

# Bottom-Up GHG Inventory and MRV of Measures

Synergies and Limitations in the Transport Sector  
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Author: Marion Vieweg



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### **Author**

Marion Vieweg specialises in transparency, policy analysis, mitigation, and the link to sustainable development. She focuses on the UNFCCC negotiations, its transparency provisions and options to enhance the level of ambition. She led the Climate Action Tracker project for 3 years and worked at the UNFCCC supporting the technical analysis of BURs. Marion is member of the Expert Group on MRV of the GIZ Transfer Project and the TWGs for Transformational Change and Transport of the ICAT Initiative.

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## Synergies and Limitations in the Transport Sector

### Background Information on the TraCS Project

The TraCS project is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and funded by the International Climate Initiative of the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

Its objective is to enable policy makers in partner countries (Vietnam and Kenya) to specify the contribution of the transport sector to the Nationally Determined Contributions (NDCs). Detailed knowledge on mitigation potentials can furthermore lead to raising the level of countries' ambitions.

The project follows a multi-level approach:

- At country level, TraCS supports (transport) ministries and other relevant authorities in systematically assessing GHG emissions in the transport sector and in calculating emission reduction potentials through the development of scenarios.
- At international level, TraCS organises an active exchange between implementing partners, technical experts and donor organisations to enhance methodological coherence in emission quantification in the transport sector (South-South and South-North dialogue). The dialogue aims to internationally increase transparency regarding emission mitigation potentials and harmonisation of methodological approaches in the transport sector.

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# Acronyms

BUR	Biennial Update Report
ECT	Emission Control Technology
GHG	Greenhouse Gas
IPCC	International Panel on Climate Change
MRV	Measurement, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Action
NC	National Communication
NDC	Nationally Determined Contributions
SD	Sustainable Development
UNFCC	United Nations Framework Convention on Climate Change

# 1. Why measure transport?

Transport activity is rapidly growing across the world, particularly in fast developing economies. The movement of passengers and freight is an essential element of social and economic activity and typically increases along with economic growth. Transport infrastructure that does not deliver the right kind of transport at the right place and time at affordable prices will hamper this economic development and cause damage to the population's health, safety and the environment (Bongardt et al., 2016).

Transport planners and policy-makers face a multitude of challenges to balance the different needs. Robust information on the current situation, past trends and likely future developments of transport needs will help decision-makers to deliver better quality transport systems that maximize the economic contribution of the sector and minimize damages. Improved accuracy and an increasing level of detail will enhance the information value and usefulness of data for different purposes.

Figure 1 illustrates the purposes for data collection in the transport sector, which include:

- International reporting on GHG inventories and policies & actions (including national communications (NCs) and biennial update reports (BURs))
- National policy making (including nationally determined contributions (NDCs) and sectoral strategies)
- Design and measurement, reporting and verification (MRV) of mitigation actions
  - internationally funded
  - nationally funded
- Transport planning at the regional and local level

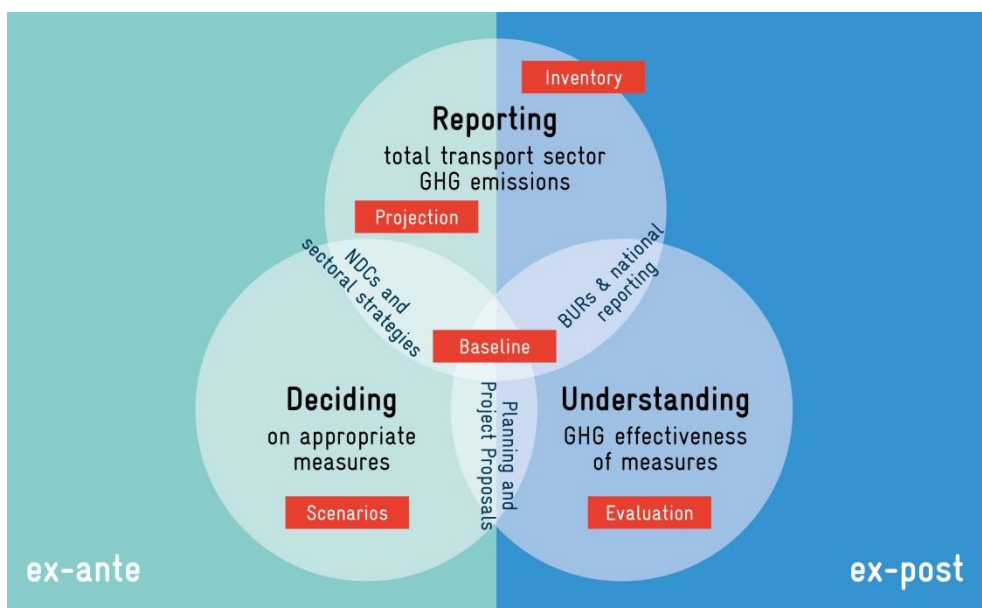


Figure 1: Purposes of data collection in the transport sector (Source: adapted from: Bongardt et al., 2016)

Measures to reduce greenhouse gas (GHG) in the transport sector are closely linked to the other challenges. The improvement of air quality, reduction of noise, congestion and fatalities are often the main driver of activities, but also have GHG mitigation effects. More and more funding is made available internationally and nationally for mitigation activities in the sector. With this comes the need to take decisions on the most effective measures to pursue and reporting on expected and achieved outcomes. At the same time, UNFCCC reporting requirements for inventories and measures increase also for developing countries. In this paper we therefore focus at GHG emissions and use the term ‘emissions’ to represent GHG emissions only.

This paper will explore the synergies between bottom-up inventories and the MRV of policies and actions in the transport sector. How far can data collected for inventory preparation be used for the MRV of measures?

To answer this, the next chapter provides a basic overview of the different levels of detail for inventory preparation. The next chapter then discusses the differences in boundary. Chapter 4 will provide the basics for calculating GHG effects of measures, which will form the basis for chapter 5, which will map how far inventory data can support the MRV of measures using three examples.

## 2. GHG inventories in the transport sector

GHG inventories are the backbone of UNFCCC reporting. Developing countries are required to use 1996 IPCC Guidelines<sup>1</sup>, although an increasing number of countries apply the newer IPCC 2006 Guidelines<sup>2</sup>. The system in both guidelines is organized around three ‘tiers’ that constitute an increasing level of accuracy. Figure 2 therefore illustrates the basic data requirements for different tiers in both guidelines and highlights the differences between tiers and between the two guidelines.

The basic logic and the underlying principle of increased data requirements remains the same for both guidelines. Higher tiers require a higher level of disaggregation and include additional information. The 2006 Guideline also considers emissions during the warm-up phase of the engine (cold start) as an additional feature for tier 3 and change the calculation method for tier 2 CO<sub>2</sub> emissions. They also add CO<sub>2</sub> emissions from urea-based catalysts as an additional category within road transportation.

