13th UIC Sustainability Conference

VIENNA 2016

Can railway operators rely on legislation to improve air pollution from trains?

Comparison with the road sector

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12, 13, 14 October 2016

Railway and air pollution in the news

Transport

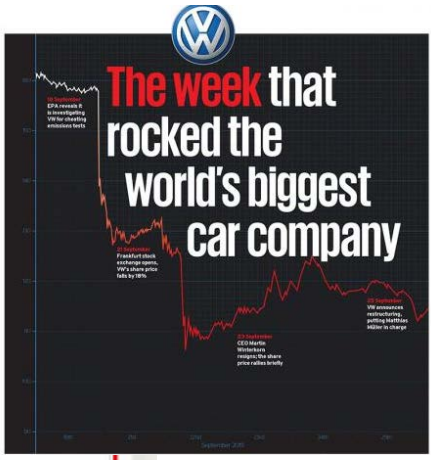
Paddington station 'more polluted than the Marylebone Road' thanks to diesel fumes from trains

RAMZY ALWAKEEL | Wednesday 9 September 2015 07:51 BST | 6 comments

Evening Standard

A few days later VW- Diesel- gate

- US EPA issue a notice of violation for about 500 000 diesel cars sold in the US
- VW recognized 11 million Euro 5 cars are fitted with the same device across the globe
- Many legal cases under way, to come



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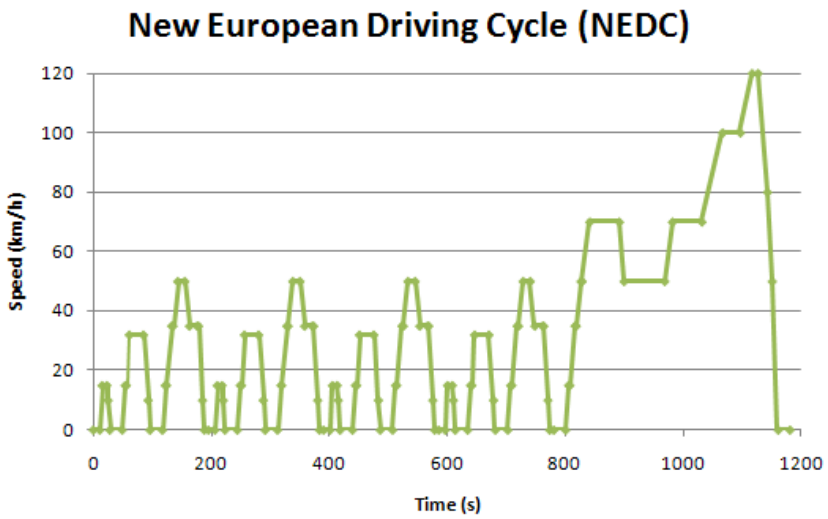
- What can operators do?

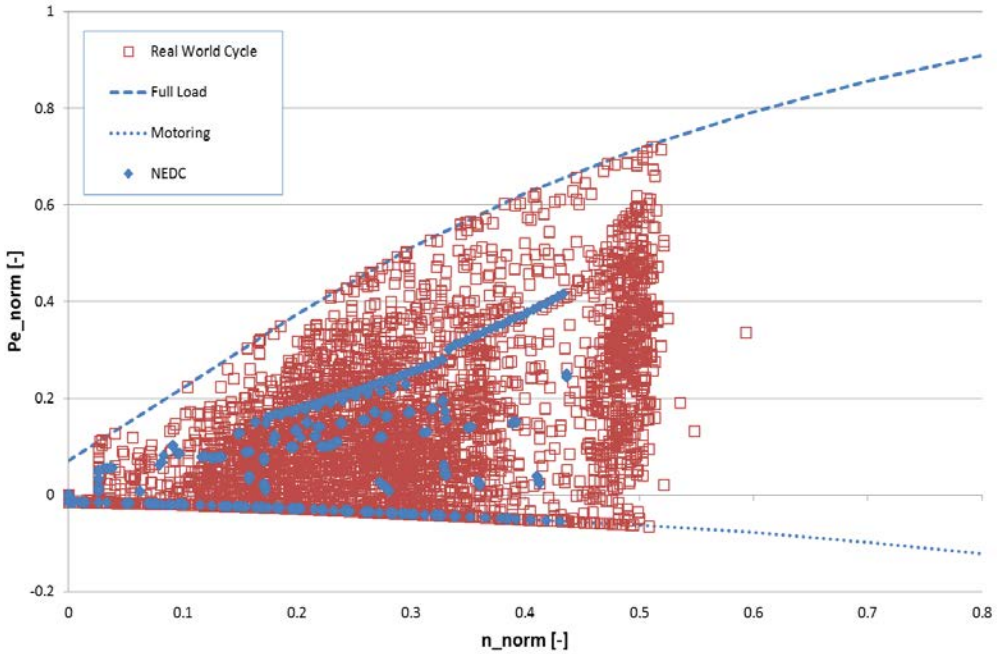
Air pollution a top priority

- Energy, CO2 and air pollution on top of the transport sector's agenda
- WHO model confirms that 92% of the world's population lives in places where air quality levels exceed WHO limits
- More than 300 000 premature deaths in the EU in 2020

