

## Fuel and technology alternatives for commercial vehicles

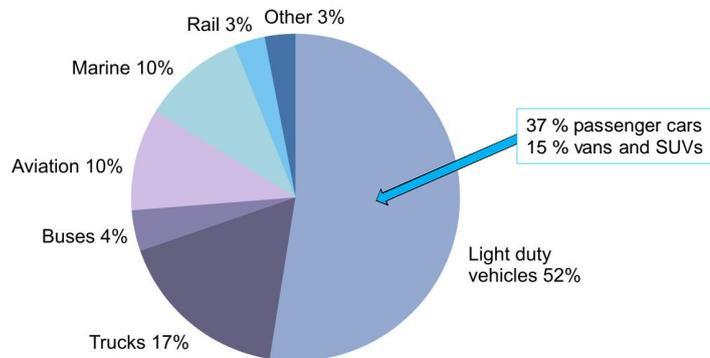
European Biofuels Technology Platform  
6th Stakeholder Plenary Meeting  
Dr. Nils-Olof Nylund  
VTT Technical Research Centre of Finland



### Outline

- Energy use in transport
- Vehicle categories
- Current state of the art (heavy-duty diesel)
- Evaluation of alternatives
- Finland goes drop-in!
- Alternative technology vehicles
- Summary

## Transport energy



- Transport is some 25 % of total final energy consumption
- Road is some 75 % of total transport
- Trucks and buses are some 30 % within road transport

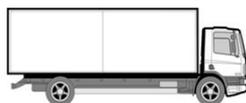
Source: WEF Repowering Transport 2011

## Commercial vehicle categories

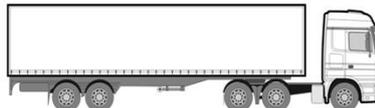
- Light commercial vehicles (vans)
- Heavy-duty vehicles



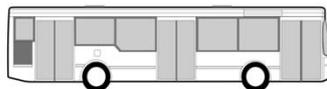
SINGLE-UNIT TRUCK



SEMI-TRAILER TRUCK



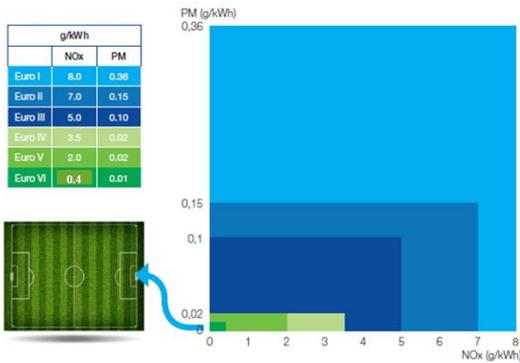
CITY BUS



COACH



## New HD vehicles (Euro VI) are extremely clean

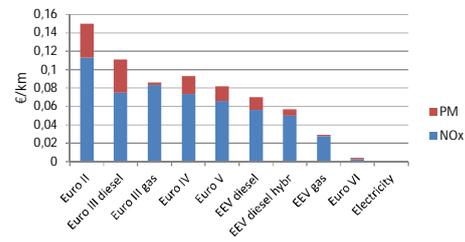


The argument that one fuel is cleaner (for regulated emissions) than another is fading away.

Ultimately the solution providing lowest CO<sub>2</sub> emissions will win!

Low emissions require high-quality fuels (zero sulphur, zero contaminants...!)

