Monitoring impacts of policies and measures
Training on Quantifying Urban Transport GHG Emissions
Leipzig, 18-19 May 2014

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Contents

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2. Basic steps for starting a GHG monitoring process
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4. Alternative and complementary monitoring issues
GHG mitigation potentials in the transport sector
Mechanisms of GHG reduction in the transport sector

Avoid
Reduce number of trips and/or distances

Shift
Choice of transport mode (Modal Split)

Improve
Vehicle efficiency (technology, usage)

Fuel
GHG intensity of energy carriers

GHG emissions of a transport activity = Transport activity (veh.km, pass.km, ton.km) x GHG emission factor

VKT (vehicle kilometres travelled)
Transport performance (e.g. Pass.km, Ton-km)

Depends on
- Vehicle efficiency
- Vehicle load
- Traffic conditions
- Driving behaviour

Specific final energy demand

Energy-specific GHG emissions

Depends on
- Final energy carrier
- greenhouse gases ($CO_2$, $CH_4$, $N_2O$)
- Consideration of upstream emissions
GHG mitigation potentials - Avoid and Shift
Specific GHG emissions of passenger transport in Heidelberg

![Graph showing specific GHG emissions in passenger transport in Heidelberg in 2010.](image)

Source: IFEU 2014

Author: Frank Dünnebeil

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Passenger transport: Avoid and Shift to public transport and non-motorized transport modes

Freight transport: Shift from road transport to rail and inland navigation

Source: Öko 2012 (Renewbility)
GHG mitigation potentials - Improve and fuel

- Tail pipe emissions
- Electricity Generation
- Well to tank emissions
- Vehicle production (incl. battery)

Source: IFEU 2011 (Umbrela)
GHG mitigation potentials - Improve and fuel

Electricity – German Average: GWP: BEV comp. with Diesel/Petrol car

Clear GHG reduction by using additional ren. energy
GHG mitigation potentials in the transport sector

GHG mitigation potentials - Improve and fuel

GHG reduction by better efficiency and more renewable energy

Source: IFEU 2011 (Umbrela)

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GHG mitigation potentials
Potential analysis for municipal measures in Ludwigshafen

- Reduction in VKT (avoid, better vehicle occupancy)
- Modal shift towards cycling
- Modal shift towards public transport
- More efficient use of vehicles
- Purchase of more energy-efficient vehicles
- Purchase of electric vehicles (bev, phev), (supplied by additional renewable energy)

Assumption: 5-10% of the target group in the passenger transport change their behaviour

IFEU 2013

Reduction of GHG emission in the transport sector

Mitigation potentials in municipalities mainly with avoid & shift measures
Basic steps for starting a GHG monitoring process
Objectives of Monitoring impacts of policies and measures

- Monitoring GHG emission reductions over time
  - for a municipality
  - for individually defined monitoring boundaries

- Comparison of real GHG emissions developments with a reduction path towards existing reduction goals

- Basis for analysing actual GHG emission effectiveness of measures within ex-post evaluations

- Assessment of further impacts of realised measures (other environmental and sustainability topics)

→ Controlling the success of GHG mitigation efforts
Basic steps for starting a GHG monitoring process

1. Characterization of the measures or policies to be monitored

2. Identification of main GHG relevant effects and definition of monitoring boundaries

3. Determination of relevant GHG calculation parameters

4. Determination of regularly available data sources
   a) Transport activities
   b) Emission factors

5. Adaption of a GHG monitoring tool
Basic steps for starting a GHG monitoring process

1) Characterization of the measures or policies

- **Main objectives**
  e.g. Climate protection, Congestion reduction, Generate financial resources for public transport improvements

- **Type of measure and mode of action**
  e.g. taxes, access limitations, information, limit values, public transport operation quality, infrastructure improvements

- **Target groups**
  e.g. inhabitants, commuters, companies, freight carriers

- **Scope of the measures**
  - Regional scope: e.g. Selected city districts, Complete city, City and surrounding region, County or national level
  - Temporal scope: all-the-year, certain weekdays or hours of the day
Basic steps for starting a GHG monitoring process
2) *Definition of monitoring boundaries*

- Which transport modes are affected by the measures
  - Direct effects within the measure scope
  - Indirect effects outside the measure scope
  - Rebound effects

- How are the transport modes affected
  - Avoid
  - Shift
  - Improve
  - Fuel

- Informative value of monitoring results increases with more measure-specific definition of monitoring boundaries
Basic steps for starting a GHG monitoring process

3) *Determination of relevant GHG calculation parameters*

- Individual GHG calculation parameters are required for each emission source.

