For Our Environment

Umwelt Bundesamt

10th Int. AVL Exhaust Gas and Particulate Emissions Forum

# HBEFA – a tool for the determination of real emission

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Section I 3.2 "Pollution Abatement and Energy Saving in Transport"

# Agenda

1. Need for transport emission inventories
2. Germany‘s tools to report transport emission inventories
3. Application areas
4. Outlook and challenges

# Status quo of nitrogen dioxide ($NO_2$)

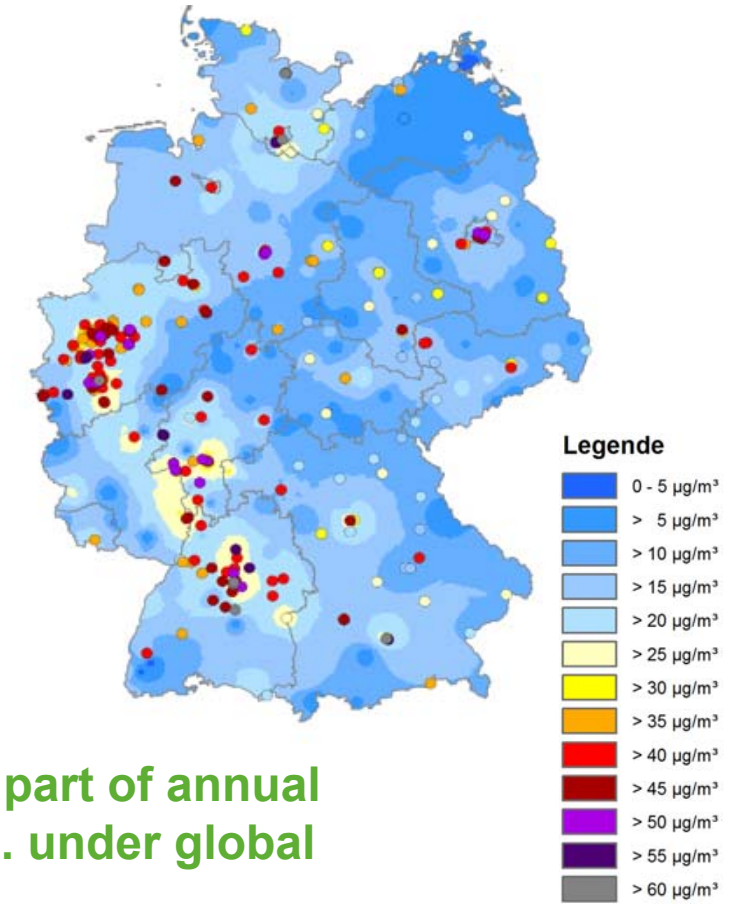
## Air quality limit (EU) and target values (WHO)

| Pollutant | EU limit values | | | WHO AQG* | | |
|---|---|---|---|---|---|---|
| $PM_{2.5}$ | 25 | µg/ m³ | (year) | 10 | µg/ m³ | (year) |
| $PM_{10}$ | 50 | µg/ m³ | (day) | 20 | µg/ m³ | (day) |
| $O_3$ | 120 | µg/ m³ | (8-hour) | 100 | µg/ m³ | (8-hour) |
| BaP | 1 | ng/ m³ | (year) | 0.12 | ng/ m³ | (year) |
| $NO_2$ | 40 | µg/ m³ | (year) | 40 | µg/ m³ | (year) |
| $SO_2$ | 125 | µg/ m³ | (day) | 20 | µg/ m³ | (day) |
| CO | 10 | µg/ m³ | (8-hour) | 10 | µg/ m³ | (8-hour) |
| Pb | 0.5 | µg/ m³ | (year) | 0.5 | µg/ m³ | (year) |
| Benzene | 5 | µg/ m³ | (year) | 1.7 | µg/ m³ | (year) |

*Air Quality Guidelines

Quelle: Umweltbundesamt

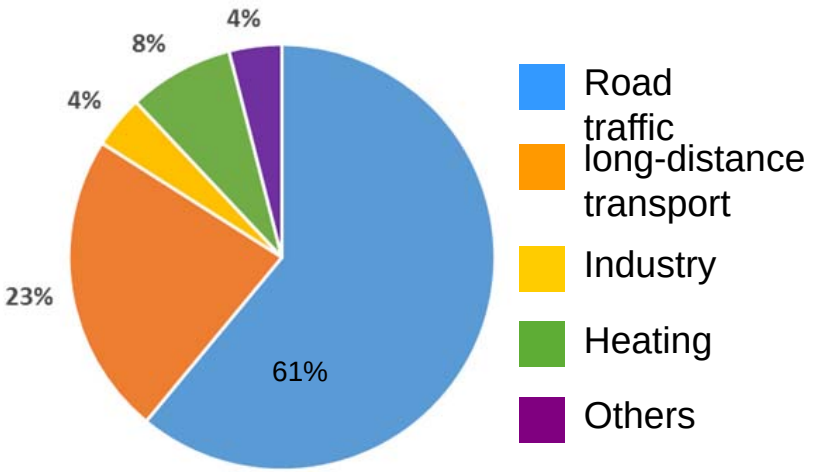
## Annual $NO_2$ concentration in Germany in 2016




**Transport emission inventories needed as part of annual reporting to national and EU authorities i.a. under global agreements (e.g. Kyoto Protocol)**

