EUROPEAN ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE AND FUEL QUALITY REQUIREMENTS

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2014-11-19

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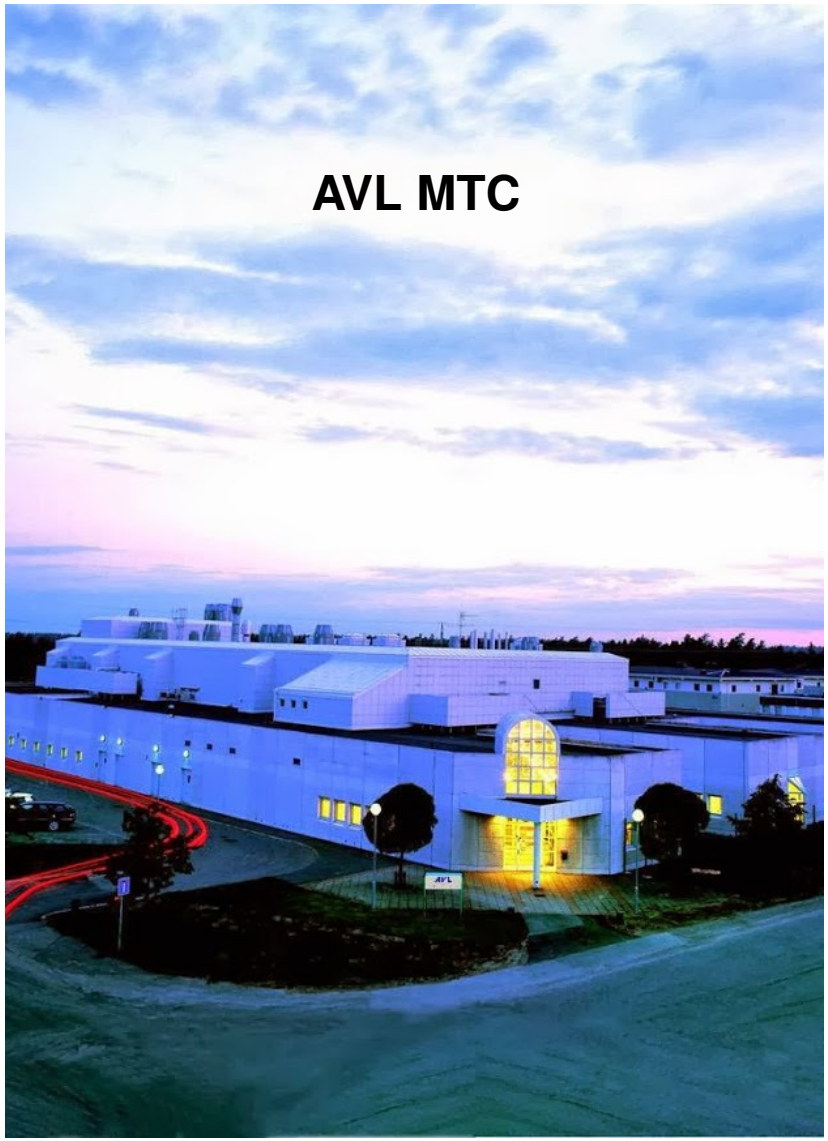

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  - Distribution system infrastructure
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  - How to assure adequate fuel quality?
  - Implications if fuel quality falls behind
- Conclusions

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE AND FUEL QUALITY REQUIREMENTS

INTRODUCTION

- How to predict the future?
- Known:
  - Europe want to get less dependent on crude oil derived energy
  - Europe want to get more energy independent
  - Europe want to reduce greenhouse gas emissions
- Will that affect us?
  - **YES!**
- We are one of the industries that will be most affected!
  - And we have quite a long lead time for development of new products
- What will change for our industry?
  - Fuel/Energy carrier?
  - Engines/Drivetrains?
  - Both?
- For an change to happen evolution needs to occur on:
  - Energy system – Fuel generation
  - Technologies on vehicle level
  - Availability of fuel – **Infrastructure**

CURRENT ALTERNATIVE FUELS SITUATION

FIVE MAIN ALTERNATIVE FUELS TODAY

- Sales volumes Europe 2012 – 2013
  - Conventional fuel - 338 738 200 ton
  - FAME - 11 409 473 Toe
  - LPG ~ 4 500 000 ton
  - Ethanol - 2 868 669 Toe
  - CNG - 2 480 000 Toe
  - HVO ~ 1 500 000 ton
- Infrastructure Europe (filling stations/ recharging points)
  - Conventional fuel ~ 131 000
  - FAME (B100) - no data
  - LPG ~ 28 000
  - Ethanol (E85) ~ 3 000
  - CNG ~ 3 000
  - HVO (100% HVO) - no data
  - Charging points ~ 21 000
  - Hydrogen ~ 50