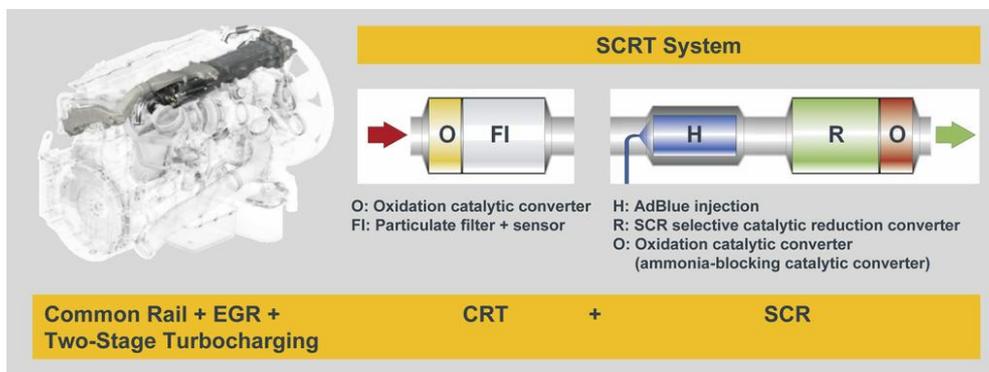
External costs for NO<sub>x</sub> and PM



07/10/2014

5

## Euro VI technology (example from MAN)



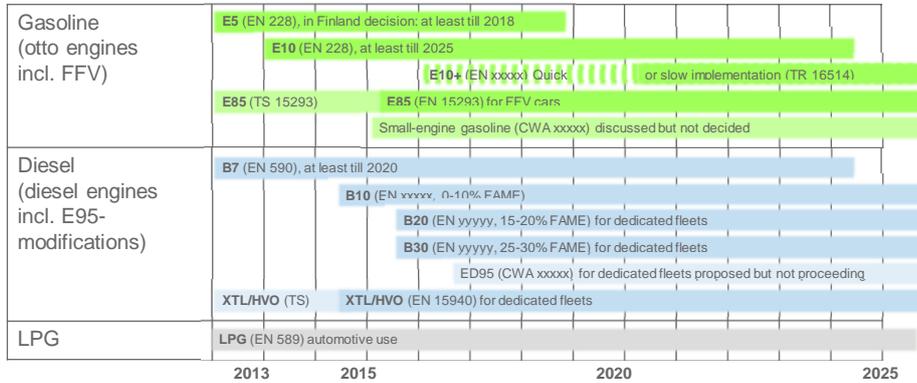
A lot of sensors missing in the picture!

07/10/2014

6

# Estimated schedules for standardisation in Europe

Note! Schedules based on estimations or planned CEN schedules and FQD review



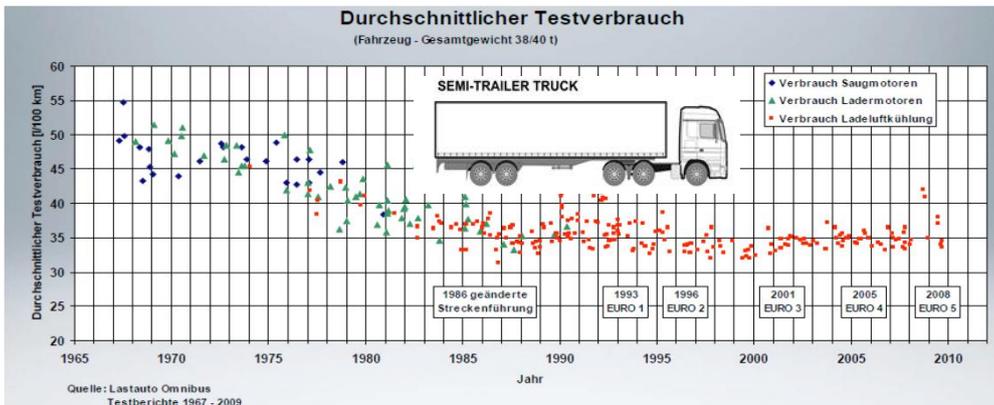
CEN = European Committee for Standardization, CWA = CEN Workshop Agreement, E10+ = 20-25% ethanol or corresponding biocontent, EN = European Standard, LPG = Liquefied Petroleum Gas, TS = Technical Specification, TR = Technical Report, XTL/HVO = paraffinic diesel

