Right on track to reduce emission from Diesel rolling stock: Results from EU project CleanER-D

Judit Sandor, UNIFE
Henning Schwarz, UIC (DB)
Venice, 26th October 2012
NRMM Directive

2004/26/EC amending 97/68/EC Directive on emissions of Non-Road Mobile Machinery

Emission limits for diesel engines in rail applications
- Stage IIIB applying from 1st January 2012
- 90% PM and 50% NOx reduction as compared with stage IIIA limits

Exhaust after-treatment equipment is required
- No or little experience in rail applications

NRMM does not regulate machinery over 560kW → Locomotive stage IIIB engines cannot be derived from other applications

For locomotive engines above 560 kW, only three years stability time is given between IIIA and IIIB engines (2009-2012)
Objectives

- Deal with common needs and uncertainties regarding the introduction of exhaust after-treatment technology in rail vehicles. From all points of view:
  - Engine design
  - Vehicle integration
  - Operation and maintenance
- Provide engine manufacturers with the opportunity of testing in-service its prototypes
  - Speed up availability of IIIB rail diesel engines
- Gain experience on how after-treatment devices perform in rail environment.
  - Optimise reliability of future IIIB solutions based on real-life experience
- Get accurate knowledge of the implementation and operational costs of new emission reduction technologies
  - Inputs yielded from real experience to allow for an Impact Assessment.

PUSH FOR THE DEVELOPMENT OF RELIABLE STAGE IIIB ENGINES AND VEHICLE SOLUTIONS
Facts and Figures

- European Seventh Framework Programme (FP7)
- Starting date 1st June 2009
- Duration: 4 years (31st May 2013)
- Total budget: 13.385.980 €
- Requested funding: 7.975.574 €
- Partners: represents all key stakeholders of the sector
Structure and Organisation

- **Operational subprojects**
  - Place in service and monitoring of first IIIB compliant rail vehicles:
    - Identify installations constraints and impacts on vehicle performance.
    - Gain experience on after-treatment devices: operation, maintenance, troubleshooting, reliability, LCC, etc.

- **Sustainability and Innovation subprojects**
  - Study of future and state-of-the-art low emissions technologies as well as hybrid solutions (feasibility and impact)
  - Analyze socio-economic impact of these technologies in the sustainability of the rail sector

- **Setup teams to coordinate the different subprojects**
System Requirement Sub-project

- Collect, review, compare and analyse results of operational SPs to provide inputs for the sustainability and innovations SPs
- RAM and LCC model to evaluate impact of stage IIIB compliance

Operational sub-projects:
- Obtain experience by real vehicle operation and in-field monitoring
GOAL: Do not restrict the project to the IIIB prototypes
- Look beyond stage IIIB emissions limits
- Learn from other sectors
- Reduce not only emissions but improve efficiency

SP6: Emerging technologies
- Assess state-of-the-art and future emission reduction technologies. Potential to learn from other transport sectors.
- Identification and evaluation of most promising low emission technologies for the rail sector.

SP7: Hybrid Solutions
- Beat the balance between engine emissions and efficiency.
- Definition of standard/synthetic duty cycles and vehicle parameters for simulation.
- Assessment on suitability and potential benefit of different hybrid solutions for different rail diesel traction modes and duty cycles.
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Henning Schwarz, UIC (DB)
Sub-project leader SP5 “Sustainability & Integration”
CleanER-D 12th UIC Sustainability Conference
Venice, 26th October 2012
Outline

- SP5 General objectives and structure
- Total emissions from transport
- Fleet scenarios
- Scenarios total emissions
- Emissions comparison
- Conclusion
SP 5 Sustainability & Integration – General objectives

- Develop reliable rail diesel vehicle **fleet and emissions scenarios** and reflect stakeholders needs and requirements (Sustainability Study)

- Integrate the results from SP1 “System Requirements”, SP6 “Emerging Technologies” and SP7 “Hybrid Solutions”
  - perform impact assessment from a railway sector perspective using **cost/ benefit** methods
  - Cost/ benefit Analysis and **Sustainability Impact Assessment**

- Develop recommendations on future emission reduction approaches and strategies of rail diesel traction in Europe
  - Recommendation regarding future emission reduction approaches and strategies
Outline

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Rail’s diesel traction share of total NOx emissions of transport is 2.5%
Rail’s diesel traction PM emissions reduced by 35% (1990 – 2008)

Emissions PM - Index (1990=100) - EU27 only (source: eea)