The 1996 Guidelines follow the same calculation method for all gases across all three tiers. The 2006 guidelines only provide fuel-based estimates for CO<sub>2</sub> with tier 2 for CO<sub>2</sub> using country-specific instead of international default values which are used in tier 1. According to the IPCC there is no Tier 3 as “it is not possible to produce significantly better results for CO<sub>2</sub> than by using the existing Tier 2” (IPCC, 2006). The 2006 guidelines also introduce

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<sup>1</sup> <http://www.ipcc-nggip.iges.or.jp/public/gl/invs6a.html>

<sup>2</sup> <http://www.ipcc-nggip.iges.or.jp/public/2006gl/>

operating conditions as an explicit element in tier 3 calculations. In the 1996 Guidelines this is only discussed implicitly<sup>3</sup>.

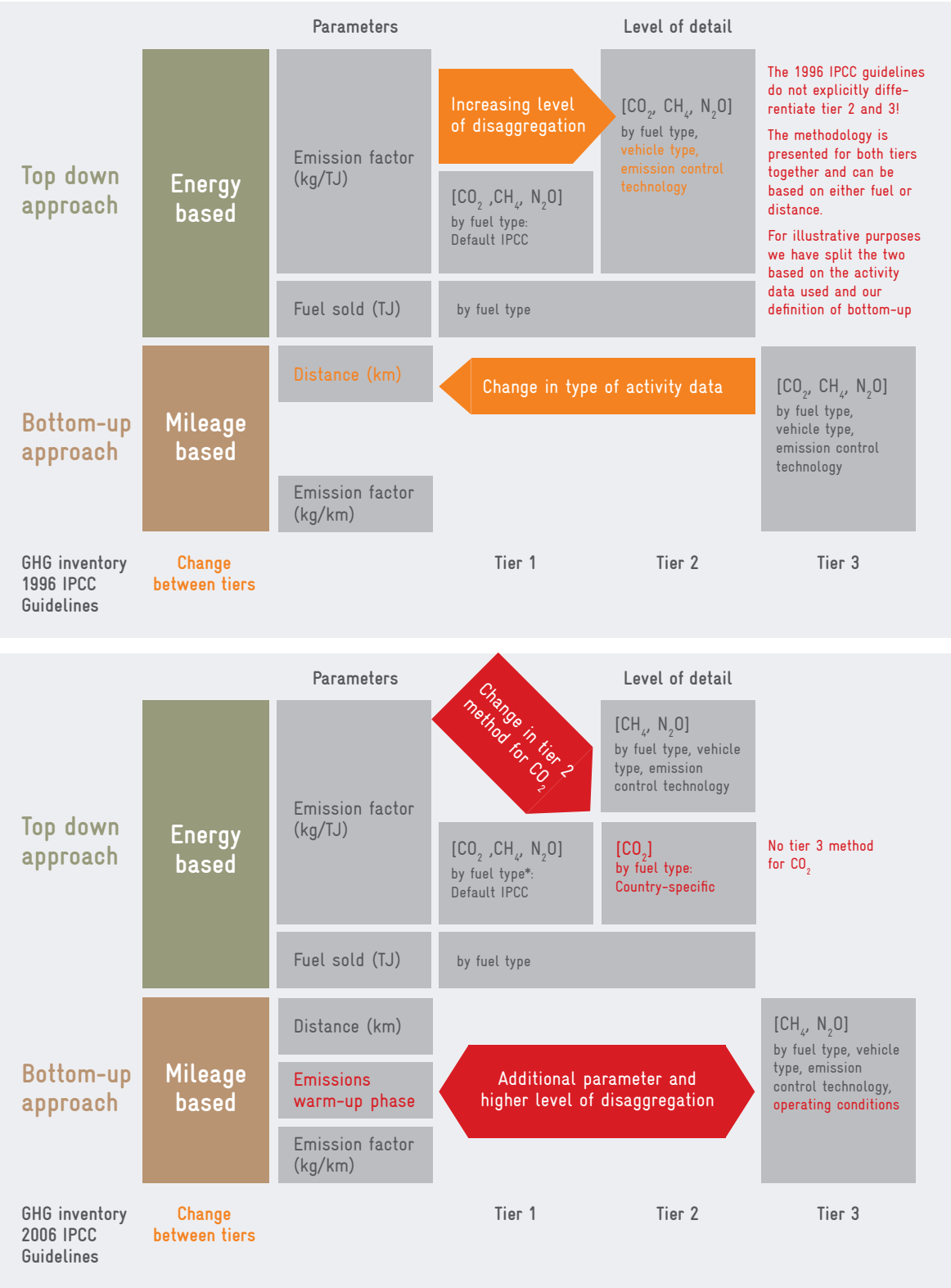


Figure 2: Basic structure of tiers for IPCC Guidelines (Source: own illustration based on IPCC, 1996, 2006)

<sup>3</sup> For more detail on bottom-up inventories see: (Bergk, Heidt, Jamet, & Knörr, 2017)



## Box 1: Activity data and top-down vs. bottom-up

The most basic equation for calculating emissions is

$$\text{Emissions} = \text{Activity} \times \text{Emission factor}$$

In the context of the IPCC Guidelines, both terms in this equation are used to specify very different things, for example:

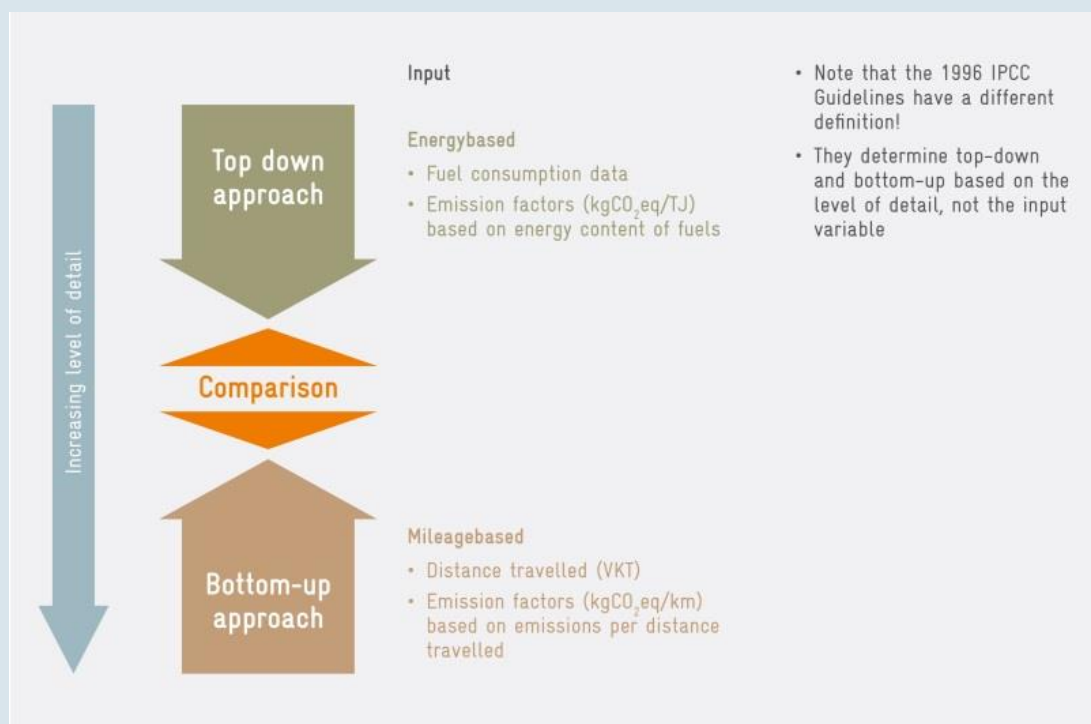
Activity = Fuel used (IPCC 2006 tier 1) ➔ Emission factor CO<sub>2</sub>e / energy content (TJ)

