Potential role of CO_2-neutral fuels for light-duty vehicles - a life-cycle assessment approach

Dirk Bosteels

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AECC is now the Association for Emissions Control and Climate

- AECC expands its scope
  - Air quality and **climate** requirements
  - Mobile and **stationary** emissions sources
  - Sustainable **components and systems**, including
    - Catalysts
    - Filters
    - Adsorbers
    - Fuel cells
    - Electrolysers
- AECC is listed in EU Transparency Register (# 78711786419-61) and has consultative status with the UN Economic and Social Council (ECOSOC)

EU legislative framework for fuels and CO_2 emissions

- Not fully supporting contribution of ICE with CO_2-neutral fuels (CNF)

Renewable Energy Directive (2023/2413)

Issue: lack of general ambition in 2030 target for transport, no target beyond 2030; very restrictive criteria for Renewable Fuels of Non-Biological Origin (RFNBO, i.e. e-fuels)

EU Emissions Trading System for buildings and transport

Issue: price cap of 45€/tonCO_2 is expected to have max impact of only 0.1€/l for petrol

CO_2 standards for vehicles
- light-duty (2023/851)
- heavy-duty (2024/1610)

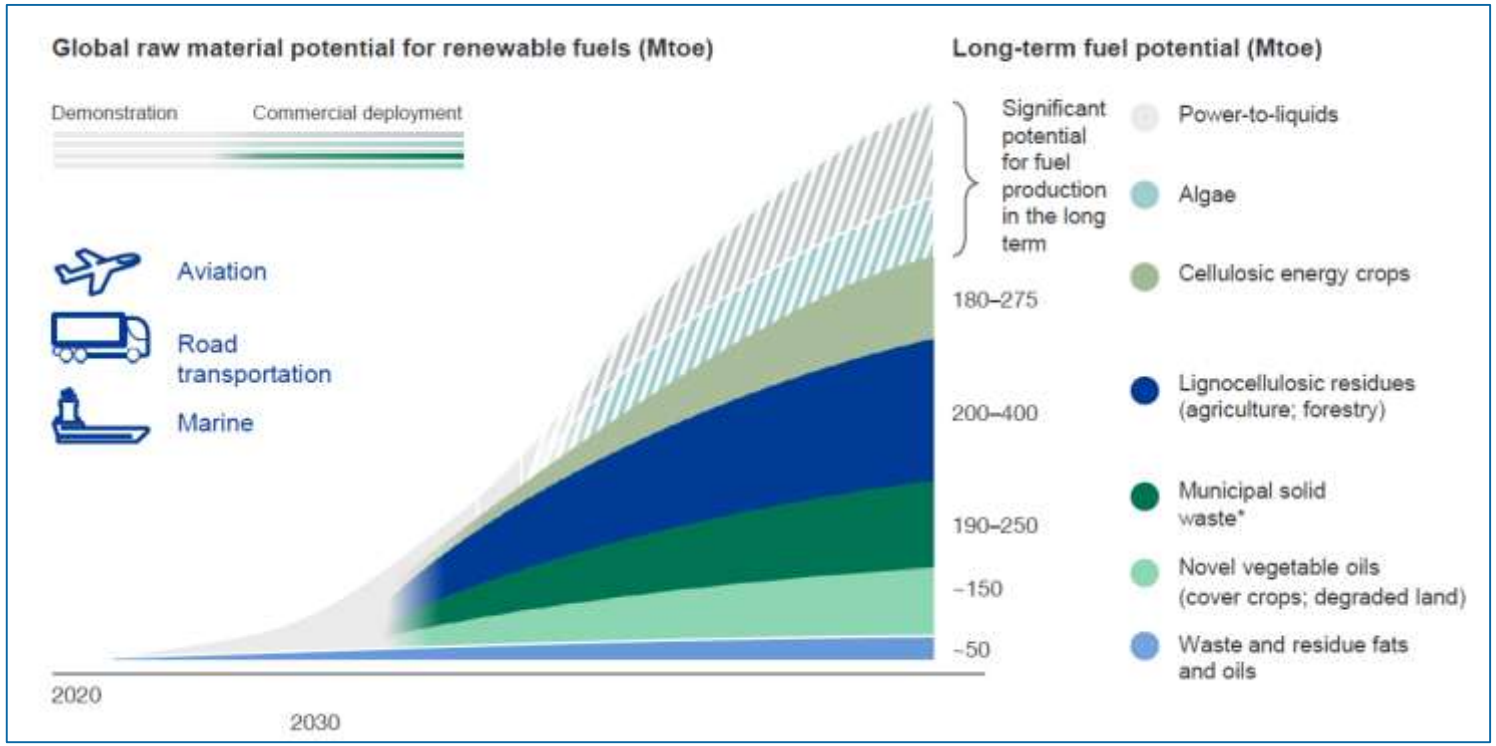
Issue: no recognition of CO_2-neutral fuels (CNFs) and no link with the Renewable Energy Directive