- Which parameters are measure-influenced?
  - Not influenced: Regular data sources and statistics suitable
  - Influenced: Measure-specific monitoring data

- Transport activities: VKT, pass.km, ton.km

- Emission factors per transport mode, depending on:
  - Fleet composition: Shares of vehicles with individual energy efficiency and fuel type
  - Shares of different traffic situations

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**Monitoring boundaries**

**Mechanisms of action**

- Direct
  - Avoid
  - Shift
  - Improve
  - Fuel

- Indirect and rebound
  - Avoid
  - Shift
  - Improve
  - Fuel

**Identify relevant parameters for GHG emissions calculation**

- Transport activities
- Emission factors

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Basic steps for starting a GHG monitoring process

4) **Determination of regularly available data sources**

a) **Transport activities**

- Alternative approaches to determine transport activities

- **Vehicle**
  - Vehicle Kilometer Traveled (VKT) (veh.km)
  - Vehicle load (persons, tons)
  - Vehicle capacity (seats, offered tons)
  - Load factor (%)
  - Transport performance (pass.km, ton-km)

- **Transport network**
  - Transport network length (km)
  - Traffic volumes (vehicles/time)
  - VKT (veh.km)

- **Passenger or transport good**
  - Number of persons or amount of tons
  - Travel distance (km)
  - Transport performance (pass.km, ton-km)
Data sources for transport activities

Periodic data availability in the future is crucial for the monitoring.

**Typical data sources for transport activities**

<table>
<thead>
<tr>
<th>Regular data sources and statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Urban transportation planning models</td>
</tr>
<tr>
<td>- National or regional models (with top-down or bottom-up regionalisation)</td>
</tr>
<tr>
<td>- Periodic household or driver surveys</td>
</tr>
<tr>
<td>- Local vehicle statistics</td>
</tr>
<tr>
<td>- Operating data of public transport operators and transport associations</td>
</tr>
<tr>
<td>- Freight transport statistics (tons, ton.km, origin-destination relation)</td>
</tr>
<tr>
<td>- Statistics on commuting traffic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure-specific monitoring data</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Starting permanent (automatic) or periodic (manual) traffic counts</td>
</tr>
<tr>
<td>- Development of a local traffic model</td>
</tr>
<tr>
<td>- Starting periodic household or driver surveys</td>
</tr>
</tbody>
</table>
### Data sources for transport activities

**Example: Data availability for Baden-Wuerttemberg**

<table>
<thead>
<tr>
<th>Means of transportation</th>
<th>Kind of data</th>
<th>Data sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger transport modes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passenger cars and two-wheelers</td>
<td>Vehicle-km by road type and municipality</td>
<td>Statistisches Landesamt Baden-Württemberg</td>
</tr>
<tr>
<td>Urban bus, tram &amp; light-rail</td>
<td>Vehicle-km, seat-km, pass.-km by municipality</td>
<td>Public transport operators, regional transport associations</td>
</tr>
<tr>
<td>Regional trains</td>
<td>train-km by municipality</td>
<td>Regional transport associations, German Railways (Regio section)</td>
</tr>
<tr>
<td>Long-distance trains</td>
<td>train-km, seat-km by propulsion (diesel, electro) and municipality</td>
<td>German Railways</td>
</tr>
<tr>
<td>Freight transport modes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light and heavy duty trucks</td>
<td>Vehicle-km by road type and municipality</td>
<td>Statistisches Landesamt Baden-Württemberg</td>
</tr>
<tr>
<td>Rail freight transport</td>
<td>train-km by propulsion (diesel, electro) and municipality</td>
<td>German Railways</td>
</tr>
<tr>
<td>Inland navigation</td>
<td>ton.km by waterway section</td>
<td>Federal statistical office</td>
</tr>
</tbody>
</table>
Basic steps for starting a GHG monitoring process

4) *Determination of regularly available data sources*

b) *Emission factors*

### Avoid+shift measures

- Average emission factors per transport mode can be used in most cases, considering weighted fleet compositions and traffic situations.

