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WNTE

WNTE control area evaluation with respect to the real-world engine operation envelope

TNO | Knowledge for Business

Iddo Riemersma, 13th plenary meeting of the Off-Cycle Informal Working Group, 5-7 April 2006

Introduction

Main question:

Is the proposed WNTE control area sufficiently wide enough?

or

Are there spots in the engine map (outside the proposed control area) that have a significant contribution in real life operation emissions?

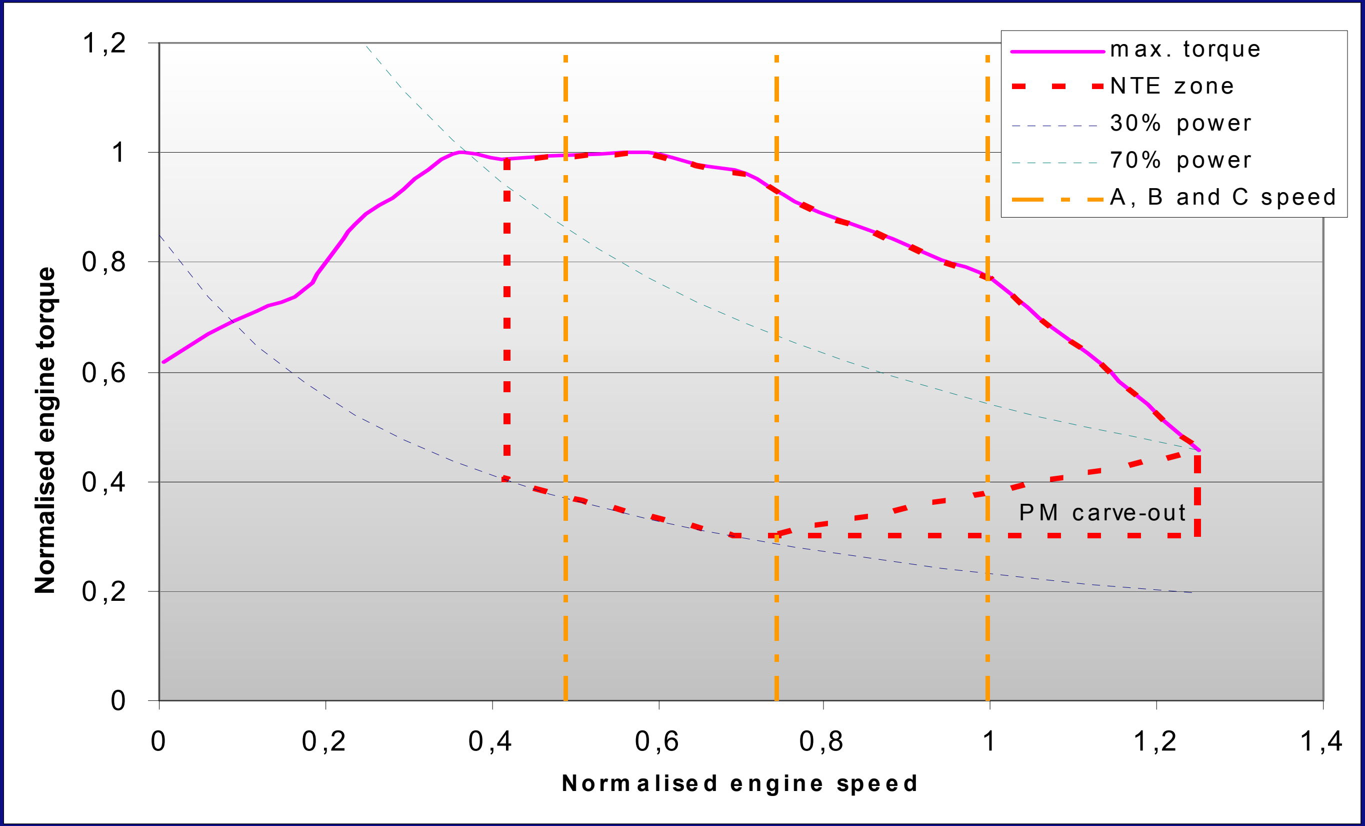
and if so,

If/how could these points be added to the proposed control area?

Presentation overview

I. Review of lower engine speed limit of the NTE zone
II. Methodology for calculating emission contributions
III. Preliminary results for typical cases of vehicle and application
IV. Further steps: WNTE evaluation project for DG Enterprise

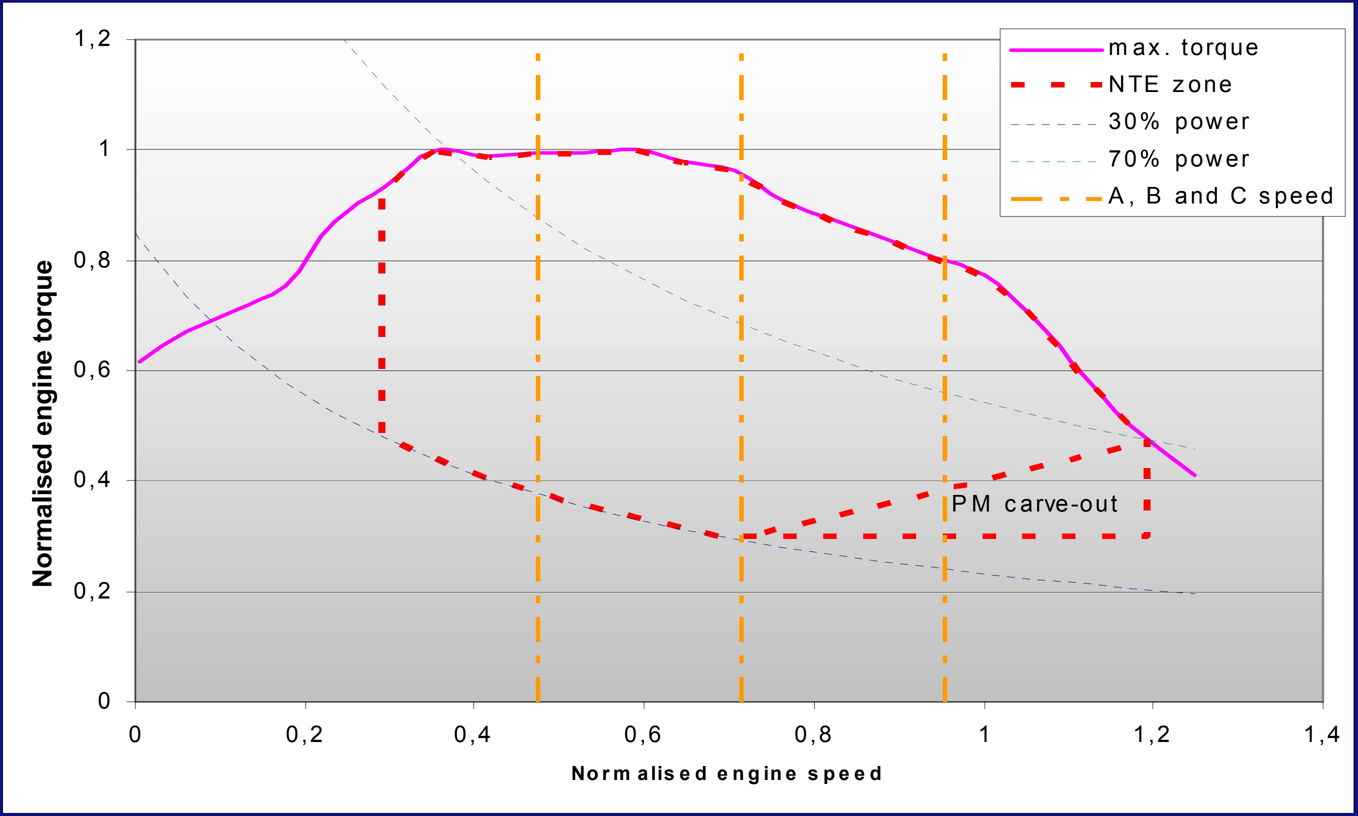
WNTE control area (work.doc. version 8)