Activity = Distance travelled (IPCC 2006 tier 3) ➔ Emission factor CO<sub>2</sub>e / vehicle kilometre (vkt)

The emission factor always directly corresponds to the type of activity data.

In transport sector MRV on the other hand “activity” usually only refers to the **distance travelled**, as “vehicle kilometre (vkt)” or “passenger kilometre (pkt)”/ “tonne-km (tkm)”.

The 1996 IPCC Guidelines define top-down and bottom-up based on the level of detail, not the input variable. In the transport sector the differentiation is, however, normally based on the type of input, i.e. what type of activity data is used as illustrated below:



Calculations based on fuel/energy consumption are referred to as top-down. Calculations based on distance travelled as bottom-up. We will use this definition throughout this report.

Data requirements for tier 3 inventories are high. As for tier 1 and 2 inventories, information is in many cases not collected for the inventory itself, but for other reasons, including the

MRV of measures and general transport planning purposes. The advantage of a tier 3 inventory is to have highly detailed and consistent information available in one single source.

There is also a growing movement to develop inventories for cities and communities. These are voluntary activities, carried out by engaged communities that aim to reduce their GHG emissions. Methodologies used vary, although some tools are available, such as the WRI GHG Protocol for Cities<sup>4</sup>. Where available, such inventories can support the MRV of actions, depending on the boundaries (see section 3). The main focus of this paper is, however, the synergies and limitations of national inventories, prepared under the reporting requirements of the UNFCCC.

Looking at the differences between inventory data and the MRV of measures, it is important to be aware of a few key terminology differences as illustrated in box 1. Particularly the terms “activity data” and “top-down / bottom-up” are not uniformly used. In communicating data requirements it is essential to clarify which definition is applied.

### 3. Boundary setting for inventories and MRV

A fundamental element in analysing GHG and other effects of transport activity is the determination of the boundary. The main dimensions for boundary setting are the geographical scope of analysis, whether upstream or downstream activities are covered, which sub-sectors are addressed, which gases are covered and what the time frame for analysis is. Table 1 provides an overview of the differences between boundaries for the MRV of actions and transport sector inventories.

Table 1: Boundary dimensions

Dimension	MRV of actions	Inventories
<b>Geographical</b>	Corridor, ride shed, urban area, region, national	National territory
<b>Upstream/downstream</b>	Energy industries sector (electricity, production + transport of fuel), agriculture and forestry sectors (biofuels), may also consider infrastructure construction, mobile fuel combustion	Mobile fuel combustion (direct emissions from vehicles' energy use)
<b>Transport sub-sector</b>	Depending on type of measure	All sub-sectors (excl. international aviation, maritime bunkers and military transport)
<b>Gases covered</b>	Depending on measure, potentially also including other air pollutants	CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O
<b>Time frame for analysis</b>	Depending on type of measure	1 year (every two years as part of BURs)

Source: adapted from (UNFCCC, 2017)

<sup>4</sup> <http://www.ghgprotocol.org/city-accounting>

The boundary for national inventories is very clearly defined in the IPCC Guidelines. Boundaries for the MRV of measures need to be defined based on the characteristics of the measure. There is a wider range of options that will be largely determined by the nature of the measure, the objective of the analysis and availability of data. The next sections discuss each dimension in more detail and offer some approaches how to reconcile differences in boundary.

### 3.1. Geographic scope

Inventories are mainly developed at the national scale<sup>5</sup>. Measures in the transport sector can range from individual roads, bus route or railway lines to national scale interventions (see chapter 4 for an overview of measures). Apart from national scale measures, such as emission standards or taxes, most other measures in the sector will have a smaller geographic scope and measures can overlap with other measures as illustrated in Figure 3.

For measures at a national scale, data from the inventory can often directly be used. This does not only relate to the reported GHG data, but also the underlying data used to calculate the inventory.

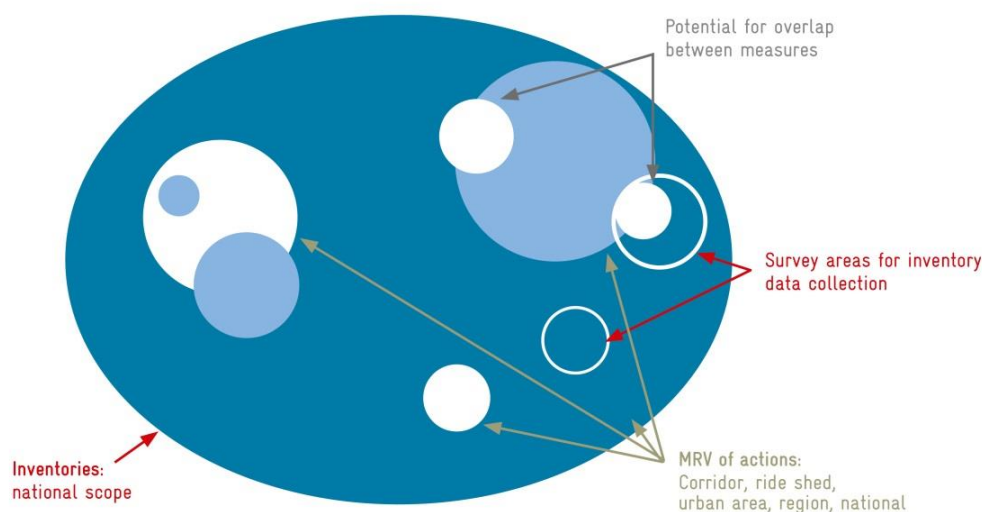


Figure 3: Differences in geographic scope (Source: own illustration)

For measures at other levels, the inventory can provide for example:

- Emission factors (GHG / fuel or GHG / km)
- Default values for fleet composition, activity (for ex-ante assessment)

<sup>5</sup> In the context of the UNFCCC only at national scale. However, there are also many regional and city-level initiatives that create inventories for their jurisdictions

- Actual data, if e.g. survey areas are selected that cover the area of the measure or proxy-data if survey area(s) are comparable

If inventories are developed using bottom-up methods, the underlying data can provide a useful source also for sub-national level measures. In the case of bottom-up inventories, data is normally collected at the local level or using surveys that aim to produce representative results. Such data is then aggregated to the national level inventory. The underlying data can be utilized for the MRV of measures. On the other hand, data that is collected for the MRV of measures can provide input to bottom-up inventory development.

