

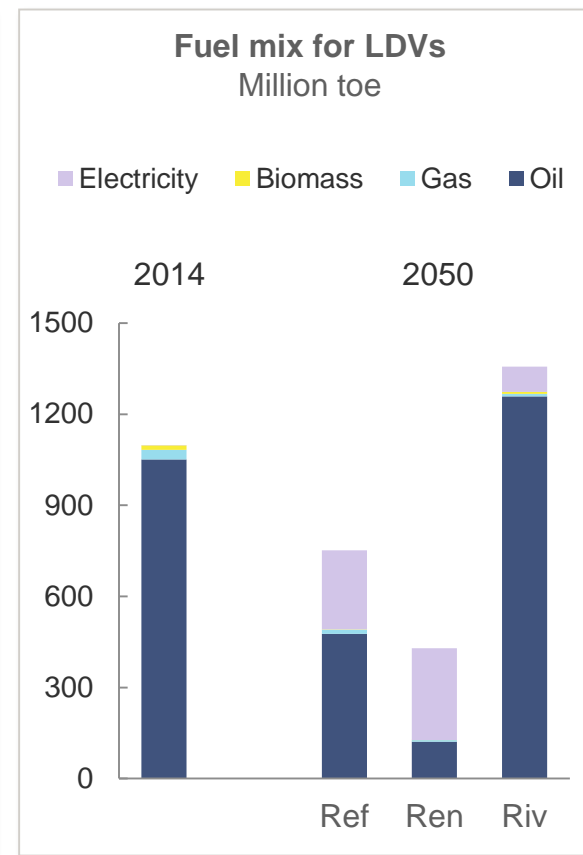
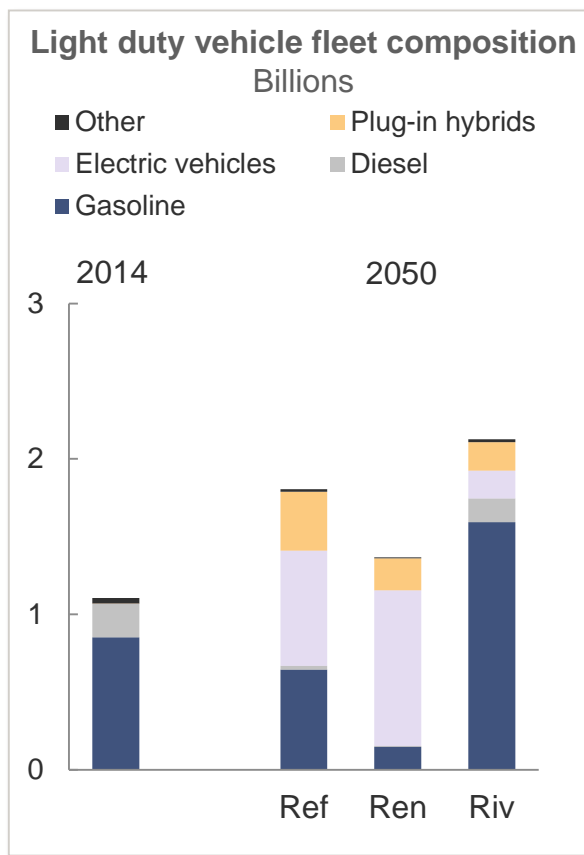
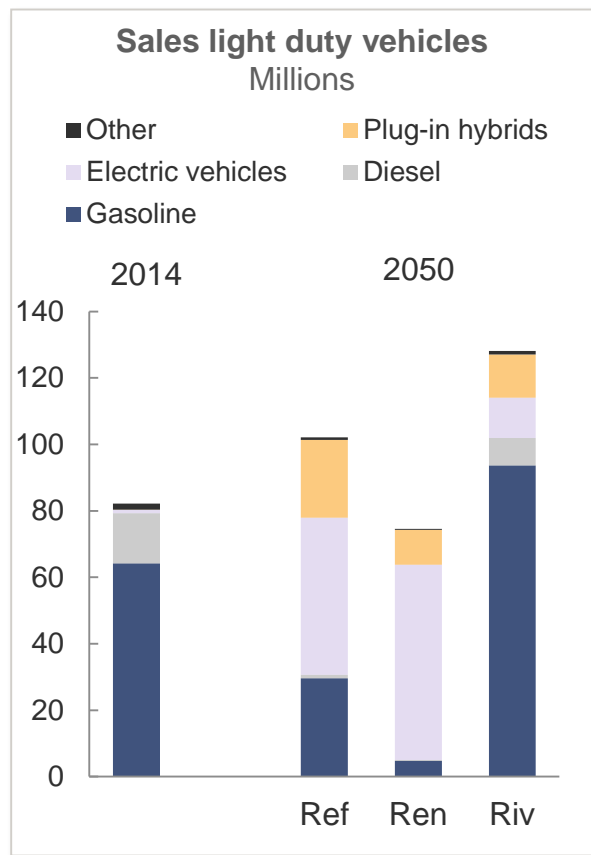