**NESTE OIL**

Source: Seppo Mikkonen /Neste Oil 2014



## Reducing CO<sub>2</sub> remains a challenge

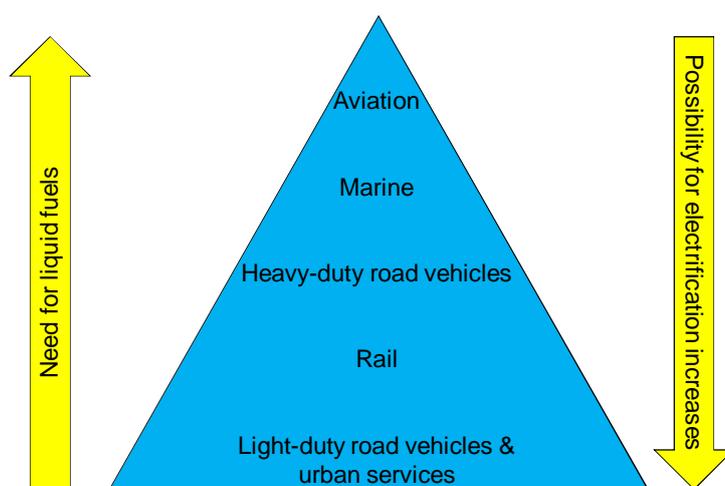


To reach the climate goals of 2050, the fuel consumption of a semi-trailer truck should be clearly less than 10 l/100 km, an annual improvement of some 3 %!

**As for technology options:  
Remember: In reality, one size doesn't fit all!**



### Hierarchy of fuels



## Electric timber truck



11

## Substitution of fossil diesel oil is crucial!

### Threats

- Already shortage of Diesel oil in Europe
- Higher share of diesel cars due to regulations of fuel consumption.
- Aviation fuels and diesel oil are competitors
- Environmental marine regulations will raise demand for diesel oil?

### Solutions

- Biofuels ought to be used in heavy vehicles
- Biomethane
- Synthetic diesel oil
- Dimethyleter (DME)
- Electrification of roads....

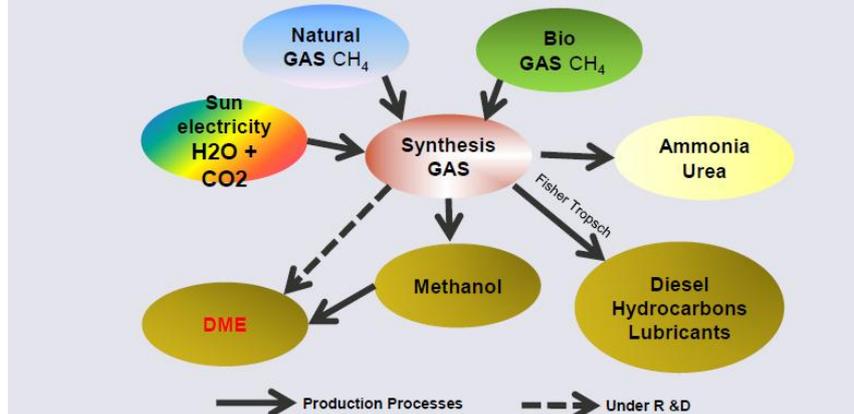
Source: Olof Hådeli 2012





## Sustainable energy carrier paths -

An energy carrier that can bring high Diesel IC energy efficiency:  
- independent of the fossil or renewable origin (sourcer to wheel)



Source: Staffan Lundgren/Volvo 2014



## Liquid hydrocarbons

- The superiority of liquid hydrocarbons is due to:

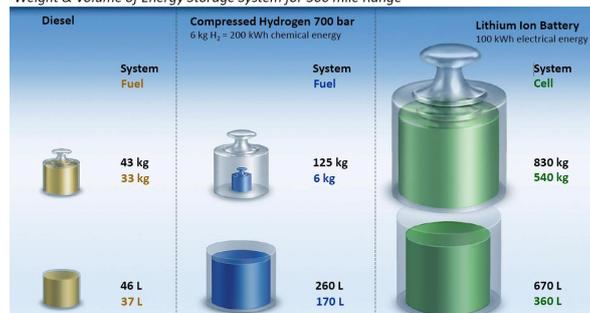
- excellent energy density
- easy handling
- easy production
- a 100 year plus tradition