CURRENT ALTERNATIVE FUELS SITUATION

FIVE MAIN ALTERNATIVE FUELS TODAY

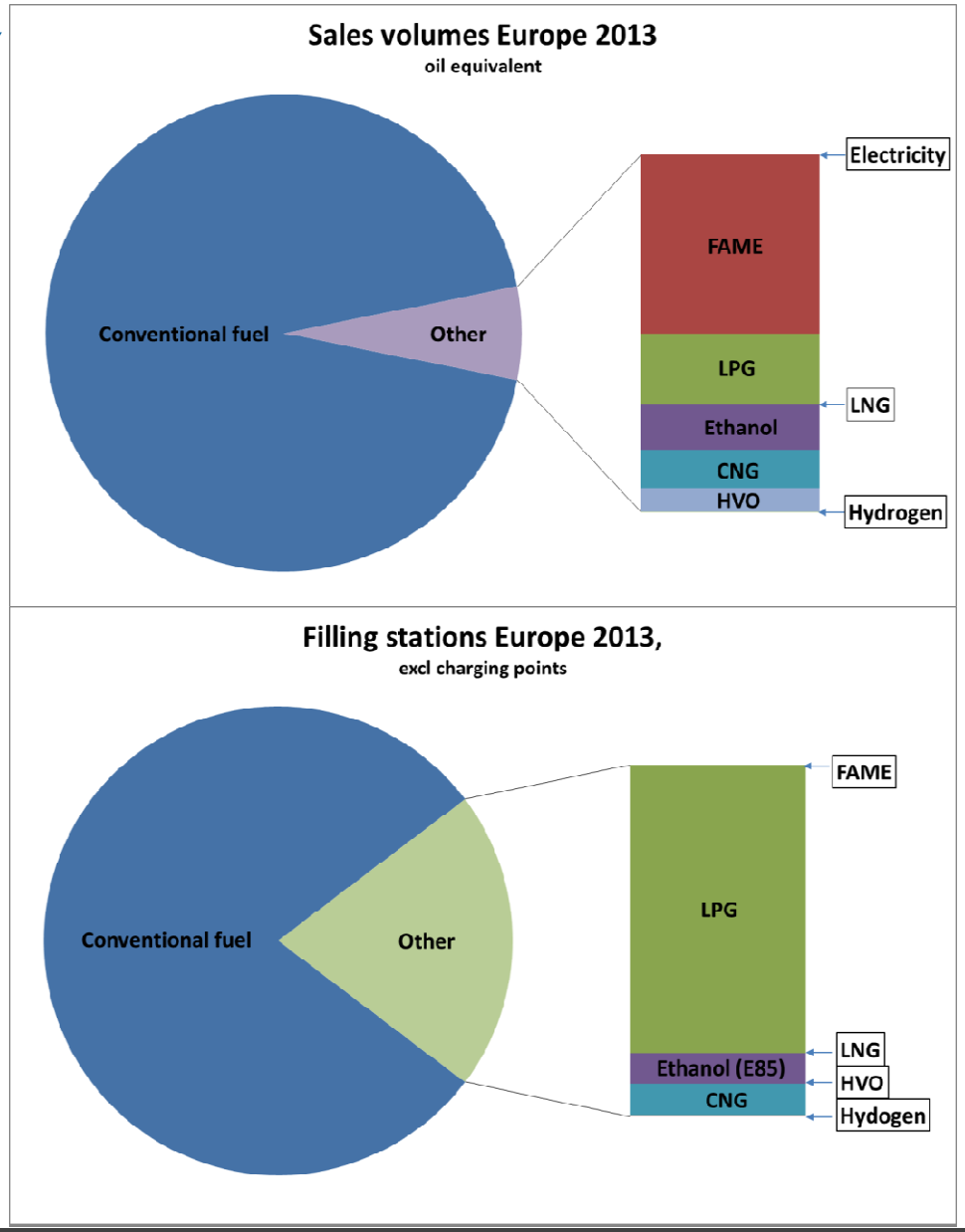
FAME
BioDiesel
B7, B100

LPG

Ethanol
E10, E85

CNG, LNG
CBG, LBG

HVO
Hydrotreated
Vegetable Oil



ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE

WHY A DIRECTIVE? – COMMISSION OPINION

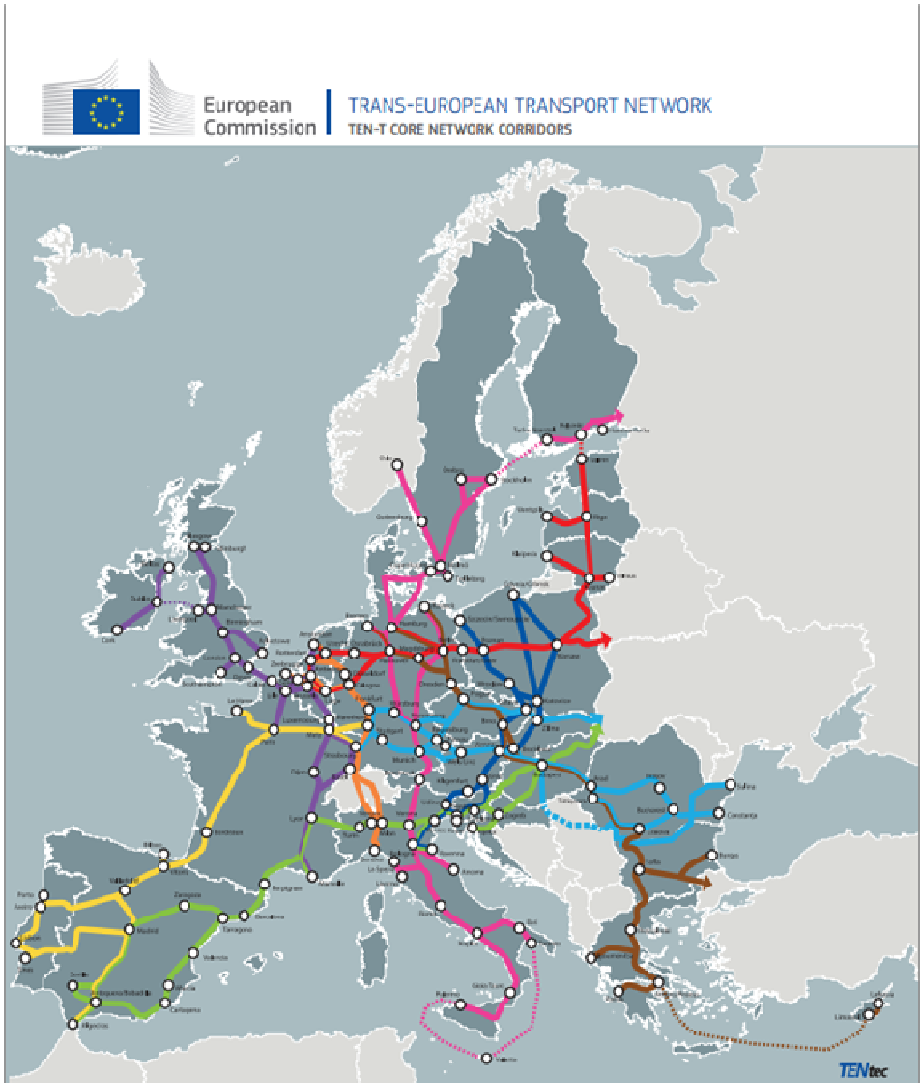
- Main barriers against increased usage of alternative fuels:
  - High cost of vehicles
  - Low level of consumer acceptance
  - Lack of recharging and refuelling stations
- The Directive wants to remove the infrastructure barriers for the use of alternative fuels
- A part of the directive also cover consumer information
  - Neutral price comparison with conventional fuels
  - Clear information about what fuels can be used by a vehicle
    - Standardised labelling in
      - Vehicle manuals
      - At dealerships
      - At recharging and refuelling points

