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Renewable fuels and quality aspects for meeting future sustainable transports

Building a sustainable European Biofuel industry Nov 4-6, 2019

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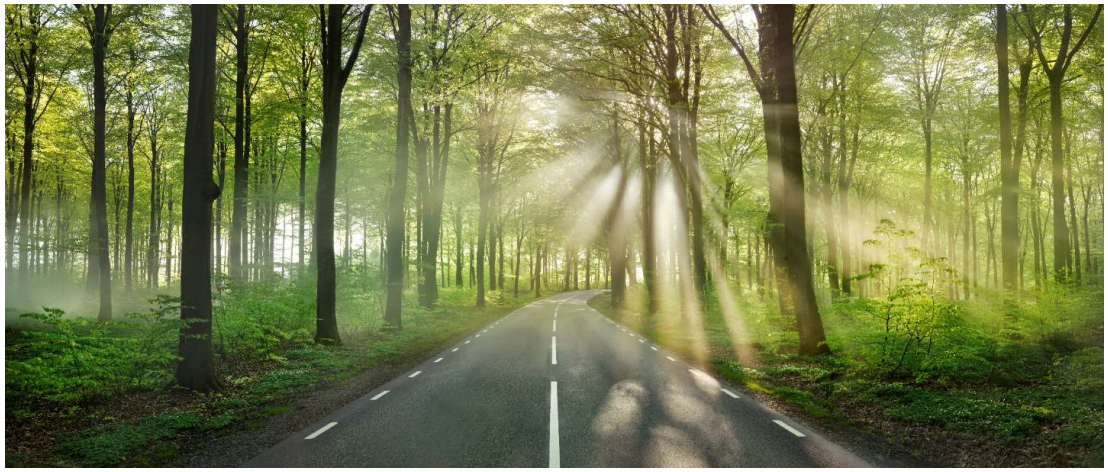
- Volvo Group
- Drivers for alternative fuels
- Alternative fuels at Volvo
- Quality of fuels
- How to meet future CO2 regulation with alternative fuels and future technologies

