Energy efficient and low carbon heavy transportation

TransDigi seminar

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Research team leader

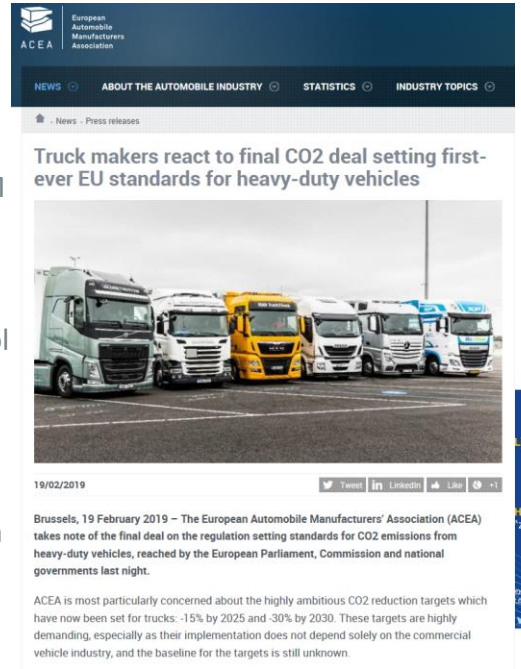
25.11.2021 VTT – beyond the obvious

Content

- Background and legislation
- State-of-the-art HDV’s performance
- Future projection of CO2 emissions

Regulation for heavy-duty road vehicles in EU

- Final decision on tailpipe CO2 emissions:
  - -15 % reduction by 2025
  - -30 % reduction by 2030
- Baseline defined based on the OEM specific emissions in 2019-2020
- Toolbox:
  - Improved engines
  - Improved interacting control systems
  - Improved aerodynamics
  - Reduced rolling resistance
  - Reduced weight
  - Hybridization/electrification



https://www.acea.be/press-releases/article/truck-makers-react-to-final-co2-deal-setting-first-ever-eu-standards-for-he

- FitFor 55 and updated Renewable Energy Directive (RED II)
  - Regulates feedstock applicable for advanced biofuels
  - Promotes uptake of renewable fuels (such as H2) in transportation
- Alternative Fuels Infrastructure Directive
- Clean vehicle directive (CVD)

Dario Dubolino 2019

Battery electric trucks

- New models coming all the time

Scania

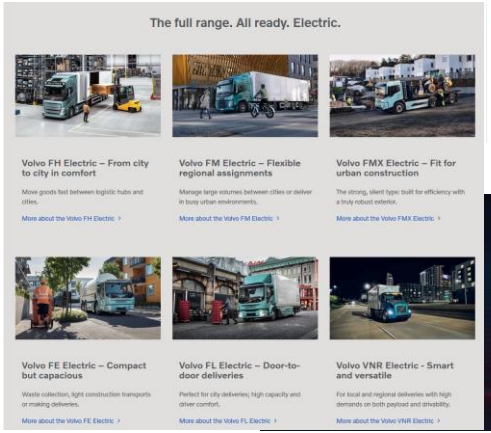
ps://www.scania.com/group/en/home/products-and-rvices/trucks/battery-electric-truck.html

MAN

in numerous real-world deployments. The IAA 2016 marked the time to shine: for the first time, MAN presented a fully electrically driven semitrailer tractor for use in inner-city night-time distribution, e.g. for food markets. In the following months, MAN built further fully electric concept vehicles based on the MAN TGM in the weight class from 18 to 26 tonnes. Since 2018, the MAN eTruck has been in use in test operations at nine CNL partner companies.

