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Estimation of the change in emissions of powered two-wheelers due to new legislation

Conrad Piasecki
Federal Highway Research Institute (BASt)



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1. Introduction

- Road transport one of the largest emitter of air pollutants and carbon dioxide (17,4 % CO₂ in Germany in 2010)
 - Growing impacts on human health and environment (toxicological effects, climate change)
 - Especially hydrocarbon emissions caused by powered two wheelers
- ➡ Impairment of air quality in urban areas
- ➡ Formation of ground-level ozone

Regulation EU 168/2013

- New emission standards for powered two-wheelers in 2016 (Euro 4) and 2020 (Euro 5)
- Evaporative emissions limited for the first time
 - Diurnal losses
 - Running losses
 - Hot soak emissions
- Their share of hydrocarbon emissions estimated to be rather high

Aim of this research project:

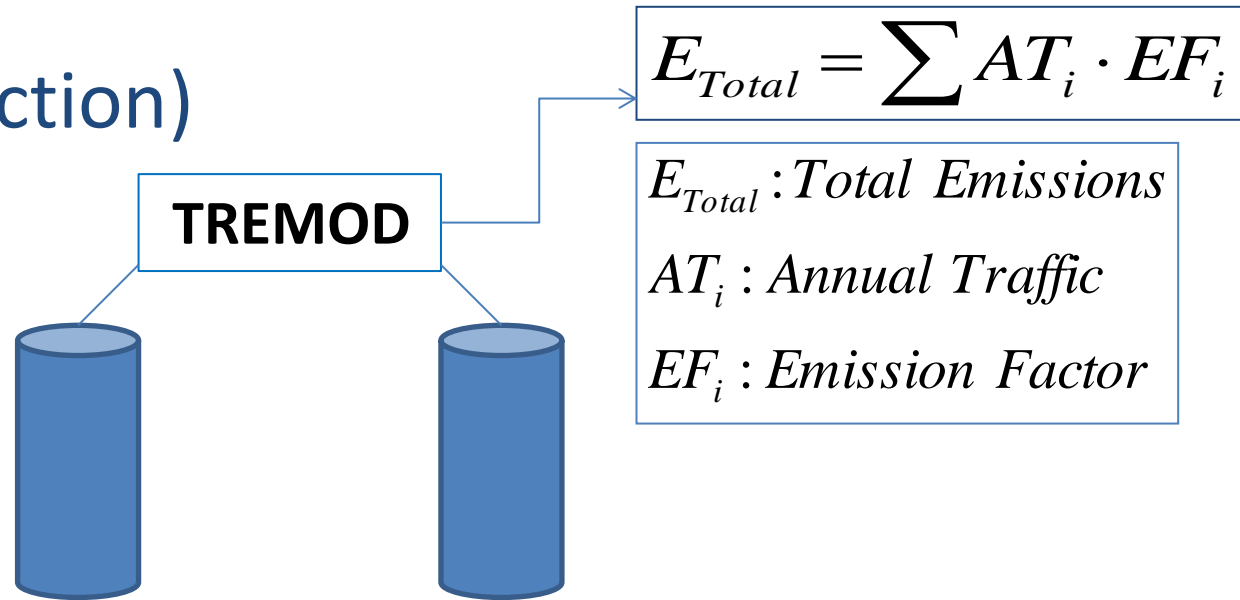
- ➔ First investigation of the evolution of exhaust hydrocarbon emissions of motorcycles after the introduction of new emission standards

TREMOD (Transport Emission Modell)

- Tool for calculation and estimation of emissions and energy consumption of road traffic in Germany
 - Contains detailed information of emissions and fuel- and energy consumption for road-, rail-, air-, and waterway transport
- Developed on behalf of the Federal Environment Agency

| Differentiation criteria | |
|--------------------------|--|
| Vehicle category | Passenger car, heavy duty vehicle, motorcycle, ... |
| Motorization / fuel | Gasoline, Diesel, LPG, CNG, ... |
| Emission standard | Euro 1, Euro 2, Euro 3, Euro 4, ... |
| Engine capacity | <50cm ³ (mopeds), <150cm ³ , 150-249cm ³ , 250-750cm ³ , >750cm ³ |
| Pollutant components | HC, NO _x , CO, CO ₂ , SO ₂ , CH ₄ , ... |
| Traffic situation | Stop & Go, Saturated, Free, ... |