Energy Taxation Directive (2003/96)

Issue: no differentiation between renewable and carbon intensive sources of electricity/fuels

Sufficient sustainable renewable fuels available

- Combining feedstocks can provide enough sustainable renewable fuel for all transport modes
- Further investments are depending on the policy framework



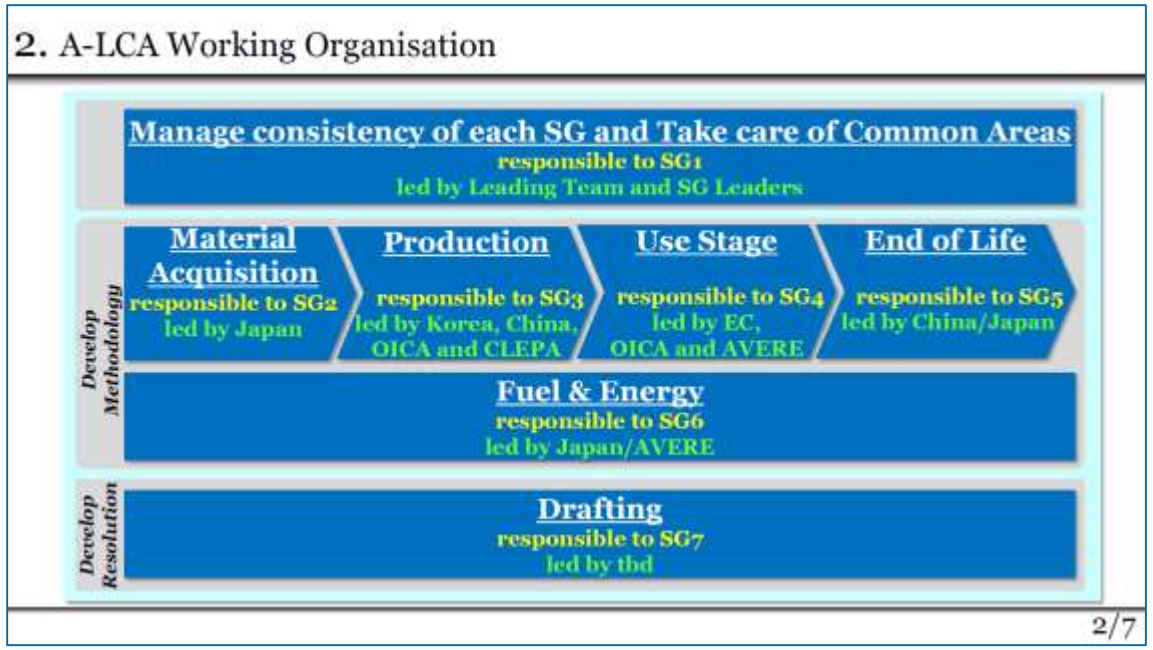
Source: Neste, Vienna Motoren Symposium 2022