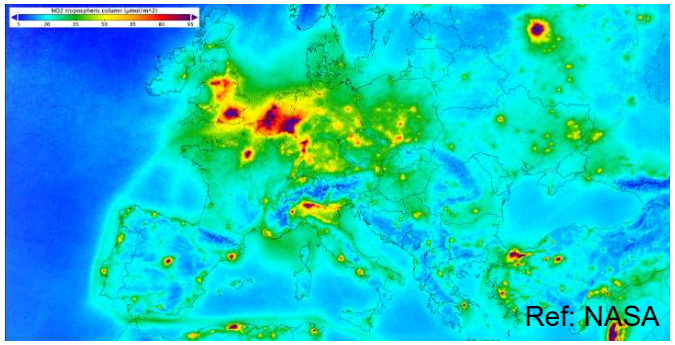


Volvo Group

- 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

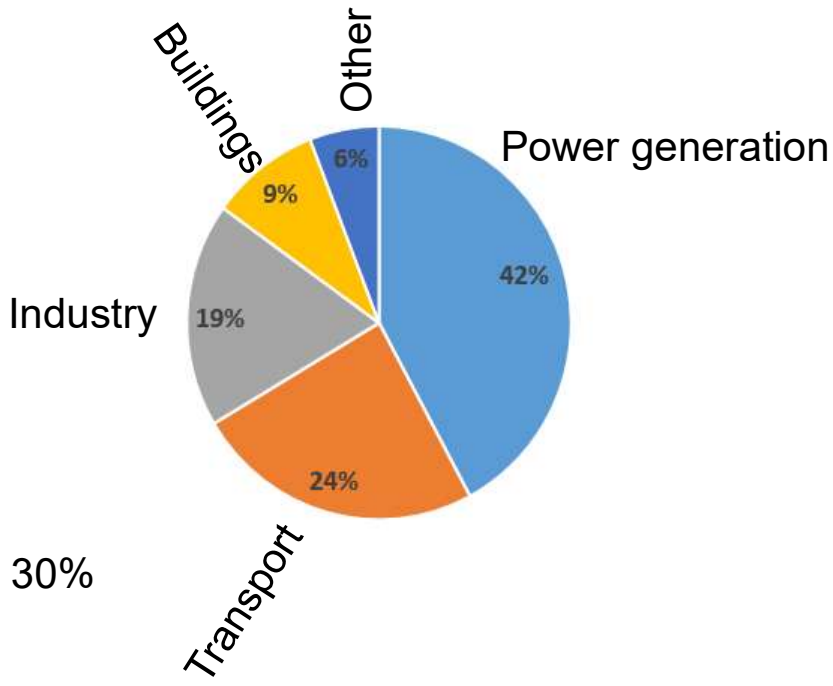
- Climate change
- Availability of energy resources and projected increasing demand
- Security of supply
- Emissions, regulated and unregulated
- Urbanisation and noise
- Customer and transport buyers