# Urban $NO_2$ emissions in the transport sector (Germany, 2015)

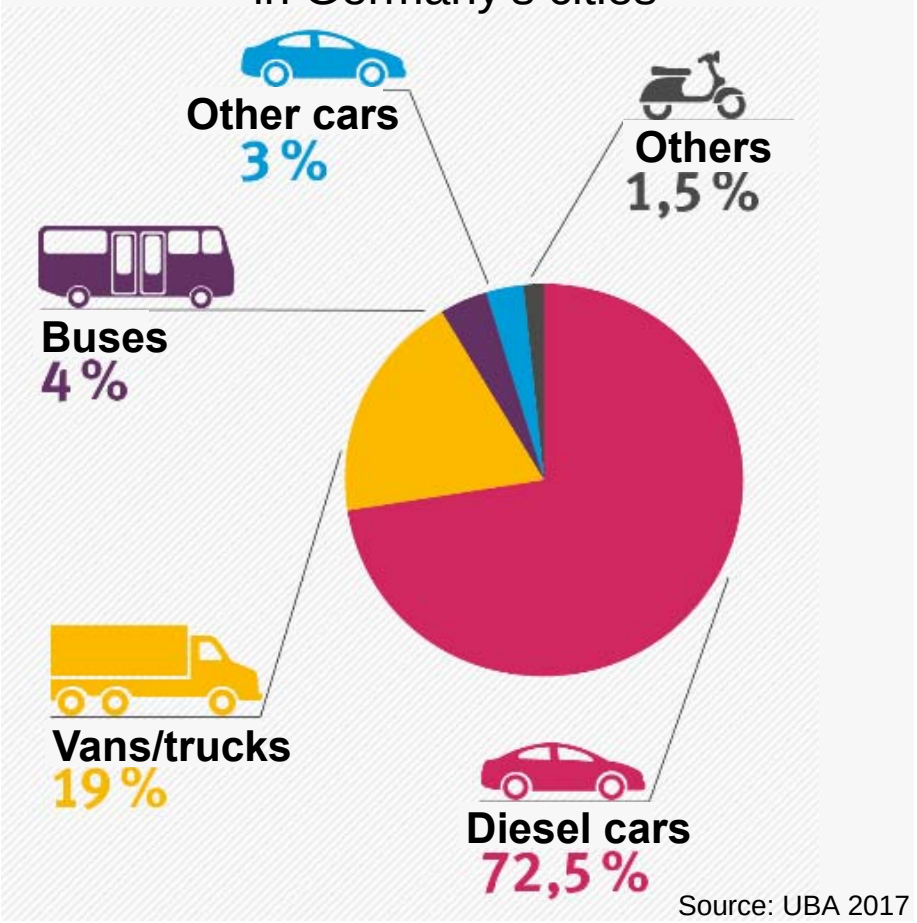
Share of $NO_2$ polluters in total in Germany's cities




- In Germany more than 60% of $NO_2$ measured in cities originated from road traffic
- Main causer of the air pollutant are diesel vehicles, particularly diesel-fueled passenger cars