### 3.2. Upstream / downstream

An inventory aims to represent the complete emissions from a country. Allocation to individual sectors is important, but, if double counting is avoided, plays a less important role than ensuring all relevant sources are covered. In cases where emissions could be attributed to more than one sector, choices were made in a way to reduce complexity and enhance accuracy.

In the transport sector, this includes that emissions from electricity used for transport activities is not included in the transport sub-section of the inventory, nor are biofuels or upstream emissions of any other fuels for that matter. The inventory methodology does also not allow including the full life-cycle of transport activities, such as the manufacture of vehicles, the construction of infrastructure or the subsequent scrapping and dismantling. Emissions related to these belong to the manufacturing industries and construction, industrial processes and product use (IPPU) and waste sectors respectively in the IPCC logic.

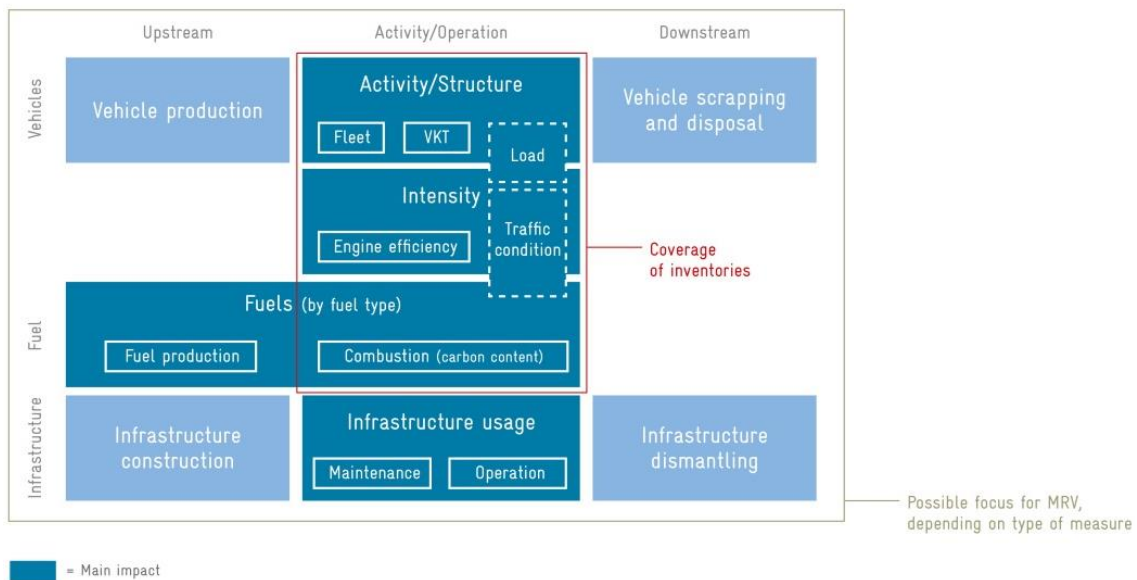


Figure 4: Upstream / downstream emissions in transport (Source: adapted from Bongardt et al., 2016)

The transport sector inventory only contains the actual emissions from fuel combustion in vehicles. GHG emissions from the operation of vehicles and transport infrastructure make the bulk of life-cycle emissions. However, for the MRV of measures potentially other elements of the life-cycle can also be relevant, depending on the nature of the measure. Particularly all fuels (i.e. including electricity and biofuels) and the emissions caused for their production are relevant whenever measures affect the type of fuel being used. For larger infrastructure measures, such as railways or metros, maintenance and operation can also pose significant sources of emissions and should be considered, particularly when conducting the analysis ex-ante to support decision-making.

Independent of the geographic scope, a range of data from the inventory can be used to make necessary adjustments to cover up- or downstream emissions if relevant for the MRV of a measure. Data from other sectors within the inventory can be used, like for example:

- Biofuel emission factors based on agriculture and forestry sector data
- Emission factors from the manufacturing (cement, iron & steel) and industry sectors (cement, lime, metal)

For information on biofuels and infrastructure emissions the usefulness of the inventory will strongly depend on the level of detail used in the respective sectors. The grid emission factor for electricity used in the transport sector is an important input and is usually provided by the responsible ministry or agency<sup>6</sup>.

### 3.3. Transport sub-sector

The 1996 IPCC Guidelines only require reporting for the sub-sectors civil aviation, road transportation, railways, navigation and other. For higher tier inventories the level of disaggregation increases, leading to the need for more detailed input data. The level of granularity in the inventory may still not be sufficient to be able to provide direct data for measures that target very specific sub-sectors, such as two-stroke motorcycles. Some means of transport may not yet be considered relevant, but may become so in the future. This is for example the case for electric bicycles and motorbikes (Bongardt, Eichhorst, Dünnebeil, & Reinhard, n.d.). In such cases the approaches outlined in chapter 3.2 need to be applied to extend sectoral coverage. Tier 1 transport sector inventories will not be able to provide any information to support the MRV of such measures at all, since only the total fuel use is used as the basis for calculation. For tier 2 and 3 the usefulness will depend on the sub-sector targeted and the granularity of the inventory, but data can very likely be utilized. Note that this applies only to the 1996 IPCC Guidelines (for the 2006 Guidelines only tier 3 provides relevant information).

