Martin Schmied, Head of Transport and Environment Division

The European Handbook of Emission Factor for Road Transport (HBEFA)

Leipzig, 19th of May 2014
Agenda

1. HBEFA: Brief introduction
2. Traffic situation approach of HBEFA
3. HBEFA in context of other emission models
Emission factors influence strongly the quality of quantification of traffic-related emissions.

\[ \text{Emission} = \text{Traffic Activity (vkm)} \times \text{Emission Factor (g/vkm)} \]

**NOx emissions of passenger cars**

- Emission factors based on type approval cycles (NEDC)
- Real world emissions factors

<table>
<thead>
<tr>
<th>Euro</th>
<th>Emission Factor (g/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro-3</td>
<td>0.8</td>
</tr>
<tr>
<td>Euro-4</td>
<td>0.6</td>
</tr>
<tr>
<td>Euro-5</td>
<td>0.4</td>
</tr>
<tr>
<td>Euro-6</td>
<td>0.2</td>
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</tbody>
</table>
HandBook on Emission Factors for Road Transport (= HBEFA)

- 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)
- in 1995 the first version of HBEFA was published, since there it was continuously enhanced
- HBEFA provides emission factors (hot, cold start, evaporation) for all regulated and important non-regulated air pollutants as well as for fuel consumption and CO₂ emission
Dependency of traffic activities and emission factors

\[ \text{Emission} = \text{Traffic Activity (vkm)} \times \text{Emission Factor (g/vkm)} \]

- emission factors have to fit to the traffic activity data and vice versa
- traffic data should ideally be given for:
  - vehicle category
  - vehicle size
  - fuel type
  - technology (emission standards)/age
  - load factor (trucks)
  - road gradient
  - traffic situation/driving cycles
HBEFA provides emission factors for different sub-segments

<table>
<thead>
<tr>
<th>Vehicle categories</th>
<th>Vehicle size</th>
<th>Fuel types</th>
<th>Emission Standards</th>
<th>Reduction technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car</td>
<td>PC &lt; 1.4 L</td>
<td>Gasoline</td>
<td>Pre Euro 1</td>
<td>Particle filter</td>
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<tr>
<td></td>
<td>PC 1.4-2.0 L</td>
<td>LPG</td>
<td>Euro 1</td>
<td>SCR</td>
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<tr>
<td></td>
<td>PC &gt; 2.0 L</td>
<td>CNG</td>
<td>Euro 2</td>
<td>EGR</td>
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<tr>
<td>Motorcycle</td>
<td></td>
<td>FFV</td>
<td>Euro 3</td>
<td></td>
</tr>
<tr>
<td>Urban bus</td>
<td>Truck ≤ 7.5 t</td>
<td></td>
<td>Euro 4</td>
<td></td>
</tr>
<tr>
<td>Coaches</td>
<td>Truck 7.5-12 t</td>
<td></td>
<td>Euro 5</td>
<td></td>
</tr>
<tr>
<td>Light duty veh.</td>
<td>Truck 12-14 t</td>
<td></td>
<td>Euro 6</td>
<td></td>
</tr>
<tr>
<td>Single truck</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Truck trailer 1)</td>
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</table>

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.
HBEFA is often data source for GHG emission inventories of Germany cities

<table>
<thead>
<tr>
<th></th>
<th>Bremen</th>
<th>Region Hannover</th>
<th>Braunschweig</th>
<th>Leipzig</th>
<th>Cologne</th>
<th>Frankfurt/Main</th>
<th>Tübingen</th>
<th>Munich</th>
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</thead>
<tbody>
<tr>
<td><strong>Fuel consumption and direct GHG emission factors</strong></td>
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<td><strong>Road</strong></td>
<td>MOBILEV (HBEFA)</td>
<td>HBEFA</td>
<td>HBEFA</td>
<td>HBEFA</td>
<td>[WWF 2009]</td>
<td>TREMOD</td>
<td>HBEFA at VISUM</td>
<td>HBEFA</td>
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<tr>
<td><strong>Public transport</strong></td>
<td>PT operator</td>
<td>PT operator</td>
<td>PT operator</td>
<td>PT operator</td>
<td>PT operator</td>
<td>TREMOD</td>
<td>PT operator</td>
<td>PT operator</td>
</tr>
<tr>
<td><strong>Rail</strong></td>
<td>-</td>
<td>German railways</td>
<td>German railways</td>
<td>UBA¹</td>
<td>TREMOD</td>
<td>TREMOD</td>
<td>-</td>
<td>German railways</td>
</tr>
<tr>
<td><strong>Inland navigation</strong></td>
<td>-</td>
<td>UBA¹</td>
<td>UBA¹</td>
<td>-</td>
<td>LANUV²</td>
<td>-</td>
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</tr>
<tr>
<td><strong>Air transport</strong></td>
<td>-</td>
<td>conclusions by analogy</td>
<td>-</td>
<td>LiULG²</td>
<td>Airport Köln-Bonn</td>
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</tbody>
</table>