Source: UBA 2016

Share of $NO_2$ polluters in road traffic in Germany's cities




Source: UBA 2017

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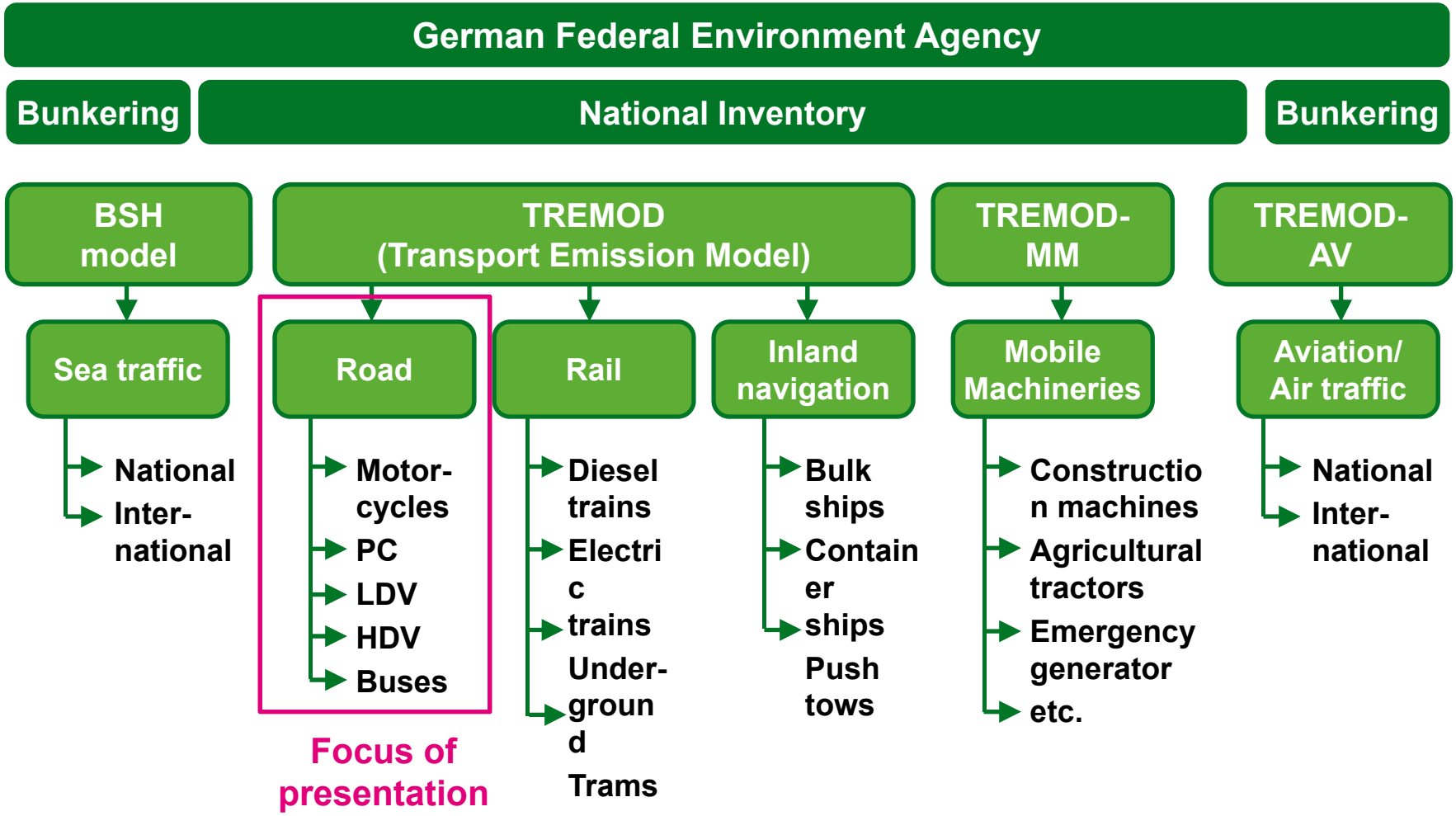
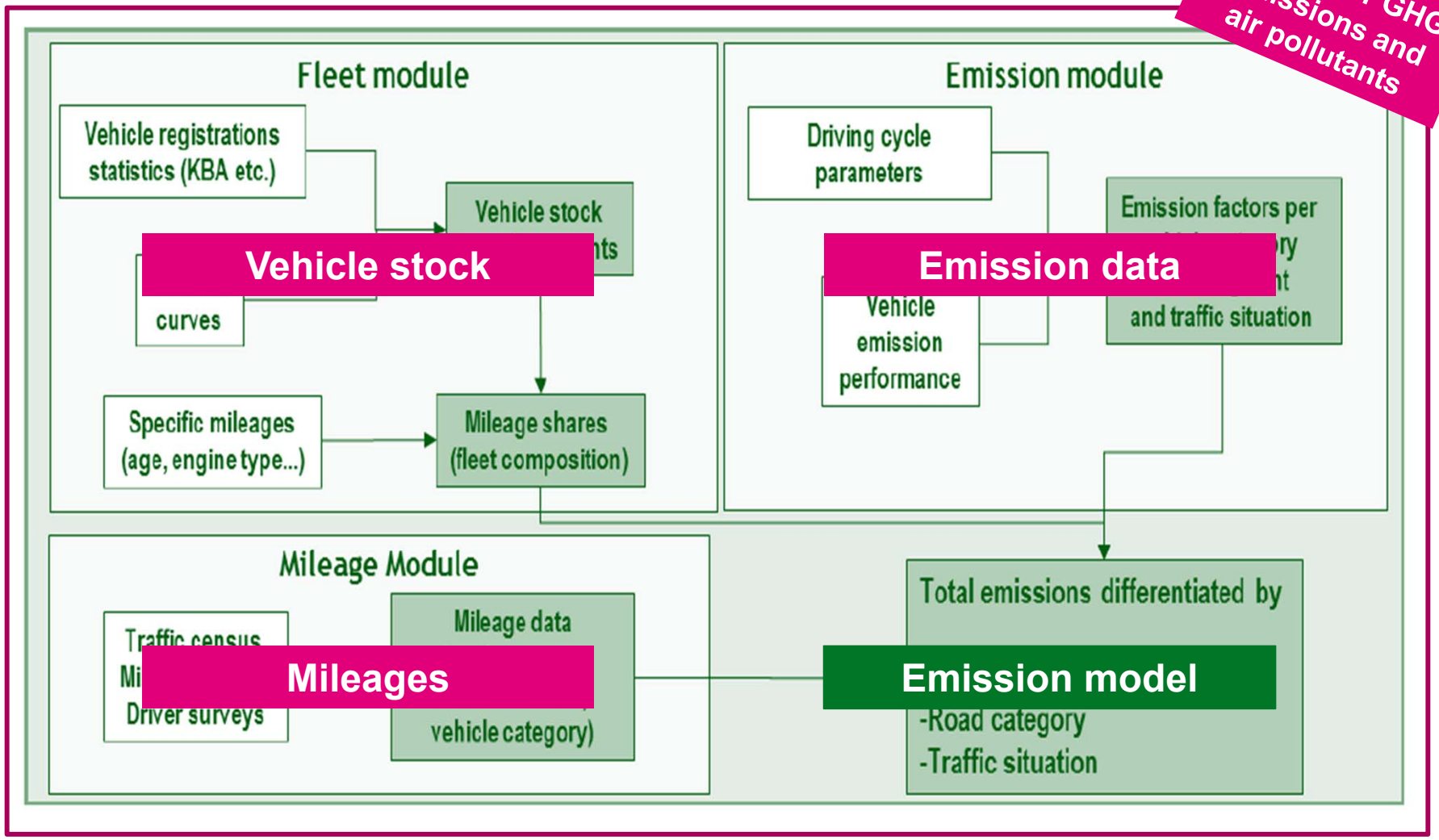
# Overview of the transport emission models used by the German Federal Environment Agency