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE

TIME FRAME FOR INTRODUCTION AND IMPLEMENTATION OF THE DIRECTIVE

- 29 September 2014 the Council adopted the directive
- Member States needs to set, and make public, their targets and national policy frameworks latest end 2016
- The Commission shall hand in an evaluation of the targets and frameworks latest end 2017
- Member States shall report their progress end 2019, 2022 and 2025
- There are to be a summary of national legislation and supporting infrastructure for alternative fuels in each member states policy framework
- The framework should also give information on the yearly government funding for:
  - Vehicle charging points and alternative fuel filling stations
  - Production of alternative fuels
  - Research, development and demonstrations of alternative fuels

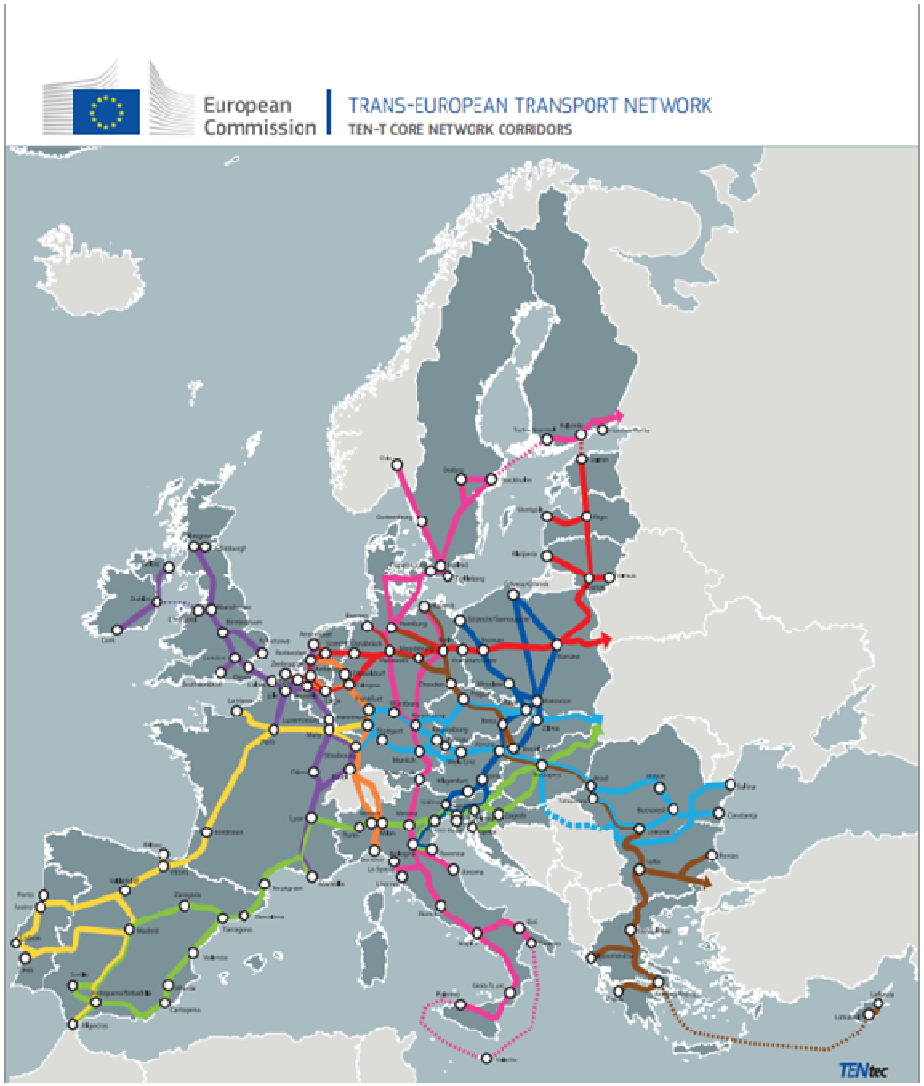
ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE



FUELS INCLUDED IN THE DIRECTIVE

- Biofuels
- Liquefied Petroleum Gas (LPG)
- Liquefied Natural Gas (LNG)
- Compressed Natural Gas (CNG)
- Hydrogen
- Electricity