https://www.truck.man.eu/de/en/man-etruck.html

Volvo

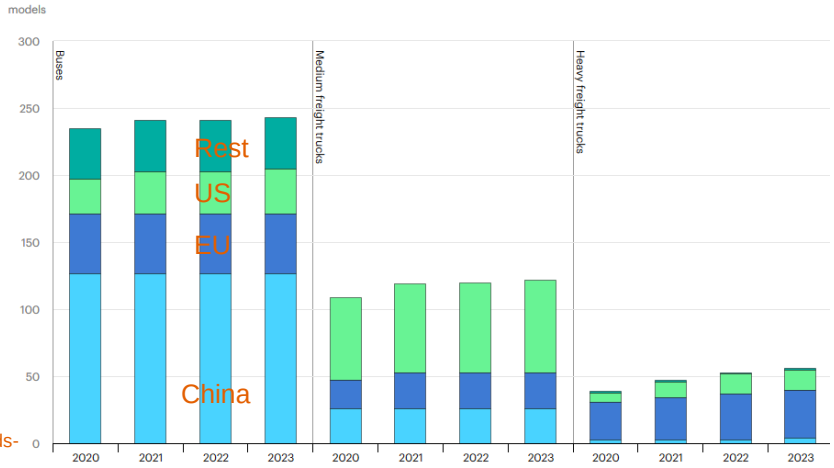


https://www.volvotrucks.com/en-en/trucks/alternative-fuels/electric-trucks.html

Mercedes-Benz

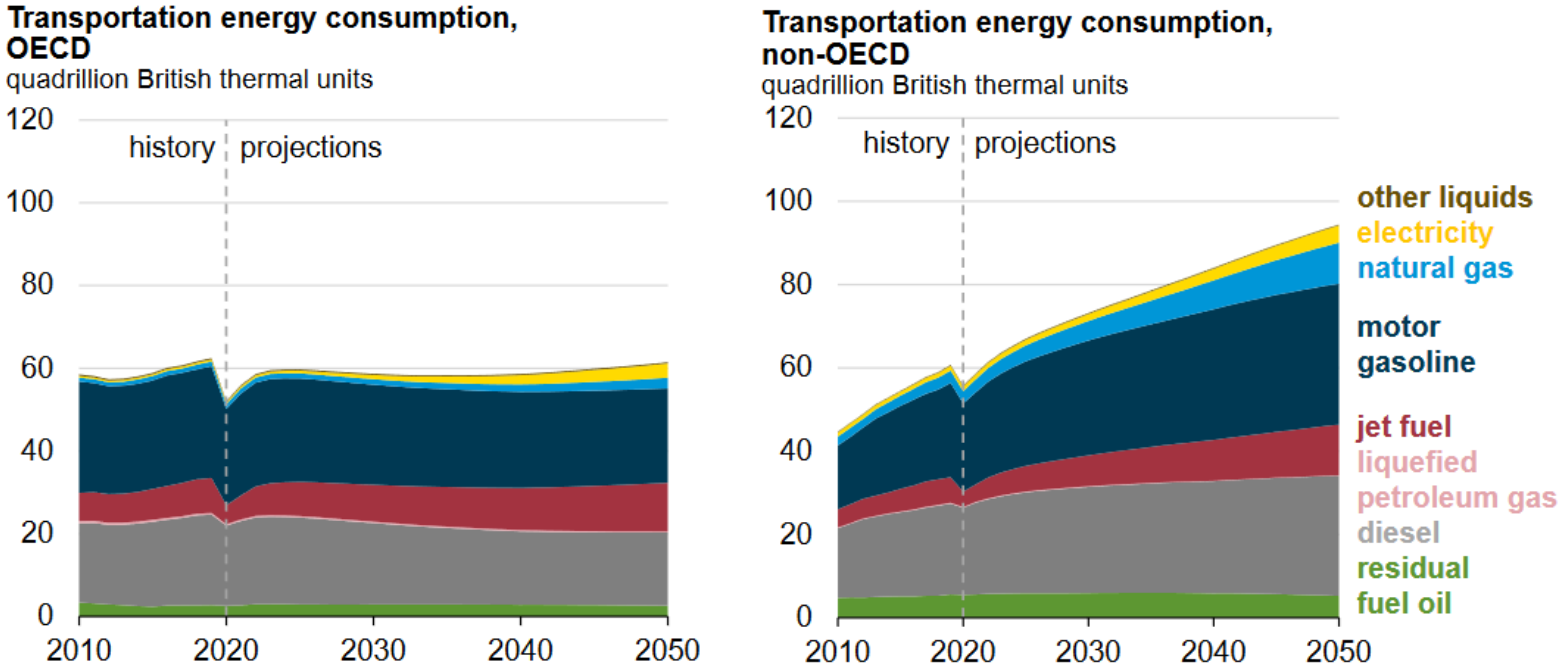
https://www.mercedes-benz-trucks.com/en_GB/emobility/world/our-offer/eactros-and-services.html

Number of electric HDVs models available by segment and year, 2020-2023



https://www.iea.org/reports/global-ev-outlook-2021/trends-and-developments-in-electric-vehicle-markets

World transport energy – big picture



U.S. Energy Information Administration, International Energy Outlook 2021,
https://www.eia.gov/outlooks/ieo/pdf/IEO2021_ChartLibrary_Transportation.pdf

