SIXTH FRAMEWORK PROGRAMME
PRIORITY [policy-oriented research priority SSP 5A]

SPECIFIC TARGETED RESEARCH OR INNOVATION PROJECT

FORWAST

Overall mapping of physical flows and stocks of resources to forecast waste quantities in Europe and identify life-cycle environmental stakes of waste prevention and recycling

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Methodology for mapping of physical stocks

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1 Introduction

1.1 Objectives of the FORWAST project

The FORWAST project intends to provide comprehensive and validated data on the material flows, stocks and environmental pressures coming from the different sectors of the life cycle of resources to waste. In the wider context of sustainable development and environment protection, the connections between the use of natural resources, their accumulation in economy and waste generation and management need to be more clearly understood. Waste management policies may affect potentially all sectors. Their influence on the use of natural resources must also account for the potential recovery of these resources from stocks, the technical and economical constraints of recycling, the side effects on the by-products associated with natural resources, and at the end, the global balance of the environmental costs and benefits.

The current uncertainties on the environmental stakes of waste policies are pre-dominantly due to a lack of real physical data on the quantities and qualities of flows of resources, either natural or coming from waste recovery. Particularly important for the latter is to account for the actual stocks of these resources that will end-up in the waste flows in the future. The objectives of the FORWAST project are therefore to:

- Provide an inventory of the historically cumulated physical stock of materials in EU-27, and to forecast the expected amounts of waste generated, per resource category, in the next 25 years.
- Provide an assessment of the life-cycle wide environmental impacts from different scenarios of waste prevention, recycling and waste treatment in the EU-27.

The project aims at accounting for all sectors in the economy (Figure 1-1 shows a possible conceptual organisation of the system) the flows, stocks and linked environmental pressures to increase the reliability of source data used in “Life Cycle Approaches” to waste management issues.

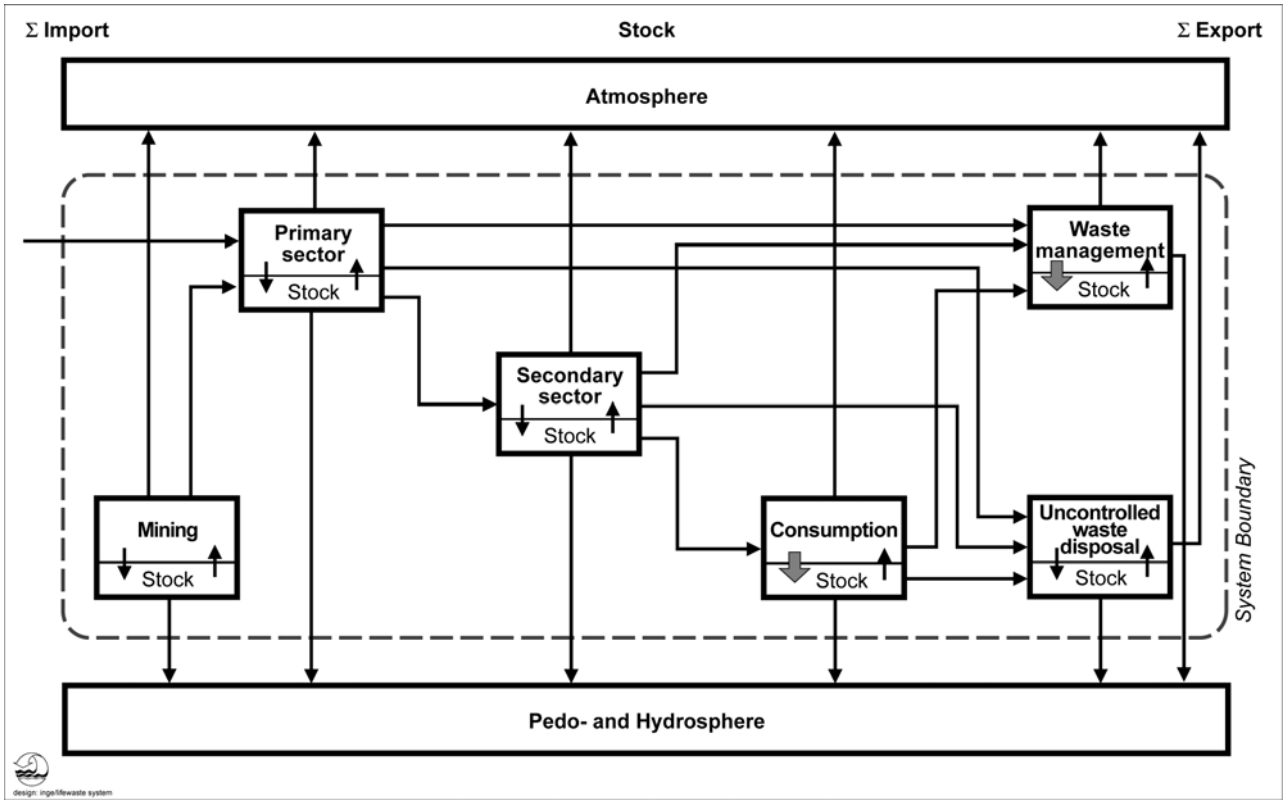

Figure 1-1: Conceptual system description (System definition)

1.2 Objectives of Workpackage 2

This workpackage will provide the required data definitions and guidelines to achieve the strategy for data acquisition. The system will be developed using Material Flow Analysis (MFA) nomenclature and procedures. The MFA methodology allows a representation of the complex reality in flows, processes and stocks (whereas stocks are treated as processes). It allows a mapping of the entire economy with most important flows and processes. These are flows which result in high mass flows, in high consumption of natural resources, large stocks and large environmental pressures.

To maintain the system clear and concentrated on the objective, it is necessary to set system boundaries, spatial and temporal for each data collection exercise. The definition of the system (boarders, processes, flows, stocks) and the selection of appropriate materials is conducted using the system model of WP1. The reporting of anthropogenic stocks is a particularly important issue considering it's use as a secondary resource in the future and/or endangering the environment. As the assessment of stocks is very sensitive, an own task is dedicated to the methodology of stock mapping. To ensure the usability of the defined system for data acquisition, a handbook will be produced for the consortium. It will ensure a homogenous coordinated carrying-out of all case-studies.

Deliverable D2-1 provides a detailed description of important resource and waste flows for inclusion in the system model [Daxbeck et al., 2008b]. Deliverable D2-2 provides a definition of the system and first estimates of transfer coefficients as well as emission factors and conversion factors [Daxbeck et al., 2008a] and Deliverable D2-4 provides a data collection guideline and forms for WP3 & 4 [Daxbeck et al., 2008c].

1.2.1 Objectives of Deliverable D2-3

One of the key objectives of the FORWAST project are to provide an inventory of the historically cumulated physical stock of materials in EU-27, and to forecast the expected amounts of waste generated, per resource category, in the next 25 years. The stocks, resulting from resource use and built up in the last decades, show chances and risks. Whether chance or risk depends on the answers to following questions: How is the emission rate originating from stocks in comparison to emissions originating from mining, processing or consumption? Is the stock emitting at all? What is the composition of the stock? How does the stock quantitatively change over the time? What waste is to be expected from the stock and when? How can the stock be used to spare natural resources? Are these resulting waste flows part of the regulated waste management?

As a basis for the achievement of these objectives in the following Deliverable D2-3 a methodology is developed to be able to map the composition and the alteration of the anthropogenic stocks. The results of the time series modelling of WP1 is compared to other data sources and procedures for estimating the existing stocks. This results in a methodology that will meet one of the project's objectives and the findings are applied to improve the final model used in WP6.

The core pieces of this deliverable are the methodology for mapping of anthropogenic stocks in chapter 2 and a case study for Austria, where this methodology is applied.

1.2.2 Link to other workpackages

All workpackages refer to one generic model for material flows, stocks and emissions, and include all materials/wastes considered, which makes the project coherent in the scientific approach and avoids overspecialisation on individual economic activities. It is composed of workpackages of different nature:

- One Framework work-package (WP0),
- Two "system modelling and data management" work-packages providing the model and data management guidelines for the other WPs (WP1 and WP2),
- Two "data mining" work packages on the acquisition and validation of data for all materials/wastes under investigation (WP3 and WP4). These WPs differ in the geographical approach: WP3 goes in-depth in a few countries which have high quality statistics, while WP4 is oriented towards complete coverage of the EU-27, with particular emphasis on East, Central and Southern Europe.
- Two "scenario and forecasting" work packages outlining the scenarios for future waste prevention, recycling and waste treatment, including environmental pressures. The calibration of the model with data from WP3 and WP4 provides the mapping of the present situation (time-zero point) in terms of material stocks, waste flows and environmental impacts, and the different scenarios are simulated on that basis (WP5 and WP6),
- One horizontal work-package on dissemination and valorisation of results (WP7).

The system modelling, data identification and management workpackages are closely connected and will have the main purpose of guiding the efforts for data acquisition in a two steps procedure. While WP1 (system modelling) will provide a global modelling approach (environmentally extended, economic input-output based materials flow accounting framework) covering the entire material metabolism (flows of resources, emissions, products and wastes) of the economy at the relevant level of detail, WP2 (data identification and management) will identify key data and data sources for the overall system model and elaborate a strategy and guideline for data acquisition,

calibration and documentation for WP3 and WP4. As a consequence this work package is especially linked to WP1 and intense interaction is foreseen.

1.3 Relevance of anthropogenic stocks for the FORWAST project

All around the world geogenic natural stocks are declining, whereas the anthropogenic stocks are rising. For example, in Austria the stock of iron in the anthroposphere will exceed the natural sources in already 15 years. This is shown in Figure 1-2, whereas in Figure 1-3 the anthropogenic stock of Austria and the most important resources with a relevance of a future management of the stocks are shown. The use of this stock is advisable, as environmental pressures can be reduced, waste can be reduced and natural resources can be spared. To achieve this ambitious goal the situation of stocks and material flows must be well known, the project FORWAST can help to tackle this opportunity.

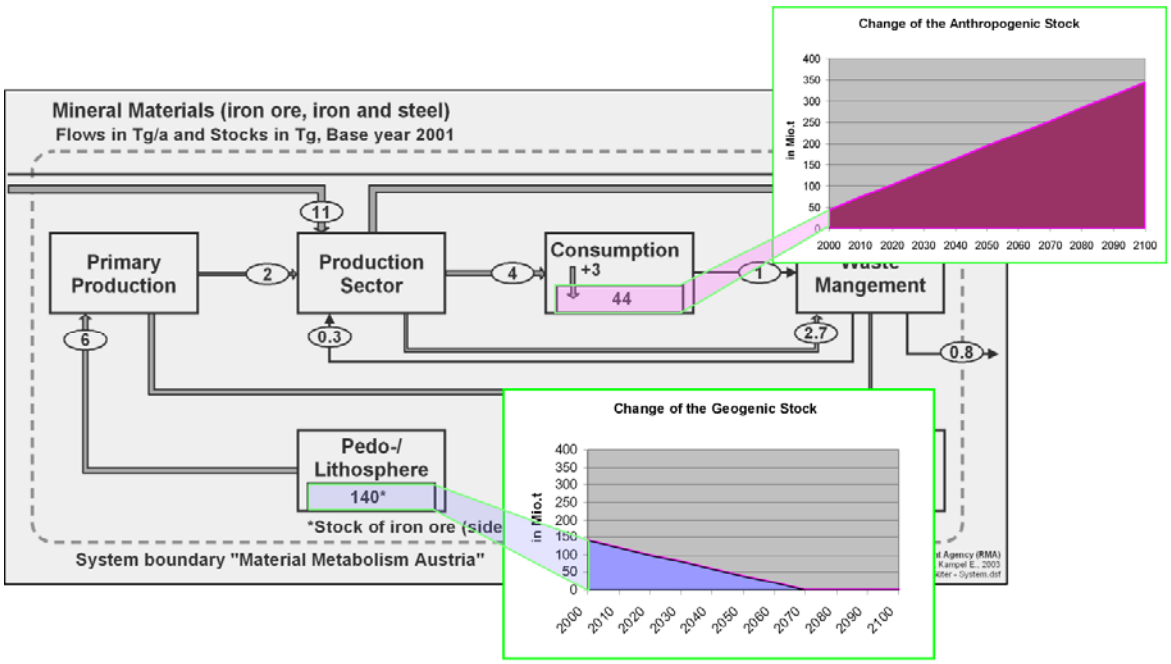

Figure 1-2: MFA for iron/steel for Austria including the geogenic and anthopogenic stocks

The situation of certain materials (e.g. metals, wood, minerals, …) is very well known but there is no mapping on European level available, regarding the entire system including the anthroposphere. Therefore it is necessary to develop an overall mapping regarding the materials of key relevance. Considering the studies already undertaken it is possible to appraise materials of key relevance, which is given when the material is because of its quality and/or quantity responsible for environmental pressures. Consequently the objective is to reduce environmental pressure by managing natural resources, material stocks or waste (prevention, recovery, recycling).

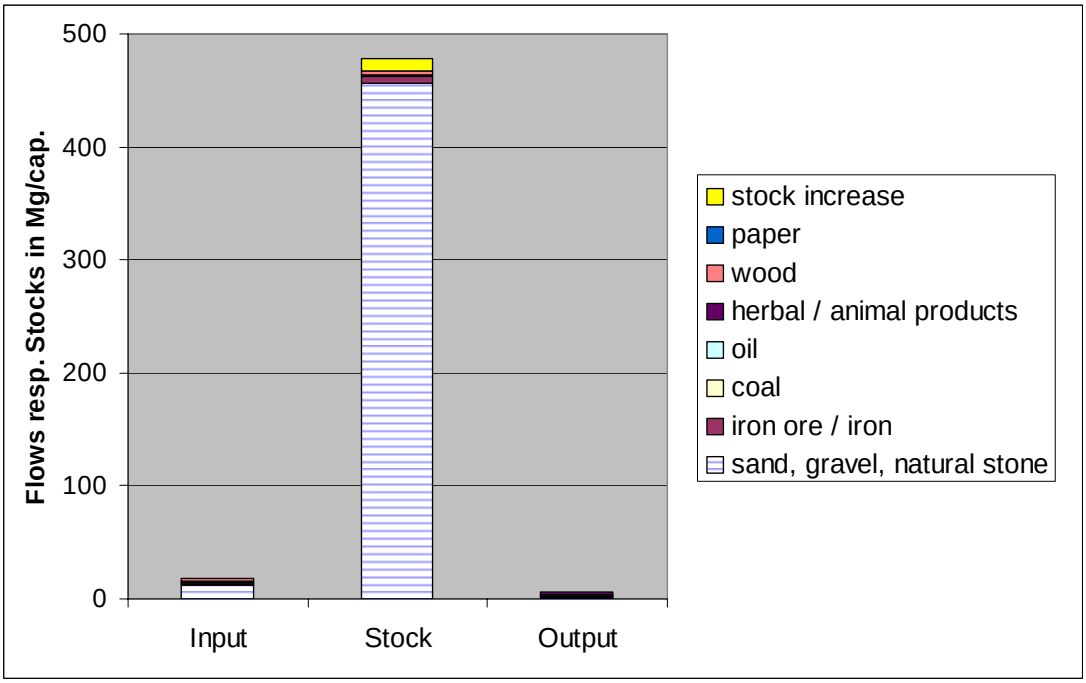

Figure 1-3: Example of the anthropogenic stock of Austria and the most important resources, showing the importance of a future management of the stocks

In the history of mankind the consumption of resources wasn't that high like in recent times. Approximately 50 percent of all of resources in the world were consumed in the last 50 years. Today the economic growth of the western countries has decelerated. Asia, especially China and India, compensate this lack of growth in the EU and the USA and lead to a ongoing increasing usage of resources. One of the main reasons of this development is the increasing number of urban inhabitants in the world. Since 2008 more than 50 percent of the world's population lives in cities and urban agglomerations. The urban infrastructure and networks are the greatest consumer of natural resources, but also an important man made stock of many materials.

For example, on average every citizen of Vienna consumes about 350 tonnes of material every year - with a doubling time of about 35 years. About 300 tonnes (85 percent) of this waste are made of carbon and silicates, 5 to 10 tonnes of steel, 5 to 10 tonnes wood, 1 ton of plastics, 300 kg of copper and approximately 300 kg of zinc. There is a lack of knowledge about his anthropogenic stocks in the urban agglomerations. More information about this mass flows and stocks can help to achieve a sustainable human development.

All resource inputs to the economy either become an output or are added to the physical anthropgenic stock. The metabolism of an economy can hence be summarised in terms of a material balance. Figure 1-4 provides an estimate of the metabolism of the EU economy on an annual per capita basis for the second half of the 1990ies. The EU economy directly takes in about 17 tonnes raw materials per capita for further processing in the production system (DMI). The directly used material input comprises about 13.5 t/cap of domestically extracted material and about 3.5 t/cap of imports. Another significant part of the domestic extraction has no further use and is shifted aside in terms of mining waste such as overburden, waste rock and tailings. For the EU, this amounts to about 15 t/cap. These hidden flows impact on the domestic environment, pollute groundwater and contribute to landscape change and constitute a major part of the domestic material outputs in terms of mining wastes. There are also "hidden flows" associated with the imports, i.e. life-cycle-

wide primary resource extractions from the foreign environment which were necessary to produce the imported goods. These are estimated to amount to about 17 t/cap for the EU imports.

A significant amount of the direct material inputs is stored in the physical stock of the EU; this concerns in particular construction minerals. The net additions to the stock of buildings, infrastructure and consumer durables are estimated to be around 10 t/cap for the EU. During use in the economic system, fossil fuels in particular are transformed and immediately released into the environment in terms of air emissions. After use, products become waste and may be recycled or finally disposed of in landfills or incineration plants. These outputs from processing to land, air and water amount to about 12 t/cap in the EU. Of those, air emissions constitute the bulk with some 10-11 t/cap, of which more than 95 percent is CO_2. About 1 t/cap of the processed output is actually waste landfilled and some minor 300 kg/cap are dissipative uses of products (e.g. fertilisers) and dissipative losses from product use (e.g. from tyres)[1].

