12th UIC
Sustainability Conference

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

Clean European Rail – Diesel

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CleanER-D 12th UIC Sustainability Conference

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Grant Agreement number: 234338

Background and Introduction
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.

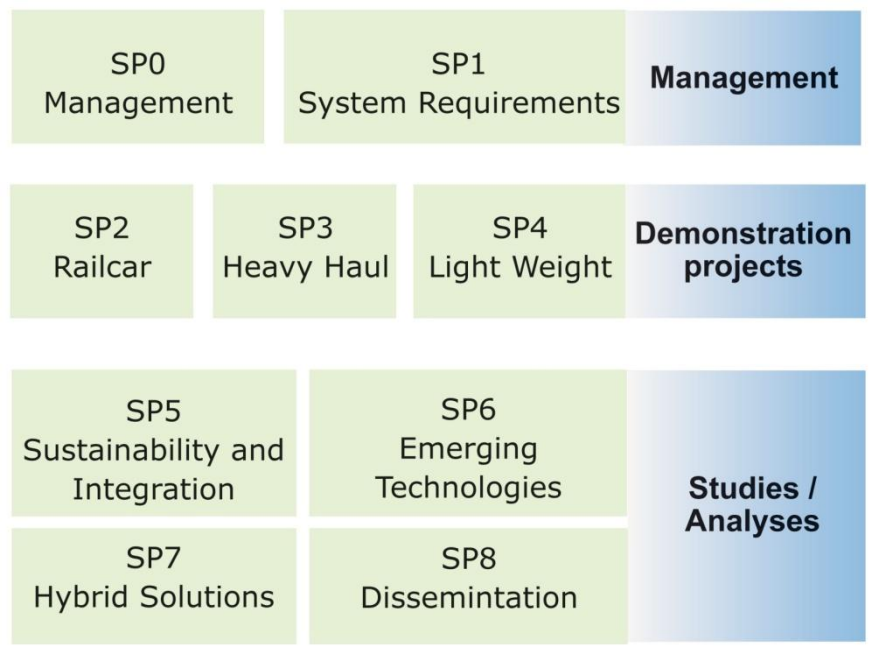
PUSH FOR THE DEVELOPMENT OF RELIABLE STAGE IIIB ENGINES AND VEHICLE SOLUTIONS

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**



Operational Part

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

Sustainability and Integration – SP6/7

- **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”

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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**

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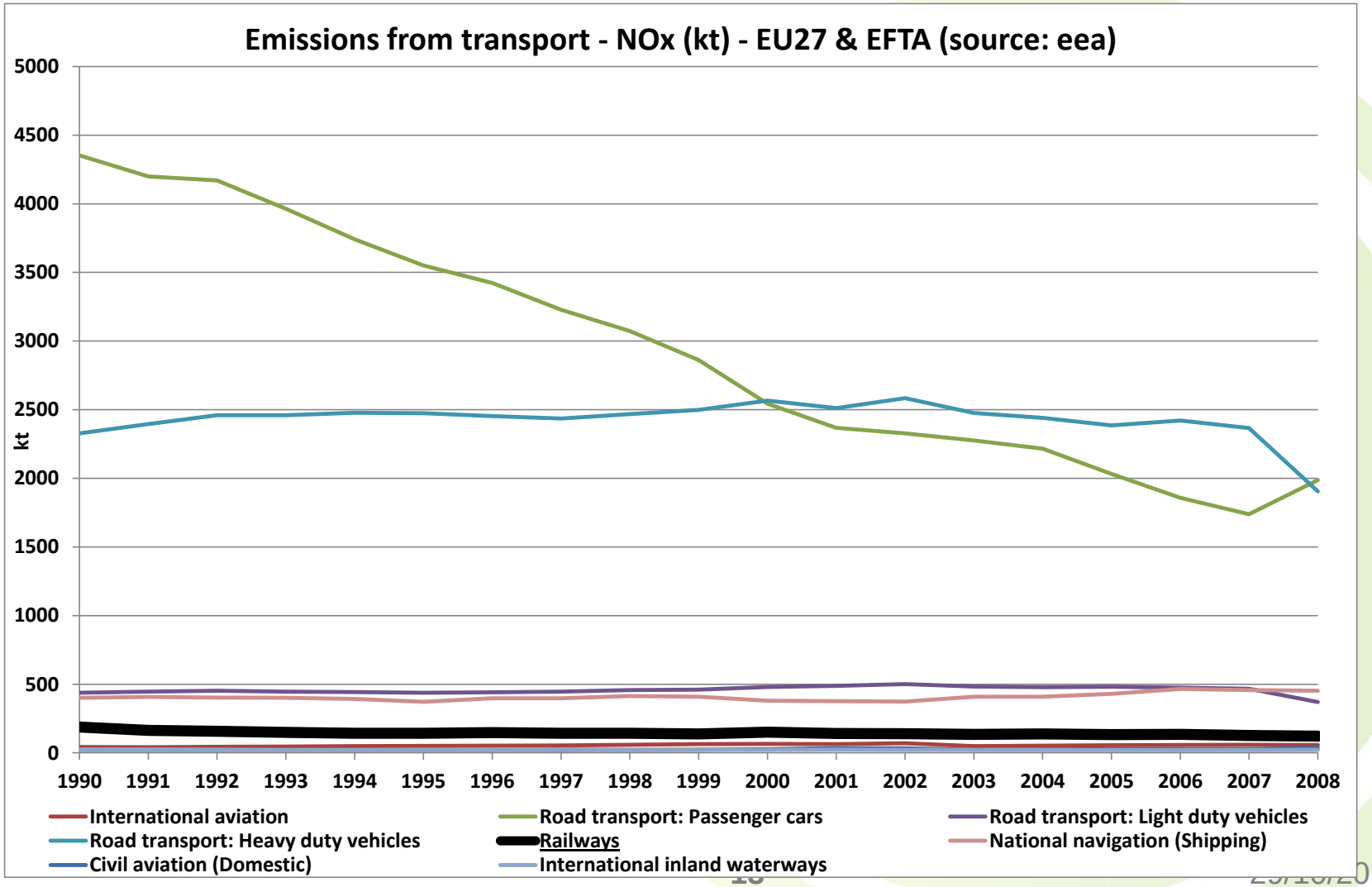
Total emissions transport