TREMOD (Function)



Emission factors

- Specific emission rate in a defined driving situation
- Based on exhaust gas measurements
- Collected in Handbook of Emission Factors (HBEFA)

Annual traffic and stock data

- Derived from driving performance surveys / counting stations
- Stock information taken from inventory register (Federal Transport Motor Authority)

3. Method

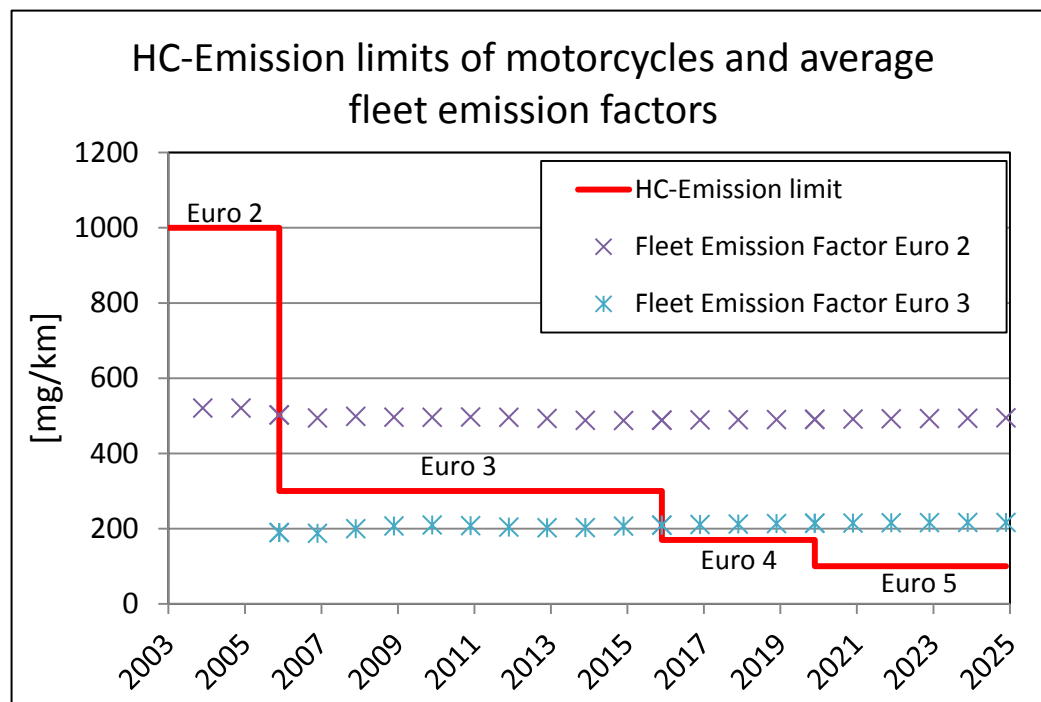
Assumptions and approach:

- TREMOD V. 5.52 includes data for motorcycles up to Euro 3
- Difficult to make assumptions of real emissions of Euro 4 and Euro 5 motorcycles as no measurement based data are available
- The adaptation of the database to the new emission standards Euro 4 and Euro 5 is done in several steps:
 1. Absolute stock numbers and annual traffic of motorcycle fleet seems appropriate (remains the same)
 2. All vehicles that are newly registered from 2016 and 2020 onwards fulfill the new emission standards
 3. The average fleet HC-Emission factors of Euro 4- and Euro 5 motorcycles are set in accordance to the new emission limits in regulation (EU) 168/2013 (Euro 4: operational hydrocarbon emission limit: 170 mg/km, Euro 5: 100 mg/km)