Low carbon transportation fuels

Energy Transition, NTNU Nov.8th 2017

Technology shift for light duty vehicles

... in all scenarios, and a revolution in Renewal



Source: IEA (history), Statoil (projections)



De-Carbonizing Energy Systems – Role of H₂ in the fuel mix?

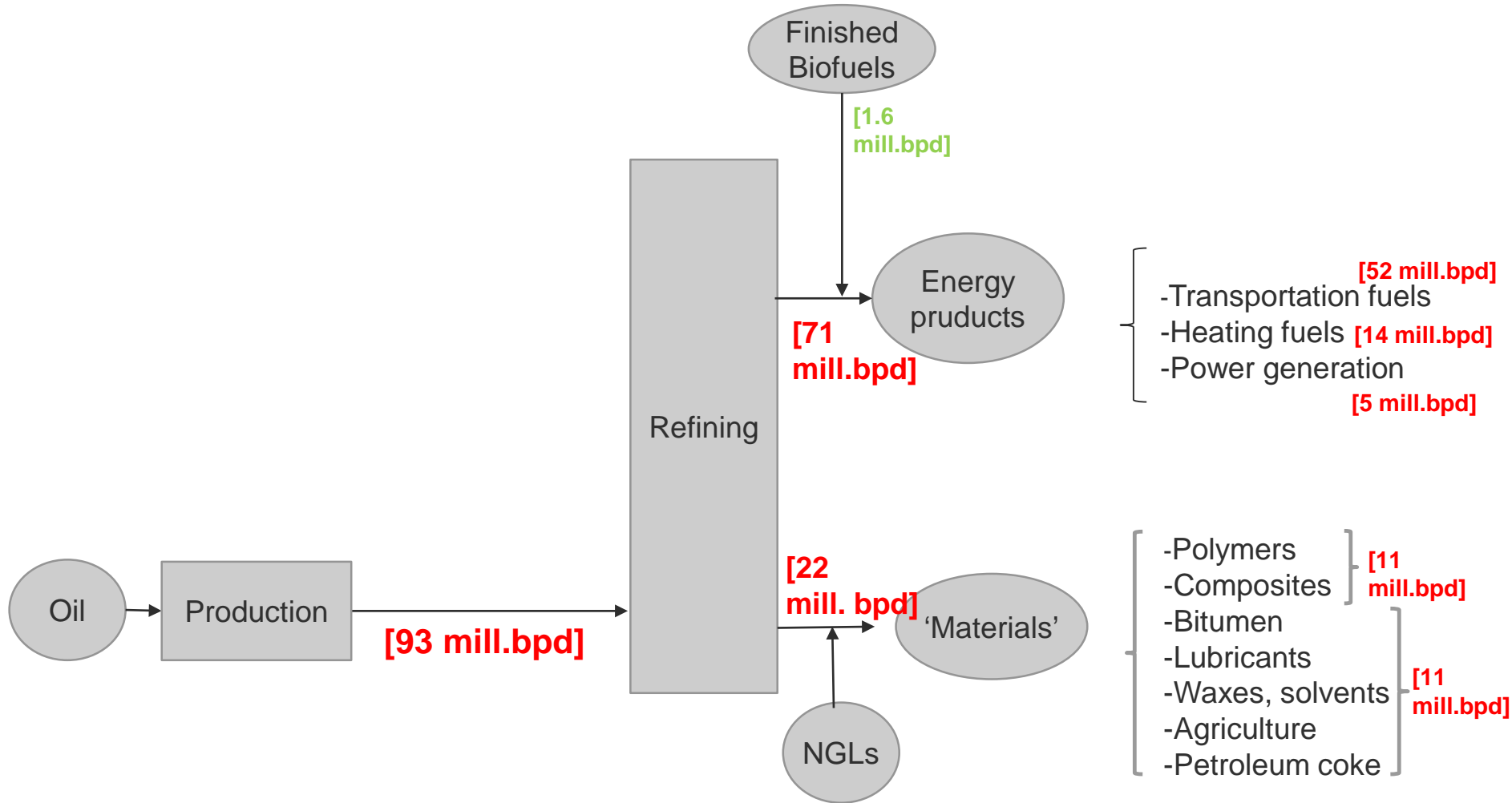