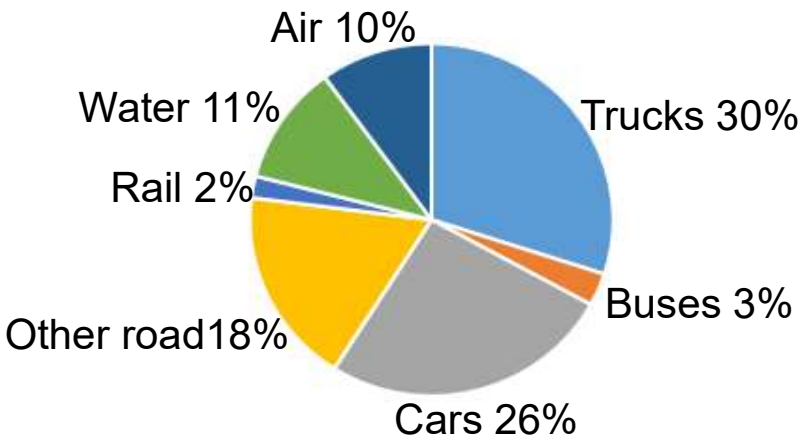
Global CO2 emissions

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

Global CO2 emissions 32,5 Gt

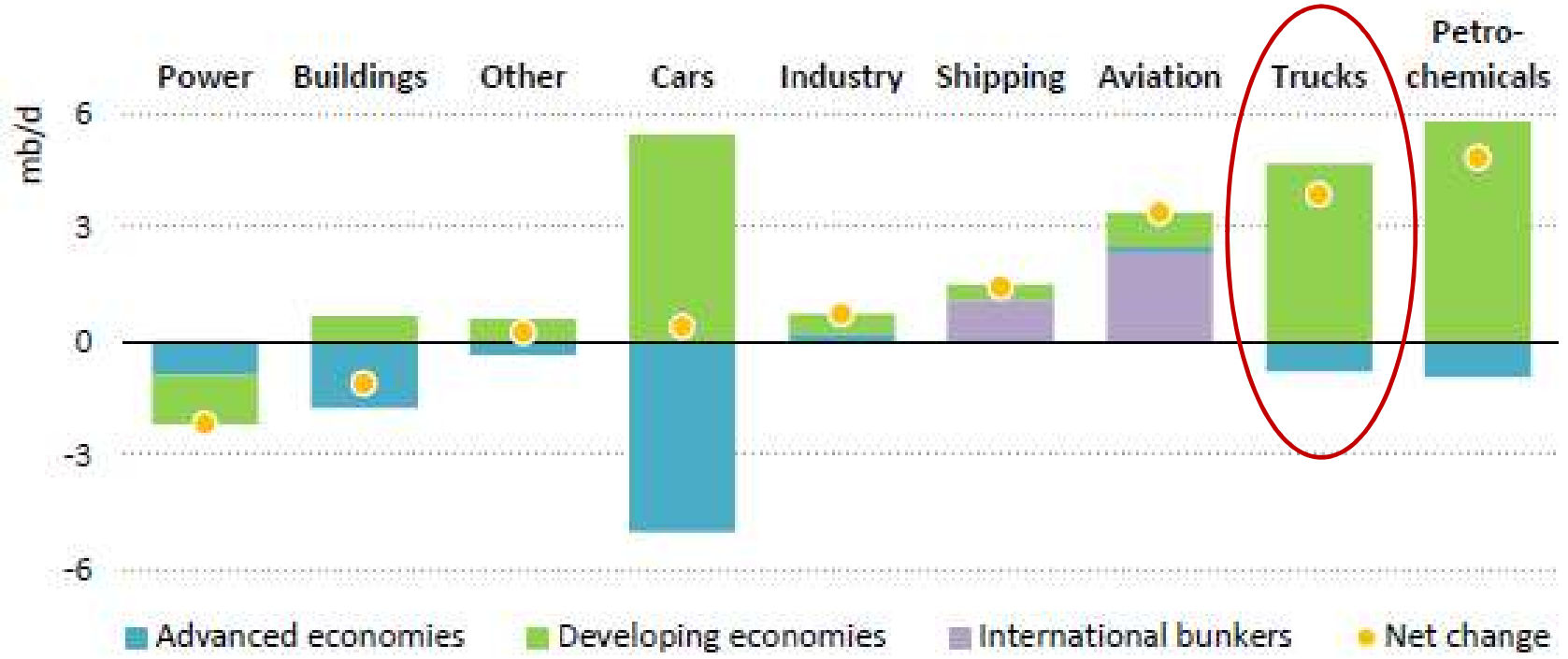


Transport 8 Gt CO2



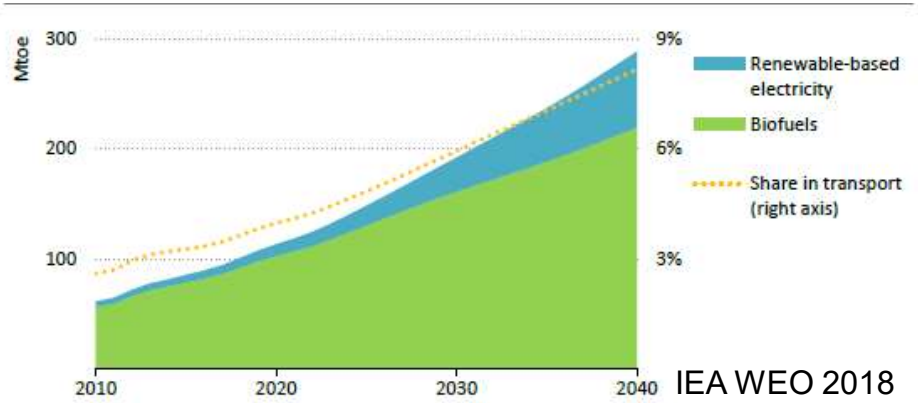
Source: IEA

Change in global oil demand by sector in the by 2017-2040



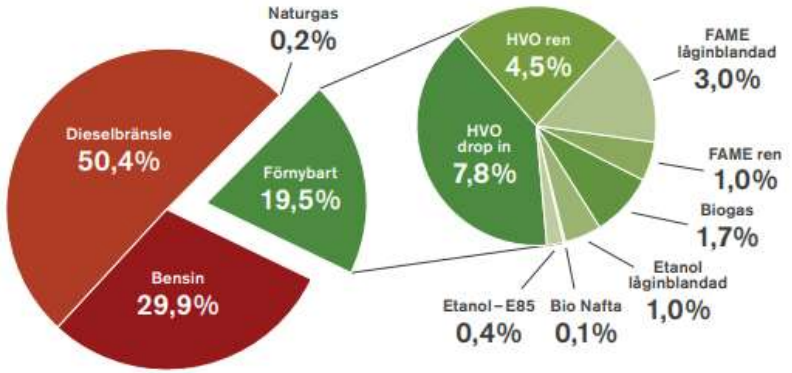
IEA WEO 2018