Car emission measurement procedure until last year

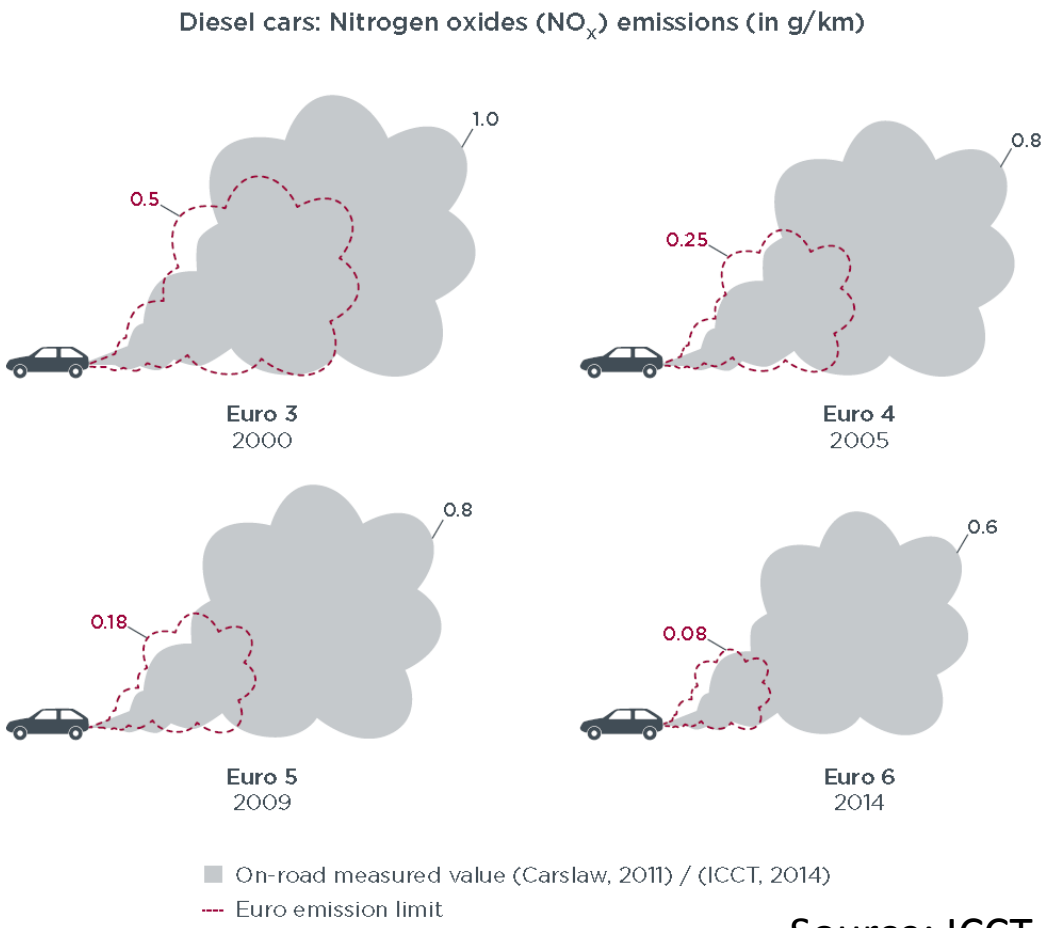
- Repeatable and reproducible test cycle
- Very narrow testing conditions
- Limited or no independent oversight





