International Transport Forum

EXPERT WORKSHOP

Mapping standards for low- and zero-emission electric heavy duty vehicles

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Beyond Batteries and Fuel Cells

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- Legislations
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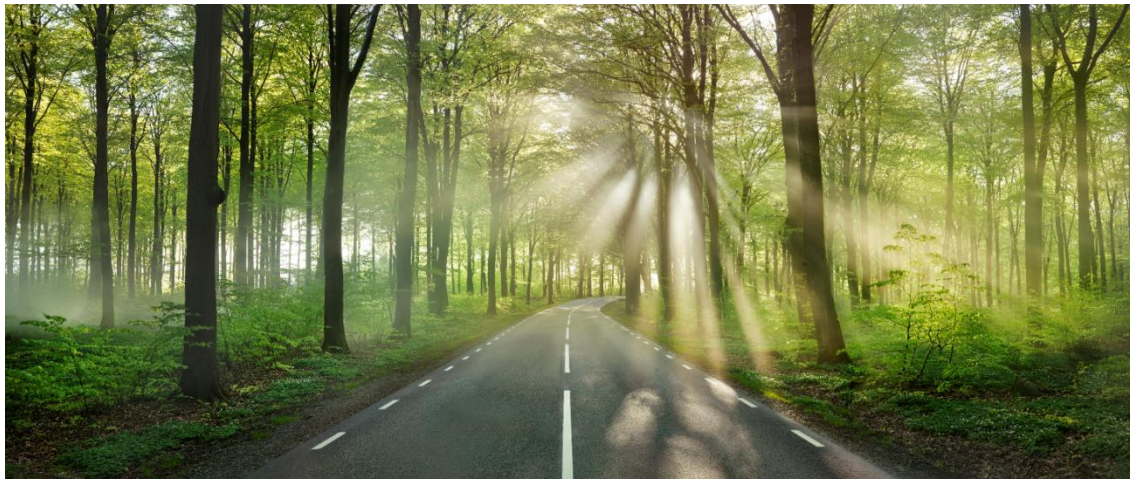
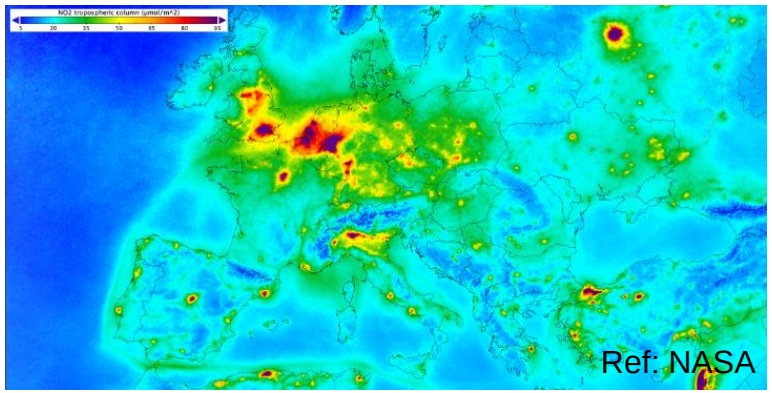


Volvo Group

- Brands: Volvo, Volvo Penta, UD, Terex Truck, Renault Trucks, Prevost, Nova Bus, Mack, Arquus
- Alliances and joint ventures: SDLG, Eicher and Dongfengs brands

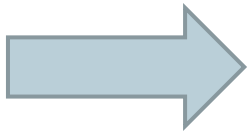
Drivers for Renewable Fuels

- Climate change
- Availability of energy resources and projected increasing demand
- Security of supply
- Emissions, regulated and unregulated
- Urbanisation and noise
- Customer and transport buyers