- Civil aviation (Domestic, LTO)
- Railways
- International aviation (LTO)
- Road transport: Passenger cars
- Road transport: Light duty vehicles
- Road transport: Heavy duty vehicles
- National navigation (Shipping)
- International inland waterways

Source: eea - European Union emission inventory report 1990-2008 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)
Rail’s diesel traction NOx emissions decreased by 35% (1990 – 2008)

**Emissions NOx - Index (1990=100) - EU27 only (source: eea)**

Source: eea - European Union emission inventory report 1990-2008 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)
SP5 General objectives and structure
Total emissions from transport
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Scenarios total emissions
Emissions comparison
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Locomotives - CleanER-D scenario

Status: Current fleet is UIC II engines or older and few IIIA. Incl. repowering & decommissioning of old vehicles. Approx. 150 new locos p.a. EU27 & EFTA, UIC members
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Total Exhaust Emissions Estimation - reduction of more than 40% PM by 2020

Total PM Exhaust Emissions from Rail Diesel Traction
CleanER-D estimation, EU27 UIC members

Rail diesel fleet CleanER-D, PM (kt)
Total exhaust emissions estimation – reduction of more than 30% NOx by 2020.
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Conclusion
NOx emissions of different transport modes

Transport case: 100 t average freight, 500 km transport distance

Results of the transport mode comparison calculation: Total NOx emissions (in kg)

Source: EcoTransIT; IFEU
PM emissions of different transport modes

Transport case: 100 t average freight, 500 km transport distance

Total PM emissions (kg)

Source: EcoTransIT; IFEU

Results of the transport mode comparison calculation: Total PM emissions (in kg)
Outline

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Conclusion

- Rail’s share of total emissions of transport are today less than 2.5% for NOx and less than 4.5% for PM
- Rail’s emissions of both NOx and PM have decreased by 35% from 1990 to 2008
- Rail’s emissions of both NOx and PM will further significantly decrease in all fleet renewal scenarios
  - Intermediary results show a decrease of more than 30% for NOx and more than 40% for PM from 2008 to 2020
- In a well-to-wheel approach rail’s emissions are on similar level compared to trucks
- Strategies to quickly migrate new technologies into the fleet will substantially further reduce emissions and maximize benefits

Next steps until the project end in summer 2013

- Finalise sustainability impact assessment
- Develop recommendations on future emission reduction approaches and strategies
Thank you very much for your attention!

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The fleet development is the basis for any emission calculation.

Basis for the fleet development were:
- Rail Diesel Study (2006)
- UIC data
- Market Study SCI-Verkehr and
- Questionnaire survey among European Operators

Data improvements compared to Rail Diesel Study:
- (Broader) Coverage of the diesel fleet of the largest rail diesel fleet operators in Europe
- Knowledge of average mileage per vehicle type, power class and age
Same picture for PM: Rail’s diesel traction share is 4.5% only.

Source: eea - European Union emission inventory report 1990-2008 under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)
Decrease of NOx and PM from rail diesel traction mainly due to expected sharp decrease of diesel locomotive fleet

- Approx. more than 2/3 of NOx & PM reduction from loco fleet decrease

But:

- Trend: former loco hauled passenger trains are exchanged by DMUs (with higher mileage)
- Total train-km decrease of locomotives only by approx. 30% due to higher average mileages of remaining loco fleet
- Increase of total train-km of DMUs due to growing DMU fleet by approx. 30% (Scenario B)
- Increase of total train-km from overall rail diesel traction (DMUs & locos, passenger & freight transport) by approx. 5% (2008-2020)
- At the same time better load factors for passenger and freight expected until 2020

Conclusion: Almost the same diesel hauled transport performance in passenger and tonne km in 2020 as in 2008, but much more efficient and clean
Well-to-wheel approach

Figure: System boundaries for Well-to-Wheel calculation
Energy consumption for defined transport per mode

Results of the transport mode comparison calculation: Total primary energy consumption (in litres petrol equivalents)

Source: EcoTransIT; IFEU
Fuel costs are dominating the LCC of the propulsion system by far.

Thus any technology, which will decrease fuel consumption and LCC will be successful on the market.

Market conditions (incentives, technologies with low LCC), which increase the fleet renewal rates will bring the greatest emission reduction.
The railway sector in Europe is committed to further improve its emission performance.

European Railways have adopted in December 2010 the “European Rail Sector Strategy 2030 and beyond”

- Exhaust emission reduction target:
  “By 2030 the European railways will reduce their total exhaust emissions of NOx and PM10 by 40% in absolute terms even with projected traffic growth compared to base year 2005”

Cleaner-D will support the sector to achieve its emission goals!