New policies scenario

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



Global Bioenergy potential

- Outlook freight transport road energy use 2030 is 37 EJ/year*
- > 10% global energy use can be replaced by biomass**
- If all biomass used in freight transport road 100% can be replaced

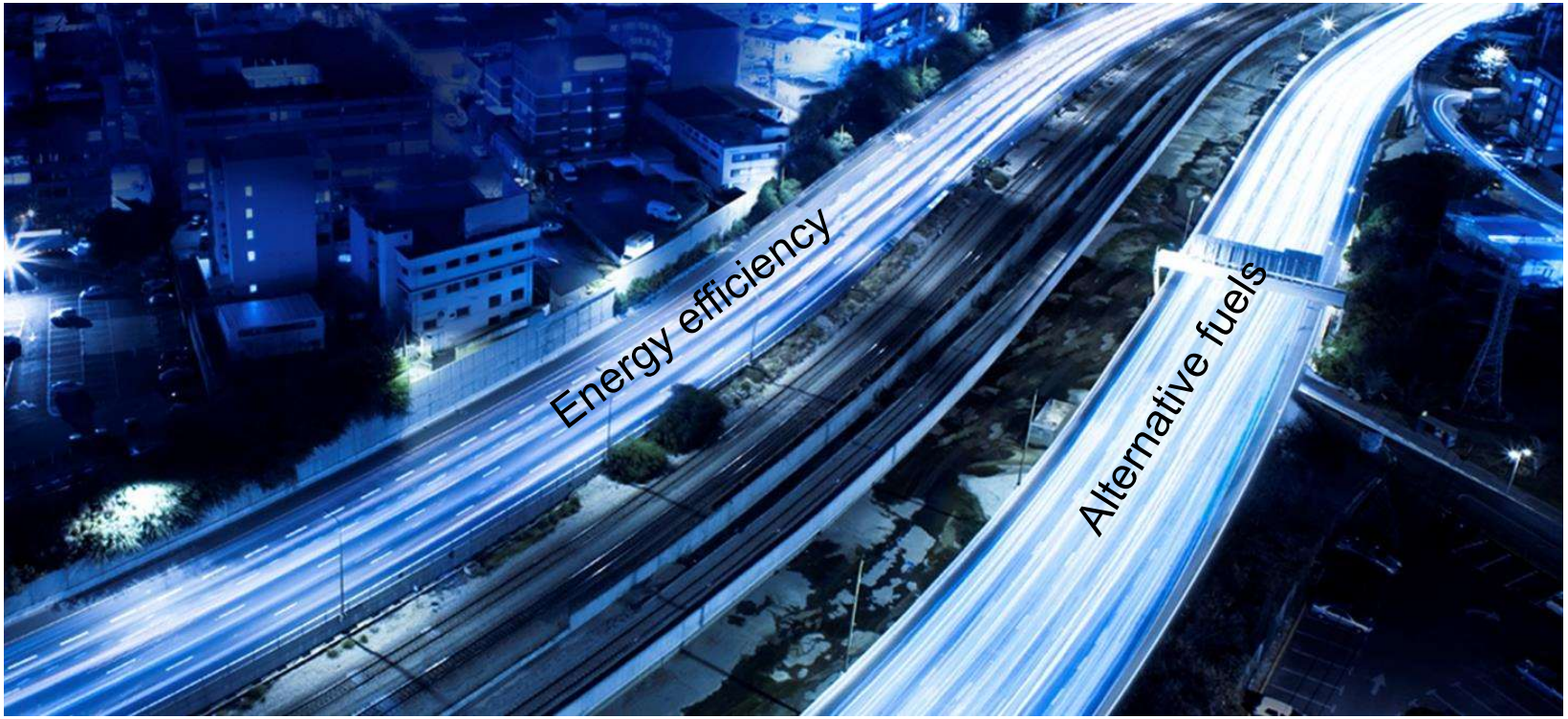
* Shell sky scenario
**IPCC Bioenergy Report