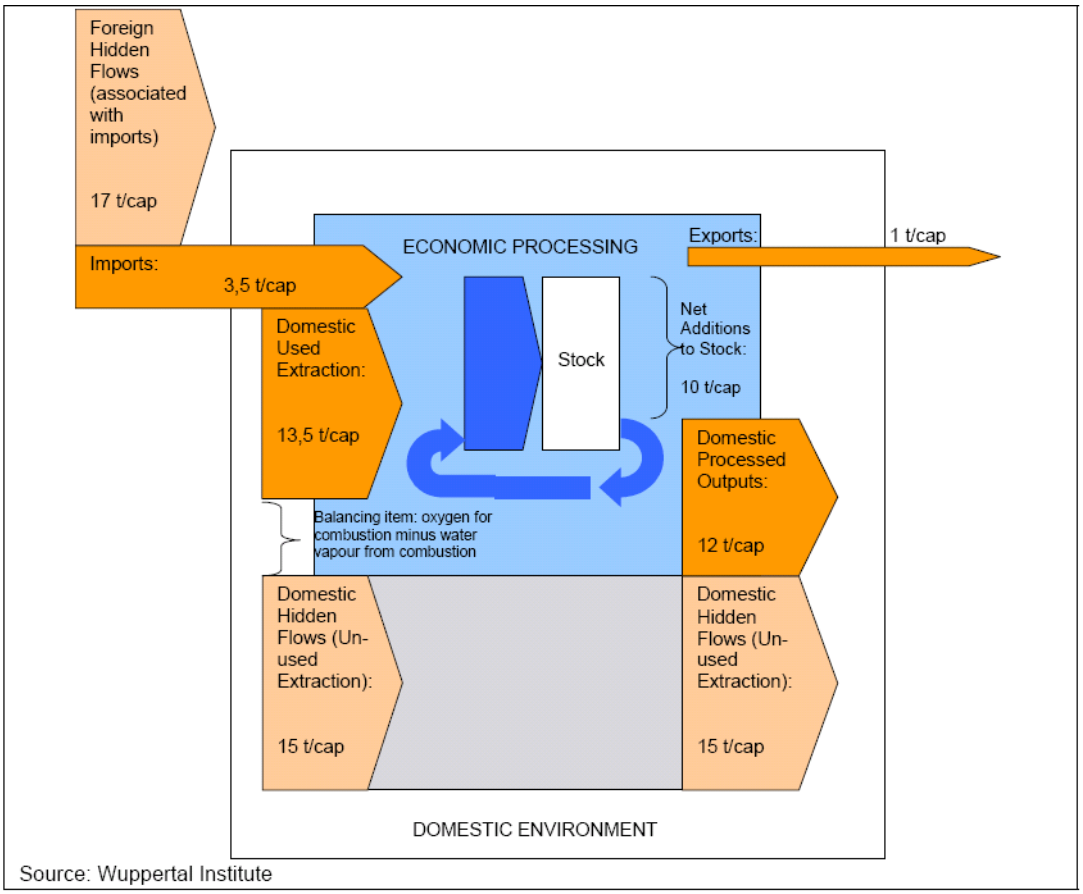

Figure 1-4: Estimated economy-wide material flows in the EU, on a per capita and year basis and for the second half of the 1990ies

It is the content of this deliverable to explain the stocks in detail in the anthroposphere. According to the 13 mentioned FORWAST-materials (Iron, aluminium, copper …) the main stocks of these raw materials are defined and illustrated. It is obvious that the full amount of flows and stocks of the anthroposphere cannot already be illustrated.

[1] Vgl. European Topic Centre on Waste and Material Flows: Resource use in European countries; p. 31; 2003

2 Methodology for mapping of stocks

2.1 Background

Data on historically accumulated stocks are one of the basis for forecasting the future waste flows. The following chapter is dedicated to the development of a methodology for the mapping of historical and current stocks based on the screening and comparison of different data sources for the assessment of stocks and stock activities.

In the following chapters the basic methodology for the mapping of stocks is described. This includes a brief description of the data collection procedure (see chapter 2.2), the selection of stock building commodities (see chapter 2.3), and a description with suggestions for the estimation the current stock (see chapter 2.4) as well as its historical development (see chapter 2.5).

2.2 Data collection procedure

The starting point for collecting data is a literature research. Data sources are most likely publications of EUROSTAT or national statistical offices, environmental protection agencies or other research institutions. Amongst others building or motor vehicles statistics as well as market research ("micro-census") serve as examples. Besides that already available information compiled within the FORWAST project is used for the estimation of stocks.

2.2.1 Procedure for estimating the current stocks

A possible way of estimating the current anthropogenic stocks systematically is provided with the method described in the following chapters. A precondition for these estimations is the consideration of durable commodities, which are commodities with a lifetime of more than one year, solely (see also chapter 2.2.2). Due to availability and quality of data and also for comparison reasons there are two ways proposed for estimating the current stocks:

1. Investigation of the number of goods within a commodity[2] being currently used multiplied by an average weight of one individual good **(direct estimation of stocks)**. Whenever suitable stock data on a national level are available, these data should be used. This could be already existing data in mass units of the flow of goods (as parts of the whole commodity) into the stock as well as data of the stock itself. Using these data reduces or even supersedes the described calculation processes for estimating the stocks with variant 2.

   Practically a list of all individual goods of each commodity (combined within one FORWAST code) has to be compiled. This list consists of all goods, which have relevance for the build up of the commodity stock. Hence a selection has to be made, where it has to be decided, which goods are chosen for consideration when estimating the stocks it which not. A default list for goods to be selected is given in the course of the description of the stock estimation

[2] In Deliverable D2-3 the term commodity is used for all goods (products), which belong to the main output ("diagonal cell value" within the matrices of the "Supply and Use Table Master") of a certain FORWAST activity.

of the individual commodities (see chapter 2.4). These defaults are open to be extended, if necessary. If it is not possible to specify individual goods within one commodity, which are relevant for the build up of stocks, another approach for stock estimation has to be chosen. By default this is done by linking a suitable "unit" (like private households or public offices) to its corresponding average mass of commodity stock, which is assumed.

2. Investigation of the yearly consumption of a commodity by weight, reduction to the percental amount, which is annually shifted into the stocks (being responsible for the build-up of the stock) and multiplied by an average lifetime of the individual commodity **(estimation of stocks via commodity flows and lifetime)**. The basic idea is that the (collected or calculated) flows of stock building commodities into the stock multiplied by the lifetimes of these commodities represent the current stock, both for immobilities and mobilities. Practically the flow of commodities into the stock is calculated by multiplying the amount of produced commodities within a certain time period with an average value for the weight of this commodity.

   Values for produced commodities within a certain time period can easily be taken out of the already compiled database of the FORWAST project ("Supply and Use Table Master"), which is available for EU-27. There for all commodities the annual flow is summed up and displayed. Basically both the values from the Supply Table as well as the Use Table can be taken into account, as they should be within a certain range (not exceeding a difference of 5 %).

   Average values for commodity weights have to be related either to mass, which is the most common case (e.g. when the amount is given in tons or kilotons), to length (when the amount is given e.g. in kilometres) or to units (e.g. number of produced pieces). Default values are provided in chapter 2.4. These default values are open to be adapted, if desired or necessary, e.g when suitable stock data are available.

   For the estimation of the expected useful life (lifetime) of an economic good (respectively commodity) amortization tables are applied. An amortization table is a tool for estimating a common expected lifetime of an economic commodity in years. Published by the German Ministry of Finance [Bundesministerium der Finanzen, 2000] it is usually used for fiscal reasons. There are tables for generally applicable commodities as well as industry-sector-specific tables. There is, for instance, an expected lifetime of three years for a personal computer or 25 years for a train.

   Default values for average commodity lifetimes are taken out of literature or calculated based on literature data (see chapter 2.4) for those stock building commodities, which are selected in chapter 2.3. These default values are open to be adapted, if desired or necessary, e.g. when suitable stock data are available.

   A detailed list of the lifetimes of different commodity groups is provided in chapter 5.1. It consists of the "AfA-Tables" [Bundesministerium der Finanzen, 2000] as well as lifetime tables for buildings and building components [Glenck et al., 2000], [Krapfenbauer, 1998] and [Stark et al., 2003]. These tables are used as basis for the assumption of the lifetimes suggested for stock estimation and can be used, if a more detailed calculation of individual commodity stocks is desired.

With one of the two proposed variants it is possible to estimate the current stocks for all the commodities, which are relevant for a build up of an anthropogenic stock. These stocks refer to the physical commodities themselves and are independent of any activity/process within the FORWAST project. This linkage has to be established separately.

On the one hand commodities are allocated to where they come from ("Supply Table") and on the other hand, where they are applied ("Use Table"). This exemplarily means that the commodity "vehicles" is allocated either to the activities, which supply vehicles (mostly the activity "Motor vehicles and trailers", see chapter 2.4.13) or to activities, which use vehicles. Hence the latter alternative distributes the vehicles to a broad number of activities, while the first comprises the vehicles largely in the activity "Motor vehicles and trailers". An allocation can be performed by using the percental distribution of each commodity to the 117 different activities/processes in either the Supply or the Use Table. What allocation option is chosen depends on the questions to be answered.

For the questions to be answered it is very likely that the composition of the considered commodities also has to be known. In chapter 2.6 a description is provided how this composition can be obtained based on the FORWAST materials selected and defined in Deliverable D2-1 [Daxbeck et al., 2008b].

2.2.2 Procedure for estimating the historical cumulated stocks

As the assumptions made in chapter 2.2.1 only refer to the current anthropogenic stocks, estimation for the historical accumulated anthropogenic stocks has to be made separately. A possible way of estimating these historical accumulated stocks systematically is provided with the method described in the following chapter. This estimation also considers any variations of quantities and lifetimes of all individual goods within each selected commodity. Default values for the calculation are given in chapter 2.5.

For all selected commodities the following information can be transferred from the investigations for estimating the current stocks as described in chapter 2.2.1:

- Numbers of goods within a selected commodity
- Average weights per individual good within a selected commodity
- Lifetimes of individual goods within a selected commodity

Furthermore the following information is required for each relevant individual good within one commodity:

- Distribution of goods leaving the anthropogenic stock during the lifetime of the product.
- Time variation of the input quantities of each considered goods into the anthropogenic stocks within the time frame of the lifetime of the respective good.
- Time variation of average weights of individual goods within the time frame of the lifetime of the respective good.
- Time variation of average lifetimes of individual goods within the time frame of the lifetime of the respective good.

Whenever suitable data on a national level on historical stocks are available, these data should be used. This could be already existing data in mass units of the flow of goods (as parts of the whole commodity) into the stock as well as data of the stock itself.

2.3 Selection of stock building commodities

In Workpackage 1 the decision is made which processes and commodities are taken into account for the establishment of the FORWAST system model. The considered commodities can be divided into short term and long term commodities. The long term commodities, which are also called

durables, are usually in use for more than one year before they become waste or emission and hence are responsible for the build up of the stocks.

For an estimation of the stocks, at first the considered commodities have to be allocated either to the short or the long term. As only the durables are responsible for the building up of the stock, any short term commodities are eliminated. The remaining long term commodities are divided into immobilities (e.g. buildings) and mobilities (e.g. transport vehicles). These two groups will be considered when stocks are estimated and mapped.

Based on the 117 activities and products (resp. commodities), which have been selected for consideration in the FORWAST system model, the commodities shown in Table 2-1 are identified for having a relevance in mapping the anthropogenic stocks and therefore proposed for consideration as stock building commodities. Commodities are cited including their code number and name within FORWAST nomenclature.

Table 2-1: Stock building commodities within the FORWAST system

Code Number	Commodity name
1	Bovine meat and milk
2	Pigs
3	Poultry and animals n.e.c.
36	Printed matter and recorded media
44	Rubber and plastic products
45	Glass, mineral wool and ceramic goods, virgin
65	Fabricated metal products, except machinery
66	Machinery and equipment n.e.c.
67	Office machinery and computers
68	Electrical machinery n.e.c.
69	Radio, television and communication equipment
70	Instruments, medical, precision, optical, clocks
71	Motor vehicles and trailers
72	Transport equipment n.e.c.
73	Furniture; other manufactured goods n.e.c.
78	Buildings, residential
79	Buildings, non-residential
80	Infrastructure, excluding buildings
106	Landfill of waste
107	Land application of waste
116	Household, home composting

For questions concerning the stocks all other commodities are suggested to be neglected. As examples “Cement” (FORWAST code 47) “Bricks” (FORWAST code 51) are mentioned, which are physically present in the stock, but in form of another commodity namely “Buildings”.

Attention has to be paid to the fact that the stock is estimated by exclusively by the consideration of individual commodities. These commodity stocks are estimated independently from any activity/process, from which the commodities are supplied respectively any activity/process which uses them (see also chapter 2.2).

2.4 Estimation of current stocks

In chapter 2.3 those commodities are indicated, which are relevant for stock building activities and hence are proposed for selection and consideration when mapping the anthropogenic stocks. For the estimation of stock quantities the procedure described in chapter 2.2 is used. Therefore certain information is required. This information is specified in the following chapter, whereas each commodity selected in chapter 2.3 is considered separately. Furthermore default data for the estimation of the anthropogenic stock are provided. These default values for stock calculation are open to be adapted, if desired or necessary, e.g. when suitable stock data are available.

2.4.1 Bovine meat and milk

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises cattle as well as raw cow milk.

Variant 1 for estimating the current stock

For the calculation of stocks the living stock of cattle is considered. Criteria for stock estimation are the number of cattle and an average mass per cattle. So only bovine meat is taken into account in form of the living animals, while bovine milk is neglected.

The following information has to be investigated:

- Number of cattle livestock

The following information concerning cattle is assumed:

- Mass of a cattle: 500 kg a piece (equivalent to 1 livestock unit according (LSU) to EUROSTAT)

The current stock is calculated by multiplying the number of animals with their average mass.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 2 years are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Bovine meat and milk”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.2 Pigs

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises swine.

Variant 1 for estimating the current stock

For the calculation of stocks the living stock of swine is considered. Criteria for stock estimation are the number of pigs and an average mass per pigs.

The following information has to be investigated:

- Number of swine livestock

The following information concerning pigs is assumed:

- Mass of a swine / pig: 150 kg a piece (0.3 LSU)

The current stock is calculated by multiplying the number of animals with their average mass.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 0.5 years is indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Pigs”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.3 Poultry and animals n.e.c.

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises poultry, horses, asses, mules or hinnies, sheep and goats as well as eggs, raw wool, raw sheep or goat milk, honey and beeswax, rabbits and pet animals, fur animals and raw furskins, silk worms and silk worm cocoons, water reptiles and frogs, snails and any other animals.

Variant 1 for estimating the current stock

For the calculation of stocks the living stock of the animals is considered. Criteria for stock estimation are the number of the following animals and an average mass per animal: poultry, horses,

asses, mules or hinnies, sheep and goats as well as rabbits. Other animals are neglected.

The following information has to be investigated:

- Number of poultry livestock
- Number of horse livestock
- Number of ass livestock
- Number of mule and hinny livestock
- Number of sheep livestock
- Number of goat livestock
- Number of rabbit livestock

The following information concerning poultry and other animals is assumed:

• Mass of a (turkey) hen / rooster:	7 kg a piece	0.014	(LSU)
• Mass of a horse:	400 kg a piece	0.8	(LSU)
• Mass of a ass:	400 kg a piece	0.8	(LSU)
• Mass of a mule or hinny:	400 kg a piece	0.8	(LSU)
• Mass of a sheep:	50 kg a piece	0.1	(LSU)
• Mass of a goat:	50 kg a piece	0.1	(LSU)
• Mass of a rabbit:	10 kg a piece	0.02	(LSU)

The current stock is calculated by multiplying the number of animals with their average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 0.7 years are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Poultry and animals n.e.c.”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.4 Printed matter and recorded media

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises various printed matter (e.g. books, brochures, leaflets, dictionaries and encyclopaedias, newspapers, journals, magazines, posters) and recorded media (e.g. printed music, gramophone records, compact discs

and tapes with music or other sound recordings, motion pictures and other video recordings, copies of software and data on discs and tapes).

Variant 1 for estimating the current stock

For the calculation of stocks libraries, archives, private households as well as other industrial sectors are considered. Criteria for stock estimation are an average weight of printed matter and recorded media stored in the above mentioned facilities.

The following information has to be investigated:

- Number of books and documents stored in libraries and archives
- Number of libraries and archives
    - Alternative: Total size of library and archive area in square meter
    - Alternative: Total length of library and archive shelves in meter
- Number of private households
- Number of public offices
- Number of company offices

The following information concerning printed matter and recorded media is assumed (based on own calculations):

- Average mass stored on one square meter of library or archive area: 150 kg[3] per square meter
- Average mass stored along one running meter of library or archive shelf: 50 kg[4] per running meter
- Average mass stored in a private household: 250 kg per private household[5]
- Average mass stored in an public office: 5,000 kg per public offices[5]
- Average mass stored in a company office: 5,000 kg per company offices[5]

The current stock is calculated by multiplying the number of libraries, archives, private households as well as public and company offices each with their individual average mass of stored printed matter and recorded media and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 14 %[6] of the input is proposed.

[3] Based on own assumptions

[4] Based on own measurement

[5] Based on own assumptions (only a marginal percentage of the used paper has a lifetime > 1 year (books, files, etc.); the predominant part of the paper consumption is used within one year (newspaper, packaging, bulk mail, etc.))

[6] Based on Austrian data concerning the yearly paper consumption (see chapter 3.1.4)

As proposed average lifetime for individual units of this commodity 10 years are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Printed matter and recorded media”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.5 Rubber and plastic products

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises all kinds of rubber tyres and tubes and diverse other natural or synthetic rubber and plastic products (e.g. packaging material, tableware, kitchenware, toilet articles).

Variant 1 for estimating the current stock

For the calculation of stocks rubber and plastic products used in private households as well as industrial sectors are considered. Criteria for stock estimation are an average weight of tyres and tubes stored in vehicles as well rubber and plastic products stored in the above mentioned facilities.

