CO₂ monitoring within Climate Alliance

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Climate Alliance CO₂ inventory rules

Upon joining Climate Alliance, cities and municipalities voluntarily commit to reducing their CO₂ emissions by 10% every five years. Monitoring success and achievement of this goal is only possible with a CO₂ inventory, which is why Climate Alliance has advocated CO₂ monitoring on the municipal level since its founding. Rules for CO₂ monitoring on the municipal level have been developed based on ethical principles (the municipality is responsible for all emissions arising from activities within their boundaries) and pragmatic approaches for bridging gaps in the data.

Key milestones in this work are:

- **1993:** A resolution is reached at the General Assembly with agreements on monitoring and reporting: reports presenting the climate protection measures and CO₂ emissions reduction achieved to date are to be prepared and published at regular intervals. The CO₂ inventory should include emissions caused by energy consumption and transport within the municipality whereby the upstream process chains should also be taken into account. Due to in part significant population migration, the Climate Alliance goal stated in Climate Alliance’s declaration should relate to the per capita emissions.

- **1995:** The “CO₂ reduction strategies in Climate Alliance” working group established in 1993 presents recommendations for monitoring progress. A catalogue of measures is prepared for the qualitative monitoring of success, and recommendations for the breakdown and representation of CO₂ emissions drafted for the quantitative monitoring.

- **1998:** Forum on “CO₂ Monitoring – Methods and Results” at the General Assembly in Lucerne (Switzerland). The Swiss member cities subsequently prepare climate protection inventories in a predominantly uniform format.

- **1999:** Workshop on monitoring at the General Assembly in Apeldoorn (Netherlands). Ten “Golden Rules” for monitoring are drafted. Moreover, a need for further research is ascertained, particularly regarding how the external influences (national and European framework conditions) and results of municipal climate protection policies can be differentiated between when monitoring success. The Secretariat analyses countless reports from members to draw conclusions on Climate Alliance’s overall success.

- **2000:** Adoption of the “Climate Alliance Declaration of Bolzano”. This document emphasises that the members seek to achieve a “significant reduction in greenhouse gas emissions”, wish to draw up “short- and mid-term targets as well as sectoral targets in the various fields of activity which enable monitoring of progress”, and wish to agree on “a monitoring system to assess progress towards our objectives, in particular instruments for the monitoring of CO₂ emissions and a set of further indicators for monitoring”. The Secretariat develops and proposes a format for overview reporting with the “Municipal Climate Protection Profile”. The status report published in 2000 is based on this format.
and presents the profiles of 30 member cities to the international community at the UN Climate Change Conference.

- **2005:** At the General Assembly, all municipalities commit to an inventory and the publication of CO₂ emissions (including those from energy consumption and the transport sector).

- **2007:** The internet-based ECORegion tool is developed in cooperation with Ecospeed according to the rules agreed by Climate Alliance. A pilot phase is implemented, which culminates in launch of the tool for all municipalities in Germany in August 2008 and subsequently of national versions (Italy: 2010; Luxembourg: 2011). The CO₂ monitoring working group accompanies this process and continuously develops further rules and calculation recommendations.

- **2011:** Around 800 municipalities in Germany meanwhile use ECORegion. Climate Alliance member inventories calculated entirely with local data covers 25% of the German population.

As the development stages outlined above show, municipal CO₂ monitoring is an ongoing process. The following CO₂ monitoring rules reflect the experience Climate Alliance has gained to date. Further developments are expected due to various changes to the “state of technology”, availability of data and legal framework conditions.

### 1.1 Definition of CO₂ monitoring within Climate Alliance

The inventory of energy-related carbon dioxide (CO₂) emissions includes the entire municipality’s share in emission of this greenhouse gas (households, industry, commerce, transport). The main source of CO₂ emissions is the combustion of fossil fuels for the generation of effective energy. Not only the direct CO₂ emissions, but also the attributable ‘out-of-town’ emissions, particularly those from power plants located outside of the city whose energy is used within the city, are to be included in the inventory.

The aim of municipal CO₂ monitoring is to extend the survey of greenhouse gases conducted on the EU and national levels to the local level and thus create reference values on the municipal level for future CO₂ reduction programmes. These reference values form the basis for determination of emission reduction goals specific to the location, for the development of strategies and measures in the priority fields of activity, and – after updating – for the review of goal achievement. A measures-related record of success is also useful in connection with concrete individual measures [Worms-2009].

### 1.2 Limitations of the CO₂ inventory

When defining the CO₂ inventory, Climate Alliance uses two terms, which are contested in expert circles: the inventory of CO₂ emissions “within the municipality” and “caused by the municipality”. Within the scope of municipal CO₂ monitoring, two contradictory terms are generally used: “territorial”
and “emitter” CO\textsubscript{2} inventory whereby the former is not defined in expert literature. The so-called source inventory is generally meant with “territorial inventory”, which forms part of the IPCC method of calculation or simply the preparation of a CO\textsubscript{2} inventory in general, regardless of the method used – within the municipal boundaries. The different approaches shall be explained in the following section.

**The source inventory (territorial inventory)**

The source inventory involves the representation of emissions relating to a country’s total primary energy supply (TPES) classified according to the emission sources, transformation fields and total final energy consumption. While emissions from imported electricity are not taken into account, those arising from the generation of electricity that is exported are included in full. While the source inventory allows for conclusions to be reached on the total CO\textsubscript{2} emitted by a country, the inclusion of electricity exports consequently means no direct conclusions are possible on the consumption behaviour of the total final energy consumers and the resulting contribution to a country’s CO\textsubscript{2} emissions [LAK-EB].

The inventory is calculated according to fuel consumption. Only the emissions from fuels required for the country’s energy production and energy conversion are included. German federal states use the source inventory to calculate their CO\textsubscript{2} inventory.