Consequences on emissions

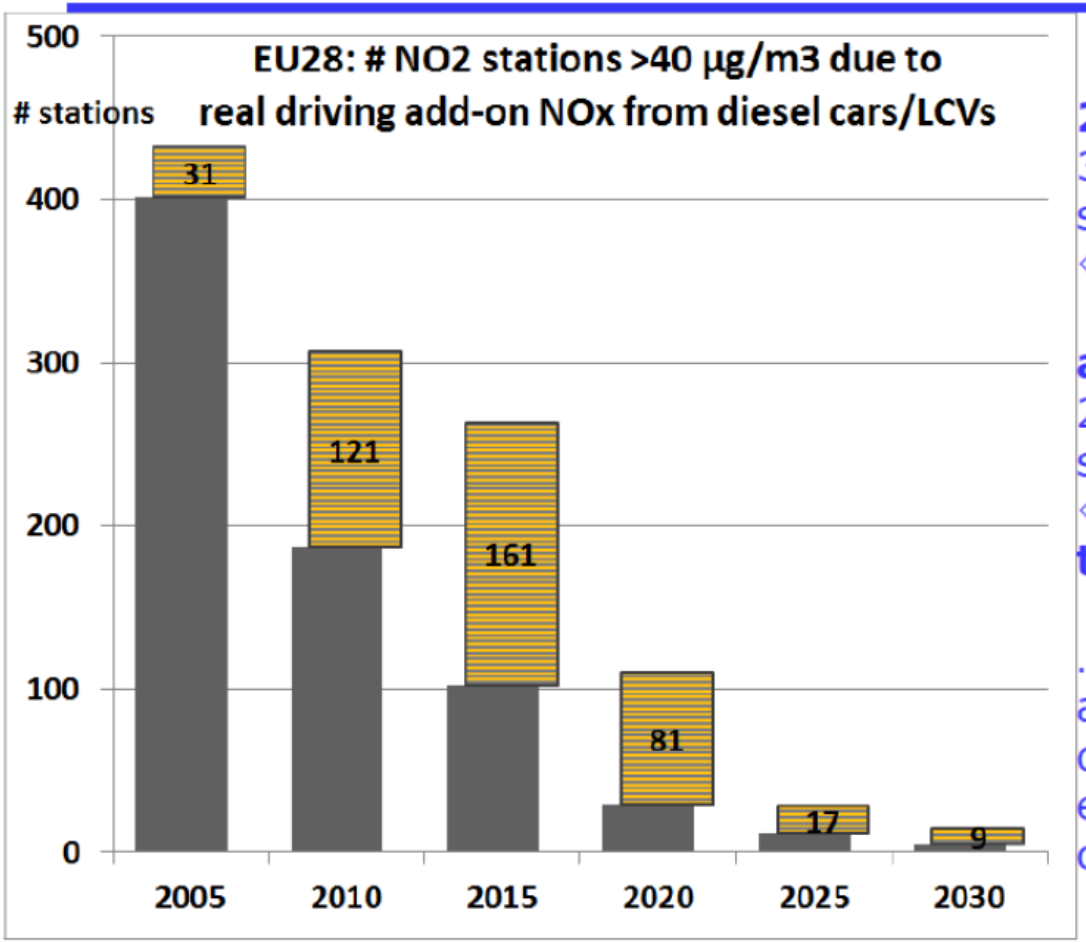
- Big and increasing discrepancy between laboratory and real life emissions
- Emission limits have tightened, real life emissions decreased in more modest proportions



Source: ICCT

Impact on air quality

- 2/3 of NOx air quality problem due to real life exceedances



2010:
300 instead of 190 stations
⇔ **one third of total**..

and 2015:
260 instead of 100 stations
⇔ **two thirds of total**...

...exceed the NO_2 ambient limit value due to "add-on" NO_x emissions from diesel cars (and LCVs)

Future legislation

- In Europe, Real Driving Emissions (RDE) legislation entering into force.
- Measurement done on the road, using Potable Equipment Measurement System (PEMS)

The RDE legislation for road vehicles

- PEMS tests have legally started also for heavy duty vehicles; trucks and buses for In Service Conformity (ISC)
- Typical trip has to be chosen for approval purposes by the vehicle manufacturer or the authorities
- Set of boundary conditions to make sure trip is representative of reality