The following information has to be investigated:

- Number of passenger vehicles (cars) in use
- Average weight of one passenger vehicle (car)
- Number of commercial road vehicles (lorries, trucks) in use
- Average weight of one commercial road vehicle (lorry, truck)
- Number of commercial off-road vehicles (agricultural and construction vehicles) in use
- Average weight of one commercial off-road vehicle
- Number of bikes (motorcycles, bicycles) in use
- Average weight of one bike (motorcycle, bicycle)
- Number of private households
- Number of public offices
- Number of company offices

The following information concerning rubber and plastic products is assumed:

- Mass of a tyre of a passenger vehicle (car): 8 kg per tyre
- Share of plastics with one passenger vehicle: 4.5 % of the vehicle
- Mass of a tyre of a commercial road vehicle (lorry, bus): 8 kg per tyre
- Share of plastics with one commercial road vehicle: 4.5 % of the vehicle
- Mass of a tyre of a agricultural and construction vehicles: 8 kg per tyre
- Share of plastics with one agricultural or construction vehicle: 4.5 % of the vehicle
- Mass of a tyre/tube of a bike (motorcycle, bicycle): 8 kg per tyre
- Share of plastics with one bike: 4.5 % of the vehicle
- Average mass of plastic products stored in a private household kg per private household: not defined
- Average mass of plastic products stored in a public office per public offices not significant
- Average mass of plastic products stored in a company office kg per company offices not significant

The current stock is calculated by multiplying the number of different vehicles each with their individual average mass of the tyres/tubes and summing them up. The mass of 2 tyres for bikes, 6 tyres (+1 spare wheel) for lorries and 4 tyres (+1 spare wheel) for all other vehicles should be considered for calculation. In countries with different climate conditions a doubling of used tires should be taken in to account.

Secondly the number of different vehicles is multiplied first with their individual average vehicle mass and second with the share of plastics within on individual vehicle type. Furthermore the number of private households as well as public and company offices are multiplied each with their individual average mass of stored plastic products and adding the result to the sum of the tyres/tubes as well as average vehicle plastics contents.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 4 years[7] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Rubber and plastic products”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.6 Glass, mineral wool and ceramic goods

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises all kind of glass and glass products (e.g. wired, coloured or tinted flat glass, glass mirrors of toughened or laminated flat glass, bottles and other containers of glass or crystal, drinking glasses and other domestic glass or crystal articles, clock or watch glasses), mineral wool (e.g. glass fibres, glass wool, stone wool) and ceramic goods (e.g. toilet, basin, bathtub, ceramic tableware and other domestic articles, ceramic hearth or wall tiles, mosaic cubes, ceramic flags and paving).

Variant 1 for estimating the current stock

For the calculation of stocks glass and ceramics used in private households as well as industrial sectors are considered. Criteria for stock estimation are an average weight of glass and ceramic goods in the above mentioned facilities. Glass and mineral wool which is used as construction material in buildings is not considered, hence mineral wool is totally neglected.

[7] Based on own assumptions

The following information has to be investigated:

- Number of private households
- Number of public offices
- Number of company offices
- Useable surface of private households
- Useable surface of public offices
- Useable surface of company offices
- Average weight per square meter window area

The following information concerning glass, mineral wool and ceramic goods are assumed:

- Average mass of glass products stored in a private household: 50 kg[8] per private household
  - Average window area per private household: 10 percent of the usable surface
- Average mass of glass products stored in an public office: not significant
  - Average window area per public office: 10 percent of the usable surface
- Average mass of glass products stored in a company office: not significant
  - Average window area per company office: 10 percent of the useable surface
- Average weight per square meter window area: 5 kg per square meter
- Average mass of ceramic products stored in a private household: 150 kg[9] per private household
- Average mass of ceramic products stored in a public office: 50 kg per every 15 employees (public offices)
- Average mass of ceramic products stored in a company office: 50 kg per every 15 employees (company offices)

The current stock is calculated by multiplying the number of private households as well as public and company offices each with their individual average mass of stored glass products and summing them up. Furthermore the number of private households as well as public and company offices are multiplied each with their individual average mass of stored ceramic products and adding the result to the sum of the glass products.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

[8] Based on own assumptions (in Austria 10 % of the living space of an average flat has to be window area; in connection with the average size of a flat and the specific weight of glass the average amount of glass per private household can be calculated)

[9] Based on own assumptions (goods made of ceramic: WCs (~15 kg), basins (~15 kg), bath tube (~30 kg), flagging (~75 kg), etc. (all together ~150 kg))

As proposed average lifetime for individual units of this commodity 25 years[10] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of "Glass, mineral wool and ceramic goods", the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.7 Fabricated metal products, except machinery

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises structural metal products; tanks, reservoirs and containers of metal, manufacture of central heating radiators and boilers; steam generators, except central heating hot water boilers; cutlery, tools and general hardware, steel drums and similar containers, light metal packaging, wire products, screw machine products, chain and springs and other fabricated metal products.

Variant 1 for estimating the current stock

For the calculation of stocks of fabricated metal products, except machinery used in private households as well as industrial sectors are considered. Criteria for stock estimation are an average weight of fabricated metal products goods in the above mentioned facilities.

The following information has to be investigated:

- Number of private households
- Number of public offices
- Number of company offices

The following information concerning fabricated metal products (except machinery) is assumed:

- Average mass of fabricated metal products stored in a private household: 150 kg[11] per private household
    - Equal to 1.75 kg of fabricated metal products per square meter usable surface
- Average mass of fabricated metal products stored in an public office: 1.75 kg per square meter useable surface (public offices)
- Average mass of fabricated metal products stored in a company office: 1.75 kg per square meter useable surface company offices

The current stock is calculated by multiplying the number of private households as well as public and company offices each with their individual average mass of stored fabricated metal products and summing them up. Furthermore the number of private households as well as public and company offices are multiplied each with their individual average mass of stored fabricated metal products and adding the result to the sum of the fabricated metal products.

Variant 2 for estimating the current stock

[10] Based on own assumptions

[11] Based on following assumption: 1 radiator heats 15m²; 1 radiator has a weight of approximately 25 kg (incl. pipe installation); using 5-6 radiators is assumed that the total weight is 150 kg of fabricated metal products per private household (average size 85 m²)

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 25 years[12] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “fabricated metal products, except machinery”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.8 Machinery and equipment n.e.c.

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises machinery for the production and use of mechanical power (e.g. engines, turbines), except aircraft, vehicle and cycle engines; general purpose machinery (e.g. pumps and compressors, taps and valves, bearings, gears, furnaces, lifting and handling equipment, cooling and ventilation equipment); agricultural and forestry machinery (e.g. tractors); machine-tools; special purpose machinery (e.g. for metallurgy, quarrying and construction, mining, food, beverage and tobacco processing, textile, apparel and leather production, paper and paperboard production); weapons and ammunition and domestic appliances (electric and non-electric).

Variant 1 for estimating the current stock

For the calculation of stocks, the following types of domestic appliances are considered: Washing machine, dishwasher, refrigerator, laundry dryer and microwave. Criteria for stock estimation are the number of appliances in use.

The following information has to be investigated:

- Number of washing machines in use
- Number of dishwashers in use
- Number of refrigerators in use
- Number of laundry dryers in use
- Number of microwaves in use

The following information concerning office machinery and computers is assumed [Hausmann, 2005]:

- Mass of a washing machine: 75 kg a piece
- Mass of a dishwasher: 50 kg a piece
- Mass of a refrigerator: 50 kg a piece

[12] Based on own assumptions

- Mass of a laundry dryer: 60 kg a piece
- Mass of a microwave: 23 kg a piece

The current stock is calculated by multiplying the number of each type of devices with their average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the "Supply and Use Table Master" for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 16 years[13] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of "Glass, mineral wool and ceramic goods", the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.9 Office machinery and computers

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises office machinery as well as computers and other information processing equipment.

Variant 1 for estimating the current stock

For the calculation of stocks, the following types of office machinery and computers are considered: personal computers, monitors, fax machines, (fixed) telephones, answering machines, copy machines and printers. Criteria for stock estimation are the number of appliances in use.

The following information has to be investigated:

- Number of personal computers (PC) in use
- Number of fax machines in use
- Number of fixed telephones in use
- Number of answering machines in use
- Number of copy machines in use
- Number of printers in use
- Number of notebooks in use

[13] Based on own assumption

The following information concerning office machinery and computers is assumed [Hausmann, 2005]:

- Mass of a personal computer: 10 kg a piece
- Mass of a monitor: 20 kg a piece
- Mass of a fax machine: 5 kg a piece
- Mass of a fixed telephone: 0.3 kg a piece
- Mass of an answering machine: 0.3 kg a piece
- Mass of a copy machine: 7 kg[14] a piece
- Mass of a printer: 7 kg[14] a piece
- Mass of a notebook: 6 kg a piece

The current stock is calculated by multiplying the number of each type of devices with their average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the "Supply and Use Table Master" for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 8 years [Bundesministerium der Finanzen, 2000] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of "Office machinery and computers", the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.10 Electrical machinery n.e.c.

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises electric motors, generators and transformers; electricity distribution and control apparatus; insulated wire and cable; accumulators, primary cells and primary batteries; lighting equipment and electric lamps and other electrical equipment.

Variant 1 for estimating the current stock

For the calculation of stocks glass and ceramics used in private households as well as industrial sectors are considered. Criteria for stock estimation are an average weight of lighting equipment and electric lamps as well as other electrical machinery in the above mentioned facilities.

[14] Based on own assumption

The following information has to be investigated:

- Number of private households
- Number of public offices
- Number of company offices

The following information concerning rubber and plastic products is assumed:

- Average mass of lighting equipment and electric lamps stored in a private household: 0.75 kg[15] per private household
  - Average illuminated area per light source and useable surface: 4.4 m²
- Average mass of lighting equipment and electric lamps stored in a public office: not significant
  - Average illuminated area per light source and useable surface: 4.4 m²
- Average mass of lighting equipment and electric lamps stored in a company office: not significant
  - Average illuminated area per light source and useable surface: 4.4 m²
- Average mass of other electrical machinery stored in a private household: x kg *(not defined)* per private household
- Average mass of other electrical machinery stored in a public office: x kg *(not defined*) per public offices
- Average mass of other electrical machinery stored in a company office: x kg *(not defined)* per company offices

The current stock is calculated by multiplying the number of private households as well as public and company offices each with their individual average mass of stored lighting equipment and electric lamps and summing them up. Furthermore the number of private households as well as public and company offices are multiplied each with their individual average mass of other electrical machinery and adding the result to the sum of the first calculation.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the "Supply and Use Table Master" for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 2 years[16] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of "Electrical machinery n.e.c.", the percentage of the flow being relevant for the build up of the stock and the average lifetime.

[15] It is assumed that each private household uses 24 illuminants (750 g); 3/4 bulbs (30 g per piece; average lifetime 1 year) and 1/3 fluorescent lamps/energy-efficient lamp (90 g per piece; average lifetime 4-10 years)

[16] Based on own assumptions (Austrian data)

2.4.11 Radio, television and communication equipment

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises electronic valves and tubes and other electronic components; television and radio transmitters and apparatus for line telephony and line telegraphy as well as television and radio receivers, sound or video recording or reproducing apparatus and associated goods.

Variant 1 for estimating the current stock

For the calculation of stocks, the following types of radio, television and communication equipment are considered: television and radio receivers, video and radio recorders, Hi-Fi systems, CD and DVD player/recorder. A criterion for stock estimation is the number of appliances in use.

The following information has to be investigated:

- Number of television receivers in use
- Number of Hi-Fi systems in use
- Number of video recorders in use
- Number of radio receivers or recorders in use
- Number of CD and DVD player or recorder in use

The following information is assumed [Hausmann, 2005]:

- Mass of a television receivers: 30 kg a piece
- Mass of a Hi-Fi system: 10 kg a piece
- Mass of a video recorder: 5 kg a piece
- Mass of a radio receivers or recorders: 2 kg a piece
- Mass of a CD player: 2 kg a piece
- Mass of a DVD player or recorder: 5 kg a piece

The current stock is calculated by multiplying the number of each type of device with its average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 3 years[17] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

[17] Based on own assumptions

The current stock is calculated by multiplying the annual flow of “Radio, television and communication equipment”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.12 Instruments, medical, precision, optical, clocks

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises medical and surgical equipment and orthopaedic appliances; instruments and appliances for measuring, checking, testing and navigating; industrial process control equipment; optical instruments and photographic equipment as well as watches and clocks.

Variant 1 for estimating the current stock

For the calculation of stocks, the following types of instruments are considered: medical and surgical equipment and orthopaedic appliances; instruments and appliances for measuring, checking, testing and navigating; industrial process control equipment; optical instruments, cameras, camcorders and clocks. A criterion for stock estimation is the number of appliances in use.

The following information has to be investigated:

- Number of medical and surgical equipment in use
- Number of orthopaedic appliances in use
- Number of instruments in use
- Number of appliances for measuring in use
- Number of control equipment in use
- Number of optical instruments in use
- Number of cameras and camcorders in use
- Number of clocks in use

The following information is assumed [Hausmann, 2005]:

- Mass of a medical and surgical equipment x kg a piece (not defined)
- Mass of an orthopaedic appliance x kg a piece (not defined)
- Mass of a instrument x kg a piece (not defined)
- Mass of a control equipment x kg a piece (not defined)
- Mass of a optical instrument x kg a piece (not defined)
- Mass of a camera: 0.35 kg a piece
- Mass of a camcorder: 1 kg a piece
- Mass of a clock: 0.05 kg[18] a piece

The current stock is calculated by multiplying the number of each type of device with its average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and

[18] Based on own assumption

administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 3 years[19] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Instruments, medical, precision, optical, clocks”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.13 Motor vehicles and trailers

According to Deliverable D2-2 [Daxbeck et al., 2008a] the physical flow of products includes motor vehicles; bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers as well as parts and accessories for motor vehicles and their engines.

Variant 1 for estimating the current stock

For the calculation of stocks, the following types of motor vehicles are considered: passenger vehicles (cars), commercial road vehicles (lorries, trucks, busses) and agricultural as well as construction vehicles. A criterion for stock estimation is the number of vehicles in use.

The following information concerning vehicles has to be investigated:

- Number of passenger vehicles (cars) in use
- Number of commercial road vehicles (lorries, trucks) in use
- Number of commercial off-road vehicles (agricultural and construction vehicles) in use -> machinery and equipment n.e.c.

The following information concerning vehicles is assumed [Daxbeck et al., 2006]:

- Mass of a passenger vehicle (car): 1.5 tons per vehicle
- Mass of a commercial road vehicle (lorry, bus): 10 tons per vehicle
- Mass of an agricultural and construction vehicle: 20 tons per vehicle → machinery and equipment n.e.c.

The current stock is calculated by multiplying the number of each type of vehicle with its average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by

[19] Based on own assumption

the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 6 years [Bundesministerium der Finanzen, 2000] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Motor vehicles and trailers”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.14 Transport equipment n.e.c.

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises ships as well as pleasure and sporting boats; railway and tramway locomotives and rolling stock; aircraft and spacecraft; motorcycles and bicycles and other transport equipment.

Variant 1 for estimating the current stock

For the calculation of stocks, the following types of transport equipment are considered: ships and boats, railway and tramway locomotives (including rolling stock), aircraft, motorcycles and bicycles. A criterion for stock estimation is the number of transport in use.

The following information concerning vehicles has to be investigated:

- Number of ships and boats in use
- Number of locomotives (railway, tramway) and rollings stock in use
- Number of aircraft in use
- Number of bikes (motorcycles, bicycles) in use

The following information concerning vehicles is assumed:

- Mass of a ship (resp. a boat): 1,000 tons[20] per ship (resp. boat)
- Mass of a locomotives (railway, tramway): 100 tons per locomotive
- Mass of an aircraft: 250 tons per aircraft (based on own assumptions)
- Mass of a motorbike (resp. bicycle): 200 kg per motorbike (resp. bicycle)

The current stock is calculated by multiplying the number of each type of transport equipment with its average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by

[20] See D2-2

the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 20 years [Bundesministerium der Finanzen, 2000] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Transport equipment n.e.c.”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.15 Furniture, other manufactured goods n.e.c.

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises furniture (e.g. chairs and seats, office and shop furniture, kitchen furniture), jewellery and related articles, musical instruments, sports goods, games and toys and miscellaneous manufacturing out of wood.

Variant 1 for estimating the current stock

For the calculation of furniture and other manufactured goods used in private households as well as offices, shops, schools, sports fields and fitness centers are considered. Criteria for stock estimation is an average weight of furniture, musical instruments, sports goods, games and toys in the above mentioned facilities.

The following information has to be investigated:

- Number of inhabitants

The following information concerning rubber and plastic products is assumed:

- Average mass of furniture per inhabitant: 516 kg [Hutter, 2001]

The current stock is calculated by multiplying the number of inhabitants with the average mass of stored furniture.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 7 years[21] are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Furniture, other manufactured goods n.e.c.”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.16 Residential buildings

Residential buildings comprise all buildings, which primarily are used for living purposes. According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises all types of residential buildings (including roofs, roof covering and waterproofing; electrical wiring and fittings, telecommunications systems, electrical heating systems, residential antennas and aerials, fire alarms, burglar alarm systems, lifts and escalators, lightning conductors; thermal, sound or vibration insulation; sanitary equipment, gas fittings, heating, ventilation, refrigeration or air-conditioning equipment and ducts, sprinkler systems; doors, windows, door and window frames, fitted kitchens, staircases, shop fittings and the like; ceilings, wooden wall coverings, movable partitions; ceramic, concrete or cut stone wall or floor tiles parquet and other wood floor coverings, carpets and linoleum floor coverings, including of rubber or plastic, terrazzo, marble, granite or slate floor or wall coverings, wallpaper; glass and mirrors).

Variant 1 for estimating the current stock

For the calculation of stocks, buildings are considered as a whole. Criteria for stock estimation are occupancy, number, size, age, composition.