**Inventory according to the IPCC guidelines**

Similar to the source inventory, the method used by the Intergovernmental Panel on Climate Change (IPCC) calculates a nation’s primary energy consumption according to fuel consumption for the production of energy in the fields of transport and industry. In addition, non-energetic emissions from industrial processes, solvents, agriculture, land use, land use change, forestry and waste are also included.

**The emitter inventory**

This involves the calculation of CO\textsubscript{2} emissions based on data from the end consumer sectors and therefore includes electricity imports and other fuel imports (petrol, diesel, kerosene, coal), and assigns the emissions in the transformation field during the generation of electricity and district heating to the final consumption. Emitter inventories are therefore an indicator of the emissions caused by end consumers in a region. The total final energy consumption includes the energy consumption from households, economic activities and the transport sector.

**The LCA approach**

Comprehensive consideration of the CO\textsubscript{2} emissions from energy and fuel imports is only possible when the Life Cycle Approach (LCA) is used [LAK-EB]. When preparing an inventory according to the LCA, the entire energy input and all CO\textsubscript{2} emissions associated with the total final energy consumption are considered. This includes the energy input and emissions:

- for the construction of power plants;
for the conversion of energy to technology, mining, exploitation, and manufacture of the fuels required, so the mining of coal, exploitation of oil and gas, production of diesel, petrol and kerosene, and the energetic use of waste and biomass;

- from the production and supply of energy, so primary energy losses depending on the efficiency and effectiveness of the plants, and the losses during energy transport.

1.3 The CO$_2$ inventory according to the Climate Alliance methodology

Calculation of emissions according to the source principle is unsuitable for municipalities. On the one hand, all municipalities obtain their electricity from the national grid and not from individual power plants. On the other, inclusion of the national power plants in the municipal CO$_2$ inventories would introduce an element of randomness into the CO$_2$ monitoring: extremely high emissions would consequently be attributed to municipalities with a coal power plant within their boundaries, while municipalities located close to a nuclear power plant would only be attributed low emissions.

Neither municipality is in fact responsible for the power plants, which are subject to the EU Emissions Trading System (EU ETS). These large power plants belong to the big energy companies, who feed the electricity generated into the national grid, or sell it to the national energy exchange. Municipalities are particularly not in a position to influence power generation at these power plants.

Given that the energy production of all power plants feeds into the national grid and municipalities then draw their power from this, only calculation with the shares and CO$_2$ emission factors of the national electricity mix into which all of the country’s power plants and energy imports flow is advisable for the municipal CO$_2$. This approach corresponds with the consumer inventory.

There are also companies and inhabitants, who generate their own electricity, which they do not feed into the public grid but use themselves. This self-generation and private consumption should be included in the CO$_2$ inventory.¹

Calculating of municipal energy generation in the CO$_2$ inventory

Preparation of a municipal inventory where emissions are calculated according to energy consumption begs the question of how the energy generated within the municipality can be calculated. Even if this is fed into the national grid and therefore contributes to a change (generally an improvement) in the CO$_2$ emission factor for electricity, the municipalities wish to include their electricity production. This is an important argument for the work within the municipalities’ political committees and PR work to document successes and advance implementation of further climate protection measures as a consequence.

Calculation with the data and CO$_2$ emission factors from the national electricity mix would be methodologically correct. However, for the reasons outlined above, Climate Alliance allows calculation of municipal electricity production as municipal energy consumption. Climate Alliance is aware that

¹ According to the data currently available, only data from the electricity fed into the grid is taken into account. No data is available on private consumption yet.
this rule leads to emissions being counted twice, as the reduction in CO\textsubscript{2} emissions from electricity are included on both the local and national levels. It is for this reason that only the municipal CO\textsubscript{2} emissions calculated with the national CO\textsubscript{2} emission factors for electricity should be taken into account in the comparison of municipalities, e.g. in the “Municipal Climate Protection Benchmark”, and calculation with representation of municipal electricity production should only be used internally within the municipality.

**Inventory of electricity (power plants from 20 MW)**

Power plants generating 20 MW or more are subject to the EU Emissions Trading System (EU ETS) and should not be taken into account in the municipal CO\textsubscript{2} inventory. Further explanations can be found below.

An inventory of power plants generating 20 MW or more isn’t permitted in the “Covenant of Mayors” inventory methodology either [EU-Mayors].

**Inventory of major emitters**

The question of which industries to include in the municipal inventory was raised at the very start of the description of this methodology. The question is, are municipalities responsible for the energy consumption of major emitters, or can municipalities influence the energy consumption and emissions of power plants or major industry with direct measures?

After some debate it was agreed that the plants’ share, which is subject to the Emissions Trading System (ETS), should not be included in the municipal CO\textsubscript{2} inventory.\(^2\) The plants subject to this system are generally large power plants and energy-intensive industrial plants, which fall under the special ETS regulations and purchase or sell emission rights, or obtain these from the government for free.

Various reasons speak against the inclusion of such plants in the inventory on the municipal level:

- The emissions limits and CO\textsubscript{2} emissions of such plants are determined by international and national policies and authorities, and are regulated by European and national legislation. Municipalities have no means of influencing these.
- National policy affects the emissions limits of such plants through the issue of free emissions certificates.
- Inclusion of the plants subject to the Emissions Trading System (ETS) in the municipal CO\textsubscript{2} inventory could also imply calculation of the associated CO\textsubscript{2} emissions certificates, which does not actually involve physical calculation of the emissions, but rather a political and economic calculation.
- The plants subject to the Emissions Trading System (ETS) aren’t included in the Covenant of Mayors [EU-Mayors] either.

\(^2\) Power plants in addition to steel, aluminium, chemical and cement works are subject to the Emissions Trading System. A list of all plants in Germany is available on the website of the German Emissions Trading Authority (*Deutsche Emissionshandelsstelle*, DEHSt).
Inventory for green electricity

Climate Alliance is currently discussing the calculation basis for green electricity within the CO₂ Monitoring working group as well as with Climate Alliance’s national coordinations in Switzerland, Italy, Austria and Luxembourg.