Ref: NASA

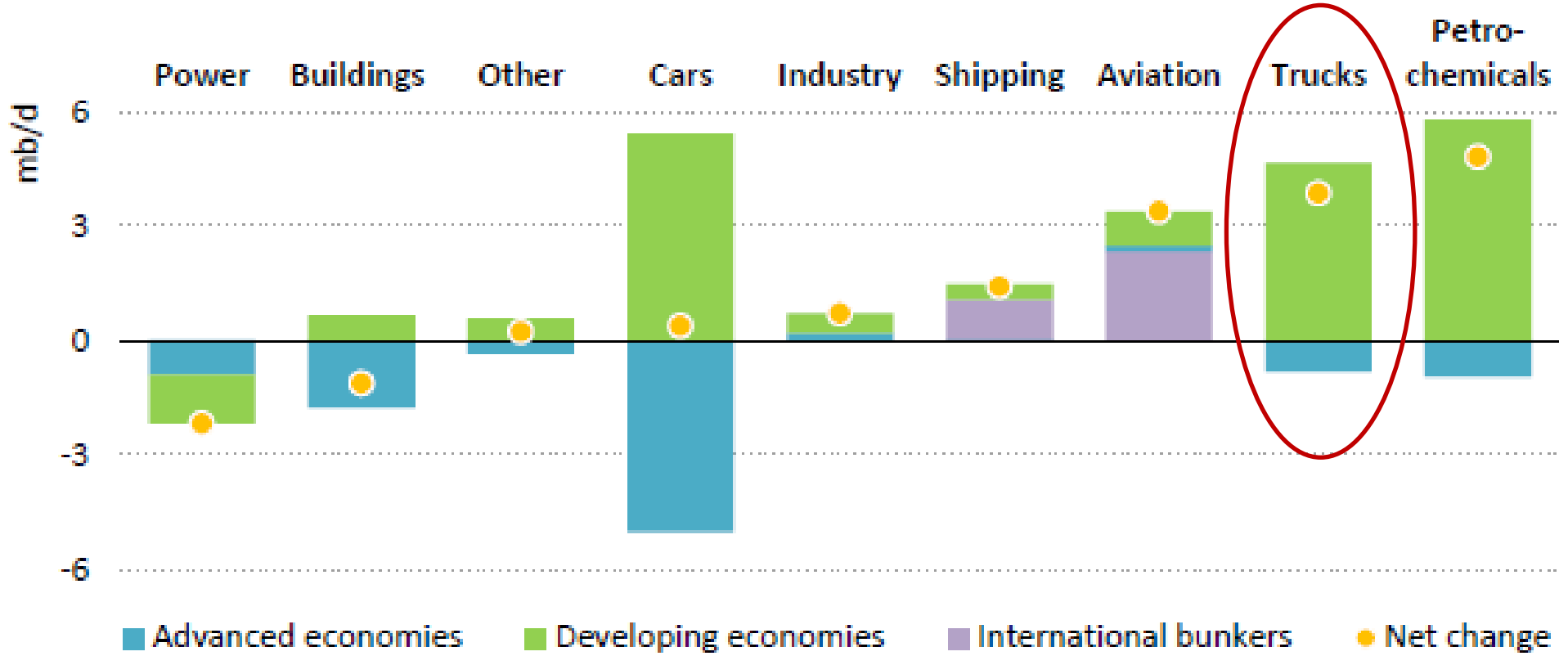
Global CO2 Emissions

- Transport 24% of CO2 emissions
- 7% of global CO2 from trucks



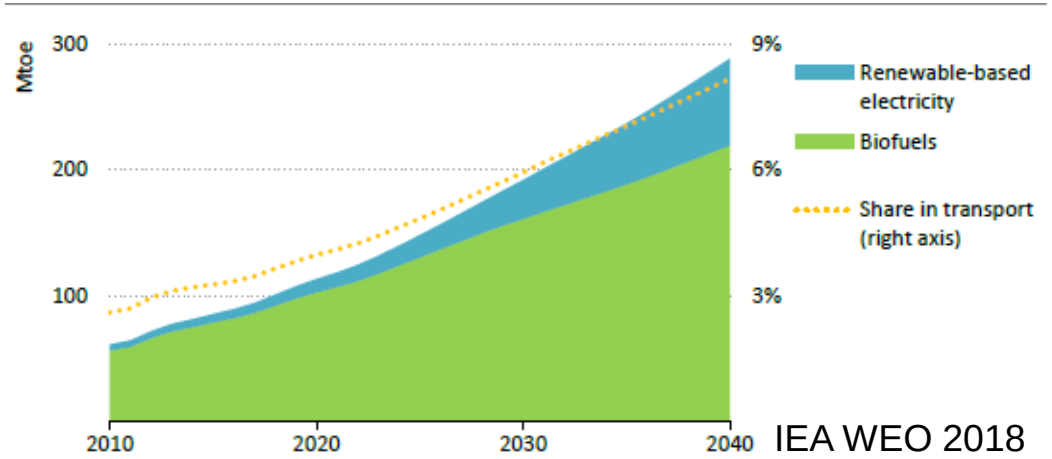
We have a hugh possibility to contribute to lower CO2 emissions

Change in Global Oil Demand by Sector in 2017-2040



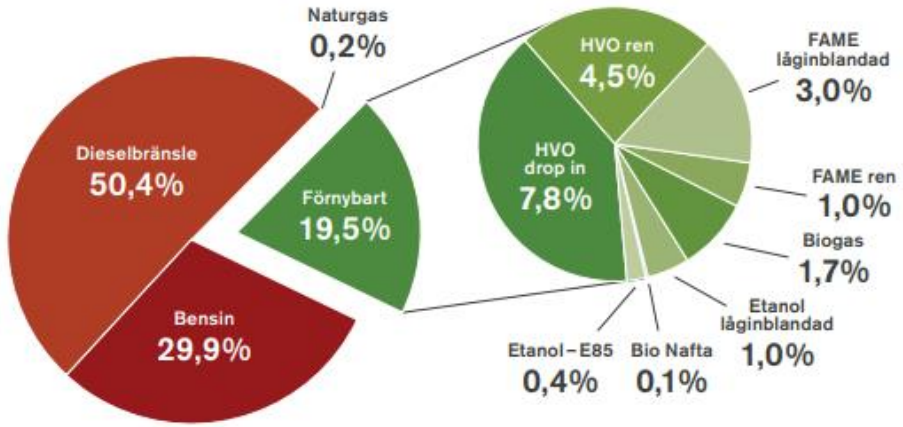
IEA WEO 2018
New policies scenario

Renewable Energy Consumption in the Transport Sector



IEA WEO 2018
New policies scenario

- IEA's forecast is 8% renewable in transport sector 2040 (Global)
- RED 14% renewable fuels in transport sector 2030 (EU)
- In Sweden 19,5% was renewable in 2018

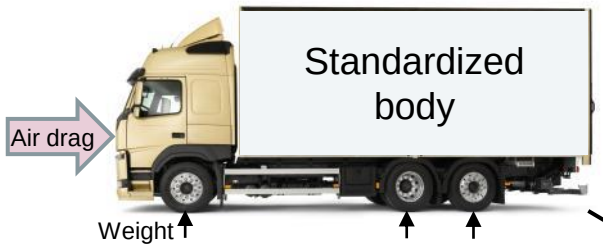


EU CO_2 emission performance standards (Limit values)

- CO_2 emissions **TTW** from new heavy-duty vehicles shall be reduced compared to the 2019 reference CO_2 emission:
  - For the reporting periods of the year 2025 onwards by 15%
  - For reporting periods of the year 2030 and later by 30%
- The reference CO_2 emissions is based on declaration/monitoring data for the period from 1 July 2019 to 30 June 2020
- The regulation apply to new vehicles:
  - Rigid lorries 4x2, >16 t
  - Rigid lorries 6x2
  - Tractors 4x2, >16 t
  - Tractors 6x2