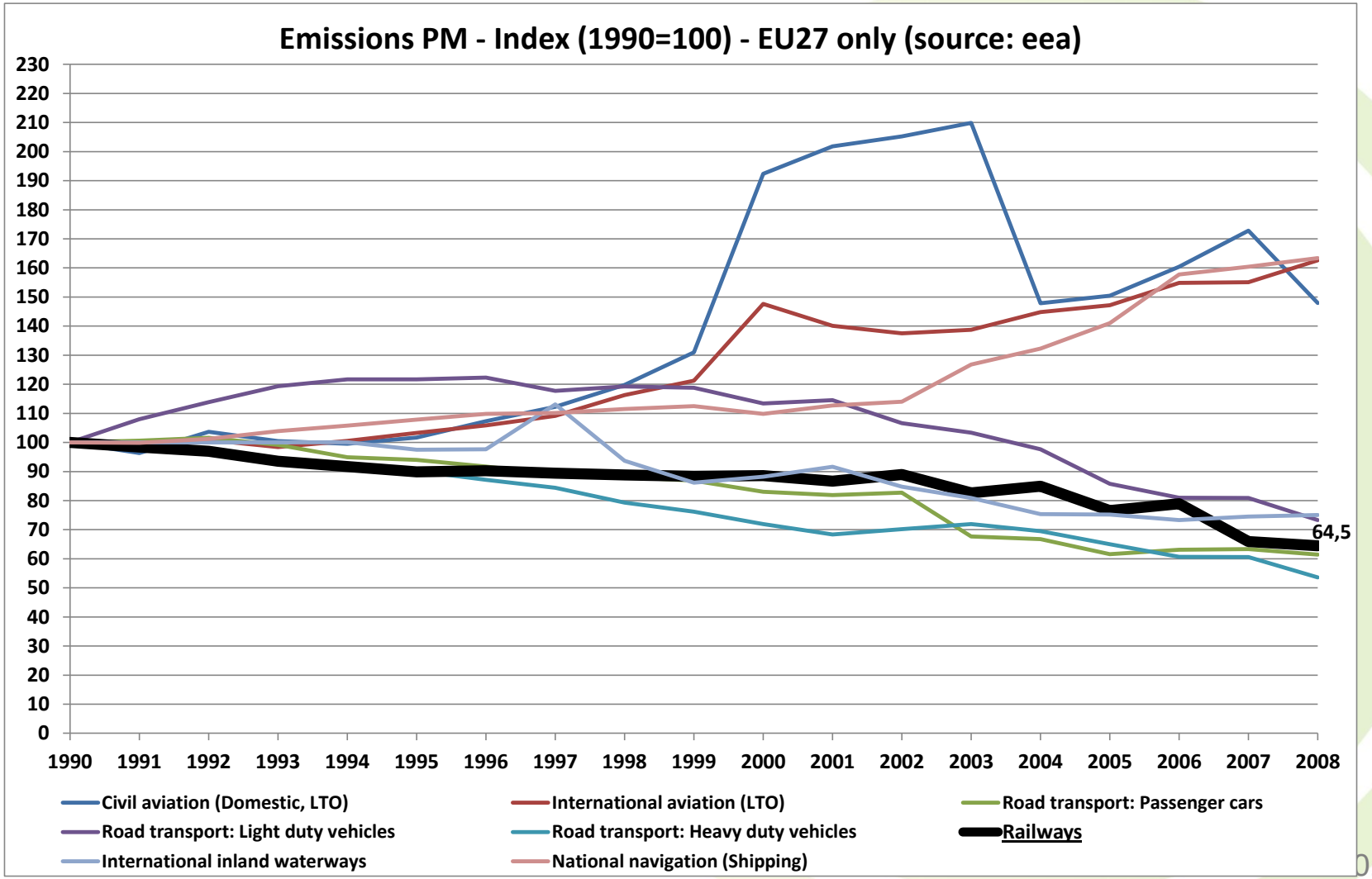
- **Rail's diesel traction share of total NOx emissions of transport is 2.5%**



Source: eea - European Union emission inventory report 1990-2008
under the UNECE Convention on Long-range Transboundary Air Pollution (LRTAP)

Total emissions transport

- Rail's diesel traction PM emissions reduced by 35% (1990 – 2008)



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Total emissions transport

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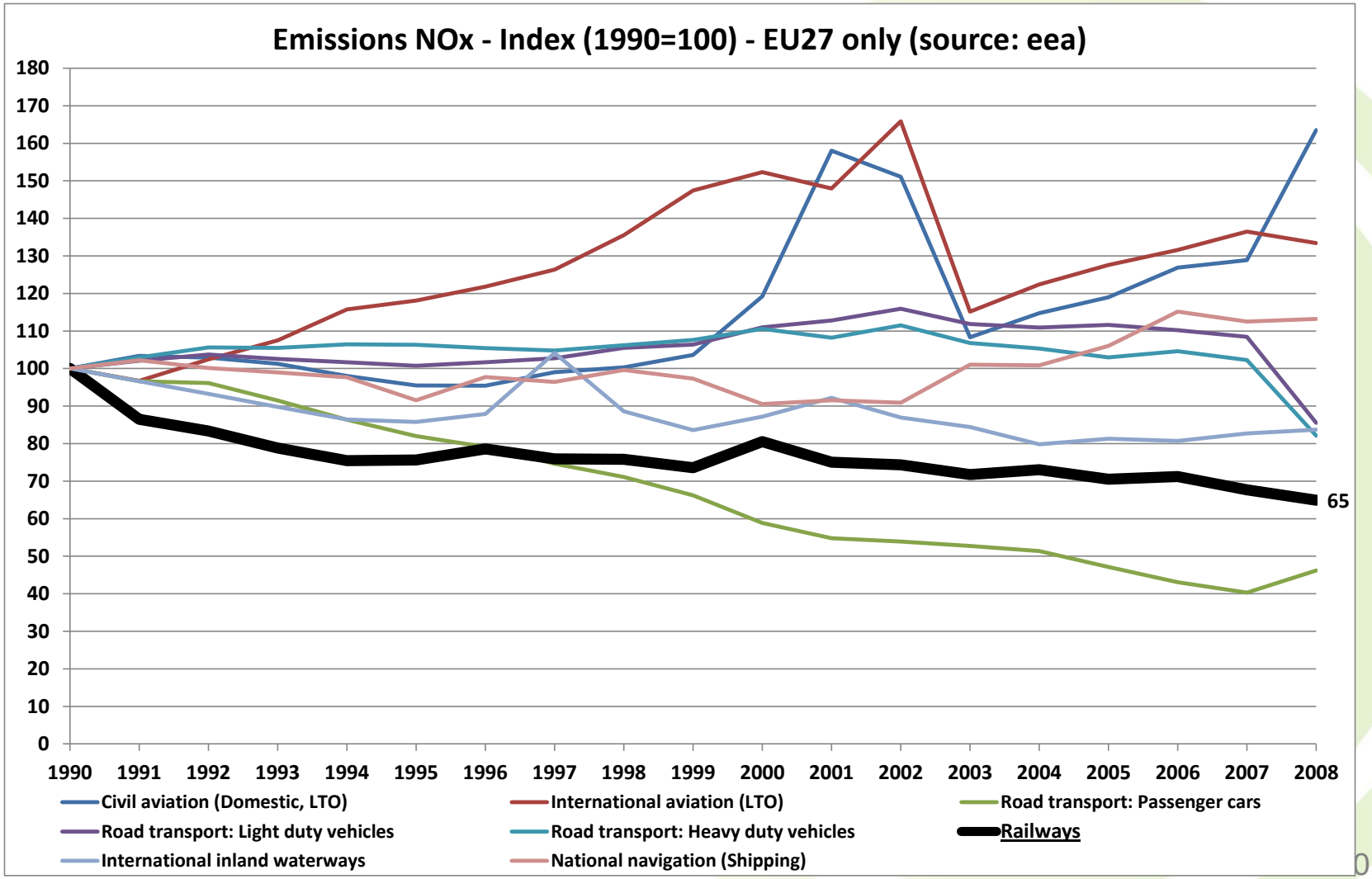