Control area for ‘average’ Euro 3 engine

Lower speed limit based on US NTE approach at $n_{lo}+0.15(n_{lo}+n_{high})$

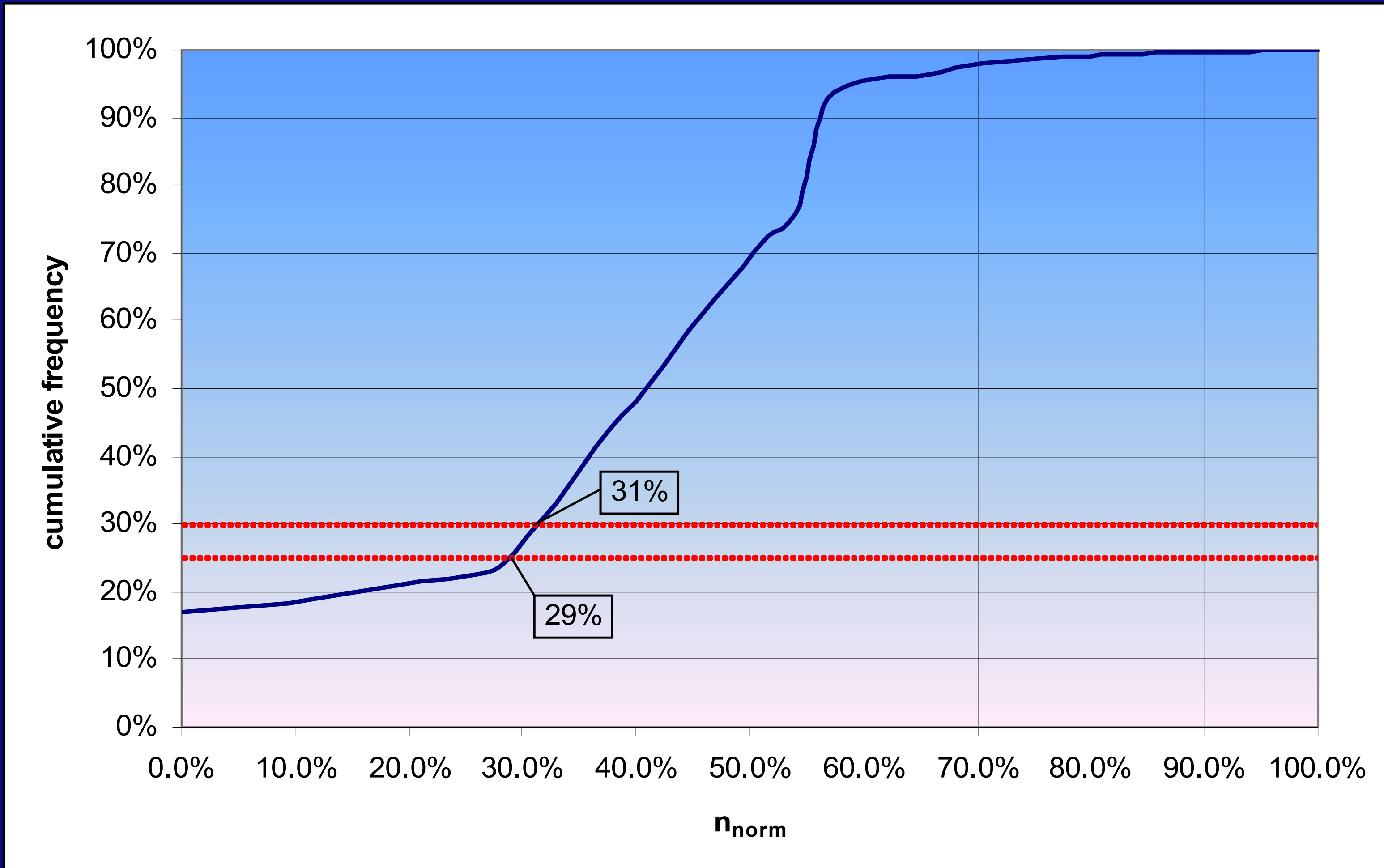
WNTE control area (work.doc. version 9)



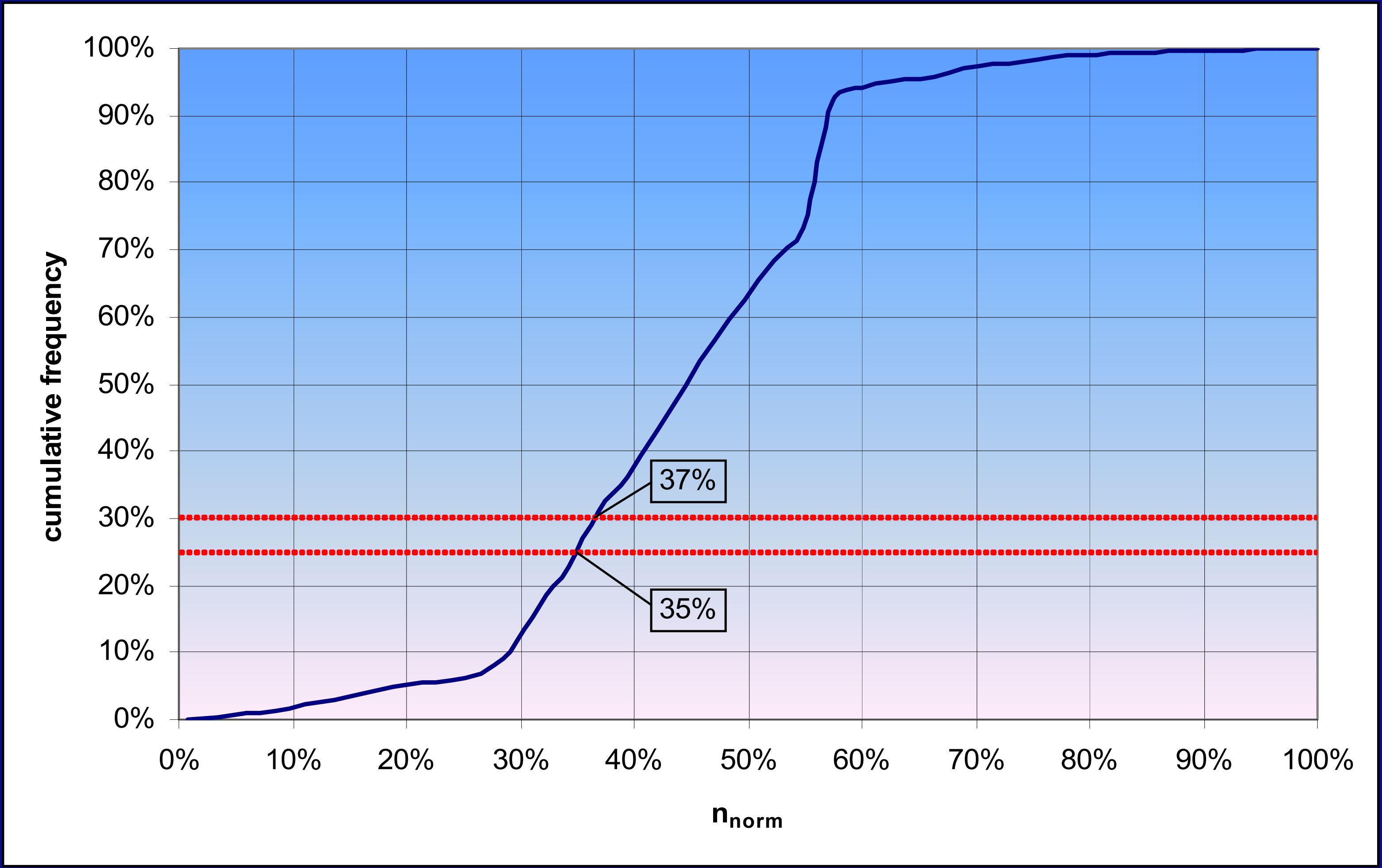
Control area for ‘average’ Euro 3 engine