Method

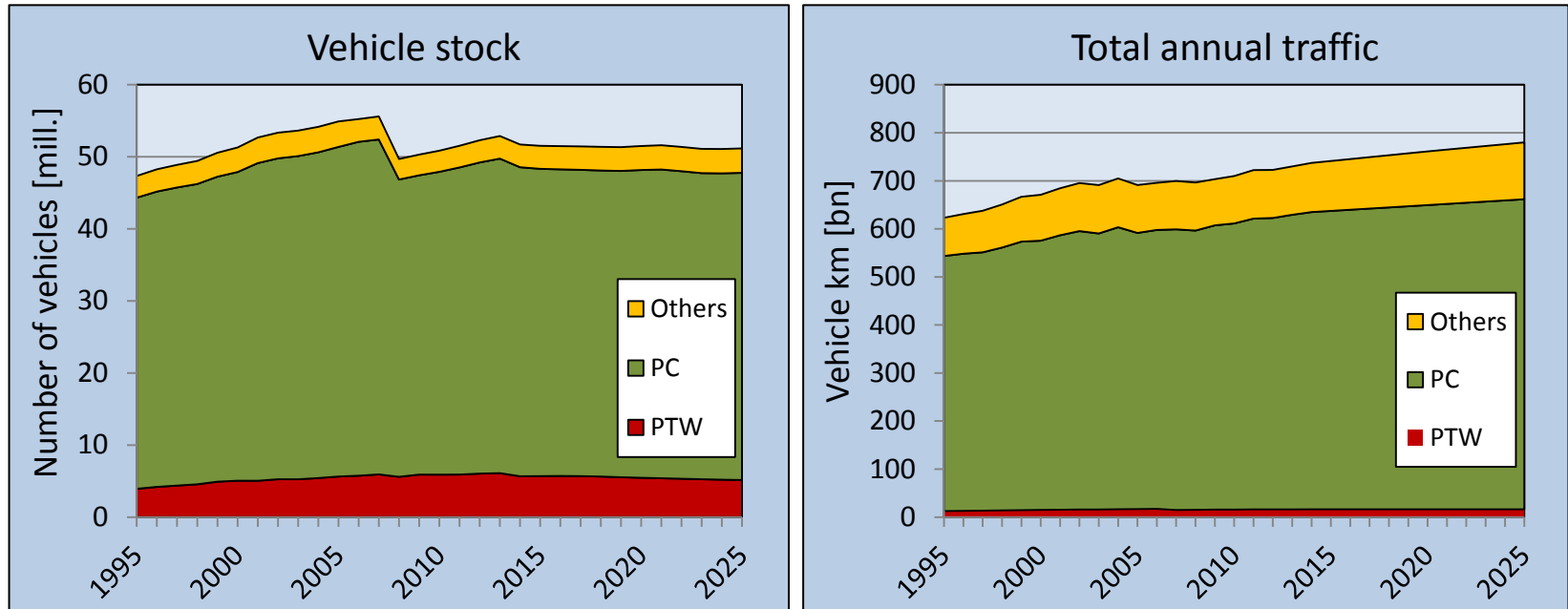
Uncertainties

- The adoption shows the **minimal reduction potential** of the new legislation as a first approximation
- It is assumed that the real hydrocarbon emissions of the Euro 4- and Euro 5 fleet will be below the limit values
- The average fleet emission factors of motorcycles with former emission standards are also below former limits