# TREMOD - Modules to calculate emissions of road transpo

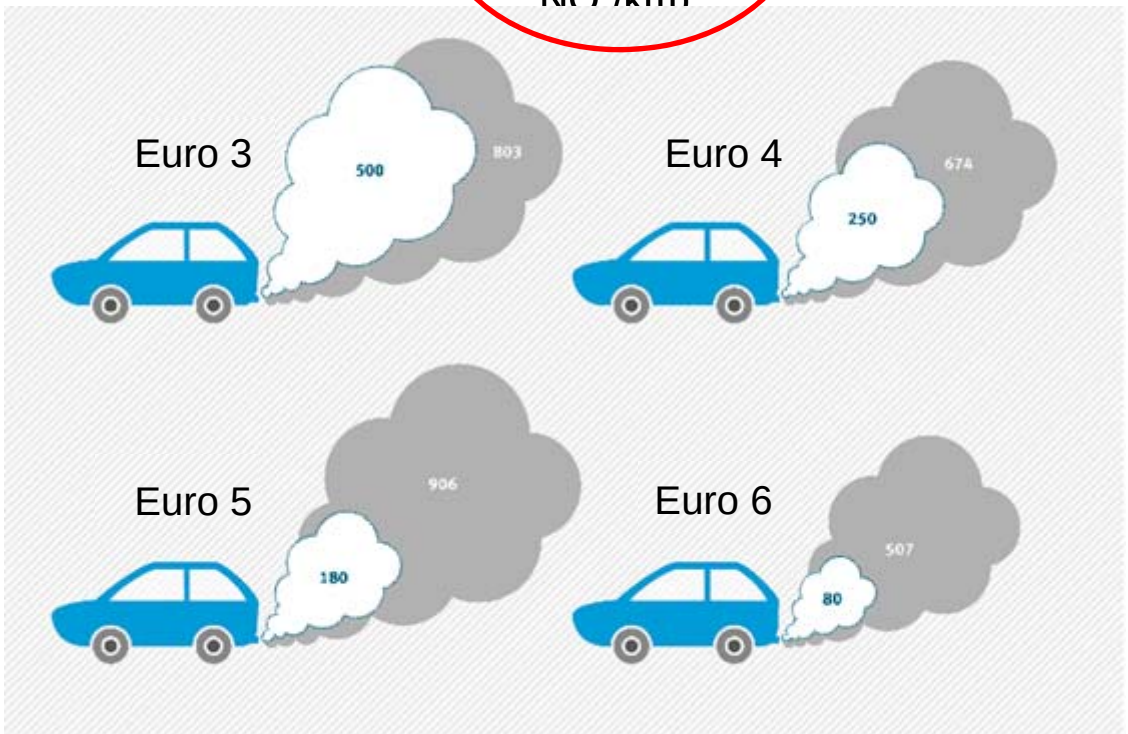
Similar for GHG emissions and air pollutants




***Source:*** IFEU 2015.

# Emission factors influence strongly the quality of quantification of traffic-related emissions

**Travel activity** (vehicle km travelled) x **Specific emission factors** (e.g. mg $NO_x$/km) = **Emission of air pollutants** (e.g. mg $NO_x$)

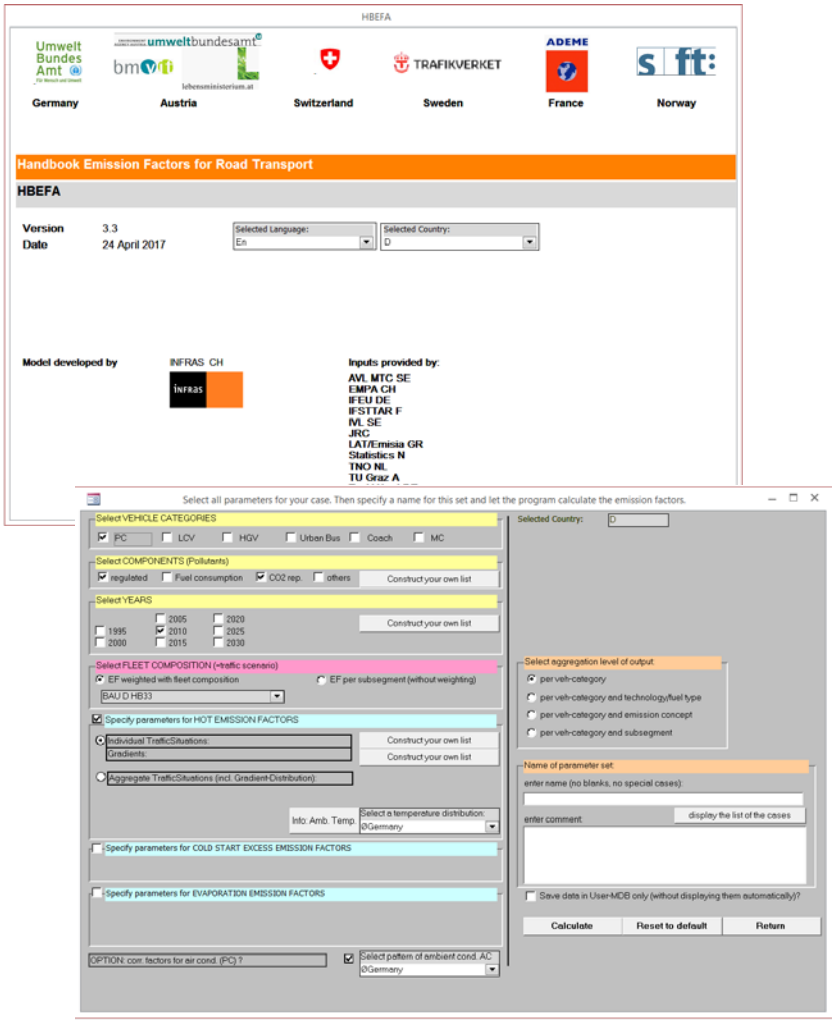



**EU emission standard in mg $NO_x$/km**

**Average real driving emissions in mg $NO_x$/km**

**Need of reliable emission factor database**
**⇨ HBEFA**

# HBEFA - HandBook of Emission FActors for road transport




- **HBEFA** is **emission factor database** for road transport which is developed on behalf of several European countries (e.g. Germany, Switzerland, Austria, Sweden, Norway, France).
- HBEFA is **publicly** available**.**
- HBEFA provides **emission factors** (**hot, cold start, evaporation**) for **all regulated** and **important non-regulated air pollutants** as well as for **fuel consumption** and **$CO_2$ emission**

# HBEFA - Data collection

Emission factors are calculated by a simulation tool named PHEM (Passenger car and Heavy duty vehicle Emission Model)

⇒ random measurements ensure the validity of the tool and its results

- Chassis dynanometer measurements with driving cycles close to real world

  ⇨ pro: enable comparability and repeatability of the test

- PEMS (Portable Emission Measurement system)