Lower speed limit is 25th percentile of cum. frequency for WHTC incl. idle

WHTC cumulative frequency including idle



WHTC cumulative frequency excluding idle



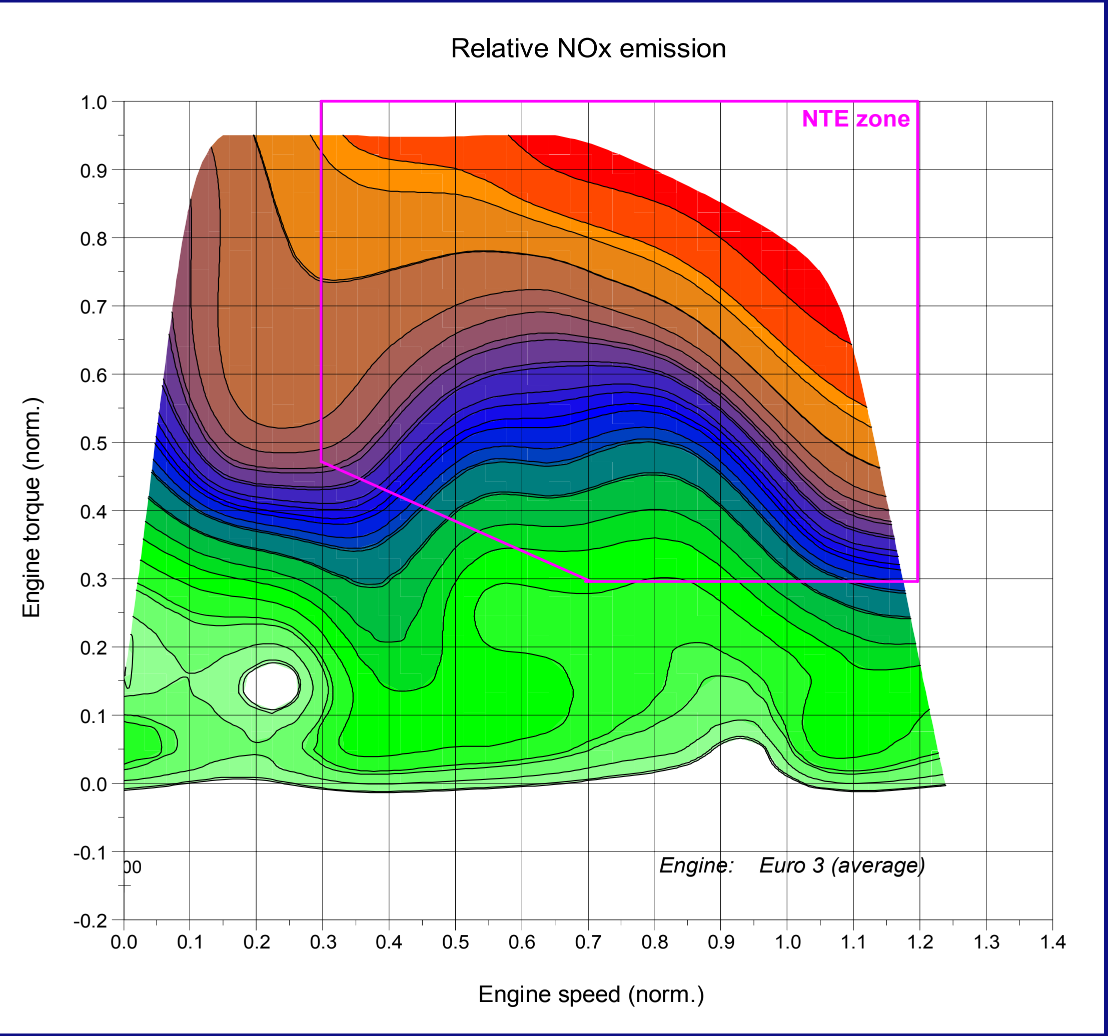
Conclusion on NTE lower engine speed limit

- 25th percentile (including idle) is close to the bend of the curve
- Increase to 30th percentile is more ‘safe’ while lower limit increase is only small
- Lower limit for 25th percentile excluding idle is higher than 30th percentile including idle

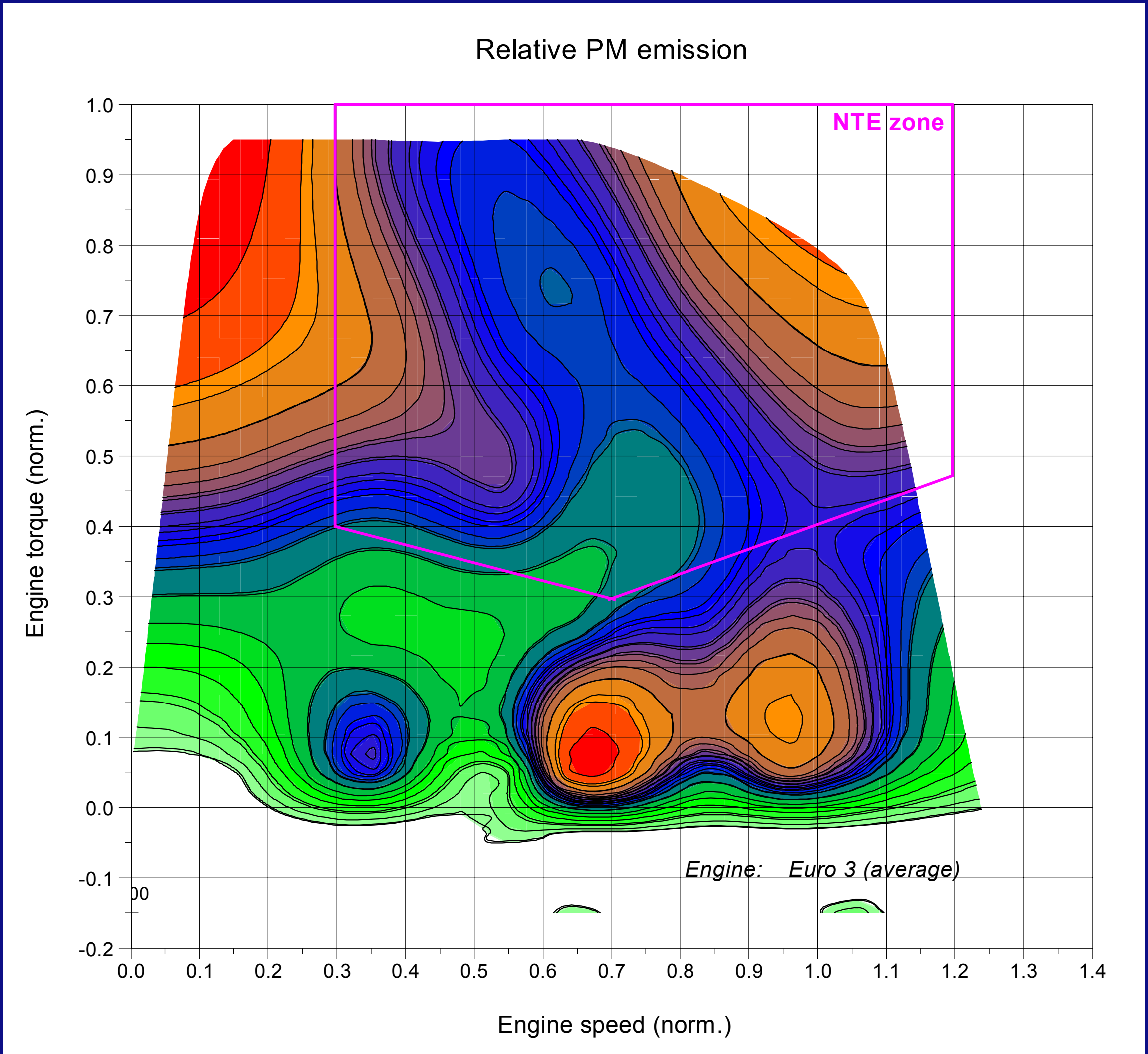
II. Methodology for calculating emission contribution

1. Determine the WNTE area for an ‘average’ engine
2. Simulate a number of representative cases (representative vehicle types over representative real-life driving cycles)
3. Calculate the emission contribution for each part of the engine map
4. Evaluate the emission contributions in- and outside the control area
5. Consider whether an extension of the NTE zone is rational against the emission map