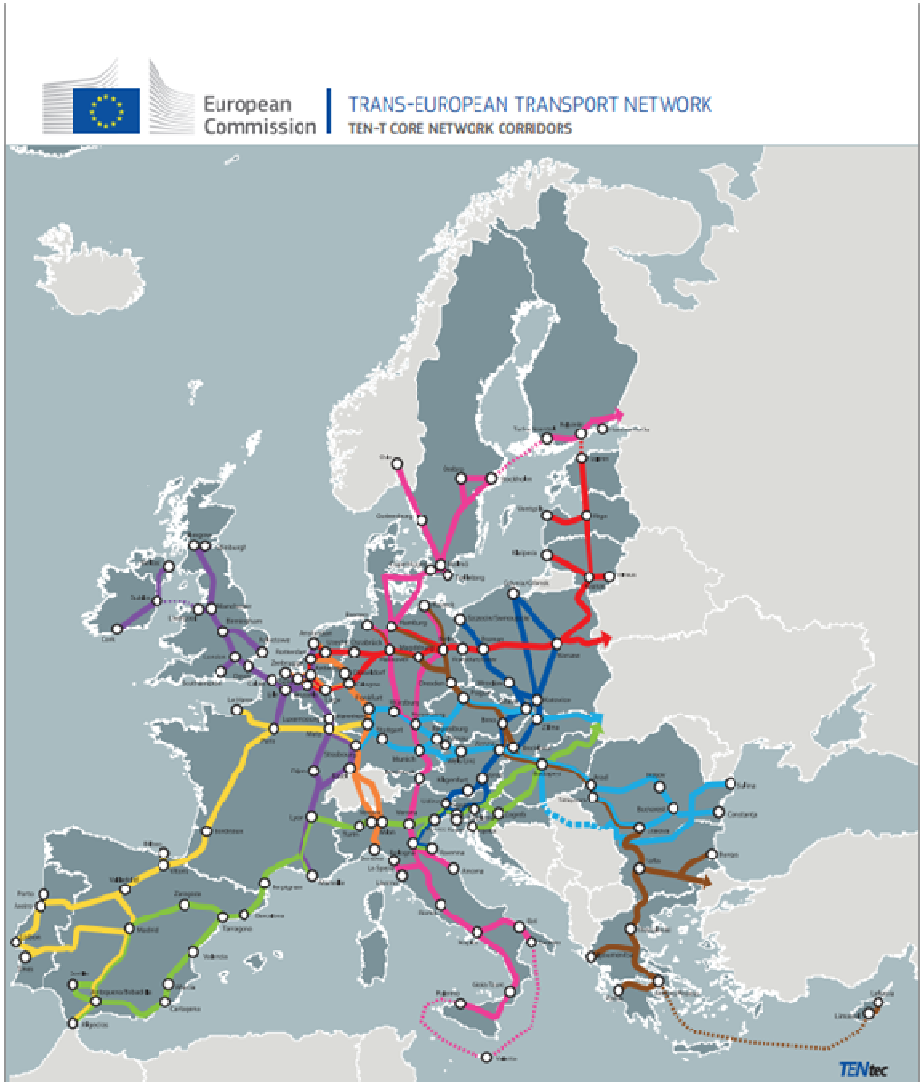
ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE



THOUGHTS IN THE DIRECTIVE - BIOFUELS

- Biofuels already have nearly 5% of the market.
- They work as blended fuels and do not require any specific infrastructure.
- A key challenge will be to ensure their sustainability.

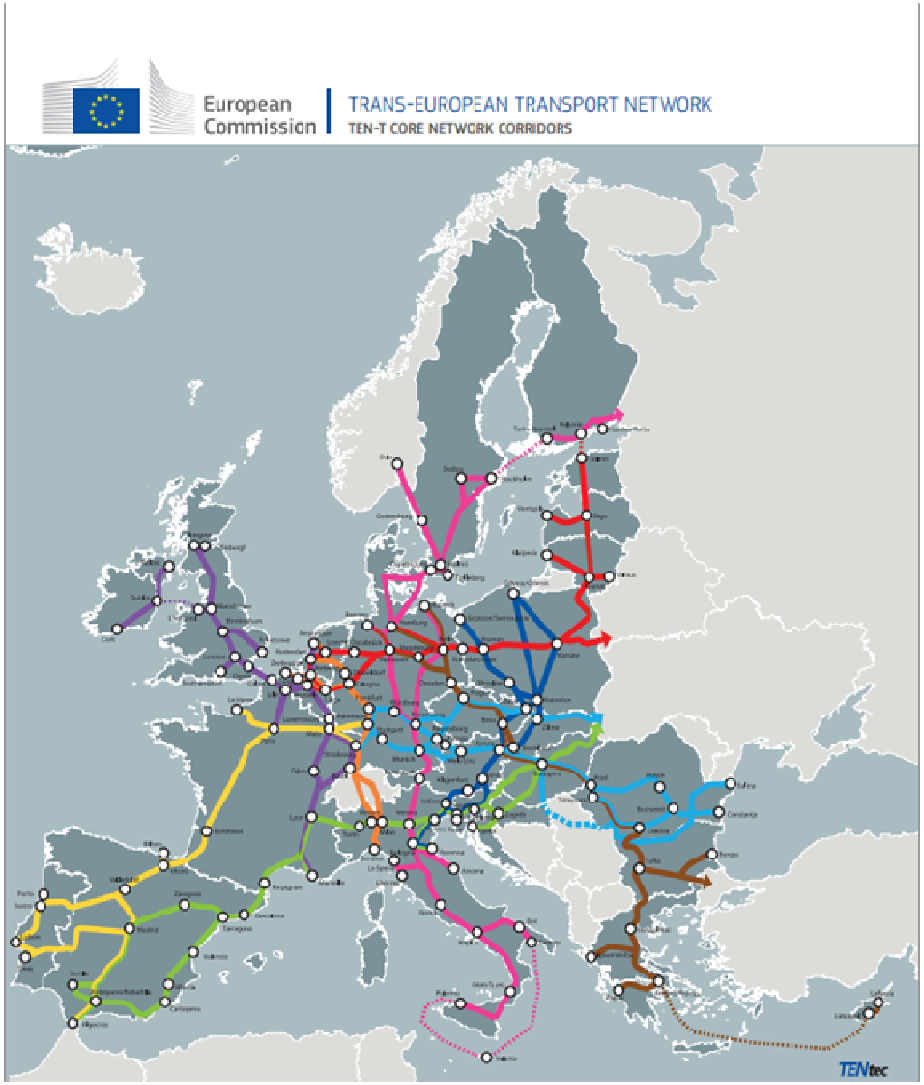
ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE



THOUGHTS IN THE DIRECTIVE - LIQUEFIED PETROLEUM GAS (LPG)

- No action is foreseen for LPG.
- The core infrastructure is already established.
  (today ~28 000 stations)

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE



THOUGHTS IN THE DIRECTIVE - NATURAL GAS (CNG & LNG)

- Common standards for CNG and LNG refuelling points by 2015
- 2020 target CNG:

  Adequate refuelling in urban and other densely populated areas.