CO2 HDV limit regulation

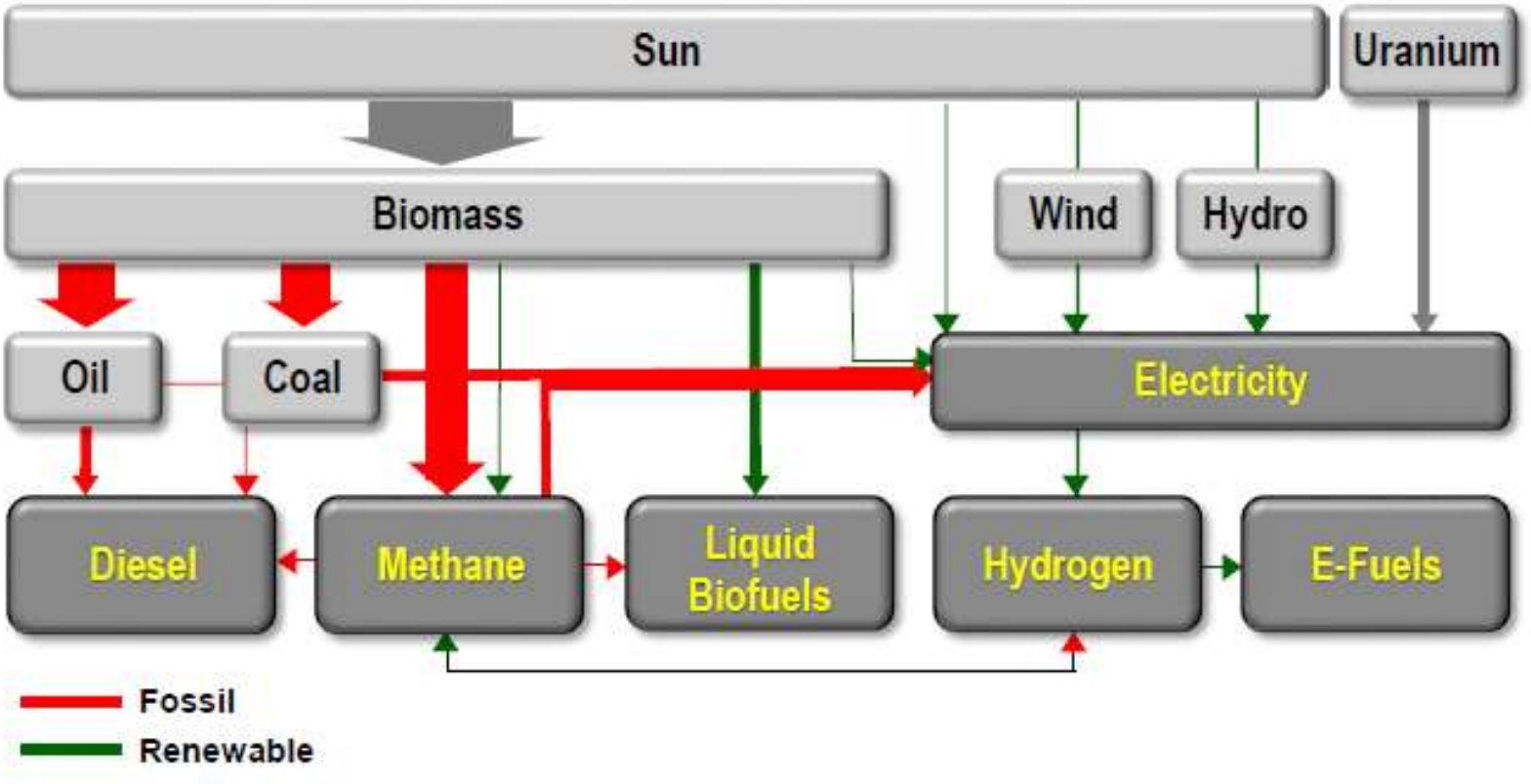
- **CO2 reduction targets:**
  - A binding target of **-15% CO2 reduction by 2025**, compared to the 2019 baseline;
  - A binding target of **-30% CO2 reduction by 2030 and later**, compared to the 2019 baseline, **to be reviewed in 2022**. The revision could end up in a demand to more than -30%