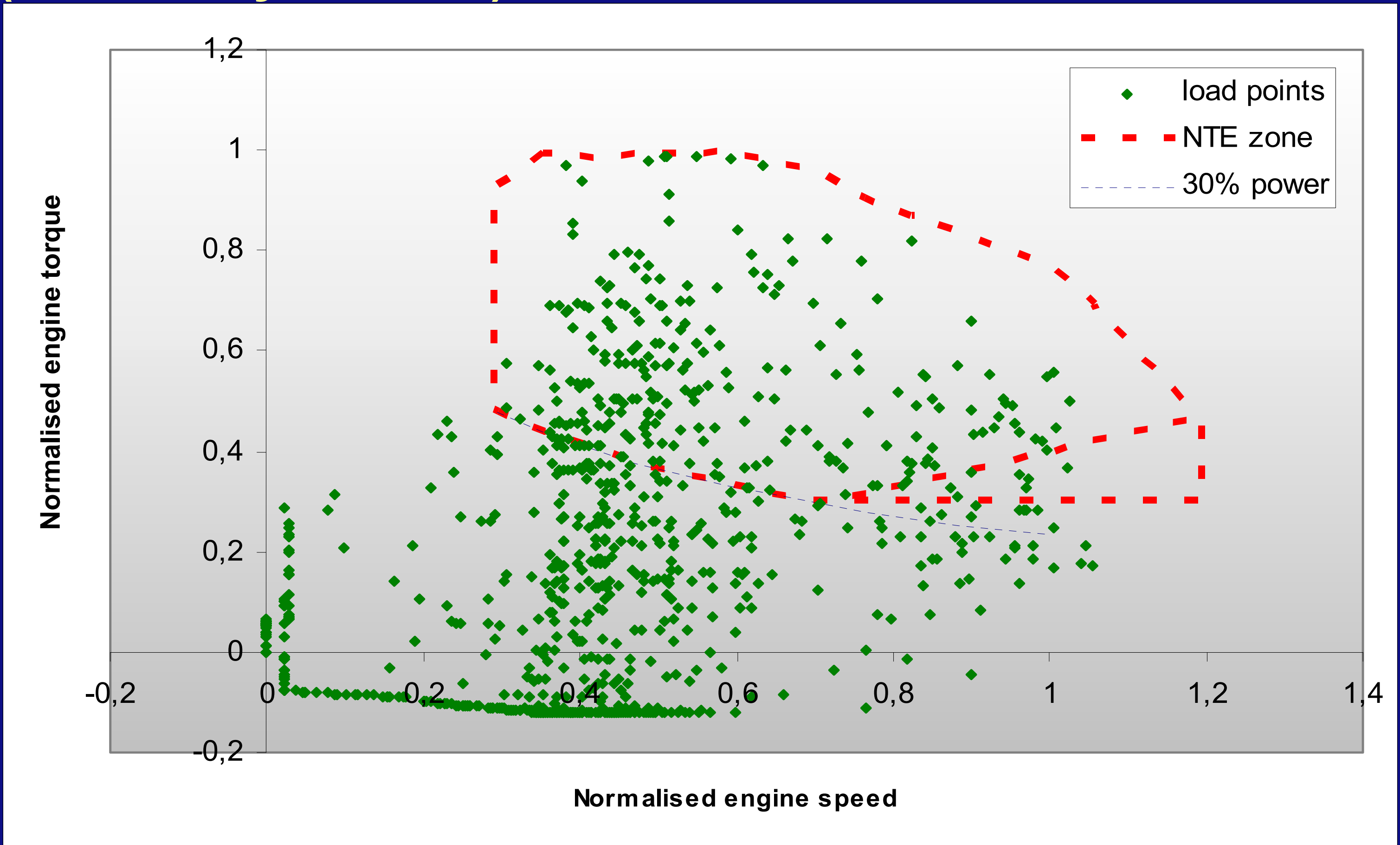
NO_x emission map in [g/h] for average Euro 3



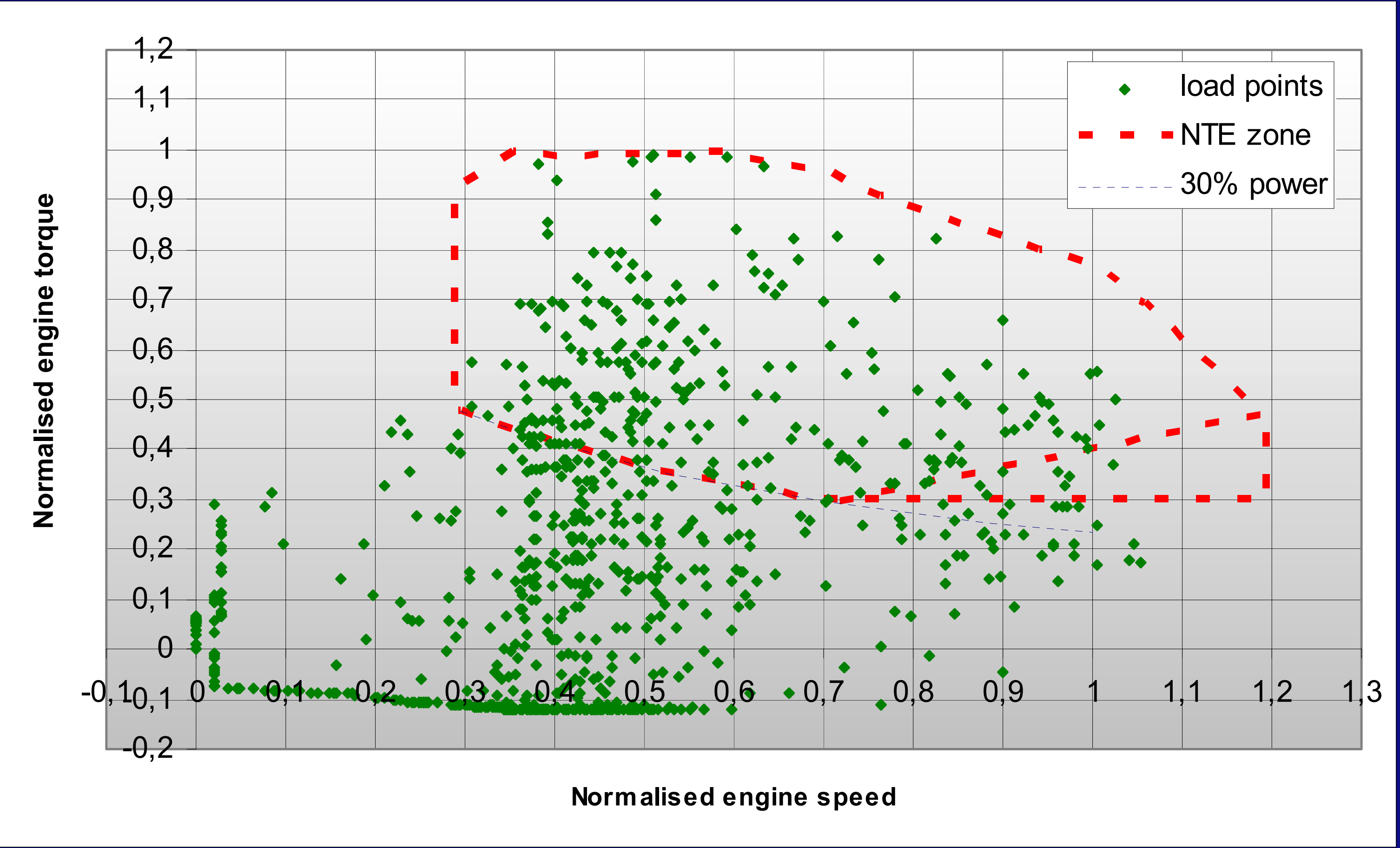
PM emission map in [g/h] for average Euro 3



Simulated city driving cycle for truck with trailer (second by second)