4. Calculations and Results

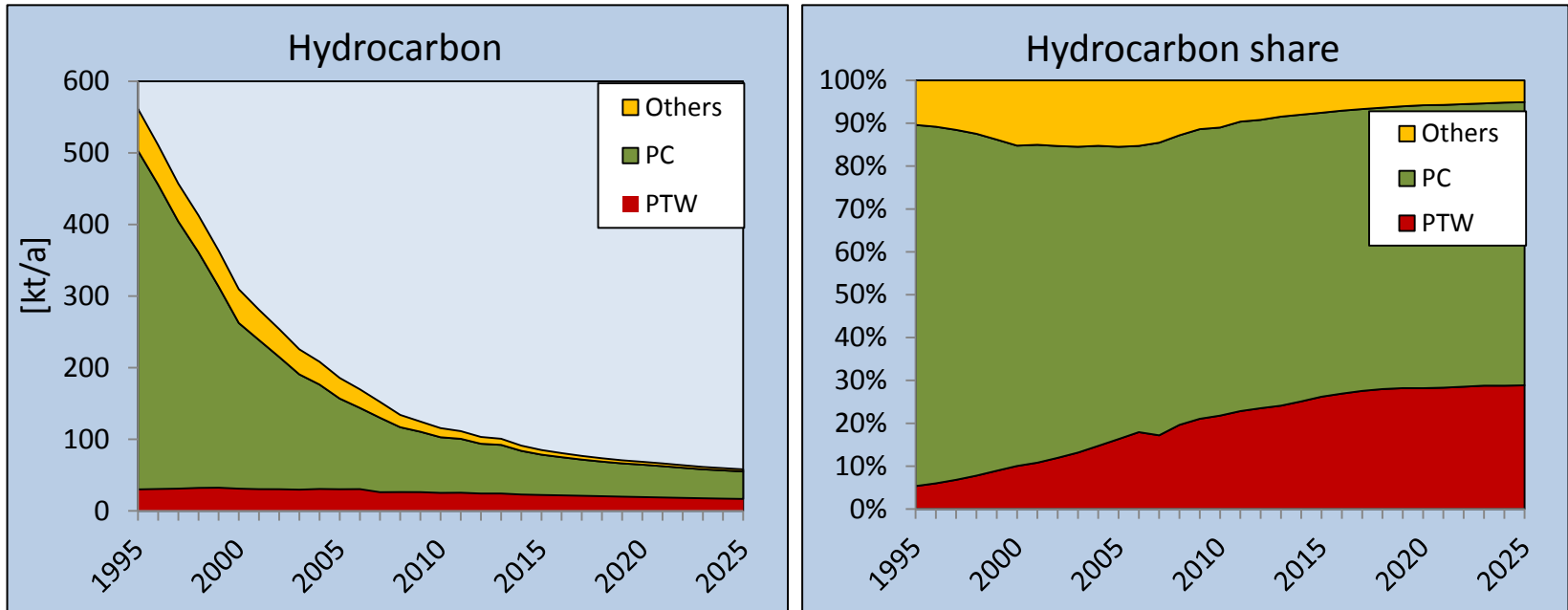
Vehicle stock and total annual traffic



- ≈ 5 million powered two-wheelers are registered in Germany (share of 10 % of all registered vehicles)
- Share to the total annual traffic: ≈ 2 - 3 %

Calculations and Results

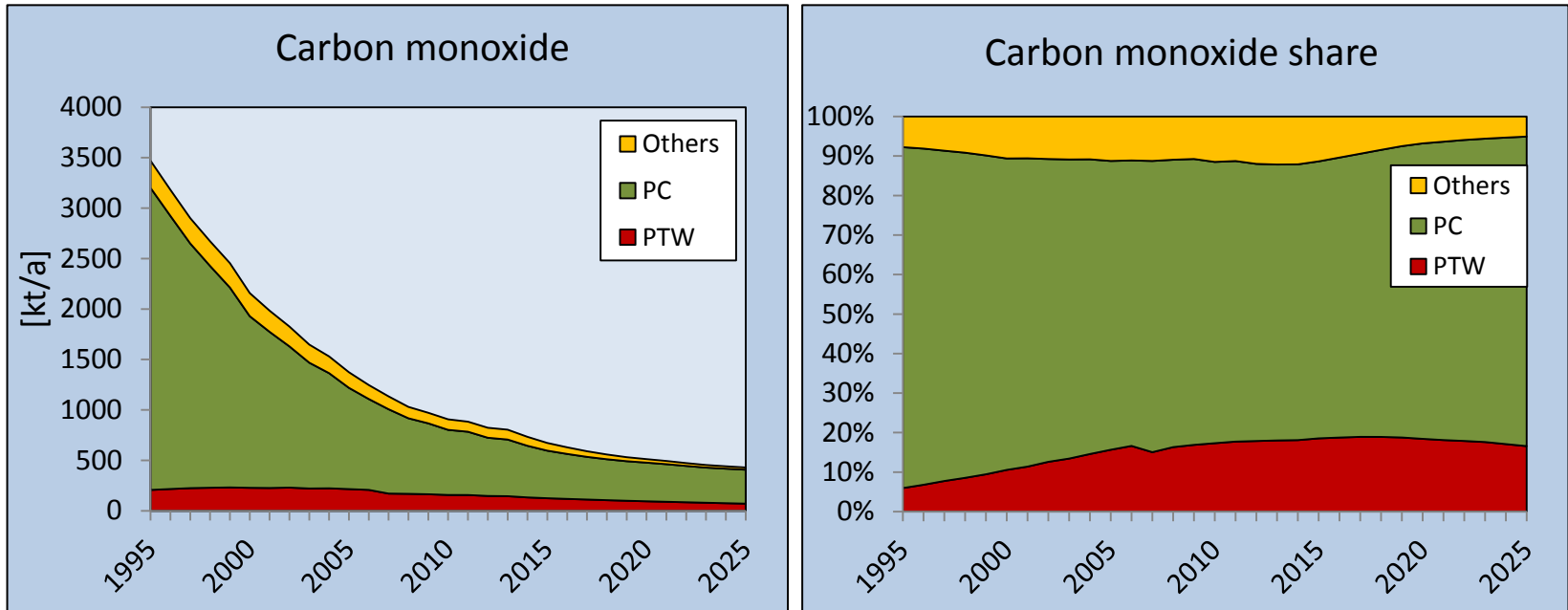
Annual hydrocarbon emissions of road traffic and it's share