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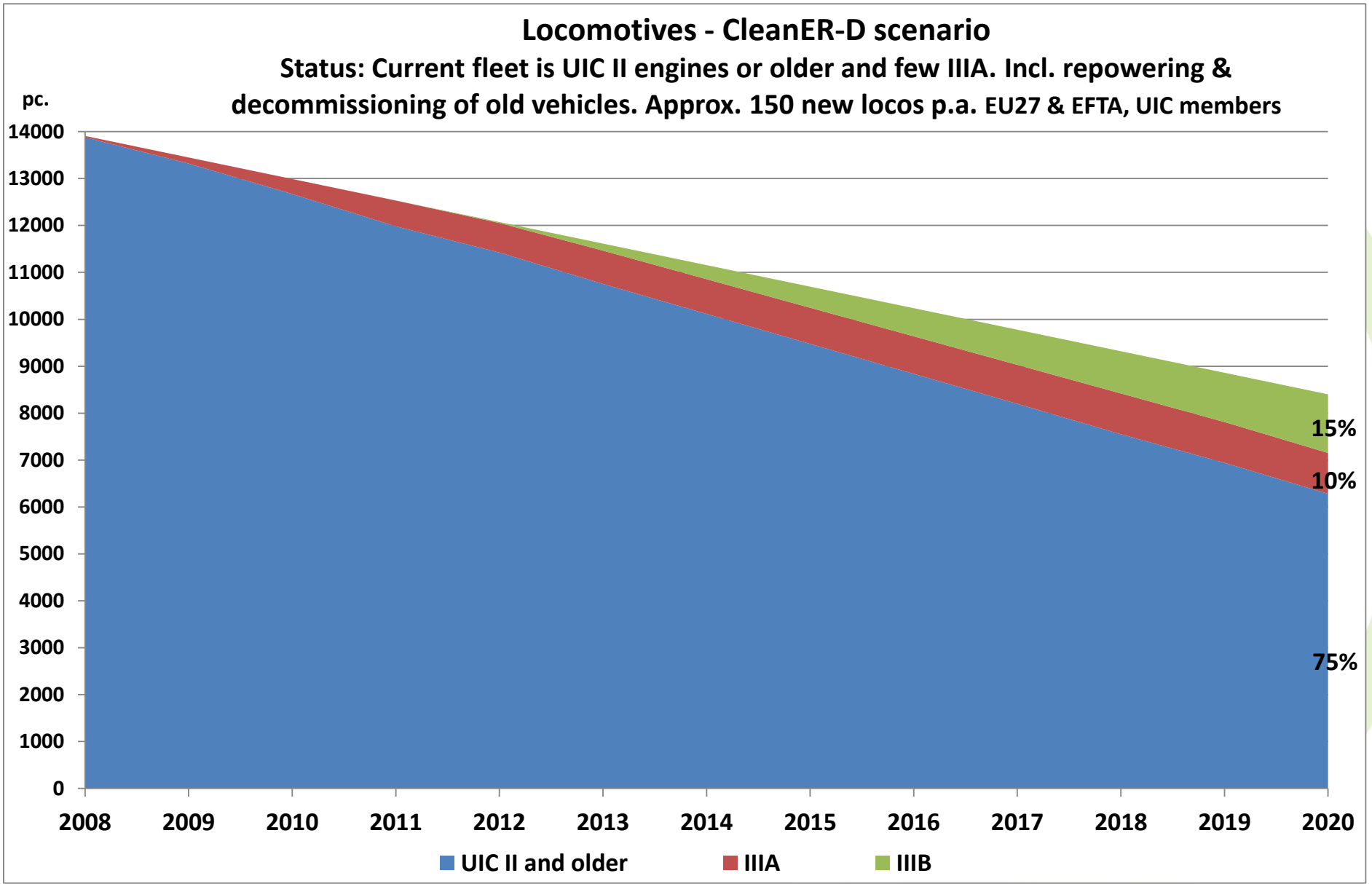
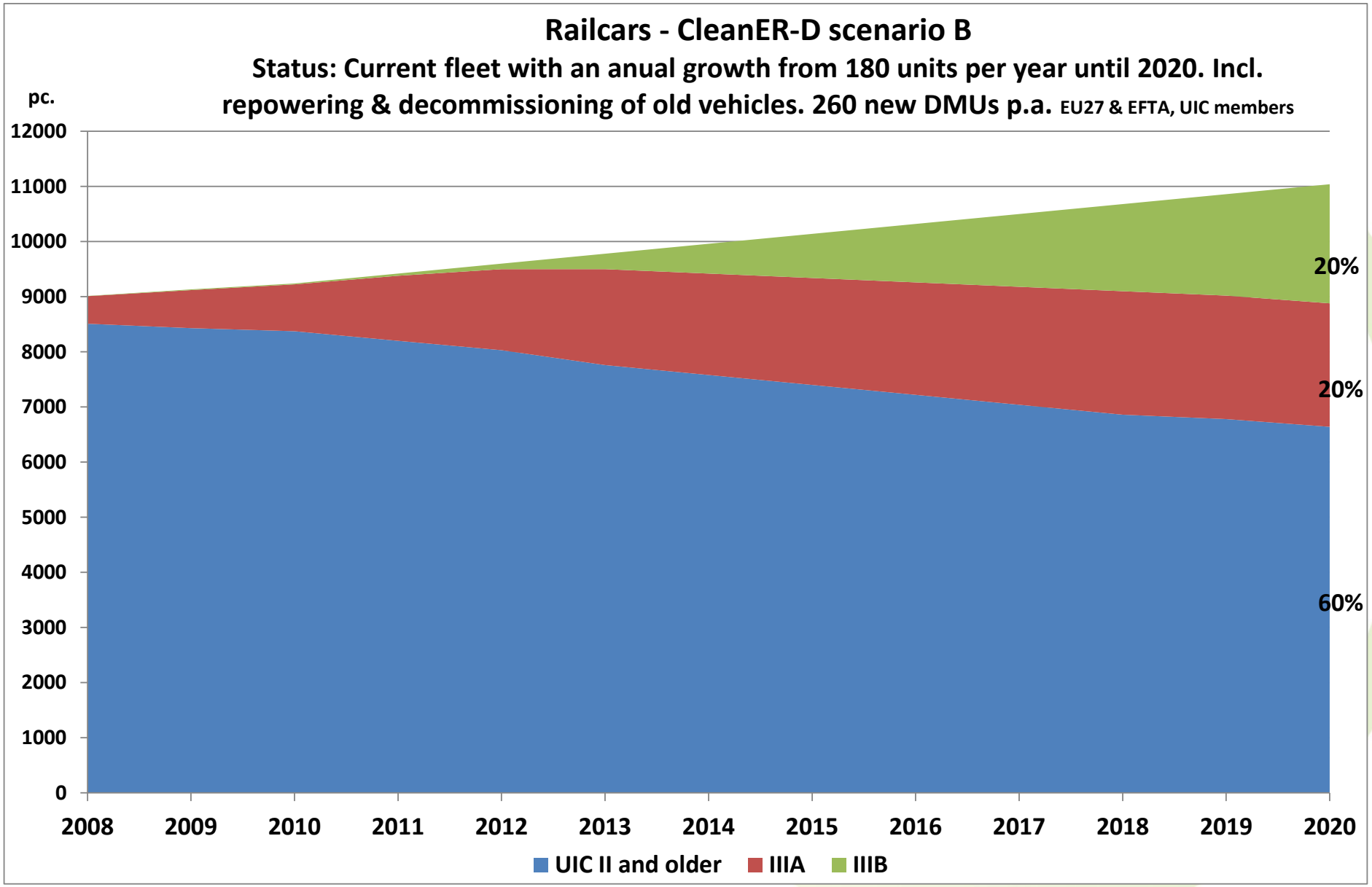
Scenario fleet development locomotives 2008-2020