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<sup>6</sup> Grid emission factors can also be estimated from the inventory if the total amount of electricity consumed is available from external sources and if

## 4. MRV of measures

Data requirements for the MRV of measures will largely depend on the type of measure. Table 2 provides an overview of some of the key measures in the transport sector. The type of measure will determine what the goal of the intervention is. This is represented in the “ASIF” framework, which is an acronym for “activity”, “structure” (or mode share), “(fuel) intensity” and “fuel (or GHG conversion factor)” (Bongardt et al., 2016).

$$\text{GHG} = \text{A} * \text{S} * \text{I} * \text{F}$$

Table 2: Selected key measures in the transport sector

Measure	Main target (within ASIF framework)
Rail infrastructure and system improvement	ASIF
National fuel economy standards (and labels)	IF
National (fuel economy related) vehicle incentives/taxes	IF
National fuel taxes (and subsidy removal)	ASIF
National alternative fuel (and propulsion system) policies and programmes	IF
Urban transport programmes, incl. mass rapid transit (MRT)	AS
Fleet renovation programmes	IF
Green logistics programmes	AS
Truck efficiency improvement programmes	IF
Efficiency programmes in shipping	IF

Source: adapted from (Bongardt et al, 2016)

Underlying the basic equation of the ASIF framework is a more detailed calculation which is illustrated in Figure 5 based on the calculation logic used in the UNFCCC Compendium on GHG Baselines and Monitoring. A measure can target one or more of the ASIF elements and underlying calculation parameters. The calculation method for freight is very similar.

Targeted parameters depend on details of the regulation

- Applicability to new vehicles or total fleet
- Standards set for fleet or individual vehicle classes

Normally these are

- Fleet composition: distribution between vehicle types
- Fuel efficiency

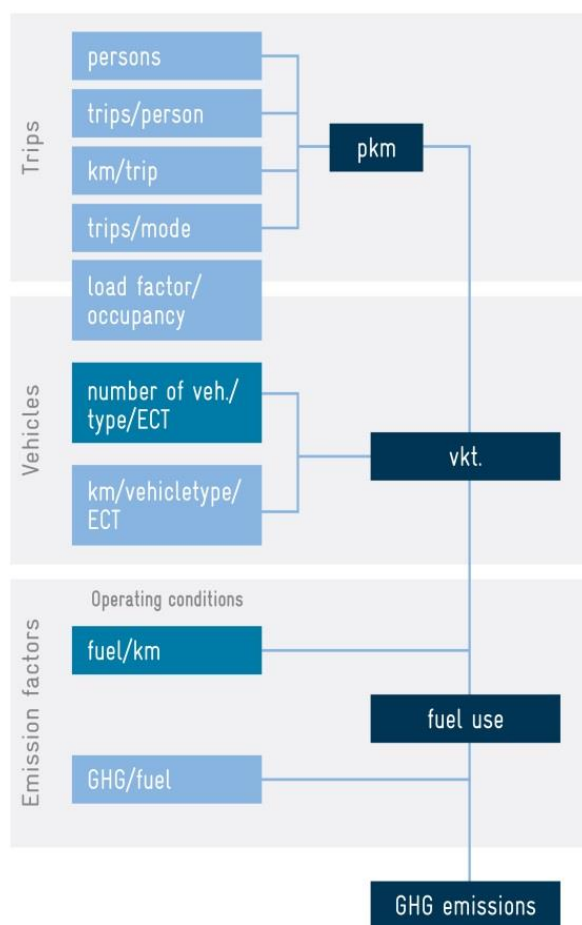


Figure 5: Basic calculation method for the MRV of measures for passenger transport (Source: Author)

Apart from the type of measure and scope, the purpose of analysis will influence data needs:

- Ex-ante assessments rely more on assumptions, default values and averages and require actual data to provide a starting point for calculations.
- Ex-post evaluation and monitoring will require actual data, particularly with respect to underlying activity data.

As in inventory preparation, the main question determining data needs is the level of disaggregation of parameters. For mitigation analysis the type of mitigation action, the intended effects, information needs of decision-makers and external requirements will determine which parameters are most relevant. The desired level of accuracy also has implications on data requirements as illustrated in Table 3. They do, however, link closely to the purposes of analysis, with ex-ante assessments normally requiring lower to medium accuracy, while monitoring and evaluation often aim to provide medium to higher accuracy.

Table 3: Example of different levels of disaggregation

Travel activity data	Degree of local data disaggregation		
	Lower accuracy	Medium accuracy	Higher accuracy
Total vehicle trips		Vehicle trips in analysis area by vehicle type	Person trips in analysis area by vehicle type
Forecast change in transit ridership		Vehicle trip length by vehicle type	Person trip length by vehicle type
Average occupancy of POV and transit vehicles*		Proposed change in transit VKT from operations (by vehicle type)	Occupancy by vehicle type
Average trip length*		Traffic speeds in corridor by vehicle type (and time of day)	Proposed change in transit VKT from operations (by vehicle type)
		Forecast travel speeds by vehicle type after strategy implementation	Traffic speeds in corridor by vehicle type (and time of day)
		Forecast change in transit ridership	Forecast travel speeds by vehicle type after strategy implementation
		Trip lengths of new transit trips*	Forecast change in transit ridership
		Prior mode shares of new transit riders*	Trip lengths of new transit trips
			Prior mode shares of new transit riders
			Adjustment for induced traffic due to lower congestion*
			Forecast change in private vehicle VKT by vehicle type (modeled)**
			All data items by time of day**

Source: adapted from (UNFCCC, 2017)

## Box 2: Further reading

A number of recent and forthcoming publications developed by or with support of GIZ may provide useful additional insights to the topic:

Bergk, F., Heidt, C., Jamet, M., & Knörr, W. (2017). *Transport Emission Inventory Development: Background Paper - DRAFT*. GIZ (forthcoming)

Bongardt et al. (2016). *Reference Document on Measurement, Reporting and Verification in the Transport Sector*. GIZ

UNFCCC (forthcoming). *Compendium on Baselines and Monitoring Methodologies: Volume 6 - Transport*

Posada et al. (forthcoming). *MRV Blueprint for Fuel Economy Standards*. GIZ

Schmid et al. (2016). *MRV Blueprint Road Freight Transport NAMA in Mexico*. GIZ

GIZ (2015). *Navigating Transport NAMAs. A practical handbook on Nationally Appropriate Mitigation Actions (NAMAs) in the transport sector*. 2nd revised edition.



## 5. Mapping data requirements

In analysing the usefulness of inventories for the MRV of measures we need to differentiate between **data that is reported as part of the inventory**, for example in BURs, and underlying **data that is used to generate the inventory**.

The inventory as officially reported mainly contains the final results, i.e. total emissions per gas and emission factors used. For tier 1 methods, this includes emissions per sub-sector (civil aviation, road transportation, railways, navigation and other) and fuel sold by fuel type per sub-sector. For tier 2 and 3 methods information provided is emissions per vehicle category and fuel sold per vehicle category and fuel type. This information has limited value for the MRV of measures:

- Tier 1 data can be used to validate calculations
- Tier 1 data can be used for rough ex-ante estimates of potential effects for some types of measures, mainly those targeting vehicle efficiency and fuel use
- Tier 2 and 3 data can be used for rough ex-ante estimates of potential effects for some types of measures, mainly those changing fleet composition

Particularly for higher tier methods, a lot more input data is required to actually calculate the emissions. This input data can be a useful input for the MRV of measures, which can then be complemented with additional, measure-specific data as illustrated in Figure 6.