RDE boundary conditions

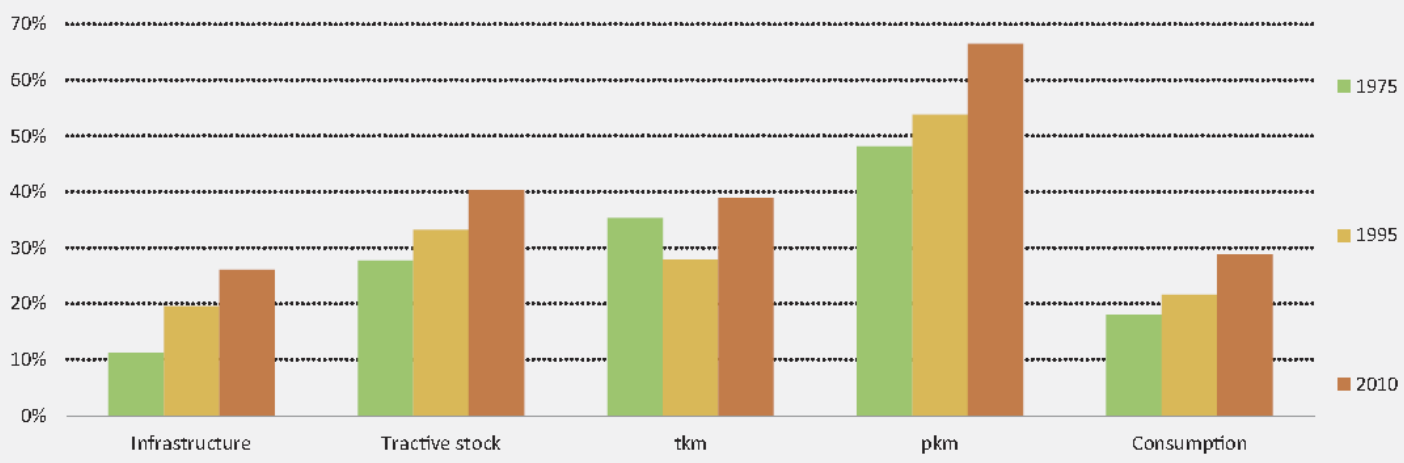
- Example for cars

Parameter		Provision set in the legal text
Payload		<90% of maximum vehicle weight
Maximum altitude	Moderate	700 m
	Extended	1300 m
Altitude difference		No more than a 100m altitude difference between start and finish
Cumulative altitude gain		1200m/100km
Ambient Temperature	Moderate	0°C to 30°C
	Extended	from -7°C to 0°C and 30°C to 35°C
Stop percentage		Between 6% and 30% of urban time
Maximum speed		145 km/h (160km/h for 3% of motorway driving time)
Dynamic boundary conditions	Maximum metric	95th percentile of v*a (speed * acceleration)
	Minimum metric	95th percentile of RPA (relative positive acceleration)
Use of auxiliary systems		Free to use as per in real life (operation not recorded)

What about the rail sector and diesel locomotives

- Diesel more than 60% of rail energy use globally
- In Europe, Diesel locomotives are part of the Non-Road Mobile Machinery legislation
- New regulation finally adopted last july 2016
- Entry into force of Stage V standards Diesel trains from 2020

Figure 6.4 Electrification evolution of the worldwide railway sector



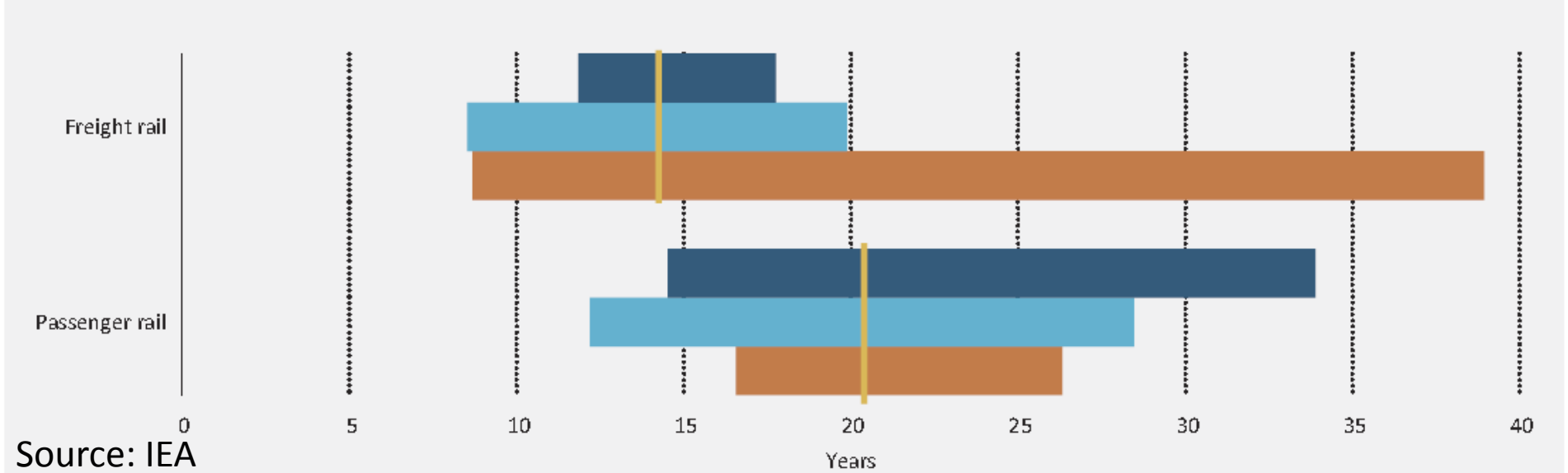
Notes: pkm = passenger kilometres; tkm = freight tonne kilometres. Consumption refers to percentage of exajoules that are electric of final energy consumption.

Source: IEA

Are diesel trains needed?