The following information concerning residential buildings has to be investigated:

- Number of buildings and apartments
- Useable surface
- Percentage of single family detached houses and semidetached houses
- Number of floors
- Construction method
- Age structure / age distribution / period of construction

The following values concerning residential buildings are assumed [Glenck et al., 1996]:

- Gross volume: 3 meter per square meter useable surface
- Mass (per volume): 0.6 tons per cubic meter gross volume (range: 0.4 to 1.5 tons)
- Mass (per area): 2.3 tons per square meter useable surface (range 0.95 to 6.3 tons)
- Average mass per residential building: 440 tons (range 300 to 800 tons)

The stock quantity is calculated by multiplying the number of living units with an average weight for the considered living unit and summing them up.

[21] Based on own assumption

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 100 years are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Residential buildings”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.17 Non-residential buildings

Non-residential buildings comprise industrial, business and office buildings as well as factories, storehouses, warehouses, shops, restaurants, guesthouses, hotels and public buildings. According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises all types of non-residential buildings (including roofs, roof covering and waterproofing; electrical wiring and fittings, telecommunications systems, electrical heating systems, residential antennas and aerials, fire alarms, burglar alarm systems, lifts and escalators, lightning conductors; thermal, sound or vibration insulation; sanitary equipment, gas fittings, heating, ventilation, refrigeration or air-conditioning equipment and ducts, sprinkler systems; doors, windows, door and window frames, fitted kitchens, staircases, shop fittings and the like; ceilings, wooden wall coverings, movable partitions; ceramic, concrete or cut stone wall or floor tiles parquet and other wood floor coverings, carpets and linoleum floor coverings, including of rubber or plastic, terrazzo, marble, granite or slate floor or wall coverings, wallpaper; glass and mirrors).

Variant 1 for estimating the current stock

For the calculation of stocks, buildings are considered as a whole. Criteria for stock estimation are occupancy, number, size, age, composition.

The following information concerning non-residential buildings has to be investigated:

- Occupancy of buildings
- Number of buildings
- Useable surface
- Number of floors
- Construction method (exterior walls)
- Age structure / age distribution / period of construction

The following values concerning non-residential buildings are assumed [Glenck et al., 1996]:

- Gross volume: 3 meter per square meter useable surface

- Mass (per volume): 0.45 tons per cubic meter gross volume (range: 0.1 to 0.6 tons)
- Mass (per area): 1.9 tons per square meter useable surface (range 0.9 to 2 tons)
- Average mass per non-residential building: 1,700 tons (range 400 to 2,200 tons)

The stock quantity is calculated by multiplying the number of living units with an average weight for the considered living unit and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the "Supply and Use Table Master" for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 50 years are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of "Non-residential buildings", the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.18 Infrastructure, excluding buildings

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises infrastructure and network constructions other than buildings including bridges, viaducts, tunnels and subways, long-distance pipelines, communication and power lines, urban pipelines, urban communication and powerlines; highways, streets, roads, other vehicular and pedestrian ways; railways and airfield runways; stadiums, swimming pools, gymnasiums, tennis courts, golf courses and other sports installations; waterways, harbour and river works, pleasure ports (marinas), locks, dams and dykes; private swimming pools)

For the calculation of stocks the following infrastructure networks are considered: roads (highways, main roads, state roads, rural roads, forest roads, bicycle tracks, parking sites), railways, water supply and sewerage systems, power and gas supply lines, district heating pipelines, telecommunication lines as well as hydro power stations.

Variant 1 for estimating the current stock

<u>Roads</u>
The following information concerning roads has to be investigated:

- Length of road system
- Road profile (e.g. number of tracks, track width, kerbs)
- Composition and layer thickness of superstructure (base layer, cover layer)

- Bridges (number, bridge deck area, construction materials, age)
- Tunnels (number, length, construction materials, age)

Assumed values concerning roads are shown in Table 2-2 [Stark et al., 2003].

Table 2-2: Specific masses for different road types

Road type	[Tons per running meter]	[Tons per square meter]
Highways (concrete)	38.1	1.66
Highways (asphalt, bitumen)	44.3	1.93
Main roads	12.4	1.78
State roads	8.6	1.57
Rural roads	5.3	0.95
Forest roads (aspalt, bitumen)	3.5	0.87
Forest roads (gravel)	2.3	0.90
Bicycle tracks	2.4	0.98
Tunnels	15	-

Railways

The following information concerning railways has to be investigated:

- Length of railway system (including tramway)
- Historical development of railway system, average annual change of the railways system's length
- Distribution of singe-track, double-track and multitrack lines
- Composition and layer thickness of base layer
- Number of (overhead line) masts and railway sleepers per kilometre
- Bridges (number, bridge deck area, construction materials, age)
- Composition of an average kilometer of railway line (total mass, share of gravel, rails, sleepers, masts, and so on)
- Mass of single components in kilogram per piece
- Average lifetime
- Number of railway stations (occupied, unoccupied) and train stops (tram stops)

The following values concerning railways are assumed [Glenck et al., 1996], [Stark et al., 2003]:

- Mass of railway system: 2.28 tons per running meter
- Mass of tramway system: 3.52 tons per running meter
- Mass of occupied railway stations: 3,500 tons per station
- Mass of unoccupied railway stations: 3,000 tons per station
- Mass of train or tram stops: 500 tons per stop

Water supply and sewerage systems

The following information concerning water supply system has to be investigated:

- Length of water supply system (feeder lines, distribution network)
- Distribution of different pipe materials and diametres
- Number of house service connections
- Number and volume of water supply reservoirs

The following information concerning sewerage systems have to be investigated:

- Length of sewerage system (sewer lines, gullies)
- Distribution of different pipe materials and diametres
- Number of house service connections
- Number of cesspools
- Number and capacity of water treatment plants

The following values concerning water supply and sewerage systems are assumed [Glenck et al., 1996], [Stark et al., 2003]:

- Mass of water supply lines: 185 kilograms per running meter
- Mass of sewer lines: 130 kilograms per running meter
- Mass of cesspools: 9 tons a piece
- Mass of water treatment plants: 4,000 tons per plant
- Mass of harbours: 3,600 tons a piece

Networks n.e.c.

The following information concerning power and gas supply lines, district heating pipelines, telecommunication lines as well as hydro and thermal power stations have to be investigated:

- Length of networks (lines, cables, pipes) per running meter
- Composition of networks (lines, cables, pipes)
- Distribution of different materials and diameters
- Layout of the networks
- Number of hydro and thermal power stations

The following values concerning networks n.e.c. are assumed [Glenck et al., 1996], [Stark et al., 2003]:

- Mass of power supply lines ranges between 5 and 20 kilogram per running meter
- Mass of gas supply lines ranges between 5 and 50 kilogram per running meter
- Mass of telecommunication lines ranges between 5 and 20 kilogram per running meter
- Mass of district heating pipelines ranges between 5 and 100 kilogram per running meter
- Mass of hydro power plants (including auxiliary buildings): 3 tons per MWh
- Mass of thermal power plants (including auxiliary buildings): 9 tons per MWh

The current stock is calculated by multiplying the number of each infrastructure type with its average mass and summing them up.

Variant 2 for estimating the current stock

To calculate the current stock of this commodity the yearly consumption, which is represented by the reference year 2003, can be taken into account. Required data are collected, adjusted and administrated during the data mining process and published within the “Supply and Use Table Master” for each country. Thus total annual flows into consumption of each commodity are already available from previous data collection activities within the FORWAST project.

As proportion of the annual flow, which is applied as durable component and hence be relevant for building up the stock, 100 % of the input is proposed.

As proposed average lifetime for individual units of this commodity 50 years are indicated. For a more precise and detailed calculation of lifetimes a list of average lifetime data based on literature research is provided in Appendix 1.

The current stock is calculated by multiplying the annual flow of “Infrastructure, excluding buildings”, the percentage of the flow being relevant for the build up of the stock and the average lifetime.

2.4.19 Landfill of waste

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises the dumping of refuse on landfills.

Landfilled amount in 2004: 9,800,000 tonnes (Austria). Regarding a population of 8,175,000 inhabitants (Austria 2004) each citizen produces 1.2 tonnes waste per year which will be landfilled.

Table 2-3: Landfilled waste in Austria (1998-2004)

	Landfilled Waste [mio. t]	Population (Austria) [head]	[tons/head]
1998	7.0	7,976,000	0.9
1999	6.0	7,992,000	0.8
2000	7.9	8,011,000	1.0
2001	7.5	8,043,000	0.9
2002	8.6	8,083,000	1.1
2003	10.5	8,117,000	1.3
2004	9.7	8,174,000	1.2
Total	**57.2**		-

2.4.20 Land application of waste

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises the application of waste on land.

In Austria the agricultural sector produces 32,360,000 tonnes of manure.

In 2004 48,000 tonnes (DM) of sewage sludge were dispensed on agricultural land [BMLFUW, 2006].

2.4.21 Home composting

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises composting activities in private gardens.

Total supply of home composting in Austria is estimated about 800,000 tonnes per year [BMLFUW, 2006]. Regarding the 3,319,000 households in Austria this means that each household in Austria produces 240 kg of compost each year.

2.5 Estimation of historical stocks

In chapter 2.4 current stock quantities are estimated based on the procedure described in chapter 2.2 for all those commodities, which are relevant for stock building activities according to chapter 2.3 and hence are proposed for selection and consideration when mapping the anthropogenic stocks. Based on that in the following chapter default data for the estimation of the historical development of the anthropogenic stock are provided. These default values for stock calculation are open to be adapted, if desired or necessary, e.g. when suitable stock data are available. In chapter 2.6 a description is provided how the composition of individual commodity stocks can be obtained based on the FORWAST materials selected and defined in Deliverable D2-1 [Daxbeck et al., 2008b].

As the assumptions made in chapter 2.2.1 only refer to the current anthropogenic stocks, estimation for the historical accumulated anthropogenic stocks has to be made separately. A possible way of estimating these historical accumulated stocks systematically is provided with the method described in the following chapter. This estimation also considers any variations of quantities and lifetimes of all individual goods within each selected commodity. Default values for the calculation are given in chapter 2.5.

For all selected commodities the following information can be transferred from the investigations for estimating the current stocks as described in chapter 2.2.1:

- Numbers of goods within a selected commodity
- Average weights per individual good within a selected commodity
- Lifetimes of individual goods within a selected commodity

Furthermore the following information is required for each relevant individual good within one commodity:

- Distribution of goods leaving the anthropogenic stock during the lifetime of the product.
- Time variation of the input quantities of each considered good into the anthropogenic stocks within the time frame of the lifetime of the respective good.
- Time variation of average weights of individual goods within the time frame of the lifetime of the respective good.
- Time variation of average lifetimes of individual goods within the time frame of the lifetime of the respective good.

Whenever suitable data on a national level on historical stocks are available, these data should be used. This could be already existing data in mass units of the flow of goods (as parts of the whole commodity) into the stock as well as data of the stock itself.

2.5.1 Example: Historical stock of Residential buildings

To obtain information concerning the historical stock of Residential buildings the following additional data is needed to create a sufficient survey of the historical stock of residential buildings in Austria:

- Existing flats per period of construction
- Average useable surface per flat and period of construction
- Average mass per square meter and period of construction
- Product composition per period of construction

The stock of residential buildings is one of the most important ones in the anthroposphere. Furthermore the construction sector is very dynamic, due to social-demographic and technical circumstances. The people's lifestyle and the construction methods have changed rapidly over the last decades. All these factors do have a tremendous impact on the composition and mass of the stock of residential buildings.

The stock of dwellings in Austria increases from more than 900,000 units in 1869 up to 3,900,000 units in 2001 (see Table 2-5). This tremendous increase is a reflexion of the demographic changes in the last 150 years. The Austrian population increased from 4.5 mio. (1870) to 8,1 mio. inhabitants. All these inhabitants need space for living. Furthermore the lifestyle of the population changes over the years. The spectrum varies from small flats for extended families in the beginning of the 20th century to the single household at the end of the century. This leads to the facts that the useable surface of residential buildings per inhabitant has increased during the last century.

Table 2-4: Stock of buildings in Austria from 1869 until 2001 (including stock changings)

Year	Stock of buildings (Austria)	stock changings [units]	stock changings [%]
1869	562,046		
1880	590,029	+ 27,983	+ 5.0
1890	614,694	+ 24,665	+ 4.2
1900	648,116	+ 33,422	+ 5.4
1910	690,731	+ 42,615	+ 6.6
1923	717,004	+ 26,273	+ 3.8
1934	805,849	+ 88,845	+ 12.4
1951	896,030	+ 90,181	+ 11.2
1961	1,049,953	+ 153,923	+ 17.2
1971	1,259,533	+ 209,580	+ 20.0
1981	1,586,841	+ 327,308	+ 26.0
1991	1,809,060	+ 222,219	+ 14.0
2001	2,046,712	+ 237,652	+ 13.1

But even the way of construction was under the influence of deep going changings - from brick buildings to ferroconcrete buildings. The way buildings are constructed has a direct influence on the mass and lifetime of the building. All this fact has to be taken into account, if the stock of residential buildings is under observation.

Table 2-5: Stock of dwellings in Austria from 1869 until 2001 (including stock changings)

Year	Stock of dwellings	stock changings [units]	stock changings [%]
1869	908,600		
1880	1,027,900	+ 119,300	+ 13.1
1890	1,134,300	+ 106,400	+ 10.4
1900	1,295,700	+ 161,400	+ 14.2
1910	1,466,200	+ 170,500	+ 13.2
1923	1,583,359	+ 117,159	+ 8.0
1934	1,784,434	+ 201,075	+ 12.7
1951	2,138,001	+ 353,567	+ 19.8
1961	2,249,678	+ 111,677	+ 5.2
1971	2,665,942	+ 416,264	+ 18.5
1981	3,052,037	+ 386,095	+ 14.5
1991	3,393,271	+ 341,234	+ 11.2
2001	3,863,262	+ 469,991	+ 13.9

As mentioned before the stock of residential buildings increased from 900,000 to 3,900,000 units within 140 years. The share of flats per period of construction is shown in Figure 2-1. 19 Percent of Austria's flats were built before 1919. The time from 1961 to 1980 was the era in which most of the flats in Austria were constructed (32%). But these facts are not enough to explain the stock of residential buildings in a sufficient way.

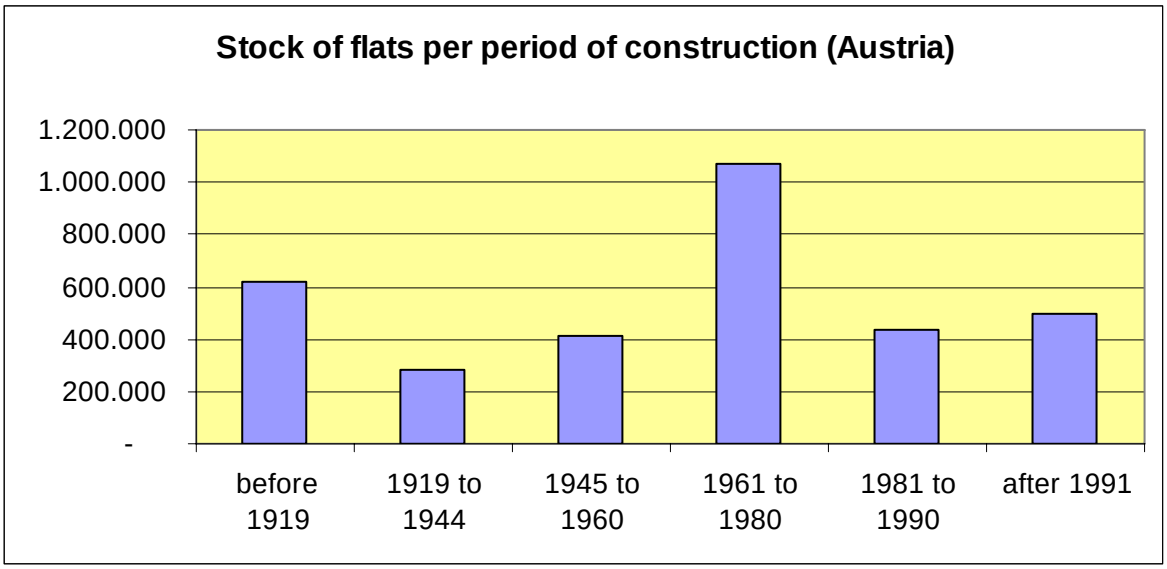

Figure 2-1: Stock of flats in Austria (2001) per period of construction

The next step is to take into account the different average useable surface per dwelling and period of construction. Each era has its own criteria of space of living. In times of war and crisis the average useable surface per dwelling decreased. In times of economical prosperity the average useable surface per unit increased.

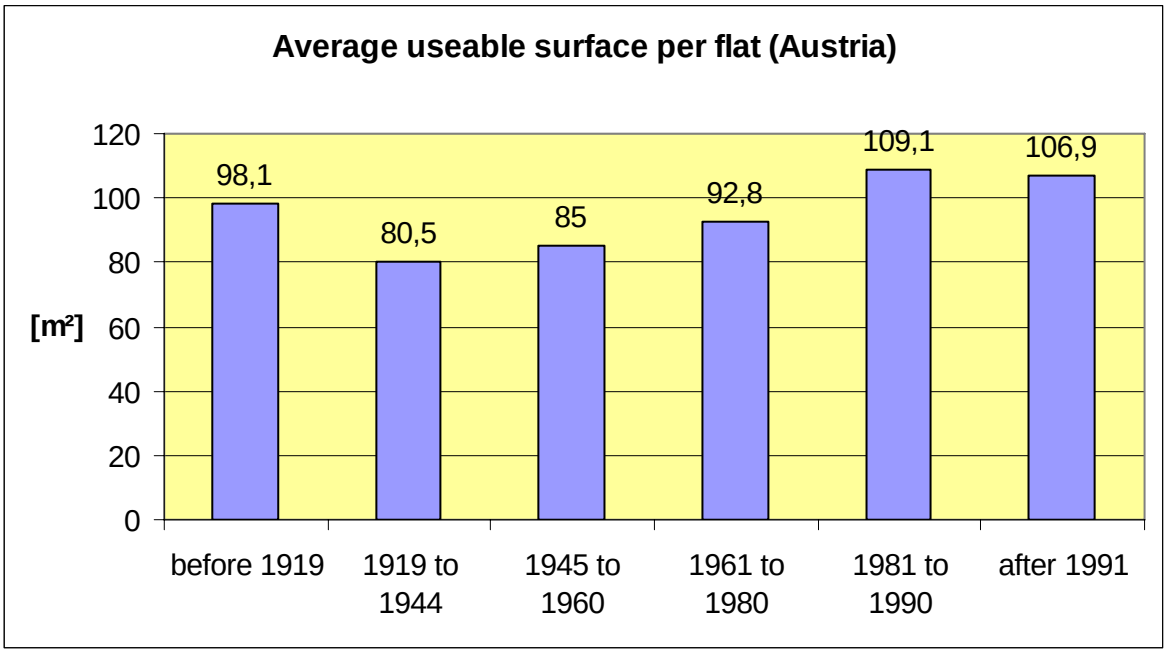

Figure 2-2: Changing in average useable surface per flat in Austria (from before 1919 until after 1991)

It is not wondering that in the era between World War I and II, respectively after World War II, the value of the average useable surface per flat was on the lowest level in the last century. Overall the size per flat ranges from a bit more than 80 m² (1919 to 1944) to 109 m² in the 1980ies.