Latest: Transforming Tesla to Hydrogen - claims it will give 1000 km reach => HESLA...

Global Oil production and usage

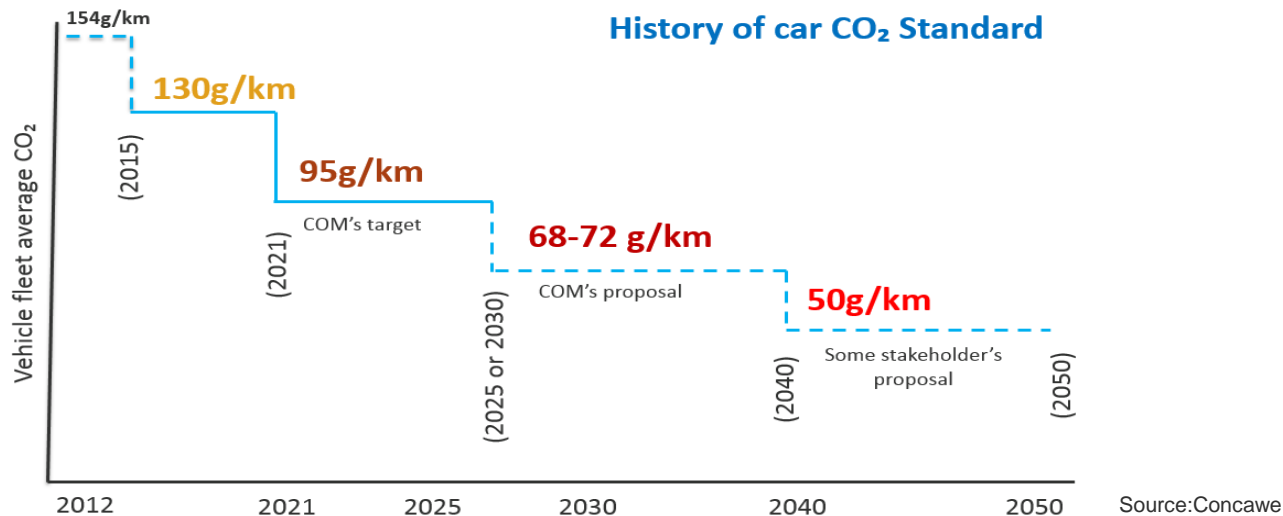
[IEA-WEO 2016 global numbers]

~56% of crude oil used as transportation fuels



Decarbonisation of road transport (LDV)