Scenario fleet development DMUs 2008-2020



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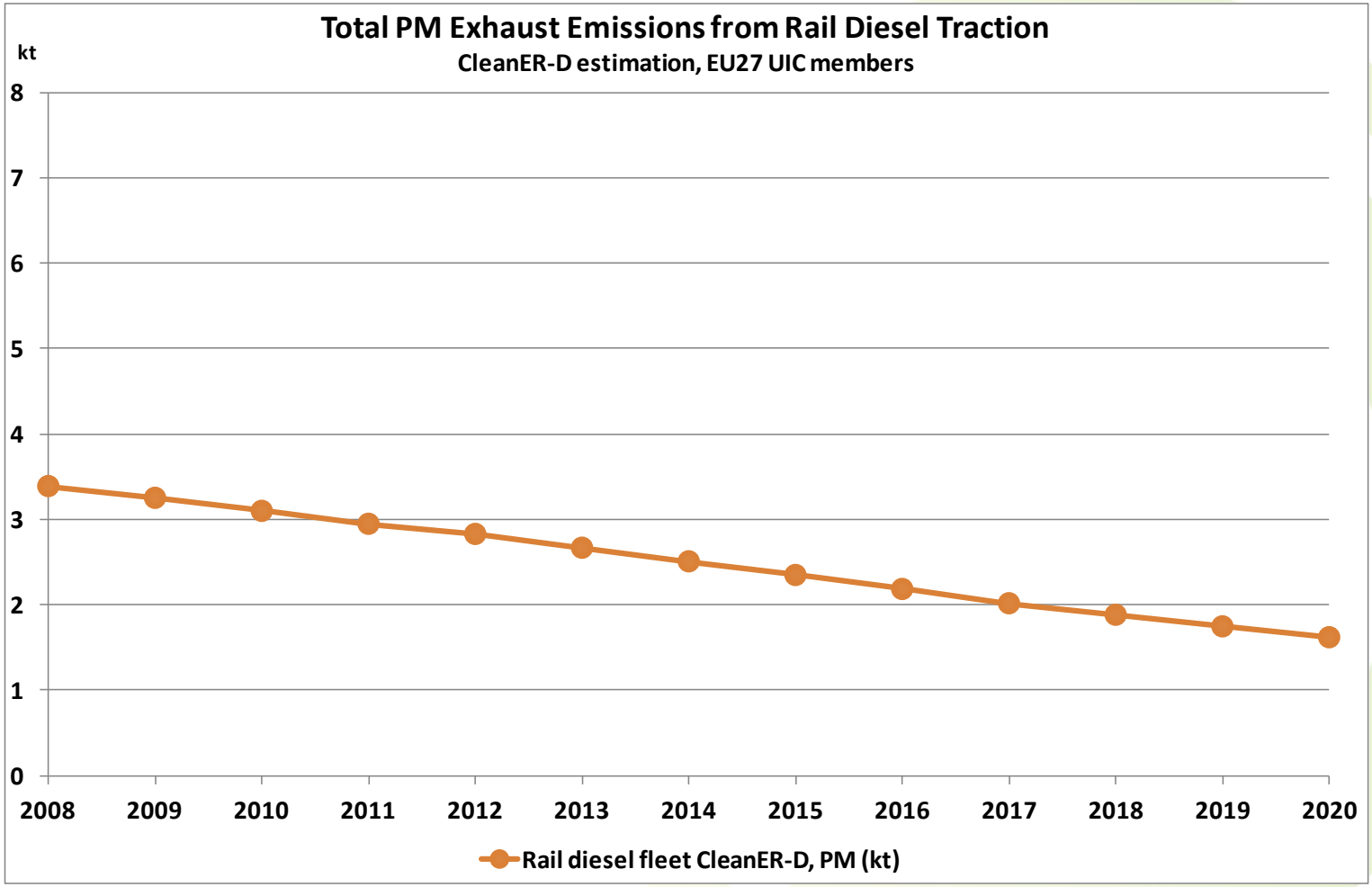
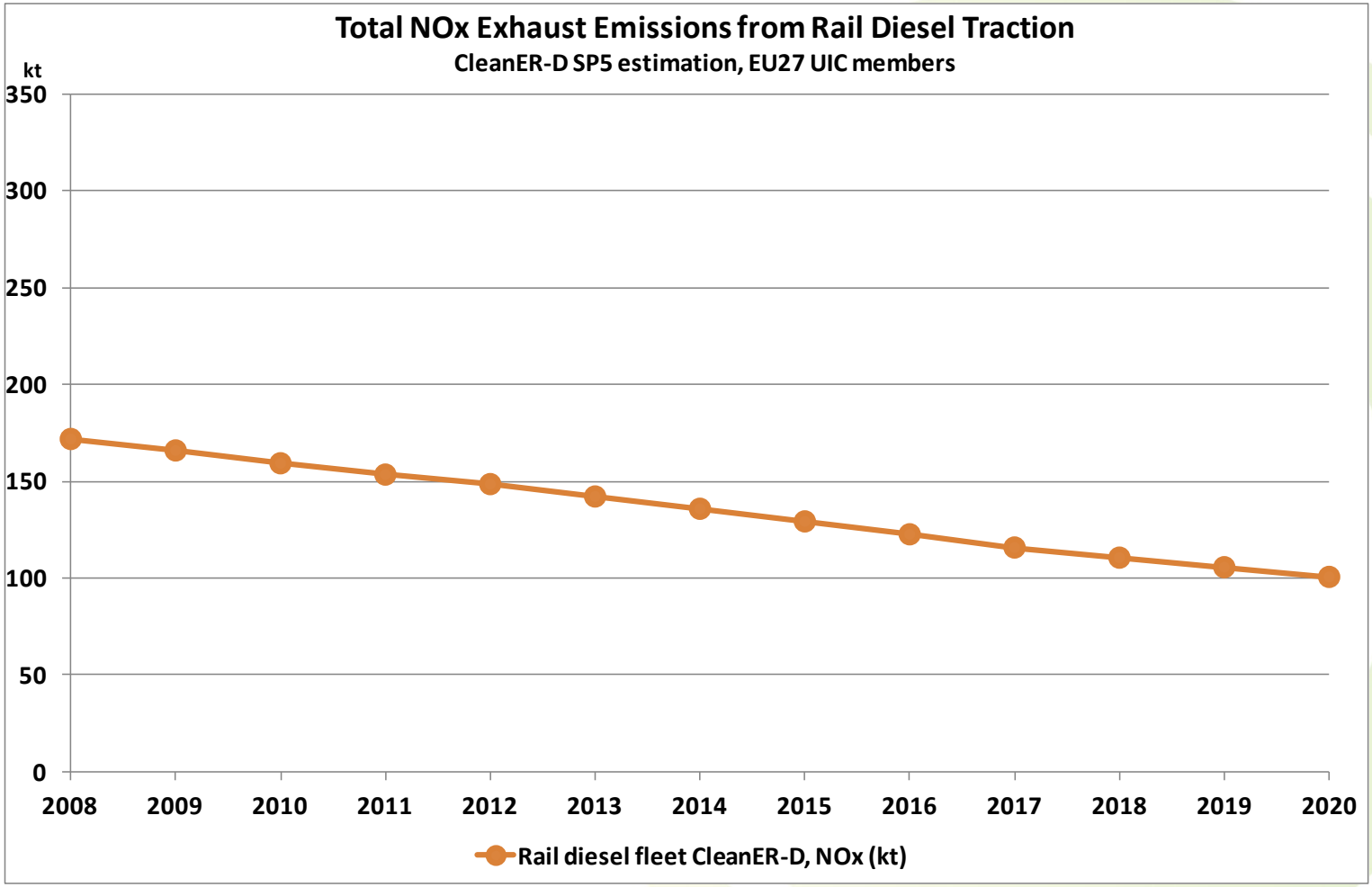
Total Exhaust Emissions Estimation - reduction of more than 40% PM by 2020