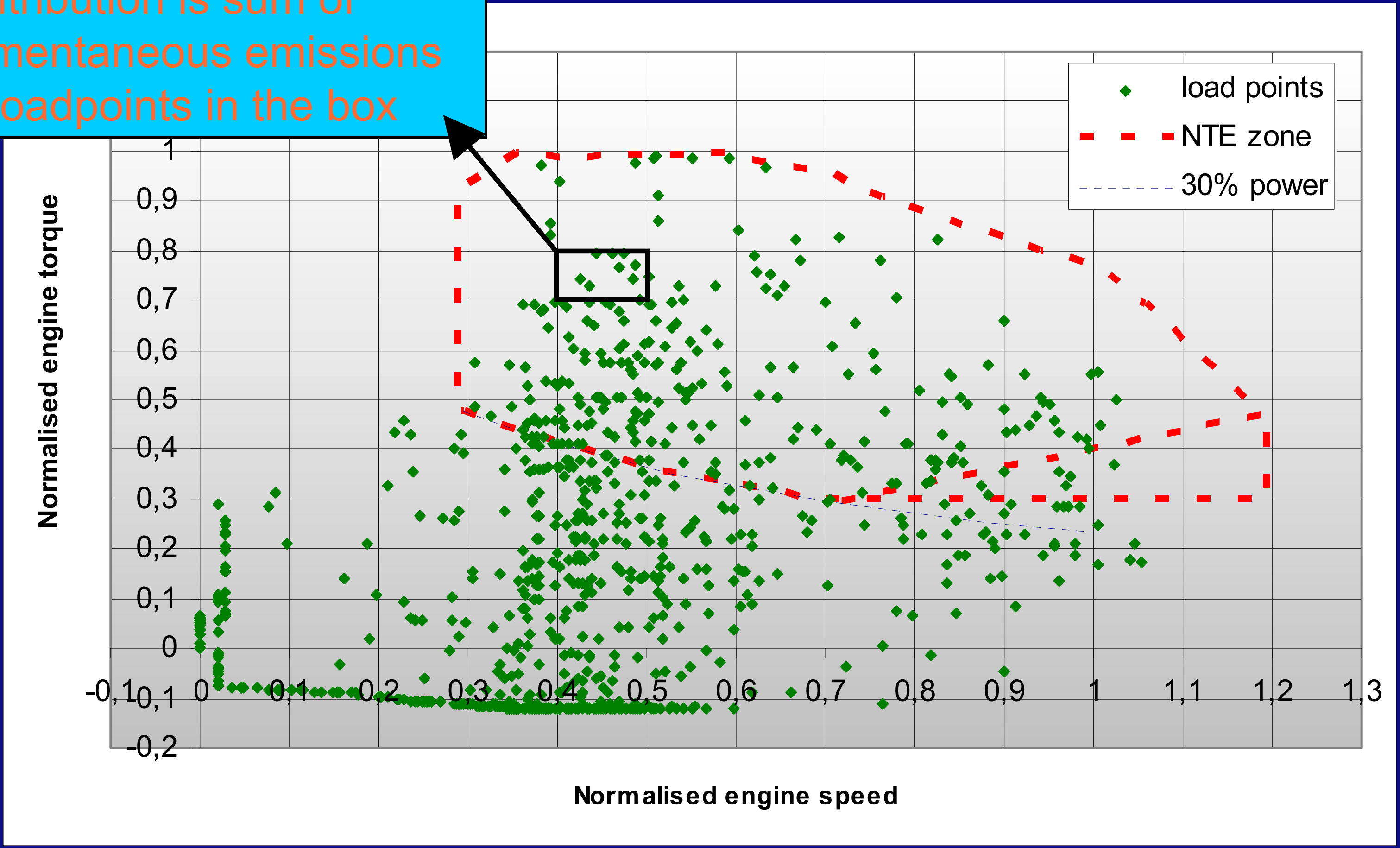


Grid is placed over the engine map

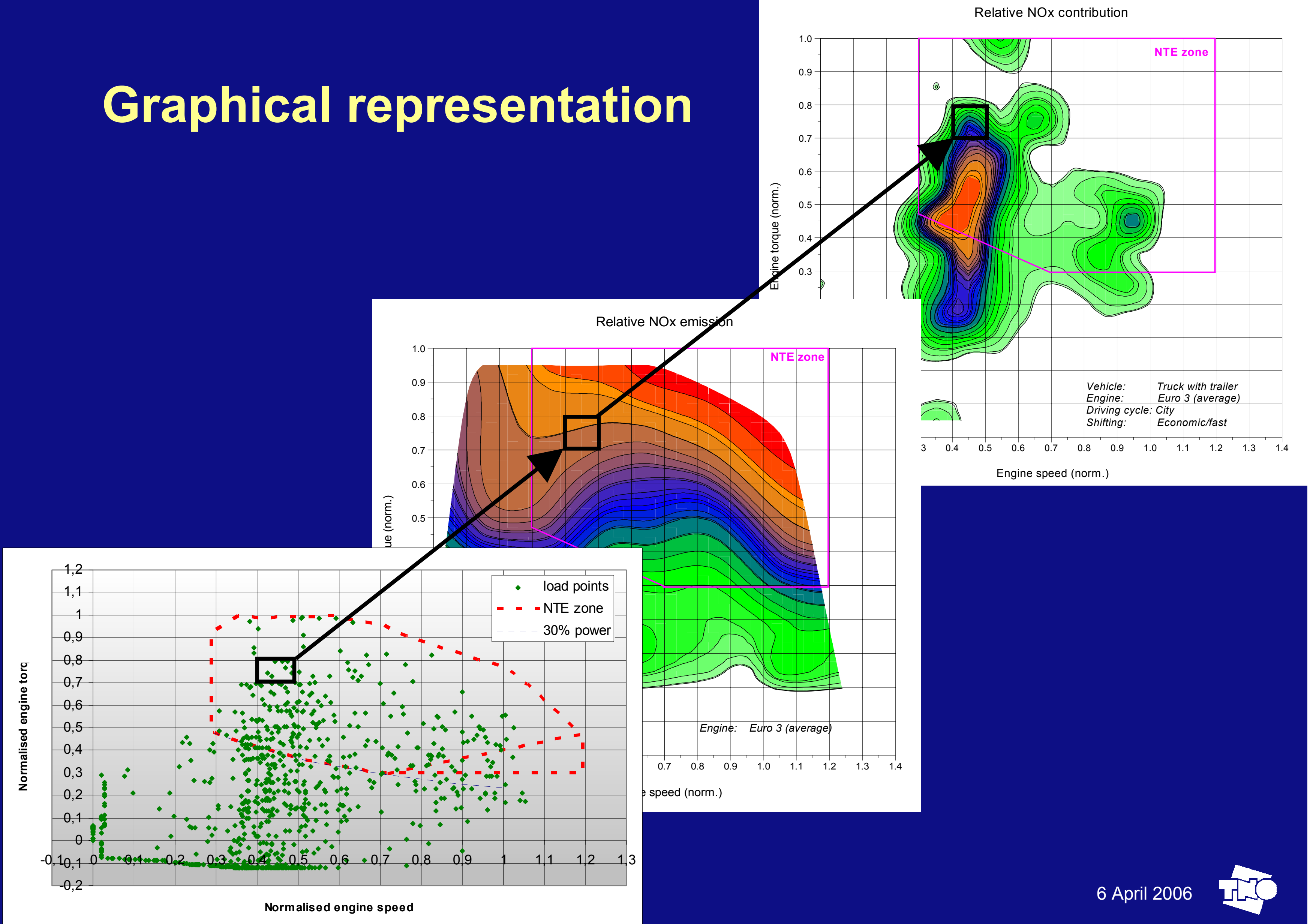


Emission contribution per box is calculated

Contribution is sum of momentaneous emissions for loadpoints in the box



Graphical representation



III. Results for typical cases

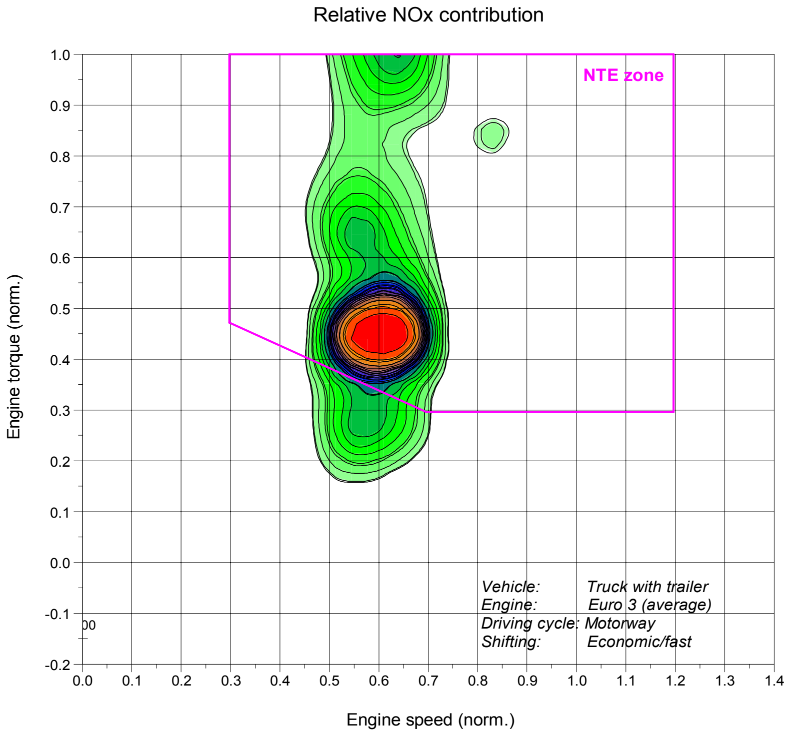
Truck with trailer on

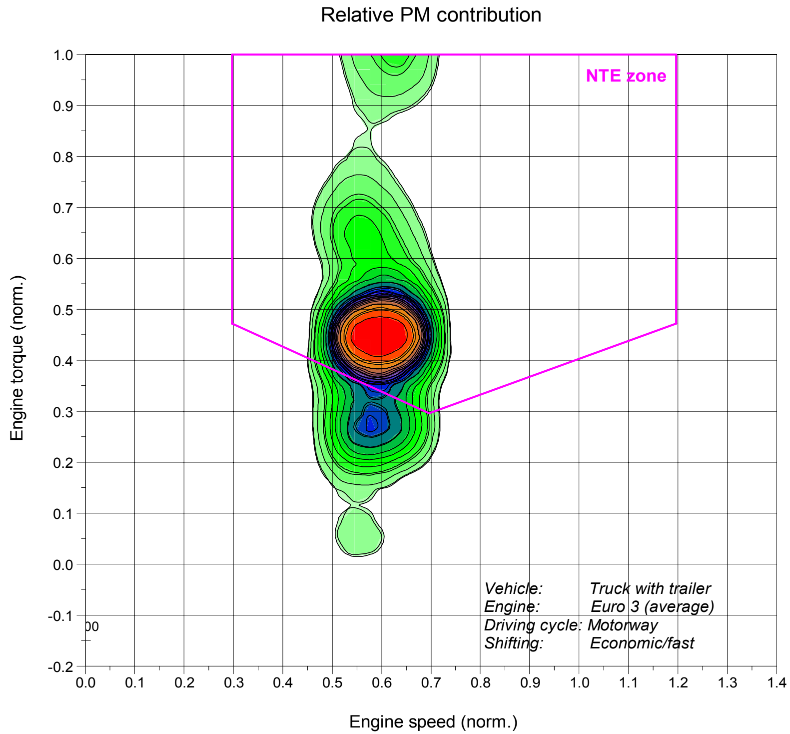
- Urban road
- Rural road
- Motorway

City bus on an urban road