- It can be suitable to aggregate different transport modes to one single emission source and use weighted average emission factors, e.g.
  - Cars + two-wheelers = private transport
  - bus, subway, lightrail, regional train = public transport

### Improve+fuel measures

- Local-specific fleet compositions and/or traffic characteristics are required for a refinement of emission factors.

- Important: Only the use of well-to-wheel emission factors ensures comprehensive monitoring of GHG effects resulting from shifts to alternative energy carriers (electricity, biofuels).
### Data sources for emission factors

- **Periodic data availability in the future is crucial for the monitoring.**

#### Typical data sources for emission factors

<table>
<thead>
<tr>
<th>Regular data sources and statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Emission factor database, including</td>
</tr>
<tr>
<td>- default emission factors for typical fleet compositions traffic situations</td>
</tr>
<tr>
<td>- detailed emission factors for more in-depth analyses</td>
</tr>
<tr>
<td><em>Source(s):</em> <em>e.g. (inter)national inventory model</em></td>
</tr>
<tr>
<td>- Local, federal or national vehicle fleet compositions</td>
</tr>
<tr>
<td>(VKT shares of different drive concepts, vehicle size, age etc.)</td>
</tr>
<tr>
<td><em>Source(s):</em> <em>e.g. local emissions inventory</em></td>
</tr>
<tr>
<td>- Local-specific traffic flow characteristics</td>
</tr>
<tr>
<td><em>Source(s):</em> <em>e.g. local traffic model</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure-specific monitoring data</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Licence plate surveys (for derivation of fleet compositions)</td>
</tr>
<tr>
<td>- Road-specific measurement and modelling of velocity and traffic flow</td>
</tr>
<tr>
<td>Emission measurements (e.g. remote sensing)</td>
</tr>
</tbody>
</table>
## International emission factors data bases for transport

<table>
<thead>
<tr>
<th></th>
<th>HBEFA</th>
<th>TREMOD</th>
<th>COPERT</th>
<th>TREMOVE</th>
<th>MOVES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Developer</strong></td>
<td>INFRAS AG</td>
<td>IFEU Heidelberg</td>
<td>EMISIA</td>
<td>TML, KU Leuven</td>
<td>US EPA</td>
</tr>
<tr>
<td><strong>Commissioner</strong></td>
<td>Several federal environmental authorities in Europe</td>
<td>Federal Environmental Agency of Germany (UBA)</td>
<td>European Environment Agency (EEA)</td>
<td>European Commission, DG Environment</td>
<td>EPA (United States Environmental Protection Agency)</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Database for emission factors</td>
<td>Emission Inventory and Scenario Calculation</td>
<td>Emission Inventory</td>
<td>Emission Inventory and Scenario Calculation</td>
<td>Emission Inventory and Scenario Calculation</td>
</tr>
<tr>
<td></td>
<td>Emission Inventory and Scenario Calculation (Exp. Version)</td>
<td>Database for emission factors and transport activity data</td>
<td>Emission Inventory</td>
<td>Database for emission factors and transport activity data</td>
<td>Database for emission factors and transport activity data</td>
</tr>
<tr>
<td><strong>Transport Modes</strong></td>
<td>Road</td>
<td>Road, Rail, Inland Water and Aircraft</td>
<td>Road</td>
<td>Road, Rail, Inland Water, Maritime</td>
<td>Road</td>
</tr>
<tr>
<td><strong>Resolution (Road)</strong></td>
<td>Vehicle, road and fuel type</td>
<td>Vehicle, road and fuel type</td>
<td>Vehicle, road and fuel type</td>
<td>Vehicle, road and fuel type</td>
<td>Vehicle, road and fuel/heat/powertrain type</td>
</tr>
<tr>
<td></td>
<td>Tank to wheel</td>
<td>Well to wheel</td>
<td>Tank to wheel</td>
<td>Well to wheel</td>
<td>Tank to wheel</td>
</tr>
<tr>
<td><strong>Software requirements</strong></td>
<td>MS ACCESS</td>
<td>MS ACCESS</td>
<td>MS ACCESS</td>
<td>MS ACCESS and EXCEL, WINZIP, GAMS</td>
<td>MySQL and JAVA</td>
</tr>
<tr>
<td><strong>Data availability</strong></td>
<td>Europe- individual purposes</td>
<td>Germany- national level</td>
<td>Europe- national level</td>
<td>Europe- national level</td>
<td>USA- national and county level</td>
</tr>
<tr>
<td><strong>Typical application</strong></td>
<td>Micro to macro scale inventories (street, city, national level) for EU emission standards</td>
<td>National inventory and scenarios for Germany</td>
<td>Macro (country level) scale inventories for EU emission standards</td>
<td>Macro scale (country/ EU level) inventories and scenarios for EU emission standards</td>
<td>Micro to macro scale (federal, state, county, city) inventories with US emission standards</td>
</tr>
</tbody>
</table>