CO_2 emissions reviews and CO_2-neutral fuels

- European Commission will review CO_2 emissions legislation
  - Light-duty in 2026, starting with a progress report in 2025
  - Heavy-duty in 2027
- Development of procedures ongoing for vehicles running exclusively on CO_2-neutral fuels (CNFs)
  - Draft Commission proposal was sent to Technical Committee on Motor Vehicles (TCMV) in Sept 2023
  - Definitions
    - Type of fuel: current draft only covers Renewable Fuels of Non-Biological Origin (RFNBO, i.e. e-fuel)
    - Minimum GHG reduction threshold: current draft requires -100% according to Renewable Energy Directive
  - Relying on OEM to ensure
    - Vehicles are equipped with a fueling monitoring and inducement system
    - Protection from tampering for the whole lifetime of the vehicle
  - Draft text also defines CO_2 emission of H_2 ICE is not to be measured
  - Discussion to follow for heavy-duty vehicles as well

Automotive Life-Cycle Assessment (A-LCA) initiatives

- AECC is part of the Informal Working Group on A-LCA at UNECE
  - Draft for adoption by GRPE in October 2025 is expected by July 2025
  - Organisation and different methodology levels under discussion



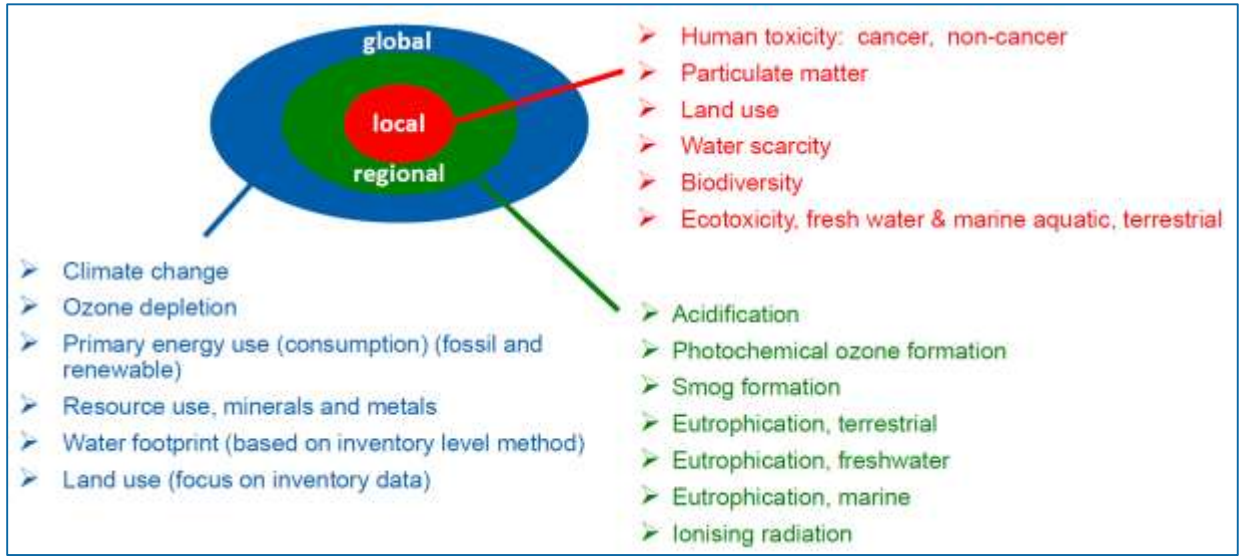
	Purpose	Degree of freedom	vehicle model	supply chain model
Level 1	strategy	multiple approaches possible	generic	generic
Level 2	strategy	multiple approaches possible	BOM & MDS	generic
Level 3	reporting	single fixed approach	BOM & MDS	partly specific
Level 4	reporting	single fixed approach	BOM & MDS	mainly specific

BOM bill of material, MDS material data system

- European Commission DG-CLIMA is to develop LCA method by 31 December 2025
  - From 1 June 2026, manufacturers may, on a voluntary basis, submit life-cycle CO_2 emissions data

LCA study by Joanneum Research

- Conducted together by AECC and IPA (International Platinum Group Metals Association)
- This presentation is a first summary of the study, dissemination of full results is foreseen in 2025
- Objective
  - Extending the Well-to-Wheel CO_2 emissions data of AECC-IPA LDV and HDV demonstrators on CNFs
  - Understand impact of LCA methodology choices under consideration by UNECE and EU
- Scope
  - Level 1-2 LCA study
  - 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