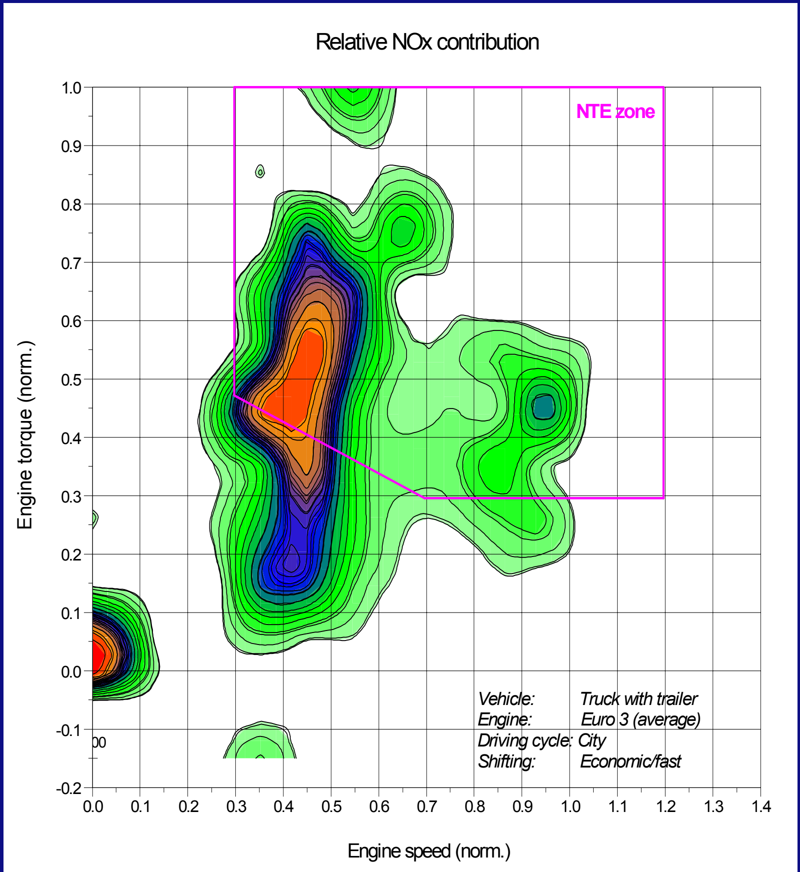
Based on (average) Euro 3 emission map

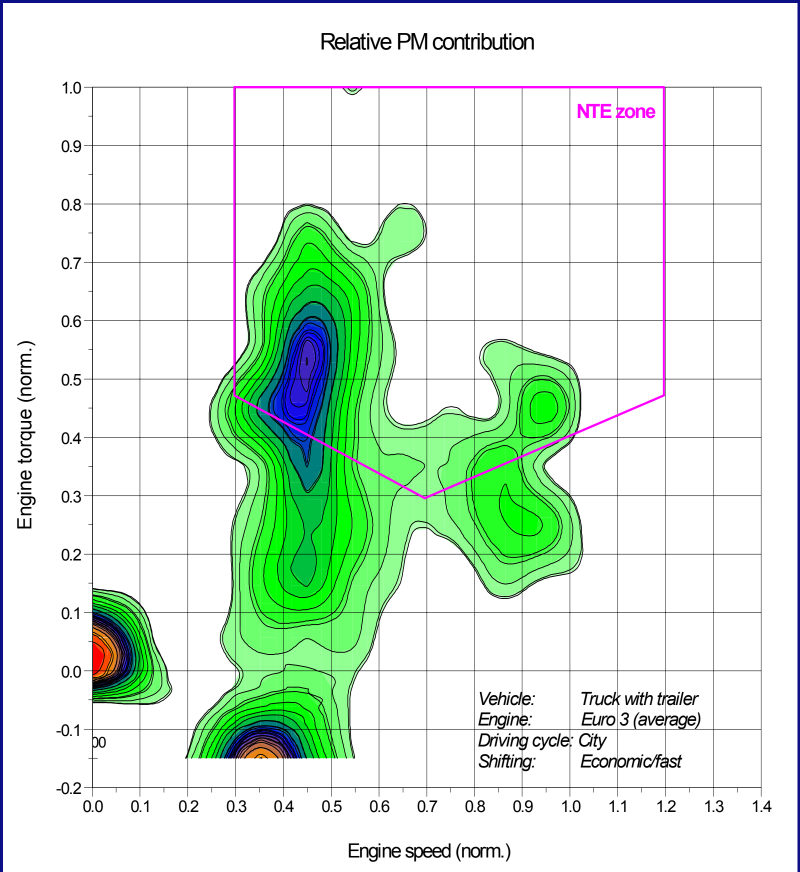
Results for NO_x and PM (truck/trailer in motorway driving)





Results for NO_x and PM (truck/trailer in city driving)

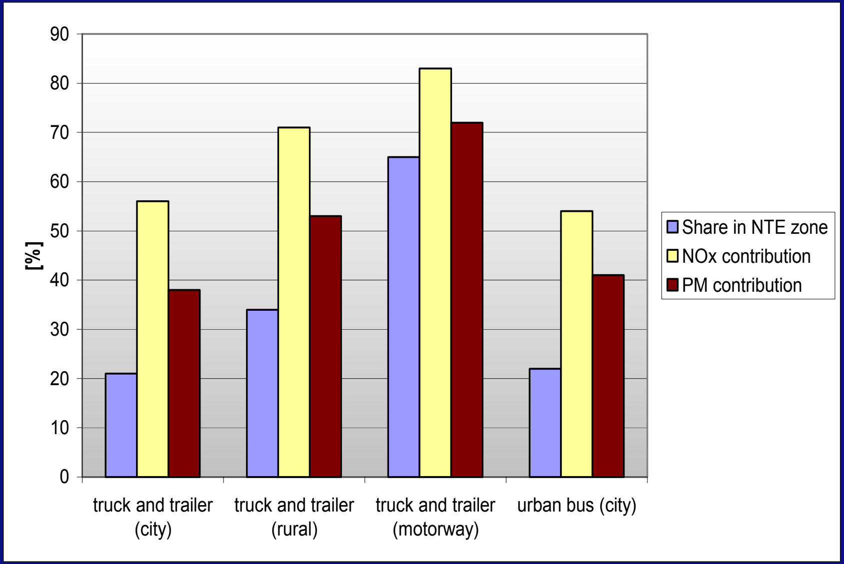




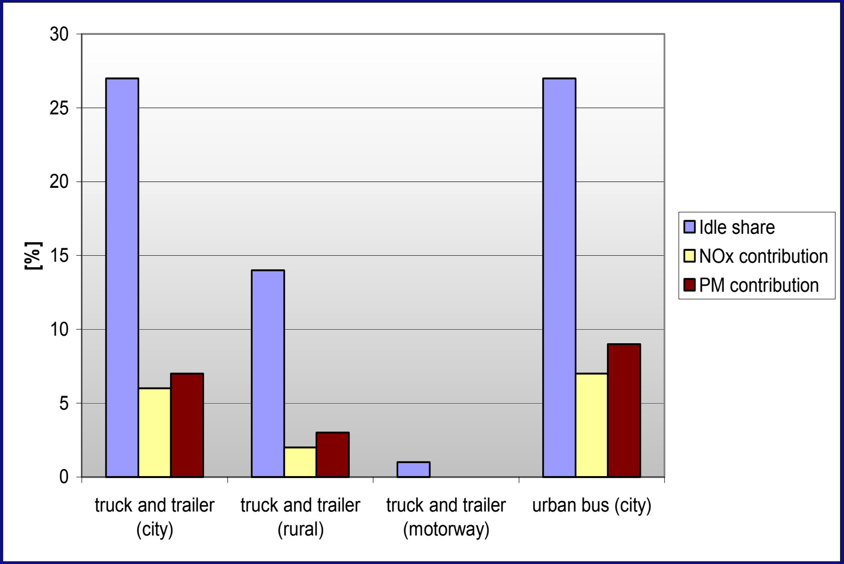
- Carve-out below 30% power excludes a high emission contribution area (for this particular case)
- Emission contribution in carve-out for PM is rather low