- Pros:
  - Flexibility of use on any rail track
  - No need to rely on infrastructure provider for energy supply
- Cons:
  - High costs, especially usage and maintenance
  - Reliability
  - Sensitivity to oil price
  - Environmental externalities

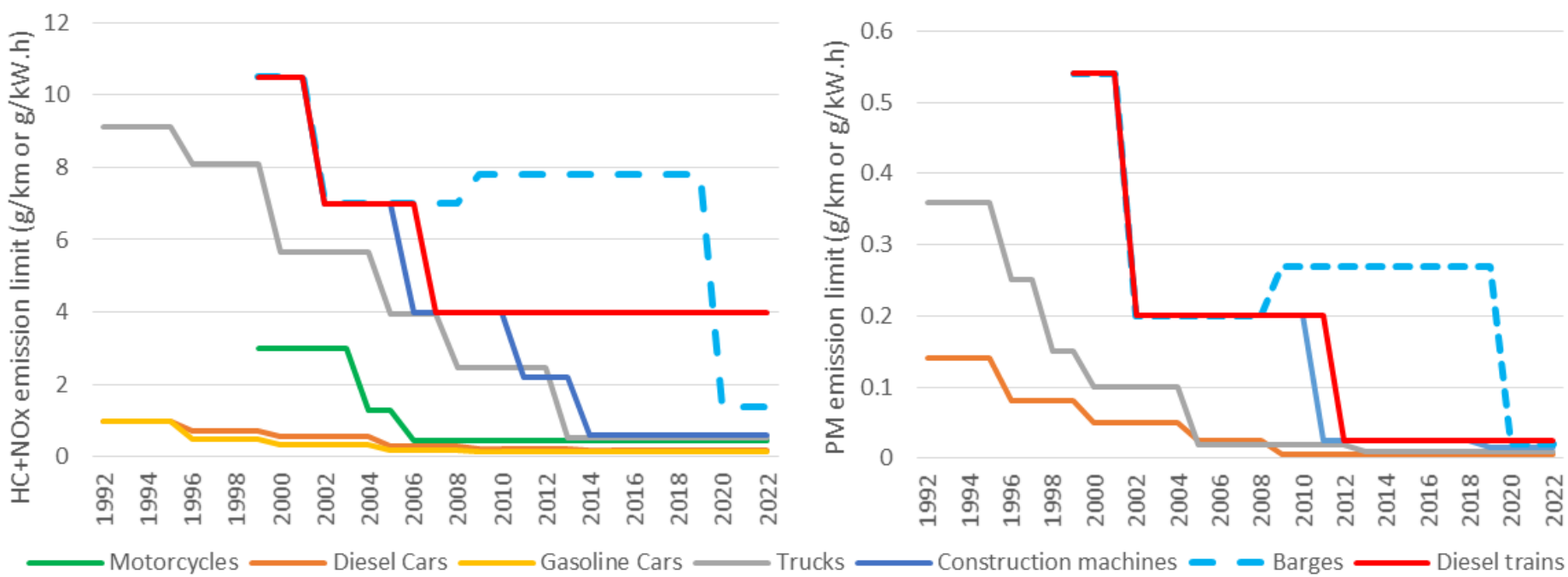
Figure 6.5 Rail applications: Sensitivity analysis (+/- 40%) for key parameters on payback period



Source: IEA

NRMM emission limit evolution

- Diesel locomotives stuck on NOx+HC
- Only engine category that probably won't need after-treatment systems, such as SCR