Source: IFEU 2012

Author: Frank Dünnebeil

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5) Adaptation of a GHG monitoring tool

Adaption of an easily operated monitoring tool considering:
- Kind and format of regularly available input data and
- Requirements on presentation of results and their further use.
Example for a GHG Monitoring tool: BICO$_2$ model

- Excel based calculation tool for GHG inventories of municipalities
- Final energy consumption & GHG emissions calculation for all energy sectors
- Nationally harmonized emission factors (for transport from TREMOD)
- Required input parameters and presentation of results are adjusted individually for each municipality for different data availability and intended further use.

### Input screen (example)

#### Jahresfahrleistung Straßenverkehr im Gemeindegebiet

<table>
<thead>
<tr>
<th>Kfz-Kategorie</th>
<th>Einheit</th>
<th>Innerorts</th>
<th>Außerorts</th>
<th>Autobahn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorisierte Zweiräder (&quot;Kräder&quot;)</td>
<td>Mio. Fz-km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pkw</td>
<td>Mio. Fz-km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leichte Nutzfahrzeuge (LNF)</td>
<td>Mio. Fz-km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lkw &gt;3,5t</td>
<td>Mio. Fz-km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Busse (Reise- + Linienbus)</td>
<td>Mio. Fz-km</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gesamt fahrleistung</td>
<td>Mio. Fz-km</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Betriebsleistungen ÖPNV & Schienenpersonennahverkehr im Gemeindegebiet

<table>
<thead>
<tr>
<th>Linienbus</th>
<th>Fahrleistung</th>
<th>Mio. Fz-km</th>
<th>Wert</th>
<th>Datenquellen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verkehrsleistung</td>
<td>Mio. Pkm</td>
<td></td>
<td>Lokale(s) Verkehrsunternehmen</td>
<td></td>
</tr>
<tr>
<td>Auslastungsgrad der Busse</td>
<td>%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stadt-/Straßenbahn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angebotene Verkehrsleistung</td>
</tr>
<tr>
<td>Verkehrsleistung</td>
</tr>
<tr>
<td>Betriebs-/Fahrplanleistung</td>
</tr>
<tr>
<td>Betriebs-/Fahrplanleistung</td>
</tr>
<tr>
<td>Auslastungsgrad der Fahrzeuge</td>
</tr>
</tbody>
</table>

### Results screen (example)

- THG-Bilanz nach Verkehrsmitteln [t CO2 Äqu.]
- THG-Bilanz nach Verkehrsmitteln und Beeinflussbarkeit [t CO2 Äqu.]
- THG nach Energieträgern [t CO2 Äqu.]