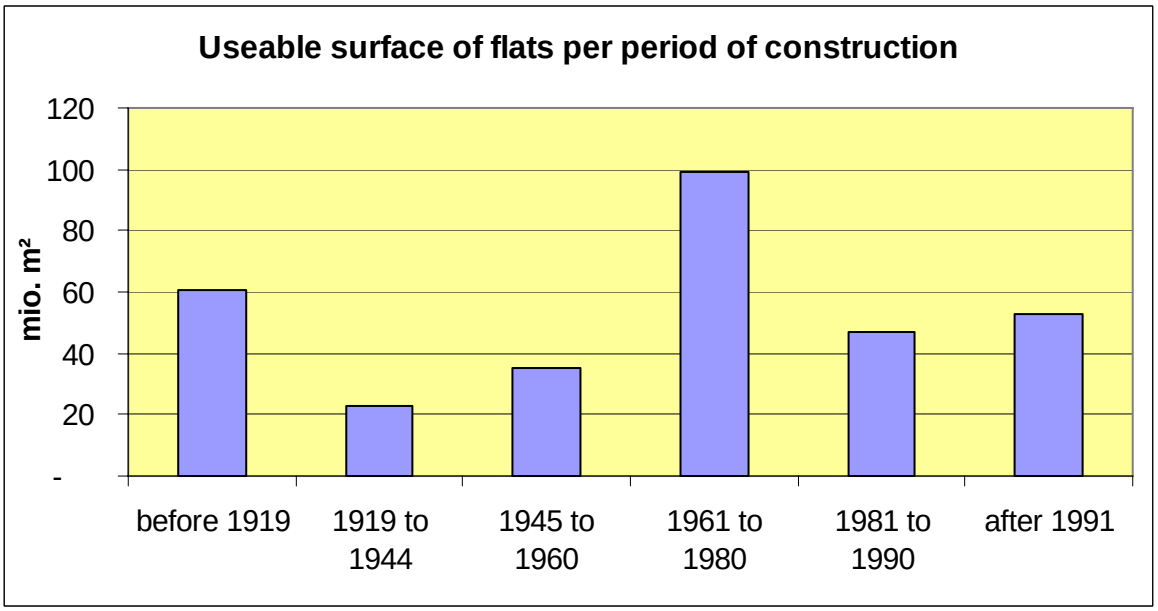

Figure 2-3: Calculated total useable surface (mio. m²) per period of construction (Austria before 1919 until after 1991)

By multiplying the appearance of the flat (per period of construction) with the related average value of the useable surface, the total supply of useable surface can be calculated. The results of this calculation are shown in Figure 2-3.

The last step to obtain a sufficient estimation of the historical stock of residential buildings in Austria is to take into account the different way of construction. As mentioned before the used materials do have a big influence on the mass and lifetime of the building.

The mass per square meter of a residential building varies highly. It is assumed that a building, constructed before 1919, has average value of 9 tons per square meter useable surface (due to superior ceiling heights; usage of stone walls). The lowest level can be observed nowadays (usage of composite building materials; e.g. plasterboard walls). In the last two decades the average mass per square meter varies from 1.5 to 1.8 tons per square meter useable surface.

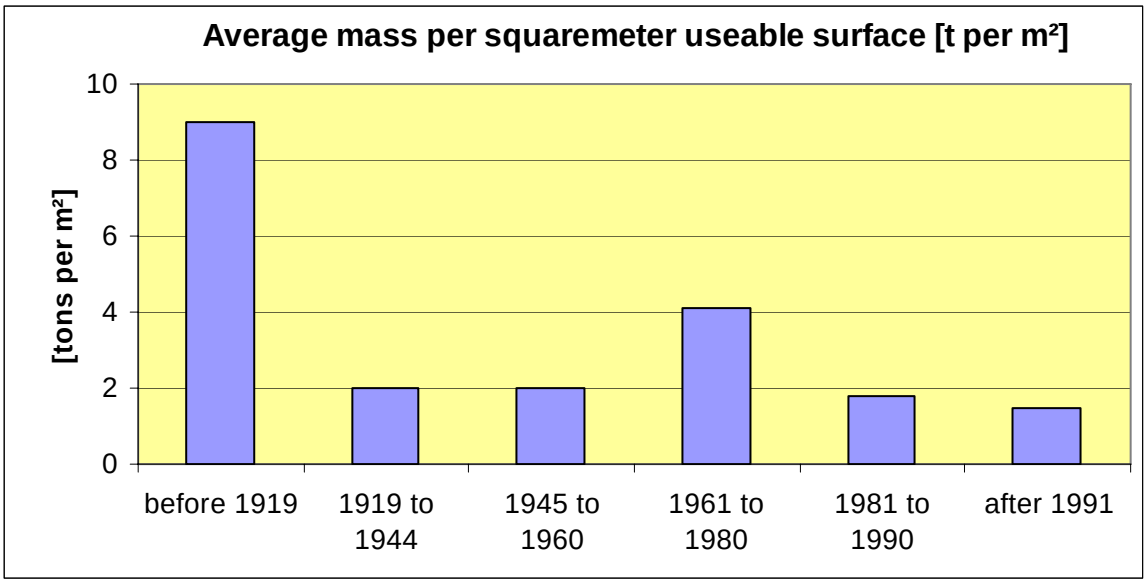

Figure 2-4: Average mass per square meter useable surface per period of construction (Austria before 1919 until after 1991)

Concerning the material composition of residential buildings the following assumption was made due to lack of information. In the best case the material composition of each year should be available. In practice only two points in time concerning the material composition of residential buildings are available. Table 2-6 shows the changing in the construction of residential buildings from 1900 until 1970.

Table 2-6: Material composition of "Residential buildings" in 1900 and 1970

Residential building	1900	1970
Non-ferrous metals	0.1 %	0.2 %
Glass	0.2 %	0.2 %
Plastics	0.3 %	2 %
Iron	0.4 %	2 %
Wood	3 %	9 %
Slags	5 %	0 %

Residential building	1900	1970
Concrete / stone	5 %	46 %
Bricks	86 %	40 %

The amount of used concrete and stone is the most important difference between a building which was build in 1900 and 1970. In the beginning of the 20th century 86 percent of a residential building were made of bricks. In the 1970ies less than the half of the used construction material were bricks. In recent decades it becomes more likely to use concrete and stone instead of bricks. The amount of used concrete and stone increases from 5 percent in 1900 up to 46 percent in 1970. Slags were an important filling material in former days. In the second half of the 20th century slags become more and more unimportant. The amount of wood used in the construction sector increased from 3 percent in 1900 to 9 percent in 1970.

Due to lack of information concerning the material composition of residential buildings nowadays it is assumed, that the material composition of buildings constructed in recent years is similar to buildings constructed in the 1970ies. Buildings constructed before 1970 do have the same material composition like in 1900. If additional data is available this material composition can be adjusted individually.

The last step is to create a time-variable compilation of the changings of the expected average lifetime of the residential buildings. It a assumed that the average lifetime ranges from more than 100 years, in the beginning of the 20th century, to 35 years nowadays.

Table 2-7: Average lifetime of residential buildings in Austria (based on own assumptions)

Austria	before 1919	1919 to 1944	1945 to 1960	1961 to 1980	1981 to 1990	after 1991
average lifetime of residential buildings	100 years	100 years	75 years	50 years	35 years	35 years

Finally all these factors an indicators are put together to obtain a sufficient image of the historical stock of residential buildings in Austria. Table 2-8 shows the results of the historical stock of residential buildings in Austria. The total recent stock of buildings does have a total amount of 1.2 Billion tons. Concerning the era of construction in combination with the total mass, the period before 1919 and the period from 1961 to 1980 are the most important ones. These two periods of construction are own 77 percent of the total stock of residential buildings.

Table 2-8: Factors and indicators to calculate the historical stock of Residential buildings in Austria

Stock of flats (Austria)	before 1919	1919 to 1944	1945 to 1960	1961 to 1980	1981 to 1990	after 1991	*TOTAL*
Austria (2001)	618,452	284,664	415,935	1,070,168	433,067	493,061	***3,315,347***
Relative distribution	19%	9%	13%	32%	13%	15%	
average useable surface per m²	98.1	80.5	85	92.8	109.1	106.9	
useable surface (Total)	60,670,141	22,915,452	35,354,475	99,311,590	47,247,610	52,708,221	***318,207,489***
Mass per m² useable surface [tons]	9	2	2	4.1	1.8	1.5	
Mass of res. buildings	546,031,271	45,830,904	70,708,950	407,177,521	85,045,697	79,062,331	***1,233,856,674***
Average lifetime of residental buildings	100 years	100 years	75 years	50 years	35 years	35 years	

Table 2-9: Time-variable changings in the material composition of residential buildings (Austria) [Schachermayer et al., 2000]

Product composition (Residential buildings)	before 1919	1919 to 1944	1945 to 1960	1961 to 1980	1981 to 1990	after 1991	
Non-ferrous metals	0.001	0.001	0.001	0.002	0.002	0.002	
Glass	0.002	0.002	0.002	0.002	0.002	0.002	
Plastics	0.003	0.003	0.003	0.02	0.02	0.02	
Iron	0.004	0.004	0.004	0.02	0.02	0.02	
Wood	0.03	0.03	0.03	0.09	0.09	0.09	
Slags	0.05	0.05	0.05	0.00	0.00	0.00	
Concrete / stone	0.05	0.05	0.05	0.46	0.46	0.46	
Bricks	0.86	0.86	0.86	0.40	0.40	0.40	
Total	1.00	1.00	1.00	1.00	1.00	1.00	
Non-ferrous metals [t]	546,031	45,831	70,709	814,355	170,091	158,125	***1,805,142***
Glass [t]	1,092,063	91,662	141,418	814,355	170,091	158,125	***2,467,713***
Plastics [t]	1,638,094	137,493	212,127	8,143,550	1,700,914	1,581,247	***13,413,424***
Iron [t]	2,184,125	183,324	282,836	8,143,550	1,700,914	1,581,247	***14,075,995***
Wood [t]	16,380,938	1,374,927	2,121,269	36,645,977	7,654,113	7,115,610	***71,292,833***
Slags [t]	27,301,564	2,291,545	3,535,448	-	-	-	***33,128,556***
Concrete / stone [t]	27,301,564	2,291,545	3,535,448	188,116,015	39,291,112	36,526,797	***297,062,480***
Bricks [t]	469,586,893	39,414,577	60,809,697	164,499,718	34,358,462	31,941,182	***800,610,529***
Total [t]	***546,031,271***	***45,830,904***	***70,708,950***	***407,177,521***	***85,045,697***	***79,062,331***	***1,233,856,674***

2.5.2 Non-residential buildings

Due to lack of information it is assumed that residential and non-residential buildings do have the same material composition over the decades. In opposite to the residential buildings the non-residential buildings have a shorter average lifetime. It is assumed that after 50 years the average non-residential building becomes waste.

Table 2-10: Material composition of current and historical stock "Non-residential buildings"

Material composition Non-Residential buildings	Recent stock	Historical stock
Aluminium		
Fibre carbon	0.09	0.03
Food carbon, (including tobacco)		
Coal carbon		
Crude oil and natural gas carbon	0.02	0.003
Carbonate carbon		
Copper		
Iron	0.02	0.004
Metals, n.e.c.	0.002	0.001
Minerals, n.e.c. (including nitrogen)	0.006	
Oxygen (only in products, but not in H2O)		
Clay and soil		
Sand, gravel and stone	0.862	0.962
Water	0.0	0.00

Table 2-11: Average lifetime "Non-residential buildings"

Average lifetime	Recent stock	Historical stock
Non-residential buildings	50 years	50 years

2.5.3 Infrastructure, excluding buildings

Table 2-12: Material composition of current and historical stock "Infrastructure, excluding buildings"

Material composition Infrastructure	Recent stock	Historical stock
Aluminium	0.001	0.001
Fibre carbon		
Food carbon, (including tobacco)		
Coal carbon		
Crude oil and natural gas carbon	0.006	0.006
Carbonate carbon	0.006	0.006
Copper		
Iron	0.074	0.074
Metals, n.e.c.		

Material composition Infrastructure	Recent stock	Historical stock
Minerals, n.e.c. (including nitrogen)	0.023	0.023
Oxygen (only in products, but not in H2O)	0.022	0.022
Clay and soil	0.052	0.052
Sand, gravel and stone	0.816	0.816
Water	0.0	0.00

Table 2-13: Average lifetime "Infrastructure, excluding buildings"

Average lifetime	Recent stock	Historical stock
Infrastructure	50 years	50 years

2.6 Commodity composition

According to Deliverable D6-4 [Weidema et al., 2008] the "Product material content matrix (Kc)", which is also known as "Product material composition matrix", is the ratio between the mass of a specific material in a product and the total mass of the product. E.g., if 70% of the product "Motor vehicles and trailers" is iron, the entry in the row for the material Fe in the column for the product "Motor vehicles and trailers" should be 0.7.

In opposite to the Resource composition matrix Kr, the Kc-Matrix considers the composition of the commodities, that are sold on the market [Daxbeck et al., 2008c]. Default data for the Kc-Matrix are provided in chapter 5.2 or can be taken out of the *"Supply and Use Table Master".*

If for certain questions the knowledge of the material composition based on the resource flows defined in Deliverable D2-1 [Daxbeck et al., 2008b] is required ("questions on a material level"), these values can be attained by multiplying the results of the stock mapping process with the referring results of the Kc-Matrix shown in chapter 5.2. Equally it can be stated that the share of each material is calculated by multiplying the total commodity mass with the percentage of the specific material. Hence the "Product material composition matrix" serves as base for the calculation of material composition on a resource level.
It is assumed that the composition of certain goods and commodities is constant over time and varies only within a certain, but small range. Therefore the commodity composition are regarded to be constant over time. If data on the alteration of commodity composition with time are available, these values should be taken into account.

3 Case study Austria

In the following chapter the provided methodology for a estimation of stocks is applied by calculation of the current stock of Austria.

3.1 Summary – Current stock Austria (2003)

Table 3-1: Summary of the current stock of Austria (2003)

Code Number	Commodity name	Current stock (2003) [tons]
1	Bovine meat and milk	1,026,000
2	Pigs	480,000
3	Poultry and animals n.e.c.	68,100
36	Printed matter and recorded media	2,890,000
44	Rubber and plastic products	663,000
45	Glass, mineral wool and ceramic goods, virgin	833,600
65	Fabricated metal products, except machinery	498,000
66	Machinery and equipment n.e.c.	954,000
67	Office machinery and computers	82,500
68	Electrical machinery n.e.c.	2,600
69	Radio, television and communication equipment	206,000
70	Instruments, medical, precision, optical, clocks	16,600
71	Motor vehicles and trailers	14,700,000
72	Transport equipment n.e.c.	111,400
73	Furniture; other manufactured goods n.e.c.	4,134,000
78	Buildings, residential	673,200,000
79	Buildings, non-residential	263,460,000
80	Infrastructure, excluding buildings	1,023,000,000
106	Landfill of waste	10,500,000
107	Land application of waste	32,408,000
116	Household, home composting	800,000
	TOTAL	**2,030,033,800**

3.1.1 Bovine meat and milk

In Austria the livestock farming sector owns approximately 2,000,000 cattle (2003). This amount is on a relative constant level. About 685,000 units of cattle were slaughtered in 2003.

Although the livestock of cattle in Austria is slightly declining. Regarding the average weight of cattle (500 kg live weight per head) a total stock total of 1,000,000 tons can be estimated.

Table 3-2: Stock of "Bovine meat and milk" Austria (1995-2003)

Year	Livestock cattle [head](1)	Average weight [1 LSU](2)	Estimated stock [tons]
1995	325,000	500 kg	162,500
1999	2,152,000	500 kg	1,076,000
2003	2,052,000	500 kg	1,026,000

(1) [Statistik Austria, 2006b]
(2) 1 Livestock Unit = 500 kg [Agarmarkt Austria]

3.1.2 Pigs

The Austrian farming sector has an approximately livestock of 3,200,000 pigs (2003). According to the assumption of an average live weight of 150 kg a livestock of 480,000 tons can be calculated. Similar to the livestock of cattle the amount of pigs and swine in Austria is declining in recent years.

Table 3-3: Sock of "Pigs" Austria (1995-2003)

Year	Livestock pigs [head](1)	Average weight [0,3 LSU]	Estimated stock [tons]
1995	3,706,000	150 kg	555,900
1999	3,433,000	150 kg	515,000
2003	3,244,000	150 kg	480,000

(1) [Statistik Austria, 2006b]
(2) [Agarmarkt Austria]

3.1.3 Poultry and animals n.e.c.

In comparison with the farming of cattle and pigs the sector of poultry and animals n.e.c. has a neglectable importance. Poultry and animals n.e.c. have an estimated stock of about 144,000 tons.

The most important subcategory is the poultry, due a huge number of livestock per head. Although the estimated stock is neglectable due to the fact that the average weight per head is on a low level. In Austria other species like sheep, goats, horses and mules are of marginal importance. This may vary from each European country to the other.