Development of ICE powertrains

PRESS INFO

11 November 2021

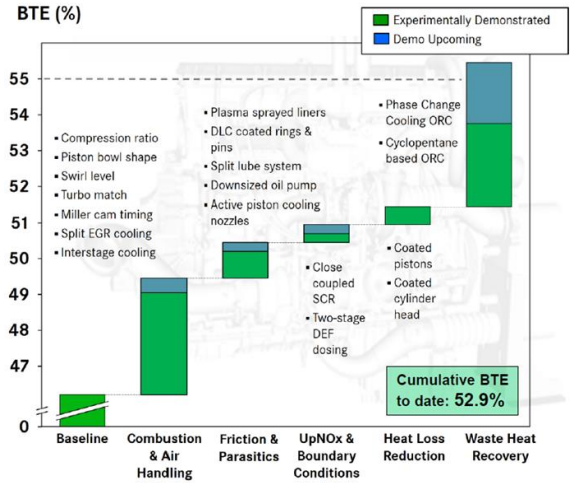
Sustainable transport for the decade ahead:

Scania brings diesel engine technology to sustainable levels

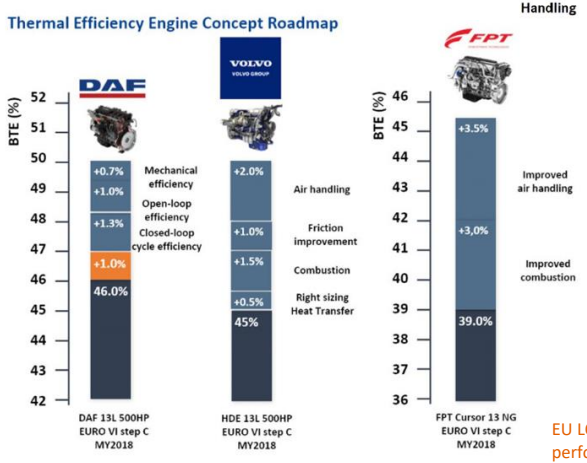
- **Scania is introducing a ground-breaking 13-litre engine range with capacity for biofuels, delivering the best total operating economy in a sustainable way**
- **Investment of 2 billion euros has resulted in fuel savings of 8 percent from the new powertrain with new engines, gearboxes and rear axles**
- **Probably the most advanced heavy truck combustion engine platform ever, intended to maintain Scania's premium position**
- **Superior performance of dual overhead cams and Scania Twin SCR, which make a vital contribution towards reaching Scania's science-based targets**
- **Compression Release Brake for improved engine braking performance**
- **The technical service life has in general been improved with 30%; flexible service intervals based on operation, and can be supported by Scania ProCare with preventive renewals**

The degree of thermal efficiency is around 50 percent for the new engines, numbers that used to be out of reach for combustion engines. Behind the impressive performance level lies ingenious engineering and utilisation of technology such as dual overhead camshafts and Scania Twin SCR dosing of AdBlue. Potent engine management systems are monitoring the powertrain, thus contributing to the total operating economy under all conditions.

Scania:
https://mb.cision.com/Public/209/3451528/b7bfbd28446b6ac2.pdf



US SuperTruck II, Daimler, https://www.energy.gov/sites/prod/files/2020/05/f75/ace100_Villeneuve_2020_o_4.29.20_250pm_TDM.pdf

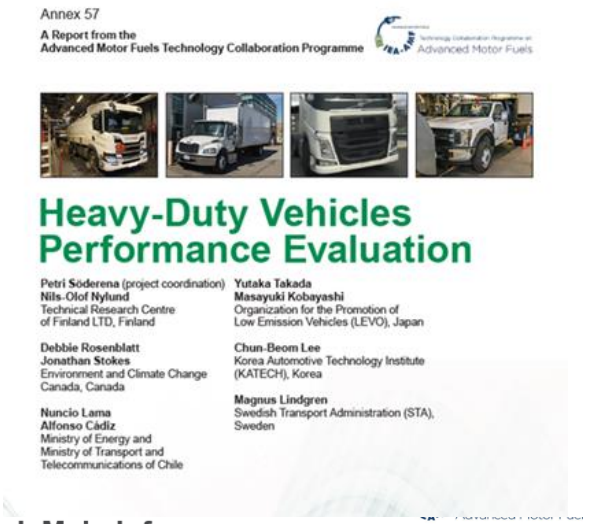


EU LONGRUN: https://h2020-longrun.eu/ice-performance-to-increase-to-pte-50/

State-of-the-art HDV's performance

State of the art ICE trucks

- IEA AMF Task 57 HDV's Performance evaluation
  - Current performance of the best-available-technology HDVs using conventional and alternative fuels
  - Joint activity with Hybrid Electric Vehicle (HEV) TCP to bring an insight how different HDV's powertrain and fuel (fossil and renewable) options perform against the CO_2 emission regulations in 2025 and 2030 perspective