- Comparison to electricity:

- diesel refuelling >10 MW
- superfast charging 300 kW
- slow charging 3,5 kW
- 10 kWh= 1 l of diesel fuel
  - cost of a 10 kWh battery 5000 – 10000 €
  - weight 100 kg

### Energy Carrier Properties: Onboard Storage Why is petroleum the dominant transportation fuel?

Weight & Volume of Energy Storage System for 300 mile Range



## Evaluation of alternative fuels/energies

- Costs
  - Cost of fuel
  - Cost of new vehicles
  - Cost of new infrastructure
  
- Vehicle performance
  - Range
  - Weight of energy storage
  - Volume of energy storage
  - Safety
  - Energy efficiency
  - (Exhaust emissions, must meet Euro VI= close to zero!)



07/10/2014

15

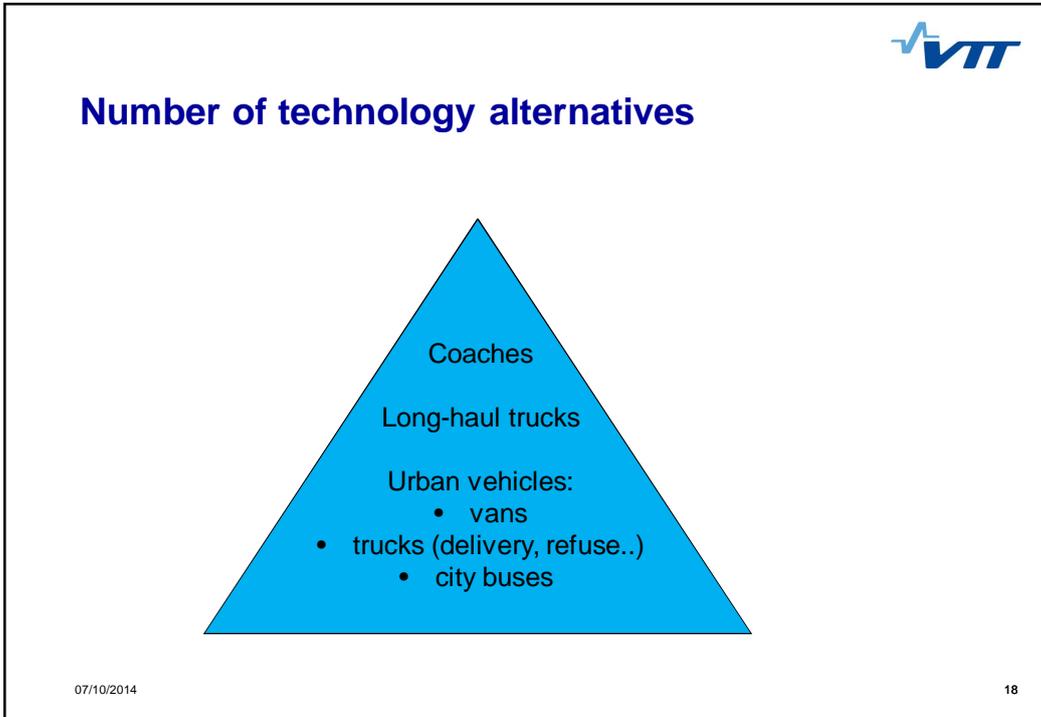
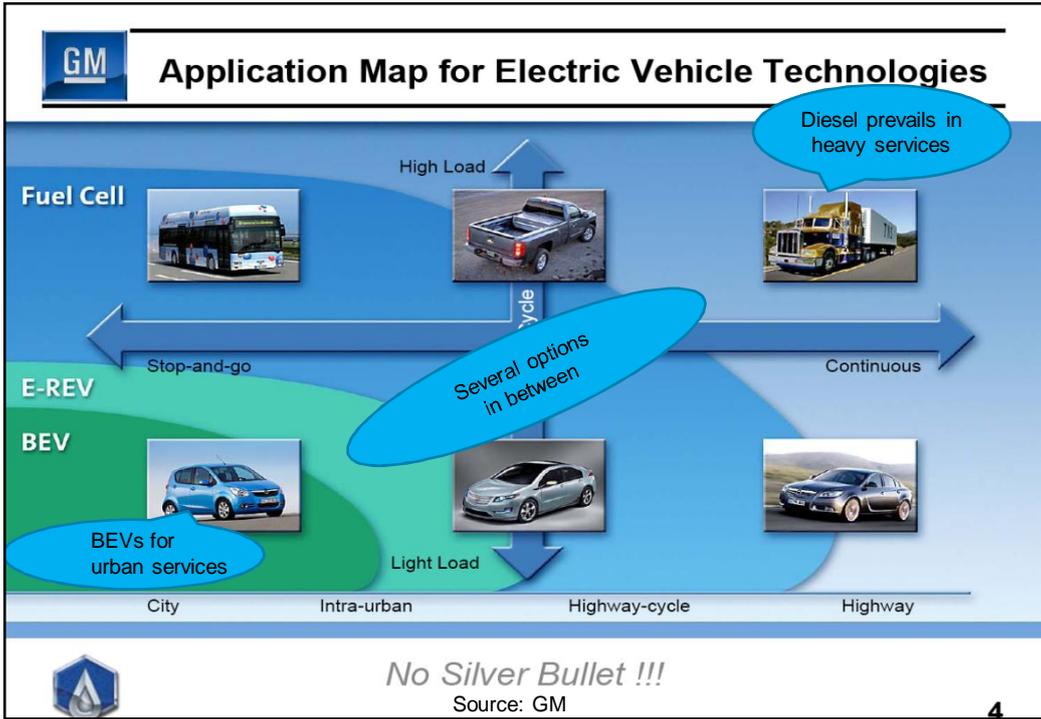
## Evaluation of alternative fuels/energies, cont.