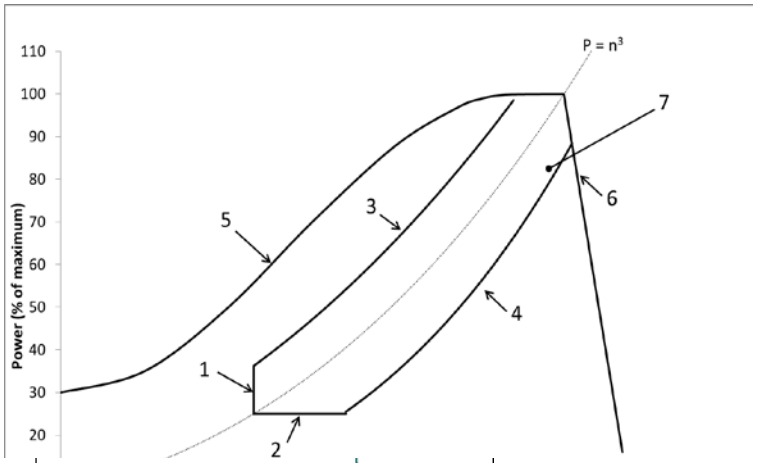


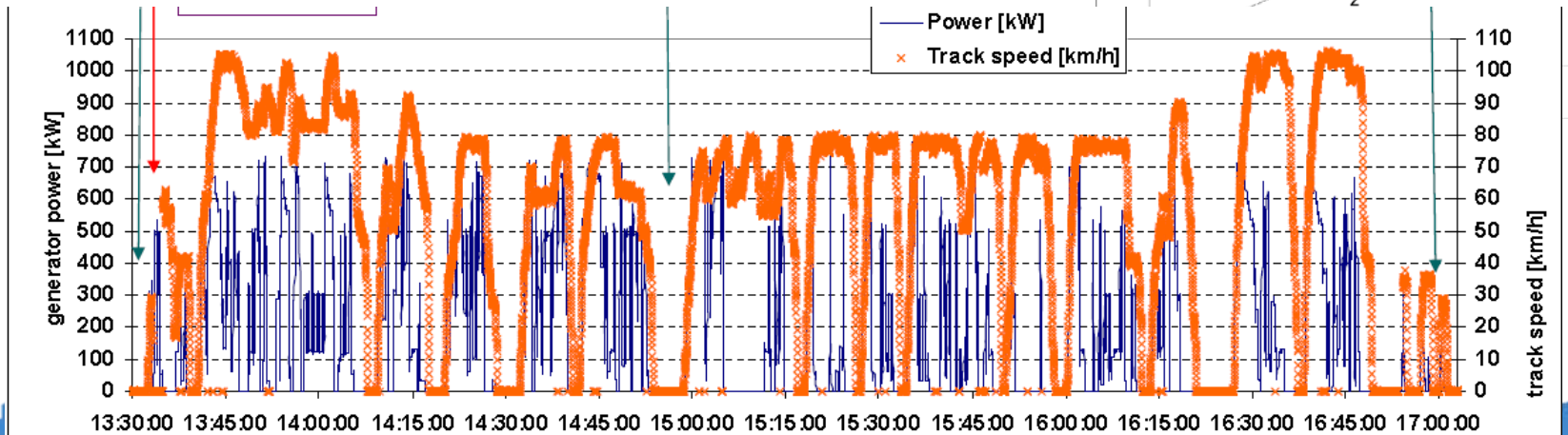
Test procedure for diesel locomotives

Table of cycle type F test modes and weighting factors

Mode number	1	2 (d)	3
Speed (a)	100%	Intermediate	Idle
Power (%)	100 (c)	50 (c)	5 (b)
Weighting factor	**0.15**	**0.25**	**0.6**

- Simplistic test cycle
- Control area (with an allowance of 100% on emission) limited
- Representative of real life?