Temperature adjustment

Temperature adjustment is generally performed on the energy consumption during a specific period so as to represent development of the CO₂ emissions independently of the impact of annual temperature fluctuations. The outcome is determination of fictitious CO₂ emissions, which would have been emitted had the annual average temperature constantly remained at the long-term average [LAK-EB]. The CO₂ Monitoring working group debated the pros and cons of temperature adjustment from the offset: the energy consumption and emissions calculated with this are, as noted in the definition, fictitious – adjustment is not to the actual emissions. Temperature adjustment should only be used when calculating the emissions resulting from heat consumption in building heating (municipal, private, commercial). This allows for evaluation of which measures (insulation, thermal insulation, new windows) have an impact on the heat consumption of buildings under constant conditions. However, there should not be any temperature adjustment of the entire heat consumption in the municipality – due to the use of heat for other purposes, e.g. in industrial/commercial demand. The level and development of energy consumption not only depends on the temperature, but also on the energy prices and economic development. They have a considerable influence on consumer behaviour meaning that “economic adjustment” may well also be necessary. Furthermore, there are several other influencing factors such as changes to the legal framework and PR campaigns, which can significantly impact consumer behaviour.

1.4 Inventory of the transport sector

Transport is the movement of persons and goods along routes within a transport infrastructure. A transport need arises as a result of the spatial separation of social activities such as living, working, education and leisure. The aim of transport is to fulfil social needs that can arise either inside or outside of the municipality. Fulfilment of such needs is the cause of traffic activities within the municipality. Major business centres are the destination of a great many commuters, and municipalities with fewer educational and leisure offerings also have a traffic flow of schoolchildren, students and people pursuing leisure activities out of the municipality. It is therefore primarily social and economic aspects in addition to the availability of routes and transport infrastructure that determine the traffic flow.

A territorial inventory of the transport sector

Some municipalities that prepare a so-called territorial inventory are only concerned with the mileage and emissions from transport within their city boundaries; the emissions from outside of these boundaries are not recorded. According to this principle, larger cities are attributed far more emissions
than smaller cities due to the larger surface area. Regardless of a municipality’s transport characteristics, calculation of the territory’s transport emissions is virtually proportional to the city’s size. As a result, lower vehicle mileage and emissions are attributed to small municipalities even when there is no public transport system and a large proportion of private vehicles, which cause the most emissions in the transport sector.

This approach is extremely problematic when it comes to calculating the air traffic: according to the territorial principle, the take-off and landing emissions are attributed to the municipality in whose territory the airport is located. The remaining emissions for the flight are assigned to the municipalities located along the flight route. The emissions from air traffic over neutral territory such as over the Atlantic must then be assigned to the international community. Due to this inconsistency in recording air traffic emissions, they are not taken into account in the territorial method, which means that 12% of emissions in the transport sector are systematically disregarded in the territorial transport inventory.

**The Climate Alliance methodology**

Due to the difficulties and inconsistencies in the territorial inventory of air traffic explained above, Climate Alliance has opted for calculation according to the emitter principle.

Climate Alliance is of the opinion that it is the behaviour of the inhabitants, availability of transport infrastructure plus the sociocultural and economic structure of a city that shape a municipality’s transport sector. Limiting transport to the city boundaries in the inventory is not useful, as people’s behaviour and the impact on a city’s economy and infrastructure does not stop at the city boundaries but in many cases extends beyond these.

Climate Alliance’s methodology attempts comprehensive recording of the transport sector with all modes of transport and energy carriers. The recording is only possible with calculation of the overall vehicle mileage and energy consumption according to the municipality inhabitants’ vehicles or with recording of all activities caused by the municipality.
Private transport

Insofar as possible, the total distance travelled by inhabitants using private vehicles is included for private transport, and the according fuel consumption and CO\textsubscript{2} emissions determined on this basis whereby the entire road network both inside and outside of the municipality is included. Using this approach, phenomena such as tank tourism do not need to be taken into account, as it is irrelevant where the fuel is purchased but rather who uses it.

Public transport

Many public transport services are offered as local modes of transport within the city boundaries (tram, underground, bus). Certain types of transport fulfil their function between different municipalities (underground, tram, inter-municipal bus transport and regional trains).

The method to calculate the vehicle mileage within specific city boundaries is methodologically straightforward and attributed to the city in which they occur. The calculation for modes of transports serving several municipalities and on which people board and alight in different municipalities is more complex. Climate Alliance has developed detailed recommendations for such scenarios.

Long-distance passenger transport

The same rules apply here as for private transport. City inhabitants’ long-distance train and plane mileage is calculated. Further information on the calculation of such mileage can be found in the transport section in ECORegion.

Freight transport

Freight transport has a direct bearing on economic activity within the municipality, meaning that freight traffic is also assigned to the municipality from which the economic activity originates, so the transport of goods, which are transshipped, transformed or manufactured in the city. Goods entering a city are also included in the place of transformation or generation.

Climate Alliance attempts to include all forms of freight transport in the inventory (via rail, ship, and road), however sea and air transport are not yet included. In future, calculation of these categories should take place according to the same principles, although the calculation basis must first be defined.

Furthermore, there are other vehicle categories, which have not yet been included in the Climate Alliance methodology, such as agricultural vehicles or so-called special vehicles (police cars, fire engines, refuse collection lorries, ambulances, etc.). In comparison with other vehicles such as private vehicles, tractor units and lorries, emissions from these vehicles are also extremely low though. Moreover, the data collection on a municipal level and calculation of such vehicles’ consumption is particularly difficult. The special vehicle category is a mixed category that includes different types of vehicles.