- How is the vehicle operated?
  - Urban service
  - Long-haul
  - Scheduled operation
  - Random operation



07/10/2014

16



## No fuss alternative for diesel vehicles: Paraffinic diesel

- Many alternative feedstocks
- Alternative processing routes
- A true drop-in alternative, up to 100 %
- No modifications to infrastructure or vehicles
- No storage issues

*Automotive fuels — Paraffinic diesel fuel from synthesis or hydrotreatment — Requirements and test methods (CEN/TS 15940:2012)*



07/10/2014

19

VTT (VTT Technical Research Centre of Finland) is an internationally networked, multi-technological research centre that produces high-quality technological solutions and innovation services for its customers. VTT contributes to the international competitiveness of its customers, and thus promotes sustainable development, employment and well-being in society. Every third Finnish technology innovation includes VTT know-how. There are 2,900 experts from various fields working at VTT. VTT's annual turnover is EUR 320 million. VTT's main offices are located in Espoo, Tampere, Oulu and Jyväskylä.

PRESS RELEASE  
Free for publication on 16 June 2014 at 1 p.m.

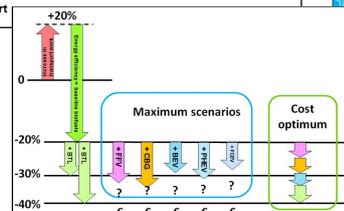
### Increase in the Use of Biofuels the Most Cost-Effective Way for Finland to Achieve the Goals of the EU's 2030 Climate and Energy Package

VTT and the Government Institute for Economic Research (VATT) have completed a study commissioned by the Ministry of Employment and the Economy and the Ministry of the Environment, assessing the impact of the EU's 2030 Climate and Energy Framework on Finland's energy system and national economy. The increased use of second-generation biofuels in road transport would provide Finland with the most cost-effective way of achieving the greenhouse gas emissions goals presented in the policy framework for the sector outside of the emissions trading system. The impact on the national economy caused by the policy framework is estimated to remain moderate, although there are still uncertainties in the estimates.