Table 3-4: Current stock of "Poultry and animals n.e.c." Austria (2003)

Species	Livestock (2003) [head](1)	Average weight(2)	LSU(3)	Estimated stock [tons]
Hen	1,373,000	7 kg	0.014	9,600
Turkey	367,000	15 kg	0.03	5,500
Sheep	325,000	50 kg	0.1	16,000
Goat	37,000	50 kg	0.1	2,000
Equids (horse, ass, mule, etc.)	87,000	400 kg	0.8	35,000
TOTAL	**-**	**-**	**-**	**68,100**

(1) [Lebensministerium, 2007]
(2) Calculated according to LSU (1 LSU = 500 kg) [Agarmarkt Austria]
(3) According to EUROSTAT

3.1.4 Printed matter and recorded media

Regarding information provided by the Austrian Library Association (OBVSG) 12.5 Mio. books and 0.7 mio. newspapers and journals are stored in Austrian libraries and archives. Assuming that one book has an average weight of 0.5 kg and a newspaper/journal 0.1 kg 6,520 tons of printed media are stored in Austrian libraries and archives.

Table 3-5: Stock of "Printed matter and recorded media" in archives and libraries (Austria 2003)

Libraries/archives	Austria (2009)[1]	Average weight[2]	Estimated stock (tons)
Books	12,900,000	0.5 kg	6,450
Newspaper/journals	700,000	0.1 kg	70
TOTAL			**6,520**

(1) [Die Österreichische Bibliothekenverbund und Service GmbH, 2009]
(2) Based on own assumptions

In comparison to paper stored in households and offices the amount of paper in archives and libraries is neglectable.

Printed matter in private households
- average mass stored in a private household: 250 kg per private household
- number of private households in Austria (2003): 3,319,000

Printed matter in public and company offices
- average mass stored in a public or company office: 5,000 kg per office
- number of company offices in Austria (2001): 396,000
- number of public offices: unknown

Unfortunately there are no statistical values concerning the average amount of used paper in Austrian households and offices. Therefore a device was used to calculate the (annual increase) stock of paper products. The total consumption of paper per year used in Austria is known. This annual consumption subtracted by the amount of waste paper leads to the annual stock increase of paper in Austria. This stock increase seems to be to high for Austria. Due to the fact that nearly one third of Austrian households uses wood as fuel for heating, it was assumed, that 250,000 tonnes of paper are incinerated. In the end the total annual stock increase is 289,000 tonnes of paper, 14 percent of the total paper consumption.

Table 3-6: Stock build-up of "Printed matter and recorded media"

	Austria [t]
Paper consumption (2005)[1]	**2,048,000**
Supply of waste paper[2]	**1,509,000**
Originate from private households	*601,000*
Originate from Industry	*756,000*
Waste paper in residual waste	*152,000*
Incineration at home (for heating)[3]	**250,000**
Stock increase of paper (per year)	**289,000**

(1) [Austropapier, 2003]
(2) [BMLFUW, 2006]
(3) Based on own assumptions

The estimated lifetime of paper in households and offices (especially books and files) is expected at 15 years. This leads to a total stock of nearly 3 mio. tonnes of paper in Austria.

Table 3-7: Current stock of "Printed matter and recorded media" Austria 2003

	Austria Yearly stock increase of paper [t]	Estimated lifetime(1)	Estimated stock [t]
Stock of paper	**289,000**	**10 years**	**2,890,000**

(1) Based on own assumptions

3.1.5 Rubber and plastic products

Tyres and tubes are the most important commodities consisting of rubber and plastic. Other necessities, which are made of rubber and plastic are packaging materials, kitchenware, tableware and toilet articles. To calculate the number of tyres used in Austria the stock of tyres is needed. With this total number of tyres in use (approximately 24.000.000) and the average weight of one tyre (8 kg) [Baccini et al., 1993] the total stock of tyres can be calculated. In Austria approximately 5 mio. vehicles use 23 mio. tyres with an estimated weight of 190.000 tons.

Table 3-8: Current stock of tyres (Austria 2003)

Vehicle	Stock of vehicles	Tyres per vehicle	Total tyres in use	Average weight per tyre(1)	Estimated stocks of tyres [t]	Average lifetime [years](2)	Potential of waste [tons/year]
Passenger car	4,054,000	4 (+1)	20,270,000	8 kg	162,000	4	40,500
Truck/lorry	326,000	6 (+1)	2,282,000	8 kg	18,000	4	4,500
Motorcycle	607,000	2	1,214,000	8 kg	9,700	4	2,400
TOTAL			**23,766,000**		**189,700**		**47,400**

(1) [Baccini et al., 1993]
(2) Based on own assumptions

Table 3-9: Current stock of plastics in vehicles (Austria 2003)

Vehicles	Absolute appearance[1] [pieces]	Estimated stock [tons]	Average amount of plastics[2] in vehicles	Stock of plastics in vehicles [t]	Average lifetime (see vehicles) [years]	Potential of waste [tons/year]
Passenger cars	4,054,000	6,081,000	4.5 %	274,000	6	45,000
Trucks, Lorries	326,000	3,260,000	4.5 %	147,000	9	16,000
Motorcycles	607,000	121,000	4.5 %	5,000	7	700
Other vehicles	519,000	1,038,000	4.5 %	47,000	12	4,000
TOTAL	**5,506,000**	**10,500,000**		**473,000**		**65,700**

[1] [Fachverband der Fahrzeugindustrie, 2008]

[2] [Baccini & Brunner, 1991]

Regarding other plastics components, except tyres, vehicles consist of 473,000 tonnes of plastics in Austria. Overall the stock of plastic is nearby 663,000 tonnes.

3.1.6 Glass, mineral wool and ceramic goods

The calculation of glass in Austria's society is made under following assumptions. Packaging glass has an average lifetime less than 1 year. Due to that only the stock-building part of the glass industry should be taken into account. Lower Austria's building law constitutes that 10 percent equivalent of the useable surface of a building should be window area. Under this permission, the useable surface of Austria's residential and non-residential buildings and an average weight per square meter glass the stock of glass in Austria can be calculated.

Table 3-10: Current stock of window glass in "Residential buildings" (Austria 2003)

Austria 2003	Useable surface [1,000m²]	Window area [1,000m²][(1)]	Mass per m² glass [kg][(2)]	Estimated stock [tons]	Average lifetime [years][(3)]	Potential of waste [tons/year]
Residential buildings	292,520	29,252	5	146,260	15	9,700

(1) Based on own assumption according to the building law of Lower Austria; the window area of residential buildings has to be at minimum 10 percent of the useable surface.
(2) Based on own assumptions
(3) Based on own assumptions (5 kg per m² sheet glass; estimated thickness: 2 millimeter)

Table 3-11: Current stock of window glass in "Non-residential buildings" (Austria 2003)

Non-Residential buildings	Useable surface [1,000m²]	Window area [1,000m²][(1)]	Mass per m² glass[(3)]	Estimated stock [tons]	Average lifetime [years][(4)]	Potential of waste [tons/year]
Hotels or similar buildings	9,200	920	5	4,600	15	306
Office buildings	39,500	3,950	5	18,250	15	1,216
Wholesale and retail						
Traffic and communication	18,100	181[(2)]	5	905	15	60
Leisure, Sports, Culture and Health						
Factory buildings, depots	58,000	580[(2)]	5	2,900	15	193
Other	52,000	520[(2)]	5	2,600	15	173
TOTAL	**176,800**	**6,151**		**29,255**		**1,948**

(1) Due to the fact that these types of non-residential buildings do have a similar design like the residential buildings it is assumed, that the window area is 10 percent of the useable surface.
(2) Due to a different usage of these building it is assumed that only 1 percent of the usable surface become window area.
(3) Based on own assumptions (5kg per m² sheet glass; estimated thickness: 2 millimeters)
(4) Based on own assumption

Table 3-12: Average mass of glass per inhabitant (Austria 2003)

Austria 2003 – Stock of Glass	Estimated stock [tons]	Population (Austria 2003)	Stock of Glass per inhabitant [t]
	146,200	8,012,000	0.018

Table 3-13: Average mass of glass per household (Austria 2003)

Austria 2003 – Stock of Glass	Estimated stock [tons]	Households (Austria 2003)	Stock of Glass per household [t]
	146,200	3,319,000	0.044

If the partners do not obtain the average useable surface of their buildings it is assumed, that one inhabitant owns 18 kg of glass.

Table 3-14: Current stock of ceramic goods in households (Austria 2003)

Austria 2003 – Stock of ceramic goods	Number of households	Average mass per household (plumbing unit)	Stock of ceramic goods (households)
Households	3,319,000	150 kg	498,000

Table 3-15: Current stock of ceramic goods in working places (Austria 2003)

Austria 2003 – Stock of ceramic goods	Number of employees[1]	plumbing unit[2] per each 15th employee	Stock of ceramic goods (working place)
Working place	3,793,000	50 kg	12,600

[1] [Statistik Austria, 2009b]
[2] one plumbing cell for every 15th employee written down in Austrian Law; http://www.arbeitsinspektion.gv.at/AI/Arbeitsstaetten/Sozialeinrichtungen/sozial030.htm

3.1.7 Fabricated metal products, except machinery

Due to lack of information concerning this commodity group following assumptions were made. Commodities like cutlery and tools do have a neglectable mass concerning this group of products. Only the use of radiators and the according pipe system was regarded. The assumption was made, that one radiator heats 15 square meters on average. Regarding the average size on an Austrian flat (~85 m²) this means that each household uses 5 to 6 radiators for heating. Assuming that each radiator and its according pipe system do have an average mass of 25 kg the total stock of fabricated metal products is about 150 kg per household. This leads to an approximately stock of 500,000 tons.

Table 3-16: Assumption concerning the heating radiators in households (Austria)

Austria 2003 – Stock of fabricated metal products	Average weight [1]	Average appearance	Average size of an Austrian flat	Used radiators	Average mass per household
Heating radiators (incl. pipe system)	25 kg	1 radiator per each 15 m² living space	85 m²	5-6 pieces	150 kg

[1] Based on own assumptions

Table 3-17: Current stock of "Fabricated metal products, except machinery" (Austria 2003)

Austria 2003	Average mass per household [kg] [1]	Number of Austrian households [2003]	Accumulated stock [tons]	Average lifetime	Potential of waste [tons]
Fabricated metal products	150	3,319,000	498,000	25	20,000

[1] Based on own assumptions

3.1.8 Machinery and equipment n.e.c.

In industrial countries private households own a lot of electrical machinery to alleviate the everyday life and advance the comfort of living. Due to the relative high weight and high lifetime expectation household appliances are an important stock within the anthroposphere. In Austria 764,900 tons of appliances are in use in Austrian private households (2003).

Regarding the total mass the washing machines are the most relevant household appliance. Nearly every household owns a washing machine. The total stock is 226.000 tonnes, a quarter of the overall stock of machinery and equipment.

Table 3-18: Current stock of household appliances (Austria 2003)

Austria 2003	Appliances per household	Appliances	Mass / Appliance	useful life[3]	accumulated stock	potential of waste
	[Piece/household]	[Piece]	[kg/piece]	[years]	[tons]	[tons/year]
Washing machine	0.95	3,114,100	75	15	233,558	15,571
Refrigerator	1.15	3,769,700	50	15	188,485	12,566
Electric stove	1.00	3,278,000	60	20	196,680	9,834
Freezer	0.74	2,425,720	50	15	121,286	8,086
Dishwasher	0.57	1,868,460	50	15	93,423	6,228
Mircowave oven	0.64	2,097,920	23	10	48,252	4,825
Laundry dryer	0.37	1,212,860	60	15	72,772	4,851
TOTAL		**17,766,760**			**954,455**	**61,961**

(1) [Statistik Austria, 2009a]
(2) [Statistik Austria, 2008] number of households in Austria 3,278,000 (2003)
(3) [Hausmann, 2005]

3.1.9 Office machinery and computers

The development of historical stock of machinery and equipment n.e.c. depends on many different indicators and changing basic conditions. To calculate the stock of additional information of the following indicators (and there changing of years) are needed:

- Population development
  - increasing, statical or declining population
- Development of the size and composition of households
  - Average size of a household
- Average appliances per household
  - level of appliances used by households
- Mass per appliance
  - changes in mass per appliance due to technical development
- Useful life time per appliance
  - changes in life time per appliance due to technical development

As mentioned before these indicators vary highly due to demographic, socio-cultural and technical basic conditions. To ease the data mining RMA provides indicators to calculate the accumulated stock based on the Austrian national economy. If necessary, these indicators can be adjusted country by country to take differences in the timeline and social-economic development into account. So each partner is invited to change these indicators due to additional information regarding the country they are working on.

Table 3-19: Current stock of "Office machinery and computers" (Austria 2003)

Office machinery and computers	Relative appearance	Absolute appearance	Average weight[2]	Estimated stocks of office machinery and computers [tons]
PC (workstations)	98.5 % (2006)[6]	390,000[4]	10 kg	3,900
Computer screen	73 %	2,423,000	20 kg	48,500
Personal computer	73 %	2,423,000	10 kg	24,200
Notebook	12 %	398,000	6 kg	2,400
Fax machine	21 %	697,000	5 kg	3,500
TOTAL				**82,500**

(1) [Statistik Austria, 2008]number of households in Austria 3,241,000 (1999/2000)
(2) based on [Hausmann, 2005]
(3) [Statistik Austria, 2008] number of households in Austria 3,319,000 (2003)
(4) [Statistik Austria, 2004a] number of workstation in Austria (2003): 396,000
(5) [Statistik Austria, 2009a]
(6) [Statistik Austria, 2006a]

As shown in Figure 3-1 the stock of household appliance in Austria is increasing since 1974. Only the stock of gas ovens is decreasing through the last decades. This calculation is based on the assumption that only the absolute number of households and the number of appliances per household vary over the decades. Information concerning the use of appliances in private households is obtained from the microcensus provided by Statistik Austria.

The average mass and life time per appliance remains untouched. It is the partner's choice to change these technical and socio-economical preconditions.

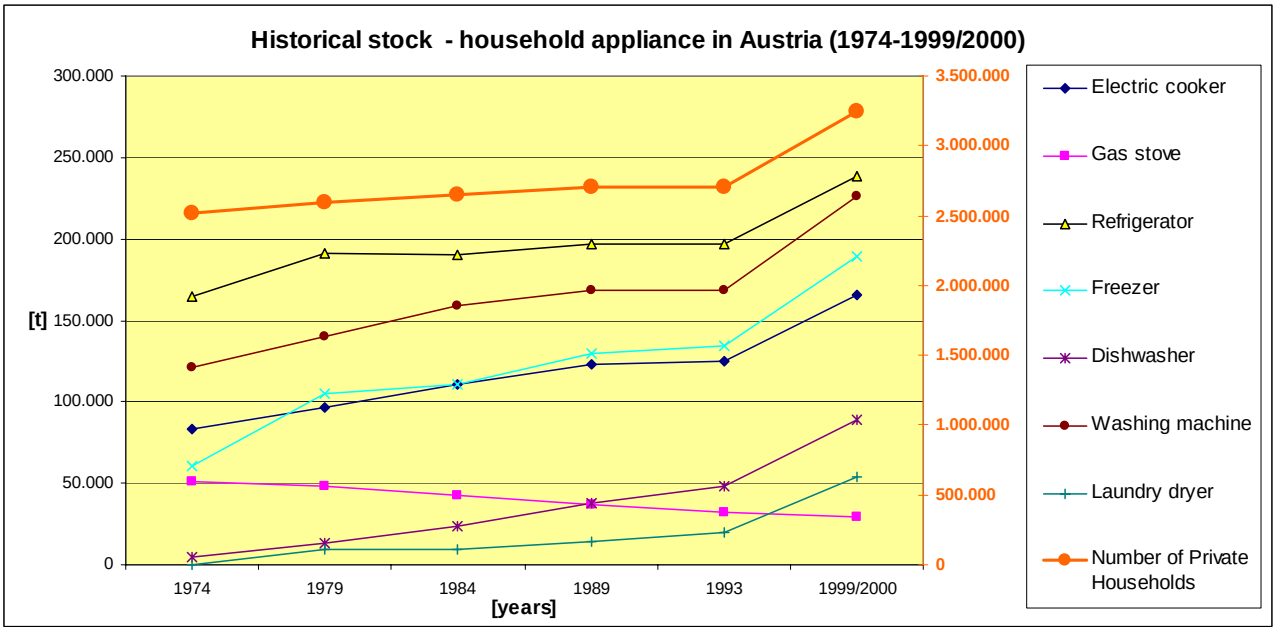

Figure 3-1: Historical stock – household appliance in Austria (1974-1999/2000)

3.1.10 Electrical machinery n.e.c.

Concerning private households in Austria a stock of 66 million lamps is assumed. This leads to an average amount of 0.75 kg of illuminant equipment stored in private households. Unfortunately there is no data concerning the use of illuminants within the industrial and commercial sector. Due

to this lack of information the following hint was chosen to obtain a first reliable assumption. The first step is to calculate the average area which is illuminated by one light source. Within 3,319,000 households in Austria 66 million light sources illumate an area of 292,000,000 square meter. This indicates that one light source illuminates an average area of 4.4 square meters. Assuming that industrial and commercial buildings do have the same level of illumination, approximately 40 million light sources are used in industrial and commercial buildings. Overall about 106 million light sources are in use in Austria.