⇒ HBEFA is central database for emission calculation on city level in Germany
HBEFA can be connected with link wise data from transport demand models

Berlin

Federal state Hessen

Switzerland (only freight)
Handbook on Emission Factors for Road Transport (HBEFA) Expert Version
Modules of the HBEFA Expert Version for the calculation of traffic-related emissions (1)
Modules of the HBEFA Expert Version for the calculation of traffic-related emissions (2)
Agenda

1. HBEFA: Brief introduction
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Development of emissions factors based on typical traffic situations

Analyses of real world driving patterns:

Choice of typical driving pattern = traffic situation:

Typical for:
- Area (urban/rural)
- Road type
- Speed limit
- Level of service

Emission factors based on traffic situations:

- Emission factors for 276 different traffic situations
- more than 120 for urban areas
Traffic situations enable analyses of transport demand management measures

Trunk road city – 50 km/h

Freeflow

Heavy

Saturated

Stop + Go

Passenger car: diesel, 1.4-2.0 l, Euro 3

+106%

+73%

CO₂

NOx
Emission factors only based on average speed are not sufficient for detailed analyses

Rural: Trunk road: 60 km/h, free flow

Rural: Distributor: 80 km/h, heavy

Rural: Distributor: 100 km/h, saturated

Passenger car: diesel, 1.4-2.0 l, Euro 3
HBEFA enables user to analyse transport demand measures

Fictive example for trunk road: Reduction of stop + go traffic

**Shares of traffic situation for trunk road**

- Stop and go
- Heavy traffic
- Saturated traffic
- Free flow

**CO\textsubscript{2} emission for diesel fueled passenger car for trunk road**

- CO\textsubscript{2} emission for a diesel-fueled passenger car (Euro 3, 1.4-2.0 l)
  - Trunk road
  - -15%
Agenda

1. HBEFA: Brief introduction
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3. HBEFA in context of other emission models
Overview of existing models used for the calculation of traffic-related emissions

<table>
<thead>
<tr>
<th>Model Name</th>
<th>Date</th>
<th>Author</th>
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<tbody>
<tr>
<td>HBEFA</td>
<td>19th of May 2014</td>
<td>Martin Schmied</td>
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<tr>
<td>TREMOD</td>
<td></td>
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<tr>
<td>MOVES</td>
<td></td>
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<tr>
<td>PΔP</td>
<td></td>
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<tr>
<td>PHEM</td>
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<td>COPERT</td>
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</table>
Overview of existing models used for the calculation of traffic-related emissions

**National level**
- TRMOD/HBEFA (Germany/Switzerland)
- COPERT (Australia/Europe)

**City/regional/project level**
- HBEFA (Europe)
- COPERT & PAP (Australia)

**Micro level (e.g. streets)**
- PHEM model (Europe)
- PAP (Australia)

**Aggregation**
- MOVES (USA)
Comparison of traffic situation and average speed approach

<table>
<thead>
<tr>
<th>Model</th>
<th>Approach</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBEFA</td>
<td>Traffic situation approach</td>
<td>Main focus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- City/local level</td>
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<td></td>
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<td>- Regional level</td>
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<td>- Project level</td>
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<tr>
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<td></td>
<td>- Comprehensive analyses of measures and scenarios</td>
</tr>
<tr>
<td>COPERT</td>
<td>Average speed approach</td>
<td>Main focus:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- National level</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Analyses of measures and scenarios on aggregated level</td>
</tr>
</tbody>
</table>

Based on HBEFA emission factors
Thank you for your attention

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