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3 The energy consumption of private vehicles includes the fuel consumption of motorcycles and cars.
4 Tank tourism denotes the phenomenon whereby drivers in areas close to the border fuel their vehicle in the neighbouring country due to the favourable (tax-related) differences in fuel prices.
vehicles. This means the mileage and consumption of these vehicles is also very different, which severely complicates calculation.

1.5 Disregard of other greenhouse gases

In Germany, 83% of the national CO$_2$ emissions are caused by the energy sector [UBA-2011]. 87% of the greenhouse gases emitted in Germany are CO$_2$ (in 2009, for example) [IPCCC-2011]. An energy inventory based on CO$_2$ therefore covers the vast majority of emissions in Germany. Furthermore, recording of the other greenhouse gases is extremely difficult on a municipal level. Climate Alliance is currently calling for an energy inventory based solely on the CO$_2$ representing all municipal areas: not only the transport sector, households, economy, and municipal buildings and infrastructure, but also non-energetic, nonpoint source emissions from agriculture, waste disposal and industry.
Implementation of the Climate Alliance CO₂ inventory concept in ECORegion

This section provides an introduction for data collection and input into ECORegion for preparation of the final inventory.

2.1 Recording energy data in ECORegion

Municipalities’ energy consumption is recorded in the following tables in ECORegion:

- **Total energy consumption** – a municipality’s total energy consumption
- **Energy consumption of households** – energy consumption of private households by energy carrier.
- **Energy consumption of economic activity** – energy consumption arising from a municipality’s economic activities.
- **Energy consumption of the municipal administration** – energy consumption for aspects that the municipal administration is responsible for.

**Overall energy consumption**

A municipality’s overall energy consumption is entered in this table. This means the energy forms consumed (electricity and district heating) and energy carriers within the municipality (according to the city boundaries).

The energy consumption data for grid-bound energy forms such as electricity and district heating, and energy carriers such as natural gas is available from the grid operators.

According to the German Environmental Information Act (Umweltinformationsgesetz, UIG) of December 22, 2004 (BGBl. I, pg. 3704), grid operators are obliged to provide municipalities and regions with this consumption information.

To date, the recording of non grid-bound energy carriers such as heating oil, wood, black and brown coal, biomass, biogas and liquid gas has proven more difficult.⁵

Implementation of EU Directive 2006/32/EC on energy services in Germany with the Act on Energy Services and Energy Efficiency Measures (Gesetz über Energiedienstleistungen und andere Energieeffizienzmaßnahmen, EDL-G) of 04.11.2010 opens up opportunities for the collection of data. According to this law, energy suppliers and companies are obliged to provide information on the quantities of energy supplied when their turnover total more than 75 gigawatt hours of energy per year, they employ ten or more people, or their annual turnover and budget exceeds 2 million euros.

By means of the statutory law, the German federal government will regulate:

1. The details of data collection and specifically
   a) which type of data can be collected,
   b) when and how the data is to be transmitted, and

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⁵ It is not the primary energy consumption of the energy carriers for power plants that should be included here, but rather the total final energy consumption, meaning the combustion of heating oil, wood or coal in heating systems or industrial processes, or the admixture or feeding of biogas into the natural gas grid.
2. use of the data.

During a meeting held in spring 2009, Climate Alliance suggested the German Federal Ministry of Economics organise this data by postcode so that the municipalities could be supplied with precise data. To date, no information is available on adherence to the law, and it cannot be said whether Climate Alliance’s proposal will be incorporated into the law.

Given that there have not yet been any other opportunities to collect data, many municipalities use heating oil and wood consumption data obtained from the chimney sweeps. In accordance with the German Federal Emission Control Act (Bundes-Immissionsschutzverordnungen, BlmSchV), chimney sweeps are obliged to keep detailed accounts of the combustion plants they check according to their performance and age.

Table 1: Combustion plant breakdown by performance and age [Worms-2009]

<table>
<thead>
<tr>
<th>Installation:</th>
<th>Performance in kW:</th>
<th>Totals:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 - &lt;11</td>
<td>11 - &lt;25</td>
</tr>
<tr>
<td>Up until 31.12.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.01.79 to 31.12.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.01.83 to 30.09.88/02.10.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01.10.88/03.10.90 to 31.12.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/01/1998 to 31/12/2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Such tables can be used to calculate the average heating oil and wood consumption, and to estimate the heating systems’ hours of operation. These calculations serve as a benchmark, but do not represent the actual consumption of these energy carriers.

Detailed information on wood, pellets and logs has also been freely available to municipalities at www.biomasseatlas.de since 2011. All combustion plants subsidised by the German Federal Office of Economics and Export Control (Bundesamt für Wirtschaft und Ausfuhrkontrolle, BAFA) are listed here. These calculations should be compared with other data, such as gas consumption in the municipalities: gas, wood and heating oil consumption is inversely proportional: the more gas connections a municipality has, the less heating oil the municipality uses. Some chimney sweep guilds such as those in Lower Saxony and Hesse already offer municipalities information on the number of combustion plants in the municipalities in a similar format to the table shown above.6

It is not photovoltaic but rather solar thermal energy that is mean with “Total energy consumption” under the solar collector category in the table.7 Information on the solar collectors installed in

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6 This table was prepared by Climate Alliance for development of the climate protection concept for the city of Worms. It now serves as a template for the recording of combustion plants in all municipalities in Germany.

7 Photovoltaic energy is actually a part of the electricity mix. It is recorded in the regional or locally-generated electricity.
municipalities in available at www.solaratlas.de. The information on this website relates to the solar thermal systems subsidised by the BAFA since 2001.

Information on the number of solar collectors and surface area installed is available on the Solaratlas website. Climate Alliance and the “European Energy Award” set a parameter of 350 kWh/m² per year (for Germany) for calculation of solar collectors’ energy yield. This parameter can be used to calculate the output of a specific surface area. Solar radiation varies throughout the different regions of Germany; 350 kWh/m² represents the average.