Table 3-20: Current stock of illuminations (Light bulbs and energy-efficient lamps) (Austria 2003

Illuminations private households	Stock [piece][1]	Mass per piece[2]	Stock of illuminants [t]	Average lifetime
Light bulb	58,000,000	30 grams	1,740	1 year
Fluorescent lamps / Energy-efficient lamp	8,000,000	90 grams	720	4-10 years
TOTAL	**66,000,000**		**2,640**	

[1] http://www.energiejoker.de/042f439b750d5660f/042f439b760cfc926/042f439b770a1b801/index.html
[2] [Obermoser & Rechberger, 2008]

Table 3-21: Number of used light sources (Residential and Non-residential building) (Austria 2003)

Buildings Austria	Useable surface [m²]	Used light sources [piece]	Average area illuminated by one light source
Residential buildings	292,520,000	66,000,000	4.4 m²
Non-residential buildings	176,800,000	40,000,000	4.4 m²
TOTAL	**469,320,000**	**106,000,000**	

3.1.11 Radio, television and communication equipment

Table 3-22: Current stock of "Radio, television and communication equipment" (Austria 2003)

Austria 2003	Appliances per household[1]	Appliances[1]	Mass per Appliance[2]	Average lifetime[2]	accumulated stock	potential of waste
	[Piece/household]	[Piece]	[kg/piece]	[years]	[tons]	[tons/year]
Television	1.46	4,785,880	30	10	143,576	14,358
Hi-Fi system	0.85	2,786,300	10	10	27,863	2,786
Video recorder	0.81	2,655,180	5	8	13,276	1,659
Radio	1.56	5,113,680	2	10	10,227	1,023
CD-Player	0.88	2,884,640	2	10	5,769	577
DVD-Player	0.32	1,048,960	5	8	5,245	656
Camcorder (digital)	0.08	262,240	0.8	8	210	26
TOTAL					**206,166**	**21,085**

[1] [Statistik Austria, 2009a]
[2] [Hausmann, 2005]

Table 3-23: Temporal development of the supply of household appliances (in tons) (Austria 1974-1999/ 2000); Source: [Statistik Austria, 2009a]

Household appliance (historical changing stock)	1974	1979	1984	1989	1993	1998	1999/2000
Television	8,324	34,312	48,447	71,462	73,871	93,219	94,322
Hi-Fi system	0	260	927	4,196	5,682	10,091	10,858
Video recorder	0	0	0	677	1,353	2,563	2,755
Radio receivers/recorder	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
CD/DVD-Player or recorder	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Line Telephony	318	483	627	707	714	n.a.	846
Mobile phones	0	0	0	0	11	n.a.	194

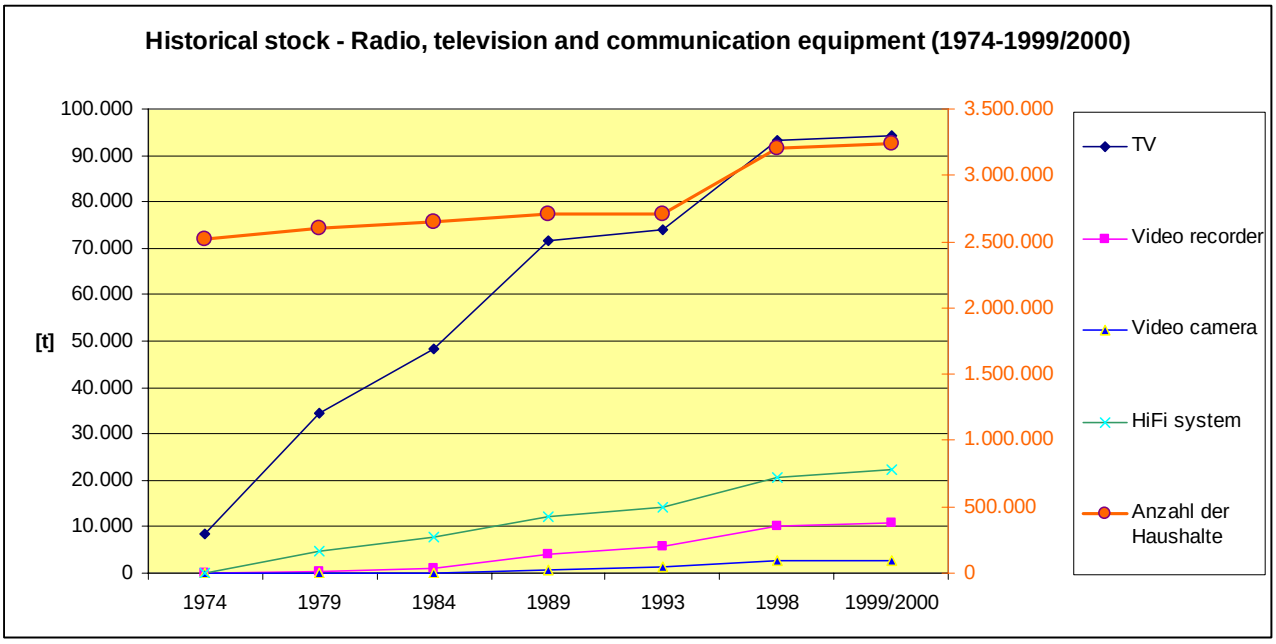

Figure 3-2: Historical stock – Household appliances (Austria 1974-1999/2000)

3.1.12 Instruments, medical and precision, optical, clocks

Due to lack of information concerning this group of commodities the following assumption was made. The average household in Austria uses 5 kg of instruments, medical, precision, optical appliances and clocks. Furthermore the average lifetime of the commodities in this group is very unequal. Because of that it was assumed that the average lifetime of this commodity group is 5 years. Regarding the amount of mass the stock of instruments, medical, precision and optical appliances are neglectable. The total stock within Austria is 16,600 tons.

Table 3-24: Current stock of "Instruments, medical and precision, optical, clocks" (Austria 2003)

Stock Austria (2003)	Number of households	Average mass per household [1] [kg]	Accumulated stock [tons]	Average lifetime	Potential of waste [tons]
Instruments, medical, and so on	3,319,000	5	16,600	5 years	3,300

Based on own assumptions

3.1.13 Motor vehicles and trailers

The stock of vehicles in Austria is one the most increasing goods in the whole national economy. The number of vehicles in Austria increased from 259,000 in 1950 to more than 5,500,000 in 2003. An accumulation of more than 20 times.

The development of historical stock of motor vehicles and trailers depends on many different indicators and changing basic conditions. To calculate the stock of additional information of the following indicators (and there changing of years) are needed:

- Population development
  - increasing, statical or declining population
- Mass per appliance
  - changes in mass per appliance due to technical development
- Useful life time per appliance
  - changes in life time per appliance due to technical development

As mentioned before these indicators vary highly due to demographic, socio-cultural and technical basic conditions. To ease the data mining RMA provides indicators to calculate the accumulated stock based on the Austrian national economy. If wanted, these indicators can be adjusted country by country to take differences in the timeline and social-economic development into account. Each partner is invited to change these indicators due to additional information regarding the country they are working on.

Table 3-25: Current stock of vehicles (Austria 2003)

Vehicles	Absolute appearance[(1)] [pieces]	Average weight[(2)]	Estimated stock [tons]
Passenger cars	4,054,000	1,500 kg	6,081,000
Trucks, Lorries	326,000	10,000 kg	3,260,000
Motorcycles	607,000	200 kg	121,000
Other vehicles	519,000	10,000 kg	5,190,000
TOTAL	**5,506,000**		**14,682,000**

(1) [Fachverband der Fahrzeugindustrie, 2008]
(2) [Daxbeck et al., 2006]

Table 3-26: Stock build-up of vehicles (Austria 1950-2003)

Vehicles – stock build-up	1950	1960	1970	1980	1990	2003
Vehicles [units] Austria	259,000	1,311,000	2,201,000	3,384,000	4,240,000	5,506,000
Index (1950 =100)	100	506	849	1,306	1,637	2,125

Table 3-27: Density of motor vehicles per 1.000 inhabitants (Austria 1950-2003)

Density of motor vehicles Austria (1950-2003)	1950	1960	1970	1980	1990	2003
Passenger cars per 1.000 inhabitants	7	57	160	298	390	505

Table 3-28: Vehicles – stock build-up (Austria 1990-2003)

Vehicles – stock build-up	1990	2003
Vehicles [units] Austria	4,240,000	5,506,000

Vehicles – stock build-up	1990	2003
Index (1990 =100)	100	130
Average weight	1,000 kg	1,500 kg
Average lifetime	9 years	9 years
Accumulated stock [t]	4,240,000	8,259,000
Index (1990 = 100)	100	187

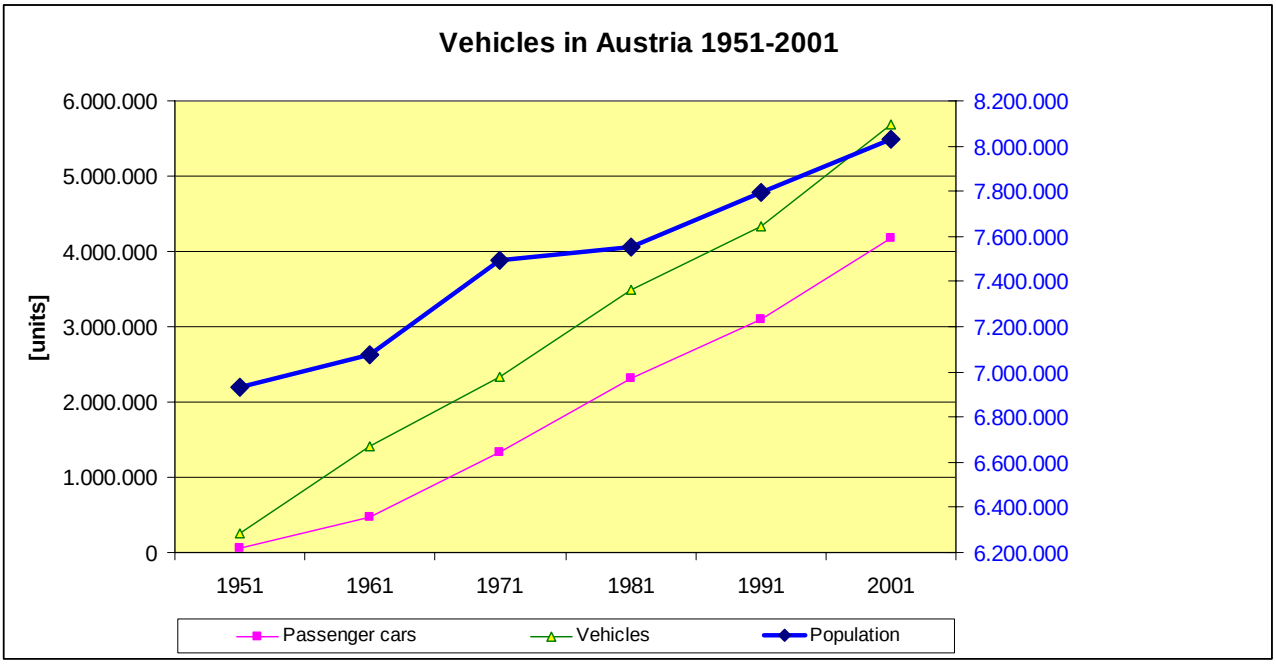

Figure 3-3: Vehicles in Austria (1951-2001)

Table 3-29: Current stock of motor vehicles (Austria 2003)

Austria 2003	Motor vehicles(1)	Mass per Vehicle	Average lifetime	accumulated stock	potential of waste
	[Piece]	[kg/piece]	[years]	[tons]	[tons/year]
Passenger car	4,054,308	1,500	6	6,081,462	1,013,577
Truck/lorry	354,852	10,000	9	3,548,520	394,280
Motorcycle	589,076	200	7	117,815	16,831
Other vehicles	420,103	10,000	12	4,201,030	350,086
TOTAL	**5,418,339**			**13,948,827**	**1,774,774**

(1) [Fachverband der Fahrzeugindustrie, 2008]

The material composition, average weight and lifetime of vehicles have changed tremendous over the last decades. The indicators provided in table should be understood as starting point for a further going research. Each partner is invited to adjust these indicators.

3.1.14 Transport equipment n.e.c.

Table 3-30: Current stock of railways in Austria (2003)

Railways	Absolute appearance[1] [pieces]	Average weight[2]	Estimated stock [tons]	Average Lifetime [years]	Potential of waste [tons/years]
Rail car	290	100 tons	29,000	25	1,160
Carriage	3,128	25 tons	78,200	25	3,130
Baggage car	107	25 tons	2,700	25	100
Mail car	20	25 tons	500	25	20
TOTAL	**3,545**		**111,400**		**4,410**

[1] [Österreichische Bundesbahnen, 2007]
[2] Based on own assumptions

Table 3-31: Current stock of airways in Austria (2003)

Airways	Absolute appearance[1] [pieces]	Average weight[2]	Estimated stock [tons]	Average lifetime [years][3]	Potential of waste [tons/year]
Airliner	88	250 tons	**22,000**	21	1,050

[1] [Austrian Airlines, 2003]
[2] Based on own assumptions
[3] [Bundesministerium der Finanzen, 2000]

3.1.15 Furniture, other manufactured goods n.e.c.

The assumptions was made that each inhabitant gains furniture and other manufactured goods with an average weight of 516 kg [Hutter, 2001]. This amount has no significant variance over decades and socio-economical circumstances, i.e. that it is unrational to gain more than one bed per person. Due to that fact, the stock of furniture correlates directly with the development of the population. Of course, the composition of the furniture, the used materials vary highly. But only the total mass of the stock is under observation.

In the case of Austria the population increased from 7,047,000 inhabitants in 1960 to 8,118,000 inhabitants in 2003. This increase of 15 percent concerning the population goes hand in hand with the rising stock of furniture. In 1960 Austrian population gains 3.5 mio tonnes of furniture. In 2003 this amount increased to more than 4 mio. tonnes.

Table 3-32: Current and historical stock of "Furniture, other manufactured goods n.e.c."

Furniture – historical stock	1960	1970	1980	1990	2003
Inhabitants in Austria	7,047,000	7,467,000	7,549,000	7,678,000	8,012,000
Furniture per capita [kg] [1]	516	516	516	516	516
Accumulated stock [t]	3,636,000	3,853,000	3,895,000	3,961,000	4,134,000

[1] [Hutter, 2001]

If necessary the indicator (furniture per capita) can be adjusted individually, due to changes over decades in the usage and/or composition of furniture and other manufactured goods.

3.1.16 Residential buildings

The construction sector is the most important stock building anthropogenic activity regarding the mass balance. Due to the complex and changing composition of buildings and a long lifetime the stock of buildings is a very inhomogenous sector. The period of construction implies a lot of information concerning the used the materials and the expected lifetime. In 2001 a bit more than 2 mio. buildings, residential and non-residential, were counted. Nearly 1.7 mio. buildings are used for residential aspects. The estimated stock of residential buildings in Austria (2001) is about 673 mio. tonnes. More than three thirds of these buildings were built after 1945. The number of buildings increased of 60 percent during the period from 1971 to 2001.

Table 3-33: Share of residential buildings per number of accommodation units (Austria 2003)

Residential buildings	1 to 2 accommodation units	3 to 10 accommodation units	11 an more accommodation units	companies	Total
Austria (2001)	1,560,000	140,000	62,000	3,500	1,765,500
In %	*88 %*	*8 %*	*3.5 %*	*0.5 %*	*100 %*

Source: Gebäude und Wohnungszählung 2001 – Hauptergebnisse Österreich

Table 3-34: Share of residential buildings per year of construction (Austria < 1919 to 2001)

Residential buildings – Period of construction	Before 1919	1919 to 1944	1945 to 1960	1961 to 1980	1981 to 1990	1991 to 2001
Austria	353,000	176,000	253,000	619,000	296,000	348,000
In %	*17.2 %*	*8.6 %*	*12.4 %*	*30.3 %*	*14.5 %*	*17 %*
	Until 1945		**After 1945**			
Austria	529,000		1,516,000			
In %	*25.9 %*		*74.1 %*			

[Statistik Austria, 2004b]

Table 3-35: Stock of residential buildings (Austria 2003)

Residential buildings Austria 2003	Flats [units]	Useable surface [1.000m²]	Mass per area [t](1)	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
1 to 2 accommodation units	1,553,000	176,000	2.3	405,000,000	100	4,050,000
3 to 10 accommodation units	694,000	51,000	2.3	117,000,000	100	1,170,000
11 and more accommodation units	977,000	65,000	2.3	150,000,000	100	1,500,000
companies	12,000	520	2.3	1,200,000	100	12,000
TOTAL	**3,236,000**	**292,520**	**2.3**	**673,200,000**		**6,732,000**

[Stark et al., 2003]
[Statistik Austria, 2004b]

Table 3-36: Stock build-up residential buildings (Austria 1971 to 2001), index-based

Historical stock – buildings (Austria)	1971	1981	1991	2001
Buildings [units]	1,281,000	1,587,000	1,809,000	2,046,000
Index (1971 = 100)	100	124	141	160

[Statistik Austria, 2004b]

Table 3-37: Stock build-up residential buildings (Austria 1919 to 2001); index-based

Historical stock – buildings (Austria)	1919	1945	1960	1980	2001
Buildings [units]	353,000	529,000	1,401,000	1,697,000	2,046,000
Index (1919 = 100)	100	150	397	481	579

[Statistik Austria, 2004b]

3.1.17 Non-residential buildings

The sector of non-residential buildings is very inhomogenous concerning the occupancy, design and measures. This group consists of hotels, office buildings, depots and buildings for wholesale, retail, communication, etc.. All together the non-residential buildings have an accumulated stock of 248 mio. tonnes; one third of the stock of residential buildings.