  ⇨ pro: reflects real world situation; includes i.e. environmental conditions

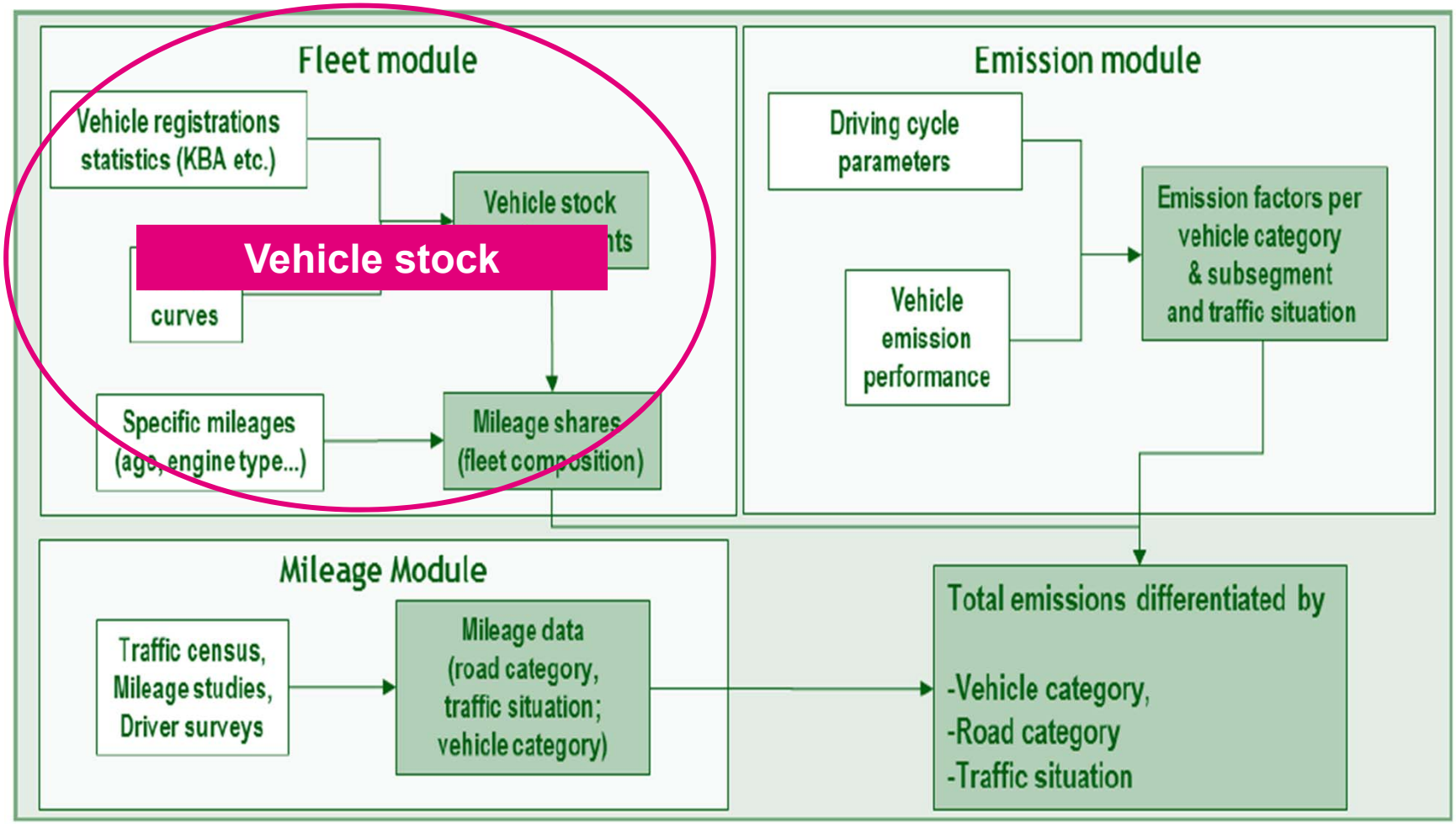
- Remote Sensing measurements

  ⇨ pro: enables data collection of a vast amount of vehicles in a short

**Collaborations of different nations yield a larger amount of data, hence covering a wider range of vehicle segments**

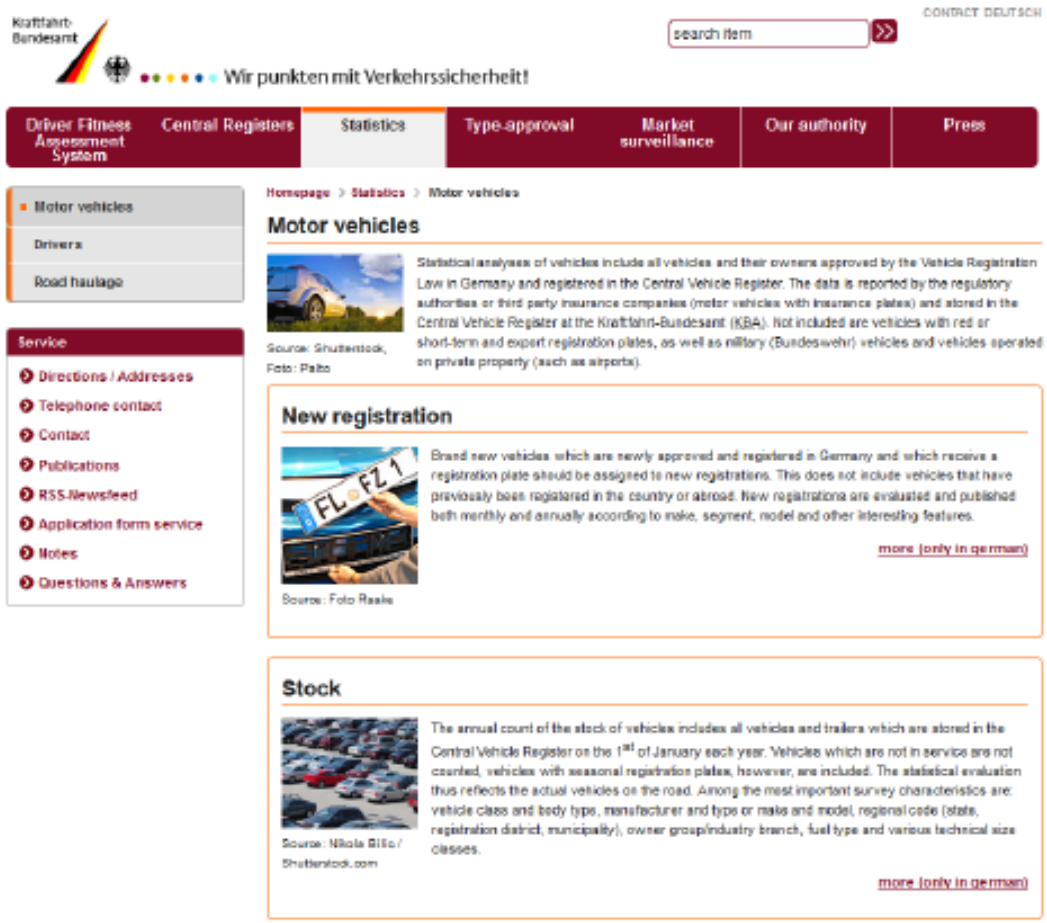
**HBEFA updates are released every 4-5 years**

# TREMOD needs data for vehicle stock, vehicle registrations and survival curves for the fleet module




***Source:*** IFEU 2015.

# Example Germany: data for vehicle population provided by the Federal Motor Transport Authority (KBA)




- Vehicle stock and new registration based on KBA statistics (www.kba.de)
- Key information:
  - Vehicle type
