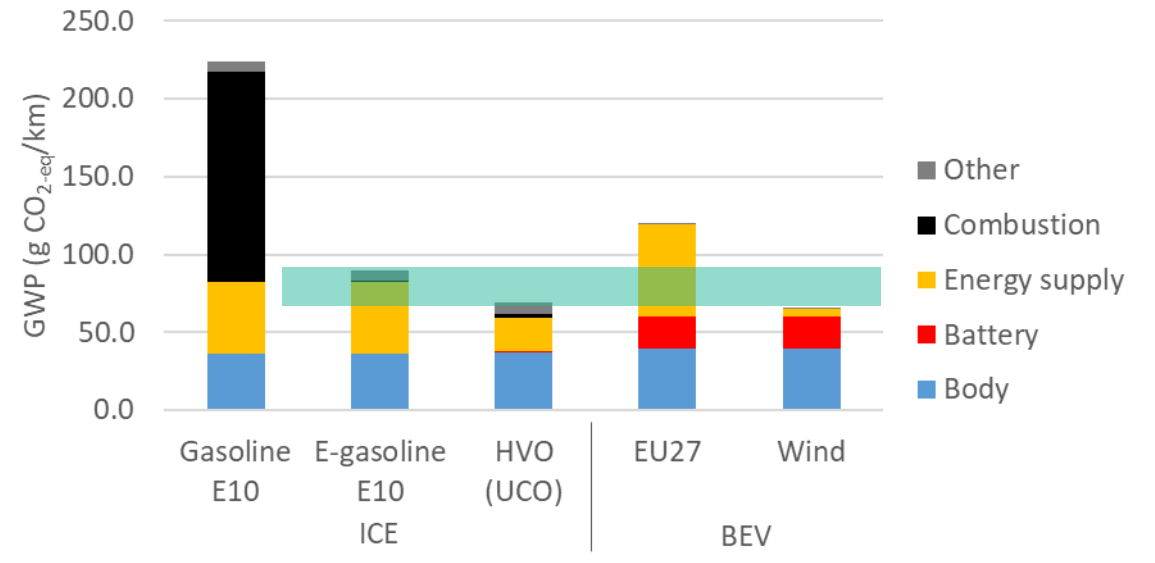
AECC and IPA LCA study

- 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

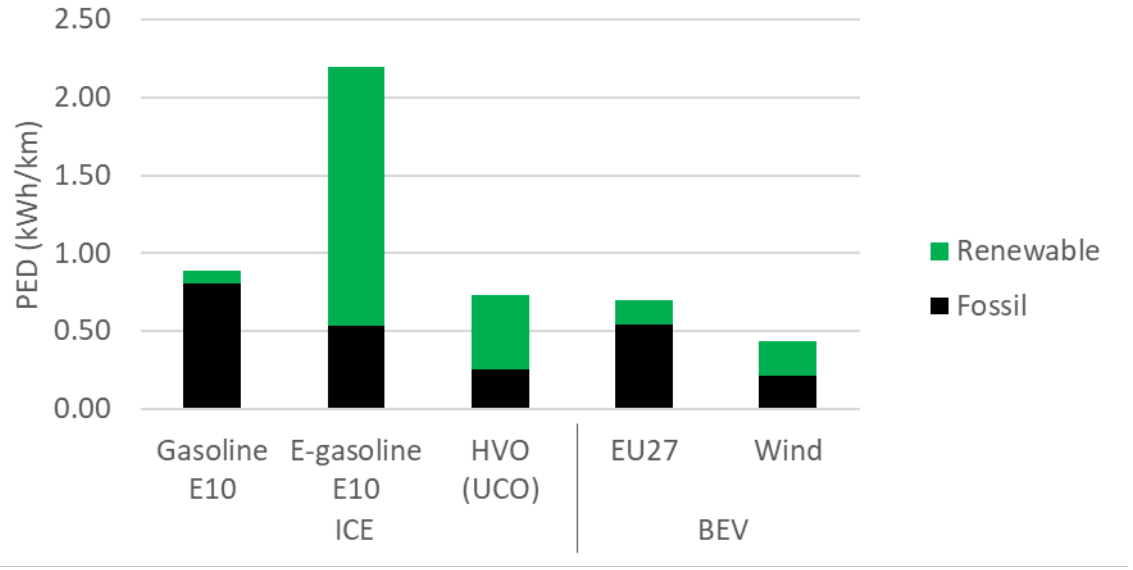
- When operated on renewable electricity/fuel
- ICE and BEV have similar emissions for production of vehicle body
  - Emissions of battery production are additionally significant for BEV
- Remaining ICE emissions are mainly from fuel supply and combustion
  - Combustion becomes net-zero in case of e-fuel 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. CO_2, CH_4 and N_2O