- 2025 target CNG/LNG (road):

  Recommended max distance between filling stations
  (TEN-T core network)
  - 150 km for CNG
  - 400 km for LNG

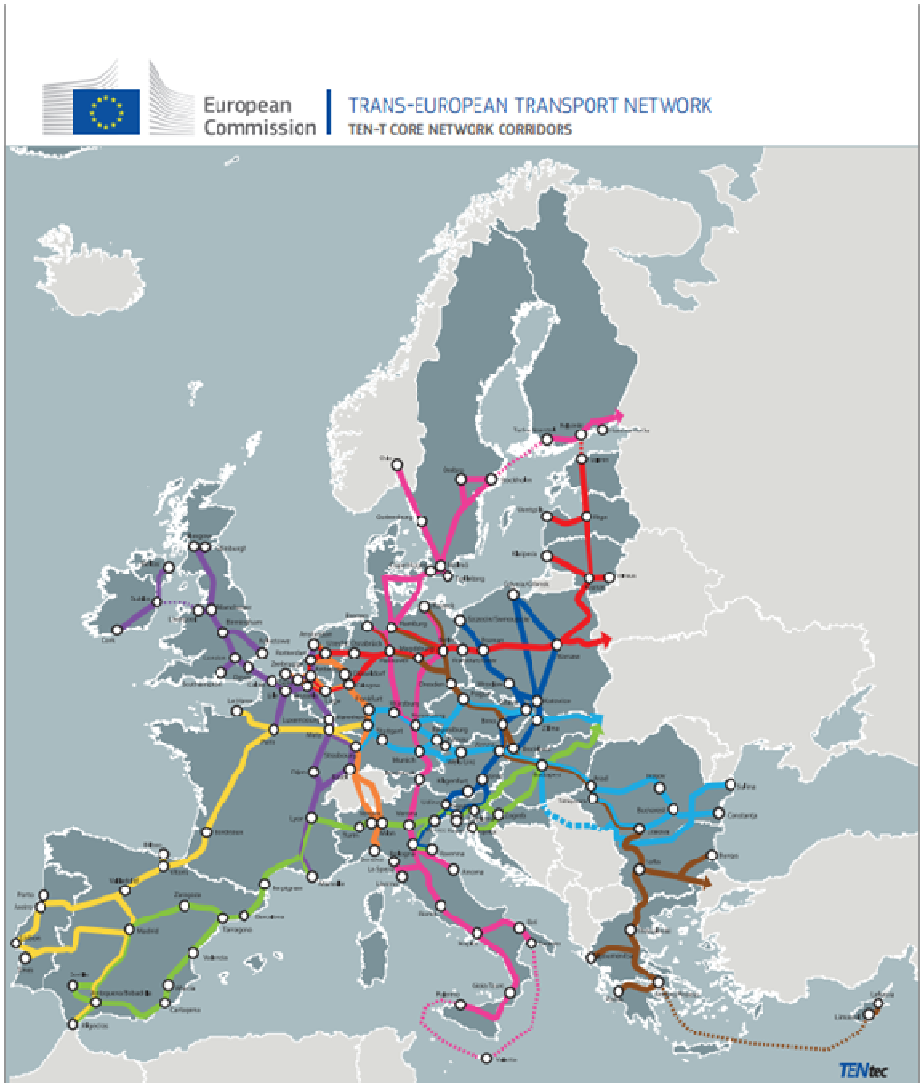
- 2025 target LNG (shipping):

  Refuelling in a sufficient number of TEN-T seaports

- 2030 target LNG (shipping):

  Refuelling in a sufficient number of TEN-T inland ports

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE

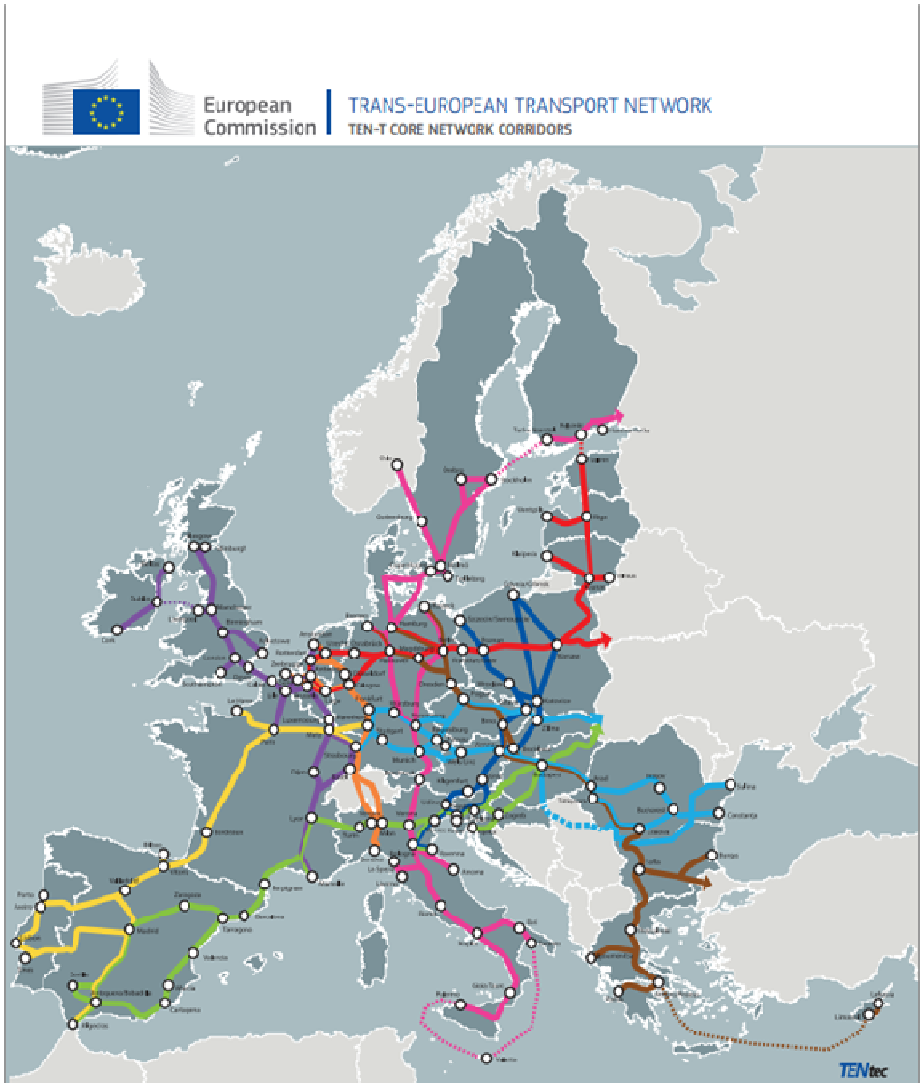


THOUGHTS IN THE DIRECTIVE - HYDROGEN

- The hydrogen infrastructure directive has changed
  - From a requirement to an option*
- A member state that choses to include Hydrogen needs to:
  - Create an infrastructure that ensure the circulation of hydrogen vehicles within the national network
  - Including cross-border links where appropriate
  - Implemented by 31 December 2025