In January 2014, the European Commission published a policy framework concerning the 2030 climate and energy policy goals, where a 40% reduction in greenhouse gas emissions is proposed for 2030 compared to the emissions in 1990. With regard to the EU's emissions trading sector (EU ETS) the reduction goal is 43%, and for sectors outside the emissions trading sectors it is 30% from the 2005 level.

In the project implemented by VTT and VATT, the impact of the emission goals on Finland's energy system and the national economy was assessed. In the project, calculations were made using three different scenarios, where Finland's emission reduction goal was 32, 36 or 40 per cent in the sectors outside the EU ETS, which include transport, building heating, waste treatment, agriculture, and some industries. In the emissions trade sector, the price of an emission right was assumed to rise to the level of EUR 50/t CO<sub>2</sub> due to the proposed EU policy. VTT made the calculations using the TIMES-VTT energy system model, where the greenhouse gas reduction measures are presented by sector.

Biofuels comprise up to 40 per cent of transport



### EU:n 2030 -ilmasto- ja energiapaketin vaikutukset Suomen energialjärjestelmään ja kansantalouteen

Taustaraportti

Tina Koljonen | Esa Pursiarmo | Antti Lehtilä | Kai Sipilä | Nils-Clof Nylund | Tomi J. Lindroos | Juha Honkatukia



20

## Alternatives for light commercial vehicles



Nissan e-NV200



Mercedes Sprinter NGT (CNG)

07/10/2014

21

## Alternatives for single-unit trucks



07/10/2014

22

## Final report now available



**Fuel and Technology Alternatives for Buses**  
Overall Energy Efficiency and Emission Performance

Nils-Olof Nyund / Kati Koponen

TECHNOLOGY  
46

### Fuel and Technology Alternatives for Buses

In 2009-2011, a comprehensive project on urban buses was carried out in collaboration with ETC Engineering Agreement on Alternative Motor Fuels and Bioenergy, with input from additional EIA Implementing Agreements. The objective of the project was to generate unbiased and solid data for use by policy- and decision-makers responsible for public transport using buses. The project consisted of four major parts: (I) a well-to-tank (WTT) assessment of alternative fuel pathways; (II) an assessment of bus and use (range-to-wheel, TRW) performance; (III) combining WTT and TRW data into well-to-wheel (WTW) data and (IV) a cost assessment, including indirect as well as direct costs.

Experts at Argonne National Laboratory, Natural Resources Canada and VTT worked on the WTT part. The WTT emissions of various fossil fuels and biofuels were assessed by using GREET model from the United States, G4 ethanol model from Canada and RECI methodology of the European Union. All these models follow the framework of life cycle assessment.

ISBN 978-92-9168-046-4 (print)  
ISBN 978-92-9168-047-1 (pdf)  
ISBN 978-92-9168-048-8 (ePub)  
ISBN 978-92-9168-049-5 (ePub)



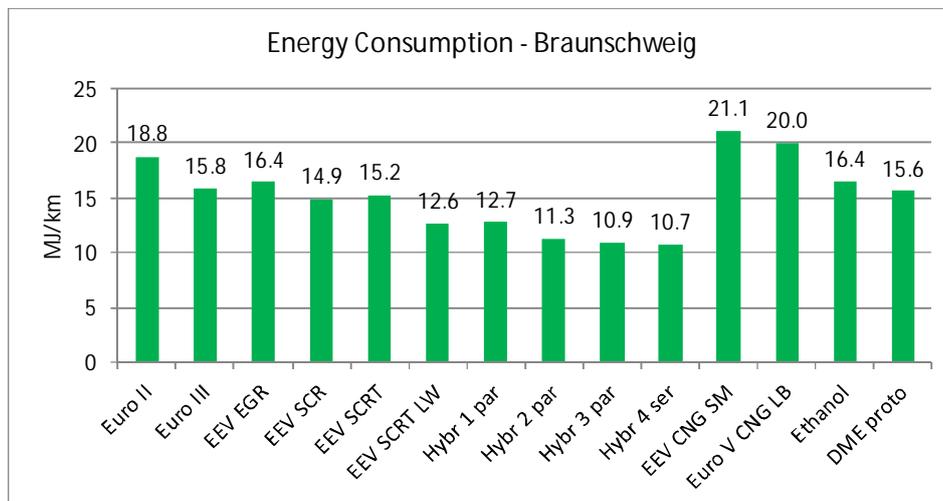
Some 400 pages including a 20-page Executive Summary