Total exhaust emissions estimation – reduction of more than 30% NOx by 2020



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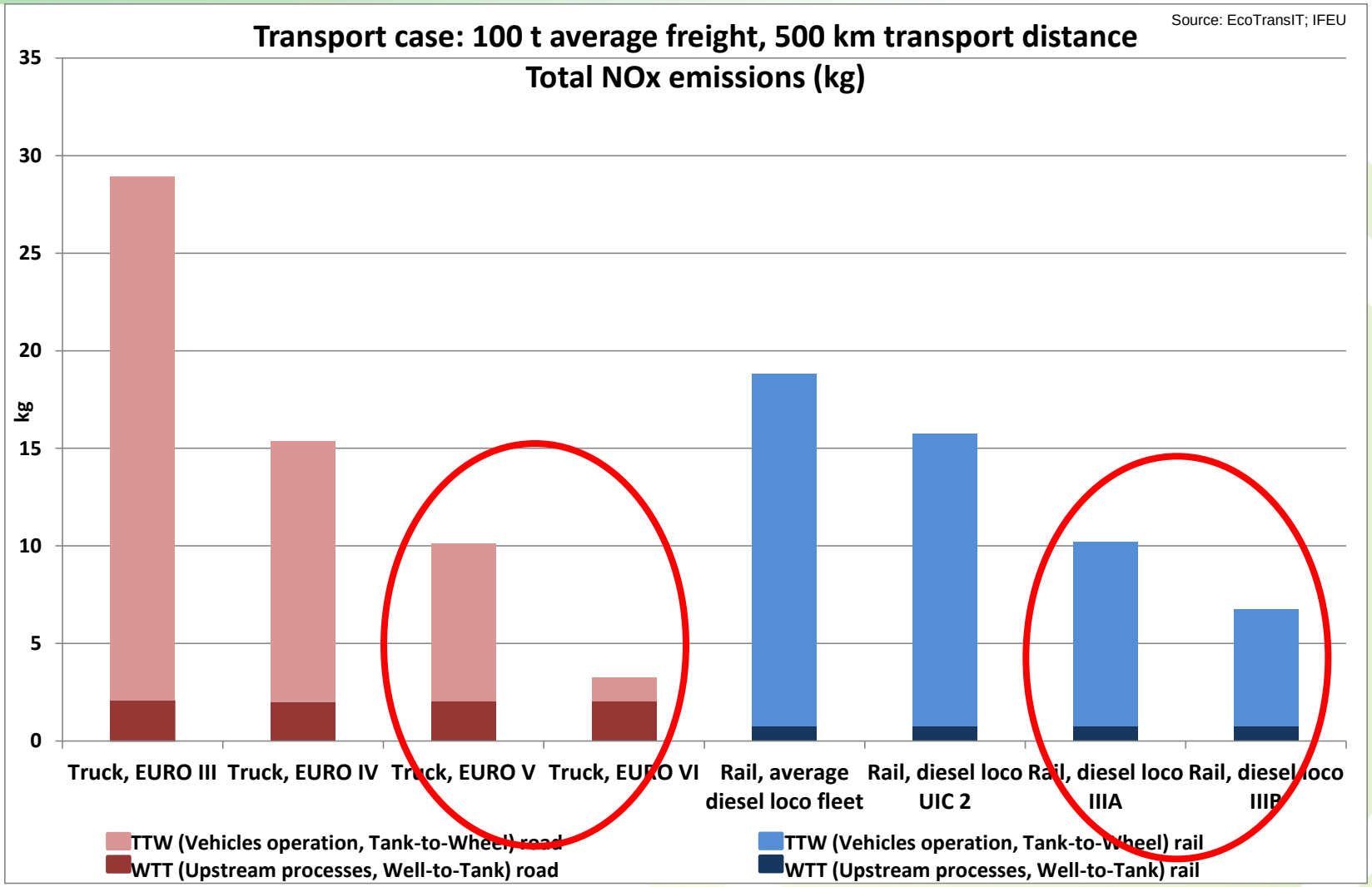
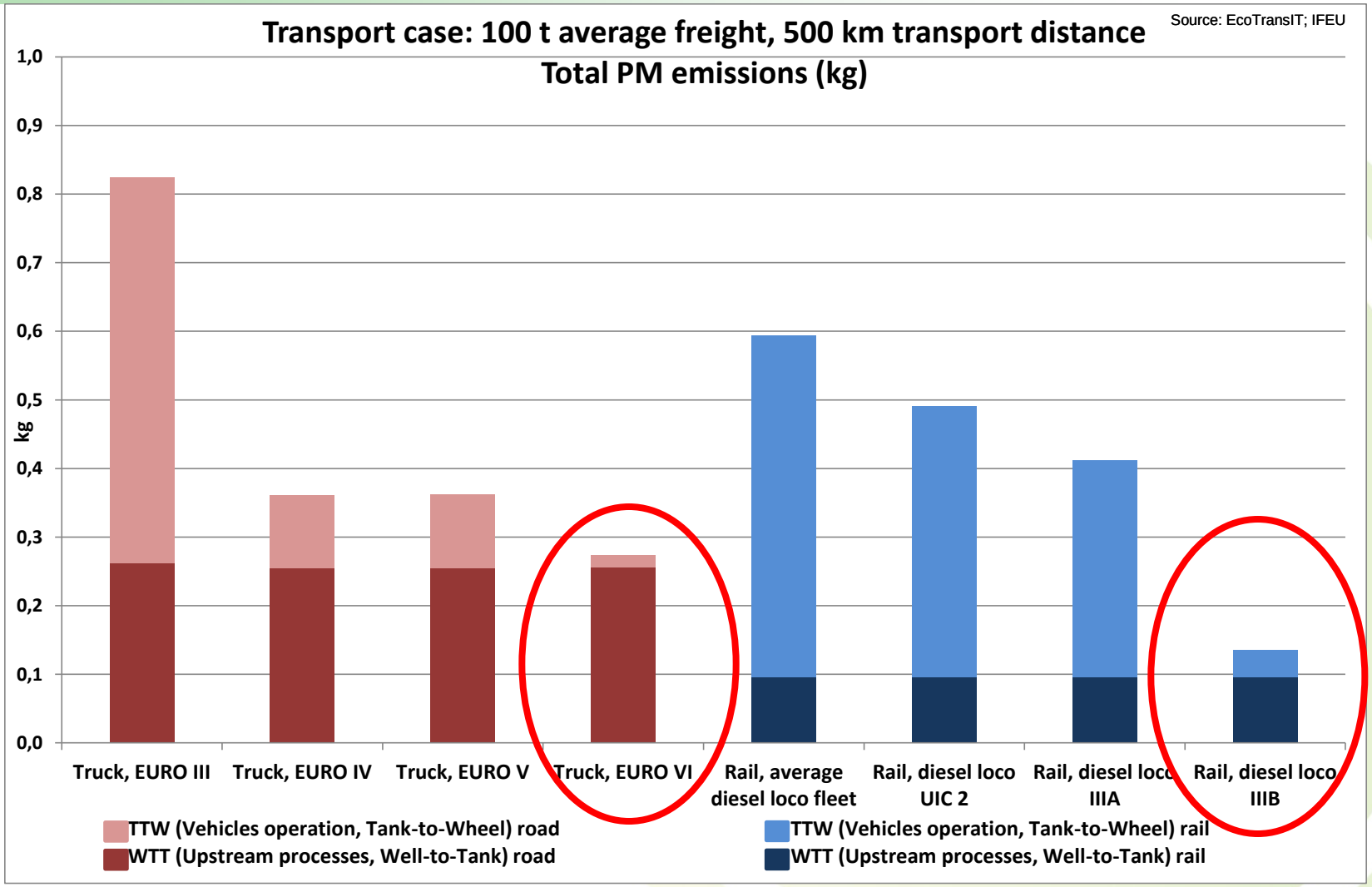
NOx emissions of different transport modes