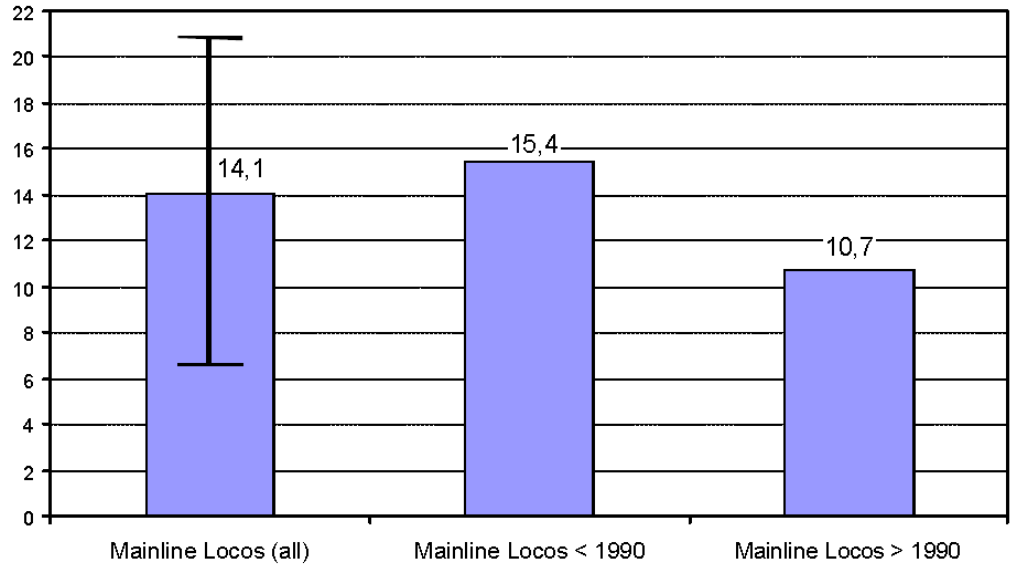


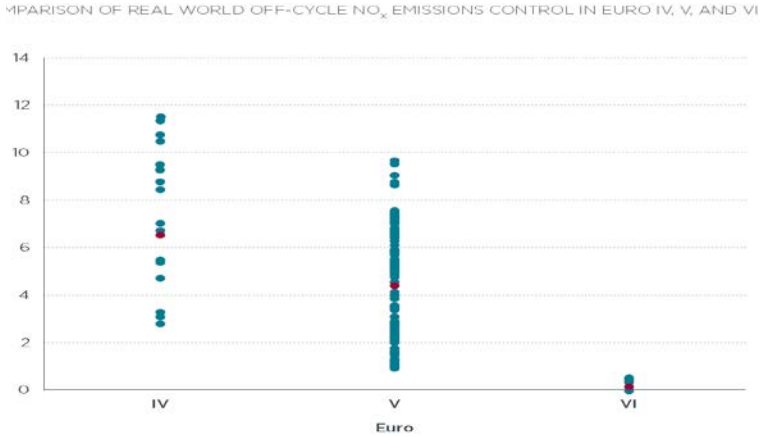
Stage V NRMM legislation

- In-Service Monitoring (ISM), using PEMS under real life conditions
- Applicable to engines subjected to pilot studies to show the feasibility of PEMS measurement
- Pilot study for rail diesel engines being started
- ISM for rail expected in the years to come…
- Already limited experience with rail PEMS measurement in the US, CZ

Trucks versus diesel locomotives

	Emission limit	Real life emission
Truck	0.4gNOx/kWh	0.13 gNOx/kWh (ICCT, 2015)
Diesel locomotive	4gNOx/kWh	10 gNOx/kWh (UIC, 2005)





3. NO_x emissions for all tests plotted vs Euro level. Red point to indicate average of all data

Fuel switching and air pollution

- Electricity generation generally good for air pollution
  - Centralized generation
  - Subject to NEC (national emission ceilings) in Europe
- Bio fuel does not bring significant air quality benefits
  - The combustion process does not differ significantly
  - Zero carbon operation by 2050 commitment not helpful for air quality
- UIC-CER commitment to zero pollutant emission by 2050 de facto excludes internal combustion engines

Conclusion: Minimizing air pollution from the rail sector

- Regulation on air pollution from diesel trains not providing a strong incentive to reduce air pollution from diesel trains
- Voluntary commitments from railways a good way forward
- Commitments existing on energy intensity, CO2, pollutant (NOx and PM)
- Encouraging operators to strengthen commitments on air pollution:
  - To electrify all operations
  - To phase out diesel
  - To reduce **real-life** pollutant emissions, of NOx, PM

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Thank you !

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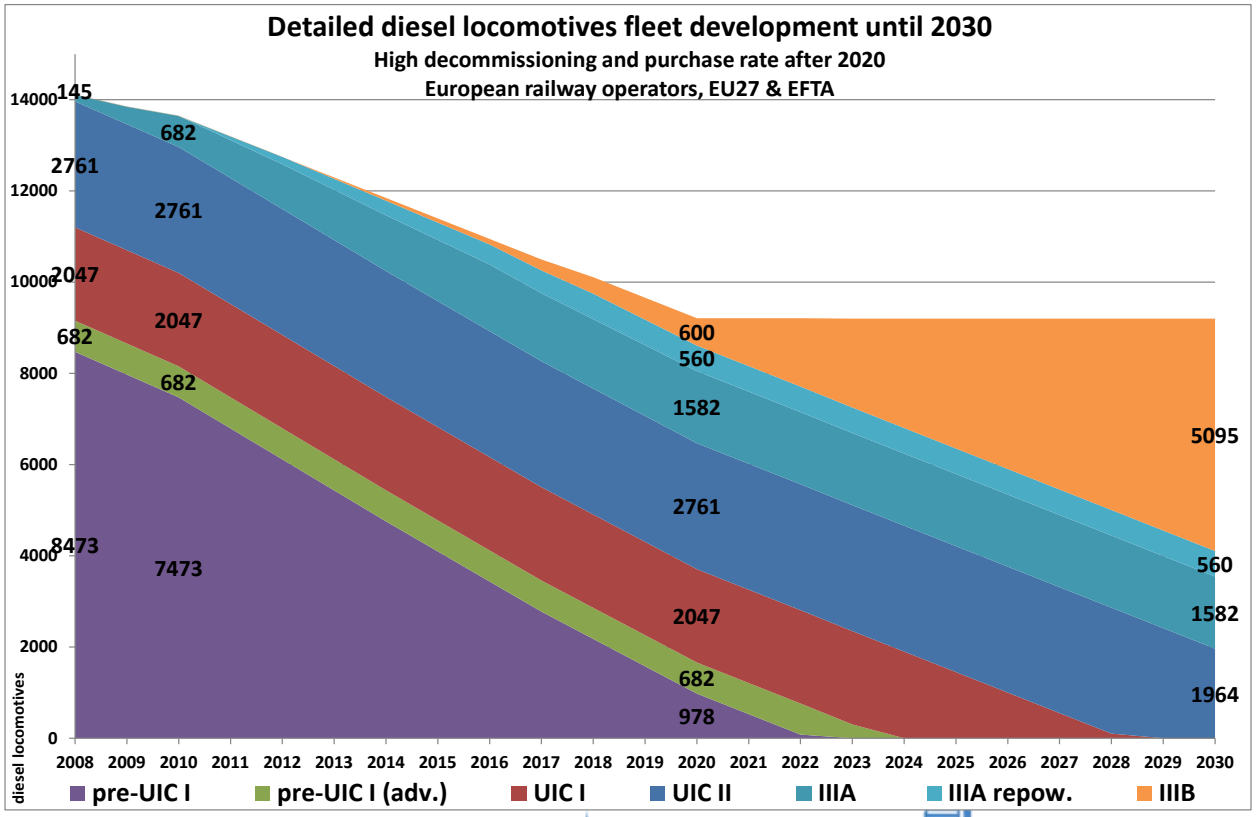
12, 13, 14 October 2016