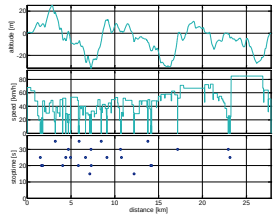
Measurement of components and calculation of CO_2

Air drag, weight and general configuration



Rolling resistance and size

Duty cycle (5 truck and 5 bus cycles)

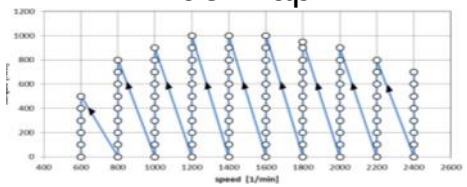


VECTO Simulation

Axle efficiency and ratio

Gearbox efficiency and ratio

Fuel map



Auxiliaries

FC/CO_2 values calculated at end of the production line

Declaration
- g/tonkm
- g/m3km
- g/passkm
- litre/100km
- km/h

Default values
- Payload
- Standard body
- Standard semitrailer etc.

How much can alternative fuels lower the CO2 emissions?

- JEC (Joint Research Center, EUCAR, Concawe) study an important input

The JEC Consortium

The **JEC**research collaboration was initiated in 2000 by:

- **J**RC: Joint Research Centre of the European Commission
- **E**UCAR: European Council for Automotive R&D
- **C**ONCAWE: Research Association of the European Oil Refining Industry

Collaborative Projects

Projects Completed since 2000:

•Well-to-Wheels (WTW) Studies
•Version 1 (2004)
•Version 2a and 2b (2007)
•Version 3 (2011)
•Version 4 (2014)
•Several ‘Impact of ethanol’ studies
•JEC Biofuels Study for a 2020 time horizon (2011)

2019: Projects in Progress

•Version 5 WTT, TTW, and WTW Studies
•Update of the JEC Alternative Fuels Study

JEC Study

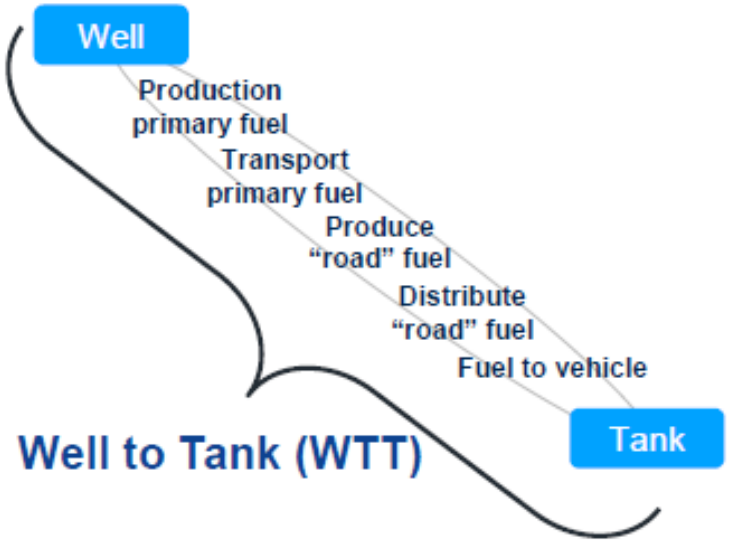
Disclaimer

- The JEC Well-to-Wheels study is a technical analysis of the energy use and GHG emissions of possible road fuel and powertrain configurations in the European context for a time horizon of 2025+.
- This study is not intended to commit the JEC partners to deliver any particular technology or conclusion included in the study.