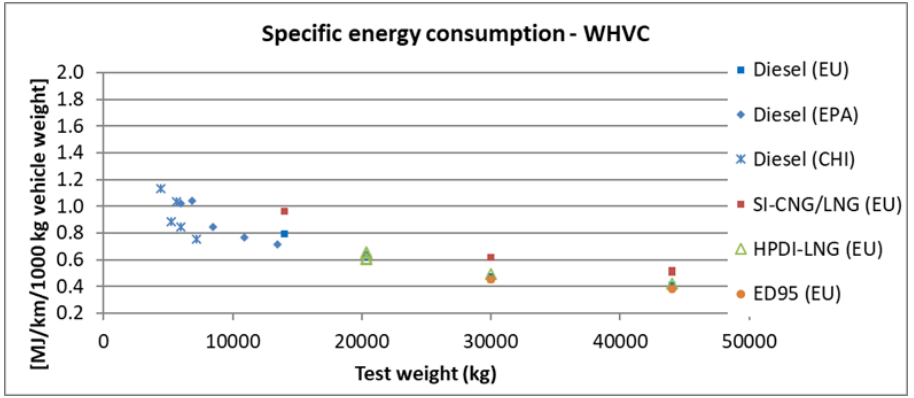
IEA AMF Task Main Info

Task Number and Title	Task 57 **HDV Performance Evaluation**
Operating Agent (institution)	VTT LTD Finland
Start and End Date	October 2018 - May 2021
Participants	Canada, Chile, Finland, Japan, Republic of Korea, Sweden
Task Sharing	Canada, Chile, Finland, Republic of Korea, Sweden
Cost Sharing	Japan and Sweden
Total Budget	~€610,000 (~$671,000 US)
Project Leader (name and email)	Petri Söderena VTT Technical Research Centre of Finland petri.soderena@vtt.fi

IEA AMF Task 57 publications

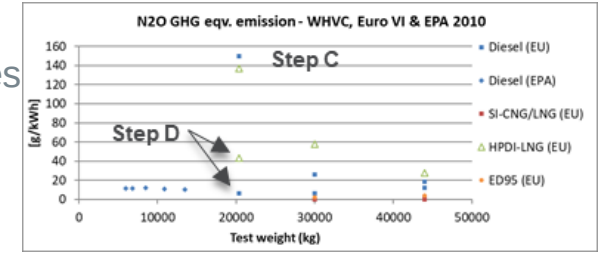
State of the art ICE trucks – Energy consumption

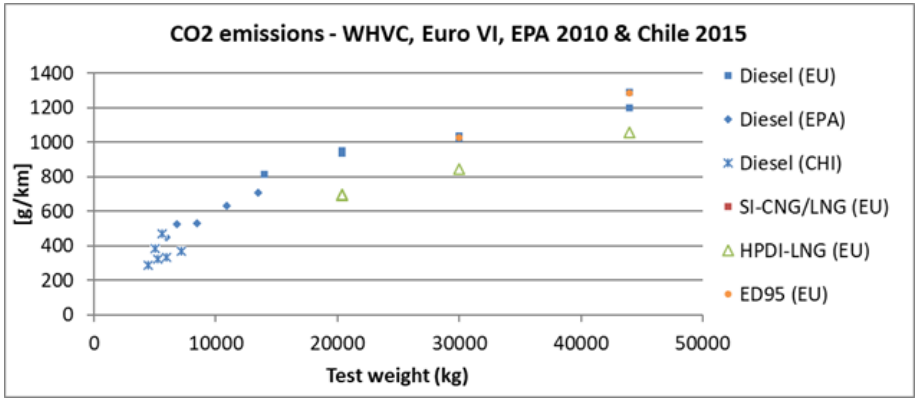
- In energy consumption (EC) wise vehicle GVW is the most effective factor – increased GVW reduces specific EC
- For the EC the combustion process has second highest effect
  - Compression ignition engines in general have lower energy consumption
  - Diesel and ED95 engines have similar efficiency
  - HDPI-LNG engine has slightly lower efficiency compared to diesel, roughly 4 to 7 % higher
  - SI-LNG/CNG engines have some 15 to 30 % higher EC compared to diesel