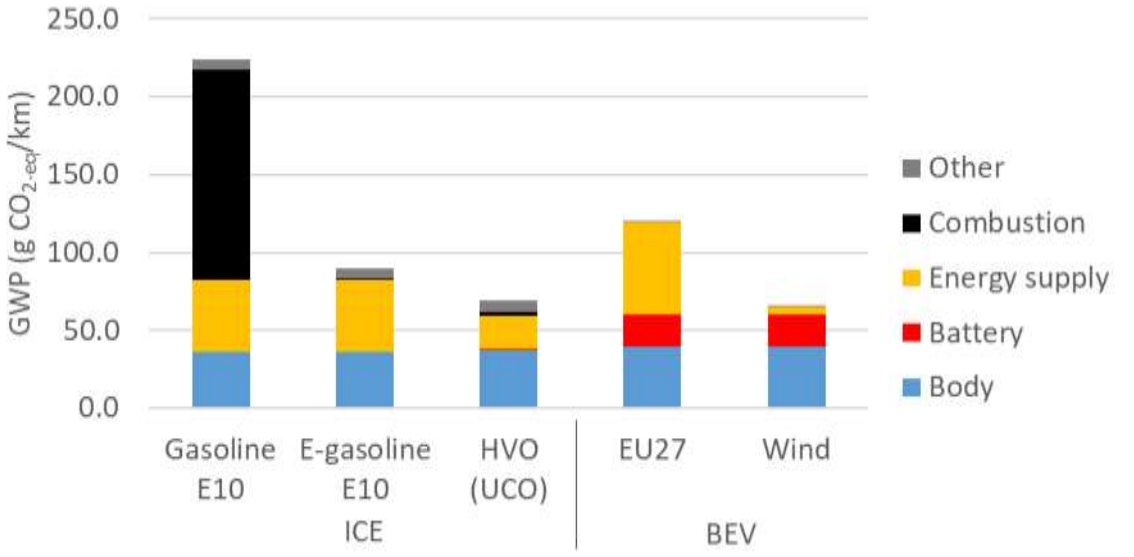
LCA study by Joanneum Research

- 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

Powertrain	Energy sources		Cars	Trucks
	Current	100% Renewable		
ICE	B7 diesel	HVO UCO (Used Cooking Oil)	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

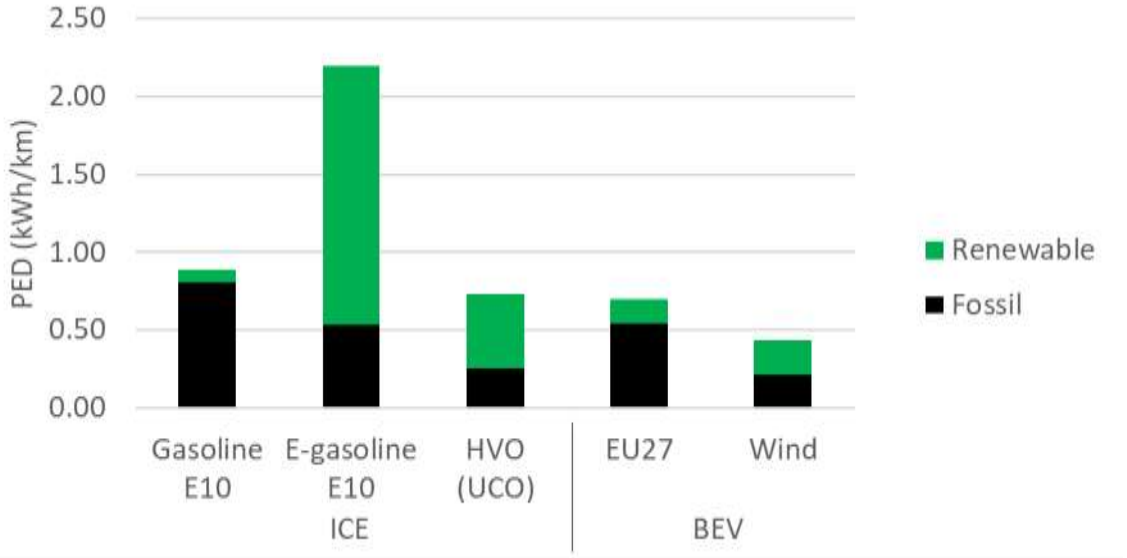
All LDV powertrains have similarly low GHG emissions