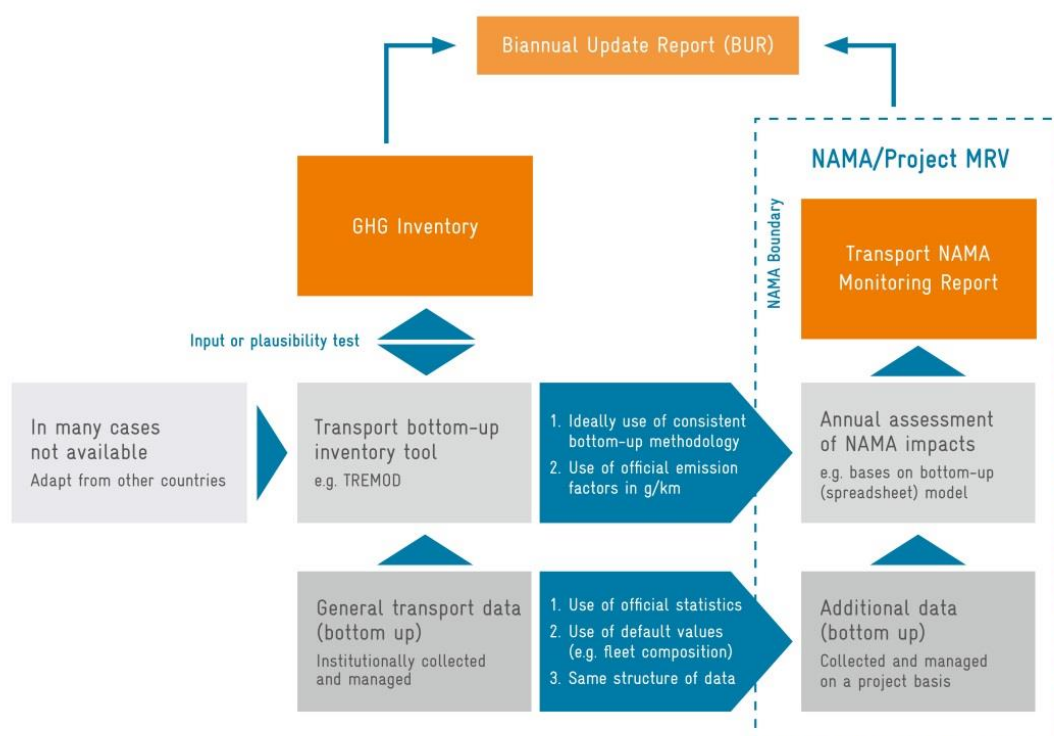


Figure 6: Relationship between inventory and MRV of measures (Source: adapted from Bongardt et al., 2016)

Particularly for bottom-up inventories the input data required for preparation contains a lot of information also required for the MRV of measures, including distance travelled (vkt) per category, emission control technology (ECT) and operating conditions incl. calculation basis for vkt and cold start emissions. The underlying data may be included in inventory reports, but will mostly be available from the modelling group / institution that is responsible for the bottom-up calculations and not shown in the inventory itself.

The following sections provide three examples and discuss the potential use of inventory data for the MRV for different types of measures.

## 5.1. Example: National vehicle-based efficiency standards

Vehicle-based efficiency standards are a widely used measure to reduce negative effects of vehicle emissions. The measure not only reduces GHG emissions, but also cuts air pollutants from vehicles. This has positive health effects, particularly in larger cities. There is a large range of different design options, such as:

- Subject of the regulation: fuel efficiency vs. GHG emissions
- Specificity: standard set for fleet vs. individual vehicle classes

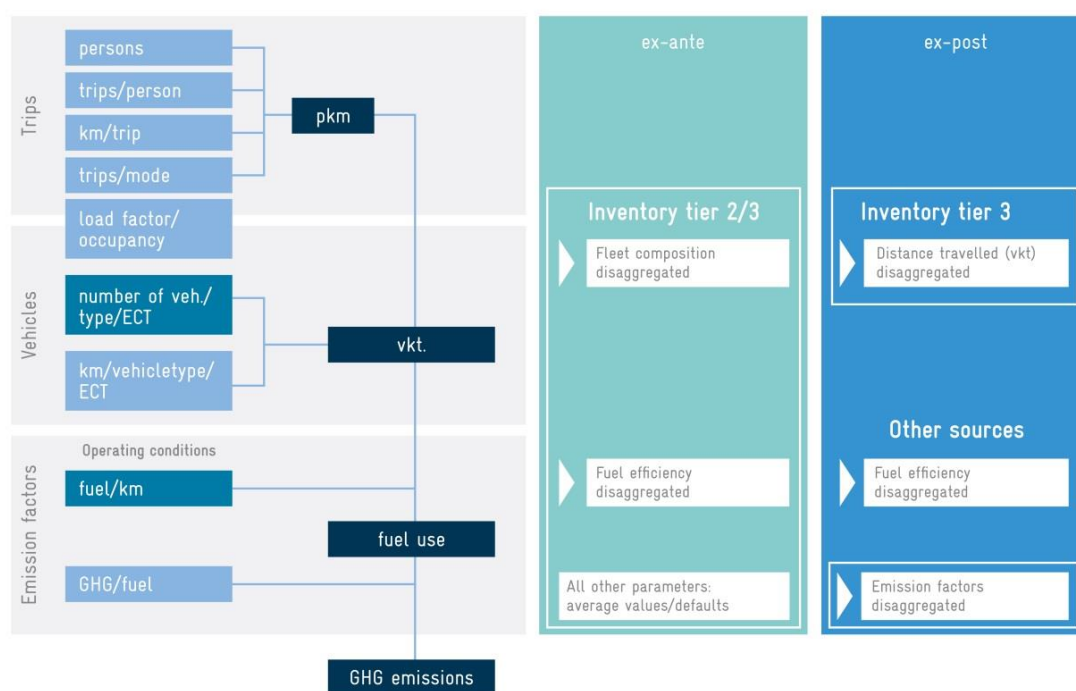


Figure 7: Targeted parameters and use of inventory data for vehicle-based efficiency standards (Source: Author)

Note: tiers in this graph relate to the 1996 IPCC Guidelines and our understanding of top-down and bottom up as defined in chapter 2

The design of the standard will impact which types of effects are intended and need to be monitored. Most regulations are designed in a way that they aim to change:

- Fleet composition<sup>7</sup> : distribution between vehicles using innovative technologies or alternative fuels, such as hybrid or electric cars
- Fuel efficiency: improvement in fuel efficiency of the overall fleet

Figure 7 illustrates which type of inventory data can be used to support the MRV of targeted parameters for this measure.