Near-surface geothermal energy or circulator pumps are meant with the term ‘ambient heat’. Information on the number of installations with details of the output is available from the lower water authorities.

Information on municipal consumption of black and brown coal and liquid gas is available from many state statistical offices.

Energy consumption – households

Similar to the information on the overall energy consumption of electricity, gas and district heating, information on the energy consumption by household is also available from all of Germany’s grid operators and energy suppliers.

All of Germany’s grid operators and energy suppliers work with load profiles for calculation of the energy consumption of agriculture, commerce (wholesalers, general commerce, bakeries, shops, etc.) and households, and are therefore in a position to give precise information on this consumption data. The energy suppliers generally use the procedure of the German Federal Association of Energy and Water Industries (Bundesverband der Energie und Wasserwirtschaft, BDEW) for the generation of standard load profiles.

The problem with temperature adjustment for the heat requirements of households has already been explained above (c.f. Section 1.2.5.).

Energy consumption – economic activity

In ECORegion, the energy consumption of economic activity is based on percentages, meaning the energy consumption of energy carriers from all economic sectors should add up to 100%.

Three traditional economic sectors are represented in the table:
- Primary sector: agriculture, forestry, fishing, and mining.
- Secondary sector: industry, the construction trade, and the supply of energy and water.
- Tertiary sector: services.

Similar to the private households, Germany’s energy suppliers and grid operators also have a breakdown of the electricity, gas and district heating consumption for all these sectors.

Recording the energy consumption of industrial enterprises is straightforward due to their status as special tariff customers at the energy suppliers. For agriculture and services, recording of the data is
also straightforward with the standard load profile procedure, as demonstrated. In addition to this, a
great many state statistical offices have prepared reports on the total energy consumption of
economic activity on a municipal level.\(^8\)
The energy consumption of major industries subject to the Emissions Trading System (ETS) should
not be included in the municipal C02 inventory (see description of the methodology).

**Energy consumption – municipal administration**

This table is the only one in ECORegion not to be calculated in the initial inventory. During
development of ECORegion for Germany, the decision was reached together with the municipalities
participating in the test phase, Climate Alliance and the B.&S.U. not to use the average German
figures for calculation of this table for the following reasons:

- No survey has been conducted in Germany on the energy consumption of municipalities,
  which would enable reliable calculation of such figures.

- Each municipality affords special characteristics and expertise, which would complicate
determination of such figures. There are municipalities that operate hospitals, schools,
waste disposal services, and water and waste water services, and others that do not.

- Every Climate Alliance municipality should actually perform energy management
  enabling the recording of such energy consumption data in detail – without having to rely
  on the necessary calculation based on the figures for Germany.

Three categories are recorded within the “Municipal administration” table:

Municipal lighting – along roads, pedestrian pathways and transport routes, and in parks.
Municipal buildings – these are the so-called municipal properties, so the administrative
buildings, town hall, schools, sports halls, swimming pools, libraries, hospitals, and everything
affording the characteristics of a building. All buildings that the municipality is obliged to
manage should be entered in this table.

Municipal infrastructure – denotes the basic technical facilities of the city relating to:

- Water/waste water, pipework, fountains, waterworks, water treatment, sewer
  system, waste water treatment plants, etc.

- Road and rail transport – bridges, tunnels, passage, railway network, bus stations
  and stops for Park & Ride services.\(^9\)

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\(^8\) Industrial enterprises with a minimum of 20 employees are generally recorded by the state statistical offices.

No real descriptions or definitions exist for such categories in Germany or Europe hence Climate Alliance has prepared its own definition following intensive research and exchanges with city planners. The term ‘municipal infrastructure’ actually has military origins: it was coined by NATO in the 1960s and subsequently adopted by city planners.

**Consumption of the municipal vehicle fleet**

Either the fuel consumption of the municipal vehicles (in litres of diesel/petrol or cubic metres of gas) or the energy consumption units [kWh] – of electric cars, for example – should be entered in these two tables. Both tables are combined for the final calculation of energy consumption and the emissions of municipal vehicles.

**What is understood by municipal vehicles?**

Similar to for municipal buildings and infrastructure, no concrete definition exists for this category. Climate Alliance has therefore prepared its own definition.

- Company vehicles (cars)
- Street cleaning vehicles and work machines
- Police cars/public order vehicles
- Fire service vehicles
- Ambulances
- Waste disposal vehicles

Climate Alliance is of the opinion that only the energy consumption and CO₂ emissions lying within the municipalities’ scope of responsibility and that can be influenced on a municipal level through implementation of climate protection measures should be recorded in the municipal administration tables. Therefore, only vehicles, which the municipality is really responsible for should be included in this table.

**2.2 Recording energy production**

The municipal/regional generation of electricity and district heating is recorded in the following tables:

- Electricity output – the electricity generated by the municipality.

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This relates solely to use of the above-mentioned tunnels, passages, etc. and the necessary railway infrastructure, not to use of the rail services themselves.
Electricity consumed regionally – the consumption share in the municipal electricity generation.

Electricity consumption mix – the consumption share in municipal and national electricity production.

Local and district heating output – the local and district heating generation.

Local and district heating consumed regionally – the consumption share in local and district heating.

Consumption district heating mix – the total local and district heating consumption.

Calculating municipal local and district heating and electricity generation in ECORegion

For all ECORegion users, the CO₂ emissions from local and district heating and electricity consumption are taken from Germany’s so-called electricity mix and district heating mix during calculation of the initial inventory. It is also assumed during calculation of the initial inventory that municipal electricity and district heating consumption corresponds exactly with the average consumption characteristics in Germany.

As with every other ECORegion table, this assumption can be refined with municipal information in the “Electricity/district heating output” and “Electricity/district heating consumed regionally” tables.