- 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



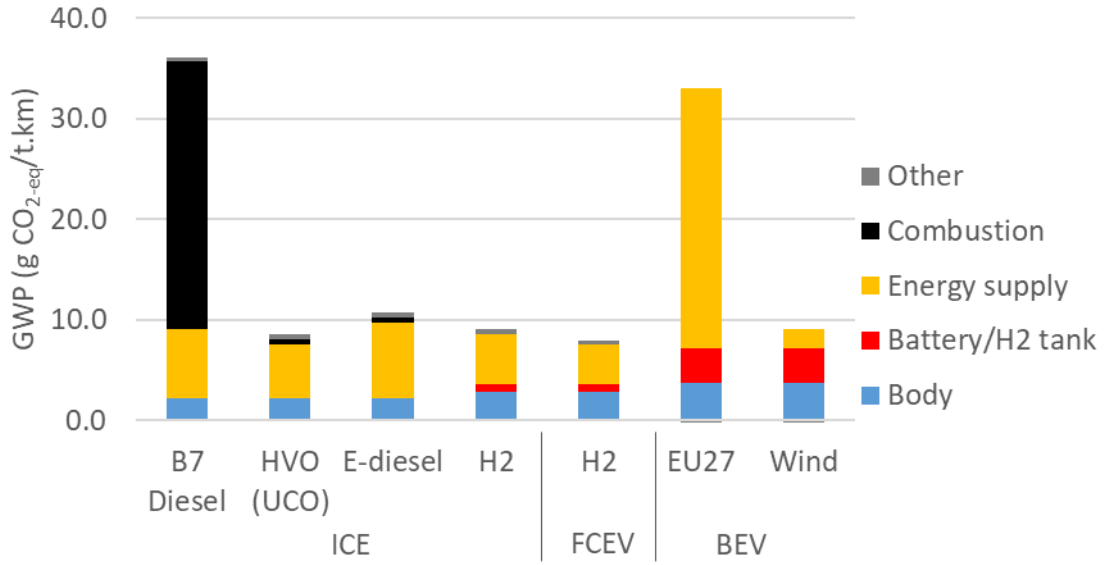
Mixed picture for Primary Energy Demand

- 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



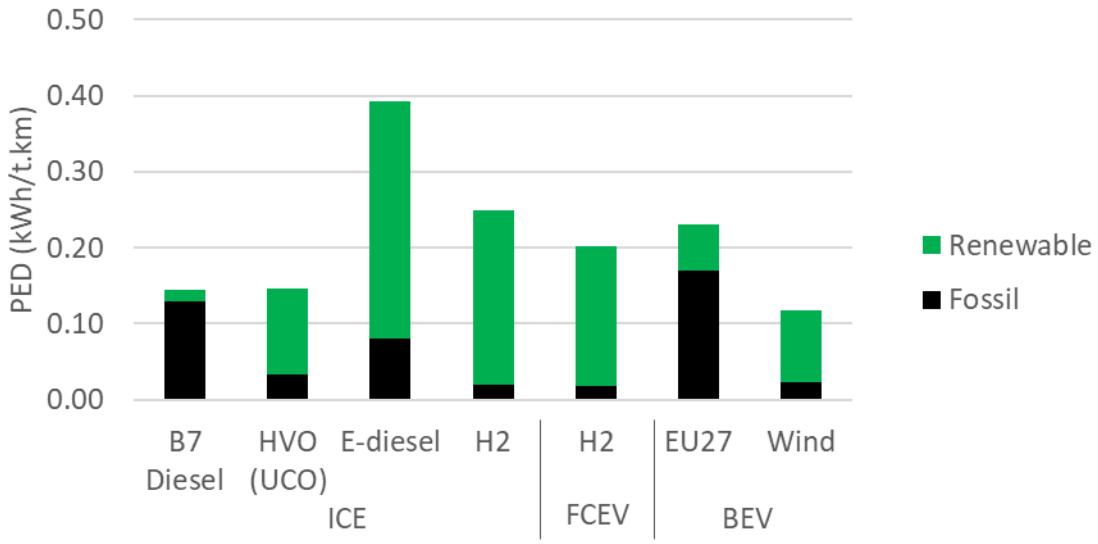
All HDV powertrains have similarly low GHG emissions