- For a full description of the study including assumptions, calculations and results, please consult the full set of reports and appendices available at: https://ec.europa.eu/jrc/en/jec

WTT -Pathways analysed

SCOPE



JEC WTT v5 IN NUMBERS

- 252 • **Total WTT pathways**
  Note: 174 pathways in V4
- 78 • **New pathways**
- 54 • **Synthetic fuel** pathways investigated
- 9 • **Energy carrier categories**

(1) Fossil derived fuel (Oil & Gas)
(2) Biogas
(3) Ethanol
(4) Biodiesel
(5) Synfuels
(6) Electricity
(7) Heat & Power
(8) H_2
(9) H_2 from Electrolysis

TTW Background

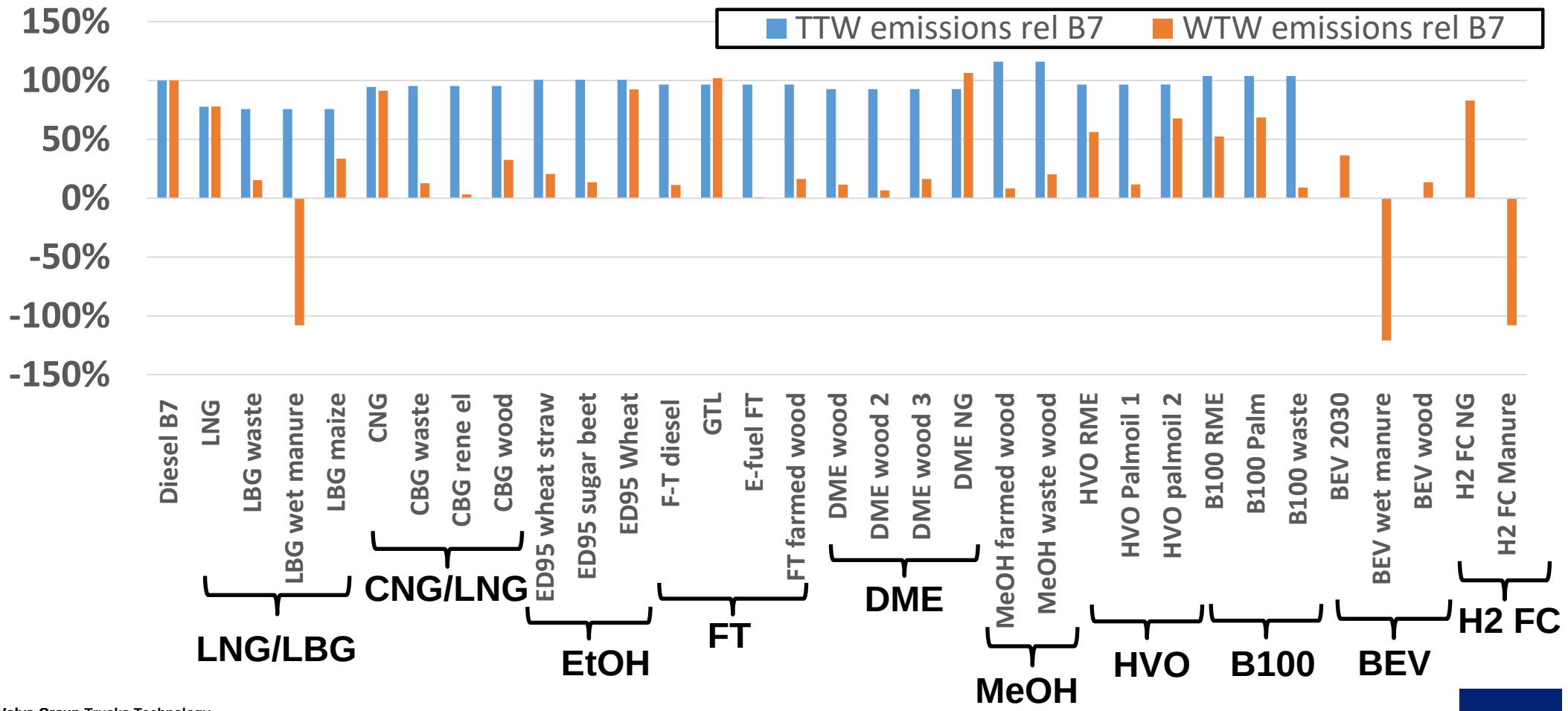
- The EUCAR Tank-to-Wheels (TTW) study provides **technology-neutral comparison** of powertrain and energy carrier combinations by estimating **GHG emissions** and **energy efficiency**.
- **New in version 5: TTW heavy-duty vehicles** (HD): representative of EU market, **generic long-haul vehicles** and specific fuels leveraging VECTO tool (2015 and 2025+), TTW simulations to reflect **groups 4 and 5**
- HD simulations have been performed by FVT from Graz University of Technology using VECTO software.