  - Vehicle size (segment, weight, capacity, engine power, …)
  - Fuel type
  - Year of registration
  - Fuel consumption in type approval cycle (NEDC)
- Annually updated in TREMOD

***Source:*** IFEU)

# HBEFA provides emission factors for different sub-segments of vehicles

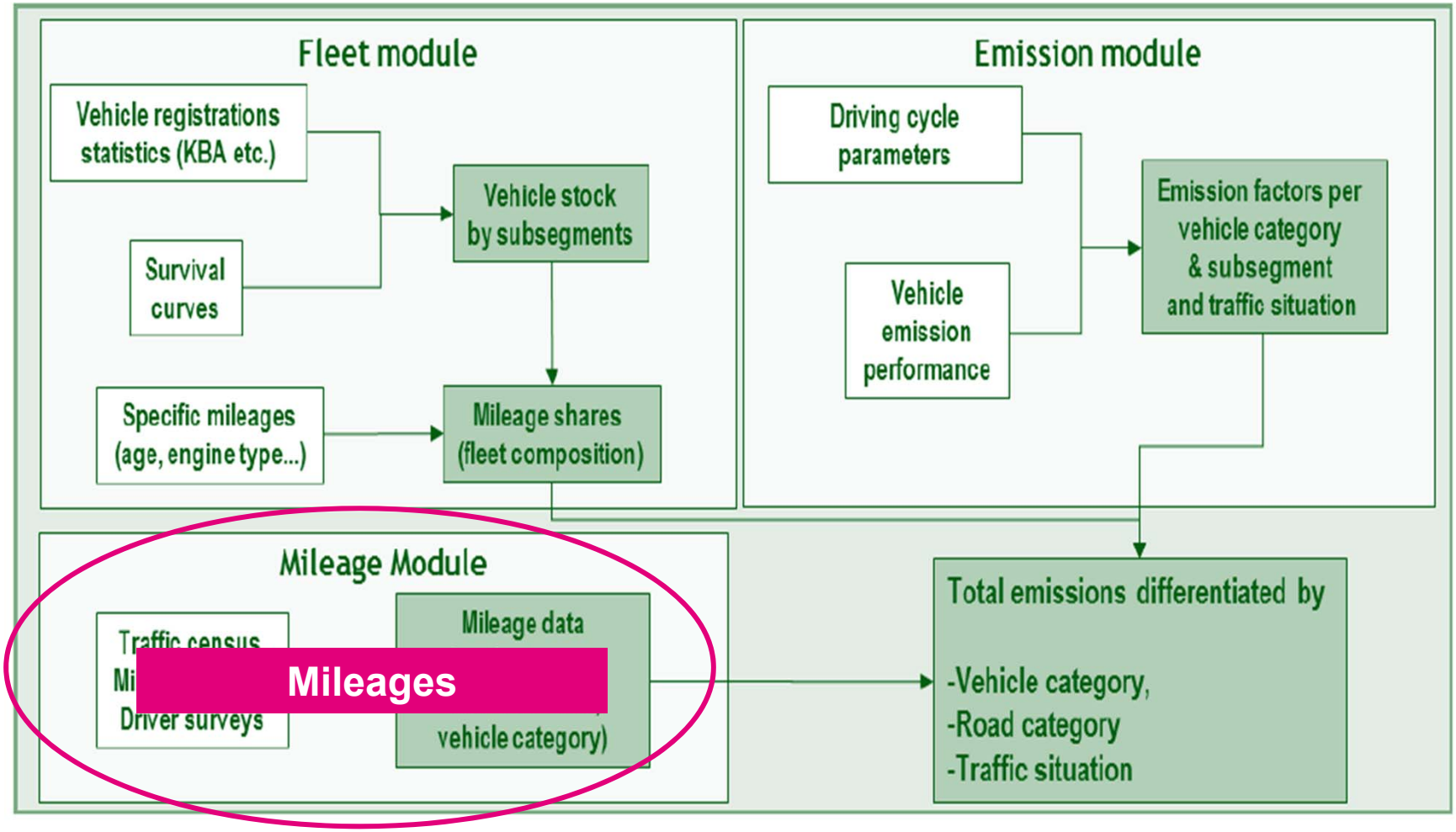
| Vehicle categories | Vehicle size | Fuel types | Emission Standards | Reduction technologies |
|---|---|---|---|---|
| Passenger Car | PC < 1.4 L | Gasoline | Pre Euro 1 | Particle filter |
| Motorcycle | PC 1.4-2.0 L | Diesel | Euro 1 | SCR |
| Urban bus | PC > 2.0 L | LPG | Euro 2 | EGR |
| Coaches | Truck ≤ 7.5 t | CNG | Euro 3 | … |
| Light duty veh. | Truck 7.5-12 t | FFV | Euro 4 | |
| Single truck | Truck 12-14 t | | Euro 5 | |
| Truck trailer[1)] | … | | Euro 6 | |