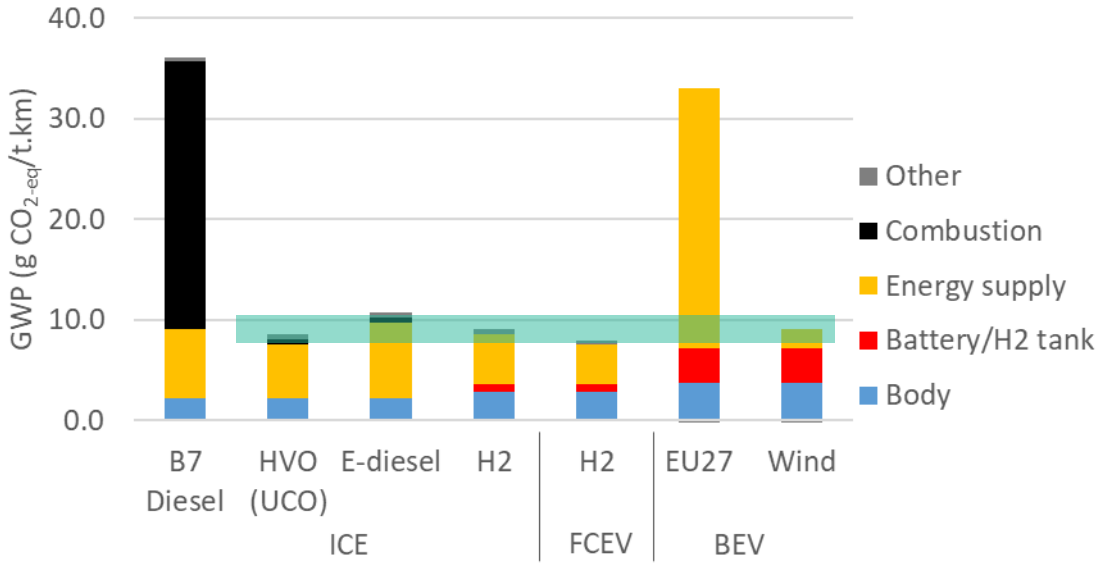
Mixed picture for Primary Energy Demand

- 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

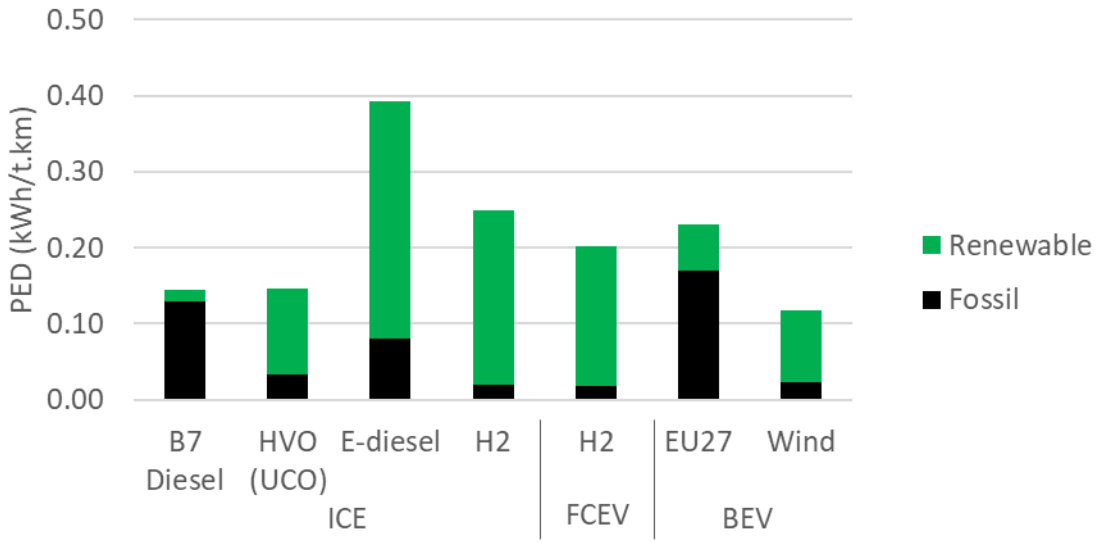
- When operated on renewable electricity/fuel
- ICE, FCEV and BEV have similar emissions for production of vehicle body
  - Emissions of battery production or H_2 tank are additionally significant for ICE, FCEV and BEV
- Remaining ICE emissions are mainly from fuel supply and combustion
  - Combustion becomes net-zero in case of e-fuel, H_2 or HVO (UCO)
- Remaining FCEV and BEV emissions are from H_2 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. CO_2, CH_4 and N_2O

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
- H_2 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
- H_2 and e-diesel can be energy carriers for renewable energy sources elsewhere in the world