Transport modes & local action field
Energy carriers & local action field
Case study: Impact monitoring for the London Congestion Charge
Case-Study: London Congestion Charge

Characterization of the measure

General
- Introduced in 2003 in Central London
- Mo-Fr; 07:00-18:00
- 21 sq.km; 200'000 inh.
- £10/day (fiscal measure)
- Exemptions für cars with <75 g CO₂/km

Main objective
- reduction of congestion

Target group
- Road vehicle drivers
- Focus: commuter
## Case-Study: London Congestion Charge

**GHG-relevant measure effects**

<table>
<thead>
<tr>
<th></th>
<th>Avoid</th>
<th>Shift</th>
<th>Improve</th>
<th>Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In CCZ</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>passenger cars</td>
<td>omitted trips; higher vehicle loads</td>
<td>shift to other transport modes</td>
<td></td>
<td>Exemptions for fuel-saving cars (for electric vehicles: upstream emissions relevant)</td>
</tr>
<tr>
<td>motorcycles</td>
<td></td>
<td></td>
<td></td>
<td>Change in traffic flow and average speed</td>
</tr>
<tr>
<td>taxis</td>
<td></td>
<td></td>
<td></td>
<td>Change in traffic flow and average speed</td>
</tr>
<tr>
<td>public transport</td>
<td>Extended PT offer (for shift from cars)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vans, lorries</td>
<td>omitted trips; higher vehicle loads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Outside CCZ</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>passenger cars</td>
<td>additional trips (diverted traffic)</td>
<td>shift to other transport modes (e.g. commuter traffic entering the CCZ)</td>
<td></td>
<td>Exemptions for fuel-saving cars (for electric vehicles: upstream emissions relevant)</td>
</tr>
<tr>
<td>motorcycles</td>
<td>-</td>
<td></td>
<td></td>
<td>Change in traffic flow and average speed</td>
</tr>
<tr>
<td>taxis</td>
<td>-</td>
<td></td>
<td></td>
<td>Change in traffic flow and average speed</td>
</tr>
<tr>
<td>public transport</td>
<td>Extended PT offer (for shift from commuting car traffic)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vans, lorries</td>
<td>additional trips (diverted traffic)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CCZ: Congestion Charging Zone**

IFEU based on TfL(2004) | Author: Frank Dünnebeil | 19th May 2014 | 27
Case-Study: London Congestion Charge

Transport activity data → Number of vehicles

Figure 3.2 Total traffic entering the charging zone during charging hours

Red: before introduction  
Blue: after introduction
Case-Study: London Congestion Charge

Transport activity data → VKT

Table 3.3 Key changes in vehicle-kilometres driven within the charging zone during charging hours. Annualised weekday 2002 compared with 2003 (post-charging)

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>2002 vkm (millions)</th>
<th>2003 vkm (millions)</th>
<th>percentage change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All vehicles</td>
<td>1.64 (100%)</td>
<td>1.45 (100%)</td>
<td>-12%</td>
</tr>
<tr>
<td>Four or more wheels</td>
<td>1.44 (88%)</td>
<td>1.23 (85%)</td>
<td>-15%</td>
</tr>
<tr>
<td>Potentially chargeable</td>
<td>1.13 (69%)</td>
<td>0.85 (58%)</td>
<td>-25%</td>
</tr>
<tr>
<td>Cars</td>
<td>0.77 (47%)</td>
<td>0.51 (35%)</td>
<td>-34%</td>
</tr>
<tr>
<td>Vans</td>
<td>0.29 (18%)</td>
<td>0.27 (19%)</td>
<td>-5%</td>
</tr>
<tr>
<td>Lorries and other</td>
<td>0.07 (4%)</td>
<td>0.07 (5%)</td>
<td>-7%</td>
</tr>
<tr>
<td>Licensed taxis</td>
<td>0.26 (16%)</td>
<td>0.31 (21%)</td>
<td>+22%</td>
</tr>
<tr>
<td>Buses and coaches</td>
<td>0.05 (3%)</td>
<td>0.07 (5%)</td>
<td>+21%</td>
</tr>
<tr>
<td>Two wheeled vehicles</td>
<td>0.20 (12%)</td>
<td>0.23 (16%)</td>
<td>+14%</td>
</tr>
</tbody>
</table>