TTW for heavy-duty vehicles

- Baseline year for vehicle simulations 2015, outlook 2025+
- **Powertrain**: Diesel (CI Compression Injection), Dual fuel (diesel + gas), Hybrid, Battery electric, Fuel cell electric, Electric road (Catenary Electric Vehicle)
- **Fuels**: **Conventional**(Diesel), **alternatives diesel fuels** (Biodiesel (B100), Paraffinic diesel (HVO hydrotreated vegetable oil, paraffinic diesel, eFuel) and ED95, **Gaseous fuels** (DME Di-Methyl-Ether), OME (Oxy-methylene-ethers), LNG (liquefied natural gas)/LBG (liquefied biogas), CNG (compressed natural gas)/CBG (compressed biogas), **Electricity, Hydrogen**
- Two applications using **VECTO test cycle**:
  - Long haul 325kW (VECTO group 5)
  - Regional haul 220kW (VECTO group 4)

Well-to-Wheels Integration

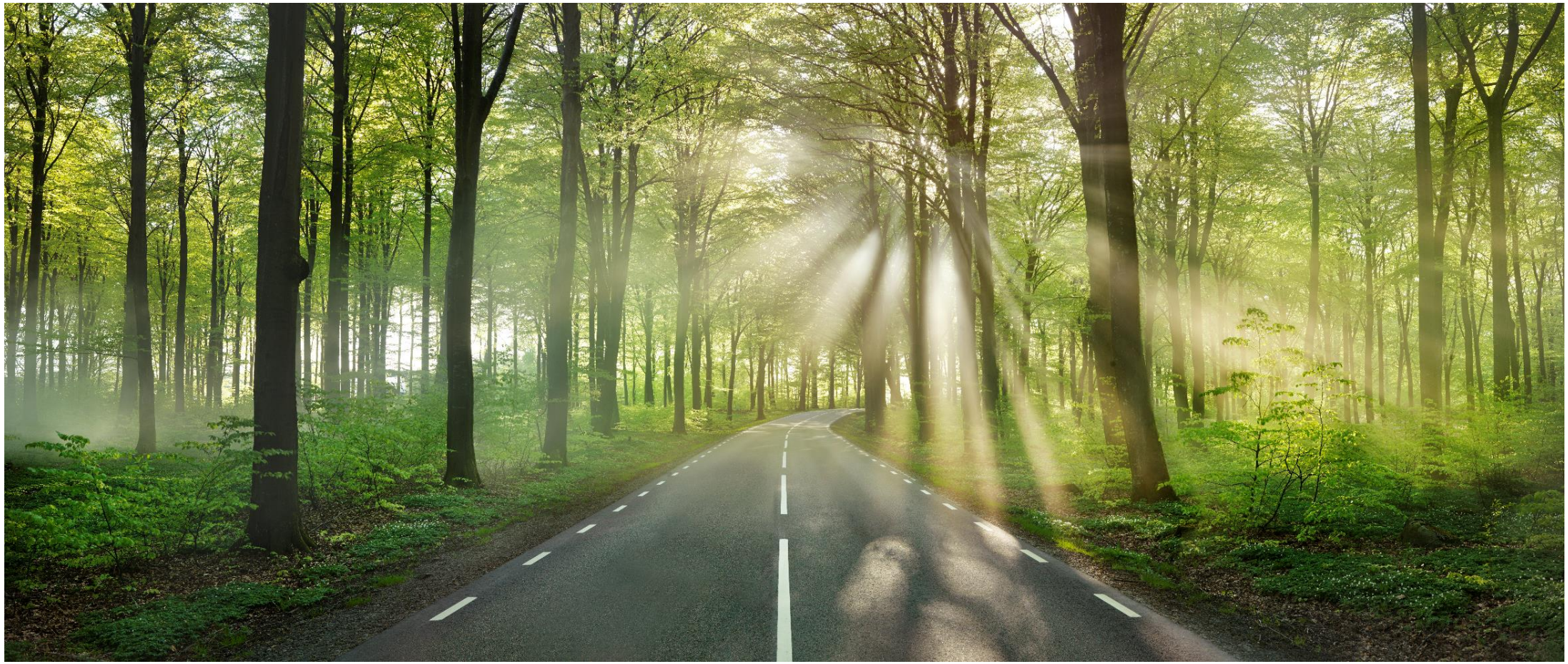
TTW and WTW CO2 emissions



Conclusions

- Many drivers for alternative fuels, one is CO2
- WTT analysis compares GHG reduction potential of multiple of pathways
- The source of the alternative fuel is very important in order to lower the global CO2 emissions

Thank you for your attention!



Back-up

Diesel B7	
LNG	LNG, road
LBG waste	Municipal waste
LBG wet manure	Upgraded biogas from wet manure as LBG, Digestate storage closed
LBG maize	Upgraded biogas from maize (whole plant) as LBG. Closed digestate storage.
CNG	NG (2030 EU mix): including LNG and biogas
CBG waste	Municipal waste
CBG rene el	Synthetic methane (as CNG) from renewable electricity and CO2 from flue gases
CBG wood	Synthetic methane (as CNG) via gasification of wood chips from short rotation forestry and methanation