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

PM emissions of different transport modes



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

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Conclusion and next steps

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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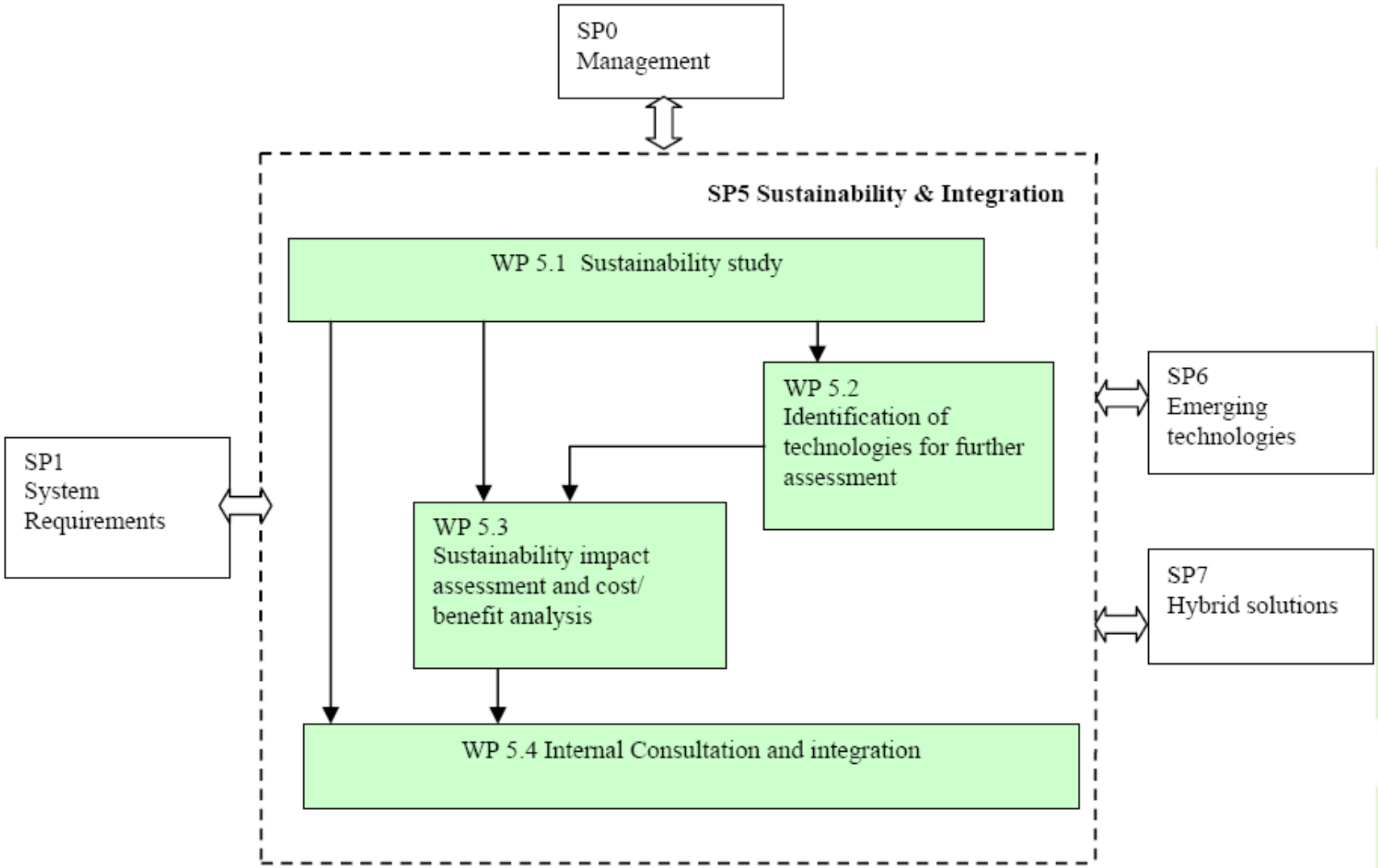
Back-up