- 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, H_2 or HVO (UCO)
- Remaining FCEV and BEV emissions are from H_2 or electricity supply



Mixed picture for Primary Energy Demand

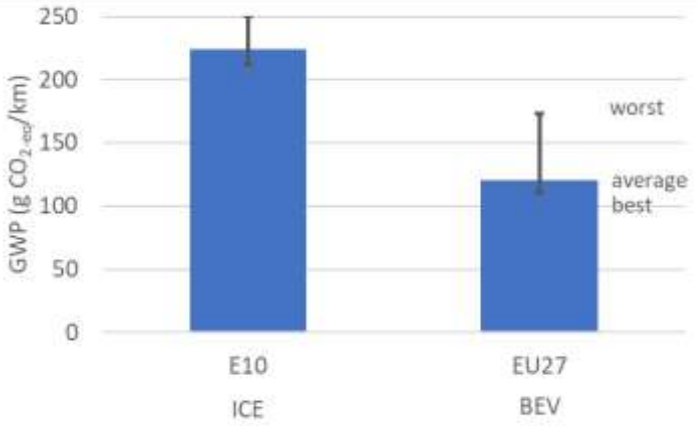
- BEV on wind and ICE on HVO (UCO) have the lowest PED from those powertrain options that are relying on renewables sources
- H_2 ICE and FCEV have higher PED, requiring higher amount of renewable sources
- ICE on e-diesel has highest PED, requiring highest amount of renewable sources
- H_2 and e-diesel can be energy carriers for renewable energy sources elsewhere in the world



Need for transparent reporting

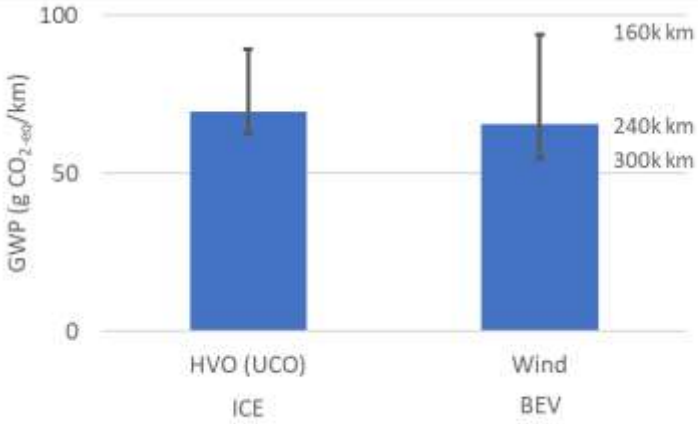
- Significant impact from base characteristics
  - Powertrain energy consumption
  - Vehicle mileage (km) definition
  - Others
    - Vehicle weight
    - Powertrain battery capacity
    - Energy/fuel emission factors
- Other methodologies under investigation
  - Additional GHG species (next to CO_2, CH_4 and N_2O)
    - Focus on H_2 as GHG
  - Allocation of emissions in case of co-products
  - End-of-Life modelling

Impact of energy consumption



Range according to GreenNCAP measurements

Impact of vehicle mileage



Summary

- The current EU legislative framework for CO_2 emissions of vehicles will be reviewed
  - Light-duty vehicles by 2026
  - Heavy-duty vehicles by 2027
  - Potential role for CO_2-neutral fuels will be assessed

- AECC-IPA LCA study by Joanneum Research
  - 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
  - Only 2 out of many impact categories investigated
  - Transparent reporting is needed for base characteristics of vehicle, powertrain and energy/fuels

THANK YOU

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