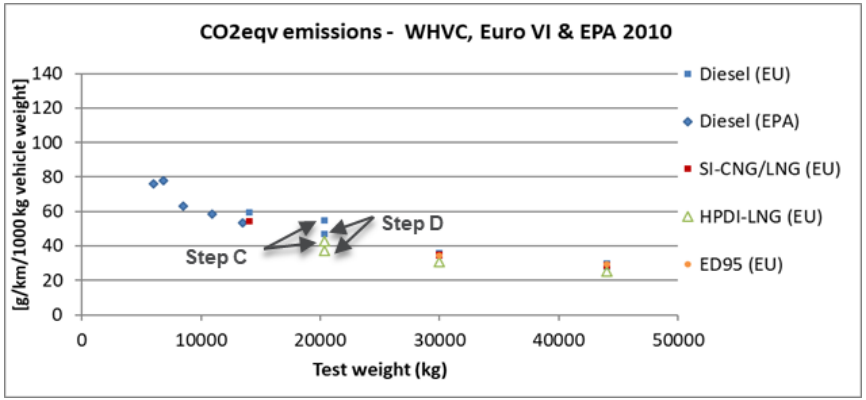


State of the art ICE trucks – CO2 emissions

- New methane fueled engines utilize the favorable carbon intensity of methane. Advantage over diesel in CO2 emissions
- ED95 engine produces roughly similar CO2 emissions as diesel
- High CO2,eqv emissions are observed with some SRC technologies due to high N2O emissions

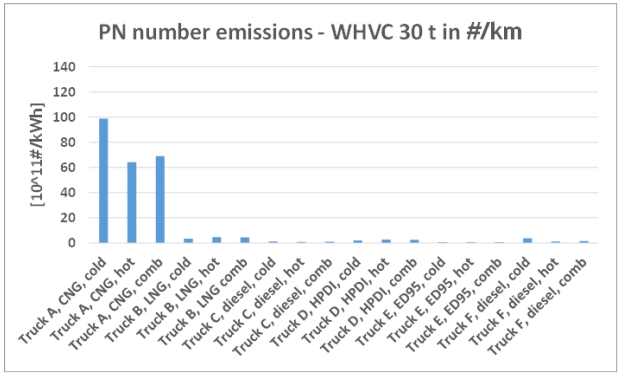


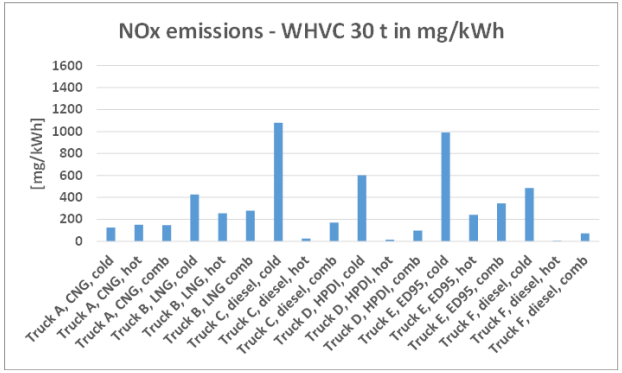


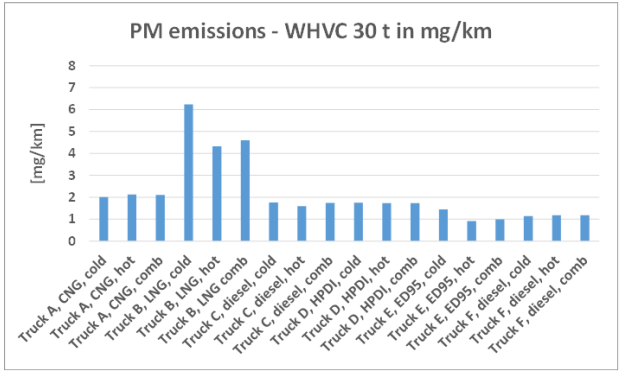


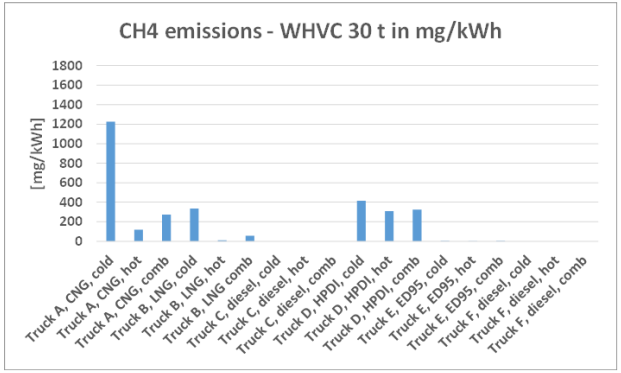
State of the art ICE trucks – pollutant emissions