EU legislation and challenges to the industry

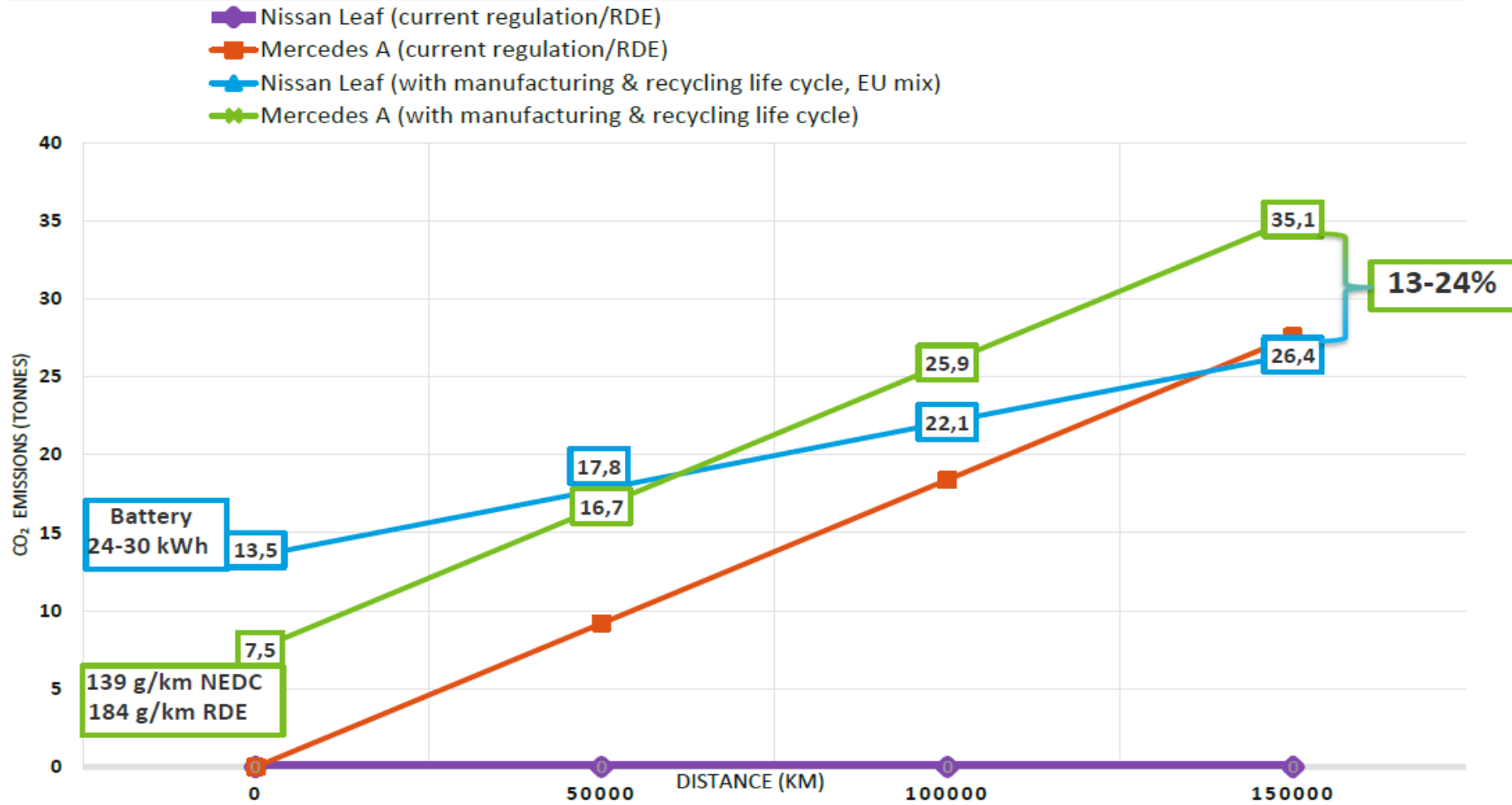


➔ *Current EU legislation drives vehicle manufacturers towards electric/hydrogen fuel cell vehicles*
-what could the oil&gas industry do to be part of the solution?

Possible actions:

- Explore the potential of improving engine *and* fuels technologies, including the driveline concept (hybridization) and the carbon intensity of oil/gas-based fuels
- Challenge the TtW perspective of the current Vehicle performance standard (above), and demonstrate cost efficient solutions with respect to WtW/LCA CO₂ reduction

Life cycle GHG Impact: Nissan Leaf vs Mercedes A class



Source: University of Trondheim, 2012/2013/2016; Nissan

LDV System definition: Engine, fuel and driveline options

1. Engine technology

- Improvement of SI and CI engines
- HCCI and GCI engines
- Opposed piston/linear piston engines
- Rotary engines
- Turbine engines