Abbreviations:

PC = Passenger car
LPG = Liquefied Petroleum Gas
CNG = Compressed Natural Gas
FFV = Flexible Fuel Vehicles
SCR = Selective Catalytic Reduction
EGR = Exhaust Gas Recirculation

[1)] Including articulated vehicles

# TREMOD needs total mileages of the vehicles for the mileage module




***Source:*** IFEU 2015.

# Example Germany: data on vehicle kilometers travelled provided by the Federal Highway Research Institute

| Input for TREMOD | Data collections in Germany | Frequency |
|---|---|---|
| Total VKT (per vehicle category and road category years) | Automatic traffic counting | annually |
| | Manual traffic counting | 5 years |
| | Comprehensive survey of counts, inspection data, interviews, etc., (1990, 1993, 2002, new in 2014) | 10 years |
| | Other surveys (toll statistics, mobility panel, mobility in Germany) | depends |
| Average VKT per vehicle (by vehicle type, size fuel, age) | Main source: Survey of vehicle mileage 1993 and 2002 (questionnaire); new values 2014 will be integrated in 2017 | 10 years |


Info Federal Highway Research Institute (BASt) on: www.bast.de

***Source:*** IFEU)

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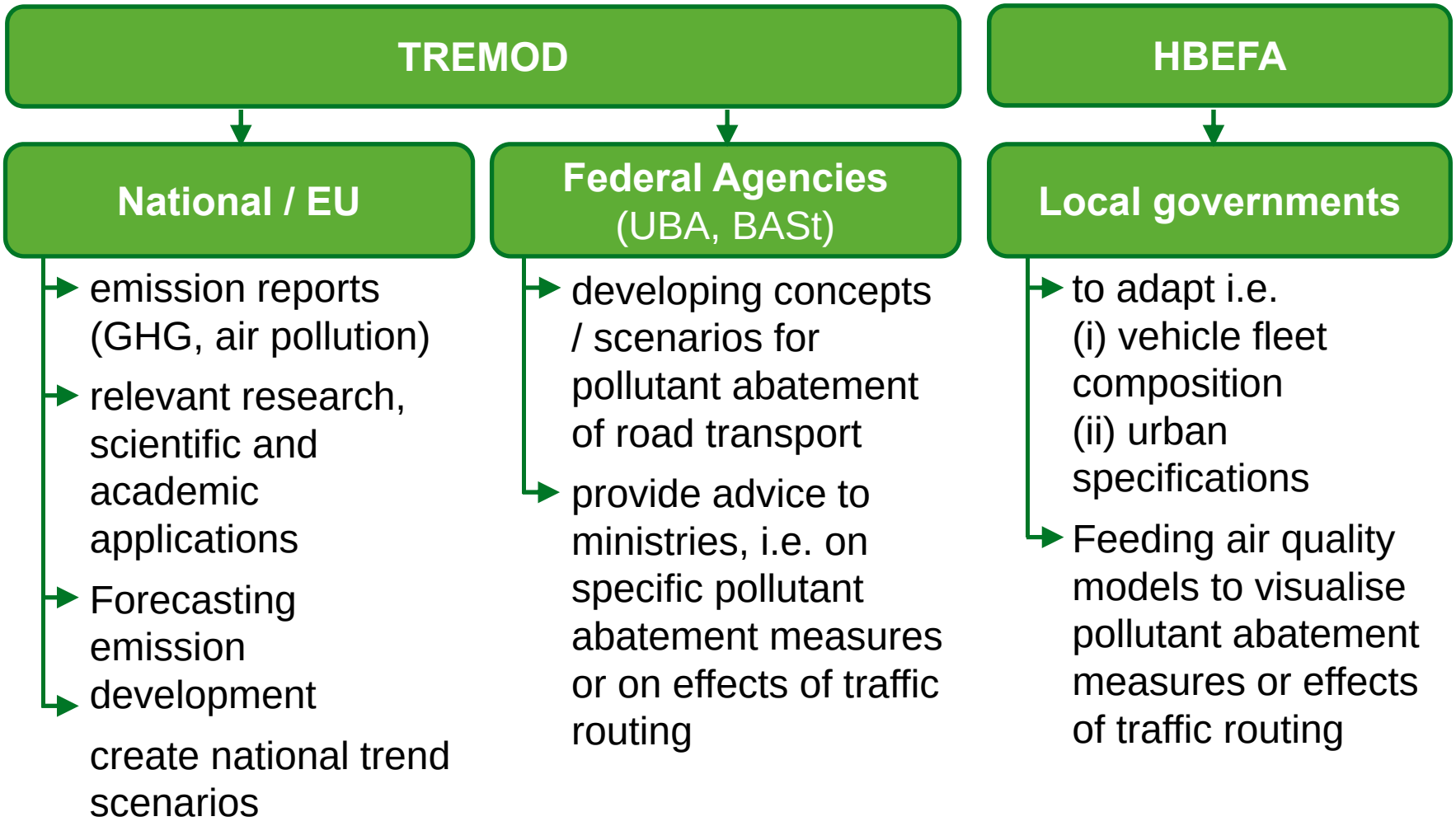
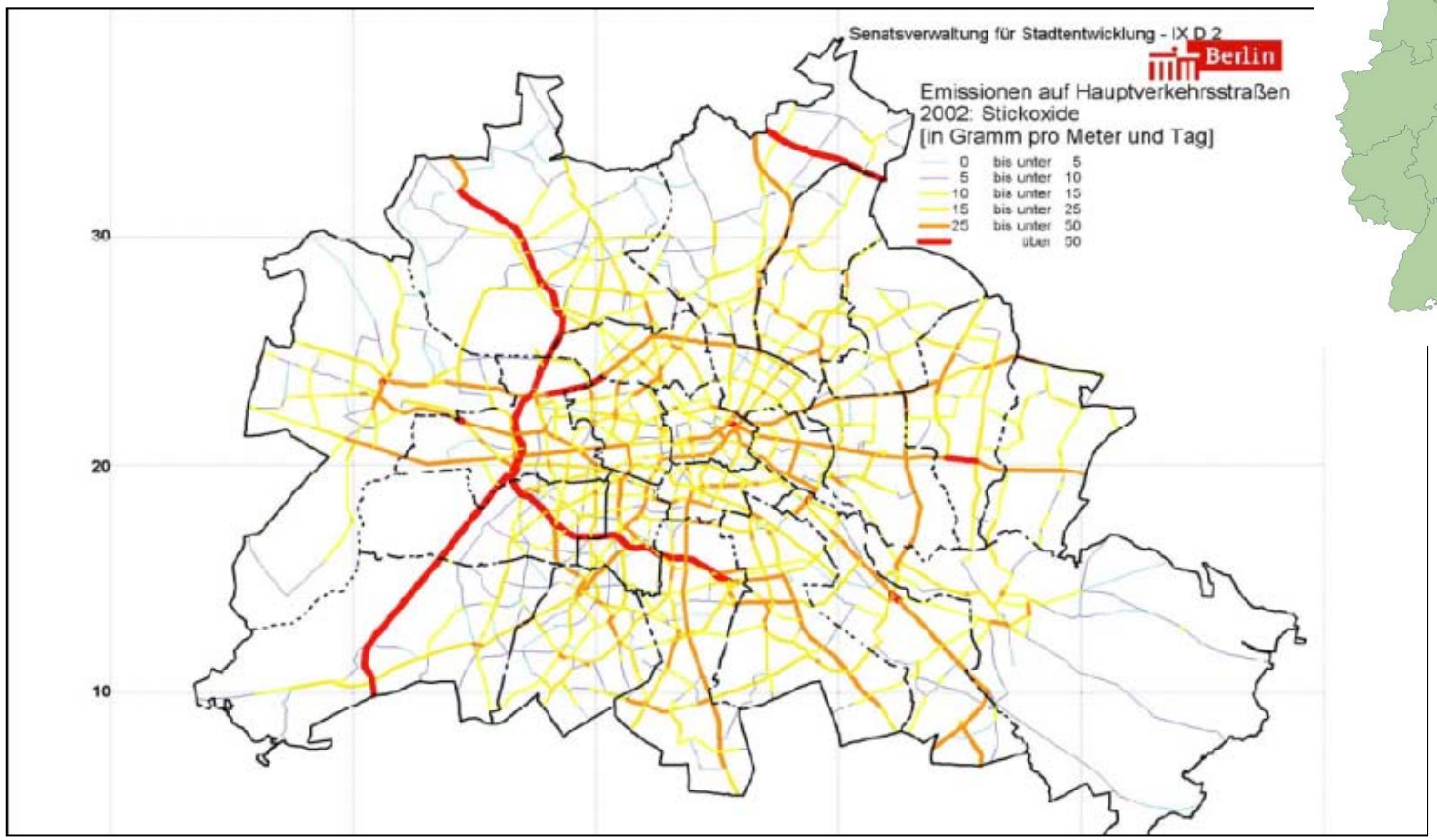
# Application areas of transport emission inventories



# Application areas – example: Local Authorities

Berlin: $NO_x$ emissions

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## Outlook

- Maintain cooperation across authorities and countries to
  a) increases the number of data hence improves the reliability of emission factors
  b) enables the coverage of  a wider range of measurements