- New Euro VI trucks capable for low pollutant emissions independent on engine type
  - Vehicles using SCR capable for close to zero NOx emissions when operating warm conditions
  - PM and PN emissions low with all engine types
  - Methane slip no more a problem
  - Spark-ignition methane engines provides also low emissions



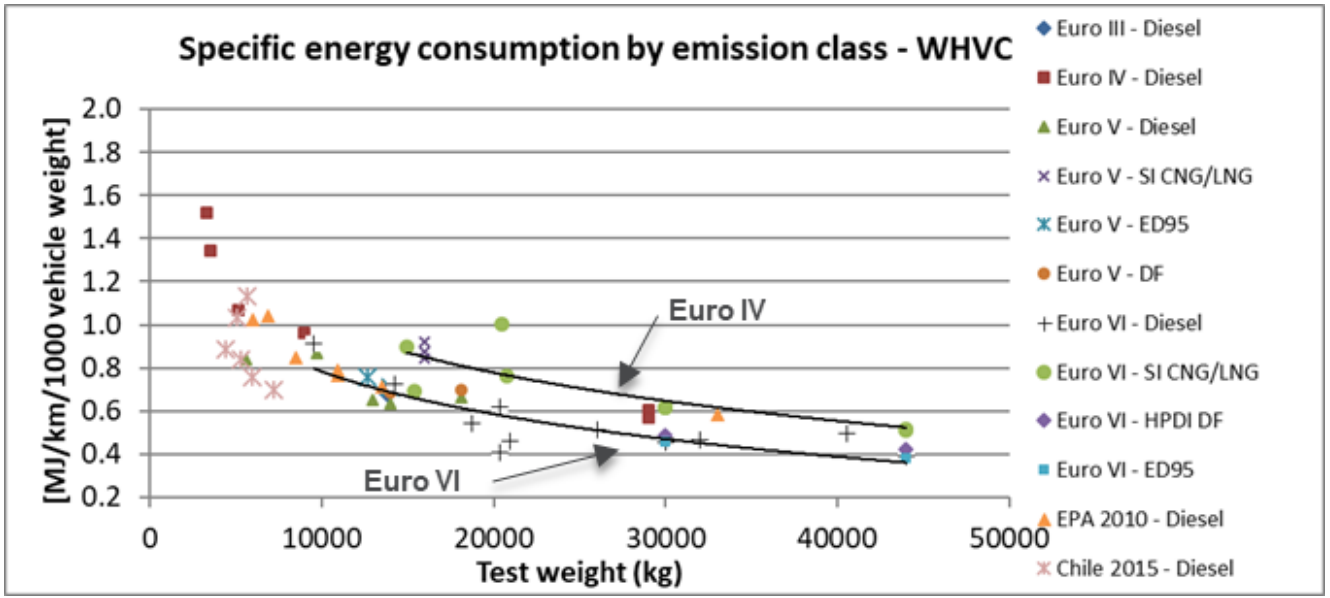






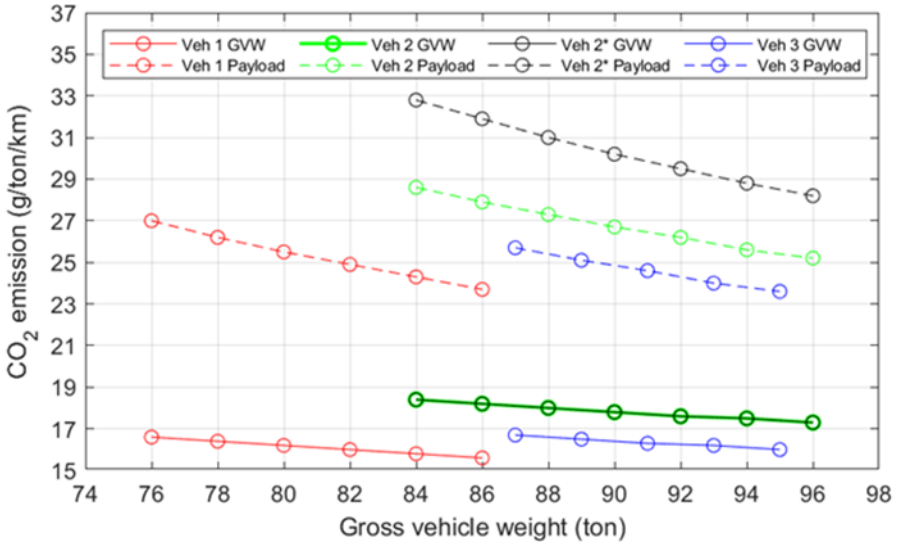
State of the art ICE trucks – Historical development