Electricity output

The local electricity generation is entered in this table according to the different electricity production methods: natural gas (CHP), biomass, photovoltaics, wind, water, waste, etc. So electricity production from municipal renewable energy plants with an output of less than 20 MW is recorded.¹⁰

- Plants with an electrical output of more than 20 MW are subject to the special Greenhouse Gas Emissions Trade Act (Treibhausgas-Emissionshandelsgesetz, TEHG) and are not considered municipal plants. This rule not only applies for CO₂ inventories prepared according to Climate Alliance’s methodology, but also according to the European Covenant of Mayors initiative, which also excludes plants with an electricity output of more than 20 MW from the inventory. Possible inclusion of these plants in municipal CO₂ inventories would mean inclusion of the CO₂ emissions certificates that these plants purchase or sell in the national and international emissions trading system, which would distort the municipal CO₂ inventory.

- Plants outside of the municipal boundaries are also excluded from the municipal CO₂ inventory.

¹⁰ Plants with an output of more than 20 MW are not taken into account in the German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG).
Nuclear and coal power plants should not be entered in this table either. These commercial plants serve general electricity generation in Germany and are already included in the national electricity mix.

Electricity consumed regionally
After entering the units of energy of municipal electricity production, municipalities should decide and enter which percentages of this output are used locally.
There are, for example, municipalities and plants that sell their electricity yield as green electricity. To avoid double counting of this electricity, which is theoretically used elsewhere, these municipalities are not allowed to enter these electricity shares as their own consumption.
Furthermore, there are renewable energy plants belonging to several municipalities that supply them with their electricity. In such cases, a decision must be reached on apportionment of the electricity supply.

Electricity consumption mix
ECORRegion calculates a local/regional electricity mix based on the information supplied on municipal electricity production and consumption. This so-called consumer electricity mix is the calculated mix of electricity generated and consumed by the municipality, and of electricity that the municipality uses but does not generate itself, which has been obtained from the German electricity mix.
The more electricity a municipality generates and uses locally, the more its electricity mix differs from the German national electricity mix. The regional/local electricity emissions are calculated using this new local electricity mix information. The higher the municipal electricity generation from renewable energy, the lower the regional CO$_2$ emission factor for electricity.

District heating output
Similar to for electricity, the local/regional production of local and district heating is entered in this table.

District heating consumed regionally
Local and district heating production is always considered to be local/region – indeed, heat cannot be transported over large distances due to the losses that occur and is therefore always used locally.\textsuperscript{11} However, the opportunity exists – particularly in large waste incinerator plants – for several municipalities to be supplied by one single plant. In these cases, the amount of heat received by each municipality is always known. Large district heating plants are generally waste incinerator, coal, cogeneration or biomass plants.

District heating consumption mix

\textsuperscript{11} Exception: the transport of latent heat accumulators.
The German district heating mix is replaced entirely by municipal information and plays no role in the calculation. The consumption mix only corresponds with the data entered by the municipality itself; the emissions are only calculated with this information.

**Cogeneration plants: a special case**
Due to the complexity of calculating CO$_2$ inventories for cogeneration plants, Climate Alliance offers a separate document with a detailed description of the difficulties of CO$_2$ inventory and concrete proposals for calculation of CO$_2$ emission factors for electricity and heat generation.

**National and regional factors**
Regional and local CO$_2$ emission factors are also calculated by ECORegion for the electricity and district heating using the local data for electricity and district heating, and calculation of the local electricity and district heating mix. These factors are extremely important in the representation of municipal climate protection endeavours and the success of certain climate protection measures within the municipalities. Regional CO$_2$ emission parameters make clear just how much CO$_2$ the municipalities save through the generation of renewable energies compared with the national mix. Counties and region forming a community are assigned additional community factors. Thus specific CO$_2$ emission factors of the electricity and district heating are prepared as weighted averages of all municipalities for the county or region.

### 2.3 Recording the transport sector in ECORegion

ECORRegion records the vehicle mileage, energy consumption and CO$_2$ emissions of the following modes of transport:

- Passenger transport – private and public passenger transport.
- Long-distance passenger transport – long-distance trains and air traffic.
- Road freight
- Other freight transport

Three key aspects influence the energy consumption of these modes of transport:

- The vehicle mileage – the number of people or goods transported, and kilometres travelled (measured in passenger, vehicle or tonne kilometres).
- The energy consumption per passenger, vehicle or tonne kilometre.
- The vehicle fuel mix – breakdown of vehicle consumption according to the fuel type.

**Passenger transport**
Passenger transport includes the mileage and emissions from private and public transport. The mileage is calculated in passenger kilometres; calculation in any other unit is not possible due to the lack of data. Rail transport data is only recorded in passenger kilometres. This unit was used for calculation of all private transport to enable uniform calculation of passenger transport in a standard unit.

**Private transport**

Private transport is understood to be motorised individual transport. This is the mileage of personal vehicles and estates (petrol and diesel) as well as motorcycles. Mopeds are not included in Climate Alliance’s calculation, as these vehicles are disregarded in many statistics and do not require a permit. The mileage of all vehicles and the associated fuel consumption was calculated using data from the annual report, “Verkehr in Zahlen” [“Transport in Figures”][VIZ], which is prepared by the German Federal Ministry of Transport, Building and Housing (Bundesministerium für Verkehr, Bau und Stadtentwicklung, BMVBS) and constitutes the largest source of transport data in Germany. This publication only features national data hence our calculations are also based on national data. Hardly any regional data analyses are available yet in the transport studies.

Our calculations relate to three key elements:

- The vehicles’ mileage in passenger kilometres
- The fuel mix [%]
- The vehicles’ specific consumption in [MJ/Pkm]

**Private passenger vehicle mileage**

As previously mentioned, the private vehicles’ mileage is calculated using national averages. In ECORRegion, this mileage is based on the number of vehicles registered in the municipality. As a result, the total mileage of private transport is calculated with the energy consumption and CO₂ emissions.