Results for different cases

NTE zone contribution
(excl. 30 sec. interval)

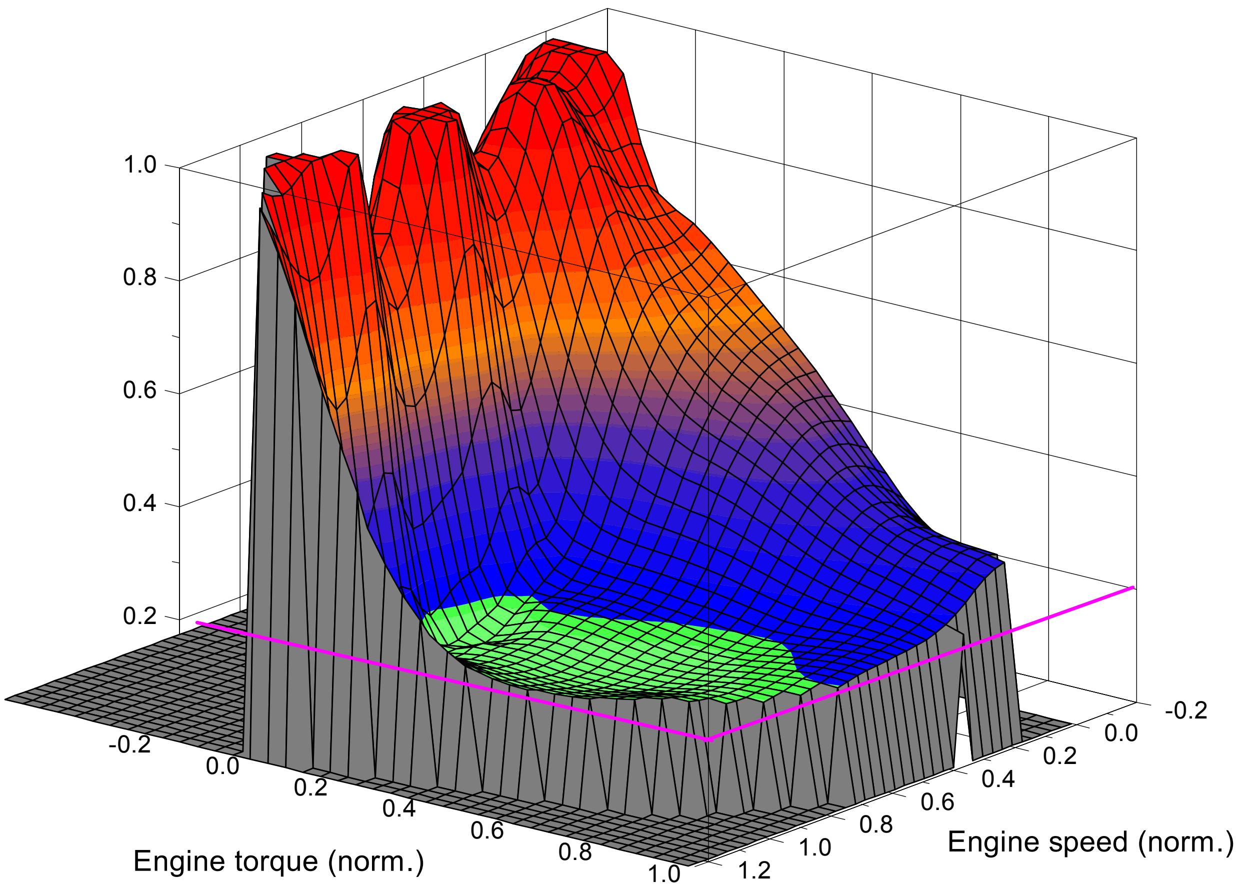


Idle contribution



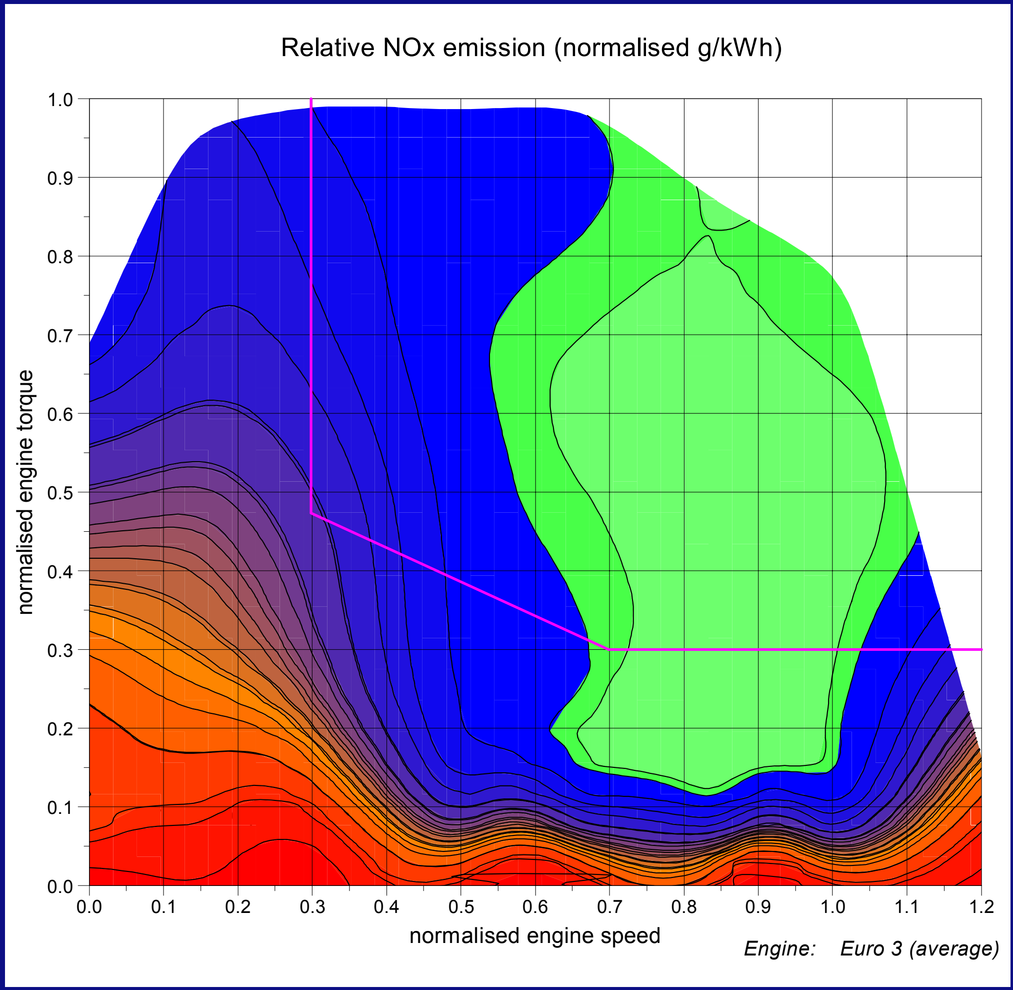
NTE share could be increased by
a larger NTE zone

Relative NOx emission [g/kWh]



Engine: Euro 3 (average)

Relative NOx emission [g/kWh]



Preliminary conclusions

- Time share of engine operation in NTE zone rather low
- Emission contribution in NTE zone is considerably higher
- Emission contribution of idle operation is comparatively low
- Carve-out below 30% power excludes a high emission contribution area (depending on the vehicle application)
- Carve out for PM seems unnecessary

BUT: this is only concluded on a limited dataset. Further research is needed and will be executed during a study for DG Enterprise

IV. Further steps: WNTE evaluation for DG Enterprise

Purpose: to appraise the suitability to European engines and driving conditions of the draft WNTE control zone concept (OCE GTR)

Funded from the DG-ENT framework contract on "**Economic and technical assistance in relation to the emission of environmental pollutants from automobiles**"

Project team:
- TNO Automotive (NL)
- TÜV Nord (D)
- TU Graz (A)
- EMPA (CH)