- The CO2 reduction target is valid for tank to wheel

Our two-path strategy

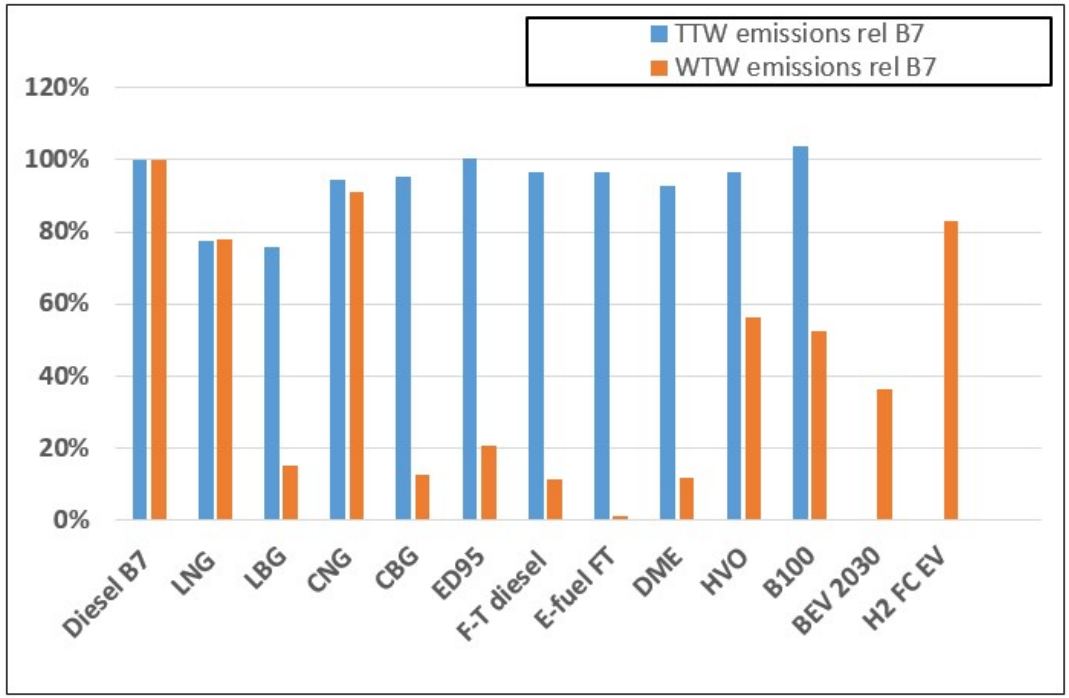


Fuels


Sun
Uranium
Biomass
Wind
Hydro
Oil
Coal
Electricity
Diesel
Methane
Liquid Biofuels
Hydrogen
E-Fuels
Fossil
Renewable

JEC (JRC, EUCAR, CONCAWE) Well to Wheel study

- Heavy Duty well to wheel
- Version 5 will be published end of Dec 2019
- 252 different pathways for fuel production
- Big variations between different pathways and sources