- 21 buses
- Combinations of vehicle, fuel & driving cycle: 180!

<http://www.vtt.fi/inf/pdf/technology/2012/T46.pdf>

<http://www.iea-amf.vtt.fi/8annexreports.html>

## Energy consumption of European vehicles Braunschweig cycle



## Volvo flags for electrification of buses

### Volvo Buses A complete new range

	Diesel buses	Gas buses	Hybrid	Electric Hybrid	Electric
<b>City buses</b>	Volvo 7900  Volvo 7900 Articulated 	Volvo 7900 Gas  Volvo 7900 Gas Articulated 	Volvo 7900 Hybrid  Volvo 7900 Hybrid Articulated 	Volvo 7900 Plug-in  Volvo 7900 Plug-in Articulated 	Volvo 7900 EI  Volvo 7900 Plug-in Articulated 
<b>Regional buses</b>	Volvo 8900 Low entry 		Volvo 8900 Hybrid Low entry 		
<b>Line-haul routes</b>	Volvo 9700 			Volvo 9700 Plug-in 	

Volvo Buses 

07/10/2014

Source: Edward Jobson/Volvo 2014

25

## Alternatives for long-haul trucks



Dual-fuel LNG



Spark-ignited CNG/LNG



DME

26

## Alternative fuels infrastructure decided upon



EUROPEAN COMMISSION

PRESS RELEASE

Brussels, 29 September 2014

### Clean fuels for transport: Member States now obliged to ensure minimum coverage of refuelling points for EU-wide mobility

New EU rules have been adopted today to ensure the build-up of alternative refuelling points across Europe with common standards for their design and use, including a common plug for recharging electric vehicles. Member States must set and make public their targets and present their national policy frameworks by end-2016.

"Alternative fuels are key to improving the security of energy supply, reducing the impact of transport on the environment and boosting EU competitiveness", said Commission Vice-President Siim Kallas, commissioner for transport. "With these new rules, the EU provides long-awaited legal certainty for companies to start investing, and the possibility for economies of scale. EU Member States requested flexibility in deploying the infrastructure. It is now up to them to develop the right national policy frameworks."

Up to now, clean fuels have been held back by three main barriers: the high cost of vehicles, a low level of consumer acceptance, and the lack of recharging and refuelling stations. This is a vicious circle. With the new directive for the deployment of the alternative fuels infrastructure, Member States will have to provide a minimum infrastructure for alternative fuels, such as electricity, hydrogen and natural gas, as well as common EU-wide standards for equipment needed and user information. Access to liquefied natural gas (LNG) for inland barges and maritime ships will provide a realistic option to meet challenges on lower emissions, in particular stricter sulphur emission limits in sensitive areas.

27

## Summary



- The current HD diesel (Euro VI) is extremely clean for regulated emissions
- Reducing CO<sub>2</sub> remains a challenge
- One size doesn't fit all, meaning that one single alternative technology will not cater for the needs of all vehicle categories
- When calculating costs, take into account need for new infrastructure, new vehicles, fuel price and vehicle efficiency
- "Drop-in" type renewable diesel is really a good option
- Number of available options vary by vehicle category (long-haul highway vs. urban services)
- With the directive on infrastructure, the Commission has focused on electricity and natural gas, not really on biofuels!

07/10/2014

28