SP 5 - Structure



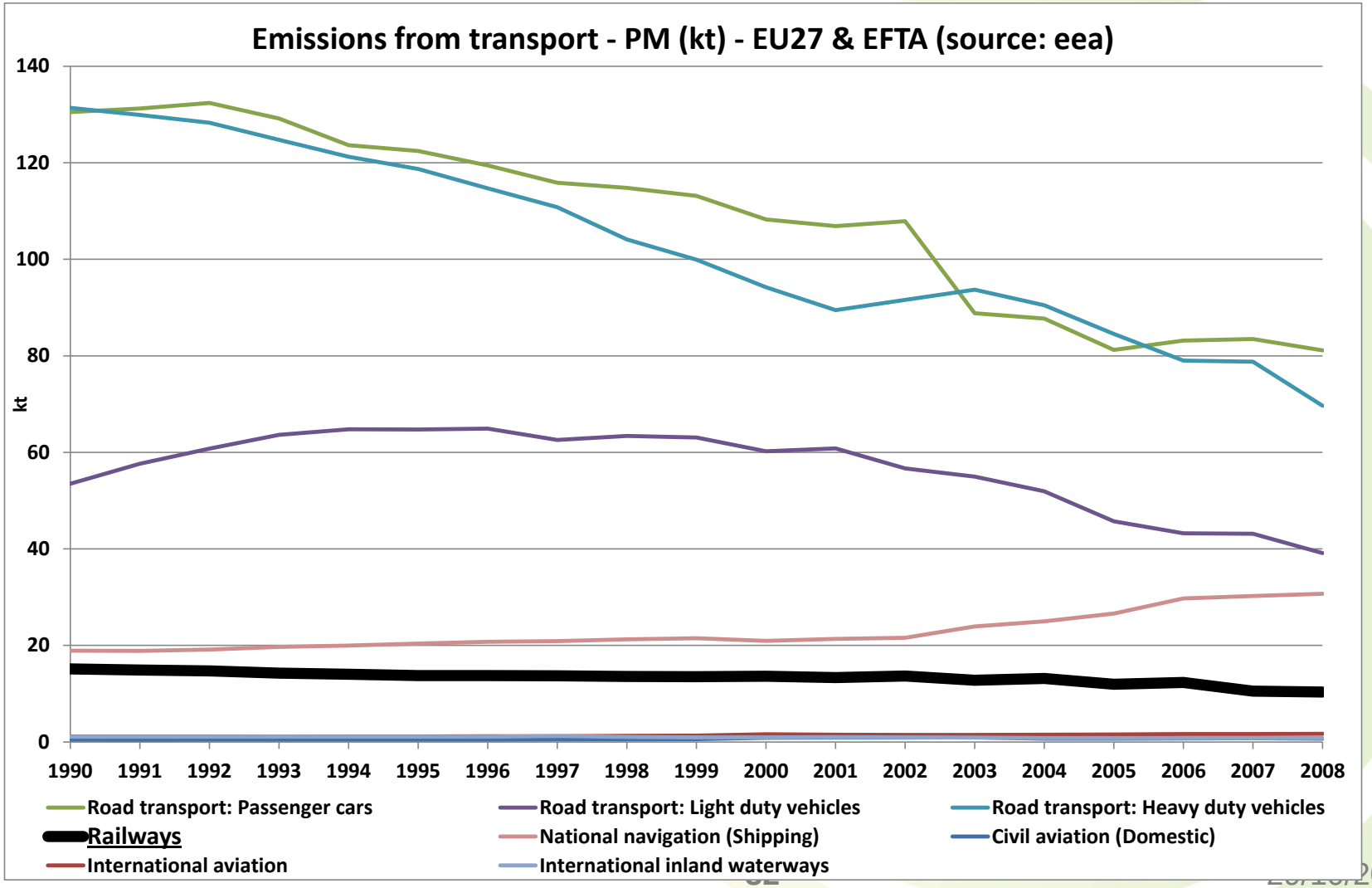
SP 5 – 12 Partners

Partner	Representatives
UIC (SP Leader)	Henning Schwarz
IZT	Roland Nolte
TEC (The Engine Consultancy)	Ahmed Al-Sened
UNIFE	Judit Sandor
Deutsche Bahn	Franz Ponholzer
Siemens	Klaus Montesi-Heimerl / Herrmann Rau
University of Newcastle	Roberto Palacin
ATOC	Bryan Donnelly
Bombardier Transportation	Andreas Degenhardt
Alstom	Dominique Hegy
MTU	Daniel Chatterjee
Voith Turbo	Gert Tekale

- 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

Total emissions transport

- Same picture for PM: Rail's diesel traction share is 4.5% only



Source: eea - European Union emission inventory report 1990-2008
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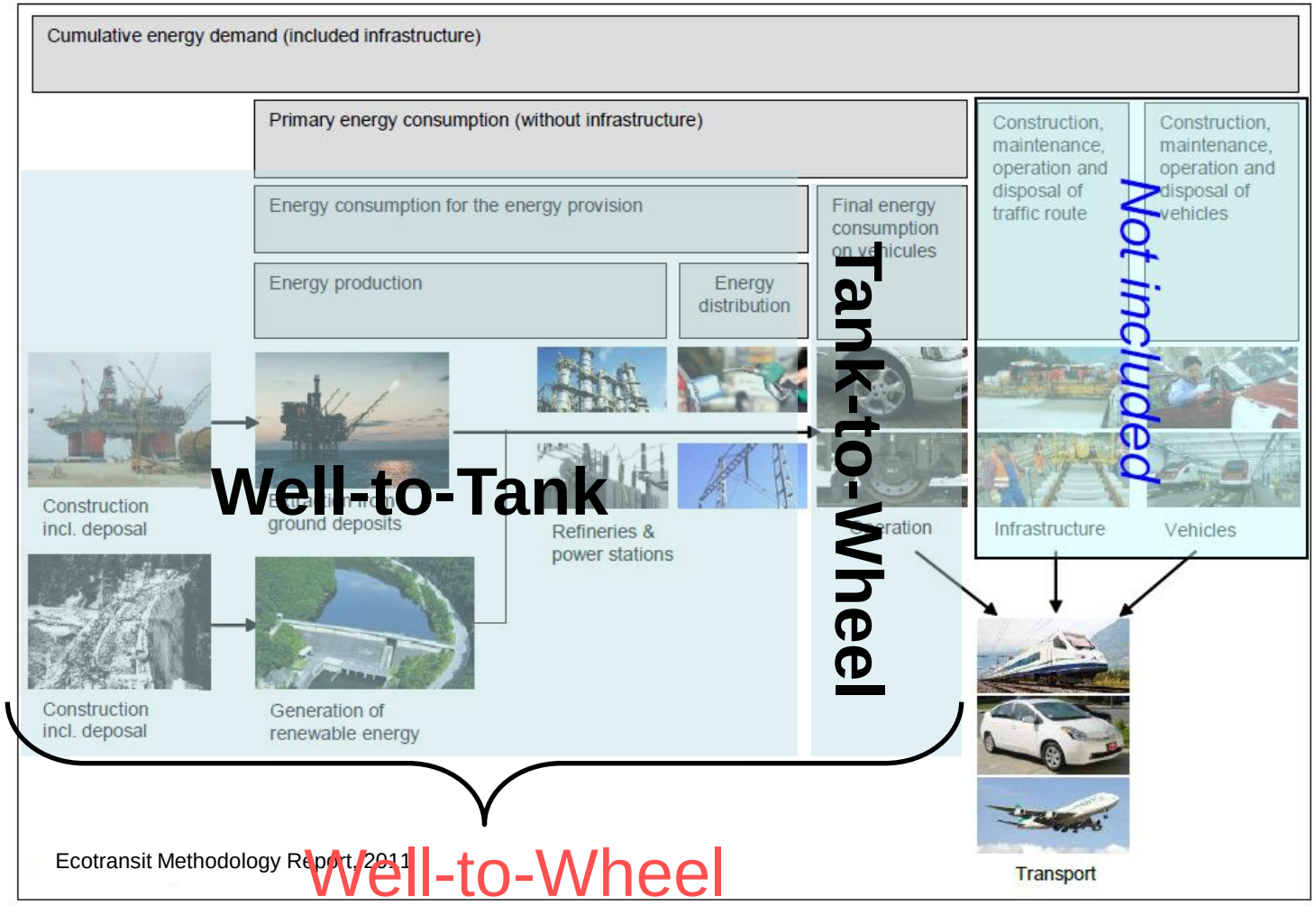
Total Exhaust Emissions Estimation - Conclusions