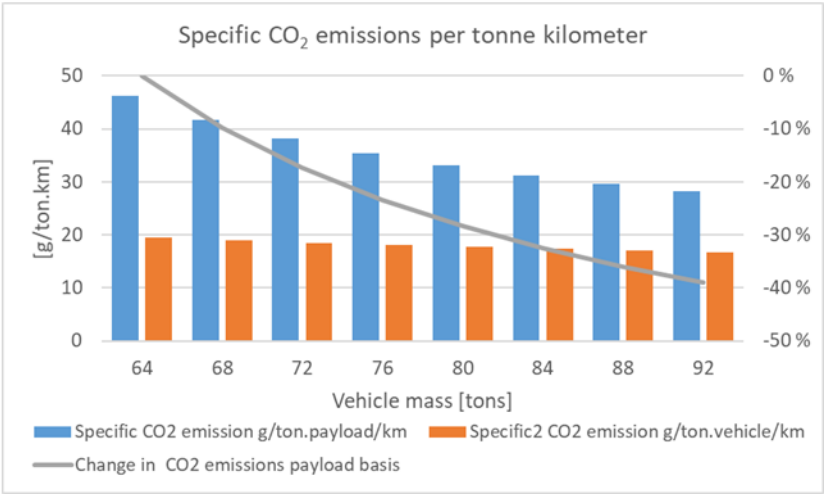
- Comparison against the previous study IEA AMF Annex 49 ”COMVEC” performed in 2014-2016



State of the art ICE trucks – Effect of payload

- Simulation results from the study performed within IEA AMF Task 57
  - HCT combinations with different configurations, gross vehicle weights and payloads