*)the member states can chose to include hydrogen in there alternative fuels national policy frameworks or not

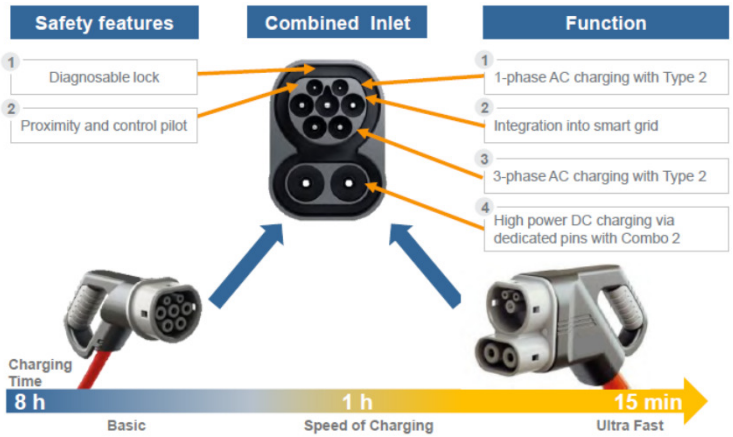
ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE



THOUGHTS IN THE DIRECTIVE - ELECTRICITY

- By 31 December 2020:
  Adequate charging points in urban and other densely populated areas
  - Recommendation:
    A minimum of one recharging point per ten electric vehicles

- Common recharging connector (plug) for the whole of Europe
  ("Combo 2" type plug, EN 62196-3)



DIRECTIVE REQUIREMENTS ON FILLING STATION INFRASTRUCTURE

LNG FILLING STATIONS

- Currently ~77 filling stations in EU
- If meeting the recommended maximum of 400 km in between filling station in the Ten-T core network

  => ~150 filling stations by 2025
- In Sweden the required number of stations would be ~5 by 2025

CNG FILLING STATIONS

- Currently ~3 000 filling stations in EU
- If meeting the recommended maximum of 150 km in between filling station in the Ten-T core network

  => ~400 filling stations by 2025
- In Sweden the required number of stations would be ~10 by 2025

DIRECTIVE RECOMMENDATION ON FILLING STATION INFRASTRUCTURE

HYDROGEN FILLING STATIONS

- Currently ~50 filling stations in EU
- If meeting the earlier recommended maximum of 300 km in between filling station in the Ten-T core network

  => ~200 filling stations by 2025
- In Sweden the required number of stations would be ~6 by 2025

ELECTRIC CHARGING POINTS

- Currently ~21 000 charging stations in EU
- With 10 vehicles per charging point and target year 2020
  =>~1 500 000 electric vehicles on the road[2]
  =>~150 000 recharging point!
- Roughly the same number of recharging points as conventional filling stations[1]

Estimated growth of sales/year[2]:

- 2013 – 50 000
- 2015 – 100 000
- 2021 – 500 000
- 2025 – 1 000 000

[1)]today ~ 260 000 000 conventional vehicles in Europe => <1/100 filling nozzzle / vehicle

[2)]analysis by the Transport and Environment (T&E) environmental think tank

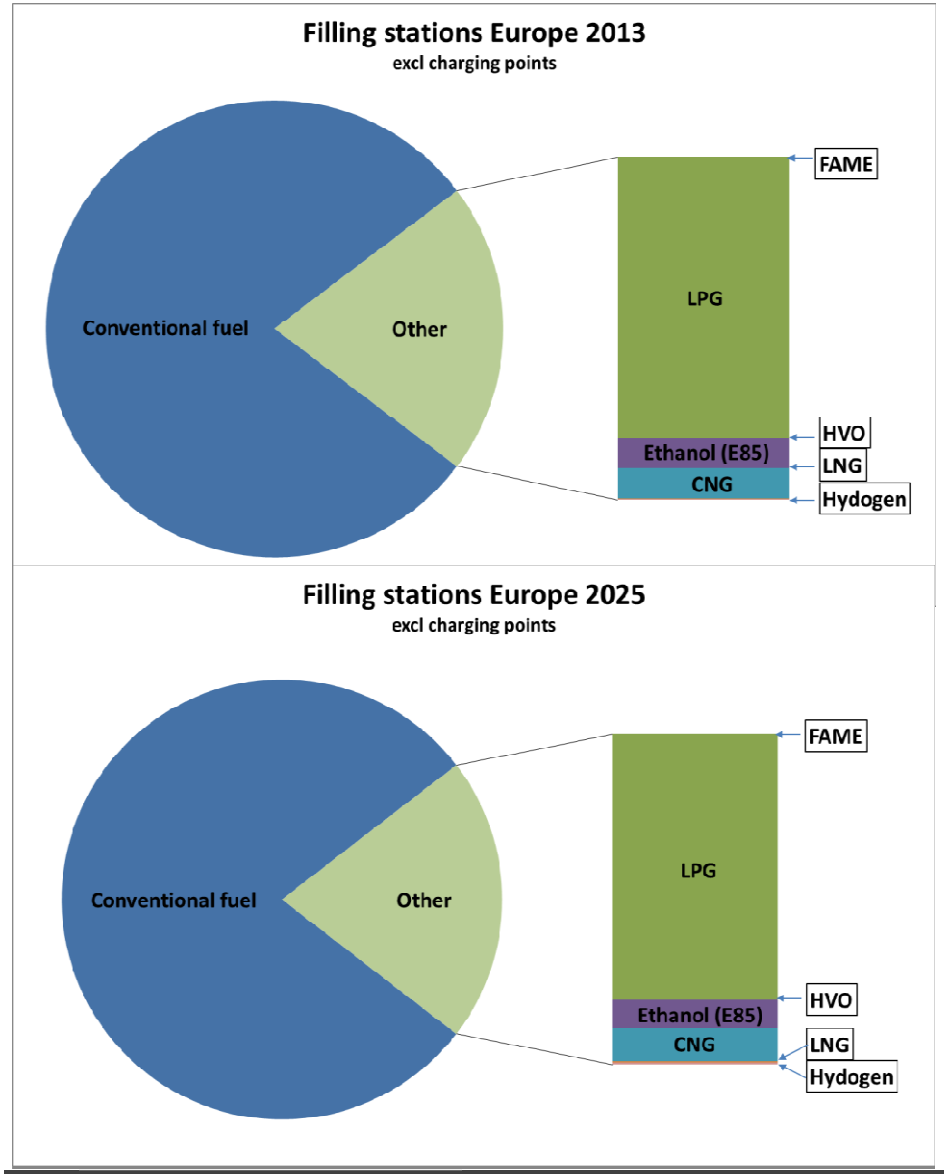
ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE