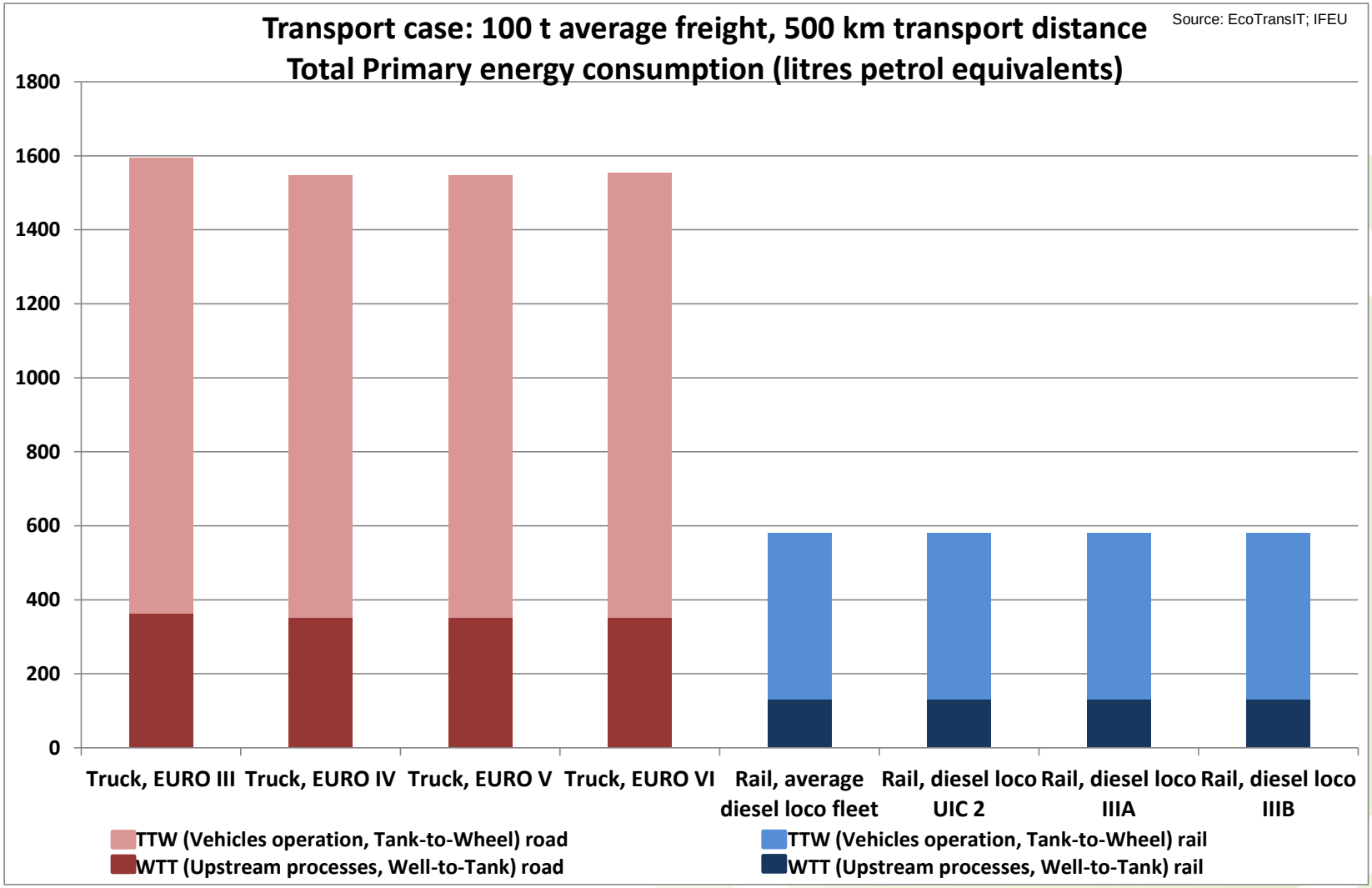
- Decrease of NOx and PM from rail diesel traction mainly due to expected sharp decrease of diesel locomotive fleet
  - Approx. more than 2/3 of NOx & PM reduction from loco fleet decrease
- But:
  - Trend: former loco hauled passenger trains are exchanged by DMUs (with higher mileage)
  - Total train-km 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



Ecotransit Methodology Report, 2011

Figure: System boundaries for Well-to-Wheel calculation

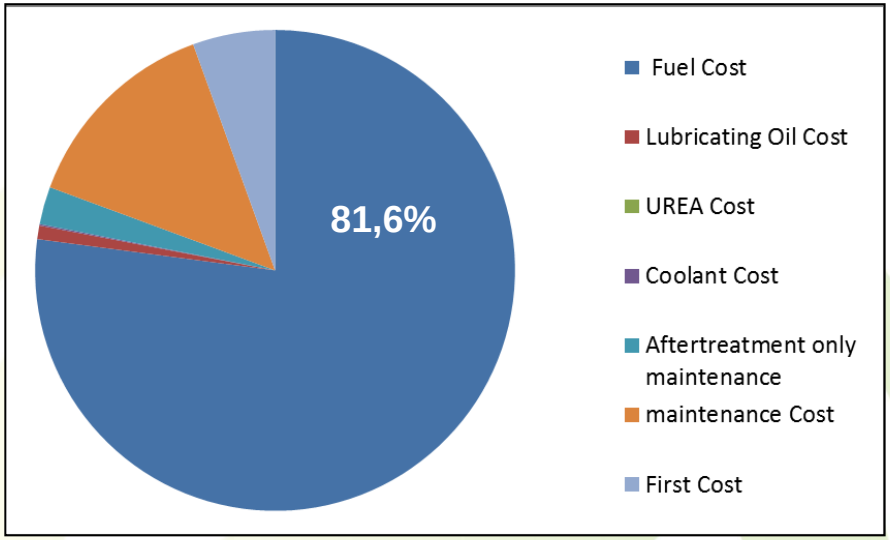
Energy consumption for defined transport per mode



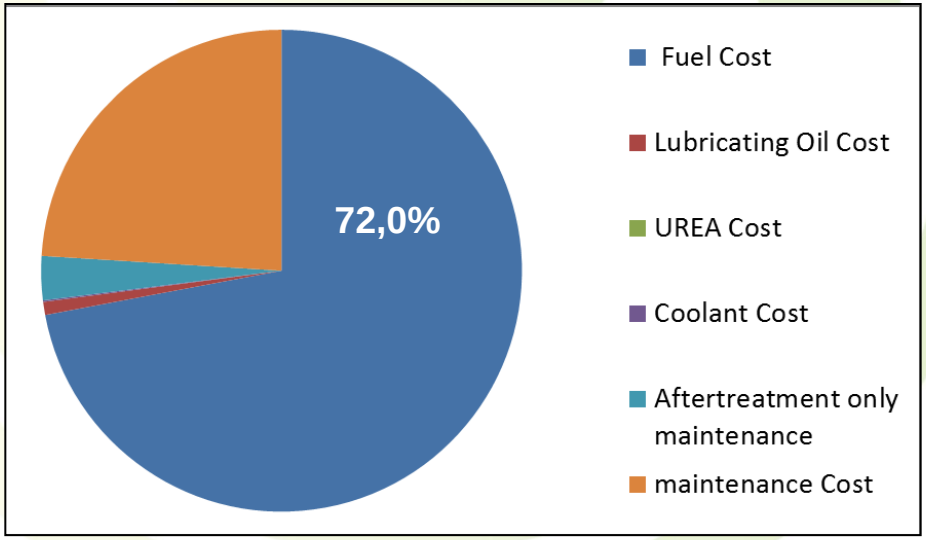
Results of the transport mode comparison calculation: Total primary energy consumption (in litres petrol equivalents)

Intermediary results Life Cycle Costs propulsion system

- 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



LCC Results for Loco with emission stage IIIB with EGR & DPF



LCC Results for DMU with emission stage IIIB with EGR & DPF

Environmental Rail Sector Strategy

- 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!