As the measure is normally implemented at the national level there are no issues with the geographic boundary. For **ex-ante** assessments tier 2 input data may be useful to make assumptions on potential effects, using fleet composition and fuel efficiency data at the disaggregated level and default/average values for emission factors and operating conditions. There can be large differences between country-specific data, particularly related to emission factors, and IPCC default values or international/regional default data (Bakker, 2016). For the MRV of measures it is therefore advisable to use country-specific data wherever possible.

For **ex-post** assessment more detailed data will be required. A tier 3 inventory can provide data on distance travelled, incl. fleet composition and emission factors (GHG/fuel). Data for the distance travelled (vkt) of new vehicles actually sold/registered can either be calculated as the difference between two inventories or can be collected externally (e.g. reported sales data, vehicle registration data, manufacturer information). Exact efficiency data will need to be collected from other sources, e.g. directly from manufacturers or from local technical institutes, research centres or universities that conduct measurements.

## 5.2. Example: National fleet renovation/scraping schemes

Fleet renovation programmes include the scrapping of old vehicles and replacement with new, more efficient models that have better emission control technology. This measure is often used to enhance the efficiency of public fleets (e.g. buses), but can also work for private passenger vehicles and light or heavy duty trucks. It is particularly interesting in countries that have a high average vehicle age. As it directly affects the number of old vehicles on the road, that usually have no or outdated emission control technologies, it can have a high impact on air pollution.

The measure targets largely the same parameters as the previous example on efficiency standards:

- Fleet composition: distribution between age categories and emission control technologies
- Fuel efficiency: improvement in fuel efficiency of the overall fleet

The fundamental difference is that the monitoring of the measure requires information on the **age structure of the vehicle fleet**. IPCC guidelines do not require information on the age structure of the fleet and subsequently information on this needs to come from other

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<sup>7</sup> Fleet composition is mainly relevant if standards are set for the fleet, not individual vehicle categories and manufacturers can “compensate” for less efficient models with highly efficient models or other fuels / propulsion technologies

sources, unless tier 3 calculations are done using a model that already includes this (e.g. TREMOD<sup>8</sup> in Germany, the International Vehicle Emission Model<sup>9</sup>). As the age of vehicles also correlates to the Euro norms, if available, information on these can be used to approximate the age structure. This means that for both ex-ante and ex-post assessments, additional information will be required to supplement the data provided in the inventory, even if a tier 3 method is used (see Figure 8).

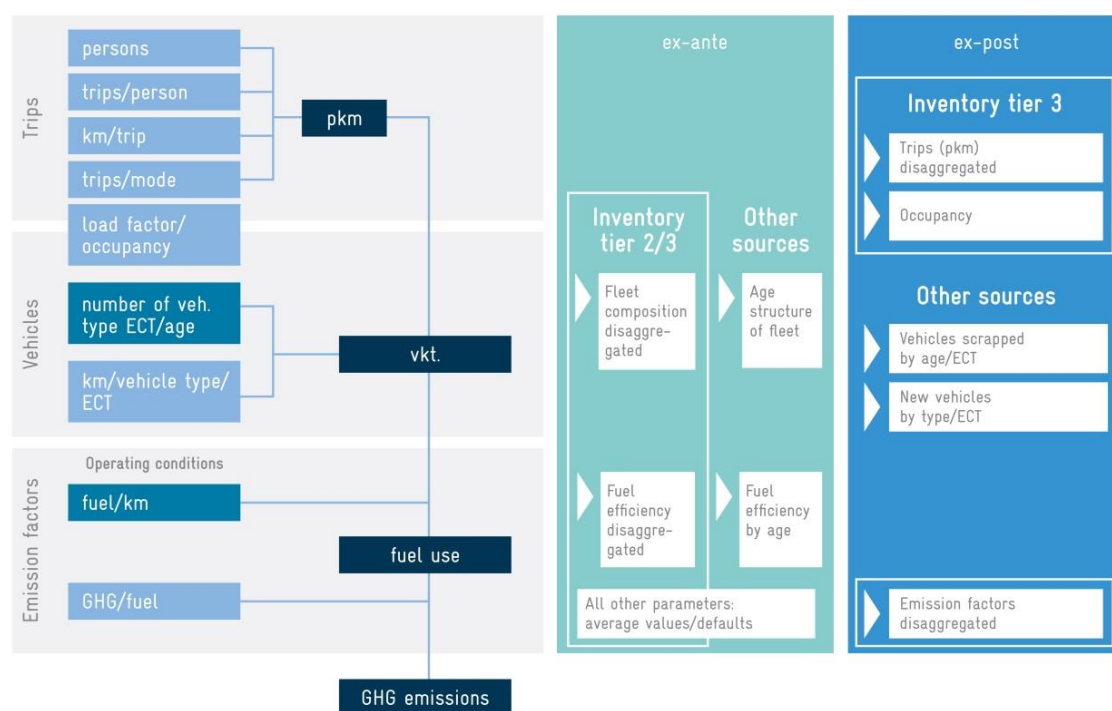


Figure 8: Targeted parameters and use of inventory data for fleet renovation programmes (Source: Author)

Note: tiers in this graph relate to the 1996 IPCC Guidelines and our understanding of top-down and bottom up as defined in chapter 2.

Also for this measure more detailed data is required for ex-post assessment. A tier 3 inventory can provide data on pkm travelled and occupancy for passenger transport. Data on the actual vehicles scrapped and potentially on new vehicles replacing them (if gathered within the programme) need to be collected additionally, for example through the operating entity of the programme.

### 5.3. Example: Mass rapid transit (MRT)

Measures to expand mass rapid transit modes include investment in infrastructure and equipment to operate mass rapid transit, such as bus rapid transit lines (BRT), tram, metro and subway lines. This covers new construction or extension of existing infrastructure, enhanced capacity, frequency, etc. Apart from GHG emission reductions, this measure can

<sup>8</sup> [https://www.ifeu.de/english/index.php?bereich=ver&seite=projekt\\_tremod](https://www.ifeu.de/english/index.php?bereich=ver&seite=projekt_tremod)

<sup>9</sup> <http://www.issrc.org/ive/>

improve traffic flow, thus reducing travel times and accidents, and provide better access to transport for the population.