Backup slides

Diesel locomotive fleet evolution

- Source: CleanerD



- CleanerD NOx reduction scenarios much lower than emission limit

SP6 Scenarios	NOx Level	Description of the emission reduction Technology
Baseline	2 g/kWh	SCR + DPF (without EGR as design proposed by SP2)
1	1 g/kWh	High rate of SCR conversion (bigger size and high consumption of Urea)
2	0.4 g/kWh	EGR + DPF + SCR (moderate size and urea consumption)
3	0.4 g/kWh	EGR + DPF + SCR (High rate)

Trucks tested in real life by ICCT

- Average Euro VI emission of 0.13gNOx/kWh

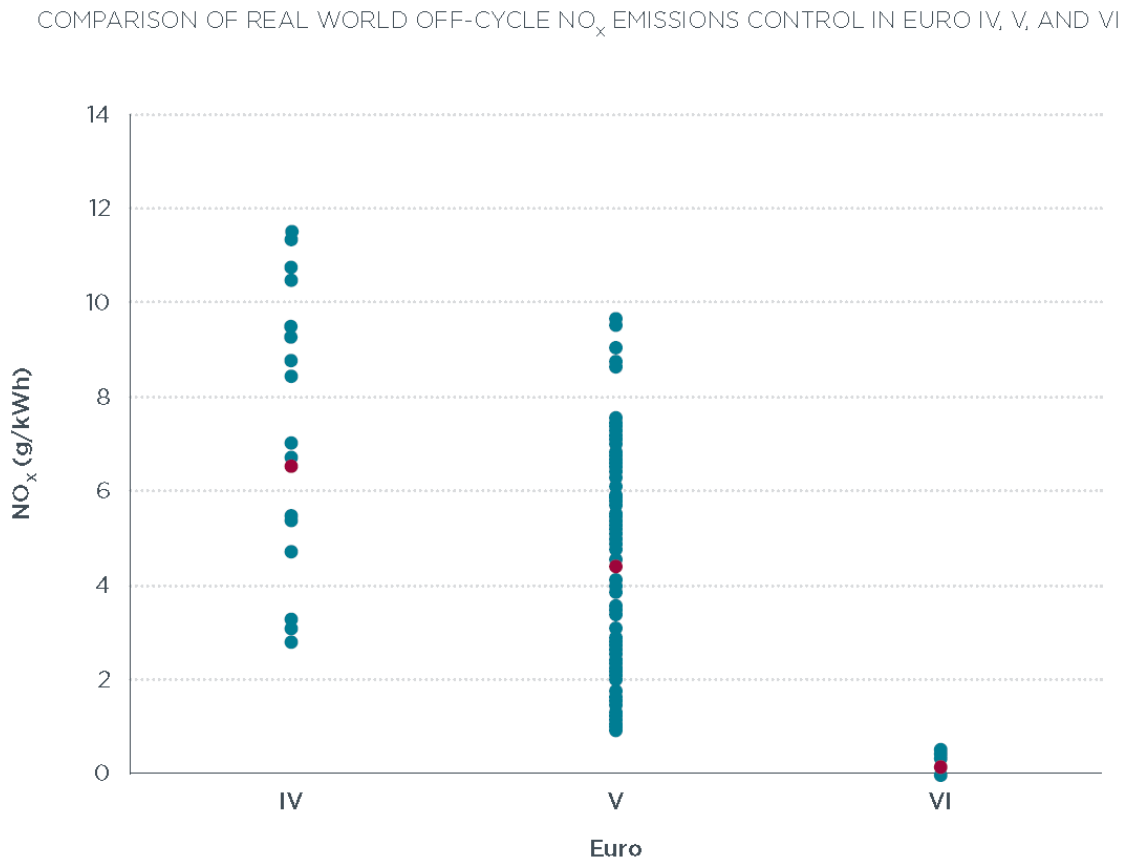


Figure 3. NO_x emissions for all tests plotted vs Euro level. Red point to indicate average of all data