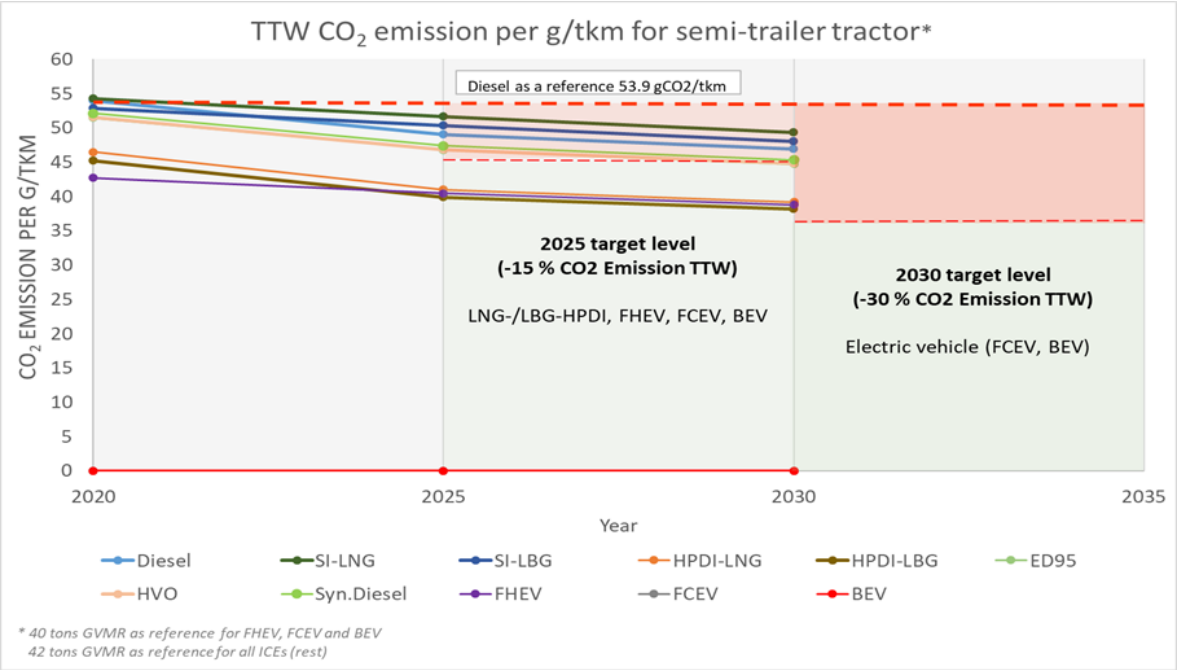




Future projection of CO2 emissions

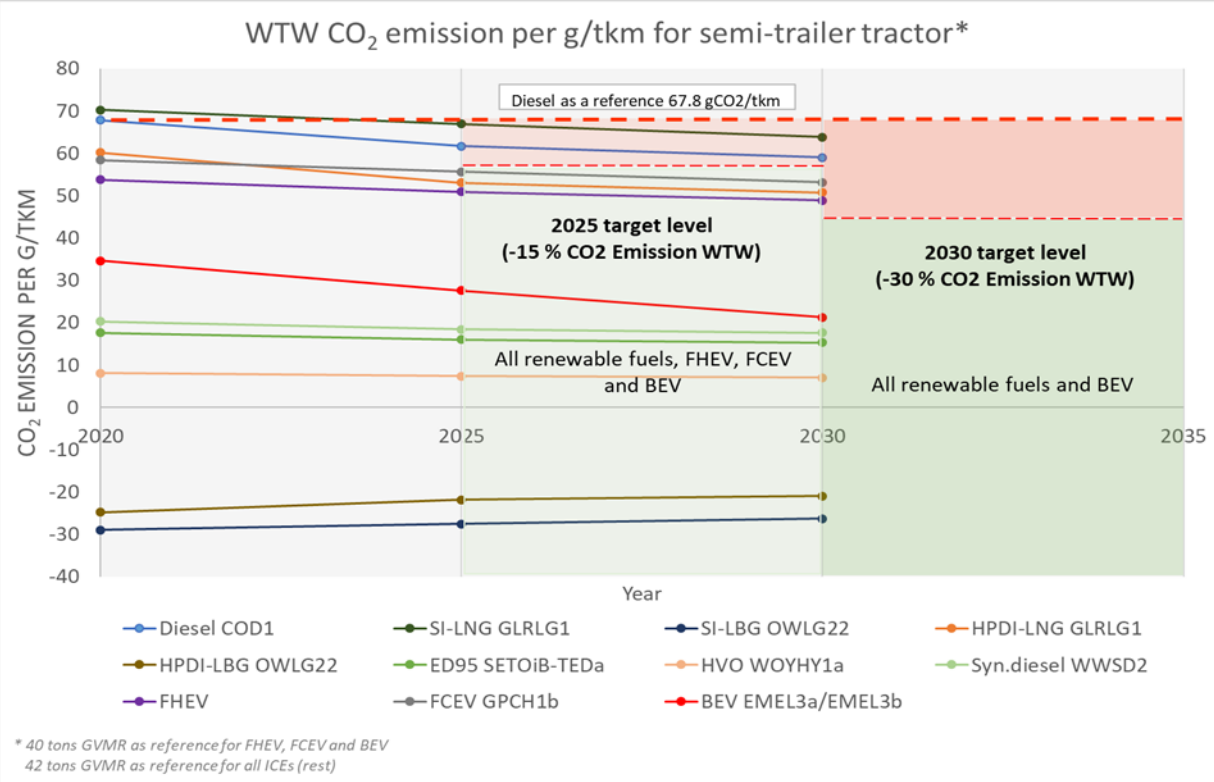
Future projection of CO2 emissions

- Based on CD results of AMF Task 57 and simulations of HEV TCP
- Energy consumption and CO2 emissions were analyzed both on TTW (end-use or tailpipe) and WTW (overall impact) basis
  - The WTT data needed for this stems from the newest version of the JEC Well-to-Tank report v5
- Estimations and demonstrations from US Super Truck II* and H2020 LONGRUN** programs were used for estimating the future ICE efficiency



* US Super Truck II
** LONGRUN

Future projection of CO2 emissions



Summary and key message

Summary and key message

- Heavy-duty truck engines operating with diesel process (i.e. compression ignition and diffusion combustion) have a clear advantage in efficiency compared to powertrains with spark-ignition engines
- New engine options, dual-fuel LNG-diesel and ED95 ethanol, provide interesting options for the future
- In tailpipe CO2 emissions SI-methane HDV engines provide slightly lower to slightly higher emissions depending on the engine loading in the specific cycle/mission
- Regarding local emissions, all the powertrain options are capable of low emissions

Summary and key message

- Vehicle level measures can have cost efficient and fast effect on CO2 emissions
  - HCT offers an effective way for reducing specific energy consumption and CO2 emissions
- HDV CO2 regulations that focus on tailpipe emissions constitute a barrier for further development of alternative fuelled trucks
  - Restricted or no development of engines for alternative fuels
  - Preference to use drop-in fuel in the legacy fleet
  - Electrification for new trucks entering the market
- Neglecting tools that are already available hinder remarkably successful achievement of the GHG targets **– We need all the renewable energy sources available**
  - **Let the end-users decide which powertrains fit the best in the specific need**

beyond

the obvious

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15/11/2019