Project scope

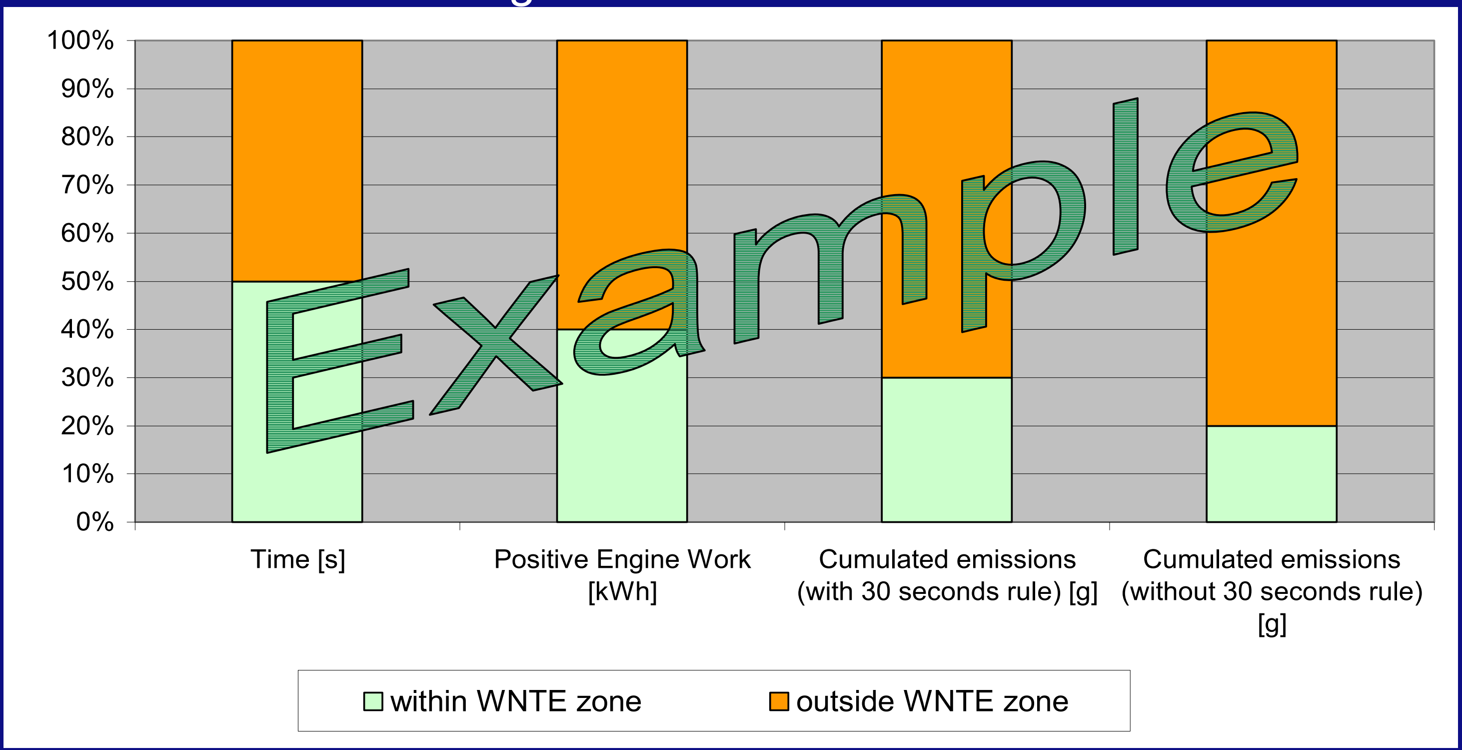
TASK 1 – Assessment of WNTE concept in current GTR

- Existing driving patterns data for representative categories of vehicle type and application (from WHDC database)
- Simulation of PM and NO_x emissions per category using current PHEM model (Euro 3 engine map)
- Graphical presentation of emissions in/outside the NTE control zone

Project scope

Output of Task 1:

- Timeshare in/outside the NTE control zone
- Positive work in/outside the NTE control zone
- Emissions in/outside the NTE control zone
- Effect of interval length on these shares of time/work/emissions



Project scope

TASK 2 – Assessment of NTE concept for future HD engines

Based on:

- Limited amount of existing data for Euro 4/5 engines (quantitative)
- Expert views on Euro 5/6 engines behaviour/calibration (qualitative)

Resulting in:

- Identifying possible limitations in NTE zone proposal

TASK 3 – Review of the effectiveness of WHDC and WNTE concepts as a whole

- Coverage of 'higher risk' areas
- Elimination of defeat devices and/or irrational control strategies
- Identifying possible limitations

Project scope

TASK 4 – Consider rationale for improving NTE definitions:

- Changing engine speed limit of NTE zone
- Review of carve outs (e.g. 30% power, PM carve out)
- 30 seconds interval
- Review of compliance factor (1.25, 1.5 or other)

TASK 5 – Assessment of ambient temperature and pressure boundaries

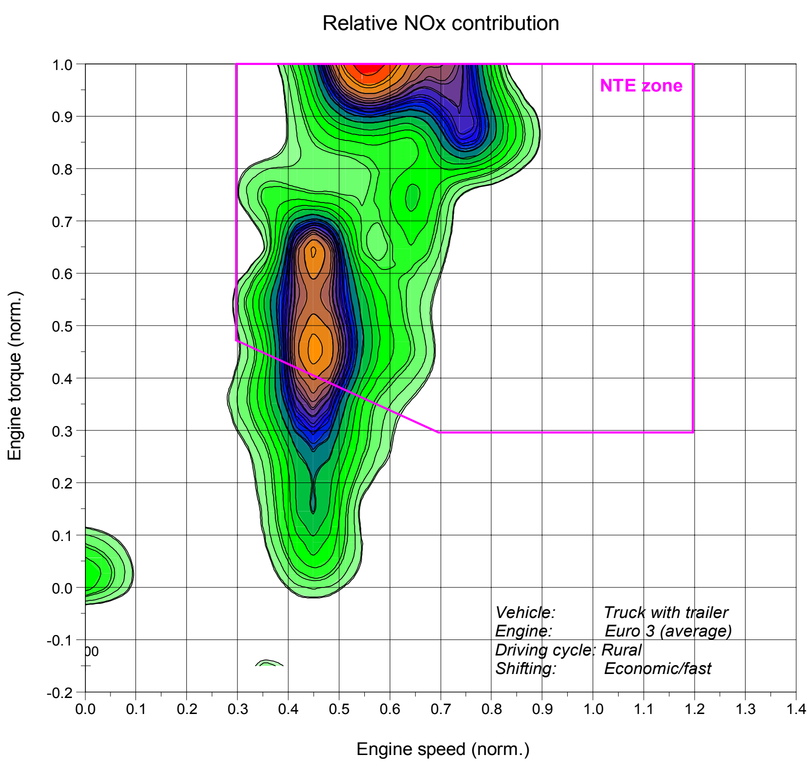
- Analysis of existing on-road measurements
- Expert view for future engine technology

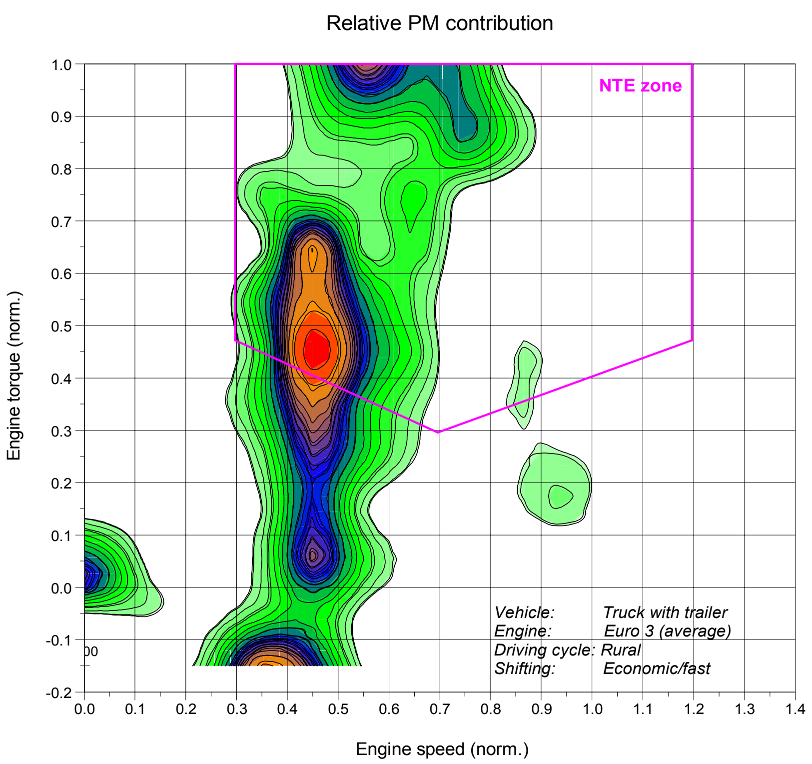
TASK 6 – Review of alternative NTE concepts

Including (but not limited to):

- Work-based window
- Compliance factor (based on BSFC instead of torque)

Results for NO_x and PM (truck/trailer in rural driving)





Results for NO_x and PM (city bus in urban driving)