**Two questions are frequently asked on the mileage:**

*German data is used in calculation of the private transport mileage. How can this calculation be prepared using municipal data?*

The only way to perform such a calculation with concrete municipal data is by conducting an in-depth analysis of municipal inhabitants’ private transport behaviour. Surveys and transport censuses would have to be carried out for this, detailing inhabitants’ specific mileage. Such surveys are cost and work-intensive, and must continually be updated hence unfortunately only a few municipalities conduct such surveys.
**In the ECORegion methodology, the mileage in rural areas and conurbations is identical.**

It is generally estimated that in Germany, those living in conurbations drive 50 hours per year and those living in rural areas cover greater distances. However, no exact surveys have been conducted on the influence of such characteristics on the annual mileage in rural areas or conurbations. Although German transport specialists are aware of these differences (“Mobility in Germany” study), a concrete study focusing on such differences in mileage has not yet been undertaken. Due to this lack of studies and figures, it has not yet been possible to calculate the differences in mileage for conurbations and rural areas.

Rural areas should conduct targeted surveys focusing on the level of this mileage to obtain municipal figures.

**Public transport mileage**

Public transport is subdivided into three categories:
- Bus transport
- Tram/underground transport
- Rail network/suburban railway transport

**Bus transport**

This includes municipal and inter-municipal bus transport. Municipal bus transport services are generally offered within the municipalities boundaries. A certain degree of overlap exists between municipalities such as Frankfurt am Main and Offenbach, which are located extremely close together. The local transport companies should know the exact mileage of bus transport, as this can be ascertained from their accounts and the number of tickets sold. Moreover, all transport companies conduct regular transport censuses, which should supply concrete figures on the number of persons transported, average passenger journey distance, and the vehicle occupancy rate. With all this information, bus companies are in a position to provide concrete information on mileage and fuel consumption per person and kilometre.

Recording the municipal mileage of inter-municipal bus transport is somewhat more complex. Given that the routes travelled by such vehicles are shared by several municipalities, the mileage must also be split between these. The simplest method for performing such a division is according to the number of stops. The total bus line mileage is divided into bus stops belonging to one municipality or the other. The municipal mileage of this route is then calculated with the proportional number of stops. Another method for dividing this mileage is simply observing passengers travelling from one municipality to the other. There are transport companies that are in a position to say how many people were transported from one stop (municipality) to another, though. They provide concrete information on the mileage of each route.
**Tram/underground transport**
These vehicle categories were recorded separately in the early stages of development of the ECORegion inventory methodology. However, it was noted that the power consumption and mileage of such vehicles cannot be distinguished between. In many municipalities, the same machines and wagons are even used in one or the other transport system.
The mileage of such vehicle categories and the associated energy consumption is available for all municipalities in Germany.

**Rail network/suburban railway transport**
As with the tram/underground transport, the energy consumption of the rail (regional trains) and the suburban railway transport tends not to be recorded separately. Calculation of the mileage of these modes of transport takes place according to the same principles as bus transport. In principle, suburban railway lines pass through several cities and municipalities. The mileage should be split so that is can be attributed to several municipalities, similar to bus transport, whereby proportional division of mileage according to the stops is possible. However, the most reliable method is to record the number of passengers travelling from one municipality to another.
Regional and suburban railway usage according to electricity and diesel are figures for Germany;\(^{12}\) the actual energy consumption of such transport systems should be available from all transport companies in Germany.\(^{13}\)

**Specific passenger transport consumption**
This is calculated in [MJ/Pkm]; a person’s consumption of a specific fuel during a journey of one kilometre in length in [MJ]. This consumption is calculated for all modes of transport recorded in ECORegion.

**Private transport:** The use of private transport (diesel and petrol-powered motorcycles and private cars) was determined from reference material prepared by the German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung, DIW) and the “Verkehr in Zahlen” [“Transport in Figures”] report. These calculations were compared with various other references and discussed with transport experts.
To date, very few European cities have concerned themselves with recording the fuel consumption of private vehicles within the municipality. As long as no sound statistics for calculation of this consumption exist on a municipal level, Climate Alliance recommends calculation with the national figures they supply.

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\(^{12}\) The data used by Climate Alliance for calculation of short and long-distance public transport is taken from the TREMOD Transport Emission Model study of Germany from which the figures for greenhouse gas calculations in Germany are obtained.
\(^{13}\) The transport companies are not always prepared to cooperate.
**Bus transport:** The consumption figures are calculated by Climate Alliance in ECORegion using the annual statistics from the Association of German Transport Companies (**Verband Deutscher Verkehrsunternehmen, VDV**). Figures on the fuel consumption of bus transport should be available on a municipal level, as – as previously mentioned – all transport companies in Germany keep track of the precise number of people transported, kilometres travelled and fuel consumed. They should be in a position to provide exact information on the data required for the CO2 inventory. Should the municipal transport company be unable to supply such data, the municipality can always perform a calculation based on the mileage divided by the fuel consumption.

**Tram/underground transport:** All ECORegion rail transport data is taken from the TREMOD study. All municipalities in Germany collection data on the energy consumption of these modes of transport.

**Regional/suburban railway transport:** Not all regional transport companies know the specific consumption of their suburban and regional trains. Should no regional data be available for the municipality, consumption can be calculated using the data available in ECORegion. These specify the average consumption of the regional rail traffic in Germany.

**Fuel mix**

Fuel consumption broken down into the different modes of transport represents the fuel mix.

**Private transport:** The fuel mix for private transport is also calculated using the national data from the “Verkehr in Zahlen” [“Transport in Figures”] report. Development of the petrol/diesel breakdown in private vehicles is reflected in the mix. To date, other energy carriers (bioethanol, biodiesel, vegetable oil, natural gas, electricity) have barely played a role and therefore haven’t yet been recorded in the statistics. Adjustment of this national data is only recommended when reliable municipal data is available. Some European municipalities calculated reliable figures for this sector when preparing the municipal statistics.