Sometimes this is coupled with fleet renovation programmes, which additionally target enhanced efficiency of vehicles used. For this example, we concentrate on the system expansion. In this case the targeted parameters are:

- Trips per mode
- Occupancy per mode
- Fuel efficiency improvements through improved operating conditions (reduced congestion)

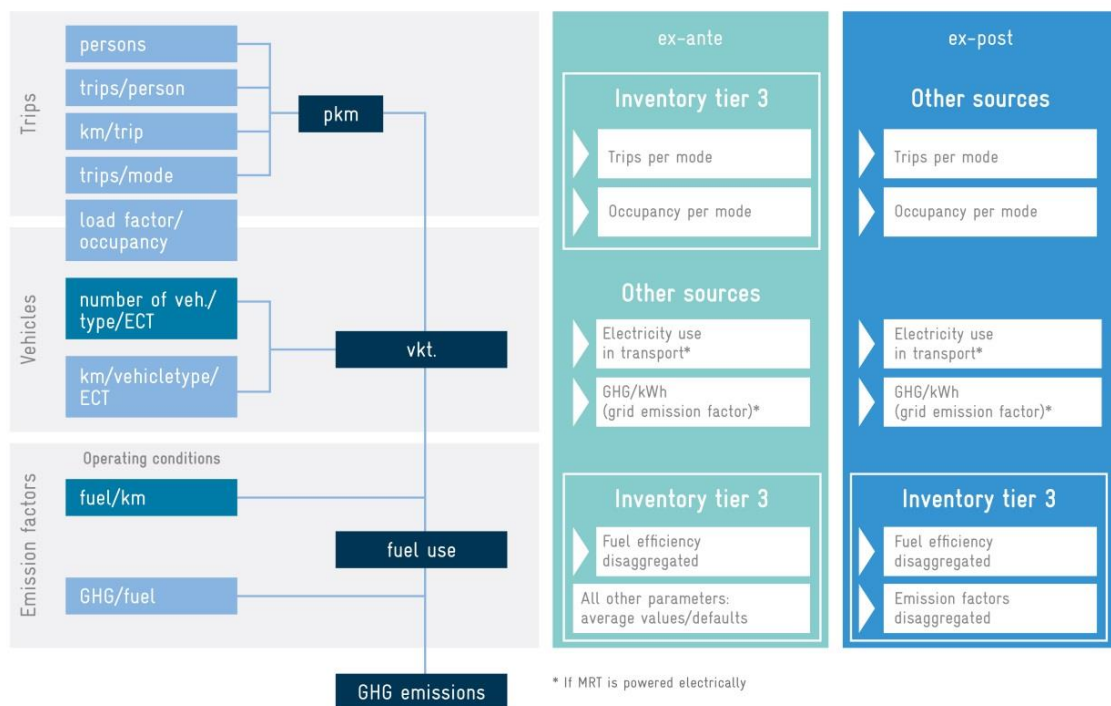


Figure 9: Targeted parameters and use of inventory data for mass rapid transit (Source: Author)

Note: tiers in this graph relate to 1996 IPCC Guidelines and our understanding of top-down and bottom up as defined in chapter 2

Only tier 3 bottom-up inventories are a source for data at a sufficient level of detail to be useful for the MRV of mass rapid transit measures. Even though these are at the national level, fuel efficiency data and emission factors for fuels can be used to inform ex-ante assessments. Travel activity data from the inventory can be usefully applied to the scope of the analysis by down scaling to the analysis boundary using a range of methods, for example using an average number of trips per person and applying this to the population of the analysis area where the measure is implemented.

For ex-post assessment fuel efficiency data and emission factors for fuel used can continue to be used from the inventory. Travel activity data will need to be collected from other sources or specifically developed for the purpose of monitoring the measure.

## 6. Limitations and synergies

### 6.1. Limitations

**Differences in geographic boundary**, as discussed in chapter 3, can limit the applicability of data, particularly for measures that are not at the national level. However, national data can in many cases provide default data, for example for fleet composition and emission factors. Especially for ex-ante assessments such default data is often sufficient to enable the assessment of effects, for example to compare different measures.

The fact that inventories only address fuel combustion from mobile sources often requires to look for additional data. In some cases information from other sectors within the inventory can provide the required information, but in many cases the coverage of **upstream and/or downstream emissions** will require additional data collection. In most cases this will include electricity use in transport (e.g. metro, electric cars) and the use of biofuels, but can extend to upstream emissions from conventional fuels, vehicle manufacture and scrapping and infrastructure construction and dismantling.

Fuel-based top-down approaches normally lack the **level of detail** required for the MRV of measures, particularly for ex-post assessments. Similar to the limitations posed by geographic coverage, aggregated data from tier 1 or 2 inventories can be used as default for some applications, for example rough ex-ante estimates. As the examples in chapter 5 show, these will in most cases be supplemented by additional data collected from other sources or specifically for the purpose.

### 6.2. Synergies

Even though inventories will only in rare cases deliver all data required for the MRV of measures, they can provide a solid starting point, particularly tier 3 inventory models for various modes. Using data from the inventory, especially from tier 3 inventory models used to generate inventory data for the various modes, ensures consistency of results with the inventory and enhances comparability between measures, as well as with national reporting to the UNFCCC. Using the same data structure and definitions helps to develop a **consistent national system for data collection and reporting**.

Data collected for the MRV of measures can also be used to supplement available national level data. If coordinated between different measures/geographic regions, data collected for the MRV of measures can provide a representative sample that can be used to estimate national values or conduct plausibility checks for national energy balances thus **helping to improve the accuracy of the inventory**.

If, for example, bottom-up data on distance travelled, occupancy, load factor, etc. are collected for the MRV of particular measures in one or more large cities, this data could be used as representative for city travel and extrapolated to the national level. Then only data on inter-city and regional travel would need to be collected to enable a bottom-up inventory.

If other measures that target inter-city or regional levels would also collect the bottom-up data in a harmonized way for their own MRV purposes, the data could be combined to allow calculation of a tier 3 inventory.

To maximize synergies: Data definitions and collection methods need to be harmonized, Frequency and timing needs to be aligned, Data formats and calculation methods used should be consistent and Institutional cooperation should be formalized.

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**Address**  
Friedrich-Ebert-Allee 40  
53113 Bonn, Germany  
T +49 228 44 60-0  
F +49 228 44 60-17 66

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**Author/Responsible/Editor.:**  
Marion Vieweg, Current Future  
Urda Eichhorst, GIZ  
Daniel Bongardt, GIZ

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Deutsche Gesellschaft für  
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Registered Offices  
Bonn und Eschborn

Friedrich-Ebert-Allee 36 + 40  
53113 Bonn/Germany  
T +49 228 44 60-0  
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5  
65760 Eschborn/Germany  
T +49 61 96 79-0  
F +49 61 96 79-11

E [info@giz.de](mailto:info@giz.de)  
I [www.giz.de](http://www.giz.de)