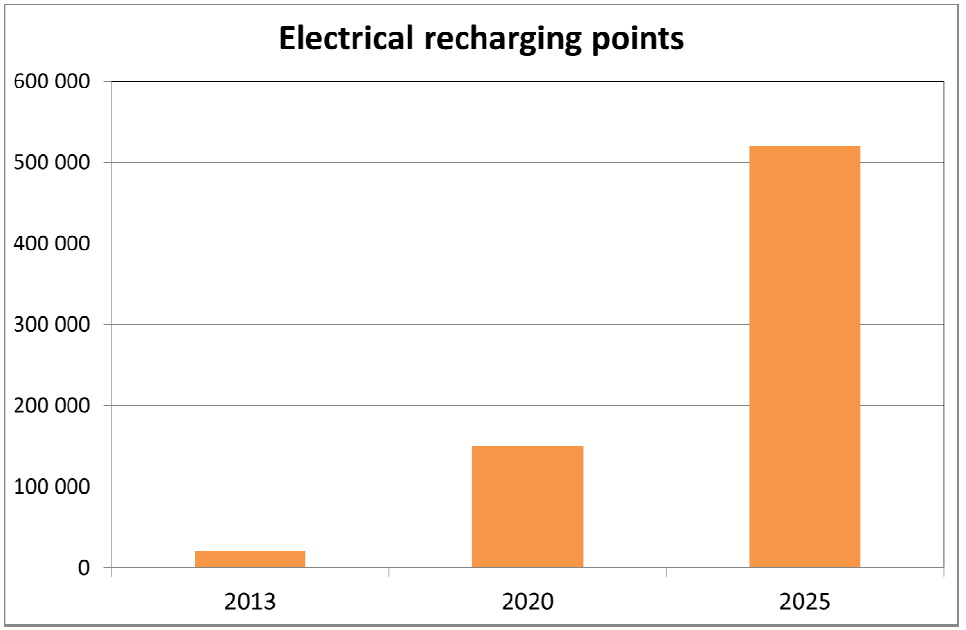
CONCLUSION OF THE INFRASTRUCTURE DIRECTIVE

- Member states must develop framework for alternative fuels infrastructure until end 2016
- The directive supports electricity, hydrogen and CNG/LNG
- For electricity the recommendation is one charging point per 10 electric vehicle by 2020
- Member states can chose to include hydrogen in the framework.
- For CNG and LNG the directive is strict
  - CNG vehicles should be able to commute freely in the entire EU by 2025.
  - LNG shall be available along the TEN-T core network by 2025
  - LNG should be available at major sea and inland ports

DIRECTIVES ALTERNATIVE FUELS INFRASTRUCTURE SITUATION 2025?

PROPOSED INFRASTRUCTURE TRANSITION 2013 - 2025





Assumptions recharging points:
Sales – analysis by the Transport and Environment (T&E) environmental think tank
Recharging points – 1 for every 10 vehicles

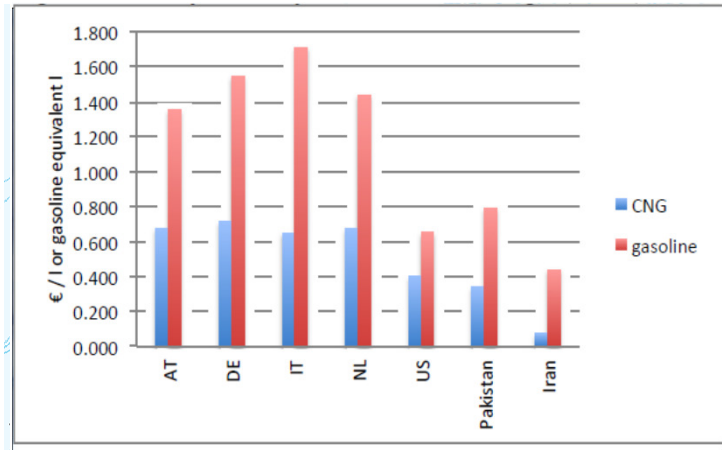
NATURAL GAS PREFERRED FUEL IN THE DIRECTIVE

WHY NATURAL GAS?

- Natural Gas is a preferred fuel in the Directive
- But the directive itself will not result in a massive infrastructure for Natural Gas as automotive fuel
- In large parts of Europe there is a mature infrastructure for using natural gas as energy carrier

  One of the main reasons why natural gas has become a preferred alternative

- Another reason is the prospect of "long term" availability within Europe
- The reduced carbon to hydrogen fraction of natural gas can help reduce CO_2 emissions
- And natural gas is price competitive on an energy basis compared to liquid hydrocarbons



sources: CNG Europe, US DoE, pakbiz.com, Zawya
note: AT - Austria, DE - Germany, IT - Italy, NL - Netherlands

NATURAL GAS PREFERRED FUEL IN THE DIRECTIVE

BUT IS IT POSSIBLE TO DEVELOP EURO VI ENGINES WITHOUT A STANDISED FUEL?