ED95 wheat straw	Wheat straw to Ethanol (500 km)
ED95 sugar beet	Ethanol: EU sugar beet to ethanol, pulp to fuel, slops used as feed for biogas
ED95 Wheat	Ethanol: EU wheatto ethanol
F-T diesel	F-T diesel from wood residue (waste) (500 km)
GTL	Remote natural gas to Syndiesel (GTL): GTL plant near remote gas field with/without CCS (C), Syndiesel imported into Europe and incorporated into diesel pool.
E-fuel FT	Syndiesel: Renewable electricity via SOEC (FT route), CO2 from flue gas
FT farmed wood	Farmed wood to syn diesel
DME wood	DME: from residual wood (truck, 500 km)
DME wood 2	Wood to DME, waste wood,
DME wood 3	farmed wood
DME NG	Piped natural gas (4000 km) to DME, synthesis plant in EU
MeOH farmed wood	waste wood, SI
MeOH waste wood	farmed wood, SI
HVO RME	Rape (HVO), meal export to animal feed, NexBTL hydrotreating process
HVO Palmoil 1	Extraction of oil from palm oil mill effluent, NEXBTL
HVO palmoil 2	Palmoil no Ch4 recovery, no heat credit, NEXBTL
B100 RME	Rape (RME), meal export to animal feed, glycerine export as chemical
B100 Palm	Palm oil to biodiesel
B100 waste	Waste cooking oil to biodiesel
BEV 2030	EU-mix medium (2030 mix) - MV
BEV wet manure	Wet manure, closed digestive storage)
BEV wood	Wood farmed, conventional small scale
H2 FC NG	C-H2: EU-mix, O/S Ref
H2 FC Manure	Upgraded biogas from wet manure sent to onsite SMR, digestate storage closed

CO_2 Potential for 2025

- Combustion improvement
- Friction reduction
- Brake energy recovery
- Exhaust energy recovery
- Air drag reduction
- Tire improvement