Note: Changes given in bold are statistically significant at the 95 percent confidence level. The percentage contribution to total charging zone traffic is also shown for each of 2002 and 2003.
Case-Study: London Congestion Charge

Emission factors

Emission factors adopted from London Atmospheric Emissions Inventory (LAEI)

- Local fleet composition: Yes
- Traffic flow characteristics: Yes
- CO₂ equivalents and upstream emissions: No

Source: Detail of the LAEI compilation procedure illustrated in (GLA 2004)
Case-Study: London Congestion Charge

Monitoring results

Table 6.3  Principal changes to emissions of NOx, PM10 and CO2. Percentage changes, 2003 compared with 2002.

<table>
<thead>
<tr>
<th>Change</th>
<th>Charging zone</th>
<th>Inner Ring Road</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOx</td>
<td>PM10</td>
</tr>
<tr>
<td>Flow change - motorcycles</td>
<td>-</td>
<td>0.4</td>
</tr>
<tr>
<td>Flow change - taxis</td>
<td>2.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Flow change - car</td>
<td>-4.5</td>
<td>-4.6</td>
</tr>
<tr>
<td>Flow change - bus and coach</td>
<td>2.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Flow change - light goods</td>
<td>-0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>Flow change - rigid goods</td>
<td>-1.6</td>
<td>-1.0</td>
</tr>
<tr>
<td>Flow change - articulated heavy</td>
<td>-0.4</td>
<td>-0.2</td>
</tr>
<tr>
<td>Traffic volume change</td>
<td>-1.4</td>
<td>-0.8</td>
</tr>
<tr>
<td>Speed change</td>
<td>-6.5</td>
<td>-5.5</td>
</tr>
<tr>
<td>Traffic volume and speed change</td>
<td>-7.9</td>
<td>-6.3</td>
</tr>
<tr>
<td>Vehicle stock change</td>
<td>-5.5</td>
<td>-9.2</td>
</tr>
<tr>
<td>Overall traffic emissions change 2003 versus 2002</td>
<td>-13.4</td>
<td>-15.5</td>
</tr>
<tr>
<td>Overall traffic emissions change 2004 versus 2003</td>
<td>-5.2</td>
<td>-6.9</td>
</tr>
</tbody>
</table>
Alternative and complementary monitoring issues
Ex-post evaluation of impacts from measures

- GHG monitoring documents the real development of GHG emissions.
- This real development is caused by the analysed measures, but also influenced by general trend and other measures.

→ Assessment of actual GHG mitigation effectiveness of specific measures requires an ex-post evaluation.

Ex-post evaluations estimate the net GHG mitigation effect of a measure by comparing the real GHG emissions development (= monitoring results) with a reliable and plausible estimate of developments without measure (= hypothetical baseline).

Source: WRI 2014
Ex-post evaluation: Baseline scenario

- Calculation of a hypothetical GHG emissions development trying to factor out all effects of the evaluated measure
  - Same assessment boundaries as in the real GHG emissions development.
  - Parameters, not affected by the measure: Adoption of real developments from the policy scenario
  - Parameters, affected by the measure: Estimation of hypothetical, but plausible developments without implementation of the measure

C) Baseline Scenario: Hypothetical GHG emissions development without measure
Monitoring implies more than GHG emissions calculation

**Example: Climate protection Benchmark**

- **Step 1:** Monitoring GHG emissions
- **Step 2:** Activity profile
- **Step 3:** Set of indicators

---

Source: IFEU 2009/2010

Author: Frank Dünebeil

19th May 2014
Climate protection Benchmark: GHG inventory

- Development of GHG emissions of the city differentiated by energy sector and energy carrier

![Chart showing CO₂ emissions by energy carrier from 1991 to 2011](chart.png)

Source: IFEU 2009/2010

Author: Frank Dünnebeil
Climate protection Benchmark: Activity Profile

- Illustrates present state and implementation of a city's climate protection activities
  - in four categories: climate policy, Energy, Traffic, Waste
  - in steps from 0 (slightly active) to 4 (exceedingly active)