- Latest emission standards (Euro VI/Euro 6) have been reached thanks to:
  - Advanced engine and aftertreatment technology
  - Together with mature fuel qualities
- But, the European standard for automotive NG is not ready
  - And the proposal is heavily influenced by
    - "All" current NG sources "should" be approved
    - Automotive is still a small portion of the total NG usage in Europe
- Parameters that makes optimisation of NG engines difficult
  - Methane Number as low as 65
  - Siloxane levels 5 times higher than component supplier recommendation
  - Sulphur level 30 mg/kg + odorisation (3 to 7 mg/kg extra)
  - Energy content can differ more than 15%
  - AFR can span from ~13,5 to ~17

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE AND FUEL QUALITY REQUIREMENTS

CONCLUSION

- EU has ambitious goals for 2030:
  - a binding EU target of at least 40% reduction of greenhouse gas emissions*
  - a binding target of at least 27% of renewable energy used at EU level
  - an energy efficiency increase of at least 27%, to be reviewed by 2020 having in mind an EU level of 30% for 2030
- The transport sector needs to contribute to reach those goals
  - By 2020 at least a 10% renewable share in the transport sector

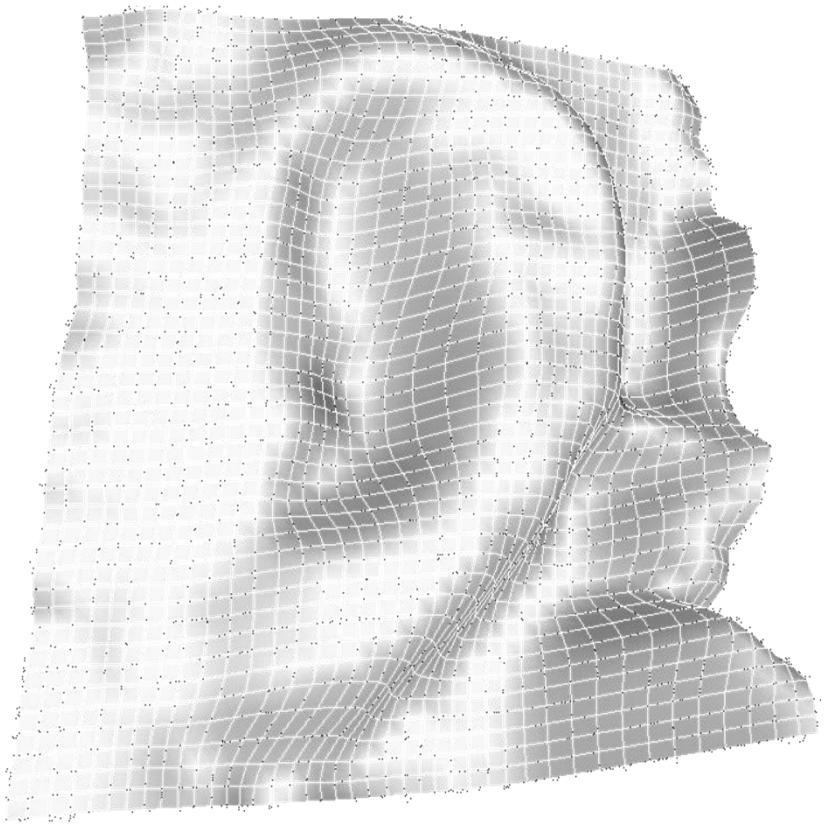
*)Compared to 1990 emission

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE AND FUEL QUALITY REQUIREMENTS

CONCLUSION

- In the Alternative Fuels Infrastructure Directive the "winners" are natural gas and electricity
  - How are we to obtain the natural gas?
    - Increased import from Russia?
    - Fracking?
  - How are we to promote renewable fuel for the transportation sector?
    - Will all resources be tied up to build up NG infrastructure?
  - And how are we to develop low emission gas engines without a fuel standard?

QUESTIONS ?



Don’t hesitate to ask…

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INFRASTRUCTURE - TEN-T - NETWORK

ROADS, RAILWAY LINES, INLAND WATERWAYS, INLAND AND MARITIME PORTS, AIRPORTS AND RAIL-ROAD TERMINALS THROUGHOUT THE 28 MEMBER STATES.

- The TEN-T consists of two planning layers:
  - 1. The "comprehensive network": a multi-modal network of relatively high density which provides all European regions. The total length of the comprehensive network amounts to:
    - - 138 072 km of railway lines
    - - 136 706 km of roads
    - - 23 506 km of inland waterways
  - 2. The "core network": a part of the comprehensive network, distinguished by its strategic importance for major European and global transport flows. The total length of the core network amounts to:
    - - 68 915 km of railway lines
    - - 59 630 km of roads
    - - 23 506 km of inland waterways

THE RENEWABLE ENERGY DIRECTIVE

THE RED IMPOSES TWO KEY REQUIREMENTS FOR THE UPTAKE OF RENEWABLE ENERGY AND – MORE SPECIFICALLY – BIOFUELS IN THE TRANSPORT SECTOR.

- EU Member States are required to meet a minimum binding target of 10% renewable energy share in the transport sector by 2020
  - All types of renewable energy used in all transport modes are included in the target setting.
  - Some renewable energy sources are counted differently. For example, the contribution of advanced biofuels towards achieving the 10% target is counted twice
  - Electricity from renewable energy sources for road transport is counted 2.5 times
  - Renewable Energy Calculations in the RED Biofuels must also meet minimum sustainability criteria as well as minimum GHG savings per unit of energy.
- Each Member State is requested to establish a National Renewable Energy Action Plan (NREAP), including information on targets for different transport and non-transport sectors
  - In addition, Member States are expected to implement measures to achieve these targets, assessing the contribution of both energy efficiency and energy saving measures.
  - The RED places the responsibility for fulfilling the RED targets on the Member States.

ALTERNATIVE FUELS INFRASTRUCTURE DIRECTIVE AND FUEL QUALITY REQUIREMENTS

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- Chairman - AVL Liquid Alternative Fuels Group
- Member of the Swedish Standardisation Committee
- Chairman – SMR's Fuels and Lubricants Committee
- Working with fuels and lubes since 1997
- At AVL since 2008
- Focus on alternative and conventional fuels

  Function – Availability - Production
- Focus on engine and transmission lubricants