- Maintain data quality standard by
  a) unified measurement criteria, i.e using standard catalogue on data collection or measurement parameters
  b) data processing
- Software and data maintenance should always be considered crucial

## Challenges

- Incorporate new measurement techniques, i.e. PEMS and Remote Sensing
- Current focus: (i) updating fuel consumption by realistic values
  (ii) identify benefits and limitations of Remote Sensing for HBEFA

# Thank you for your attention!

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# Authorities teamwork for GHG emission report

- Germany reports emissions of GHGs (direct and indirect GHG) within the scope of United Nations Framework Convention on Climate Change and the Kyoto Protocol
- The UNFCCC Reporting Guidelines and the Kyoto Protocol demands the determination of institutional arrangements for GHG emission reporting in each country (in Germany it is done by an “Agreement by State Secretaries on the National System”)

  => this determines BMUB (Ministry of Environment) to be in authority and the German Environment Agency as requested Single National Entity
- Various departments within UBA gather data to their topics, i.e. emissions from transport sector (in-house directive)
- All federal authorities are obligated to cooperate to fulfil legal tasks on a national level as e.g. emission report (German government’s rules of procedure)

Because HBEFA and TREMOD are crucial to calculate emissions in the transport sector as part of the national emission report the authorities of the ministry of transport are obligated to deliver required data.