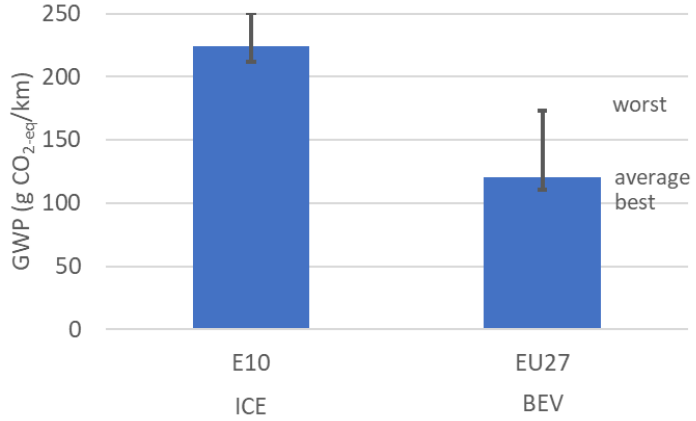
Methodologies investigated

- Levelling concept 1 - 4
- Additional GHG species (next to CO_2, CH_4 and N_2O)
  - Focus on global warming potential of H_2
    - 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

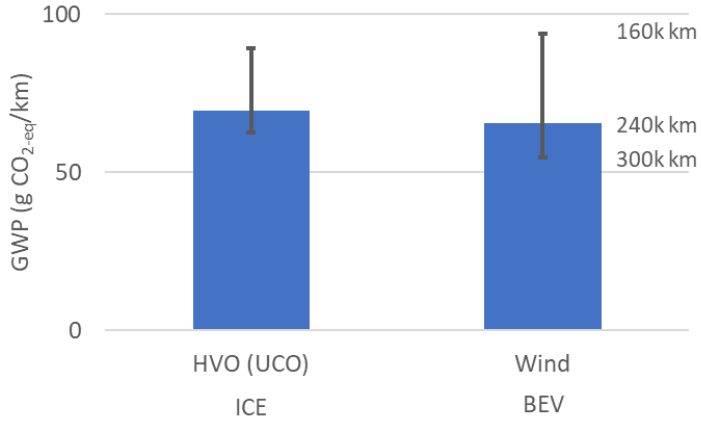
- Most significant methodology impact is from base characteristics
  - Powertrain energy consumption
  - Vehicle mileage (km) definition
  - Others
    - Vehicle weight
    - Powertrain battery capacity
    - Energy/fuel emission factors

Impact of energy consumption



Range according to GreenNCAP measurements

Impact of vehicle mileage



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 H_2/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 FOR YOUR ATTENTION

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