- Share of hydrocarbon emissions to the total hydrocarbon emissions increases up to 25 % by 2025
- Reduction of hydrocarbon emissions about 80 % up today due to Catalytic converters

Calculations and Results

Annual carbon monoxide emissions of road traffic and it's share

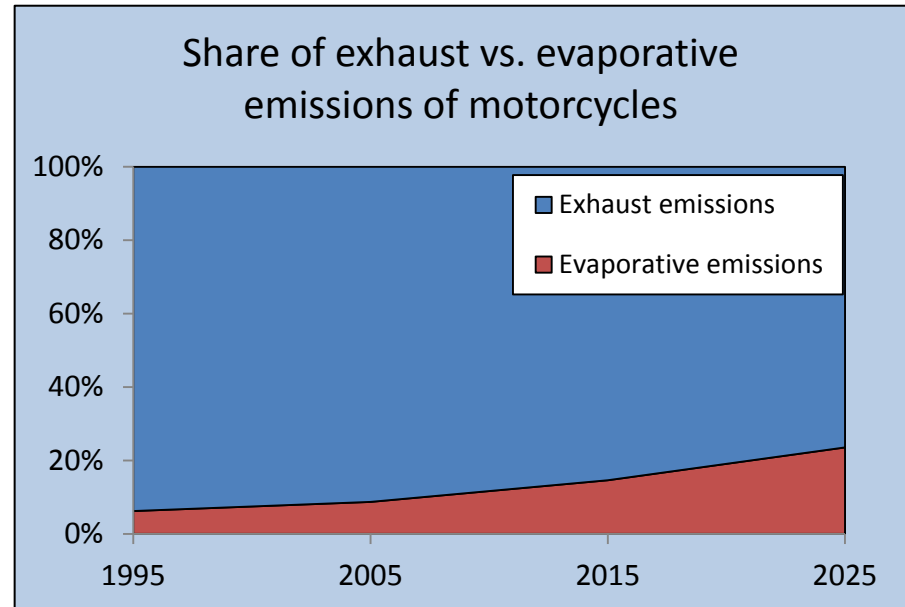


- Analogous situation as with the hydrocarbon emissions
- Carbon monoxide Reduction about 85 % up today due to exhaust gas after treatment systems