Source: IFEU 2009/2010

Activity Profile Germany
Climate protection Benchmark: Activity Profile - Mobility

<table>
<thead>
<tr>
<th>Mobility</th>
<th>1: getting started</th>
<th>2: moving forward</th>
<th>3: forging ahead</th>
<th>4: taking the lead</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 Involve your staff in your sustainable mobility plans</td>
<td>inform your employees about the environmental impact of their travel to and from work and about the alternatives</td>
<td>set up a mobility plan for the local administration</td>
<td>adapt the number and type of your vehicles to the specific needs (including car-sharing possibilities)</td>
<td>purchase fuel efficient, alternative fueled and electric vehicles</td>
</tr>
<tr>
<td>M2 Reduce transport demand by sustainable land use planning</td>
<td>investigate sustainable transport solutions (low surface area, mix of functions) when (re)designing residential areas or for housing projects</td>
<td>introduce criteria for urban planning that aim at reducing transport demand, and promoting public transportation</td>
<td>plan in favor of pedestrians and cyclists, traffic calming as well as energy efficient and responsible car use</td>
<td>implement innovative models of urban design regarding transport (car free residential areas etc.)</td>
</tr>
<tr>
<td>M3 Increase the share of zero carbon transport modes</td>
<td>set targets to increase the rate of cycling and walking modes</td>
<td>work on the progressive enlargement and improvement of your cycling and pedestrian network</td>
<td>consider cyclists and pedestrians as main actors when reorganizing the distribution of roadways</td>
<td>become a cycling city exempt of cars!</td>
</tr>
<tr>
<td>M4 Provide convenient public transport</td>
<td>increase insights in the possibilities of existing public transport</td>
<td>improve public transport facilities and services</td>
<td>develop and implement action plans on the priority and expansion of public transport</td>
<td>achieve a best practice public transport system (broad choice of public transport, simple and cheap access to tickets, regional alliance)</td>
</tr>
<tr>
<td>M5 Restrict traffic flows by managing parking space</td>
<td>increase compliance with existing parking regulations (diminish wild parking)</td>
<td>start in the city centre to use parking and access restrictions to tempt users back to sustainable modes of transport</td>
<td>set up and implement step-by-step an integrated parking programme</td>
<td>introduce regulations to limit parking space in new developments</td>
</tr>
<tr>
<td>M6 Promote responsible car use of citizens</td>
<td>consider the applicable legal framework and analyze potential users of efficient schemes (car-sharing, energy-efficient vehicles)</td>
<td>promote eco-driving, car-sharing and car pooling</td>
<td>promote the purchase of energy-efficient vehicles</td>
<td>develop a local low energy infrastructure (smaller and more efficient vehicles, interconnect users, eco-driving)</td>
</tr>
</tbody>
</table>

Source: IFEU 2009/2010

Author: Frank Dünebeil
19th May 2014
Climate protection Benchmark: Set of indicators

- Transparent overview over the effects of climate protection activities with significant indicators
- Identification of areas with need for action
- Description of data quality for each indicator
Measure-specific indicators - Example
*Indicators for improving a regional network of cycling routes*

**Indicators for direct effects**
- Length of the cycling network
- Number of cyclists, e.g. from
  - periodic counts at selected main routes of the cycling network,
  - surveys in households, companies, public institutions
  - frequency of use of bicycle parking facilities
- Quality of cycle traffic, e.g.
  - number of accidents per cycling activity (from policy statistics)

**Indicators for indirect effects**
- Mobility surveys (modal shift from passenger cars)
- Traffic counts for passenger cars at selected roads with parallel cycling route (from regular traffic monitorings or own counts)
- Total VKT of passenger cars in the region (e.g. from statistical office)
Monitoring implies more than GHG emissions calculation

Sustainability

Environment

- Air quality
- Climate
- Noise
- Bio diversity
- and more

Society

Economy
Thank you for your attention!

Questions and remarks?

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