Table 3-38: Stock of Non-residential buildings (Austria 2003)

Non-Residential buildings	Austria 2001[1] [units]	Useable surface [1.000m²]	Tons per m²(2)	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
Hotels or similar buildings	36,000	9,200	2.3	21,160,000	50	423,200
Office buildings	32,000	39,500	2.3	90,850,000	50	1,817,000
Wholesale and retail	33,000					
Traffic and communication	4,000	18,100	2.3	41,630,000	50	832,600
Leisure, Sports, Culture and Health	15,000					
Factory buildings, depots	72,000	58,000	1.9	11,020,000	50	220,400
Other	90,000	52,000	1.9	98,800,000	50	1,976,000
TOTAL	**282,000**	**176,800**		**263,460,000**		**5,269,200**

(1) [Statistik Austria, 2004b]
(2) [Stark et al., 2003]

3.1.18 Infrastructure, excluding buildings

The sector of infrastructure consists of networks, which are mainly used by traffic, energy and water supply. The road network is the most important part of the infrastructure, regarding the mass. More than 1 billion tonnes, mainly sand, gravel and stone, are used in the existing road network of Austria. In comparison to this amount the stock of the railways (14 mio. t) is negelectable. It is obvious that the material

Table 3-39: Stock of road network (Austria 2003)

Road network	Running meter(1) [km]	Tons per running meter(2) [tons per m]	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
Highways	1,999	38.1	76,000,000	19	4,000,000
State road	24,605	8.6	212,000,000	19	11,000,000
Rural road	83,000	5.3	440,000,000	19	23,000,000
Forest roads (gravel)	127,000	2.3	292,000,000	19	15,000,000

Road network	Running meter[(1)] [km]	Tons per running meter[(2)] [tons per m]	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
Tunnels	208	15	3,000,000	19	160,000
TOTAL			**1,023,000,000**		**53,160,000**

(2) [Stark et al., 2003]

Table 3-40: Stock of railroad network (Austria 2003)

Railroad network	Running meter [km]	Tons per running meter[(2)]	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
Tracks	5,656[(1)]	2.28	12,900,000	50	258,000
Tramway	512.5	3.52	1,800,000	50	36,000
Vienna	*201 (Subway) 227 (Tramway)*	*3.52*	*1,500,000*	*50*	*30,000*
Graz	*44*	*3.52*	*155,000*	*50*	*3,100*
Linz	*21*	*3.52*	*74,000*	*50*	*1,480*
Innsbruck	*19,5*	*3.52*	*69,000*	*50*	*1,380*
TOTAL			**14,000,000**		**329,960**

(1) [Österreichische Bundesbahnen, 2007]
(2) [Glenck et al., 1996]

Table 3-41: Stock of other networks (Austria 2003)

Networks	Running meter [km]	Tons per running meter[(2)]	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
Water supply	32,000	0,185	5,920,000	50	118,400
Sewerage	28,000	0,13	3,640,000	50	72,800
District heating	2,950	0,1	295,000	50	5,900
Electricity	340,000	0,02	6,800,000	50	136,000
Gas pipelines	25,000	0,025	625,000	50	12,500
Other networks (telecommunication, etc.	185,000	0,02	3,700,000	50	74,000
TOTAL			**20,980,000**		**419,600**

[Glenck et al., 1996]
[Stark et al., 2003]

Table 3-42: Stock of power plants (Austria 2003)

Power plants	Capacity[(1)] [MWh]	Tons per MWh[(2)]	Estimated stock [tons]	Average lifetime [years]	Potential of waste [tons/year]
Thermic power plant	815	9	7,300	50	150
Hydroelectric power plant	5.300	3	15,900	50	300
TOTAL			**23,200**		**450**

(1) Source: Verbund http://www.verbund.at/cps/rde/xchg/internet/hs.xsl/index.htm
(2) [Glenck et al., 1996]

3.1.19 Landfill of waste

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises the dumping of refuse on landfills.

In 2004 about 9,800,000 tonnes of waste were landfilled in Austria. Regarding 8,175,000 inhabitants (Austria 2004) this leads to 1.2 tonnes landfilled waste per inhabitant.

Table 3-43: Landfilled waste in Austria (1998-2004)

	Landfilled Waste [mio. t]	Population (Austria) [head]	[tons/cap.]
1998	7.0	7,976,000	0.9
1999	6.0	7,992,000	0.8
2000	7.9	8,011,000	1.0
2001	7.5	8,043,000	0.9
2002	8.6	8,083,000	1.1
2003	10.5	8,117,000	1.3
2004	9.7	8,174,000	1.2
Total	***57.2***		

3.1.20 Land application of waste

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises the application of waste on land.

In Austria the agricultural sector produces 32,360,000 tonnes of manure.

In 2004 48,000 tonnes (DM) of sewage sludge were dispensed on agricultural land.

3.1.21 Home composting

According to Deliverable D2-2 [Daxbeck et al., 2008a] this commodity comprises composting activities in private gardens.

Total supply of home composting in Austria is estimated about 800,000 tonnes per year [BMLFUW, 2006]. Regarding 3.3 mio. households in Austria this means that each household in Austria produces 240 kg of compost each year.

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5 Appendices

5.1 Appendix 1 – Default values for commodity lifetime

For the estimation of the expected useful life (lifetime) of an economic good (respectively commodity) amortization tables are applied. An amortization table is a tool for estimating a common expected lifetime of an economic commodity in years. Published by the German Ministry of Finance [Bundesministerium der Finanzen, 2000] it is usually used for fiscal reasons. There are tables for generally applicable commodities as well as industry-sector-specific tables. The lifetimes of certain generally applicable commodities is shown in chapter 5.1.1. Lifetime tables for buildings and building components are shown in chapter 5.1.2. These tables are used as basis for the assumption of the lifetimes suggested for stock estimation (see chapter 2.4) and can be used, if a more detailed calculation of individual commodity stocks is desired.

5.1.1 AfA-Tables

In this chapter "AfA-Tables" for generally applicable commodities are shown (see Table 5-1 to Table 5-7). Additional data for commodity lifetimes represented by "AfA-Tables" are available on the website of the German Ministry of Finance [Bundesministerium der Finanzen, 2000]. "AfA" here is short for "Amortization for abrasion" ("Abschreibung für Abnutzung").

Table 5-1: Lifetimes of immobile properties

Immobile properties	Lifetime [years]
Lightweight construction buildings	14
Sports halls	20
Air-inflated tents	10
Cold storage halls	20
Warehouses, barracks, sheds	16
Site huts	8
Beer tent	8
Pump and transformer stations	20
Silos (concrete)	33
Silos (steel)	25
Silos (plastics)	17
Chimneys, funnels (brickwork, concrete)	33
Chimneys, funnels (metal)	10
Loading platforms	25

Table 5-2: Lifetimes of real estate facilities

Real estate facilities	Lifetime [years]
Roads, pavements, parking lots, sealed yards (hardcore)	19
Roads, pavements, parking lots, sealed yards (stone, gravel, slag)	9

Real estate facilities	Lifetime [years]
Bridges (steel, concrete)	33
Bridges (wood)	15
Fencings (wood)	5
Fencings (others)	17
Exterior lightings	19
Navigation systems, gantry signs	10
Bank reinforcements	20
Irrigation systems, fountains, wells	20
Drainage systems (brickwork, concrete)	33
Drainage systems (clay, plastics)	13
Sewage treatment plants	20
Fire water ponds	20
Water reservoirs	20
Green areas, recreation areas	15
Golf courses	20

Table 5-3: Lifetimes of plants in general

Plants in general	Lifetime
Steam raising (boiler with attachments)	15
Electricity generation (rectifier, charging systems, emergency generators, current generators, etc.)	19
Accumulators	10
Combined heat and power units	10
Wind generators	16
Solar energy plants (photovoltaics)	20
Solar energy plants	10
Hot air machines, refrigerating plants, compressors, cooling fans, etc.	14
Boilers, including pressure boilers	15
Water treatment plants	12
Water-softening plants	12
Water-purification plants	11
Compressor units	12
Heat exchanger	15
Controlling units and measuring sets in general	18
Emission measuring devices	8
Material testing devices	10
Ultrasound scanner	10
Electronic surveying devices	8
Mechanical surveying devices	12
Elevators, screw conveyors, conveyor ways, overhead conveyors, band conveyors and slat conveyors	14
Tack system with rotating discs, points, signaling systems, etc. according to legislative regulations	33
Other tack systems with turntables, points, signaling systems, etc.	15
Fixed crane systems or crane systems on bars	21

Plants in general	Lifetime
Other crane systems	14
Stationary elevators/lifts, winches, stages, elevating platforms, scaffolds,	15
Mobile elevators/lifts, winches, stages, elevatin platforms, scaffolds	11
High rack facilities	15
Transport containers, portable buildings, office containers and mobile homes	10
Mounted equipments of shops, restaurants and shop windows	8
Neon signs	9
Showcases, glass cabinets	9
Weighbridges	20
Filling stations and taps for fuels and lubricants	14
Fuel tanks	25
Car wash installations	10
Escape devices, dust exhaust appliances,	14
Alarm and supervisory systems	11
Sprinkler systems	20

Table 5-4: Lifetimes of vehicles

Vehicles	Lifetime [years]
Railway vehicles	25
Passenger vehicles, multi-purpose vehicles	6
Motorbikes, motor scooters, bicycles	7
Freight vehicles, trucks, lorries	9
Tractors	12
Small tractors	8
Trailers	11
Railway buses, Omnibuses	9
Fire-fighting vehicles, fire trucks	10
Rescue vehicles, ambulances	6
Recreation vehicles, campers, caravans	8
Site trailers	12
Aeroplanes	21
Helicopters	19
Hot-air baloons	5
Airships	8
Barges	20
Pontoons	30
Yachts, sailing boats	20
Other means of transport (electric trolleys, fork lifts, lift trucks)	8

Table 5-5: Lifetimes of plant and factory equipment

Plant and factory equipment	Lifetime
Economic goods of workshops, laboratories and warehouses	14

Plant and factory equipment	Lifetime
Economic goods of shops	8
Boothes	6
Cooling equipment	8
Mobile air conditioning plants	11
Mobile aeration and ventilation equipment	10
Grease traps	5
Magnetic separators	6
Wet dedusters	5
Mobile hot-air cold-air blowers	11
Mobile space heaters	9
Working tents	6
Computer telephone switchboards	10
Communication terminals in general	8
Wireless transmitting apparatus	5
Fax machines	6
Private mobile radio apparatus	11
Antenna masts	10
Addressing machines, enveloping machines, franking machines	8
Paging machines	8
Large-scale computers	7
Workstations, personal computers, notebooks and their peripheral equipment (printers, scanners, displays, etc.)	3
Photographic apparatus, telerecorders and audio devices (TV, CD players, recorders, loudspeakers, radios, Hi-Fi, cameras, monitors, etc.)	7
Public address systems	9
Data display machines, video beamers	8
Cash registers	6
Typewriters	9
Electronic plotters	8
Mechanical plotters	14
Replicators	7
Time recorders	8
Money checking, sorting, changing and counting machines	7
Shredders	8
Card readers	8
Office furniture	13
Sales counters	10
Kiosks, stalls	8
Plants in buildings	10
Steel cabinets	14
Safes	23
Security containers	25
Conventional carpets	8
High-grade carpets (1.000 DM/m² and up)	15
Work of art (not from celebrated artists)	15
Scales (for fruits, vegetables, meat, etc.)	11

Plant and factory equipment	Lifetime
Pneumatic tube installations	10

Table 5-6: Lifetimes of machine tools and converting machines

Machine tools and converting machines	Lifetime
Jointers	13
Bending machines	13
Fixed drilling machines	16
Mobile drilling machines	8
Pilot and pneumatic drills	7
Brushing machines	10
Lathes	16
Fixed milling machines	15
Mobile milling machines	8
Fixed planers	16
Mobile planers	9
Fixed polishing machines	13
Mobile polishing machines	5
Presses and punches	14
Gripping dies	10
Tampers and vibratory plates	11
Fixed saws	14
Mobile saws	8
Fixed rippers	10
Mobile rippers	7
Sandblasters	9
Fixed grinding machines	15
Mobile grinding machines	8
Fixed cutting machines and scissors	13
Mobile cutting machines and scissors	8
Shredders	6
Welding and soldering equipment	13
Bottling plants	10
Packing machines	13
Gathering machines	12
Stemping machine	8
Banderoling machine	8
Other machine tools and converting machines (folding, glueing, sharpening, cauterizing, coating, printing, anodizing, degreasing, burring, eroding, tag-ging, notching, tinting, filing, pouring, electroplating, engraving, hardening, tacking, enameling, rive)	13

Table 5-7: Lifetimes of other commodities

Other commodities	Lifetime [years]
Cement mixers, concrete mixers	6
Floor polishers	8
Desinfection machines	10
Dishwashers	7
High-pressure cleaners	8
Industrial vacuum cleaners	7
Road sweepers, street cleaners	9
Clearing equipment	9
Sterilizers	10
Carpet purifiers	7
Washing machines	10
Dryers, dehumidifiers	5
Laundry dryers	8
Vending machines (beverages), empties machines	7
Vending machines (cigarettes)	8
Vending machines (others)	5
Gambling machines	4
Music machines, juke boxes	8
Video machines	6
Other entertainment machines (e.g. flippers)	5
Flagpoles, flagstaffs	10
Refrigerators, iceboxes	10
Laboratory equipment (microscopes, precision balances)	13
Microwave devices	8
Lawn mowers, mowing machines	9
Toilet cubicles, portable toilets	9
Centrifuges	10

5.1.2 Lifetimes of buildings and building components

In this chapter tables with lifetimes for buildings and building components are shown (see Table 5-8 and Table 5-9).

Table 5-8: Lifetimes of buildings and streets

Type of building, building components		Lifetime [Years]	Source
Buildings	Buildings before 1945	200	[Glenck et al., 2000]
	Buildings 1945 - 1980	75	[Glenck et al., 2000]
	Buildings after 1945	100	[Glenck et al., 2000]
	Interior construction in general	10 - 30	[Stark et al., 2003]
	Mechanical services	15 - 30	[Stark et al., 2003]
	Carcass	up to 80	[Stark et al., 2003]

Type of building, building components		Lifetime [Years]	Source
	Vicinity of the construction	20 - 50	[Stark et al., 2003]
Streets	Category country road		
	Carriageway surfacing	10 - 20	[Stark et al., 2003]
	Surface	20 - 30	[Stark et al., 2003]
	Base course	30 - 40	[Stark et al., 2003]

Table 5-9: Lifetimes of building components

Building components		Lifetime [Years]	Source
Components of concrete	Exposed concrete	> 70	[Stark et al., 2003]
	Fibre cement enclosure	40 - 50	[Stark et al., 2003]
	Underground buildings	> 70	[Stark et al., 2003]
	Road bridge	> 50	[Stark et al., 2003]
Ready mixed mortar and synthetic plasters	Outside	15 - 25	[Stark et al., 2003]
	Minerally fixed high-grade plaster	20 - 50	[Stark et al., 2003]
	Gypsification inside	50	[Stark et al., 2003]
	Plaster inside	30 - 60	[Stark et al., 2003]
	Screed	30 - 70	[Stark et al., 2003]
Surface protection agents	Coating of metal sheets	10 - 20	[Stark et al., 2003]
	Coating of window frames	10	[Stark et al., 2003]
	Building envelope	10 - 30	[Stark et al., 2003]
	Plastic dispersion on exposed wood	max. 10	[Stark et al., 2003]
Caulking Compounds	Patty joint	10 - 20	[Stark et al., 2003]
	Silicon cladding outside	max. 5	[Stark et al., 2003]
	Silicon joints wet section	1 - 3	[Stark et al., 2003]
Liner sheets and thermal insulation products	External walls towards soil	10 - 15	[Stark et al., 2003]
	Walls outside	20 - 50	[Stark et al., 2003]
	Flat roof	20 - 40	[Stark et al., 2003]
	Steep roof	40 - 60	[Stark et al., 2003]
Structural glass	Glazing	10 - 15	[Stark et al., 2003]
	Insulating glass	15 - 20	[Stark et al., 2003]
Plastic products	Fanlights and domes	10 - 20	[Stark et al., 2003]
	Plastic cover inside	10 - 30	[Stark et al., 2003]
Metals	Facade components steel and aluminium	40 - 50	[Stark et al., 2003]
	Copper sheets	30 - 60	[Stark et al., 2003]
	Galvanized iron sheet	10 - 30	[Stark et al., 2003]
	Roofing galvanized sheet	15 - 25	[Stark et al., 2003]
Wood	Curtain-walling; without maintenance	10 - 20	[Stark et al., 2003]
	Wall covering inside	max. 30	[Stark et al., 2003]
	Parquet	max. 30	[Stark et al., 2003]

Building components		Lifetime [Years]	Source
	Wood wet-dry; copper beech - spruce - oak	20 - 45 - 120	[Krapfenbauer, 1998]
	Wood constant wet; copper beech - spruce - oak	10 - 60 - 700	[Krapfenbauer, 1998]
	Wood permanent dry; copper beech - spruce - oak	800 - 900 - 1800	[Krapfenbauer, 1998]
Blocks and burnt products	Party wall inside	15 - 50	[Stark et al., 2003]
	Flaggings	25 - 60	[Stark et al., 2003]

5.2 Appendix 2 – Material composition matrix

	Product No.	1	2	3	36	44	45	65	66	67	68	69	70	71	72	73	78	79	80
	Material No. / Materials \ Products	Bovine meat and milk	Pigs	Poultry and animals n.e.c.	Printed matter and recorded media	Rubber and plastic products	Glass, mineral wool and ceramic goods, virgin	Fabricated metal products, except machinery	Machinery and equipment n.e.c.	Office machinery and computers	Electrical machinery n.e.c.	Radio, television and communication equipment	Instruments, medical, precision, optical, clocks	Motor vehicles and trailers	Transport equipment n.e.c.	Furniture; other manufactured goods n.e.c.	Buildings, residential	Buildings, non-residential	Infrastructure, excluding buildings
Product material composition (K_c)																			
Al	1	Aluminium						0,001										0,001	0,001	0,001
BI	2	Fibre carbon						0,000										0,009	0,009	0,000
BO	3	Food carbon, (including tobacco)						0,000										0,000	0,000	0,000
CC	4	Coal carbon						0,000										0,000	0,000	0,000
CH	5	Crude oil and natural gas carbon						0,000										0,006	0,006	0,006
CO	6	Carbonate carbon						0,000										0,001	0,001	0,006
Cu	7	Copper						0,000										0,000	0,000	0,000
Fe	8	Iron						0,000										0,007	0,007	0,074
ME	9	Metals, n.e.c.						0,000										0,001	0,001	0,000
MI	10	Minerals, n.e.c. (including nitrogen)						0,004										0,010	0,010	0,023
O	11	Oxygen (only in products, but not in H2O)						0,001										0,013	0,013	0,022
SO	12	Clay and soil						0,329										0,005	0,005	0,052
ST	13	Sand, gravel and stone						0,665										0,947	0,947	0,816
		Water	0,51	0,45	0,55	0,07	0	0,000									0,1	0,0	0,0	0,0
T		**Total material (T)**	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	**1**	**1**	**1**