**Bus transport:** In the past, the bus transport fuel mix comprised 100% diesel, however for several years now, a portion has been obtained from gas, biogas, vegetable oil and ethanol, among other fuels. The according fuel mix breakdown should be used if these new energy carriers are used in bus transport on the municipal or regional level. This leads to a reduction in emissions from bus transport.

**Rail network/suburban railway transport:** The breakdown of electricity/diesel for regional/suburban trains is taken from the TREMOD study and therefore reflects the national
trend. It is possible to enter regional data from the various regional rail companies, however this
data has not been made public yet.

**Long-distance passenger transport**

This denotes the mileage of long-distance trains (Intercity and Intercity Express trains) and air traffic.
All data for these modes of transport is taken from the TREMOD study. The mileage, specific
consumption and fuel mix of long-distance passenger transport is calculated for all municipalities in
Germany with figures based on the number of inhabitants. In Climate Alliance’s opinion, amendments
to or deletion of the data is not permissible for the following reasons:

- The method of calculation for the transport sector was discussed at length during
development of the ECORegion with the 14 municipalities participating in the test phase, as was the calculation bases for long-distance transport.

- Due to the data currently available, the assignment of long-distance transport to the
municipal level is not possible. The mileage and consumption data available to date is
kept very general and calculated on a national basis. In the statistics, there is not yet any
information on the flight behaviour or long-distance journeys undertaken by the
inhabitants of specific municipalities or regions. Due to this lack of information,
replacement of the initial inventory data with municipal data is not permitted.

However, there are municipalities who have begun deleting these tables on the grounds that there is
no airport within the city boundaries. As explained in the methodological introduction, calculations for
the transport sector are conducted according to the emitter principle: the emissions from this sector
are not accorded to the motorway or airport but to those causing the emissions. Because no statistical
option other than proportional allocation of these emissions according to the number of inhabitants in
the municipality is yet available, deletion of these tables leads to distortion of the inventory, which is
subsequently no longer deemed a complete inventory by Climate Alliance.

In recent years, emissions from air traffic have risen continuously due to low-budget airlines and the
increase in flight mileage.\(^{14}\) Argumentation in another direction contradicts the population’s
consumption behaviour and the actual development of emissions in Germany.

**Freight transport**

ECORRegion subdivides freight transport into three categories:

\(^{14}\) The emissions and energy consumption of air traffic per inhabitants has tripled since 1990 [TREMOD].
The air and sea freight mileage is not included in our calculation methodology at present.

**Road freight**

The mileage of lorries and tractor units is recorded in road freight. Due to their nominal mileage and consumption,\(^{15}\) other vehicles such as ordinary road tractors (including tractors for agricultural and forestry) are not included in our methodology. In Germany, the energy consumption of lorries and tractor units is four times higher than that of ordinary road tractors [KB-2008].

Calculation of the road freight mileage is only possible in vehicle kilometres. Climate Alliance did attempt a calculation in tonne kilometres to align this data with other freight transport data, however this proved impossible due to the state of data in Germany. The road transport information in tonne kilometres is simply too inaccurate and vague (toll system), meaning calculation of the mileage with reliable figures is only possible in vehicle kilometres.

ECORRegion calculates the mileage, energy consumption and CO\(_2\) emissions of road freight transport automatically using the data on the lorries and tractor units registered in the municipality. The average mileage and consumption figures for petrol and diesel were used for this. As yet, no municipal surveys exist on the mileage and consumption of road transport hence only calculation with national data is practical.

A calculation of the road transport was conducted with a survey of the vehicles registered in the municipality directly connected with the municipality’s economic structure. More CO\(_2\) emissions are attributed to logistics centres and municipalities with a large number of shipping companies.

**Miscellaneous freight transport**

This is subdivided into two categories: rail and ship freight. Mileage is recorded in tonne kilometres.

**Rail freight**: This data is also obtained from the TREMOD study. Many municipalities in Germany have already entered their own data (available from *Deutsche Bahn*) into ECORRegion for these categories. Exact statistics on the freight trains arriving, departing and passing through are normally kept at the station.

**Ship freight**: For the initial inventory, the ship freight mileage was calculated using the national data from the “Verkehr in Zahlen” [“Transport in Figures”] report and the Federal Association of

\(^{15}\) The number of these vehicles, their consumption and mileage is relatively small in comparison with other tractors hence they are not included in the municipal inventories. Due to the leading role agricultural machines can play in the CO\(_2\) inventory of smaller municipalities; these should be included accordingly in the future.
German Inland Water Transportation (*Bundesverband der Deutschen Binnenschifffahrt*, BDB). Similar to for rail freight, municipal data is available from the responsible port authorities, who record data on all the ships entering and leaving a particular port (with information on the cargo and destination).

Several methodological considerations should be noted on both data sets in the information in ECORegion

Only the freight mileage leaving from the city/municipality in question should be considered. This allows for calculation of the freight that was generated or transferred in the city/municipality in question. The calculation therefore correlates directly with economic activity within the city/municipality. Freight arriving in or passing through the city/municipality should be included in the inventory at their place of origin. Thus the calculation is methodologically consistent with calculation according to the number of registered lorries and tractor units. Only freight transport mileage directly connected to economic activity in the city/municipality is included here.

**Specific consumption**

Due to the lack of local/regional data for the specific consumption of ship and rail freight, Climate Alliance recommends calculation using national data.

**Fuel mix**

Over the past 20 years, the ship freight fuel mix was 100% diesel. The rail freight fuel mix was calculated using national data from the TREMOD study.\(^\text{16}\)

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\(^\text{16}\) Local/regional data is not expected in the medium term.
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