Drop-in fuels

- Can be used in present fleet and infrastructure
- Do not reduce tailpipe CO2 emissions, but can reduce the well to wheel CO2 emissions with up to 90%
- Drop-in fuels in diesel:
  - FAME
  - Paraffinic fuels (HVO, GTL, BTL, PTL)

CNG/LNG/biomethane

- LNG/LBG
  - In HPDI* engines the CO2 emissions can be reduced by 20% tailpipe and by 100% well to wheel for biomethane
  - Liquified and cooled methane down to -160 deg C
  - Methane slip/evaporation can be an issue if the truck is parked during long time
- CNG/CBG
  - The CO2 emissions can be reduced by 8% tailpipe and by 100% well to wheel for biomethane

*High Pressure Direct Injection

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EV and H2

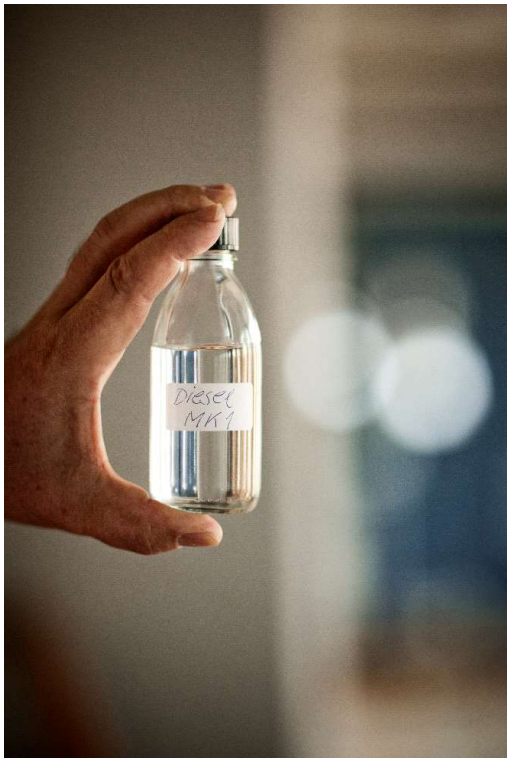
- Zero tail pipe emissions (local and global)
- Depending on source of the electricity and hydrogen; big variations in well to wheel CO2 emissions
- Infrastructure challenges for both EV and H2

Methanol, Ethanol and DME

- MeOH
- EtOH
  - Can be used in CI engines with ignition improver
  - Or in HPDI engines with diesel as igniter
  - MeOH is very poisoning
  - Sulfur-free fuels beneficial for aftertreatment systems
- DME
  - Standardization work ongoing in DIN
  - Odorant and lubricant additive are needed
  - Compressed to 5 bar to be in liquid phase
  - Sulfur-free fuel beneficial for aftertreatment systems
  - Non-toxic fuel
  - Low soot emissions, easier to control NOx with EGR

Standardization and quality of fuels

- Extremely efficient aftertreatment and FIE systems require high quality fuels (low sulfur, low aromatics, cleaning additives are required)
- Standards to be fulfilled (meet environmental, safety and healthy requirements)
- All new fuels need to be tested and evaluated
- Certification fuels are required in order to meet emission legislations



Commercial vehicles are used in commercial conditions

- A move to non-fossil fuels will come when profitability levels are viable
- Political decisions will be needed
  - Long term vision
  - Short term incentives
- Important principles
  - Energy efficiency and GHG
  - “Work done” principle
  - An international perspective
  - Stable and predictable measures
  - Specification of new fuels

CO_2 Potential for 2025

- Combustion improvement
- Friction reduction
- Brake energy recovery
- Exhaust energy recovery
- Air drag reduction (with a short nose)
- Tire improvement

Summary

- Volvo can provide technical solutions for various of alternative fuels
- Key issues
  - Availability
  - Infrastructure
  - Quality
  - Customer
- Profitability essential for all
- Alternative fuels and new technology the way forward

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Thank you for your attention!