2. Fuel technology (liquid fuels)

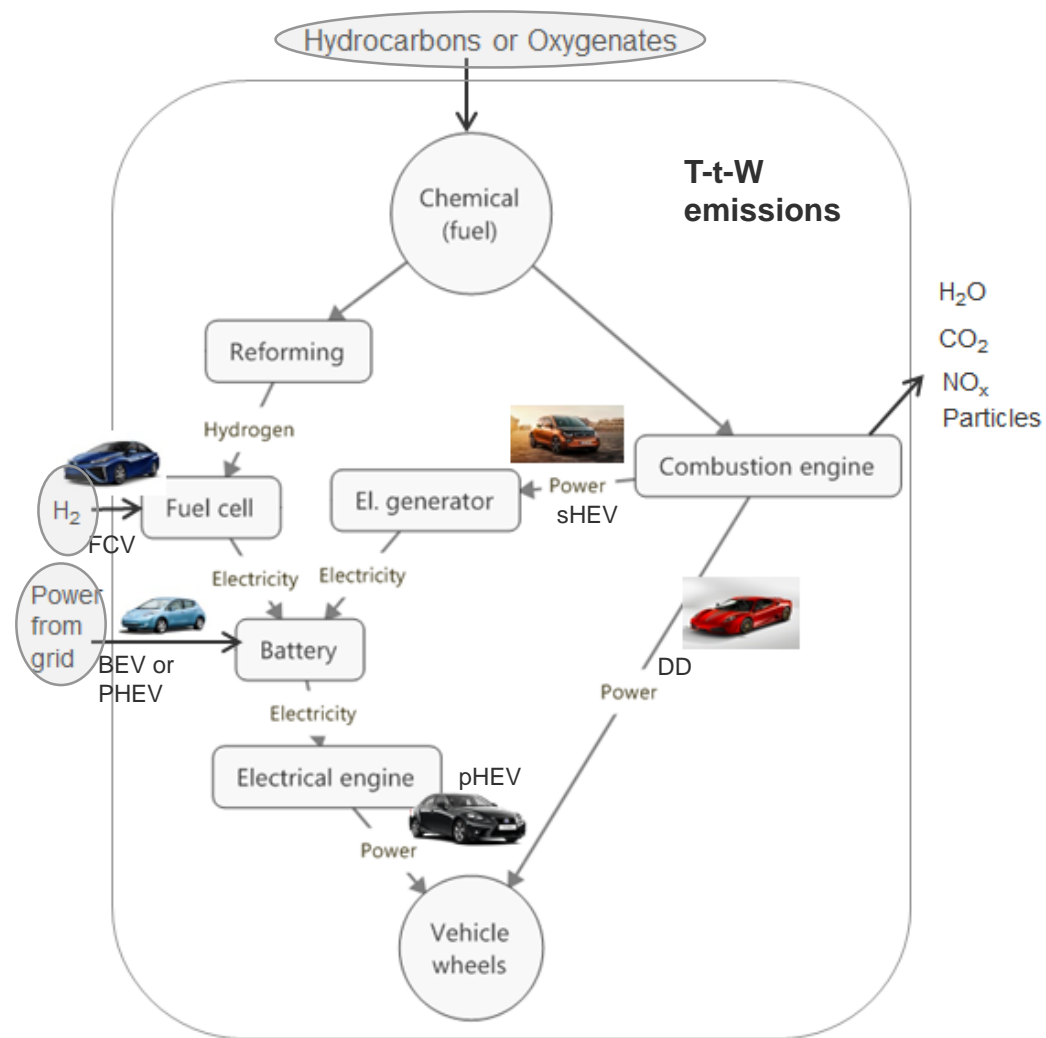
- Hydrogen-rich gasoline, kero or diesel
- High octane gasoline
- Straight-run (light) naphtha
- Biofuels

3. Driveline technology

- Direct drive by ICE (DD)
- Battery Electric (BEV)
- Parallel hybrid (pHEV)
- Serial hybrid (sHEV)
- Plug-in hybrids (PHEV)