Calculations and Results

Evaporative vs. Exhaust emissions

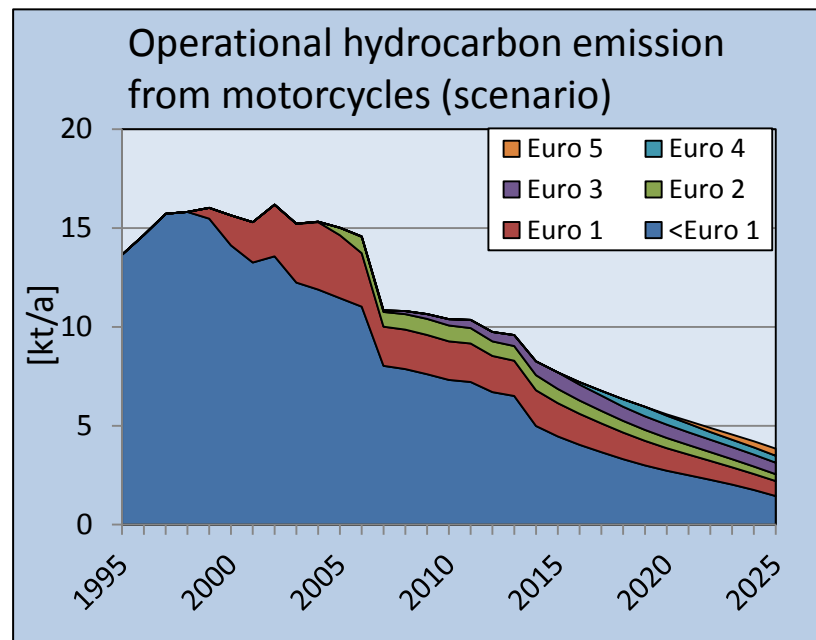
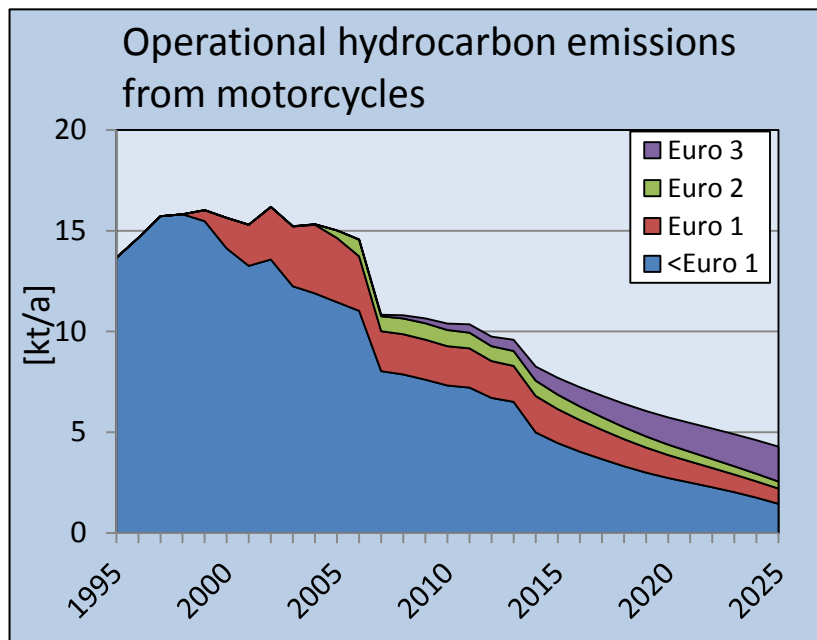
- ≈ 22 % of hydrocarbon emissions caused by fuel evaporation in 2025
- Increase of share of evaporative emissions due to decrease in exhaust emissions
- ➔ New vehicle technologies
- ➔ Stricter operational limit values
- Total amount of evaporative fuel fractions remains almost the same



Regulation of fuel evaporation limits for the first time
(Further investigations within upcoming research projects)

Calculations and Results

Change in hydrocarbon emissions from motorcycles



- Decrease in operational hydrocarbon emissions in the period 2015-2025 about 50 % or 3850 t/a
- Without new emission levels decline would only be approximately 44 % or 3400 t/a
- **First estimation of the reduction potential of 6 % (450 t/a) due to new regulation**

5. Conclusion

- Low appearing reduction potential through the steady decline of the overall hydrocarbon emissions of pre-Euro 3 vehicles
 - Decrease of mileage of old motorcycles
 - older motorcycles, especially pre-Euro 1 standard, are replaced by new ones
- Emission trajectories obtained in this research project are to be verified in upcoming research projects
 - Exhaust measurements on test benches after the introduction of the new emission levels and generation of emission factors
 - Next step: New emission data and traffic information are to be implemented in calculation tools like TREMOD
- First measurement-based data of evaporative emissions in this vehicle class are available then



Thank you for your attention!

Conrad Piasecki
Federal Highway Research Institute (BASt)