Criteria for system screening

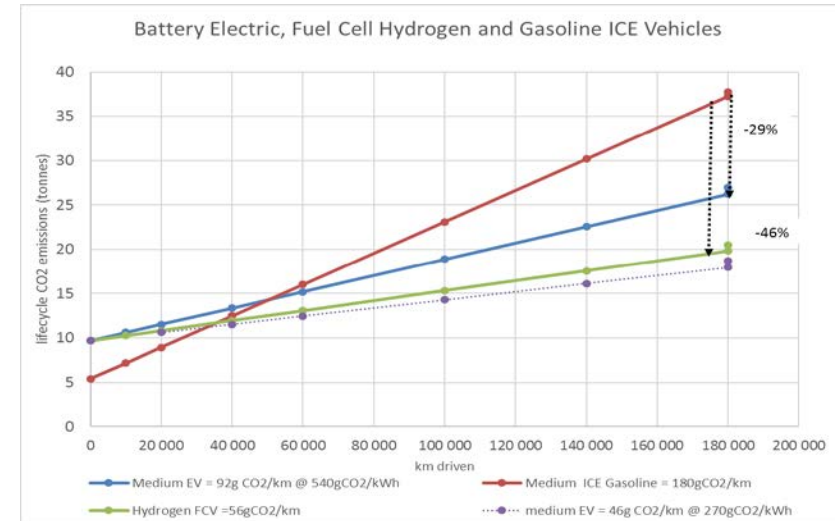
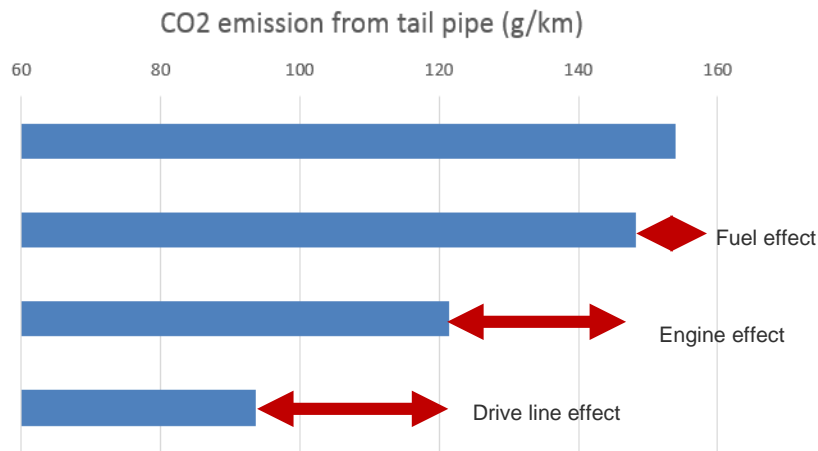
- CO₂-intensity (TtW, WtW or LCA)
- Local air quality
- Technical maturity
- Implementation



BEVs and Hydrogen fuel cell vehicles as benchmark

Summary (LDV)

The current total life cycle (LCA) CO₂ footprint of fossil and electrical cars in the EU (i.e. today's EU el-mix) differs less than 30%



Combinations of new engine/driveline and oil-derived fuel technology have been identified with a substantial potential for reduction in the W-t-W CO₂ emissions

- There is a range of combinations of new engine and fuel technology with similar, improved CO₂ intensity but varying technical maturity and implementation challenges
- Fuel: Paraffinic fuels generally have lower CO₂ intensity (g CO₂/MJ) than aromatic fuels
- Driveline: Series hybrid vehicles represents a good LDV GHG solution
- CO₂ intensity for various systems should be based on a WtW (LCA) perspective



OGCI's mission is to use our collective resources to accelerate actions that mitigate the greenhouse gas emissions from the oil and gas industry's operations and the use of its products, while still meeting the world's energy needs. <http://www.oilandgasclimateinitiative.com/about.html>

OGCI Climate Invest

-Transport Work Group

Our focus is on working closely with manufacturers in all modes of transportation, with the aim of developing more efficient engines and advanced fuel-engine combinations that minimize the sector's greenhouse gas impact.

We are on the look-out for potentially game-changing technologies that could have a long-term impact on greenhouse gas reduction.

<http://www.oilandgasclimateinitiative.com/climateInvestments.html>



Low Carbon Transportation Fuels 2050?

For discussion.....

	LDV	HDV	Trains	Maritime	Aviation
Electricity	x		x	(x)	
Low emission ICE	x	x	(x)	(x)	
H ₂		(x)	x	x	
Biofuels					x

How to reduce emissions from vehicles

